Patterns of Distribution and Abundance of Breeding Colonial Waterbirds in the Interior of California, 2009–2012

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and

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Cover photo: Multi-species colony, dominated by American White Pelicans (*Pelecanus erythrorhynchos*) and Ring-billed and California gulls (*Larus delawarensis* and *L. californicus*), on a large rocky islet in the east lobe of Clear Lake National Wildlife Refuge, Modoc County, California. Photo, 18 May 2009, by the author.

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This is Contribution Number 1992 of Point Blue Conservation Science.

EXECUTIVE SUMMARY

As part of an 11-state inventory of colonial waterbirds in the western United States organized by U.S. Fish and Wildlife Service, Point Blue (formerly PRBO) Conservation Science conducted or coordinated surveys of breeding colonial waterbirds throughout most of California from 2009–2012. Primary goals were to document the abundance, distribution, and broad-scale habitat use patterns of colonial waterbirds in the interior of the state; evaluate the effect of environmental conditions during the survey period; compare results to those for some species also surveyed in 1997–1999; identify current or future threats to the region's colonial waterbirds; and inform development of a monitoring strategy for colonial waterbirds in California and throughout the interior of the western United States.

The 15 primary species surveyed in California included the Eared Grebe (*Podiceps nigricollis*), Double-crested Cormorant (*Phalacrocorax auritus*), American White Pelican (*Pelecanus erythrorhynchos*), Great Blue Heron (*Ardea herodias*), Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), Cattle Egret (*Bubulcus ibis*), Black-crowned Night-Heron (*Nycticorax nycticorax*), White-faced Ibis (*Plegadis chihi*), Franklin's Gull (*Leucophaeus pipixcan*), Ring-billed Gull (*Larus delawarensis*), California Gull (*Larus californicus*), Caspian Tern (*Hydroprogne caspia*), Black Tern (*Childonias niger*), and Forster's Tern (*Sterna forsteri*). For all of the interior of California, an estimated minimum of 11,327 pairs of Eared Grebes were nesting at 16 sites, 8791 pairs of Double-crested Cormorants at 60 sites, 3104 pairs of American White Pelicans at 2 sites, 6804 pairs of Ring-billed Gulls at 6 sites, 26,340 pairs of California Gulls at 8 sites, 1221 pairs of Caspian Terns at 2 sites, 2029 pairs of Black Terns (at 42 sites in northeastern California, at an undetermined number of locations in Sacramento Valley rice fields, and at 7 sites in rice fields in the northern San Joaquin Valley), and 610 pairs of Forster's Terns at about 12 sites. The number of breeding pairs for the Eared Grebe, American White Pelican, Ring-billed Gull, and Black Tern also serve as statewide estimates given in California these species breed entirely, or almost exclusively, in the interior. Statewide, an estimated 5517 pairs of Great Blue Herons were nesting at about 399 sites, 7973 pairs of Great Egrets at about 182 sites, 1888 pairs of Snowy Egrets at about 79 sites, 2678 pairs of Cattle Egrets at about 20 sites, 2443 pairs of Black-crowned Night-Herons at about 104 sites, and 25,550 pairs of White-faced Ibis at about 20 sites. Including colonies on the central coast surveyed by others, an estimated 49,783 pairs of California Gulls bred in California in 2009.

Climatic conditions had a strong influence on the distribution and abundance of most waterbird species during the 2009–2012 surveys. Precipitation was below the long-term mean in most regions of the state in three of four years during, and two years prior to, the survey period. Precipitation was well above the long-term mean only in the winter of 2010–11 before the 2011 nesting season. Because drought greatly reduced foraging and nesting habitat in many regions, our population estimates for some species for the interior of the state are well below those from prior surveys in the late 1990s under wetter conditions. The effect of drought was particularly evident on gull and tern colonies, though patterns of decline and shifting distribution were not consistent at all sites on in all geographic regions.

Colonial waterbirds face a host of threats, which have changed over time, but the greatest threat to these birds in California currently is the combination of habitat loss, degradation, and fragmentation.

Plans for long-term monitoring of colonial waterbirds will need to take into account the large fluctuations in their distribution and abundance over short-term cycles of drought and flood, as evidenced by the substantial differences in patterns documented for some species in 2009–2012 relative to those in 1997–1999. Monitoring designs will also need to factor in the expectation of greater environmental fluctuations with ongoing climate change.

INTRODUCTION

Efforts to promote the conservation of waterbirds throughout North America recognize the importance of inventorying and monitoring. Such work is crucial for determining conservation status, detecting population trends, assessing habitat health, and evaluating whether management actions and environmental change are affecting waterbirds (Kushlan et al. 2002). To fulfill this need, from 2009 to 2012, the U.S. Fish and Wildlife Service coordinated the Western Colonial Waterbird Survey, a broad-scale inventory of 19 species of colonial waterbirds in 11 western states (www.fws.gov/mountain-prairie/species/birds/western_colonial/index.html). Goals were to document the species composition, size, and location of colonies; estimate minimum regional population sizes for each breeding species; produce an atlas of colonies; and establish a baseline for development of a long-term monitoring program for colonial waterbirds in the West. Because of a prior census of gull and tern colonies in coastal Washington, Oregon, and California in 2006 and 2007, the more recent 11-state effort did not survey these species in coastal areas (Seto 2008). For the 11-state area, an atlas has been produced for the 8 interior states (Cavitt et al. 2014) and another is in development for the 3 coastal states (R. Doster pers. comm.).

To ensure adequate coverage of the vast expanse of the West, regional experts planned, coordinated, and implemented the surveys at the state level. In California, Point Blue (formerly PRBO) Conservation Science coordinated and conducted surveys of colonial waterbirds throughout the interior of this state with the extensive aid of many collaborating organizations and individuals. The 15 primary breeding species targeted on surveys included the Eared Grebe (*Podiceps nigricollis*), Double-crested Cormorant (*Phalacrocorax auritus*), American White Pelican (*Pelecanus erythrorhynchos*), Great Blue Heron (*Ardea herodias*), Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), Cattle Egret (*Bubulcus ibis*), Black-crowned Night-Heron (*Nycticorax nycticorax*), White-faced Ibis (*Plegadis chihi*), Franklin's Gull (*Leucophaeus pipixcan*), Ring-billed Gull (*Larus delawarensis*), California Gull (*Larus californicus*), Caspian Tern (*Hydroprogne caspia*), Black Tern (*Childonias niger*), and Forster's Tern (*Sterna forsteri*). The project initially intended to also conduct a statewide survey of colonies of the Western Grebe (*Aechmophorus occidentalis*) and Clark's Grebe (*A. clarkii*), but limits to staffing and funding precluded this task. In addition, observers counted nests of five species that were not part of the broader 11-state survey because of their very low abundance and limited distribution in the interior West: Little Blue Heron (*Egretta caerulea*), Yellow-crowned Night-Heron (*Nyctanassa violacea*), Least Tern (*Sternula antillarum*), Gull-billed Tern (*Gelochelidon nilotica*), and Black Skimmer (*Rynchops niger*).

This report describes the abundance, distribution, and broad-scale habitat use patterns of colonial waterbirds in the interior of California in the period 2009–2012, interprets results on the basis of environmental conditions during the survey period and prior survey data for some species, and discusses current and future threats to colonial waterbirds in the state. It also outlines how the recent surveys can inform development of a monitoring strategy for colonial waterbirds in California and throughout the interior of the western United States.

STUDY AREA AND METHODS

BACKGROUND AND OVERALL APPROACH

In organizing statewide surveys of colonial nesting waterbirds, the author based the timing and extent of field work on a combination of factors: extensive information gathered on the locations of historical and recent colonies, broad-scale knowledge of wetland and other potential foraging and nesting habitats from extensive surveys of migrant and breeding shorebirds and waterbirds across much of the state since the 1980s, discussions with a broad network of collaborators developed over the years, and, of course, available funding.

Information gained from statewide surveys of the interior populations of seven species of colonial waterbirds from 1997–1999 (Shuford 2010), which were also among the target species in the 2009–2012 project, and comprehensive surveys of all shorebirds and waterbirds in the Klamath Basin in 2003 and 2004 (Shuford et al. 2006), were particularly valuable. The author supplemented searches for information on colonies from published and unpublished literature and databases (e.g., California Natural Diversity Database) by communicating with various field biologists prior to fieldwork and by pursuing additional leads when out in the field or between fields seasons. These efforts were greatly enhanced by biologists who shared survey data from ongoing local or regional monitoring projects or who, under subcontract to the current project, conducted or coordinated surveys of one or more species in regions where they had extensive knowledge (and contacts) and/or had conducted surveys in the past.

In an ideal world it would have been best to conduct statewide surveys of all target species in the same year under the same environmental conditions. This was not possible, however, and hence the project took a regional approach. Fieldwork in 2009 focused on a select set of species that breed mainly in northeastern California; in 2010 on remaining species in northeastern California plus Black Terns in the Central Valley; in 2011 on additional species in the Sacramento Valley, Delta, and the northern and central coastal slope (and particularly the San Francisco Bay area); and in 2012 on the coastal slope of southern California, the Salton Sea and adjacent Imperial Valley, and the Owens and lower Colorado River valleys. Descriptions of these study regions and the survey methods used in each are detailed in the following sections. Overall, observers used a combination of ground, boat, and aerial surveys with methods varying among species, colony sites, and regions depending on species' nesting habits and local conditions, such as variation in nesting substrates, proximity of other nesting species, and accessibility of colony sites. Aerial surveys were particularly valuable for photographing some large and remote colonies and for covering large areas, such as the Central Valley, that would not have been possible to survey adequately by other methods.

At each colony site, observers tried to obtain the best estimate of the number of active nests/nesting pairs for each species. Active nests were defined as those at the time of the survey that were attended by an adult(s), held eggs or young, or showed signs of occupancy (e.g., extensive guano) earlier in the current breeding season. As much as possible, surveys were timed around peak nesting, which, of course, varies among species. So in some cases follow-up surveys were conducted at a subsequent date to accommodate colonies with both early and later-nesting species. Complicating matters further, some species breed asynchronously within a colony site or vary their timing of breeding across years or among sites in the same year. This sometimes required multiple surveys to ensure a count close to or at the peak of nesting. Studies show that for some seabird species, at least, that peak nest counts can substantially underestimate the number of breeding pairs (Seavy and Reynolds 2009). It is unclear, however, to what degree this potential bias affected nesting pair estimates for the colonial waterbird species that were surveyed. Regardless, our counts are indices of the number of breeding pairs, and, hence, should be comparable to future estimates if the surveys on which they are based are conducted using the same methods and at the same time in the nesting cycle.

In some wading birds colonies, it was not possible to assign to species guano-stained nests that were not occupied by adults or young. These had to be assigned to a relevant species pair (e.g., Snowy Egret/Black-crowned Night-Heron, Great Egret/Great Blue Heron) with similar-sized nests. Sometimes, but not always, these could be apportioned among the species if observers identified enough other nests by their occupants. At some individual sites, or for certain species in particular regions (e.g., Black Terns in rice fields in the Central Valley), it was not possible to estimate nesting pairs by counting nests. Such exceptions are noted below in sections that detail the geographic areas and species surveyed in particular years.

ESTIMATING REGIONAL AND STATEWIDE POPULATION ESTIMATES

The regional approach to surveys by year allowed us to survey the entire breeding range in the state in a single year for the American White Pelican, Ring-billed Gull, California Gull (with the aid of collaborators at coastal colonies), and Black Tern. Surveys of the statewide range of the Eared Grebe occurred over two years, but northeastern California, which holds the vast majority of the state's breeding population, was surveyed in one year. The statewide or interior range of each of the remaining species was surveyed by region over 2–4 years, as detailed below. To obtain a statewide or interior population estimate for each species, the author summed the regional estimates, which, with but few exceptions, included the (single) best count for each of the individual colonies during the specific year of the regional survey. This introduced an unknown degree of uncertainty in the total population estimate when regional counts occurred in different years because it was not possible to gauge how much regional populations varied from year to year. At least most years of the survey period had similar environmental conditions (i.e., below average precipitation), which likely reduced the year-to-year variation in breeding numbers over these years. Still, it seems likely that the totals obtained (by summing the regional estimates) are minimum estimates of statewide or interior breeding numbers. Regardless, summing counts taken over more than one year is often the only feasible way to obtain an overall population estimate when surveying multiple species and large numbers of colonies spread over an extensive geographic area (e.g., see Carter et al. 1992 for California seabirds).

The focus of the 11-state inventory was on the interior populations of most colonial waterbirds given the combination of the species selected for surveys, that eight of the states are landlocked, and that inventories for the three coastal states excluded coastal breeding gulls and terns surveyed under a prior inventory. In California, several species—the Eared Grebe, American White Pelican, Franklin's Gull, Ring-billed Gull, and Black Tern—breed entirely or almost exclusively well inland in the state, hence totals of their breeding numbers serve as estimates of both the species' statewide and interior populations.

Things get more complicated for other species that breed both inland and on the coast, particularly given that there is no clear-cut boundary for where the “interior” leaves off and the “coast” begins. For practical reasons, the author treated this distinction differently, or ignored it entirely, for certain species or species groups. Double-crested Cormorant colonies on the coast of California have long been surveyed as part of seabird inventories or monitoring (Carter et al. 1992, Capitolo et al. 2012). To avoid overlap with efforts focused on coastal seabirds, the “interior” survey area of the California colonial waterbird inventory excludes coastal cormorant colonies on offshore islands or rocks, coastal bluffs, within estuaries, or otherwise within 10 km of the ocean or estuarine shoreline; for the San Francisco Bay estuary, the Carquinez Strait at Interstate-80 is considered the boundary between coastal and interior. The various species of long-legged waders (herons, egrets, night-herons, ibis) breed both on the coast and far inland, though on the coast they nest primarily in close proximity to estuaries and only rarely on offshore rocks. Regardless, given the lack of overlap with species included in coastal seabird surveys, there seemed no reason to make any distinction between coastal and interior colonies and hence overall numbers presented here for these species are minimum statewide population estimates.

Three other larid species (California Gull, Caspian Tern, and Forster’s Tern) breed both in the interior and in coastal estuaries, but, as noted above, the coastal colonies of gulls and terns were excluded from the 11-state colonial waterbird inventory. Fortunately coastal colonies of these species generally are well separated from those in the interior; the closest “interior” colony for any of these species was over 20 km from the ocean shoreline and most were much further inland. Hence, overall numbers presented here for these species are minimum population estimates for the interior of the state. One exception is that both an interior and statewide estimate is presented for the California Gull. The latter estimate is given for this species because coastal colony data were readily available for the same year as the survey of gull colonies in the interior; such was not the case for the other two species.

SURVEY PROTOCOLS

In California, observers generally followed the survey protocols of the Western Colonial Waterbird Survey (Jones 2008). Still, it was necessary to refine these or adopt other methods for situations not covered by the WCWS (e.g., Black Terns nesting in rice fields). Regardless, details of survey methods are provided within the following sections (organized by survey region, year, and species or species group) or the reader is referred to details in prior publications (e.g., Shuford et al. 2001, Shuford 2010). The collective "we" is used throughout to describe those conducting surveys, often a combination of Point Blue staff, collaborating biologists, and volunteers.

NORTHEASTERN CALIFORNIA: 2009

The principal study area was northeastern and east-central California, including all or portions of Siskiyou, Modoc, Shasta, Lassen, Plumas, Sierra, Nevada, Placer, El Dorado, Alpine, and Mono counties. Although much of this sparsely populated region is relatively arid, it has extensive potential nesting habitat for waterbirds in marshes, lakes, and reservoirs. These habitats are scattered widely, primarily from 4000 to 6000 feet (1220–1830 m) elevation, in plateaus, large valleys, or basins receiving drainage from nearby mountains. Although we also surveyed colonial waterbirds at Upper Klamath Marsh within Upper Klamath NWR at the north end of Upper Klamath Lake, Klamath County, Oregon, those data are not included in this report (see Shuford and Henderson 2010). Finally, the author coordinated surveys of California Gull colonies in northeastern California with those being conducted by collaborators in the interior at Mono Lake and Laurel Pond, Mono County; Owens Lake, Inyo County; Salton Sea, Imperial County; San Francisco Bay, Santa Clara, Alameda, Contra Costa, and San Francisco counties; and Southeast Farallon Island, San Francisco County.

The breeding season of 2009 followed a 3-year period of drought, as documented by data for the two geographic climate divisions that together comprise most of the northeastern California study area of this project (Figure 1). Precipitation totals for the climate year (1 July–30 June) in 2006–07, 2007–08, and 2008–09 were, respectively, 57.4, 66.7, and 72.7 cm in the Sacramento Drainage division and 29.1, 39.1, and 39.6 cm in the Northeast Interior Drainage division (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html). These precipitation totals represent, respectively, 64%, 75%, and 82% of the long-term average (n = 119 yrs) for the Sacramento division and 56%, 75%, and 76% for the Northeast Interior division. Consequently a number of terminal lakes, reservoirs, or wetlands in northeastern California were dry or had very low water levels; these patterns are discussed more fully below.

Fieldwork in 2009 focused on a select set of species—the American White Pelican, Ring-billed Gull, California Gull, and Caspian Tern—that breed entirely or mainly in the interior of the state on islands in lakes, reservoirs, or wetlands in northeastern California. We also surveyed other species nesting on these islands, including the Double-crested Cormorant, Great Blue Heron, Great Egret, and Black-crowned Night-Heron. In addition we also surveyed herons, egrets, night-herons, and the White-faced Ibis at other sites at Clear Lake, Lower Klamath, and Tule Lake NWRs. Finally, we searched for rookeries of cormorants and Great Blue Herons at other known or potential colony sites in the region.

Pelicans and Cormorants

We surveyed nesting pelicans exclusively by aerial photography, but used aerial, boat, and ground surveys for cormorants depending on nesting substrate and accessibility of the colonies.

Aerial photographic surveys. On 12 May, we conducted aerial photographic surveys of colonies dominated by the American White Pelican and Double-crested Cormorant at Sheepy Lake on Lower Klamath NWR, Siskiyou County, and Clear Lake NWR, Modoc County, in California and at Upper Klamath Marsh, Oregon. Other colonial species nesting in association with the pelicans and cormorants at these sites that we also counted from aerial photos included the Great Blue Heron, egrets (either Great or Snowy), and Black-crowned Night-Heron (see below).

At each colony, Shuford took multiple overlapping digital photographs with a single-lens reflex digital camera (Canon EOS 40D) with a 300 mm lens, and a few colony overview shots with a 50 mm lens, while the plane circled at about 70 to 95 knots at about 175 to 200 m above the colony. This distance above the colonies provided the best possible photographs while avoiding flushing birds from their nests. Phil Henderson used standardized methods, developed by other biologists for surveying coastal seabird colonies (P. Capitolo, G. J. McChesney, and H. R. Carter in litt.), to count numbers of pelicans, cormorants, and other associated species. This involved first sorting the digital images to obtain a subset of overlapping reference photos of the highest resolution and contrast, which were enhanced, as needed, by using appropriate software. The latter was also used to mark boundaries for subareas counted, on the basis of identifiable landmarks, and to mark all nests and adults of the target species. For all colonies or sub-colonies, the estimated number of pairs of pelicans and cormorants equals the number of active nests (those with incubating or brooding adults, eggs, or chicks). In some years, because of asynchronous nesting among sub-colonies of pelicans, counting is difficult in the few areas where medium- to large-sized chicks already have gathered into crèches by the time of May surveys; this was not the case in 2009.

Boat surveys. On 13 May, Henderson and Shuford counted Double-crested Cormorant nests in juniper trees on two islands at Lake Shastina from a boat circling slowly, and stopping at intervals, about 50 m from the islands; we counted at various vantage points and mapped nests within individual trees to avoid under- or overcounting. On 21 May, Lew Oring took Shuford and Henderson by motor boat to an island between Buck Point and Little Troxel Point on Eagle Lake to conduct a survey where Oring had observed nesting cormorants on 7 May.

Ground surveys. On 22 May, Henderson and Shuford used binoculars and a spotting scope to count cormorant nests in a snag near the west shore of Butt Valley Reservoir while looking from several vantage points on a road on the reservoir's east shore. We mapped nests to ensure an accurate count, but it is possible that one or more nests on the far side of the snag were not visible from our east-shore vantage points. An attempt to access the steep west shore from roads to obtain closer looks from an entirely different vantage point proved unfruitful. We also surveyed for cormorants at Antelope Lake (14 May), Plumas County, but we did not see any evidence of cormorant nesting.

Herons and Egrets

Methods of surveying nesting herons, egrets, and night-herons varied among sites depending on nesting substrate and accessibility of the colonies. Surveys of egrets and night-herons nesting in marshes posed the greatest problems because of nest timing relative to survey timing, shifting of colonies, and difficulties with visibility or access. Also, it was often not possible to distinguish between Great and Snowy egrets, particularly on aerial surveys, or to obtain adequate samples from boat or shoreline counts to accurately determine the ratio of the two species.

Aerial surveys. On the 12 May aerial survey, we photographed ardeids nesting on islands at Clear Lake NWR and in marshes at Upper Klamath Marsh and Sheepy Lake. On a 27 May flyover, Dave Mauser visually estimated the number of egrets nesting in a large willow clump on the east side of "The U" peninsula at Clear Lake NWR; John Beckstrand and Henderson landed on the shore in an airboat and walked to this site for closer observation on 17 June. During aerial surveys of nesting pairs of ducks, Mauser and Beckstrand also estimated the number of nests of egrets in marshes in Sump 1B of Tule Lake NWR (27 May) and Unit 12C of Lower Klamath NWR (29 May).

Boat surveys. Because of the difficulty of detecting small numbers of Black-crowned Night-Herons and Snowy Egrets on photographs of the rocky islands at Clear Lake NWR, we also surveyed those species from an airboat on 18 May and 17 June. We made counts of adults but were unable to locate nests of these species at this site. Mauser conducted a survey of egrets and night-herons at Unit 12C of Lower Klamath NWR by Jon Boat on 17 June, and he and Beckstrand conducted an additional airboat survey for those species at Units 6A and 12C on Lower Klamath NWR on 23 June. Henderson surveyed egrets and night-herons in the western portion of Unit 12C from a kayak on 18 June. On a 13 May boat survey at Lake Shastina, Henderson and Shuford also counted Great Blue Heron nests in junipers on two islands using the same methods as for cormorants described above.

Ground surveys. Henderson and Shuford conducted ground counts to survey known Great Blue Heron colonies or to search for new ones in the following areas: Klamath River from the junction of Highway 96 and Interstate 5 (south of town of Hornbrook) upstream (east and north) to the Oregon border (including shores of, and slopes above, Irongate Reservoir and Copco Lake) and riparian along Cottonwood Creek (and other tall trees nearby) from the vicinity of Hornbrook downstream (south) to Klamath River (19–20 May), Siskiyou County; Baum Lake, Shasta County (23 May); west shore of Eagle Lake from Pelican Point south to Slough Point (accessed by boat, 21 May), Lassen County; and Lake Almanor (22 May) and Indian Valley, near Crescent Mills (15 May), Plumas County. At each colony located (all in trees), we counted the number of active nests (adult sitting on nest or young visible). To maximize accuracy, we mapped all nests in each tree and spent considerable time watching colonies to document if nests were active. The active status of nests was often revealed by noting previously obscured chicks moving or standing up in nests or by adults flying in to land on visible nests that, until then, were not obviously occupied or to nests obscured by limbs or dense foliage.

In an attempt to refine aerial estimates of numbers of egret and night-heron nests in marshes at Lower Klamath NWR, Henderson conducted dawn flyout counts of these species at Units 12C (0450–0550, 17 June; 0430–0540, 19 June) and 6A (0445–0600, 18 June). Likewise, he conducted a dusk flyout count for night-herons at Unit 12C (1900–2035, 17 June). During the day, Henderson counted egrets and night-herons from the shoreline at Unit 12C (12 May) and Unit 6A (17 June); Shuford also counted egrets at Unit 12C (12 June) as part of another project.

Henderson and Shuford conducted searches for herons, egrets, and night-herons at the Dakin and Fleming Units of Honey Lake Wildlife Area (WA, 14 May), Leavitt Lake (14 May), and Willow Creek WA (21 May), Lassen County.

During the course of gull surveys, Kristie Nelson, Ann Griener, and others counted night-heron nests (one by one) in bushes on islands in Mono Lake (accessed by boat, 25–26 May); Nelson and Griener also counted night-heron nests in bushes on an island in Laurel Pond, Mono County (accessed by kayak, 28 May).

Estimating pairs. Our estimates of the total number of breeding pairs of egrets and night-herons were crude because of the difficulty of counting nests in large colonies in marshes. Numbers of egret nests were estimated visually from a plane at Unit 12C of Lower Klamath NWR and Tule Lake Sump1B, and hence were rough. Also, we excluded the 40 nests/pairs from Tule Lake from the overall total because that colony was abandoned relatively early in the season, and birds may have relocated to a colony that subsequently formed at Unit 6A of Lower Klamath. With a drawdown of water in Tule Lake Sump 1B initiated on 1 May, it was likely that toward the end of May no water remained under that egret colony (D. Mauser pers. comm.); lacking a boat survey when this colony was active, it is possible that night-herons may have initiated nesting there but went undetected. Counts of adult egrets on ground or boat surveys of Units 6A and 12C of Lower Klamath NWR provided ratios of the number of Great Egrets to Snowy Egrets. When counts of total adults were the only ones available, we divided these by two to estimate breeding pairs. For night-herons, we obtained direct counts of nests only at two sites in Mono County, where birds were nesting in bushes on islands. At four other sites, we made counts of adults only, which, again, we divided by two to estimate numbers of breeding pairs.

Ring-billed and California Gulls

Survey timing. During the period 12–22 May, Henderson and Shuford, aided at some sites by collaborating biologists and volunteers, conducted ground and boat surveys to search for active gull colonies in northeastern California. We made direct counts of nests or breeding adults, or documented a lack of nesting, at the following sites: Lake Shastina (13 May), Meiss Lake, Butte Valley WA (12 May), and Unit 6A on Lower Klamath NWR (18 May), Siskiyou County; Clear Lake NWR (18 May), Goose Lake (16–17 May), Big Sage Reservoir (16 May), Fairchild Swamp (16 May), Middle Alkali Lake (17 May), and Dorris Reservoir on Modoc NWR (16 May), Modoc County; Eagle Lake (21 May) and Honey Lake WA (14 May), Lassen County; and Lake Almanor (22 May) and Lake Davis (15 May), Plumas County. We accessed active colonies on islands or peninsulas by power boat, airboat, or canoe. On aerial photographic surveys on 12 May, described above, we documented a lack of nesting gulls at irregularly occupied colony sites at Sheepy Lake on Lower Klamath NWR, Siskiyou County, and at Tule Lake NWR, Siskiyou and Modoc counties. Bob Smith (pers. comm.) confirmed that no gulls were nesting in 2009 at Shasta Valley WA, Siskiyou County, where Ring-billed Gulls are known to have nested at Steamboat Lake in only one prior year. As part of other work in the Oregon portion of the Klamath Basin, Shuford located a previously unrecorded gull colony on intentionally flooded agricultural land about 10 mi (16 km) south of the town of Klamath Falls (10 June).

To enable an estimate of the entire statewide breeding population of California Gulls in 2009, the author also obtained data from nests counts at other interior colonies in east-central and extreme southeastern California and from colonies on the central coast. In Mono County, Point Blue biologist Kristie Nelson conducted a count of gulls nests at Laurel Pond (28 May) and she shared data from nests counts at Mono Lake (24–27 May) conducted by a team of biologists and volunteers as part of a long-term monitoring project in collaboration with the Mono Lake Committee. Bill Deane/Los Angeles Department of Water and Power (LADWP) contributed nests counts from Owens Lake (26–29 May), Inyo County, conducted by a team of six LADWP biologists (Chris Allen, Bill Deane, Debbie House, Jason Morgan, Jeff Nordin, Collette Zemitis) and two Point Blue biologists (Gary Page, Dave Shuford) as part of a long-term monitoring project for Snowy Plovers (*Charadrius alexandrinus*) and other waterbirds. For the Salton Sea, Imperial County, Kathy Molina provided data from nest counts conducted at two sites (18 May, 8 June) as part of a long-term monitoring project of various species of breeding larids. Likewise, collaborating biologists provided data for nest counts at the following coastal colonies of California Gulls censused as part of ongoing monitoring efforts: Carley Schacter/San Francisco Bay Bird Observatory for seven colonies in south San Francisco Bay (4–21 [mostly 13–21] May); Susan Euing/San Francisco Bay NWR for Alameda Point in central San Francisco Bay (9 June); Dan Roby and Dan Battaglia/Oregon State University, for Brooks Island in central San Francisco Bay (9 May); Sara Acosta/Point Blue for Alcatraz Island in central San Francisco Bay

(1 June); and Russ Bradley and Pete Warzybok/Point Blue for Southeast Farallon Island (10 June) in the Pacific Ocean 25 miles west of San Francisco.

Census methods at interior colonies. At most northeastern California colonies (and at Mono Lake and Laurel Pond), observers made counts by walking through colonies and marking each active nest (eggs or chicks) individually (on the rim or on an adjacent rock or weed) with a dab of paint to avoid over- or undercounting. Tempera paint, mixed at a ratio of about five parts liquid paint to one part water, was applied by squeezing the paint mixture through a nail hole made in the top of a 16-ounce plastic bottle. For those colonies, the estimated number of nesting pairs equals the number of nests counted.

At Clear Lake NWR, to minimize disturbance to other species nesting in close proximity to gulls, we counted all adults gulls at those colonies, generally by groups of 5's, from the stable platform of an airboat stopped at intervals, and anchored as needed, as we circled the nesting islands about 60 m offshore. As in the past, we estimated the number of nests on these islands as 0.71 of the number of adults counted for the Ring-billed Gull and 0.72 for the California, the ratios at Clear Lake in 1994 at colonies in open terrain where we could count both nests and adults (Shuford and Ryan 2000).

At Owens Lake, where small numbers of gulls were nesting at scattered sites on the edges of levees or on islands in shallow ponds, observers counted incubating adults on nests using binoculars, spotting scopes, or the naked eye. At the Salton Sea, where gulls nested on islands in small impoundments at two sites, biologists used binoculars and scopes to make weekly counts of incubating birds from nearby vantage points outside of colonies; the number of nests reported for each site is the highest single-day count (K. Molina pers. comm.).

Census methods at coastal California Gull colonies. At most colonies in San Francisco Bay, observers conducted nest counts at each on a single day near the peak of the egg laying season. At six colonies in south San Francisco Bay, observers counted nests (without marking them) while walking through the colony; at the Moffett B2 salt pond, where gulls are nesting on an island with Caspian Terns, observers counted gull nests from a distance using a spotting scope (C. Schacter pers. comm.). Biologists monitored nests at the Alameda Point and Alcatraz colonies by a combination of periodic walk-through counts and ones taken from a distance (S. Euing, S. Acosta pers. comm.); at both sites, peak single-day nest counts reported here were obtained by the walk-through method. At Brooks Island, biologists counted total nesting gulls, including both California Gulls and Western Gulls (*Larus occidentalis*), from digital aerial photographs of the colony area taken primarily for the purpose of surveying nesting Caspian Terns (D. Roby and D. Battaglia pers. comm.). Because it was not possible to count gull nests or to distinguish adults of the two species from those photographs, we first estimated the number of nesting California Gulls from the ratio of California to Western gulls obtained from ground counts of portions of the Brooks Island colony in 2008. We then estimated nesting pairs of California Gulls at that site using the ratio of adults to nests from counts at Clear Lake NWR in the interior in 1994 as described above. At Southeast Farallon Island, biologists positioned on the lighthouse hill used spotting scopes to count adult gulls sitting in incubation posture on apparent nests on the marine terrace below every five days from early April to mid-July; the number of nesting pairs was estimated from the peak single-day nest count (P. Warzybok pers. comm.). Inspection of aerial photographs taken to count rooftop nests of Western Gulls revealed an adult California Gull on a nest on the Capitola Mall in Santa Cruz County on the central coast (P. Capitolo and J. Davis pers. comm.).

Franklin's Gulls

We did not document breeding by Franklin's Gulls in northeastern California in 2009 despite circumstantial evidence and a strong suspicion that they were nesting in marshes of Units 6A and 12C of Lower Klamath NWR and in Sump 1B of Tule Lake NWR in association with egrets, night-herons, and ibis. These gulls flew out of tule clumps and circled airboats during surveys of egrets and night-herons at Units 6A and 12C in mid-June as described above, and we counted adult Franklin's Gulls in adjacent refuge units in mid-June. At no time did we see any nests, eggs, or chicks of this species.

Caspian Terns

Because colonies of this species in northeastern California are typically associated with gull colonies, observers looked for tern colonies at all of the sites that were surveyed for gulls in mid-May, as described above, which included all sites where Caspian Terns have nested in recent years (Shuford and Craig 2002, USFWS unpubl. data). Although May surveys are not ideal for obtaining estimates of breeding pairs of terns, because terns typically delay nesting a few weeks relative to gulls, they usually are adequate to determine if the terns are on territory and beginning to nest. In May, we observed Caspian Terns on territory on a nesting island only at Clear Lake NWR. To obtain a better estimate of nesting pairs, Henderson and John Beckstrand returned to Clear Lake NWR on 17 June, where they counted adults and nests from an airboat anchored close to the shore of the nesting island. Also, on the off chance that Caspian Terns might subsequently have established colonies at sites where no breeding evidence was observed in May, Henderson made follow-up visits to Lake Shastina (16 June), Meiss Lake on Butte Valley WA (16 June), Dorris Reservoir on Modoc NWR (16 June), Big Sage Reservoir (19 June), and Goose Lake (California portion, 19 June). Likewise, Pam Cherny confirmed that no Caspian Tern colony was active at Honey Lake WA in June.

NORTHEASTERN CALIFORNIA: 2010

Target species in 2010 were mainly three widespread or locally numerous breeders not surveyed in this region in 2009: the Eared Grebe, Black Tern, and Forster's Tern. We also surveyed for local colonies of herons, egrets, night-herons, and ibis. Our efforts focused on valleys of the Cascade, Klamath, and Sierra Nevada mountains, the Modoc Plateau, and the Great Basin desert of all or portions of Siskiyou, Shasta, Modoc, Lassen, Plumas, Sierra, Nevada, Placer, and El Dorado counties. Tern habitat in marshes, lakes, and reservoirs occurred from 4000 to 6000 feet (1220-1830 m) elevation in intermountain valleys or in depressions in the Modoc Plateau. David Haines conducted surveys of colonial waterbirds throughout this region from 2 June through 15 July; Shuford assisted for two weeks, one at each end of this period. We surveyed almost all the sites detailed in the appendices and tables in Shuford (2010), plus a few others not covered on comparable surveys in 1997. We were unable to survey a few areas with high potential for nesting terns, because of physical barriers on public lands or lack of permission to access private properties (mostly same sites inaccessible in 1997). We conducted most surveys on foot, but occasionally Haines used a kayak on larger or deeper water bodies. Shuford also conducted surveys at reservoirs and wetlands in east-central California (Alpine and Mono counties), primarily for Eared Grebes, from 18–20 July and 1–2 August.

We made accommodations for three species—the Eared Grebe, White-faced Ibis, and Forster's Tern—that are known to breed asynchronously within a colony site or vary their timing of breeding both across years or among sites in the same year. This variation in nest timing poses significant challenges to obtaining accurate censuses of breeding numbers at individual sites and over all breeding sites in a broad area. To address this issue, we conducted repeat visits to important breeding sites for Eared Grebes or Forster's Terns at Lower Klamath and Tule Lake NWRs, Siskiyou and Modoc counties, Eagle Lake, Lassen County, and Bridgeport and Crowley

Lake reservoirs, Mono County. Because these species generally breed out in the open or in accessible areas at these sites, we had confidence in survey numbers as they changed with different visits over the season. We did not survey major ibis colonies multiple times across the season, primarily for lack of time. It is unclear, however, if multiple surveys would have provided much more reliable numbers without additional work to understand the dynamics of ibis colony attendance given close approach and counting of individual nests usually is not possible (see discussion below).

Two sets of climatic conditions dominated in northeastern California in 2010. First, ongoing drought (Figure 1) left many shallow-water marshes or lakes in the region dry or greatly reduced in extent. Precipitation in the climate year (1 July–30 June) 2009–10 was 90.6 cm in the Sacramento Drainage division and 48.2 cm in the Northeast Interior Basins division, which combined encompass most of the study area. These figures represent 102% and 93%, respectively, of the long-term means (n = 119 yrs) for these areas (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html). More importantly, precipitation in each of the three prior years ranged from 64–82% and 56–76% of the long-term means for the respective climate divisions. By contrast, precipitation in the three years prior to comparable broad-scale tern surveys in northeastern California in 1997 ranged from 120–171% and 129–166% of the long-term means for the respective climate divisions.

Secondly, the early part of the tern nesting season of 2010 was unusually cool, affecting tern nesting phenology as described below. Mean temperatures for May–June for the Sacramento Drainage and Northeast Interior Basins divisions were 1.69°F (0.94°C) and 3.17°F (1.77°C) cooler than the long-term means (n = 116 yrs) for those regions, respectively (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html). By contrast, mean May–June temperatures for the respective climate divisions were 2.26°F (1.25°C) and 1.63°F (0.9°C) warmer than the long-term means in 1997, the year of a prior broad-scale survey of terns.

Black Terns

We conducted surveys of Black and Forster’s terns throughout their known ranges in the interior of California mostly in 2010. Prior statewide inland surveys in 1997–1999 (Shuford et al. 2001, Shuford 2010) provided valuable information that aided in field work and the interpretation of results in 2010. We varied field survey methods among regions, to match local logistical constraints, and timed surveys to follow the passage of most migrants and begin with the initiation of nesting.

It was impractical to count all nests of this species in the many wetlands in this region. So, depending on circumstances, we used three types of counts and corresponding methods to estimate numbers of breeding pairs of terns—total nests, total disturbed adults, and total visible undisturbed adults—as described in detail in Shuford et al. (2001). Correction factors used to estimate breeding pairs for the latter two methods were derived in 1997. When data are available to make more than one estimate, we present only the method of apparent highest reliability, as outlined in Shuford et al. (2001).

The atypically cool spring in northeastern California in 2010 delayed nesting phenology of Black Terns compared to that in 1997, a year with above average spring temperatures. In 1997, Black Terns appeared to be well established at breeding marshes and most of their nests had full clutches by the end of May. Although we began surveys much later in 2010, for the first 10 days of June few birds were on full clutches and many appeared to be foraging away from breeding marshes. At this time, we noted many terns foraging over bodies of open water—a pattern also typical of various species of swallows during inclement weather—and afterwards leaving these sites in singles or small groups headed toward extensively vegetated breeding marshes. These seasonally atypical patterns of tern behavior posed substantial challenges to interpreting numbers of breeding terns in the first third of June. Tern numbers at that time seemed atypically low at marshes with suitable breeding habitat, even when many nests were located, and numbers were elevated at sites with extensive open water where few if any terns usually breed. Lacking confidence in interpreting numbers at individual marshes in early June, we resurveyed most of these sites again 7–10 days later; we did not revisit marshes that were dry in early June.

Forster's Terns

Depending on circumstances, we used three types of counts and corresponding methods to estimate numbers of breeding pairs of Forster's Terns—total nests, total disturbed adults, and total visible undisturbed adults—as described in detail in Shuford (2010). Correction factors used to estimate breeding pairs for the latter two methods were derived in 1997. When data are available to make more than one estimate, data are presented for only the method of apparent highest reliability, as outlined in Shuford (2010). It is likely that all methods provide conservative estimates, particularly because the timing of nest initiation for Forster's Terns at individual sites can vary considerably among years or subcolonies (Gould 1974, Shaw 1998).

Eared Grebes

We made estimates of nesting pairs of grebes at 14 colony sites either by counts of total nests, partial nest counts and counts of total adults, or counts of total courting adults. We counted nests by paddling a kayak out to colonies where birds were nesting in or around tall marsh vegetation or were in the open far out on large water bodies, by walking out in shallow water on the edges of large water bodies or across smaller and shallower ones, and by scoping from the shoreline. We sometimes had to base estimates of nesting pairs on counts of total adults when it was not possible to penetrate dense marsh vegetation to count most nests but the close approach of a kayak forced adults out onto the open water. Because of the issues of protracted and asynchronous breeding, we made two or more visits to the sites with the largest colonies: Lower Klamath NWR, Unit 6A (16 June, 30 June, 11 July), Tule Lake NWR, Sump 1-A (29 June, 12 July), Tule Lake NWR, Sump 1-B (14 June, 29 June, 12 July), Siskiyou County; Eagle Lake, North Basin (6 and 15 July) and Leavitt Lake (6 and 15 July), Lassen County; and Bridgeport Reservoir (19 July, 2 August) and Crowley Lake Reservoir (20 July, 1 August), Mono County.

White-faced Ibis

We estimated the number of pairs of nesting White-faced Ibis at eight sites in northeastern California using various methods. Shuford counted adults flying out at dawn at the four largest colonies: Lower Klamath NWR (Unit 6A, 15 and 16 June; with Dave Mauser), Siskiyou County; Leavitt Lake (6 and 7 July) and Willow Creek WA (8 July), Lassen County; and Sierra Valley (25 June), Plumas County. These flyout counts assume that during the incubation and early nestling periods that one member of the pair would remain at the nest while the other adult would leave the nesting area at dawn to forage elsewhere. If so, the number of adults flying out of the colony at dawn appears to provide a reasonable estimate of the number of nesting pairs. On the basis of photos and observations during an aerial survey for various species of waterbirds on 15 June, Dan Battaglia and colleagues (Oregon State University) estimated the number of nesting pairs at a private wetland at the south end of Goose Lake, Modoc County. David Haines estimated ibis pairs by counting nests or vigilant adults at the smallest colonies: Egg Lake (27 June, 13 July) and Whitehorse Flat (28 June, 7 July), Modoc County, and Mountain Meadows Reservoir, Lassen County (14 July).

Although dawn flyout counts are routinely used to estimated nesting pairs of ibis, the assumption that during the incubation or early chick phase that one adult of each pair flies out of the colony to forage while their mate stays in the colony to attend the nest does not appear to have been tested. In addition, no correction factors appear to be available to adjust for the fact that at a given time there may be considerable variation in nest timing with the colony, or for counts that occur early or late in the nesting cycle when adults may not be compelled to stay in the colony to attend eggs or small chicks. At Willow Creek WA, the only colony we entered with a reasonable number of nests, most nests on 8 July had small- to medium-sized young. But many nests also were empty (or with dead chicks or cracked eggs) with extensive guano, indicating an earlier wave of nesting. How such variation here or elsewhere might affect colony counts is unclear.

Egrets and Night-Herons

At the two sites in northeastern California where we found egrets and night-herons nesting in 2010, we made rough estimates of nesting pairs by counting adults because our visits were late in the season and/or nests were tucked in dense patches of trees.

CENTRAL VALLEY: 2010

The Central Valley, surrounded by mountains except at its western drainage into the San Francisco Bay estuary, averages about 644 km long and 64 km wide. It is divided into the Sacramento Valley, draining southward, the San Joaquin Valley, draining northward, and the Sacramento–San Joaquin River Delta (hereafter Delta), where these rivers converge. The Sacramento Valley is further divided into the Colusa, Butte, Sutter, American, and Yolo drainage basins, and the San Joaquin Valley into the San Joaquin Basin and, the usually closed, Tulare Basin. Over 90% of the Central Valley's historic wetlands have been lost (Frayer et al. 1989, Kempka et al. 1991), and, overall, breeding habitat for waterbirds typically is scarce. The dominant land use in the Central Valley is agriculture, and certain irrigated crops can provide nesting or foraging habitats for breeding waterbirds. Large areas of cultivated rice *(Oryza sativa)* fields in the Sacramento Valley, and smaller areas in the Delta and San Joaquin Basin, typically provide potential nesting habitat for the Black Tern but not the Forster's Tern. Other habitats in the Central Valley sometimes suitable for breeding terns include managed wetlands on refuges and duck clubs (limited summer water), flood water storage or recharge facilities (e.g., South Wilbur Flood Area, Kern Fan Element Water Bank), reservoirs, and agricultural lands flooded by spring runoff after winters with exceptionally high precipitation.

