Coastal California (BCR 32) Waterbird Conservation Plan

Encompassing the Coastal Slope and Coast Ranges of Central and Southern California and the Central Valley

Coastal California (BCR 32) Waterbird Conservation Plan

Encompassing the Coastal Slope and Coast Ranges of Central and Southern California and the Central Valley

W. David Shuford

Additional Species Account Authors:

Lyann A. Comrack, Meredith Elliott, Catherine M. Hickey, Gary L. Ivey, John P. Kelly, Dan Robinette, Cheryl Strong

Published by U.S. Fish and Wildlife Service, Pacific Southwest Region

Author contact information:

W. David Shuford
Point Blue Conservation Science
3820 Cypress Drive # 11
Petaluma, CA 94954
dshuford@pointblue.org
www.pointblue.org

Typography and design: Timothy W. Brittain

Recommended Citation:

Shuford, W. D. (author and editor). 2014. Coastal California (BCR 32) Waterbird Conservation Plan: Encompassing the coastal slope and Coast Ranges of central and southern California and the Central Valley. A plan associated with the Waterbird Conservation for the Americas initiative. U.S. Fish and Wildlife Service, Region 8, 2800 Cottage Way, Sacramento, CA 95825.

CONTENTS

Acknowledgments

The preparation of this conservation plan would not have been possible without the aid of a host of people whose contributions were extensive and varied. The following people participated in planning meetings, shared valuable information or insights, wrote species accounts, or reviewed individual sections or the entire manuscript: Sarah Allen, Dan Anderson, Carol Beardmore, Steve Bobzien, John Bradley, Steve Bruggemann, Joelle Buffa, Paul Buttner, Brian Collins, Charles Collins, Carole Combs, Lyann Comrack, Chris Conard, Dan Cooper, Elizabeth Copper, Emilie Craig, Rob Doster, Meredith Elliott, Jules Evens, Jack Fancher, Chad Fien, Scott Frazer, Steve Glover, Christine Hamilton, Rob Hansen, Loren Hays, Catherine Hickey, Mark Herzog, Rob Holbrook, Craig Isola, Gary Ivey, Kathy Keane, John Kelly, Peter Knapp, Dave Krueper, Dean Kwasny, Steve Laymon, Gerry McChesney, Bill McIver, Myrnie Mayville, Kyra Mills, Gary Page, Eduardo Palacios, Robert Patton, Mark Rauzon, Charles Rewa, Orien Richmond, Dan Robinette, Martin Ruane, Chris Schoneman, Annie Schultz, Sandra Scoggin, Jeff Seay, Nanette Seto, John Sterling, Cheryl Strong, Ramona Swenson, John Trochet, Jennifer Wheeler, Pam Williams, Mike Wolder, Shauna Wolf, and Tara Zimmerman.

These individuals kindly provided photographs, not all of which could be used, to liven up the text: Thomas Blackman, Len Blumin, Mike Carpenter, Charles Collins, Rob Doster, Floyd Hayes, Kathy Keane, Michael Kern, Peter LaTourette, Leslie Morris, Vic Murayama, Mark Rauzon, Tracy Strahl, and Lon (LA) Yarbrough.

Diana Stralberg kindly prepared Figure 1. Thanks to the Don Edwards San Francisco Bay NWR Complex, Cosumnes River Preserve, and Carlsbad U.S. Fish and Wildlife Office for hosting initial group planning meetings. Rob Doster, Nanette Seto, Marie Strassburger, and Tara Zimmerman of U.S. Fish and Wildlife Service and Catherine Hickey, Gary Page, and Nils Warnock at PRBO (now Point Blue) Conservation Science provided valuable support and guidance throughout the development of the plan. Special thanks to Rob Doster for support in the final stages of publication. Primary funding for this work was provided by U.S. Fish and Wildlife Service Regions 1 and 8, with additional support from the S. D. Bechtel, Jr. Foundation and the Gordon and Betty Moore Foundation. Thanks to the Central Valley Joint Venture for hosting a digital version of the present document on their website.

This is Contribution No. 1884 of Point Blue Conservation Science.

Photograph Credits

Front Cover: Clark's Grebe (*Aechmophorus clarkii*) on nest, Lake Hodges, San Diego County, 12 October 2013; © Vic Murayama.

Page ii: Caspian Terns (*Hydroprogne caspia*), juvenile begging from adult, Abbott's Lagoon, Point Reyes National Seashore, Marin County, 5 September 2004; © Peter LaTourrette.

Page iv: Pied-billed Grebe (*Podilymbus podiceps*) in slough, Shollenberger Park, Petaluma, Sonoma County, 24 February 2005; © Len Blumin.

Page v: Least Bittern (*Ixobrychus exilis*) crouching in reeds while foraging, Martinez Shoreline Regional Park, Contra Costa County, 28 Dec 2010; © Mark J. Rauzon.

Page 2: Greater Sandhill Cranes (*Grus canadensis tabida*), Cosumnes River Preserve, Sacramento County, 4 November 2007; © Lon (LA) Yarbrough.

Page 6: California Clapper Rail (*Rallus longirostris obsoletus*) in salt marsh, Muzzi Marsh, Corte Madera, Marin County, 21 December 2010; © Len Blumin.

Page 12: California Least Terns (*Sternula antillarum browni*), adult and fledgling with fish, Ponto Beach, San Diego County, 19 July 2011; © Thomas A. Blackman.

Page 33: Various waterbirds, particularly egrets (*Ardea alba* and *Egretta thula*) and ibis (*Plegadis chihi*), foraging in a shallow pond, Delevan National Wildlife Refuge (NWR), Colusa County, 24 August 2010; © Mike Carpenter.

Page 34: California Gull (*Larus californicus*) colony, former salt pond A6 (Knapp property), south San Francisco Bay, Santa Clara County, 13 May 2009; © Michael D. Kern.

Page 37: Brown Pelicans (*Pelecanus occidentalis*), roosting flock, Point La Jolla, San Diego County, 6 January 2011; © Thomas A. Blackman.

Page 46: Snowy Egret (*Egretta thula*) hunting, San Diego Bay, Chula Vista, San Diego County, 15 January 2013; © Vic Murayama.

Page 52: Black Skimmer (*Rynchops niger*), in flight, Bolsa Chica Ecological Reserve, Orange County, 10 July 2012; © Thomas A. Blackman.

Page 58: Great Blue Herons (*Ardea herodias*) in courtship display, Lincoln, Placer County, 25 March 2013; © Leslie Morris Photography.

Page 60: American White Pelicans (*Pelecanus erythrorhynchos*) in flight, over Adobe Creek, Baylands Nature Preserve, Palo Alto, Santa Clara County, 3 September 2001; © Peter LaTourrette.

Page 72: Sora (*Porzana carolina*) in flooded salt marsh, Arrowhead Marsh, Oakland, Alameda County, 3 January 2011; © Mark J. Rauzon.

Page 73: American Bittern (*Botaurus lentiginosus*) in rice field, Montna Farms, Sutter County, 1 June 2012; © Leslie Morris Photography.

Page 85: Double-crested Cormorant (*Phalacrocorax auritus*) perched and preening, Rodeo Lagoon, Golden Gate National Recreation Area, Marin County, 9 April 2006; © Len Blumin.

Page 91: White Faced Ibis (*Plegadis chihi*), flock landing, near Live Oak, Sutter County, 15 January 2011; © Leslie Morris Photography.

Back Cover: Elegant (*Thalasseus elegans*) and Royal (*Thalasseus maximus*) tern colony, salt works, San Diego Bay NWR, San Diego County, 10 June 2009; © Tracy Strahl.

EXECUTIVE SUMMARY

The Coastal California Waterbird Conservation Plan is a regional plan associated with the larger Waterbird Conservation for the Americas initiative. The Coastal California plan focuses on the U.S. portion of Bird Conservation Region (BCR) 32, which encompasses the coastal slope and Coast Ranges of central and southern California and the Central Valley. The Coastal California plan provides a framework whereby a partnership of individuals and institutions can implement the broader initiative's vision regionally by sustaining or restoring the distribution, diversity, and abundance of populations and habitats of breeding, migratory, and nonbreeding waterbirds in BCR 32.

The Coastal California plan includes 46 species of waterbirds (loons, grebes, pelicans, cormorants, herons, egrets, night-herons, bitterns, ibis, rails, gallinules, coots, cranes, gulls, terns, and skimmers). For species using both estuarine and open ocean waters, conservation focuses only on estuaries and associated outer coast sandy beaches; true seabirds that forage exclusively or mainly in the open ocean are not addressed.

Because of its mild climate and plentiful resource base, the Coastal California region is very rich ecologically and its wetlands and agricultural lands are of continental importance to wintering and migrating waterbirds and of regional importance to some breeding populations. Data on the population sizes and trends of waterbirds in BCR 32 overall are quite limited, but it is clear that many species have declined greatly historically. Conversely, some have increased dramatically and now pose threats to other breeding species and to the success of large-scale restoration projects.

Key conservation issues and threats to waterbirds in the region include habitat loss and degradation; changing or detrimental agricultural, municipal, or industrial practices in altered habitats; poor or toxic water quality and oil spills; increasing competition for water; diseases; subsidized and introduced predators; invasive species; human disturbance; conflicts with human interests; inter-species conflicts; and the long-term effects of climate change and sea-level rise.

Of 48 species and subspecies of waterbirds in the region ranked for conservation priority, 9 were considered of high conservation concern, 4 of moderate concern, 25 of low concern, and 10 of lowest concern. Of the 13 taxa ranked of high or moderate conservation concern in BCR 32, 9 have been given comparable or higher conservation status through other state or federal designations or rankings. Lack of concordance of BCR 32 waterbird rankings with some state or federal designations likely reflects the differing geographic areas over which waterbirds were ranked, variation of criteria among ranking systems or designations, or both.

Conservation strategies for birds increasingly rely on establishing desirable population goals for species and measureable habitat goals needed to reach those population objectives. Given the meager prior data on population trends for most waterbird species in BCR 32, this plan takes a tiered approach in assigning population goals that varies for federally and state listed species, priority waterbird species, and the remaining waterbird species in BCR 32. Lacking information for most species on the link between population objectives and the amount and quality of habitat needed to support those population levels, the BCR 32 waterbird plan mainly relies on assessments of habitat needs generated by recovery plans and joint venture implementation plans coupled with subjective assessments of additional needs. Obtaining the necessary information to refine or initially set population and habitat goals for all waterbirds in BCR 32 should be a very high conservation priority.

To enable effective conservation in BCR 32, it will be necessary to accurately monitor population trends of waterbirds. Ideally, monitoring in BCR 32 should track trends in waterbird populations and vital rates at the regional level while concurrently serving as a component of monitoring at the continental scale. High priority research needs are ones that will (1) inform the effective implementation of conservation priorities in the region, (2) fill large gaps in the knowledge of species' biology or ecology, or (3) address overarching needs for multiple waterbirds species and other wetland-dependent birds. For individual species, the priority of related research should be raised for waterbirds ranked of moderate or high conservation concern in BCR 32.

Successful conservation of waterbirds in BCR 32 will be possible only if an informed and engaged constituency values these birds and supports measures to protect them and to create, restore, or enhance suitable wetland, agricultural, and upland habitats. Because of commonalities across bird conservation initiatives, the education and outreach goals and strategies for BCR 32 draw heavily on strategies recommended by joint ventures and regional conservation plans that focus on wetland-dependent birds in and adjacent to the BCR 32 region.

Implementation of effective on-the-ground conservation of waterbirds in the Coastal California region will require the collaborative efforts of a broad coalition of public and private agencies, conservation organizations, interest groups, and individuals. Although the challenges of waterbird conservation are great, key goals and objectives can be met by collective action on the recommendations of this plan and those of key partners dedicated to wetland conservation.

CHAPTER 1

Introduction

Recent efforts to promote the conservation of birds in North America generally fall under four major bird conservation initiatives: the North American Waterfowl Management Plan (NAWMP Plan Committee 2004), Canadian and U.S. shorebird conservation plans (Donaldson et al. 2000, Brown et al. 2001), Partners in Flight's North American Landbird Conservation Plan (Rich et al. 2004), and Waterbird Conservation for the Americas' North American Waterbird Conservation Plan (Kushlan et al. 2002). The North American Bird Conservation Initiative (U.S. NABCI Committee 2000) aims to address common needs of these and other initiatives and to identify new resources for conservation. These and some other important initiatives are described in greater detail in Appendix 1. To maximize their effectiveness, all of these focus expertise and resources on identified subregions, typically defined on a geographic or ecological basis. Regional (or habitat-based) plans have been completed for most of these initiatives. Among the gaps are regional waterbird conservation plans for a number of regions, termed Bird Conservation Regions (BCR). This document—a regional waterbird conservation plan for Coastal California (BCR 32)—adds to the whole suite of conservation initiatives, but particularly to the Waterbird Conservation for the Americas initiative. The latter builds on an impressive history of conservation efforts for waterbirds starting in the 19th century and works within a legal framework built over time (Appendix 2).

Waterbird Conservation for the Americas was the last to form of the four big initiatives organized by bird group. Although some of its regional plans, based mainly on individual or groups of BCRs, have been completed (e.g., Beyersbergen et al. 2004, Ivey and Herziger 2006, Wires et al. 2010), many others are still being developed. Implementation of these regional plans is mainly through regional joint ventures established through the North American Waterfowl Management Plan. The Coastal California Waterbird Conservation Plan of this document focuses on the United States portion of BCR 32, which includes the coastal slope of central and southern California and the Central Valley. It is hoped that the remainder of BCR 32 in Mexico, which encompasses the coastal slope of northern Baja California Norte, will be included in a later version of this conservation plan or will be addressed by national waterbird planning in Mexico.

Much of the U.S. portion of BCR 32 is encompassed by three joint ventures: the Central Valley Joint Venture (CVJV 2006), San Francisco Bay Joint Venture (Steere and Schaefer 2001), and Sonoran Joint Venture (SJVTC 2006). The primary area in BCR 32 excluded by these joint ventures—in fact, the only substantial area in North America not included in any joint venture—is the central coastal region of California that includes all or most of Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara counties. Still, the three joint ventures are the primary broad-scale conservation planning units for birds in BCR 32, and their implementation plans are drawn on heavily in the current document.

The details of geographic coverage of the plan and the species of waterbirds included (most species, exclusive of waterfowl and shorebirds) are described below.

GOALS AND OBJECTIVES

The Waterbird Conservation for the Americas initiative promotes a vision in which the "distribution, diversity, and abundance of populations and habitats of breeding, migratory, and nonbreeding waterbirds are sustained or restored throughout the lands and waters of the Americas" (www.waterbirdconservation.org). The Coastal California plan provides a framework whereby a partnership of individuals and institutions can implement this vision regionally by successfully advancing these key goals and objectives within BCR 32:

- At a minimum, maintain the current diversity and abundance of waterbirds and the ecological integrity of the suite of habitats or other vital features that support them.
- Wherever feasible, create, restore, or enhance habitats or other ecological needs that will increase populations of waterbirds that have declined from the effects of human activities.
- Promote research that will advance knowledge useful to managers to enable them to provide the maximum benefits for waterbirds within the constraints of limited resources applied to a finite land base.
- Manage habitats to restore their suitability to waterbirds when human activities have enabled the colonization of non-native species or large increases in particular native species that prove detrimental to certain species or groups of waterbirds.
- Promote the collection of baseline data to fill gaps in knowledge of the regional status of waterbirds.
- Conduct monitoring that will effectively track trends in waterbird populations and vital rates at the regional level while concurrently serving as a component of monitoring at the continental scale.
- Develop partnerships with private landowners to seek ways to enhance habitat for waterbirds while maintaining the economic viability of owners' lands.
- Foster education and outreach to policy makers and the general public to inform them of the intrinsic value of waterbirds and the ecological and human benefits of sustaining and enhancing waterbird habitats.
- Promote a management vision cognizant of the long-term effects of climate change.
- Conduct all these activities without hindering conservation efforts for other flora and fauna and while maintaining sensitivities to competing human interests.

Species Coverage

The species covered in the Coastal California plan (Table 1) are those waterbirds not already covered by the North American Waterfowl Management Plan and the U.S. Shorebird Conservation Plan and are not true seabirds, as discussed below. Thus, the species in the Coastal California plan are a subset of those waterbirds in the families Gaviidae (loons), Podicipedidae (grebes), Pelecanidae (pelicans), Phalacrocoracidae (cormorants), Ardeidae (herons, bitterns, and allies), Threskiornithidae (ibises and spoonbills), Rallidae (rails, gallinules, and coots), Gruidae (cranes), and Laridae (skuas, gulls, terns, and skimmers). Species covered in these families are those that occur inland or in coastal estuaries either as breeders or in sufficient numbers at other seasons to warrant conservation measures on their behalf. Scientific and common names of species, found in Table 1, follow the treatment of the AOU Check-list of North American Birds (AOU 1998) and its supplements (42nd–53rd) published in *The Auk*; subspecific taxonomy follows that of the AOU (1957), as modified by subsequent published sources.

For species that use both coastal estuaries and the open ocean (i.e., loons, grebes, pelicans, cormorants, gulls, terns, and skimmers), this plan addresses their conservation needs only in the context of estuaries and associated habitats such as outer coast sandy beaches. True seabirds that forage exclusively or mainly in the open ocean are excluded altogether, even if small numbers breed or forage regularly within the outer portions of large estuaries such as San Francisco Bay, e.g., Brandt's Cormorant (*Phalacrocorax penincillatus*), Pelagic Cormorant (*Phalacrocorax pelagicus*), and Pigeon Guillemot (*Cepphus columba*). Conservation needs associated with true seabirds and their habitats (e.g., shoreline cliffs, offshore rocks, and open ocean) have been partly addressed in a marine bird conservation plan for the California Current (Mills et al. 2005) and a regional seabird conservation plan for the Pacific region (USFWS 2005a). These two plans will serve as the foundation for developing a complementary conservation plan for seabirds in the California Current marine ecosystem under the umbrella of the North American Waterbird Conservation Plan.

Table 1 Patterns of Seasonal Status and Inland versus Estuarine Occurrence for the 46 Species Covered by the Coastal California (BCR 32) Waterbird Conservation Plan[a]

Common Name[c]	Scientific Name	Seasonal Status[b]	Area of coverage[d]	
			Inland	Estuaries
Red-throated Loon	*Gavia stellata*	WR	–	X
Pacific Loon	*Gavia pacifica*	WR	–	X
Common Loon	*Gavia immer*	WR	X	X
Pied-billed Grebe*	*Podilymbus podiceps*	YR	X	X
Horned Grebe	*Podiceps auritus*	WR	–	X
Eared Grebe*	*Podiceps nigricollis*	YR	X	X
Western Grebe*	*Aechmophorus occidentalis*	YR	X	X
Clark's Grebe*	*Aechmophorus clarkii*	YR	X	X
Double-crested Cormorant*	*Phalacrocorax auritus*	YR	X	X
American White Pelican	*Pelecanus erythrorhynchos*	WR	X	X
Brown Pelican	*Pelecanus occidentalis*	PV	–	X
American Bittern*	*Botaurus lentiginosus*	YR	X	–
Least Bittern*	*Ixobrychus exilis*	YR	X	–
Great Blue Heron*	*Ardea herodias*	YR	X	X
Great Egret*	*Ardea alba*	YR	X	X
Snowy Egret*	*Egretta thula*	YR	X	X
Cattle Egret*	*Bubulcus ibis*	YR	X	–
Green Heron*	*Butorides virescens*	YR	X	–
Black-crowned Night-Heron*	*Nycticorax nycticorax*	YR	X	X
White-faced Ibis*	*Plegadis chihi*	YR	X	–
Yellow Rail	*Coturnicops noveboracensis*	WR	–	X
Black Rail*	*Laterallus jamaicensis*	YR	X	X
Clapper Rail*	*Rallus longirostris*	YR	–	X
Virginia Rail*	*Rallus limicola*	YR	X	X
Sora*	*Porzana carolina*	YR	X	X
Common Gallinule*	*Gallinula galeata*	YR	X	–
American Coot*	*Fulica americana*	YR	X	X
Sandhill Crane	*Grus canadensis*	WR	X	–
Bonaparte's Gull	*Chroicocephalus philadelphia*	WR	X	X
Heermann's Gull	*Larus heermanni*	PV	–	X
Mew Gull	*Larus canus*	WR	X	X
Ring-billed Gull	*Larus delawarensis*	WR	X	X
Western Gull*	*Larus occidentalis*	YR	–	X
California Gull*	*Larus californicus*	YR	X	X
Herring Gull	*Larus argentatus*	WR	X	X
Thayer's Gull	*Larus thayeri*	WR	–	X
Glaucous-winged Gull	*Larus glaucescens*	WR	–	X
Least Tern*, [e]	*Sternula antillarum*	SR	X	X
Gull-billed Tern*	*Gelochelidon nilotica*	SR	–	X
Caspian Tern*	*Hydroprogne caspia*	SR	X	X
Black Tern*	*Chlidonias niger*	SR	X	–
Common Tern	*Sterna hirundo*	M	X	X
Forster's Tern*	*Sterna forsteri*	YR	X	X
Royal Tern*	*Thalasseus maxima*	PV	–	X
Elegant Tern*	*Thalasseus elegans*	PV	–	X
Black Skimmer*	*Rynchops niger*	YR	–	X

[a]Some waterbird species that occur in BCR 32 irregularly, or regularly in very small numbers, as migrants or winter visitors (either inland or in estuaries) are excluded from further consideration because conservation actions in the region likely would have little effect on their overall populations.

[b]Primary seasonal status of each species in BCR 32. YR, year-round resident; WR, winter resident; SR, summer resident; M, migrant; PV, postbreeding visitor.

[c]*, breeds regularly within area of coverage.

[d]X, occurs inland or in estuaries as either a regular breeder or in sufficient numbers at others seasons to warrant consideration by the BCR 32 waterbird plan; –, does not occur or occurs very rarely, in estuaries or inland, within the BCR 32 boundaries. Species using primarily tidal wetlands that extend beyond the S.F. Bay estuary to Suisun Marsh, a transitional area considered part of the Central Valley, are designated as occurring only in "estuaries." Likewise, species occurring mainly in freshwater wetlands inland but also in such wetlands directly adjacent to tidal estuaries are designated as occurring only "inland."

[e]Has bred irregularly inland in the region only very locally in the Tulare Basin in the southern San Joaquin Valley and in the Sacramento–San Joaquin River Delta.

CHAPTER 2

Description of the Coastal California Region

GEOGRAPHIC EXTENT

The area covered by this plan includes BCR 32 (Coastal California), exclusive of that portion in Baja California Norte (Figure 1). It is bounded to the north by BCR 5 (Northern Pacific Rainforest), to the east by BCRs 15 (Sierra Nevada) and 33 (Sonoran and Mohave Deserts), to the south by the United States–Mexico border, and to the west by the ocean-estuarine interface. This area is essentially the coastal slope and adjacent Coast Ranges (from Sonoma and Lake counties south through San Diego County) and the Central Valley of California. All coastal estuaries are included, with boundaries at the ocean generally being the estuary mouth, e.g., the boundary for the San Francisco Bay estuary is the Golden Gate. Excluded are the rocky shoreline, cliff, and open ocean habitats used by true seabirds, though, as noted above, habitats closely associated with estuaries, such as outer coast sandy beaches, are included.

PHYSICAL GEOGRAPHY

The Coastal California Region—comprising roughly half of the state—consists of two main regions: (1) the Central Valley, California's largest, draining west to the San Francisco Bay estuary, and (2) the coastal slope and shoreline of central and southern California. Within the mountains separating these two main regions are some valleys with relatively large wetlands, lakes, and reservoirs—all draining to the coast, either via the Central Valley and on to the San Francisco Bay estuary or by smaller coastward draining watersheds. Water draining into the Central Valley comes mainly from snowmelt runoff and rainfall from the Cascade and (principally) Sierra Nevada mountain ranges to the east, the Tehachapi Mountains to the south, and the Coast Ranges to the west. These waters, supplemented by local rainfall within the Central Valley, flow into the Sacramento River to the north and the San Joaquin River to the south, then merge and flow westward into the San Francisco Bay estuary. Remaining waters draining to the coastal slope come from the west flanks of the Coast Ranges in central and southern California and from the Transverse and Peninsular ranges in southern California.

Central Valley

California's Central Valley, averaging about 644 km long and 64 km wide, runs north to south through the heart of the state, where it is surrounded by mountains except at its western drainage into the San Francisco Bay estuary. The Central Valley is divided mainly into the Sacramento Valley, draining southward, the San Joaquin Valley, draining northward, the Sacramento–San Joaquin River Delta (hereafter Delta), where these rivers converge, and Suisun Marsh, where land-locked wetlands merge with tidal-dominated habitats of the San Francisco Bay estuary. The San Joaquin Valley can be subdivided into the northward draining San Joaquin Basin and, usually closed, Tulare Basin. Some authors further divide the Sacramento Valley into the Colusa, Butte, Sutter, American, and Yolo basins (see USFWS 1990, CVJV 2006), but rather than true basins these are areas for convenience generally set off and bounded on two sides by major rivers.

The Central Valley has been a particular focus of wetland conservation because of the conversion of most native habitats to a landscape now dominated by one of the most productive agricultural areas in the world. Few natural wetlands remain. Hence, today waterbirds in this region use managed (seasonal, semipermanent, and permanent) wetlands in state wildlife areas, federal refuges, duck clubs, or other reserves; rain-moistened, irrigated, or (naturally or intentionally) flooded agricultural habitats; and a variety of other shallow-water environments created for agricultural, municipal, or industrial purposes. Important types of agricultural fields used by waterbirds include rice fields (both summer and winter), alfalfa or other irrigated hay crops, and irrigated pastures. Other

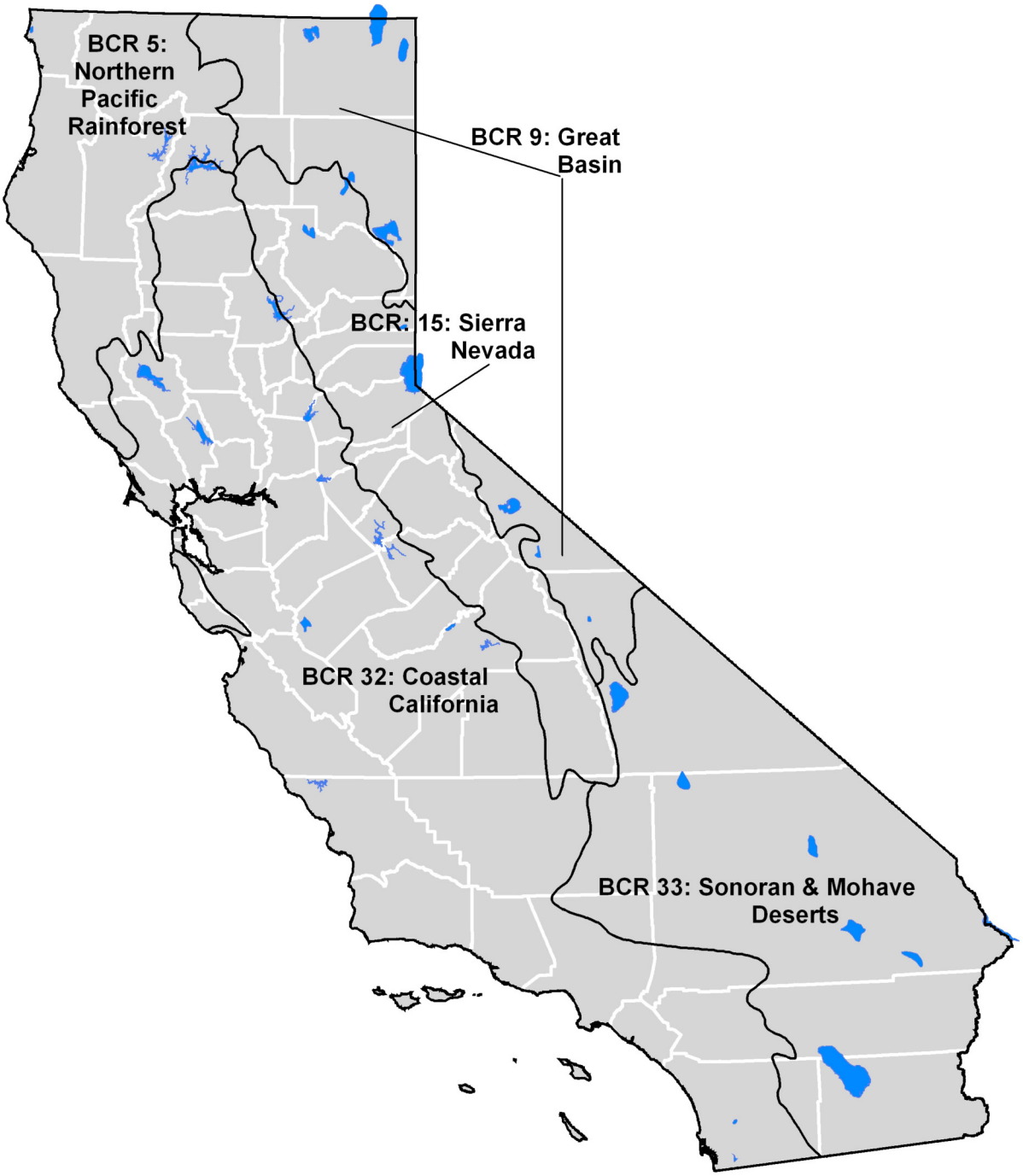

Figure 1. Location of the U.S. portion of BCR 32, Coastal California, in the context of other BCRs also partly within California.

waterbird habitats include agricultural canals and ditches, saline agricultural evaporation ponds, remnant saline lakes, dairy lagoons and other farm ponds, fish ponds, oxbow lakes, park or other urban ponds, ponds at food processing plants, reservoirs, sewage ponds, slough channels, storm water retention ponds, water recharge ponds, vernal pools and other ephemeral wetlands, and miscellaneous water bodies. Readers should consult Heitmeyer et al. (1989) for additional information on the physiography and extent of historical and recent wetlands and croplands by subregion of the Central Valley.

Coastal Slope

With the region's many near-coastal mountains, wetlands on the coastal slope are mainly found within a relatively narrow strip of coastal plains and often where major rivers and streams form estuaries, lagoons, and associated freshwater wetlands near the land-sea interface. Most prominent of these is the San Francisco Bay estuary, one of the largest on the entire Pacific coast. Other prominent estuarine complexes on or near the immediate coast of the BCR are, from north to south, Bodega Harbor, Sonoma County; Estero Americano,

Sonoma and Marin counties; Estero San Antonio, Tomales Bay, Abbott's Lagoon, Drakes and Limantour esteros, and Bolinas Lagoon, Marin County; Pescadero Marsh, San Mateo County; Pajaro River mouth, Santa Cruz and Monterey counties; Elkhorn Slough and Salinas River mouth, Monterey County; Morro Bay, San Luis Obispo County; Santa Maria River estuary, San Luis Obispo and Santa Barbara counties; Santa Ynez River estuary, Devereaux Slough, Goleta Slough, and Sandyland Slough, Santa Barbara County; Santa Clara River estuary and Mugu Lagoon, Ventura County; Malibu Lagoon, Los Angeles River, and San Gabriel River mouth, Los Angeles County; Seal Beach National Wildlife Refuge (NWR), Bolsa Chica Ecological Reserve, Santa Ana River mouth, San Joaquin Marsh, and Upper Newport Bay, Orange County; and Santa Margarita River mouth, Buena Vista, Aqua Hedionda, Bataquitos, San Elijo, San Dieguito, and Penasquitos lagoons, Mission Bay/San Diego Flood Control Channel, San Diego Bay, and Tijuana River estuary, San Diego County. See Hickey et al. (2003, Appendix B) for brief descriptions of habitat, ownership, and management responsibility for most of the estuaries on the California coast.

Although exact figures are not available for the entire coastline of BCR 32, the U.S. coast south of San Francisco Bay has about 1046 km of coastline, of which 59% is sand beach, 38% rocky shoreline, and 2% gravel or cobble beach (USACE 1971).

Important inland lakes and reservoirs for waterbirds include Clear Lake, Lake County; O'Neill Forebay, Merced County; Lake San Antonio, Monterey County; Lake Cachuma, Santa Barbara County; Lake Elsinore, Perris Reservoir, San Jacinto Wildlife Area, and Mystic Lake, Riverside County; and Lake Henshaw and Lake Hodges, San Diego County.

Important habitats for waterbirds on the immediate coast include saltwater bays, estuaries, salt marshes, brackish marshes, and associated freshwater marshes; salt ponds, sandy beaches; and rivers mouths and sloughs. Managed wetlands are of lesser overall importance on the immediate coast than in the Central Valley, but may be important locally on the coast or inland on the coastal slope. On the coastal slope, waterbirds also use a variety of freshwater habitats, including lakes, reservoirs, rivers and streams, freshwater marshes, seasonal wetlands, sewage ponds, farm ponds, and miscellaneous water bodies. Irrigates fields, grasslands, and pastures can be important locally to waterbirds, particularly where the coastal plain is wide and not yet developed.

Ecological Importance

Because of its mild climate and plentiful resource base, the Coastal California region is very rich ecologically. Although comparable analyses are unavailable at the BCR scale, as a state California supports exceptional biodiversity because of its large size, diverse habitats and environmental heterogeneity, and relative isolation from the rest of the continent (Stein et al. 2000, Stein 2002). In terms of its flora and fauna, California leads the nation in overall species richness, number of state endemics, and rare species. In a ranking among the 50 states for species richness for groups of plants and animals, California ranked first for plants and mammals, fourth for birds, and fifth for reptiles. Although the Coastal California region includes only a portion of California, the figures are still a rough gauge of BCR 32's overall ecological importance. This rich flora and fauna is supported by a diverse suite of habitats, with wetlands being only one of them.

For birds, the importance of BCR 32 for waterfowl, shorebirds, and other waterbirds is emphasized by both the abundance of these groups overall in the region and the high proportion of various species or subspecies' populations occurring there. Wetlands and agricultural lands in the Coastal California region are of continental importance to wintering and migrating waterfowl, shorebirds, and other waterbirds and of regional importance to breeding populations of some of these groups. More details on the importance of these populations on a continental scale are provided below.

The wetlands of BCR 32 are also important, of course, to a wide variety of other birds, mammals, fish, reptiles, amphibians, and invertebrates. Likewise, these wetlands provide a host of ecological and economic services to humans, not all of which are well appreciated by the public. Important ecological values of wetlands include flood control, storm buffering, aquifer recharge, water quality improvement, sediment and nutrient cycling, erosion control, carbon sequestration, and biodiversity maintenance (Mitsch and Gosselink 2000, Economics for the Environment Consultancy 2005).

The ecological importance of wetlands are enhanced by the mosaic of surrounding habitats, which may provide ecological services that benefit wetland function or habitat values for wetland-dependent birds and other wildlife. For example, grasslands, riparian woodlands, or irrigated agricultural fields may provide nesting sites or foraging habitat for various waterbirds.

Role of BCR 32 in North American Waterbird Conservation

Although accurate estimates of population sizes of many waterbird species are lacking for BCR 32, it is still clear that this region is of continental importance for the conservation of waterbirds. Collectively, the information available for some wetland-dependent species not covered in this plan, plus those waterbirds that are included, demonstrates the continental value of wetlands in the region to birds.

Within BCR 32, broad-scale survey data are available for most species of waterfowl and shorebirds but for only a few of the 46 waterbird species included in this plan. The Central Valley alone supports about 60% of the waterfowl (exclusive of sea ducks) wintering in the Pacific Flyway (USFWS 1990). The San Francisco Bay estuary holds >50% of the diving (bay and sea) ducks wintering in the Pacific Flyway and hosts one of the largest wintering populations of Canvasbacks (*Aythya valisineria*) in North America (Accurso 1992, Takekawa et al. 2000). The California coast and the Central Valley are both

key areas for migratory and wintering shorebirds. In particular, the San Francisco Bay estuary holds more shorebirds than any other site on the Pacific coast of the conterminous United States (Page et al. 1999). Likewise, the Central Valley is one of the most important regions for shorebirds in western North America, holding more birds in winter and spring than any other inland area (Shuford et al. 1998).

Paralleling the above patterns, the Coastal California region holds 2 of 43 key wintering areas (identified on the basis of band recoveries; Mikuska et al. 1998) and 2 of 32 important habitat areas (Butler et al. 2000) for North American herons and egrets: the greater San Francisco Bay estuary and adjoining Central Valley, and southern California. In winter, the Central Valley hosts 100% of the Central Valley Population of the Greater Sandhill Crane (*Grus canadensis tabida*) and >95% of the Pacific Flyway Population of the Lesser Sandhill Crane (*G. c. canadensis*) (Ivey, species account in Appendix 4 *this volume*). The Central Valley is also a regionally important area for wintering White-faced Ibis (Shuford et al. 1996). Although no definitive data exist, observations of species' abundance and movements indicate the Coastal California region and the inshore ocean waters of the adjacent California Current collectively are of continental importance to populations of various species of wintering gulls and to the postbreeding populations of the California Brown Pelican (*Pelecanus occidentalis californicus*), Heermann's Gull, and Elegant Tern moving north from southern California and (mainly) Mexico.

The Coastal California region is also important for a number of year-round resident or summer resident breeding waterbirds. Its tidal marshes are extremely important to rails, holding the entire world and U.S. populations of the state and federally endangered California Clapper Rail (*Rallus longirostris obsoletus*) and Light-footed Clapper Rail (*R. l. levipes*), respectively (Albertson and Evens 2000, Zembal et al. 2006), and >90% of that of the California Black Rail (*Laterallus jamaicensis coturniculus*) (Evens and Nur 2002). Although statewide inventories of heron and egret rookeries have been conducted in California (Mallett 1970, 1972; Gould 1973, Belluomini 1978, Schlorff 1982b), these have not been comprehensive and are now quite dated. Still, these document BCR 32 as being of at least regional, if not continental, importance to breeding herons and egrets. Within BCR 32, areas of documented importance for nesting herons and egrets include the Central Valley (citations above) and the greater San Francisco Bay area (Kelly et al. 2006). BCR 32 is of regional importance for breeding terns and skimmers, as detailed below. The California Gull colony in San Francisco Bay has increased exponentially to be the second largest in the state (Shuford and Ryan 2000, Strong et al. 2004). Some, though, consider this a detriment rather than an asset because gull predation on other ground-nesting shorebirds and waterbirds may hinder maintenance of substantial nesting populations of these species in the bay, thereby thwarting efforts at effective salt pond restoration (Ackerman et al. 2006).

Threats to Ecological Integrity

Habitat loss and degradation is the greatest threat to birds as a whole throughout California (Shuford and Gardali 2008), the United States (Wilcove et al. 1998), and the world (Collar et al. 1994). Loss of habitat integrity also appears to be the main threat to waterbirds in BCR 32, though impacts vary among subregions as described below.

Central Valley

Before European settlement, California's Central Valley contained extensive shallow-water wetland habitat, which varied dramatically both seasonally and annually depending on the amount of flooding from winter rains or high spring runoff from snowmelt. These ephemeral wetlands were highly productive, and when they persisted into spring and summer provided important habitat for many species of breeding waterbirds. Now the Central Valley is among the most altered landscapes in North America, as its historic wetlands and deep soils enabled its conversion to the most productive agricultural area on the continent. With almost nothing remaining of the natural wetlands and landscape in this region, most nesting waterbirds currently rely on various agricultural habitats (e.g., rice fields, agricultural evaporation ponds), reservoirs, managed wetlands, modified major river channels, and (rarely) naturally flooded fields that remain wet through the summer. Reliance on the many shallow-water environments maintained for agricultural, municipal, or industrial needs is generally risky, as future changes in management practices to serve human economies may reduce benefits to wildlife.

The figure of an over 90% loss of historic wetlands in the Central Valley (Frayer et al. 1989, Kempka et al. 1991) underestimates the true extent of habitat loss for breeding waterbirds, as it is calculated on the basis of winter, rather than summer, habitat. Nor does it fully reflect the almost complete loss of the valley's natural hydrologic regime. The modest compensation for the loss of historic habitat, moreover, has been far greater in winter than summer. Today extensive acreage of managed wetlands—principally on private duck clubs (two-thirds) and state and federal refuges (one-third)—is available in winter. These managed wetlands support large numbers of waterfowl, shorebirds, and other waterbirds from fall through early spring, when most acreage is flooded. But very little of this habitat, mostly in deep-water brood ponds, is maintained through late spring and summer when it would be valuable to breeding waterbirds. Flooded agricultural fields (particularly rice) also support large numbers of various wetland-dependent birds in winter, but overall they are less important for breeding waterbirds.

It is hard to imagine the extent of waterbird breeding habitat, particularly ephemeral overflow lands, that was available prior to the massive alteration of the Central Valley's natural hydrology. Formerly, almost annual flooding in winter and spring of the Sacramento Valley's major rivers formed vast flood basins and huge, shallow seasonal lakes, which occurred in a diverse mosaic with permanent wetlands, vernal pools,

and an array of upland habitats (Thompson 1961, Katibah 1984, Scott and Marquiss 1984). Hall (1880) estimated 324,000 ha of the Sacramento Valley were subject to inundation from annual overflow and an additional 117,000 ha by "occasional temporary overflow." In the San Joaquin Valley, he estimated 253,000 ha of swamp land were subject to periodic inundation. In the Tulare Basin alone the fluctuating margins of Tulare Lake—formerly the largest freshwater lake and marsh system west of the Mississippi River (Johnson et al. 1993, Thelander and Crabtree 1994)—could engulf many thousands of additional hectares after a series of wet winters. Although it is unclear how much ephemeral habitat remained through the breeding season, the vast flood plains and natural flood basins delayed transmission of flood flows, reduced peak flows and velocities, and increased summer river flows, as the expansive floodwaters slowly drained back into the rivers, sometimes through July, or evaporated (The Bay Institute 1998). The buffering effect of the flood basins shifted high upstream flows of January to May to a period of high river outflow from March to June. 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). Hence, the latter region likely had the most ephemeral habitat for breeding waterbirds.

Today's water management infrastructure keeps rivers behind dams or within their banks, except during extreme flood events after which water usually rapidly drains or is pumped back into river and bypass channels, leaving few areas of shallow water as breeding or foraging habitat for waterbirds. The exception is the closed Tulare Basin where in extreme winters flood waters are diverted into shallow storage basins or run unchecked into fields. Flood frequency has decreased such that floods in the Sacramento Valley that occurred historically about every 2 years now occur once every 7 to 13 years and historical 10-year floods every 100 years (The Bay Institute 1998). Valleywide, the volumes of large floods remain largely unchanged, but only in very heavy snowpack years do flood flows approach historic levels in the San Joaquin Valley.

The great historic loss of wetlands was inadvertently mitigated in the Sacramento Valley by expansion of rice to the current annual level of about 160,000 to 210,000 ha, which may far exceed the average extent of shallow-water habitat available there historically in summer. Although rice acreage has been increasing in the Sacramento Valley overall in the last decade (www.nass.usda.gov/Statistics_by_State/California/index.asp), urban expansion is reducing the acreage of this crop between Sacramento and the Marysville–Yuba City area. Local loss of rice habitat may affect various species differentially if their densities vary across the broader landscape. For example, highest densities of breeding shorebirds in the Sacramento Valley generally occur in areas adjacent to rapid urban expansion (Shuford et al. 2007), whereas surveys of Black Terns generally found the highest densities in the counties farthest from human population centers (Shuford et al. 2001). Additionally, this monotypic rice habitat is structurally depauperate, and a given extent of rice undoubtedly supports far fewer species of breeding waterbirds than a comparable amount of structurally diverse historic wetlands. Regardless, wetlands lost in the San Joaquin Valley have been replaced to only a tiny degree by rice agriculture, which has declined there since the mid-1950s.

Changes in practices in rice agriculture have also increased winter waterbird habitat. Since the implementation of a legally mandated reduction in rice field burning to improve air quality that began in 1992, the extent of winter flooding of rice in the Sacramento Valley has expanded greatly as a method of rice stubble decomposition (Spell et al. 1995, Fleskes et al. 2005a, Miller et al. 2010). This increased flooding of rice fields has been associated with major shifts in the distribution of wintering waterfowl from elsewhere in the broader Central Valley to the Sacramento Valley (Fleskes et al. 2005b) and may have had similar effects on shorebirds and other waterbirds. At the same time, however, decreases in the acreage of unflooded rice that is plowed, burned, or left as harvested has reduced foraging opportunities for some species of waterfowl (Miller et al. 2010) and Sandhill Cranes (Littlefield 2002).

Urban growth directly threatens wetlands, most notably at the wetlands complex of the Grasslands Ecological Area near Los Banos (Weissman and Strong 2001). Urbanization continues to reduce agricultural lands in the Central Valley at a rate among the highest in North America (American Farmland Trust 1995, Sorensen et al. 1997).

Coastal Slope

As in the Central Valley, natural wetlands on the coast have also been greatly altered by human activities during the past 200 years. About two-thirds of the estimated 154,200 ha of prime tidal wetlands at the turn of the century have been degraded or destroyed by development for agricultural, industrial, urban, and other purposes (Speth 1979). These losses typically have been greatest in the areas of greatest human habitation in the San Francisco Bay area and on the southern California coast. The San Francisco Bay estuary—the largest contiguous tidal marsh system on the Pacific Coast—consisted of over 200,000 ha of mud flats and salt marsh (Josselyn 1983). This estuary's 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 >90% of the original wetlands have been lost to urban development, agricultural fields, or salt ponds, or degraded by habitat alterations, pollution, and introductions of exotic species. The types and degree of such changes are comparable for many other coastal estuaries, particularly those adjacent to large urban population centers.

The threat to coastal wetlands is ongoing, and pressure will increase with the growth of the human population. From 1980 to 2003, California led all U.S. states in absolute coastal population growth, adding 9.9 million people to coastal areas, and ranked sixth in percent increase (47%) in coastal popula-

tion (Crossett et al. 2004). In 2003, Los Angeles, Orange, and San Diego counties, respectively, were the first, fourth, and fifth most populous counties in the United States. Of the 10 coastal counties in the nation that experienced the greatest increases in population from 1980 to 2003, 6 were in California. Projections indicate that San Diego County will be the leading coastal county in population increase from 2003 to 2008. San Diego, Orange, San Bernardino, and Riverside counties will account for 12% of the nation's expected coastal population growth (Crossett et al. 2004). Projected growth will also be high in the San Francisco Bay region.

CHAPTER 3

Waterbirds in BCR 32

PATTERNS OF SEASONAL USE AND DISPERSION

Seasonal Use Patterns

BCR 32's relatively mild climate makes it hospitable to large numbers of waterbirds year round, yet the species using this region exhibit a variety of primary seasonal use patterns. Of the 46 species of waterbirds covered by the BCR 32 plan, 24 are primarily year-round residents and breeders, 13 are winter residents, 4 are summer residents and breeders, 4 are postbreeding visitors from the south, and 1 is a migrant using the area only in spring and fall (Table 1). Even within these categories there is variation, both major and minor, regional and local. The population sizes of some year-round residents may be relatively stable throughout the year, whereas the populations of others may swell greatly in winter with an influx of migrants from outside the region. Some species occur in far greater numbers and over a much broader area as postbreeding visitors than in other seasonal roles but still may have a small component of breeders in the region (e.g., Elegant Tern). Additionally, species that occur primarily in winter often have much smaller populations of over summering nonbreeders. It is beyond the scope of this plan to discuss the details of seasonal use patterns of waterbirds and how these vary among species or within smaller regions of BCR 32, but the reader is encouraged to review detailed regional avifaunal works (e.g., Shuford et al. 1989, Unitt 2004) to better understand these dynamics. As described below, many species also vary in whether they congregate or disperse to breed or whether they spread out or concentrate during migration and winter.

Colonial vs. Noncolonial Breeders

When breeding, waterbirds exhibit two main strategies: congregating in relatively large numbers at conspicuous colonies or rookeries (often with conspecifics) or dispersing to nest solitarily, often within concealing vegetation. Of the 31 primary breeding species and subspecies of waterbirds in BCR 32, 20 are best characterized as colonial breeders, 11 as solitary breeders (Table 2). This breakdown has a strong taxonomic component, as all 7 members of the family rallidae (rails, coots, gallinules) represented are solitary breeders. The other solitary breeders include two species of bitterns and a heron, and one species of grebe. The primary needs of any type of breeding waterbird are adequate and readily available food, protection from predators, isolation from disturbance, and appropriate nesting substrate.

WINTERING, POSTBREEDING, AND MIGRANT WATERBIRDS

The mild climate and abundant resources of BCR 32 attract large numbers of waterbirds in the nonbreeding season. When no longer restricted to foraging within the vicinity of their breeding colony or territory, waterbirds may disperse or migrate short or very long distances, depending on their seasonal use strategy, to exploit abundant food resources available locally or broadly within BCR 32. Habitats for wintering, migrating, staging, and postbreeding waterbirds must meet their needs for short-term survival and provide sufficient food stores to enable them to migrate or disperse back to breeding areas in condition to nest successfully.

In the Central Valley, waterbirds may congregate in large numbers at extensive wetland complexes like that of the Grasslands Ecological Area near Los Banos in the San Joaquin Valley or those in the Sacramento Valley surrounded by vast acreage of flooded rice fields in the winter. They may concentrate in wetlands for some needs and agricultural fields for others, or they may be widely distributed across these two broad classes of habitat types. Other species of waterbirds may

Table 2 Coloniality and Geographic Affinities of Breeding Species in BCR 32

Common Name	Coloniality	Geographic Affinities
Pied-billed Grebe	Solitary	widespread
Eared Grebe	Colonial	widespread
Western Grebe	Colonial	widespread
Clark's Grebe	Colonial	widespread
Double-crested Cormorant	Colonial	widespread
American Bittern	Solitary	widespread
Least Bittern	Solitary	widespread
Great Blue Heron	Colonial	widespread
Great Egret	Colonial	widespread
Snowy Egret	Colonial	widespread
Cattle Egret	Colonial	widespread
Green Heron	Solitary	widespread
Black-crowned Night-Heron	Colonial	widespread
White-faced Ibis	Colonial	widespread; interior
California Black Rail	Solitary	northern
Clapper Rail		
California Clapper Rail	Solitary	coastal; northern
Light-footed Clapper Rail	Solitary	coastal; southern
Virginia Rail	Solitary	widespread
Sora	Solitary	widespread
Common Gallinule	Solitary	widespread
American Coot	Solitary	widespread
Western Gull	Colonial	coastal
California Gull	Colonial	northern; coastal
California Least Tern	Colonial	southern; coastal
Gull-billed Tern	Colonial	southern; coastal
Caspian Tern	Colonial	widespread
Black Tern	Colonial	northern; interior
Forster's Tern	Colonial	widespread
Royal Tern	Colonial	southern; coastal
Elegant Tern	Colonial	southern; coastal
Black Skimmer	Colonial	southern; coastal

congregate on the deeper waters of inland lakes and reservoirs. On the coast, the largest numbers of waterbirds typically coalesce in shallow bays and estuaries (and their associated tidal, brackish, and freshwater wetlands), with many species moving back and forth from these protected waters to the inshore zone of the adjacent ocean. Large concentrations may be ephemeral, as birds temporarily exploit huge numbers of fish such as Pacific herring (*Clupea pallasi*) and northern anchovy (*Engraulis mordax*) when they enter bays for short periods to lay eggs or forage. Some species of waterbirds may rely on the availability of herring or herring roe to meet their winter energy requirements, but the extent to which particular wintering species depend on herring is unknown (Weathers and Kelly 2007).

Status and Biology of Breeding Waterbirds

The following sections describe patterns of habitat use, distribution, population trends, and conservation concerns for waterbirds in BCR 32. Much additional information on these topics can be found in the species accounts in Appendix 4 or in the relevant *Birds of North America* accounts (http://bna.birds.co.rnell.edu/bna).

Habitat Needs

Nesting substrates. The 31 species or subspecies of waterbirds breeding in BCR 32 vary considerably with respect to both their nesting substrate preferences and their foraging habitat needs. Thirteen taxa, at least in part, nest on platforms within concealing marsh vegetation; these include two bitterns, three species of wading birds, six rails, and two terns (Table 3). Ten species nest on barren to sparsely vegetated islands; these are gulls (2), terns (6), and skimmers (1), but also the cormorant to a limited extent. Of eight species using trees and shrubs for nesting, one is the Double-crested Cormorant and seven are wading birds. The seven species nesting on open-water platforms include four species of grebes, the American Coot, and the Forster's and Black terns. The cormorant and the Western Gull also use artificial structures extensively, four species of herons and egrets occasionally, and the Caspian Tern rarely. The endangered California Least Tern (*Sternula antillarum browni*) is the only species of waterbird discussed that nests extensively on sandy beaches (but also on some artificial sites in estuaries).

These patterns of nest placement by waterbirds have evolved to minimize the effects of predation on their populations. Almost all waterbird nests are provided some protection by isolation from ground predators or by concealment from both aerial and ground predators. Many of the larger species, or smaller ones that are strong, agile flyers or divers (e.g., small terns and grebes), nest in the open, but protection is granted by isolation on islands, floating nest platforms, or in trees, often augmented by the increased vigilance or nest defense afforded by large numbers of waterbirds nesting in colonies. Species that are small or weak flyers, like rails, tend to place their nests within concealing vegetation where less vulnerable to predation. Conversely, nests placed over water sometimes risk inundation from rising water levels or extreme high tides; falling water levels may expose nests to predation by ground predators. In the past, waterbirds had a greater "luxury" in having more alternative nesting sites to which to relocate when forced to move by predation; likewise, with extensive habitat, new colony sites probably took longer to be located by potential predators. Today, habitat can be so limited that few alternative nesting sites are available. In the case of the California Least Tern, sandy beaches are used so intensively for human recreation that very few nesting sites are currently available, and hence there is a need to actively protect colonies from predators and human disturbance on an ongoing basis if the species is to survive.

Foraging habitat use. There is broad overlap in the main types of habitats that waterbird use for foraging in BCR 32 during the breeding season (Table 4), but a few generalizations are warranted. Many of the species nesting on the ground on islands—mainly gulls, terns, skimmers—forage in shallow

Table 3 Nesting Substrate Use by Breeding Waterbird Species in BCR 32[a]

Species	Trees or Shrubs[b]	Artificial Structure[c]	Islands[d]	Sandy Beach	Open-water Platform[e]	Concealed Platform[f]
Pied-billed Grebe	–	–	–	–	X	–
Eared Grebe	–	–	–	–	X	–
Western Grebe	–	–	–	–	X	–
Clark's Grebe	–	–	–	–	X	–
Double-crested Cormorant	X	X	x	–	–	–
American Bittern	–	–	–	–	–	X
Least Bittern	–	–	–	–	–	X
Great Blue Heron	X	x	–	–	–	–
Great Egret	X	x	–	–	–	–
Snowy Egret	X	x	–	–	–	X
Cattle Egret	X	–	–	–	–	–
Green Heron	X	–	–	–	–	–
Black-crowned Night-Heron	X	x	–	–	–	X
White-faced Ibis	x	–	–	–	–	X
California Black Rail	–	–	–	–	–	X
Clapper Rail						
California Clapper Rail	–	–	–	–	–	X
Light-footed Clapper Rail	–	–	–	–	–	X
Virginia Rail	–	–	–	–	–	X
Sora	–	–	–	–	–	X
Common Gallinule	–	–	–	–	–	X
American Coot	–	–	–	–	X	–
Western Gull	–	X	X	–	–	–
California Gull	–	–	X	–	–	–
California Least Tern	–	–	X	X	–	–
Gull-billed Tern	–	–	X	–	–	–
Caspian Tern	–	x	X	–	–	–
Black Tern	–	–	–	–	X	X
Forster's Tern	–	–	X	–	X	X
Royal Tern	–	–	X	–	–	–
Elegant Tern	–	–	X	–	–	–
Black Skimmer	–	–	X	–	–	–

[a]Species (or subspecies) assigned to five categories with respect to their use of substrate types for nesting. X, major use; x, minor use. Prevalence of major versus minor use categories may differ in other parts of the species range, e.g., Double-crested Cormorants nest on islands much more frequently in other parts of their California range. Sources: Carter et al. 1992, Shuford and Craig 2002,Unitt 2004, Kelly et al. 2006, personal observations.

[b]Includes various types of trees, snags, shrubs, and, occasionally, artificially structures.

[c]Includes a variety of structures such as bridges; large power towers; rooftops; abandoned dredges, piers, platforms, barges, and boats; buoys and channel markers; etc.

[d]Mainly barren or sparsely vegetated islands but sometimes also isolated peninsulas or levees within salt ponds.

[e]Platforms built of vegetation (or earthen mounds), typically attached to rooted vegetation, suspended in large algae mats, or built up from the bottom of the water body.

[f]Platforms of vegetation typically built in concealing marsh plants where suspended above (sometimes high above) the water; for smaller species, nests usually screened from above by marsh vegetation.

estuarine waters. The two species of gulls, being generalists, also forage on tidal flats and at landfills or other sites, wet or dry, where abundant food is provided by humans; the California Gull ranges more widely than the Western into upland habitats. Three of the terns also use inland habitats, varying from those with mostly open water to ones with low-stature emergent vegetation (or rice fields or other agricultural habitats that mimic them). The four species of grebes and the Double-crested Cormorant occupy habitats with extensive open water, as long as requisite nesting substrates are available. In concordance with their nest substrate needs, the two bitterns and seven taxa of rails use habitats with extensive emergent vegetation; three of the rails make exclusive or extensive use of emergent tidal marsh habitat. Of the remaining seven species of wading birds, four use almost all types of wetlands, fresh or salt, with shallow open water, and two of these make extensive use of agricultural fields and grasslands. The Green Heron forages mainly along the margins of streams and ponds, and the Cattle Egret and White-faced Ibis mainly in pastures and irrigated fields (e.g., alfalfa); the ibis also forages in open emergent wetlands.

Table 4 Use of Major Foraging Habitats by Breeding Waterbird Species in BCR 32[a]

Species	Open Estuary[b]	Tidal Marsh[c]	Lakes, Reservoirs, Streams[d]	Open Emergent Wetlands[e]	Closed Emergent Wetlands[f]	Agricultural Fields[g]
Pied-billed Grebe	–	–	X	X	–	–
Eared Grebe	–	–	–	X	–	–
Western Grebe	–	–	X	X	–	–
Clark's Grebe	–	–	X	X	–	–
Double-crested Cormorant	X	–	X	X	–	–
American Bittern	–	–	–	X	X	–
Least Bittern	–	–	–	X	X	–
Great Blue Heron	X	X	X	X	–	X
Great Egret	X	X	X	X	–	X
Snowy Egret	X	X	X	X	–	–
Cattle Egret	–	–	–	–	–	X
Green Heron	–	–	X	–	–	–
Black-crowned Night-Heron	X	–	–	X	–	–
White-faced Ibis	–	–	–	X	–	X
California Black Rail	–	X	–	X	–	–
Clapper Rail						
California Clapper Rail	–	X	–	–	–	–
Light-footed Clapper Rail	–	X	–	–	–	–
Virginia Rail	–	–	–	X	X	–
Sora	–	–	–	X	X	–
Common Gallinule	–	–	–	X	X	–
American Coot	–	–	–	X	–	–
Western Gull	X	–	–	–	–	–
California Gull	X	–	X	X	–	X
California Least Tern	X	–	X	–	–	–
Gull-billed Tern	X	–	–	–	–	X
Caspian Tern	X	–	X	–	–	–
Black Tern	–	–	–	X	–	–
Forster's Tern	X	–	X	X	–	–
Royal Tern	X	–	–	–	–	–
Elegant Tern	X	–	–	–	–	–
Black Skimmer	X	–	–	–	–	–

[a]Species (or subspecies) assigned to six broad habitat categories with respect to use during the breeding season.

[b]Generally the shallow waters of estuaries for foraging, but may also include tidal flats and deeper estuarine waters.

[c]Tidal marshes dominated by *Salicoria*, *Spartina*, etc., usually with some tidal channels and pools.

[d]Open water bodies with relatively deep water, but usually with some shallows on edges and some fringing marsh vegetation.

[e]Shallow-water marshes with open water predominating over dense vegetation; includes rice fields, which mimic low-stature wetlands.

[f]Shallow-water marshes dominated with dense vegetation.

[g]Often irrigated fields (particularly alfalfa) and pastures, but sometimes dry uplands.

Distribution

Of the 31 breeders, 21 are characterized as being widespread in their distribution (Table 2), though the bulk of the White-faced Ibis breeding population is in the interior and all of the Western Gull breeding population is along the (entire) immediate coast. Of the six species with southern geographic affinities, all are associated with coastal estuarine environments in this BCR. Four—the Light-footed Clapper Rail and Gull-billed, Royal, and Elegant terns—reach the northern limit of their ranges on the Pacific coast in southern California. Although the California Least Tern and Black Skimmer's breeding ranges reach their northern limit on the Pacific coast in the San Francisco Bay estuary, the bulk of their populations, particularly for the skimmer, are in the south-coastal portion of the BCR. Four species breeding in the BCR have northern geographic affinities. Although the Black Rail occurs irregularly south to northern coastal Baja California, the vast majority of its population is in the northern reaches of the San Francisco Bay estuary. The California Clapper Rail is currently restricted to the San Francisco Bay estuary. Excluding a few failed nesting attempts in peripheral areas, breeding by the California Gull in BCR 32 is restricted to San Francisco Bay; though the breeding population there is large, this is the only coastal breeding area within the species' entire range. The Black Tern breeds in the BCR only in the Central

Valley, where the vast majority of birds are concentrated to the north in Sacramento Valley rice fields.

Population Estimates and Trends

Data on the population sizes and trends of breeding waterbirds in BCR 32 overall are quite limited. Data are generally the best when adequate funding for coordinated monitoring is available because species (or subspecies) are listed as threatened or endangered (e.g., California Least Tern, two subspecies of Clapper Rail) or are of particular management concern (e.g., Caspian Tern because of effects on salmon recovery efforts). Regional population estimates and trends are also available for some species (e.g., Elegant Tern) that nest in very few colonies, typically on lands managed as refuges or wildlife reserves or where concerns for threatened or endangered species require monitoring. Analyses of Breeding Bird Survey (BBS) data for BCR 32 are available for only 21 of the 32 breeding species (or species pairs) covered by this plan. Of the 21, 5 showed non-significant declining trends; 16 showed increasing trends, of which only 6 were significant (Table 5). Overall, data on population estimates and trends are particularly poor for many widespread breeders, particularly for solitary nesting and secretive species. Even when data are collected, there is much variability in data quality, frequency and duration of data gathering, and geographic extent of coverage, such that data may be very limited, incomplete, and hard to obtain. Still, there are good population data for some species at the subregional, local, or site-specific level. The following paragraphs describe information on population sizes and trends when these are known for the region as a whole, important subregions, or key sites for particular species.

Grebes. There are no adequate regionwide population estimates for any of the four grebe species breeding in BCR 32. Ivey (2004) summarized anecdotal information on numbers of Western and Clark's grebes nesting at various sites in California, but these data are inadequate for estimating regional population sizes or trends. BBS data for BCR 32 from 1968 to 2009 show non-significant increasing trends for the Pied-billed Grebe and Western/Clark's Grebe and a non-significant declining trend for Eared Grebe (Table 5).

Double-crested Cormorant. Carter et al. (1995) estimated 2857 Double-crested Cormorants were breeding in the greater San Francisco Bay estuary (including Suisun Marsh) in 1990. Excluding the 331 cormorants nesting in trees at Morro Bay State Park in 1989 and 65 nesting on a dredge in the south San Diego saltworks in 1991, the remaining 4145 birds along the outer coast of BCR 32 (Russian River south) during this period were nesting on mainland cliffs, offshore rocks, or islands. Numbers of cormorants nesting in San Francisco Bay increased dramatically in the 1980s with colonization of major bay bridges and power towers; likewise, numbers nesting on the outer coast of California increased greatly, as evidenced both by increases at all colonies monitored annually since the mid-1970s and by establishment of new colonies (Carter et al. 1992, 1995). Adkins et al. (2010) reported 2201 and 1450 breeding cormorant pairs (4402 and 2900 individuals) in San Francisco Bay in 2001–2003 and 2008, respectively, indicating no clear trend since the 1990 surveys by Carter et al. (1995).

Surveys in 1999 estimated 1732 breeding cormorants in the interior of BCR 32 (54% in Central Valley, 46% on coastal slope or Coast Ranges; Table 2 in Shuford 2010).

BBS data show a significant increasing trend for the Double-crested Cormorant in BCR 32 from 1968 to 2009 (Table 5).

Herons and egrets. Only limited data, all from the Breeding Bird Survey, are available on regionwide populations sizes and population trends of ardeids (bitterns, herons, egrets,

Table 5 Breeding Bird Survey (BBS) Trend Data for 21 Waterbird Species or Species Pairs in BCR 32 from 1968 to 2009 (from Sauer et al. 2011)

	1968–2009[a]			
Species	Trend[b]	95% CI	*n*	Credibility[c]
Pied-billed Grebe	1.6	–1.2, 4.5	53	medium
Eared Grebe	–14.4	–32.0, 2.3	5	low
Western/Clark's Grebe	8.9	4.2, 14.6	21	low
Double-crested Cormorant	**12.9**	8.1, 17.7	30	medium
American Bittern	1.2	–1.4, 3.8	22	medium
Great Blue Heron	0.7	–0.4, 1.7	73	high
Great Egret	**7.8**	5.7, 10.1	48	medium
Snowy Egret	**6.4**	2.5, 10.1	25	medium
Cattle Egret	16.3	2.7, 31.3	13	low
Green Heron	**2.8**	0.8, 4.8	56	medium
Black-crowned Night-Heron	**2.8**	0.2, 5.1	42	medium
White-faced Ibis	31.2	18.1, 45.3	10	low
Virginia Rail	2.3	–5.3, 10.7	8	low
Sora	–8.1	–17.9, 0.6	7	low
Common Gallinule	–0.2	–3.9, 3.5	21	medium
American Coot	–3.2	–6.1, –0.8	74	high
Western Gull	1.3	–3.7, 7.2	10	low
California Gull	2.2	–4.3, 10.6	20	low
Caspian Tern	**4.4**	0.2, 8.7	25	medium
Black Tern	0.4	–7.3, 8.1	5	low
Forster's Tern	–1.1	–5.3, 3.1	15	medium

[a]BBS data presented: Trend, % change/year; 95% Confidence Interval (CI); *n*, number of survey routes on which species was encountered during interval 1968–2009.

[b]Statistically significant trend data in bold type.

[c]Regional credibility rankings of blue, yellow, and red as defined by Sauer et al. (2011) are given comparable rankings here of high, medium, and low, respectively. High credibility (blue), data with at least 14 samples, of moderate precision, and of moderate abundance on survey routes; medium credibility (yellow), data with a deficiency (low abundance, small sample size, "quite imprecise" in detecting long-term trends); low (red), data with an important deficiency (very low abundance, very small sample size, "very imprecise" in detecting long-term trends). Species with a low (red) rating suggest they are not well sampled by the BBS in BCR 32; even data falling in the high (blue) category may not provide valid results (Sauer et al. 2011).

night-herons), but valuable subregional data are available. BBS data for the whole of BCR 32 from 1968 to 2009 show significant increasing trends for the Great Egret, Snowy Egret, Green Heron, and Black-crowned Night-Heron and non-significant increasing trends for the American Bittern, Great Blue Heron, and Cattle Egret (Table 5).

Monitoring of colonial nesting herons and egrets in the greater San Francisco Bay region by Audubon Canyon Ranch and San Francisco Bay Bird Observatory from 1991 to 2005, documented an average of 73 active colony sites per year, comprising about 62 colonies of the Great Blue Heron, 25 of the Great Egret, 13 of the Black-crowned Night-Heron, and 12 of the Snowy Egret (Kelly et al. 2006). The average annual number of nests in the region from 1994 to 2005 was 516 for the Great Blue Heron, 878 for the Great Egret, 834 for the Black-crowned Night-Heron, and 587 for the Snowy Egret; numbers of the latter two species are considered low because of the difficulty of counting nests in dense vegetation. From 1994 to 2005, the Cattle Egret nested at 1–2 sites, with nest numbers ranging from only 1 to 23. Nest abundances of all species were stable or increasing from 1994 to 2005. The Great Blue Heron showed no significant linear trend from the entire period but increased significantly by an average of 25 nests per year 1999–2005. The Great Egret showed a significant increase in nest numbers overall, reflecting primarily a sharp increase in 2004 and 2005. Nests numbers from 1994–2005 declined at a significant rate of -4.5%/yr for the Black-crowned Night-Heron and at a non-significant rate of -1.5%/yr for the Snowy Egret. Recent analyses, however, revealed substantial significant declines in nesting abundance of -12%/yr for both species since 2002 (J. P. Kelly pers. comm., Pitkin and Wood 2011). The significant increase in the small number of nesting Cattle Egrets reflected an increase at one colony.

Using data from atlas field work from 1997 to 2001 and a compilation of prior anecdotal information, Unitt (2004) described the current status and trends of herons and egrets nesting in San Diego County. From 1997 to 2001, about 250–300 pairs of Great Blue Herons nested at 30 sites in the county; the majority were at the six largest colonies, as 13 held isolated pairs and 17 others held 2–54 nests. Great Blue Heron numbers appear to have increased only modestly in the county, as suggested by data from the San Diego Christmas Bird Count (CBC). After first nesting in San Diego County in 1988, Great Egrets increased to about 75 nesting pairs by 2000, with establishment of additional small colonies continuing thereafter. First recorded nesting in 1979, the Snowy Egret continued to establish new nesting colonies, yet CBC data for the county suggest the species' numbers, in winter at least, may have peaked in the 1970s and 1980s and may have declined since the early 1990s. Numbers of Black-crowned Night-Herons appear to have remained stable in the county, but those of the Cattle Egret increased dramatically then declined abruptly. The latter species was first recorded in 1964, and following a major fall influx in 1977, breeding was first recorded in 1979. The population reached its peak in the 1980s and has declined since. During the 1997–2001 atlas, there were only two colonies: one of 43 nests, another of 1–2 pairs. Counts on the San Diego CBC reached a peak of 3512 in 1985 then decreased to 6 in 1995 and none thereafter; numbers on other CBCs in the county have also decreased since 1997.

White-faced Ibis. Although coordinated surveys of breeding ibis using consistent protocols have not been conducted in BCR 32, sharply increasing trends are evident from monitoring at federal refuges and state wildlife areas. After indications of nesting on private lands nearby in 1982–1984, ibis first nested on the Sacramento NWR complex at Colusa NWR, where numbers increased from 50 to 250 pairs from 1985 to 1989. After a hiatus for 9 years, subsequently ibis have nested on Sutter and Delevan NWRs. Collective counts at those sites increased from 150 to 4573 pairs from 1999 to 2002, dropped to 0 in 2003, then increased again to 2029 and 1500 pairs in 2004 and 2005, respectively (all Sacramento NWR unpubl. data). These are not total counts for the Sacramento Valley, as some ibis colonies on private lands have not been surveyed (M. Wolder pers. comm.). Dawn flyout counts of ibis at nesting colonies at Mendota WA in the central San Joaquin Valley increased from 927 in 1992, when the colony was first established, to 7615 in 2005 (Mendota WA unpubl. data). Ibis have nested at Kern NWR in the southern San Joaquin Valley since at least 1994, when 75 nests were estimated, and appear to have nested annually since, except in 2002. Counts have varied but reached a peak of at least 7000 nests and 10,545 ibis in 2005 (Kern NWR unpubl. data). An estimated 460 pairs were nesting nearby in the Tulare Basin in 1997, and likely were nesting in other years (R. Hansen in Earnst et al. 1998). From 1997 to 2001, there were two small colonies (maximum count at largest was 34 birds), possibly others, on the coastal slope of San Diego County (Unitt 2004). In 2011, there were at least two small colonies in San Diego County (P. Lehman fide R. Doster).

BBS data show a non-significant increasing trend for the White-faced Ibis in BCR 32 from 1968 to 2009 (Table 5).

Rails. BBS data for BCR 32 from 1968 to 2009 show a non-significant increasing trend for the Virginia Rail and non-significant decreasing trends for the Sora, Common Gallinule, and American Coot (Table 5).

Population estimates for the California Black Rail from surveys in 1996 and 2001 are 7200 and 12,000, 7100 and 15,000, and 289 and 280 individuals in the Suisun Marsh–Carquinez Straits, San Pablo Bay, and Outer Coast (Bodega–Pt. Reyes) areas, respectively (Evens and Nur 2002, Spautz et al. 2005). Estimates of the total population of the California Clapper Rail in the San Francisco Bay estuary were 4200–6000 birds in the 1970s, 1200–1500 in the mid-1980s, 700 in 1988, 300–500 in 1990–91, 1040–1264 in the mid-to-late 1990s, and an average of 1425 from 2005–2008 (Liu et al. 2009 and references therein). Assessing the population status of Clapper Rails in San Francisco Bay is difficult because of the rail's secretive behavior and inconsistent and variable vocalizations and the variation in survey effort and

methods used to collect data over many decades (Liu et al. 2009). The population of the Light-footed Clapper Rail in southern California has increased from an average of 193 pairs in 1980–1989 to 264 pairs in 1990–1999 to 307 pairs in 2001–2006; the population exceeded 350 pairs each year from 2004 to 2006, reaching 408 pairs in 2006 (Zembal et al. 2006).

Gulls. The size of the California Gull population in San Francisco Bay—the only one in BCR 32 —has increased exponentially from about 412 breeding individuals in 1982 to over 46,000 in 2009 (Strong et al. 2004, SFBBO unpubl. data). Carter et al. (1992) estimated the number of Western Gulls breeding along the entire California coast was 44,452 individuals in 1975–1980 (reevaluation of numbers in Sowls et al. 1980) and 61,760 in 1989–1991. Although this 39% increase in part reflects numbers at sites in San Francisco Bay and along the southern California mainland not counted in 1975–1980, most of the change was fueled by a 31% increase in numbers at known colonies between the two periods. This may reflect patterns within BCR 32, though the bulk of the birds counted were on the outer coast or offshore islands outside the BCR 32 boundary, and a comparison of birds within the estuaries of BCR 32 is hampered by a lack of data from the earlier survey from San Francisco Bay, the largest such site.

BBS data for BCR 32 from 1968 to 2009 show non-significant increasing trends for both the California Gull and Western Gull (Table 5).

Terns and skimmers. Estimated numbers of nesting pairs of Gull-billed Terns at the San Diego Bay saltworks increased from the one pair that colonized in 1986 to 30 pairs in 1992, dipped to 8–20 pairs for the rest of the 1990s, then increased to an average of 54 pairs from 2006 to 2009 (San Diego Bay NWR unpubl. data).

From 1997 to 2004, estimates of the number of Caspian Terns nesting in BCR 32 ranged from 1498 to 2158 pairs (median 1893) (Shuford and Craig 2002, USFWS unpubl. data).

Since their colonization of south San Diego Bay in 1959, and later expansion to other colony sites in southern California, the Royal Tern has increased only slightly, the Elegant Tern exponentially. Numbers of Royal Terns breeding in California have been quite variable, even since colonization of Bolsa Chica Ecological Reserve (1988) and the Port of Los Angeles (1998), with totals ranging mainly from 20 to 40 pairs; peak nests counts at south San Diego Bay were 30, 36, 28, and 38 in 1960, 1999, 2003, and 2004, respectively, with counts of 1–2 nests in most other years (San Diego Bay NWR, K. Keane, and C. Collins unpubl. data). Total numbers of Elegant Terns nesting collectively at three sites on the southern California coast (south San Diego Bay, Bolsa Chica, Port of Los Angeles) increased greatly from 1993 to 2004. Counts of 2125 and 1280 in 1993 and 1994, respectively, jumped to a plateau ranging mostly from 3400 to 5900 from 1995 to 2002, then jumped again to about 13,300 and 11,200 in 2003 and 2004, respectively (San Diego Bay NWR, K. Keane, and C. Collins unpubl. data).

There are no regionwide population estimates or trend data for the Forster's Tern in BCR 32. Subregional estimates of breeding Forster's Terns include about 1082 in the San Joaquin Valley in 1998 (Shuford 2010), an average of 2710 (1628–4312) in central and south San Francisco Bay from 1998 to 2003 (Strong et al. 2004), and about 200 to 1200 at the south San Diego Bay saltworks since 1963 (Unitt 2004). There was a significant decline in numbers in San Francisco Bay from 1984 to 2003, but the baywide totals did not include data for one site in San Pablo Bay, which held 1314 terns in 2002 (46–274 terns in 3 other years with data).

Following the initiation of predator control measures in the 1980s and adoption of standardized monitoring protocols across all breeding sites in 1993, the size of the California Least Tern population in California has increased from about 2000 breeding pairs in the early 1990s to reach a plateau varying from about 6400 to 7100 pairs from 2003 to 2010 (Marschalek 2011).

For the Black Tern, there are no adequate population trend data for BCR 32, but Shuford et al. (2001) estimated that in 1998 about 2213 pairs bred in the Central Valley (89.8% in Sacramento Valley, 10.2% in San Joaquin Valley).

Since colonization of south San Diego Bay in 1976, Black Skimmers have expanded to breed at six additional sites from there north to, and including, south San Francisco Bay; the coastal nesting population was roughly 1000 pairs in 2005 (Collins and Garrett 1996, Molina 2008).

BBS data for BCR 32 from 1968 to 2009 show a significant increasing trend for the Caspian Tern, a non-significant increasing trend for the Black Tern, and a non-significant declining trend for the Forster's Tern (Table 5).

Key Habitats and Sites

The most important ("key") sites and habitats for breeding waterbirds in the region can be difficult to define both because of a lack of information and because many species are dispersed widely across their breeding ranges. Almost all coastal estuaries and large wetland complexes in the interior, most of which have been noted above, are important to waterbirds. Likewise, all major rivers and streams in, or draining into, the Central Valley are important to some species, particularly as nesting sites for colonies of herons, egrets, and cormorants. Additionally, certain agricultural lands, particularly rice fields, are important to some breeding waterbirds, as are some lakes and reservoirs. Though by no means an exhaustive list, important sites to breeding waterbirds are discussed below by major taxonomic groups. Because of the massive loss of historical wetlands in the region, really all wetlands that currently support breeding waterbirds are important.

Grebes. Breeding sites for all grebes are widely dispersed, particularly so for the Pied-billed Grebe, the lone solitary nester among the four grebe species breeding in the region. It is difficult to describe important sites for breeding Eared Grebes in the region both because the size of the nesting population is relatively small and because the species breeds at many sites

on an ephemeral basis depending on annual and local conditions. Western and Clark's grebes breed at a large number of lakes and reservoirs in the region. Some important sites, such as Clear Lake, Lake County, are known, but a lack of a comprehensive inventory of all sites, and the great annual variability in numbers breeding at some sites, makes it hard to compare the importance of sites for these two grebe species. Ivey's (2004) partial compilation of breeding sites of Western and Clark's grebes in California will form the basis for further efforts to identify key sites for these species.

Double-crested Cormorant. San Francisco Bay and the Central Valley are the most important regions for this cormorant. Breeding sites are widely dispersed in the Central Valley, but more concentrated in San Francisco Bay, where most currently are breeding on the large cross-bay bridges (Richmond–San Rafael, San Francisco–Oakland Bay, and San Mateo bridges) and on power towers in the South Bay. Numbers on bridges can be depressed temporarily during bridge maintenance or construction for seismic retrofitting.

Herons and egrets. The two species of solitary nesting bitterns are widely dispersed among numerous breeding sites, so it is likely that the largest wetlands or wetland complexes with suitable freshwater marsh are the most important to these species. The most extensive areas of suitable habitat are mainly in the Central Valley. Prime areas include the large complex of federal state, and private wetlands within the Sacramento Valley; state and private wetlands in Suisun Marsh; state, federal, and private wetlands in the Grasslands Ecological Area near Los Banos (plus Mendota WA to the south) in the central San Joaquin Valley; and Kern NWR, nearby duck clubs, and the South Wilbur and Hacienda Ranch flood basins in the Tulare Basin in the southern San Joaquin Valley. The latter flood basins, in particular, vary enormously in their importance to waterbirds on an annual basis depending on water availability, which is highest in years of extreme precipitation. American Bitterns are one of the most numerous, or at least most conspicuous, waterbirds in the extensive (>200,000-ha) region of rice fields in the Sacramento Valley. Least Bitterns are not known from rice fields and have not been recorded as widely in wetlands of the Central Valley as have American Bitterns. Known areas of importance to the Least Bittern include Sacramento Valley wetlands, Suisun Marsh, Mendota WA, and the Tulare Basin, though further field work is likely to identify more sites, particularly on private lands (Sterling 2008). The solitary nesting Green Heron generally is widely distributed in the region, though localized in riparian areas where it nests in trees and forages along the edges of major rivers, streams, and creeks and some lakes and ponds.

Nesting sites of colonial nesting herons and egrets are widely dispersed throughout the BCR. The distribution of their colonies generally is influenced by the proximity of suitable foraging areas, competition for food and foraging areas, and risk of predation or disturbance (references in Kelly et al. 2006). Great Blue Herons and Great Egrets depend on the extent and quality of wetland foraging landscapes within 10 km of colony sites (Kelly et al. 2008). In some cases, colony sites, such as islands, that provide protection from predators may offset their greater distance from prime foraging areas (Kelly et al. 2007).

Currently nesting sites and population sizes of colonies are best documented for the San Francisco Bay region (Kelly et al. 2006), but there are many colonies scattered elsewhere along the coastal slope (e.g., Unitt 2004) and throughout the Central Valley. Although many colonies cluster near estuarine and wetland foraging areas, many are also located in cottonwoods, sycamores, oaks, or other large trees along major rivers and streams or in groves of eucalyptus or other large planted trees in agricultural areas; eucalyptus and other non-native trees are also important nesting substrates near estuaries and other wetlands on the coast (Unitt 2004, Kelly et al. 2006). Both freshwater wetlands and agricultural fields are important foraging areas in the Central Valley; pastures and irrigated fields, particularly alfalfa, are important for Cattle Egrets throughout the region. In the San Francisco Bay region, colonies of the Great Blue Heron are the most widely distributed. Those of the Great Egret, Snowy Egret, and Black-crowned Night-Heron are fewer but larger, and generally distributed consistent with a preference for tidal foraging areas (Kelly et al. 2006).

White-faced Ibis. As noted above, all key nesting sites for this species are currently in the Central Valley. These include Sutter and Delevan NWRs in the Sacramento Valley and Mendota WA and Kern NWR in the San Joaquin Valley; a few sites on private lands may also be important at least occasionally. Breeding ibis forage extensively in both agricultural fields and managed wetlands in proximity to their colonies; rice fields are particularly important in the Sacramento Valley, alfalfa and pastures in the San Joaquin Valley.

Rails. The four species that breed in freshwater wetlands—Virginia Rail, Sora, Common Gallinule, and American Coot—are widely distributed and hence important wetlands for them appear to be the largest ones. As noted above, key wetlands for the Black Rail are the upper elevation tidal marshes of San Pablo Bay and the Suisun Marsh–Carquinez Straits region in the northern reaches of the San Francisco Bay estuary. The California Clapper Rail is restricted to the greater San Francisco Bay estuary, with largest numbers in the South Bay and San Pablo Bay and small numbers in the Central Bay and Suisun Marsh (Albertson and Evens 2000). The Light-footed Clapper Rail is restricted to (mostly) tidal and freshwater coastal marshes from (irregularly) Santa Barbara County in southern California south to San Quintin Bay in northern Baja California. In 2006, the breeding-season survey of the southern California coast found this rail at 18 sites. Two of these accounted for 64% of the California breeding population: Upper Newport Bay (39%), Orange County, and Tijuana Marsh NWR (25%), San Diego County. Other sites each holding ≥4% of the total (collectively 25%) included Mugu Lagoon, Ventura County; Seal Beach NWR, Orange County; and Batiquitos, San Elijo, and San Dieguito lagoons, San Diego County (Zembal et al. 2006).

Gulls. The California Gull breeding population, restricted to San Francisco Bay, is concentrated in the South Bay with

very small numbers in the Central Bay. Of the 16,475 pairs breeding at seven sites in the South Bay salt ponds in 2006, 59% were at Alviso (Knapp, pond A6), 23% at Coyote Hills (2A/3A), and 15% at Mowry (M1/M2) (SFBBO unpubl. data). Excluding the bulk of the California population of Western Gulls nesting on mainland cliffs, offshore rocks, and islands, hence outside of the BCR 32 boundary, the vast majority of these gulls nesting within coastal estuaries are found in San Francisco Bay, with many fewer at scattered sites such as Bodega Harbor, Elkhorn Slough, Moss Landing Harbor, and San Diego Bay (Carter et al. 1992)

Terns and Skimmers. The breeding populations of several larids are concentrated at very few sites, almost exclusively in human-created habitats, on the southern California coast. The Gull-billed Tern nests only at the saltworks in south San Diego Bay, and the Royal and Elegant terns only at south San Diego Bay, Bolsa Chica Ecological Reserve, and the Port of Los Angeles (see above).

Although its range extends north to San Francisco Bay, the vast majority of the coastal Black Skimmer breeding population is concentrated in six sites in southern California, with the bulk of skimmers at south San Diego Bay, Upper Newport Bay, and Bolsa Chica (Molina 2008).

The range of the California Least Tern also extends north to San Francisco Bay but likewise is concentrated in southern California. In 2010, sites each holding >5% of the entire state breeding population of breeding California Least Terns included Marine Corps Base Camp Pendleton (26%), Naval Base Coronado (17%), Point Mugu (10%), Batiquitos Lagoon (7%), Bolsa Chica (7%), and Huntington State Beach (6%); the site in northern California with the highest percentage of the total was Alameda Point (4%) in San Francisco Bay (Marschalek 2011).

Sites in BCR 32 (all on the coast) that each have held >100 pairs of nesting Caspian Terns in at least one year from 1997 to 2004 include Brooks Island, Knight Island, Alameda, Baumberg, and Alviso (A7) in San Francisco Bay, Salinas River NWR, Bolsa Chica Ecological Reserve, Los Angeles Harbor, and south San Diego Bay (Shuford and Craig 2002, USFWS unpubl. data). During this period the highest numbers have consistently been at Brooks Island (500–1040 pairs) and south San Diego Bay (198–380 pairs). Over the longer term, though, areas of concentration in San Francisco Bay have shifted substantially: since 1982, five other sites besides Brooks Island have held the largest colony in a given year (Strong et al. 2004).

The key areas for Forster's Terns include San Francisco and south San Diego bays, and for the Black Tern the primary area is the complex of rice fields in the Sacramento Valley (see above).

Spatial and Temporal Variability in Breeding

Because annual precipitation varies greatly in BCR 32, habitat conditions also can vary substantially, particularly during periods of extremely wet and dry years. Surveys of nesting waterbirds in the Central Valley in summer 1998, following a very wet El Niño winter, provided some of the best conditions for nesting waterbirds in that region since the 1950s. Shallow-water breeding habitat increased primarily in the Tulare Basin, where large areas of agricultural land were flooded, intentionally or unintentionally, and secondarily near Los Banos, Merced County, on refuges and in flood-control bypasses. These surveys found Eared Grebes, Double-crested Cormorants, herons and egrets, White-faced Ibis, and Caspian, Forster's, and Black Terns breeding in many areas where they typically do not do so (Shuford et al. 2001, D. Shuford pers. obs.). Such variability makes it hard to assess what typical population sizes and breeding distributions are without many years of comparable surveys over a range of representative environmental conditions.

Patterns of seasonal weather and annual reproductive performance of herons and egrets in the San Francisco Bay region suggested that a sharp decline in nest abundances in 1999, particularly in Suisun Bay and south San Francisco Bay, may have resulted from reduced recruitment associated with increased juvenile mortality of birds hatched during a drought in 1997 and experiencing heavy rainfall during the winter 1997–98 El Niño (Kelly et al. 2006). In this study, timing of nest initiation varied not only among species but also among colonies of the same species in different subregions of the San Francisco Bay area. Earlier nesting by Great Blue Herons and Snowy Egrets in subregions dominated by freshwater wetlands was consistent with the relatively early availability of seasonally flooded marshes, ephemeral creeks, and receding ponds after normal periods of winter rainfall (Kelly et al. 2006). By contrast, later nesting near tidal areas suggested the importance of estuarine prey as spring salinities rise and fish abundances increase with the seasonal influxes and productivity of estuarine breeders from marine habitats.

All of these patterns of variation in nesting abundance and timing are important to consider when conducting and interpreting the results of broad-scale inventories of nesting waterbirds. Such surveys are typically constrained by the difficulty of conducting censuses at all sites over multiple years, and often single surveys stretch over much of the breeding season given the large area being covered, which means the timing at individual sites may not always be ideal for obtaining the best counts. It is apparent, though, that involvement of dedicated volunteers can vastly increase the reach of such surveys (e.g., Kelly et al. 2006).

Status and Biology of Migrant and Wintering Waterbirds

Population Estimates and Trends

Data on the population sizes and trends of waterbirds occurring in BCR 32 as winter visitors, migrants, or post-breeding visitors are much more limited than for waterbirds breeding in this region. Almost no rigorous broad-scale monitoring programs are in place to assess the status of nonbreeding waterbirds across BCR 32. Good monitoring data on winter-

ing waterbirds are available for select sites (e.g., Tomales Bay, Bolinas Lagoon, etc.), but it is unclear if population trends detected at this scale are representative of broader regions or just reflect local conditions.

The midwinter waterfowl surveys coordinated by U.S. Fish and Wildlife Service do count numbers of Sandhill Cranes and American Coots. Although large, cranes can be difficult to count from the air (Littlefield 2008), and further it is not possible to distinguish the crane subspecies from planes. One hundred percent of the Central Valley population of the Greater Sandhill Crane, estimated at 8000–10,000 individuals, winters in this region, and surveys on the breeding grounds suggests its population is increasing (Ivey and Herziger 2001; Ivey, species account in Appendix 4 *this volume*). Over 95% of the Pacific Flyway Population of Lesser Sandhill Cranes winters in the Central Valley; the estimated number of Lessers in the Central Valley is about 25,000 individuals and the population is stable or possibly declining slightly (Littlefield 2008; Ivey, species account in Appendix 4 *this volume*).

Numbers of White-faced Ibis wintering in California have increased substantially in recent decades and continue to do so at least regionally. Winter numbers reached a low in the state in the 1970s, began to increase in the 1980s, and increased sharply in the early 1990s (Shuford et al. 1996). Surveys in 1994–1995 found concentrations of 2000–3000 in the Sacramento Valley and 8000 in the Grasslands Ecological Area in the San Joaquin Valley; additional surveys in 1995–1996 estimated 10,000–12,000 ibis in the greater Grasslands area. Numbers of wintering ibis have continued to increase, at least in the Sacramento Valley. There ibis counts on the annual midwinter waterfowl survey in January covering the area north of Highway 20, west of Highway 99, and south of Stony Creek, which includes the major public and private managed wetland and rice fields, increased steadily from 6262 in 2001 to 20,929 in 2007 (Sacramento NWR unpubl. data). CBC data also show increasing trends in ibis numbers overall on the coastal slope of southern California in the 1980s and 1990s (Shuford et al. 1996). This pattern was not universal, though, as declining numbers on the San Diego CBC were attributable to the termination of alfalfa growing and abandonment of most agricultural land in the Tijuana River valley, the only area where the species was ever regular on the count. As noted above, numbers of Cattle Egrets likewise plummeted on the San Diego CBC from the mid-1980s to the mid-1990s, dropping from thousands to none in the Tijuana River valley for reasons comparable to those leading to the demise of ibis in that area (Unitt 2004). CBC data can be useful for detecting and explaining local trends in waterbirds (e.g., Unitt 2004 for various species), but, as noted above, until effort-adjusted annual indices and trends for standard areas are developed for CBC data its value will be limited in monitoring or assessing trends across larger regions such as a BCR.

Key Habitats and Sites

Because of the region's mild climate and low elevations, large numbers of waterbirds migrate to the area for the winter, augmenting both the number of species and, particularly, the overall abundance of waterbirds in both the region's tidal and freshwater wetlands (e.g., Shuford et al. 1989 for patterns in Pt. Reyes wetlands). Of the 46 species of waterbirds covered by this plan, 37 are either year-round residents or winter residents from the north, and these are augmented from summer to early winter by an additional 4 species that occur as postbreeding visitors from the south (Table 1). Waterbird numbers generally reach a nadir in summer, and many areas see large influxes of loons, grebes, pelicans, coots, gulls, and other species after the breeding season.

Overall there is a strong correspondence between the key sites and habitats for waterbirds in BCR 32 in the breeding and nonbreeding seasons, particularly along the coast. The extent of habitat at most important tidal estuaries on the coast remains roughly the same year round, but estuaries' value to waterbirds may be enhanced by the proximity of nearby seasonal wetlands formed by winter rains. Inland, most of the key managed wetlands in the Central Valley are collectively augmented in the fall and winter by the intentional flooding of many thousands of acres for waterfowl, thereby also greatly expanding the base of seasonal wetlands available to other waterbirds. In the Sacramento Valley, extensive additional habitat for waterbirds is provided by the intentional flooding of large areas of rice fields for waterfowl and the decomposition of rice stubble. During periods of heavy rainfall, very large areas of agricultural lands in the Central Valley, particularly in the Sacramento Valley, can be flooded ephemerally when streams and rivers overflow their banks. Even without large-scale flooding, the value of pastures and grasslands to waterbirds can be enhanced by the moistening of soil and local pooling of water from winter rains. Likewise, waters of lakes and reservoirs throughout the region are replenished by winter rains.

CHAPTER 4

Conservation Issues and Threats to Waterbirds

The challenges faced by waterbirds in the Coastal California region are many and varied. Key conservation issues and known or potential threats to waterbirds in the region include habitat loss and degradation; changing or detrimental agricultural, municipal, or industrial practices in altered habitats; poor or toxic water quality and oil spills; increasing competition for water among municipal, agricultural, and wildlife interests; diseases; subsidized and introduced predators; invasive species; human disturbance; conflicts with human interests; inter-species conflicts; and the long-term effects of climate change and sea-level rise.

LOSS OF HABITAT INTEGRITY

With an increasing population and the expanding reach of human activities, waterbirds face ongoing threats of habitat loss, degradation, and fragmentation. Collectively these are the greatest threat to waterbirds in BCR 32 and in North America as a whole. Although historical losses have been staggering, the rate of decline generally has lessened and in some cases have been reversed by efforts such as the San Francisco Bay and Central Valley joint ventures (Steere and Schaefer 2001, CVJV 2006) or likely will be in the future from specific habitat-based initiatives (USFWS 2009a). Loss of habitat integrity at the landscape scale is likely to adversely impact species such as herons and egrets that depend on large wetland areas surrounding nesting sites for foraging (Kelly et al. 2008). Habitat changes can also have secondary indirect effects on waterbirds as outlined in the paragraphs below.

Habitat Alterations Favoring Predators

Degradation of tidal marshes by placement of dikes and rip rap at their edges provides access and habitat to mammalian predators that may prey on rails (Evens and Nur 2002, J. Evens pers. comm.). Marsh integrity may also be reduced by paths and boardwalks that further increase vulnerability of rails to predators. Predation pressure by avian predators, particularly Great Egrets and Great Blue Herons, appears to be augmented when habitat alterations remove transitional upland vegetation where rails otherwise would escape when forced from salt marshes by high tides (Evens and Page 1986). Loss of wetlands may concentrate predators (e.g., predation on waterbirds by night-herons and oversummering gulls in the Tulare Basin).

Siltation

Land use practices that increase siltation rates may accelerate the natural processes of infill and succession of habitats in estuaries (e.g., Bolinas Lagoon). Although generally undesirable, the effects of accelerated infill may favor some species of waterbirds and negatively affect others.

Collisions

Placement of transportation facilities or other human infrastructure in close proximity to high use areas of waterbirds can cause mortality from aircraft strikes and collisions with power lines, fences, or other structures.

Liquefied Natural Gas Plans

Several proposals have been made to place liquefied natural gas terminals at various locations along the southern California coast (www.energy.ca.gov/lng/projects.html). It is unclear whether these plans will be implemented and, if so, what environmental impacts might occur to waterbirds in this region.

Changing or Detrimental Agricultural, Municipal, or Industrial Practices

A wide range of agricultural, municipal, and industrial practices have known or potential effects on waterbirds, both positive and negative. The following describes some areas of particular concern.

A $24 billion agriculture industry (NASS 2006) dominates land use in the Central Valley, and its future could influence waterbird habitat tremendously, either positively or negatively, via shifting cropping patterns or farming practices in response to economic forces and technological advances. For example, large-scale expansion of orchards or vineyards in some areas at the expense of irrigated pastures and alfalfa fields may be reducing foraging habitat for various waterbirds, particularly for ibis, herons, and egrets. Similarly, some current agricultural practices may pose challenges for waterbirds. Rapid short-term drawdowns of water in rice fields, practiced early in the season by some growers, may result in increased predation rates on Black Tern nests, reduced foraging opportunities, or the destruction of nests when fields are reflooded (Lee 1984). In winter, the current flooding of extensive acreage of rice fields in the Sacramento Valley for stubble decomposition is beneficial to many waterbirds, but it is not compatible with Sandhill Crane use (G. Ivey pers. comm.).

Secure nesting sites generally appear to be more limited in agricultural settings than in managed wetlands with suitable islands. At agricultural evaporation ponds managed to eliminate vegetative cover and potential nesting islands, waterbirds nesting mainly on barren linear levees experience average losses of about 90%–95% of all nests to predation (primarily by coyotes, *Canis latrans*) (R. Hansen and J. Seay/H. T. Harvey unpubl. data). Also, islands or other secure nest sites generally are unavailable in the extensive rice fields of the Sacramento Valley that otherwise provide extensive foraging habitat for some species.

Competition for Water

Securing a dependable, high-quality water supply for wetlands is a never-ending challenge in light of California's expanding human population, arid climate, and a water-delivery system already stretched to its limits. In the Central Valley, ensuring reliable and affordable water supplies for wetland management may be the greatest challenge facing those working to conserve waterfowl, shorebirds, and waterbirds (CVJV 2006). Demand for water in the Central Valley has increased rapidly as factors such as in-stream dedication for threatened and endangered fish species, human population growth, and urbanization have reduced water supplies for many wetlands. Consequently, stakeholders with competing agricultural, urban, and environmental interests are lobbying intensely for reallocation of existing supplies. Many private wetland managers rely on water supplies that are reduced in dry years, depend on agricultural return flows, or have low-priority contracts with water purveyors. Even if water reliability can be increased for these wetlands this would not guarantee long-term affordability.

Competition for increasingly valuable water is bound to intensify, and recent gains from legislation providing a reliable water supply for wetlands through the Central Valley Project Improvement Act (Title 34 of Public Law 102-575) have not been fully implemented (CVJV 2006) and could be reversed in the future. Meanwhile, water transfers for municipal use may both reduce the water available for wetlands and increase its costs. Municipal water districts have begun to purchase water from water districts in the Sacramento Valley, which can affect the amount of rice available to waterbirds and the agricultural drainwater available for managed wetlands (C. Isola in litt.). Currently, a shortage of adequate facilities to transport water to potential purchasers is limiting such transfers, but they should increase substantially in the future as infrastructure is upgraded to facilitate transport. Maintaining shallow water in wetlands in the breeding season is particularly costly because of high evaporation rates in the Central Valley at that time. For example, the costs for water for semi-permanent and permanent wetlands needed by waterbirds is 2–2.5 times that for seasonal wetlands.

The Central Valley Joint Venture estimates that 2,285,453 acre-feet of water are needed to meet their integrated habitat objectives for waterfowl, shorebirds, waterbirds, and riparian songbirds (CVJV 2006). Of the total, 1,129,151 acre-feet are needed for current wetlands, 658,803 for restored wetlands to meet bird habitat objectives, and 497,500 for winter-flooded agricultural lands when bird habitat objectives have been met. The joint venture outlined the current and future water issues within nine subregions of the Central Valley and recommended a suite of actions and strategies to meet the challenges of securing adequate water supplies for wetlands in that region. Implementation of these actions will likely be even more difficult in the longer term as climate change alters precipitation, snowpack, and runoff patterns in the Sierra Nevada, which supplies the bulk of the water to the Central Valley.

Although competition for water is pervasive throughout BCR 32, in the Coast Ranges and on the coastal slope managed wetlands are not nearly as extensive as in the Central Valley and hence freshwater requirements for them are not as great. Still, in the Coast Ranges freshwater inflows are needed to maintain large lakes and reservoirs and on the immediate coast freshwater flows are important to maintaining proper salinities and ecosystem functions in estuaries. Within all of these habitats, there is a need for high quality water whether it is saline, brackish, or fresh.

Contaminants

Waterbirds are exposed to a wide variety of contaminants either directly in foraging or nesting habitats or, particularly, via the prey they consume. The contaminants discussed here are both the ones of greatest concern and the most well

studied. It is unclear if any contaminants currently are having population-level effects on waterbirds in BCR 32. Still, further research and ongoing monitoring of contaminants is warranted.

Organochlorine Pesticides

These contaminants were formerly of great concern before the banning of use of DDT in the United States in the 1970s. Recent studies have shown low level concern for these contaminants in waterbirds in San Francisco Bay, the Central Valley, and southern California. From eggs collected from 1989 to 1991 and analyzed for organochlorine pesticides, polycholorinated biphenyl (PCBs), and inorganic trace elements, Hothem et al. (1995) found some evidence of impairment of reproduction of Black-crowned Night-Herons and Snowy Egrets nesting in these regions, but concentrations of contaminants were generally lower than threshold levels for such effects. For the endangered California Clapper Rail in San Francisco Bay, residues of 10 organochlorines detected in eggs were low and decreased two- to three-fold from 1975 to 1986–1987, whereas eggshell thickness remained unchanged and comparable to eggs collected prior to 1940 (Lonzarich et al. 1992). Eggs of California Least Terns collected in San Francisco and San Diego bays in the 1980s had organochlorine levels similar to, or lower than, those not found to impair reproduction; the only contaminant that appeared to be elevated was total PCBs in San Francisco Bay (Hothem and Zador 1995).

Although there appear to be no studies of the effects of contaminants on breeding White-faced Ibis in BCR 32, there is some evidence of eggshell thinning and cracked eggs in the Sacramento Valley (references in Yates et al. 2010). Although DDT/DDE contamination in ibis eggs currently is generally relatively low at many colonies in the West, it remains elevated at colonies such as Carson Lake, Nevada, Cibola NWR, Arizona, and the Finney Lake Unit of Imperial Wildlife Area in the Imperial Valley, California (Yates et al. 2010). At Carson Lake there is continued evidence of lowered reproductive success correlated with elevated concentrations of DDE in eggs (Henny 1997, King et al. 2003, Yates et al. 2010).

Satellite telemetry of blood-sampled ibis and an evaluation of earthworms collected at ibis wintering sites indicated that a wintering area near the California-Mexico (Imperial Valley–Mexicali Valley) border was the likely source of the comparatively high DDE concentrations found in a segment of the ibis population nesting at Carson Lake (Yates et al. 2010). By contrast, many of the Carson Lake ibis with low to medium DDE concentrations in their blood were wintering in areas of the Central Valley (both Sacramento and San Joaquin valleys) with low to medium DDE concentrations in earthworms. Even if DDT/DDE is having some effect on ibis breeding in BCR 32, the ongoing increase in this region of numbers of both breeding and wintering ibis suggests contaminants are not having a population-level effect.

Selenium

In the late 1970s and early 1980s, high levels of salts and trace elements in agricultural drainwater in the San Joaquin Valley, sent to wetlands to provide wildlife habitat or to agricultural evaporation ponds for disposal, resulted in bioaccumulation of selenium sufficient to harm reproduction of waterbirds (Ohlendorf 2002). Exposure to selenium has since been reduced by closing wetlands with extreme concentrations or by providing uncontaminated water. Despite steady declines in selenium levels, concentrations in some species still exceed those known to impair reproduction. It is unknown if there are sublethal effects of selenium on chicks at this, the most vulnerable, stage of the species' life cycle.

Evaporation-pond operators have been required to reduce the risk of wildlife contamination by closing some ponds, making remaining ponds less attractive to birds, and creating nearby uncontaminated wetlands as alternative habitat (Moore et al. 1990, Steele and Bradford 1991, Bradford 1992). Modifications to discourage bird use—removal of islands, increasing the steepness of levee slopes, maintenance of relatively high (0.6 m) water levels, and hazing—that greatly reduced the number of waterbirds nesting at large complexes of ponds in the Tulare Basin have been offset by the creation of highly managed compensation wetlands (equipped, for example, with an electric predator-exclusion fence 1.3 m high) that support high numbers and densities of nesting avocets and stilts, though apparently few colonial waterbirds (Davis et al. 2005, 2008). Despite these improvements, waterbirds may remain at risk when foraging at canals carrying drainwater with high concentrations of selenium.

In San Francisco Bay, selenium concentrations in California Clapper Rail eggs were highest in a sample from a marsh adjacent to an oil refinery, but, overall, individual concentrations were slightly lower than values associated with embryotoxicity in other rallids (Lonzarich et al. 1992).

Mercury

Contamination of waters in the Coast Ranges, Central Valley, and San Francisco Bay region, from mercury mining in the Coast Ranges and use of this mercury in gold mining activities in the Sierra Nevada, is a source of concern for waterbirds. For example, the proximate cause of elevated levels of Hg in Western and Clark's grebes and other fish eating birds at Clear Lake, Lake County, has been mostly from point source erosion or acid mine drainage input from a Superfund mining site (Anderson et al. 2008). In 1992, Hg residues in grebes at Clear Lake were elevated relative to those at two comparison sites in northeastern California (Eagle Lake and Tule Lake) and were approaching approximate threshold levels for reproductive effects in birds. Still, there were no discernible population-level effects of Hg measured in adult grebes during intensive studies from 1992 to 2001 (and at least through 2006; Anderson et al. 2008). Improved nesting success of grebes was not attributable to mine site remediation and declining Hg residues (exposure) but rather to protection of colonies from

major disturbance events. It is possible, however, that young grebes in the first year of life before breeding may be the most vulnerable to lower, but perhaps still ecologically or individually significant, exposures of MeHg.

Assessment of the risks of mercury (Hg) contamination has been a major focus in the Delta and San Francisco Bay estuary in recent years (e.g., Ackerman et al. 2007, Eagles-Smith et al. 2009). Of four species in San Francisco Bay evaluated for Hg, concentrations were highest in the tissues of two fish-eating birds—the Forster's Tern and Caspian Tern—but also elevated in an invertebrate-foraging shorebird—the Black-necked Stilt (Eagles-Smith et al. 2009). Exposure varied temporally and by habitat. Hg concentrations increased with the time birds spent in the estuary, and species more associated with marshes and salt ponds had higher concentrations than those more associated with open-bay and tidal mudflats. Breeding waterbirds were at elevated risk of Hg-induced reproductive impairment. This was particularly the case for Forster's Terns, for which 48% of breeding birds were at high risk from their Hg levels.

In the mid-1980s, concentration of mercury in eggs of California Clapper Rails from San Francisco Bay were comparable to concentrations associated with reproductive effects in other avian species (Lonzarich et al. 1992).

PDBEs

Concentrations of polybrominated diphenyl ether (PBDE) in humans and wildlife in California, and particularly the San Francisco Bay area, are among the highest reported in the world (Shaw and Kannan 2009). Although the effects of these flame retardants on wildlife are poorly known, they have been recorded in high concentrations in eggs of terns and cormorants in San Francisco Bay (She et al. 2008, Klosterhaus et al. 2012). PBDEs have been associated with various reproductive effects in other bird species at levels comparable to those found in tern eggs in San Francisco Bay. Although the use of PBDEs is being phased out, continued monitoring is warranted given their potential for toxicity, the reservoir in consumer products still in use, and the anticipated time lag between decreased use and accumulation in the environment (Klosterhaus et al. 2012).

Miscellaneous Contaminants

The effects of contaminants on waterbirds using sewage ponds and agricultural fields are poorly known. Use of pesticides in rice fields has caused occasional mortality in waterfowl, raptors, and, rarely, shorebirds, but no chronic problem has been documented (Littrell 1988). It is unclear, though, what effect pesticides may have on the invertebrates on which waterbirds feed in rice fields. Loss of invertebrate diversity or biomass could lead to chick starvation. Studies, however, showing that some female Mallards (*Anas platyrhynchos*) renest after losing first broods and that ducklings' survival rate is 60% suggest that the quantity of invertebrates in rice fields is adequate (G. Yarris pers. comm.).

Diseases and Toxins

Waterbirds in BCR 32 are at risk from a variety of diseases, none of which currently appear to be causing long-term, population-level effects to any species. Such diseases, however, might have greater impact in the future if, for example, habitat loss concentrates birds in fewer or smaller areas and if disease outbreaks generally continue to increase as they have in recent decades. The diseases and biological toxins of most concern are described below; additional information on these and other avian diseases can be found in Friend and Franson (1999).

Algal Toxins

Periodic blooms of algae (true algae, dinoflagellates, and cyanobacteria or blue-green algae) occur widely in marine and freshwater bodies (Creekmore 1999). Although many blooms are merely an aesthetic nuisance, some species of algae produce lethal toxins, and the frequency of occurrence of harmful algae appears to have increased in recent years. The detrimental impact of red tides and cyanobacteria blooms on wetland, shore, and pelagic species has long been suspected but has not often been substantiated because information on the effects of these toxins in fish and wildlife species is lacking and diagnostic tools are limited. Some of these toxins such as domoic acid (amnesic shellfish poisoning), saxitoxin (paralytic shellfish poisoning or PSP toxin), brevetoxin, and cyanobacterial toxins (including anatoxins, microcystins, and nodularins) have been suspected, but they have rarely been documented to cause bird mortality.

In addition to toxins, the harmful effects of algae may include depletion of dissolved oxygen in water, occlusion of sunlight, and physical damage to the gills of fish. All of these can lead to mortality of aquatic invertebrates, aquatic plants, or fish and may produce an environment conducive to botulism (Creekmore 1999). Transmission of toxins occurs by ingestion of food or water.

Many bird and mammal species can be affected by algal toxins, and reports of avian mortality are of die-offs that occur in conjunction with a bloom (Creekmore 1999). Domoic acid poisoning caused mortality in Brown Pelicans and Brandt's Cormorants on the central California coast in 1991 (Work et al. 1993). Subsequently, the size and frequency of die-offs from domoic acid have increased and extended to southern California and Baja California (Sierra Beltrán et al. 1997, http://w.bird-rescue.org/pelican_domoic.html). Brevetoxin has been suspected as the cause of mortality in Lesser Scaup, and saxitoxin has been strongly suspected as the cause of mortality in seabirds, including terns, cormorants, fulmars, gulls, murres, loons, and shearwaters (Creekmore 1999). Cyanobacterial toxicosis has been suspected in mortalities of free-ranging ducks, geese, Eared Grebes, and gulls.

Avian Botulism

Avian botulism is a paralytic, often fatal, disease caused when birds ingest toxin produced by the anaerobic bacterium *Clostridium botulinum.* Seven distinct types of toxin, designated by the letters A to G, have been identified. Filter-feeding and dabbling waterfowl and probing shorebirds appear to be among the species at greatest from avian botulism (type C). Of other wetlands birds, gulls (type C, E) and loons (type E) are affected frequently and herons (type C) infrequently (Rocke and Friend 1999). Most type C botulism outbreaks within the United States occur west of the Mississippi River, and type E outbreaks in birds are much less frequent and, within the United States, have been confined to the Great Lakes region. In 1996, over 10,000 pelicans and nearly 10,000 other fish-eating birds (egrets, gulls, herons, night-herons; also Eared Grebes) died from type C botulism at the Salton Sea (Rocke et al. 2004). Most prior die-offs of fishing-eating birds were caused by type E toxin, and the Salton Sea outbreaks occurred via a novel transmission mechanism by ingestion of an exotic fish species, tilapia (*Oreochromis mossambicus*).