Black Terns

In recent decades, the vast majority of Black Terns nesting in the Central Valley do so in cultivated rice fields (Shuford et al. 2001). In 2010, there were 225,815 ha of planted rice in the Central Valley: 222,473 ha (98.5%) in the Sacramento Valley and 5342 ha (2.4%) in the Delta and northern San Joaquin Valley. In contrast to its positive relationship with the extent of wetlands in northeastern California, near-term precipitation appears to have little effect on the amount of rice planted in the Sacramento Valley. The 222,000 ha of rice planted in 2010, when precipitation in the Sacramento Drainage division in the previous winter was about average following three years of drought, compares to about 187,000 ha planted at the time of the last comprehensive survey in 1998, when precipitation in the previous winter was very high following three years also above the long-term mean (Figure 1).

In the Sacramento Valley, we sampled Black Terns using the roadside survey methods described in detail by Shuford et al. (2001). Khara Strum coordinated and conducted these surveys with extensive assistance from Rob Doster (USFWS) and two other skilled volunteers. Observers covered multiple survey routes of varying lengths in Glenn, Colusa, Butte, Sutter, Yuba, Yolo, Placer, and Sacramento counties from 27 May to 12 June 2010. They counted terns, and kept track of the amount of rice acreage, within a census zone 0.1-mi (160-m) wide on each side of the road.

Kristin Sesser and Dan Skalos compiled these data and determined the mean density of terns per 100 hectares for each county (or grouping of counties) by calculating the mean density for all of the county’s routes weighted by habitat miles, i.e., the total number of miles of suitable habitat covered with both sides of the road tallied separately. They estimated the total number of breeding terns in each county by multiplying tern density per county times the number of hectares of planted rice per county (www.nass.usda.gov/Statistics_by_State/California/ Publications/County_Estimates/index.asp), adjusted by a correction factor of 0.93, the estimated proportion of rice planted at the time of our surveys (see Shuford et al. 2001 for additional details). As we also did in 1998, we estimated the number of *breeding pairs* in Sacramento Valley rice fields equals the estimate of the total number of breeding terns (derived from density data) divided by 1.27, the mean ratio of undisturbed adult counts to nests obtained in low-stature wetlands in northeastern California in 1997 (see Shuford et al. 2001).

Planting of rice was delayed in the Sacramento Valley in 2010 because of the cool and wet spring. The 20.7 cm of precipitation in the Sacramento Drainage Division in Apr–May 2010 was 183% of the long-term mean for that period; Apr–May temperatures were 4.08°F (2.27°C) cooler than the long-term mean (n = 116 yrs) for that region (www.wrcc.dri.edu/divisional.html). From weekly agricultural reports, we estimated that 93% of the rice was planted by the time of our surveys in 2010 (80% planted by 23 May, 90% by 30 May, 93% by 6 June, 97% by 13 June; U.S. Dept. Agric./National Agric. Statistics Service). Likewise, unseasonably cool weather slowed emergence and growth of the crop by about a week over normal (15% emerged by 23 May, 40% by 30 May, 55% by 6 June, 70% by 13 June; USDA/NASS Weekly Weather and Crop Bulletins), so visibility of terns in rice was good at the time of surveys.

By contrast, the limited extent of rice cultivation in the Delta and northern San Joaquin Valley enables comprehensive surveys of potential nesting habitat for Black Terns. On 5 days from 17–25 June 2010, Joan Humphrey surveyed the 647, 2590, 1012, and 1093 ha of planted rice in Stanislaus, San Joaquin, Merced, and Fresno counties, respectively (County Agricultural Commissioner reports), and counted mainly visible undisturbed adults. Although the potential to damage crops precluded entering fields, in a few instances she did obtain counts of total nests or total disturbed adults when looking into fields from adjacent levees. Hence, we estimated numbers of pairs of Black Terns in these counties by the three methods outlined above for northeastern California, using the correction factors derived in the latter region in 1997 (see Shuford et al. 2001 for details).

SACRAMENTO VALLEY AND DELTA: 2011

Precipitation in this region in the winter of 2010–11, preceding the 2011 breeding season, was well above average, but was preceded by a winter of average precipitation following three very dry winters (Figure 1). Precipitation totals for the climate year (1 July–30 June) in 2006–07, 2007–08, 2008–09, 2009–10, and 2010–11 were, respectively, 57.4, 66.7, 72.7, 90.6, and 115.0 cm in the Sacramento Drainage division, representing, respectively, 64%, 75%, 82%, 102%, and 129% of the long-term average (n = 119 yrs) for that region (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html).

Cormorants, Herons, Egrets, Night-Herons

In 2011, we searched this region for colonies of herons, egrets, night-herons, and cormorants using a combination of aerial, ground, and (limited) boat surveys. Although most potential habitat was on the floor of these portions of the Central Valley, we also looked for colonies along rivers, creeks, wetlands, ponds, and reservoirs in the Sierra Nevada foothills on the east and in east-flowing drainages of the Coast Ranges to the west.

Aerial surveys. We used aerial surveys extensively in this region because of its relatively large size and the great amount of potential nesting habitat. The aerial surveys were particularly valuable in locating new colonies and viewing ones in inaccessible areas. We conducted day-long flights in a Cessna 185 to search for colonies in the Sacramento Valley on 5 May, 6 May, and 3 June and in the Delta on 13 and 19 May, departing from and returning to Sacramento Executive Airport on all dates. We used GPS units to record our flight path and the location of individual colonies. Two observers looked for colonies: one in the front (next to the pilot) looking out the right side of the plane, the second in the back looking mainly out of the left side of the plane but also sliding over to look out the right side as needed. After spotting a colony, we circled it at least once, but often multiple times, until both observers judged that we had gotten the best estimate of the number of nests of each species present.

Because the target species were mainly tree, and occasionally marsh, nesters, we focused aerial surveys on key riparian and marsh areas, including major rivers and creeks, tree-lined bypasses and drainage canals, Delta islands, and managed wetlands. Flights in the Sacramento Valley covered all or part of the following counties: Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Yuba, Placer, Yolo, and Sacramento (details in Appendix 1). Those in the Delta covered all or parts of Yolo, Sacramento, Solano, Contra Costa, San Joaquin, Amador, and Calaveras counties.

After locating colonies from the air and making rough estimates of nest numbers, we had hoped to revisit colonies on the ground soon thereafter to obtain more accurate counts. Staff (Shuford, Strum) and volunteers attempted such follow-up counts, but often this was not possible or yielded poor results. Obtaining access on the ground was particularly difficult in large stands of mature riparian forest along the Sacramento River. Many of these sites require access to or through private land. Generally more daunting, however, was the extreme difficulty of penetrating the dense, jungle-like vegetation or crossing sloughs to get close enough to colonies to attempt nest counts. Even when observers reached colonies on the periphery of riparian stands, they still sometimes could see only a small portion of the entire colony as many nests were concealed by intervening trees, vines, or other vegetation. On occasion all the ground observer could see was the odd heron or egret flying in and landing out of site in the vicinity of the colony coordinates obtained from the air. In the Delta, many colonies are on small islands in major rivers or channels between the large diked islands, but we were unable to launch follow-up boat surveys to attempt close-up counts of such colonies.

Although the accuracy of aerial surveys was limited by short observation times when in motion and by vegetation obscuring some nests from above, such surveys worked the best for Great Egrets and Great Blue Herons, which tend to nest in the open near the top of the canopy. Conversely, when it was possible to access colonies on the ground observers were better able to see nests of the smaller species (Snowy Egret, Cattle Egret, and Black-crowned Night-Heron), which tend to nest much lower in the canopy and, hence, can be difficult to see from a plane.

Ground surveys. Biologists from various refuges, wildlife areas, and preserves contributed nest numbers from ground counts on their properties, including various units of the Sacramento NWR Complex, Stone Lakes NWR, Gray Lodge WA, Cosumnes River Preserve, and SRCSD Bufferlands. Point Blue staff (Shuford, Strum) and volunteers also conducted ground counts at various colonies identified from the air, as described above, and other colonies with good access and visibility identified by other means. Chris Conard coordinated volunteers in Sacramento County and also spent several days searching for, or coordinating others to count, colonies in residential areas in the greater Sacramento area, including Rio Linda, South Natomas, Rosemont, and Elk Grove. Ed Whisler contributed colony data obtained by volunteers for the Yolo County Breeding Bird Atlas project. On 14 and 15 June, Shuford drove all roads in the west side of Interstate 5 from Rd. 25 near Orland south to, and including, the town of Williams to search for colonies in a gap of coverage on aerial surveys of the Sacramento Valley. For the same purpose, on 16 June, Jim Dunn and Nancy Sage searched for colonies in an area bounded by Hahn and Grimes-Arbuckle roads (N), Hwy 45 (E), Yolo County Line Rd. (S), and Interstate 5 (W); to the west, they covered a much smaller area bounded by Hahn Rd. (N), Cortina School Rd. (W), Hillgate Rd. (S), and I-5 (E).

Boat surveys. There were just a few colony counts from water craft, including some on the upper Sacramento River by power boat, on Clear Lake by canoe, and in the Delta by kayak.

Reconciling counts. When observers did get counts from both the air and the ground (or boat), the author had to make a subjective assessment to reconcile the numbers, as it was not always clear which was the most accurate. Sometimes a judgment was made that one survey method provided the best estimate for one species, the other method for another species.

NORTHERN AND CENTRAL COAST: 2011

This area varies from the highly developed counties around San Francisco Bay, with its extensive wetland habitats, to the generally sparsely populated counties to the north and south, where the land generally rises steeply from the sea to coastal hills and mountains punctuated with occasional estuaries and river mouths. Preceding the 2011 breeding season, precipitation in this region in the winter of 2010–11 was well above average in contrast to the prior winter of slightly above average precipitation following three very dry winters (Figure 2). Precipitation totals for the climate year (1 July–30 June) in 2006–07, 2007–08, 2008–09, 2009–10, and 2010–11 were, respectively, 94.9, 103.0, 88.0, 125.6, and 141.0 cm in the North Coast Drainage division and 27.9, 44.0, 39.3, 64.6, and 69.7 cm in the Central Coast Drainage division (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html). These precipitation totals represent, respectively, 77%, 84%, 71%, 102%, and 114% of the long-term average (n = 119 yrs) for North Coast division and 53%, 83%, 74%, 122%, and 132% for the Central Coast division.

Cormorants, Herons, Egrets, Night-Herons

Target species in this region were mainly cormorants, herons, egrets, and night-herons given the overall 11-state project did not include gulls, terns, and skimmers nesting in coastal estuaries given these had been surveyed by another project in 2006 and 2007.

Work in the coastal region in 2011 was coordinated by John Kelly and Emiko Condeso of Audubon Canyon Ranch. The bulk of the data they contributed was from the large number of colonies monitored annually by volunteers in the San Francisco Bay Area in collaboration with San Francisco Bay Bird Observatory (see Kelly et al. 2006). The latter project covers all or most of Marin, Sonoma, Napa, Solano, western Contra Costa, western Alameda, San Francisco, San Mateo, and Santa Clara counties (map, p. 2 in Kelly et al. 2006). At the colonies monitored annually in the San Francisco Bay Area, volunteers visit them multiple times during the nesting season; data contributed to this project in 2011 were for the highest counts of active nests (as defined above) during the season. Most surveys were ground counts, but some observers used boats to make counts at colonies on islands in San Francisco Bay or sites difficult to access otherwise in Suisun Marsh.

Outside of the Bay Area, John Sterling coordinated surveys, conducted mainly by volunteers, in Del Norte, Humboldt, Mendocino, Santa Cruz, San Benito, Monterey, and San Luis Obispo counties. Overall these areas are more sparsely populated by humans but have a much more limited extent of wetland habitat than in the Bay Area. Observers in these areas conducted counts on single dates from mid-May to mid-June. In addition, Shuford and Sterling conducted an aerial survey on 12 May to search for colonies along the Salinas River and vicinity in Monterey and San Luis Obispo counties. The region surveyed included the Salinas River, from the vicinity of its headwaters at Santa Margarita Lake, San Luis Obispo County, downstream to the Hwy 68 bridge near the town of Salinas, Monterey County, and San Antonio and Nacimiento reservoirs and their respective rivers downstream to the Salinas River (except portions of these tributaries within Camp Roberts Military Reservation). Observers did *not* attempt follow-up ground counts at the colonies located by plane.

SAN JOAQUIN VALLEY: 2012

Although drier than the Sacramento Valley and Delta, the San Joaquin Valley is also dominated by agriculture with nesting and foraging habitat for waterbirds mainly at managed wetlands, along rivers and streams, and at water recharge basins, reservoirs, or other water bodies. The 2012 breeding season in this region was preceded by a very dry winter in 2011–12; drought conditions since 2006–07 had been broken only temporarily in 2010–11 (Figure 1). Precipitation totals for the climate year (1 July–30 June) in 2006–07, 2007–08, 2008–09, 2009–10, 2010–11, and 2011–12 were, respectively, 28.1, 37.8, 40.1, 55.0, 74.3, and 33.3 cm in the San Joaquin Drainage division, representing, respectively, 55%, 75%, 79%, 109%, 147%, and 66% of the long-term average (n = 119 yrs) for that region (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html).

Cormorants, Herons, Egrets, Night-Herons

The methods used to locate and count colonies are the same as those described above for the Sacramento Valley and Delta in 2011. As in those regions, aerial surveys were very important for locating and counting colonies in the San Joaquin Valley in 2012. We conducted four day-long flights in a Cessna 185. Surveys on 8 May and 9 May originated and returned to Fresno-Yosemite International Airport and covered suitable portions of Fresno, Kings, Tulare, and Kern counties (details in Appendix 1). Flights on 15 and 16 May originated and returned to the Sacramento Executive Airport and covered all or portions of Stanislaus, Merced, Tuolumne, Mariposa, and Madera counties.

Point Blue staff (Gilbert, Gregory, Shuford) and volunteers also attempted to access and count colonies on the ground that we located by plane and to survey additional wading bird colonies based on collaborator leads. The most extensive of such surveys were conducted by Shuford from 10–21 May, when he also searched for other nesting species, such as grebes and terns, that can be difficult to document on aerial surveys or may nest in habitats or sites not targeted for aerial coverage. Dennis Wollington kindly shared data from ongoing monitoring of multiple wading bird colonies scattered over various units of the San Luis NWR Complex in Merced and Stanislaus counties.

Eared Grebes and Terns

We asked staff and volunteers conducting ground surveys of wading birds to be on the lookout for potential nesting habitat for grebes and terns. We also kept an eye out for such habitat on aerial flights, but with the dry preceding winter we found little of it. In addition, Shuford spent from 24–27 June surveying for nesting grebes and terns in all accessible shallow-water habitat that seemed suitable in Fresno, Kings, Tulare, and Kern counties. This included many sites previously searched in May, knowing these species can nest over a protracted period, and various duck clubs in the Tulare Basin with summer water. Areas searched by staff and volunteers included the sites where Caspian, Black, and Forster's terns had nested in this region during prior broad-scale surveys in the late 1990s (Shuford 2010).

SOUTHERN COAST: 2012

The study area for the coastal slope of southern California included the coastal plain, interior valleys, and some montane valleys or depressions, all draining westward to the Pacific Ocean. This region, much of which is highly developed, encompassed southern Santa Barbara, southern Ventura, southern Los Angeles, Orange, western Riverside, southwestern San Bernardino, and western San Diego counties. The primary target species for surveys in this area were the species of herons, egrets, night-herons, and cormorants surveyed in northern California. Observers also obtained some data for a few inland colonies of terns and skimmers and for some other rarer species of wading birds.

The 2012 breeding season in this region was preceded by a very dry winter in 2011–12, preceded by two winters of above average precipitation after three very dry ones starting in

2006–07 (Figure 3). Precipitation totals for the climate year (1 July–30 June) in 2006–07, 2007–08, 2008–09, 2009–10, 2010–11, and 2011–12 were, respectively, 13.8, 39.6, 30.8, 51.4, 63.0, and 29.0 cm in the South Coast Drainage division, representing, respectively, 31%, 89%, 69%, 115%, 141%, and 65% of the long-term average (n = 119 yrs) for that region (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html).

Dan Cooper conducted and coordinated counts at colonies based on known potential nesting areas in coastal southern California compiled from published and gray literature and by soliciting local and regional experts. The primary field technicians who conducted surveys were Kim Oldehoeft (L.A./Orange Co.), Julie Szabo (Riverside Co.), Matt Whitmire (L.A. Co.) and Francesca Zern (San Diego Co.). Volunteers covered a smaller number of sites.

Cormorants, Herons, Egrets, Night-Herons

As elsewhere, observers tried to obtain the best estimate of the number of active nests/nesting pairs for each species present. This region had many mixed-species colonies dominated by Black-crowned Night-Herons and Snowy Egrets and a relatively high proportion of guano-stained nests that could not be assigned to a particular species.

Terns and Skimmers

Counts of terns and skimmers were rough estimates because of the difficulty of seeing nests of these species on islands with obscuring vegetation, and a desire not to disturb nesting birds by walking on the islands.

SALTON SEA AND IMPERIAL VALLEY: 2012

The Salton Sea, in Imperial and Riverside counties, is a large saline water body formed in the early 1900s when floodwaters of the Colorado River overwhelmed water diversion infrastructure and waters flowed unconstrained into the Salton Sink for over a year. Water currently flowing into the Salton Sea comes mainly from tailwater from the extensive irrigated fields in the adjacent Imperial Valley to the south. Lake levels are currently in a trajectory of steady decline. Additional waterbird habitat occurs in wetlands impoundments of the Sony Bono Salton Sea NWR and the Wister Unit of Imperial WA adjacent to the south end of the Salton and at the Finney-Ramer Unit of Imperial WA in the Imperial Valley; ardeids also sometimes nest in eucalyptus or other large trees in that valley.

Along with the goal of the broader 11-state project, surveys of colonial waterbirds at the Salton Sea and Imperial Valley in 2012 aimed to provide current estimates of the size and location of nesting colonies to enable comparisons to prior comprehensive surveys in this region in 1999 (Shuford et al. 2000, Molina 2004, Molina and Sturm 2004, Molina and Shuford 2013). Observers used a combination of aerial, airboat, and ground surveys to document the location and abundance of colonies of waterbirds at the Salton Sea and Imperial Valley in 2012. Besides surveying these target species of the Western Colonial Waterbird Survey known to breed regularly or irregularly in the Salton Sea–Imperial Valley area—the Double-crested Cormorant, Great Blue Heron, Great Egret, Snowy Egret, Cattle Egret, Black-crowned Night-Heron, White-faced Ibis, California Gull, Caspian Tern, and Forster's Tern—we also surveyed for additional species that nest regularly—Gull-billed Tern (*Gelochelidon nilotica*) and Black Skimmer (*Rynchops niger*)—or irregularly—Laughing Gull (*Leucophaeus atricilla*)—at the Salton Sea but are primarily coastal breeding species that are at or near the northern edge of their breeding range at the Salton Sea. We did not find evidence of nesting at the Salton Sea in 2012 for the Forster's Tern or Laughing Gull and, hence, they are not discussed further for this region.

The 2012 breeding season in this region was preceded by a very dry winter in 2011–12, preceded by two winters of above average precipitation after three very dry ones starting in 2006–07 (Figure 3). Precipitation totals for the climate year (1 July–30 June) in 2006–07, 2007–08, 2008–09, 2009–10, 2010–11, and 2011–12 were, respectively, 5.2, 13.3, 12.6, 18.3, 17.6, and 9.6 cm in the Southeast Desert Basins division, representing, respectively, 33%, 85%, 81%, 117%, 113%, and 61% of the long-term average (n = 119 yrs) for that region (Western Regional Climate Center; www.wrcc.dri.edu/divisional.html).

Cormorants, Herons, Egrets, Night-Herons

Aerial surveys. From a twin-engine Partenavia aircraft, Shuford took digital photographs of the Double-crested Cormorant colony on Mullet Island at the south end of the Salton Sea on 15 February and 14 March 2012 using the same equipment and flight strategy as reported above for colonies at Clear Lake NWR, Modoc County.

Because visual observations and overview photos clearly showed much higher numbers of nesting cormorants in February than in March, we used the February photos to make the best estimate of the number of cormorant nests on Mullet Island in 2012. After Shuford did a preliminary sort of the full set of photos, Molina tallied the numbers of active cormorant and Great Blue Heron nests on Mullet Island from a smaller set of the February photos. She first reviewed over 200 images and from these selected a subset of overlapping images and pieced them together to form a panoramic composite of the entire island. Using the zoom capability of the program Photoshop, each active nest was marked with a red dot (cormorant) or a green one (heron). The marked images were then "gridded" to facilitate an accurate visual counting of nests. We estimated the total number of pairs of cormorants as the number of active nests (those with incubating or brooding adults, eggs, or chicks). The presence of nest material was used as a criterion to confirm an active nest in cases where it otherwise was unclear if a bird was sitting on a nest. Given some nests were likely missed because they were obscured on images by shadows cast by large rocks, our estimate of the total number of nests is likely conservative.

On 15 February and 14 March, Shuford also did reconnaissance flights elsewhere on the Salton Sea to look for other large colonies. On the former date the flight covered the entire shoreline of the Salton Sea, on the latter just the south end of the sea and particularly the deltas of the Alamo and New rivers. Prior to conducting airboat and ground-based surveys (see below), Molina likewise conducted aerial reconnaissance surveys on 15 March and 10 May 2012. These covered the entire shoreline of the Salton Sea, adjacent wetlands on the Wister Unit of Imperial WA and the Salton Sea NWR (Hazard Unit, Union Tract, Unit 1), and the Finney and Ramer units of Imperial WA in the Imperial Valley. These surveys were to look for the establishment of large colonies around the sea, to identify colonies that otherwise might not have been seen from airboats on the Salton Sea looking toward the shore (or were farther afield in the Imperial Valley), and to assess conditions around the sea that may have changed since the most recent aerial reconnaissance or airboat surveys.

Airboat surveys. Molina partnered with staff from the Salton Sea NWR to conduct airboat surveys for colonies on the Salton Sea. Airboat surveys included all potential habitat on the entire south end of the Salton Sea on 23 March 2012 and the entire north end of the sea on 30 March. An additional airboat survey on 4 June at the south end of the sea focused mainly on the mouths and deltas of the New and Alamo rivers, where some large colonies had formed in the past. Because the 10 May aerial reconnaissance found no suitable wetland habitat and a lack of nesting activity by herons, egrets, and cormorants at the north end of the sea, it was deemed unnecessary to conduct a follow-up airboat survey at the north end in June as was done at the south end.

Ground-based surveys. Away from the Salton Sea shoreline, Molina drove to sites in the Imperial Valley to conduct ground-based surveys at sites where colonies were known to be active in 2012 (Wister Unit, Ramer Lake), had been active in the past (Dogwood and Harris tamarisk grove, Westmorland eucalyptus grove, Finney Lake), or seemed to have a high potential for colonies (Fig Lagoon). Surveys were conducted on 29 March and 5 June 2012 at all sites, with the exception that Finney Lake was surveyed on the ground only in March, because of a lack of nesting activity during both aerial flights, and Fig Lagoon just once on 20 April, when no suitable habitat was found. No attempt was made to survey other potential nesting habitat along major drains or in large stands of planted trees in the agricultural matrix of the Imperial Valley. If any colonies were missed in this region, it seems likely they would have been small given the conspicuousness of large colonies. In addition, Molina surveyed for colonies in Morton Bay at the southeast end of the Salton Sea from adjacent levees on 30 March and 6 June.

Gulls, Terns, Skimmers

To complete the picture, Molina also contributed data on the size and location of larid colonies at the Salton Sea from her annual monitoring of their status and reproductive success. Nesting numbers reported here for 2012 are the highest single-day count from over 10 visits to each larid colony across the breeding season.

LOWER COLORADO RIVER, MOJAVE RIVER, AND OWENS RIVER VALLEYS: 2012

As detailed above for the Salton Sea, the 2012 breeding season in the southern California deserts was preceded by a very dry winter in 2011–12, preceded by two winters of above average precipitation after three dry ones starting in 2006–07 (Figure 3).

Cormorants, Herons, Egrets, Night-Herons

On 14 March, after a survey at the Salton Sea, Shuford conducted an aerial survey to search for colonies of herons, egrets, and cormorants along the California side of the lower Colorado River from the Arizona border just north of Yuma north to the Nevada border just north of Needles, California. The pilot oriented the plane so that Shuford, the sole observer, could look out the right side of the plane at the main riparian corridor along the river as we traveled north. The pilot also circled back to make additional passes over wider stretches of riparian or wetlands or those further back from the river. After completing the survey along the Colorado River, we flew west and picked up the Mojave River near Baker and flew its length from there west and south to the base of the San Bernardino Mountains near Hesperia. Again, the pilot made additional passes to ensure coverage of wider areas of riparian vegetation or ponds or reservoirs back from the river. We then returned to Hemet where the flight originated.

On 18 April, Shuford left Fresno on a flight that traversed the Sierra going up the San Joaquin River drainage and crossing the crest near Mammoth Lakes. We then headed south to Bishop, where we picked up Kristie Nelson. We then surveyed most of the length of the Owens River within Inyo County from Pleasants Valley Reservoir on the north to Little Lake on the south, searching for colonies of the Great Blue Heron, the only tree nester known to breed regularly in that area. Shuford looked out of the right side of the plane, Nelson out of the left. Besides flying the main riparian corridor of the Owens River, we also diverted to make additional passes where the riparian vegetation widened and to cover areas where stands of large cottonwoods were surrounded by irrigated pastures (e.g., Round Valley). After reaching Little Lake on the south, we reversed course and flew more on the west side of the valley to cover any areas we missed on the way south. After dropping off Nelson at Bishop, we crossed the Sierra and followed the Kings River drainage back to Fresno.

On these flights we used the same methods for locating and counting colonies as we did on flights in the Central Valley, with the exception that Shuford took photographs of one heron colony near Independence in the Owens Valley from which he later counted nests.

In the Owens Valley and along the upper Mojave River, volunteers counted heron nests at some colonies they had located previously and some after we located them from the air; counts varied from one date to multiple dates across the nesting season. In addition, Chris McCreedy spent a long day on 31 May searching for wading bird colonies in the Palo Verde Valley near Blythe, the largest extent of irrigated agriculture on the California side of the lower Colorado River, covering about one half of that area and locating two small colonies. This complemented the aerial survey of the Colorado River, which did not locate any colonies.

KLAMATH RIVER COUNTRY: 2012

Herons

On the basis of colony location data from Bob Claypole, California Natural Diversity Database (some quite dated), and John Hunter, Shuford searched for heron colonies from 27 May to 2 June in Shasta, (mainly) western Siskiyou, and northern Humboldt counties. The Shasta County area surveyed was the McCloud River arm of Lake Shasta, including a recently reported colony at Turntable Bay and all stretches of the main arm and side bays that were visible from access points along adjacent Forest Service roads, and a couple sites off Hwy. 299 (one west of Burney, the other including Hat Creek and the Pit River upstream of Lake Britton). In Siskiyou

County, Shuford checked a colony site near the Mt. Shasta Fish Hatchery; portions of the Shasta River visible from N. Old Stage Rd., Edgewood Rd., Slough Rd., Louie Rd., Big Springs Rd., and Jackson Ranch Rd.; stretches of the Klamath River (including specific former colony sites) accessible from Hwy. 96 (and some side roads parallel to the river) from Interstate 5 on the east going west and south to Somes Bar; the main stem and north fork of the Salmon River from Somes Bar to Etna; and the Scott River and its forks and tributaries as viewed from major roads on the edge of and across the Scott Valley. In Humboldt County, Shuford searched limited accessible portions of the Klamath River from just south of Somes Bar to Weitchpec, and of the Trinity River from Weitchpec south to Willow Creek. In addition, on 21 May, John Hunter checked three sites in Trinity County with prior colony reports: Salyer Fire Station, Lewiston Fish Hatchery, and Trinity Lake.

The Klamath, Trinity, and Salmon rivers were particularly hard to survey and consequently we likely missed some small heron colonies in this region. River access is limited along major roads because of the generally steep sides of these river canyons, but even with decent access it is difficult to pick out small heron colonies against the continuous conifer cover on most of the canyon slopes. Aerial surveys likely would not be feasible in the future because of the need to maintain high flight elevations for safety's sake in the narrow, windy river canyons. The best bet for future surveys likely would be to do so from a river raft.

WHITE-FACED IBIS: 2010–2012

Rob Doster compiled data on ibis colonies beyond those surveyed in northeastern California in 2009–2010. This included colonies in the Central Valley from 2010–2012 and on the coastal slope of southern California in 2011–2012. At large colonies, survey methods ranged from dawn flyout counts (Natomas Conservancy, Mendota WA, Toledo Pit) to rough estimates from daytime counts of visible adults, and at small colonies included counts of adults or nests.

DATA SUMMARY AND PRESENTATION

For the 13 most widespread and numerous of the 15 target breeding species, data were summarized in tables and text by geographic regions of California and mapped for all or portions of the state. For the other two target species (American White Pelican, Franklin's Gull), data were included in the text but not in tables; maps were generated for the pelican (two colonies), but not for the gull because of inconclusive evidence of nesting in the Klamath Basin.

ECOREGIONS

For summarizing geographic patterns of colony occurrence, the author chose to primarily use the geographic subdivisions of California from the Jepson manual (Hickman et al. 1993), hereafter referred to as ecoregions. The Jepson system is hierarchical with three floristic provinces divided into a total of 10 regions and 23 subregions. The California Floristic Province, the largest, encompasses six regions: Northwestern California (NW), Cascade Ranges (CaR), Sierra Nevada (SN), Great Central Valley (GV), Central Western California (CW), and Southwestern California (SW). The Great Basin Province includes the Modoc Plateau (MP) and East of Sierra Nevada (SNE) regions and the Desert Province the Mojave Desert (DMoj) and Sonoran Desert (DSon) regions. Colony data are generally summarized by 11 ecoregions of California, 9 of which are Jepson regions and 2 are the Sacramento Valley (ScV) and San Joaquin Valley (SnJV) subregions of the Jepson's Great Central Valley region (Figure 4).

CENTRAL VALLEY JOINT VENTURE REGIONS

When applicable, tables also show colony occurrence with respect to the subregions of the Central Valley used by the Central Valley Joint Venture (CVJV 2006). The primary CVJV subdivisions are the Sacramento Valley (SV; includes the Colusa, Butte, Sutter, American, and Yolo basins), Suisun Marsh (SM), Delta (DE), San Joaquin Basin (SJB), and Tulare Basin (TB) (Figure 5). The CVJV considers the latter two to be subdivisions of the San Joaquin Valley. Data are not summarized in the text by CVJV subregions, but the tabular data by subregions should be useful in revising the waterbird chapter in the update of the CVJV implementation plan currently in progress.

Some confusion is possible when using the Jepson and CVJV systems in tandem. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley. Mismatches between the two classifications are noted in footnotes to tables, but generally should be of limited concern given the text discusses patterns of distribution only within the context of the Jepson ecoregions.

Mapping

Dennis Jongsomjit created maps for individual species showing the distribution and relative size of colonies in California in 2009–2012 using ArcMap Version 9.3.1 (© 1999–2009 ESRI Inc.); values for categories of relative abundance were based on natural breaks in the data. He also recreated maps that originally appeared in Shuford (2010) for the 7 waterbirds species also included in statewide surveys in the period 1997–1999. These enabled comparisons of the distribution of colonies between 1997–1999 and 2009–2012 when survey data are available for both periods.

RESULTS

From 2009–2012, we documented the distribution and relative abundance of 15 species of colonial nesting waterbirds in California as part of the 11-state inventory of the Western Colonial Waterbird Survey. We also gathered limited information on the status of 5 additional species of colonial waterbirds that are not part of the broader 11-state survey because of their very low abundance and limited distribution in the interior West. The following accounts summarize the status of these 20 species in the state during our 4-year survey period and compared the status to that during 1997–1999 for the 7 species that were surveyed statewide in both periods.

Eared Grebe

Surveys in (mostly) 2010 and 2012, estimated about 11,327 pairs of Eared Grebes were nesting in California, primarily in the northeastern part of the state (Tables 1 and 2; Figure 6). About 70% of these were in the Modoc Plateau ecoregion, mainly at Tule Lake and Lower Klamath NWRs, Siskiyou County. Substantial numbers were also at Eagle Lake, Lassen County, near the edge of the adjacent Cascade Ranges ecoregion, and at Bridgeport and Crowley Lake reservoirs, Mono County, in the East of the Sierra Nevada ecoregion.

Double-crested Cormorant

An estimated 8791 breeding pairs of Double-crested Cormorants in the interior of the state in 2009–2012 exceeded the total of 6975 pairs on a comparable survey in 2009 (Table 3). In 2009–2012, cormorants were breeding in all but 2 of the 11 California ecoregions, but numbers were highly concentrated with 75% of the total pairs at one site—Mullet Island, Imperial County, at the south end of the Salton Sea in the Sonoran Desert ecoregion (79% of statewide total;

Tables 1 and 3). The ecoregions with the next highest proportions were the Sacramento Valley and San Joaquin Valley with about 8% and 6% of the total, respectively. Somewhat better observer coverage on the recent surveys probably accounts for some of the increase in numbers and colony locations since 1999 (see Figures 7 and 8), but the species appears to be continuing to increase as a breeder in the interior of the state (Table 3) as it has throughout western North America as a whole (Adkins et al. 2014). The colony at Mullet Island at the Salton Sea has been the second largest colony in western North America since at least the late 1990s, exceeded in size by only one coastal colony, East Sand Island at the mouth of the Columbia River, Oregon. In fact, the 6594 pairs at Mullet Island in 2012 was equivalent to about 21% of the approximately 31,200 pairs estimated for all of western North America for 2009 (Adkins et al. 2014). Unfortunately, the Mullet Island colony is no longer active, as cormorants did not breed there in 2013 and 2014. An ongoing decline in water levels has enabled land predators to easily reach the island, which has discouraged cormorant nesting (T. Anderson/Salton Sea NWR pers. comm.).

AMERICAN WHITE PELICAN

In 2009, there were about 3104 pairs of nesting pelicans at 2 sites in the Klamath Basin within the Modoc Plateau ecoregion of California: 2918 pairs on the Rocky Islets in the east lobe of Clear Lake NWR, Modoc County, and 186 pairs at Sheepy Lake on Lower Klamath NWR, Siskiyou County (Figure 9). These nesting sites are the only ones currently that are consistently occupied by pelicans in both the California portion of the Klamath Basin and in California as a whole (Shuford 2005, Shuford et al. 2006; Figures 9 and 10). The total of 3104 pairs of nesting pelicans for these two California sites combined in 2009 compares with 631 pairs (614, Clear Lake; 17, Sheepy Lake) in 2003 and 2592 pairs (2190, Clear Lake; 402, Sheepy Lake) in 2004, the most recent years for which comparable detailed photographic surveys are available (Shuford et al. 2006). The totals for 2004 and 2009 are near the high end and that in 2003 is near the low end of counts from prior years. The below normal number of nesting pelicans in the Klamath Basin in 2003 likely reflected both nest abandonment during a stormy spring and a reduction of the number and extent of nesting islands at Clear Lake in response to low water levels (Shuford et al. 2006).

GREAT BLUE HERON

An estimated 5517 pairs of Great Blue Herons were breeding in California in 2009–2012. Although not the most numerous, the Great Blue Heron was the most widespread colonial waterbird species in the state, occurring in all 11 ecoregions and occupying more breeding colony sites than any other species (Tables 1 and 4; Figure 11–13). Colonies were particularly concentrated in the Sacramento Valley and San Joaquin Valley ecoregions, which combined accounted for about 54% of total breeding pairs about equally split between them (Table 1). These herons were also numerous in the three ecoregions along the immediate coast and in the Sonoran Desert ecoregion, primarily at the Salton Sea. Colonies were located mainly in stands of tall tree in close proximity to coastal estuaries, large inland water bodies, and along major rivers and creeks adjacent to rice fields, other flooded-irrigated forage crops, or wetlands. In the Central Valley, colony size tended to become smaller toward the periphery of the valley and in the adjacent foothills. A zoomed-in view of the Sacramento Valley and northern San Joaquin Valley ecoregions shows the close association of colonies with major rivers (Figure 12). The Salton Sea held some of the largest colonies in southern California (Table 4, Figure 13).

GREAT EGRET

Surveys estimated a total of about 7973 breeding pairs of Great Egrets in California in 2009–2012. Great Egret colonies occurred in 9 of 11 ecoregions, being absent only in the East of the Sierra and Mojave Desert ecoregions (Table 5, Figure 14). Otherwise the overall distribution of the Great Egret was fairly similar to that of the Great Blue Heron. The Great Egret, however, occurred in fewer and generally larger colonies than the Great Blue Heron and also was more concentrated in some ecoregions and sparser in others than the heron (cf. Figures 11–13 with 14–15). Great Egrets were particularly concentrated in the Sacramento Valley and San Joaquin Valley ecoregions, which held 56% and 19%, respectively, of the statewide total of estimated breeding pairs (Table 1 and 5). Great Egrets frequently bred in the same colonies with Great Blue Herons, and the two species' nesting and foraging habitats, as described above for the heron, overlapped substantially. The particularly high concentration of Great Egrets in the Sacramento Valley may reflect high use of the extensive acreage of rice in that region for foraging. Roadside surveys across the Sacramento Valley in the late May and early June 2012 found densities of Great Egrets were higher than those of Great Blue Herons in flooded wetlands, alfalfa, rice, and irrigated pasture (Point Blue unpubl. data).

SNOWY EGRET

Surveys estimated about 1888 pairs of Snowy Egrets were nesting in California in 2009–2012. This estimate is probably low, as at several sites where surveys were conducted late in the season it was not possible to distinguish used, guano-stained nests of the Snowy Egret from those of the Black-crowned Night-Heron or Cattle Egret. Similarly, at one site there were large numbers of small white egrets on nests within dense tamarisk that could not be distinguished to species during an aerial survey. Still, Snowy Egret colonies occurred in 8 of 11 ecoregions, being absent only in the Cascade Ranges, East of the Sierra, and Mojave Desert ecoregions (Table 6, Figure 16). Colonies and numbers of Snowy Egrets were most prevalent in the San Francisco Bay area of the Central Western California ecoregion, the Sacramento Valley ecoregion, and the Southwestern California ecoregion (Table 6, Figures 16–17). The smaller ardeid species—the Snowy Egret, Cattle Egret, and Black-crowned Night-Heron—frequently established mixed colonies in trees in residential neighborhoods, parks, or other human-dominated environments, but also in some remote locations in the lower strata of trees where Great Blue Herons and Great Egrets were nesting.

CATTLE EGRET

Surveys estimated that about 2678 pairs of Cattle Egrets were breeding in California in 2009–2012. Cattle Egrets colonies occurred in only 5 of 11 California ecoregions, but the vast majority of egrets were in just 3 ecoregions (Table 1 and 7, Figure 18). The Sonoran Desert, San Joaquin Valley, and Sacramento Valley ecoregions held 64%, 17%, and 14% of the statewide total, respectively. In the Sonoran Desert, most of the egrets were at a single colony in the Imperial Valley (Ramer Lake on the Finney-Ramer Unit of Imperial WA) with smaller numbers at two sites at the Salton Sea. For unknown reasons, the total for the Imperial Valley/Salton Sea in 2012 was only 25% of the total in 1999 when the last survey was conducted in the area (Shuford et al. 2000, Molina and Sturm 2004, Molina and Shuford 2013). Away from the Imperial Valley/Salton Sea, most Cattle Egrets nested in mixed-species colonies (mainly with Snowy Egrets and night-herons) in ornamental trees close to human habitation.

BLACK-CROWNED NIGHT-HERON

Surveys estimated that about 2443 pairs of Black-crowned Night-Herons were nesting in California in 2009–2012. These night-herons were breeding in 9 of 11 California ecoregions, but 90% were split among the three ecoregions along the coast and the two in the Central Valley (Tables 1 and 8, Figure 19). Of these, the Sacramento Valley ecoregion held the greatest proportion at 36% of the statewide total. Although many night-herons were nesting in mixed-species colonies with small egrets species in ornamental trees close to human habitation, many others were nesting in native trees in more isolated settings in mixed-species colonies that also included Great Blue Herons and Great Egrets..

WHITE-FACED IBIS

Surveys estimated about 25,550 pairs of White-faced Ibis were nesting in California in 2009–2012, but this may be an under- or overestimate given that surveys were conducted over multiple years even in some ecoregions (Table 9). Nesting ibis occurred in 5 of 11 California ecoregions, but the bulk were in 3 of these (Tables 1 and 9, Figure 20). The San Joaquin Valley, Modoc Plateau, and Sacramento Valley ecoregions held 58%, 28%, and 12% of the statewide total, respectively. Estimates reached or exceeded 1000 pairs at 7 colonies, with the largest being 9620 pairs at the Toledo Pit, Tulare County (Table 9).

FRANKLIN'S GULL

Franklin's Gulls are known to have nested in the state only in northeastern California (summary in Shuford 2010). We did not document breeding by Franklin's Gulls in 2009 (or 2010) despite circumstantial evidence and a strong suspicion that they were nesting in marshes of Units 6A and 12C of Lower Klamath NWR and in Sump 1B of Tule Lake NWR (all in Modoc Plateau ecoregion) in association with egrets, night-herons, and ibis. These gulls flew out of tule clumps and circled boats during surveys of egrets and night-herons at Units 6A and 12C in mid-June 2009. Observers obtained counts of 30 adult Franklin's Gulls roosting on a small island in Unit 6A on 17 June; 39 adults in Unit 12C seen from adjacent roads on 12 June and about 30 flying out of tule clumps in Unit 12C on the approach of a boat on 17 June; and 234 and 305 adults roosting or foraging in Unit 12B on 12 and 17 June, respectively (P. Henderson, D. Mauser, D. Shuford pers. obs.). Unit 12B is immediately north of Unit 12C, but, unlike the latter, lacks suitable nesting substrate. Hence, we lack both documentation of nesting and an estimate of the number of pairs of nesting Franklin's Gulls in this region in 2009.

RING-BILLED GULL AND CALIFORNIA GULL

An estimated 6804 pairs of Ring-billed and 26,340 pairs of California Gulls were nesting in the interior of the state in 2009 (Table 10). An additional 23,443 pairs of California Gulls were nesting on the coast, almost exclusively in San Francisco Bay, in 2009. About 56% of the Ring-billed Gulls were in the Modoc Plateau ecoregion with the remainder roughly equally split between the adjacent Cascade Ranges and Sierra Nevada ecoregions (Tables 1 and 10, Figure 21). California Gulls nested in the interior of the state in five ecoregions, but because of the large size of the Mono Lake colony 92% of the interior nesting population was in the East of the Sierra ecoregion (Table 1, Figure 22).

Reduced water levels at lakes and reservoirs in 2009 had a substantial effect on both the numbers and distribution of nesting Ring-billed and California gulls in the interior of the state (cf. Figures 21 and 22 and Figures 23 and 24). In fact, the patterns of abundance and distribution in 2009 were outliers compared to those in the four years from 1994 to 1997 when prior broad-scale surveys were conducted in northeastern California (Table 10). In terms of abundance, the total of 6804 pairs of Ring-billed Gulls in 2009 represents only 54–66% of the totals in the three years when surveys of all key colonies were conducted. Likewise, the total of 2060 pairs of California Gulls in 2009 in the same area where Ring-billed Gulls nest (Plumas County northward) represents only 36–59% of the totals for that region in four years from 1994 to 1997.