In a noteworthy type C botulism event in the Tulare Basin in the southern San Joaquin Valley, in the period 1938–1944, 14,800 birds were picked up, all but 60 of which were waterfowl (McClean 1946). Of the 60 other birds, half were waterbirds (Eared Grebe, "Western" Grebe, American Bittern, Great Blue Heron, American Coot), the rest shorebirds.

Factors thought to be critical in the timing and location of botulism outbreaks include optimal environmental conditions for spore germination and bacterial growth, suitable material or substrates that provide energy for bacterial replication, and a means of toxin transfer to birds. Most botulism outbreaks take place during the summer and fall when ambient temperatures are high, but several other environmental factors (pH, salinity, and oxidation-reduction potential in the sediments and water column) appear to significantly influence the likelihood of botulism outbreaks in wetlands. Transmission may occur by direct ingestion of decaying organic matter or some other means of toxin transfer from the substrate to the birds, presumably through zooplankton or invertebrate food items that inadvertently consumed the toxin.

Avian Cholera

Avian cholera is a contagious disease from infection by the bacterium *Pasteurella multocida*. A primary source for infection is contamination of wetlands and other areas from body discharges of diseased birds (Friend 1999). Transmission occurs through ingestion, bird-to-bird contact, aerosol dispersion, and biting insects. Waterfowl and several other types of waterbirds are the wild bird species most often involved in major die-offs from avian cholera. In waterbirds, losses are greatest for coots and gulls and infrequent for loons, grebes, pelicans, cormorants, herons, egrets, cranes, and rails. Die-offs from avian cholera are frequent in California and can occur at any season.

Avian Influenza

The H5N1 avian influenza virus has been of great concern because of mortality in poultry, humans, other mammals, and wild birds and the possibility that a mutated or recombinant form of the virus could emerge that would more easily pass among humans and, hence, have a real potential for a global influenza pandemic. This virus has been detected across a diverse range of free-ranging wild birds. Birds with affinities for wetland habitats, however, account for nearly 60% of the wild species infected with this virus and account for the greatest proportion of wildlife mortalities (FAO 2007). Waterbird groups in which the avian influenza virus has been detected in wild or captive birds include grebes, cormorants, rails, coots, and gulls. Although this virus has yet to be detected in humans or wildlife in North America, sampling of wild birds is ongoing because of the likelihood of transmission by long-distance migrants.

Newcastle Disease

Because the virus causing exotic Newcastle disease can be very lethal and poses a serious threat to the U.S. poultry industry, extensive efforts have been made to eradicate it (Walker et al. 1973). The probable source in many outbreaks in poultry in the United States, including California, is from imported pet birds, especially psittacine and mynah birds. Within BCR 32, the disease has been detected in poultry in the San Francisco Bay area, the Central Valley, and, particularly, the coastal slope of southern California. Newcastle disease has spread to some species of colonial waterbirds. The most affected species is the Double-crested Cormorant. Substantial mortality of juveniles at various colonies in Canada and the northern United States in the early 1990s (Wobeser et al. 1993, Glaser et al. 1999) marked the first time that this disease caused high mortality in wild birds (Kuiken 1999). Evidence of a lethal strain of Newcastle disease at the Salton Sea in the Colorado Desert of California in 1997 and 1998 was the first diagnosis in wild birds west of the Rocky Mountains in the United States (Friend 2002). Although large-scale mortality at the Mullet Island cormorant colony at the Salton Sea was attributed to Newcastle disease (Friend 2002), this event was poorly studied and mortality and colony abandonment may have had other or multiple causes. Regardless, Newcastle disease subsequently is not known to have had population-level effects on cormorants at the Salton Sea or elsewhere in California.

Steatitus or Yellow Fat Disease

A prominent symptom of steatitus in affected birds is excessive abdominal deposits of a waxy yellow fat. This disease has caused substantial mortality of Great Blue Herons and Black-crowned Night-Herons in coastal southern California and has been reported from herons at Chesapeake Bay on the East Coast. Little has been published about this disease

in birds, but it appears to be linked to Vitamin E deficiency (Nichols et al. 1986). Potential causes of the disease in herons include a dietary shift to fish species high in polyunsaturated fats, consumption of dead (or possibly dying) rancid fish containing large quantities of oxidized fatty acids, or exposure to algal toxins from cyanobacteria by ingestion of water with their prey or indirectly by ingesting prey containing microcystins (Nichols et al. 1986; www.pwrc.usgs.gov/health/Rattner/rattner_blackwaternwr.cfm, suggests algal toxins the culprit).

West Nile Virus

West Nile Virus (WNV) virus has spread rapidly over North America in the last decade and has been detected in over 300 species of birds (Komar 2003). Although some groups, particularly corvids, have experienced high rates of mortality and declining populations, waterbirds generally have not been severely affected by WNV. In California, ardeids (herons and egrets) are among the most frequently infected bird groups (Wheeler et al. 2009). Although the Black-crowned Night-Heron is particularly at risk to WNV, which may be an important cause of mortality among nestlings of this species (Reisen et al. 2009), there appears to be no evidence of associated declines of night-herons in areas with a high prevalence of WNV (Wheeler et al. 2009). See Pitkin and Wood (2011), however, for recent declines in night-heron nesting abundance in San Francisco Bay. Because communal roosting or nesting facilitates both mosquito-borne and direct bird-to-bird transmission of WNV, colonial nesting ardeids would seem to be at greater risk than solitary nesting waterbirds (Wheeler et al. 2009). Still, mosquito infection rates were low at two nesting sites in Yolo County, and ardeid nesting colonies do not appear to be a focus of early season and rapid amplification of WNV in California (Reisen et al. 2009). Infection rates of ardeids also vary with landscape features of the colonies. In contrast to the evidence of ardeids nesting at two colonies in trees over dry land in Yolo County showing repeated infection with WNV, there was little evidence of WVN infection at an ardeid colony in trees over water in Imperial County (Reisen et al. 2009).

Subsidized and Introduced Predators

Predation on waterbirds and their nests is particularly a problem where nesting birds are concentrated in limited remnant habitat and predator numbers are increased by human activities. As detailed below, increasing predation rates can be a result of the augmentation of native predator populations from indirect subsidies of food (or other resources) or the introduction and expansion of non-native predators. Predator removal programs have had mixed success, and ones focusing on a single species are unlikely to be successful. For example, a study using trip cameras in south San Francisco Bay documented multiple species sequentially predating eggs at a nest (Meckstroth and Miles 2005). If selected predator species are reduced out of the total predator assemblage, non-targeted nest predators may increase because of decreased interspecific competition and predation from targeted predators, or local removal of target predators may create vacancies into which conspecifics may quickly immigrate (references in Meckstroth and Miles 2005).

It would be valuable to continue studies on the effects of predators on nesting waterbirds (e.g., difference in insular versus non-insular sites) and to update current predator management plans (e.g., Foerster and Takekawa 1991) to address the full suite of native and non-native mammalian and avian predators. Even with a multispecies focus, it would be worthwhile to place particular emphasize on species of predators that have greatly increased in recent decades or species and individuals known to target nests.

Impacts of Subsidized Predators

Numbers of American Crows (*Corvus brachyrhynchos*) and Common Ravens (*Corvus corax*)—members of the family Corvidae (or corvids)—have increased dramatically in recent decades throughout the West, including California and the San Francisco Bay region (Liebezeit and George 2002, Kelly et al. 2002). These generalist foragers thrive in highly disturbed habitats, including agricultural, suburban, and urban areas. The availability of concentrated human food resources that "subsidize" corvids, including garbage at landfills, is considered a key factor in their increasing populations. These resources augment corvids' reproductive success, leading to increases in their numbers, expansion of their ranges, and heightened impacts on other species—particularly those with small and vulnerable populations. Crows and ravens are both known to be important predators on threatened and endangered species, including the California Least Tern (Marschalek 2011).

Resident ravens that nest near heron or egret nesting colonies exhibit variable rates of nest predation, but some ravens may obtain most or all of their nesting energy requirements from predatory activities in heronries (Kelly et al. 2005). Black-crowned Night-Herons and Snowy Egrets are particularly vulnerable to nest predation by Common Ravens (Kelly et al. 2005), and significant declines in their nesting abundances (Pitkin and Wood 2011) occurred after regional increases in raven numbers (Kelly et al. 2002). It is remains unknown, however, if these declines were caused by ravens.

Ravens are also particularly adept at using telephone poles, electrical power towers, buildings, and other human structures as nest substrates. Because ravens are known to fly up to 65 km (40 mi) in a day and range over several hundred kilometers throughout the year, any concentrated food resource, such as a landfill, could influence raven populations over a broad area (Boarman 2003). Crows also are known to forage or fly to roost sites up to 18 km (11 mi) from daytime territories or activity centers (Liebezeit and George 2002). Although ravens and crows generally move less than 3–7 km (2–4 mi) in a day (references cited in Kelly et al. 2002), this does not take into account non-breeders, which are not tied to

nest sites and can occur in large numbers in areas of concentrated food (e.g., low hundreds of non-breeding ravens occur on Pt. Reyes peninsula; J. Roth pers. comm.). Thus nesting waterbirds can be vulnerable to heightened levels of predation from subsidized predators at wetlands some distance from concentrated food resources.

Likewise, there is concern that nesting California Gulls—increasing exponentially in San Francisco Bay in part because of subsidized food resources at landfills—may be heightening predation rates on other species of waterbirds (Ackerman et al. 2006). Although gull predation has the potential to thwart efforts at effective salt pond restoration in the bay, it is as yet unclear what species are most affected and whether this predation is having population-level effects in causing population declines in any species (Shuford 2008a).

Populations of some native mammals—particularly the striped skunk (*Mephitis mephitis*) and raccoon (*Procyon lotor*)—are also augmented by supplemental food sources available in urban environments. A study in south San Francisco Bay indicated that the predator control program in the area has had little impact on reducing certain predators and did not enhance numbers or success of ground-nesting waterbirds (Meckstroth and Miles 2005). Although predator removal programs in the South Bay have been effective in reducing numbers of the non-native red fox (*Vulpes vulpes*), the striped skunk, comprising 84% of all predators removed, remains the most common nest predator at study sites in the region. Long-term (≥ 5 years) predator removal had mixed results on waterbird nesting success (Meckstroth and Miles 2005). Removal areas had higher nest densities but lower hatching success than at reference sites, such that both areas had similar overall production.

Non-native Predators

Increasing populations of introduced red foxes have been of concern because of impacts to waterbirds and others species. In the San Francisco Bay estuary, the red fox is considered the primary proximate threat to persistence of the federally threatened California Clapper Rail (Albertson 1995). Harding et al. (2001) reported that fox removal appeared to have a strong positive effect on the bay's rail population from 1991 to 1996. They emphasized, however, the importance of reducing juvenile survival and reproduction of foxes, beyond just removal of adults, and that management strategies needed to be predicated on better knowledge of the ecology and demographics of local fox populations. Further, they indicated that fox immigration could greatly influence long-term management success and that immigration into sensitive habitats presumably could be prevented by trapping foxes at entry points or erecting barriers to movement. In the past few years, however, trapping efforts have removed few red foxes, suggesting that this species may no longer pose as great a threat as it once did (C. Strong pers. comm.).

Free-roaming or feral cats (*Felis catus*)—of wide concern for their effects on wild birds (e.g., Jurek 1994)—are also a focus of predator removal programs in San Francisco Bay (Meckstroth and Miles 2005), and Norway rats (*Rattus norvegicus*) are an important predator on California Clapper Rail nests (Albertson and Evens 2000).

Invasive Species

Invasive species may affect waterbirds by altering habitat structure, degrading nesting habitat, and changing invertebrate communities. Among the hundreds of introduced species in the region, some are now particularly widespread or otherwise have substantially degraded wildlife habitat. The specific effects of these invasive species on waterbird populations, however, are poorly known.

Invasive Spartina

Over the last 25 years, non-native species of cordgrass (*Spartina* spp.), particularly hybrids of the Atlantic smooth cordgrass (*Spartina alterniflora*), have rapidly invaded open mudlfats in San Francisco Bay (Ayres et al. 2004), altering habitat, reducing macrofaunal densities, and shifting species composition (Neira et al. 2006). In areas of invasion, surface-feeding invertebrates—important prey for shorebirds, rails, and other waterbirds—are greatly reduced.

Of particular concern are the potential effects that the spread of invasive *Spartina*, or its control, may have on the endangered California Clapper Rail, particularly in the central and south portions of the estuary where non-native *Spartina* is most widespread. To date, the evidence on the effects on these rails is equivocal, perhaps in part because impacts may vary between the short and long term. McBroom (2008) reported that Clapper Rail data from 2005–2007 surveys (during years of *Spartina* treatment) indicated the baywide rail population may be in an upward trajectory. Observations also suggested there was little to no relationship between the treatment of invasive *Spartina* and regional rail populations. Still, very high densities of rails found in some East Bay marshes aggressively invaded by non-native *Spartina* have dropped sharply after *Spartina* treatment (S. Bobzien unpubl. data). Although it is uncertain if high rail densities in *Spartina*-invaded marshes reflects enhanced habitat quality (Evens et al. 2010), it might be prudent to consider limiting the treatment of invasive *Spartina* until native *Spartina* marshes newly restored elsewhere in the bay have been colonized by rails. Over the long term, however, a predicted reduction in channel density and complexity—important habitat features for California Clapper Rails—in marshes invaded by non-native *Spartina* is likely to reduce the availability of foraging habitat for the rails (Evens et al. 2010).

Perennial Pepperweed or Whitetop

Perennial pepperweed (*Lepidium latifolium*) is an invasive weed now widespread throughout California and the western United States. Spreading by seeds or root fragments, it has

expanded into wetland edges, salt marshes and estuaries, levees and irrigation canals, roadsides, rangelands, meadows, and riparian borders and openings. In such areas, it can form large monotypic stands that crowd out native plant communities. Reported effects on waterbirds—mainly degradation of upland or insular nesting habitat—are largely anecdotal and more study is needed.

Tamarisk or Saltcedar

Native to the Old World, tamarisk or saltcedar (*Tamarix* spp.) is now widespread in western North America, including the drier, low elevations of California. It is most pervasive in riparian habitat along streams, where it generally forms monotypic stands of shrubs and small trees. Tamarisk also grows on pond or lake edges and in some wetlands. Tamarisk is salt-, fire-, and flood-tolerant, and reduces native plant diversity. Monocultures of tamarisk (except temporarily after burning) generally have the lowest density and diversity of landbirds of any riparian habitat (Rosenberg et al. 1991). The effect of tamarisk on waterbirds appears to be less than on landbirds because it is confined mainly to wetland edges. Although tamarisk displaces some marsh habitat, wading birds (cormorants, ibis, and egrets) will nest in tamarisk stands in open water (D. Shuford pers. obs.).

Giant Reed

Another Old World native, giant reed (*Arundo donax*) is a tall perennial grass that grows in many-stemmed, cane-like clumps. In California, it is now an aggressive invasive, particularly along rivers of the coastal slope of southern California but also in the San Francisco Bay region, central coast, and Central Valley. Like tamarisk, it displaces native vegetation on the edges of streams, ponds, and ditches. Giant reed's greatest wildlife impact is the reduction of habitat for riparian landbirds, though it does displace some wetland vegetation suitable for waterbirds. It also may indirectly affect prey of some waterbirds because, unlike native riparian plants, giant reed provides little shading to the in-stream habitat, leading to increased water temperatures and reduced habitat quality (Dudley 2000).

Water Primrose

Creeping water primrose (*Ludwigia peploides* ssp. *montevidensis*) is a perennial aquatic plant that forms virtually impenetrable mats and outcompetes native aquatic plants. This invasive plant (native to South America) occurs in BCR 32 in the Central Valley and along the north-central coast, San Francisco Bay region, and southern California coast in wetlands, ditches, ponds, slow moving streams, and along edges of lakes and reservoirs. Efforts to control extensive areas of *Ludwigia* in the Laguna de Santa Rosa, Sonoma County, have had only limited success. Specific effects of water primrose on waterbirds are unknown but may include loss of open water foraging areas, reduction of aquatic prey, and degradation of water quality.

Water Hyacinth

Native to South America, water hyacinth (*Eichhornia crassipes*) is a floating aquatic plant that has been introduced to the Delta. As with most aquatic invasive plants, little is known about its effects on waterbirds. It is clear, however, that water hyacinth is not functionally equivalent to the native pennywort (*Hydrocotyle umbellata*), which occurs in similar habitats in the Delta (Toft et al. 2003). There are substantial differences between hyacinth and pennywort in structure, associated invertebrates, and fish diets; invertebrates associated with hyacinth occur less in the diets of adjacent fish than do invertebrates associated with pennywort.

Spanish Sunflower

Spanish sunflower (*Pulicaria paludosa*) is an invasive of concern in the western San Joaquin Valley and coastal southern California, but little is known of its effects on waterbirds.

Other Plant Species

There are many other invasive plant species that may displace native aquatic plants or otherwise reduce the suitability of habitats for waterbirds. Information on these species and the ones discussed above is widely available in national, state, and local databases, websites, and guidebooks (e.g., www.invasivespeciesinfo.gov/aquatics/main.shtml, www.cal-ipc.org, and www.sfei.org/nis/index.html). Unfortunately little appears to have been written on the specific effects of these invasive plants on waterbirds.

Invasive Invertebrates and Vertebrates

Many species of exotic invertebrates (barnacles, clams, mussels, snails, crabs, isopods, worms, jellyfish, sponges) and vertebrates (mainly fish) have invaded aquatic systems in California (Cohen and Carlton 1995, Anonymous 2007, Cohen 2011). Introductions have occurred from a variety of accidental and intention means. Key among these are from ballast waters of international ships discharged in port; attachment or clinging to hulls of ships, boats, boat trailers, and barges; attachment to intended introduced species such as oysters and clams for commercial harvesting; intended introduction for commercial or sport fishery or mariculture; release of unwanted organisms by aquarists or bait fishermen; and natural spread from the original point of introduction. Since the mid-1800s, large numbers of exotic species have invaded the Pacific coast, and the new species continue to arrive at an exponentially increasing rate (Cohen 2011). Within BCR 32, 65 exotic marine species have been recorded in Elkhorn Slough, 106 in southern California bays, and 175 in salt and brackish tidal wetlands of the San Francisco Bay estuary

(with >75 additional species in tidal freshwaters of the Delta). Perhaps as many as 100–200 other species are "cryptogenic" in the bay, i.e., it is unknown if they are native or exotic.

The cumulative effect of the establishment of these nonnatives is unknown, but they have greatly reduced native populations, replaced native communities, and altered habitat structure and energy flows (Cohen 2011). Waterbirds feed on many of these introduced species, but little research has been done to evaluate whether the establishment of exotics has reduced the prey base or otherwise had detrimental effects on waterbirds.

Observations of prey remains beneath heron and egret colonies near freshwater wetlands in the San Francisco Bay area (e.g., Suisun Marsh) and Sacramento Valley (J. P. Kelly, C. Isola pers. comm.) suggest these birds forage heavily on nonnative crayfish (*Procambarus clarkii*). It is unclear, though, to what extent introduced crayfish have affected the overall prey base for herons and egrets.

Studies on shorebirds and diving ducks suggest that the effects are mixed. For example, the introduction of the Manila clam (*Tapes philippinarum*) into European coastal waters has provided the Eurasian Oystercatcher (*Haematopus ostralegus ostralegus*) with a new food resource, which has reduced the predicted over-winter mortality of oystercatchers (Cadlow et al. 2007). In San Francisco Bay, the Asian clam (*Potamocorbula amurensis*) has increased since its introduction in 1986 and now greatly outnumbers the native and formerly dominant clam *Macoma balthica.* By several metrics, the Asian clam is an energetically more valuable food source for Lesser Scaup (*Aythya affinis*) than the native clam, though the former's greater concentration of some contaminants has increased the risk of toxicity to scaup and a range of benthic predators (Richman and Lovvorn 2004).

Human Disturbance

Disturbance may affect waterbirds primarily by reducing reproductive success, lowering foraging time or opportunities, and causing direct mortality. Human disturbance is a well known cause of reproductive failure in a wide range of seabirds (Carney and Sydeman 1999, but also see Nisbet 2000 and Carney and Sydeman 2000). Regionwide, recreational activities—including expanding use of jet skis, kayaks, motor boats, and ATVs—may cause disturbance to waterbirds, though the level of impact in most cases is unknown or poorly documented. Disturbance to *Aechmophorus* grebes from boats or other watercraft have caused nest abandonment, destruction of floating nests from boat wakes, increased egg and nest predation, and ultimately colony failure (references in Gericke 2006a, b). Ironically, airboats applying herbicide at Clear Lake to combat the invasive aquatic plant *Hydrilla* have destroyed entire grebe colonies (Robison et al. 2009).

Disturbance to heron and egret colonies may cause nest or colony abandonment, and specific adverse effects include egg and nestling mortality, premature fledging, reduced body mass or slower growth of nestlings, and reduced settlement of breeders in the colony (references in Kelly et al. 2006). At some colonies, herons and egrets will tolerate human activity at close range (e.g., Hothem and Hatch 2004). Still, tolerance levels vary greatly over time and among heronries, and even temporary abandonment can cause nest failure from inclement weather or attacks by opportunistic predators such as crows or ravens (references in Kelly et al. 2006). The responses of nesting herons and egrets to disturbance by humans also vary with differences in the structure of the nesting habitat and types of human activity (Kelly 2002). Herons and egrets nesting in very tall trees or dense vegetation may be less sensitive to disturbance, whereas those nesting in open habitat or isolated trees tend to react earlier and more intensely to approaching humans. Disturbance trials conducted at 23 heronries in the San Francisco Bay Area indicated substantial tolerance of approaching humans at some heronries but considerable variation in responses among heronries and the stages of nesting (Kelly 2002). The results were consistent with the need for buffer zones of 100–200 m based on the responses of nesting birds to a single person approaching on foot, but generally the size of buffer zones should be increased with increasing frequency, duration, or extent of human activity (Kelly et al. 2006). Because heronries vary widely in their responses to disturbance, those authors recommended establishing buffer zones of at least 200 m around heronries to minimize the potential adverse effects of human intrusion during the nesting season.

Conflicts with Human Interests

In some instances, waterbirds may come into conflict with humans over resources. Sometimes these conflicts are real but at other times perceptions of harm to human interests are overinflated or false. For example, often in the past fish-eating birds were persecuted on the assumption they must be depressing fish populations without any information to support these claims. Some of the most frequent conflicts are described here.

Aquaculture and Fish Hatcheries

One of the most frequent cases of conflict involves predation by herons or cormorants on fish at aquaculture facilities or fish hatcheries, where potential prey is highly concentrated. Although operators sometimes obtain permits for lethal control when fish losses are high, mortality from this factor does not appear to have had any population-level effects on targeted species of waterbirds. Discouragement of waterbirds by other means have had mixed success (Draulans 1987).

Oyster cultivation has the potential to degrade foraging habitat for waterbirds. Studies in Humboldt Bay (Connolly and Colwell 2005) and Tomales Bay (Kelly et al. 1996) showed mixed results, with species of shorebirds and wading birds varying in whether they were more abundant in oyster cultivation or control plots. Similarly, other studies have also shown mixed effects on birds from aquaculture (NRC 2010).

Aquaculture can be a source of food for some waterbirds but also a cause for disturbance and degradation of habitat. Mariculture, for example, can be a source of marine litter, which can entangle or be ingested by birds.

Human Health Concerns

Colonies of herons and egrets in urban and suburban settings can lead to health concerns, real or imagined, or simply to fouling of areas used for human recreation or habitation. Diseases of concern in such settings, though the risk is relatively low, include histoplasmosis and psittacosis. The former is caused by breathing in the spores of the fungus *Histoplasma capsulatum*, which grows as a mold in the soil (www.ncbi.nlm.nih.gov/pubmedhealth/PMH0002073). Soil that contains bird (or bat) droppings may have larger amounts of this fungus. Psittacosis is an infection caused by *Chlamydophila psittaci,* a type of bacteria shed by birds in their feces or nasal discharges and transmitted by inhalation or ingestion (www.websters-online-dictionary.org/definitions/psittacosis). Although typical birds involved are parrots, parakeets, and budgerigars, a variety of birds, including herons, can carry the disease.

The incidence of urban and suburban colonies appears to be increasing. The species most often nesting in such situations are the smaller ones, the Black-crowned Night-Heron, Snowy Egret, and Cattle Egret. These species appear to be more tolerant of human activities than are the larger species, such as the Great Blue Heron and Great Egret. Although birds' nests are protected by the Migratory Bird Treaty Act, frequently efforts are made to displace the colonies by hazing (e.g., Telfair et al. 2000, Crouch et al. 2002, Parkes 2007, Hattori 2009). Passive hazing may attempt to minimize site attractiveness by the placement of kites, balloons, and Mylar strips; removal of nests materials or old nests; and tree trimming and removal. Active hazing may include the use of hand-held lasers, bioacoustics (distress calls, other electronic harassment sounds), propane cannons, and pyrotechnics. In one town in the Sacramento Valley, the local fire department was called in to hose nests out of trees in residential yards (R. Doster pers. comm.). Displacement may take a number of years and it may just shift the problem elsewhere or split the colony into several smaller groups (Hattori 2009, C. Isola and W. Carlson pers. comm.).

Inter-species Conflicts

Unfortunately, sometimes the interests of one species of conservation concern can be pitted against another. For example, the (formerly) state endangered Peregrine Falcon is one of the most frequent predators of the state and federally endangered California Least Tern (Marschalek 2011). Similarly, there has been considerably controversy over management actions targeting the Gull-billed Tern, a Bird Species of Special Concern in California, because it sometimes preys on chicks, and rarely eggs, of the California Least Tern and federally threatened Western Snowy Plover (*Charadrius alexandrinus nivosus*) (Molina and Marschalek 2003).

In the southern San Joaquin Valley, Cattle Egrets from a nearby colony have preyed on eggs and young of Tricolored Blackbirds (*Agelaius tricolor*) nesting in grain fields near dairies, causing nesting failure of some of the largest remaining colonies of this blackbird (Meese 2012), which is of conservation concern at both the state and federal level (Shuford and Gardali 2008, USFWS 2008).

In other cases, expanding populations of some species may potentially outcompete other species for nesting space. There is concern that increasing numbers of Double-crested Cormorants and Cattle Egrets may be displacing herons and other egrets at rookeries in the Central Valley. There appears, however, to be no data on such displacement, and, regardless, there likewise does not appear to be any evidence that herons or other egrets have exhibited population declines in response to this or other factors.

Climate Change and Sea-level Rise

In the last decade or so, an enormous body of evidence has accumulated on the economic, social, and wildlife impacts of climate change. The key global evidence on climate change effects is summarized in the most recent synthesis report of the Intergovernmental Panel on Climate Change (2007). Many actions to cope with climate change, however, will need to be taken at different scales, which has spawned summaries of projected climate change effects by geographic regions (e.g., California subregions; PRBO 2011), economic sectors (e.g., agriculture; Cavagnaro et al. 2006, Merrill et al. 2011), or habitats (e.g., wetlands; Erwin 2009).

Key patterns expected for California and the BCR 32 subregion from current climate projections include increasing temperatures, more precipitation as rain than snow, earlier runoff, more intense storms, and accelerating sea-level rise (summaries in PRBO 2011). This may lead to more winter flooding and drier springs in the Central Valley. There is less certainty about likely precipitation scenarios, with a slight tilt in the range of projections toward lower precipitation in the future. Precipitation patterns are projected to show latitudinal variation, with levels increasing to the north and declining to the south. Indirect effects of climate change may include more intense and more frequent El Niño events and increased harmful algal blooms, which have been indirectly associated with blooms of biotoxins that have caused illness and mortality in birds and marine mammals. Climate change effects will, of course, not be operating in isolation, and layered on top will be other threats, the foremost being the effects of an expanding human population and increasing competition for scarce water supplies.

In coastal areas, key concerns are the projected impacts of accelerating sea-level rise. A web application for the San Francisco Bay estuary provides projections, which can be revised with new information, on future sea levels, marsh vegetation, and bird distributions in this region (Veloz et al.

2011). This allows visualizations of impacts under moderate (0.52 m) and high (1.65 m) sea-level-rise scenarios, low and high sediment availability, and at 20-yr intervals from 2030 to 2110. The site presents projections of future bird distribution for five saltmarsh species, including two waterbirds (California Black Rail, California Clapper Rail). Although the accuracy of such projections are unknown, and they assume no mitigation to offset effects of rising sea levels, they provide valuable information to use to anticipate and plan for likely impacts. Proactive regional planning efforts are assessing the vulnerabilities and adaptation strategies for coping with rising waters in the San Francisco Bay estuary (e.g., BCDC 2011).

In the interior, climate change may reduce the extent or alter the suitability of wetland and agricultural habitats that waterbirds depend on. The effects on waterbirds may be greatest in the Central Valley, where the largest interior wetlands and agricultural production are centered. Delta islands are particularly prone to levee failure and flooding from a combination of sea-level rise, subsidence, changing inflows, and earthquakes (Mount and Twiss 2005). Because agriculture in California is so important to both the state's economy and the nation's food supply, there is considerable concern over agriculture's ability to adapt to future climate change statewide (Cavagnaro et al. 2006, Merrill et al. 2011) and in the Central Valley in particular (Jackson et al. 2009, Lee et al. 2009, Lobell et al. 2009). Agriculture faces increasing difficulties with water supply and management (Purkey et al. 2008, Medellin-Azuara et al. 2009), and changing climate may alter which crops are grown in particular regions. Such effects would likely be greatest on waterbirds if the extent of rice lands and flood-irrigated crops such as alfalfa and irrigated pasture are reduced in the Central Valley.

The Central Valley, San Francisco Bay, and Sonoran joint ventures increasingly are highlighting on their websites and planning documents (e.g., CVJV 2009) the need to adapt to climate change threats to continue to provide adequate habitat for waterbirds in the future. With increasing amounts of research, funding, and planning at the national, regional, and local levels devoted to mitigating climate change impacts, it will be important stay abreast of emerging climate change adaption strategies.

CHAPTER 5

Conservation Priority of Waterbirds in BCR 32

PRIORITIZATION PROCESS

To enable effective conservation of waterbirds in BCR 32, it is valuable to rank the conservation priority of the key species, subspecies, and distinct populations of waterbirds in this region. As in other regions in North America, the ranking of waterbirds for conservation priority within BCR 32 was hampered by limited data on population sizes and trends for many species. Still, we took a quantitative approach to ranking, using qualitative information to supplement the former or when a qualitative assessment was the only viable option. As described below, species, subspecies, or distinct populations were first scored on various biological factors and then ranked on the basis of these using a categorical approach.

Factor Scores

Because the BCR 32 plan is linked to the broader North American Waterbird Conservation Plan, we attempted to step down the ranking process for BCR 32 from the assessment protocol used at the continental level (Appendix 2 in Kushlan et al. 2002). To assign conservation concern categories for waterbirds in BCR 32, each species, subspecies, or distinct population was first scored for four criteria. For three of these—population trend (PT), threats to breeding (TB), and threats to non-breeding (TN)—factor scores were assigned using the continental definitions (Appendix 2 in Kushlan et al. 2002), with minor modifications, as applied to the status in BCR 32. An additional score was assigned for percentage of entire range (EN; loosely endemism), which is an estimate of the proportion of the continental range or population that occurs in BCR 32 in either the breeding or nonbreeding season (adapted from Shuford and Gardali 2008). Scores for population trend and percent of entire range are based, when possible, on quantitative information, whereas scores for threats to breeding and threats to nonbreeding are based on qualitative information. All factors are scaled from 1 to 5 in order of increasing vulnerability.

Scores were *not* assigned at the BCR 32 level for the continental factors population size (PS), breeding distribution (BD), and nonbreeding distribution (ND). It was judged that population size was more relevant at the continental level knowing some species with peripheral and hence small populations in BCR 32 would be given an over-weighted conservation priority in the BCR if scored for population size in the BCR. Likewise, if breeding and nonbreeding distribution were scored at the BCR level, species with wide continental distributions would be given high scores if their range extended only peripherally into BCR 32. Using EN (as described above) is more relevant, as this measures the proportion of the entire continental range or population occurring in BCR 32 in either the breeding or nonbreeding season.

The following are the definitions of the four factors used to score waterbirds for conservation priority in BCR 32:

Population Trend (PT): This factor reflects estimated population trend based on existing information. The time period over which trends were estimated was 1970 to the present.

5 – biologically significant population decline
4 – apparent population decline
3 – apparently stable population
2 – apparent population increase
1 – biologically significant population increase

Threats to Breeding (TB): This factor rates the threats affecting most or all of the total BCR 32 population of each species during their respective breeding season. The importance of vulnerability from breeding concentration (coloniality) was considered when scoring this factor. Species that do not breed in BCR 32 received a designation of "not applicable" (na) for this score.

5 – known threats are actually occurring and can be documented; concentration results in actual risk.
4 – significant potential threats exist, but have not actually occurred; concentration results in high potential risk.
3 – no known threats, or information not available; concentration not a risk.
2 – threats assumed to be low from all factors including concentration.
1 – demonstrably secure.

Threats to Nonbreeding (TN): This factor rates the threats known to exist for each species during their nonbreeding season. The scores are the same as for the "threats to breeding" factor, but generally without the additional risk from concentration during breeding. Some populations, however, may be vulnerable in the nonbreeding season when concentrating in large numbers at foraging or roosting sites. Species that occur to only a limited degree or not at all in BCR 32 during the nonbreeding season received a designation of "not applicable" (na) for this score.

Percentage of Entire Range within BCR 32 (EN): This criterion measures what proportion of a species, subspecies, or distinct population's North American range or population occurs within BCR 32 at any season. Having a high proportion of the overall range or population within the BCR 32 is considered of greater concern than if only a small proportion of the range or population occurs in the BCR. If the population in question occurs in the BCR in more than one season, it is scored for the season in which the highest proportion of its overall population occurs in the BCR.

Proportion of North American range or population within BCR 32:

5 – 100% (endemic)
4 – >80% but <100% (near-endemic)
3 – >50%–80% (semi-endemic)
2 – >20%–50%
1 – ≤20%

Categories of Conservation Concern for BCR 32

The following five categories of conservation concern are adapted from those in Kushlan et al. (2002) using the four factor scores described above. Species, subspecies, and distinct populations were assigned to them using a categorical approach on the basis of the following category definitions and series of categorization rules. In a departure from Kushlan et al. (2002), we included provisions to retain heightened conservation concern for some populations that may be increasing. These provisions apply to species, subspecies, or distinct populations that occur largely or mostly within BCR 32 and appear to be increasing primarily because of intense management. In such cases, evidence suggests that increasing or stable populations likely would revert to former patterns of decline if intense management was halted, and, hence, continued conservation concern is warranted.

Also, in applying the definitions it is important to remember that for species such as pelicans, cormorants, loons, grebes, gulls, and terns that the BCR boundary to the west includes coastal estuaries and associated sandy beaches, but does *not* encompass any of the open ocean, including the inshore zone (or offshore islands or rocks) used by many of these species. This is complicated by the fact that many individuals of these species move freely between estuaries and the nearshore ocean. Hence, when gauging threats, these should be ones that pertain to estuarine, freshwater, or other habitats exclusive of the open ocean. Likewise, when assessing the "percent of entire range" within BCR 32, this should not include the ocean or offshore islands or rocks.

1. Highest Concern: This includes all species with significant population declines and either low populations or some other high risk factor.

Rule 1. PT = 5 *and* either TB or TN = 5.

2. High Concern: Populations generally are known or thought to be declining and also have some other known or potential threat, or most or all of the continental population is concentrated in BCR 32. Some may not currently be declining (or even may be increasing) but likely would be declining without intense active management.

Rule 2a. PT = 4 or 5 *and* TB or TN = 4 or 5 (but not 5 *and* 5 as per rule 1); or

Rule 2b. PT = <4 but likely would be 4 or 5 without intensive ongoing management *and* EN = 4 or 5; or

Rule 2c. PT = 2 or 3, but TB or TN = 4 or 5 *and* EN = 4 or 5.

3. Moderate Concern: Populations are either declining with moderate threats or concentration in BCR 32, or stable with known or potential threats or relatively high concentration in BCR 32.

Rule 3a. PT = 5 *and* either TB, TN, or EN = 2; or

Rule 3b. PT = 4 *and* either TB, TN, or EN = 3; or

Rule 3c. PT = 3 *and* either TB or TN = 4 or 5, or EN = 4.

4. Low Concern: Populations of these species are either stable with moderate threats or concentration in BCR 32, or increasing but with known or potential threats.

Rule 4a. PT = 3 *and* either TB or TN = 3, or EN = 2; or

Rule 4b. PT = 1 or 2 *and* either TB or TN = 4 or 5, or EN = 3.

5. Lowest Concern: All other species that were scored. Populations either stable or increasing with no appreciable threats and occurring widely outside BCR 32.

Rule 5. Does not meet any previous rule.

Results of Prioritization

Of the 48 species, subspecies, or distinct populations of waterbirds that we assigned conservation factor scores within BCR 32, we ranked 9 as being of high conservation concern, 4 of moderate concern, 25 of low concern, and 10 of lowest concern (Table 6). Following Kushlan et al. (2002), we also categorized these waterbirds according to their global geographic affinities. Of the 48, 12 had a primary geographic affinity to North America, 16 to the Western Hemisphere, 8 to the Northern Hemisphere, and 12 were Cosmopolitan (Table 7).

Of the 13 taxa ranked here of high or moderate conservation concern in BCR 32, 9 have been given comparable or higher conservation status through other state or federal designations or rankings. Of the nine ranked as waterbirds of high conservation concern in BCR 32, three are listed as both state and federally endangered (Light-footed Clapper Rail, California Clapper Rail, California Least Tern), two are listed as state threatened (California Black Rail, Greater Sandhill Crane), two are designated as California bird species of special concern (Least Bittern, Yellow Rail) or federal birds of conservation concern at the U.S. and BCR 32 levels (Yellow Rail), and two currently have no such designation at the state or federal level (Western Grebe, Clark's Grebe). Of the four ranked as waterbirds of moderate conservation concern in BCR 32, two are designated as California bird species of special concern (Lesser Sandhill Crane, Black Tern), and two currently have no such designation at the state or federal level (Eared Grebe, Forster's Tern). By contrast, three species ranked as waterbirds of low conservation concern in BCR 32 are designated as California bird species of special concern (American White Pelican, Gull-billed Tern, and Black Skimmer) or federal birds of conservation concern at both the U.S. and BCR 32 levels (Gull-billed Tern, and Black Skimmer). Lack of concordance of BCR 32 waterbird rankings with some state or federal designations likely reflects the differing geographic areas over which waterbirds were ranked, variation of criteria among ranking systems or designations, or both.

Conservation rankings of waterbirds in BCR 32 should be reevaluated periodically to take into account changes in status, new knowledge, or other factors that may influence rankings. Regardless of rankings, conservation efforts should be made to ensure that we maintain substantial viable population of all waterbirds in BCR 32.

Table 6 Conservation Factor Scores and Concern Categories at the Continental and BCR Level for the 46 Species Covered by the Coastal California (BCR 32) Waterbird Conservation Plan[a]

Species Name	Continental Conservation Factor Scores[b]						Continental Category of Concern[c]	BCR 32 Conservation Factor Scores[d]				BCR 32 Category of Concern[e] (applicable rule)	Sources for BCR 32 Factor Scores
	PT	PS	TB	TN	BD	ND		PT	TB	TN	EN		
Red-throated Loon	4	3	4	5	2	3	high	3	na	3	1	low (4a)	
Pacific Loon	3	1	4	4	3	3	moderate	3	na	3	1	low (4a)	
Common Loon	3	2	4	4	2	2	moderate	3	na	3	1	low (4a)	
Pied-billed Grebe	4?	2	4	4	2	3	high	3	3	3	1	low (4a)	Sauer et al. 2011
Horned Grebe	4	2	4	4	3	3	high	3	na	3	1	low (4a)	
Eared Grebe	3	1	2	4	2	3	moderate	3	2	4	1	moderate (3c)	
Western Grebe	3	2	4	4	3	3	moderate	4	5	5	1	high (2a)	Ivey 2004, Robison et al. 2009
Clark's Grebe	3	3	3	3	3	3	low	4	5	5	1	high (2a)	Ivey 2004, Robison et al. 2009
Double-crested Cormorant	1	2	2	2	2	2	lowest	1	4	2	1	low (4b)	Carter et al. 1995, Adkins et al. 2010
American White Pelican	3	2	4	3	2	2	moderate	3	na	3	1	low (4a)	
Brown Pelican	3	2	4	4	3	3	moderate						
California Brown Pelican								1	na	4	3	low (4b)	Anderson et al. 2007, USFWS 2007
American Bittern	4	2	5	5	3	3	high	3	3	3	1	low (4a)	
Least Bittern	4	2	4	4	3	4	high	4	4	4	1	high (2a)	Sterling 2008
Great Blue Heron	1	2	2	2	2	3	lowest	3	2	2	1	lowest (5)	Kelly et al. 2006, Sauer et al. 2011
Great Egret	1	2	2	2	?	?	lowest	3	2	2	1	lowest (5)	Kelly et al. 2006, Sauer et al. 2011
Snowy Egret	4	2	4	3	3	4	high	2	4	2	1	low (4b)	Kelly et al. 2006, Sauer et al. 2011
Cattle Egret	2	1	2	2	3	3	lowest	1	2	2	1	lowest (5)	
Green Heron	2	3	2	3	2	4	low	2	3	4	1	low (4b)	Sauer et al. 2008
Black-crowned Night-Heron	4	3	3	3	2	3	moderate	2	4	2	1	low (4b)	Kelly et al. 2006, Sauer et al. 2011
White-faced Ibis	2	2	4	3	3	4	low	1	3	2	2	lowest (5)	Shuford et al. 1996, Earnst et al. 1998
Yellow Rail	4	3	4	5	3	4	high	4	na	4	1	high (2a)	
Black Rail	5	2-3	5	4	4	4	highest						
California Black Rail								3	4	4	4	high (2c)	Evens et al. 1991, Spautz et al. 2005
Clapper Rail	3	2	4	4	4	5	moderate						
California Clapper Rail								4	5	5	5	high (2a)	Albertson & Evens 2000, Liu et al. 2009
Light-footed Clapper Rail								1	5	5	5	high (2b)	Zembel et al. 2007
Virginia Rail	3	2	4	4	3	4	moderate	3	3	3	1	low (4a)	
Sora	4	2	4	4	3	3	high	3	3	3	1	low (4a)	
Common Gallinule	3	1	4	3	2	3	moderate	3	3	2	1	low (4a)	Sauer et al. 2011
American Coot	2	1	2	3	2	3	low	3	2	1	1	lowest (5)	Sauer et al. 2011

Species Name	Continental Conservation Factor Scores[b] PT	PS	TB	TN	BD	ND	Continental Category of Concern[c]	BCR 32 Conservation Factor Scores[d] PT	TB	TN	EN	BCR 32 Category of Concern[e] (applicable rule)	Sources for BCR 32 Factor Scores
Sandhill Crane	2	2	3?	3?	3	4	low						
Lesser Sandhill Crane								3	na	3	4	moderate (3c)	Littlefield 2008
Greater Sandhill Crane								2	na	4	5	high (2c)	Ivey & Herziger 2001
Bonaparte's Gull	?	3	3	3	1	2	moderate	3	na	2	1	lowest (5)	
Heermann's Gull	3	2	4	5	5	4	moderate	3	na	2	2	low (4a)	
Mew Gull	4	2	1	1	2	2	lowest	3	na	2	2	low (4a)	
Ring-billed Gull	1	1	1	1	2	2	lowest	2	na	2	1	lowest (5)	
Western Gull	2	2	2	2	4	4	low	3	3	2	3	low (4a)	Sauer et al. 2011
California Gull	3	2	5	2	2	3	moderate	1	2	2	2	lowest (5)	Strong et al. 2004
Herring Gull	3	2	3	2	1	1	low	3	na	2	1	lowest (5)	
Thayer's Gull	3	3	3	5	3	2	moderate	3	na	2	2	low (4a)	
Glaucous-winged Gull	3	2	2	2	3	3	low	3	na	2	1	lowest (5)	
Least Tern	4	2	5	4	3	2	high						
California Least Tern								1	5	na	4	high (2b)	Akçakaya et al. 2003, Marschalek 2011
Gull-billed Tern	4	3	4	2	3	2	high						
Western Gull-billed Tern								1	5	na	1	low (4b)	Molina et al. 2010
Caspian Tern	2	3	4	2	2	2	low	3	3	na	1	low (4a)	USFWS unpubl. data
Black Tern	3	2	4	3	2	2	moderate	3	4	na	1	moderate (3c)	Shuford et al. 2001, 2008b
Forster's Tern	4	3	3	2	2	2	moderate	4	3	2	1	moderate (3b)	Strong et al. 2004
Royal Tern	3	2	4	3	3	3	moderate	1	4	2	1	low (4b)	
Elegant Tern	3	3	4	4	4	3	moderate	1	4	2	2	low (4b)	
Common Tern	2	2	5	4	2	1	low	3	na	2	1	lowest (5)	
Black Skimmer	4	2	4	3	3	3	high	1	4	2	1	low (4b)	Molina 2008

[a]For details on the Conservation Concern Categories and Factor Scores of the North American Waterbird Conservation Plan (NAWCP) see Kushlan et al. (2002) or http://www.waterbirdconservation.org/assessment.html.

[b]To evaluate conservation status at the continental scale, the NAWCP scored each waterbird species on six variables (factors): PT, population trend; PS, population size; TB, threats to breeding; TN, threats to non-breeding; BD, breeding distribution; and ND, non-breeding distribution (see Methods).

[c]The NAWCP used factors scores to assign each waterbird species to one of six categories of conservation concern at the continental level using a step-wise, categorical approach (see Methods): highest concern (formerly "highly imperiled"), high concern, moderate concern, low concern, and lowest concern (formerly "not currently at risk").

[d]To assign conservation concern categories for BCR 32, each species, subspecies, or distinct population was first scored for four criteria. For three of these (PT, TB, TN), factor scores were assigned using the continental definitions but applied to the status in BCR 32. An additional score was assigned for EN, percent of entire range, which is an estimate of the proportion of the continental population that occurs in BCR 32. na, not applicable, i.e., species or subspecies does not occur in BCR 32 in the breeding season or in the nonbreeding season (post-breeding, migration, or winter).

[e]See Methods for a description of how conservation concern categories were assigned for BCR 32.

Table 7 Matrix of BCR 32 Conservation Concern Categories and Geographic Affinities of Waterbirds Covered by the Coastal California (BCR 32) Waterbird Conservation Plan

Conservation Concern Category[a]	Global Distribution Categories[b]			
	North America	Western Hemisphere	Northern Hemisphere	Cosmopolitan
Highest Concern				
High Concern	Western Grebe Clarks' Grebe Yellow Rail	Least Bittern California Black Rail California Clapper Rail Light-footed Clapper Rail California Least Tern	Greater Sandhill Crane	
Moderate Concern	Forster's Tern		Lesser Sandhill Crane	Eared Grebe Black Tern
Low Concern	Double-crested Cormorant American White Pelican American Bittern Green Heron Heermann's Gull Western Gull	Pied-billed Grebe California Brown Pelican Snowy Egret White-faced Ibis Virginia Rail Sora Elegant Tern Black Skimmer	Red-throated Loon Pacific Loon Common Loon Horned Grebe Thayer's Gull	Black-crowned Night-Heron Common Gallinule Mew Gull Gull-billed Tern Caspian Tern Royal Tern
Lowest Concern	Ring-billed Gull California Gull	Great Blue Heron American Coot Bonaparte's Gull	Glaucous-winged Gull	Great Egret Cattle Egret Herring Gull Common Tern

[a]Methods for assigning conservation concern categories for BCR 32 are adapted and modified from those in the North American Waterbird Conservation Plan (Kushlan et al. 2002) and at http://www.waterbirdconservation.org/assessment.html; See details in Table 6 and the text of the present document.

[b]Global distribution categories are defined broadly as: North America, species that breed and winter only in North America as defined in the NAWCP; Western Hemisphere, species that breed and winter in North and South America and associated oceanic regions; Northern Hemisphere, species (except those included in the above categories) that breed and winter in the Northern Hemisphere and associated oceanic regions; Cosmopolitan, species that breed and winter in most hemispheres including North America and associated oceanic regions.

CHAPTER 6

CONSERVATION GOALS

Conservation goals for birds increasingly rely on establishing desirable population goals for species and measureable habitat goals needed to reach those population objectives. The methods used to establish population and habitat goals may vary considerably, largely depending on the availability of baseline data on population levels prior to periods of decline plus the extent of knowledge of the links between population sizes and the extent or quality of habitat. For BCR 32, some of the methods used to establish conservation goals for other species of wetland birds—mainly waterfowl and shorebirds—are discussed below followed by those that seem most applicable to waterbirds in this region.

POPULATION GOALS

Although some regional waterbird plans have established specific population goals for many, but not all, species in the region (e.g., Ivey and Herziger 2006), a lack of reliable data on the population sizes of most species or subspecies of waterbirds in BCR 32 argued for a different approach in this region. The approach varies depending on the level of conservation concern for particular species and the level of knowledge of the size and population trends of species or subspecies. Although setting population goals (e.g., increase by 50%) for species that lack current population estimates is problematic given it will not be possible to measure if the goal is attained, it still seems warranted to register the degree of population increase that is desired given past declines and ongoing threats to the current population.

The sections that follow described how population goals have been set for species listed under the federal Endangered Species Act; for waterfowl, shorebirds, or waterbirds by the joint ventures that encompass parts of BCR 32; and for the current BCR 32 waterbird plan.

Population Goals: Listed Species

Federally listed species. Of the waterbirds ranked of high conservation concern in BCR 32 and listed as federally endangered, all three have recovery plans that have subsequently been updated or given 5-year reviews: Light-footed Clapper Rail (USFWS 1985a, 2009b), California Clapper Rail (USFWS 1984, 2009a), and California Least Tern (USFWS 1985b, 2006). All of these plans and subsequent revisions have recovery goals, which may include population goals (overall and by management area), habitat size and quality goals, and target reproductive rates that must be satisfied for the taxon to be downlisted or delisted. In some cases, reaching the population goal has not been sufficient for a change in listing status. For example, the population of the California Least Tern has increased to nearly six times the population recovery criterion, but no other recovery goal has been fully met (USFWS 2006). Recent analyses, however, indicate that current methods are underestimating reproductive rates of the terns (K. Keane pers. comm.), suggesting that recovery goals should be reevaluated on the basis of these findings and the long-term increase in the tern population. Regardless, goals for these listed taxa seem best evaluated within the framework of recovery plans and their respective recovery teams.

State listed species. Of the waterbirds ranked of high conservation concern in BCR 32 and listed as state threatened, neither the California Black Rail nor Greater Sandhill Crane have recovery plans and, hence, do not have population or other recovery goals.

Population Goals: Joint Ventures

Central Valley. The Central Valley Joint Venture's (CVJV) primary region of concern encompasses part or all of 19 counties in the agricultural heart of the state. As with many

JV's, the CVJV's population objectives for duck species are stepped down from the continental objectives developed by the North American Waterfowl Management Plan (NAWMP Plan Committee 2004) based on environmental conditions and breeding waterfowl numbers in the 1970s, with some adjustments for certain species (CVJV 2006). Objectives for geese and swans are based on the numbers recorded on winter waterfowl surveys in 1998–1999 and 1999–2000 (Fleskes et al. 2000, CVJV 2006).

Given the lack of long-term data on continental populations of shorebirds, there is no basis for stepping down shorebirds objectives to the joint venture level. Instead, the CVJV (2006) developed population objectives for shorebirds from broad-scale surveys of wintering shorebirds in the Central Valley conducted from 1992 to 1994 (Shuford et al. 1998), adjusted upward to account for missing birds and depressed numbers during the survey period.

Limited baseline data on continental and regional population sizes of most species of waterbirds to date have precluded setting population goals for waterbirds in the Central Valley (CVJV 2006).

San Francisco Bay Region. The San Francisco Bay Joint Venture (SFBJV) encompasses part or all of nine counties surrounding the San Francisco Bay estuary. The SFBJV's primary waterfowl goal is to sustain wintering populations of key waterfowl species (canvasback, scaup, scoters) at recent peak population levels recorded in 1989–90 (Steere and Schaefer 2001; highest numbers during three years of intensive surveys, Accurso 1992). A secondary goal of the SFBJV is to consistently support wintering populations of other bay indicator waterfowl species (Mallard, Northern Pintail, Northern Shoveler, and Ruddy Duck) at the peak levels recorded in 1987–1990.

The SFBJV implementation strategy did not set any specific population objectives for shorebirds or waterbirds (Steere and Schaefer 2001). A subsequent guiding document for revising the strategy proposed a breeding population objective of 500 individuals of the federally threatened Western Snowy Plover and simply maintaining or increasing populations of other breeding, migrating, or wintering shorebirds in the bay; no population objectives for waterbirds were proposed (PRBO 2004).

Southern Coastal Slope. The geographic extent of the Sonoran Joint Venture (SJV) is divided into several subregions, one of which, the "Californian Coasts and Mountains Region," includes the southern part of BCR 32 from Point Conception in Santa Barbara County south into Baja California Norte (SJVTC 2006). The U.S. portion of this region within the BCR 32 waterbird plan is considered the coastal slope of southern California. The SJV ranked the regional conservation concern of all regularly occurring bird species within each of that JV's four subregions, each of which encompases part or all of one or more BCRs. Within each subregion, species were assigned one of four population objectives for the next 30 years: (1) *Double population* – if a species' population has declined by >50% in the last 30 years, the objective is to increase the population by 100%; (2) *Increase by 50%* – if a population has declined by 15%–49% in the last 30 years, the objective is to increase the population by 50%; (3) *Maintain/Determine Status* – if the population trend is highly variable or lacks sufficient data, the objective is to maintain the population while the species' trend is being determined; and (4) *Maintain* – if the population is stable, the objective is to maintain the population.

Population Goals: BCR 32 Waterbird Plan

Given the meager prior data on population trends for most waterbird species in BCR 32, this plan takes a tiered approach in assigning population objectives that varies for federally and state listed species, priority waterbird species, and the remaining waterbird species in BCR 32 (Table 8). The justification for goals for each of the three groups is described below.

Listed Species. Because all the federally listed waterbird species that occur in BCR 32 have recovery plans with population and other recovery goals, and recovery teams to implement them, it seemed best to endorse those goals as is without further modification (Table 8). The two state-listed subspecies in BCR 32 currently do not have recovery plans or population goals, so those are treated in the same manner as other high and moderate priority species as described below.

High and Moderate Priority Species in BCR 32s. Under this category are those species that were ranked either of High or Moderate conservation concern in BCR 32 (Tables 6 and 7). The population goal for all species ranked of High Concern in BCR 32 (exclusive of federally listed species) is to increase the population by 100% in the next 20 years. The population goal for all species ranked of Moderate Concern in BCR 32 is to increase the population by 50% in the next 20 years.

Lower Priority Species in BCR 32. The population goal for all species ranked of Low or Lowest Concern in BCR 32 is at a minimum to maintain the current population and hopefully to increase it, by an unspecified amount, in the future.

Habitat Goals

Although methods for establishing habitat goals for wetland-dependent birds generally are based on the best scientific information, these may range from rigorous modeling exercises to purely subjective assessments. The following sections outline how this has been done for various federally listed species, for waterfowl, shorebirds, or waterbirds by the joint ventures that encompass parts of BCR 32, and for the current BCR 32 waterbird plan.

Habitat Goals: Listed Species

Recovery plans for listed species generally set some objectives for the extent, quality, and distribution of habitat that needs to be protected, restored, or enhanced to ensure recovery of the species, subspecies, or distinct population segment in question. In some cases, goals may be set individually for

Table 8 Population Objectives for BCR 32 Waterbirds Tiered by Levels of Conservation Concern

BCR 32 Conservation Concern Category[a]	Other Conservation Status[b]	Population Size in BCR 32 (season)[c]	Population Objective in BCR 32[d]	Additional Requirements or Recommendations[e]
High Concern (federally listed)				
California Clapper Rail	FE, SE	1425 (breeding)	2221 rails for downlisting to threatened status: 1185 central/Sern SF Bay, 936 San Pablo Bay, 100 Suisun Bay (USFWS 2009a; see for higher population goals required for delisting)	Goals for habitat acreage and quality (well-developed channels, high-tide escape cover) across three recovery units and various marsh complexes within them; protection and management of habitat on outer coast at Tomales Bay; control of invasive plants; site-specific management plans; and predator management (USFWS 2009a).
Light-footed Clapper Rail	FE, SE	~886 (breeding)	1600 (800 pairs; USFWS 2009b)	Goal of protecting and managing ~4000 ha of wetland habitat consisting of at least 50% of marsh vegetation suitable for rails in at least 20 marsh complexes (USFWS 2009b).
California Least Tern	FE, SE	~14,482 (breeding)	At least 1200 breeding pairs (2400 adults) in at least 20 of 23 coastal management areas (USFWS 2006)	Each of the 20 "secure" coastal management areas must have at least 20 breeding pairs and each must have a 5-year mean reproductive rate of at least 1.0 young fledged per breeding pair (USFWS 2006). San Francisco Bay, Mission Bay, and San Diego Bay must be included within the 20 secure management areas with 4, 6, and 6 secure colonies, respectively.
High Concern (other)				
Western Grebe	–	unknown (breeding)	Increase by 100%	
Clarks' Grebe	–	unknown (breeding)	Increase by 100%	
Least Bittern	BSSC	unknown (breeding)	Increase by 100%	
Yellow Rail	BSSC, BCC	unknown (winter)	Increase by 100%	
California Black Rail	ST, BCC	27,280+ (breeding)	Increase by 100%	
Greater Sandhill Crane	ST	8000–10,000 (winter)	Increase by 100%	
Moderate Concern				
Eared Grebe	–	unknown (breeding; winter)	Increase by 50%	
Lesser Sandhill Crane	BSSC	~35,000 (winter)	Increase by 50%	
Black Tern	BSSC	~4426 (breeding)	Increase by 50%	Focus conservation in San Joaquin Valley, where greatest historical losses.
Forster's Tern	–	unknown (breeding)	Increase by 50%	
Low and Lowest Concern (all other species)		mostly unknown	Maintain or increase populations	

[a]Methods for assigning conservation concern categories for BCR 32 are adapted and modified from those in the North American Waterbird Conservation Plan (Kushlan et al. 2002) and at www.waterbirdconservation.org/assessment.html; see details in Table 6 and the text of the present document.

[b]FE, federally endangered; SE, state endangered; ST, state threatened; BSSC, California bird species of special concern; BCC, U.S. Fish and Wildlife Service bird of conservation concern (in BCR 32).

[c]Estimated population size in BCR 32 for the relevant season (source of information listed elsewhere in text or in species accounts).

[d]Population objectives for federally listed species from respective recovery plans; see text for other high, moderate, low, and lowest concern species.

[e]Requirements and recommendations mostly from recovery plans.

each of a suite of species and for the entire degraded ecosystem that supports the listed species. For example, the draft recovery plan for tidal marsh ecosystems of northern and central California features five endangered species—the California Clapper Rail, the salt marsh harvest mouse (*Reithrodontomys raviventris*), and three listed plants—and addresses 11 additional species of concern, including 5 subspecies of birds (USFWS 2009a). Recovery for each taxon is based on meeting goals across as many as five geographic subareas areas (recovery units) and various marsh complexes within them. The habitat objectives, and other recovery goals, for the California Clapper Rail are summarized here in Table 8 (see USFWS 2009a), as are the goals for the Light-footed Clapper Rail and California Least Tern from their respective recovery plans cited therein.

Habitat Goals: Joint Ventures

Central Valley. The Central Valley Joint Venture implementation plan (CVJV 2006) used energetics modeling to determine habitat goals for wintering waterfowl and shorebirds in that region. Starting with population objectives for a particular bird group, the models used data on daily energy needs of individual birds and the density of suitable foods in key habitat types to estimate the amount of wetland or agricultural habitat needed to support the desired bird population. The implementation plan's habitat goals for wintering waterfowl require restoration of 108,527 acres of seasonal wetlands, part of which has already been met, and for enhancement (post-harvest flooding, or unflooded fields not deeply plowed after harvest) of 307,000 acres of agricultural croplands (mainly rice and corn), all of which has been met. Modeling for shorebirds and a subjective assessment for waterbirds suggests that currently no additional winter habitat is needed for these groups beyond what is estimated for waterfowl. Pending any additional information to the contrary, the BCR 32 waterbird plan judges that this assumption is a reasonable one for populations of waterbirds wintering in this region. An exception to needs beyond those for waterfowl is the additional need for shorebirds of 4527 acres of early flooded (July to mid-Aug) seasonal wetland habitat prior to typical initiation of flooding of waterfowl habitat. It seems likely that this early flooded habitat would also benefit a variety of waterbirds.

The CVJV (2006) implementation plan did not determine habitat goals for breeding waterfowl because of a lack of a clear link between population objectives and the amount of habitat needed to support some range in numbers of breeding ducks. The implementation plan, however, does subjectively estimate 5-year habitat objectives of an additional 12,500 acres of semi-permanent wetlands: 7500 and 5000 acres for breeding shorebirds and waterbirds, respectively. This JV also estimated a need of a total of 10,000 acres of riparian habitat for riparian songbirds and tree-nesting waterbirds. Although the estimated need for tree-nesting waterbirds totals 5000 acres, the JV plan judges that all but 1300 of these (in the Tulare Basin) can be met by the 8700 acres of riparian restoration needed by songbirds. Field observations suggest, however, that suitable foraging sites in ephemeral wetland or irrigated agricultural habitat may be a much greater limiting factor than riparian nesting sites given herons and egrets frequently nest in eucalyptus woodlots or windbreaks or in ornamental trees.

San Francisco Bay Region. The SFBJV's implementation plan (Steere and Schaefer 2001) set overall habitat goals by a process that evaluated and modified those devised by the extensive efforts of the San Francisco Bay Area Wetlands Ecosystem Goals Project (Goals Project 1999). These goals are based on the best available scientific information and professional judgment, but are not derived from energetic modeling or other quantitative analyses. Over two decades, the SFBJV plans to protect, restore, and enhance, respectively, 63,000, 37,000, and 35,000 acres of the bay's habitats (tidal marshes, tidal flats, salt ponds, lagoons, and beaches); 37,000, 7000, and 23,000 acres of adjoining seasonal wetlands (diked wetlands, grasslands and associated wetlands); and 7000, 5000, and 22,000 acres of lakes, creeks, and riparian corridors (Steere and Schaefer 2001). Although these goals take into account the habitat needs of various species of plants and animals, there are no specific habitat goals set for waterfowl, shorebirds, or waterbirds.

The San Francisco Bay Subtidal Habitat Goals Project (SFBSHGP 2010) also identified habitats in San Francisco Bay needing protection and restoration. The goals specifically identify waterbirds as benefiting from the overall project and from a few of the specific objectives, such as cross-habitat oil spill prevention and reduction of contaminated soils.

Southern Coastal Slope. The Sonoran Joint Venture did not set specific habitat objectives within the four subregions of the overall area, including the California Coasts and Mountains Region, but rather recommended various species-specific conservation actions, most of which involved habitat restoration or enhancement (SJVTC 2006).

Habitat Goals: BCR 32 Waterbird Plan

Lacking information for most species on the link between population objectives and the amount and quality of habitat needed to support those population levels, the BCR 32 waterbird plan mainly relies on assessments of habitat needs generated by recovery plans and joint venture implementation plans coupled with subjective assessments of additional needs. As described above, only two of the three joint ventures operating in BCR 32 quantified habitat goals in their implementation plans and, of these, the Central Valley Joint Venture is the only one that addressed waterbirds specifically. Hence, the following sections describes what habitat objectives have been set for listed species, those set by region, which of the latter are specific to waterbirds, and where habitat goals are lacking entirely for broad areas.

Listed species. The habitat goals for the three federally listed subspecies of waterbirds in BCR 32 are outlined in Table 8; greater details are, of course, found in the relevant recovery plans. The BCR 32 waterbird plan endorses these

goals for listed species and the processes in place to revise them as needed.

Central Valley. The CVJV (2006) judged that meeting their population goals for wintering waterfowl (restoring 108,527 acres of seasonal wetlands, enhancing 307,000 acres of agricultural croplands) would also meet the needs of wintering waterbirds in that region. Lacking any evidence to the contrary, this seems to be a reasonable assumption. The CVJV did, however, estimate an additional need for shorebirds of 4527 acres of seasonal wetlands in July to mid-Aug, which undoubtedly would also benefit a variety of waterbirds given the dearth of such habitat in the Central Valley at that time. If this habitat were managed primarily to maintain shallow, open water for shorebirds, it would be valuable to increase the objective by 50% to 100% (6790–9054 acres) to manage for waterbirds that use habitats with deeper water, greater vegetation density, or more fish prey. Depending on their characteristics, some of these seasonal wetlands might also benefit breeding waterbirds, such as grebes, that have protracted and variable breeding periods that may extend into July or August.

In addition, the CVJV (2006) subjectively estimated the need over five years of an additional 7500 and 5000 acres of semi-permanent wetlands for breeding shorebirds and waterbirds, respectively. It is unclear why the CVJV identified a greater breeding habitat need for shorebirds than for waterbirds. To the contrary, the extensive use of sewage ponds, agricultural canals and ditches, and water-storage facilities by breeding shorebirds in the Central Valley (Shuford et al. 2007), and the much more limited use of these habitats by breeding waterbirds (D. Shuford pers. obs.), suggests that the need for additional breeding habitat in this region may be as great or greater for waterbirds than for shorebirds. For this reason, the BCR 32 waterbird plan recommends that the habitat objective for semi-permanent wetlands for breeding waterbirds be increased by 50% to 100% to 7500–10,000 acres.

Also, there is a need for additional acreage of late-season seasonal wetlands for breeding waterbirds. Historically in the Central Valley there was extensive wetland habitat created by late winter or early spring flooding from rains or snowmelt, with the latter peaking in some regions in June. Today such habitat occurs fortuitously and irregularly in the Central Valley, primarily in the Tulare Basin, when floodwaters exceed the storage capacity of upstream reservoirs. Such habitat can provide ideal breeding or foraging habitat for Black and Forster's terns, Eared Grebes, and White-faced Ibis, as well as for many species of ducks and shorebirds (Shuford et al. 2001, Shuford 2010, pers. obs.). For this reason, the BCR 32 waterbird plan recommends an additional habitat objective of 2500 acres of late-season seasonal wetlands, first flooded in March or April, for breeding waterbirds. It also would be valuable to design conveyance structures and dedicated habitat areas that could accommodate floodwaters in years of exceptional runoff to increase this ephemeral habitat to a much greater extent when the opportunity arises.

The CVJV also estimated a need of restoring a total of 10,000 acres of riparian habitat for songbirds and tree-nesting waterbirds combined, with all but 1300 of these for waterbirds (in the Tulare Basin) being met by the 8700 needed by songbirds. As noted previously, suitable foraging sites for waterbirds in ephemeral wetland or irrigated agricultural habitat may be a much greater limiting factor than riparian nesting sites for tree-nesting herons, egrets, and cormorants.

Central coast region. Over two decades, the San Francisco Bay Joint Venture plans to protect, restore, and enhance, respectively, 63,000, 37,000, and 35,000 acres of the bay's tidal habitats, salt ponds, lagoons, and beaches; 37,000, 7000, and 23,000 acres of adjoining seasonal wetlands; and 7000, 5000, and 22,000 acres of lakes, creeks, and riparian corridors (Steere and Schaefer 2001). Lacking population goals for waterbirds, or known links between population levels and habitat extent or quality, it is uncertain if these habitat goals will meet waterbird needs in this region. Subsequently, the final environmental impact statement/report was prepared for the South Bay Salt Pond Restoration Project (SBSPRP 2007), the largest tidal wetland restoration project on the West Coast. When completed over many decades, this project will restore about 15,000 acres of commercial salt ponds to a mosaic of tidal wetlands and other habitats. The outcome will likely fall somewhere between two scenarios: 50:50 (7500:7500 acres) or 90:10 (13,400:1600 acres) tidal to managed ponds. Under all outcomes, about 1600 acres of managed ponds will be reconfigured and intensively managed to improve foraging, roosting, and nesting opportunities for shorebirds, waterfowl, and other waterbirds. The project sets no specific population or habitat goals for particular waterbird species, but outcomes with a higher tidal wetlands component are likely to favor species like California Clapper Rail over other waterbirds.

Although the extensive habitat restoration goals in the greater San Francisco Bay estuary should enhance waterbird populations in this region, the future prospects for waterbirds are less certain for the region of the central California coast from Santa Cruz County south through most of Santa Barbara County where no joint ventures are active and no comprehensive wetland restoration projects are planned. Still, key wetlands in this area, such as Elkhorn Slough, Monterey County, are largely protected and being managed to maintain and enhance wetland habitats and ecological function (ESNERR 2006).

Southern coast region. This region lies within the Sonoran Joint Venture, but appears not to have had a comprehensive assessment of waterbird habitat needs either by the JV or other regional partnerships. As in the central coast south of San Francisco Bay, key wetland habitats on the southern coast receive substantial protection, and ecosystem efforts are being made to maintain or enhance wetland habitats for waterbirds and other resources (e.g., San Diego Bay; Anonymous 2007).

Priorities and Recommendations

Obtaining the necessary information to refine or initially set population and habitat goals for all waterbirds in BCR 32 should be a very high conservation priority. This is

underscored by the lack of basic data on the population sizes and trends of most waterbird species in this region. Without knowledge of the current status of species' populations it is not possible to set quantifiable goals or measure progress toward their attainment. Priorities and recommendations for waterbird monitoring in BCR 32 are made in Chapter 7 below.

Setting habitat goals for waterbirds in BCR 32 currently is even more elusive than setting population goals. Although the Central Valley Joint Venture implementation plan (CVJV 2006) sets habitat goals for waterfowl and shorebirds on the basis of energetics modeling, which estimates the amount of wetland or agricultural habitats needed from data on food availability and birds resource needs, this had not yet been done for waterbirds. Complicating the application of such models to waterbirds is the broad suite of species involved, considerable variation in the fish, invertebrate, or other food resources they require, and limited data on both these food and other ecological requirements of individual waterbird species. Because of these constraints, it may be more reasonable to set habitat goals on the basis of densities or other measures of waterbird use of various wetland and agricultural habitats. Regardless, it should be a high priority to develop a defensible method of estimating habitat goals for waterbirds in BCR 32.

CHAPTER 7

Inventorying and Population Monitoring

GOALS AND OBJECTIVES

To enable effective conservation in BCR 32, it will be necessary to accurately monitor population trends of waterbirds. Otherwise, it will not be possible to identify waterbirds populations in the early stages of decline, when conservation actions are most likely to be effective; to evaluate the factors contributing to declines; or to track the success of conservation actions in reversing declines and meeting population or habitat goals for waterbirds. Ideally, monitoring in BCR 32 should track trends in waterbird populations and vital rates at the regional level while concurrently serving as a component of monitoring at the continental scale. Often inventories are conducted first to provide a baseline to use in developing a monitoring program. When discussed here, monitoring generally refers to programs to track population trends over time at the local, regional, or continental scale. Monitoring often also refers to efforts to track the response of waterbirds, or other plants and animals, to specific habitat alteration or restoration projects. While this is a valid use of the term, it is not the one emphasized here.

EXISTING EFFORTS

Although there is currently no effective program that monitors all waterbirds throughout BCR 32, broad-scale inventories have been conducted for a few species, and some species are monitored annually at local sites or in subregions of the BCR (Appendix 3). Data are best for breeding species, particularly colonial nesting waterbirds, and sparse or less rigorous for migrant or wintering waterbirds.

Inventorying

When there are only limited historical or recent data on population sizes, inventorying can provide a solid baseline from which monitoring efforts can be based. Although no projects have specifically attempted to inventory waterbirds in BCR 32, some broader-scale projects have inventoried some breeding species in all or large portions of this region (Appendix 3). Broad-scale coordinated inventory projects are by their nature just preliminary, though necessary, steps in establishing solid monitoring programs. First, the size of breeding populations of many species fluctuates considerably from year to year in response to short-term fluctuations in climate and habitat. Thus, this will require collection of many years of data to assess the normal range of population numbers to establish a baseline against which population goals can be set and their attainment measured.

Monitoring

Because the two long-standing, continental-scale monitoring programs—the Breeding Bird Survey and Christmas Bird Count—provide only limited information on population trends of waterbirds in BCR 32, there is a need for development of an effective monitoring program that will track the population trends of breeding, wintering, and migrant waterbirds across this region. Some monitoring programs do exist for waterbirds in BCR 32, but long-term abundance data for these birds are of variable quality, exist for a small subset of areas and species, and are mainly from just the last two to three decades (Appendix 3). Most such monitoring is conducted at the local scale by wildlife areas and refuges, nonprofit organizations, or independent researchers focusing on individual colonies or the full suite of wintering birds at local areas. Sometimes fortuitously, rather than by design, these efforts collectively amount to a *de facto* monitoring program, but may lack coordination, standardization, and a high likelihood of long-term continuity. But, without high quality data it will be very hard to identify the conservation problems of waterbirds or to further focus on identifying their

causes and remedies. The importance of coordinated monitoring cannot be overemphasized. Abundance estimates or trend assessments for broad regions made by compiling incomplete data gathered independently in different years, by different methods, and under varying climatic conditions typically provide ambiguous results of limited value for conservation (see discussion in Shuford 2010).

Priorities and Recommendations

Knowing the limits of current monitoring efforts in BCR 32, bulleted recommendations below offer suggestions for improvement so that such efforts are best suited to aid in the conservation of waterbirds in this region. As much as possible, scientifically rigorous and standardized monitoring protocols for BCR 32 should integrate with those for colonial waterbirds or secretive marshbirds currently being developed at the continental scale. Although scientific rigor is important, there will be a need in some cases for protocols to be flexible to accommodate variation in survey methods among sites when logistical constraints preclude their consistent application (see discussion in Shuford 2010). Monitoring will also need to account for California's highly seasonal precipitation and runoff and the great year-to-year variation in these parameters, which can cause wetlands or ephemeral habitats to vary markedly in extent, or temporarily disappear, over relatively short periods of time. This may influence the sampling interval or the length of time needed to evaluate trends. Some additional recommendations for monitoring in BCR 32 are found in individual species accounts in Appendix 4.

A recommendation that applies to all monitoring is the need to contribute all data to a centrally managed database that will enable rapid analysis and dissemination of information on the status and trends of waterbirds to facilitate timely conservation actions. Online tools are needed to enable visualization of trends, indices, or other patterns that will boost conservation effectiveness.

Just as important as developing a scientifically rigorous monitoring program with the capability to rapidly disseminate results is the need to ensure higher-level organizational support for monitoring, including long-term commitment and financial support.

Colonial Waterbirds

- Complete the inventory of the Western Colonial Waterbird Survey. Then conduct additional surveys under a wider range of climatic conditions so design of a monitoring program for colonial waterbirds can be tailored to capture the response of waterbirds to the full range of environmental fluctuation.
- Design a monitoring program for colonial waterbirds in BCR 32 that will be in synch with larger-scale programs by using standardized protocols and methods that enable tracking population trends at both continental and regional scales. Include methods for monitoring the Black Tern, a semi-colonial breeder that requires roadside-transect sampling in the extensive area of Sacramento Valley rice fields.
- Develop a program to monitor vital rates of colonial waterbirds as an early warning system that will identify when subpar reproductive performance is likely to lead to future population declines of these long-lived species.

Solitary Breeders

- Develop a BCR 32 program to monitor solitary breeding waterbirds, most of which are in a group termed "secretive marshbirds" (bitterns, rails, coots, gallinules, Pied-billed Grebe). This program should integrate with current efforts to standardize protocols and sampling design to make inferences at larger scales, as appropriate.
- Evaluate whether the BBS already adequately samples some of the secretive marshbirds (perhaps coots, gallinules, Pied-billed Grebe) and the Green Heron, the only other solitary breeder in the region not included in the former category.

Wintering and Migrant Waterbirds

- Assess whether Christmas Bird Count data may already be adequate to monitor some numerous and widespread waterbirds that winter in BCR 32.
- Design a program for BCR 32 that effectively monitors wintering and migrant waterbirds not already adequately sampled by another program. Evaluate whether protocols and methods that are being designed to monitor shorebirds in California by the Pacific Flyway Shorebird Survey (www.prbo.org/cms/119) might also be applicable to waterbirds and whether at a future date it might be possible to integrate shorebird and waterbird monitoring under one program.
- Evaluate all local monitoring projects in BCR 32 to assess whether integration of these projects and expansion to new sites could form the basis for a regionwide monitoring program or whether entirely new protocols and methods would be necessary.

CHAPTER 8

Research Needs

PRIORITIES AND RECOMMENDATIONS

Given the limitless potential for research projects on waterbirds in BCR 32, high priority research needs are ones that will (1) inform the effective implementation of conservation priorities in the region, (2) fill large gaps in the knowledge of species' biology or ecology, or (3) address overarching needs for multiple waterbirds species and other wetland-dependent birds. For individual species, the priority of related research should be raised for waterbirds ranked of moderate or high conservation concern in BCR 32. It is clear that the knowledge of the biology and ecology of most waterbird species in the region is poorly known making it difficult to identify limiting factors or actions needed to effect conservation. Additional research recommendations are included in individual species accounts in Appendix 4.

Overarching or Multi-species Needs

- *Tracking net landscape trends* – track gains, losses, and net change of key habitats for waterbirds, shorebirds, and waterfowl in the Central Valley at the landscape scale to assess conservation progress and aid in setting appropriate habitat objectives (CVJV 2009). Important habitats to track include seasonal, semi-permanent, and permanent wetlands, rice (totals grown, winter-flooded), corn (totals grown, winter-flooded, plowed, etc.), other wildlife-friendly crops (e.g., alfalfa, irrigated pasture), riparian habitat, and upland nesting cover.
- *Tracking incompatible habitat trends* – track gains, losses, and net change in the Central Valley of incompatible habitats, particularly perennial crops (e.g., vineyards, orchards) and residential and commercial development (CVJV 2009).
- *Tracking overall agricultural trends* – monitor general agricultural trends in the Central Valley to better assess impending conservation challenges or opportunities (CVJV 2009).
- *Assess landscape features* – to maximize the benefits of wetland restoration or agricultural enhancements in the Central Valley, identify broader landscape features that influence the value of local sites to groups and individual species of breeding and wintering waterbirds (CVJV 2009). Identify how such landscape features vary regionally with the particular matrix of wetlands, agriculture crops, and urban development
- *Use by crop and treatment* – study the response of waterbirds to post-harvest flooding or flood irrigation in key crop types (rice, corn, alfalfa, irrigated pasture) and how that varies among post-harvest treatments or varying irrigation practices. Determine how prey availability in various crop treatments affects waterbird use.
- *Prey availability* – conduct studies of fish and invertebrate prey availability for waterbirds in freshwater wetlands, croplands, and a range of estuarine and tidal marsh habitats.
- *Sedimentation effects in restored salt ponds* – conduct studies of sediment deposition rates in restored salt ponds in south San Francisco Bay to see if they are adequate to support emergent tidal habitat and whether restored tidal areas significantly reduce habitat area or ecological functioning, including bird diversity and abundance (SBSPRP 2007, Appendix D).
- *Habitat enhancement and reduction* – study the net effect on waterbirds of the reduction of nesting habitat by restoring former salt ponds to tidal action balanced against enhancing habitat values of remaining ponds (e.g., building nesting islands). Quantify these effects on waterbird abundance, predation rates, disease, food availability, etc. (SBSPRP 2007, Appendix D).
- *Nesting island configurations* – evaluate how different island configurations (size, number, edge slope, veg-

etation, dispersion) affect the abundance of nesting waterbirds in former salt ponds, freshwater wetlands, reservoirs, etc.
- *Effects of salt pond water levels and salinity* – study how the prey base and waterbird use of salt ponds managed for target water and salinity levels compares to that in existing ponds lacking such management (SBSPRP 2007, Appendix D).
- *Mercury accumulation* – study bioaccumulation patterns of mercury in waterbirds in response to tidal habitat restoration and changing pond management in San Francisco Bay (SBSPRP 2007, Appendix D).
- *Predation effects* – continue studies of the effects of generalist predators (e.g., California Gulls, ravens, crows, raccoons, skunks, etc.) on nesting waterbirds and, where impacts are high, how to mitigate these effects.
- *Disturbance effects* – study the effects on nesting or foraging waterbirds of human disturbance from shoreline or on-water activities and if and how such effects can be mitigated.
- *Limiting factors* – for all waterbirds ranked of high or moderate conservation priority in BCR 32, conduct studies on the life stages and factors (at both local and landscape scales) that limit reproductive success or overwinter survival. For species or subspecies in decline, identify populations that are contributing positively or negatively to the trend and what factors are responsible.
- *Understudied areas* – conduct research on waterbird use and ecology at inland lakes and reservoirs, which generally have been much less studied than have been coastal estuaries and wetlands and agricultural habitats in the Central Valley.
- *Interchange* – assess the level of interchange of waterbirds among small coastal estuaries and whether birds are dependent on a suite of habitats in the area.
- *Sea-level rise modeling* – continue to improve spatial models of the projected effects of sea-level rise on breeding and foraging rails in coastal estuaries.

Species-specific Studies

Eared Grebe
- Study the factors that influence the suitability of wetlands or agricultural evaporation ponds in the Central Valley for successful nesting and the great annual and seasonal variation in nest timing both among and within individual sites.
- Conduct focused studies on foraging ecology of grebes in the San Francisco Bay estuary and adjacent ponds.

Western and Clark's Grebes
- Conduct color-marking or radio-telemetry studies to determine the degree of individuals' fidelity to nest sites and the connectivity of breeding, migration, staging, and wintering areas.

American White Pelican
- Evaluate whether it might be possible to reestablish nesting at any former (or comparable) breeding sites in the Central Valley.
- Initiate detailed studies of the winter foraging ecology at various sites and couple these with studies of fish populations and water quality.
- Conduct radio- and satellite-telemetry studies to determine foraging movements and dispersal patterns during the non-breeding season.

Double-crested Cormorant
- Use color-marked or radio-tagged birds to study the foraging, dispersal, and migratory movements of cormorants to better understand the suite of habitats they use, the linkages among them, and how habitat use patterns change with fluctuating environmental conditions.
- Use marked birds to elucidate the extent of interchange between inland and coastal breeding populations and if the degree or timing of mixing is influenced by climatic or oceanic conditions, breeding failures, or other factors.
- Conduct a diet study of different colonies to understand the composition of prey species and its potential links to breeding success.
- Explore causes for sudden increases of populations at new breeding sites (e.g., Tomales Bay).

Snowy Egret
- Determine patterns of foraging dispersion near important colony sites, the relative use of feeding areas within major wetland subregions, and seasonal differences in regional and subregional abundance and distribution.
- Measure variation in natal dispersal and inter-annual movements of adults between colony sites.

White-faced Ibis
- Study the causes of rapid shifts in colony locations and sizes.
- Investigate in the Central Valley if pesticides and other contaminants are being concentrated in ibis and their eggs and whether there are adverse effects on reproductive success.

Yellow Rail
- Develop techniques to survey and monitor wintering populations of this secretive and seasonally silent species.
- Describe habitat needs on the wintering grounds and identify all known or potential wintering habitat in BCR 32, focusing attention on historical locations.

Black Rail
- Identify key features of suitable nesting habitat and monitor nests to better estimate nesting success.
- Evaluate the requirements of rail escape cover at high tides and how this can best be achieved in marsh restoration projects.

California Clapper Rail
- Identify the factors that influence rails' response to variations in tidal marsh habitat created from salt pond restoration in San Francisco Bay (SBSPRP 2007, Appendix D).

- Study rail use of tidal marshes dominated by invasive *Spartina* and its hybrids and evaluate how best to eradicate invasive *Spartina* while having no or limited effect on rails until marshes are recolonized by native *Spartina*.
- Monitor nests to better estimate nesting success and determine causes of nest failure.
- Monitor winter survival rates and determine limits to survival.

Sandhill Crane

- Identify key nighttime roost sites, their characteristics (size, water depth, vegetation structure, isolation from disturbance, surrounding land use), and their proximity to key foraging areas (CVJV 2009).
- Compare crane foraging habitat use with habitat availability, food availability, and management practices to identify factors associated with crane abundance and distribution (CVJV 2009).
- Use GIS mapping of roost sites and key foraging locations and associated data (e.g., ownership status, land use) to inform conservation planning (CVJV 2009).
- Assess food availability for cranes in key crops (rice, corn), and among different post-harvest crop treatments (flooding, dry, chopped and rolled, disced), to inform modeling of habitat needs and objectives.
- Evaluate effects of agricultural changes in the Central Valley on crane use and distribution (Pacific Flyway Council 1997).

California Gull

- Conduct studies of the factors influencing reproductive success and population size of waterbird species suspected of being negatively affected by California Gulls; include experimental studies examining the differences in success between control study sites and ones at which habitat is manipulated in ways judged likely to reduce gull problems.
- Supplement ongoing monitoring of the size and location of gull colonies in San Francisco Bay with annual estimates of reproductive success, as the effect of management actions on a long-lived species like this one may take a long time to detect by just counting nests.
- Conduct studies of gull movements and foraging patterns during the nesting season, particularly at landfills in south San Francisco Bay suspected of maintaining gull populations.
- Determine the effect of tidal flooding for restoration on gull nesting sites, particularly the dry salt pond with the largest gull colony (~17,000 gulls) in south San Francisco Bay; assess where gulls move to nest and what effect they have on waterbirds nesting on nearby levees and salt ponds islands.

Gull-billed Tern

- Conduct demographic studies to determine survival, fecundity, and the degree of mixing among breeding at sites in southern California and western Mexico.
- Continue studies of the diet of Gull-billed Terns in San Diego Bay, their effect on listed species nesting in proximity, and ways to mitigate any problems without harming the species.

Caspian Tern

- Continue research on the diet of this tern in San Francisco Bay to inform efforts to establish or augment colonies there to aid in efforts to relocate terns from the Columbia River estuary.
- Use color- or radio-marked birds to study tern movements in response to changing conditions, possible interchange between inland and coastal colonies, and migratory pathways and wintering areas of locally produced terns.

Elegant Tern

- Study the factors contributing to shifting colony sites and large annual variation in breeding numbers on the southern California coast.

Forster's Tern

- Study features of optimal tern habitat structure, vegetative cover, and island dispersion to enable creation of habitat in San Francisco Bay that has reduced vulnerability to predation by California Gulls.
- Investigate the degree of interchange between coastal and interior colonies and how this might be affected by the extent of interior habitat fluctuating with environmental conditions or by prey availability in San Francisco Bay.

California Least Tern

- Conduct further studies and analyses of current estimates of reproductive success to firmly establish whether these rates are truly too low to meet down-listing criteria or whether the estimates of success are artificially low because of the difficulties of accurately tracking cryptic chicks, mobile juveniles, and renesting adults.
- Better quantify predation and its effects on California Least Terns in both urban and undeveloped habitats.
- Study diet, chick provisioning rates, and important foraging areas near breeding colonies; determine how California Least Tern prey availability is related to colony attendance and defense against predators.
- Evaluate the extent to which various management actions are increasing nesting and productivity.

Black Tern

- Study what conditions in rice fields are correlated with the establishment of tern colonies and how various crop cultivation practices affect hatching and nesting success.
- Assess whether the value of rice fields to Black Terns equals that of ephemeral overflow habitat or natural marshes.
- Conduct research on the foraging and nesting ecology of Black Terns in rice fields, movements of banded birds with changing water conditions or other agricultural practices, and population demography to identify if reproductive rates are high enough in rice to maintain long-term population stability.

Black Skimmer

- Conduct studies of diet, foraging, provisioning behavior, and nest attendance to elucidate factors that influence the low apparent reproductive success in some years.
- Conduct demographic studies to determine fledging success, juvenile survival, adult longevity, recruitment, and the degree of mixing among breeders at sites within the southern California–Baja California region.
- Develop standardized indices of reproductive success since some colony sites demonstrate poor productivity which cannot be explained by predation alone.

CHAPTER 9

Education and Outreach Strategy

Effective conservation of waterbirds will be possible only if an informed and engaged constituency values these birds and supports measures to protect them and to create, restore, or enhance suitable wetland, agricultural, and upland habitats. If properly informed and united in a common purpose, educators, conservationists, outdoor enthusiasts, natural resource managers, policy makers, and the general public can be formidable conservators of wetland birds.

Launching an effective outreach and education program involves a number of key steps: identifying priority target audiences and strategies for reaching them, gathering important information and determining critical messages to convey, developing model education and outreach materials to incorporate into local programs, crafting mechanisms of information exchange and dialog, and evaluating results and adapting approaches as necessary (Kushlan et al. 2002). Especially valuable are local programs that offer individuals opportunities for life-changing experiences through real world engagement with waterbirds and their habitats. That said, reaching some audiences, particularly younger ones, likely will not be effective today without the savvy use of the internet and other digital and social media.

The numerous environmental education programs already in existence offer great opportunities for collaboration and partnership to advance the conservation of waterbirds and other species. The multiple joint ventures and conservation initiatives active in the BCR 32 region have already spent considerable effort in identifying and implementing goals for outreach and education to further the conservation and stewardship of wetland-dependent birds. Although waterfowl, shorebirds, waterbirds, and marsh landbirds have somewhat different life history requirements, they still have in common basic biological needs, including an adequate water supply, uncontaminated habitat, rich food resources, and shelter. Because of these commonalities, goals and strategies of outreach and education programs usually are applicable to all groups of wetland-dependent birds. Hence, this section draws heavily on strategies recommended by joint ventures and regional conservation plans that focus on wetland-dependent birds in and adjacent to the BCR 32 region (Steele and Schafer 2001, Kushlan et al. 2002, Hickey et al. 2003, Ivey and Herziger 2006, Sonoran Joint Venture 2008). Although stressing strategies applicable across multiple species and species groups, there will be instances where education is needed to address threats particularly relevant to waterbirds or individual species.

KEY MESSAGES

Although waterbirds have unique characteristics and needs, they share their habitats with a host of other animal species, including waterfowl, shorebirds, marsh landbirds, mammals, reptiles, amphibians, invertebrates, and, of course, humans. Just as we all share the same planet, all of these species likewise must share the resources of their common habitats. Hence, efforts to conserve and protect waterbirds will necessarily require a multi-species, ecosystem approach.

Equally as crucial, educators, resource managers, and conservationists will need to reach diverse audiences with clear, concise, and accurate information on how to maintain or increase waterbird populations by enhancing habitats and reducing threats. Although it is important that such information be science based, it may be even more vital to foster trust and inclusivity, identify common ground, and engage constituents in field experiences and restoration projects to fuel their passion and commitment to waterbird conservation.

Some other key overarching messages regarding waterbirds:

- Waterbirds comprise a diverse collection of taxonomic groups (loons; grebes; pelican and cormorants; herons, egrets, night-herons, and bitterns; ibis; rails and coots; cranes; gulls, terns, and skimmers) and foraging guilds

that depend primarily on wetlands or moist or wet agricultural fields or uplands.
- Because of its mild climate and diverse habitats, the Coastal California region hosts waterbirds populations of regional and continental importance.
- Waterbirds, like all wildlife, require specific habitats (or habitat features) to complete critical phases of their life cycle.
- Key habitats for waterbirds vary locally and regionally, ranging from coastal bays, estuaries, beaches, tidal marshes, and lagoons to adjacent or inland freshwater marshes, lakes, reservoirs, rivers, irrigated agricultural fields, pastures, and more.
- Many of these habitats are greatly reduced from historical levels, currently threatened, dominated by human activities, or replaced by non-compatible land uses.
- Managing to create, restore, or enhance habitats and food resources for waterbirds can be challenging not only because such needs may vary greatly across seasons (breeding, migration, winter) and among waterbird species, but such efforts also must balance the needs of other wildlife and humans.
- Increasing the challenges of managing for waterbirds is a paucity of scientific information on their biology and ecology relative to that available for some other wetland birds such as waterfowl.
- Still, landowners and land stewards can manage for waterbirds without sacrificing other objectives.
- The threats faced by waterbirds in this region though many and varied are not insurmountable. Key issues include habitat loss and degradation; changing or detrimental practices in altered habitats; poor or toxic water quality and oil spills; increasing competition for water; diseases; subsidized and introduced predators; invasive species; human disturbance; conflicts with human interests; inter-species conflicts; and the long-term effects of climate change and sea-level rise.
- Water is a critical limited resource under increasing demand that must be managed effectively to meet the needs of both wildlife and humans.
- Water needed for waterbirds must be of high quality, in sufficient quantity, and available at the proper season.
- Many waterbirds rely on ephemeral shallow-water habitat, which in the past occurred much more frequently before dynamic flooding events were curtailed. Thus, processes that encourage dynamism should be encouraged where appropriate.
- Despite their adaptability, waterbirds rely on reasonably predictable food and resting areas at key migratory stopovers, wintering areas, and breeding sites.
- Some waterbirds nesting in urban or other areas of high human use are almost entirely dependent on ongoing active management for their survival.
- Wetlands not only support waterbirds and other wildlife populations but also benefit humans by improving water quality by filtering contaminants and excess nutrients, providing flood control, and nourishing the food chain of commercially and recreationally important fish and shellfish populations.

Objectives and Strategies

Regional Coordinator

Although active environmental educations programs and conservation initiatives can do much to advance conservation of waterbirds through their current outreach activities, it would be valuable to have a dedicated education position to coordinate outreach efforts in the Coastal California region for all groups of wetland-dependent birds. To be most effective, it would be best to have a funded position, perhaps shared across the Central Valley, San Francisco Bay, and Sonoran joint ventures. Such a coordinator could work with the outreach committees of the joint ventures and form partnerships with a broad coalition of other groups active in environmental education or other outreach activities.

In working with other groups, the following are some strategies to maximize overall effectiveness for conveying messages about the conservation of waterbirds and other wetland-dependent birds.

Target Audiences

To best tailor messages about conservation of wetland-dependent birds, it is important to identify key target audiences and stakeholder groups and the strategies to effectively reach them given their focus, orientation, and concerns. Because of the rich human diversity of California, effective communication will require multi-lingual information exchange. Likewise, varied and creative communication tools and strategies will help reach the widest audience. Although this section is organized by key audiences, in practice there will be many times when programs or outreach materials will inform more than one group.

Private landowners and land stewards

This group is composed of farmers, ranchers, irrigation districts, water districts, power companies and others who manage land for agricultural production, water delivery, power generation, or other resource production or delivery purposes. Key strategies for informing and supporting private landowners and land stewards include:
- Taking time to both sit down and get in the field to listen to concerns, constraints, and uncertainties that landowners and resource deliverers face in their day-to-day operations before proposing new management practices.
- Promoting workshops with specific groups of likeminded stakeholders (e.g., water delivery agencies, single-crop farmer groups) to share information and brainstorm ideas for new practices that may benefit waterbirds while maintaining efficiencies and profitability of their operations.
- Informing farmers and ranchers of the full range of avail-

able government incentive programs that promote wildlife conservation on agricultural lands and the ones that may be best suited for their particular circumstances (see Gray 2009; www.nabci-us.org/aboutnabci/FBGuide1.pdf).
- Informing stakeholders of other programs that provide incentives to landowners for restoration and conservation.
- Engaging individual growers and landowners to allow research on their properties that will study which practices will benefit wildlife while maintaining sustainable and profitable agriculture. When beneficial practices are identified, disseminate this information broadly to other growers and landowners to promote their adoption so that wildlife benefits can be expanded over the largest possible geographic area.
- Reaching private landowners through flyers, brochures, pocket guides, posters, and talks at local grower's clubs and associations, NRCS Resource Conservation Districts, water and power conferences, etc.
- Partnering growers with organizers of bird festivals to bring participants out to working lands to observe wildlife and learn about farming practices that benefit waterbirds.
- Bringing groups of stakeholders into the field to observe wildlife and share with them knowledge of the life histories of waterbirds that depend on and coexist with properly managed habitats.
- Writing articles about waterbirds for stakeholder newsletters to communicate the need for proper habitat management; reprinting these for additional one-on-one distribution and sparking conversations.

Resources users

This group comprises a broad cross-section of society who use public and private lands for recreation: fisherman, hunters, off-highway vehicle users, boaters and other watercraft users, and various other outdoor recreation enthusiasts such as birders, hikers, dog walkers, etc. Key strategies for informing and supporting resource users include:
- Submitting articles on waterbirds to magazines that target particular user groups, tailoring the information so it is most relevant to each group.
- Emphasizing to users that conservation of habitats important to waterbirds helps maintain open space and enhances the resource values of the lands that support their recreational activities.
- Educating users about sensitive habitats or habitat features for waterbirds that they should avoid or maintain safe distances from when pursuing their activities. Such areas to avoid include colony nesting sites, key roosting sites, and important foraging areas.
- Noting that while seasonal or local closures may be necessary to protect waterbirds that large areas will still be available for recreation.
- Educating users about mortality of waterbirds from discarded fishing line and plastic six-pack holders, propellers of boats operated close to diving waterbirds, and lead shot ingested by waterbirds.
- Providing informative signage and educations materials at key focal points, such as boat docks, kayak launching sites, campgrounds, day use areas, visitors centers, trailheads, small stores at recreation areas, outdoor recreation stores in urban areas, or other sites where outdoor enthusiasts congregate.
- Being strategic about signage in considering whether it might do more harm than good in drawing attention to colonies in areas where enforcement is limited or lacking.
- Giving presentations on waterbirds at meetings or conferences of specific user groups, tailoring the message to particular activities engaged in by the audience and the relevant species and habitats likely to be encountered.
- Leading field trips to observe waterbirds in areas used for recreational activities.

Educators

This audience is composed of school teachers, students, and educators in both the public and private arenas. Key strategies for informing and supporting this key constituency include:
- Developing activities, curriculums, wetland kits, brochures, posters, and online information resources that are specific to waterbird biology, ecology, and conservation.
- Using these resources to inform local educators and students but also to reach larger audiences by sharing them through environmental education clearinghouses, such as Environment for the America's Bird Education Resource Directory (http://birdday.org/education/resource-index).
- Leading field trips to educate young people about waterbirds, their habitats, and conservation challenges they face.
- Actively involving young people in habitat restoration projects that will benefit waterbirds.
- Informing educators of volunteer opportunities or scholarships for young people to attend conferences or workshops to connect them with inspirational people actively engaged in the study and conservation of waterbirds.
- Challenging students to engage in problem solving by documenting environmental degradation that affects waterbirds, highlighting solutions to restore or enhance habitats, and using this information to foster widespread awareness of the need to overcome environmental, social, and economic issues that hinder effective conservation of waterbirds.

Land managers

Those managing federal, state, local, or private parks, refuges, wildlife areas, and reserves already manage their lands for wildlife and compatible uses and likely will be receptive to adopting new innovative practices that will benefit wetland birds. Key strategies for informing and supporting land managers include:

- Getting land managers and biologists into the field together to share knowledge, technical expertise, and ideas, and to discuss the kinds of information that managers need and how biologists and researchers might provide it.
- Developing clear and concise messages for advising managers on best conservation practices via presentations, workshops, videos, booklets, brochures, handouts, and interactive online decision-support tools.
- Developing a waterbird management manual, along the lines of one done for shorebirds (Helmers 1992), as a primary source for summaries of habitat and water needs, ecology, and best management practices for waterbirds and how these vary among habitats and waterbird species.
- Providing technical knowledge to inform updates of agency management plans.
- Emphasizing to managers the importance of collaborating with broad-scale inventory and monitoring projects needed to inform improved conservation outcomes for waterbirds.
- Holding workshops to inform managers of current monitoring programs and to seek their advice on what types of monitoring data would help them in managing for waterbirds.
- Collaborating with managers to develop and install proper signage to inform the public on actions needed to protect and enhance habitats for waterbirds.
- Promoting volunteerism to help managers implement restoration projects, control noxious weeds, and monitor long-term population trends of waterbirds or their response to specific management practices.
- Providing information to guide restoration projects that would benefit waterbirds.

General public

This means almost everyone, including our families, friends, work associates, members of civic organizations, service or social clubs, and the like. Key strategies for educating the public about waterbirds include:

- Giving presentations at gatherings to inspire appreciation and foster a positive sentiment for waterbirds in general and the aesthetic and practical benefits these birds and their habitats provide to us and our communities.
- Sharing knowledge and enthusiasm for waterbirds and the natural world through informal outings or, simply, animated conversation.
- Leading field trips to nearby habitats to observe waterbirds and awaken an interest and appreciation for these and other species. Following up with brochures, birding trail maps, website links, or other resources that will further their appreciation and opportunities to see and learn about waterbirds.
- Providing kiosks with information about waterbirds at key viewing areas.
- Installing striking statues, paintings, or other artwork of waterbirds at prominent locations in public spaces.
- Developing real-time video feeds on the internet showing behaviors at nest sites or other areas where waterbirds regularly congregate.
- Developing, recommending, or sharing videos, movies, or TV programs that highlight the beauty of waterbirds and honor the complex ecological role they play in the environment.
- Using science-based facts to allay concerns about fish-eating waterbirds (e.g., most have little impact on commercial or recreational interests, and when they do they can be managed effectively) or diseases carried by mosquitoes in wetland habitats (e.g., West Nile virus).
- Offering practical advice on how to tactfully resolve occasional conflicts with waterbirds, such as egrets and night-herons establishing colonies in trees in parks, marinas, or residential yards.

Policy makers

It is very important to inform federal, state, and local legislators, council members, resource boards, or others who pass legislation or set policy of the importance of waterbirds and their habitats. Key elements of a strategy to educate and influence policy makers include:

- Demonstrating the broad support for waterbirds and key wetland and agricultural habitats by inviting policy makers to attend multi-partner gatherings to celebrate conservation success stories.
- Informing policy makers of science-based facts and positive public sentiment for waterbirds when decisions are required that will influence wetland or irrigated agricultural habitats needed by these birds.
- Providing opportunities at wetland or agricultural conferences for decision makers to give presentations on their perspective on relevant policy issues that affect wildlife.
- Emphasizing specific policies or regulations that if incorporated in laws or ordinances would have the greatest benefits for protecting or enhancing populations of waterbirds.
- Suggesting solutions to resource conflicts that will serve both human and wildlife needs.
- Educating policy makers of the need for full funding for current agricultural incentive programs and habitat restoration and enhancement projects and the need for additional funding for currently unmet needs.
- Emphasizing that funding for research is also important to enable optimal effectiveness of habitat and incentive programs.

CHAPTER 10

Funding Needs and Sources

The costs of restoring and enhancing habitat and conducting monitoring, research, and outreach for waterbirds in BCR 32 will be enormous but are difficult to estimate. Still, it is safe to say that all of these costs will increase in future years.

WETLAND RESTORATION COSTS

Although habitat goals for waterbirds are unavailable for much of BCR 32, preliminary goals for the Central Valley allow some rough estimates of costs for habitat restoration for waterbirds in that region. The BCR 32 plan estimates that habitat needs for waterbirds in the Central Valley (exclusive of those met by obtaining current goals for waterfowl) total about 16,790–21,554 acres: 6790–9054 of early flooded seasonal wetlands for post-breeding waterbirds, 7500–10,000 acres of semi-permanent wetlands for breeding waterbirds, and 2500 acres of late-season seasonal wetlands for breeding waterbirds. The CVJV (2006) estimated the cost of restoration of both seasonal and semi-permanent wetlands at $3000/acre, inclusive of construction costs, staff time for design and permitting, easement costs to landowners, etc. Hence, the cost of meeting estimated BCR 32 habitat needs for waterbirds in the Central Valley would be roughly $50.4 to $64.7 million. The CVJV did not estimate the costs of wetland enhancement or of acquiring reliable water because costs for these factors, respectively, vary widely by project and among years.

The San Francisco Bay Joint Venture (Steere and Schaefer 2001) estimated that bay restoration projects, which formerly often meant only breaching a dike, now may cost from $4,000 to $20,000/acre to account for extensive grading, planting, new dike construction, or temporary irrigation. The SFBJV further estimated the cost of reaching its overall habitat objectives over the next 20 years at $1.7 billion, with the total swelling to $3.8 billion if a higher cost estimate of $20,000/acre is used. Regardless, it is unclear how much of the SFBJV's habitat acreage objectives would benefit waterbirds. The South Bay Salt Pond Restoration Project alone, through its Phase 1, has a price tag of about $208 million; $100 million of this was for acquisition, the remainder for initial stewardship, long-term planning, restoration, and various studies (SBSPRP 2009).

SPECIES-SPECIFIC FUNDING

In some cases, costs estimates are available for multi-faceted conservation projects for individual species. For example, Ivey (2004) developed four-year budgets for conservation programs for Western and Clark's grebes at eight sites in California, including three in BCR 32. Each of these projects included at least two of the following components: educating the public, seasonal closures of nesting colonies, installation of wave barriers, improvement of nesting habitat, or monitoring and evaluating colonies. Costs of the individual projects ranged from about $180,000 to $233,000 for the three largest sites to $4,000 to $36,000 for the five smaller ones.

FUNDING SOURCES

Because of the great need, funds for waterbird conservation in BCR 32 must come from a variety of sources and will require the collaborative efforts of many agencies, organizations, and individuals to secure them. Primary funding sources for wetland restoration and enhancement in the Central Valley are grants from the North American Wetland Conservation Act (NAWCA) and the various incentive-based conservation programs authorized under the federal Farm Bill (see Gray 2009 for a description of the individual programs).

For coastal California, both the San Francisco Bay Joint Venture (www.sfbayjv.org/grants.php) and the Southern California Wetlands Recovery Project (www.scwrp.org/funding.htm) maintain extensive listings of federal, state, local agency, and private funding sources suitable for wetland restoration and enhancement.

CHAPTER 11

Implementation and Coordination

The Coastal California (BCR 32) Waterbird Conservation Plan should be implemented in alignment with the goals of the North American Waterbird Conservation Plan (Kushlan et al. 2002) in coordination with the sponsoring Waterbird Conservation for the Americas initiative (www.waterbirdconservation.org). Effective on-the-ground conservation of waterbirds in the Coastal California region will require the collaborative efforts of a broad coalition of public and private agencies, conservation organizations, interest groups, and individuals. It will be crucial to coordinate with well-established consortiums such as the various joint ventures of the North American Waterfowl Management Plan. Three of the continent's 18 joint ventures—the Central Valley, San Francisco Bay, and Sonoran—encompass large portions of BCR 32, with the geographic limits of the former two lying entirely within this region. It would be appropriate for these JVs to take lead roles in implementing the waterbird conservation plan in their respective portions of BCR 32.

Of the three, the Central Valley Joint Venture (CVJV) covers the largest geographic area, California's expansive Central Valley in the heart of the state. The CVJV Management Board consists of 21 partnering agencies and organizations (www.centralvalleyjointventure.org/partnership/cvjv-partners). The CVJV promotes goals and strategies for the conservation of waterbirds through its current overarching implementation plan (CVJV 2006) and its specific monitoring and evaluation plan for shorebirds and waterbirds (CVJV 2009). The Central Valley Shorebird-Waterbird Working Group—a subcommittee of the CVJV's Technical Committee—provides technical guidance on waterbird conservation issues in the region and is active in planning, implementation, and evaluation of the JV's goals for waterbirds and waterbird habitat. The shorebird-waterbird group also coordinates with the JV's waterfowl working group on common habitat and conservation issues in the Central Valley.

The San Francisco Bay Joint Venture (SFBJV) encompasses all or large parts of nine counties surrounding the San Francisco Bay estuary, by far the largest wetland system on the California coast. The SFBJV's Management Board comprises 26 agencies and organizations (www.sfbayjv.org/partners.php). The SFBJV Conservation Delivery Committee provides technical guidance and executes the JV's implementation strategy.

The Sonoran Joint Venture (SJV) encompasses all or part of 10 BCRs, mainly in desert regions of southern California, southern Nevada, Arizona, and Baja California and Sonora, Mexico. It does, however, include the U.S. portion of BCR 32 from Point Conception to (and beyond) the Mexican border. The SJV's Management Board is a bi-national coalition of 18 organizations and agencies. The SJV's Technical Committee provides technical guidance for biological planning, recommendations, prioritization, and evaluation and translates goals and objective of the various bird initiatives to meaningful goals and objectives at the JV, BCR, state, and local scales. It would be valuable for the SJV to coordinate with the Southern California Wetlands Recovery Project (SCWRP), which overlaps with the SJV's footprint on the southern coast. The SCWRP aims to accelerate the pace, extent, and effectiveness of coastal wetland restoration by developing and implementing a regional prioritization plan for the acquisition, restoration, and enhancement of coastal wetlands and watersheds (www.scwrp.org).

Some parts of BCR 32 do not fall within the boundaries of any of the joint ventures. These areas include eastern Napa County north of San Francisco Bay and the central coast of California encompassing all or most of Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara counties. The gap in Napa County could easily be bridged by incorporation of this area either in the CVJV or SFBJV. Despite a lack of overarching conservation planning in the central coast region, some of the coastal estuaries in this area (e.g., Elkhorn Slough) are managed to maintain and enhance wetland habitats. It would be valuable to link these efforts

with those at other central coast estuaries and to form a coalition to implement the waterbird conservation plan in this region. A list of organizations and agencies with management or regulatory responsibilities in the California coastal zone that might participate in waterbird conservation planning can be found in Hickey et al. (2003, Appendix E).

Beyond coordinating with JV's of the North American Waterfowl Management Plan, it will be crucial to integrate waterbird conservation efforts with those of other major conservation initiatives, including the U.S. Shorebird Conservation Plan, Partners in Flight, and the overarching North American Bird Conservation Initiative.

Like other states, California has developed a comprehensive wildlife action plan that outlines steps to conserve wildlife and key habitats before they become increasingly rare and difficult to protect (CDFG 2007). Conservation efforts recommended in the waterbird conservation plan should be coordinated with those in the wildlife action plan. Similarly, updates of the latter plan should incorporate relevant materials from the waterbird conservation plan.

LITERATURE CITED

Accurso, L. M. 1992. Distribution and abundance of wintering waterfowl on San Francisco Bay 1988–1990. Unpublished Master's thesis, Humboldt State Univ., Arcata, Calif.

Ackerman, J. T., C. A. Eagles-Smith, G. H. Heinz, S. E. Wainright–De La Cruz, J. Y. Takekawa, T. L. Adelsbach, A. K. Miles, D. J. Hoffman, S. E. Schwarzbach, T. H. Suchanek, and T. C. Maurer. 2007. Mercury in birds of the San Francisco Bay–Delta: Trophic pathways, bioaccumulation, and ecotoxicological risk to avian reproduction. 2006 annual administrative report, U.S. Geological Survey, Western Ecological Research Station, Davis, and U.S. Fish & Wildlife Serv., Environmental Contaminants Division, Sacramento. Available at www.werc.usgs.gov/ProductDetails.aspx?ID=3472.