With respect to distribution, of the five sites in this region that held >1000 pairs of gulls in any year from 1994–1997 only one—Clear Lake NWR—did so in 2009 (Table 10). Low water levels at Meiss Lake (Butte Valley WA), Goose Lake, Big Sage Reservoir, and Hartson Reservoir (Honey Lake WA) were so low that all potential nesting islands were connected to the shoreline. Conversely, in 2009 large gulls colonies were active at two sites—Dorris Reservoir on Modoc NWR and Lake Davis—that were unoccupied from 1994–1997. Similarly, Lake Shastina held at most about 350 pairs of gulls in previous years but over 2700 pairs in 2009. It seems likely that Dorris Reservoir may have absorbed gulls that might otherwise have nested relatively close by at either Goose Lake or Big Sage Reservoir, and the same may have been true for Lake Davis with respect to Honey Lake WA. Although water levels at Lake Shastina were also unusually low in 2009, again reflecting drought conditions, this increased rather than reduced its nesting potential. Because suitable nesting substrate is located in a deep portion of the reservoir, one island typically occupied by nesting gulls increased in size and another one that is usually just below the surface, and supports small numbers of nesting herons and cormorants in emergent trees, was further exposed in 2009 to allow gull nesting.

CASPIAN TERN

Surveys estimated 1221 pairs of Caspian Terns were nesting in the interior of California in 2009–2012: 1177 pairs at the Salton Sea in the Sonoran Desert ecoregion in 2012 and 44 pairs at Clear Lake NWR in the Modoc Plateau ecoregion in 2009 (Table 11, Figure 25). By contrast, an estimated 1762 pairs nested in 8 sites the interior (3 at the Salton Sea) in 1997 and about 794 pairs at 7 sites in 1999 (Figure 26), when site coverage was slightly better than in 1997. Also, several sites were active in the Tulare Basin in the southern San Joaquin Valley in 1998 that were not active in either 1997 or 1999. In all of these years, totals for the interior were greatly affected by numbers of nesting pairs at the Salton Sea (~1200 in 1997, ~800 in 1998, 211 in 1999). In 2011 there were about 1350 pairs of Caspian Terns in the interior of California: 1114 at 1 site at the Salton Sea and 236 pairs at 4 sites in the Klamath Basin (Collis et al. 2012). Of the 4 Klamath Basin sites, 3 were at sites where artificial islands were recently built (see below).

Similar to the case for gulls, with the exception of a small Caspian Tern colony at Clear Lake NWR (44 pairs) other traditional colonies in the Modoc Plateau ecoregion were inactive in 2009. At Meiss Lake (Butte Valley WA), Goose Lake, Big Sage Reservoir, and Hartson Reservoir (Honey Lake WA) drought conditions left water levels so low that all potential tern nesting islands were landbridged or otherwise accessible to ground predators. In combination with the Clear Lake colony, these Modoc Plateau colonies collectively held over 400 nesting pairs of Caspian Terns when all were surveyed in 1997 and 1999 (Shuford 2010). With the exception of limited nesting on islands at Clear Lake NWR in 2011 (12 pairs) and 2012 (~60 pairs), all the traditional Modoc Plateau colonies have been inactive from 2010 to 2013 (Bird Research Northwest annual reports; www.birdresearchnw.org/project-info/publications-&-reports/). There were no known active colonies in the San Joaquin Valley in this period as well (J. Seay pers. comm.).

These drought effects in the Modoc Plateau ecoregion have been offset to some degree by the creation of artificial islands at three sites in the California portion of the Klamath Basin NWR Complex (Sheepy Lake, Lower Klamath NWR; Orems Unit, Lower Klamath NWR; Sump 1-B, Tule Lake NWR). This is part of a much broader effort to redistribute terns from the largest Caspian Tern colony in North America at the Columbia River estuary, Oregon, where terns prey on juveniles of threatened and endangered salmonids, to other coastal and interior sites in the Pacific states (USFWS 2005, Collis et al. 2012). Terns were attracted to the newly created islands with decoys and tape playbacks of tern vocalizations, and efforts to maintain the tern populations included limited lethal control of gulls that prey on tern eggs and chicks (Bird Research Northwest annual reports; http://www.birdresearchnw.org/project-info/publications-&-reports/). The Orems Unit has had minimal use (2 pairs that failed in 2011) and was dry and inactive in 2012 and 2013 due to drought. Including 2010, when only the Sheepy Lake colony was active (258 pairs), numbers on the artificial islands have ranged from 224–419 pairs from 2010–2013. Nesting success has been poor in some years, with near or compete failure at the Sump 1-B site in the three years when terns attempted nesting. It remains to be seen if the artificial islands will increase the regional tern population of the Modoc Plateau once wet conditions return and islands again become available at other traditional breeding sites in the region.

BLACK TERN

Surveys estimated about 2029 pairs of Black Terns were breeding in California in 2010, which was only about 49% of the statewide total for surveys in 1997–1998 (Shuford et al. 2001). Numbers were lower in 2010 than in 1997–1998 for all breeding regions for the species in the state (Figures 27 and 28). The 1033 pairs for the Cascade Ranges, (northern) Sierra Nevada, and Modoc Plateau ecoregions combined represented only about 52% of the total for northeastern California in 1997 (Table 12). Drought conditions reduced the number, or size of, breeding sites, thereby greatly shrinking the available habitat in the region in 2010. The Modoc Plateau ecoregion accounted for 97% and 88% of the Black Terns breeding in northeastern California in 2010 and 1997, respectively.

From roadside surveys, we estimated that about 1198 (888–1508) adult terns, or about 943 (699–1187) pairs, bred in Sacramento Valley rice fields in 2010 (Table 13). This estimate of breeding pairs for 2010 was only about 47% of the number estimated for that region in 1998 (see Shuford et al. 2001). Highest densities in 2010 were in Yuba and Glenn counties versus in Colusa and Glenn counties in 1998 (Table 13). In the San Joaquin Valley, about 22 pairs bred at 1 site in rice fields southwest of the city of Merced, Merced County, and about 31 pairs bred at 6 scattered sites in rice fields in northern Fresno County southeast of the town of South Dos Palos, Merced County (USFWS database). The 53 pairs estimated for the San Joaquin Basin was about 71% of that the total for that region in 1998. There was no evidence of any Black Terns breeding in the Tulare Basin in the southern San Joaquin Valley in 2012, in contrast to the 151 pairs estimated there in 1998. Hence, the number of pairs of nesting terns estimated for the entire San Joaquin Valley in 2010–2012 was only about 23% of the total for that region in 1998 (Shuford et al. 2001).

FORSTER'S TERN

Surveys estimated about 610 pairs of Forster's Terns were breeding in the interior of California in 2010–2012. Colonies of this species occurred in 5 of 11 California ecoregions (Table 1, Figure 29). About 64% of the interior total was represented by 3 sites in the Klamath Basin NWR Complex in the Modoc Plateau ecoregion and an additional 25% at 1 site in the interior of the Southwestern California ecoregion (Tables 1 and 14). The estimate for the interior population for California in 2010–2012 was about 25% of that for 1997–1998 (Table 14), reflecting a loss of potential nesting habitat from drought in recent years (cf. Figures 29 and 30).

OTHER SPECIES

Surveys on the coastal slope and deserts of southern California in 2012 documented breeding of five additional species of colonial waterbirds that were not part of the broader 11-state survey because these species do not breed widely in the interior of the West. Little Blue Herons (3 nests) were breeding at Mission Bay, Sea World, San Diego County (F. Zern and J. Pea pers. obs.). Likewise, Yellow-crowned Night-Herons were nesting at Mission Bay, Sea World (1 nest) and at Imperial Sports Park (2 nests), San Diego County (F. Zern, J. Pea, and J. Szabo pers. obs.). As part of a long-term study of larids at the Salton Sea, there were high seasonal counts of 155 nests of the Gull-billed Tern and 138 nests of the Black Skimmer at the 312 Reservoir of the Wister Unit of Imperial Wildlife Area, Imperial County (K. Molina unpubl. data). There were also an estimated 50 pairs of skimmers and 12 pairs of Least Terns nesting at Burris Basin 2 of the Orange County Water District (D. Willick pers. obs.), over 20 km inland from the ocean. Multiple colonies of each of these species occur on the immediate coast in estuaries or on beaches; annual surveys are conducted at all of the Least Tern colonies (e.g., Frost 2013).

DISCUSSION

ACCURACY AND CHALLENGES OF COUNTS

The degree of accuracy and repeatability of counts of colonial waterbirds can vary considerably among species, colony sites, nesting substrates, and time of the breeding season. This was readily apparent during statewide surveys in the interior of the state in both 1997–1999 (Shuford 2010) and 2009–2012 (this report). The following paragraphs outline some of the challenges inherent in obtaining accurate counts or estimates of nests or breeding pairs and how these varied both within and among species.

If timed properly to match the peak of nesting, the counts of nests of pelicans and cormorants on open islands from aerial photographs are among the most accurate of any counts taken. One-by-one counts of gull nests while walking through the colonies are also very accurate but cause disturbance to the birds, which may cause some loss of eggs predated by neighboring gulls. When gulls are nesting in close proximity to other species, it is inadvisable to enter the colony, and it often is not possible to count all gull nests accurately from the periphery of the colony. An alternative is to count all the adult gulls and adjust those numbers by a correction factor derived at a site where it is possible to accurately count both adults and nests from a location adjacent to the colony.

Species that nest on different substrates may be relatively easy to count in one but not in another. As noted, cormorants nesting on open islands are straightforward to count from aerial photos. But this technique does not work nearly as well when the birds are nesting in trees with leafy canopies, where visual estimates of nest numbers from the ground may be preferable. When Eared Grebes and Forster's Terns build nests of aquatic vegetation well out in the open on large water bodies their nests can be easy to count one by one, as may be the case when these terns nest on bare or sparely vegetated islands. When these species tuck their nests within small openings in, or the edges of, taller marsh vegetation, however, it may require kayaking out to and slipping through openings in tall clumps of cattails or tules to locate nests, which is not always easy or possible. In some cases, it may require counting the number of adult Forster's Terns nesting in marshes and using correction factors to estimate the number of breeding pairs (see Methods). For Black Terns it may be possible to count all nests at a site by wading out into the shallow water of marshes with low-stature vegetation, but this may not be possible in some locations and may be too time consuming if there are a large number of sites to survey. Alternatives are to count all adults at a site and to use correction factors, which vary depending on whether the colony was disturbed or undisturbed at the time of the survey (see Methods). In the large area of rice fields on private land in the Sacramento Valley it is not possible to locate all Black Tern colonies, so we conducted roadside surveys to obtain estimates of tern densities (and a measure of variation among survey routes) to estimate tern numbers over the entire region (see Methods).

Timing the counts to the peak of nesting is always desirable. This is not always easy to do, however, particularly for some species, such as the Eared Grebe, Forster's Tern, Black-crowned Night-Heron, and Snowy Egret, for which the timing of peak nesting may vary considerable annually or among sites in the same year. For such species, it is preferable to do multiple counts across the season, though this is not always feasible. Counts late in the seasonal nesting cycle my leave the observer unable to assign to species the guano-stained nests of the various small ardeids that obviously have been used that season but are no longer occupied by adults or young. In 2010, we initiated surveys of Black Terns in northeastern California about a week or two later than we had in that region in 1997. But cold and rainy weather persisted into June in 2010, delaying tern nesting and causing us to resurvey some sites that we counted early in the season when many birds were not yet on nests as they had been at that time in 1997.

When species are nesting in substrates with extensive screening vegetation it can be difficult to determine the accuracy of nest counts. At the extreme end, species like the White-faced Ibis may be nesting in tall marsh vegetation where few if any nests are visible from the periphery of the marsh. In such cases, a standard method is to count the number of adults flying out of the colony at dawn. If conducted when nests have eggs or small young, the assumption is that each adult flying out of the colony represents one nest as the other adult of each pair should remain behind to tend the nest. This also assumes that all adults present are breeding and their nests are at the same stage of the breeding cycle. The latter in particular is a risky assumption given that nesting may be asynchronous among birds in a colony. We also had difficulties counting egrets nesting in marshes at Lower Klamath NWR (Shuford and Henderson 2010).

A more typical challenge is to obtain good nest counts for various species of herons and egrets nesting in stands of leafed-out trees. In such cases, the vegetation may obscure the location of nests in an individual tree, or the entire tree may block the view of nesting trees farther away from the observer. Observers may compensate to some degree by moving their location to obtain different vantage points. But such options may be limited by impenetrable vegetation or restricted access to private property. Even with adequate observer mobility, additional nests may be visible from a new location but nests seen previously may not be. For early nesting species like the Great Blue Heron it may be possible to counts nests before the trees are well leafed out. If so, this often is just a partial solution. Most colonies in the lowlands of California contain more than one species, some of which usually start nesting later than others when new leaves are developed, or the nesting trees may by native or ornamental trees that hold their leaves or needles year round.

Aerial surveys can provide a good overview of a colony, particular when the breeding species are mainly Great Egrets or Great Blue Herons, which both tend to nest at or near the top of the canopy. The drawback, however, is the short time available to make an estimate of nests numbers, usually for more than one species, while the plane is speeding by the colony. This can be alleviated to some degree by circling the colony several times, but that is no panacea. Also, the ease of initially locating colonies on aerial reconnaissance surveys depends on the size and species composition of the colonies. Large colonies, particularly those dominated by white-plumaged egrets, are much easier to locate than are smaller colonies, particularly ones composed of just a few pairs of Great Blue Herons given their blue-gray plumage and gray stick nests blend in well with tree trunks and obscuring vegetation. Photographing tree colonies can be difficult because nests may be within multiple layers of the canopy, and it is not easy to piece together photos of a three dimensional object taken from various angles. Furthermore it is usually not feasible to photograph large numbers of colonies because of the additional time required to take photos from the airplane when the time and expense of the flights is limiting. Photos also need to be sorted, pieced together, and counted, which takes considerable time and may still provide unsatisfactory results.

We conducted many days of aerial surveys, particularly to search for and count the large number of colonies of tree-nesting ardeids and cormorants located in large stands of riparian trees along major rivers in the Central Valley. We initially had the naïve notion that we would make rough counts of the nests from the airplane and, once located, we could go back to the colony on the ground where we could make a more leisurely and accurate count. We were quickly disabused of this fantasy, as often it was not possible to get close to colonies on the ground because of private property, impenetrable vegetation, or sloughs to cross. Or, it might be possible to see just a portion of the colony from the only access point on the edge of a riparian stand, or the observer may still face the general problem described above of the difficulty of obtaining a tight count because of vegetation blocking the view of some nests. In such cases, mapping the locations of nests is helpful, as is spending considerable time at the colony; over time, young may stand up in nests that were not initially visible or adults returning to the colony may reveal nests when they land.

Overall, it is difficult to determine the accuracy of counts or estimates of nests or breeding pairs for many species of colonial waterbirds, i.e., how close the counts or estimates are to the actual number present at a site or across an entire region. Accuracy of counts can be influenced by these (and other) factors: the size of the area to be searched; available resources; variation in effects of climatic conditions on habitat availability by region when counts are spread over more the one year; seasonal variation in the number of nests or adults present (or visible) when counts span an extended period within a breeding season; and variation in the probability of detection of nests and adults depending on the surrounding landscape, nesting substrate or vegetation type, species' behavior, species' color, observer experience, etc. The project did not have the resources to quantify how such factors might have influenced the accuracy of counts in 2009–2012. Hence, the author selected the census methods and protocols he judged would provide the most accurate estimates depending on the species involved, logistical constraints around colony accessibility, needs to minimize disturbance, and the difficulty of covering such a large state with limited resources (see Methods).

If future statewide inventories are contemplated, it would be advisable to use the most accurate method of counting for the particular species, nesting substrate, and time of the season and to try, as much as possible, to closely repeat the protocols and methods of counting used in 2009–2012 to facilitate comparisons. Modifications may, of course, be needed or desirable depending on conditions at the time of a future inventory or advances in knowledge or technology that may improve survey accuracy over what is possible currently. Any long-term monitoring program for colonial waterbirds developed for California in the future likely will rely on sampling a subset of colonies or habitats given the much greater effort and resources needed to survey all colonies throughout the interior of the state, as was attempted in the 2009–2012 inventory (see discussion below).

DROUGHT CONDITIONS

Climatic conditions in California over the last 20 years have been highly variable, ranging from very wet to extremely dry. Statewide surveys in the interior of California from 1997–1999 of a subset of colonial waterbird species (Shuford 2010) occurred during a period of well above average precipitation (Figure 31). Conversely, the more inclusive 2009–2012 surveys overlapped with an extended period of drought that began in 2006–07. Despite being interrupted by one year of heightened precipitation (129% of long-term mean), this dry period has so far persisted two years beyond the completion of waterbird surveys in 2012 (Figure 31) and is considered the most severe statewide drought in living memory (and very probably over a century; www.weatherwest.com/archives/1658).

A lack of long-term monitoring data on the populations of colonial waterbirds in the interior of California limits conclusions on drought effects, but data for this region for a set of species inventoried in both 1997–1999 and 2009–2012 provides some valuable insights. As detailed above, breeding populations in the latter period were greatly reduced for the Ring-billed Gull, California Gull, Caspian Tern, Black Tern, and Forster's Tern in northeastern California and also for the latter three species in the Central Valley, i.e., throughout the interior breeding ranges in the state for all of these species. Drought likely affected other species lacking surveys in both periods. Effects on most species, whether monitored or not, undoubtedly have been even more severe since 2012, as the record drought continues to reduce the acreage of wetlands and irrigated agriculture used by waterbirds.

THREATS TO WATERBIRDS

Colonial waterbirds face a host of threats, which have changed over time, but the greatest threat to these birds in California currently is the combination of habitat loss, degradation, and fragmentation. This is also the case throughout North America. Other threats to waterbirds in California include increasing competition for water among municipal, agricultural, and wildlife interests; changing or detrimental agricultural, municipal, or industrial practices in altered habitats; poor or toxic water quality and oil spills; diseases; subsidized and introduced predators; invasive species; human disturbance; conflicts with human interests; inter-species conflicts; and the long-term effects of climate change (Shuford 2010, Shuford 2014).

The current severe California drought that has persisted since 2006–2007 emphasizes the importance of reliable waters supplies for wetlands and irrigated crops that are prime foraging habitats for waterbirds. Although waterbirds are adapted to periodic droughts, there are, of course, limits to their adaptability. Beyond desiccation of foraging habitats when water is scarce, water diversions for human uses may increase the frequency of predator access to nesting islands that become connected to the mainland. Competition for water will only increase in the future with the expanding human population unless intense water conservation is practiced widely. Ironically, water conservation measures in agriculture may decrease the foraging value of some crops to waterbirds if there is a move to drip or sprinkler irrigation in crops that are currently flood irrigated.

Areas of the state where overallocation of water supplies has been a particular problem in recent years include the Klamath Basin, Central Valley, and Salton Sea (summaries in Shuford 2010). Some of the potential threats in these regions that have previously been identified have been realized. As noted above, a steady decline in water levels in the Salton Sea by 2013 had forced the abandonment of the huge colony of Double-crested Cormorants on Mullet Island, which represented by far the largest colony in the interior of California and the second largest in the Pacific states. In addition, the increasing salinity as water levels drop at the Salton Sea will ultimately greatly reduce fish populations upon which various species of nesting waterbirds depend. With water level declines and salinity increases predicted to accelerate rapidly after 2017, the ecological, economic, and societal costs will be great if no action is taken to offset the impacts of these changes (Cohen 2014).

Solving or preventing the problems noted here will require broad-based support, collaboration among various conservation initiatives at both the national and regional level, and extensive education of the general public and their local and legislative representatives.

FUTURE MONITORING

One of the primary goals of the 11-state inventory of the Western Colonial Waterbird Survey, of which these California surveys were a part, was to provide a baseline for the development of a long-term monitoring program for this group of species throughout the western United States (Seto 2008). Such an inventory is a prerequisite for a long-term monitoring program, as are standardized protocols and methodologies for surveying colonial waterbirds, which are available for the western United States (Jones 2008) and for all of North America (Steinkamp et al. 2003). Although it is beyond the scope of this report to make specific recommendations for how to conduct long-term monitoring of colonial waterbirds in the interior of California, the following provides an overview of important issues to consider when developing such a program.

Developing any long-term monitoring program requires first defining objectives and goals. Steinkamp et al. (2003) emphasized that when designing a monitoring program it is important to think beyond a goal of measuring change in numbers over time so that the information collected can be effectively used to evaluate management practices and to make management decisions. They also outlined other pertinent questions and considerations, noting the geographic scale and objectives will greatly influence the design of the program. For example, is the main objective to detect population declines that may require management actions, or is the main interest in documenting colony locations? Another key element is deciding what landscape scale the program will focus on for determining the status and trends of waterbird populations. This scale might be the entire state of California, for example, or perhaps particular ecoregions, watersheds, parks, federal refuges, state wildlife areas, private nature reserves, or other geographic or administrative entities. Any monitoring at the statewide scale undoubtedly will require the collaboration of a wide range of federal and state agencies, nonprofits, or other groups that may be focused primarily at smaller scales and may already have local monitoring programs in place. Ideally, protocols and methodologies can be standardized, modified, or adapted so that trends can be accurately assessed for both the smallest and largest scales important to various collaborators when data are combined.

Other key decisions are whether there are particular species or populations that deserve priority for monitoring, whether to monitor all populations at the selected scale or rather to sample or select populations to monitor, the frequency of surveys (annually, every 2–3 years, etc.), and what is an acceptable magnitude of change that should be detectable with reasonable precision over a specified time period (Steinkamp et al. 2003). The Pacific Flyway Council (2013a, b) took these factors into consideration when prioritizing the monitoring of western populations of the Double-crested Cormorant and American White Pelican in response to predation of these species on fish resources valued by humans.

In California, decisions on monitoring frequency should take into account that the state's precipitation is highly seasonal and annual totals vary greatly from year to year. Thus, wetlands or terminal lakes may vary markedly in extent, or disappear, over relatively short periods of time. This suggests surveys should be conducted at short intervals, ideally annually. Otherwise, monitoring at longer intervals risks that data may better reflect the variation in climate rather than the long-term trends of the species' population. While the desired levels of precision and ability to detect trends should strongly influence the sampling effort, resource limitations ultimately will dictate the frequency of surveys.

Given monitoring all colonies and populations of colonial waterbirds in California is not feasible on a regular basis, any statewide monitoring program will need to adopt a statistically robust sampling framework. This should reduce sampling error resulting from spatial variation in densities of waterbirds influenced by habitat or other factors, temporal variability in colony attendance by the stage of the nesting cycle, and differences in the probability of detecting birds that vary within and among species and habitats and over time (Steinkamp et al. 2003).

In developing a monitoring program for colonial waterbirds in California, it would be valuable to use a team approach to take advantage of the broad range of experience and expertise available on sampling design and in conducting field surveys. Lessons can be learned from ongoing monitoring of waterbirds at the local and regional level (e.g., Molina and Sturm 2004, Kelly et al. 2006), from the California-wide surveys in 1997–1999 (Shuford 2010) and 2009–2012 (this report), and from the recent multi-state surveys (Cavitt et al. 2014). The current experimentation with use of Unmanned Aerial Systems (a.k.a. drones) for conducting wildlife surveys (e.g., Ogden 2013) suggests the possibility that the way biologists monitor colonial waterbirds may change rapidly in coming years.

Regardless of the methods employed for waterbird monitoring there will always be the need to store data in a centrally managed database, such as the California Avian Data Center (http://data.prbo.org/cadc2/). Tools on such websites allow the data to easily be retrieved, visualized, analyzed for trends, and used to support decisions by land managers.

Even a well-designed and -executed monitoring program may falter if there is not institutional support at various levels to maintain training of biologists and volunteers to consistently conduct surveys in a standardized manner, coordinate data collection, submit data to a central depository, analyze data, disseminate the results of analyses, and implement research and management as needed when analyses document consistent population declines. Without such institutional commitment it will be very difficult to ensure the long-term conservation of waterbirds. If early warnings of decline are unavailable, and actions are not taken to reverse them, listing may be needed and recovery may be difficult, expensive, and contentious.

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Appendix 1. Site coverage on aerial surveys of the Central Valley in 2011 and 2012 (not necessarily in the order listed).

Sacramento Valley: 5 May, 6 May, and 3 June 2011.

On the three aerial survey days for the Sacramento Valley, we searched the following areas: the length of the Sacramento River (and adjacent oxbow lakes) from the city of Sacramento north to Lake Shasta in the vicinity of Lakeview; Sierra rivers, creeks, and reservoirs including the Feather River, Yuba River, Cross Canal, Auburn Ravine, Coon Creek, Yankee Slough, Bear River, Camp Far West Reservoir, Reed's Creek, South Honcut Creek, District 10 north of Yuba City, Wyman Ravine, Thermolito Afterbay, Butte Creek and tributaries, Butte Sink, and Dry Creek; creeks and reservoirs draining from the Coast Ranges, including Cottonwood Creek, Walker Creek, Stony Creek from the confluence of the Sacramento River upstream to the diversion dam west of Stonyford, Black Butte Lake, Stony Gorge Reservoir, East Park Reservoir, Little Stony Creek, Cache Creek from the vicinity of Rumsey downstream to and including the Cache Creek Settling Basin, and Putah Creek from Lake Berryessa downstream to Davis (rest to Putah Sinks on another day); and the Yolo (part), Sutter, and Tisdale bypasses.

Delta: 13 and 19 May 2011.

The 13 May aerial survey in the Delta focused mainly on rivers, creeks, and reservoirs draining from the Sierra Nevada, including Deer Creek upstream to near Rancho Murieta; Cosumnes River Preserve; Cosumnes River upstream to Rancho Murieta and lakes Clementia, Chesbro, and Calero to the north and unnamed small reservoirs and wetlands to the south; Dry Creek along the Sacramento–San Joaquin County line upstream to its intersection with Hwy. 88; Tracy Lake; the Mokulemne River upstream to and including Camanche Reservoir; New Hogan Reservoir and Calaveras River downstream to just shy of Hwy. 99; Morman Slough (part), San Joaquin River and adjacent lakes and wetlands from French Camp Slough south to confluence with Stanislaus River; Stanislaus River upstream to Knights Ferry; Miller Lake; Woodward Reservoir; and Salt Springs Valley Reservoir (and smaller lakes/reservoirs nearby). At end of first aerial day in Delta covered Paradise Cut from Hwy. 205 west to Old River up to Widdows, Eucalyptus, and Kings islands just north of Clifton Court Forebay, then various Delta sloughs on the way back to Sacramento.

On our 19 May aerial survey, we covered all of the main islands, rivers, sloughs, channels, and wetlands in a roughly triangular area in the heart of the Delta. Besides searching a few areas of limited water in the Yolo Bypass, the area covered was bounded on the west by the Sacramento Deep Water Ship Channel, Liberty Island, Cache and Lindsey sloughs, the Sacramento River down to the west end of Sherman Island, on the south by Hwy. 4, and Interstate 5 on the east.

San Joaquin Valley: 8, 9, 15, and 16 May 2012.

Areas surveyed by plane on 8 and 9 May included the San Joaquin River (and adjacent ponds and wetlands) from, and including Millerton Lake, downstream to Hwy. 152 just north of the Fresno County line; Fresno Slough; Boggs Slough; Kings River (including North and Clark's forks) from Hwy. 41 at Stratford upstream to Pine Flat Dam, including adjacent sloughs (e.g., Byrd Slough), ponds, and wetlands; miscellaneous ponds east of Clovis and Dog, Dry, and Little Dry creeks up to Prather; St. John's River from east side of Hwy. 99 and Kaweah River near Hwy. 198 upstream to Lake Kaweah Dam, then ~8 mi north up Dry Creek; Outside, Inside, and Elk Bayou creeks from Exeter downstream to confluence of Tule River; Tule River from just west of Hwy. 43 upstream to Lake Success, then ~10 mi up South Fork, 16 mi up North Fork, and 3 mi up Middle Fork of Tule River; Deer Creek from Hwy 43 east of Alpaugh to ~15 mi east of Hwy 65; Poso Creek upstream from 4 to 23 mi east of Hwy 46; Lake Woolomes; Kern River from where it no longer closely parallels Hwy. 178 downstream across Hwy. 99 continuing to the Kern Fan Element near Interstate 5; Costerisan Farms Lake; Wind Wolves Preserve 4 mi up San Emigdio Creek; Hacienda Ranch; and South Wilbur Flood Area.

Area surveyed by plane on 15 and 16 May included Don Pedro Reservoir; Tuolumne River from Don Pedro dam downstream to the San Joaquin River; Moccasin Creek (part); Dry Creek from north of the north arm of Modesto Reservoir downstream to the eastern edge of the city of Modesto; Modesto Reservoir; Kelsey Reservoir; Lake McClure; Merced River from Lake McClure dam downstream to the San Joaquin River; Yosemite Lake; H. V. Eastman Lake; Chowchilla River from Eastman dam downstream to jct. with Madera Canal; Hensley Lake; Fresno River from Henseley dam to eastern outskirts of city of Madera; Los Banos Reservoir and 3 mi up Los Banos Creek; San Luis Reservoir; O'Neill Forebay; San Joaquin River (including adjacent ponds, oxbow lakes, and wetlands) from Hwy. 152 north/downstream to the confluence of the Stanislaus River; and private lands of the Grasslands Ecological Area near Los Banos (federal refuges and state wildlife areas covered on the ground).

Table 1 Percentage of Nesting Pairs by Ecoregion for 14 Species of Colonial Waterbirds from Statewide Surveys of the Interior of California, 2009–2012[a]

	NW	CW	SW	ScV	SnJV	CaR	SN	MP	SNE	DMoj	DSon
Eared Grebe	0	0	0	0	<1	16	<1	70	13	<1	0
Double-crested Cormorant	1	<1	3	8	6	<1	<1	2	0	0	79
American White Pelican	0	0	0	0	0	0	0	100	0	0	0
Great Blue Heron	7	8	9	27	27	1	5	1	1	<1	13
Great Egret	3	8	2	56	19	1	3	6	0	0	2
Snowy Egret	7	32	20	29	6	0	<1	2	0	0	4
Cattle Egret	1	0	5	14	17	0	0	0	0	0	64
Black-crowned Night-Heron	13	14	18	36	9	0	0	7	3	<1	<1
White-faced Ibis	0	0	1	12	58	0	<1	28	0	0	0
Ring-billed Gull	0	0	0	0	0	23	20	56	0	0	0
California Gull	0	0	0	0	0	4	1	2	92	0	<1
Caspian Tern	0	0	0	0	0	0	0	4	0	0	96
Black Tern	0	0	0	46	3	2	0	49	0	0	0
Forster's Tern	0	0	25	0	3	<1	8	64	0	0	0

[a]Ecoregions of California are those of the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

Table 2 Estimated Numbers of Pairs of Eared Grebes at Colonies in California by Ecoregion, 2010 and 2012[a]

Site	Elev. (ft)	Survey date	Type of Count[b] Nests	Adults	Estimated pairs[c]
SAN JOAQUIN VALLEY (Tulare Basin)					
Kings County					
Tulare Lake Drainage District, North Evaporation Basin	195	24 June 2012	5	121	5[d]
Ecoregion total					***5***
CASCADE RANGES					
Siskiyou County (part)					
Shasta Valley WA, Steamboat Lake	2618	30 June 2010	14	26	14
Cedar Lake	2664	1 July 2010	4	–	4
Nelson Lake	2595	8 July 2010	2	6	2
Lassen County (part)					
Poison Lake	5566	4 July 2010	111	–	111[e]
Eagle Lake, North Basin	5111	15 July 2010	(433)	3237	1619[f]
McCoy Flat Reservoir	5550	4 July 2010	–	67	34[g]
Ecoregion total					***1784***
SIERRA NEVADA					
Lassen County (part)					
Mountain Meadows Reservoir	5046	14 July 2010	(12)	177	89[h]
Ecoregion total					***89***
MODOC PLATEAU					
Siskiyou County (part)					
Lower Klamath NWR, Unit 6A	4083	16 June-11 July 2010	1331	–	1331[i]
Tule Lake NWR					
Sump 1-A	4037	12 July 2010	4814	–	4814[j]
Sump 1-B	4037	14 June 2010	1199	–	1199[k]
Lassen County (part)					
Boot Lake	6560	25 June 2010	–	82	41[l]
Leavitt Lake	4100	15 July 2010	546	–	546
Ecoregion total					***7931***
EAST OF SIERRA NEVADA					
Mono County					
Bridgeport Reservoir	6460	2 August 2010	680	–	680[m]
Crowley Lake Reservoir	6770	1 August 2010	835	–	835[n]
Ecoregion total					***1515***
MOJAVE DESERT					
Kern County					
China Lake Waste Treatment Plant	2200	17 May 2012	3	9	3[o]
Ecoregion total					***3***
GRAND TOTAL					**11,327**

Table 2 (cont'd)

[a]Ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]Observers attempted to count total grebe nests. When this was not possible, they made a partial nest count, included here within parentheses, and tried to count all breeding adults at the colony. –, no data available.

[c]A count of total nests is the best estimate of breeding pairs. Lacking such a count, the total number of adults was divided by two to obtain an estimate of breeding pairs (odd numbers first rounded up to nearest even number).

[d]Nest count likely a low estimate of nesting numbers given many birds paired but lacking nests on survey date. Counted a total of 182 grebes: 121 in the evaporation ponds, 61 in two adjacent wetlands cells.

[e]Of 111 nests counted, lots with eggshells and few with one or two eggs. Chicks seen in water and riding on adults' backs; first site of 2010 season with young/hatched-out eggs.

[f]With lake low from drought, North Basin was the only area with suitable nesting habitat for this species; survey conditions subpar, as observer could not move well by kayak or by foot because of thick muck and tules. On 6 July, courtship in progress but no nests observed; count of 1570 grebes when observer in kayak pushed birds out of tules into open water. On 15 July, partial count of 433 nests (most had at least one egg) and full count of 3237 adult grebes when birds again pushed into open water.

[g]Raft of grebes seen; some paired birds in courtship displays. Grebes may have bred later but observer unable to return to site.

[h]Nests deep in tule clumps; this the only colony visited where no nests were visible on edge of vegetation. Partial count of 12 nests, but breeding pairs estimated from count of 177 adults pushed into open water.

[i]Colony asynchronous. Counts of 786 nests on 16 June, 403 new nests on 30 June, and 142 more on 11 July.

[j]Two large subcolonies: one of 1126 nests (17 on 29 June), one of 3688 nests (1972 on 29 June); some grebes still nest building on 12 July, so colony may still have been growing.

[k]Two subcolonies, both of which ultimately failed, likely from a marked draw down in water level between mid- to late-June. First subcolony had 1199 nests on 14 June, 361 on 29 June, and 0 on 12 July; the second was not yet active on 14 June but had 473 nests on 29 June, 0 on 12 July. Given the possibility that the second subcolony formed from birds that failed at the first, conservatively estimated 1199 breeding pairs from the nest count at first subcolony on 14 June.

[l]Grebes on lake with mats of the floating yellow pond-lily (*Nuphar luteum* ssp. *polysepalum*); algae growing on lake, particularly in association with lily-pad habitat. No nests seen, but still early in season and little nesting elsewhere at this date.

[m]Grebes nesting near south shore of reservoir, where observers estimated about 440 nests on 19 July, 680 on 2 Aug.

[n]Grebes nesting mainly in colony in northeast cove of lake, where observers counted 679 nests on 20 July and 835 on 1 Aug.

[o]17 May: 3 nests with adults incubating, 3 others partially constructed, 9 adults in area total; 30 May: area with nests previously had dried significantly, no grebes present; 22 June: no nests and 28 adult grebes; 17 July: no nests, 47 adults, and 1 pair possibly nesting at pond 4 and few still calling and swimming in pairs; 6 Aug: 1 nest w/hatchlings in cattail substrate (in different pond than nests on 17 May), 19 adults counted.

Table 3 Estimated Numbers of Pairs of Double-crested Cormorants at Colonies in the Interior of California by Ecoregion, 2009–2012 and 1999[a]

Site	Elev. (ft)	Ecoregion[b]	CVJV Region[c]	Survey Date 2009–2012	Estimated Pairs 2009–2012[d]	Estimated Pairs 1999[d]
NORTHWESTERN CALIFORNIA						
Lake County						
Clear Lake						
Mouth of Holiday Cove	1333	NW	na	10 Apr 2011	0	25
Long Tule Point	1332	NW	na	10 Apr 2011	0	57
East of Quercus Point	1332	NW	na	10 Apr 2011	0	—[e]
Slater Island, Anderson Marsh	1334	NW	na	10 Apr 2011	0	15
Upper Rodman Slough	1326	NW	na	10 Apr 2011	53	0
Indian Valley Reservoir	1478	NW	na	22 May 2011	3	0
Sonoma County (part)						
Delta Pond	55	NW	na	3 Apr 2011	27	0
Laguna de Santa Rosa, Alpha Farms	75	NW	na	4 June 2011	0	59
Napa County						
Lake Hennessey, Chiles Creek	355	NW	na	22 May 2011	10	0
Ecoregion total					***93***	***156***
CENTRAL WESTERN CALIFORNIA						
Sonoma County (part)						
Petaluma wastewater plant	14	CW	na	17 June 2011	4	6
San Benito County						
San Felipe Lake	138	CW	na	30 May 2012	0	—[f]
San Luis Obispo County						
Twitchell Reservoir	750	CW	na	31 May 2011	30	—[g]
Ecoregion total					***34***	***6***
SOUTHWESTERN CALIFORNIA						
Los Angeles County[h]						
San Gabriel River, Pico Rivera	154	SW	na	24 May 2012	0	~6
Sepulveda Dam Recreational Area, Sepulveda Basin WA	690	SW	na	21 May 2012	12	0
Legg Lake	217	SW	na	24 May 2012	30	0
Orange County						
Orange Co. Water District, Anaheim Lake	239	SW	na	31 May 2012	168	105
Riverside County (part)						
Prado Basin near dam	488	SW	na	13 Apr 2012	55	30+
Mystic Lake	1428	SW	na	dry in 2012	0	64
San Diego County			na			
Sweetwater Reservoir	237	SW	na	10 June 2012	0	28
Ecoregion total					***265***	***233***

Table 3 (cont'd)

Site	Elev. (ft)	Ecoregion[b]	CVJV Region[c]	Survey Date 2009–2012	Estimated Pairs 2009–2012[d]	Estimated Pairs 1999[d]
SACRAMENTO VALLEY						
Glenn County						
Howard Slough, at Butte Creek	62	ScV	SV	3 June 2011	5	0
Butte County						
Sacramento River, Mile 188 (W of Murphy's Slough)	123	ScV	SV	3 June 2011	1	–
Sacramento River, Mile 180.5-1 (Llano Seco)	99	ScV	SV	30 June 2011	33	15
Gray Lodge WA, Colony 1	57	ScV	SV	24 May 2011	19	0
Colusa County						
Butte Sink, nr. confluence Butte Creek and Angel Slough	54	ScV	SV	6 May 2011	100	0
Colusa NWR, T14.4	42	ScV	SV	20 May 2011	3	0
Sutter County						
North Butte Country Club, Butte Sink	52	ScV	SV	5 May 2011	0	65
Sutter Bypass W, N of Nelson Slough	27	ScV	SV	20 May 2011	1	0
Sutter Bypass W, E of Knight's Landing	18	ScV	SV	6 May 2011	15	0
Sutter Bypass, ~8 km NE of Knights Landing	30	ScV	SV	6 May 2011	0	12
Yolo County						
Sacramento River, Mile 102.5 (Beaver Lake)	32	ScV	SV	24 May 2011	44	16
Knights Landing Ridge Cut	27	ScV	SV	23 May 2011	2	—
Port of Sacramento	8	ScV	SV	1 June 2011	1	0
Solano County						
Bohannon	6	ScV	SM	25 May 2011	158	0
Wheeler	4	ScV	SM	25 May 2011	80	110
Spoonbill	3	ScV	SM	25 May 2011	25	0
Hass Slough	-2	ScV	SM	19 May 2011	4	—
Prospect Slough	-2	ScV	SM	19 May 2011	6	—
Sacramento County						
American River, Mississippi Bar	135	ScV	SV	7 May 2011	37	—
Stone Lakes NWR						
North Stone Lake	7	ScV	DE	31 Mar 2011	26	154
Sun River	7	ScV	DE	1 May 2011	30	0
SRCSD Bufferlands, Morrison Creek #1	6	ScV	DE	8 Apr 2011	53	0
Cosumnes River Preserve, Horseshoe Lake	35	ScV	DE	15 May 2011	17	3
Pellandini Ranch, W of Twin Cities	18	ScV	DE	19 May 2011	0	29
Ecoregion total					***660***	***404***

Table 3 (cont'd)

Site	Elev. (ft)	Ecoregion[b]	CVJV Region[c]	Survey Date 2009–2012	Estimated Pairs 2009–2012[d]	Estimated Pairs 1999[d]
SAN JOAQUIN VALLEY						
Contra Costa County						
Eucalyptus Island	11	SnJV	DE	27 May 2011	27	0
Alameda County						
Arroyo del Valle, Shadow Cliffs Regional Park	357	SnJV	[i]	8 May 2011	23	—[j]
San Joaquin County						
Potato Slough	17	SnJV	DE	19 May 2011	20	0
Venice Tip (#1 and #2)	20	SnJV	DE	19 May 2011	210	9
Stanislaus County						
San Joaquin River NWR, Christman Island	33	SnJV	SJB	15 May 2012	0	12
Merced County						
San Joaquin River, Mile 121 (SE of Hills Ferry)	58	SnJV	SJB	15 May 2012	20	0
San Luis NWR						
Colony 8 (FT-1A)	67	SnJV	SJB	28 Feb 2012	1	0
Colony 1, San Joaquin River	71	SnJV	SJB	15 May 2012	10	0
Colony 5 (WB-3)	78	SnJV	SJB	19 Mar 2012	5	22
Eastside Canal 1	91	SnJV	SJB	31 May 2012	7	0
San Joaquin River, Turner Island	92	SnJV	SJB	15 May 2012	60	0
Madera County						
San Joaquin River, Sycamore Island	263	SnJV	[i]	11 May 2012	6	0
Fresno County						
San Joaquin River, Mile 242.5	224	SnJV	SJB	10 May 2012	1	—
San Joaquin River, Milburn Unit, SJR Ecological Reserve	240	SnJV	[i]	10 May 2012	52	9
Leaky Acres	333	SnJV	[i]	11 May 2012	5	—
Kings County						
South Wilbur Flood Area, Tulare Lake Drainage District	195	SnJV	TB	9 May 2012	90	119
East Hacienda Ranch Flood Basin, Tulare Lake Drainage District	206	SnJV	TB	9 May 2012	0	6
Tulare County						
Alpaugh Irrigation Reservoir	208	SnJV	TB	19 Apr 2013	6	0
Kern County						
Kern County Water Agency	409	SnJV	[i]	21 May 2012	10	—
Costerisan Farms Lake	329	SnJV	[i]	9 May 2012	10	—
Ecoregion total					***563***	***177***
CASCADE RANGE						
Siskiyou County (part)						
Lake Shastina (north)	2809	CaR	na	13 May 2009	41	—[k]

Table 3 (cont'd)

Site	Elev. (ft)	Ecoregion[b]	CVJV Region[c]	Survey Date 2009–2012	Estimated Pairs 2009–2012[d]	Estimated Pairs 1999[d]
Lassen County						
Eagle Lake						
Pelican Point	5122	CaR	na	7 May 2009	0	118
island between Buck Pt. and Little Troxel Pt.	5111	CaR	na	7 May 2009	2	0
Plumas County (part)						
Lake Almanor, Almanor Peninsula	4529	CaR	na	8 June 2011	15	—
Ecoregion total					***58***	***118***
SIERRA NEVADA						
Plumas County (part)						
Butt Valley Reservoir	4145	SN	na	22 May 2009	11	24
Yuba County						
Yuba River, above Daguerra Point Dam	132	SN	SV	18 May 2011	1	0
Ecoregion total					***12***	***24***
MODOC PLATEAU						
Siskiyou County (part)						
Butte Valley WA (Meiss Lake)	4241	MP	na	12 May 2009	0	84
Lower Klamath NWR (Sheepy Lake)	4083	MP	na	12 May 2009	79	62
Modoc County						
Tule Lake NWR (lower) Sump 1-B	4040	MP	na	multiple dates 2009	0	172
Clear Lake NWR	4484	MP	na	12 May 2009	126	114
Ecoregion total					***205***	***432***
SONORAN DESERT						
Riverside County (part)						
Salton Sea						
76th Ave.	-233	DSon	na	30 Mar 2012	1	0
Johnson Street	-233	DSon	na	30 Mar 2012	0	(2)
Imperial County						
Salton Sea						
East side Poe Road	-233	DSon	na	23 Mar 2012	0	(13)
New River mouth						
West	-233	DSon	na	23 Mar 2012	0	(2)
Delta	-233	DSon	na	23 Mar 2012	0	(26)
East	-233	DSon	na	23 Mar 2012	0	(2)
Alamo River Delta	-230	DSon	na	23 Mar 2012	0	(106)
Mallard Road duck club	-214	DSon	na	29 Mar 2012	1	0
Mullet Island	-200	DSon	na	15 Feb 2012	6594	**5425**[l]
Ramer Lake, Imperial WA	-174	DSon	na	29 Mar 2012	305	(18)
Ecoregion total					***6901***	***5425***
GRAND TOTAL					**8791**	**6975**[m]

Table 3 (cont'd)

[a]The "interior" survey area excludes coastal colonies on offshore islands or rocks, coastal bluffs, within estuaries, or otherwise within 10 km of the ocean or estuarine shoreline; for the San Francisco Bay estuary, the Carquinez Strait at Interstate-80 is considered the boundary between coastal and interior. Data for 1999, or referred to for that year, from Shuford (2010) unless otherwise noted. –, no survey made.