Ackerman, J. T., J. Y. Takekawa, C. Strong, N. Athearn, and A. Rex. 2006. California Gull distribution, abundance, and predation on waterbird eggs and chicks in south San Francisco Bay. Final report of U.S. Geological Survey, Western Ecological Research Center, Davis and Vallejo, Calif. Available at www.werc.usgs.gov/ProductDetails.aspx?ID=3361.

Acosta, S., J. Thayer, M. Pitkin, W. Merkle, and C. Hellwig. 2006. Ecological studies of nesting seabirds on Alcatraz Island, 2006. Draft report to Golden Gate National Recreation Area, Fort Mason, Bldg. 210, San Francisco, CA 94123. Available at http://sfnps.org/download_product/2751/0.

Adkins, J. Y., D. D. Roby, and 27 alphabetically listed co-authors. 2010. A status assessment of the Double-crested Cormorant (*Phalacrocorax auritus*) in western North America: 1998–2009. Final report to U.S. Army Corps of Engineers, Portland District, 333 SW First Ave., Portland, OR 97204. Available at www.birdresearchnw.org/CEDocuments/Downloads_GetFile.aspx?id=385086&fd=0.

Aigner, P. A., J. Tecklin, and C. E. Koehler. 1995. Probable breeding population of the Black Rail in Yuba County, California. Western Birds 26:157–160.

Akçakaya, H. R., J. L. Atwood, D. Breininger, C. T. Collins, and B. Duncan. 2003. Metapopulation dynamics of the California Least Tern. Journal of Wildlife Management 67:829–842.

Albertson, J. D. 1995. Ecology of the California Clapper Rail in South San Francisco Bay. M.A. thesis. San Francisco State University, San Francisco.

Albertson, J. D., and J. G. Evens. 2000. California Clapper Rail (*Rallus longirostris obsoletus*), in Baylands ecosystem species and community profiles: Life histories and environmental requirements of key plants, fish, and wildlife (P. R. Olofson, ed.), pp. 332–341. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif. Available at http://sfep.sfei.org/wp-content/uploads/2012/12/1Species_and_Community_Profiles.pdf.

American Farmland Trust. 1995. Alternatives for future urban growth in California's Central Valley: The bottom line for agriculture and taxpayers. American Farmland Trust, 1200 18th St. NW, Suite 800, Washington, DC 20036. Available at www.farmland.org/programs/states/futureisnow/default.asp.

American Ornithologists' Union. 1957. Check-list of North American Birds, 5th ed. Am. Ornithol. Union, Baltimore.

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th ed. Am. Ornithol. Union, Washington, DC.

Anderson, D. W. 2007. Western and Clark's grebe conservation and management at Clear Lake, California: Annual report for year 2 (2006). Unpublished report to the National Fish and Wildlife Foundation and the American Trader Trustee Council. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=17836.

Anderson, D. W., C. J. Henny, C. Godinez-Reyes, F. Gress, E. L. Palacios, K. Santos del Prado, and J. Bredy. 2007. Size of the California Brown Pelican metapopulation during a non–El Niño Year. Open-File Report 2007-1299, U.S. Geological Survey, Reston, Virginia. Available at http://pubs.usgs.gov/of/2007/1299.

Anderson, D. W., D. T. King, and J. Coulson, eds. 2005. The biology and conservation of the American White Pelican. Waterbirds (Special Publ. 1) 28.

Anderson, D. W., T. H. Suchanek, C. A. Eagles-Smith, and T. M. Cahill Jr. 2008. Mercury residues and productivity in Osprey and grebes from a mine-dominated ecosystem. Ecological Applications 18 (Supplement): A227–A238.

Anonymous. 2007. San Diego Bay: Integrated Natural Resources Management Plan Preliminary Draft. Available at http://sdbayinrmp.org/2lib.draft.htm.

Ayres, D. R., D. L. Smith, K. Zaremba, S. Klohr, and D. R. Strong. 2004. Spread of exotic cordgrasses and hybrids (*Spartina* sp.) in the tidal marshes of San Francisco Bay, California, USA. Biological Invasions 6:221–231.

Baltz, D. M., G. V. Morejohn, and B. S. Antrim. 1979. Size selective predation and food habits of two California terns. Western Birds 10:17–24.

(San Francisco) Bay Conservation and Development Commission (BCDC). 2011. Living with a rising bay: Vulnerability and adaptation in San Francisco Bay and on its shoreline. Staff report. San Francisco Bay Conservation and Development Commission, 50 California St., Suite 2600, San Francisco, CA 94111. Available at www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf.

The Bay Institute. 1998. From the Sierra to the sea: The ecological history of the San Francisco Bay–Delta watershed. Report of The Bay Institute of San Francisco, 55 Shaver St., Suite 330, San Rafael, CA 94901. Available at www.bay.org/publications.

Belluomini, L. A. 1978. Statewide heron rookery inventory. Nongame Wildl. Investigations Rep., Proj. W-54-R-10, Job IV-1, Calif. Dept. Fish & Game, Sacramento.

Berner, M., B. Grummer, R. Leong, and M. Rippey. 2003. Breeding Birds of Napa County, California: An Illustrated Atlas of Nesting Birds. Napa-Solano Audubon Soc., Vallejo, Calif.

Beyersbergen, G. W., N. D. Niemuth, and M. R. Norton, coordinators. 2004. Northern Prairie and Parkland Waterbird Conservation Plan: A plan associated with the Waterbird Conservation for the Americas initiative. Prairie Pothole Joint Venture, Denver, CO. Available at www.waterbirdconservation.org/northern_prairie_parklands.html.

Boarman, W. I. 2003. Managing a subsidized predator population: Reducing Common Raven predation on Desert Tortoises. Environmental Management 32:205–217.

Bookhout, T. A. 1995. Yellow Rail (*Coturnicops noveboracensis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 139. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Bousman, W. G. 2007. Breeding Bird Atlas of Santa Clara County, California. Santa Clara Valley Audubon Society, Cupertino.

Bradford, D. F. 1992. Potential sites and mechanisms for creating wetland habitat in the southern San Joaquin Valley. Final report for Calif. Dept. Water Resources, Sacramento. Available from Calif. Dept. Water Resources, Publications and Paperwork Management Office, P.O. Box 942836, Sacramento, CA 94236-0001.

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The United States Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, P. O. Box 1770, Manomet, MA 02345. Available at www.shorebirdplan.org/plan-and-council.

Buckley, P. A., and F. G. Buckley. 2002. Royal Tern (*Sterna maxima*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 700. Birds N. Am., Philadelphia.

Burness, G. P., K. Lefevre, and C. T. Collins. 1999. Elegant Tern (*Sterna elegans*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 404. Birds N. Am., Philadelphia.

Burridge, B., ed. 1995. Sonoma County Breeding Bird Atlas. Madrone Audubon Soc., Santa Rosa, Calif. Available at http://audubon.sonoma.net/birding/scbba1995.pdf.

Butler, R. W., J. A. Kushlan, and I. J. Davidson. 2000. Herons in North America, Central America and the West Indies, in Heron Conservation (J. A. Kushlan and H. Hafner, eds.), pp. 151–175. Academic Press, San Diego.

Bystrak, D. 1981. The North American Breeding Bird Survey. Studies in Avian Biology 6:34–41.

Caldow, R. W. G., R. A. Stillman, S. E. A. le V. dit Durell, A. D. West, S. McGrorty, J. D. Goss-Custard, P. J. Wood, and J. Humphreys. 2007. Benefits to shorebirds from invasion of a non-native shellfish. Proceedings Royal Society B 274:1449–1455.

California Department of Fish and Game (CDFG). 2007. California wildlife: Conservation challenges (California's Wildlife Action Plan). Report of Calif. Dept. Fish & Game prepared by the Wildlife Diversity Project, Wildlife Health Center, Univ. Calif., Davis. Available at www.dfg.ca.gov/SWAP/2005/docs/SWAP/2005.pdf.

California Partners in Flight (B. Allen, lead author). 2000. The draft grassland bird conservation plan: A strategy for protecting and managing grassland habitats and associated birds in California. Version 1.0. Point Reyes Bird Observatory, 4990 Shoreline Hwy. 1, Stinson Beach, CA 94970. Available at www.prbo.org/calpif/plans.html.

California Partners in Flight (S. Zack, lead author). 2002. The oak woodland bird conservation plan: A strategy for protecting and managing oak woodland habitats and associated birds in California. Version 2.0. Point Reyes Bird Observatory, 4990 Shoreline Hwy. 1, Stinson Beach, CA 94970. Available at www.prbo.org/calpif/plans.html.

Carney, K. M., and W. J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68–79.

Carney, K. M., and W. J. Sydeman. 2000. Response: Disturbance, habituation and management of waterbirds. Waterbirds 23:333–334.

Carter, H. R., G. J. McChesney, D. L. Jaques, C. S. Strong, M. W. Parker, J. E. Takekawa, D. L. Jory, and D. L. Whitworth. 1992. Breeding populations of seabirds in California, 1989–1991. Unpublished draft report, U.S. Fish & Wildl. Serv., Northern Prairie Wildl. Research Ctr., 6924 Tremont Rd., Dixon, CA 95620. Available from Carter Biol. Consulting, 1015 Hampshire Rd., Victoria, BC V8S 4S8, Canada.

Carter, H. C., A. L. Sowls, M. S. Rodway, U. W. Wilson, R. W. Lowe, G. J. McChesney, F. Gress, and D. W. Anderson. 1995. Population size, trends, and conservation problems of the Double-crested Cormorant on the Pacific coast of North America. Colonial Waterbirds 18 (Special Publ. 1): 189–215.

Cavagnaro, T., L. Jackson, and K. Scow. 2006. Climate change: Challenges and solutions for California agricultural landscapes. A paper (CEC-500-2005-189-SF) from the California Climate Change Center. California Energy Commission, Sacramento. Available at www.energy.ca.gov/2005publications/CEC-500-2005-189/CEC-500-2005-189-SF.PDF.

Central Valley Joint Venture (CVJV). 2006. Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat. U.S. Fish & Wildl. Serv., Sacramento. Available at www.centralvalleyjointventure.org/science.

Central Valley Joint Venture (CVJV). 2009. Central Valley Joint Venture Monitoring and Evaluation Plan: Shorebirds and Waterbirds. U.S. Fish & Wildl. Serv., Sacramento. Available at www.centralvalleyjointventure.org/assets/pdf/cvjv_shorebird_plan.pdf.

Cohen, A. N. 2011. The exotics guide: Non-native marine species of the North American Pacific coast. Center for Research on Aquatic Bioinvasions, Richmond, CA, and San Francisco Estuary Institute, Oakland. Available at www.exoticsguide.org.

Cohen, A. N., and J. T. Carlton. 1995. Nonindigenous aquatic species in a United States estuary: A case study of the biological invasions of the San Francisco Bay and Delta. A report to U.S. Fish

& Wildl. Serv., Washington, DC, and the National Sea Grant College Program Connecticut Sea Grant. Available at http://nsgl.gso.uri.edu/conn/connt95002/connt95002index.html.

Collar, N., M. J. Crosby, and A. J. Stattersfield. 1994. Birds to watch 2: The world list of threatened birds. BirdLife Conservation Series no. 4, BirdLife International, Cambridge, UK.

Collins, C. T., and K. L. Garrett. 1996. The Black Skimmer in California: An overview. Western Birds 27:127–135.

Collins, C. T., W. A. Schew, and E. Burkett. 1991. Elegant Terns breeding in Orange County, California. American Birds 45:393–395.

Connolly, L. M., and M. A. Colwell. 2005. Comparative use of longline oysterbeds and adjacent mudflats by waterbirds. Bird Conservation International 15:237–255.

Conroy, M. J., R. J. Cooper, S. A. Rush, K. W. Stodola, B. L. Nuse, and M. S. Woodrey. 2010. Effective use of data from marshbird monitoring programs for conservation decision-making. Waterbirds 33:397–404.

Conway, C. J. 2009. Standardized North American marsh bird monitoring protocols. Wildlife Research Report 2009-02. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, Arizona. Available at www.cals.arizona.edu/research/azfwru/NationalMarshBird (click on field methods, download survey protocol).

Cooper, D. S. 2004. Important Bird Areas of California. Audubon California, Pasadena.

Creekmore, L. H. 1999. Algal toxins, in Field manual of wildlife diseases: General field procedures and diseases of birds (M. Friend and J. C. Franson, technical editors), Chapter 36, pp. 261–266. Biological Resources Division Information and Technology Report 1999-001. U.S. Geological Survey, Washington, DC. Available at www.nwhc.usgs.gov/publications/field_manual.

Crossett, K. M., T. J. Culliton, P. C. Wiley, and T. R. Goodspeed. 2004. Population trends along the coastal United States: 1980–2008. Coastal Trends Report Series, U.S. Dept. Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. Available at www.oceanservice.noaa.gov/programs/mb/supp_cstl_population.html.

Crouch, S., C. Paquette, and D. Vilas. 2002. Relocation of a large Black-crowned Night-Heron colony in southern California. Waterbirds 25:474–478.

Cullen, S. A., J. R. Jehl Jr., and G. L. Nuechterlein. 1999. Eared Grebe (*Podiceps nigricollis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 433. Birds N. Am., Philadelphia.

Cuthbert, F. J., and L. R. Wires. 1999. Caspian Tern (*Sterna caspia*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 403. Birds N. Am., Philadelphia.

Dahl, T. E., R. D. Young, and M. C. Caldwell. 1997. Status and trends of wetlands in the conterminous United States. U.S. Dept. Interior, Fish & Wildl. Serv., Washington, DC.

Dakin, R. E. 2000. Nest site selection by Forster's Terns (*Sterna forsteri*). Unpublished M.S. thesis, San Jose State Univ., San Jose, Calif.

Davis, D. E., C. H. Hanson, and R. B. Hansen. 2005. Constructed wetland habitat for American Avocet and Black-necked Stilt nesting and foraging: Performance monitoring, 1995–2004. Available from Tulare Lake Drainage District, P. O. Box 985, Corcoran, CA 93212.

Davis, D. E., C. H. Hanson, and R. B. Hansen. 2008. Constructed wetland habitat for American Avocet and Black-Necked Stilt foraging and nesting. Journal of Wildlife Management 72:143–151.

Day, J. H., and M. A. Colwell. 1998. Waterbird communities in rice fields subjected to different post-harvest treatments. Colonial Waterbirds 21:185–197.

Dierks, A. J. 1990. Parental care and diet of California Gull (*Larus californicus*) chicks at Alviso, California. M.S. thesis, Moss Landing Marine Labs, San Jose State Univ., San Jose, Calif.

Donaldson, G. M., C. Hyslop, R. I. G. Morrison, H. L. Dickson, and I. Davidson. 2000. Canadian Shorebird Conservation Plan. Available from Canadian Wildlife Service, Environment Canada, Ottawa, Ontario K1A 0H3 or at www.ec.gc.ca/mbc-com/default.asp?lang=En&n=D1610AB7-1.

Doughty, R. W. 1975. Feather Fashions and Bird Preservation: A Study in Nature Protection. Univ. Calif. Press, Berkeley.

Draulans, D. 1987. The effectiveness of attempts to reduce predation by fish-eating birds: A review. Biological Conservation 41:219–232.

Dudley, T. 2000. *Arundo donax*, in Invasive Plants of California's Wildlands (C. C. Bossard, J. M. Randall, and M. C. Hoshovsky, eds.). Univ. Calif. Press, Berkeley. Available at www.cal-ipc.org/ip/management/ipcw/sciname.php.

Dunn, E. H., and D. J. Agro. 1995. Black Tern (*Chlidonias niger*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 147. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Dunn, E. H., C. M. Francis, P. J. Blancher, S. R. Drennan, M. A. Howe, D. Lepage, C. S. Robbins, K. V. Rosenberg, J. R. Sauer, and K. G. Smith. 2005. Enhancing the scientific value of the Christmas Bird Count. Auk 122:338–346.

Eagles-Smith, C. A., J. T. Ackerman, S. W. De La Cruz, T. L. Adelsbach, and J. Y. Takekawa. 2009. Mercury bioaccumulation and risk to three waterbird foraging guilds is influenced by foraging ecology and breeding stage. Environmental Pollution 157:1993–2002.

Earnst, S. L., L. Neel, G. L. Ivey, and T. Zimmerman. 1998. Status of the White-faced Ibis: Breeding colony dynamics of the Great Basin population, 1985–1997. Colonial Waterbirds 21:301–313.

Economics for the Environment Consultancy (eftec). 2005. The economic, social and ecological value of ecosystem services: A literature review. Final report for the Department for Environment, Food, and Rural Affairs. Available from eftec, 16 Percy Street, London W1T 1DT or at http://jncc.defra.gov.uk/page-4025.

Eddleman, W. R., R. E. Flores, and M. L. Legare. 1994. Black Rail (*Laterallus jamaicensis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 123. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Elkhorn Slough National Estuarine Research Reserve (ESNERR). 2006. Elkhorn Slough National Estuarine Research Reserve Final Management Plan 2007–2011. Available at www.elkhornslough.org/esnerr/index.htm.

Erwin, K. L. 2009. Wetlands and global climate change: The role of wetland restoration in a changing world. Wetlands Ecology and Management 17:71–84.

Evans, R. M., and F. L. Knopf. 1993. American White Pelican (*Pelecanus erythrorhynchos*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 57. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Evens, J. G., and N. Nur. 2002. California Black Rails in the San Francisco Bay region: Spatial and temporal variation in distribution and abundance. Bird Populations 6:1–12.

Evens, J. G., and G. W. Page. 1986. Predation on Black Rails during high tides in salt marshes. Condor 88:107–109.

Evens, J. G., G. W. Page, S. A. Laymon, and R. W. Stallcup. 1991. Distribution, relative abundance, and status of the California Black Rail in western North America. Condor 93:952–966.

Evens, J., K. Zaremba, and J. Albertson. 2010. Non-native cordgrass and the California Clapper Rail: Biogeographical overlap between an invasive plant and an endangered bird, in Proceedings of the Third International Conference on Invasive Spartina (D. R. Ayres, D. W. Kerr, S. D. Ericson, and P. R. Olofson, eds.), pp. 185–189. San Francisco Estuary Invasive Spartina Project of the State Coastal Conservancy, Oakland, Calif. Available at www.spartina.org/project_documents/Conference_proceedings.htm.

Evers, D. C. 2004. Status assessment and conservation plan for the Common Loon (*Gavia immer*) in North America. U.S. Fish & Wild. Serv., Hadley, Mass. Available at http://alaska.fws.gov/mbsp/mbm/loons/pdf/Common_Loon_Status_Assessment.pdf.

Fleskes, J. P., W. M. Perry, K. L. Petrik, R. Spell, and F. Reid. 2005a. Changes in area of winter-flooded and dry rice in the northern Central Valley of California determined by satellite imagery. California Fish and Game 91:207–215.

Fleskes, J., J. Yee, M. Casazza, J. Daugherty, and B. Perry. 2000. Waterfowl distribution, movements and habitat use relative to recent habitat changes in the Central Valley of California: A cooperative project to investigate impacts of the Central Valley Habitat Joint Venture and changing agricultural practices on the ecology of wintering waterfowl. Published Progress Report. U.S. Geological Survey, Dixon, Calif.

Fleskes, J. P., J. L. Yee, M. L. Casazza, M. R. Miller, J. Y. Takekawa, and D. L. Orthmeyer. 2005b. Waterfowl distribution, movements, and habitat use relative to recent habitat changes in the Central Valley of California: A cooperative project to investigate impacts of the Central Valley Joint Venture and changing agricultural practices on the ecology of wintering waterfowl. Final report. U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, Dixon, Calif. Available at www.werc.usgs.gov/ProductDetails.aspx?ID=3247.

Foerster, K. S., and J. E. Takekawa. 1991. San Francisco Bay National Wildlife Refuge predator management plan and final environmental assessment. U.S. Fish & Wild. Serv., San Francisco Bay National Wildlife Refuge, P.O. Box 524, Newark, CA 94560.

Food and Agriculture Organization of the United Nations (FAO). 2007. Wild birds and avian Influenza: An introduction to applied field research and disease sampling techniques (D. Whitworth, S. H. Newman, T. Mundkur, and P. Harris, eds.). FAO Animal Production and Health Manual, No. 5. Rome. Available at www.fao.org/docrep/010/a1521e/a1521e00.htm.

Francis, C. M., P. J. Blancher, S. R. Drennan, E. H. Dunn, M. A. Howe, D. Lepage, C. S. Robbins, K. V. Rosenberg, J. R. Sauer, and K. G. Smith. 2004. Improving the Christmas Bird Count: Report of a review panel. American Birds 58:34–43.

Frayer, W. E., D. D. Peters, and H. R. Pywell. 1989. Wetlands of the California Central Valley: Status and trends. U.S. Fish & Wildl. Serv., Portland, OR. Available at www.fws.gov/wetlands/Documents/Wetlands-of-the-California-Central-Valley-Status-and-Trends-1939-to-mid-1980s.pdf.

Friend, M. 1999. Avian cholera, in Field manual of wildlife diseases: General field procedures and diseases of birds (M. Friend and J. C. Franson, technical editors), Chapter 7, pp. 75–92. Biological Resources Division Information and Technology Report 1999-001. U.S. Geological Survey, Washington, DC. Available at www.nwhc.usgs.gov/publications/field_manual.

Friend, M. 2002. Avian disease at the Salton Sea. Hydrobiologia 473:293–306.

Friend, M., and J. C. Franson, technical editors. 1999. Field manual of wildlife diseases: General field procedures and diseases of birds. Biological Resources Division Information and Technology Report 1999-001. U.S. Geological Survey, Washington, DC. Available at www.nwhc.usgs.gov/publications/field_manual.

Gallagher, S. R. 1997. Atlas of Breeding Birds, Orange County, California. Sea and Sage Audubon Soc., Irvine, Calif.

Gazzaniga, K. T. 1996. Overwintering of Black Skimmers in California: Site fidelity and inter-site movements. Western Birds 27:136–142.

Gericke, S. M. 2006a. Exploring the effects of disturbance events on Western and Clark's grebes (*Aechmophorus occidentalis* and *A. clarkii*) at Clear Lake, California. M.S. thesis, University of California, Davis.

Gericke, S. M. 2006b. Western and Clark's grebe conservation and management at Clear Lake, California: Annual report for year one. Unpublished report to the American Trader Trustee Council and National Fish and Wildlife Foundation. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=17832.

Gibbs, J. P., S. Melvin, and F. A. Reid. 1992. American Bittern (*Botaurus lentiginosus*), in The Birds of North America (A. Poole, P. Stettenheim, and F. Gill, eds.), no. 18. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Gilmer, D. S., K. A. Gonzales, M. A. Wolder, and N. R. Graves. 1998. Nongame and upland gamebird surveys on Sacramento Valley National Wildlife Refuges, 1986–1993. Western Birds 29:83–102.

Glaser, L. C., I. K. Barker, D. V. C. Weseloh, J. Ludwig, R. M. Windingstad, D. W. Key, and T. K. Bollinger. 1999. The 1992 epizootic of Newcastle disease in Double-crested Cormorants in North America. Journal of Wildlife Diseases 35:319–330.

Glover, S. 2009. Contra Costa County Breeding Bird Atlas. Mount Diablo Audubon Society, Walnut Creek, Calif. Maps (only) available at www.flyingemu.com/ccosta.

Goals Project. 1999. Baylands Ecosystem Habitat Goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco/S.F. Bay Regional Water Quality Control Board, Oakland, Calif. Available at www.sfei.org/sites/default/files/sfbaygoals031799.pdf.

Goals Project. 2000. Baylands ecosystem species and community profiles: Life histories and environmental requirements of key plants, fish, and wildlife (P. R. Olofson, ed.). Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif. Available at http://sfep.sfei.org/wp-content/uploads/2012/12/1Species_and_Community_Profiles.pdf.

Gochfeld, M., and J. Burger. 1994. Black Skimmer (*Rynchops niger*), in the Birds of North America (A. Poole and F. Gill, eds.), no. 108. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Gould, G. I., Jr. 1973. Statewide heron rookery study. Special Wildl. Investigations Rep., Proj. W-54-R-4, Job III-5, Calif. Dept. Fish & Game, Sacramento.

Gould, G. I., Jr. 1986. Inland nesting waterbird survey. Nongame Wildl. Investigations Rep., Proj. W-65-R-3, Job III-2, Calif. Dept. Fish & Game, Sacramento.

Gould, G. I., Jr. 1987. Inland nesting waterbird survey. Nongame Wildl. Investigations Rep., Proj. W-65-R-4, Job III-2, Calif. Dept. Fish & Game, Sacramento.

Graham, F., Jr. (with C. W. Buchheister). 1990. The Audubon Ark: A History of the National Audubon Society. Alfred A. Knopf, New York.

Gray, R. 2009. Field guide to the 2008 Farm Bill for fish and wildlife conservation. Version 1.1. A publication of the U.S. NABCI Committee and the Intermountain West Joint Venture. Available at www.nabci-us.org/aboutnabci/FBGuide1.pdf.

Grinnell, J., and A. H. Miller. 1944. The distribution of the birds of California. Pac. Coast Avifauna 27.

Hall, W. H. 1880. Drainage of the valleys and the improvement of the navigation of rivers. Report of the State Engineer to the Legislature of the State of California, Session 1880, in three parts.

Harding, E. K., D. F. Doak, and J. D. Albertson. 2001. Evaluating the effectiveness of predator control: The non-native red fox as a case study. Conservation Biology 15:1114–1122.

Hatch, J. J., and D. V. Weseloh. 1999. Double-crested Cormorant (*Phalacrocorax auritus*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 441. Birds N. Am., Philadelphia.

Hattori, M. 2009. Adaptive management of urban wildlife: Resolving human-heron conflicts. Master's thesis. University of California, Davis.

Heitmeyer, M. E., D. P. Connelly, and R. L. Pederson. 1989. The Central, Imperial, and Coachella valleys of California, in Habitat management for migrating and wintering waterfowl in North America (L. M. Smith, R. L. Pederson, and R. M. Kiminski, eds.), pp. 475–505. Texas Tech. Univ. Press, Lubbock, Texas.

Helmers, D. L. 1992. Shorebird management manual. Western Hemisphere Shorebird Reserve Network, Manomet, Mass. Available at www.lmvjv.org/library/Shorebird_Management_Manual_1992.pdf.

Henny, C. J. 1997. DDE still high in White-faced Ibis eggs from Carson Lake, Nevada. Colonial Waterbirds 20:478–484.

Hickey, C., W. D. Shuford, G. W. Page, and S. Warnock. 2003. The Southern Pacific Shorebird Conservation Plan: A strategy for supporting California's Central Valley and coastal shorebird populations. Version 1.1. Available from PRBO Conservation Science, 3820 Cypress Drive #11, Petaluma, CA 94954 or at www.prbo.org/cms/docs/wetlands/SPSCPlan_010904.pdf.

Hothem, R. L., and D. Bergen. 2007. Reproductive success of Black-crowned Night-Herons and Snowy Egrets at Alcatraz Island, San Francisco Bay, California: 2006. USGS Administrative Rep., prepared for Golden Gate National Recreation Area, National Park Service. Available from U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, 6924 Tremont Rd., Dixon, CA 95620 or at www.werc.usgs.gov/ProductDetails.aspx?ID=3444.

Hothem, R. L., and D. Hatch. 2004. Reproductive success of the Black-crowned Night-Heron at Alcatraz Island, San Francisco Bay, California, 1990–2002. Waterbirds 27:112–125.

Hothem, R. L., and A. N. Powell. 2000. Contaminants in eggs of Western Snowy Plovers and California Least Terns: Is there a link to population decline? Bulletin of Environmental Contamination and Toxicology 65:42–50.

Hothem, R. L., D. L. Roster, K. A. King, T. J. Keldsen, K. C. Marois, and S. E. Wainwright. 1995. Spatial and temporal trends of contaminants in eggs of wading birds from San Francisco Bay, California. Environmental Toxicology and Chemistry 14:1319–1331.

Hothem, R. L., and S. G. Zador. 1995. Environmental contaminants in eggs of California Least Terns (*Sterna antillarum browni*). Bulletin of Environmental Contamination and Toxicology 55:658–665.

Howell, S. N. G., and S. Webb. 1995. A Guide to the Birds of Mexico and Northern Central America. Oxford Univ. Press, New York.

Hunt, G. L., Jr., R. L. Pitman, M. Naughton, K. Winnett, A. Newman, P. R. Kelly, and K. T. Briggs. 1981. Reproductive ecology and foraging habits of breeding seabirds, in Summary of marine mammal and seabird surveys of the Southern California Bight area 1975–1978, vol. 3—Investigators' reports, part 3—Seabirds, book 2. Publ. PB-81-248-05, U.S. Dept. Commerce, Natl. Tech. Information Serv., Springfield, Virginia.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Core Writing Team, R. K Pachauri and A Reisinger, eds.). IPCC, Geneva, Switzerland. Available at www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

Ivey, G. L. 2004. Conservation assessment and management plan for breeding Western and Clark's grebes in California. Unpublished report for the American Trader Trustee Council. National Fish and Wildlife Foundation, San Francisco. Available at www.darrp.noaa.gov/southwest/amtrader/pdf/grebe.pdf.

Ivey, G. L. 2005. Mitigating loss of Sandhill Crane habitat in south Sacramento County. Unpublished report to The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632.

Ivey, G. L., and C. P. Herziger. 2001. Distribution of greater sandhill crane pairs in California, 2000. Calif. Dept. Fish & Game, Sacramento.

Ivey, G. L., and C. P. Herziger. 2003. Sandhill Crane monitoring at Staten Island, San Joaquin County, California, 2002-03. Available from The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632 or at www.wccwg.nacwg.org/pdf/staten-cranes.pdf.

Ivey, G. L., and C. P. Herziger, compilers. 2006. Intermountain West Waterbird Conservation Plan. Version 1.2. A plan associated with the Waterbird Conservation for the Americas Initiative. U.S. Fish & Wildl. Serv., Pacific Region, Portland, OR. Available at www.waterbirdconservation.org/intermountain_west.html.

Jackson, L. E., F. Santos-Martin, A. D. Hollander, W. R. Horwath, R. E. Howitt, J. B. Kramer, A. T. O'Geen, B. S. Orlove, J. W. Six, S. K. Sokolow, D. A. Sumner, T. P. Tomich, and S. M. Wheeler. 2009. Potential for adaptation to climate change in an agricultural landscape in the Central Valley of California. A paper (CEC-500-2009-044-F) from the California Climate Change Center. California Energy Commission, Sacramento. Available at www.energy.ca.gov/2009publications/CEC-500-2009-044/CEC-500-2009-044-F.PDF.

Jehl, J. R., Jr., W. S. Boyd, D. S. Paul, and D. W. Anderson. 2002. Massive collapse and rapid rebound: Population dynamics of Eared Grebes (*Podiceps nigricollis*) during an ENSO event. Auk 119:1162–1166.

Johnson, D. H., J. P. Gibbs, M. Herzog, S. Lor, N. D. Niemuth, C. A. Ribic, M. Seamans, T. L. Shaffer, W. G. Shriver, S. V. Stehman, and W. L. Thompson. 2009. A sampling design framework for monitoring secretive marshbirds. Waterbirds 32:203–215.

Johnson, S., G. Haslam, and R. Dawson. 1993. The Great Central Valley: California's Heartland. Univ. Calif. Press, Berkeley.

Jones, P. A. 1986. Aspects of the reproductive biology of the California Gull in Alviso, California. M.A. thesis, San Francisco State Univ., San Francisco.

Josselyn, M. 1983. The ecology of San Francisco Bay tidal marshes: A community profile. FWS/OBS-83/23. U.S. Fish & Wildl. Serv., Division of Biological Services, Washington, DC. Available at www.nwrc.usgs.gov/techrpt/83-23.pdf.

Jurek, R. M. 1994. A bibliography of feral, stray, and free-ranging domestic cats in relation to wildlife conservation. Nongame Bird and Mammal Program Rep. 94-5. Calif. Dept. Fish & Game, Sacramento. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=2938.

Katibah, E. F. 1984. A brief history of riparian forests in the Central Valley of California, in California riparian systems (R. E. Warner and K. M. Hendrix, eds.), pp. 23–29. Univ. Calif. Press, Berkeley.

Kelly, J. P. 2002. Disturbance patterns in heronries: A safe place to nest. Ardeid 2002:1–3. Publication of Audubon Canyon Ranch, Stinson Beach, Calif. Available at www.egret.org/ardeid.

Kelly, J. P., K. L Etienne, and J. E. Roth. 2002. Abundance and distribution of the Common Raven and American Crow in the San Francisco Bay area, California. Western Birds 33:202–217.

Kelly, J. P., K. L. Etienne, and J. E. Roth. 2005. Factors influencing nest predatory behaviors of Common Ravens in heronries. Condor 107:402–415.

Kelly, J. P., K. Etienne, C. Strong, M. McCaustland, and M. Parkes. 2006. Annotated atlas and implications for the conservation of heron and egret nesting colonies in the San Francisco Bay area. ACR Tech. Rep. 90-3-17. Available from Audubon Canyon Ranch, 4990 Shoreline Hwy. 1, Stinson Beach, CA 94970 or at www.egret.org/atlas.

Kelly, J. P., K. L. Etienne, C. Strong, M. McCaustland, and M. L. Parkes. 2007. Status, trends, and implications for the conservation of heron and egret nesting colonies in the San Francisco Bay area. Waterbirds 30:455–478.

Kelly, J. P., J. G. Evens, R. W. Stallcup, and D. Wimpfheimer. 1996. The effects of aquaculture on habitat use of wintering shorebirds. California Fish and Game 82:160–174.

Kelly, J. P., D. Stralberg, K. L. Etienne, and M. McCaustland. 2008. Landscape influences on the quality of heron and egret colony sites. Wetlands 28:257–275.

Kelly, J. P., and S. L. Tappen. 1998. Distribution, abundance, and implications for conservation of winter waterbirds on Tomales Bay, California. Western Birds 29:103–120.

Kempka, R. G., R. P. Kollasch, and J. D. Olson. 1991. Aerial techniques measure shrinking waterfowl habitat. Geo Info Systems. November/December 1991, pp. 48–52. Eugene, OR.

King, K. A., B. J. Zaun, H. M. Schotborgh, and C. Hurt. 2003. DDE-induced eggshell thinning in White-Faced ibis: A continuing problem in the western United States. Southwestern Naturalist 48:356–364.

Klosterhaus, S. L., H. M. Stapleton, M. J. La Guardia, and D. J. Greig. 2012. Brominated and chlorinated flame retardants in San Francisco Bay sediments and wildlife. Environment International 47:56–65.

Komar, N. 2003. West Nile virus: Epidemiology and ecology in North America. Advances in Virus Research 61:185–234.

Kuiken, T. 1999. Review of Newcastle disease in cormorants. Waterbirds 22:333–347.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. Acosta Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan. Version 1. Waterbird Conservation for the Americas, Washington, DC. Available at www.waterbirdconservation.org/nawcp.html.

Layne, V. L., R. J. Richmond, and P. J. Metropulos. 1996. First nesting of Black Skimmers on San Francisco Bay. Western Birds 27:159–162.

Lee, J., S. De Gryze, and J. Six. 2009. Effect of climate change on field crop production in the Central Valley of California. A paper (CEC-500-2009-041-F) from the California Climate Change Center. California Energy Commission, Sacramento. Available at www.energy.ca.gov/2009publications/CEC-500-2009-041/CEC-500-2009-041-D.PDF.

Lee, R. C., Jr. 1984. Nesting biology of the Black Tern (*Chlidonias niger*) in rice fields of the Central Valley, California. Master's thesis, Calif. State Univ., Sacramento.

Liebezeit, J. R., and T. L. George. 2002. A summary of predation by corvids on threatened and endangered species in California and management recommendations to reduce corvid predation. Rep. 2002-02, Species Conservation and Recovery Program, Calif. Dept. Fish & Game, Sacramento. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=2907.

Littlefield, C. D. 2002. Winter foraging habitat of Greater Sandhill Cranes in northern California. Western Birds 33:51–60.

Littlefield, C. D. 2008. Lesser Sandhill Crane (*Grus canadensis canadensis*), in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp. 167–172. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, and Calif. Dept. Fish & Game, Sacramento. Available at www.dfg.ca.gov/wildlife/nongame/ssc/birds.html.

Littlefield, C. D., and G. L. Ivey. 2000. Conservation assessment for Greater Sandhill Cranes wintering on the Cosumnes River floodplain and Delta regions of California. The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632.

Littrell, E. E. 1988. Waterfowl mortality in rice fields treated with the carbamate, carbofuran. California Fish and Game 74:226–231.

Liu, L., J. Wood, N. Nur, D. Stralberg, and M. Herzog. 2009. California Clapper Rail (*Rallus longirostris obsoletus*) population monitoring: 2005–2008. Unpublished report to Calif. Dept. Fish & Game, Stockton. PRBO Conservation Science (Contrib. 1960), 3820 Cypress Dr. #11, Petaluma, CA 94954. Available at www.prbo.org/cms/docs/wetlands/CLRA_DFG_Report_P0630020_FINAL.pdf.

Lobell, D. B., A. Torney, and C. B. Field. 2009. Climate extremes in California agriculture. A paper (CEC-500-2009-040-F) from the California Climate Change Center. California Energy Commission, Sacramento. Available at www.energy.ca.gov/2009publications/CEC-500-2009-040/CEC-500-2009-040-F.PDF.

Lonzarich D. G., T. E. Harvey, and J. E. Takekawa. 1992. Trace element and organochlorine concentrations in California Clapper Rail (*Rallus longirostris obsoletus*) eggs. Archives of Environmental Contamination and Toxicology 23:147–153.

McBroom, J. 2008. Regional trends in California Clapper Rail abundance at non-native Spartina-invaded sites in the San Francisco estuary from 2005 to 2007. Report to the State Coastal Conservancy San Francisco Estuary Invasive Spartina Project, 1330 Broadway, 13th Floor, Oakland, CA 94612. Available at www.spartina.org/project_documents/clapper_rails/project-clra-trends.htm.

McClean, D. D. 1946. Duck disease at Tulare Lake. California Fish and Game 32:71–80.

McIntyre, J. W., and J. F. Barr. 1997. Common Loon (*Gavia immer*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 313. Acad. Nat. Sci., Philadelphia, PA, and Am. Ornithol. Union, Washington, DC.

McNicholl, M. K., P. E. Lowther, and J. A. Hall. 2001. Forster's Tern (*Sterna forsteri*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 595. Birds N. Am., Philadelphia.

Mallette, R. D. 1970. Statewide heron rookery study. Special Wildl. Investigations Rep., Proj. W-54-R2, Job III-5, Calif. Dept. Fish & Game, Sacramento.

Mallette, R. D. 1972. Statewide heron rookery study. Special Wildl. Investigations Rep., Proj. W-54-R-3, Job III-5, Calif. Dept. Fish & Game, Sacramento.

Marschalek, D. A. 2011. California Least Tern breeding survey, 2010 season. Wildlife Branch, Nongame Wildlife Program Report 2011-06. Calif. Dept. Fish & Game, Sacramento. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentVersionID=59326.

Meckstroth, A. M., and A. K. Miles. 2005. Predator removal and nesting waterbird success at San Francisco Bay, California. Waterbirds 28:250–255.

Medellin-Azuara, J., C. R. Connell, K. Madani, J. R. Lund, and R. E. Howitt. 2009. Water management adaptation with climate change. A paper (CEC-500-2009-049-F) from the California Climate Change Center. California Energy Commission, Sacramento. Available at www.energy.ca.gov/2009publications/CEC-500-2009-049/CEC-500-2009-049-F.PDF.

Meese, R. J. 2012. Cattle egret predation causing reproductive failures of nesting tricolored blackbirds. California Fish and Game 98:47–50.

Merrill, J., R. Brillinger, and A. Heartwell. 2011. **Ready… or not?:** An assessment of California agriculture's readiness for climate change. California Climate and Agriculture Network, P.O. Box 1366, Sebastopol, CA 95473. Available at www.calclimateag.org/our-work/ready-or-not.

Mikuska, T., J. A. Kushlan, and S. Hartley. 1998. Key areas for wintering North American Herons. Colonial Waterbirds 21:125–134.

Miller, M. R., J. D. Garr, and P. S. Coates. 2010. Changes in the status of harvested rice fields in the Sacramento Valley, California: Implications for wintering waterfowl. Wetlands 30:939–947.

Mills, K. L., W. J. Sydeman, and P. J. Hodum, eds. 2005. The California Current Marine Bird Conservation Plan. Version 1.0. Available from PRBO Conservation Science, 3820 Cypress Drive #11, Petaluma, CA 94954 or at www.prbo.org/cms/index.php?mid=66.

Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands, 3rd ed. John Wiley & Sons, New York.

Molina, K. C. 2008. Black Skimmer (*Rynchops niger*), in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp. 199–204. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, and Calif. Dept. Fish & Game, Sacramento. Available at www.dfg.ca.gov/wildlife/nongame/ssc/birds.html.

Molina, K. C., R. M. Erwin, E. Palacios, E. Mellink, and N. W. H. Seto. 2010. Status review and conservation recommendations for the Gull-billed Tern (*Gelochelidon nilotica*) in North America. Biol. Tech. Publ. BTP-R1013-2010. U.S. Fish & Wildl. Serv., Route 1, Box 166, Shephardstown, WV 25443. Available at http://digitalmedia.fws.gov/cdm/ref/collection/document/id/1524.

Molina, K. C., and D. A. Marschalek. 2003. Foraging behavior and diet of breeding Western Gull-billed Terns (*Sterna nilotica vanrossemi*) in San Diego Bay, California. Species Conservation and Recovery Program Report, 2003-01, Habitat Conservation Planning Branch, Calif. Dept. Fish & Game, Sacramento. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=2904.

Moore, S. B., J. Winckel, S. J. Detwiler, S. A. Klasing, P. A. Gaul, N. R. Kanim, B. E. Kesser, A. B. DeBevec, K. Beardsley, and L. K. Puckett. 1990. Fish and wildlife resources and agricultural drainage in the San Joaquin Valley, California, vol. 1. Report of the San Joaquin Valley Drainage Program, 1220 N St., Sacramento, CA 95814.

Mount, J. F., and R. Twiss. 2005. Subsidence, sea level rise, seismicity in the Sacramento–San Joaquin Delta. San Francisco Estuary and Watershed Science 3(1): 1–18. Available at www.escholarship.org/uc/item/4k44725p.

National Agricultural Statistics Service, California Field Office (NASS). 2006. California Agricultural Statistics, 2005. Natl. Agric. Statistics Serv., Calif. Field Office, P. O. Box 1258, Sacramento, CA 95812-1258. Available at www.nass.usda.gov/Statistics_by_State/California/Publications/California_Ag_Statistics/Reports/index.asp.

National Audubon Society. 2002. The Christmas Bird Count Historical Results. Online at www.audubon.org/bird/cbc [20 June 2006].

National Research Council (NRC). 2010. Ecosystem concepts for sustainable bivalve mariculture. National Academic Press, Washington DC. Available at www.nap.edu/catalog.php?record_id=12802.

Neira, C., E. D. Grosholz, L. A. Levin, and R. Blake. 2006. Mechanisms generating modification of benthos following tidal flat invasion by a spartina hybrid. Ecological Applications 16:1391–1404.

Nichols, D. K., V. L. Campbell, and R. J. Montali. 1986. Pansteatitis in Great Blue Herons. Journal American Veterinary Medical Association 189:1110–1112.

Nisbet, I. C. T. 2000. Commentary: Disturbance, habituation, and management of waterbird colonies. Waterbirds 23:312–332.

North American Waterfowl Management Plan, Plan Committee (NAWMP Plan Committee). 2004. North American Waterfowl Management Plan 2004. Strategic guidance: Strengthening the biological foundation. Canadian Wildl. Serv., U.S. Fish & Wildl. Serv., Secretaria de Medio Ambiente y Recursos Naturales. Available at www.nawmp.ca/pdf/04update-en.pdf.

O'Donnel, C., and B. J. Fjeldsá (compilers). 1997. Grebes: Status survey and conservation action plan. IUCN/SSC Grebe Specialist Group. IUCN, Gland, Switzerland, and Cambridge, UK. Available at http://data.iucn.org/dbtw-wpd/edocs/1997-058.pdf.

Ohlendorf, H. M. 2002. The birds of Kesterson Reservoir: A historical perspective. Aquatic Toxicology 57:1–10.

Orr, O. H., Jr. 1992. Saving American Birds: T. Gilbert Pearson and the Founding of the Audubon Movement. Univ. Press Florida, Gainesville.

Pacific Flyway Council. 1997. Pacific Flyway management plan for the Central Valley Population of Greater Sandhill Cranes. Pacific Flyway Study Committee (c/o USFWS, Pacific Flyway Representative), Portland, OR 97232-4181. Available at www.pacificflyway.gov/Documents/Cvgsc_plan.pdf.

Page, G. W., L. E. Stenzel, and J. E. Kjelmyr. 1999. Overview of shorebird abundance and distribution in wetlands of the Pacific coast of the contiguous United States. Condor 101:461–471.

Parkes, M. L. 2007. Residential Cattle Egret colonies in Texas: Geography, reproductive success, and management. Master's thesis. Texas A&M University, College Station, Texas.

Parnell, J. F., R. M. Erwin, and K. C. Molina. 1995. Gull-billed Tern (*Sterna nilotica*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 140. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Parsons, K. C., and T. L. Master. 2000. Snowy Egret (*Egretta thula*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 489. Birds N. Am., Philadelphia.

Pierotti, R. J., and C. A. Annett. 1995. Western Gull (*Larus occidentalis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 174. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Pitkin, M., and J. Wood, eds. 2011. The State of the Birds, San Francisco Bay. PRBO Conservation Science and the San Francisco Bay Joint Venture. Available at http://data.prbo.org/sfstateofthebirds.

PRBO Conservation Science, eds. 2004. Conservation objectives for the San Francisco Bay estuary as outlined in planning documents of North America's major bird conservation initiatives: A guiding document for revisions to 'Restoring the Estuary,' the implementation strategy of the San Francisco Bay Joint Venture. Available at www.sfbayjv.org/pdfs/strategy/SFBJV_GuidingDocument_121504.pdf.

PRBO Conservation Science. 2011. Projected effects of climate change in California: Ecoregional summaries emphasizing consequences for wildlife. Version 1.0. Available at http://data.prbo.org/apps/bssc/climatechange.

Price, J. 1999. When women were women, men were men, and birds were hats, in Flight Maps: Adventures with Nature in Modern America. Basic Books, New York.

Purkey, D. R., B. Joyce, S. Vicuna, M. W. Hanemann, L. L. Dale, D. Yates, and J. A. Dracup. 2008. Robust analysis of future climate change impacts on water for agriculture and other sectors: A case study. Climatic Change 87 (Supplement 1): S109–S122.

Reisen, W. K., S. Wheeler, M. V. Armijos, Y. Fang, S. Garcia, K. Kelley, and S. Wright. 2009. Role of communally nesting Ardeid birds in the epidemiology of West Nile virus revisited. Vector-borne and Zoonotic Diseases 9:275–280.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY. Available at www.partnersinflight.org/cont_plan (Version: March 2005).

Richman, S. E., and J. R. Lovvorn. 2004. Relative foraging value to lesser scaup ducks of native and exotic clams from San Francisco Bay. Ecological Applications 14:1217–1231.

Richmond, B., H. Green, and D. C. Rice. 2011. Alameda County Breeding Bird Atlas. Golden Gate and Ohlone Audubon Societies, Berkeley, Calif.

Richmond, O. R., J. Tecklin, and S. R. Beissenger. 2008. Distribution of California Black Rails in the Sierra Nevada foothills. Journal of Field Ornithology 79:381–390.

Riparian Habitat Joint Venture. 2004. The riparian bird conservation plan: A strategy for reversing the decline of riparian-associated birds in California. Version 2.0. Calif. Partners in Flight. Available at www.prbo.org/calpif/plans.html.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The Breeding Bird Survey: Its first fifteen years, 1965–1979. Resource Publication 157, U.S. Dept. Interior, Fish & Wildl. Serv., Washington, DC.

Robison, K. M., R. E. Weems, and D. W. Anderson. 2009. Western and Clark's grebe conservation and management in California: Annual report for year four (2008). Unpublished report to the American Trader and Kure/Stuyvesant Trustee Councils and National Fish and Wildlife Foundation. http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=17852.

Robison, K. M., R. E. Weems, D. W. Anderson, and F. Gress. 2010. Western and Clark's grebe conservation and management in California: Annual report, 2009. Unpublished report to the American Trader and Kure/Stuyvesant Trustee Councils and National Fish and Wildlife Foundation. California Institute of Environmental Studies, 3408 Whaler Ave., Davis, CA 95616. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=45718.

Roberson, D., and C. Tenney, eds. 1993. Atlas of the Breeding Birds of Monterey County, California. Monterey Peninsula Audubon Soc., Carmel, Calif.

Rocke, T. E., and M. Friend. 1999. Avian botulism, in Field manual of wildlife diseases: General field procedures and diseases of birds (M. Friend and J. C. Franson, technical editors), Chapter 38, pp. 271–281. Biological Resources Division Information and Technology Report 1999-001. U.S. Geological Survey, Washington, DC. Available at www.nwhc.usgs.gov/publications/field_manual.

Rocke, T. E., P. Nol, C. Pelizza, and K. K. Sturm. 2004. Type C botulism in pelicans and other fish-eating birds at the Salton Sea. Studies in Avian Biology 27:136–140.

Rosenberg, K. V., R. D. Ohmart, W. C. Hunter, and B. W. Anderson. 1991. Birds of the Lower Colorado River Valley. Univ. Ariz. Press, Tucson.

Ryan, T. P. 2000. Forster's Tern (*Sterna forsteri*), in Goals Project. Baylands ecosystem species and community profiles: Life histories

and environmental requirements of key plants, fish, and wildlife (P. R. Olofson, ed.), pp. 351–355. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif. Available at http://sfep.sfei.org/wp-content/uploads/2012/12/1Species_and_Community_Profiles.pdf.

Ryder, R. R., and D. E. Manry. 1994. White faced Ibis (*Plegadis chihi*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 130. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

San Francisco Bay Subtidal Habitat Goals Project (SFBSHGP). 2010. San Francisco Bay Subtidal Habitat Goals Report: Conservation planning for the submerged areas of the bay. State Coastal Conservancy, 1330 Broadway, Suite 1300, Oakland, CA 94612. Available at www.sfbaysubtidal.org/report.html.

San Francisco Field Ornithologists. 2003. (draft) San Francisco Breeding Bird Atlas. Available at www.markeaton.org/sffo1/Breeding%20Ecology/San%20Francisco%20Breeding%20Bird%20Atlas.pdf.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski Jr., and W. A. Link. 2011. The North American Breeding Bird Survey, results and analysis 1966–2009. Version 3.23.2011. USGS Patuxent Wildlife Research Center, Laurel, Maryland. Available at www.mbr-pwrc.usgs.gov/bbs/bbs.html.

Schaffner, F. C. 1985. Royal Tern nesting attempts in California: Isolated or significant incidents? Western Birds 16:71–80.

Schaffner, F. C. 1986. Trends in Elegant Tern and northern anchovy populations in California. Condor 88:347–354.

Schlorff, R. W. 1982a. Inland nesting waterbird survey. Nongame Wildl. Investigations Rep., Proj. W-54-R-14, Job III-2, Calif. Dept. Fish & Game, Sacramento.

Schlorff, R. 1982b. Heronry inventory. Nongame Wildl. Investigations Rep., Project W-54-R-14, Job III-8.0. Calif. Dept. Fish & Game, Habitat Conservation Planning Branch, 1416 Ninth St., Sacramento, CA 95814. Available at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=40685.

Schlorff, R. W. 1983. Inland nesting waterbird survey. Nongame Wildl. Investigations Rep., Proj. W-54-R-15, Job III-2, Calif. Dept. Fish & Game, Sacramento.

Schlorff, R. W. 1984. Inland nesting waterbird survey. Nongame Wildl. Investigations Rep., Proj. W-65-R-1, Job III-2, Calif. Dept. Fish & Game, Sacramento.

Scott, L. B., and S. K. Marquiss. 1984. An historical overview of the Sacramento River, in California riparian systems (R. E. Warner and K. M. Hendrix, eds.), pp. 51–57. Univ. Calif. Press, Berkeley.

Sequoia Audubon Society. 2001. San Mateo County Breeding Bird Atlas. Sequoia Audubon Soc., Woodside, Calif.

Shaw, S. D., and K. Kannan. 2009. Polybrominated diphenyl ethers in marine ecosystems of the American continents: Foresight from current knowledge. Reviews on Environmental Health 24:157–229.

She, J., A. Holden, T. Adelsbach, M. Tanner S. E. Schwarzbach, J. L. Yee, et al. 2008. Concentrations and time trends of polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) in aquatic bird eggs from San Francisco Bay, CA 2000–2003. Chemosphere 73:S201–209.

Shuford, W. D. 1993. The Marin County Breeding Bird Atlas: A Distribution and Natural History of Coastal California Birds. Calif. Avifauna Ser. 1. Bushtit Books, Bolinas, Calif. Available at http://archive.org/details/marincountybreed00shuf.

Shuford, W. D. 1999. Status assessment and conservation plan for the Black Tern (*Chlidonias niger surinamensis*) in North America. U.S. Dept. Interior, Fish & Wildl. Serv., Denver Federal Ctr., Denver, CO 80225-0486.

Shuford, W. D. 2005. Historic and current status of breeding American White Pelicans in California. Waterbirds 28 (Special Publ. 1): 35–47.

Shuford, W. D. 2008a. A synthesis of information on California Gulls to further attainment of salt pond restoration goals in South San Francisco Bay. Report to the Coastal Conservancy Association and the South Bay Salt Pond Restoration Project. PRBO Conservation Science (Contrib. 1642), 3820 Cypress Dr. #11, Petaluma, CA 94954. Available at www.southbayrestoration.org/documents/technical.

Shuford, W. D. 2008b. Black Tern (*Chlidonias niger*), in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp. 193–198. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, and Calif. Dept. Fish & Game, Sacramento. Available at www.dfg.ca.gov/wildlife/nongame/ssc/birds.html.

Shuford, W. D. 2010. Inland-breeding pelicans, cormorants, gulls, and terns in California: A catalogue, digital atlas, and conservation tool. Wildlife Branch, Nongame Wildlife Program Report 2010-01. Calif. Dept. Fish & Game, Sacramento. Available (minus digital atlas) at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=24095.

Shuford, W. D., and D. P. Craig. 2002. Status assessment and conservation recommendations for the Caspian Tern (*Sterna caspia*) in North America. U.S. Dept. Interior, Fish & Wildl. Serv., Portland, OR. Available at www.fws.gov/pacific/migratorybirds/PDF/CATE%20Status%20Assessment.pdf.

Shuford, W. D., and T. Gardali, eds. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, and Calif. Dept. Fish & Game, Sacramento. Available at www.dfg.ca.gov/wildlife/nongame/ssc/birds.html.

Shuford, W. D., C. M. Hickey, R. J. Safran, and G. W. Page. 1996. A review of the status of the White-faced Ibis in winter in California. Western Birds 27:169–196.

Shuford, W. D., J. M. Humphrey, R. B. Hansen, G. W. Page, L. E. Stenzel, and C. M. Hickey. 2007. Summer distribution, abundance, and habitat use of Black-necked Stilts and American Avocets in California's Central Valley. Western Birds 38:11–28.

Shuford, W. D., J. M. Humphrey, and N. Nur. 1999. Surveys of terns and cormorants in California's Central Valley in 1998. Final report of Point Reyes Bird Observatory (Contrib. 772), 4990 Shoreline Hwy. 1, Stinson Beach, CA 94970. Available from PRBO Conservation Science, 3820 Cypress Dr. #11, Petaluma, CA 94954.