[b]Ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[c]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley. na, CVJV subregions not applicable for Jepson regions other than the two in the Central Valley.

[d]Pairs estimated from direct count of nests (1 nest = 1pair) unless otherwise noted.

[e]Not checked in 1999, but 175 pairs in 1998.

[f]Not checked in 1999, but 11 pairs in 1998.

[g]Unclear if active in 1999. As of 2014, it had been active irregularly (depending on water levels) for about 15 years (W. Fritz pers. comm.). First available count was of 23 active nests in two sycamores on 18 June 2011 (inactive in 2014; T. Edell pers. comm.).

[h]Although no nest counts were available until 2002, another colony had been active in the county since about 1995 at the Rio Hondo Spreading Grounds (K. Powell *fide* B. Daniels). A third colony was active at the Sepulveda Wildlife Area in 2003 (M. Kotin *fide* K. Garrett).

[i]Mismatch between Jepson and CVJV area boundaries. In this case, all such colonies fall within the Jepson San Joaquin Valley ecoregion but not within any of the subdivisions of the Central Valley as defined by the CVJV. Such colonies may or may not occur at elevations higher than 300 ft., the CVJV's upper elevation boundary for the Central Valley.

[j]Not checked in 1999, but likely inactive that year as no cormorants nesting in 1998 and 2000 (K. Tokatlian *fide* E. Condeso).

[k]Not checked in 1999, but 5 and 8 pairs in 1997 and 1998, respectively.

[l]In 1999, circumstances warranted treating the entire Salton Sea area (North End Salton Sea, Riverside Co., and South End Salton, Imperial Co., and their respective subcolonies) as a single site. The estimate of nesting pairs for the entire Salton Sea was from the peak single-day (19 February) count of nests on Mullet Island given the relatively small number of nests established elsewhere at the Salton Sea after late February may have represented the relocation of adults that failed earlier at Mullet (see Methods in Shuford 2010).

[m]The discrepancy between the 6865 pairs reported in Shuford (2010) for the 1999 survey and the 6975 reported here reflects a slight enlargement of the interior survey area in 2009–2012, to include Suisun Marsh, and a comparable retrospective enlargement of the 1999 survey area, leading to the addition of a count of 110 pairs at one site in Suisun Marsh in 1999 that was not included in the prior total.

Table 4 Estimated Numbers of Pairs of Great Blue Herons at Colonies in California by Ecoregion, 2009–2012

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
NORTHWESTERN CALIFORNIA					
Del Norte County					
Prince Island	100	NW	–	6/4/2011	2
Shadow Lane and Ocean Drive	245	NW	–	8/26/2011	7
Tillas Slough	20	NW	–	8/26/2011	2
Lower Lake and Pala Rds	15	NW	–	8/26/2011	3
Lakeview Road	14	NW	–	8/26/2011	1
Elk Valley Road	27	NW	–	8/26/2011	3
Siskiyou County (part)					
Klamath River, Mile 184.5 (nr. Klamathon Bridge)	2148	NW	–	5/19/2009	17
Klamath River, Mile 162.3 (Cougar Gulch)	1795	NW	–	5/29/2012	1
Klamath River, Mile 156.5 (Walker Bridge)	1680	NW	–	5/29/2012	1
Klamath River, Mile 158 (Eagle's Nest Golf Course)	1792	NW	–	5/29/2012	3
Klamath River, Mile 108 (Happy Camp)	1074	NW	–	5/30/2012	1
Klamath River, Mile 117 (China Point)	1372	NW	–	5/30/2012	2
Sission Pond	3417	NW	–	6/2/2012	16
Humboldt County					
Indian Island	9	NW	–	6/18/2011	10
Hookton Slough	60	NW	–	6/1/2011	5
Trinity County					
Trinity Lake, Ridgeville peninsula	2463	NW	–	5/21/2012	3
Mendocino County					
Big River 1	33	NW	–	5/24/2011	5
Albion River	4	NW	–	6/30/2011	6
Rogina Heights	700	NW	–	6/2/2011	7
Fetzer-Hopland	502	NW	–	5/24/2011	6
Glenn County (part)					
Stony Creek, above Black Butte Reservoir	476	NW	–	5/5/2011	2
Stony Creek, between Stony Gorge and Black Butte reservoirs	987	NW	–	6/3/2011	2
Lake County					
Clear Lake					
Upper Rodman Slough	1326	NW	–	4/10/2011	46
Long Tule Point	1330	NW	–	4/10/2011	84

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
W of Clear Lake SP	1331	NW	–	4/10/2011	2
Slater island, Anderson Marsh	1360	NW	–	3/20/2011	53
Sonoma County (part)					
Cloverdale	356	NW	–	3/7/2011	2
Oak Knoll	378	NW	–	April 2011	5
Wine Creek	577	NW	–	5/17/2011	10
Fitch Mountain	171	NW	–	5/24/2011	7
Chalk Hill Road	208	NW	–	5/6/2011	3
Riverfront Park	63	NW	–	3/4/2011	12
Oddfellows	169	NW	–	4/29/2011	2
Novavine	551	NW	–	5/6/2011	1
Delta Pond	55	NW	–	4/3/2011	23
Alpha Farm	72	NW	–	6/4/2011	1
Vigilante Road	400	NW	–	3/5/2011	1
Napa County (part)					
Pope Valley 2	632	NW	–	April 2011	15
Bell Canyon Reservoir	434	NW	–	3/4/2011	10
Lake Hennessey, Chiles Creek	355	NW	–	5/8/2011	6
Yolo County (part)					
Cache Creek, nr. Rumsey Rancheria	269	NW	–	5/15/2012	2
Ecoregion total					***390***
CENTRAL WESTERN CALIFORNIA					
Sonoma County (part)					
Freezeout Road	302	CW	–	4/27/2011	12
Bodega Bay, Bay Flat Road #1	10	CW	–	6/6/2011	11
McNear Channel	14	CW	–	2/28/2011	4
Petaluma Wastewater Plant	14	CW	–	4/2/2011	13
Sears Point	3	CW	–	5/11/2011	2
Napa County (part)					
Hagen Road	175	CW	–	4/12/2011	13
Congress Valley	157	CW	–	6/18/2011	7
South Kelly	144	CW	–	4/3/2011	17
Skaggs Island eucalyptus	5	CW	–	6/12/2011	1
Solano County (part)					
Green Valley and Via Palo Linda	97	CW	–	3/5/2011	1
Lake Herman	76	CW	–	3/23/2011	2
Mare Island	12	CW	–	3/26/2011	6

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Marin County					
Sand Point	69	CW	–	5/7/2011	2
Blake's Landing South	93	CW	–	6/8/2011	6
Channel Drive	30	CW	–	5/7/2011	7
Inverness Park	87	CW	–	5/6/2011	3
Bel Marin Keys	7	CW	–	6/4/2011	5
Bear Valley	68	CW	–	4/1/2011	4
Drakes Estero	54	CW	–	5/6/2011	10
North San Pedro Road 2	26	CW	–	4/14/2011	2
West Marin Island	45	CW	–	6/2/2011	10
Bolinas and Kent	6	CW	–	4/4/2011	10
DeSilva Island	38	CW	–	4/4/2011	13
Raccoon Straits	14	CW	–	5/6/2011	6
San Francisco County					
Alcatraz Island	22	CW	–	4/4/2011	1
Palace of Fine Arts	14	CW	–	5/21/2011	1
Stow Lake	291	CW	–	4/4/2011	3
Lake Merced					
North	32	CW	–	4/2/2011	6
Mesa	36	CW	–	2/23/2011	3
South	22	CW	–	4/29/2011	2
San Mateo					
Steinberger Slough	7	CW	–	4/2/2011	3
Portola Valley	47	CW	–	6/12/2011	21
Contra Costa County					
San Pablo Dam	334	CW	–	4/4/2011	28
Alamo	380	CW	–	April 2011	3
Alameda County					
Alameda NWR	7	CW	–	6/21/2011	1
Lake Chabot	230	CW	–	6/5/2011	6
Don Castro	238	CW	–	6/18/2011	9
Livermore VA Park & Hospital	552	CW	–	3/7/2011	3
Eden Landing (E9/E14)	5	CW	–	3/8/2011	3
Eden Landing Heron House	4	CW	–	4/4/2011	7
Sunol Water Temple	234	CW	–	5/14/2011	12
Santa Clara County					
Ovation Court	25	CW	–	4/4/2011	17
Grant Lake (Ranch)	1685	CW	–	4/1/2011	1

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Vasona County Park	313	CW	–	4/3/2011	4
Coyote Parkway Lakes	233	CW	–	6/3/2011	1
Llagas Creek, Morgan Hill	336	CW	–	6/3/2011	8
San Felipe Lake	214	CW	–	5/30/2012	8
Santa Cruz County					
Upper Santa Cruz Harbor	23	CW	–	5/24/2011	3
Pinto Lake	130	CW	–	5/24/2011	7
Monterey County					
Elkhorn Slough	20	CW	–	6/13/2011	15
Monroe Street	72	CW	–	5/26/2011	5
Point Lobos	12	CW	–	5/13/2011	3
San Ardo	411	CW	–	5/12/2011	8
Salinas River, upstream from San Ardo	434	CW	–	5/12/2011	7
Salinas River, downstream from Bradley	468	CW	–	5/12/2011	5
Salinas River, upstream from Bradley	531	CW	–	5/12/2011	26
San Benito County					
Tres Pinos River	964	CW	–	5/27/2011	6
Paicines Ranch	690	CW	–	5/26/2011	5
San Luis Obispo County					
Nacimiento River below reservoir	591	CW	–	5/12/2011	2
Atascadero	918	CW	–	5/19/2011	3
Trout Creek	996	CW	–	5/12/2011	3
Bayshore Village	49	CW	–	5/24/2011	7
Morro Bay State Park (Fairbank Point)	15	CW	–	5/19/2011	4
Laguna Lake	128	CW	–	5/26/2011	4
Avila Beach	144	CW	–	5/20/2011	4
Biddle Regional Park	331	CW	–	5/20/2011	14
Twitchell Reservoir	750	CW	–	5/31/2011	5
Ecoregion total					***454***
SOUTHWESTERN CALIFORNIA					
Santa Barbara County					
Goleta Beach Co. Park	11	SW	–	5/20/2012	10
Carpinteria Salt Marsh	9	SW	–	6/3/2012	3
Ventura County					
Camarillo	116	SW	–	6/11/2012	2
Channel Islands Harbor, Peninsula Rd.	12	SW	–	5/30/2012	7
Port Hueneme, Tomahawk	10	SW	–	5/24/2010	3

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Los Angeles County					
Castaic Lagoon	1236	SW	–	5/2/2012	2
Cogswell Reservoir	2412	SW	–	6/8/2012	5
San Gabriel Reservoir					
North	1472	SW	–	7/15/2012	4
South	1532	SW	–	7/15/2012	10
Sepulveda Dam Recreational Area, Balboa Golf Course	698	SW	–	5/23/2012	4
Silver Lake Reservoir	461	SW	–	6/6/2012	3
Puddingstone Reservoir	948	SW	–	5/9/2012	1
Legg Lake	217	SW	–	5/24/2012	6
Malibu Lagoon, Malibu Colony Rd.	10	SW	–	6/13/2012	1
Marina del Rey					
Bora Bora Way	13	SW	–	5/29/2012	7
Mariners Village	21	SW	–	6/27/2012	11
US Coast Guard	16	SW	–	6/5/2012	10
El Dorado Park, Area III	29	SW	–	6/12/2012	2
Port of L.A./Long Beach					
Harry Bridges Memorial Park	24	SW	–	6/12/2012	15
US Coast Guard Base	11	SW	–	6/8/2012	16
Alamitos Bay	11	SW	–	6/2/2012	20
Orange County					
Orange County Water District					
Warner Basin	250	SW	–	5/31/2012	10
Burris Basin 1	187	SW	–	5/31/2012	7
Naval Weapons Station Seal Beach	11	SW	–	spring 2012	10
Sunset Aquatic Marina	3	SW	–	5/27/2012	41
Bolsa Chica Wetlands	29	SW	–	5/27/2012	4
Huntington Central Park	2	SW	–	5/27/2012	2
San Diego Creek	33	SW	–	6/25/2011	1
Santa Ana River Mouth	5	SW	–	6/27/2012	2
Dana Point Harbor					
Dana Dr.	0	SW	–	5/20/2012	11
Puerto Place North	20	SW	–	5/20/2012	3
San Bernardino County					
Prado Basin (part)					
Prado Regional Park 1	542	SW	–	5/26/2012	3
Prado Regional Park 2	506	SW	–	5/26/2012	3
Prado Dog Park	521	SW	–	6/23/2012	6

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Riverside County					
Prado Basin (part))					
Willow Forest	488	SW	–	4/23/2012	15
Edge Willow Forest	488	SW	–	5/3/2013	5
Rancho Jurupa Regional Park	740	SW	–	4/27/2012	1
Lake Perris	1617	SW	–	5/10/2012	4
Lake Elsinore					
Nebraska St.	1269	SW	–	5/5/2012	9
Rome Hill	1259	SW	–	5/5/2012	13
Lake Hemet	4360	SW	–	5/15/2012	4
Lake Skinner	1502	SW	–	5/9/2012	3
San Diego County					
MCBCP, Lake O'Neill	102	SW	–	4/3/2012	12
Oceanside Harbor	17	SW	–	5/18/2012	13
Lake Wohlford	1484	SW	–	6/5/2012	1[d]
Carlsbad	183	SW	–	5/18/2012	9
Batiquitos Lagoon, South Shore	40	SW	–	5/18/2012	4
Escondido Creek	28	SW	–	5/20/2012	14
Solana Beach, North Sierra Ave.	61	SW	–	5/19/2012	2
Lindo Lake	407	SW	–	6/6/2012	2
Lake Murray	538	SW	–	6/10/2012	2
Mission Bay					
Hubbs-Sea World	9	SW	–	6/11/2012	41
Sea World	20	SW	–	6/11/2012	12
Sportsmen's Seafood	12	SW	–	5/19/2012	6
Naval Air Station North Island					
Curtis St & Roe St (Bldg 427)	15	SW	–	3/9/2012	1
Murray St & 3rd Rd	18	SW	–	4/13/2012	8
Heron Park	14	SW	–	3/9/2012	5
NE of Bldg 3	17	SW	–	3/9/2012	3
Roosevelt Blvd (Bldg 8)	19	SW	–	3/9/2012	1
NW of N 4th and Saufley St	20	SW	–	4/13/2012	9
Saufley St & Roosevelt Blvd (Bldg 8)	21	SW	–	3/9/2012	1
Naval Base Point Loma, SSC					
Craig and Lassing roads	17	SW	–	3/9/2012	2
Entrance	28	SW	–	1/10/2012	1
Bldg 120	13	SW	–	7/13/2012	1
nr. Dolphin Facility on Craig Rd.	8	SW	–	4/27/2012	17
Naval Base Point Loma, Main Base					
Magnetic silencing facility	10	SW	–	2/24/2012	1

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Anne's Alley & Sylvester Rd.	58	SW	–	2/10/2012	13
Between Bldgs 211 & 140	30	SW	–	7/13/2012	6
Command Ctr between Bldgs 138 & 139	45	SW	–	4/27/2012	7
Ecoregion total					***493***
SACRAMENTO VALLEY					
Tehama County (part)					
Sacramento River, Mile 236 (Mooney Island)	239	ScV	SV	5/5/2011	20
Sacramento River, Mile 232 (Flynn Unit)	212	ScV	SV	5/5/2011	12
Sacramento River, Mile 219 (Woodson Bridge)	175	ScV	SV	5/5/2011	12
Sacramento River, Mile 214 (Merrill's Landing)	166	ScV	SV	5/5/2011	3
Sacramento River, Mile 209.5 (Burch Creek)	152	ScV	SV	5/5/2011	40
Stony Creek, below Black Butte Dam	379	ScV	[e]	6/3/2011	20
Glenn County (part)					
Stony Creek, N of Co. Rd. 7	315	ScV	[e]	6/3/2011	5
Stony Creek, W of I-5	277	ScV	SV	6/3/2011	7
Walker Creek near Artois	176	ScV	SV	6/9/2011	10
Sacramento River, Mile 180-2 (Jacinto Unit)	84	ScV	SV	5/5/2011	5
Sacramento River, Mile 173 (Larkins Childrens Rancho)	80	ScV	SV	5/5/2011	10
Sacramento River, Mile 166 (W of Afton)	75	ScV	SV	5/5/2011	3
Howard Slough, at Butte Creek	62	ScV	SV	6/3/2011	30
Butte County					
Sacramento River, Mile 188 (W of Murphy's Slough)	123	ScV	SV	6/3/2011	35
Sacramento River, Mile 180.5-1 (Llano Seco easement)	99	ScV	SV	May 2011	5
Llano Seco Rancho, Angel Slough	102	ScV	SV	5/16/2011	12
Gray Lodge WA					
Colony 1	57	ScV	SV	5/24/2011	13
Colony 2	77	SV	SV	5/24/2011	3
Wyman Ravine	102	ScV	SV	6/3/2011	125
Colusa County					
Sacramento River, Mile 162 (Boggs Bend)	82	ScV	SV	5/5/2011	40
Butte Sink, nr. confluence Butte Creek and Angel Slough	54	ScV	SV	5/6/2011	50

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Sacramento River, Mile 157 (Compton Landing)	53	ScV	SV	5/5/2011	25
Stone Corral Creek	148	ScV	SV	5/19/2011	4
Sacramento River, Mile 148 (Colusa Indian Community)	57	ScV	SV	5/17/2011	13
Sacramento River, Mile 138 (Moons Bend)	46	ScV	SV	5/17/2011	19
Colusa NWR, T14.4	42	ScV	SV	5/20/2011	15
Sacramento River, Mile 129 (Twentymile Bar)	48	ScV	SV	5/5/2011	6
Sutter County					
Lower Butte Sink	52	ScV	SV	5/6/2011	10
Sutter Bypass W, NW of Hwy 20	45	ScV	SV	5/20/2011	6
Sutter Bypass W, E of Long Lake	37	ScV	SV	5/6/2011	20
Sutter Bypass W, N of Gilsizer Slough	27	ScV	SV	5/6/2011	40
Sutter Bypass W, N of Nelson Slough	27	ScV	SV	5/20/2011	22
Sutter Bypass W, E of Knight's Landing	18	ScV	SV	5/6/2011	20
Sutter NWR, T1.2	32	ScV	SV	3/9/2011	38
Feather River, Mile 20 (Abbott Lake)	42	ScV	SV	5/5/2011	40
Feather River, Mile 17 (O'Connor Lakes)	40	ScV	SV	5/5/2011	3
Coon Creek, Trowbridge U	43	ScV	SV	5/24/2011	5
Sacramento River, Mile 81 (Fremont Landing)	29	ScV	SV	5/6/2011	10
Sacramento River, Mile 75.5 (Sutter-Sac Co. Line)	32	ScV	SV	5/5/2011	6
Yuba County (part)					
South Honcut (Prairie) Creek	99	ScV	SV	5/6/2011	4
Feather River, Mile 41.5 (Live Oak)	67	ScV	SV	5/6/2011	60
Reed's Creek, at Hwy 70	51	ScV	SV	5/6/2011	10
Feather River, Mile 13 (Lake of the Woods)	32	ScV	SV	5/5/2011	20
Placer County (part)					
Coon Creek Triangle	86	ScV	SV	5/6/2011	10
Lincoln 1	182	ScV	SV	5/10/2011	10
Lincoln 2	147	ScV	SV	5/18/2011	3
Auburn Ravine	73	ScV	SV	5/6/2011	5
Yolo County (part)					
Cache Creek, above Capay Dam	224	ScV	[e]	6/3/2011	16
Sacramento River, Mile 102.5 (Beaver Lake)	32	ScV	SV	5/24/2011	27
Knights Landing Ridge Cut	27	ScV	SV	5/5/2011	10

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Sacramento River, Mile 69.5 (Elkhorn Regional Park)	32	ScV	SV	5/30/2011	29
Sacramento River DWSC, Mile 39 (Yolo Bypass WA)	26	ScV	SV	4/5/2011	53
Putah Creek, E of Winters	117	ScV	SV	5/22/2011	7
Putah Creek, below Lake Solano Dam	120	ScV	SV	6/3/2011	10
Little Holland Tract	11	ScV	SV	5/19/2011	20
Liberty Island	7	ScV	SV	5/19/2011	10
Liberty Cut #1	11	ScV	SV	5/19/2011	4
Liberty Cut #2	8	ScV	SV	5/19/2011	2
Solano County (part)					
Haas Slough	-2	ScV	DE	5/19/2011	12
Campbell Ranch	22	ScV	SV	4/16/2011	16
Sacramento River DWSC, Mile 22.5	5	ScV	DE	5/19/2011	12
Prospect Slough	-2	ScV	DE	5/19/2011	1
Sacramento River DWSC, Mile 21.5	10	ScV	DE	5/19/2011	5
Willota Drive	51	ScV	[e]	5/6/2011	4
Steamboat Slough, Mile 21 (Howard Landing Ferry)	5	ScV	DE	5/19/2011	10
Sacramento River DWSC, Mile 19	-1	ScV	DE	5/19/2011	5
Volanti	5	ScV	SM	5/25/2011	10
Bohannon	6	ScV	SM	5/25/2011	16
Joice Island Annex and South	5	ScV	SM	5/25/2011	10
Sacramento River, Mile 8 (Decker Island)	1	ScV	DE	5/16/2011	22
Wheeler	4	ScV	SM	5/25/2011	4
Spoonbill	3	ScV	SM	5/25/2011	9
Sacramento County (part)					
Dry Creek, Hansen 2	30	ScV	SV	5/29/2011	15
American River, Mississippi Bar	135	ScV	SV	5/7/2011	13
American River, Sacramento Bar 2	76	ScV	SV	5/31/2011	2
American River, William Pond	40	ScV	SV	5/29/2011	8
Cosumnes River, Mile 32 (Rancho Murieta)	134	ScV	DE	5/13/2011	12
SRCSD Bufferlands					
Lost Lake	5	ScV	DE	3/17/2011	3
Morrison Creek #2	4	ScV	DE	3/9/2011	47
Stone Lakes NWR					
North Stone Lake	7	ScV	DE	3/31/2011	11
Sun River	7	ScV	DE	3/13/2011	9

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Cosumnes River Preserve					
Horseshoe Lake	35	ScV	DE	5/15/2011	26
Laguna Creek	18	ScV	DE	6/3/2011	1
Tall Forest	8	ScV	DE	5/19/2011	30
Snodgrass Slough	7	ScV	DE	5/19/2011	12
Steamboat Slough, Mile 18.5 (Walker Landing)	6	ScV	DE	5/19/2011	9
Sacramento River, Mile 14 (Brannan Island)	4	ScV	DE	5/19/2011	15
Sherman Lake	3	ScV	DE	5/25/2011	14
Andrus Island (Delta Loop)	7	ScV	DE	5/19/2011	30
Ecoregion total					***1465***
SAN JOAQUIN VALLEY					
Contra Costa County (part)					
Piper and Sand Mound Sloughs	4	SnJV	[e]	5/19/2011	17
Palm Tract	5	SnJV	[e]	5/23/2011	6
Eucalyptus Island	11	SnJV	DE	5/13/2011	100
Alameda County (part)					
Arroyo del Valle, Shadow Cliffs Regional Park	357	SnJV	[e]	4/4/2011	15
San Joaquin County					
Mokelumne River, W of Hwy 88	84	SnJV	DE	5/13/2011	20
Mokelumne River, Mile 41	44	SnJV	DE	5/13/2011	6
White Slough Wildlife Area	2	SnJV	DE	5/25/2011	37
Potato Slough	17	SnJV	DE	5/19/2011	2
Calaveras River, Duck Creek Mouth	129	SnJV	DE	5/13/2011	10
Venice Tip #2	20	SnJV	DE	5/19/2011	6
Rindge Tract	6	SnJV	DE	5/13/2011	25
Connection Slough	5	SnJV	DE	5/19/2011	5
San Joaquin River, Mile 33.5 (Walters Island)	1	SnJV	DE	5/19/2011	80
Woodward Island	4	SnJV	DE	5/23/2011	27
San Joaquin River, Mile 45	8	SnJV	DE	5/23/2011	15
San Joaquin River, Mile 60 (Paradise Cut)	8	SnJV	DE	5/13/2011	22
Stanislaus County					
Woodward Reservoir	253	SnJV	DE	6/4/2012	7
Stanislaus River, Mile 53 (Knight's Ferry)	160	SnJV	[e]	5/13/2011	15
Stanislaus River, Mile 44 (Kerr Park)	120	SnJV	DE	5/13/2011	13
Stanislaus River, Mile 39.5 (Oakdale)	101	SnJV	SJB	5/13/2011	30
San Joaquin River, Mile 79 (San Joaquin River NWR, GC-1)	32	SnJV	SJB	2/23/2012	32
San Joaquin River, Mile 94.5 (Modesto WTP)	42	SnJV	SJB	5/15/2012	1

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Tuolumne River, Mile 35.5	96	SnJV	SJB	5/15/2012	23
Tuolumne River, Mile 38	121	SnJV	SJB	5/15/2012	8
Tuolumne River, Mile 27	67	SnJV	SJB	5/15/2012	4
Merced County					
Merced River, Mile 41	175	SnJV	SJB	5/16/2012	15
Merced River, Mile 35	131	SnJV	SJB	5/16/2012	10
San Joaquin River, Mile 113 (West Hilmar WA)	58	SnJV	SJB	5/15/2012	5
Yosemite Lake	257	SnJV	SJB	5/21/2012	17
San Joaquin River, Mile 121 (SE of Hills Ferry)	58	SnJV	SJB	5/15/2012	35
Eastside Canal 1	91	SnJV	SJB	5/31/2012	3
Eastside Canal 2	90	SnJV	SJB	5/21/2012	4
San Joaquin River, Mile 127.5 (Great Valley Grasslands SP)	67	SnJV	SJB	5/15/2012	26
San Luis NWR					
Colony 8 (FT-1A)	67	SnJV	SJB	2/28/2012	47
Colony1, San Joaquin River	71	SnJV	SJB	5/15/2012	18
Colony 5 (WB-3)	78	SnJV	SJB	3/19/2012	69
Colony 7 (EB-4), San Joaquin River	82	SnJV	SJB	2/16/2012	127
Eastside Bypass	81	SnJV	SJB	5/15/2012	8
Merced NWR					
Colony AP-1	92	SnJV	SJB	2/23/2012	13
Colony DS-1	108	SnJV	SJB	3/19/2012	6
Colony HO-1	110	SnJV	SJB	2/15/2012	13
Colony MB-2	98	SnJV	SJB	3/19/2012	1
San Joaquin River, Turner Island	92	SnJV	SJB	5/15/2012	45
San Luis Creek (NE of Santa Nella)	118	SnJV	SJB	5/19/2012	12
South Grasslands 1	103	SnJV	SJB	5/18/2012	29
South Grasslands 2	100	SnJV	SJB	5/18/2012	8
Central Dos Palos	117	SnJV	SJB	6/7/2012	1
Madera County					
Chowchilla River	362	SnJV	[e]	5/16/2012	25
San Joaquin River at Millerton Dam	392	SnJV	[e]	5/20/2012	6
San Joaquin River, near Lone Willow Slough	127	SnJV	SJB	5/18/2012	8
San Joaquin River, Firebaugh	143	SnJV	SJB	5/18/2012	14
San Joaquin River, Sycamore Island	263	SnJV	[e]	5/11/2012	9
Fresno County					
San Joaquin River, Rank Island 1	285	SnJV	[e]	5/21/2012	7
San Joaquin River, Rank Island 2	285	SnJV	[e]	5/21/2012	8
Dry Creek, W of Hwy 168	568	SnJV	[e]	5/12/2012	8

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
San Joaquin River, River Mile 242.5	224	SnJV	SJB	5/10/2012	2
San Joaquin River, S of Firebaugh	146	SnJV	SJB	5/18/2012	17
Byrd Slough	382	SnJV	[e]	5/12/2012	41
Mendota WA, Fresno Slough	161	SnJV	TB	3/26/2012	69
Kings County					
Boggs Slough 2	213	SnJV	TB	5/8/2012	50
Kent and 12th Ave.	220	SnJV	TB	5/14/2012	2
South Wilbur Flood Area, Tulare Lake Drainage District	195	SnJV	TB	5/9/2012	12
Tulare County (part)					
Kaweah River 1	490	SnJV	[e]	5/13/2012	9
Kaweah River 2	444	SnJV	[e]	5/8/2012	15
Kaweah River 3	394	SnJV	[e]	5/8/2012	60
Tule River, at Creighton Ranch	223	SnJV	TB	5/9/2012	80
Porterville	475	SnJV	[e]	5/13/2012	22
Kern County					
Kern River, Hart Park Lake	491	SnJV	[e]	5/3/2012	5
Kern County Water Agency	409	SnJV	[e]	5/21/2012	3
Ecoregion total					***1510***
CASCADE RANGE					
Siskiyou County (part)					
Klamath River, below Copco Dam	2486	CaR	–	5/20/2009	15
Klamath River, Mile 188.5 (Blue Heron RV Park)	2186	CaR	–	5/19/2009	11
Lake Shastina	2809	CaR	–	5/13/2009	10
Lassen County					
Eagle Lake, NW of Slough Point	5145	CaR	–	5/21/2009	4
Shasta County					
Lake Shasta, Turntable Bay	1185	CaR	–	5/27/2012	3
Tehama County (part)					
Sacramento River, Mile 272 (Bloody Island)	356	CaR	–	5/5/2011	5
Sacramento River, Mile 259 (Lookout Mtn.)	303	CaR	–	5/5/2011	12
Ecoregion total					***60***

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
SIERRA NEVADA					
Plumas County					
Lake Almanor, nr. Canyon Dam Boat Launch	4515	SN	–	5/22/2009	12
Indian Valley, nr. Crescent Mills	3597	SN	–	5/15/2009	2
Yuba County (part)					
Yuba River, above Daguerra Point Dam	132	SN	SV	6/3/2011	60
Placer County (part)					
Doty Ravine	240	SN	SV	5/17/2011	18
Sacramento County (part)					
Dry Creek, County Line	173	SN	DE	5/13/2011	8
American River, Folsom Prison	132	SN	[f]	5/7/2011	15
El Dorado County					
Folsom Lake					
Anderson Island	469	SN	–	5/7/2011	10
Lake Hills	469	SN	–	5/25/2011	5
Indian Creek	1526	SN	–	5/15/2011	2[d]
Amador County					
Dry Creek, Amador	188	SN	DE	5/13/2011	5
Calaveras County					
South Camanche Reservoir	271	SN	[f]	5/13/2011	40
Calaveras River, Jenny Lind	212	SN	[f]	5/30/2011	21
Rock Creek	348	SN	–	4/17/2011	2
Copperopolis, Stage Coach Rd.	839	SN	–	5/30/2011	6
Tuolumne County					
Lake Don Pedro Marina	830	SN	–	5/21/2012	7
Mariposa County					
Fish Camp	4998	SN	–	6/14/2012	1
Stanislaus County (part)					
Tuolumne River, Mile 49	183	SN	[f]	5/15/2012	4
Tuolumne River, Mile 48	165	SN	[f]	5/15/2012	5
Tuolumne River, Mile 41	143	SN	SJB	5/15/2012	18
Tuolumne River, Mile 45	153	SN	SJB	5/15/2012	20
Tulare County (part)					
Tule River, River Island	738	SN	–	5/14/2012	18
Tule River, South Fork	798	SN	–	5/13/2012	11
Ecoregion total					***290***

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
MODOC PLATEAU					
Siskiyou County (part)					
Lower Klamath NWR, Sheepy Lake	4083	MP	–	5/12/2009	8
Modoc County					
Clear Lake NWR, islands	4484	MP	–	5/12/2009	26
Baum Lake	2993	MP	–	5/23/2009	34
Ecoregion total					***68***
EAST OF SIERRA NEVADA					
Mono County					
Owens River, upper	7095	SE	–	5/18/2009	14
Inyo County					
Round Valley	4528	SNE	–	mid-Mar 2012	1
Owens River, Pleasants Valley	4267	SNE	–	5/11/2009	3
Bishop Airport (Wye Rd.)	4138	SNE	–	3/24/2012	10
Big Pine (Baker Creek)	4014	SNE	–	3/29/2012	5
Fort Independence	3864	SNE	–	4/18/2012	17
Reinhackle Spring	3752	SNE	–	4/18/2012	7
Lone Pine	3761	SNE	–	5/4/2009	1
Ecoregion total					***58***
MOJAVE DESERT					
San Bernardino County (part)					
Mojave Narrows	2763	DMoj	–	4/24/2012	8
Ecoregion total					***8***
SONORAN DESERT					
Riverside County (part)					
Palo Verde Valley, F Canal	278	DSon	–	5/31/2012	6
Palo Verde Valley, 34th Ave.	244	DSon	–	5/31/2012	4
Salton Sea (part)					
Arthur Street	-226	DSon	–	3/30/2012	2
Johnson Street	-233	DSon	–	3/30/2012	106
Whitewater River Delta	-233	DSon	–	3/30/2012	6
76th Ave	-233	DSon	–	3/30/2012	136
81st Ave	-233	DSon	–	3/30/2012	67
83rd Ave	-233	DSon	–	3/30/2012	3
84th Ave	-233	DSon	–	3/30/2012	18

Table 4 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Regions[b]	Survey Date	Estimated Pairs[c]
Imperial County					
Salton Sea (part)					
Mallard Rd duck club	-214	DSon	–	3/29/2012	96
Imperial WA, Wister Unit, 515 Reservoir	-213	DSon	–	6/6/2012	15
Wister Offshore	-231	DSon	–	3/23/2012	28
Mullet Island	-200	DSon	–	2/15/2012	25
Alamo River Delta	-232	DSon	–	3/23/2012	3
Morton Bay	-228	DSon	–	6/6/2012	20
Red Hill Bay	-233	DSon	–	3/23/2012	10
Salton Sea Test Base	-233	DSon	–	3/23/2012	38
Obsidian Butte	-233	DSon	–	3/23/2012	24
San Felipe Creek/Wash	-233	DSon	–	3/23/2012	48
New River Delta	-233	DSon	–	3/23/2012	37
Elmore Desert Ranch	-231	DSon	–	3/23/2012	10
Trifolium Drain	-233	DSon	–	3/23/2012	4
Imperial WA, Finney-Ramer Unit, Ramer Lake	-174	DSon	–	3/29/2012	15
Ecoregion total					***721***
GRAND TOTAL					**5517**

[a]Ecoregions of California are those of the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of the two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley. –, CVJV subregions do not apply to the listed Jepson ecoregion.

[c]Pairs estimated from direct count of nests (1 nest = 1pair) unless otherwise noted.

[d]Because of distant or obscured views of the colony, the number of pairs estimated by dividing the count of adults by two.

[e]Mismatch between Jepson and CVJV area boundaries. In this case, all such colonies fall within either the Jepson Sacramento Valley or San Joaquin Valley ecoregions but not within any of the subdivisions of the Central Valley as defined by the CVJV. Such colonies may or may not occur at elevations higher than 300 ft., the CVJV's upper elevation boundary for the Central Valley.

[f]Mismatch between Jepson and CVJV area boundaries. In this case, all such colonies fall within the Jepson Sierra Nevada ecoregion, but also either (1) fall within one of the CVJV subdivisions of the Central Valley or (2) do not fall within a specific CVJV subdivision but occur below 300 ft. elevation, the CVJV's upper elevation boundary for the Central Valley.

Table 5 Estimated Numbers of Pairs of Great Egrets at Colonies in California by Ecoregion, 2009–2012

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
NORTHWESTERN CALIFORNIA					
Del Norte County					
Mudhen Village	51	NW	–	8/26/2011	5
Prince Island	100	NW	–	6/4/2011	3
Humboldt County					
Hookton Slough	60	NW	–	6/1/2011	45
Indian Island	9	NW	–	6/18/2011	60
Lake County					
Clear Lake					
Upper Rodman Slough	1326	NW	–	5/22/2011	9
Lower Rodman Slough	1330	NW	–	5/22/2011	2
Slater Island, Anderson Marsh	1360	NW	–	5/22/2011	11
Sonoma County (part)					
Fitch Mountain	171	NW	–	5/24/2011	3
Chalk Hill Road	208	NW	–	5/6/2011	8
Delta Pond	55	NW	–	4/3/2011	6
West 9th St, Santa Rosa	131	NW	–	5/11/2011	61
Ecoregion total					***213***
CENTRAL WESTERN CALIFORNIA					
Sonoma County					
Bodega Bay Flat Road #1	10	CW	–	5/6/2011	10
Valley Ford	86	CW	–	5/6/2011	21
Petaluma Wastewater Plant	14	CW	–	5/2/2011	20
Sears Point	3	CW	–	5/11/2011	17
Napa County					
Congress Valley	157	CW	–	6/18/2011	17
South Kelly	144	CW	–	6/5/2011	53
Solano County (part)					
Gold Hill	12	CW	–	6/18/2011	108
Marin County					
Blake's Landing South	93	CW	–	6/8/2011	15
Inverness Park	87	CW	–	5/6/2011	2
Bel Marin Keys	7	CW	–	5/9/2011	34
Tree Farm	63	CW	–	5/5/2011	12
Drakes Estero	54	CW	–	6/18/2011	6
Picher Canyon	160	CW	–	5/6/2011	66
Bolinas and Kent	6	CW	–	7/5/2011	4
West Marin Island	45	CW	–	6/2/2011	61

Table 5 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
Contra Costa County					
San Pablo Dam	334	CW	–	4/26/2011	16
Alameda County					
Bay Farm Island, Alameda	7	CW	–	5/21/2011	14
Ruus Park	16	CW	–	5/22/2011	38
Lakeshore Park, Newark	21	CW	–	5/22/2011	6
Lake Elizabeth	55	CW	–	6/20/2011	9
Santa Clara County					
Shorebird Way	17	CW	–	4/5/2011	40
Almaden Lake	193	CW	–	4/3/2011	16
Llagas Creek, Morgan Hill	336	CW	–	6/18/2011	10
Santa Cruz County					
Pinto Lake	130	CW	–	5/24/2011	11
Monterey County					
Elkhorn Slough	20	CW	–	6/13/2011	22
San Luis Obispo County					
Twitchell Reservoir	750	CW	–	5/31/2011	1
Morro Bay State Park, Fairbank Point	15	CW	–	5/19/2011	7
Ecoregion total					***636***
SOUTHWESTERN CALIFORNIA					
Santa Barbara County					
Goleta Beach Co. Park	11	SW	–	5/20/2012	8
Los Angeles County					
Malibu Lagoon, Malibu Country Mart	14	SW	–	5/23/2012	3
Marina del Rey, Admiralty Way	20	SW	–	6/5/2012	1
Orange County					
San Diego Creek	33	SW	–	6/25/2012	5
Riverside County (part)					
Lake Elsinore					
Nebraska St.	1269	SW	–	5/5/2012	22
Rome Hill	1259	SW	–	5/5/2012	50
San Diego County					
Lake Wohlford	1484	SW	–	6/5/2012	4[d]
Batiquitos Lagoon, Aviara Cove	18	SW	–	5/18/2012	1[d]
Escondido Creek	28	SW	–	5/20/2012	12
Lindo Lake	407	SW	–	6/6/2012	25
Naval Base Point Loma, SSC, Entrance	28	SW	–	5/25/2012	17

Table 5 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
Naval Base Point Loma, Main Base					
Between Bldg 211 & 140	30	SW	–	7/13/2012	1
Command Ctr between Bldgs 138 & 139	45	SW	–	6/8/2012	1
Ecoregion total					***150***
SACRAMENTO VALLEY					
Tehama County (part)					
Sacramento River, Mile 236 (Mooney Island)	239	ScV	SV	5/5/2011	80
Sacramento River, Mile 232 (Flynn Unit)	212	ScV	SV	5/5/2011	2
Sacramento River, Mile 219 (Woodson Bridge)	175	ScV	SV	5/5/2011	2
Sacramento River, Mile 209.5 (Burch Creek)	152	ScV	SV	5/5/2011	80
Glenn County					
Stony Creek, W of I-5	277	ScV	SV	6/3/2011	15
Walker Creek near Artois	176	ScV	SV	6/3/2011	160
Co Rd 39	158	ScV	SV	6/14/2011	20
Sacramento River, Mile 180-2 (Jacinto Unit)	84	ScV	SV	5/5/2011	30
Sacramento River, Mile 173 (Larkins Childrens Rancho)	80	ScV	SV	5/5/2011	20
Howard Slough, at Butte Creek	62	ScV	SV	6/3/2011	250
Butte County					
Sacramento River, Mile 188 (W of Murphy's Slough)	123	ScV	SV	6/3/2011	3
Llano Seco Rancho, Angel Slough	102	ScV	SV	5/5/2011	180
Sacramento River, Mile 180.5-1 (Llano Seco easement)	99	ScV	SV	May	5
Wyman Ravine	102	ScV	SV	6/3/2011	350
Gray Lode WA					
Colony 1	57	ScV	SV	5/24/2011	41
Colony 2	77	ScV	SV	5/24/2011	1
Colusa County					
Sacramento River, Mile 162 (Boggs Bend)	82	ScV	SV	5/5/2011	150
Butte Sink, nr. confluence Butte Creek and Angel Slough	54	ScV	SV	5/6/2011	250
Sacramento River, Mile 157 (Compton Landing)	53	ScV	SV	5/5/2011	10
Stone Corral Creek	148	ScV	SV	5/19/2011	39

Table 5 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
Sacramento River, Mile 148 (Colusa Indian Community)	57	ScV	SV	5/5/2011	330
Sacramento River, Mile 138 (Moons Bend)	46	ScV	SV	5/5/2011	50
Colusa NWR, T14.4	42	ScV	SV	5/20/2011	10
Sacramento River, Mile 129 (Twentymile Bar)	48	ScV	SV	5/5/2011	80
Sycamore Slough	43	ScV	SV	5/29/2011	36
Sacramento River, Mile 120 (Tisdale Weir)	34	ScV	SV	5/5/2011	230
Sutter County					
Lower Butte Sink	52	ScV	SV	5/6/2011	30
Sutter Bypass W, NW of Hwy 20	45	ScV	SV	5/20/2011	1
Sutter Bypass W, E of Long Lake	37	ScV	SV	5/6/2011	120
Sutter NWR, T1.2	32	ScV	SV	5/18/2011	17
Feather River, Mile 20 (Abbott Lake)	42	ScV	SV	5/5/2011	190
Feather River, Mile 17 (O'Connor Lakes)	40	ScV	SV	5/5/2011	30
Sutter Bypass W, N of Gilsizer Slough	27	ScV	SV	5/6/2011	60
Sutter Bypass W, N of Nelson Slough	27	ScV	SV	5/20/2011	21
Coon Creek, Trowbridge U	43	ScV	SV	5/6/2011	120
Sutter Bypass W, E of Knight's Landing	18	ScV	SV	5/6/2011	20
Sacramento River, Mile 81 (Fremont Landing)	29	ScV	SV	5/6/2011	30
Sacramento River, Mile 75.5 (Sutter-Sac Co. Line)	32	ScV	SV	5/5/2011	1
Yuba County					
South Honcut (Prairie) Creek	99	ScV	SV	5/6/2011	16
Feather River, Mile 41.5 (Live Oak)	67	ScV	SV	5/6/2011	50
Reed's Creek, at Hwy 70	51	ScV	SV	5/6/2011	20
Feather River, Mile 13 (Lake of the Woods)	32	ScV	SV	5/5/2011	40
Placer County					
Coon Creek Triangle	86	ScV	SV	5/6/2011	60
Lincoln 1	182	ScV	SV	5/10/2011	36
Auburn Ravine	73	ScV	SV	5/6/2011	70
Yolo County					
Sacramento River, Mile 102.5 (Beaver Lake)	32	ScV	SV	5/24/2011	97
Knights Landing Ridge Cut	27	ScV	SV	5/5/2011	60
Sacramento River, Mile 69.5 (Elkhorn Regional Park)	32	ScV	SV	5/30/2011	131
Co Rd 103 (Tauzer)	42	ScV	SV	5/15/2011	50

Table 5 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
Sacramento River DWSC, Mile 39 (Yolo Bypass WA)	26	ScV	SV	4/5/2011	1
Solano County					
Weber and Fox	66	ScV	SV	6/1/2011	29
Campbell Ranch	22	ScV	SV	4/18/2011	17
Willota Drive	51	ScV	SV	5/20/2011	31
Prospect Slough	-2	ScV	DE	5/19/2011	1
Steamboat Slough, Mile 21 (Howard Landing Ferry)	5	ScV	DE	5/19/2011	35
Bohannon	6	ScV	SM	5/25/2011	197
Joice Island Annex and South	5	ScV	SM	5/25/2011	26
Spoonbill	3	ScV	SM	5/25/2011	110
Sacramento County (part)					
Dry Creek, Hansen 2	30	ScV	SV	5/29/2011	24
American River, Mississippi Bar	135	ScV	SV	5/7/2011	50
American River, William Pond	40	ScV	SV	5/29/2011	11
Cosumnes River, Mile 32 (Rancho Murieta)	134	ScV	DE	5/13/2011	2
SRCSD Bufferlands, Morrison Creek #2	4	ScV	DE	4/8/2011	71
Cosumnes River Preserve					
Horseshoe Lake	35	ScV	DE	5/15/2011	126
Laguna Creek	18	ScV	DE	6/3/2011	3
Tall Forest	8	ScV	DE	5/19/2011	50
Sherman Lake	3	ScV	DE	5/25/2011	1
Ecoregion total					***4479***
SAN JOAQUIN VALLEY					
Sacramento County (part)					
Andrus Island (Delta Loop)	7	SnJV	DE	5/19/2011	60
Contra Costa County (part)					
Eucalyptus Island	11	SnJV	DE	5/13/2011	15
Alameda County (part)					
Arroyo del Valley, Shadow Cliffs Regional Park	357	SnJV	[e]	5/22/2011	8
San Joaquin County					
Mokelumne River, W of Hwy 88	84	SnJV	DE	5/13/2011	80
Mokelumne River, Mile 41	44	SnJV	DE	5/13/2011	9
White Slough Wildlife Area	2	SnJV	DE	5/25/2011	19
San Joaquin River, Mile 33.5 (Walters Island)	1	SnJV	DE	5/19/2011	70
San Joaquin River, Mile 45	8	SnJV	DE	5/23/2011	4

Table 5 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
Stanislaus County					
Woodward Reservoir	253	SnJV	DE	6/4/2012	62
Stanislaus River, Mile 53 (Knight's Ferry)	160	SnJV	[e]	5/13/2011	1
Stanislaus River, Mile 44 (Kerr Park)	120	SnJV	DE	5/13/2011	12
San Joaquin River, Mile 79 (San Joaquin River NWR, GC-1)	32	SnJV	SJB	5/15/2012	175
Tuolumne River, Mile 38	121	SnJV	SJB	5/18/2012	4
Merced County					
Merced River, Mile 41	175	SnJV	SJB	5/16/2012	30
San Joaquin River, Mile 121 (SE of Hills Ferry)	58	SnJV	SJB	5/15/2012	110
Eastside Canal 2	90	SnJV	SJB	5/21/2012	16
San Luis NWR, Colony 8 (FT-1A)	67	SnJV	SJB	4/16/2012	28
San Joaquin River, Mile 127.5 (Great Valley Grasslands SP)	67	SnJV	SJB	5/15/2012	45
San Joaquin River, Turner Island	92	SnJV	SJB	5/15/2012	220
San Luis Creek (NE of Santa Nella)	118	SnJV	SJB	5/19/2012	33
Dos Palos High School	118	SnJV	SJB	6/7/2012	5
Madera County					
San Joaquin River at Millerton Dam	392	SnJV	[e]	5/20/2012	4
San Joaquin River, near Lone Willow Slough	127	SnJV	SJB	5/18/2012	1
San Joaquin River, Sycamore Island	263	SnJV	[e]	5/11/2012	18
Fresno County					
San Joaquin River, River Ranch	133	SnJV	SJB	5/18/2012	32
San Joaquin River, Rank Island 1	285	SnJV	[e]	5/21/2012	15
San Joaquin River, Rank Island 2	285	SnJV	[e]	5/21/2012	5
Dry Creek, W of Hwy 168	568	SnJV	[e]	5/12/2012	2
San Joaquin River, S of Firebaugh	146	SnJV	SJB	5/18/2012	30
Roeding Park, Storyland	297	SnJV	TB	5/10/2012	7
Byrd Slough	382	SnJV	[e]	5/8/2012	70
Kings County					
Boggs Slough 2	213	SnJV	TB	5/8/2012	50
Corcoran	198	SnJV	TB	5/19/2012	119
South Wilbur Flood Area, Tulare Lake Drainage District	195	SnJV	TB	5/9/2012	18
Tulare County (part)					
Kaweah River 1	490	SnJV	[e]	5/8/2012	12
Kaweah River 3	394	SnJV	[e]	5/13/2012	12

Table 5 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
Porterville	475	SnJV	[e]	5/13/2012	4
Alpaugh Irrigation District Reservoir	208	SnJV	TB	4/19/2013	5
Kern County					
Kern County Water Agency	409	SnJV	[e]	6/14/2012	9
Costerisan Farms Lake	329	SnJV	[e]	5/20/2012	94
Ecoregion total					***1513***
CASCADE RANGE					
Tehama County (part)					
Sacramento River, Mile 272 (Bloody Island)	356	CaR	–	5/5/2011	100
Sacramento River, Mile 259 (Lookout Mtn.)	303	CaR	–	5/5/2011	2
Ecoregion total					***102***
SIERRA NEVADA					
Yuba County (part)					
Yuba River, above Daguerra Point Dam	132	SN	SV[f]	6/3/2011	85
Placer County (part)					
Doty Ravine	240	SN	SV[f]	5/17/2011	12
Amador County					
Dry Creek, Amador	188	SN	DE[f]	5/13/2011	1
Calaveras County					
South Camanche Reservoir	271	SN	[f]	5/13/2011	70
Calaveras River, Jenny Lind	212	SN	[f]	5/30/2011	4
Copperopolis, Stage Coach Rd.	839	SN	–	5/30/2011	16
Stanislaus County					
Tuolumne River, Mile 48	165	SN	[f]	5/15/2012	15
Tuolumne River, Mile 41	143	SN	SJB[f]	5/15/2012	12
Tulare County (part)					
Tule River, River Island	738	SN	–	5/9/2012	15
Ecoregion total					***230***
MODOC PLATEAU					
Siskiyou County					
Lower Klamath NWR					
Unit 6A	4083	MP	–	6/23/2009	94[g]
Unit 12C	4083	MP	–	5/29/2009	328
Modoc County					
Tule Lake NWR, Sump 1B	4037	MP	–	5/27/2009	40

Table 5 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV[b] Regions	Survey Date	Estimated Pairs[c]
Clear Lake NWR					
islands	4484	MP	–	5/12/2009	9
"The U" willows	4484	MP	–	5/27/2009	22
Lassen County					
Leavitt Lake					
Northeast	4100	MP	–	7/6/2010	25[h]
Southwest	4100	MP	–	7/7/2010	3[h]
Ecoregion total					***521***
SONORAN DESERT					
Riverside County (part)					
Palo Verde Valley, F Canal	278	DSon	–	5/31/2012	3
Palo Verde Valley, 34th Ave.	244		–	5/31/2012	1
Imperial County					
Salton Sea					
Mallard Rd duck club	-214	DSon	–	6/6/2012	45
Imperial WA, Wister Unit, 515 Reservoir	-213	DSon	–	6/6/2012	3
Morton Bay	-224	DSon	–	6/6/2012	1
Imperial WA, Finney-Ramer Unit, Ramer Lake	-174	DSon	–	6/5/2012	76
Ecoregion total					***129***
GRAND TOTAL					**7973**

[a]Ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; SV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley.

[c]Pairs estimated from direct count of nests (1 nest = 1pair) unless otherwise noted.

[d]Because of distant or obscured views of the colony, the number of pairs estimated by dividing the count of adults by two.

[e]Mismatch between Jepson and CVJV area boundaries. In this case, all such colonies fall within the Jepson San Joaquin Valley ecoregion, but do not fall within any of the CVJV subdivisions of the Central Valley. Most, but not all, of these colonies occur at elevations higher than 300 ft., the CVJV's upper elevation boundary for the Central Valley.

[f]Mismatch between Jepson and CVJV area boundaries. In this case, all such colonies fall within the Jepson Sierra Nevada ecoregion, but also either (1) fall within one of the CVJV subdivisions of the Central Valley or (2) do not fall within a specific CVJV subdivision but occur below 300 ft. elevation, the CVJV's upper elevation boundary for the Central Valley.

Table 5 (cont'd)

[g]Number of pairs of egret species estimated by dividing by two the count of adults from an airboat survey of a nesting colony located in various tall tule patches, where nests were difficult to count without undue disturbance. The proportion of Great to Snowy egrets was estimated from the ratio of the two species counted when flying out of the colony after dawn on a subsequent date.

[h]Number of nesting pairs estimated as equivalent to the number of Great Egrets flying out of the colony after dawn with the assumption that one adult remained behind at the nest.

Table 6 Estimated Numbers of Pairs of Snowy Egrets at Colonies in California by Ecoregion, 2009–2012

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
NORTHWESTERN CALIFORNIA					
Del Norte County					
Prince Island	100	NW	–	4 June 2011	30
Humboldt County					
Indian Island	9	NW	–	18 June 2011	1
Hookton Slough	60	NW	–	1 June 2011	1
Sonoma County (part)					
West 9th St, Santa Rosa	131	NW	–	11 May 2011	93
Ecoregion total					***125***
CENTRAL WESTERN CALIFORNIA					
Sonoma County (part)					
McNear Channel	14	CW	–	16 May 2011	16
Petaluma Wastewater Plant	14	CW	–	2 April 2011	2
Napa County					
Congress Valley	157	CW	–	18 June 2011	9
South Kelly	144	CW	–	8 May 2011	86
Solano County (part)					
Gold Hill	12	CW	–	22 June 2011	91
Marin County					
West Marin Island	45	CW	–	2 June 2011	89
San Francisco County					
Alcatraz Island	22	CW	–	9 May 2011	83
Alameda County					
Bay Farm Island, Alameda	7	CW	–	20 June 2011	16
Ruus Park	16	CW	–	12 June 2011	10
Lakeshore Park, Newark	21	CW	–	22 May 2011	76
Lake Elizabeth	55	CW	–	20 June 2011	84
Santa Clara County					
Palo Alto Baylands	7	CW	–	9 July 2011	17
Shorebird Way	17	CW	–	11 July 2011	5
Vasona Reservoir Island	303	CW	–	7 May 2011	1
Almaden Lake	193	CW	–	3 June 2011	4
San Luis Obispo County					
Morro Bay Power Plant	5	CW	–	19 May 2011	18
Ecoregion total					***607***
SOUTHWESTERN CALIFORNIA					
Santa Barbara County					
Pershing Park	14	SW	–	5 June 2012	4

Table 6 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
Ventura County					
Point Mugu					
Lark and Oriole	7	SW	–	2 July 2010	2
BOQ	10	SW	–	24 May 2010	2
Rancho Simi Community Park	815	SW	–	15 May 2012	1[d]
Los Angeles County					
Malibu Lagoon, Malibu Country Mart	14	SW	–	23 May 2012	6
Marina del Rey					
Admiralty Way	20	SW	–	5 June 2012	2
Marquesas Way	11	SW	–	29 May 2012	25
Port of L.A./Long Beach					
Ferry St.		SW	–	8 June 2012	25
Catalina Landing	14	SW	–	3 June 2012	29
Belmont Shore	11	SW	–	2 June 2012	6
El Dorado Park, Duck Pond	14	SW	–	3 June 2012	3
Orange County					
Orange Co. Water District, Conrock Basin	255	SW	–	31 May 2012	50
Mile Square Park	51	SW	–	27 May 2012	20
Dana Point Harbor, Puerto Place South	6	SW	–	20 May 2012	27
Riverside County					
Lake Elsinore, Nebraska St.	1269	SW	–	5 May 2012	7
San Diego County					
Batiquitos Lagoon, Aviara Cove	18	SW	–	18 May 2012	2[e]
Solana Beach, Mellmo	64	SW	–	20 May 2012	74
Lake Wohlford	1484	SW	–	5 June 2012	4[e]
San Diego Zoo, Safari Park, African Loop		SW	–	5 June 2012	2
Lindo Lake	407	SW	–	6 June 2012	20
Mission Bay, Sea World	20	SW	–	11 June 2012	18
Naval Air Station North Island					
HR (Bldg 252)	21	SW	–	11 May 2012	19
HR (Bldg 277)	22	SW	–	22 June 2012	1
Read Rd (Bldg 465)	26	SW	–	8 June 2012	7
Naval Base San Diego, NAVFAC Public Works (Bldg 121)	11	SW	–	25 May 2012	14
Imperial Beach Sports Park	20	SW	–	19 May 2012	5
Ecoregion total					***375***
SACRAMENTO VALLEY					
Glenn County					
Willows, Circle K	137	ScV	SV	9 June 2011	56

Table 6 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
Sacramento River, Mile 173 (Larkins Childrens Rancho)	80	ScV	SV	5 May 2011	20
Butte County					
Gray Lodge WA					
Colony 1	57	ScV	SV	24 May 2011	4
Colony 2	77	ScV	SV	24 May 2011	3
Wyman Ravine	102	ScV	SV	3 June 2011	3[f]
Colusa County					
Maxwell					
Olive Ave.	95	ScV	SV	9 June 2011	7
Cosner Ave.	90	ScV	SV	13 June 2011	5
Sutter County					
Sutter Bypass W, N of Gilsizer Slough	27	ScV	SV	20 May 2011	1
Feather River, Mile 20 (Abbott Lake)	42	ScV	SV	5 May 2011	30
Yolo County					
Hillcrest Drive	117	ScV	SV	17 June 2011	50
Co Rd 103 (Tauzer)	42	ScV	SV	15 May 2011	110
Solano County (part)					
Willota Drive	55	ScV	SV	8 June 2011	8
Weber and Fox	66	ScV	SV	1 June 2011	177
Sacramento County					
Natomas Basin Conservancy, BKS Tract	19	ScV	SV	24 June 2011	12
Rio Linda, Magdelina St.	46	ScV	SV	25 June 2011	22
South Natomas, Aquino Dr.	13	ScV	SV	3 August 2011	15
Rosemont, Port Dr.	50	ScV	DE	30 May 2011	8
Sacramento, Summertide Way	25	ScV	DE	20 May 2011	19
Ecoregion total					***550***
SAN JOAQUIN VALLEY					
Merced County					
Dos Palos High School	118	ScJV	SJB	7 June 2012	15
Fresno County					
Oso de Oro Lake Park	318	ScJV	[g]	11 May 2012	16
Roeding Park, Storyland	297	ScJV	TB	10 May 2012	5
Kings County					
Corcoran	198	ScJV	TB	4 June 2012	30
South Wilbur Flood Area, Tulare Lake Drainage District	195	ScJV	TB	6 June 2012	40
Tulare County					
Alpaugh Irrigation District Reservoir	208	ScJV	TB	19 April 2013	3
Kern County					
Costerisan Farms Lake	329	ScJV	TB	20 May 2012	10[h]
Ecoregion total					***119***
SIERRA NEVADA					
Yuba County					
Yuba River, above Daguerra Point Dam	132	SN	SV	18 May 2011	2

Table 6 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
Placer County					
Doty Ravine	240	SN	SV	17 May 2011	1
Ecoregion total					***3***
MODOC PLATEAU					
Siskiyou County					
Lower Klamath NWR					
Unit 6A	4083	MP	–	23 June 2009	6[i]
Unit 12C	4083	MP	–	29 May 2009	22
Lassen County					
Leavitt Lake, Northeast	4100	MP	–	6 July 2010	10[j]
Ecoregion total					***38***
SONORAN DESERT					
Imperial County					
Salton Sea					
Imperial WA, Wister Unit, 515 Reservoir	-213	DSon	–	6 June 2012	26
Morton Bay	-224	DSon	–	6 June 2012	20
Imperial WA, Finney-Ramer Unit, Ramer Lake	-174	DSon	–	5 June 2012	25
Ecoregion total					***71***
GRAND TOTAL					**1888**

[a]Ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley. –, CVJV subregions do not apply to the listed Jepson ecoregion.

[c]Pairs estimated from direct count of nests (1 nest = 1pair) unless otherwise noted.

[d]One pair on the basis of two adults courting at nest.

[e]Difficult to see nests, so estimate based on count of adults divided by two.

[f]Rough estimate of at least 3 pairs from aerial survey.

[g]Mismatch between Jepson and CVJV area boundaries. In this case, the colony falls within the Jepson San Joaquin Valley ecoregion but not within any of the subdivisions of the Central Valley as defined by the CVJV; it also occurs at an elevation slightly higher than 300 ft., the CVJV's upper elevation boundary for the Central Valley.

[h]Partial count of one nest and about 15 other adults gave rough estimate of about 10 pairs.

[i]Estimate of unidentified egret species on 23 June boat survey apportioned by ratio of Great to Snowy egrets on 18 June dawn flyout count, then divided by two.

[j]Rough estimate from dawn flyout count.

Table 7 Estimated Numbers of Pairs of Cattle Egrets at Colonies in California by Ecoregion, 2011–2012

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey date	Estimated pairs[c]
NORTHWESTERN CALIFORNIA					
Sonoma County					
West 9th St, Santa Rosa	131	NW	–	21 April 2011	40
Ecoregion total					***40***
SOUTHWESTERN CALIFORNIA					
Riverside County					
San Jacinto WTP	1495	SW	–	10 May 2012	63
San Diego County					
San Diego Zoo, Safari Park, African Loop	418	SW	–	5 June 2012	61
Ecoregion total					***124***
SACRAMENTO VALLEY					
Glenn County					
Willows, Circle K	137	ScV	SV	9 June 2011	16
Colusa County					
Maxwell					
Olive Ave.	95	ScV	SV	9 June 2011	10
Cosner Ave.	90	ScV	SV	13 June 2011	20
Yolo County					
Hillcrest Drive	117	ScV	SV	17 June 2011	70
Co Rd 103 (Tauzer)	42	ScV	SV	15 May 2011	80
Solano County					
Weber and Fox	66	ScV	SV	1 June 2011	145
Sacramento County					
Rosemont, Port Dr.	50	ScV	DE	30 May 2011	20
Sacramento, Summertide Way	25	ScV	DE	20 May 2011	2
Ecoregion total					***363***
SAN JOAQUIN VALLEY					
Merced County					
Dos Palos High School	118	SnJV	SJB	7 June 2012	7[d]
Fresno County					
Oso de Oro Lake Park	318	SnJV	[e]	11 May 2012	13
Roeding Park, Storyland	297	SnJV	TB	10 May 2012	161
Kings County					
Corcoran	198	SnJV	TB	4 June 2012	36
Tulare County					
Alpaugh Irrigation District Reservoir	208	SnJV	TB	22 Apr 2012	138[f]

Table 7 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey date	Estimated pairs[c]
Kern County					
Costerisan Farms Lake	329	SnJV	TB	20 May 2012	30
Ecoregion total					***450***
SONORAN DESERT					
Imperial County					
Salton Sea					
Imperial WA, Wister Unit, 515 Reservoir	-213	DSon	–	6 June 2012	32
Morton Bay	-224	DSon	–	6 June 2012	155
Imperial WA, Finney-Ramer Unit, Ramer Lake	-174	DSon	–	5 June 2012	1514
Ecoregion total					***1701***
GRAND TOTAL					**2678[g]**

[a]Ecoregions used here are subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley. –, CVJV subregions do not apply to the listed Jepson ecoregion.

[c]Pairs estimated from direct count of nests (1 nest = 1pair) unless otherwise noted.

[d]Observer saw 7 nests and 15 adults in eucalyptus trees. Also saw 130 adults flying in and out of willows, but unable to approach closely to count nests. Estimated number of breeding birds as 14 in eucalyptus (7 nests x 2) and 130 in willows, for total of 144 (pairs = 72, i.e., 144÷2).

[e]Mismatch between Jepson and CVJV area boundaries. In this case, the colony falls within the Jepson San Joaquin Valley ecoregion but not within any of the subdivisions of the Central Valley as defined by the CVJV; it also occurs at an elevation slightly higher than 300 ft., the CVJV's upper elevation boundary for the Central Valley.

[f]Observer made dawn and dusk counts daily from 20–23 Apr at a time when egrets were engaged in nest building and incubation. Best count of 275 adults rounded to 276 and divided by two as estimate of number of breeding pairs.

[g]Overall total likely an underestimate. At three colonies in Kings (2) and Kern (1) counties, aerial surveys estimated 550 nests of Cattle/Snowy egrets. Observations on edge of one colony identified 30 Cattle Egrets nests, but the remainder of the egret nests at this and the other sites were not identified to species.

Table 8 Estimated Numbers of Pairs of Black-crowned Night-Herons at Colonies in California by Ecoregion, 2009–2012

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
NORTHWESTERN CALIFORNIA					
Del Norte County					
Prince Island	100	NW	–	4 June 2011	20
Tolowa Slough	13	NW	–	26 Aug 2011	10
Humboldt County					
Blue Lake					
Blue Lake Grange	80	NW	–	6 June 2011	12
Railroad Ave	80	NW	–	5 June 2011	5
Indian Island	9	NW	–	18 June 2011	5
Hookton Slough	60	NW	–	1 June 2011	8
Lake County					
Clear Lake, Library Park	1332	NW	–	22 May and 24 June 2011	74
Sonoma County (part)					
West 9th St, Santa Rosa	131	NW	–	21 April 2011	174
Ecoregion total					***308***
CENTRAL WESTERN CALIFORNIA					
Sonoma County (part)					
Bodega Bay, Bay Flat Road #1	10	CW	–	6 June 2011	2
Penngrove	110	CW	–	22 April 2011	21
Napa County					
Congress Valley	157	CW	–	18 June 2011	5
South Kelly	144	CW	–	5 June 2011	85
Solano County (part)					
Gold Hill	12	CW	–	22 June 2011	22
Marin County					
West Marin Island	45	CW	–	2 June 2011	48
San Francisco County					
Alcatraz Island	22	CW	–	13 June 2011	50
Alameda County					
Hayward Shoreline	6	CW	–	9 June 2011	4
Lakeshore Park, Newark	21	CW	–	5 March 2011	13
Lake Elizabeth	55	CW	–	9 May 2011	7
Santa Clara County					
Palo Alto Baylands	7	CW	–	2 April 2011	33
Vasona Reservoir Island	303	CW	–	7 May 2011	3
Almaden Lake	193	CW	–	3 Apr 2011	6
Lake Cunningham	130	CW	–	6 March 2011	2

Table 8 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
Monterey County					
Packard Ranch	10	CW	–	10 June 2011	3[d]
San Luis Obispo County					
Morro Bay Power Plant	5	CW	–	19 May 2011	37
Ecoregion total					***341***
SOUTHWESTERN CALIFORNIA					
Santa Barbara County					
Pershing Park	14	SW	–	5 June 2012	1
Ventura County					
Fremont Middle School	61	SW	–	28 May 2012	18
Point Mugu					
Lark and Oriole	7	SW	–	24 May 2010	8
BOQ	10	SW	–	18 June 2010	9
Rancho Simi Community Park	815	SW	–	15 May 2012	3
Los Angeles County (part)					
Malibu Lagoon, Malibu Country Mart	14	SW	–	23 May 2012	4
Marina del Rey					
Admiralty Way	20	SW	–	5 June 2012	1
Marquesas Way	11	SW	–	29 May 2012	24
Redondo Beach Esplanade	80	SW	–	3 May 2012	2
Port of L.A./Long Beach					
Port O'Call	10	SW	–	23 May 2012	6
Ferry St.	13	SW	–	8 June 2012	25
Catalina Landing	14	SW	–	3 June 2012	16
Harry Bridges	24	SW	–	12 June 2012	2
Belmont Shore	11	SW	–	2 June 2012	2
Alamitos Bay	11	SW	–	2 June 2012	1
El Dorado Park, Duck Pond	14	SW	–	3 June 2012	2
Orange County					
Dana Point Harbor, Puerto Place South	6	SW	–	20 May 2012	34
San Bernardino County					
Cucamonga-Guasti Regional Park	1004	SW	–	26 May 2012	23
Prado Basin, Prado Regional Park 3	531	SW	–	26 May 2012	1
Riverside County					
Lake Elsinore, Nebraska St.	1269	SW	–	5 May 2012	29
Canyon Lake	1394	SW	–	28 May 2012	1
San Diego County			–		
Oceanside Harbor	17	SW	–	18 May 2012	3
Lake Wohlford	1484	SW	–	5 June 2012	1[e]

Table 8 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
San Diego Zoo, Safari Park					
Lagoon Trail	536	SW	–	5 June 2012	2
African Loop	418	SW	–	5 June 2012	3
Solana Beach					
Acacia Ave.	62	SW	–	11 June 2012	2
Mellmo	64	SW	–	20 May 2012	11
Post Office	57	SW	–	20 May 2012	4
Lindo Lake	407	SW	–	6 June 2012	25
Naval Station North Island					
HR (Bldg 252)	21	SW	–	13 April 2012	59
HR (Bldg 277)	22	SW	–	13 April 2012	39
Bldg 277 Courtyard	20	SW	–	27 April 2012	4
Saufley St & Roosevelt Blvd (Bldg 6)	21	SW	–	9 March 2012	27
Read Rd (Bldg 465)	26	SW	–	25 May 2012	19
Naval Base San Diego					
NAVFAC Public Works (Bldg 121)	11	SW	–	8 June 2012	10
Donnelly Hall (Bldg 3362)	15	SW	–	9 March 2012	1
Imperial Beach Sports Park	20	SW	–	19 May 2012	8
Ecoregion total					***430***
SACRAMENTO VALLEY					
Glenn County					
Walker Creek near Artois	176	ScV	SV	9 June 2011	21
Co Rd 39	158	ScV	SV	14 June 2011	1[f]
Willows, Circle K	137	ScV	SV	9 June 2011	42
Butte County					
Gray Lodge WA					
Colony 1	57	ScV	SV	24 May 2011	15
Colony 2	77	ScV	SV	24 May 2011	4
Wyman Ravine	102	ScV	SV	26 May 2011	9
Colusa County					
Maxwell					
Olive Ave.	95	ScV	SV	9 June 2011	19
Cosner Ave.	90	ScV	SV	13 June 2011	8
Sacramento River, Mile 148 (Colusa Indian Community)	57	ScV	SV	17 May 2011	9
Sycamore Slough	43	ScV	SV	29 May 2011	21
Sacramento River, Mile 129 (Twentymile Bar)	48	ScV	SV	29 May 2011	1
Yolo County					
Sacramento River, Mile 102.5 (Beaver Lake)	32	ScV	SV	24 May 2011	28
Madison	148	ScV	SV	15 May 2011	16

Table 8 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
Co Rd 94B	118	ScV	SV	12 June 2011	50
Hillcrest Drive	117	ScV	SV	17 June 2011	90
Co Rd 103 (Tauzer)	42	ScV	SV	15 May 2011	360
Solano County (part)					
Weber and Fox	66	ScV	SV	1 June 2011	83
Bohannon	6	ScV	SM	25 May 2011	6
Sacramento County					
Natomas Basin Conservancy, BKS Tract	19	ScV	SV	26 May 2011	50
Rio Linda, Magdelina St.	46	ScV	SV	29 May 2011	13
South Natomas, Aquino Dr.	13	ScV	SV	3 August 2011	20
Rosemont, Port Dr.	50	ScV	DE	30 May 2011	8
SRCSD Bufferlands, 1992 Planting	3	ScV	DE	28 June 2011	1
Sacramento, Summertide Way	25	ScV	DE	20 May 2011	8
Elk Grove, Desta Court	30	ScV	DE	20 May 2011	6
Cosumnes River Preserve, Horseshoe Lake	35	ScV	DE	15 May 2011	1
Ecoregion total					***890***
SAN JOAQUIN VALLEY					
Merced County					
Dos Palos High School	118	SnJV	SJB	7 June 2012	35
Fresno County					
Oso de Oro Lake Park	318	SnJV	[g]	11 May 2012	19
Roeding Park, Storyland	297	SnJV	TB	10 May 2012	2
Kings County					
Corcoran	198	SnJV	TB	19 May 2012	77
South Wilbur Flood Area, Tulare Lake Drainage District	195	SnJV	TB	6 June 2012	73
Kern County					
Costerisan Farms Lake	329	SnJV	[g]	20 May 2012	15[h]
Ecoregion total					***221***
MODOC PLATEAU					
Siskiyou County					
Lower Klamath NWR					
Unit 6A	4083	MP	–	23 June 2009	25[i]
Unit 12C	4083	MP	–	17 June 2009	12[i]
Modoc County					
Clear Lake NWR, islands	4484	MP	–	18 May 2009	6[j]
Lassen County					
Leavitt Lake, Northeast	4100	MP	–	6 July 2010	2[k]

Table 8 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey Date	Estimated Pairs[c]
Shasta County					
Hanna property	3313	MP	–	19 May 2010	8[l]
Ecoregion total					***166***
EAST OF SIERRA NEVADA					
Mono County					
Mono Lake, Negit Islands	6382	SNE	–	25–26 May 2009	31
Laurel Pond	7128	SNE	–	28 May 2009	40
Ecoregion total					***71***
MOJAVE DESERT					
Los Angeles County (part)					
Apollo Park	2335	MD	–	27 Apr 2012	3
Ecoregion total					***3***
SONORAN DESERT					
Imperial County					
Salton Sea					
Imperial WA, Wister Unit, 515 Reservoir	-213	DSon	–	6 June 2012	2
Morton Bay	-224	DSon	–	6 June 2012	2
Imperial WA, Finney-Ramer Unit, Ramer Lake	-174	DSon	–	5 June 2012	9
Ecoregion total					***13***
GRAND TOTAL					**2443**

[a]Ecoregions used here are a subset of all of those for California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of the two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley. –, CVJV subregions do not apply to the listed Jepson ecoregion.

[c]Pairs estimated from direct count of nests (1 nest = 1pair) unless otherwise noted.

[d]Pairs estimated from count of adults divided by two; site of prior nesting, and behavior of adults suggested nests hidden from view.

[e]Distant views precluded direct observation of nests, so pair estimate based on count of adults divided by two.

[f]Estimated minimum of one pair nesting in eucalyptus grove with Great Egret colony. One adult night-heron flew from edge of eucalyptus grove on observer approach, and several heard calling inside grove; no nests seen bur difficult to walk around under this large grove.

Table 8 (cont'd)

[g]Mismatch between Jepson and CVJV area boundaries. In this case, the colonies falls within the Jepson San Joaquin Valley ecoregion but not within any of the subdivisions of the Central Valley as defined by the CVJV; they also occur at an elevation slightly higher than 300 ft., the CVJV's upper elevation boundary for the Central Valley.

[h]Rough pair estimate from observation of adults sitting on two nests and about 20 other adults seen; also, about 10 juvenile birds seen, but unclear if a product of this or the prior year's nesting effort.

[i]Rough estimate of pairs from dividing count of adults by two (from airboat survey of marsh).

jRough estimate of pairs from dividing count of adults by two (from airboat anchored off rocky islands with multi-species colony).

[k]Bare minimum estimate of 4+ nests from observations of a couple of "clumps" of fledgling night-herons out on willow branches (no adults or occupied nests of the species seen).

[l]Rough pair estimate from congregation of about 15 adults (and some juveniles) in white-washed trees around pond; adult count rounded to next even number and divided by two.

Table 9 Estimated Numbers of Pairs of White-faced Ibis at Colonies in California by Ecoregion, 2010–2012

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey date	Estimated pairs
SOUTHWESTERN CALIFORNIA					
Riverside County					
Hemet Water Treatment Plant Wetlands	1490	SW	–	13 Apr 2011	250[c]
San Bernardino County					
Chino Airport	600	SW	–	12 June 2012	8[c]
San Diego County					
Las Penasquitos Lagoon	3	SW	–	5 April 2011	2[d]
San Diego Zoo Safari Park	450	SW	–	5 April 2011	75[c]
Ecoregion total					***335***
SACRAMENTO VALLEY					
Colusa County					
Delevan NWR	55	ScV	SV	23 June 2010	600[c]
Sacramento County					
Natomas Conservancy	20	ScV	SV	27 June 2010	2500[e]
Ecoregion total					***3100***
SAN JOAQUIN VALLEY					
Fresno County					
Mendota WA	160	SnJV	TB	21 May 2010	3860[e]
Tulare County					
Toledo Pit	235	SnJV	TB	8 May 2012	9620[e]
Dead Pig Pond	210	SnJV	TB	28 March 2011	1000[c]
Alpaugh Irrigation District Reservoir	205	SnJV	TB	1 May 2011	250[c]
Kern County					
ECLA Pond	225	SnJV	TB	28 Mar 2011	175[c]
Ecoregion total					***14,905***
SIERRA NEVADA					
Lassen County (part)					
Mountain Meadows Reservoir	5046	SN	–	14 July 2010	9[f]
Ecoregion total					***9***
MODOC PLATEAU					
Siskiyou County					
Lower Klamath NWR, Unit 6A	4083	MP	–	15 June 2010	2348[e]
Modoc County					
Whitehorse Flat Reservoir	4388	MP	–	7 July 2010	56[g]
Egg Lake	4250	MP	–	13 July 2010	3[h]
Goose Lake, south end	4716	MP	–	15 June 2010	250[i]
Lassen County (part)					
Willow Creek WA, Pond 5	4900	MP	–	8 July 2010	302[e]
Leavitt Lake					
Northeast	4100	MP	–	6 July 2010	1504[e]
Southwest	4100	MP	–	7 July 2010	845[e]

Table 9 (cont'd)

Site	Elev. (ft)	Ecoregion[a]	CVJV Region[b]	Survey date	Estimated pairs
Plumas County					
Sierra Valley	4878	MP	–	25 June 2010	1893[e]
Ecoregion total					***7201***
GRAND TOTAL					**25,550**

[a]Ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Because there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley, some waterbird colonies might be located in one but not the other of the two namesakes. Likewise, the boundaries of some of the other Jepson ecoregions that surround the Central Valley may overlap with some of the CVJV subregions of the Central Valley. –, CVJV subregions do not apply to the listed Jepson ecoregion.

[c]Rough estimate of the number of adults divided by two.

[d]Rough estimate of probably two or more nests.

[e]Estimate of number of breeding pairs of from dawn flyout counts, which consider that each adult flying out of the colony at dawn represents one nest or pair of ibis (see Methods for details and assumptions).

[f]Observer kayaked out to tule patches near southeast section of lake and flushed nine ibis from the vegetation; birds circled and always returned to same location every time disturbed. Estimate of nine pairs on assumption that each of the nine ibis was associated with one nest.

[g]Dawn flyout count unsuccessful because of poor background viewing conditions. Observer then walked into marsh and flushed 56 ibis from bulrushes and saw at least 10 nests (all with 2–3 eggs). Estimate of nesting pairs assumed that each flushed ibis represented one nest or pair.

[h]Observer walked into the marsh and saw 87 ibis on 27 June and 44 on 13 July, but none of these birds circled the observer as they typically do when flushed from nests. A conservative estimate of three pairs is based on the observation on 13 July of three inactive ibis nests in an area where water had receded in the marsh.

[i]Rough estimate of >500 ibis seen at colony from airplane; divided 500 by 2 to obtain a rough estimate of pairs/nests.

Table 10 Estimated Numbers of Pairs of Ring-billed and California Gulls at Colonies in California by Ecoregion[a], 1994 to 2009[b]

		Ring-billed Gull					California Gull[c]				
Site	Elev. (ft)	1994	1995	1996	1997	2009	1994	1995	1996	1997	2009
CENTRAL WESTERN CALIFORNIA											
Santa Clara, Alameda, Contra Costa, and S.F. counties											
San Francisco Bay		0	0	0	0	0	4500	4357	4312	5076	23,347
San Francisco County											
Southeast Farallon Island		0	0	0	0	0	0	0	0	0	95
Santa Cruz County											
Capitola Mall		0	0	0	0	0	0	0	0	0	1
Ecoregion totals		***0***	***0***	***0***	***0***	***0***	***4500***	***4357***	***4312***	***5076***	***23,443***
CASCADE RANGES											
Siskiyou County (part)											
Lake Shastina	2798	~15	73	~50	221	1589	~300	151	~103	123	1149
Steamboat Lake, Shasta Valley WA	2621	~15	0	0	0	0	0	0	0	0	0
Lassen County (part)											
Eagle Lake	5122	0	132	0	0	0	0	201	0	0	1
Ecoregion totals		***~30***	***205***	***~50***	***221***	***1589***	***~300***	***352***	***~103***	***123***	***1150***
SIERRA NEVADA											
Plumas County											
Lake Davis	5786	0	0	0	0	1384	0	0	0	0	392
Ecoregion totals	***5786***	***0***	***0***	***0***	***0***	***1384***	***0***	***0***	***0***	***0***	***392***
MODOC PLATEAU											
Siskiyou County (part)											
Meiss Lake, Butte Valley WA	4241	3190	3158	4087	3475	0	327	1803	1873	2145	0
Lower Klamath NWR											
Sheepy Lake	4089	178	–	–	79	0	269	–	–	8	0
Unit 6A	4085	0	0	0	0	116	43	52	87	96	0
Modoc County											
Clear Lake NWR	4489	2868	2942	3747	3680	2726	1175	1769	1488	1355	518
Goose Lake	4710	0	0	0	1117	0	0	0	0	73	0
Big Sage Reservoir	4906	3007	2052	–	1586	0	76	11	–	28	0
Middle Alkali Lake	4485	0	0	0	0	0	71	0	0	0	0
Dorris Resv., Modoc NWR	4402	0	0	0	0	986	0	0	0	0	0

Table 10 (cont'd)

Site	Elev. (ft)	Ring-billed Gull					California Gull[c]				
		1994	1995	1996	1997	2009	1994	1995	1996	1997	2009
Lassen County (part)											
Honey Lake WA	3997	1931	1961	1727	2502	3	1247	1317	1510	1913	0
Ecoregion totals		***11,174***	***10, 113***	***(9561)***	***12,439***	***3831***	***3208***	***4952***	***4958***	***5618***	***518***
EAST OF SIERRA NEVADA											
Mono County											
Mono Lake	6400	0	0	0	0	0	31,670	24927	23,750	24,957	23,766
Laurel Pond	7135	–	–	–	–	0	–	–	–	–	139
Inyo County											
Owens Lake	3570	–	–	–	–	0	–	–	–	–	317
Ecoregion totals		0	0	0	0	0	***31,670***	***24927***	***23,750***	***24,957***	***24,222***
SONORAN DESERT											
Imperial and Riverside counties											
Salton Sea	-225	0	0	0	0	0	0	0	2	22	58
Ecoregion totals		***0***	***0***	***0***	***0***	***0***	***0***	***0***	***2***	***22***	***58***
GRAND TOTALS		**11,204**	**10,318**	**(9,611)[c]**	**12,660**	**6804**	**39,678**	**34,588**	**33,125**	**35,796**	**49,783**

[a]Ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[b]Data generally from direct nest counts (see Methods for exceptions). Gulls nesting on multiple islands at some sites, particularly the larger ones such as Mono Lake and San Francisco Bay. –, no survey made; 0, survey taken but no nesting gulls found. Data 1994–1997 from Shuford and Ryan (2000) and Shuford (2010).

[c]No nesting gulls found at Lake Almanor, Plumas County, where they previously bred at least sporadically. No nesting gulls found at Tule Lake, Siskiyou and Modoc counties, in 1994, 1997, and 2009, and it is unlikely that they nested there in 1995 and 1996, despite prior irregular occupancy.

[d]The total for the Ring-billed in 1996 is probably low by at least 1500 to 2000 pairs because Big Sage Reservoir was not surveyed that year.

Table 11 Estimated Numbers of Pairs of Caspian Terns at Colonies in the Interior of California by Ecoregion, 2009–2012 and 1999[a]

Site	Elev. (ft)	Ecoregion[b]	CVJV Region[c]	Survey Date 2009–2012	Estimated Pairs[d] 2009–2012	Estimated Pairs[d] 1999
SOUTHWESTERN CALIFORNIA						
Riverside County						
Lake Elsinore	1242	SW	na	–	–	14
Ecoregion total					***–***	***14***
SAN JOAQUIN VALLEY						
Kings County						
Lemoore NAS sewage ponds	221	SnJV	TB	–	–	0
South Evaporation Basin, Westlake Farms	192	SnJV	TB	multiple dates 2012	0	0
Tulare lakebed, ~14 km E of Kettleman City	179	SnJV	TB	9 May 2012	0	0
South Wilbur Flood Area, Tulare Lake Drainage District	198	SnJV	TB	6 June 2012	0	27[b]
South Evaporation Basin, Tulare Lake Drainage District	216	SnJV	TB	multiple dates 2012	0	0
Ecoregion total					***0***	***27***
MODOC PLATEAU						
Siskiyou County						
Butte Valley WA (Meiss Lake)	4241	MP	na	16 June 2009	0	27
Modoc County						
Clear Lake NWR	4489	MP	na	17 June 2009	44[e]	118
Goose Lake	4710	MP	na	19 June 2009	0	310
Big Sage Reservoir	4903	MP	na	19 June 2009	0	0
Lassen County						
Dakin Unit (Hartson Reservoir), Honey Lake WA	3997	MP	na	June 2009	0[f]	87+
Ecoregion total					***44***	***542***
SONORAN DESERT						
Imperial County						
South End Salton Sea, Salton Sea NWR HQ, Pond D	-230	DSon	na	7 May 2012	1177	211
Ecoregion total					***1177***	***211***
GRAND TOTAL					**1221**	**794**

[a]The "interior" survey area excludes coastal tern colonies within or adjacent to estuaries; for the San Francisco Bay estuary, the Carquinez Strait at Interstate-80 is considered the boundary between coastal and interior. Data for 1999 are from Shuford (2010) unless otherwise noted. –, no survey made.

[b]Ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert.

[c]The Central Valley Joint Venture (CVJV) divides the Central Valley into five major subregions (Figure 5): Sacramento Valley, SV; Delta DE; Suisun Marsh, SM; San Joaquin Basin, SJB; Tulare Basin, TB; the JV considers the latter two to be subdivisions of the San Joaquin Valley. Though not an issue here, note that there are different boundaries for what the Jepson and CVJV classifications both call the Sacramento Valley and San Joaquin Valley. na, CVJV subregions not applicable for Jepson regions other than the two in the Central Valley.

Table 11 (cont'd)

[d]Pairs estimated from direct count of nests (1 nest = 1pair) unless otherwise noted.

[e]Observers recorded 71 adult Caspian Terns on territory in mid-June, nestled within a large colony of Ring-billed Gulls on a rocky islet on the east lobe of the lake. Only a few of these birds were sitting down as if on nests, so it was difficult to estimate the number of breeding pairs at this site. To do so (see Shuford 2010), we multiplied the number of adults counted by 0.62 to approximately estimate numbers of breeding pairs on the basis of the average ratio of nests to adults at sites on the California coast (0.625, Carter et al. 1992, p. I-45) and the California interior (0.61, D. Shuford unpubl. data).

[f]On 14 May 2009 visit, no terns were nesting at Hartson Reservoir or the adjacent pond 5A on the Dakin Unit of Honey Lake WA; suitable islands were lacking at Hartson, and the water surrounding the few islands at 5A was very shallow. P. Cherny confirmed that no tern colony was active in June 2009.

Table 12 Estimated Numbers of Pairs of Black Terns at Wetland Colony Sites in Northeastern California by Ecoregon[a], 2010 and 1997

Site	Elev. (ft)	Survey date 2010	Estimated pairs[b] 2010	Estimated pairs[b] 1997
CASCADE RANGES				
Siskiyou County (part)				
Grass Lake	5008	13 June	14[2]	22[3]
Lassen County (part)				
Mosquito Flat	6185	2 July	2[2]	0
Poison Lake	5566	4 July	9[2]	38[2]
Ashurst Lake	6319	2 July	7[2]	2[3]
Dry Lake, Grass Valley	4639	4 July	0	5[3]
Straylor Lake	5272	2 July	0	9[3]
Long Lake	5345	2 July	0	5[3]
Gordon Lake	6006	2 July	0	9[3]
Pine Creek wetlands	5633	4 July	0	7[3]
McCoy waterpit	5499	5 July	0	9[3]
Eagle Lake				
Spaulding	5117	5 July	0	73[3]
North Basin	5111	6 July	3[2]	17[3]
Troxel	5120	6 July	0	22[3]
Ecoregion total			***35***	***218***
SIERRA NEVADA				
Lassen County (part)				
Mountain Meadows Reservoir	5057	14 July	0	11[2]
Ecoregion total			***0***	***11***
MODOC PLATEAU				
Siskiyou County				
Butte Valley WA, Unit 7C	4244	30 June	0	11[2]
Butte Valley National Grasslands	4246	30 June	0	2[3]
Orr Lake	4660	17 June	0	6[3]
Dry Lake	4633	17 June	0	3[3]
Lower Klamath NWR				
Unit 4D	4085	15 June	0	12[1]
Unit 4E	4085	15 June	0	37[2]
Unit 6A	4083	17 June	1[1]	0
Unit 6C	4084	15 June	94[3]	0
Tule Lake NWR, Sump 1-B	4037	29 June	2[1]	0
Barnum Flat Reservoir	4379	28 June	2[2]	54[3]
Modoc County				
Dry Lake	4142	13 June	1[1]	9[3]
Fourmile Valley	4908	12 June	28[3]	27[1]
Wild Horse Valley	4898	12 June	11[3]	3[1]
Buchanan Flat	5179	11 June	16[3]	21[1]
Weed Valley	5083	11 June	237[3]	160[3]
Baseball Reservoir	5260	11 June	14[3]	42[1]
Dry Valley Reservoir	4920	22 June	28[3]	30[1]

Table 12 (cont'd)

Site	Elev. (ft)	Survey date 2010	Estimated pairs[b]	
			2010	1997
Hager Basin North	4962	2 June	0	14[1]
Hager Basin South	4965	2 June	0	18[1]
Telephone Flat Reservoir	5001	9 June	0	7[1]
South Mountain Reservoir	5087	9 June	11[3]	2[1]
Pease Flat	5310	10 June	20[2]	47[3]
Mud Lake	5318	11 June	0	16[1]
Crowder Mountain Reservoir	5133	9 June	0	40[1]
Whitney Reservoir	4699	4 June	0	5[2]
Stovepipe Flat Tank	4990	5 June	10[3]	–
Hackamore Reservoir	4694	4 June	9[3]	10[2]
Henski/Spaulding Reservoir	4754	13 June	34[3]	20[2]
Beeler Reservoir	4779	13 June	0	13[2]
Pinkys Pond	4898	13 June	31[3]	7[2]
Widow Valley	5055	5 June	0	64[3]
Bucher Swamp	5031	5 June	0	96[3]
Williams Reservoir	5023	5 June	15[3]	–
Six Shooter Tank	5033	4 June	7[1]	9[2]
Deadhorse Flat Reservoir	4964	7 June	0	35[3]
Surveyors Valley	4974	6 June	0	28[3]
Boles Meadow (marsh)	4880	7 June	25[3]	166[3]
Fletcher Creek Reservoir	4888	22 June	131[3]	31[1]
Reservoir N	4980	23 June	13[3]	0
Jacks Swamp	4832	8 June	0	26[1]
Dead Horse Reservoir	5024	8 June	0	11[1]
Jesse Valley	5035	24 June	6[3]	10[3]
Mosquito Lake	4392	28 June	7[2]	0
Whitehorse Flat Reservoir	4392	28 June	0	29[3]
Egg Lake	4250	28 June	41[3]	270[3]
Taylor Creek wetlands	4193	27 June	0	101[3]
Lookout Ranch	4165	13 July	56[3]	–
Ash Creek WA 1 (part)	4144	27 June	37[3]	0
Ash Creek WA 2 (part)	4153	27 June	14[3]	0
Warm Springs Valley	4320	26 June	16[3]	–
Wild rice fields, Rd. 54	4318	26 June	33[3]	–
Shasta County				
Bald Mountain Reservoir	4046	3 July	5[2]	0
Lassen County (part)				
Ash Creek WA (part)	4145	27 June	4[2]	0
Muck Valley	4188	1 July	0	42[3]
Hoover Flat Reservoir	5518	1July	0	6[3]
Moll Reservoir	5264	2 July	0	17[2]
Oxendine Spring	5338	2 July	0	5[2]
Ash Valley (main)	5057	2 July	0	52[3]
Ash Valley (southeast)	5064	2 July	0	7[3]
Red Rock Lakes complex	6037	24 June	0	57[3]
Boot Lake	6560	25 June	8[3]	12[3]

Table 12 (cont'd)

Site	Elev. (ft)	Survey date 2010	Estimated pairs[b] 2010	Estimated pairs[b] 1997
Willow Creek WA				
Pond 5	4877	8 July	7[3]	0
Pond 13	4885	7 July	12[3]	0
Pond 14	4880	7 July	6[3]	0
Pond 16	4888	7 July	0	10[3]
Pond 18	4886	7 July	6[3]	0
Horse Lake	5068	7 July	0	8[2]
Honey Lake N, private	3999	5 July	0	3[2]
Ecoregion total			***998***	***1711***
GRAND TOTAL			**1033**	**1940**

[a]The three relevant ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): CaR, Cascade Ranges; SN, Sierra Nevada; and MP, Modoc Plateau.

[b]Numbers of pairs estimated by three methods, listed here in order of apparent reliability, on the basis of [1]numbers of total nests, [2]counts of total disturbed adults, and [3]counts of total undisturbed adults (see Methods in Shuford et al. 2001). When data enable more than one type of estimate, the estimate presented is from the method of highest apparent reliability. Numbers for 1997 from Shuford et al. (2001).

Table 13 Estimated Numbers of Black Terns Counted in the Sacramento Valley from Roadside Surveys of Rice Fields, 29 May to 10 June 1998 and 1 to 11 June 2010. Data for 1998 from Shuford et al. (2001)

County	Hectares planted rice[a]		Survey routes (*n*)		Distance surveyed (km)[b]		Terns per 100 ha (± SE)[c]		Terns estimated ± (SE)[d]	
	1998	2010	1998	2010	1998	2010	1998	2010	1998	2010
Colusa	36,637	57,583	38	30	370	453	2.67 (0.67)	0.37 (0.13)	978 (245)	215 (75)
Sutter-Yolo-Sacramento[e]	36,485	60,293	26	36	285	611	0.70 (0.23)	0.32 (0.11)	225 (84)	191 (66)
Sutter	27,553	43,658	15	24	204	474	–	0.41 (0.15)	–	178 (65)
Butte	26,645	35,302	10	7	235	166	0.85 (0.31)	0.72 (0.43)	226 (82)	253 (150)
Glenn	25,131	32,216	44	26	353	362	3.68 (1.56)	1.12 (0.29)	925 (392)	362 (94)
Yuba	11,294	14,565	16	9	122	100	1.22 (0.44)	1.25 (0.71)	138 (50)	182 (103)
Yolo	6177	15,431	10	12	69	137	–	0 (0)	–	0 (0)
Placer	4239	6234	4	4	47	61	0 (0)	0 (0)	0	0
Sacramento	2755	1204	1	0	11	0	–	–	–	–
Tehama	363	405[f]	0	0	0	0	–	–	–	–
Total	140,794	206,570	138	112	1411	1752	1.80 (0.54)[i]	0.58 (0.15)[i]	2523 (754)	1198 (310)

[a]Planted rice acreage adjusted to account for estimate that only 75% (1998) and 93% (2010) of the total for the year had been planted at the time of our surveys (see Methods).

[b]Each side of road tallied separately.

[c]Density estimates for each county are means of survey routes, weighted by distance surveyed. SE, standard error.

[d]Tern numbers estimated by multiplying densities on roadside surveys times acreage of available rice fields. Standard errors represent variation in densities of terns on survey routes but do not account for possible error in the estimate of the amount of planted rice at the time of tern surveys.

[e]Data for these counties pooled for density estimates and analyses in 1998 because of small sample sizes for Yolo and Sacramento counties.

[f]Rice acreage in Tehama County estimated in 2010. Although we surveyed no routes in Tehama. Co. in either 1998 or 2010, prior evidence suggests that terns do not breed in that area. If they do now, numbers would be very small, given the limited rice acreage, and insignificant relative to totals for the entire Sacramento Valley.

[i]Mean of county density estimates, weighted by hectares of rice.

Table 14 Estimated Numbers of Pairs of Forster's Terns at Colonies in the Interior of California by Ecoregion, 2010–2012 and 1997–1998[a]

Site	Elev. (ft)	Survey date 2010–2012	Estimated pairs[b]	
			2010–2012	1997–1998
SOUTHWESTERN CALIFORNIA				
Orange County				
Orange County Water District, Burris Basin 2	185	4 August 2012	150[c]	0
Ecoregion total			***150***	***0***
SAN JOAQUIN VALLEY				
Stanislaus County				
Turlock Lake	246	14 July 2012	8[3]	75[2]
Fresno County				
Leaky Acres	333	30 May 2012	8[1]	–
Kings County				
Corcoran Irrigation District, Resv. #1	221	24 June 2012	0	51[2]
Corcoran Irrigation District, Resv. #2	219	19 May 2012	0	3[1]
Lost Hills Water District and Rainbow Ranch compensation wetland	180	dry in 2012	0	4[1]
S of Hacienda Ranch Flood Basin #1	206	9 May 2012	0	134[1]
S of Hacienda Ranch Flood Basin #2	206	9 May 2012	0	74[1]
Tulare Lake Drainage District, South Evaporation Basin	216	multiple visits in 2012	0	1[1]
Tulare County				
Alpaugh Irrigation District Reservoir lands	208	25 June 2012	0	38[2]
~2 km W of Road 40, ~6 km S of Alpaugh	208	9 May 2012	0	128[2]
Kern County				
Kern Fan Element Water Bank (Pond W-2)	296	9 May 2012	0	33[2]
Ecoregion total			***16***	***541***
CASCADE RANGE				
Lassen County (part)				
Eagle Lake[d]	5111	6 July 2010	3[2]	86[3]
Ecoregion total			***3***	***86***
SIERRA NEVADA				
Lassen County (part)				
Mountain Meadows Reservoir	5046	14 July 2010	52[2]	38[3]
El Dorado County				
Pope Marsh, South Lake Tahoe	6234	4 July 2010	0	16[1]
Ecoregion total			***52***	***54***
MODOC PLATEAU				
Siskiyou County				
Prather Ranch north	4264	30 June 2010	0	8[3]

Table 14 (cont'd)

Site	Elev. (ft)	Survey date 2010–2012	Estimated pairs[b] 2010–2012	1997–1998
Butte Valley WA (Meiss Lake)	4241	30 June 2010	0	98[3]
Lower Klamath NWR				
Unit 3A	4085	15 June 2010	0	29[3]
Unit 4D	4085	15 June 2010	0	18[1]
Unit 4E	4085	15 June 2010	0	46[1]
Unit 6A	4083	16 June 2010	248[1]	0
Unit 11B	4080	16 June 2010	0	63[1]
Tule Lake NWR Sump 1-A	4037	12 July 2010	63[1]	226[3]
Tule Lake NWR Sump 1-B	4037	29 June 2010	37[1]	0
Shasta County				
Horr Pond	3312	3 July 2010	0	4[3]
Modoc County				
Whitehorse Flat Reservoir	4388	28 June 2010	28[2]	0
Egg Lake	4255	28June 2010	0	22[3]
Boles Meadow (islands)	4888	7 June 2010	0	443[1]
Fairchild Swamp	4906	6 June 2010	0	116[3]
Lookout Ranch	4165	13 July 2010	1[2]	–
Raker and Thomas Reservoir	4953	23 June 2010	0	8[1]
Goose Lake	4710	24 June 2010	0	458[2]
Lassen County				
Ash Creek WA	4146	27 June 2010	7[3]	~14[2]
Boot Lake	6560	25 June 2010	5[2]	0
Grasshopper Valley	5315	6 July 2010	0	54[3]
Horse Lake	5068	7 July 2010	0	19[3]
Red Rock Lakes complex	6037	24 June 2010	0	4[3]
Leavitt Lake	4104	6 &15 July 2010	0	31[1]
Honey Lake WA, Fleming Unit (Pond 15)	3997	5 July 2010	0	7[1]
Honey Lake North, private	3999	5 July 2010	0	2[1]
Plumas County				
Sierra Valley (S of steel bridge)	4876	25 June 2010	0	6[2]
Ecoregion total			***389***	***1676***
GRAND TOTAL			**610**	**2357**

[a]The "interior" survey area excludes coastal tern colonies within or adjacent to estuaries. The ecoregions used here are a subset of those for all of California in the Jepson manual (Figure 4): NW, Northwestern California; CW, Central Western California; SW, Southwestern California; ScV, Sacramento Valley; SnJV, San Joaquin Valley; CaR, Cascade Ranges; SN, Sierra Nevada; MP, Modoc Plateau; SNE, East of Sierra Nevada; DMoj, Mojave Desert; DSon, Sonoran Desert. Data for 1997–1999 are from Shuford (2010) unless otherwise noted.

[b]Number of pairs estimated by three methods listed here in order of apparent reliability, on the basis of [1]numbers of total nests, [2]best counts of total undisturbed adults, or [3]best counts of disturbed adults (see Methods in Shuford 2010). When data enable more than one type of estimate, the estimate presented is from the method of highest apparent reliability. –, no data available.

[c]Island was overgrown with weeds, hence viewing nesting activity difficult. On the basis of 150–200 fledglings seen 'at one time' over the summer, a rough estimate of 150 nesting pairs.

[d]In 2010, all nesting was in the marsh in the North Basin. Of 123 Forster's Terns counted from 8–9 July 1997 (representing an estimated 86 pairs), 14 were along the southwest shore from south of Pelican Point south to cove near Eagle Lake Resort, 90 at Spaulding, 4 in Delta Bay, 1 in Buck Bay, 11 in North Basin, 2 at Troxel, and 1 in Duck Island Bay.

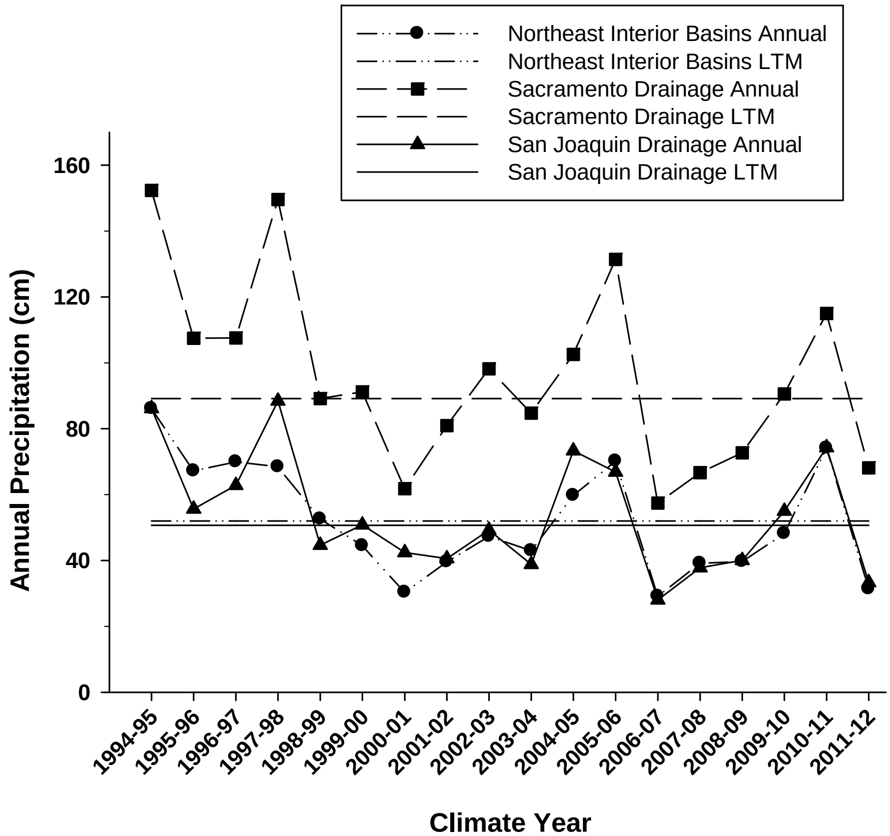

Figure 1. Annual precipitation for the climate years (1 July-30 June) 1994–95 to 2011–12, compared to the respective long-term means (n = 117 yrs), for the Northeast Interior Basins, Sacramento Drainage, and San Joaquin Drainage climate divisions for California. Data from the Western Regional Climate Center (www.wrcc.dri.edu/divisional.html).

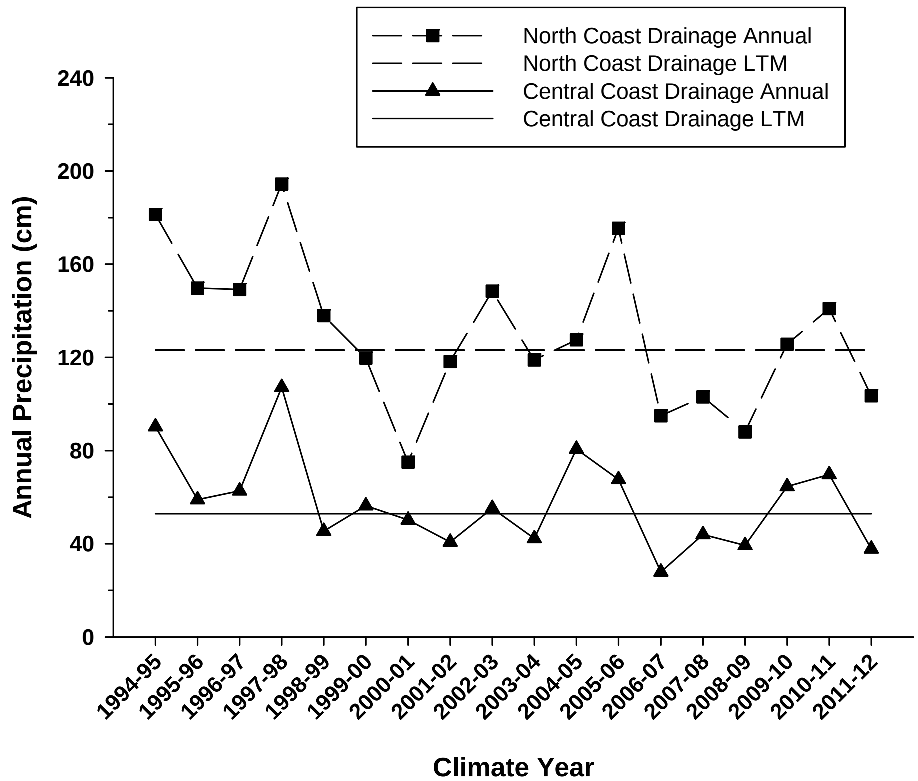

Figure 2. Annual precipitation for the climate years (1 July-30 June) 1994–95 to 2011–12, compared to the respective long-term means (*n* = 117 yrs), for the North Coast Drainage and the Central Coast Drainage climate divisions for California. Data from the Western Regional Climate Center (www.wrcc.dri.edu/divisional.html).

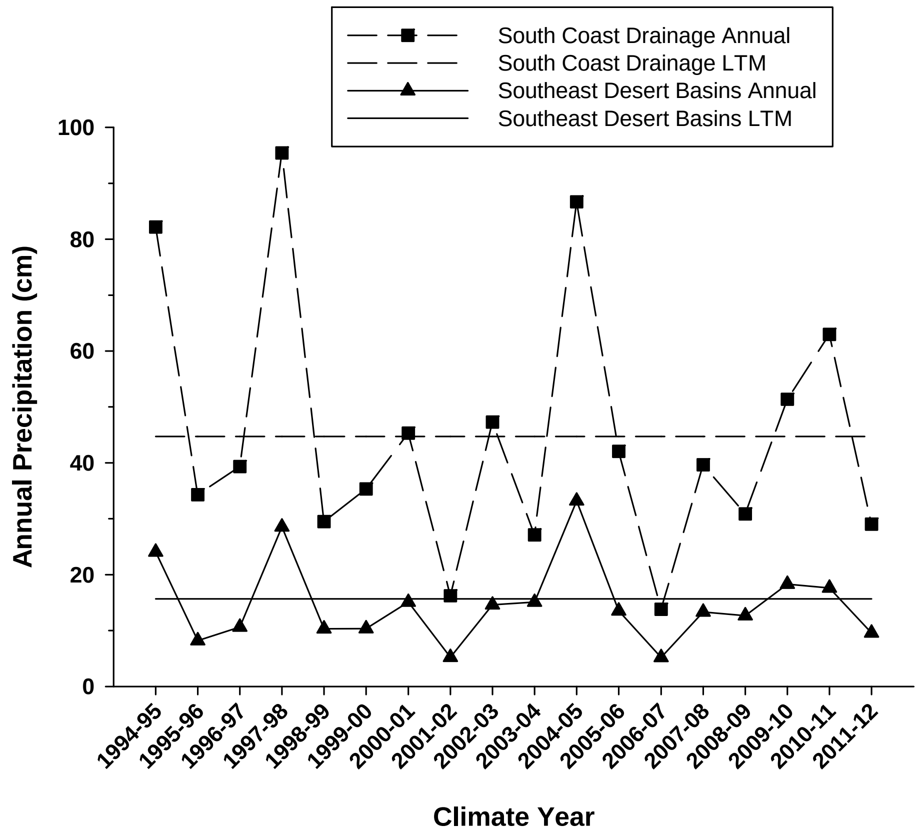

Figure 3. Annual precipitation for the climate years (1 July-30 June) 1994–95 to 2011–12, compared to the respective long-term means (*n* = 117 yrs), for the South Coast Drainage and the Southeast Desert Basins climate divisions for California. Data from the Western Regional Climate Center (www.wrcc.dri.edu/divisional.htm).

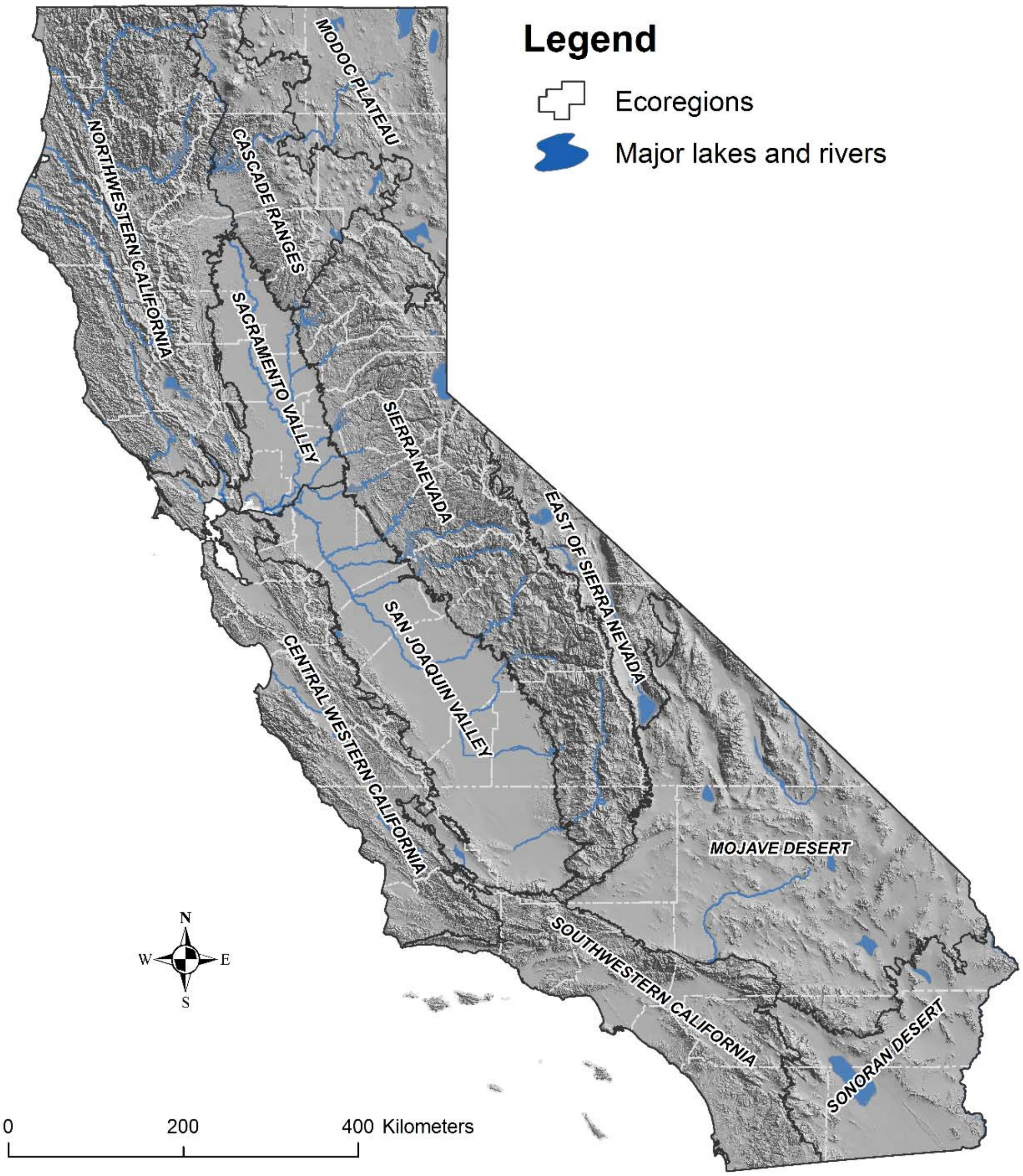

Figure 4. Ecoregions—based on the Jepson manual’s geographic subdivisions of California (Hickman et al. 1993)—used for mapping and summarizing data from statewide surveys of waterbird colonies, 2009–2012.

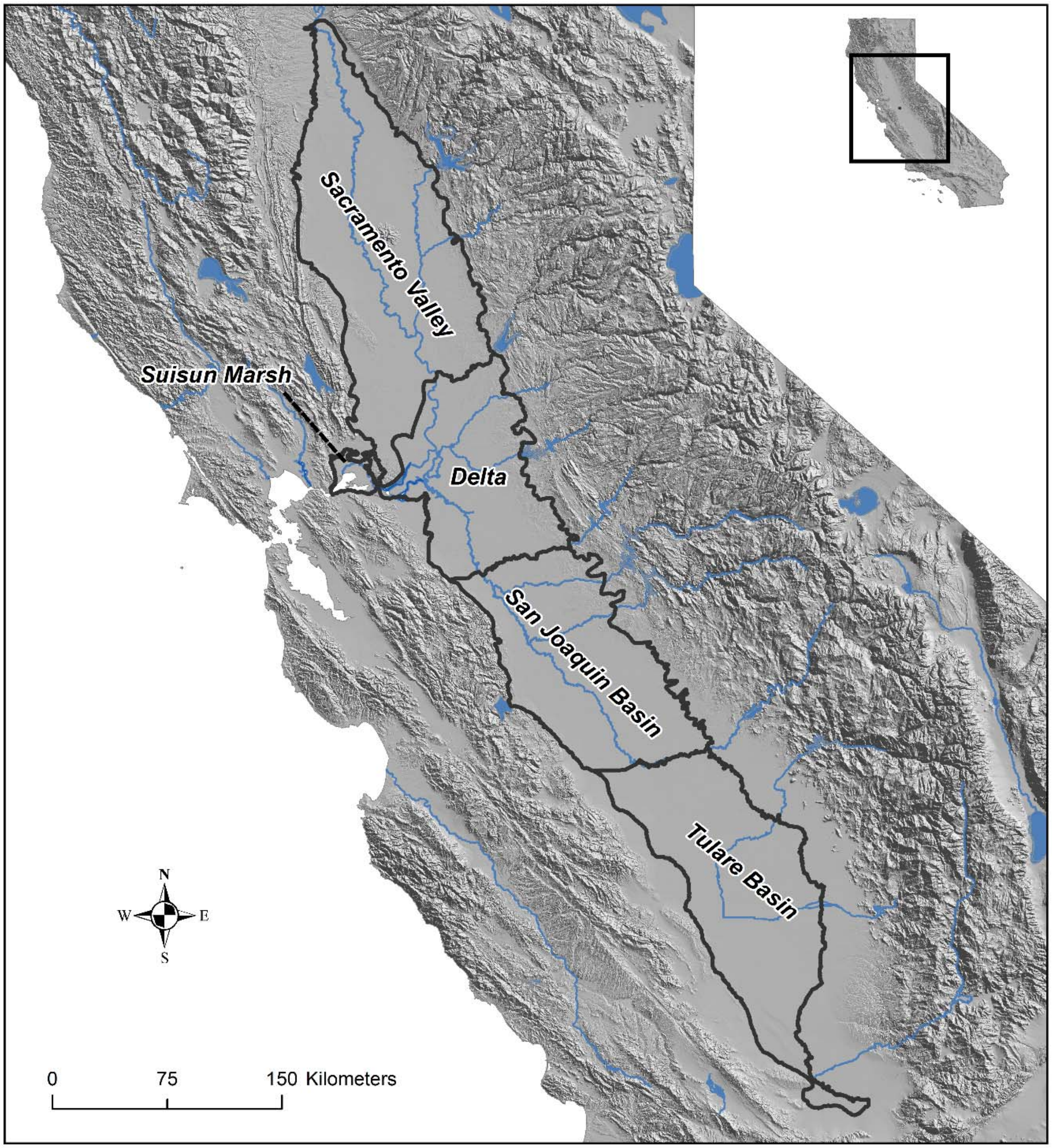

Figure 5. Major subdivisions of the Central Valley used by the Central Valley Joint Venture (CVJV 2006). Where applicable, report tables indicate which waterbird colonies fall within these subdivisions.

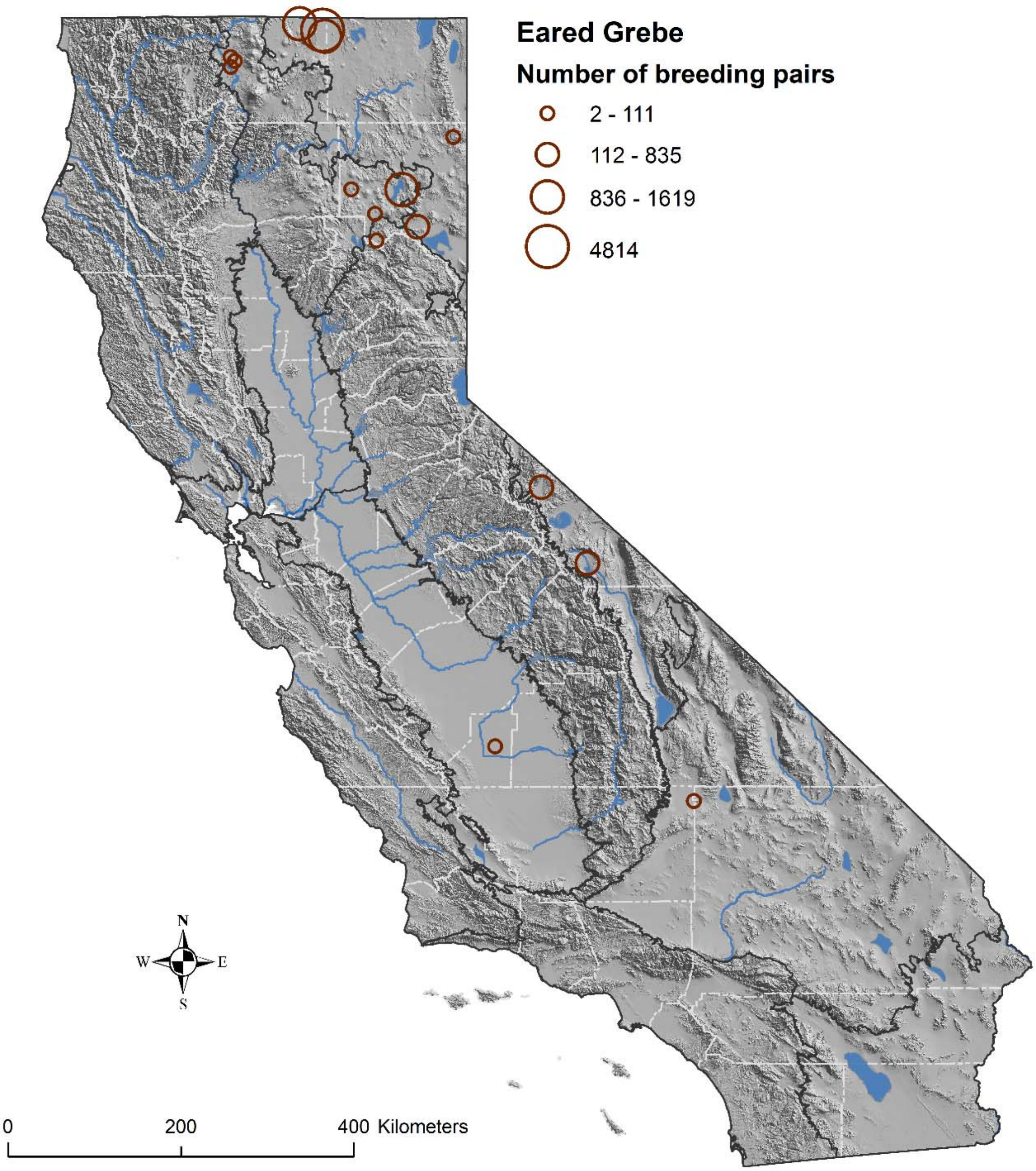

Figure 6. Distribution and relative size of Eared Grebe colonies in California from statewide surveys, 2010–2012 (see Table 2).

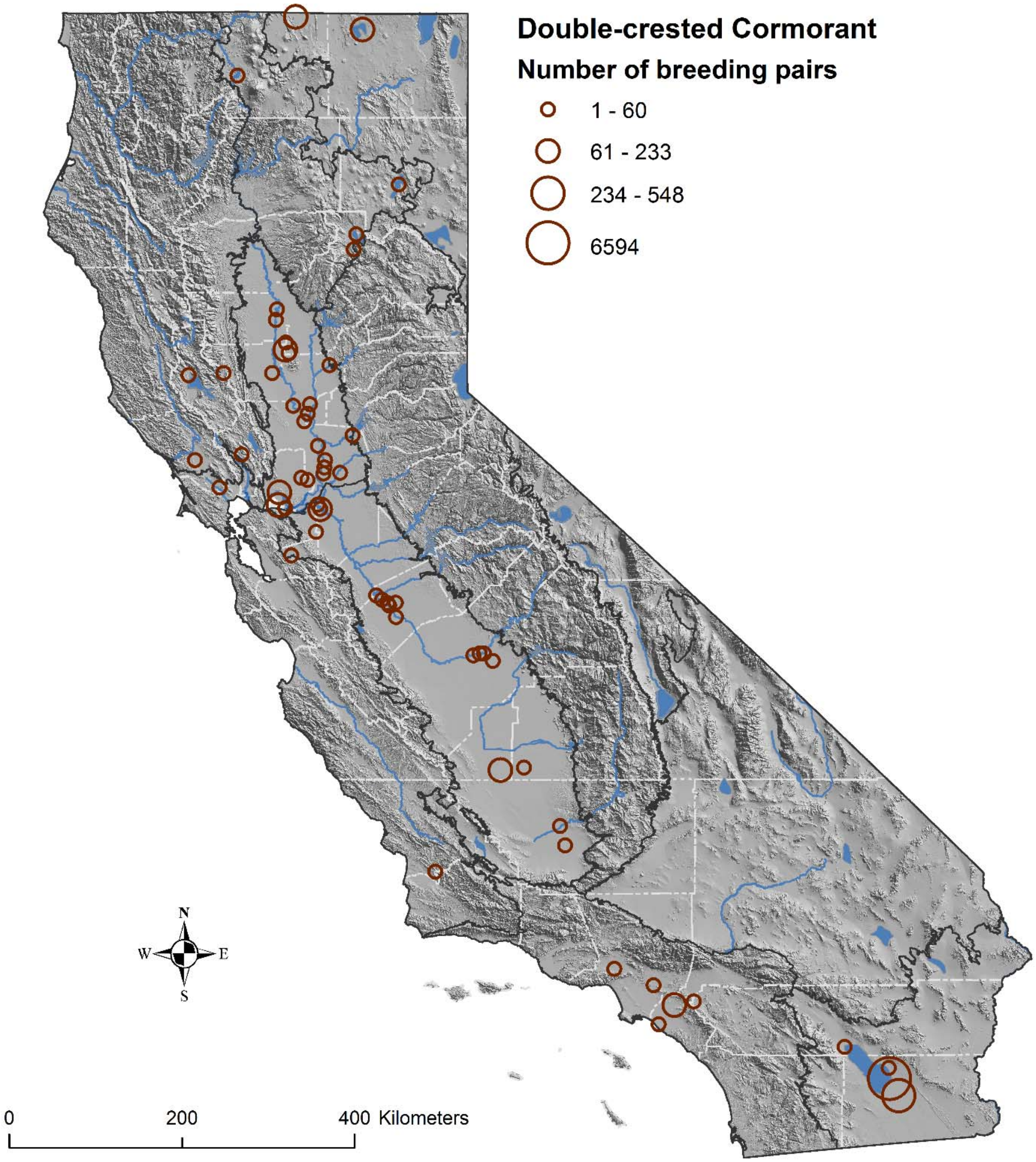

Figure 7. Distribution and relative size of Double-crested Cormorant colonies in California from statewide surveys, 2009–2012 (see Table 3).

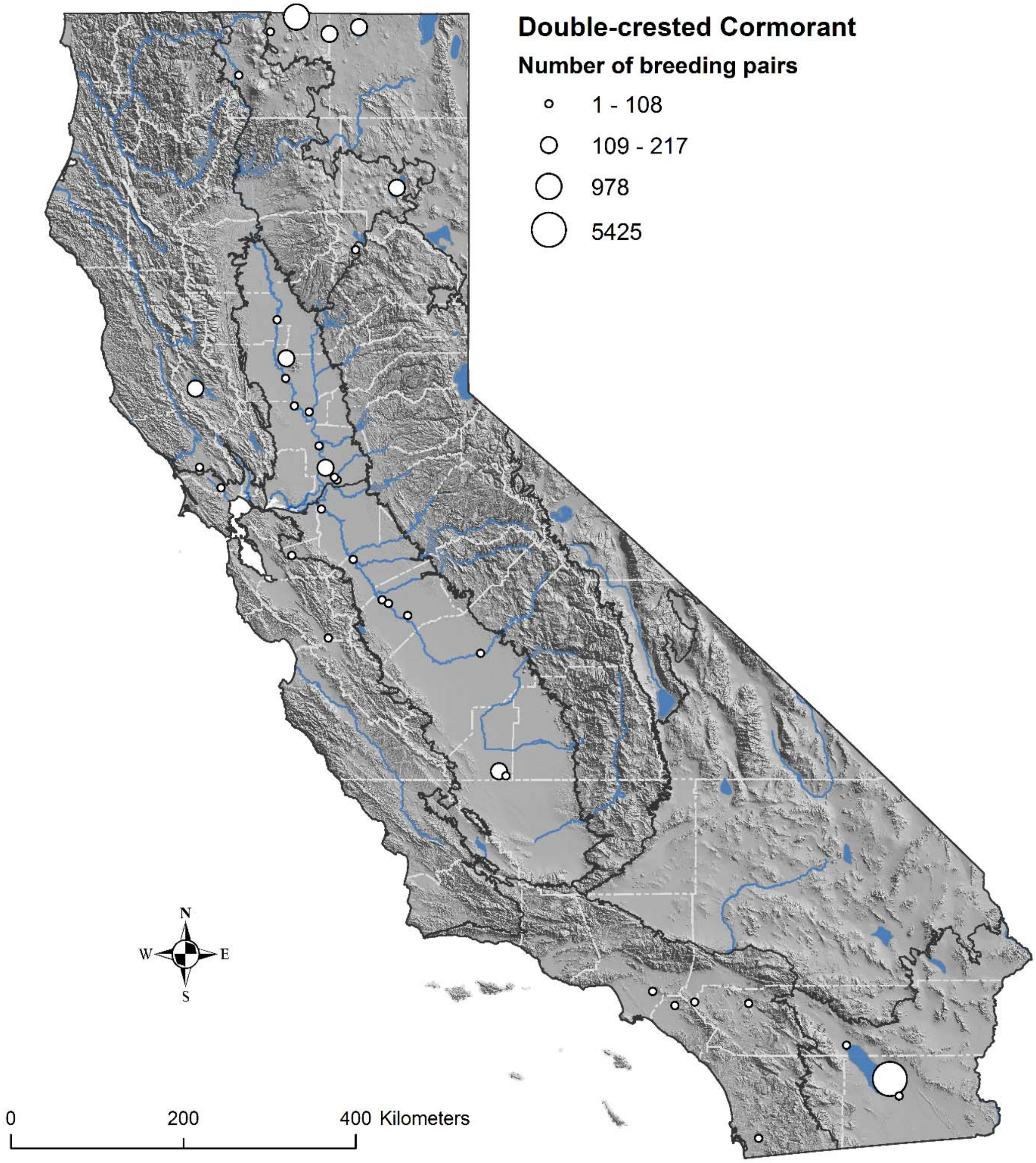

Figure 8. Distribution and relative size of Double-crested Cormorant colonies in California from statewide surveys, 1997–1999 (See Table 3; map from Shuford 2010).

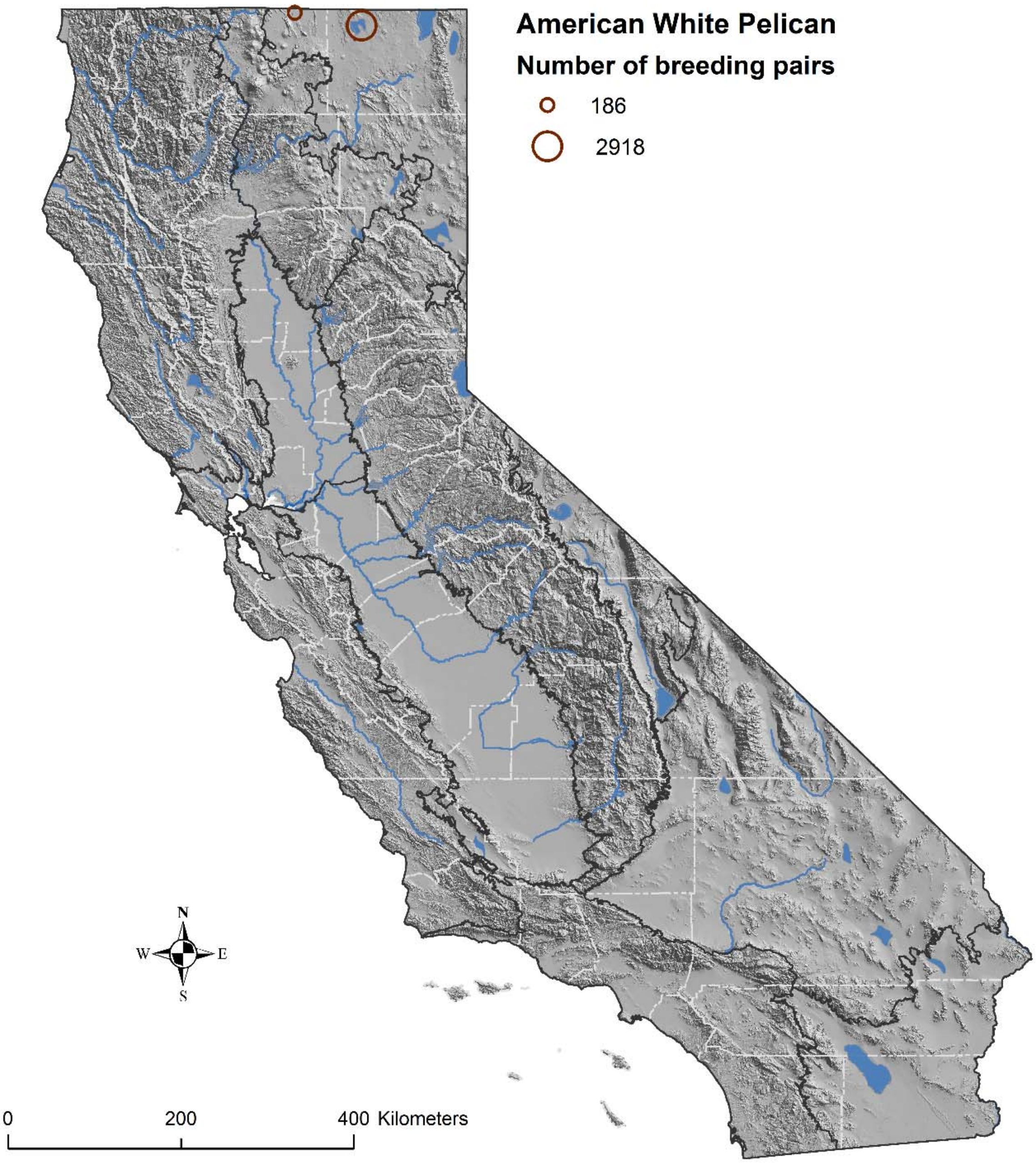

Figure 9. Distribution and relative size of American White Pelican colonies in California from surveys in 2009.

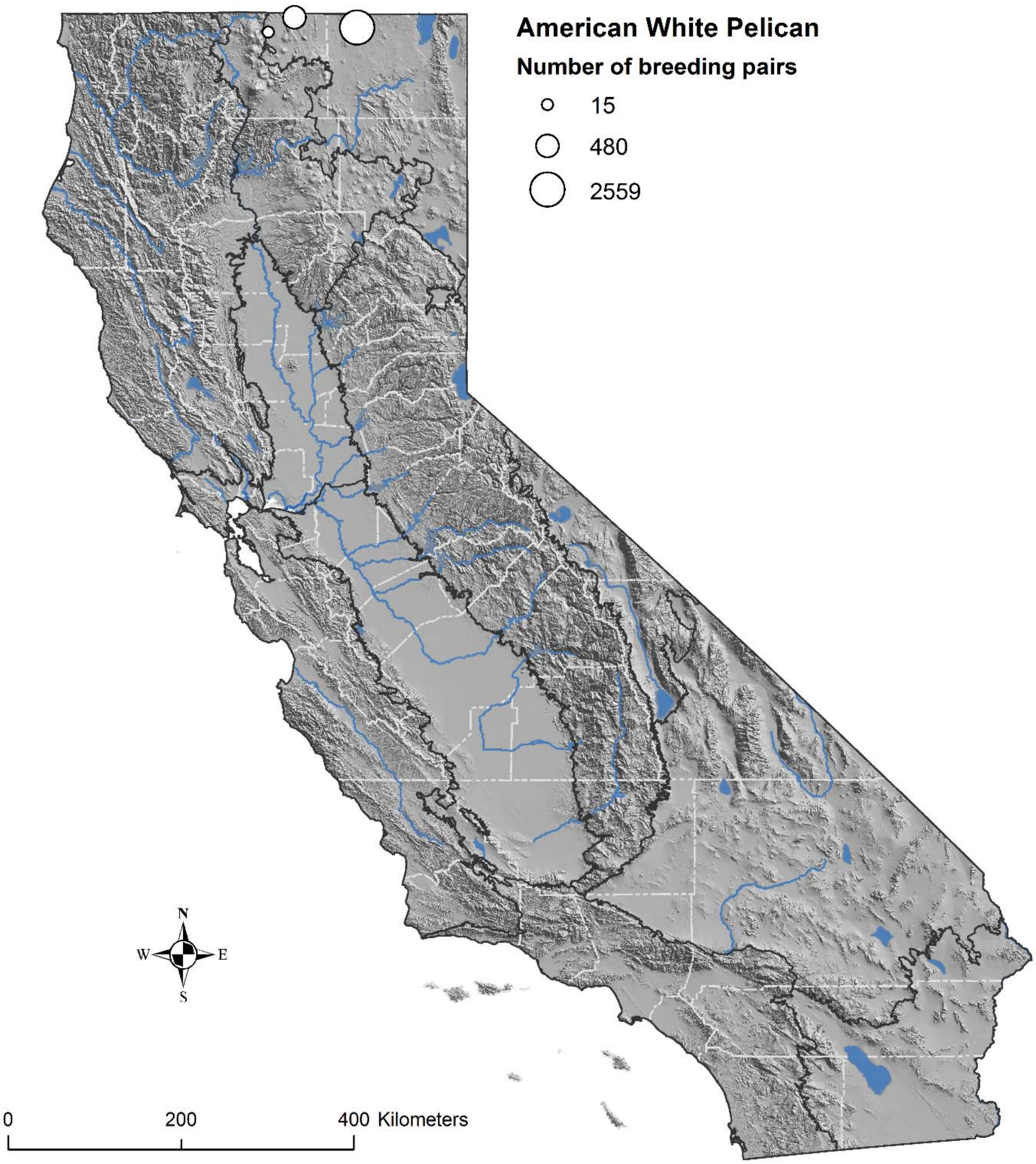

Figure 10. Distribution and relative size of American White Pelican colonies in California from surveys, 1997–1999 (from Shuford 2010).

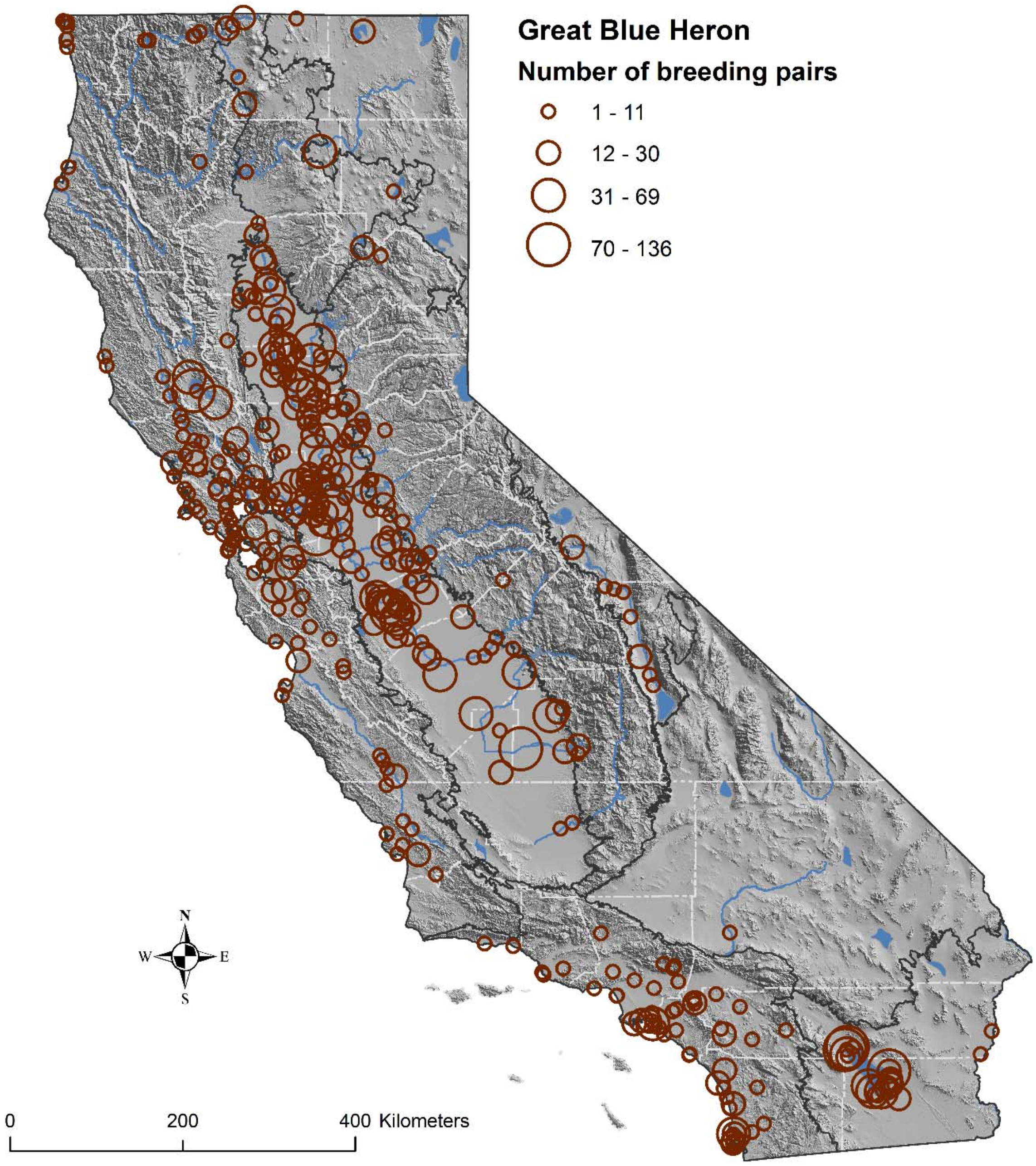

Figure 11. Distribution and relative size of Great Blue Heron colonies in California from statewide surveys, 2009–2012 (see Table 4).

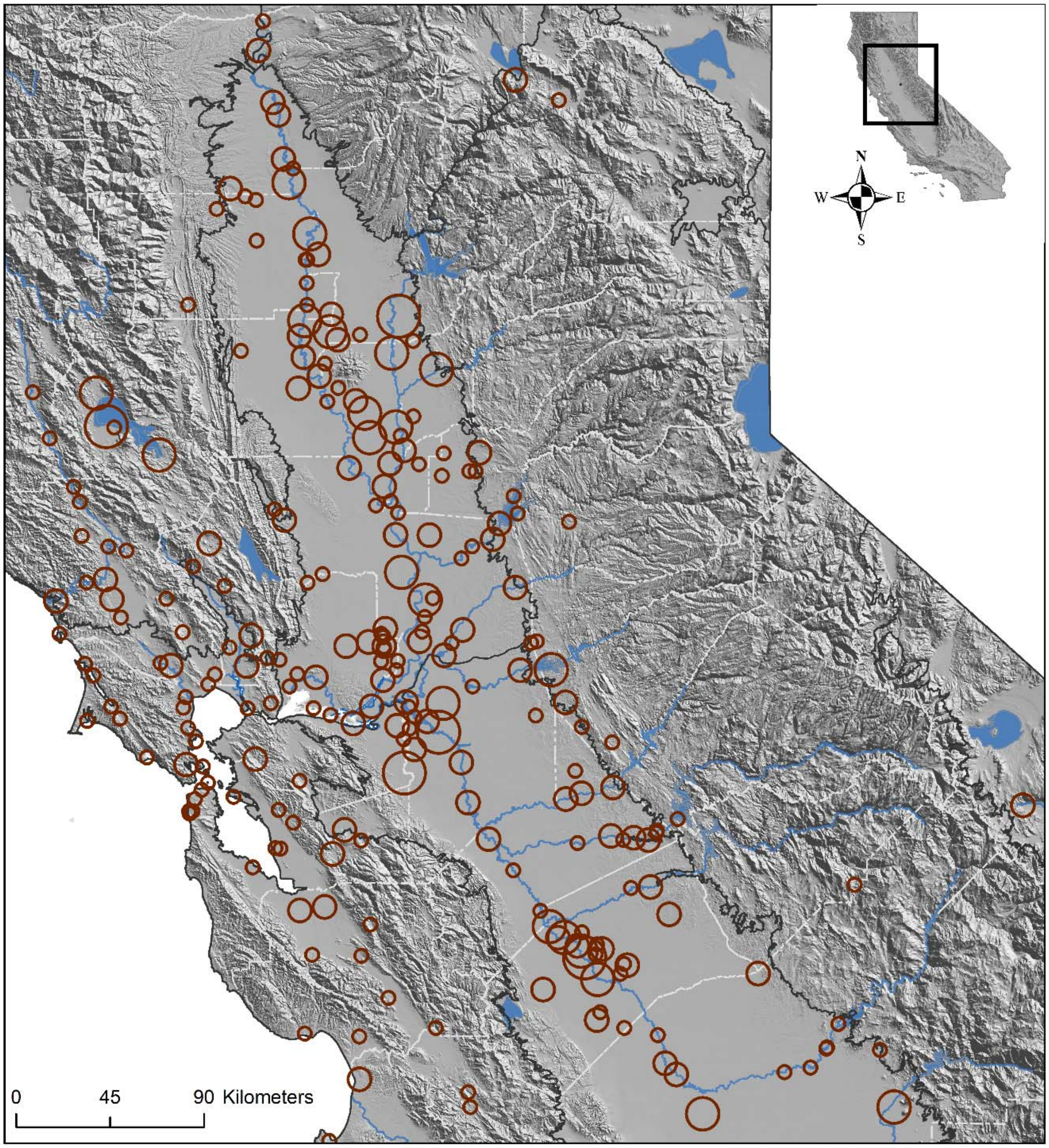

Figure 12. Distribution and relative size of Great Blue Heron colonies in areas of concentration in the Sacramento Valley, Delta, northern San Joaquin Valley, and central coast of California from statewide surveys, 2009–2012 (see Figure 11 and Table 4).

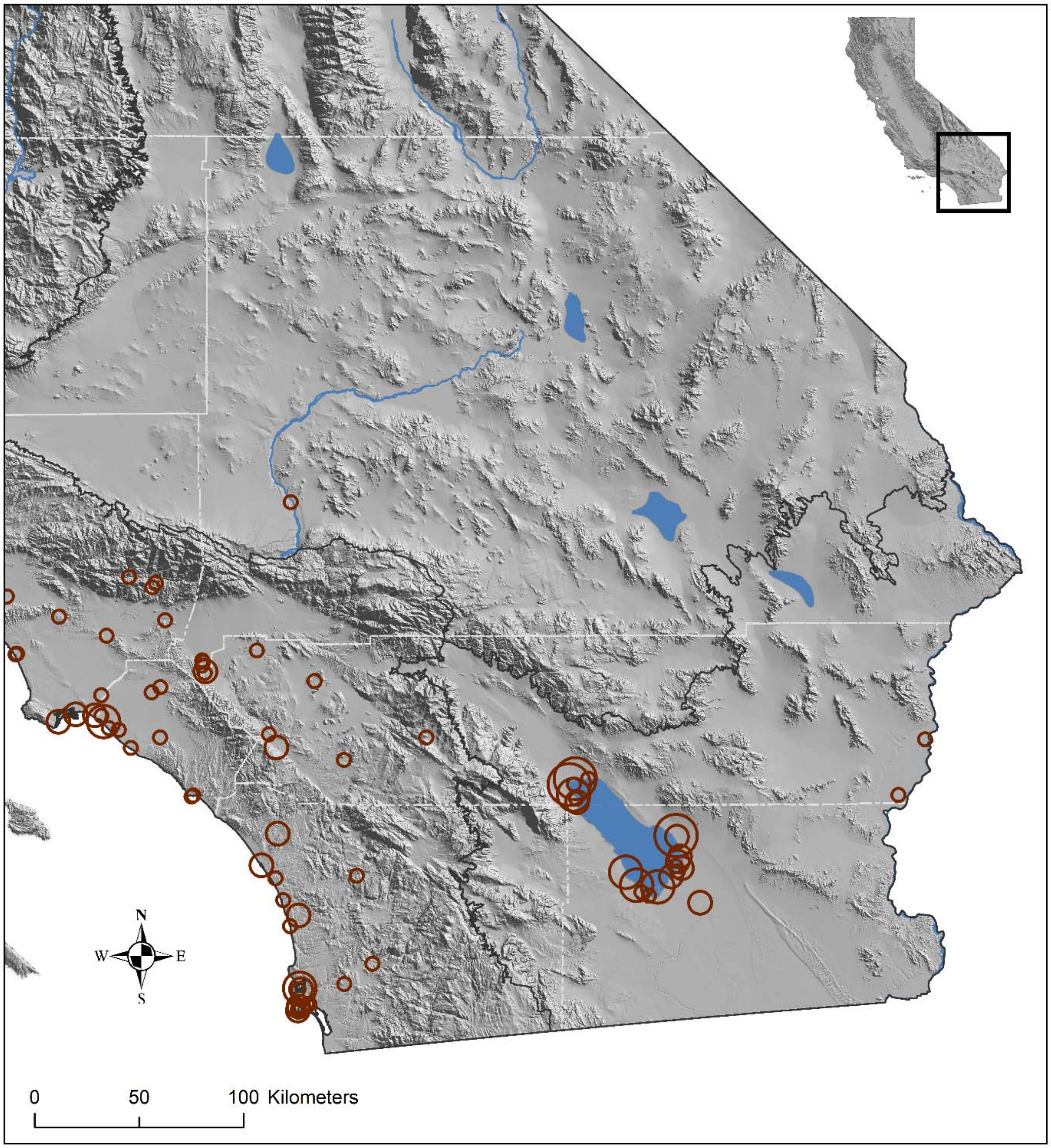

Figure 13. Distribution and relative size of Great Blue Heron colonies in areas of concentration on the coastal slope and at the Salton Sea in southern California from surveys in 2012 (see Figure 11 and Table 4).

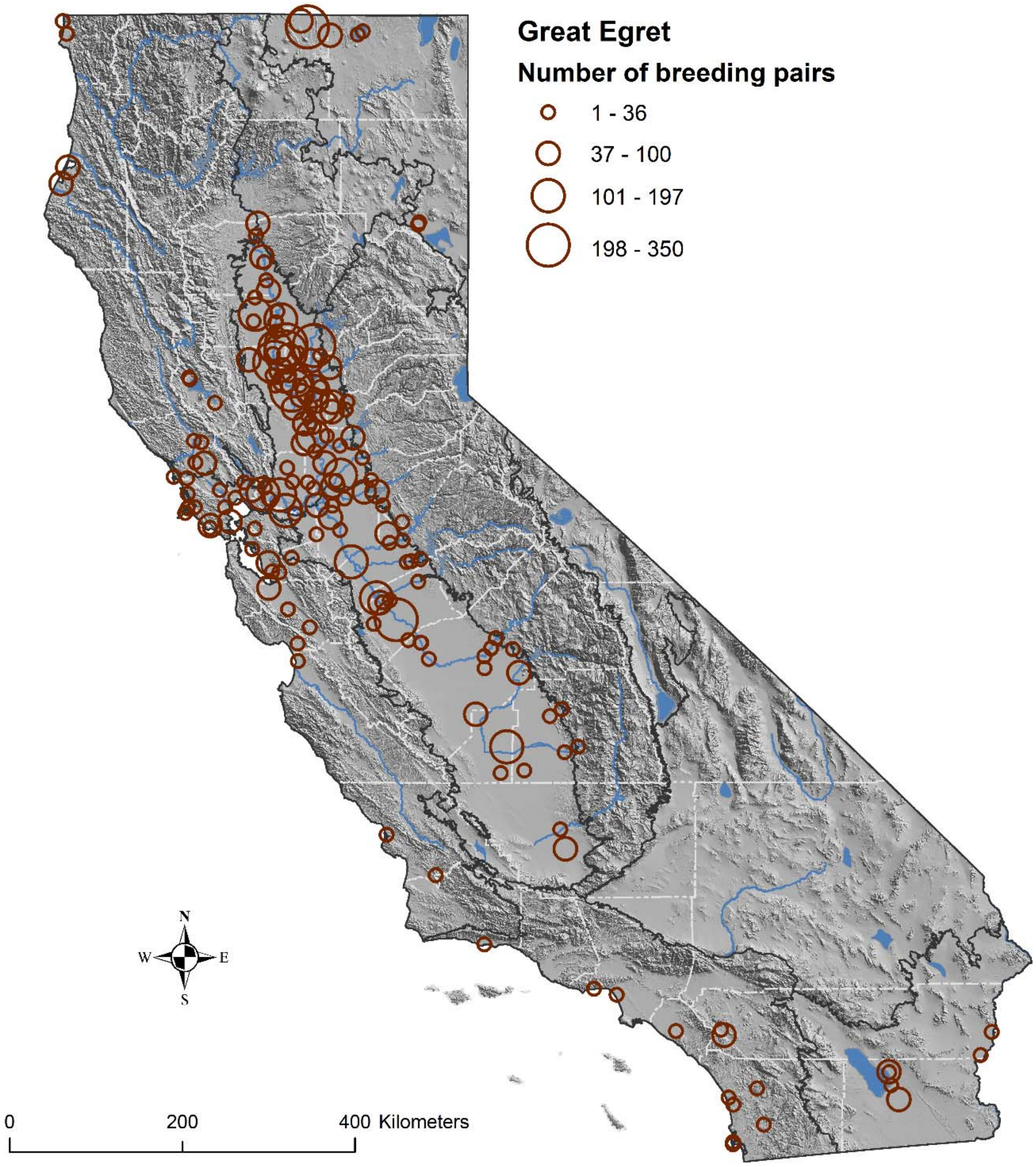

Figure 14. Distribution and relative size of Great Egret colonies in California from statewide surveys, 2009–2012 (see Table 5).

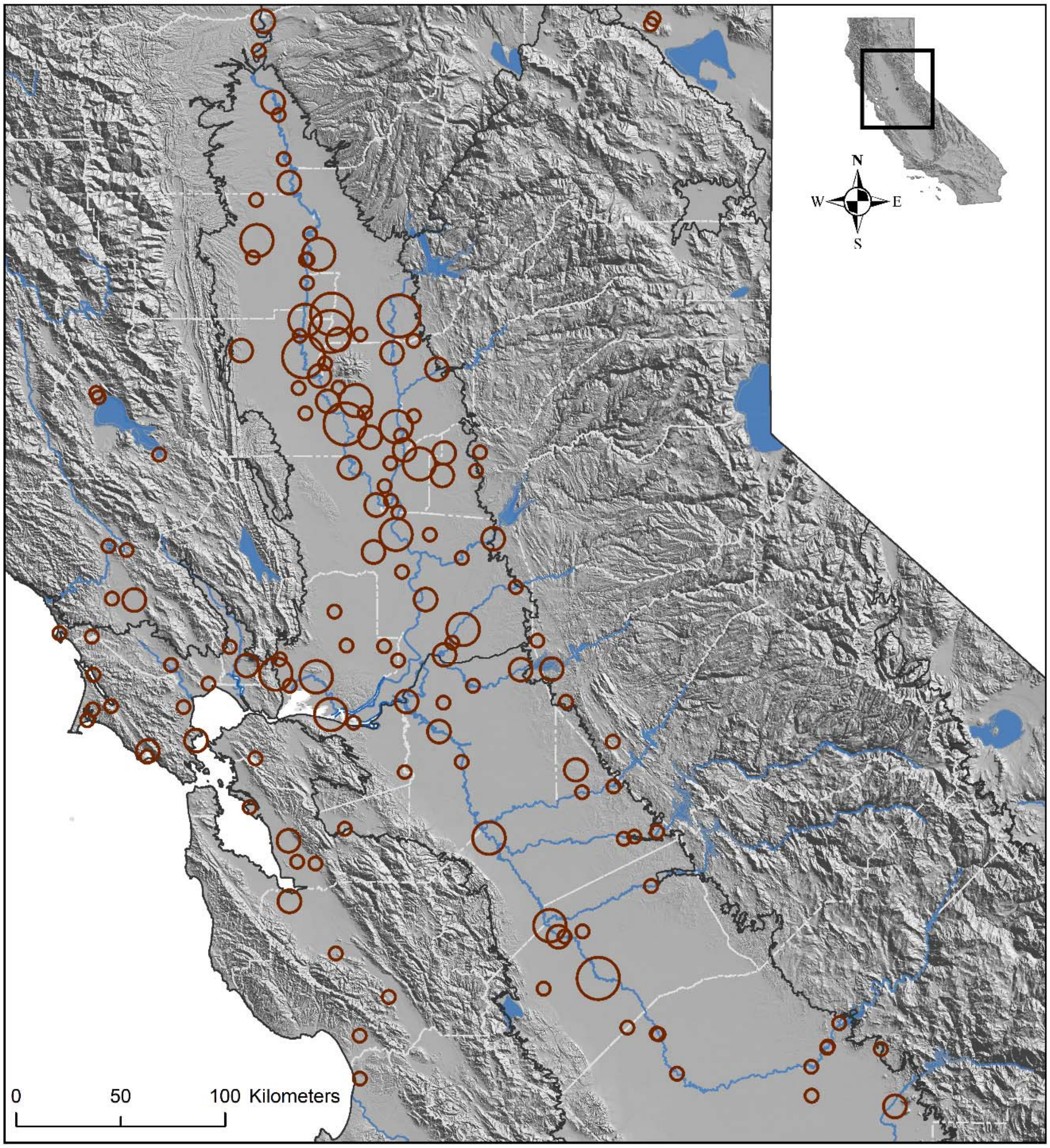

Figure 15. Distribution and relative size of Great Egret colonies in areas of concentration in the Sacramento Valley, Delta, northern San Joaquin Valley, and central coast of California from statewide surveys, 2009–2012 (see Figure 14 and Table 5).

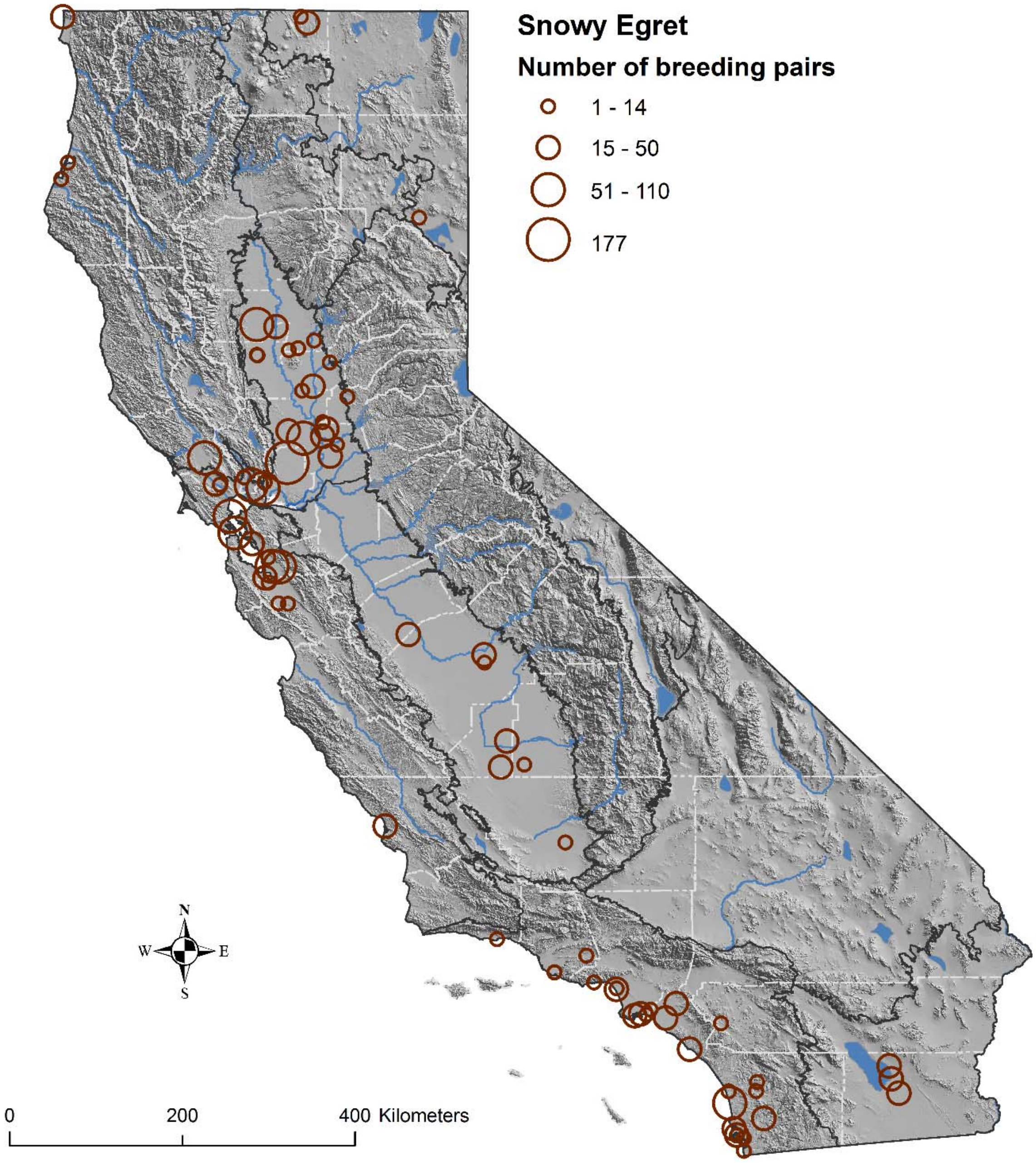

Figure 16. Distribution and relative size of Snowy Egret colonies in California from statewide surveys, 2009–2012 (see Table 6).

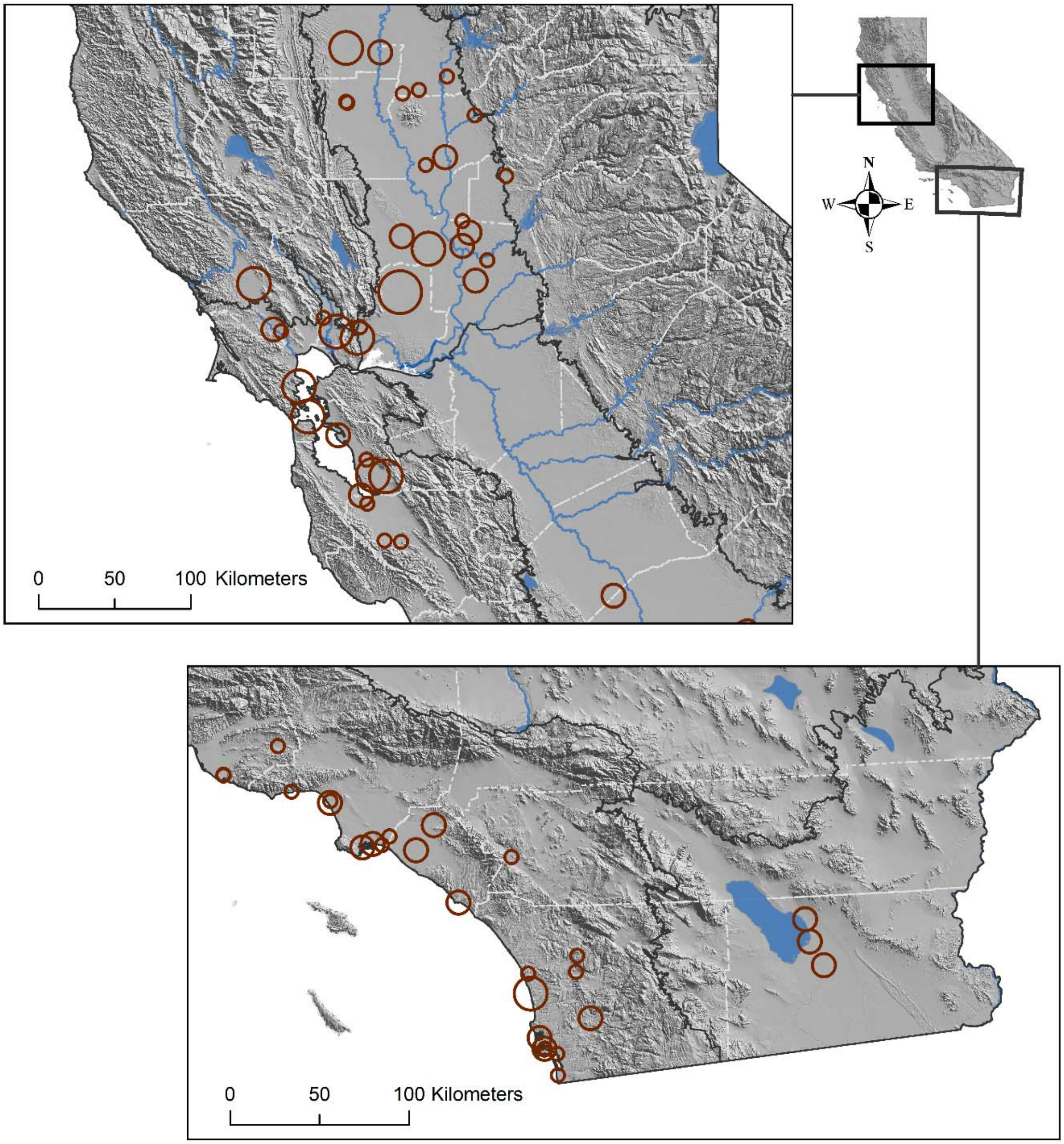

Figure 17. Distribution and relative size of Snowy Egret colonies in areas of concentration in the Sacramento Valley and San Francisco Bay area of northern California (above) and on the coastal slope and in the Salton Sea/Imperial Valley area of southern California (below); see Figure 16 and Table 6.

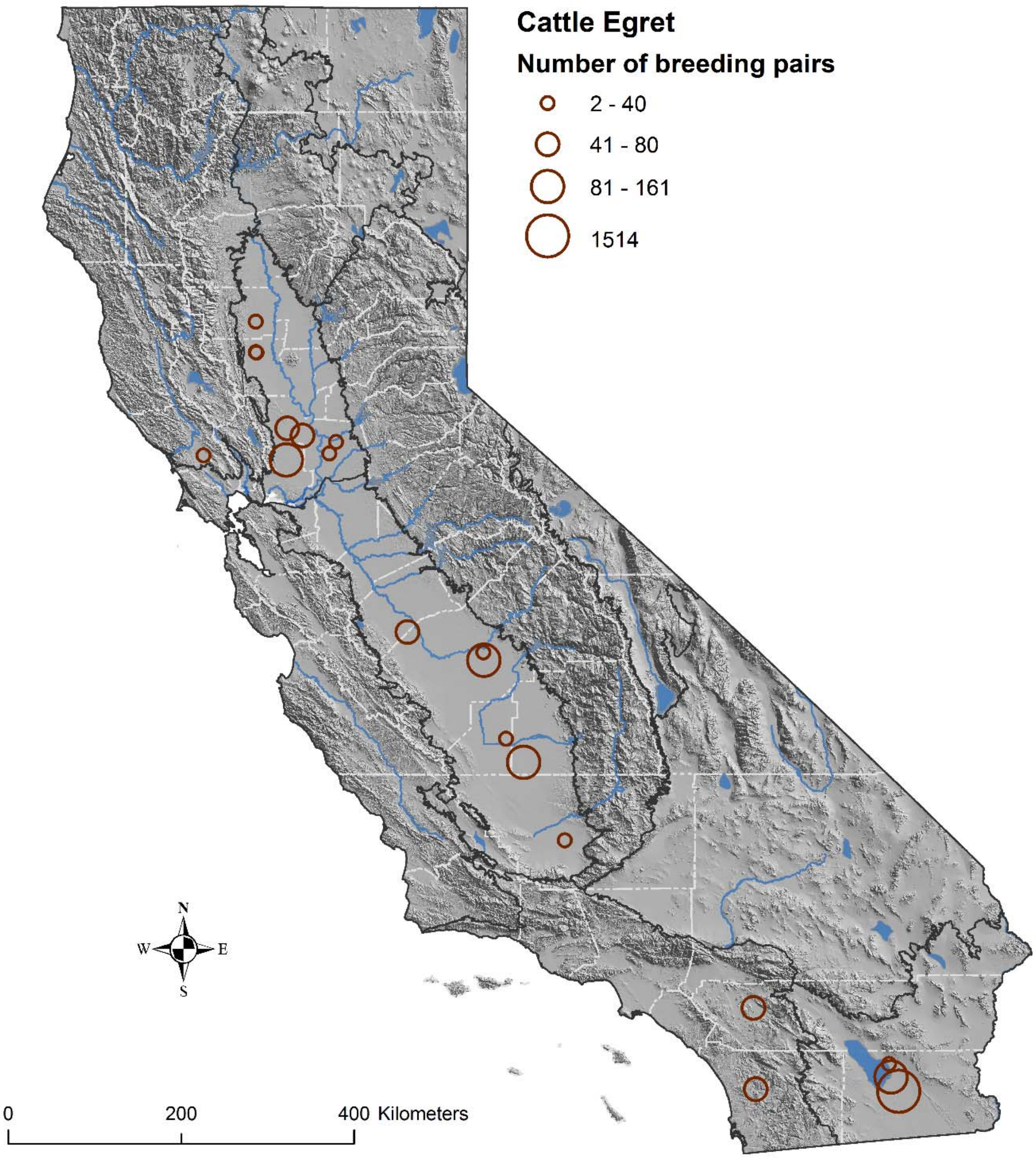

Figure 18. Distribution and relative size of Cattle Egret colonies in California from statewide surveys, 2009–2012 (see Table 7).

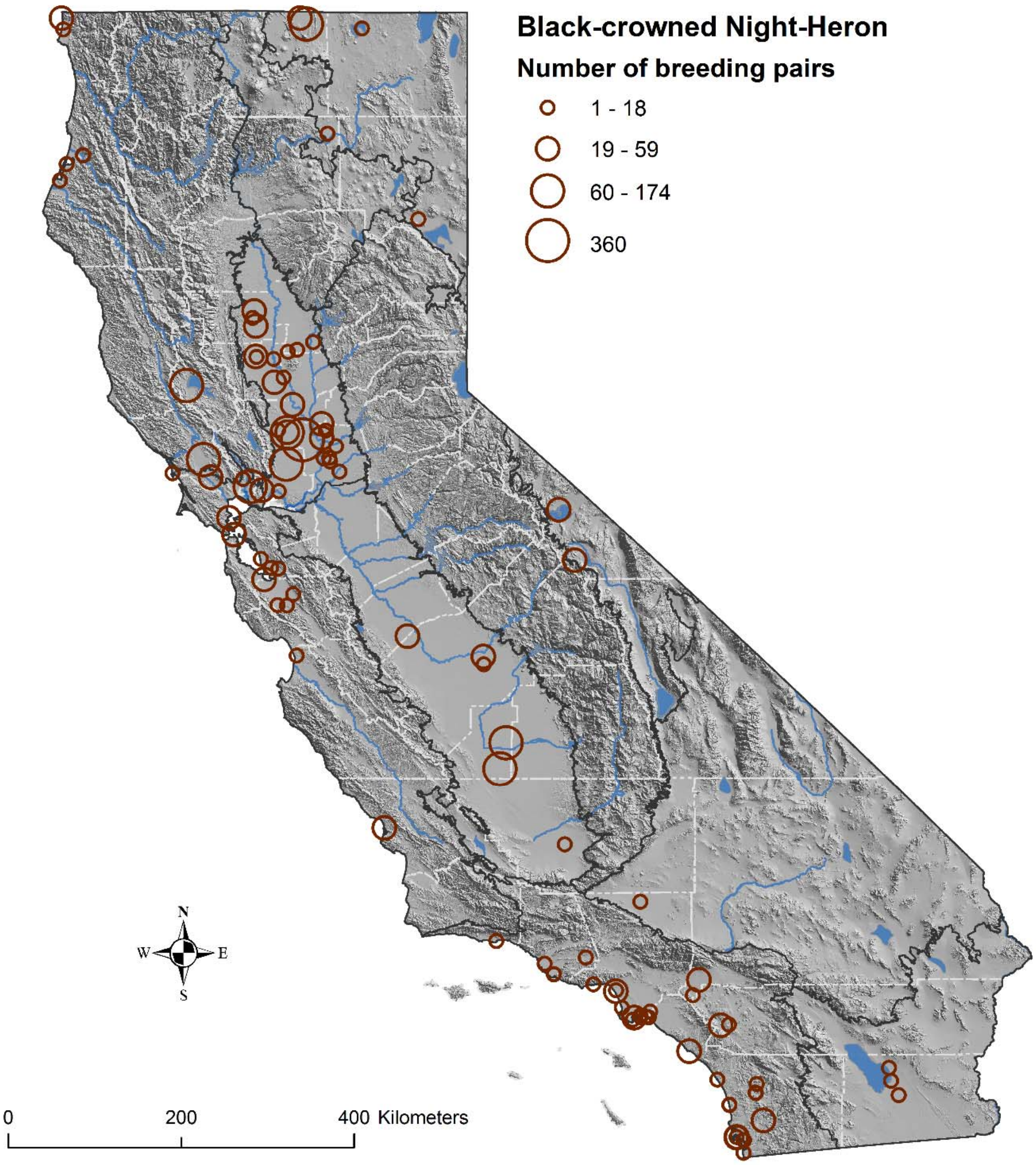

Figure 19. Distribution and relative size of Black-crowned Night-Heron colonies in California from statewide surveys, 2009–2012 (see Table 8).

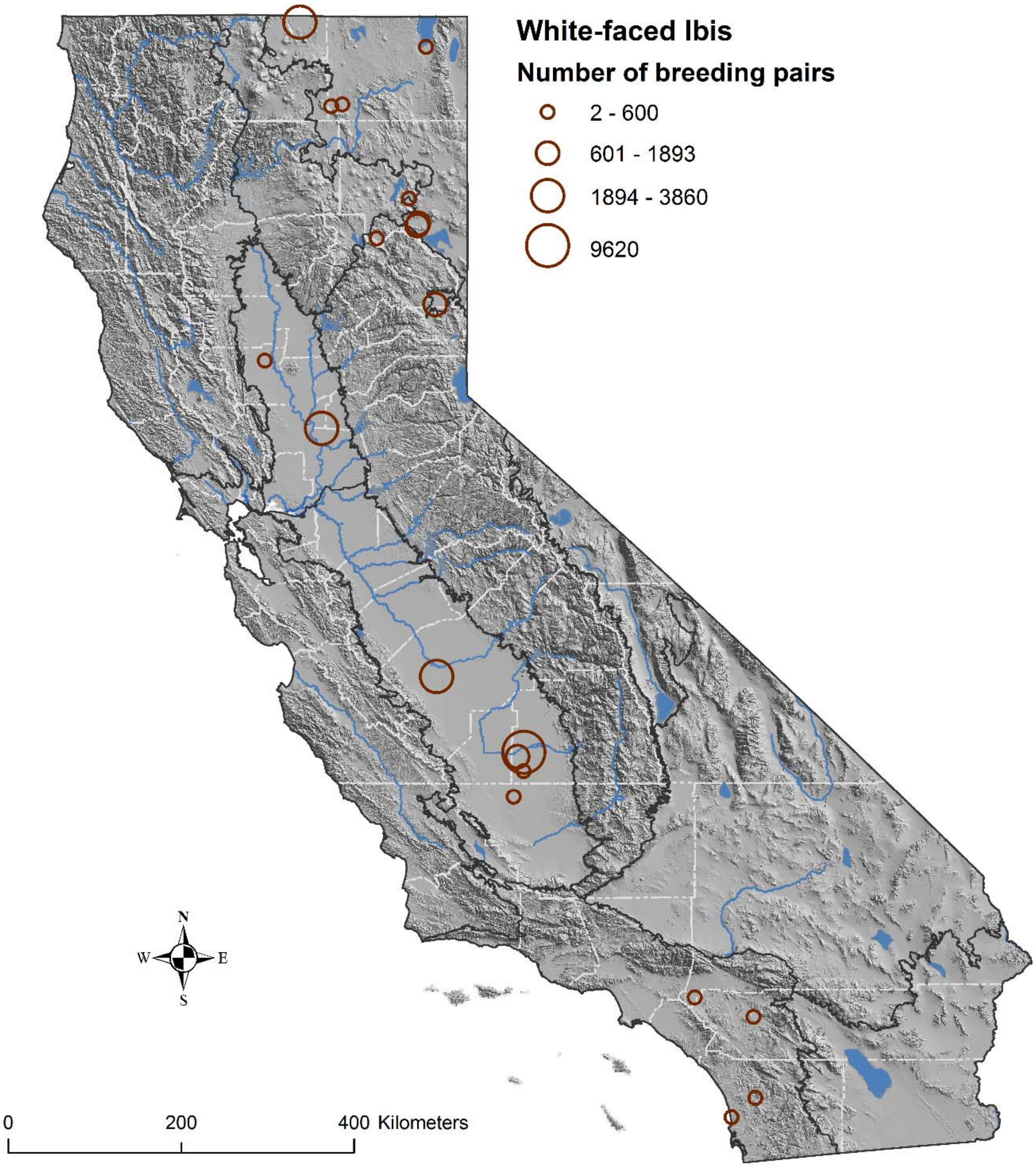

Figure 20. Distribution and relative size of White-faced Ibis colonies in California from statewide surveys, 2009–2012 (see Table 9).

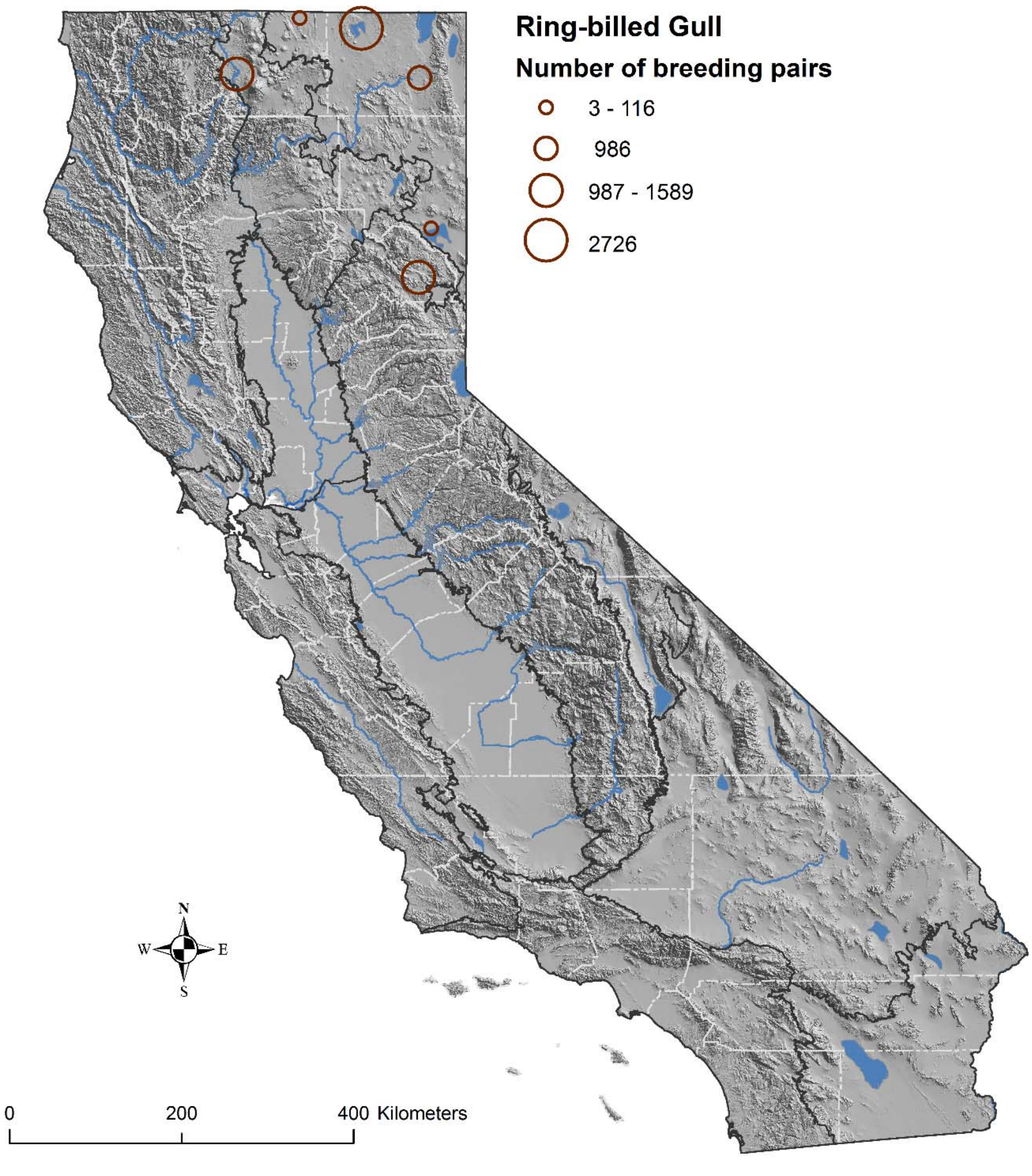

Figure 21. Distribution and relative size of Ring-billed Gull colonies in California from surveys of the known breeding range in the northeastern portion of the state in 2009 (see Table 10).

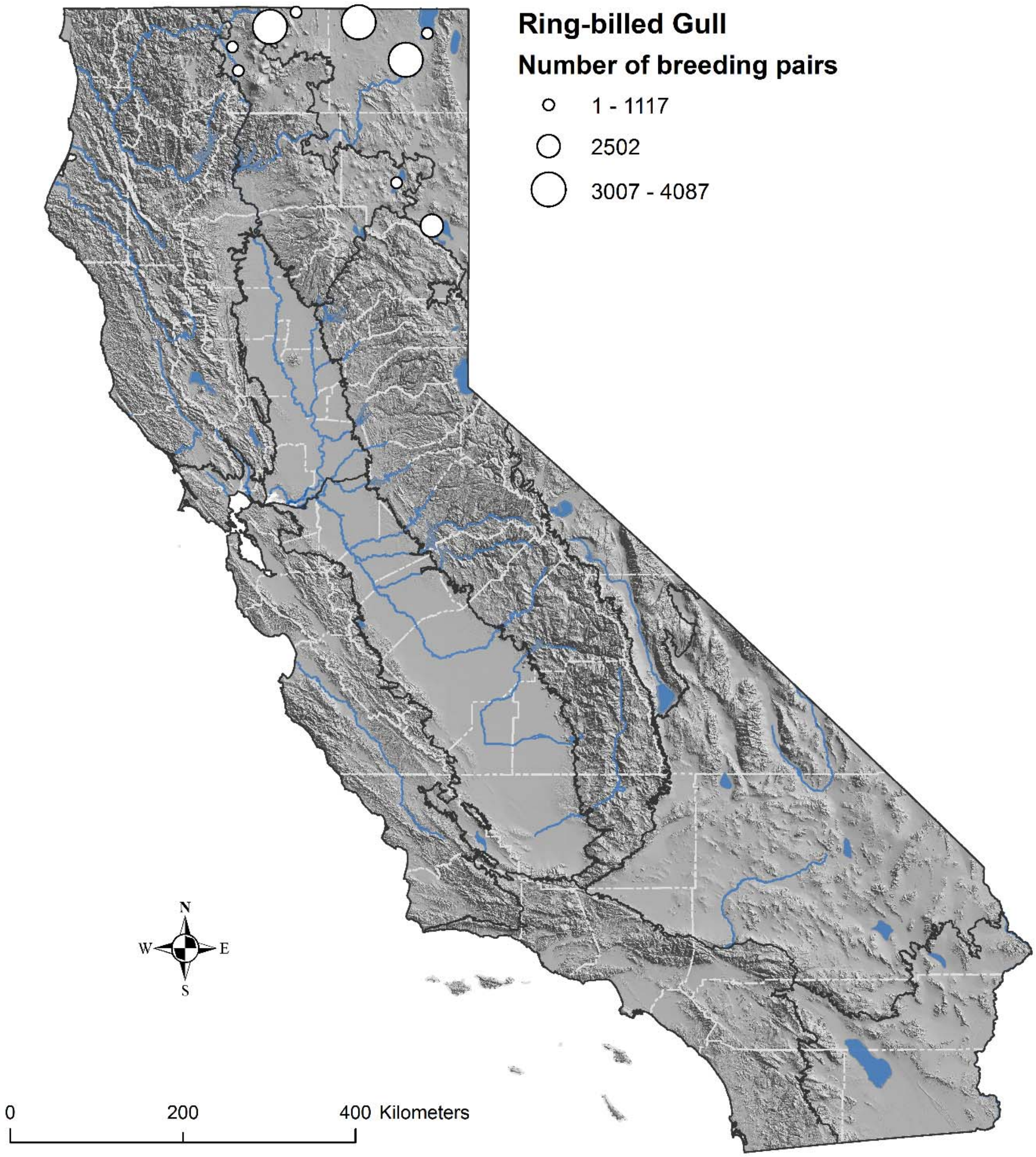

Figure 22. Distribution and relative size of Ring-billed Gull colonies in California from surveys of the known breeding range in the northeastern portion of the state, 1994–1997 (see Table 10; map from Shuford 2010).

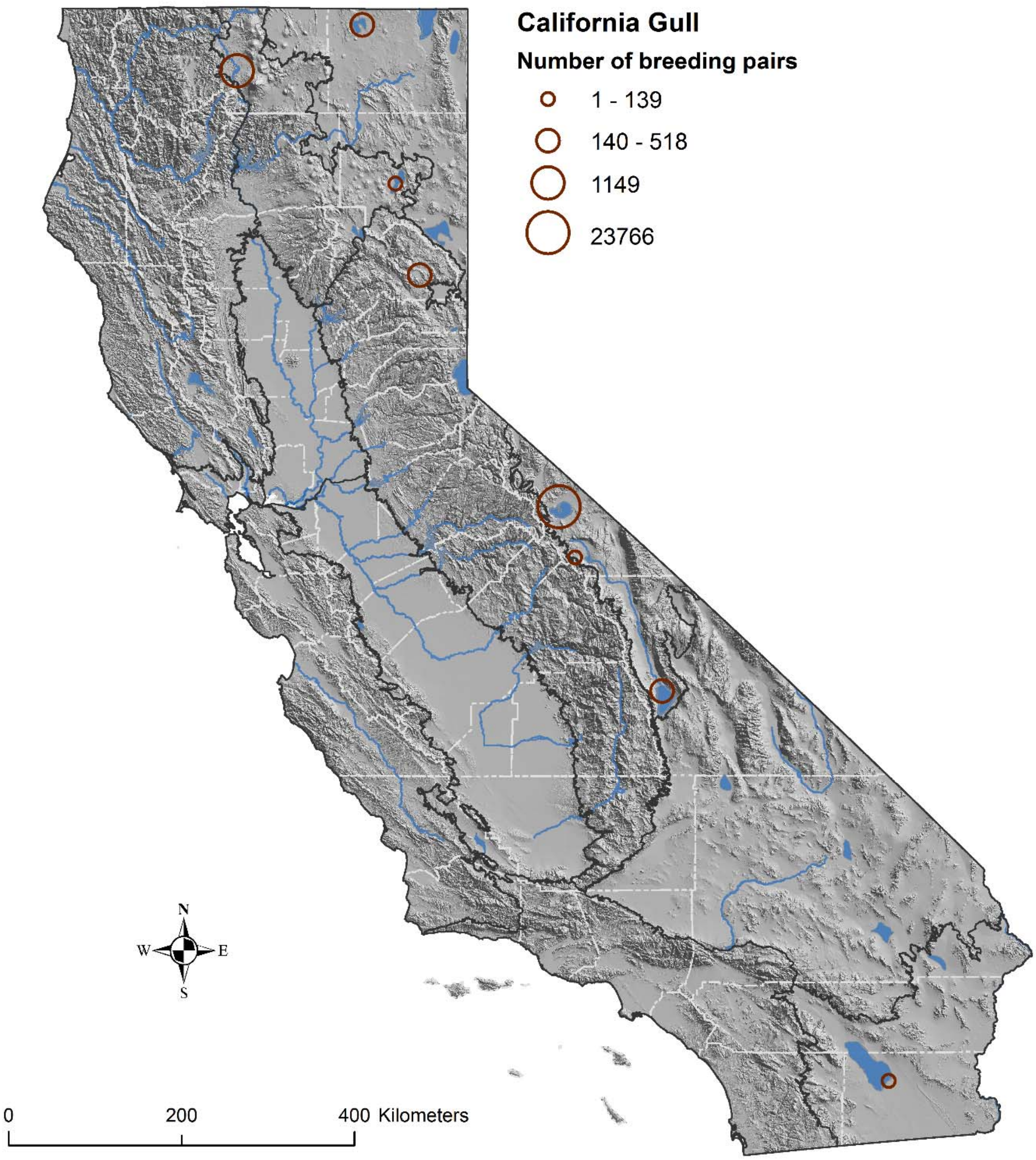

Figure 23. Distribution and relative size of California Gull colonies in California from statewide surveys in 2009 (see Table 10).

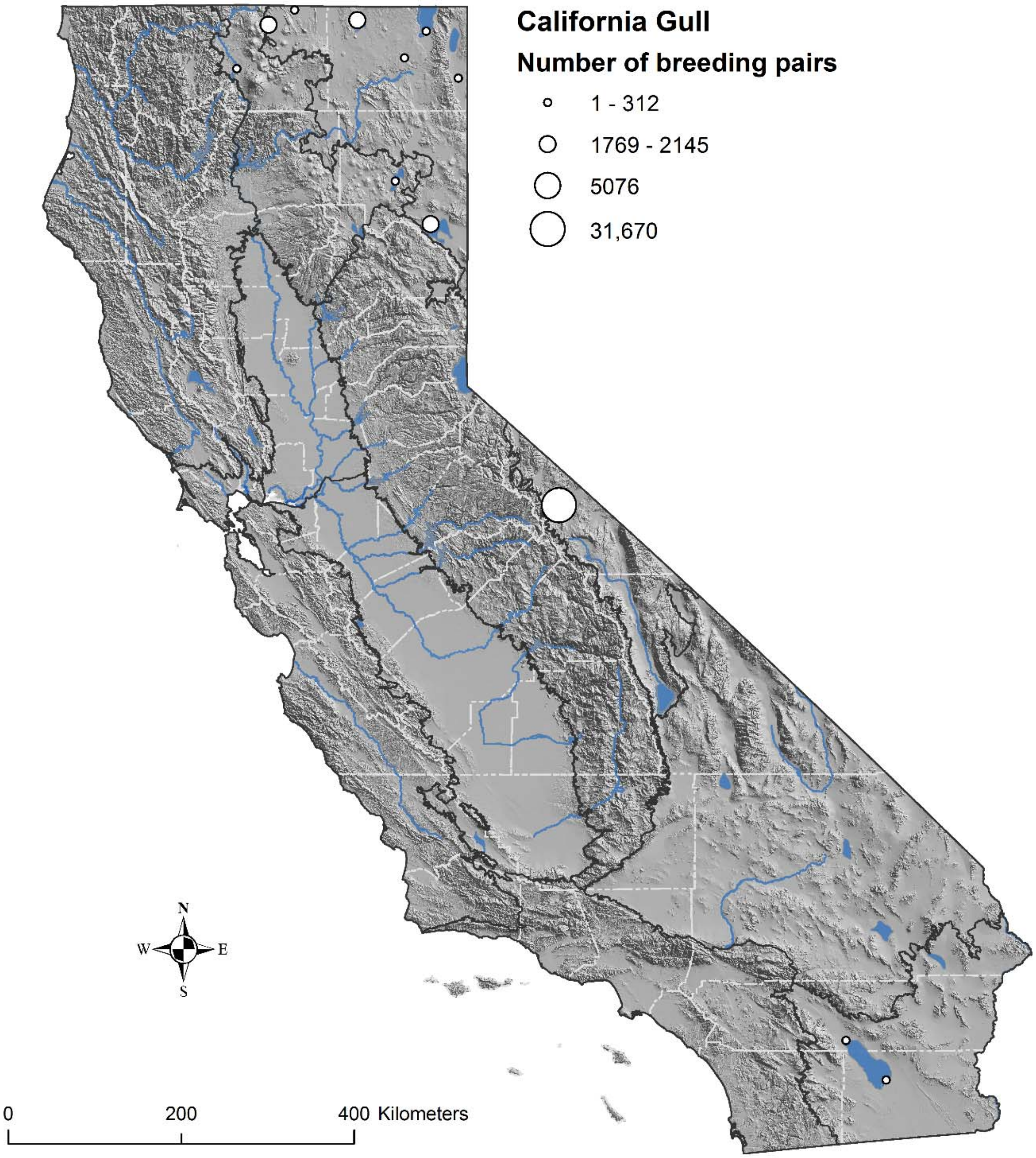

Figure 24. Distribution and relative size of California Gull colonies in California from statewide surveys, 1994–1997 (see Table 10; map from Shuford 2010).

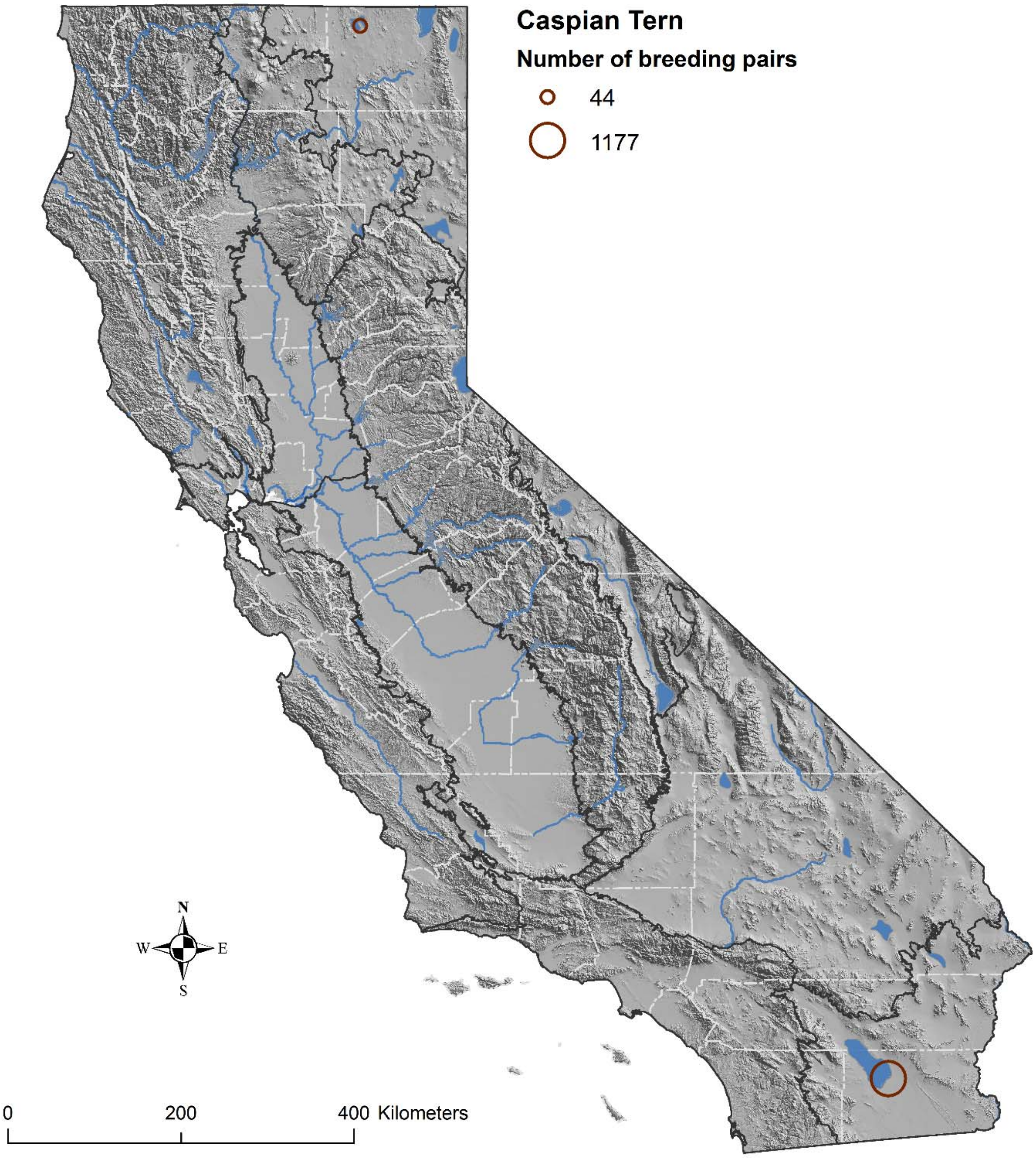

Figure 25. Distribution and relative size of Caspian Tern colonies in California from statewide surveys, 2009–2012 (see Table 11).

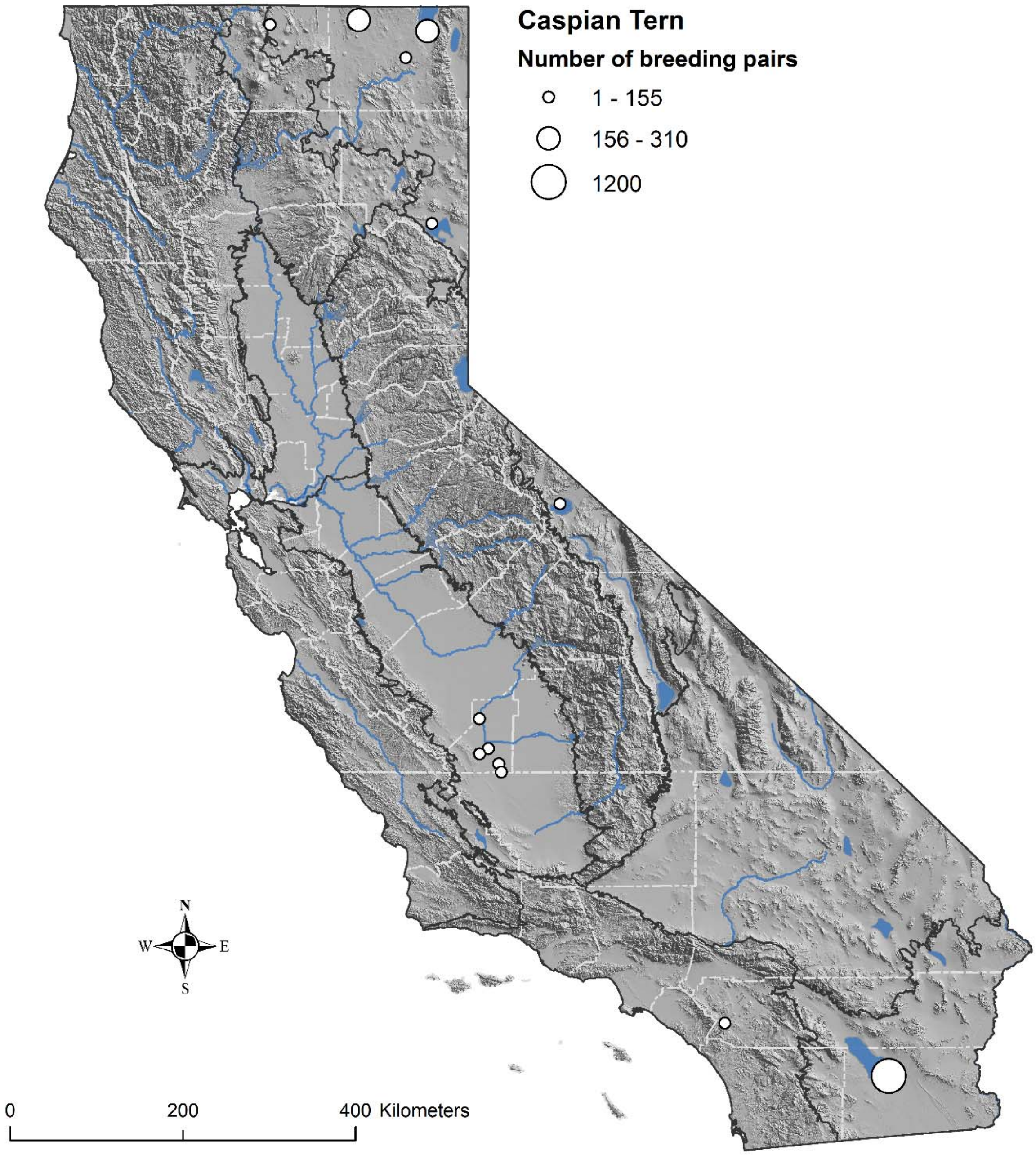

Figure 26. Distribution and relative size of Caspian Tern colonies in California from statewide surveys, 1997–1999 (See Table 11; map from Shuford 2010).

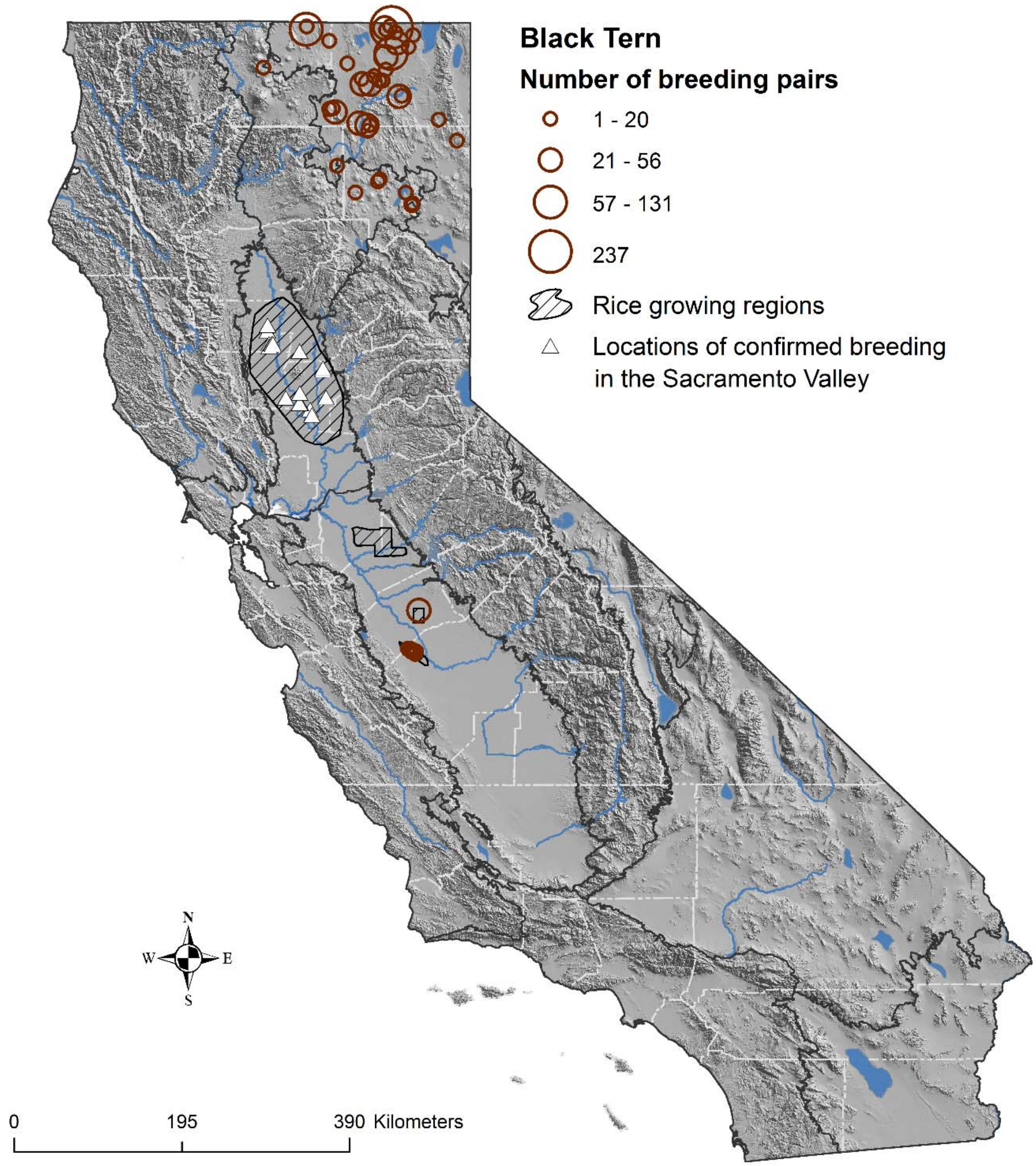

Figure 27. Distribution and relative size of Black Tern colonies in northeastern California and in the northern San Joaquin Valley from surveys in 2010 (see Table 12); surveys in the southern San Joaquin Valley in 2012 did not locate any colonies of this species. Triangles in the area of Sacramento Valley rice fields represent locations of confirmed breeding documented while using roadside surveys in 2010 to sample tern densities in this extensive habitat, where limited access precludes locating all colonies (see Table 13).

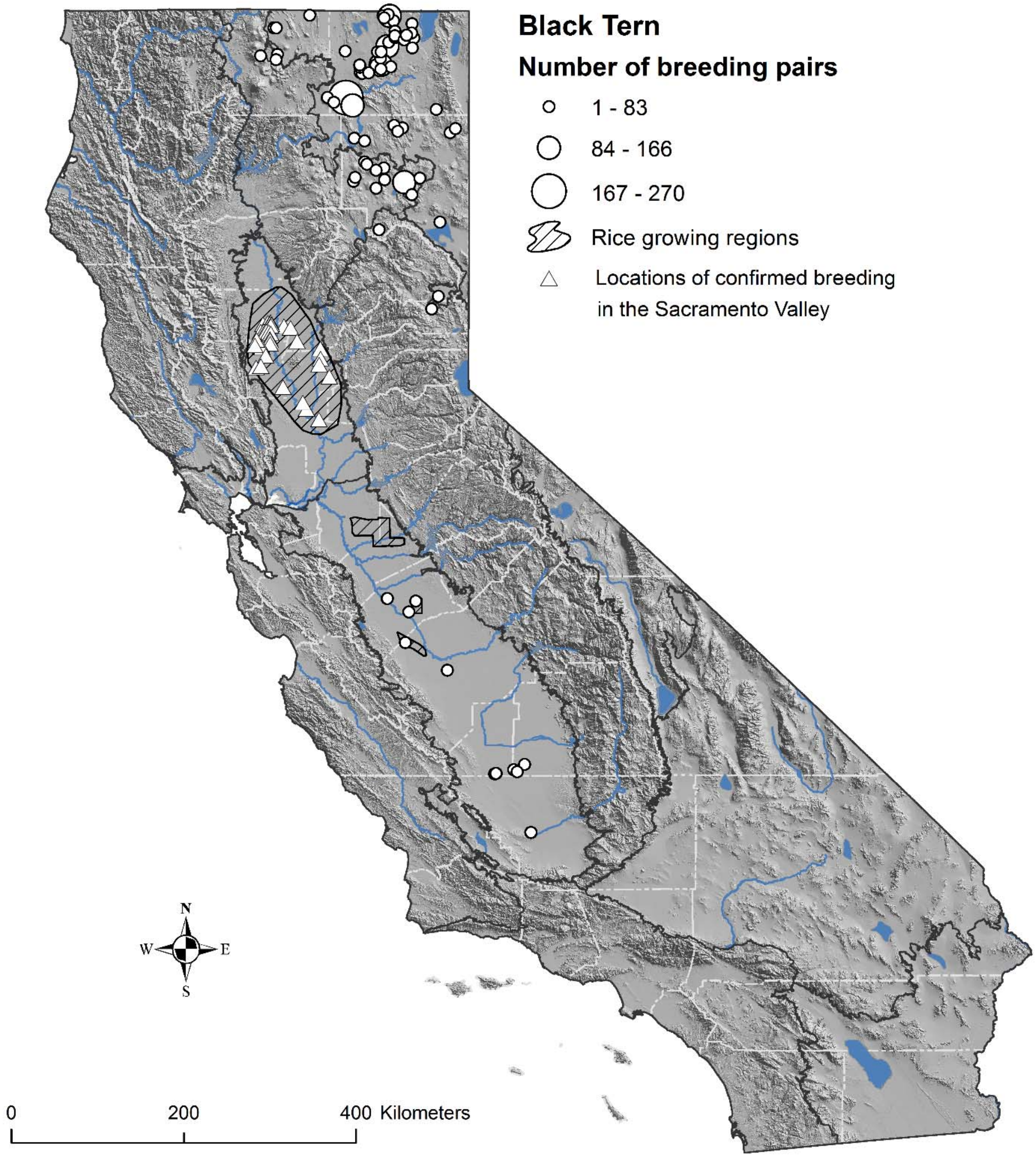

Figure 28. Distribution and relative size of Black Tern colonies in California from statewide surveys, 1997–1999 (Shuford et al. 2001, Shuford 2010). Triangles in the area of Sacramento Valley rice fields represent locations of confirmed breeding documented while using roadside surveys in 1998 to sample tern densities in this extensive habitat, where limited access precludes locating all colonies (see Table 13).

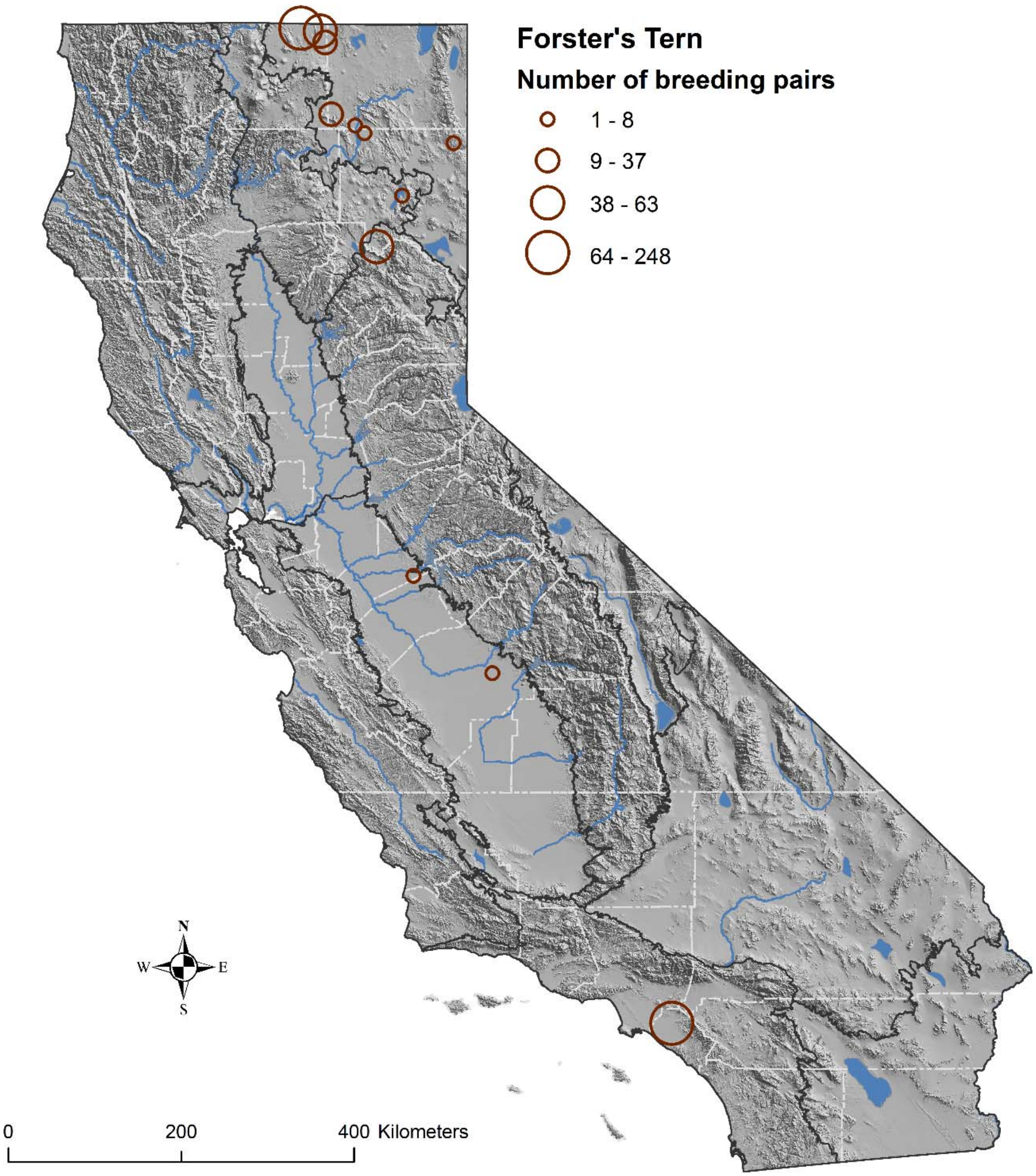

Figure 29. Distribution and relative size of Forster’s Tern colonies in California from statewide surveys, 2009–2012 (see Table 14).

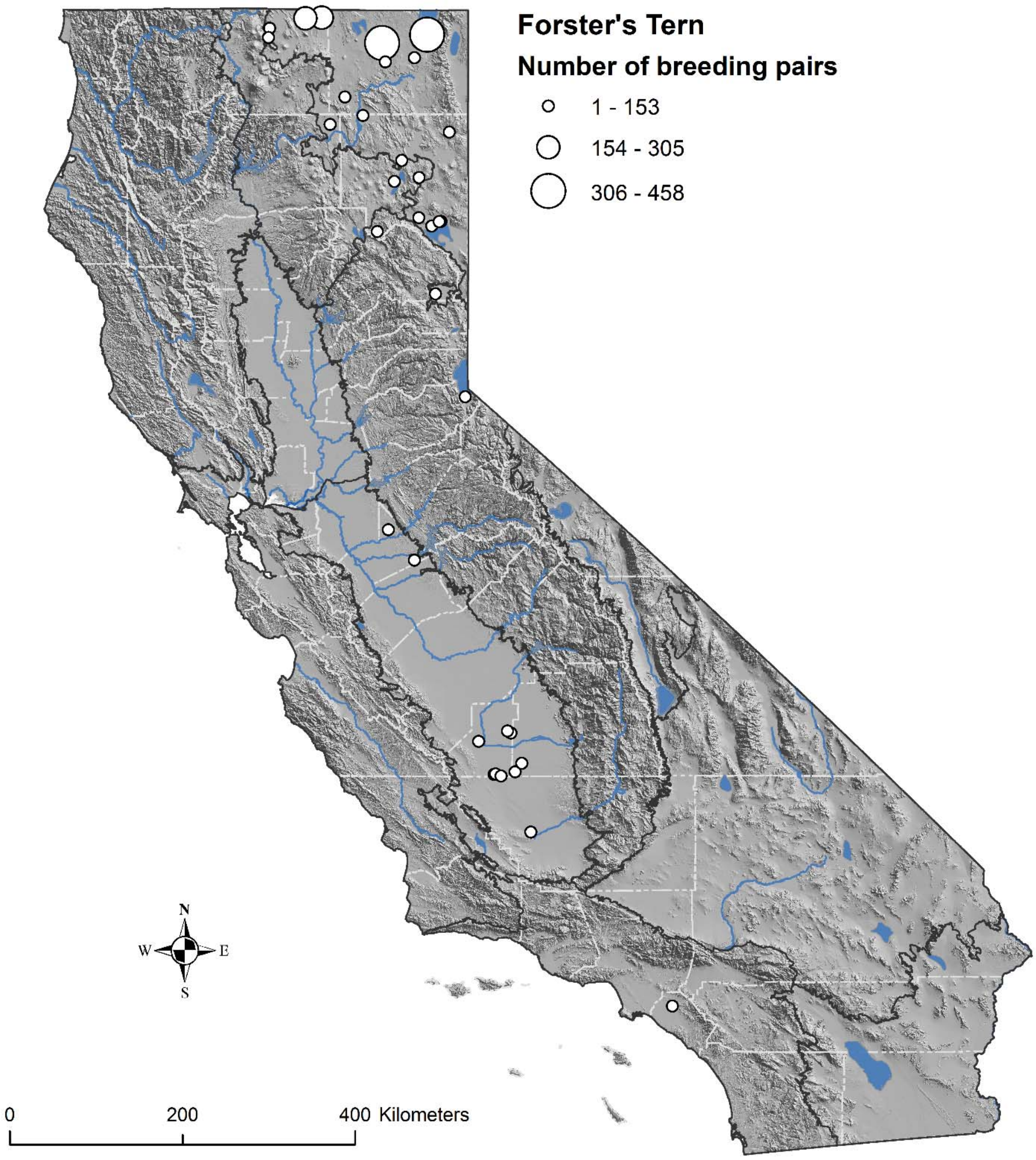

Figure 30. Distribution and relative size of Forster’s Tern colonies in California from statewide surveys, 1997–1999 (see Table 14; map from Shuford 2010).

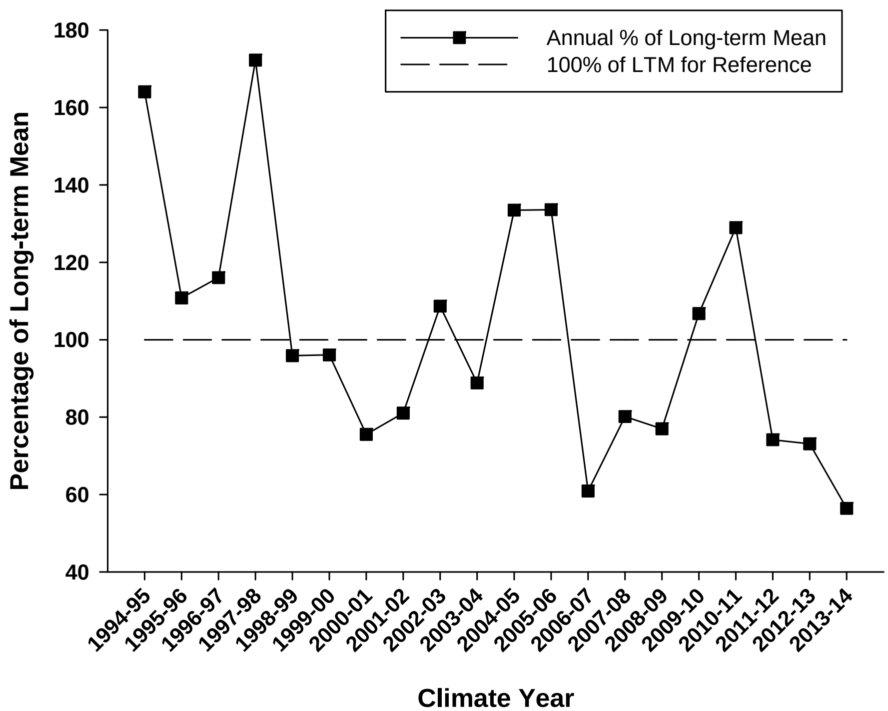

Figure 31. Annual precipitation for the entire state of California, as a percentage of the long-term mean (*n* = 119 yrs), for the climate years (1 July-30 June) 1994–95 to 2013–14. Data from the Western Regional Climate Center (www.wrcc.dri.edu/divisional.html).