Shuford, W. D., J. M. Humphrey, and N. Nur. 2001. Breeding status of the Black Tern in California. Western Birds 32:189–217.

Shuford, W. D., G. W. Page, J. G. Evens, and L. E. Stenzel. 1989. Seasonal abundance of waterbirds at Point Reyes: A coastal California perspective. Western Birds 20:137–265.

Shuford, W. D., G. W. Page, and J. E. Kjelmyr. 1998. Patterns and dynamics of shorebird use of California's Central Valley. Condor 100:227–244.

Shuford, W. D., and T. P. Ryan. 2000. Nesting populations of California and Ring-billed gulls in California: Recent surveys and historical status. Western Birds 31:133–164.

Sierra Beltrán, A., M. Palafox-Uribe, J. Grajales-Montiel, A. Cruz-Villacorta, and J. L. Ochoa. 1997. Sea bird mortality at Cabo San Lucas, Mexico: Evidence that toxic diatom blooms are spreading. Toxicon 35:447–453.

Sonoran Joint Venture. 2008. SJV communications, education, and outreach plan. Updated 9 January 2008. Available from Sonoran Joint Venture, 738 North Fifth Ave., Suite 102 Tucson, AZ 85705.

Sonoran Joint Venture Technical Committee (SJVTC). 2006. Sonoran Joint Venture: Bird Conservation Plan (C. J. Beardmore, ed.). Version 1.0. Sonoran Joint Venture, Tucson. Available at http://sonoranjv.org/wp-content/uploads/2011/02/SJVConsPlan121206.pdf.

Sorensen, A. A., R. P. Greene, and K. Russ. 1997. Farming on the edge. American Farmland Trust, Center for Agriculture in the Environment, c/o Northern Illinois Univ., P. O. Box 987, DeKalb, IL 60115.

South Bay Salt Pond Restoration Project (SBSPRP). 2007. South Bay Salt Pond Restoration Project: Final environmental impact statement/report. Prepared by EDAW, Philip Williams and Associates, Ltd., H. T. Harvey and Associates, Brown and Caldwell, and Geomatrix. Submitted to U.S. Fish & Wildl. Serv. and Calif. Dept. Fish & Game. Available at www.southbayrestoration.org/EIR/downloads.html.

South Bay Salt Pond Restoration Project (SBSPRP). 2009. South Bay Salt Pond Restoration Project Status Report, August 24, 2009. Available at www.southbayrestoration.org/track-our-progress.

Sowls, A. L., A. R. DeGange, J. W. Nelson, and G. S. Lester. 1980. Catalog of California seabird colonies. U.S. Dept. Interior, Fish & Wildl. Serv., Biol. Serv. Program. FWS/OBS-80/37.

Spautz, H., N. Nur, and D. Stralberg. 2005. California Black Rail (*Laterallus jamaicensis coturniculus*) distribution and abundance in relation to habitat and landscape features in the San Francisco Bay estuary, in Bird conservation implementation and integration in the Americas: Proceedings of the Third International Partners in Flight Conference, March 20-24, 2002, Asilomar, CA (C. J. Ralph and T. D. Rich, eds.). USDA Forest Serv. Gen. Tech. Rep. PSW-GTR-191. Available at www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/465-468.pdf.

Spell, R., R. Kempka, and F. Reid. 1995. Evaluation of winter flooding of ricelands in the Central Valley of California using satellite imagery, in Versatility of wetlands in the agricultural landscape (K. L. Campbell, ed.), pp. 357–366. American Society of Agricultural Engineers, Tampa, Florida.

Spendelow, J. A., and S. R. Patton. 1988. National atlas of coastal waterbird colonies in the contiguous United States: 1976–1982. U.S. Fish & Wildl. Serv. Biol. Rep. 88(5). U.S. Fish & Wildl. Serv., Washington, DC.

Speth, J. 1979. Conservation and management of coastal wetlands in California. Studies in Avian Biology 2:151–155.

Steele, N. L. C., and D. F. Bradford. 1991. Habitats, siting, and management of potential wetlands in the southern San Joaquin Valley, California. ESE Rep. 91-07, Calif. Dept. Water Resources, P. O. Box 942836, Sacramento, CA 94236.

Steere, J. T., and N. Schaefer. 2001. Restoring the estuary: Implementation strategy of the San Francisco Bay Joint Venture. San Francisco Bay Joint Venture, Oakland, Calif. Available at www.sfbayjv.org/estuarybook.php.

Stein, B. A. 2002. States of the union: Ranking America's biodiversity. NatureServe, Arlington, VA. Available at www.natureserve.org/publications/statesUnion.jsp.

Stein, B. A., L. S. Kutner, G. A. Hammerson, L. L. Master, and L. E. Morse. 2000. State of the states: Geographic patterns of diversity, rarity, and endemism, in Precious Heritage: The Status of Biodiversity in the United States (B. A. Stein, L. S. Kutner, and J. S. Adams, eds.), Chapter 5, pp. 119–157. Oxford Univ. Press, New York.

Steinkamp, M., B. Peterjohn, V. Byrd, H. Carter, and R. Lowe. 2003. Breeding season survey techniques for seabirds and colonial waterbirds throughout North America. Draft manual available at www.waterbirdconservation.org/pubs/PSGManual03.PDF.

Sterling, J. 2008. Least Bittern (*Ixobrychus exilis*), in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp. 136–142. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, and Calif. Dept. Fish & Game, Sacramento. Available at www.dfg.ca.gov/wildlife/nongame/ssc/birds.html.

Stillman, R. A., A. D. West, R. W. G. Caldow, and S. E. A. le V. dit Durell. 2007. Predicting the effect of disturbance on coastal birds. Ibis 149:73–81.

Storer, R. W., and G. L. Nuechterlein. 1992. Western Grebe (*Aechmophorus occidentalis*) and Clark's Grebe (*A. clarkii*), in The Birds of North America (A. Poole, P. Stettenheim, and F. Gill, eds.), no. 26. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Strong, C. M., L. B. Spear, T. P. Ryan, and R. E. Dakin. 2004. Forster's Tern, Caspian Tern, and California Gull colonies in San Francisco Bay: Habitat use, numbers and trends, 1982–2003. Waterbirds 27:411–423.

Suryan, R. M., D. P. Craig, D. D. Roby, N. D. Chelgren, K. Collis, W. D. Shuford, and D. E. Lyons. 2004. Redistribution and growth of the Caspian Tern population in the Pacific Coast region of North America, 1981–2000. Condor 106:777–790.

Takekawa, J. Y., G. W. Page, J. M. Alexander, and D. R. Becker. 2000. Waterfowl and shorebirds of the San Francisco Bay estuary, in Baylands ecosystem species and community profiles: Life histories and environmental requirements of key plants, fish, and wildlife (P. R. Olofson, ed.), pp. 309–316. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif. Available at http://sfep.sfei.org/wp-content/uploads/2012/12/1Species_and_Community_Profiles.pdf.

Tecklin, J. 2000. Distribution and abundance of the California Black Rail (*Laterallus jamaicensis coturniculus*) in the Sacramento Valley region with accounts of ecology and call behavior of the subspecies. Technical report. Contract numbers FG6154WM and FG6154-1WM. Calif. Dept. Fish & Game, Sacramento.

Telfair, R. C. II., B. C. Thompson, and L. Tschirhart. 2000. Nuisance heronries in Texas: Characteristics and management. 2nd ed. Tex-

as Parks and Wildlife, Texas. Available at http://agrilifecdn.tamu.edu/txwildlifeservices/files/2011/07/Nuisance-Heronies.pdf.

Thelander, C. G., and M. Crabtree. 1994. Life on the Edge: A Guide to California's Endangered Natural Resources. Vol. 1: wildlife. Biosystems Books, Santa Cruz, Calif.

Thompson, B. C., J. A. Jackson, J. Burger, L. A. Hill, E. M. Kirsch, and J. L. Atwood. 1997. Least Tern (*Sterna antillarum*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 290. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Annals of the Association of American Geographers 51:294–315.

Toft, J. D., C. A. Simenstad, J. R. Cordell, and L. F. Grimaldo. 2003. The effects of introduced water hyacinth on habitat structure, invertebrate assemblages, and fish diets. Estuaries 26:746–758.

U.S. Army Corps of Engineers (USACE). 1971. National shoreline study: California regional inventory. Report of U.S. Army Corps of Engineers, 630 Sansome St., San Francisco, CA 94111.

U.S. Fish and Wildlife Service (USFWS). 1984. Salt marsh harvest mouse and California clapper rail recovery plan. U.S. Fish & Wildl. Serv., Portland, Oregon. Available at http://ecos.fws.gov/docs/recovery_plan/841116.pdf.

U.S. Fish and Wildlife Service (USFWS). 1985a. Recovery plan for the Light-footed Clapper Rail. U.S. Fish & Wildl. Serv., Portland, Oregon. Available at http://ecos.fws.gov/docs/recovery_plan/850624.pdf.

U.S. Fish and Wildlife Service (USFWS). 1985b. Recovery plan for the California Least Tern, *Sterna antillarum browni*. U.S. Fish & Wildl. Serv., Portland, Oregon. Available at http://ecos.fws.gov/docs/recovery_plan/850927_w%20signature.pdf.

U.S. Fish and Wildlife Service (USFWS). 1990. Central Valley Habitat Joint Venture Implementation Plan: A component of the North American Waterfowl Management Plan. U.S. Fish & Wildl. Serv., Sacramento. Available at www.centralvalleyjointventure.org/science.

U.S. Fish and Wildlife Service (USFWS). 2005a. Regional seabird conservation plan, Pacific region. U.S. Fish & Wildl. Serv., Migratory Birds and Habitat Programs, 911 NE 11th Ave., Portland, OR 97232. Available at www.fws.gov/pacific/migratorybirds/archive.html.

U.S. Fish and Wildlife Service (USFWS). 2005b. Caspian Tern management to reduce predation of juvenile salmonids in the Columbia River estuary: Final Environmental Impact Statement. U.S. Fish & Wildl. Serv., Migratory Birds and Habitat Programs, 911 NE 11th Avenue, Portland, OR 97232. Available at www.fws.gov/pacific/migratorybirds/archive.html.

U.S. Fish and Wildlife Service (USFWS). 2006. California least tern (*Sternula antillarum browni*). 5-year review: Summary and evaluation. U.S. Fish & Wildl. Serv., Carlsbad Fish and Wildlife Office, Carlsbad, Calif. Available at http://ecos.fws.gov/docs/five_year_review/doc775.pdf.

U.S. Fish and Wildlife Service (USFWS). 2007. Listed distinct population segment of the Brown Pelican (*Pelacanus occidentalis*). 5-year review: Summary and evaluation. U.S. Fish & Wildl. Serv., Division of Ecological Services, Albuquerque, New Mexico. Available at www.fws.gov/southwest/es/Documents/R2ES/Brown_Pelican_5-yr_Review_FINAL.pdf.

U.S. Fish and Wildlife Service (USFWS). 2008. Birds of Conservation Concern 2008. U.S. Fish & Wildl. Serv., Div. Migratory Bird Mgmt., Arlington, Virginia. Available at http://digitalmedia.fws.gov/cdm/ref/collection/document/id/1404.

U.S. Fish and Wildlife Service (USFWS). 2009a. Draft recovery plan for tidal marsh ecosystems of northern and central California. U.S. Fish & Wildl. Serv., Region 8, Sacramento. Available at http://ecos.fws.gov/docs/recovery_plan/TMRP_Intro_1.pdf.

U.S. Fish and Wildlife Service (USFWS). 2009b. Light-footed Clapper Rail (*Rallus longirostris levipes*). 5-year review: Summary and evaluation. U.S. Fish & Wildl. Serv., Carlsbad Fish and Wildlife Office, Carlsbad, Calif. Available at http://ecos.fws.gov/docs/five_year_review/doc2573.pdf.

U.S. North American Bird Conservation Initiative Committee (U.S. NABCI Committee). 2000. The North American Bird Conservation Initiative in the United States: A vision of American bird conservation. Available from U.S. Fish & Wildl. Serv., Division of North American Waterfowl and Wetlands, 4401 N. Fairfax Dr., Suite 110, Arlington, VA 22203 or at www.nabci-us.org/aboutnabci/NABCIfndtn.pdf.

Unitt, P. 2004. San Diego County bird atlas. Proc. San Diego Soc. Nat. Hist. 39.

Veloz, S., M. Fitzgibbon, D. Stralberg, S. Michaile, D. Jongsomjit, D. Moody, N. Nur, L. Salas, J. Wood, and G. Ballard. 2011. San Francisco Bay sea-level rise: Climate change scenarios for tidal marsh habitats. Web application: www.prbo.org/sfbayslr. PRBO Conservation Science, Petaluma, Calif.

Walker, J. W., B. R. Heron, and M. A. Mixson. 1973. Exotic Newcastle disease eradication program in the United States. Avian Diseases 17:486–503.

Warnock, N., G. W. Page, T. D. Ruhlen, N. Nur, J. Y. Takekawa, and J. Hanson. 2002. Management and conservation of San Francisco Bay salt ponds: Effects of pond salinity, area, tide, and season on Pacific Flyway waterbirds. Waterbirds 25:79–92.

Weathers, W. W., and J. P. Kelly. 2007. Energy footprints on Tomales Bay: The importance of ephemeral food abundance. The Ardeid 2007:4–6. Available at www.egret.org/ardeid.

Weissman, K. G., and D. Strong. 2001. Land use and economics study: Grassland Ecological Area, Merced County, California. Unpublished report prepared for the Grassland Water District, 22759 Mercey Springs Rd., Los Banos, CA 93635. Available at www.traenviro.com/cgwd/geastudy.htm.

Wheeler, S. S., C. M. Barker, Y. Fang, M. V. Armijos, B. D. Carroll, S. Husted, W. O. Johnson, and W. K. Reisen. 2009. Differential impact of West Nile virus on California birds. Condor 111:1–20.

Wilcove, D. S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States: Assessing the relative importance of habitat destruction, alien species, pollution, overexploitation, and disease. BioScience 48:607–615.

Winkler, D. W. 1996. California Gull (*Larus californicus*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 259. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Wires, L. R., and F. J. Cuthbert. 2000. Trends in Caspian Tern numbers and distribution in North America: A review. Waterbirds 23:388–404.

Wires, L. R., F. J. Cuthbert, D. R. Trexel, and A. R. Joshi. 2001. Status of the Double-crested Cormorant (*Phalacrocorax auritus*) in

North America. Final Report to U.S. Fish & Wildl. Serv. Available from U.S. Fish & Wildl. Serv., Div. Migratory Bird Mgmt., 4401 North Fairfax Dr., MS 634, Arlington, VA 22203 or at http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/cormorant/status.pdf.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. "Chip" Weseloh, R. P. Russell, and F. J. Cuthbert. 2010. Upper Mississippi Valley/Great Lakes Waterbird Conservation Plan. A plan associated with the Waterbird Conservation for the Americas initiative. Final Report to the U. S. Fish and Wildlife Service, Fort Snelling, Minnesota. Available at www.waterbirdconservation.org/umvgl.html.

Wobeser, G., F. A. Leighton, R. Norman, D. J. Myers, D. Onderka, M. J. Pybus, J. L. Neufeld, G. A. Fox, and D. J. Alexander. 1993. Newcastle disease in wild water birds in western Canada, 1990. Canadian Veterinary Journal 34:353–359.

Work, T. M., B. Barr, A. M. Beale, L. Fritz, M. A. Quilliam, and J. L. C. Wright. 1993. Epidemiology of domoic acid poisoning in Brown Pelicans (*Pelecanus occidentalis*) and Brandt's Cormorants (*Phalacrocorax penicillatus*) in California. Journal Zoo Wildlife Medicine 24:54–62.

Yates, M. A., M. R. Fuller, C. J. Henny, W. S. Seegar, and J. Garcia. 2010. Wintering area DDE source to migratory white-faced ibis revealed by satellite telemetry and prey sampling. Ecotoxicology 19:153–162.

Zembal, R., S. Hoffman, and J. Konecny. 2007. Status and distribution of the Light-footed Clapper Rail in California, 2007. Unpublished report to Calif. Dept. Fish & Game, South Coast Region, Sensitive Bird and Mammal Monitoring Program, 4949 Viewridge Ave., San Diego, CA 92123 and U.S. Fish & Wildl. Serv., 6010 Hidden Valley Rd., Carlsbad, CA 92008. Available at www.clapperrail.com/documents/Census2007.pdf.

APPENDICES

APPENDIX 1

Bird Conservation Initiatives

Although waterbirds have greatly benefited by the creation of federal, state, and private refuges, wildlife areas, and preserves, the advancement of conservation of wetland-dependent birds is increasingly focused on partnerships formed around major conservation initiatives that are taxomic-, habitat-, or site-based. These generally also are science-based and involve multi-sector partnerships of government agencies, nongovernmental conservation organizations, academic institutions, private companies, and individuals working collaboratively to promote conservation agendas of common interest. Those initiatives particularly relevant, either directly or indirectly, to waterbirds in BCR 32 are described here.

North American Waterfowl Management Plan

Formed in 1986, this initiative is an international effort by Canada, the United States, and Mexico to conserve waterfowl throughout the continent and to return waterfowl numbers to their levels in the 1970s by enhancing wetland and upland habitat (NAWMP Plan Committee 2004). Although international in scope, specific projects generally are implemented at the regional level though 17 joint ventures (JVs). Three of these JVs—the Central Valley, San Francisco, and Sonoran—encompass large parts of the geographic area within BCR 32. The CVJV encompasses the entire Central Valley (www.centralvalleyjointventure.org), the SFBJV the San Francisco Bay watersheds and the outer coasts of Sonoma, Marin, San Francisco, and San Mateo counties (www.sfbayjv.org), and the SJV (in part) the coastal slope from Point Conception, Santa Barbara County, south to BCR 32's terminus in Baja California Norte (www.sonoranjv.org).

U.S. Shorebird Conservation Plan

Initiated in 1997, the plan's partners are committed to restoring and maintaining stable and self-sustaining populations of shorebirds in the United States and throughout the Western Hemisphere (Brown et al. 2001). On-the-ground efforts to maintain or enhance viable habitats for shorebirds are organized under 11 regional working groups and their regional plans, generally implemented through relevant JVs. The Southern Pacific Shorebird Conservation Plan (Hickey et al. 2003) encompasses all of the U.S. portion of BCR 32 and works to implement its goals within the framework of the three regional JVs discussed above.

Partners in Flight's North American Landbird Conservation Plan

Formed in 1990, Partners in Flight (PIF) is committed to conserve the resident, short-distance, and Neotropical migrant landbirds that occupy every major biome and habitat on the continent (Rich et al. 2004). The current continental plan covers native breeding landbirds in Canada and the United States but will expand soon to include landbirds breeding in Mexico. Implementation of the plan's objectives will be through multi-sector partnerships, including JVs. In California, landbird conservation efforts center on various California PIF bird conservation plans, which are habitat-based: riparian (RHJV 2004), grassland (CPIF 2000), and oak woodland (CPIF 2002). All of these habitats may provide requisites for nesting or foraging for some waterbirds.

Waterbird Conservation for the Americas (North American Waterbird Conservation Plan)

Launched in 1998, the North American Waterbird Conservation Plan supports a vision for sustaining or restoring the distribution, diversity, and abundance of waterbirds (seabirds, coastal waterbirds, wading birds, marshbirds) and their habitats throughout the lands and waters of the Americas (Kushlan et al. 2002, www.waterbirdconservation.org). Colonial waterbirds were ranked for conservation status in the original plan but marshbirds not until 2006 (www.waterbirdconservation.org/assessment.html). Implementation is envisioned through 16 waterbird conservation planning regions, coordinating through appropriate JVs, though some regional plans, like this one, are focusing on smaller areas.

North American Bird Conservation Initiative

The North American Bird Conservation Initiative (NABCI) was formed from the increasing recognition that the overlapping conservation interests of the initiatives discussed above could be better served through more integrated planning and delivery of bird conservation (U.S. NABCI Committee 2000). Thus, NABCI is a coalition of bird conservation organizations and initiatives striving to increase resources for regionally based, biologically driven, landscape-oriented partnerships and to make them more effective by fostering integrated bird conservation based on sound science, effective management, and efficient use of resources (www.nabci-us.org).

Ramsar Convention on Wetlands

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (www.ramsar.org). Contracting Parties to the convention designate sites to Ramsar's List of Wetlands of International Importance (the "Ramsar List"). For addition to this wetlands network, sites must meet one of various criteria. To qualify on the basis of their importance to waterbirds (all aquatic birds), sites must regularly support 20,000 or more waterbirds or 1% of the individuals in a population of one species or subspecies

of waterbird. The inclusion of a site on this list confers upon it the prestige of international recognition and obliges the government to take all steps necessary to ensure the maintenance of the ecological character of the site. Sites within BCR 32 included on the Ramsar List are Bolinas Lagoon, Tomales Bay, San Francisco Bay, Grasslands Ecological Area, and Tijuana River National Estuarine Research Reserve (http://ramsar.wetlands.org).

Western Hemisphere Shorebird Reserve Network

Begun in 1984, the Western Hemisphere Shorebird Reserve Network (WHSRN) is a conservation initiative that identifies important migratory staging and stopover sites for shorebirds in the Western Hemisphere (www.whsrn.org). Sites (or landscapes) are identified as being of regional, international, or hemispheric importance with respect to three categories defined on the basis of the number of total shorebirds that visit a site each year or if a site holds a relatively high proportion of a "biogeographic population" of an individual species. In BCR 32, sites designated by WHSRN along the coast are San Francisco Bay (hemispheric), Elkhorn Slough (regional), and South Dan Diego Bay (regional), and in the Central Valley are the Sacramento Valley (international) and Grasslands Ecological Area (near Los Banos; international). Landowners voluntarily agree to make shorebird conservation a priority, protect and manage shorebird habitat, and keep WHSRN informed of changes in the site's status. Although no legal protection is provided, designation of sites raises public awareness of their importance and may generate conservation funding opportunities.

Important Bird Areas

The Important Bird Areas (IBA) program of BirdLife International is a global network of priority areas for the conservation of birds that are globally threatened, range restricted, biome (or habitat) restricted, or congregate in large numbers (www.birdlife.org/action/science/sites/index.html). In the United States, the American Bird Conservancy is identifying globally important IBA sites (www.abcbirds.org/abcprograms/domestic/iba/index.html), National Audubon Society the IBAs of state significance (www.audubon.org/bird/iba). The goal of the IBA program is not only to provide well-deserved recognition to important sites but also to mobilize the resources and constituency needed to protect them. California Audubon has identified about 150 IBAs in California, many of which are important to waterbirds (Cooper 2004).

APPENDIX 2

History and Legal Framework for Bird Conservation

In the 19th century and early 20th century, humans were heavily exploiting birds for their feathers, meat, and eggs, but demand waned as changing attitudes prompted legal regulations. Conservation efforts were galvanized by the grassroots, woman-built movement to combat the slaughter of birds for their feathers to adorn hats, other clothes, and accessories (Doughty 1975, Graham 1990, Orr 1992, Price 1999). The toll was greatest on waterbirds, particularly egrets, herons, and terns. The first Audubon Society was short-lived, lasting only from 1886 to 1888. Rejuvenated by the founding of the Massachusetts Audubon Society in 1896, other states quickly followed suit, seeding an enduring broad-scale movement. Clubs joined in a loose federation in 1901, then incorporated to become the National Association of Audubon Societies for the Protection of Wild Birds and Animals in 1905 (since 1940, National Audubon Society), consisting of societies in 34 states, the District of Columbia, and the territory of Oklahoma (Orr 1992).

Efforts by Audubon and other conservation groups lead quickly to legislative successes. An initial focus of the groups was to convince state legislatures to adopt the American Ornithologists' Union's model law, proposed in 1886, aimed at prohibiting the killing of all nongame birds except for scientific study. The number of state's passing versions of the AOU model law was only 5 by 1900 then swelled by another 33 by 1905. The Lacey Act, the first federal conservation legislation, prohibited the interstate shipment of wild birds and other animals killed in violation of state laws. In 1911, the Audubon (Shea-White) Plumage Bill in New York crippled the domestic feather trade, and in 1913 amendments to the federal Underwood-Simmons Tariff Bill banned the import of wild-bird plumes from other countries (many first shipped from the United States to European milliners then re-imported). In 1913, the federal Migratory Bird Act (Weeks-McLean Law), designed to stop commercial market hunting and the illegal shipment of migratory birds from state to state, was passed and the first migratory bird hunting regulations were adopted. The Migratory Bird Act, resting on weak constitutional grounds, was soon superseded by the comparable international treaties listed below.

Concurrent with state and federal regulatory actions, President Theodore Roosevelt established the first federal bird preserve at Pelican Island, Florida, in 1903, one of 53 sanctuaries for birds and other wildlife created by the end of his presidency in 1909. For some years, the system of federal refuges was protected by wardens funded by the Audubon societies; wardens for various other bird colonies and rookeries were funded by the AOU and Audubon beginning in 1900.

Waterbirds are currently protected throughout their ranges in North America by the Migratory Bird Treaty Act (1918) in the United States, the Migratory Bird Convention Act (1916) in Canada, and the Convention for the Protection of Migratory Birds and Game Mammals (1936) in Mexico. The U.S. Endangered Species Act (1973; strengthened predecessors,1966–1969) and the California Endangered Species Act (1970) provide strict legal protection for various birds at risk of extinction, including a number of waterbirds in the Coastal California region. Lists of federal Birds of Conservation Concern (USFWS 2008) and California Bird Species of Special Concern (Shuford and Gardali 2008) also direct attention to aid other declining or vulnerable birds that warrant immediate conservation actions.

Some wetland habitats in the United States used by waterbirds are provided limited protection by the Clean Water Act (Section 404) and the Food Security Act (Swampbuster Provision, 1985). As historically enforced, these measures are insufficient to prevent net losses of wetland habitat. Despite permit requirements, almost 500,000 hectares of wetlands were estimated lost to dredge and fill materials in the conterminous United States between 1985 and 1995 (Dahl et al. 1997). The measures' effectiveness is further eroded by a 2001 U.S. Supreme Court ruling, open to interpretation, that denies protection under Section 404 to isolated nonnavigable, intrastate wetlands used by migratory birds.

Most countries in Central and South America, where some waterbirds migrate to spend the winter, have no or limited legal mechanisms to protect waterbirds or their habitats; for countries with some provisions for protection, enforcement and effectiveness are variable. National-scale assessments of waterbird (including waterfowl and shorebird) conservation activities and capacities for each country in Central and South America are available at www.waterbirdconservation.org.

APPENDIX 3

Existing Inventorying, Monitoring, and Research

Current and recent inventorying, monitoring, and research efforts for waterbirds in BCR 32 are described in separate sections below. Collectively these efforts have been conducted under a multitude of programs, organizations, or partnerships; for widely ranging purposes; and at various time frames and scales. Of the three categories, inventorying and research are generally conducted at local or regional scales, whereas monitoring more often will range from local up to the continental scale.

Inventorying

Single and multi-species inventories

- *All waterbirds* (SF Bay) – USGS and SFBBO conduct monthly counts of all birds in former and active salt ponds in south San Francisco Bay (56 salt ponds since 2002, USGS; 32 more since 2005, SFBBO).
- *Nesting seabirds* – comprehensive surveys of all species of seabirds that breed on the California coast have been conducted twice: 1975–1980 (Sowls et al. 1980, Hunt et al. 1981) and 1989–1991 (Carter et al. 1992, 1995). Although most of these seabird colonies are on islands, offshore rocks, or cliffs outside the boundaries of BCR 32, these inventories did provide data on the breeding population sizes and colony locations of Western Gulls and Double-crested Cormorant within estuaries on the entire California coast.
- *Western Colonial Waterbird Survey* – From 2009 to 2012, U.S. Fish and Wildlife Service is coordinating an inventory of colonial waterbirds across 11 western states (www.fws.gov/mountain-prairie/species/birds/western_colonial/index.html); for coastal states, surveys are being conducted only for interior colony sites. Surveys for California have covered 14 species, most of which breed in BCR 32.
- *Nesting waterbirds* (interior California) – CDFG conducted surveys of nesting waterbirds in the interior of California in the 1980s (Schlorff 1982a, 1983, 1984; Gould 1986, 1987).
- *Nesting waterbirds* (interior California) – from 1997 to 1999, PRBO conducted surveys in the interior of California for seven species of colonial nesting waterbirds: American White Pelican, Double-crested Cormorant, Ring-billed Gull, California Gull, Caspian Tern, Black Tern, and Forster's Tern (Shuford et al. 1999, 2001; Shuford 2010).
- *Wintering and migrant waterbirds* (Point Reyes) – PRBO has inventoried nonbreeding waterbirds at various sites on the Point Reyes peninsula (Abbott's Lagoon, Drakes and Limantour esteros, Bolinas Lagoon) periodically since the late 1960s (Shuford et al. 1989, PRBO unpubl. data). Counts of all waterbirds at Bolinas Lagoon have been conducted annually from winter 1972–73 to the present (graphed and described through 2004–05; PRBO unpubl. data at www.prbo.org/cms/366)
- *All nesting waterbirds* (California) – in the California portion of BCR 32, breeding bird atlases have gathered data on the distribution and, sometimes, abundance of waterbirds (and other species) in the counties of Marin (Shuford 1993), Sonoma (Burridge 1995, second atlas

in progress), Napa (Berner et al. 2003), Solano (in progress), Sacramento, Contra Costa (Glover 2009), Alameda (Richmond et al. 2011), San Francisco (San Francisco Field Ornithologists 2003), San Mateo (Sequoia Audubon Society 2001), Santa Clara (Bousman 2007), Santa Cruz, Monterey (Roberson and Tenney 1993), San Luis Obispo, Santa Barbara (in progress), Ventura (in progress), Los Angeles, Orange (Gallagher 1997), and San Diego (Unitt 2004; also winter information).

- *Herons and egrets* (California) – CDFG inventoried heron and egret rookeries in the state from the early 1970s through early 1980s (Mallett 1970, 1972; Gould 1973; Belluomini 1978; Schlorff 1982b).
- *Sandhill Cranes* (Central Valley) – CDFG has conducted valleywide crane surveys; also counted at various refuges, wildlife areas, and preserves (e.g., Pixley NWR).
- *California Black Rail* (edge of Sacramento Valley and Sierra Nevada foothills) – efforts have been made to locate breeding sites in Butte, Yuba, Nevada, and Placer counties as part of a broad-scale inventorying effort from 1994 to 2004 and a monitoring program from 2002 to the present (Aigner et al. 1995, Tecklin 2000, O. Richmond in litt.)
- *California Clapper Rail* (San Francisco Bay estuary) – inventories of the California Clapper Rail have been conducted periodically in portions of the estuary, but the first comprehensive baywide survey was conducted in 2005–2006 (M. Herzog in litt.).

Monitoring

The main active monitoring programs relevant to waterbirds organized at the continental level are the Christmas Bird Count (CBC) and North American Breeding Bird Survey (BBS). Currently these efforts provide data of only limited use in detecting trends in waterbird numbers in BCR 32. As described below, other efforts are underway to correct this deficiency.

Christmas Bird Count. The Christmas Bird Count, a volunteer effort coordinated by National Audubon Society since 1900 to gather data on early winter abundance of birds, is the longest-running and geographically most widespread survey of bird life in the Western Hemisphere. Although analysis and interpretation of these data are limited given the program was not intended or designed for population monitoring, the CBC is still a rich, though largely untapped, source of information for documenting annual and long-term patterns of change in winter distribution of birds (Francis et al. 2004, Dunn et al. 2005). Issues of accessibility have been resolved by the availability of data online (www.audubon.org/bird/cbc/hr/index.html). Still, the effort and expertise needed to adjust for the CBCs two primary limitations—variability of count effort within and among circles and nonrandom distribution of the circles—preclude the wide use of these data for assessing trends of winter populations of birds in North America. A scientific panel's recommendations to develop effort-adjusted annual indices and trends for standard areas of various size (Francis et al. 2004, Dunn et al. 2005) have not yet been implemented. For these reasons, CBC data were used to assess trends in waterbirds in BCR 32 only when published analyses were available for particular species (e.g., White-faced Ibis; Shuford et al. 1996).

Breeding Bird Survey (BBS). Begun in 1966 (1968 in California), the Breeding Bird Survey is a long-term, large-scale avian monitoring program that tracks the status and trends of North American bird populations (www.pwrc.usgs.gov/BBS/index.html). This volunteer effort, coordinated jointly by the USGS Patuxent Wildlife Research Center and the Canadian Wildlife Service's National Wildlife Research Center, consists of a large number of roadside point-count transects on secondary roads; each route is about 24.5 miles (39.2 km) long and is composed of 50 point counts spaced at 0.5-mile (800-m). Starting in 1997, regularly updated and well-analyzed results have been easily available online (Sauer et al. 2011). Trend data and abundance indices are presented at various scales: survey-wide (continental), state and provincial, physiographic strata, and (since 2004) BCR. Given the relatively small sample sizes available at the BCR level, and the known deficiency of BBS methodology in surveying wetland birds, colonial nesters, and certain other species (Bystrak 1981, Robbins et al. 1986), the BBS is not very effective in monitoring waterbirds in BCR 32 (see Population Estimates and Trends section above).

Colonial Waterbird Monitoring. The (now-dormant) Colonial Bird Register, a cooperative effort between National Audubon Society and Cornell Laboratory of Science, was an attempt to create a long-term database to compile information on the location, habitat characteristics, species composition, and abundance of waterbirds at colonies throughout the United States and parts of Canada. Data were collected opportunistically rather than by a sampling design, and the project lasted from only the mid-1970s to late 1980s. As described below, recent efforts to develop broad-scale monitoring programs include a comparable continentwide repository of colonial waterbird data; in some areas, such data are also compiled at the state, provincial, and local level.

Scientifically rigorous and standardized monitoring protocols for breeding colonial waterbirds, and recommendations for conducting inventories, have been drafted under the auspices of the Waterbird Conservation for the Americas initiative (Steinkamp et al. 2003). Modeled after the Pacific Seabird Group database, U.S. Geological Survey's Patuxent Wildlife Research Center has developed a centralized colonial waterbird database as part the National Bird Population Data Center (Waterbird Monitoring Partnership, www.pwrc.usgs.gov/cwb/database). This centralized database was designed to store time-series data on populations of colonial waterbirds from monitoring surveys to facilitate the estimation of trends across regions, provinces, and states. This database contains data from USFWS-funded coastal surveys, from Maine to Georgia, conducted in the mid-1990s, plus information published in a number of colonial waterbird atlases in the United

States and Canada. The database is also intended to safeguard the data from the Colonial Bird Register, the USFWS-sponsored Great Lakes waterbird surveys, and, ultimately, the Western Colonial Waterbird Survey. This database, however, has been plagued with funding shortages and it is currently dormant.

Marshbird Monitoring. Also under the banner of the Waterbird Conservation for the Americas initiative, efforts are underway to develop a continental-scale monitoring program to estimate temporal and spatial changes in abundance of selected breeding secretive marshbird species (e.g., rails, bitterns) at continental, national, regional, and, possibly, local scales. Population data will be tied to ancillary data on habitat to inform population and habitat management strategies (www.fws.gov/birds/waterbirds/monitoring/marshmonitoring.html). Progress has been made in developing a standard protocol (Conway 2009), but consensus has yet to be reached on an overall approach to sampling design that would be feasible for the diverse regions of the continent while also producing adequate continental-scale information (Johnson et al. 2009, Conroy et al. 2010).

Midwinter Waterfowl Surveys. These annual aerial surveys of waterfowl organized by U.S. Fish and Wildlife Service also count some other species, with these varying locally or regionally. Midwinter waterfowl surveys within BCR 32 also count American Coots and Sandhill Cranes (M. Wolder pers. comm.). Coots occur throughout the region, and there are some additional data available on them from the limited harvest of this species in the region. Cranes occur almost exclusively in the Central Valley, and it is not possible to distinguish the different subspecies from the air. Observers also count White-faced Ibis in the Sacramento Valley north of Highway 20 (M. Wolder pers. comm.), and Western/Clark's Grebes in San Francisco Bay and the outer coast estuaries, bays, harbors, and lagoons in the Bodega–Point Reyes area (J. Buffa pers. comm.).

Other single- or multi-species monitoring programs at the local and regional level within BCR 32 are outlined below.

Multi-species monitoring

- *All waterbirds* (Sacramento Valley) – since 1986, biologists have conducted year-round censuses to monitor nongame birds, including waterbirds, at refuges (Sacramento, Delevan, Colusa, and Sutter) of the Sacramento NWR Complex (Gilmer et al. 1998, USFWS unpubl. data).
- *All waterbirds* (Tulare Basin of San Joaquin Valley) – consulting companies have monitored waterbirds year round at most sets of agricultural evaporation ponds and associated wetlands in this area since the early to mid-1990s (J. Seay and R. Hansen in litt.).
- *All waterbirds* (Elkhorn Slough) – since 2000, the Elkhorn Slough National Estuarine Research Reserve (ESNERR) has monitored abundance and species richness of all species of waterbirds (including shorebirds and waterfowl) using counts at five sites taken one or twice a month (www.elkhornslough.org/research/PDF/shorebird.pdf).
- *All waterbirds* (Buena Vista Lagoon) – Buena Vista Audubon conducts a monthly count of all birds, including waterbirds, at this site (www.bvaudubon.org/BvLagoon.htm).
- *Wintering waterbirds* (Tomales Bay) – Audubon Canyon Ranch (ACR) has counted wintering waterbirds on this bay since the mid-1980s (Kelly and Tappen 1998, ACR unpubl. data).
- *Various waterbirds* (Pt. Mugu Naval Air Station) – biologists monitor terns, pelicans, Light-footed Clapper Rails, Black Skimmers, herons and egrets (on shorebird surveys); recently started marshbird playback surveys.
- *Various waterbirds* (southern San Diego County) – quarterly/monthly counts of waterbirds at various coastal lagoons.
- *Various colonial waterbirds* (Alcatraz Island, central San Francisco Bay) – on this island, biologists have monitoring the population size and reproductive success of the Black-crowned Night-Heron (since 1990) and Snowy Egret (since 1997) (Hothem and Hatch 2004, Hothem and Bergen 2007) and that of the Western Gull (plus other seabirds, since 1996) and California Gull (since 2004) (Acosta et al. 2006).
- *Various colonial waterbirds* (Mendota Wildlife Area, San Joaquin Valley) – biologists at this site have monitored numbers of nesting White-faced Ibis (since 1992), Western and Clark's grebes (since 1994), and Great Blue Herons (since 1995) (S. Bruggemann in litt.).
- *Herons,egrets, night-herons, cormorants* (San Francisco Bay area) – heron and egret colonies have been monitored in the north bay by ACR since 1990, in the south bay by San Francisco Bay Bird Observatory (SFBBO) since 1982; this work led to publication of an atlas of the region's colonies (Kelly et al. 2006).
- *Herons, egrets, cormorants, terns* (Elkhorn Slough) – ESNERR has monitored population size and reproductive success of a colony of Great Blue Herons (established 1985), Great Egrets (1992), and Double-crested Cormorants (1997) annually since 1985, and that of a colony of Caspian Terns annually since 1992 (www.elkhornslough.org/research/biomonitor_bird.htm).
- *Herons and egrets* (southern California coast) – colonies on military bases are monitored annually.
- *Gulls, terns, skimmers* (south San Francisco Bay) – SFBBO has been monitoring nesting Caspian and Forster's terns and California Gulls since 1982 (Strong et al. 2004, SFBBO unpubl. data) and Black Skimmers since their colonization in 1994 (Layne et al. 1996, SFBBO unpubl. data); where nesting with gulls, Double-crested Cormorants also get opportunistic coverage (SFBBO unpubl. data).
- *Terns and skimmers* (southern California coast) – nesting numbers are monitored at Bolsa Chica Ecological Reserve (C. Collins pers. comm.), Port of Los Angeles (K. Keane pers. comm.), and San Diego Bay NWR (R. Patton and B. Collins pers. comm.).

- *Western and Clark's Grebes* (Clear Lake, Thermalito Afterbay) – Dan Anderson, Gary Ivey, and Audubon California have conducted surveys of nesting numbers at Clear Lake, Lake County, and Thermalito Afterbay, Butte County (Ivey 2004; Robison et al. 2009, 2010; F. Hayes/Audubon California unpubl. data).
- *Virginia Rail and Sora* – these species have been counted incidentally on Clapper Rail surveys in south San Francisco Bay (also some call counts).

Single-species monitoring

- *Brown Pelican* – biologists have counted pelicans at nighttime roost at the proposed Alameda NWR.
- *California Black Rail* (edge of Sacramento Valley and Sierra Nevada foothills) – following an initial inventory program from 1994 to 2000, annual monitoring of this species has been conducted in Butte, Yuba, and Nevada counties from 2002 to the present; over this period, the number of sites monitored for the presence or absence of Black Rails has increased from about 100 to 195 (O. Richmond in litt.).
- *California Clapper Rail* – staff of San Francisco Bay NWR and California Department of Fish and Game have conducted annual winter counts of California Clapper Rails in south San Francisco Bay since the mid-1980s; breeding counts have also been conducted annually since the late 1990s (sporadically before). Annual counts are not conducted in the northern portions of the San Francisco Bay estuary.
- *Light-footed Clapper Rail* – the California population of this subspecies has been monitored annually since 1980 (Zembal et al. 2006).
- *Caspian Tern* – USFWS has been coordinating annual surveys of nesting numbers at colonies of this species throughout western North America, including all of BCR 32, since 1997 (Shuford and Craig 2002, USFWS unpubl. data).
- *California Least Tern* – after initial surveys of breeding colonies in 1969 and 1970, subsequently all colonies on the California coast (San Francisco Bay area south to Mexican border) have been monitored annually to quantify breeding numbers and nesting success for each colony (Marschalek 2011).
- *Black Rail* – comprehensive sampling of Black Rail populations in its California stronghold in the San Francisco Bay estuary has been conducted in 1986–1989, 1996, and 2001 (Evens et al. 1991, Evens and Nur 2002, Spautz et al. 2005).
- *Double-crested Cormorant* – PRBO and Mark Rauzon periodically have conducted surveys of nest numbers and nesting success of cormorants on major bridges in San Francisco Bay (Richmond–San Rafael Bridge, Bay Bridge); in concert, Western Gulls nesting on bridges have been surveyed opportunistically.
- *White-faced Ibis* (Central Valley) – numbers of nesting ibis have been counted at colonies at the Sacramento NWR complex (since 1985), Mendota WA (since 1992), and Kern and Pixley NWRs (since 1990).
- *Cormorants, Caspian Tern, California Gull* – U.S. Fish and Wildlife Service conducts annual photographic surveys of cormorant colonies in San Francisco Bay; in most years they also have photographed Caspian Terns nesting in proximity to Double-crested Cormorants at Knight Island in San Pablo Bay (Until ~2006 when a levee was breached and these species abandoned nesting here). At Brooks Island, they also have photographed the Caspian Tern colony since 2004 and the California Gull colony since 2006 (G. McChesney in litt.)

Compilations of Anecdotal Information

Some of the anecdotal information available in the following sources may serve as a coarse substitute in tracking population trends when rigorous monitoring data are unavailable, or it may provide valuable preliminary information to researchers designing inventorying or monitoring projects.

- *North American Birds* – regional editors for the Middle Pacific (northern California) and Southern Pacific (southern California) regions compile data on waterbirds (and other species) and publish quarterly seasonal reports; focus is on out-of-range species, but also information on colony sizes, high counts, changes in status and distribution, etc.
- *California Natural Diversity Database* – compilation of historic records and current information on waterbirds (and other species); most data on special-status and colonial species (data available by paid subscription only).
- *Habitat Conservation Plans (HCP)* – regional HCPs compile data on waterbirds (and other species) with a focus on special-status species.
- *Environmental Impacts Statements (EIS) and Environmental Impact Reports (EIR)* – compile or summarize information on waterbirds (and other species) focusing on special-status species.

Research

Research on waterbirds in BCR 32 is conducted by a variety of organizations, such as federal and state agencies, university faculty and graduate students, nonprofit research organizations, and others, often in collaboration with state and federal resources agencies. Instead of presenting a long bulleted list of all key research projects, as is done above for inventorying and monitoring, relevant research on waterbirds is cited in pertinent sections of this plan.

APPENDIX 4

Waterbird Species Accounts

Common Loon (*Gavia immer*)

Status Summary

Continental conservation priority: Moderate concern.
BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	na
Threats to non-breeding:	3
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.
Abundance and population trend in North America: Worldwide population 500,000–700,000 (most in Canada). Following declines in the early to mid-twentieth century, numbers have been relatively stable in recent decades, as indicated by a non-significant BBS trend (1966–2009) of 0.8%/yr.
Abundance and population trend in BCR 32: Does not breed in BCR, and data on size or trends of its wintering or migrant populations are lacking.
Percent of continental population (wintering) in BCR 32: Unknown, but estimated ≤20%.

Global Distribution

Breeds mostly in North America, where occurs throughout most of Alaska and Canada (except extreme northern regions, part of southern Canadian Prairies) and in parts of the extreme northern United States (n. Washington, nw. Montana, nw. Wyoming; n. Great Lakes region; and n. New England). Winters mainly on the Pacific Coast from s. Alaska south to Baja California, the Gulf of California, and the west coast of Mexico to at least Colima; the Atlantic Coast from the Maritime Provinces south to Florida; and along the Gulf Coast of the United States south to n. Vera Cruz, Mexico. Smaller numbers winter inland on large water bodies, at least as far north as Great Lakes, but by mid-winter most in northern areas (or at higher elevations) are forced south by the freezing of lakes.

Occurrence in BCR 32

Occurs locally throughout the region in migration (mainly Apr–May, Oct–Nov) and winter with many fewer non-breeders remaining through summer.

Habitat Requirements

Most numerous on coastal estuaries, lagoons, and larger bays with fewer inland, mainly on larger lakes and reservoirs. Whether Common Loons exhibit between-year site fidelity is unknown. The main requirements are abundant prey and clear water (particularly during breeding). The diet is dominated by fish—mainly tapered, soft-scaled species, particular those most readily available and susceptible to capture—but also includes amphibians, crustaceans (crabs, crayfish), mollusks, annelids, aquatic insects and, occasionally, vegetable matter.

Issues in BCR 32

- Concern exists for potential overharvest of fish (e.g., herring) that are important prey of loons.
- Increasing human disturbance on estuaries and reservoirs potentially may reduce the fitness of loons by limiting their foraging time.
- Contaminants may pose problems for loons, particularly if re-suspended by dredging or scouring of estuarine sediments by flood events.
- Poor management of upland habitats may lead to erosion and high turbidity when runoff enters bays and reservoirs thereby hindering loons' foraging efficiency, particularly if flooding coincides with the mid-winter flightless period, which limits their ability to move to more suitable foraging areas.
- Oil spills in coastal estuaries and bays potentially may cause extensive mortality of loons.

Existing Actions

A continental status assessment and conservation plan is available (http://alaska.fws.gov/mbsp/mbm/loons/pdf/Common_Loon_Status_Assessment.pdf).

Research and Monitoring Needs

- Study the potential impacts of contaminants (pesticides, mercury, lead) concentrated in loons via their fish prey.
- Study the impacts of human disturbance on foraging loons and potential ways to regulate humans uses that substantially interfere with loons' ability to forage.

Needed Management Actions

- Regulate the use of various types of watercraft or other forms of human disturbance in important foraging areas for loons.
- Regulate fish harvest in coastal estuaries and large inland water bodies to maintain sustainable prey resources for loons.
- Limit erosion near shorelines and drainages into water bodies to maintain clear water suitable for loon foraging.
- Maintain readiness, training, and equipment to contain any oil spills in coastal estuaries and bays.

Primary regional contact(s): John Kelly, Audubon Canyon Ranch; Dave Shuford, PRBO Conservation Science.

References

Evers, D. C. 2004. Status assessment and conservation plan for the Common Loon (*Gavia immer*) in North America. U.S. Fish & Wild. Serv., Hadley, Mass. (http://alaska.fws.gov/mbsp/mbm/loons/pdf/Common_Loon_Status_Assessment.pdf).

Kelly, J. P., and S. L. Tappen. 1998. Distribution, abundance, and implications for conservation of winter waterbirds on Tomales Bay, California. W. Birds 29:103–120.

McIntyre, J. W., and J. F. Barr. 1997. Common Loon (*Gavia*

immer), in The Birds of North America (A. Poole and F. Gill, eds.), no. 313. Acad. Nat. Sci., Philadelphia, PA, and Am. Ornithol. Union, Washington, DC.

Shuford, W. D., G. W. Page, J. G. Evens, and L. E. Stenzel. 1989. Seasonal abundance of waterbirds at Point Reyes: A coastal California perspective. W. Birds 20:137–265.

Account author: W. David Shuford.

Eared Grebe (*Podiceps nigricollis*)

Status Summary

Continental conservation priority: Moderate concern.

BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	2
Threats to non-breeding:	4
Percent of population in BCR:	1

BCR 32 conservation priority: Moderate concern.

Abundance and population trend in North America: Population estimated from aerial photography at staging areas (fall 1997) at 3.56 million. North American population has shown marked declines followed by rapid rebounds, but data from key fall staging area at Mono Lake suggests a declining trend. Non-significant increasing BBS trend of 4.8%/yr (1966–2009; data with an important deficiency).

Abundance and population trend in BCR 32: Winter-spring surveys on the San Francisco Bay in 2006 averaged ~10,000 Eared Grebes (USGS and SFBBO, unpubl. data); counts from 2000-1 on a subset of salt ponds counted up to 27,000 indicating a possible recent decline.

Percent of continental population in BCR 32: Of the roughly 20,000 counted on the 2006 CBC, about 55% (~11,500) were counted within BCR 32.

Global Distribution

Eared Grebes breed locally from British Columbia to sw. Manitoba, south to c. Mexico, and west to ne. California. Their wintering range is more restricted, with tens of thousands around islands in n. and c. Gulf of California, Baja California Sur, and the Salton Sea. Smaller groupings occur in coastal bays and inland lakes from sw. British Columbia south to El Salvador, to c. Texas and inland Mexico. In Oct. >99% of North American breeding adults undergo molt migration to hypersaline lakes (Great Salt Lake, Utah, and Mono Lake, California) where they remain for months before continuing on to wintering grounds. Outside the Americas, occurs from British Isles south to South Africa, to se. Russia, and sw. and s. Asia east to India and Pakistan.

Occurrence in BCR 32

Eared Grebes occur throughout BCR 32. Thousands winter and/or migrate through on salt evaporator ponds in San Francisco Bay and along the Channel Islands. Breed locally, somewhat sporadically, and in small numbers throughout the region on appropriate waters from the San Francisco Bay inland to Fresno and San Bernardino Counties, and s. to San Diego County.

Habitat Requirements

Breeding locations vary from year to year depending on water levels. Colonial breeder on shallow lakes with floating vegetation, from sea level to over 6000 ft. The disappearance of historical colonies due to drying of lakes somewhat compensated for with the establishment of colonies on reservoirs and sewage treatment ponds. Wintering habitats include coastal bays, freshwater marsh, and seasonal wetlands. In San Francisco Bay, birds found on medium to high-salinity salt evaporator ponds where they roost and forage on brine shrimp (*Artemia salina*), water boatmen (*Corixidae* spp.), and brine flies (*Ephydra* spp.)

Issues in BCR 32

- A decrease in the amount of hypersaline salt-pond habitat due to tidal restoration in San Francisco Bay is a concern.
- Increasing demand for fresh water in urban areas limits nesting sites and threatens saline lakes in the region where Eared Grebes winter.
- Contaminants, including selenium in the Central Valley, pose a threat to breeding birds.

Existing Actions

No known specific actions currently target this species in BCR 32. The Eared Grebe is a "salt pond specialist" included in project planning for salt pond restoration in the San Francisco Bay estuary.

Research and Monitoring Needs

- Conduct focused studies on foraging ecology in the San Francisco Bay estuary.
- Determine how catastrophic events including disease, contaminants, and El Niño–related starvation affect the long-term health of the population.

Needed Management Actions

Maintain high salinity ponds within the San Francisco Bay estuary for wintering and migratory use. To maintain breeding colonies throughout the region, provide undisturbed open water habitat with appropriate vegetation for nest construction.

Primary regional contact(s):

Dave Shuford, PRBO Conservation Science, and Cheryl Strong, Don Edwards San Francisco Bay National Wildlife Refuge.

References

Cullen, S. A., J. R. Jehl Jr., and G. L. Nuechterlein. 1999. Eared Grebe (*Podiceps nigricollis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 433. Birds N. Am., Philadelphia.

Goals Project. 2000. Baylands ecosystem species and community profiles: Life histories and environmental requirements of key plants, fish, and wildlife (P. R. Olofson, ed.). Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif. (http://sfep.sfei.org/wp-content/uploads/2012/12/1Species_and_Community_Profiles.pdf).

Grinnell, J., and A. H. Miller. 1944. The distribution of the birds of California. Pac. Coast Avifauna 27.

Jehl, J. R., Jr., W. S. Boyd, D. S. Paul, and D. W. Anderson. 2002. Massive collapse and rapid rebound: Population dynamics of Eared Grebes (*Podiceps nigricollis*) during an ENSO event. Auk 119:1162–1166.

National Audubon Society. 2002. The Christmas Bird Count Historical Results. Online at www.audubon.org/bird/cbc [20 June 2006].

Warnock, N., G. W. Page, T. D. Ruhlen, N. Nur, J. Y. Takekawa, and J. Hanson. 2002. Management and conservation of San Francisco Bay salt ponds: Effects of pond salinity, area, tide, and season on Pacific Flyway waterbirds. Waterbirds 25:79–92.

Account author: Cheryl Strong.

Western Grebe (*Aechmophorus occidentalis*)

Status Summary

Continental conservation priority: Moderate concern.
BCR 32 conservation scores:

Population trend:	4
Threats to breeding:	5
Threats to non-breeding:	5
Percent of population in BCR:	1

BCR 32 conservation priority: High concern.
Abundance and population trend in North America: >110,000 breeders. BBS data (Western/Clark's combined) show a non-significant declining trend of -2.0%/yr (1968–2009; data deficient).
Abundance and population trend in BCR 32: Size of breeding and (larger) wintering populations are unknown. BBS data (Western/Clark's combined) show a (non-significant) increasing trend of 8.9%/yr (1968–2009; data with a major deficiency).
Percent of continental population in BCR 32: Unknown and varies by season.

Global Distribution

Breeds broadly but locally in western North America from s.-central British Columbia east to s. Manitoba and south to n. Baja California, Arizona (except sw.), s. Colorado, w. Minnesota, and e.-central Wisconsin; resident at some sites in interior north at least to n.-central California west of Sierra Nevada. Also resident and breeding in interior Mexico south to Guerrero and w. Puebla. Winters mainly from se. Alaska, coastal s. British Columbia, s. Utah, Colorado, New Mexico, and w. and (rarely) s. Texas south through Baja California, the Gulf of Mexico, and the west coast of Mexico in Sonora and Sinaloa.

Occurrence in BCR 32

A year-round resident throughout the region. Locally common at scattered inland breeding colonies. Non-breeders occur locally throughout the region, and the species is most numerous and widespread in fall and winter when birds concentrate mainly along the coast but also at some inland sites (particularly Clear Lake, Lake Co.).

Habitat Requirements

Breeds at colonies inland at large lakes, marshes, sloughs, and reservoirs with extensive areas of open water usually bordered by emergent vegetation; winters at a greater number of freshwater sites inland, but largest numbers then in coastal bays, estuaries, and lagoons. The main requirements appear to be emergent or other aquatic vegetation for nest building and attachment and abundant prey and clear water for foraging. Differences in habitat requirements between Western and Clark's grebes are subtle but the former tends to forage in shallower water and closer to shore than the latter. The diet is primarily a wide variety of fish but also includes salamanders, crustaceans, polychaete worms, and insects (grasshoppers, variety of aquatic forms).

Issues in BCR 32

- Disturbance can flush adults from nests causing loss of eggs and chicks to exposure or predation. Adults and chicks are sometimes killed directly by boats, and chicks separated from parents may die of exposure. Grebes may die of entanglement in discarded fishing line or plastic six-pack rings.
- Fluctuating or declining water levels can lead to abandonment or heighten predation at low water levels; low and declining water levels also can result in mortality of flightless molting grebes.
- Contaminants (DDT, mercury) have caused mortality and lowered reproductive success in the past and remain of concern, particularly with respect to sublethal effects.
- Oil spills in bays or estuaries can cause extensive mortality.
- Diseases (e.g., botulism, avian cholera) have caused grebe mortality but may increase as a problem with the recent spread of West Nile virus, Newcastle disease, and avian influenza.

Existing Actions

- Recommended actions for breeding Western and Clark's grebes are included in a conservation assessment and management plan for these species in California (Ivey 2004).
- Needs also are addressed in a worldwide conservation plan for grebes (O'Donnel and Fjeldsá 1997).

Research and Monitoring Needs

- Conduct studies at major colonies to identify the life stages or factors limiting breeding success and those controlling substantial year-to-year variation in numbers of nest initiations.
- Establish a broad-scale monitoring program for breeding colonies, taking into account the great year-to-year variation in nesting numbers at some sites. Evaluate the effectiveness of the CBC in monitoring winter numbers, and, if found lacking, consider alternative approaches.
- Initiate color-marking or radio-telemetry studies to determine the degree of individuals' fidelity to nest sites and the connectivity of breeding, migration staging, and wintering areas.

Needed Management Actions

- Post educational materials to encourage those engaged in boating or shoreline activities to avoid colonies and to clean up discarded fishing line or plastic. If voluntary measures are ineffective, initiate closures of areas near colonies during the breeding season.
- Where feasible, maintain relatively stable water levels during the breeding season.
- Restrict recreational development or expansion along shorelines adjacent to known or potential colony sites.
- As needed, establish no-wake zones for power boats to reduce flooding or destruction of nests.

Primary regional contact(s):

Dan Anderson, University of California Davis; Gary Ivey; Floyd Hayes, Pacific Union College; Dave Shuford, PRBO Conservation Science.

References

Ivey, G. L. 2004. Conservation assessment and management plan for breeding Western and Clark's grebes in California. Unpublished report for the American Trader Trustee Council. National Fish and Wildlife Foundation, San Francisco. (www.darrp.noaa.gov/southwest/amtrader/pdf/grebe.pdf).

Kelly, J. P., and S. L. Tappen. 1998. Distribution, abundance, and implications for conservation of winter waterbirds on Tomales Bay, California. W. Birds 29:103–120.

O'Donnel, C., and B. J. Fjeldsá (compilers). 1997. Grebes: Status survey and conservation action plan. IUCN/SSC Grebe Specialist Group. IUCN, Gland, Switzerland, and Cambridge, UK (http://data.iucn.org/dbtw-wpd/edocs/1997-058.pdf).

Robison, K. M., R. E. Weems, D. W. Anderson, and F. Gress. 2010. Western and Clark's grebe conservation and management in California: Annual report, 2009. Unpublished report to the American Trader and Kure/Stuyvesant Trustee Councils and National Fish and Wildlife Foundation. California Institute of Environmental Studies, 3408 Whaler Ave., Davis, CA 95616. (http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=45718).

Shuford, W. D., G. W. Page, J. G. Evens, and L. E. Stenzel. 1989. Seasonal abundance of waterbirds at Point Reyes: A coastal California perspective. W. Birds 20:137–265.

Storer, R. W., and G. L. Nuechterlein. 1992. Western Grebe (*Aechmophorus occidentalis*) and Clark's Grebe (*A. clarkii*), in The Birds of North America (A. Poole, P. Stettenheim, and F. Gill, eds.), no. 26. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Account author: W. David Shuford.

Clark's Grebe (*Aechmophorus clarkii*)

Status Summary

Continental conservation priority: Low concern.

BCR 32 conservation scores:

Population trend:	4
Threats to breeding:	5
Threats to non-breeding:	5
Percent of population in BCR:	1

BCR 32 conservation priority: High concern.

Abundance and population trend in North America: 10,000–20,000 individuals. BBS data (Western/Clark's combined) show a non-significant declining trend of -2.0%/yr (1968–2009; data deficient).

Abundance and population trend in BCR 32: Size of breeding and (larger) wintering populations are unknown. BBS data (Western/Clark's combined) show a (non-significant) increasing trend of 8.9%/yr (1968–2009; data with a major deficiency).

Percent of continental population in BCR 32: Unknown and varies by season.

Global Distribution

Breeds broadly but locally in western North America from s.-central British Columbia east to sw. Manitoba and south to n. Baja California, Arizona (except sw.), sw. and ne. New Mexico, and s. Colorado; resident at some sites in interior at least to n.-central California west of Sierra Nevada. Also resident and breeding in interior Mexico south to Guerrero and w. Puebla. Winters along the coast and near coastal lowlands from s. British Columbia (rare to casual north of c. California) south through Baja California and probably the Gulf of Mexico.

Occurrence in BCR 32

A year-round resident throughout the region. Locally uncommon at scattered inland breeding colonies. Nonbreeders occur locally throughout the region, and the species is most numerous and widespread in fall and winter when birds concentrate mainly on the coast but also at some inland sites.

Habitat Requirements

Breeds at colonies inland at large lakes, marshes, sloughs, and reservoirs with extensive areas of open water usually bordered by emergent vegetation; winters at a greater number of

freshwater sites inland, but largest numbers then in coastal bays, estuaries, and lagoons. The main requirements appear to be emergent or other aquatic vegetation for nest building and attachment and abundant prey and clear water for foraging. Differences in habitat requirements between Clark's and Western grebes are subtle but the former tends to forage in deeper water and farther from shore than the latter. The diet is primarily a wide variety of fish but also includes salamanders, crustaceans, polychaete worms, and insects (grasshoppers, variety of aquatic forms).

Issues in BCR 32

- Disturbance can flush adults from nests causing loss of eggs and chicks to exposure or predation. Adults and chicks are sometimes killed directly by boats, and chicks separated from parents may die of exposure. Grebes may die of entanglement in discarded fishing line or plastic six-pack rings.
- Fluctuating or declining water levels can lead to abandonment or heighten predation at low water levels; low and declining water levels also can result in mortality of flightless molting grebes.
- Contaminants (DDT, mercury) have caused mortality and lowered reproductive success in the past and remain of concern, particularly with respect to sublethal effects.
- Oil spills in bays or estuaries can cause extensive mortality.
- Diseases (e.g., botulism, avian cholera) have caused grebe mortality but may increase as a problem with the recent spread of West Nile virus, Newcastle disease, and avian influenza.

Existing Actions

- Recommended actions for breeding Western and Clark's grebes are included in a conservation assessment and management plan for these species in California (Ivey 2004).
- Needs also are addressed in a worldwide conservation plan for grebes (O'Donnel and Fjeldsá 1997).

Research and Monitoring Needs

- Conduct studies at major colonies to identify the life stages or factors limiting breeding success and those controlling substantial year-to-year variation in numbers of nest initiations.
- Establish a broad-scale monitoring program for breeding colonies, taking into account the great year-to-year variation in nesting numbers at some sites. Evaluate the effectiveness of the CBC in monitoring winter numbers, and, if found lacking, consider alternative approaches.
- Initiate color-marking or radio-telemetry studies to determine the degree of individuals' fidelity to nest sites and the connectivity of breeding, migration staging, and wintering areas.

Needed Management Actions

- Post educational materials to encourage those engaged in boating or shoreline activities to avoid colonies and to clean up discarded fishing line or plastic. If voluntary measures are ineffective, initiate closures of areas near colonies during the breeding season.
- Where feasible, maintain relatively stable water levels during the breeding season.
- Restrict recreational development or expansion along shorelines adjacent to known or potential colony sites.
- As needed, establish no-wake zones for power boats to reduce flooding or destruction of nests.

Primary regional contact(s):

Dan Anderson, University of California Davis; Gary Ivey; Floyd Hayes, Pacific Union College; Dave Shuford, PRBO Conservation Science.

References

Ivey, G. L. 2004. Conservation assessment and management plan for breeding Western and Clark's grebes in California. Unpublished report for the American Trader Trustee Council. National Fish and Wildlife Foundation, San Francisco (www.darrp.noaa.gov/southwest/amtrader/pdf/grebe.pdf).

Kelly, J. P., and S. L. Tappen. 1998. Distribution, abundance, and implications for conservation of winter waterbirds on Tomales Bay, California. W. Birds 29:103–120.

O'Donnel, C., and B. J. Fjeldsá (compilers). 1997. Grebes: Status survey and conservation action plan. IUCN/SSC Grebe Specialist Group. IUCN, Gland, Switzerland, and Cambridge, UK (http://data.iucn.org/dbtw-wpd/edocs/1997-058.pdf).

Robison, K. M., R. E. Weems, D. W. Anderson, and F. Gress. 2010. Western and Clark's grebe conservation and management in California: Annual report, 2009. Unpublished report to the American Trader and Kure/Stuyvesant Trustee Councils and National Fish and Wildlife Foundation. California Institute of Environmental Studies, 3408 Whaler Ave., Davis, CA 95616 (http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=45718).

Shuford, W. D., G. W. Page, J. G. Evens, and L. E. Stenzel. 1989. Seasonal abundance of waterbirds at Point Reyes: A coastal California perspective. W. Birds 20:137–265.

Storer, R. W., and G. L. Nuechterlein. 1992. Western Grebe (*Aechmophorus occidentalis*) and Clark's Grebe (*A. clarkii*), in The Birds of North America (A. Poole, P. Stettenheim, and F. Gill, eds.), no. 26. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Account author: W. David Shuford.

Double-crested Cormorant (*Phalacrocorax auritus*)

Status Summary

Continental conservation priority: Lowest concern.

BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	4
Threats to non-breeding:	2
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.

Abundance and population trend in North America: 700,000 to 740,000 breeders. Significant increasing BBS trend of 4.7%/yr (1966–2009), and colony data show significant increases in many regions of North America since the late 1970s.

Abundance and population trend in BCR 32: About 5000 breeders. Significant increasing BBS trend (1968–2009) of 12.9%/yr (data deficient); after historical declines, numbers at coastal colonies have increased since the 1970s, but data for the interior are inadequate for trend assessment, though also suggestive of increasing trend. Numbers in south San Francisco Bay have increased from a few dozen at one nesting site to >500 pairs at eight sites.

Percent of continental population (breeding) in BCR 32: <1%.

Global Distribution

Breeds widely in North America: on the Pacific Coast from s. Alaska to Baja California, the Gulf of California, and adjacent mainland Mexico; the Atlantic Coast from the Maritime Provinces to Florida, in the Caribbean, and coastal Yucatán Peninsula and n. Belize; and in the interior mainly from the Prairie Provinces south locally to northern Mexico. In winter, occupies most of coastal and near-coastal breeding range but retracts from most of northern interior and north Atlantic coast to seasonally occupy coastal lowlands from mid-Atlantic States southward; the U.S. and Mexican Gulf Coast south to Belize; and the southern U.S. and northeastern Mexican interior. In southern areas, migrants from the north mix with resident birds. Nonbreeders can be found widely in the general breeding range, including far from colonies, and some birds remain to oversummer in the wintering range.

Occurrence in BCR 32

A year-round resident throughout the region. Locally common at and near scattered breeding colonies mainly in San Francisco Bay and the Central Valley but also in the Coast Ranges or on the coastal slope. Nonbreeders occur locally throughout the region, and the species is most numerous and widespread in fall and winter when birds concentrate mostly in coastal estuaries and at some inland reservoirs.

Habitat Requirements

Regionally, forages in coastal estuaries and an array of freshwater habitats, including lakes, large open-water marshes, reservoirs, floodwater impoundments, ponds, and large rivers. Also requires suitable daytime loafing areas, nighttime roosts, and nest sites secure from ground predators and close (typically <10 km) to foraging areas. Nest sites in estuaries have mainly been on artificial structures, such as large bridges, large power towers, and dredges, but also on islands or levees in salt ponds. Inland in the region, nests typically are built in live or dead trees with their bases in water, on islands, or on the shores of lakes or rivers; nesting trees are typically shared with breeding herons and egrets. These cormorants are opportunistic foragers that take a wide variety of prey depending on availability; birds typically feed close (<5 km) to shore in shallow (<8 m deep), open water. At most sites the diet is almost entirely fish but infrequently may include aquatic insects, crustaceans, and amphibians.

Issues in BCR 32

- Greatest threats to inland breeders are a lack of high quality water at wetlands and potential human disturbance at nesting colonies.
- Bridge-nesting cormorants are at risk from disturbance from routine bridge maintenance activities.
- Contaminants have caused reproductive failures in the past and continue to be a potential threat to the species.
- Although cormorants have been killed under permits issued to fish farmers in the San Joaquin Valley in the early 1990s, conflicts with commercial and recreational fishermen currently do not appear to be a substantial problem in California as is the case in many regions of North America.

Existing Actions

Continental status assessment available (www.fws.gov/migratorybirds/CurrentBirdIssues/Management/cormorant/status.pdf).

Research and Monitoring Needs

- Identify source and sink populations and determine which population parameters contribute the most to population limitation in estuarine- and inland-nesting cormorants.
- Use color-marked or radio-tagged birds to study the foraging, dispersal, and migratory movements of cormorants to better understand the suite of habitats they use, the linkages among them, and how habitat use patterns change with fluctuating environmental conditions.
- Use marked birds to elucidate the extent of interchange between inland and coastal breeding populations and if the degree or timing of mixing is influenced by climatic or oceanic conditions, breeding failures, or other factors.
- Conduct a diet study of different colonies to understand the composition of prey species and its potential links to breeding success.

Needed Management Actions

- Minimize human disturbance by restricting public access and limiting colony entry to researchers unless absolutely necessary.

- Schedule bridge maintenance activities for the non-breeding season.
- Provide or maintain nesting islands of suitable size, substrate, and isolation, and maintain water levels within a range that avoids flooding or connecting islands to the mainland.

Primary regional contact(s): Mark Rauzon; Dave Shuford, PRBO Conservation Science; Cheryl Strong, Don Edwards San Francisco Bay National Wildlife Refuge.

References

Carter, H. C., A. L. Sowls, M. S. Rodway, U. W. Wilson, R. W. Lowe, G. J. McChesney, F. Gress, and D. W. Anderson. 1995. Population size, trends, and conservation problems of the Double-crested Cormorant on the Pacific coast of North America. Colonial Waterbirds 18 (Special Publ. 1): 189–215.

Hatch, J. J., and D. V. Weseloh. 1999. Double-crested Cormorant (*Phalacrocorax auritus*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 441. Birds N. Am., Philadelphia.

Shuford, W. D. 2010. Inland-breeding pelicans, cormorants, gulls, and terns in California: A catalogue, digital atlas, and conservation tool. Wildl. Branch, Nongame Wildl. Progr. Rep. 2010-01. Calif. Dept. Fish & Game, Sacramento. Available (minus digital atlas) at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=24095.

Wires, L. R., F. J. Cuthbert, D. R. Trexel, and A. R. Joshi. 2001. Status of the Double-crested Cormorant (*Phalacrocorax auritus*) in North America. Final Report to U.S. Fish & Wildl. Serv. Available from U.S. Fish & Wildl. Serv., Div. Migratory Bird Mgmt., 4401 North Fairfax Dr., MS 634, Arlington, VA 22203 or at www.fws.gov/migratorybirds/CurrentBirdIssues/Management/cormorant/status.pdf.

Account author: W. David Shuford.

American White Pelican (*Pelecanus erythrorhynchos*)

Status Summary

Continental conservation priority: Moderate concern.
BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	na
Threats to non-breeding:	3
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.
Abundance and population trend in North America: ~134,000 breeders in 1998–2001, and combined numbers at a subset of all colonies counted in both periods have more than doubled from 1979–1981 to 1998–2001. Non-significant increasing BBS trend of 5.1%/yr (1966–2009; data with an important deficiency).
Abundance and population trend in BCR 32: Non-significant increasing BBS trend of 21.2%/yr (1968–2009; data with an important deficiency) but these data really not applicable as species has not bred in BCR 32 during the BBS survey period. Total numbers in BCR in winter and migration are unknown.
Percent of continental population in BCR 32 (in winter or migration): Unknown, but estimated ≤20%.

Global Distribution

Breeds primarily in the interior of North America from the Canadian and U.S. Prairies patchily south and west through the Intermountain West, reaching its southwestern limit in s. Oregon, ne. California, and w. Nevada. Can be separated into two groups, one breeding and migrating east, the other west, of the continental divide; additional small non-migratory groups breed irregularly on the central Texas coast, on the n. Gulf coast of Mexico, and, in winter, in n.-central Mexico. Winters primarily on the Pacific Coast and lowlands from central California and s. Arizona south through Baja California and west Mexico to Nicaragua, and from Florida and the Gulf States south through the Gulf coast and central plateau of Mexico to the n. Yucatán Peninsula. Post-breeders from western colonies may disperse widely (many north and east) before migrating south; small numbers of nonbreeders may summer, or disperse to, nearly anywhere in the normal migrant and winter ranges.

Occurrence in BCR 32

Formerly bred in the Central Valley but has not done so since the early 1950s. Currently is common locally throughout the region during migration or in winter, with largest numbers apparently in the San Francisco Bay region. Non-breeders and perhaps returning early-season failed breeders may occur within the migratory or winter range in spring and summer months.

Habitat Requirements

American White Pelicans typically forage, often cooperatively in flocks, in shallow (0.3–2.5 m) inland waters, such as open areas in marshes and along lake or river edges, and in coastal estuaries and lagoons. During less frequent foraging in deep water, they steal prey brought to the surface by other birds, particularly Double-crested Cormorants; pelicans also may rob gulls or other pelicans trying to swallow large fish. These pelicans are adapted to shift foraging sites in response to cycles of drought and flood, and long-distance movements to forage have been documented during breeding; little appears to be known about winter site fidelity. The diet is mainly "rough" fish of low economic value—predominately small schooling fish but also larger sluggish bottom feeders—as well as salamanders and crayfish. Additional requirements during the non-breeding season are suitable daytime loafing areas and nighttime roosts free from disturbance and ground predators.

Issues in BCR 32

- Documented die-offs from disease to date have been limited in this BCR but are cause for concern because of large die-offs from Type C botulism elsewhere where

pelicans concentrate in the non-breeding season and from West Nile virus and possibly Newcastle disease virus at breeding colonies.
- Although the effects of contaminants (reproductive failure and mortality on the breeding grounds, mortality at wintering sites or migratory staging areas) have declined in recent decades, they still remain of concern.
- Water availability and quality are of concern at wetlands in the Central Valley, and sustainable healthy fish populations are at risk at interior and coastal sites because of diversions of water and contaminants in runoff.

Existing Actions

Recent published summary of status and conservation issues (Anderson et al. 2005).

Research and Monitoring Needs

- Initiate detailed studies of the winter foraging ecology at various sites and couple these with studies of fish populations and water quality.
- Periodically evaluate pesticides and contaminants in pelicans, and study disease events at sites where they concentrate in the nonbreeding season.
- Conduct radio- and satellite-telemetry studies to determine foraging movements and dispersal patterns during the non-breeding season.

Needed Management Actions

- Investigate the possibility of restoring potential nesting habitat in the southern San Joaquin Valley, where the species last bred in the BCR.
- Maintain or enhance nongame fish populations for pelicans, restoring prey species at pelican foraging areas as necessary. Ensure prey availability by maintaining shallow (1–2 m) water depths and, when feasible, drawing down levels to provide foraging opportunities.
- Provide and maintain isolated loafing and roosting areas.

Primary regional contact(s):

Dan Anderson, University of California Davis; Dave Shuford, PRBO Conservation Science.

References

Anderson, D. W., D. T. King, and J. Coulson, eds. 2005. The biology and conservation of the American White Pelican. Waterbirds (Special Publ. 1) 28.

Evans, R. M., and F. L. Knopf. 1993. American White Pelican (*Pelecanus erythrorhynchos*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 57. Acad. Nat. Sci., Philadelphia, PA, and Am. Ornithol. Union, Washington, DC.

Shuford, W. D. 2005. Historic and current status of breeding American White Pelicans in California. Waterbirds 28 (Special Publ. 1): 35–47.

Account author: W. David Shuford.

American Bittern (*Botaurus lentiginosus*)

Status Summary

Continental conservation priority: High concern.
BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	3
Threats to non-breeding:	3
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.
Abundance and population trend in North America: No data on overall numbers but abundance in favorable habitat may reach 40 calling birds per 100 ha. Non-significant declining BBS trend of -1.1%/yr (1966–2009; data deficient).
Abundance and population trend in BCR 32: No data on overall numbers or densities in favorable habitats within this region. Non-significant increasing BBS trend of 1.2%/yr (1968–2009; data deficient).
Percent of continental population in BCR 32: Unknown but varies seasonally.

Global Distribution

Breeds in North America from extreme se. Alaska, central interior British Columbia, s. Mackenzie, n. Manitoba, n. Ontario, central Quebec, and Newfoundland south locally to coastal s. California, central Arizona (formerly), s. New Mexico, Texas, central Arkansas, central and w. Tennessee, w. Kentucky, central Ohio, s. Pennsylvania, ne. West Virginia, e. Maryland, and e. Virginia; at least formerly, bred also in Louisiana, Florida, Puebla, and México. Winters from e.-central British Columbia, w. Washington, w. Oregon, n. Nevada, n. and central Utah, n. Arizona, central New Mexico, n. Texas, the Gulf states and s. New England (casual farther north), south to s. Mexico and Cuba, rarely (or formerly) to Costa Rica and Panama, and to the central Caribbean.

Occurrence in BCR 32

Occurs year round and breeds locally but widely in suitable habitat throughout the California portion of BCR 32. Largest numbers in California's Central Valley, and particularly numerous (or visible?) in the extensive rice fields of the Sacramento Valley during the breeding season. Occurs more widely in winter when resident populations apparently are swelled by migrants.

Habitat Requirements

Occupies a variety of mainly freshwater (rarely brackish or tidal) wetlands with tall emergent vegetation and abundant prey. More numerous in larger than smaller wetlands, and, where studied in the Midwest and East, found only or mainly at wetlands >4–10 ha in size. Uses habitats with relatively shallow water: <10 cm in some areas, mean 10 cm in others. Typically nests solitarily in dense marsh vegetation over water 5–20 cm in depth but sometimes over dry ground in structurally comparable herbaceous cover in uplands surrounding a wetland basin; birds foraging in rice fields likely nest in denser and taller vegetation in nearby

canals or weedy upland fields. The diet consists mainly of insects (mostly aquatic, also grasshoppers), frogs and salamanders, fish, crayfish, snakes (mainly garter and water), small mammals (mainly voles) and a few crabs, spiders, and other invertebrates.

Issues in BCR 32

- Loss and degradation of historic wetlands, which surely caused major population declines in bitterns, have been offset to an unknown degree by the planting of extensive rice fields (160,000–200,000 ha annually) in the Sacramento Valley and recently by the creation more widely of new wetlands to meet waterfowl needs.
- Recent wetland gains have been primarily in fall and winter, though, leaving shallowly flooded dense emergent wetlands in short supply during the breeding season.
- Pesticides and other contaminants may have effects on bitterns or their aquatic prey but no studies are available.
- Invasive plants, such as Purple Loosestrife (*Lythrum salicaria*), may reduce habitat suitability but such effects have not been rigorously documented.

Existing Actions

No known specific actions currently target this species in BCR 32.

Research and Monitoring Needs

- Conduct studies of all aspects of the species' biology and ecology, particularly to identify the life stages and factors limiting its populations.
- Identify the features of wetland habitats that support high densities of bitterns and sustain high reproductive success.
- Develop a monitoring program and protocol, aligned with national schemes, to obtain data on relative abundance and to track population trends at the BCR level or finer.
- Evaluate the effects, if any, of pesticides and other contaminants on the reproductive success of bitterns and on their prey populations.

Needed Management Actions

- Preserve large shallow wetlands with dense emergent vegetation and create additional habitat that is available during the breeding season.
- Manage available wetlands to provide robust emergent vegetation for nesting and concealment and relatively shallow water (10–15 cm) for foraging.

Primary regional contact(s): Fritz Reid, Ducks Unlimited.

References

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th ed. Am. Ornithol. Union, Washington, DC.

Gibbs, J. P., S. Melvin, and F. A. Reid. 1992. American Bittern (*Botaurus lentiginosus*), in The Birds of North America (A. Poole, P. Stettenheim, and F. Gill, eds.), no. 18. Acad. Nat. Sci., Philadelphia, PA, and Am. Ornithol. Union, Washington, DC.

Account author: W. David Shuford.

Snowy Egret (*Egretta thula*)

Status Summary

Continental conservation priority: High concern.

BCR 32 conservation scores:

Population trend:	2
Threats to breeding:	4
Threats to non-breeding:	2
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.

Abundance and population trend in North America: Nesting population >143,000 individuals (159,000 in 1970s), subject to considerable flux since the mid-twentieth century and substantial uncertainty about recent population trends. Non-significant increasing BBS trend of 1.9%/yr (1966–2009).

Abundance and population trend in BCR 32: Nesting population >2500 individuals, based on subregional estimates in 2003–2005 and Central Valley survey in 1982; in the San Francisco Bay area, a significant declining trend of -12%/yr, 2002–2010, and non-significant decline of -1.5%/yr, 1994–2010. Significant increasing BBS trend of 6.4%/yr (1968–2009; data deficient).

Percent of continental population in BCR 32: >1.7% of continental breeding population; "key" continental wintering areas with >5% of winter band recoveries include (1) the San Francisco Bay area and Central Valley and (2) San Diego County (and area eastward to Colorado River).

Global Distribution

In United States, breeds principally along the Atlantic and Gulf coasts, in extensive inland areas along the Mississippi and Arkansas rivers, and in a block from Louisiana to east Texas; in the western U.S., breeds primarily in the Central Valley and coastal areas of California, the Salton Sea, along the lower Colorado River, and in pockets throughout western states. Breeding extends down both coasts of Mexico, through the Caribbean islands, and south to Chile and Argentina. Key wintering areas are the Atlantic Coast, Bahamas, Cuba, Greater Antilles, and Gulf and Pacific coasts south to Central America.

Occurrence in BCR 32

Colony sites are incompletely known; widely scattered throughout the Central Valley and the San Francisco Bay area, sporadically in small colonies along coastal lowlands (primarily, San Diego County), and uncommonly in higher areas of the outer Coast Ranges. Coastal occurrences south of

San Francisco are more widespread in winter than during the nesting season.

Habitat Requirements

Primarily a species of coastal wetlands and large wetland basins. Nests in trees or shrubs on islands; in trees within suburban areas near coastal lagoons, bays, or other large wetland systems; and in tule or *Typha* sp. beds of brackish or freshwater marshes. Usually nests in mixed-species heronries, often with Black-crowned Night-Herons; typically builds nests below the vegetation canopy. Forages in salt marsh pools and along shorelines of bays, lagoons, lowland streams, marshes, and swamps; also forages in rice fields, irrigation ditches and canals, and in diked, managed wetlands. Prefers open pools in dense marshes or swamps, the confluences or mouths of tidal creeks, channels that connect managed wetlands, and open shallows (5–25 cm) on the edges of rivers, lakes, reservoirs, bays and lagoons. Most feeding areas have tidal or seasonal fluctuations in water level. Prey consist primarily of small fish (60%–87% in Texas and East Coast), variable amounts of crustaceans (including crayfish), and small proportions of invertebrates and amphibians; 94% of prey <2 cm in San Francisco Bay.

Issues in BCR 32

- Nesting disturbance by humans or individual nest predators, including human commensals (e.g., raccoons, feral cats, or Common Ravens), can result in nest failure or colony site abandonment.
- Declines in foraging habitat suitability related to water quality, nutrient enrichment, or management of seasonal water depth, can lead to colony relocation and reduced use of wetlands.
- Declining availability of isolated islands or other safe areas for nesting within reasonable distances (<10 km) of important feeding areas may limit populations.
- Pesticides and other contaminants (e.g., DDT, PCBs, mercury, selenium) have caused mortality and can impair reproductive success.

Existing Actions

- Infrequent efforts by local planning departments and the State Coastal Commission to limit nest disturbance.
- Some protective management of heronries in state and federal refuges.

Research and Monitoring Needs

- Conduct surveys to assess region-wide nesting abundance and trends; surveys are especially needed in the Central Valley.
- Determine the relative use of feeding areas within major wetland subregions.
- Determine patterns of foraging dispersion near important colony sites.
- Evaluate seasonal differences in regional and subregional abundance and distribution.
- Measure variation in natal dispersal and inter-annual movements of adults between colony sites.

Needed Management Actions

- Protect existing heronries from major increases in human activity, including direct human disturbance, land development, and nearby construction activities.
- Prevent destruction of heronries during non-breeding periods, when sites are unoccupied.
- Reduce the occurrence of nest predators, especially human commensals, near existing heronries.
- Integrate appropriate water-level regimes and habitat objectives into wetland management plans.
- Limit recreational use of important shallow-water feeding areas.
- Promote collaborative management of habitat needs across wetland subregions.

Primary regional contact(s): John Kelly, Audubon Canyon Ranch; Cheryl Strong, Don Edwards San Francisco Bay National Wildlife Refuge; Philip Unitt, San Diego Museum of Natural History.

References

Kelly, J. P., K. Etienne, C. Strong, M. McCaustland, and M. Parkes. 2006. Annotated atlas and implications for the conservation of heron and egret nesting colonies in the San Francisco Bay area. ACR Tech. Rep. 90-3-17 (www.egret.org/atlas).

Mikuska, T., J. A. Kushlan, and S. Hartley. 1998. Key areas for wintering North American herons. Colonial Waterbirds 21:125–134.

Parsons, K. C., and T. L. Master. 2000. Snowy Egret (*Egretta thula*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 489. Birds N. Am., Philadelphia.

Schlorff, R. 1982. Heronry inventory. Nongame Wildl. Invest. Rep., Project W-54-R-14, Job III-8.0. Calif. Dept. Fish & Game, Habitat Conserv. Planning Branch, 1416 Ninth St., Sacramento, CA 95814 (http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=40685).

Spendelow, J. A., and S. R. Patton. 1988. National atlas of coastal waterbird colonies in the contiguous United States: 1976–1982. U.S. Fish & Wildl. Serv. Biol. Rep. 88(5). U.S. Fish & Wildl. Serv., Washington, DC.

Unitt, P. 2004. San Diego County bird atlas. Proc. San Diego Soc. Nat. Hist. 39.

Account author: John P. Kelly.

White-faced Ibis (*Plegadis chihi*)

Status Summary

Continental conservation priority: Low concern.
BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	3
Threats to non-breeding:	2
Percent of population in BCR:	2

BCR 32 conservation priority: Lowest concern.
Abundance and population trend in North America: >100,000 breeders. Major declines in 1960s and 1970s but subsequently numbers have increased greatly and the range has expanded. Significant increasing BBS trend of 4.5%/yr (1968–2009; data deficient).
Abundance and population trend in BCR 32: Roughly 32,000 breeders in 2005. Declining numbers in California reached their nadir in the 1970s, but both breeding and wintering numbers have increased greatly since the mid-1980s. Non-significant BBS trend of 31.2%/yr (1968–2009; data with a important deficiency).
Percent of continental population in BCR 32: unknown.

Global Distribution

Breeds in North America locally from n. California, e. Oregon, se. Washington (rarely), s. Idaho, Montana, s. Alberta (rarely), n.-central North Dakota, and (formerly) sw. Minnesota south to Durango, Jalisco (perhaps elsewhere on Mexican Plateau), s. and e. Texas, s. Louisiana, coastal Alabama (rarely), and occasionally (or formerly) in nw. Iowa and possibly Florida. Also breeds in central and s. South America both east and west of the Andes. Winters from n.-central California, sw. Arizona, and the Gulf coast of Texas and s. Louisiana south through Mexico (including Baja California) to the Pacific lowlands of Guatemala; also in general breeding range in South America.

Occurrence in BCR 32

Occurs year round, but numbers generally greater and distribution broader in winter coincident with an influx of migrants. Currently breeds very locally in the Central Valley and (in very small numbers) on the coastal slope of southern California. Key breeding areas (≥500 breeders) since the 1980s include Colusa NWR, Sutter NWR, Delevan NWR (Rennick Unit), Natomas Basin, and Yolo Bypass WA in the Sacramento Valley, and Mendota WA, Kern NWR, and private wetlands in the Tulare Basin, in the San Joaquin Valley. Colonies may be ephemeral and change size rapidly. Key wintering concentrations in the Central Valley have been in rice fields around refuges in the trough of the Sacramento Valley and at wetlands and agricultural fields in the Grasslands Ecological Area near Los Banos in the San Joaquin Valley. On the coastal slope, core areas of most regular occurrence in winter are near Pt. Mugu, Ventura County; the Prado Basin and adjacent Santa Ana River Valley area, western San Bernardino and Riverside counties; and lowlands of northwestern San Diego County.

Habitat Requirements

Typically breeds inland in shallow freshwater marshes in tall emergent vegetation (in early stages of succession) or in stands of flooded low-stature tamarisk (*Tamarix* spp.) trees. Colonies are generally isolated from ground predators and human disturbance. Foraging habitats include shallow managed wetlands, ephemeral wetlands, rice fields, flood-irrigated crops (particularly alfalfa) and pastures, and the margins of lakes and coastal lagoons. The diet is mainly aquatic and moist-soil invertebrates (especially earthworms and larval insects) but also leeches, spiders, snails, crayfish, small fish, frogs, and bivalves.

Issues in BCR 32

- Ibis are losing foraging areas in the Central Valley from conversion of alfalfa and pastures to other unsuitable agricultural (such as vineyards) or to urban expansion.
- An ever tightening water supply from rapid human population growth may reduce the future availability of water for wetlands and for flood irrigation of agricultural fields.
- Remaining agricultural foraging habitat on the coastal slope is being lost to ongoing development.
- Ibis are at risk from pesticides and other contaminants concentrated in their prey.

Existing Actions

A status assessment with conservation recommendations for White-faced Ibis in the West is in preparation.

Research and Monitoring Needs

- Study the causes of rapid shifts in colony locations and sizes.
- Identify the life stages and factors (at both local and landscape scales) limiting ibis populations.
- Investigate in the Central Valley if pesticides and other contaminants are being concentrated in ibis and their eggs and whether there are adverse effects on reproductive success.
- Continue annual monitoring of colonies on refuges and, if possible, expand this to include all large colonies on private lands. Evaluate whether ongoing Christmas Bird Counts are effective in monitoring winter numbers in California, and, if needed, develop alternative methods.

Needed Management Actions

- Preserve or secure habitat and water rights for all known colony sites, major foraging areas, and key roosting areas.
- Manage known colony sites, as feasible, to maintain emergent nesting habitat and shallow foraging areas (both on wetlands and in surrounding agricultural landscapes).
- Work with agricultural interests, providing incentives as needed, to maintain flood-irrigated crops and pastures and to promote (e.g., organic) practices that favor earthworms or other key ibis prey.

- Work with national and international partners to reduce pesticide use, particularly in wintering areas where currently unregulated.

Primary regional contact(s): Mike Wolder, Sacramento NWR Complex, and Steve Bruggemann, Mendota WA.

References

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th ed. Am. Ornithol. Union, Washington, DC.

Earnst, S. L., L. Neel, G. L. Ivey, and T. Zimmerman. 1998. Status of the White-faced Ibis: Breeding colony dynamics of the Great Basin population, 1985–1997. Colonial Waterbirds 20:301–313.

Henny, C. J. 1997. DDE still high in White-faced Ibis eggs from Carson Lake, Nevada. Colonial Waterbirds 20:478–484.

Ryder, R. R., and D. E. Manry. 1994. White faced Ibis (*Plegadis chihi*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 130. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Shuford, W. D., C. M. Hickey, R. J. Safran, and G. W. Page. 1996. A review of the status of the White-faced Ibis in winter in California. W. Birds 27:169–196.

Account author: W. David Shuford.

Yellow Rail (*Coturnicops noveboracensis*)

Status Summary

Continental conservation priority: High concern.

BCR 32 conservation scores:

Population trend:	4
Threats to breeding:	na
Threats to non-breeding:	4
Percent of population in BCR:	1

BCR 32 conservation priority: High concern.

Abundance and population trend in North America: No information.

Abundance and population trend in BCR 32: As of 2007, about 35 records document occurrence in the coastal zone and the Central Valley with most of these dated prior to 1937. Currently, very small numbers winter along the coast and in the Suisun Marsh (over 20 records for the region since 1970). There are no recent records from the Central Valley.

Percent of continental population in BCR 32: Negligible.

Global Distribution

Current North American breeding range extends from Great Slave Lake, Northwest Territories, east to James Bay and Gaspe Peninsula, Quebec, south to ne. Montana and east through n. Michigan and n. Maine. Disjunct population in s. Oregon; possible breeding in n. California. Historic breeding range extended further south to n. Illinois and central Ohio and included ne. California. Winters in coastal North Carolina south to Florida and west to s. Texas. Also occurs in coastal and central California.

Occurrence in BCR 32

Rare winter visitor to coastal marshes from Sonoma County south to San Diego County with most records from the San Francisco Bay region. Recent coastal records include Tomales Bay and elsewhere in Marin County (about a dozen records); Alameda, Alameda County; Palo Alto Baylands, Santa Clara County; Harkins Slough, Santa Cruz County; Pt. Pinos, Monterey County; Santa Barbara, Santa Barbara County; Manhattan Beach, Los Angeles County; and Santee, San Diego County (last three records were of birds found in urban areas). Two birds were captured at Grizzly Island Wildlife Area in the Suisun Marsh, Solano County, during January/February 2002 and single birds were detected there in December 2002. Historically, also occurred at several inland locations including Los Banos, Merced County; Shandon, San Luis Obispo County; and Corona, Riverside County.

Habitat Requirements

Poorly known. Occupies wet meadows, freshwater marsh, brackish marsh and coastal tidal marshes. In general, diet includes small snails, earthworms, insects and other invertebrates. Additionally, seeds of sedges and other marsh plants are consumed in fall and winter.

Issues in BCR 32

- Habitat loss.
- In tidal marshes, barriers to high tide refugia increase threat of predation from herons, egrets, raptors, the introduced red fox (*Vulpes fulva*), feral cats, and other predators.
- Because poorly known and difficult to study, not taken into consideration when marsh restoration projects are planned or land management activities undertaken.

Existing Actions

No known specific actions currently target this species in BCR 32.

Research and Monitoring Needs

- Develop techniques to survey and monitor wintering populations of this silent and secretive species.
- Perform annual monitoring at locations with recent rail records (e.g., Tomales Bay, Grizzly Island).
- Describe habitat needs on wintering grounds.
- Identify all known or potential wintering habitat in BCR 32, focusing attention on historical locations.
- Understand migrational patterns.

Needed Management Actions

- Prioritize key wintering habitats and develop management plans that incorporate Yellow Rail needs into management schemes.
- Evaluate current management practices on public lands

to determine if they conflict with providing adequate habitat for Yellow Rails.
- Avoid construction-related and other activities that could disturb Yellow Rails.
- Provide high-tide refugia for Yellow Rails at key wintering areas.
- Study the effects of predation on Yellow Rails and other sensitive marsh species (e.g., Black Rail, Clapper Rail); develop and implement management strategies to reduce impacts to all these species.

Primary regional contact(s): John Sterling.

References

Bookhout, T. A. 1995. Yellow Rail (*Coturnicops noveboracensis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 139. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Grinnell, J., and A. H. Miller. 1944. The distribution of the birds of California. Pac. Coast Avifauna 27.

Sterling, J. 2008. Yellow Rail (*Coturnicops noveboracensis*), in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp. 163–166. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, and Calif. Dept. Fish & Game, Sacramento (www.dfg.ca.gov/wildlife/nongame/ssc/birds.html).

Account author: Lyann A. Comrack.

Black Rail (*Laterallus jamaicensis*)

Status Summary

Continental conservation priority: Highest concern.

BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	4
Threats to non-breeding:	4
Percent of population in BCR:	4

BCR 32 conservation priority: High concern.

Abundance and population trend in North America: Few baseline data. Population declines must have occurred from the massive habitat destruction in the last century. Evidence of range contraction for the East Coast, Midwest, and California.

Abundance and population trend in BCR 32: Over 90% of California's Black Rails occur in the n. San Francisco Bay area. Population estimates in 2001 were: San Pablo Bay, 15,000 individuals (range 11,000–19,000); Suisun Bay, 12,000 (6700–17,200); and Bolinas Lagoon and Tomales Bay, 280 (2–606). Apparently no longer breeds in south San Francisco Bay but occurs in winter. Population estimates for the Sacramento–San Joaquin River Delta (Delta) are unavailable. Recently found at 90 sites in the Sierra Nevada foothills, where deemed "locally common," but population and trend data unavailable. Historical records exist from Santa Cruz (probable migrant) south to San Diego (nesting confirmed at several San Diego locations), and at a few inland sites, including Chino and San Bernardino, San Bernardino Co., and Riverside, Riverside, Co.; now extirpated from this part of California.

Percent of continental population in BCR 32: Unknown.

Global Distribution

Of five subspecies, two occur in North America: *L. j. jamaicensis* of the East, *L. j. coturniculus* of California and Baja California. Birds found in Peru, Chile, and Argentina represent several other subspecies. Broad but patchy and irregular distribution across North American range. *L. j. jamaicensis* breeding/summer records on Atlantic coast from Connecticut south to New Jersey; resident from North Carolina south to s. Florida; on Gulf coast, resident in Florida, se. Alabama, and se. Texas. Winters along Gulf coast from Mississippi west to ne. Texas. Inland breeding/summer records for s. Pennsylvania; North Carolina south to central Georgia; s. Michigan, Wisconsin, and Minnesota south to n. Ohio, Indiana, central Illinois, n. Missouri, Kansas, and central Oklahoma. Breeding-season records for Mexico (Veracruz), Belize, Cuba, Jamaica, and Panama. *L. j. coturniculus* is resident in California (Bodega Bay, San Francisco Bay area, Suisun Marsh, Sierra foothills, Morro Bay, Salton Sea and vicinity, lower Colorado River); breeding-season records for ne. Baja California.

Occurrence in BCR 32

Year-round resident. Patchy along the coast from Tomales Bay, Marin Co., south to Morro Bay, San Luis Obispo Co. The greater San Francisco Bay estuary (including Suisun Marsh, Solano Co.) is the species' population center for the BCR. Found sparsely in the Delta (White Slough, Lodi, San Joaquin Co.). Recently discovered in the Sierra foothills of Yuba, Butte, Placer, and Nevada counties up to about 250 m in elevation.

Habitat Requirements

Tidal salt, brackish, and freshwater marshes. In tidal habitat, rails prefer high marsh at the upper limit of tidal flooding with dense cover, usually pickleweed (*Salicornia virginiana*) or sedges <10 cm tall; freshwater inflow may be important. The marsh's age, size, degree of channelization, soil, and water salinity are also important. May avoid habitats dominated by salt grass (*Distichlis spicata*). In freshwater marshes, found in dense stands dominated by cattails (*Typha* sp.), rushes (*Juncus* sp.), or bulrushes (*Scirpus* sp.); vegetation tends to be <3 cm high. Shallow, perennial water usually associated with seeps and springs also important. Nest variable but usually well-concealed in marsh vegetation; built on ground (rarely) or up to ~30 cm above ground, with a thin platform to flat or deeply cupped; often with a domed top for concealment, with a side entrance. Diet (poorly studied) includes small (<1 cm)

insects, other arthropods, and seeds. In tidal marshes, Black Rail occurrence is correlated positively with insects and spider abundance, negatively with amphipod abundance. Probably uses runways of mice and other rodents to move through marsh. Where overlap, may avoid areas with dense populations of California Clapper Rails (*Rallus longirostris levipes*), which may prey on young.

Issues in BCR 32

- Habitat loss, fragmentation, and degradation.
- Water-management practices for agriculture; flood control projects.
- Salt production in coastal areas.
- Urban development.
- In tidal marshes, barriers to high-tide refugia increase threat of predation from herons, egrets, raptors, introduced red foxes (*Vulpes fulva*), feral cats, and other predators.
- Contaminants and oil spills.
- Diversion of freshwater inflow into the north San Francisco Bay.
- Lining irrigation fixtures, which eliminates shallow wetlands fed by seepage.

Existing Actions

- Listed as a threatened species under the California Endangered Species Act. Considered a "fully protected" species under California Fish and Game Code Section 3511.
- Included on the U.S. Fish and Wildlife Service's 2008 list of Birds of Conservation Concern.
- South San Francisco Bay wetland restoration progressing; Black Rail included as focal species.
- University of California's Black Rail Project continues to study the species' ecology and habitat preferences in the Sierra Nevada foothills.

Research and Monitoring Needs

- Despite recent gains, the species is poorly known and difficult to study; undertake studies of basic biology, especially population parameters and ecology.
- Conduct nest monitoring to better estimate nesting success.
- Identify sink and source populations and the factors that influence them.
- Further study potential contaminant impacts.
- Assess potential impact on the rails' food supply of spraying wetlands for mosquito abatement as part of a West Nile Virus eradication campaign.
- Periodically survey for presence of Black Rails in restored marshes in coastal southern California that have benefited Light-footed Clapper Rails (*R. l. obsoletus*).

Needed Management Actions

- Create suitable upland habitat buffers in tidal areas to provide high-tide refugia.
- Ensure that south San Francisco Bay wetland restoration improves nesting habitat and high-tide refugia for Black Rails.
- Preserve large shallow wetlands with dense, short emergent vegetation; create additional suitable breeding habitat in historic range.
- Manage lands during breeding season to maintain shallow water and emergent vegetation of suitable height and cover.
- Study impacts to habitat quality of non-native, invasive plants (e.g., *Spartina alterniflora*, tamarisk, *Arundo, Lepidium latifolium*); as appropriate, control and replace with suitable native vegetation at key Black Rail marshes.
- Eliminate or carefully manage grazing in occupied Black Rail habitat.
- Assess practicality of re-establishing Black Rails within historic range (s. San Francisco Bay, southern California).

Primary regional contact(s):
Jules Evens, Avocet Research Associates; Jerry Tecklin, U.C. Sierra Foothill Research & Extension Center/The Black Rail Project.

References

Aigner, P. A., J. Tecklin, and C. E. Koehler. 1995. Probable breeding population of the Black Rail in Yuba County, California. W. Birds 26:157–160.

Eddleman, W. R., R. E. Flores, and M. L. Legare. 1994. Black Rail (*Laterallus jamaicensis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 123. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Evens, J. G., G. W. Page, S. A. Laymon, and R. W. Stallcup. 1991. Distribution, relative abundance, and status of the California Black Rail in western North America. Condor 93:952–966.

Richmond, O. R., J. Tecklin, and S. R. Beissenger. 2008. Distribution of California Black Rails in the Sierra Nevada foothills. Journal of Field Ornithology 79:381–390.

Shuford, W. D. 1993. The Marin County Breeding Bird Atlas: A Distributional and Natural History of Coastal California Birds. Calif. Avifauna Ser. 1. Bushtit Books, Bolinas, Calif. (http://archive.org/details/marincountybreed00shuf).

Spautz, H., N. Nur, and D. Stralberg. 2005. California Black Rail (*Laterallus jamaicensis coturniculus*) distribution and abundance in relation to habitat and landscape features in the San Francisco Bay estuary. USDA Forest Serv. Gen. Tech. Rep. PSW-GTR-191 (www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/465-468.pdf).

Account author: Lyann A. Comrack.

Greater Sandhill Crane (*Grus canadensis tabida*)

Status Summary

Continental conservation priority (full species): Low concern.
BCR 32 conservation scores (subspecies):

Population trend:	2
Threats to breeding:	na
Threats to non-breeding:	4
Percent of population in BCR:	5

BCR 32 conservation priority (subspecies): High concern.
Abundance and population trend in North America (full species): Significant increasing BBS trend of 5.3%/yr (1966–2009).
Abundance and population trend in BCR 32 (subspecies): estimated 8000–10,000; increasing.
Percent of continental population in BCR 32 (subspecies): Approximately 12%, but 100% of the Central Valley Population of the Greater Sandhill Crane winters in the Central Valley.

Global Distribution

The Sandhill Crane includes six subspecies: three migratory (Lesser, Greater and Canadian), which breed from eastern Siberia widely across the n. United States and Canada and winter in restricted areas in the s. United States and n. Mexico, and three non-migratory subspecies (Mississippi, Cuban, and Florida), which occur year round in restricted regions of the s. United States and Cuba. The Greater Sandhill Crane is further divided into five populations (Eastern, Prairie, Rocky Mountain, Lower Colorado River, Central Valley). The latter breeds in s. British Columbia, sw. Washington, c. and e. Oregon, ne. California, and w. Nevada and winters in California's Central Valley.

Occurrence in BCR 32

The Central Valley Population occurs in that region in the non-breeding season (early Sep to mid-Mar). Birds concentrate primarily in a few areas in the Sacramento Valley (particularly the Butte Sink) and in the heart of the Sacramento–San Joaquin River Delta, with very small numbers at a few sites in the San Joaquin Valley (mainly Modesto area).

Habitat Requirements

Occupies agricultural regions that have extensive cereal and other small grain crops, with associated grasslands and wetlands used for foraging and larger wetlands used for night roosting. Diet consists of grain, grass and sedge roots, invertebrates, crayfish, and rodents. Use areas are site-specific and limited in discrete regions of the Central Valley; use is perpetuated by the species' strong philopatry to wintering sites.

Issues in BCR 32

- Loss of habitat in traditional wintering sites to encroachment of orchards, vineyards, and urbanization.
- Major mortality factor is powerline collisions; lines should be marked or buried at major crane wintering sites.
- Need for expansion of roost site options and foraging range.

Existing Actions

- Listed as a threatened species under the California Endangered Species Act.
- Management plan completed for Central Valley Population.

Research and Monitoring Needs

- Monitor population status.
- Investigate the taxonomic classification of the various "large cranes" wintering in California.
- Evaluate effects of agricultural changes in the Central Valley on crane use and distribution.
- Mark individuals to determine migration paths and important wintering sites of certain population segments.
- Develop more accurate estimates of size of various populations of Pacific Flyway cranes.

Needed Management Actions

- Complete draft state recovery plan.
- Mitigate habitat loss in important crane use areas of Cosumnes/Stone Lakes Floodplains, east Sacramento–San Joaquin River Delta region, northern Sacramento Valley (Butte Creek drainage west of Hwy 99), and San Joaquin River NWR region.
- Manage foraging habitat by providing seasonal wetlands, cereal grain food plots, and crop residues in harvested cereal grain fields.
- Protect important traditional night roost sites and provide additional roost sites to expand cranes' foraging range.
- Minimize disturbance at roost and foraging sites during the wintering period (mid-Sep to mid-Mar).
- Reduce mortality by marking or burying problem powerlines in crane use areas.
- Detailed recommendations are provided in Pacific Flyway Council 1997, Littlefield and Ivey 2000, and Ivey and Herziger 2003.

Primary regional contact(s):
Ron Schlorff, Calif. Dept. Fish & Game; Carroll D. Littlefield; Gary L. Ivey.

References

Ivey, G. L. 2005. Mitigating loss of Sandhill Crane habitat in south Sacramento County. Unpublished report to The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632.

Ivey, G. L., and C. P. Herziger. 2001. Distribution of greater sandhill crane pairs in California, 2000. Report to Calif. Dept. Fish & Game, Sacramento.

Ivey G. L., and C. P. Herziger. 2003. Sandhill Crane monitoring at Staten Island, San Joaquin County, California, 2002-03. Available from The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632 or at www.wccwg.nacwg.org/pdf/staten-cranes.pdf.

Ivey, G. L., C. P. Herziger, and T. J. Hoffmann. 2005. Annual movements of Pacific coast Sandhill Cranes. Proceedings North American Crane Workshop 9:25–35.

Littlefield, C. D., and G. L. Ivey. 2000. Conservation assessment for Greater Sandhill Cranes wintering on the Cosumnes River floodplain and Delta regions of California. The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632.

Pacific Flyway Council. 1997. Pacific Flyway management plan for the Central Valley Population of Greater Sandhill Cranes. Pacific Flyway Study Committee (c/o USFWS, Pacific Flyway Representative), Portland, OR 97232-4181 (www.pacificflyway.gov/Documents/Cvgsc_plan.pdf).

Account author: Gary L. Ivey.

Lesser Sandhill Crane (*Grus canadensis canadensis*)

Status Summary

Continental conservation priority (full species): Low concern.

BCR 32 conservation scores (subspecies):

Population trend:	3
Threats to breeding:	na
Threats to non-breeding:	3
Percent of population in BCR:	4

BCR 32 conservation priority (subspecies): Moderate concern.

Abundance and population trend in North America (full species): Significant increasing BBS trend of 5.3%/yr (1966–2009).

Abundance and population trend in BCR 32 (subspecies): estimated 35,000; stable, possibly increasing.

Percent of continental population in BCR 32 (subspecies): Approximately 10%, but >95% of Pacific Flyway Population (PFP) of the Lesser Sandhill Crane winters in this BCR.

Global Distribution

The Sandhill Crane includes six subspecies: three migratory (Lesser, Greater and Canadian), which breed from eastern Siberia widely across the n. United States and Canada and winter in restricted areas in the s. United States and n. Mexico, and three non-migratory subspecies (Mississippi, Cuban, and Florida), which occur year round in restricted regions of the s. United States and Cuba. The Lesser Sandhill Crane is further divided into two populations (Mid-continent, Pacific Flyway). The latter breeds in s. Alaska and winters mainly in California's Central Valley.

Occurrence in BCR 32

The Pacific Flyway Population occurs during the non-breeding season (early Sep to mid-Mar) mainly in California's Central Valley. Areas of concentration include the Sacramento Valley, Sacramento–San Joaquin River Delta, and San Joaquin Valley (especially nr. Modesto, nr. Merced NWR, Tulare Basin), and in the Carrizo Plain within the Coast Ranges west of the s. San Joaquin Valley.

Habitat Requirements

Occupies agricultural regions that have extensive cereal and other small grain crops, with associated grasslands and wetlands used for foraging and larger wetlands used for night roosting. Diet consists of grain, grass and sedge roots, invertebrates, crayfish, and rodents. Use areas are site-specific and limited in discrete regions of the Central Valley; use is perpetuated by the species' strong philopatry to wintering sites.

Issues in BCR 32

- Loss of habitat in traditional wintering sites to encroachment of orchards, vineyards, and urbanization.
- Major mortality factor is powerline collisions; lines should be marked or buried at major crane wintering sites.
- Need for expansion of roost site options and foraging range.

Existing Actions

Management plan completed for the Pacific Flyway Population of the Lesser Sandhill Crane.

Research and Monitoring Needs

- Monitor population status.
- Mark individuals to determine their breeding and wintering patterns and to delineate population bounds.
- Develop more accurate estimates of various populations of Pacific Flyway cranes.

Needed Management Actions

- Mitigate habitat loss in important crane use areas of Cosumnes/Stone Lakes Floodplains, east Sacramento–San Joaquin Delta region, northern Sacramento Valley (Butte Creek drainage west of Hwy 99), and San Joaquin River NWR region.
- Identify and catalog the habitats used by PFP sandhill cranes.
- Manage foraging habitat by providing seasonal wetlands, cereal grain food plots, and crop residues in harvested cereal grain fields.
- Protect important traditional night roost sites and provide additional roost sites to expand cranes' foraging range.
- Minimize disturbance at roosts and foraging sites during the wintering period (mid-Sep to mid-Mar).
- Reduce mortality by marking or burying problem powerlines in crane use areas.
- Detailed recommendations are provided in Pacific Flyway Council (1997), Littlefield and Ivey (2000), Ivey and Herziger (2003), and Littlefield (undated).

Primary regional contact(s): Ron Schlorff, Calif. Dept. Fish & Game; Carroll D. Littlefield; Gary L. Ivey.

References

Ivey, G. L. 2005. Mitigating loss of Sandhill Crane habitat in south Sacramento County. Unpublished report to The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632.

Ivey, G. L., and C. P. Herziger. 2001. Distribution of greater sandhill crane pairs in California, 2000. Report to Calif. Dept. Fish & Game, Sacramento.

Ivey G. L., and C. P. Herziger. 2003. Sandhill Crane monitoring at Staten Island, San Joaquin County, California, 2002-03. Available from The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632 or at www.wccwg.nacwg.org/pdf/staten-cranes.pdf.

Littlefield, C. D. 2008. Lesser Sandhill Crane (*Grus canadensis canadensis)*, in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp.167–172. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, CA, and Calif. Dept. Fish & Game, Sacramento (www.dfg.ca.gov/wildlife/nongame/ssc/birds.html).

Littlefield, C. D., and G. L. Ivey. 2000. Conservation assessment for Greater Sandhill Cranes wintering on the Cosumnes River floodplain and Delta regions of California. The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Galt, CA 95632.

Pacific Flyway Council. 1983. Management plan for the Pacific Flyway population of Lesser Sandhill Cranes. U.S. Fish & Wildl. Serv., Div. Migratory Bird Mgmt., Portland, OR (http://pacificflyway.gov/Documents/Pclsc_plan.pdf).

Account author: Gary L. Ivey.

Western Gull (*Larus occidentalis*)

Status Summary

Continental conservation priority: Low concern.

BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	3
Threats to non-breeding:	2
Percent of population in BCR:	3

BCR 32 conservation priority: Low concern.

Abundance and population trend in North America: >70,000 breeders. The overall population trend is likely driven by that in California, where numbers at known colonies in 1975–1980 increased 31% by 1989–1991. Numbers may currently be at an all-time high in response to garbage and fish offal provided by an expanding human population. Non-significant declining BBS trend of -1.5%/yr (1968–2009; data deficient).

Abundance and population trend in BCR 32: ~3600 (90% in San Francisco Bay estuary). Non-significant increasing BBS trend of 1.3%/yr (1968–2009; data with important deficiency); the BBS likely includes birds on the outer coast, which is not considered part of this BCR under the regional waterbird plan. Closures of many dumps may be reducing gull numbers in highly urbanized estuaries, such as San Francisco Bay, though no data are available. No extensive data on size of estuarine colonies in California prior to 1989–1991 and no rangewide surveys since.

Percent of continental population in BCR 32: ~5% (exclusive of outer coast).

Global Distribution

Breeds along the Pacific coast of North America from sw. British Columbia south to w.-central Baja California (Isla Asunción) and Guadalupe Island; hybridizes extensively with the Glaucous-winged Gull (*Larus glaucescens*) from Coos Bay, Oregon, northward. Consists of two subspecies: *L. o. occidentalis* (breeding north of Monterey Bay) and *L. o. wymani* (Monterey Bay southward). Winters from south-coastal British Columbia south to the tip of Baja California.

Occurrence in BCR 32

Although occurs widely on the outer coast (outside the BCR 32 boundary), within the BCR found year round mainly in coastal estuaries, where numbers (at least at some) increase in fall. Birds may range a few kilometers inland to bathe or drink at lakes and reservoirs or to forage at dumps (rarely to Central Valley). Within the BCR, breeds in only a few coastal estuaries, including Bodega Harbor, San Francisco Bay estuary, Elkhorn Slough–Moss Landing Harbor area, and San Diego Bay and vicinity. In the San Francisco Bay estuary, breeds as far as Suisun Bay in the northeast and Alviso in the south.

Habitat Requirements

A marine species that forages in estuaries, bays, lagoons, tidal reefs, beaches, and ocean waters mostly within 50 km (few to 95 km) of shore. On the outer coast (outside the BCR 32 boundary), breeds mainly on islands, offshore rocks, and sea cliffs but in coastal estuaries also breeds extensively on artificial habitats, such as breakwaters, wharfs, piers, light poles, and bridges. Like most gulls, the species is a generalist forager. The primary items in the diet are a variety of fish, marine invertebrates (euphausiids, barnacles, bivalves, crabs, starfish), and human refuse; also eggs, young, and adults of other seabirds.

Issues in BCR 32

- The relatively small population size and restricted distribution increase the species' vulnerability, though it is of limited immediate conservation concern.
- The species is potentially at risk from introduced predators, human disturbance, oil pollution, pesticides and other contaminants, and avian diseases, though none of these individually or in combination currently pose population-level threats.

- Perhaps the greatest conservation concern is the potential effects that the gulls may be having in preying on, disturbing, or displacing other declining or vulnerable bird species; this is unstudied but likely a much smaller potential problem that that posed by the more numerous California Gull (*Larus californicus*) in San Francisco Bay.

Existing Actions

Included in regional seabird conservation plans.

Research and Monitoring Needs

- Study the biology of this species in San Francisco Bay to determine if it is causing adverse effects on other species of waterbirds.
- Study the diet of San Francisco Bay breeders to estimate the proportion of food obtained from human versus natural sources and whether this has changed with the closure of many bayside dumps.

Needed Management Actions

Maintain and protect known colonies, considering other management options if problems with other species are detected.

Primary regional contact(s): Cheryl Strong, Don Edwards San Francisco Bay National Wildlife Refuge; Russ Bradley, PRBO Conservation Science.

References

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th ed. Am. Ornithol. Union, Washington, DC.

Carter, H. R., G. J. McChesney, D. L. Jaques, C. S. Strong, M. W. Parker, J. E. Takekawa, D. L. Jory, and D. L. Whitworth. 1992. Breeding populations of seabirds in California, 1989–1991. Unpublished report, U.S. Fish & Wildl. Serv., Dixon, Calif. Available from Carter Biol. Consulting, 1015 Hampshire Rd., Victoria, BC V8S 4S8, Canada.

Mills, K. L., W. J. Sydeman, and P. J. Hodum, eds. 2005. The California Current Marine Bird Conservation Plan, version 1.0. Available from PRBO Conservation Science, 3820 Cypress Dr. #11, Petaluma, CA 94954 or at www.prbo.org/cms/index.php?mid=66.

Pierotti, R. J., and C. A. Annett. 1995. Western Gull (*Larus occidentalis*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 174. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Shuford, W. D., G. W. Page, J. G. Evens, and L. E. Stenzel. 1989. Seasonal abundance of waterbirds at Point Reyes: A coastal California perspective. W. Birds 20:137–265.

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific region. U.S. Fish & Wildl. Serv., Migratory Birds and Habitat Programs, 911 NE 11th Ave., Portland, OR 97232 (www.fws.gov/pacific/migratorybirds/archive.html).

Account author: W. David Shuford.

California Gull (*Larus californicus*)

Status Summary

Continental conservation priority: Moderate concern.

BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	2
Threats to non-breeding:	2
Percent of population in BCR:	2

BCR 32 conservation priority: Lowest concern.

Abundance and population trend in North America: >414,000 breeders. Numbers increased in the 20th century. Non-significant declining BBS trend of -0.4%/yr (1968–2009; data deficient).

Abundance and population trend in BCR 32: San Francisco Bay colony monitoring has documented exponential growth from 412 breeding individuals in 1982 to 46,000+ in 2009. Non-significant increasing BBS trend of 2.2%/yr (1968–2009; data with an important deficiency). Many more occur in migration and winter but count data are lacking.

Percent of continental population (breeding) in BCR 32: ~10%.

Global Distribution

California Gulls breed at scattered locations in the interior of North America, primarily from the s.-central taiga of Canada south through the Great Plains to s. Colorado and west and south through the Columbia Plateaus and Great Basin desert to e.-central California. Winters primarily along the Pacific Coast and slope from s. British Columbia (sparingly) south to s. Baja California, the Gulf of California, and, less commonly, to the s.-central Pacific coast of mainland Mexico. Many non-breeding birds remain in the wintering range in summer, and small numbers occur throughout the breeding range.

Occurrence in BCR 32

Nests at various sites in central and (mainly) south San Francisco Bay, the only coastal breeding region for the species. Small numbers recently attempted to nest offshore on Southeast Fallon Island; attempts to breed at the Davis Wastewater Treatment Plant are the first in the Central Valley in many decades. Occurs year round, but numbers in the Central Valley and coastal lowlands swell greatly during migration and winter.

Habitat Requirements

In San Francisco Bay, gulls have nested on earthen islands and levees in salt ponds, a dry salt pond (largest colony), a tidal island, larger islands (Brooks, Alcatraz), and a bare high marsh habitat (no longer active). As generalist foragers, these gulls obtain prey or scavenge in numerous habitats, including the open ocean, coastal estuaries, lagoons, beaches, salt ponds, freshwater ponds and marshes, plowed fields, pastures, playing fields, parking lots, and, particularly, dumps. Like other gulls, omnivorous and opportunistic, hence the diet is broad and variable, including small mammals, fish, frogs and toads,

various invertebrates and insects (brine shrimp, brine and alkali flies, damselflies, grasshoppers, cicadas, earthworms, etc.), garbage, and the eggs and young of their own or other species.

Issues in BCR 32

Because of ongoing increases in nesting California Gulls, conservation concern in San Francisco Bay is focusing not on the gulls themselves but rather on the potential effects that the gulls may be having in preying on, disturbing, or displacing other declining or vulnerable bird species.

Existing Actions

- Planning meetings in San Francisco Bay are discussing potential options for limiting the effect of increasing "nuisance" species, including California Gulls, on the nests, chicks, and adults of shorebirds and terns. General options being discussed include manipulation of current habitat, design of future habitat restoration projects, harassment, and lethal control.
- Hazing at one of two major landfills in the south bay has greatly reduced gull use at this site.
- Breaching of dikes for saltmarsh restoration displaced gulls at the largest colony in the south bay. Gulls shifting to attempt to nest at a nearby Snowy Plover breeding site were successfully discouraged from breeding by repeated hazing.

Research and Monitoring Needs

- Conduct focused studies of the factors influencing reproductive success and population size of bird species suspected of being negatively affected by California Gulls. Particularly valuable would be experimental studies examining the differences in success between control study sites and ones at which habitat is manipulated in manners likely to reduce gull problems.
- Continue ongoing monitoring of the size and location of gull colonies in San Francisco Bay. If possible, monitor reproductive success, as the effect of management actions on a long-lived species like this one may take a long time to detect by just counting nests.
- Conduct studies of gull movements and foraging patterns during the nesting season, particularly at landfills in the south bay suspected of maintaining gull populations.

Needed Management Actions

- Reduce human food sources (e.g., open dumps) that are exploited by California Gulls on a region-wide basis throughout the San Francisco Bay area.
- Consider the necessity of reducing nesting habitat for California Gulls while maintaining it for other colonial or solitary ground-nesting birds.

Primary regional contact(s): Christina Donehower, San Francisco Bay Bird Observatory; Cheryl Strong, Don Edwards San Francisco Bay National Wildlife Refuge; Josh Ackerman, U.S. Geological Survey.

References

Ackerman, J. T., J. Y. Takekawa, C. Strong, N. Athearn, and A. Rex. 2006. California Gull distribution, abundance, and predation on waterbird eggs and chicks in south San Francisco Bay. Final report of U.S. Geological Survey, Western Ecological Research Center, Davis and Vallejo, Calif. (www.werc.usgs.gov/ProductDetails.aspx?ID=3361).

Dierks, A. J. 1990. Parental care and diet of California Gull (*Larus californicus*) chicks at Alviso, California. M.S. thesis, Moss Landing Marine Labs, San Jose State Univ., San Jose, Calif.

Jones, P. A. 1986. Aspects of the reproductive biology of the California Gull in Alviso, California. M.A. thesis, San Francisco State Univ., San Francisco.

Shuford, W. D. 2008. A synthesis of information on California Gulls to further attainment of salt pond restoration goals in South San Francisco Bay. Report to the Coastal Conservancy Association and the South Bay Salt Pond Restoration Project (www.southbayrestoration.org/documents/technical).

Shuford, W. D., and T. P. Ryan. 2000. Nesting populations of California and Ring-billed gulls in California: Recent surveys and historical status. W. Birds 31:133–164.

Strong, C. M., L. B. Spear, T. P. Ryan, and R. E. Dakin. 2004. Forster's Tern, Caspian Tern, and California Gull colonies in San Francisco Bay: Habitat use, numbers and trends, 1982–2003. Waterbirds 27:411–423.

Winkler, D. W. 1996. California Gull (*Larus californicus*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 259. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Account author: W. David Shuford.

Least Tern (*Sternula antillarum*)

Status Summary

Continental conservation priority: High concern.

BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	5
Threats to non-breeding:	na
Percent of population in BCR:	4

BCR 32 conservation priority: High concern.

Abundance and population trend in North America (full species): Estimated 60,000–100,000 breeders. Non-significant declining BBS trend of -4.3% per year (1966–2009; data with an important deficiency).

Abundance and population trend in BCR 32: With the exception of birds breeding in Mexico, the entire population of the California Least Tern (*S. a. browni*) breeds within BCR 32; estimated population of subspecies is 13,700–14,700 breeders. The California breeding population has increased approximately 10-fold since being listed as federally endangered in

1970 and has increased by about 60% from 1995 to reach a period of relative stability from 2003 to 2010.

Percent of continental population in BCR 32: The California breeding population is approximately 14%–25% of the North American population.

Global Distribution

Five sub-species described breeding in various areas of North, Central, and South America. Breeders widely distributed throughout the coastal U.S., on the Atlantic coast (s. Maine to s. Florida), the Gulf Coast (s. Florida west to s. Texas), and the Pacific coast (San Francisco Bay to Mexican border). Also breeds locally inland from the Ohio, Missouri, and Mississippi rivers west throughout Great Plains to e. Montana, e. Colorado, and e. New Mexico. In Mexico, breeds on both coasts of Baja California and the Pacific (Sonora south to Oaxaca) and Atlantic coasts (n. Tamaulipas and n. and e. Yucatan Peninsula). Also in Belize and w. Honduras, throughout the Caribbean islands, and on islands off the coast of Venezuela. The winter distribution is not well known, but Least Terns have been found along the Pacific and Atlantic coasts of Mexico and eastern coasts of Central and South America as far south as n. Argentina and s. Brazil.

Occurrence in BCR 32

California Least Terns breed along the coast from San Francisco Bay south to the Mexican border, with the bulk in southern California. In 2010, the vast majority were in San Diego County (60%) and Los Angeles/Orange counties (22%), the remainder in Ventura County (11%), San Luis Obispo/Santa Barbara counties (1%), and the San Francisco Bay area (6%).

Habitat Requirements

Non-vegetated substrates (i.e. beaches, dried mudflats, levees, shell islands, sand pits, etc.) near water sources (i.e. lagoon, estuary, ocean, etc.). Preferably, substrates should be soft enough to allow birds to scrape nest cups, and habitat should be elevated enough to avoid flooding at high tide. Due to development and increased use of coastal areas, Least Terns have resorted to nesting in other habitats, such as agricultural fields, sparsely vegetated lands near airports, parking lots, and rooftops (only documented in inland subspecies).

Issues in BCR 32

Key issues for Least Terns are predators, suspected food shortages, contaminants, habitat destruction, and disturbance at breeding sites (researchers and non-researchers).

Existing Actions

- California Least Tern listed as an endangered species under both the California and federal endangered species acts.
- Population estimates and monitoring of reproductive success of existing sites continues through the collective efforts of federal, state, and non-governmental agencies.

Research and Monitoring Needs

- Conduct long-term studies on inter-colony movements, migration routes, and important wintering areas.
- Gather capture-recapture data to better understand current vital rates.
- Determine the amount of habitat needed for full recovery of the species and subspecies.
- Determine levels of various heavy metal and chemical contaminants (e.g., Hg, DDT, PCB) and their effects on reproductive success and survival.
- Obtain a more quantified measure of predation and its effects on terns in both urban and undeveloped habitats.
- Conduct research on diet, chick provisioning rates, and important foraging areas near breeding colonies.
- Understand how tern prey availability is related to colony attendance and defense against predators.
- Determine the extent to which various management measures are increasing nesting and productivity.
- Evaluated each colony to identify its role and influence in the metapopulation.

Needed Management Actions

- A comprehensive management plan that incorporates existing data and identifies areas where information is lacking.
- Management actions should be focused on the colonies that have the greatest influence on the metapopulation to maximize management effectiveness.

Primary regional contact(s): Charles Collins, California State University, Long Beach; Kathy Keane, Keane Biological Consultants; Dan Robinette and Meredith Elliott, PRBO Conservation Science.

References

Akçakaya, H. R., J. L. Atwood, D. Breininger, C. T. Collins, and B. Duncan. 2003. Metapopulation dynamics of the California Least Tern. J. Wildl. Mgmt. 67:829–842.

Hothem, R. L., and A. N. Powell. 2000. Contaminants in eggs of Western Snowy Plovers and California Least Terns: Is there a link to population decline? Bull. Environ. Contam. and Toxicol. 65:42–50.

Marschalek, D. A. 2011. California Least Tern breeding survey, 2010 season. Wildlife Branch, Nongame Wildlife Program Report 2011-06. Calif. Dept. Fish & Game, Sacramento (http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentVersionID=59326).

Thompson, B. C., J. A. Jackson, J. Burger, L. A. Hill, E. M. Kirsch, and J. L. Atwood. 1997. Least Tern (*Sterna antillarum*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 290. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Account authors: Meredith Elliott and Dan Robinette.

Gull-billed Tern (*Gelochelidon nilotica*)

Status Summary

Continental conservation priority: High concern.
BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	5
Threats to non-breeding:	na
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.
Abundance and population trend in North America (full species): About 8700 breeders. Numbers erratic locally but overall probably stable at least in most parts of the United States. Non-significant increasing BBS trend of 1.1%/yr (1966–2009; data with an important deficiency).
Abundance and population trend in BCR 32: One pair colonized the San Diego saltworks in 1986. Since, the overall trend, with an intervening dip, has been one of increase to 57 pairs in 2009.
Percent of continental population in BCR 32: <1%.

Global Distribution

A cosmopolitan species with perhaps six subspecies, two described (validity uncertain) in North America. *S. n. aranea* breeds locally along the Atlantic Coast from Long Island, New York, or (more regularly) s. New Jersey south to Florida, the Bahamas, and Virgin Islands and west on the Gulf Coast to se. Texas and (presumably) south in Mexico to central Veracruz (probably also coastal Yucatan); winters from North Carolina or (more regularly) sw. Florida across the Gulf Coast to Mexico and on to Honduras. *S. n. vanrossemi* (total 1500–1600 breeders) nests very locally from s. California (San Diego, Salton Sea) south to the central Baja California peninsula and the west coast of Mexico in Sinaloa, Nayarit, and Colima (perhaps Sonora); winters in n. Gulf of California and along the west coast of Mexico locally from s. Sonora south to Nayarit and Oaxaca, perhaps to Honduras and Costa Rica.

Occurrence in BCR 32

A very local summer resident and breeder from early or mid-March to mid-September. The only breeding site in BCR 32 at the San Diego Bay saltworks is one of only two in the western United States (other at Salton Sea) and one of 14 known in western North America. After establishment in 1986, the San Diego colony increased to 30 pairs in 1992, dipped to 8–20 pairs for the rest of the 1990s, then increased to an average of 54 pairs from 2006–2009.

Habitat Requirements

The San Diego colony is located on isolated, mostly barren, sections of earthen dikes of salt evaporation ponds in proximity to other colonial waterbirds, particularly other species of larids. Gull-billed Terns feed mainly by dipping to capture prey from the surface of shallow aquatic and sparsely vegetated terrestrial substrates, rarely landing on or plunging to the surface, and may pursue aerial prey, such as swarming insects. At San Diego Bay, terns forage up to 8–9 km (likely father) from the colony, most often in a narrow band of intertidal wet sand and shallow water along bay- and ocean-fronting beaches. Less often, terns feed on the upper beach (including sparsely vegetated dunes) and over upland scrub but avoid open water away from the bay or ocean shores. The diet includes fish, insects, marine invertebrates, reptiles, small mammals, and chicks of small birds. The diet at San Diego is largely small marine invertebrates (primarily mole crabs) and fish, and infrequently lizards, crabs, dragonflies, various insects, and very small chicks (rarely eggs) of shorebirds and terns. Many of the fish are taken by kleptoparasitizing Forster's Terns.

Issues in BCR 32

- Though currently suspended, there is concern that lethal control of Gull-billed Terns at San Diego Bay, for their predation on chicks of the federally listed California Least Tern and Western Snowy Plover (*Charadrius alexandrinus nivosus*), could be re-implemented or replaced by other methods, such as nest removal.
- Despite a modest increasing trend, the small size of the San Diego colony leaves the species vulnerable to extirpation as a breeder in the BCR; potential threats in this regard include human disturbance and predation by large numbers of feral and domestic pets from adjacent urban areas.
- Concern exists for the potential effects on nesting and foraging habitat of Gull-billed Terns from proposed plans for habitat restoration on refuge lands in south San Diego Bay.
- Although levels of contaminants in sampled eggs are below those thought to cause reproductive impairment, they still are of conservation concern.

Existing Actions

A status assessment is completed, and a petition to list under the federal Endangered Species Act is under review. (Currently designated a California Bird Species of Special Concern.)

Research and Monitoring Needs

- Conduct demographic studies to determine survival, fecundity, and the degree of mixing among breeding sites in southern California and western Mexico.
- Monitor known colonies and search for new ones in the California–Baja–west Mexico region.
- Conduct studies of the potential effects of contaminants on terns breeding in San Diego Bay.
- Determine the validity of the distinction between the subspecies *aranea* and *vanrossemi*.

Needed Management Actions

- Maintain protection for current nesting and foraging habitat in San Diego Bay and, if possible, increase or enhance these as part of plans to restore habitats on refuge lands.

- Place a permanent moratorium on lethal or other control measures on terns at San Diego Bay.
- Protect the San Diego colony from predation by feral or domestic pets.

Primary regional contact(s): Brian Collins, San Diego Bay NWR Complex; Kathy Molina, Natural History Museum of Los Angeles County; Robert Patton.

References

Molina, K. C., R. M. Erwin, E. Palacios, E. Mellink, and N. W. H. Seto. 2010. Status review and conservation recommendations for the Gull-billed Tern (*Gelochelidon nilotica*) in North America. U.S.D.I., Fish & Wildlife Service, Biological Tech. Publ., FWS/BTP-R1013-2010, Washington, DC (http://digitalmedia.fws.gov/cdm/ref/collection/document/id/1524).

Molina, K. C., and D. A. Marschalek. 2003. Foraging behavior and diet of breeding Western Gull-billed Terns (*Sterna nilotica vanrossemi*) in San Diego Bay, California. Species Conservation and Recovery Program Rep. 2003-01, Calif. Dept. Fish & Game, Habitat Conservation Planning Branch, Sacramento (http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=2904).

Parnell, J. F., R. M. Erwin, and K. C. Molina. 1995. Gull-billed Tern (*Sterna nilotica*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 140. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Account author: W. David Shuford.

Caspian Tern (*Hydroprogne caspia*)

Status Summary

Continental conservation priority: Low concern.
BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	3
Threats to non-breeding:	na
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.
Abundance and population trend in North America: 64,000 to 68,000 breeders. Following historical declines, since the late 1970s colony numbers have increased in four of five major breeding regions in North America. Non-significant increasing BBS trend of 0.9%/yr (1966–2009; data deficient).
Abundance and population trend in BCR 32: ~3400 breeders. Historical declines and shift from interior to coastal colonies, with overall colony numbers relatively stable in the last thirty years. Significant increasing BBS trend of 4.4%/yr (data deficient).
Percent of continental population in BCR 32: ≤1%.

Global Distribution

A (nearly) cosmopolitan, monotypic species that occurs widely in the Old and New worlds. In North America, it breeds at scattered sites across the continent and migrates south to winter primarily on the Pacific Coast from s. California south through w. Mexico and (locally) Central America; inland in the Central Volcanic Belt and Atlantic (Gulf) Slope of Mexico; along the southern U.S. Atlantic Coast, the U.S. and Mexican Gulf Coast, (locally) along the Caribbean/Atlantic coast of Central America and northern South America; and locally in the West Indies.

Occurrence in BCR 32

Locally fairly common at and near scattered breeding colonies mainly in coastal estuaries from San Francisco Bay southward and irregularly in the Tulare Basin of the southern San Joaquin Valley and at one site on the coastal slope of southern California. Migrants (and some non-breeders) occur locally throughout the region, and small numbers currently winter regularly on the southern coast north to Morro Bay and casually inland in central and southern California.

Habitat Requirements

Caspian Terns nest in colonies (rarely as single pairs) usually near or adjacent to other colonial nesting waterbirds and close to abundant prey resources. They formerly nested mainly in the interior at freshwater lakes and marshes but now primarily on human-created habitats on the coast. Nests are typically in open, barren to sparsely vegetated areas. Coastal nest sites include salt pond levees, dredge spoil islands, islands created for salt marsh restoration or to enhance nesting sites for endangered Least Terns, and, infrequently, natural islands or depressions scraped bare for dredge materials; one recent colony is on an insular, dilapidated pier. In the Tulare Basin, nest sites include intact or broken levees of agricultural evaporation ponds, sewage ponds, floodwater storage basins, and flooded agricultural fields. The diet is almost entirely small fish but may include crayfish and insects. Being generalist foragers, Caspians tend to prey on the fish most available locally, thus key species in the diet vary by colony and year.

Issues in BCR 32

- Limited in the interior by a lack of high quality nesting and foraging habitat. Colonies on the highly (human) populated coast are at risk from encroaching development, disturbance, and non-native predators.
- Because of their fish-dominated diet, these terns remain at risk from the concentration of contaminants via their prey.

Existing Actions

- Continental status assessment with conservation recommendations completed.
- A plan to reduce fisheries conflicts in the Columbia River estuary includes managing habitat to redistribute a portion of the very large colony there to up to seven sites in the Pacific Coast/Western region (including three in California in San Francisco Bay) identified on the basis of an initial assessment of known and potential nesting sites within that region.

- Clearing or thinning of vegetation has been conducted at some coastal sites to maintain suitable nesting habitat as has predator control to avoid colony abandonment.

Research and Monitoring Needs

- Study population demography to identify which breeding sites are sources or sinks for the overall population and the life history stages at which populations are most limited.
- Continue research on the possible effects of contaminants on this species in San Francisco Bay and expand such work to other breeding areas in the region.
- Use color- or radio-marked birds to study tern movements in response to changing conditions, possible interchange between inland and coastal colonies, and migratory pathways and wintering areas of locally produced terns.

Needed Management Actions

- Restore, enhance, and provide long-term protection for suitable wetlands and maintain isolation of nesting and roosting sites from encroaching development, human disturbance, and ground predators.
- In the Tulare Basin, consider enhancing tern habitat primarily in years of exceptional runoff, when it will do the most good. Make some nesting habitat available annually and maintain additional incipient habitat that when flooded in wet periods will provide suitable nesting islands.

Primary regional contact(s): Dave Shuford, PRBO Conservation Science; Cheryl Strong, Don Edwards San Francisco Bay NWR.

References

Cuthbert, F. J., and L. R. Wires. 1999. Caspian Tern (*Sterna caspia*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 403. Birds N. Am., Philadelphia.

Shuford, W. D., and D. P. Craig. 2002. Status assessment and conservation recommendations for the Caspian Tern (*Sterna caspia*) in North America. U.S.D.I., Fish & Wildl. Serv., Portland, OR (www.fws.gov/pacific/migratorybirds/archive.html).

Suryan, R. M., D. P. Craig, D. D. Roby, N. D. Chelgren, K. Collis, W. D. Shuford, and D. E. Lyons. 2004. Redistribution and growth of the Caspian Tern population in the Pacific Coast region of North America, 1981–2000. Condor 106:777–790.

U.S. Fish and Wildlife Service. 2005. Caspian Tern management to reduce predation of juvenile salmonids in the Columbia River estuary: Final Environmental Impact Statement. U.S. Fish & Wildl. Serv., Migratory Birds and Habitat Programs, 911 NE 11th Avenue, Portland, OR 97232 (www.fws.gov/pacific/migratorybirds/archive.html).

Wires, L. R., and F. J. Cuthbert. 2000. Trends in Caspian Tern numbers and distribution in North America: A review. Waterbirds 23:388–404.

Account author: W. David Shuford.

Black Tern (*Chlidonias niger*)

Status Summary

Continental conservation priority: Moderate concern.
BCR 32 conservation scores:

Population trend:	3
Threats to breeding:	4
Threats to non-breeding:	na
Percent of population in BCR:	1

BCR 32 conservation priority: Moderate concern.
Abundance and population trend in North America: 100,000 to 500,000 breeders. Non-significant declining BBS trend of -3.5%/yr (1966–2009; data with an important deficiency).
Abundance and population trend in BCR 32: 4000 to 5000 breeders. Non-significant increasing BBS trend 0.4%/yr (1968–2009; data with an important deficiency).
Percent of continental population in BCR 32: <1%.

Global Distribution

Composed of two subspecies: *C. n. niger* in the Old World, *C. n. surinamensis* in the New World. In North America, the species breeds widely across central and southern Canada and the northern United States, reaching its southwestern breeding limit in California's Central Valley; birds migrate broadly across North and Middle America to wintering grounds mainly in marine and marine-coastal areas of Middle and northern South America. Also occurs in these habitats in summer outside the breeding range, mainly from the Gulf Coast south to northern South America and at the Salton Sea in southern California.

Occurrence in BCR 32

Locally fairly common in scattered breeding colonies in Central Valley rice fields; breeds irregularly (mainly in very wet years) in other shallow-water habitats in this region. More widespread during migration, when a few birds reach the coast; formerly more numerous on the southern coast during migration.

Habitat Requirements

Nests in shallow, highly productive emergent wetlands or their equivalents. In BCR 32, most birds now breed in cultivated rice fields. Breeding is infrequent in managed marshes in the Sacramento Valley, and, mainly in very wet years, in flooded agricultural fields with residual crops or weeds or other low stature wetlands in the San Joaquin Valley. Diet of breeding terns typically is mainly insects, particularly damselflies and dragonflies, but also includes spiders, amphipods, crayfish, small mollusks, and small fish. Fish sometimes may dominate the diet by mass and provide an important source of calcium. Migrants in the interior may concentrate on swarming insects.

Issues in BCR 32

- Very few terns breed in habitat managed mainly for wildlife, and a corresponding concentration of terns in agricultural lands of uncertain (long-term) reliability and quality is risky.
- High competition and cost for water may limit the ability to manage for species using ephemeral shallow-water wetlands in the Central Valley, where evaporation rates are high.
- Contaminants may be of concern given the species' insectivorous feeding habits and concentration for breeding in cultivated rice fields.

Existing Actions

- Continental status assessment and conservation plan completed.
- Designated a California Bird Species of Special Concern.

Research and Monitoring Needs

- Assess whether the value of rice fields to terns equals that of ephemeral overflow habitat or natural marshes.
- Conduct studies to examine concerns about the potential effects on terns of agricultural pesticides and crop cultivation practices in rice fields.
- Study what conditions in rice fields are correlated with the establishment of tern colonies.
- Conduct research on the foraging and nesting ecology of terns in rice fields, on movements of banded birds with changing water conditions or other agricultural practices, and on population demography to identify if reproductive rates are high enough in rice to maintain long-term population stability.
- Design and implement a monitoring program in the Central Valley based on a set of standardized roadside transects in rice fields in the Sacramento Valley run in early June.

Needed Management Actions

- Restore, enhance, and protect suitable wetlands, and maintain isolation of colonies from humans and ground predators.
- Consider enhancing tern habitat primarily in years of exceptional runoff, when it will do the most good and is most feasible.
- When possible, flood fields containing residual vegetation or crop stubble for use as breeding habitat. Explore retiring fields with marginal crop yields and putting them in a conservation bank to be flooded when water is available. Weigh such flooding against possible mortality of waterbirds from botulism disease outbreaks, which might be reduced by rotating fields to be flooded and choosing areas with no prior evidence of disease.

Primary regional contact(s): Dave Shuford, PRBO Conservation Science.

References

Dunn, E. H., and D. J. Agro. 1995. Black Tern (*Chlidonias niger*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 147. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Shuford, W. D. 1999. Status assessment and conservation plan for the Black Tern (*Chlidonias niger surinamensis*) in North America. U.S.D.I., Fish & Wildl. Serv., Denver Federal Ctr., Denver, CO 80225-0486.

Shuford, W. D. 2008. Black Tern (*Chlidonias niger*), in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W. D. Shuford and T. Gardali, eds.), pp. 193–198. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, CA, and Calif. Dept. Fish & Game, Sacramento (www.dfg.ca.gov/wildlife/nongame/ssc/birds.html).

Shuford, W. D., J. M. Humphrey, and N. Nur. 2001. Breeding status of the Black Tern in California. W. Birds 32:189–217.

Account author: W. David Shuford.

Forster's Tern (*Sterna forsteri*)

Status Summary

Continental conservation priority: Moderate concern.

BCR 32 conservation scores:

Population trend:	4
Threats to breeding:	3
Threats to non-breeding:	2
Percent of population in BCR:	1

BCR 32 conservation priority: Moderate concern.

Abundance and population trend in North America: 47,000–51,500 breeders. Non-significant declining BBS trend of -1.7%/yr (1966–2009; data with an important deficiency).

Abundance and population trend in BCR 32: About 2500–3500 breeders. Non-significant declining BBS trend of -1.1%/yr (1968–2009; data deficient). Declining trend in San Francisco Bay (1982–2003) difficult to interpret because of some missing data and potential regional interchange of breeders, e.g., lowest total for 21 years in SF Bay in 1998 coincided with exceptional breeding numbers in the San Joaquin Valley that year in response to greatly enhanced nesting conditions following an El Niño winter. Since the 1960s, numbers generally have increased in San Diego Bay.

Percent of continental population in BCR 32: Roughly 5%.

Global Distribution

Breeds locally coast to coast in North America and from s.-central Canada south to n. Baja California Norte and the Gulf Coast of Tamaulipas, Mexico. Largest fairly contiguous breeding areas are in an arc across the prairies of s. Canada and the n. United States and in the Intermountain West of ne. California, se. Oregon, n. Nevada, s. Idaho, and n. Utah.

Winters on the Pacific Coast from n. California (mainly SF Bay area) south through Baja California and west Mexico to El Salvador; on the Atlantic Coast from s. New Jersey south through Florida; along the Gulf Coast States and Mexico south to the Yucatán; from Honduras south (rarely) to Costa Rica and Panama; and inland in s. California, portions of the Gulf Coast States and Florida, and in Mexico in Baja, on the Atlantic and Pacific slopes, and the central interior.

Occurrence in BCR 32

Occurs year round in the Sacramento–San Joaquin River Delta, along the outer coast, and locally inland on the coastal slope from s. California southward; occurs throughout the BCR in migration. Breeds locally in the Central Valley (formerly s. Sacramento Valley, currently only in San Joaquin Valley) and along the coast from the San Francisco Bay estuary south to Mexican border. Largest breeding numbers are in San Francisco Bay estuary, Bolsa Chica Ecological Reserve, San Diego Bay, and in (some years) the San Joaquin Valley.

Habitat Requirements

In coastal California, most terns nest on dredge spoil islands or degraded insular levees in current or former salt ponds, but also in slough channels, diked marshes, and muted tidal wetlands. In the Central Valley in 1998, following an El Niño winter, most terns nested on former nest mounds of coots or on island fragments of levees in flooded agricultural fields with residual crops or weeds; also on islands in a large open-water reservoir and a compensation wetland, on the edges of emergent marsh or on former grebe or coot nest mounds at small open-water reservoirs, and on an internal levee of an agricultural evaporation basin. Forster's Terns typically forage by plunge-diving, often from hovering flight, into the shallow waters (or upper surface) of marshes, lakes, reservoirs, streams, salt ponds, estuaries, and inshore marine areas. Overall diet is primarily small fish and some arthropods. The dominant fish in the diet at Elkhorn Slough, Monterey County, in July were mostly juveniles of shiner perch (*Cymatogaster aggregata*), northern anchovy (*Engraulis mordax*), and arrow goby (*Clevelandia ios*).

Issues in BCR 32

- In most years, lack of suitable habitat in the Central Valley is limiting to this species.
- Terns nesting at evaporation ponds and alternative wetlands in the San Joaquin Valley have very high rates of predation from native predators, and those nesting in coastal areas adjoining extensive urbanization are at risk from predation by large numbers of feral and domestic pets.
- Human disturbance is an issue at some coastal and interior sites.
- Pesticides and other contaminants have been found at elevated levels in eggs of this species in San Francisco Bay, though no reproductive effects have been documented there (currently under study).
- Forster's Terns in San Francisco Bay are at risk from direct displacement or egg and chick predation by a rapidly expanding population of nesting California Gulls.

Existing Actions

This species, along with other colonial nesters, is included in planning for the South Bay Salt Pond Restoration Project in San Francisco Bay.

Research and Monitoring Needs

- Continue to study the effects of California Gulls on nesting Forster's Terns in San Francisco Bay.
- Conduct demographic studies to determine factors or life stages that limit the species, and investigate the degree of interchange between coastal and interior colonies.
- Conduct a regionwide survey of the breeding population about every 10 years, during typical climatic and habitat conditions, to document potential range shifts and calibrate long-term monitoring data; continue annual monitoring at key coastal sites.

Needed Management Actions

- Maintain protection for nesting and foraging habitats, and increase or enhance these during restoration on refuge lands in San Francisco and San Diego bays.
- Increase nesting habitat in the Central Valley by securing additional water supplies and by designing wetlands with features attractive to the terns (e.g., barren nesting islands, abundant small fish).

Primary regional contact(s): Josh Ackerman, U.S. Geological Survey; Brian Collins, San Diego Bay NWR Complex; Charles Collins, Calif. State Univ., Long Beach; Christina Donehower, San Francisco Bay Bird Observatory; Robert Patton; Dave Shuford, PRBO Conservation Science.

References

Baltz, D. M., G. V. Morejohn, and B. S. Antrim. 1979. Size selective predation and food habits of two California terns. W. Birds 10:17–24.

Dakin, R. E. 2000. Nest site selection by Forster's Terns (*Sterna forsteri*). Unpublished M.S. thesis, San Jose State Univ., San Jose, Calif.

McNicholl, M. K., P. E. Lowther, and J. A. Hall. 2001. Forster's Tern (*Sterna forsteri*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 595. Birds N. Am., Philadelphia.

Ryan, T. P. 2000. Forster's Tern (*Sterna forsteri*), in Goals Project. Baylands ecosystem species and community profiles: Life histories and environmental requirements of key plants, fish, and wildlife (P. R. Olofson, ed.), pp. 351–355. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif. (http://sfep.sfei.org/wp-content/uploads/2012/12/1Species_and_Community_Profiles.pdf).

Shuford, W. D. 2010. Inland-breeding pelicans, cormo-

rants, gulls, and terns in California: A catalogue, digital atlas, and conservation tool. Wildl. Branch, Nongame Wildl. Program Rep. 2010-01. Calif. Dept. Fish & Game, Sacramento (http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=24095).

Strong, C. M., L. B. Spear, T. P. Ryan, and R. E. Dakin. 2004. Forster's Tern, Caspian Tern, and California Gull colonies in San Francisco Bay: Habitat use, numbers and trends, 1982–2003. Waterbirds 27:411–423.

Account author: W. David Shuford.

Royal Tern (*Thalasseus maxima*)

Status Summary

Continental conservation priority: Moderate concern.

BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	4
Threats to non-breeding:	2
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.

Abundance and population trend in North America: 100,000–150,000 breeders. Overall, numbers generally appear to be holding constant, though few systematic population data for colonies in most of range. Non-significant declining BBS trend of -1.9%/yr (1966–2009; data deficient).

Abundance and population trend in BCR 32: Breeding numbers have increased from two (one pair) in 1959 to presently an average of <100 (numbers variable year to year). Post-breeding and winter numbers have declined historically but still today substantially exceed current breeding numbers.

Percent of continental population (breeding) in BCR 32: <0.1%.

Global Distribution

Two subspecies: *S. m. albididorsalis* in the Old World (w. Africa), *S. m. maxima* in the New World. In North America, breeds locally on Pacific Coast from s. California south to n. Baja California Sur, Gulf of California (south to Isla Raza), n. Sinaloa, and Islas Tres Marias; on Atlantic Coast from Virginia (irregularly se. Maryland) south to Florida and on Gulf Coast west to s. Texas; on islets off Yucatán, Mexico, and (possibly) Belize; and in West Indies. In South America, breeds locally on north coast and austral region (Argentina, perhaps Uruguay and Brazil). Post-breeding dispersal north on Pacific Coast to s.-central California, on Atlantic Coast to Massachusetts (rarely to Maritime Provinces), and north from West Indies to Bermuda. Winters mainly on Pacific Coast from s.-central California south to Peru, Atlantic and Gulf coasts from n. North Carolina south to Panama and the Guianas, and in West Indies.

Occurrence in BCR 32

Breeds very locally. First recorded (one pair) nesting at south San Diego Bay in 1959; colonies initiated at Bolsa Chica, Orange Co., in 1988 and at the Port of Los Angeles, Los Angeles Co., in 1998. Although timing and abundance was variable, post-breeders from Mexican waters formerly ranged north to the San Francisco Bay and Pt. Reyes area (exceptionally Humboldt Bay) in all months (peak numbers Sep–Mar, when formerly "fairly common"). Considered less regular after about 1912, at least north of southern California, and since the 1950s post-breeding and wintering numbers much diminished with birds now regular north only to the Morro Bay area, San Luis Obispo Co. Declining numbers and range retraction coincided with a drastic reduction in Pacific Sardines (*Sardinops sagax*) in central and southern California while Elegant Tern numbers and their Northern Anchovy (*Engraulis mordax*) prey were increasing.

Habitat Requirements

In California, has nested in association with dense aggregations of Elegant Terns in barren to sparsely vegetated habitat; like the latter species, appears to require a prior nucleus of other larid species that are more aggressive in attacking intruders. Colonies are on isolated earthen dikes of salt ponds or dredge-formed islands in estuaries and harbors close to feeding areas. Flocks of resting terns form on beaches (particularly at estuary mouths) and mudflats. Birds forage in shallow marine waters of bays, estuaries, lagoons, and inshore ocean waters, though apparently also (rarely?) on the open ocean far from shore. Diet in California poorly known but appears to be mainly close inshore schooling fish of the families Atherinidae (probably largely Topsmelt, *Atherinops affinis*) and Engraulidae.

Issues in BCR 32

- Integrity of nesting sites at risk from elevated human disturbance and predation from feral or domestic animals spilling over from the adjacent densely populated cities of southern California.
- The colony site at Port of Los Angeles likely will be lost, as created with the intent to develop it as a shipping-container port. Loss may reduce BCR breeding numbers, though population may be limited more by food supply than by available nesting habitat, as breeding numbers vary greatly annually despite the extent of nesting habitat remaining relatively stable.
- Habitat restoration at San Diego Bay and Bolsa Chica potentially could impact the species, but difficult to evaluate given preferred management options have not yet been selected.
- Contaminants have not been studied in the small California breeding population but likely are not a threat on the basis of knowledge gained from Elegant Terns nesting at the same sites.
- Oil spills and pollution (urban runoff, industrial wastes) may degrade important foraging areas.

Existing Actions

Receives de-facto protection because of proximity to breeding colonies of the Endangered California Least Tern and other species of colonial waterbirds.

Research and Monitoring Needs

- Conduct ecological and demographic studies to determine factors and life stages limiting the species.
- Investigate the relationship between prey abundance and numbers of nesting terns and their reproductive success.

Needed Management Actions

- Protect and enhance nesting habitat at San Diego Bay and Bolsa Chica.
- Offset the expected loss at the Port of Los Angeles by creating alternative habitat there, expanding habitat at the other colonies, or creating new habitat elsewhere in southern California.

Primary regional contact(s): Brian Collins, San Diego Bay NWR Complex; Charles Collins, Calif. State Univ., Long Beach; Kathy Keane, Keane Biological Consulting; Robert Patton.

References

Buckley, P. A., and F. G. Buckley. 2002. Royal Tern (*Sterna maxima*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 700. Birds N. Am., Philadelphia.

Collins, C. T., W. A. Schew, and E. Burkett. 1991. Elegant Terns breeding in Orange County, California. Am. Birds 45:393–395.

Roberson, D. 2002. Monterey Birds, 2nd ed. Monterey Peninsula Audubon Soc., Carmel, Calif.

Schaffner, F. C. 1985. Royal Tern nesting attempts in California: Isolated or significant incidents? W. Birds 16:71–80.

Schaffner, F. C. 1986. Trends in Elegant Tern and northern anchovy populations in California. Condor 88:347–354.

Shuford, W. D., G. W. Page, J. G. Evens, and L. E. Stenzel. 1989. Seasonal abundance of waterbirds at Point Reyes: A coastal California perspective. W. Birds 20:137–265.

Account author: W. David Shuford.

Elegant Tern (*Thalasseus elegans*)

Status Summary

Continental conservation priority: Moderate concern.

BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	4
Threats to non-breeding:	2
Percent of population in BCR:	2

BCR 32 conservation priority: Low concern.

Abundance and population trend in North America: 34,000–60,000 breeders (no recent precise data). Long-term trend uncertain. Overall number of colonies reduced by losses in Mexico but offset to an unknown degree by new colonies in southern California. Few recent or precise data from Mexican colonies, so unclear if rapid increase in California (twofold since mid-1990s) is representative of the entire North American breeding population.

Abundance and population trend in BCR 32: Exponential increase from 62 breeders in 1959 to about 22,400–26,600 in 2003–2004; size of larger post-breeding population unknown but variable.

Percent of continental population in BCR 32: Uncertain and varies by season.

Global Distribution

Breeds locally on the Pacific coast from s. California south to c. Baja California and in the Gulf of California south to Isla Raza (holding, at least formerly, 90%–97% of global breeding population). After breeding, birds disperse north along the Pacific Coast mainly as far as c. or n. California, less frequently (years of warm water intrusion, such as El Niño) to Oregon, s. Washington, and (rarely) British Columbia. Summer nonbreeders occur mainly from c. California south to Costa Rica. Winters mainly in South America south to Puerto Montt, Chile; local and irregular from Nayarit, Mexico, south through Panama, and common south of Ecuador.

Occurrence in BCR 32

Increasing anchovy stocks in 1953–1954 that peaked in 1959–1960 (1957–1958 El Niño) seem to explain the upswing in numbers of post-breeding terns in California in the 1950s and the formation of the state's first breeding colony in south San Diego Bay in 1959; colonies initiated at Bolsa Chica, Orange Co., in 1987 and at the Port of Los Angeles, Los Angeles Co., in 1998. Prior to the 1950s, post-breeders ventured rarely and irregularly north only to San Francisco Bay (Aug–Oct). Currently large numbers (thousands in peak years) regularly reach the north-central coast (mainly late Jun–Oct); birds now tend to arrive earlier and remain later, and the regular post-breeding range extends north (beyond BCR 32) to Humboldt County. Marked variation in timing of arrival (and abundance) appears to reflect anchovy abundance and oceanographic conditions, with arrival generally progressively later with increasing latitude.

Habitat Requirements

Nests in dense aggregations in low, flat and barren to sparsely vegetated habitat, but appears to require prior nucleus of other larid species that are more aggressive in attacking intruders. California colonies are on isolated earthen dikes of salt ponds or dredge-formed islands in estuaries and harbors. Roosts on isolated coastal mudflats, sandy beaches, islands, and artificial structures. Birds forage in estuaries, bays, harbors, lagoons, and inshore ocean waters mostly within 4 km of shore; breeding birds forage mainly >8 km (up to 25 km) from colony. Diet is usually schooling fishes and very rarely includes crustaceans. Northern Anchovy (*Engraulis mordax*) is the principal prey at two California colonies, but other species comprising >5% of the diet in a given year are Topsmelt (*Atherinops affinis*), Longjaw Mudsucker (*Gillichthys mirabilis*), Anchovies (*Anchoa* spp.), California Grunion (*Leuresthes tenuis*), Jack Mackerel (*Trachurus symmetricus*), Surfperch (Embiotocidae), and Pacific Sardine (*Sardinops sagax*).

Issues in BCR 32

- Integrity of nesting sites at risk from elevated human disturbance and predation from feral or domestic animals spilling over from the adjacent densely populated cities of southern California.
- The colony site at Port of Los Angeles likely will be lost, as created with the intent to develop it as a shipping-container port; loss may reduce BCR breeding numbers, though population may be limited more by food supply than by available nesting habitat given two-fold increase in breeding numbers in the late 1990s to early 2000s when extent of nesting habitat was relatively stable.
- Habitat restoration at San Diego Bay and Bolsa Chica potentially could impact the species, but difficult to evaluate given preferred management options have not yet been selected.
- Contaminants have been detected in terns and eggs but not considered a threat to population.
- Oil spills and pollution (urban runoff, industrial wastes) may degrade important foraging areas.

Existing Actions

Receives de-facto protection because of proximity to breeding colonies of the Endangered California Least Tern and other species of colonial waterbirds.

Research and Monitoring Needs

- Conduct standardized, regular censuses at all of the colonies in the entire range, as it is difficult to manage in BCR 32 without knowledge of overall trends for the species.
- Conduct ecological and demographic studies to determine factors and life stages limiting the species.

Needed Management Actions

- Protect and enhance nesting habitat at San Diego Bay and Bolsa Chica.
- Offset the expected loss at the Port of Los Angeles by creating alternative habitat there, expanding habitat at the other colonies, or creating new habitat elsewhere in southern California.

Primary regional contact(s):
Brian Collins, San Diego Bay NWR Complex; Charles Collins, Calif. State Univ., Long Beach; Kathy Keane, Keane Biological Consulting; Robert Patton.

References

Burness, G. P., K. Lefevre, and C. T. Collins. 1999. Elegant Tern (*Sterna elegans*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 404. Birds N. Am., Philadelphia.

Collins, C. T., W. A. Schew, and E. Burkett. 1991. Elegant Terns breeding in Orange County, California. Am. Birds 45:393–395.

Roberson, D. 2002. Monterey Birds, 2nd ed. Monterey Peninsula Audubon Soc., Carmel, CA.

Schaffner, F. C. 1985. Royal Tern nesting attempts in California: Isolated or significant incidents? W. Birds 16: 71–80.

Schaffner, F. C. 1986. Trends in Elegant Tern and northern anchovy populations in California. Condor 88:347–354.

Shuford, W. D., G. W. Page, J. G. Evens, and L. E. Stenzel. 1989. Seasonal abundance of waterbirds at Point Reyes: A coastal California perspective. W. Birds 20:137–265.

Account author: W. David Shuford.

Black Skimmer (*Rynchops niger*)

Status Summary

Continental conservation priority: High concern
BCR 32 conservation scores:

Population trend:	1
Threats to breeding:	4
Threats to non-breeding:	2
Percent of population in BCR:	1

BCR 32 conservation priority: Low concern.
Abundance and population trend in North America: 65,000–70,000 breeders. Non-significant declining BBS trend of -4.4%/yr (1966–2009; data deficient).
Abundance and population trend in BCR 32: On average, about 1800–2000 breeders from 1995 to the present, with high variability in abundance and reproductive success at individual sites.
Percent of continental population in BCR 32: <3%.

Global Distribution

One subspecies recognized in North America, *R. n. niger*. On the Atlantic coast, breeds from s. Massachusetts to s. Florida and along the Gulf Coast west to Texas and south to the Yucatan Peninsula. In the West, breeds primarily in coastal s. California and the Salton Sea, but a few pairs now nest in central and n. California. In western Mexico, breeds very locally from Baja California Norte south to Sinaloa, Nayarit, and Colima. On the Atlantic coast, winters from North Carolina south to Florida and along the Gulf Coast west to Texas and south to e. Mexico and the West Indies. On the Pacific coast, winters from s. California south to Baja California and the Gulf of California, and from Sonora on the west coast of Mexico south to El Salvador and Nicaragua.

Occurrence in BCR 32

A year-round resident in coastal Los Angeles, Orange, and San Diego counties, and more recently in Santa Clara County. Although the breeding range has expanded north along the Pacific coast to San Francisco Bay, in BCR 32 the majority of the breeding population occurs in coastal southern California. Winters locally in substantial numbers on the coast of southern California from Santa Barbara to San Diego counties. Small numbers at Morro Bay, San Luis Obispo County, appear to be mainly spring and fall migrants.

Habitat Requirements

For nesting requires large areas of bare earth sufficiently isolated from terrestrial predators and other disturbances. Colonies most often form on small constructed islands or on isolated sections of eroded impoundment levees. In winter, flocks commonly roost on urban beaches well above the tide line or on mud flats in estuaries. Beach sites that are habitually used by skimmers are often associated with estuaries or protected harbors and are near the mouths of rivers or other drainage channels. Skimmers forage for small fish and possibly crustaceans by cutting or "skimming" the water's surface with the lower mandible in the calm shallows of harbors, lagoons, bays, estuaries, ponds, and river channels in fresh as well as estuarine and marine waters.

Issues in BCR 32

- Nest attempts and success may be negatively affected by large aggregations of roosting and breeding waterbirds (e.g., American White Pelicans, Elegant Terns, California Gulls).
- Increased disturbance by humans, pets, and feral animals and the associated increased predation opportunities by avian predators can disrupt nesting attempts of entire colonies and significantly reduce annual nesting success.
- Mortality of chicks and eggs from natural elements are potential threats if exacerbated by human disturbance or other activities that compromise habitat suitability.
- Ingestion of oil during preening of feathers may have deleterious effects.
- Catastrophic oil spills on large sections of shoreline habitat could adversely affect important loafing and foraging areas.

Existing Actions

Designated a California Bird Species of Special Concern.

Research and Monitoring Needs

- Conduct studies of diet, foraging, provisioning behavior, and nest attendance to elucidate factors that influence the low apparent reproductive success in some years.
- Conduct demographic studies to determine fledging success, juvenile survival, adult longevity, recruitment, and the degree of mixing among breeders at sites within the southern California–Baja California region.
- Monitor population size and trend using standardized protocols across colonies.
- Develop standardized indices of reproductive success since some colony sites demonstrate poor productivity, which cannot be explained by predation alone.

Needed Management Actions

- Protect and maintain the extent and integrity of all existing nesting habitats and incorporate such protections in developing restoration plans.
- Modify existing nesting habitat by augmenting problematic substrates with sand, shell, or fine gravel, and enhance the isolation of sites from terrestrial predators and humans.
- Establish additional colony sites at coastal locations where crowding and interference by large flocks of breeding terns or resting waterbirds may reduce nest success.
- Protect productive foraging areas that may be especially vulnerable to contamination, such as protected inlets, bays, and lagoons.

Primary regional contact(s): Kathy Molina, Natural History Museum of Los Angeles County; Charles Collins, Calif. State Univ., Long Beach.

References

Collins, C. T., and K. L. Garrett. 1996. The Black Skimmer in California: An overview. W. Birds 27:127–135.

Gazzaniga, K. T. 1996. Overwintering of Black Skimmers in California: Site fidelity and inter-site movements. W. Birds 27:136–142.

Gochfeld, M., and J. Burger. 1994. Black Skimmer (*Rynchops niger*), in the Birds of North America (A. Poole and F. Gill, eds.), no. 108. Acad. Nat. Sci., Philadelphia, and Am. Ornithol. Union, Washington, DC.

Howell, S. N. G., and S. Webb. 1995. A Guide to the Birds of Mexico and Northern Central America. Oxford Univ. Press, New York.

Account author: Catherine M. Hickey.

Point Blue Conservation Science

Waterbird Conservation for the Americas

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR