Avifauna of the Salton Sea

Abundance, Distribution, and Annual Phenology

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Point Reyes Bird Observatory

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by

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Abbreviations

PRBO	Point Reyes Bird Observatory
SSNWR	Sonny Bono Salton Sea National Wildlife Refuge
WA	Wildlife Area
Wister Unit	Wister Unit of Imperial Wildlife Area (WA)

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Abstract

As part of a multi-disciplinary reconnaissance survey in 1999, we used a variety of survey methods to describe patterns of abundance, distribution, annual phenology, and broadscale habitat associations of birds at the Salton Sea. These surveys further documented the great importance of the Salton Sea within the Pacific Flyway to wintering, migratory, and breeding waterbirds. Surveys of waterbirds (other than Eared Grebes) at the Salton Sea and adjacent habitats, estimated about 187,000 individuals in January, 88,000 in April, 170,000 in August, and 261,000 in November. Additional surveys of Eared Grebes in November and December suggested the total population of all waterbirds was about 434,000 to 583,000 in those months, respectively. Surveys also documented breeding by about 14,000 pairs of colonial waterbirds. Waterbirds were not equally distributed around the Sea, and areas of particular importance to them were the northern, southwestern, southern, and southeastern shorelines. By contrast, certain wading birds and shorebirds were much more numerous in agricultural fields of the Imperial Valley than in wetland habitats at the Salton Sea. Various studies indicate the Salton Sea is of regional or national importance to various species groups – pelicans and cormorants, wading birds, waterfowl, shorebirds, gulls and terns – and to particular species -- the Eared Grebe, American White Pelican, Double-crested Cormorant, Cattle Egret, White-faced Ibis, Yuma Clapper Rail, Snowy Plover, Mountain Plover, Gull-billed Tern, Caspian Tern, Black Tern, and Black Skimmer.

Projects to restore the ecosystem's health by reducing salinity and limiting bird die-offs should be carefully assessed to ensure they do not have unintended impacts and are not placed where large numbers of breeding, roosting, or foraging birds currently concentrate. Similarly, plans to enhance opportunities for recreation or commerce at the Sea should aim to avoid or minimize disturbance to birds. Future research should focus on filling gaps in knowledge needed to effectively solve problems facing birds at the Salton Sea.

Chapter 1
Introduction

The Salton Sea, as an integral part of the Río Colorado Delta region, supports large numbers and a great variety of avian species and arguably is one of the most important wetlands to birds in North America. A number of bird species have populations in the Salton Sea area that are of regional or continental importance in size or are highly vulnerable. Additionally, the Salton Sea serves as a vital migratory stopover and wintering area for species that breed elsewhere in western North America. Because of this connectivity, the health of populations of many species of waterbirds is linked to that of the Salton Sea. Great concern recently has been expressed about the fate of the Salton Sea ecosystem because of increasing salinity, contamination from agricultural and urban sources, disease outbreaks, and large die-offs of waterbirds (e.g., USFWS 1997).

Although key information on the avifauna of the Salton Sea has been summarized (Shuford et al. 1999), various proposals to deal with problems of ecosystem health are hampered by the limited quantitative data available on the status and ecology of birds

using this area. As part of a multi-disciplinary reconnaissance survey coordinated by the Salton Sea Science Subcommittee, we conducted a year-long study to document the annual phenology, distribution, abundance, and broadscale habitat associations of birds using the Salton Sea and adjacent habitats. Here we report the results of those surveys, interpret their relevance to the Salton Sea Restoration Project EIR/EIS, and make recommendations for further research needs.

Chapter 2
Conclusions

Importance of the Salton Sea to Pacific Flyway Waterbirds

Our studies in 1999 further documented the great importance of the Salton Sea to birds in the Pacific Flyway of western North America. The Salton Sea is an important part of the Río Colorado Delta region, including the northern Gulf of California, and contains some of the highest biological diversity in the southwestern United States. This is especially true for birds. To date, 402 native and 5 non-native bird species have been recorded in the Salton Sea area, including about 100 breeding species (Patten 1999). In addition, the sheer number of birds using the Salton Sea at various times of the year is particularly noteworthy. Our surveys in 1999 suggest that a minimum of 500,000 waterbirds inhabited the Salton Sea in winter. While this number is impressive, in prior years the Eared Grebe population at the Sea alone has reached 3.5 million birds (R. McKernan pers. comm. in Jehl 1988).

As well as holding large numbers of birds, the Salton Sea also hosts populations of various species that are of continental or regional importance. For example, 90% or more of the entire North American population of the Eared Grebe may pass through the Sea in some years (J. R. Jehl, Jr. in litt.). Our peak count of about 25,000 American White Pelicans at the Salton Sea in 1999 was similar to the range of about 26,500 to 33,000 in recent years (Setmire et al. 1990, McCaskie 1999). These numbers represent about 23% to 30% of the entire North American breeding population and actually exceed the estimate of about 18,600 for the western population, which breeds and winters west of the continental divide (Johnsgard 1993). Counts of 16,000 to 19,000 White-faced Ibis in the Imperial Valley further documented that area as one of the most important wintering sites for these birds in western North America (Shuford et al. 1996). Surveys of the endangered Yuma Clapper Rail indicate that the Salton Sea holds about 40% of the taxa's entire population in the U.S. (Yuma Clapper Rail Recovery Team unpubl. data.). Waterfowl numbers at the Salton Sea and nearby wetlands reached at least 55,000 individuals in 1999, and numbers from 1978 to 1987 averaged >75,000 individuals (Heitmeyer et al. 1989).

Shorebird totals at the Salton Sea in some years have exceeded 100,000 individuals in both spring and fall (PRBO and R. McKernan unpubl. data). Regional comparisons indicate the Salton Sea is one of only eight sites in the interior of western North America that holds over 10,000 shorebirds in fall and one of five such sites in spring (PRBO unpubl. data). In terms of overall shorebird numbers, the Salton Sea is the most important area in the Intermountain and Desert region of the West in spring and the second most important, after Great Salt Lake, in fall. Shorebird populations at the Salton

Sea from 1989 to 1995 averaged 24,000 in December, 90,000 in April, and about 85,000 individuals in August. Shorebird surveys in 1999 provided additional documentation for these patterns and added a total of about 70,000 shorebirds in November, a month for which prior thorough surveys were lacking. Surveys in 1999 confirmed that the Salton Sea supports the largest population of wintering Snowy Plovers in the interior of western North America (Shuford et al. 1995) and is one of a handful of key breeding areas in the interior of California (Page et al. 1991). Surveys in 1999 indicate the Imperial Valley is even more important than previously recognized for the Mountain Plover, as it held about 30% to 38% of the species' entire population of 8000 to 10,000 birds (Anonymous 1999).

In 1999, we estimated a total gull population of over 40,000 individuals at the Salton Sea, not including many additional thousands using agricultural lands in the adjacent Imperial Valley. These numbers suggest that the Salton Sea is one of, if not the, most important area in the interior of western North America for wintering gulls. A count of over 4000 Black Terns at the Salton Sea in August 1999 appears to be the only comprehensive count at that site, although Small (1994) reported "tens of thousands" there during the period of peak occurrence in July and August. Regardless, the Salton Sea in one of the most important sites in western North America for migrating Black Terns (Shuford 1999). The Salton Sea also supports very large populations of colonial nesting waterbirds. Breeding colonies of particular species – Double-crested Cormorant, Cattle Egret, Gull-billed Tern, Caspian Tern, and Black Skimmer – in recent years have been among the largest in western North America.

Areas of Importance to Birds at the Salton Sea

Important habitats for birds are not equally distributed around the Salton Sea. Our studies in 1999 documented the great importance to a variety of birds of habitats along the northern, southwestern, southern, and southeastern shorelines of the Salton Sea (Figure 2-1). These shoreline areas hosted large numbers of birds overall, important nesting, roosting, and foraging sites, and habitats for various taxa of conservation concern. Inshore waters within a kilometer of the entire shoreline also appeared to be important to a variety of diving waterbirds. Additionally, agricultural fields of the Imperial Valley were of much greater importance to particular species of wading birds and shorebirds than were habitats at the Salton Sea.

Chapter 3
Recommendations

Conservation Concerns

Although the Salton Sea hosts about 19 species of waterbirds of conservation concern (Table 3-1), many other species that concentrate there potentially are at great risk from disease, contaminants, or human encroachment. Birds at the Sea particularly hard hit by mortality during the 1990s include the Eared Grebe (150,000 in 1992, unknown causes); American White Pelican (9,000 in 1996, botulism); Brown Pelican (1,200 in 1996, botulism); and waterfowl, shorebirds, and waders (>11,000 in 1998, avian cholera) (see summary in Shuford et al. 1999). Although die-offs occur sporadically at many other Pacific Flyway wetlands, the magnitude of those at the Salton Sea and the species

affected, particularly diving and fish-eating birds, make them of special concern. Setmire et al. (1990, 1993) and the Imperial Irrigation District (1994) have reviewed the results of bird contaminant studies at the Salton Sea, which indicate birds are at risk to selenium, boron, and DDE. Although birds appear to be at greatest risk from agricultural drain waters in the Imperial Valley, many species that use the Salton Sea move to and from irrigated agricultural lands of the Imperial Valley and the Sea. Human activities also potentially could impact birds at sites where they concentrate at the Sea. Nesting waterbirds, which occur at the Salton Sea in large numbers, are sensitive to colony intrusions (Carney and Sydeman 1999 and references therein), which may expose unattended eggs and young to extreme thermal conditions and result in overheating and death in a short period of time (Grant 1982, Molina 1999). Hence, the nesting success of these populations, particularly of ground nesters, may be closely linked to the degree of colony disturbances (Molina 1996).

The Salton Sea Restoration Project (Tetra Tech 2000) addresses most of these issues, but the initial solutions proposed focus primarily on reducing the salinity of the Sea via various engineering alternatives. Although reducing salinity may stave off the collapse of the Sea's fish populations and, by extension, those of fish-eating birds, it is unclear what affect, if any, a decrease in salinity will have in reducing bird mortality from diseases or other agents that may be triggered by perhaps unrelated factors. Nevertheless, any proposed projects to reduce salinity should be carefully evaluated and implemented only if they can provide substantial habitat improvements without negatively impacting the suitability of current habitats.

As guidelines for addressing conservations concerns for birds at the Salton Sea, we recommend that restoration efforts focus on and develop specific measures for:

- protecting and enhancing habitats for species of conservation concern.
- protecting and enhancing habitats currently used by large numbers of nesting, roosting, and foraging birds.
- reducing the future number and severity of bird die-off events by continuing the funding of ongoing research and monitoring and by implementing solutions as knowledge becomes available. Potential solutions should consider various methods to reduce the high nutrient levels in the Sea, which may lead to anoxic conditions contributing to fish die-offs.
- evaluating all proposed engineering solutions to ensure that all such alternatives do not pose potential risks to birds and, if they do, that these impacts are mitigated.
- evaluating all plans to increase human recreation or commerce at the Sea to assess potential direct impacts and those of increased disturbance on breeding, roosting, and foraging birds and to assess the actions needed to alleviate, reduce, or mitigate these impacts.
- monitoring bird populations to evaluate whether restoration alternatives provide proposed benefits, or unforeseen impacts, and, when possible, to develop adaptive management recommendations for actions to improve bird habitats and ecosystem health.
- conducting additional research to fill in key gaps in knowledge needed to effectively address conservation concerns of birds at the Sea.

Although it is beyond the scope of this document to provide a detailed critique of the draft Salton Sea Restoration Project EIS/EIR (Tetra Tech 2000), we recommend that additional consideration be given to the following issues of conservation concern at the Salton Sea by reviewing the literature and consulting with experts regarding:

- the potential impacts on diving birds using inshore waters of placement of large evaporation pond complexes along the southwestern shore of the Sea.
- the possible impacts to birds of concentrations of selenium, boron, or other heavy metals, which have caused bird deformities at similar evaporation basins in California's San Joaquin Valley.
- the possible impacts of predators on nesting shorebirds, terns, or skimmers concentrated on the levees and dikes of proposed evaporation ponds.
- evaluation of placement of evaporation ponds at sites other than those currently proposed (if other issues can be adequately addressed) to lessen impacts to birds.
- evaluation of building additional freshwater impoundments along the eastern shoreline between the north end of the Wister Unit and Bombay Beach or along the southern shore to link Units 1 and 2 of SSNWR.
- assessing the feasibility of implementing seasonal or complete closures of access to key nesting and roosting sites, such as the New and Alamo river deltas, where recreation currently is allowed.
- evaluation of the cumulative impacts of reduced water deliveries to waterbirds using agricultural fields in the Imperial Valley.
- maintenance of quasi-wilderness status in certain areas, such as the shoreline between Salton City and the Salton Sea Test Base, by designating them off limits to motorized travel. Such action would reduce impacts to breeding, roosting, and foraging birds and maintain areas where visitors can experience solitude when viewing wildlife.
- restoration of native riparian areas near the Sea and control of non-native invasive species in these habitats.

Research Needs

Despite the studies to date, there are still large gaps in the knowledge needed to effectively solve the problems facing birds at the Salton Sea. Areas of bird research that particularly seem to be lacking or need substantial additional work fall under the following categories:

(1) Habitat use – little quantitative information is available on the within-Sea distribution and habitat needs of most species of waterbirds, data that will be crucial to ensure that any large scale projects designed to solve problems, such as increasing salinity, will not harm important species or habitats. Time series studies are needed to see how birds use the Sea at different water elevations both on a seasonal and long-term basis. Additional research is needed of how various waterbirds exploit irrigated agricultural fields for foraging and how projected declines in water availability in the region might affect their populations.

(2) Disturbance – research is needed on the effects of investigator and recreational disturbances on nesting colonies, isolated roosting sites, and areas that regularly

concentrate large numbers of birds. Such studies would contribute to the development of future monitoring protocols and management policies that help to ensure long-term viability of the areas' bird populations.

(3) Diseases – continuation of current research is needed to identify the causes of large scale die-offs, mechanisms of disease transmission, and factors that trigger these events before solutions can be implemented to reduce their effects. Detailed non-intrusive studies are needed of the effect of Newcastle disease on the reproductive success of Double-crested Cormorants and other colonial birds breeding on Mullet Island.

(4) Contaminants – additional studies are needed to understand the sources, mechanisms of uptake, and effect of contaminants on survival and reproduction of birds.

(5) Dietary studies – crucial to both disease and contaminant work will be more research on the diet of key species of birds, an area of study that has been particularly poorly represented in the past. A focus on seasonal changes in bird diets would make an important contribution to understanding the dynamics of the Salton Sea ecosystem. Especially needed are collaborative projects between bird researchers and fish and invertebrate researchers.

(6) Demographics – long-term studies are needed of the reproductive success and demographics of colonial nesting waterbirds, which may be linked to disease, contaminant, and dietary research. The judicious use of invasive methodologies in studies of colony productivity, chick growth, and nutritional requirements is needed to monitor the health of the Sea's nesting populations.

(7) Connectivity and dispersal – research is needed on the daily and seasonal use patterns and movements of birds between agricultural fields in the Imperial and Coachella valleys and the Sea and movements among various portions of the Sea. On a larger scale, research is needed on the dispersal patterns and migratory movements of birds between the Salton Sea and various other wetlands, such as the Río Colorado Delta and the Gulf of California. Banding and, particularly, radio-telemetry work are best suited for answering such questions.

(8) Monitoring – ongoing research and monitoring is needed to understand seasonal and long-term population dynamics and to assess the effectiveness of any large scale projects implemented to resolve the Sea's ecological problems.

(9) Passerines – there is a need to add to the very limited quantitative data on the importance of the Salton Sea area to migratory, wintering, and breeding landbirds, particularly those dependent on riparian and wetland habitats. Research is needed on the demographics and factors affecting reproductive success of landbirds, potential impacts of cowbirds on riparian birds, and the feasibility of restoring native vegetation in riparian areas.

Chapter 4
Study Area and Methods

The overall study area included the shoreline and open water of the Salton Sea; adjacent fresh or brackish marshes, freshwater impoundments, and riparian areas; and isolated freshwater marshes, lakes, ponds, and the extensive irrigated agricultural fields of the Imperial Valley (Figure 4-1 and 4-2). To obtain data on the annual phenology,

distribution, abundance, habitat associations, and, in some cases, breeding productivity of birds at the Sea, we used a suite of survey methods and protocols designed to survey particular species, groups of species, or certain aspects of their biology. The various survey methods and protocols are described below:

Comprehensive Waterbird Surveys

Comprehensive surveys were designed to document the overall abundance, distribution, and broadscale habitat associations of most waterbirds using the Salton Sea and nearby wetlands and marshes. These surveys were conducted over four relatively short periods during mid-winter (22 January-5 February), spring migration (17-18 April), fall migration (13-16 August), and early winter (11-15 November). In contrast to the other three, the 22 January to 5 February survey actually involved two separate surveys of the Sea, one to cover shorebirds and raptors [22-30 (mostly 22-27) January] and the other to cover all other waterbirds (29 January-5 February). On each census, a team of observers surveyed the entire Salton Sea shoreline and open water zone within 0.5 km of shore, adjacent marshes and impoundments, and various sites in the Imperial Valley, including the Finney-Ramer Unit of Imperial WA south of Calipatria and private duck clubs near Brawley. Observers included project staff and skilled volunteers. The number of observers on particular surveys were 5 and 7 on the respective surveys in late January, 17 in April, 16 in August, and 19 in November. Surveys were conducted with the aid of binoculars and spotting scopes by observers generally traveling by vehicle or on foot. During summer months, surveys of the shoreline from Iberia Wash at Salton City south to, and including, the New River were accomplished with the extensive additional aid of an airboat to reduce the risk of heat exhaustion on long walks that otherwise would have been necessitated by the limited access to this area by vehicles.

To obtain data on the patterns of distribution and habitat use of birds around the Sea, the survey area was divided into 19 shoreline segments (with adjacent open water zone) and three complexes of freshwater marshes and impoundments (Figure 4-3). For analyses and data presentation, data for various subareas of a particular area were often lumped.

The various segments starting at the north end of the Sea and progressing counterclockwise are:

Area 1 – Whitewater River Delta and vicinity.
- Subarea 1A – the exposed shoreline east and west of Johnson Street, the solitary point of access.
- Subarea 1B – the shoreline along the east and west levees of the Whitewater River.

Area 2 – Whitewater River south to Desert Shores: includes the accessible shoreline from the end of 76th Avenue levee northeasterly toward the Whitewater River mouth and south to just south of 84th Avenue. Additional vehicular access points include Kings Road and 81st Avenue; the shoreline south to Desert Shores is steep-sided and relatively inaccessible except at Desert Shores.

Area 3 – Desert Shores (inclusive) south to Salton Sea Beach.

Area 4 – Salton Sea Beach (inclusive) south to and including Gravel Wash.

Area 5 – Salton City: Gravel Wash south to and including Iberia Wash.

Area 6 – Iberia Wash to the northern boundary of the Salton Sea (Naval) Test Base.

Area 7 – Salton Sea Test Base: northern boundary to the pier at southern boundary.
Area 8 – San Felipe Creek Delta: Test Base pier south to the north end of the Elmore Ranch seawall.
Area 9 – Elmore Ranch: north end of ranch seawall south to the projected terminus of Barth Road at the shoreline.
Area 10 – end of Poe Road: accessible shoreline walking west toward Elmore Ranch and east toward the shoreline fronting Salton Sea National Wildlife Refuge (SSNWR) Unit 1 ponds.
Area 11 – shoreline of SSNWR and vicinity: west end of SSNWR Unit 1 east to Garst Road.
- Subarea 11A – Unit 1 Beach: west end of SSNWR Unit 1 east to the projected end of Foulds Road at the shoreline.
- Subarea 11B – New River Delta: the accessible shoreline from the projected end of Foulds Road east out around the New River channel/spit to the end of Bowles Road; includes SSNWR's (intermittent) freshwater marsh at Bruchard and Foulds roads.
- Subarea 11C – Bowles Road northeast to the intersection of Garst Road and the Red Hill Marina causeway; includes the area south of causeway and marina.
- Subarea 11D – Alamo River Delta: the shoreline from the Red Hill Marina causeway north out and around Red Hill and the Alamo River channel/spit and east to the levee just east of the end of Garst Road and west of the end of Schrimpf Road.
- Subarea 11E – Mullet Island.

Area 12 – shoreline fronting Davis Road and the Wister Unit of Imperial Wildlife Area (WA).
- Subarea 12A – shoreline paralleling Davis Road from Schrimpf Road to just north of Noffsinger Road and east of the adjacent parallel seaward sand spit.
- Subarea 12B – Wister shoreline along the west side of the sand spit from its southern terminus north to the "Access to Sea" road west of campground.
- Subarea 12C – Wister beach from the "Access to Sea" road west of campground north to and including Ibis Road.

Area 13 – marshes near the north end of the Wister Unit north to the end of Niland Marina Road.
Area 14 – Niland Marina Road north to south end of Bombay Beach seawall.
Area 15 – Bombay Beach: seawall at south end north to north end of Bombay Beach State Campground.
Area 16 – north end of the Bombay Beach State Campground to and including Bob's Playa Riviera; access primarily at south and north ends.
Area 17 – Salt Creek Delta and vicinity: Bob's Playa Riviera to and including the north end of Salt Creek beach; access primarily at south and north ends.
Area 18 – north end of Salt Creek beach to and including North Shore Marina; access at various beaches of Salton Sea State Recreation Area and private marinas.
Area 19 – North Shore Marina west to east side of cove east of Johnson Street; access only at marina and at Hayes and Colfax roads.

The various freshwater marsh and pond complexes are:

Area 20 – various pond complexes of SSNWR and vicinity.
- Subarea 20A – SSNWR Unit 1 impoundments.
- Subarea 20B – ponds north and south of McKendry Road by Obsidian Butte.
- Subarea 20C – SSNWR headquarters impoundments.
- Subarea 20D – SSNWR Hazard Tract impoundments north and south of the Alamo River.

Area 21 – impoundments of the Wister Unit of Imperial WA and adjacent private duck clubs.
- Subarea 21A – private duck clubs south and/or east of the Wister Unit.
- Subarea 21B – Wister Unit freshwater impoundments

Area 22 – freshwater impoundments in the Imperial Valley, including the Finney-Ramer Unit of Imperial WA and various private duck clubs.
- Subarea 22A – Ramer Lake
- Subarea 22B – Finney Lake
- Subarea 22C – "Keystone" duck club
- Subarea 22D – D&K /Mesquite Lake duck club.
- Area 22E – Ostercamp duck club.
- Area 22F – McElvaney duck club.
- Area 22G – Wilderness Unlimited duck club.

On these surveys, we recorded all shorebirds and other waterbirds except Eared Grebes, American White Pelicans, Brown Pelicans, Double-crested Cormorants, American Coots, and waterfowl, which were counted on aerial surveys as described in another section below. On the January comprehensive survey, Western and Clark's grebes were not surveyed in all areas and the Pied-billed Grebe, all rails, all gulls, and all terns were not surveyed in areas 3-5.

We instructed observers, when possible, to identify all birds to species. Groups of unidentified waterbirds fell mostly into seven categories: large grebes of the genus *Aechmophorus*, either Western or Clark's grebes; white egrets, mostly Snowy and Cattle egrets; yellowlegs, either Greater or Lesser yellowlegs; small sandpipers of the genus *Calidris*, primarily Western Sandpipers, Least Sandpipers, and Dunlin; dowitchers, either Short-billed or (primarily) Long-billed dowitchers; phalaropes, either Wilson's or Red-necked phalaropes; and various gulls of the genus *Larus*. For analytical purposes we grouped both identified and unidentified dowitchers as dowitcher spp. owing to the difficulty of identifying most individuals to species on surveys. We assigned other unidentified waterbirds to species using methods described in Page et al. (1999), leaving some in unidentified categories when the ratio of unidentified to identified was high. Scientific names for all species of waterbirds and raptors recorded on any survey are listed in Appendix A. Summaries of all waterbirds tallied by individual census area (segment) for each of the four comprehensive surveys are presented in Appendixes B1-4.

Partial Waterbird Surveys

Partial surveys were designed to document the seasonal occurrence patterns of waterbirds at the Salton Sea. To this end, a subset of shoreline segments was selected for repeated surveys throughout the year. These areas and subareas, described above, were 1A-B, 8, 11A-D, 12A, 20A-D, and 21B. Each of these were surveyed once a month

during winter and mid-summer and twice a month during spring and fall migration. Otherwise, census protocol was the same as for comprehensive surveys, except that surveys were conducted primarily by project staff K. Molina and B. Mulrooney with occasional assistance by M. Patten. The 14 specific survey periods were 13-21 February, 13-22 March, 28 March-3 April, 29 April-2 May, 19-22 May, 14-18 June, 1-6 July, 12-16 July, 2-5 August, 30 August-2 September, 13-16 September, 4-7 October, 17-21 October, and 12-16 December. Area 8 was not covered on the 4-7 October survey because of windy conditions, but data for this segment were estimated by taking the mean of the two counts on either side of this survey. Finally, data from the same subset of areas surveyed on the 4 comprehensive surveys were combined with the 14 partial surveys for a total of 18 surveys used to describe annual phenology.

Rails and Other Marsh Bird Surveys

To document patterns of distribution, relative abundance, and habitat use of various rails and other marsh birds, we conducted breeding season surveys using tape playbacks. Although we focused primarily on the federally endangered Yuma Clapper Rail and the state threatened Black Rail, we also concurrently surveyed the American and Least bitterns, Green Heron, Sora, Virginia Rail, and Common Moorhen. For the latter group of species, data were obtained from incidental aural or visual detections, as available time precluded playing tapes with specific vocalizations of all species.

Yuma Clapper Rails

We attempted to survey Clapper Rails in a variety of marsh habitats around the periphery of the Salton Sea using methods developed by the Yuma Clapper Rail Recovery Team. Major survey efforts occurred at previously known Clapper Rail areas, particularly the Wister Unit of Imperial WA and SSNWR. Rails were surveyed at 103 stations in three general areas at Wister (between Mallard Road to the north and Alcott Road to the south); at 7 areas within Unit 1 and 11 areas within Unit 2 of SSNWR; at 6 off refuge sites covered in previous years; and at 18 stations in 4 areas not traditionally covered in previous years (Figure 4-4). Additionally, incidental Clapper Rail data were collected at Finney Lake during a Black Rail survey.

Surveys within both the Wister Unit of Imperial WA and SSNWR followed established transects from previous years and were conducted by personnel of the respective refuges. Surveys at all new off refuge sites were conducted by PRBO biologists K. Molina and B. Mulrooney. All transects were surveyed twice between 24 April and 15 May to detect birds responding to taped vocalizations of Clapper Rails. On each transect, observers picked listening stations within appropriate marsh habitat. At each station, they played a tape for two minutes, stopped to listen for responses for two minutes, and then played the tape again for two minutes. Observers recorded birds responding to the tapes as well as incidental sightings of rails. In general, stations along a transect were 70 to 100 yards apart depending on the habitat.

Black Rails

We surveyed Black Rails around the Salton Sea using methods developed by Evens et al. (1991) to detect birds responding to taped vocalizations ("*grr*" and "*kic-kic-kerr*" calls). Within appropriate marsh habitat, observers selected transects with a set of

listening stations, totaling 42 stations in 18 areas. At each station, they played a Black Rail tape for two minutes, stopped to listen for responses for two minutes, and then played the tape again for two minutes. From 24 April to 15 May, each transect was surveyed twice with the exception of the Pumice, Bruchard, and Finney areas, which were surveyed only once.

Snowy Plover Surveys

For comparison to prior winter and breeding season surveys (Shuford et al.1995), we conducted three comprehensive surveys of the entire shoreline of the Salton Sea for Snowy Plovers. The winter surveys from 22-30 January and 11-14 November, when plovers are flocking and easiest to detect, were conducted as part of the comprehensive surveys described above. The breeding season survey from 21-31 May was a separate survey focusing entirely on Snowy Plovers. At that season, surveying is made more difficult by adults sitting cryptically on nests and by adults with chicks sometimes moving long distances to mob observers. To minimize these problems, observers were asked to follow a more stringent protocol in May than in winter. Hence, observers were instructed to use both binoculars and spotting scopes to repeatedly scan long distances up and down beaches and alkali flats to try to detect incubating plovers before they snuck off nests and scattered. Also, observers were asked to zig-zag back and forth across beaches and alkali flats to try to otherwise detect roosting or incubating plovers or those foraging behind shoreline berms where they might not be visible from the upper beach. On very wide beaches and alkali flats, such as in Area 6 between Salton City and the Naval Test Base, two observers worked in tandem, one working the upper beach or alkali flats and the other the immediate shoreline, zig-zagging as needed. Although the primary purpose of the survey was to document the abundance and distribution of breeding adult plovers around the Sea, observers also were asked to record the following additional information: (1) the number and contents of any nests found, (2) the number (and relative size) of chicks in any broods encountered, and, when possible, (3) to determine the sex of adults and (4) to distinguish between adults and juveniles that had already fledged and reached adult size by the time of the survey. The breeding season survey was conducted by three project staff and two skilled volunteers. For data analysis, adult-sized birds of unknown age (mostly seen flying) in May were apportioned according to the ratio of adults and juveniles identified across all areas.

Roost Counts

To obtain data on the population sizes of certain waterbirds that forage primarily in irrigated agricultural fields in the Imperial Valley rather than at the Salton Sea, we conducted eight roost counts on the following dates in fall and winter: 27 January, 13 February, 13 March, 14 August, 15 September, 21 October, 11 November, and 16 December. Counts were conducted at most known roosting sites for these species in the Imperial Valley (Figure 4-3). Counts were taken simultaneously at three to six sites on each survey (Table 4-1). Observers (at least 2 at each site) were asked to be in place about 1.5 hours before dusk and to count the number of Great Blue Herons, Great, Snowy and Cattle egrets, White-faced Ibis, and Sandhill Cranes that arrived at, or departed from, a site before nightfall. To guard against double-counting birds that left sites before dark to eventually roost at another site, we subtracted the departures from the sum of the

arrivals and those present at the onset of the count to arrive at a net total. Counts were terminated when birds stopped arriving or when it became too dark to see.

Mountain Plover Surveys

We estimated winter population size and documented habitat use patterns of Mountain Plovers by conducting three comprehensive surveys of most (80-90%) of the agricultural lands in the Imperial Valley. The survey area was bounded on the north by the Salton Sea, Wister Unit of Imperial WA, and agricultural lands north of Niland; on the east by the East Highline Canal; on the south by the Mexican border; and on the west by the interface of agricultural lands and roads with desert scrub (Figure 4-5). Project staff and skilled volunteers conducted all surveys. Counting twice all individuals participating on both days of two-day survey periods, 11 observers in 8 parties counted on the 14-15 February survey, 19 observers in 12 parties on the 13-14 November survey, and 26 observers in 15 parties on the 11-12 December survey. Observers drove all accessible roads and used binoculars and spotting scopes to carefully scan fields with appropriate plover habitat, i.e., those with barren ground or sparse low growth. On all surveys observers recorded and mapped the location of all flocks and described the types of fields on which plovers occurred. In November and December, observers gathered additional data on the behavior (foraging, roosting, or flying) of plovers and on characteristics of fields where plovers were observed (percent cover of vegetation vs. bare ground, dominant plant species, average plant height, burned or grazed vs. unburned or ungrazed, etc.). Limited data also were collected on Long-billed Curlews, particularly in November and December.

Agricultural Field Transects

To assess habitat use by birds in agricultural fields, we conducted monthly surveys of five 5-mile-long (8.05 km) roadside transects located in the northern Imperial Valley just south of the Salton Sea (Figure 4-5). Project staff K. Molina and B. Mulrooney conducted all surveys on the following dates: 15 January, 6 February, 6 March, 2 April, 16 May, 7 June, 8 July, 11 August, 9 September, 14 October, 10 November, and 10 December. To reduce sampling bias, the order in which transects were surveyed and the starting point of individual transects were alternated between successive survey periods. They recorded the numbers of all species of birds found in agricultural fields adjacent to both sides of each roadside transect. Additional data collected for each sighting were the behavior of birds (foraging, resting, flying, displaying) and their distance from the road ($\leq$0.1 mi, >0.1 mi<0.2 mi, $\geq$ 0.2 mi). Fields were categorized into general types (bare, alfalfa, grassy, leafy, leafy/alfalfa, open water, and unsuitable), stage of cultivation (burned, mowed, tilled, grazed, growing), degree of moisture (dry, damp, partially flooded, entirely flooded), and crop height (bare, 0-5 cm, 5-10 cm, 10-20 cm, >20 cm).

Colonial Nesting Waterbird Surveys

We used several methods to document the distribution, abundance, nesting chronology, and nesting success of colonial nesting waterbird colonies at the Salton Sea in 1999 as described below.

Aerial Photographic Surveys

To avoid disturbance and increase the accuracy of nest counts of Double-crested Cormorants and Great Blue Herons compared with those in prior years, we used a fixed-wing aircraft to conduct photographic surveys of colonies nesting on bare ground and rocks at Mullet Island at the south end of the Salton Sea on 1 February, 19 February, 25 March, and 16 April. While the plane slowed to about 70 to 90 knots and circled at 130 to 160 m over the island, D. Shuford shot multiple rolls of overlapping photographs of the nesting colonies using a Canon EOS single-lens reflex camera with a 300 mm lens and ASA 200 color film. J. Roth used standardized methods developed for surveying coastal seabird colonies (G. J. McChesney and H. R. Carter in litt.) to count the numbers of cormorant and heron nests. Photographs (slides) were first sorted to obtain a subset of overlapping reference photos of the highest resolution and contrast. These were then projected on a large sheet of white paper (27" x 34" easel), and nests and birds were marked with a fine marker using identifiable landmarks as reference points to avoid double-counting. Active nests were considered those in which incubating or brooding adults, eggs, or chicks were visible. Although eggs and, particularly, young were often visible in nests, the frequency and resolution of the photographs were not adequate for estimating nest productivity but did provide some information on the phenology of nesting.

Using the same field methods, K. Sturm or D. Shuford photographed aggregations of herons, egrets, and cormorants nesting in trees and marsh vegetation at the New and Alamo river mouths on 25 March, 3 April, 16 April, 27 May, and 28 May. Subsequently, slides were converted to 10 x 15 cm glossy prints, which were first sorted to obtain a subset of reference photos of the highest resolution and contrast. These prints were overlapped and taped together to provide a composite photo of the colonies, or sub-colonies, from which adults and nests were counted directly. Great Blue Heron and Double-crested Cormorant nests and adults were readily identifiable on prints, but it was difficult to identify Great, Snowy, and Cattle egrets to species or to distinguish their nests. Consequently, for the latter species we estimated the number of active nests by first adjusting the counts of adult white egrets from 28 May aerial photographs by the following ratios derived from a 16 June boat survey – Great Egret (2%), Snowy Egret (4%), and Cattle Egret (94%). These numbers were then divided by two (adults/nest) to obtain a minimum estimate of nesting pairs of these species. Data from aerial surveys of these colonies were combined with data from other survey methods described below to estimate the total numbers of nesting pairs at the Sea.

Airboat Surveys

K. Sturm, with occasional assistance from others, surveyed the shoreline of the Salton Sea via airboat to document the distribution and abundance of all major cormorant and ardeid (heron, egret, night-heron) colonies. Surveys were conducted at nearly monthly intervals during the period 22 January through 16 July, but not all colonies were visited on a particular date. Surveys of some of the smaller colonies continued only through April. Dates of ariboat surveys were 22 and 29 January; 2, 3, 12, 16, 17, and 18 February; 2, 3, 9, 16, 17, 19, 22, 24, 26, and 30 March; 2, 5, 9, 13, 14, 17, 20, 21, 26, 27, and 28 April; 5, 6, 7, 24, and 27 May; 16, 18, and 30 June; and 2, 8, and 16 July. Airboat

surveys were supplemented by vehicular visits by K. Sturm or PRBO staff to additional colonies at Ramer Lake (6 and 14 May) and the Westmorland eucalyptus grove (8 July) away from the Salton Sea shoreline. On each survey, observers recorded the number of active nests and the general stage of nesting, using categories described below, for each species at each site.

Brief descriptions of the colony sites surveyed and their nesting substrates are listed below in clockwise order beginning at the Whitewater River at the north end of the Sea (Figure 4-6):

Johnson Street – an extensive area of flooded snags and a small barren islet.
Colfax Street – a sand/barnacle bar connected to the shoreline.
Bombay Beach North – a small group of flooded snags along the shore north of Bombay Beach.
Mallard Road – a hunt blind within the Wister Unit of Imperial WA.
Ibis/South Ibis Road – several groups of snags near Ibis Road in the Wister Unit.
Wister – a group of hunt blinds near the shoreline in the Wister Unit.
Mullet Island – a large rocky island near the southeastern shoreline.
Morton Bay – two small low-lying earthen islets and several hunt blinds.
Alamo River Delta – the *Phragmites/Tamarix*-lined channels and island at the mouth and the hunt blinds in the vicinity of the river.
Red Hill – a series of flooded snags near Garst Road south of the Red Hill.
Rock Hill – a group of small barren islets in an impoundment at the SSNWR headquarters.
Obsidian Butte – a near-shore rock and barnacle islet; a collection of snags in the vicinity were not used in 1999.
New River East – a small group of flooded snags.
New River Delta – the *Phragmites*-lined river channels and *Tamarix* marshes.
New River West – a combination of hunt blinds, isolated snags, and a barge (all New River sites are represented by a single label in Figure 4-6).
Trifolium 1 West – an area of flooded snags.
Poe Road – a small group of flooded snags near the road's terminus.
San Felipe Creek South – a small group of flooded snags and hunt blinds.
Naval Test Base – the tops of flooded artificial structures and a small group of flooded snags.
81st Avenue – several isolated hunt blinds.
76th Avenue – an extensive area of flooded snags and the line of power poles.

Arboreal colony sites used in prior years but not in 1999 were Lack/Lindsey, Vail Ranch, and West Whitewater. Two additional sites used that are south of the Salton Sea in the Imperial Valley are:

Ramer Lake – an extensive area of flooded snags in the southern portion of the lake.
Westmorland Eucalyptus Grove – a mature stand of trees, away from water, south of the town of Westmorland.

Ardeid and Larid Productivity Studies

More detailed studies were conducted to gather data on nesting chronology and nesting success of Great Blue Herons and larids (gulls, terns, and skimmers) as described below. During each colony survey, observers recorded the number of adults and active

nests for each species. We defined an active nest as one that appeared well-maintained (for ardeids) and was attended by at least one adult. Larid colonies were surveyed during midday when all active nests should be attended. We used behavioral and postural cues of attending adults as indicators of the stage of nesting and assigned all active nests to one of the following categories:

(1) nest building – adults transporting nest material to nest sites or at least one adult standing at a nest.
(2) incubating – adults sitting or lying on nests indicating the presence of eggs.
(3) hatching – nests with downy or naked young.
(4) fledged – nests with feathered and well-developed young nearing independence.

Based on their ease of observation from the shoreline, we opportunistically selected three Great Blue Heron colonies at which to estimate nesting success. From 7 March through 13 July, we non-intrusively monitored a subset of nests at the Johnson Street (n = 30 nests) and 76th Avenue (n = 26 nests) colonies near the Whitewater River mouth at the north end and the New River East (n = 43 nests) colony at the south end of the Sea (Figure 4-6). Instead of marking nests, we mapped nests with positions sufficiently unique or isolated to facilitate their subsequent recognition over time. During each visit to these colonies, we assigned each mapped nest to nesting stage as described above to enable determination of the outcome of each nesting attempt to the near-fledging stage. We considered a nest successful if we observed at least one well developed chick in or near it. We then calculated the percent of successful nests for each of our sub-samples to estimate Great Blue Heron nesting success at the three sites.

As part of an independent and ongoing study, K. Molina and associates collected data on the size and productivity of larid colonies. These surveys were performed on foot or by kayak at weekly to semi-monthly intervals from 7 March through 8 September. Larid colonies generally were surveyed from a distance. Infrequent vists, however, were made to some sites to ascertain the stage of nesting or, in some cases, to document apparent nesting failures. Additionally, young gulls, terns, and skimmers were banded late in the nesting season.

Estimating Total Nesting Pairs

Estimating the total number of nesting pairs for each species of colonial waterbird at the Salton Sea was complicated by several factors, including (1) the lack of marked nests and individuals, (2) our inability to survey all sites on a single day, and (3) a high level of intra- and inter-colony nesting asynchrony. Such asynchrony was likely exacerbated by several complete colony desertions by some species, resulting in failed breeders moving to other colony sites. For each species at each colony site, we estimated the peak number of nesting pairs as the greatest number of nests recorded on a single colony visit. To avoid double-counting any renesting pairs that changed colony sites after failing in their initial attempts, we excluded high counts that occurred shortly after colony failures at nearby sites. We then summed the remaining high counts for each site to obtain an estimate of the total number of nesting pairs at the Salton Sea. Although we knew of no complete colony failures for the Double-crested Cormorant, we used the peak count from Mullet Island only as the estimate of the total number of nesting pairs of that species for the Salton Sea. This seems justified as the vast majority of cormorants had initiated nests on Mullet Island by early January, and the relatively small number of nests

established elsewhere on the Sea after 28 February may have represented the relocation of some adults that failed in initial attempts at Mullet.

We believe our combined methodology for surveying nesting colonies produced reasonable, minimum estimates of nesting pairs for most species. We maintained aerial coverage of the entire shoreline and adjacent habitats throughout the breeding season, minimizing the possibility that significant colonies went undetected. Still we may have missed small colonies of the more secretive species, such as the Black-crowned Night-Heron and Snowy Egret, which might have nested within dense marshes away from the Salton Sea proper. Peak numbers of nest attempts for arboreal nesters were likely underestimated because of the difficulty of viewing dense aggregations of nests stratified within three dimensional and, sometimes, dense habitats. Count accuracy was greatest for the Double-crested Cormorant on Mullet Island and for all larids, which nested on the ground in the open.

Aerial Surveys for Various Waterbirds

Pelicans and Cormorants

Mostly in tandem with photographic surveys of nesting colonies at Mullet Island and at the New and Alamo river mouths, K. Molina and D. Shuford also conducted visual aerial surveys of American White and Brown pelicans and Double-crested Cormorants around the periphery of the Salton Sea from a fixed-wing Cessna aircraft. We began all surveys at the southern shoreline at the end of Garst Road and conducted one or two counterclockwise circumnavigations of the Sea. We maintained a course parallel to and about 0.5 km from the shoreline, flying at heights varying from about 60 to 90 m and at speeds of about 70 to 100 knots. All individuals of the above species were counted off both sides of the plane – whether on the water, flying, or roosting onshore – and were tallied by the 19 shoreline areas (and subareas) described above. In addition, we also counted birds while flying multiple parallel transects across various pond complexes adjacent to the Sea (Areas 14A&B, 20C-D). Aerial survey dates were: 28 January, 12 February, 5 March, 16 April, 28 May, and 16 August. The species in question also were counted on surveys, described below, designed primarily to obtain data on the distribution and abundance of Eared Grebes and Ruddy Ducks.

Eared Grebes, Aechmophorus Grebes, and Ruddy Ducks

We initially planned to conduct surveys for Eared Grebes following new aerial photographic techniques pioneered at Mono Lake, California (Boyd and Jehl 1998). We abandoned these efforts, however, when we found from viewing initial photographs that it was not possible to distinguish Eared Grebes from relatively large numbers of Ruddy Ducks, other waterfowl, and, particularly, masses of the fish tilapia *(Oreochromis mossambicus:* Cichlidae) swimming or floating dead on the Sea's surface, none of which hamper photographic survey efforts at Mono Lake.

Instead, R. McKernan and K. Molina conducted four aerial surveys using methods similar to those used by McKernan in prior years. Survey dates were 19 March, 28 March, 29 November, and 17 December. Surveys were conducted from a Cessna 172 high-wing airplane flying at speeds of 70 to 90 knots at altitudes varying between 60 and 90 m above the water. Three aerial transects were conducted during each flight (Figure

4-7): (1) transect one covered the entire inshore zone of the Sea by flying a route parallel to and about 0.5 km out from the shoreline, (2) transect two traversed a north-south track over the open water zone about 6 to 8km out from the west shoreline, and (3) transect three traversed a south-north track over the open water zone about 8 to 10 km out from the eastern shoreline. Observers viewed from opposite sides of the aircraft and counted birds out to the distance at which species could be readily identified. This distance usually was about 0.5 km, but varied with the size of birds, whether birds occurred in flocks or singly, observers' orientation relative to the sun, or smoothness or choppiness of the water's surface. Only birds positively identified were included in totals. Although surveys focused on Eared Grebes and Ruddy Ducks, observers also counted Western and Clark's grebes, American White and Brown pelicans, and Double-crested Cormorants; on the 19 March survey all species but Eared Grebe were counted only from the inshore side of the plane. Because of difficulties in separating Western and Clark's grebes from the air, all observations of these species were grouped as *Aechmophorus* spp.

Spatial distribution patterns of birds were assessed on the inshore transect by tallying birds separately within PRBO's shoreline segments. On November and December surveys birds were tallied for all 19 segments (Figure 4-3), whereas on March surveys data were lumped by 10 groupings of these segments. On openwater transects, data for November and December were tallied for segments between 20 UTM waypoints established by an onboard GPS, whereas in March general patterns of distribution were plotted on a map.

Black Terns

In conjunction with the August comprehensive ground survey, we also counted all Black Terns on a 16 August aerial survey, which followed the same protocol described above for pelicans and cormorants. In addition, we conducted aerial surveys for Black Tern over irrigated agricultural fields in the Imperial Valley by flying six parallel transects about 25-30 km long and spaced 5 km apart (Figure 4-5).

Aerial Waterfowl Surveys

SSNWR biologists conducted aerial waterfowl surveys of the Salton Sea shoreline, adjacent marshes and impoundments, and Imperial Valley duck clubs and reservoirs on 8 January, 9 March, 3 April, 27 May, and 18 November 1999, following a standard survey protocol used each year by refuge biologists to document the relative abundance and distribution of waterfowl in this area. K. Sturm was the observer on all surveys, except for the18 November count conducted by S. Johnson. Surveys were conducted from a fixed-wing aircraft flying at heights varying from about 75 to 90 m above the land and water's surface at speeds of about 70 to 100 knots. All observations were made by a single observer (aided at times by the pilot) looking off the right (shoreward) side of the plane. Surveys began with impoundments in the Imperial Valley then shifted to a counterclockwise circumnavigation of the Salton Sea on which the plane followed a course parallel to and about 0.4 km from shore (Figure 4-7). The circumnavigation was periodically broken to fly multiple parallel transects over complexes of marshes and freshwater impoundments adjacent to the shoreline. Observers focused on counting all geese, ducks, and American Coots, but also tallied Eared Grebes and American White and Brown pelicans. Bird numbers were tallied

separately for 2 areas of the Sea (Imperial County shoreline, Riverside County shoreline) and 7 impoundment complexes [SSNWR Unit 1, SSNWR Unit 2 (Refuge Hdqtrs. ponds, Union Tract, Hazard Tract), south shore duck clubs, Wister Unit of Imperial WA, Finney and Ramer lakes, duck clubs and reservoirs south of Brawley, and northshore/Coachella duck clubs and fish farms].

To compliment the aerial surveys, PRBO biologists K. Molina and B. Mulrooney conducted independent ground surveys of waterfowl on a subset of freshwater impoundments at the south end of the Sea. Ground surveys were conducted on dates (6-12 March, 30 March to 4 April, 29 May, and 15-16 November) adjacent to or bracketing four aerial survey dates. On each survey they recorded all waterfowl in each of six PRBO census areas: the shoreline of SSNWR and vicinity (part, Area 11C), south Wister shoreline (12A), SSNWR Unit 1 (20A), SSNWR headquarters ponds (20C), SSNWR Hazard Tract (20D), and Wister Unit freshwater ponds (21B).

Chapter 5
Results and Discussion

Patterns of Species Richness, Abundance, Distribution, and Phenology

In 1999, we recorded a total of 107 species of native waterbirds on all of our various surveys combined. On the four comprehensive surveys of the Salton Sea and nearby wetlands, we recorded a total of 70 species of waterbirds: 49 in January, 55 in April, 63 in August, and 54 in November (Table 5-1). We recorded a total of 107,790 individuals on the January comprehensive, 64,007 in April, 107,132 in August, and 151,613 in November. Additional counts or estimates of waterfowl and coots at the Salton Sea and of herons, egrets, ibis, and cranes coming to roosts after foraging in Imperial Valley fields swell the seasonal totals to about 186,913 in January, 88,431 in April, 169,809 in August, and 261,499 in November (Table 5-2). These totals do not include Eared Grebes, surveyed in 1999 only in March, November, and December. Adding the Eared Grebe count for November provides an estimate of about 434,049 waterbirds at the Salton Sea that month. If numbers of other waterbirds remained relatively constant from November to December and the Eared Grebe count for the latter month was added, there probably were about 583,000 waterbirds at the Salton Sea in December. Even this total is on the low end of potential winter numbers, as counts of Eared Grebes alone reached about 1 to 1.75 million in January 1988 and 3.5 million in March 1988 (Jehl 1988).

Waterbirds were not equally distributed around the Salton Sea (Figure 5-1a, b). In all seasons, highest overall numbers of waterbirds occurred primarily along the southeastern shoreline and secondarily along the northern shoreline of the Sea (Figure 5-1a). The shoreline along the Wister Unit also held the highest densities of waterbirds in all seasons, but especially in August and November (Figure 5-1b). Otherwise densities were relatively similar in other regions of the Salton Sea shoreline with the exception of generally lower densities along the northeastern shoreline in most seasons.

Patterns of bird distribution around the Sea varied among the major groups of waterbirds and among seasons. Numbers of pelicans and cormorants generally were highest at the south end of the Sea except in November, when they were widely

distributed around the perimeter (Figure 5-2a). Densities of pelicans and cormorants were highest at the south end in January and among the lowest there in November, when many areas showed high densities (Figure 5-2b). For wading birds (primarily herons, egrets, and night-herons), both highest numbers and densities were in the north and south ends of the Sea (Figures 5-3a, b). At all seasons, shorebird numbers were highest along the southeastern shoreline near the Wister Unit with smaller concentrations along the northern, southern, and western shorelines (Figure 5-4a). Shorebird densities were particularly impressive along the Wister shoreline at all seasons (Figure 4-b). Gulls and terns did not consistently concentrate in high numbers in any particular area; an exception was a concentration of gulls in the northwestern portion of the Sea in November (Figure 5-5a). Similarly, gull and tern densities were not consistently high in any particular regions of the Sea (Figure 5-5b).

Although overall bird numbers at the Salton Sea reached a peak in winter, patterns of seasonal occurrence varied among various groups of birds (Figure 5-6a). Numbers of pelicaniformes (pelicans and cormorants) and waterfowl (ducks and geese) rose relatively quickly in fall to reach peak numbers by at least November, whereas gull numbers appeared to increase throughout the fall and early winter to reach a peak in late winter. Numbers of wading birds (herons, egrets, ibis, storks) were relatively stable throughout the year. An increase in wader numbers from June through August, after a dip in April and May, perhaps reflected an increase in observations of nesting adults after completion of nesting, the movement of locally fledged young to wetland foraging areas, or an influx of post-breeding birds from elsewhere. By contrast, shorebirds increased from seasonal lows in late May and early June to reach peak numbers from August to November and thereafter maintained a lower plateau in winter. Terns similarly increased from spring to reach yearly highs from June through September, then mostly departed for the winter by December.

Data from a suite of other surveys provide more details on the patterns of occurrence of various species of waterbirds at the Salton Sea in 1999 as described below.

Grebes

Numbers of Pied-billed Grebes ranged from 15 to 56 individuals on four comprehensive surveys of the Salton Sea and nearby wetlands (Table 5-1). This species resided year round with no obvious peaks in occurrence (Table 5-1, Figure 5-6b); highest numbers were in November and in August and September on comprehensive and partial surveys, respectively. Almost all Pied-billed Grebes were observed on freshwater impoundments.

Aerial surveys in 1999 estimated 47,561 to 58,412 Eared Grebes at the Salton Sea in March, 172,550 in November, and 321,575 in December (Table 5-3). Over four surveys, an average of 88.9% (SE = 4.3, min.-max. = 78.0-99.3) of all Eared Grebes occurred in the inshore zone within 1 km of land. Overall, these small grebes were widely and relatively evenly distributed within the inshore zone, except for a tendency for reduced numbers along the northeastern shoreline in March and November (Table 5-3). Eared Grebes generally were widely distributed on offshore transects.

Aerial surveys in 1999 estimated 7123 to 8620 Western and Clark's grebes *(Aechmophorus* spp.) at the Salton Sea in March, 1508 in November, and 3830 in December. By contrast, large grebes reached peak numbers in July and August, and

irregularly through November, on more frequent surveys of a subset of shoreline areas, primarily at the south end of the Sea (Figure 5-6b). Numbers recorded there, however, may reflect local shifts rather than Sea-wide patterns of occurrence. Over the four aerial surveys, an average of 78.5% (SE = 6.3, min.-max. = 64.0-92.0) of all large grebes occurred in the inshore zone within 1 km of land. Overall, large grebes were widely and relatively evenly distributed within the inshore zone, except for a tendency for reduced numbers along the western and southwestern shorelines in March and the southeastern and northeastern shorelines in November. Counts of large grebes in the inshore zone in November were 936 and 1092 by ground and aerial observers, respectively (Tables 5-1 and 5-3). This suggests that ground counts of 719 and 734 large grebes in April and August, respectively, were good approximations of grebes numbers in the inshore zone in those months, which lacked aerial counts. Ground observations indicated a fairly even split between Western and Clark's grebes in April and August and a 3:1 ratio, respectively, in November (Table 5-1). In both November and December, about 85% of large grebes in the offshore zone were at the northern end of transect 3 in the northeastern section of the Sea.

Pelicans and Cormorants

Three species of fish-eating pelecaniformes (pelicans and cormorants) were among the most numerous birds at the Salton Sea in 1999. Both the American White Pelican and the Double-crested Cormorant reached highest numbers in winter with peak counts, respectively, of 24,974 individuals in December and 18,504 in January (Figure 5-6b, Table 5-1). By contrast, the Brown Pelican occurred primarily from mid-June to early October (Figure 5-6b) with a high count of 1995 birds in mid-August (Table 5-1). A very large colony of the Double-crested Cormorant again formed on Mullet Islet, but neither the White Pelican, a historic breeder, or the Brown Pelican, a sporadic breeder in recent years, nested at the Sea in 1999 (see Colonial Nesting Waterbirds section below). Large concentrations of pelicans and cormorants roosted at isolated sites around the Sea, particularly at the far reaches of the New and Alamo river deltas.

Herons, Egrets, Ibis, Storks, and Cranes

On our comprehensive surveys we recorded 10 native species of long-legged wading birds: 8 species of ardeids (herons, egrets, night-herons), the White-faced Ibis, and the Wood Stork (Table 5-1). Wader numbers totaled 2475 individuals in January, 2254 in April, 5965 in August, and 4111 in November (Table 5-1). Of the ardeids, the Great Blue Heron, Great Egret, Snowy Egret, and Cattle Egret each exceeded 1000 individuals on at least one comprehensive survey of the Salton Sea and adjacent wetlands (Table 5-1).

Three species of waders were much more numerous than suggested by our comprehensive surveys, which did not cover agricultural lands in the Imperial Valley. Peak counts of birds coming to night-time roosts after foraging in irrigated fields in the Imperial Valley were about 40,000 Cattle Egrets in August, 37,438 White-faced Ibis in October, and 320 Sandhill Cranes in October.

Patterns of seasonal occurrence varied considerably among species of wading birds. Numbers of the Great Blue Heron and Black-crowned Night-Heron appeared to be relatively stable throughout the year; the reason for the mid-August spike in night-heron

numbers is unknown (Figure 5-6c). Although data are limited, the American Bittern was the only species occurring year round for which numbers appeared to increase in winter (Figure 5-6b). Numbers of the Great Egret, Snowy Egret, and Green Heron reached peaks in July and August, perhaps reflecting an influx of post-breeding birds, then declined from fall to winter. Wood Storks occurred in small numbers only from mid-June to mid-September (Figure 5-6d). Numbers of Cattle Egrets along the Salton Sea shoreline fluctuated irregularly (Figure 5-6c), presumably reflecting shifts to and from their preferred foraging areas in agricultural fields or from nesting colonies. White-faced Ibis attained highest numbers along the Salton Sea shoreline from January through March and in June and early July (Figure 5-6d). Counts at roost sites in the Imperial Valley in fall and winter, however, indicated ibis reached peaks in September and October but still maintained high populations in winter (Figure 5-7). By contrast, Cattle Egret numbers at roosts declined steadily from an August peak to much lower winter numbers by December or January. Sandhill Cranes occurred only in fall and winter and in relatively stable numbers. Monthly counts at roosts in the Imperial Valley in January and February and from October to December ranged from 255 to 320 individuals, except for a tally of 37 birds on the November survey, which presumably missed an important roost site during that period.

Other than counts of nesting pairs of ardieds at colonies around the Salton Sea (SSNWR files), there are few prior data on the sizes of wading bird populations in this area. Shuford et al. (1996) reported on counts of wintering ibis at roost sites in the Imperial Valley from 1994 to 1996, which reached up to about 16,000 individuals. Lower numbers overall during that period than in 1999 may reflect an increase in observer coverage. Sandhill Crane numbers in 1999 fell within the range of about 200 to 350 birds found on prior surveys in the 1990s (Shuford et al. 1999).

Patterns of abundance and distribution of breeding wading birds at the Salton Sea in 1999 are discussed below in the Colonial Nesting Waterbirds section.

Waterfowl

The Salton Sea is primarily a wintering area for ducks and geese. Numbers of waterfowl on five aerial surveys of the Salton Sea area in 1999 ranged from a high of about 55,062 individuals of 17 taxa in January to a low of 1742 individuals of 9 taxa in late May (Table 5-4). On the January survey, dabbling ducks comprised 48% of all waterfowl, geese 41%, and diving ducks 11%. Geese were almost exclusively Snow or Ross's geese; ground observations indicate the former species typically predominates at the Sea. In January, dabbling ducks were dominated by the Northern Shoveler (50%), Northern Pintail (24%), Green-winged Teal (16%), and American Wigeon (8%), whereas diving ducks were dominated by the Ruddy Duck (83%). The proportion of waterfowl comprised by diving ducks, and the proportion of Ruddy Ducks within that group, appear to be underestimated by the standard surveys for waterfowl. The latter focus on inshore waters of the Sea and adjacent freshwater impoundments and do not cover offshore waters where substantial numbers of Ruddy Ducks can be found as described below. By March, waterfowl numbers had declined to about 39,539 individuals (Table 5-4), primarily as a result of departures of geese and Northern Pintails and despite an increase in scaup and Ruddy Ducks. Numbers of waterfowl continued to decline through April, reached yearly lows in late May, and built up again to winter levels by November.

Additional aerial surveys for various diving waterbirds also included estimates of Ruddy Duck numbers, which ranged from 3924 to 5120 in March, to 26,584 in November, and 32,680 in December (Table 5-3). Over four surveys, an average of 81.6% (SE = 9.8, min.-max. = 54.0-99.3) of all Ruddy Ducks occurred in the inshore zone within 1 km of land. This suggests that traditional waterfowl surveys concentrating on the inshore zone may at times miss the substantial proportion of Ruddy Ducks in the Sea's offshore waters. The disparity of higher Ruddy Duck numbers on the traditional waterfowl survey in early March versus the diving waterbird surveys in late March may reflect departure of Ruddy Ducks over the course of the month or perhaps difficulties in separating that species from similar-sized Eared Grebes.

The abundance and ratios of various species of waterfowl estimated by ground counts (Tables 5-5 and 5-6) were similar to those on traditional aerial surveys except in November when the aerial survey (Table 5-4) estimated much higher numbers and a disproportionate ratio of many species relative to ground counts.

Distribution patterns of waterfowl varied among regions of the study area. As is typical, Snow and Ross's geese in 1999 were found exclusively at the south end of the Sea in or around SSNWR, the Wister Unit of Imperial WA, and nearby duck clubs. Despite the apparent underestimation of their numbers, diving ducks predominated on the inshore waters of the Sea at all seasons (Figure 5-8). By contrast, dabbling ducks predominated on freshwater impoundments adjacent to and primarily at the south end of the Sea. Diving ducks numbers also exceeded or equaled those for dabbling ducks in the Imperial Valley because Ruddy Ducks also concentrate there in modest numbers on reservoirs. Aerial surveys for various diving birds found Ruddy Ducks concentrated near the northern and western shorelines and offshore zone in March, but spread out along the entire inshore zone in November and December (Table 5-3). Of the 2899 Ruddy Ducks in the offshore zone in December, 96% were at the northern end of transect 3 in the northeastern section of the Sea.

Until data from many prior years of annual waterfowl surveys are compiled and analyzed, it will be difficult to assess whether patterns of species composition, abundance, and distribution of waterfowl at the Salton Sea have changed over time. Although Heitmeyer et al. (1989) published data on the average numbers of various species of waterfowl in the Imperial and Coachella valleys from 1978 to 1987, they did not describe the extent of year-to-year variation of numbers, making it difficult to interpret data from a single year such as 1999. For example, although numbers of waterfowl in January 1999 were below the average of about 77,000 on mid-winter counts from 1978 to 1987 (Heitmeyer et al. 1989), it is unclear if the 1999 numbers fall within the range of variation of prior years. Even when data from prior years are analyzed it will be important to view any changes in waterfowl numbers in a broader context. Patterns at the Salton Sea might simply parallel those for the Pacific Flyway as a whole, where species such as the Northern Pintail have declined greatly since the 1970s (Banks and Springer 1994), rather than reflecting changing conditions at the Sea.

Raptors

We collected limited data on raptors in 1999, primarily via comprehensive and partial surveys of the shoreline of the Salton Sea and incidentally via surveys of waterbirds in the Imperial Valley. We recorded a total of 14 species of raptors on 4

comprehensive surveys of the Salton Sea (Table 5-7). As a whole, raptors reached highest numbers along the Salton Sea shoreline in winter; this pattern was most pronounced for the Northern Harrier (Figure 5-6e). By contrast, numbers of Turkey Vultures were lowest in winter. Incidental observations suggest that numbers of raptors would have been much greater, and the composition of species observed would have been different, if we had surveyed extensive areas of irrigated agricultural fields in the Imperial Valley rather than shoreline habitats.

Rails and Other Secretive Marsh Birds

The Yuma Clapper Rail Recovery Team conducts annual surveys of this federally endangered species. Observers detected a total of 279 Clapper Rails in the Salton Sea area in 1999: 271 in marshes immediately around the Salton Sea and 3 at Lower Finney Lake and 5 at Holtville Main Drain in the northern Imperial Valley (Table 5-8, Figure 4-4). Highest concentrations were in the Wister Unit of Imperial WA and Unit 2 of SSNWR. Smaller numbers were in Unit 1 of SSNWR and a few small marshes along the east side of the Sea. No birds were detected at the north end or along the west side of the Sea. At Wister, section A supported the highest numbers of Clapper Rails on both the April and mid-May surveys (Table 5-8), but there appeared to be movement of birds from sections B and C into A between these surveys. In section A, a mean of 2.5 rails (± 2.5 SD, n = 36 stations) was detected per survey station in April and 3.9 rails (± 2.9 SD) in May. In sections B and C, respectively, means of 1.5 rails (± 2.3 SD, n = 35 stations) and 1.1 rails (± 0.8 SD, n = 32 stations) were detected per station in April and 0.7 rails (± 1.6 SD) and 0.8 rails (± 1.3 SD) in May.

We did not detect any Black Rails on our surveys in 1999. The Black Rail is a rare breeder at and around the Salton Sea (Laymon et al. 1990, Evens et al. 1991, Patten 1999), where the only systematic survey for the species produced a total of 23 birds in 1989 (Laymon et al. 1990). Although Black Rail occurrence around the Sea is expected to be sporadic, reflecting frequent and extensive marshland modifications in the area (Evens et al. 1991), the lack of detections of this species in 1999 likely reflects an absence of a systematic survey rather than of the species itself.

The Yuma Clapper Rail, Virginia Rail, Sora, and Common Moorhen were the most frequently detected marsh birds both on rail surveys of freshwater marshes around the Salton Sea (exclusive of the Wister Unit and SSNWR) and on partial surveys of most waterbirds on selected portions of the Salton Sea shoreline (Table 5-9, Figure 5-6d). The Clapper Rail and Common Moorhen occurred year round, whereas the Virginia Rail and Sora were detected primarily in the fall and winter (Figure 5-6d).

Shorebirds

We detected a total of 29 species of shorebirds on 4 comprehensive surveys of the Salton Sea area in 1999. Shorebird totals were 27,169 individuals in January, 36,675 in April, 74,758 in August, and 70,059 in November (Table 5-1). These compare with averages on prior surveys of about 24,000 in December (n = 2), 90,000 in April (n = 4), and 85,000 in August (n = 4) (PRBO and R. McKernan unpubl. data). The relatively low numbers in April 1999 compared with prior years may have represented a lack of coincidence of the 1999 survey dates with the peak passage of Western Sandpipers, which can move through very rapidly in large numbers.

The ten taxa that exceeded 1000 individuals on at least one survey in 1999 were the Black-bellied Plover, Black-necked Stilt, American Avocet, Willet, Long-billed Curlew, Marbled Godwit, Western Sandpiper, Least Sandpiper, dowitchers, and Wilson's Phalarope. During three seasons three taxa accounted for at least 75% of the totals: American Avocet, Western Sandpiper, and dowitchers in April; Black-necked Stilt, American Avocet, and Western Sandpiper in August; and American Avocet, Western Sandpiper, and dowitchers in November. In January it took five taxa to exceed 75% of the shorebird total.

The Mountain Plover, Whimbrel, and Long-billed Curlew all were much more numerous in agricultural fields in the Imperial Valley than in shoreline or other wetland habitats at or near the Salton Sea. We conducted broadscale surveys of the Imperial Valley only for the Mountain Plover as described below. A prior high count of about 9837 Whimbrels at the Salton Sea in April 1989 (PRBO and R. McKernan unpubl. data) was almost exclusively from agricultural fields in the Imperial Valley, which received only limited coverage. The order of magnitude of Long-billed Curlew abundance in the Imperial Valley is indicated by counts of about 2655 individuals in a single flock near Calipatria on 13 November 1999, a total of about 5593 from coverage of about 60% of the Imperial Valley by six observers involved in a Mountain Plover survey on 11-12 December 1999, and 7476 on a multi-observer survey of the Salton Sea and portions of the Imperial Valley in August 1995 (PRBO and R. McKernan unpubl. data). The Black-bellied Plover also is fairly numerous in agricultural fields, and a roosting flock of 758 individuals at the New River Delta on 2 February 1999 likely moved there after foraging in nearby fields.

Seasonal patterns of occurrence varied greatly among the species of regularly occurring shorebirds (Figure 5-6f, g, h, i; Table 5-10). Of 25 such species, four were primarily year-round residents and breeders, 11 were primarily winter residents, and 10 were primarily migrants (Table 5-10). Of the year-round residents, the Black-necked Stilt and American Avocet also showed large peaks, representing fall migrants, in July and August and August to early November, respectively. Of the species occurring primarily as migrants, the Red Knot, Sanderling, and, particularly, the Whimbrel were more numerous in spring than fall, whereas the Wilson's and Red-necked phalaropes were much more numerous in fall than spring.

Snowy Plover

Surveys in 1999 confirmed the importance of the Salton Sea to Snowy Plovers as documented by prior studies (Page et al. 1991, Shuford et al. 1995). Numbers of breeding and wintering plovers in 1999 were similar to those in prior years, and birds concentrated in similar areas (Table 5-11). At all seasons, plovers concentrate primarily on sandy beaches and sand or alkali flats along the western and southeastern shorelines of the Sea. Areas of particular importance include the shoreline and expansive alkali flats from Iberia Wash south through the northern portion of the Salton Sea Test Base and San Felipe Creek Delta (Area 6, northern part of 7, and 8) and the shoreline, breached impoundments, and sand spit paralleling Davis Road and the Wister Unit of Imperial WA (Area 12). In 1999, these areas, respectively, held about 44% and 33% of all plovers in January and 55% and 18% in May.

Mountain Plover

Although California's Central and Imperial valleys are widely considered the primary wintering areas for the Mountain Plover (Knopf and Rupert 1995), our surveys suggest the latter area may be of much more crucial importance than previously thought. In 1999, we counted about 2486 Mountain Plovers in the Imperial Valley in February, 2790 in November, and 3758 in December. The increase in numbers across surveys may reflect a parallel increase in observer coverage. Regardless, the mean number for these three surveys represents about 30% to 38% of the species' estimated population of 8000 to 10,000 individuals (Anonymous 1999). On prior surveys across the California wintering range, the 2072 and 755 Mountain Plovers recorded in the Imperial Valley in 1994 and 1998, respectively, represented 61% and 35% of the totals of 3390 and 2179 individuals found statewide (B. Barnes in litt., CDFG unpubl. data, K. Hunting in litt.). The higher totals in the Imperial Valley in 1999 almost surely reflect an increase in observer coverage there over prior years rather than a population increase. Counts of Mountain Plovers on the Salton Sea (south) Christmas Bird Count, covering only part of the northern Imperial Valley, have ranged from 1-1003 birds (median = 180 birds) from 1979 to 1998.

In 1999, plovers were distributed widely over the Imperial Valley with no consistent areas of concentration (Figure 5-9), presumably reflecting the shifting availability of suitable fields with the temporal and spatial variation in cultivation practices. Concentrations of plovers in a relatively few sites in February appeared to reflect a preference by plovers for burned fields at that season as described below.

Although all Mountain Plovers on our surveys of the Imperial Valley were found in agricultural fields, the types of fields used varied by season. In February, 81% (2010) of all plovers were in stubble hayfields burned after harvest; the remainder, except for 3 individuals in a asparagus stubble field, were in short-stature, stubble hayfields yet to be burned. Most of the burned fields had some sparse new green growth. In three complexes of burned stubble hayfields holding about 1184 plovers, residual stubble about 3 to 5 cm tall covered about 50% of the ground with the remainder bare of vegetation. In November, 35% of the plovers were in bare tilled fields and 65% in fields of various crop types with new growth averaging <3 cm in height and ranging up to 95% vegetative cover. In December, 47% were in bare tilled fields and 53% were in fields of various crop types, primarily in new stages of growth, ranging from <5% to 100% vegetative cover. Of the plovers in fields with new crops, 69% occurred in fields in which plant height averaged <5 cm, 10% in which it averaged 5-10 cm, and 21% in which it averaged >10-20 cm. Additional practices that produced the low stature and sparse cover of vegetation attractive to plovers included grazing and mowing or harvesting of hay crops. Plovers using bare fields appeared to prefer actively or recently tilled fields. This appeared particularly to be the case in December when at least 649 (37%) of 1777 plovers in bare fields were in ones in which tractors were actively working; an additional but unknown percent were in fields that had recently been tilled. Tilled fields used by plovers tended to be relatively flat and smooth rather than undulating and with large dirt clods. Although many fields with growing crops used by plovers were relatively flat throughout, many others had raised beds with flats tops and narrow intervening furrows in which plovers often stood or crouched.

Gulls, Terns, and Skimmers

Gulls

We recorded a total of 13 species of gulls on comprehensive surveys of the Salton Sea. Totals for all species were 42,847 individuals in January, 9043 in April, 11,358 in August, and 41,694 in November (Table 5-1). The Ring-billed, California, and Herring gulls accounted for >98% of all individuals in January and November, whereas just the Ring-billed and California gulls accounted for >92% in April and August. The Ring-billed Gull alone accounted for 55% to 65% of all gulls at the Salton Sea in November and January, respectively. However, many thousands of Ring-billed Gulls also winter in agricultural fields of the Imperial Valley, where the species is proportionately even more dominant than on the shoreline of the Sea. Ring-billed Gulls accounted for 6580 (99.4%) of the 6616 gulls identified on monthly agricultural field transects in the northern Imperial Valley just south of the Salton Sea.

Of the six species occurring in substantial numbers, three (Ring-billed, California, Herring) were primarily winter residents, two (Laughing, Yellow-footed) were primarily fall visitants from the Gulf of California, and one (Bonaparte's) was primarily a winter resident showing peaks during migration (Figure 5-6j). Apparent increases in numbers of wintering gulls over the fall and winter may reflect the pattern documented for California Gulls in which birds along the Pacific Coast move progressively southward from fall through winter (Pugesek et al. 1999). Only the Laughing and California gulls have bred at the Salton Sea; see Colonial Nesting Waterbirds section below.

Terns and Skimmers

We recorded five species of terns and the Black Skimmer on comprehensive surveys of the Salton Sea (Table 5-1). These species totaled 22 individuals in January, 365 in April, 8611 in August, and 254 in November. Numbers of Gull-billed and Black terns probably were slightly underestimated because some individuals forage over irrigated agricultural fields. For example, totals of 31 and 539 Black Terns were recorded on 5 agricultural field transects in the northern Imperial Valley on 16 May and 11 August, respectively. By contrast, we did not see any Black Terns on a 16 August aerial survey of agricultural fields further south in the Imperial Valley (Figure 4-5), suggesting that Black Terns forage over fields primarily near the Salton Sea.

All species reached peak numbers in summer or fall, and the Caspian Tern was the only species that maintained a small wintering population (Figure 5-6k). The Black, Caspian, and Forster's terns were the most numerous species, respectively, in August, together accounting for 91% of all terns and skimmers at that season. Peak numbers of the three regular breeding species – Gull-billed Tern, Caspian Tern, and Black Skimmer – were probably reached by augmentation of the adult breeding population by locally fledged young and movement of adults and juveniles from elsewhere. Although Forster's Terns breed irregularly at the Salton Sea, they did not do so in 1999, and, hence, peak numbers reflect post-breeding movement from elsewhere. Small numbers of Black Terns arrived in spring and some remained through summer, but most individuals occurred primarily in the fall. See the Colonial Nesting Waterbirds section below for data on breeding terns and skimmers in 1999.

Colonial Nesting Waterbirds

Abundance, Species Richness, Distribution, and Colony Success

In 1999, the Salton Sea supported over 14,000 pairs of colonial breeders comprised of 11 species representing three families (Table 5-12). Together the Cattle Egret, Double-crested Cormorant, Great Blue Heron, and Black Skimmer accounted for 94% of all nesting pairs. Colonial nesters bred at 21 sites on or near the shoreline of the Sea and at Ramer Lake and near Westmorland in the Imperial Valley (Figure 4-6). Most nesting sites and concentrations were near the Whitewater River mouth at the north end of the Sea or between, and including, the New and Alamo river deltas along the southeastern shoreline. The Great Blue Heron, Double-crested Cormorant, and Great Egret nested at 18, 8, and 6 sites, respectively, whereas all other species nested at 1 to 4 sites (Table 5-12). Species richness was highest at Johnson Street, where 7 of the 11 species nested. Species richness of ardeids also was high at the Alamo River and 76th Avenue, where four species bred at each site. Species richness of larids was highest at Rock Hill on the Salton Sea NWR, where four species bred in an area managed specifically for terns and skimmers. Large colonies dominated primarily by cormorants and Cattle Egrets formed at Mullet Island and the Westmorland eucalptus grove, respectively.

While our study was not designed to quantify nesting success for species other than the Great Blue Heron, we did record large scale disruptions to nesting. Ardeids and cormorants deserted whole colonies at the New River Delta and Ramer Lake as did larids at Johnson and Colfax streets. Great Egrets also abandoned nest attempts at Ibis Road. Qualitative assessments of colony site mortality by refuge personnel indicated that the previously high levels of mortality experienced at some sites, such as for cormorants at Mullet Island in 1997, were not apparent in 1999 (SSNWR files). Also different from previous years was the notable absence of large numbers of cormorants exhibiting symptoms of illness (e.g. paralysis, SSNWR files).

Patterns of abundance, distribution, nesting chronology, and nesting success by species are presented below:

Cormorants

A total of over 5400 pairs of Double-crested Cormorants nested at eight colony sites (Figure 4-6, Tables 5-12 and 5-13). The largest aggregation, by far, occurred on the rocky ledges and slopes of Mullet Island. Assuming an incubation period of 25 to 28 days (Hatch and Weseloh 1999), the presence of young on aerial photos taken 19 February, coupled with observations of incubating birds in late January, suggest that the earliest nest initiations at Mullet probably began by early January. Nearly 900 nestlings and over 500 broods of large young were counted on aerial photos taken on 25 March. Although quantification of nesting success through to fledging is lacking, available photo documentation suggests that cormorants were relatively successful through the hatching phase compared to previous years (SSNWR files). Reasons for the abandonment of the colony at Ramer Lake soon after its establishment, and of that at the New River Delta, remain unknown (Table 5-13).

Ardeids

A total of about 888 pairs of Great Blue Herons nested at 18 sites (Figure 4-6, Tables 5-12 and 5-13). Great Blues exploited a variety of natural and artificial nest substrates. Assuming a 28-day incubation period (Butler 1992), early March observations of well-developed young at the 76th Avenue colony suggest that herons initiated nests by early January. Nest success of a sample of Great Blue Heron nests at the Johnson Street, New River East, and 76th Avenue colonies averaged 66% (range = 50-86%, Table 5-14). Despite the complete abandonment of the large colony at the New River Delta, our observations of well-developed young at many sites, coupled with the results of our monitoring efforts, suggest that Great Blue Heron nesting success was relatively high for colonies that remained intact.

A total of about 165 pairs of Great Egrets nested at six sites (Figure 4-6, Tables 5-12 and 5-13). Great Egrets bred primarily in snag stands at the 76th Avenue, Johnson Street, New River Delta, and Ramer Lake colonies and in the dense stands of *Phragmites* and *Tamarix* at the Alamo River Delta. Our earliest observations of nest-building and incubation for Great Egrets occurred in mid-March. A relatively large colony of this species at Ramer Lake was abandoned only a week or two after it was established. Great Egrets also abandoned nest attempts at the New River Delta by mid-April and at the Ibis/Ibis Road South colony by mid- to late May. The failure of nests at Ibis Road was due to the destruction of nesting platforms during heavy winds (D. Barnum pers. comm.). The colonies of Great Egrets at 76th Avenue and Johnson Street remained intact throughout our observations, although we could not confirm the presence of well-developed young. We believe that at least some, if not most, of the nest attempts at these sites were successful.

A total of about 170 pairs of Snowy Egrets established nests at four sites (Figure 4-6, Tables 5-12 and 5-13). Snowy Egrets bred primarily in the snag stands at 76th Avenue and the *Phragmites/Tamarix*-lined channels and island of the Alamo River Delta. Our observations at the 76th Avenue colony indicated that these egrets first initiated nests in late May and began hatching chicks by late June. Long-range observation distances, lack of survey effort late in the season, and the late discovery of the Westmorland colony prevented an evaluation of nesting success for Snowy Egrets at other colonies.

A total of about 102 pairs of Black-crowned Night-Herons nested at three colony sites (Figure 4-6, Tables 5-12 and 5-13). Our observations at Johnson Street indicated that night-herons had established nests by early May. The appearance of numerous well-developed young by 11 June suggests that the Johnson Street night-herons were highly successful. Late nest initiations at 76th Avenue and the lack of survey effort late in the season, and the late discovery of the Westmorland colony precluded a complete evaluation of nesting success.

A total of over 6000 pairs of Cattle Egrets bred at two sites (Figure 4-6, Tables 5-12 and 5-13). Observations at the Alamo River Delta suggested that Cattle Egrets began to establish territories in late April. Long-range observation distances, the density of the colony, and lack of survey effort later in the season precluded an evaluation of nesting success for this colony. A relatively low level of mortality possibly related to an outbreak of disease involving Cattle Egrets, and potentially Snowy Egrets, was noted by refuge and health center personnel late in the nesting season (S. Johnson pers. comm.).

An observation at the Westmorland Eucalyptus Grove on 8 July indicated that this colony was highly successful by early July.

Larids

Laughing Gulls nest infrequently at the Salton Sea. We noted one pair of Laughing Gulls attending a nest at Rock Hill on 27 May (Figure 4-6, Tables 5-12 and 5-13). This attempt was unsuccessful, although the adults continued to attend the nest site until 15 July (Molina in press). At least 40 pairs of California Gulls nested at Obsidian Butte (Figure 4-6, Tables 5-12 and 5-13). Nest initiations were apparent by early May. Observations in early June of numerous well-developed young (Molina in press) indicated that the colony was highly successful.

A total of about 101 pairs of Gull-billed Terns nested at Johnson Street and Rock Hill (Figure 4-6, Tables 5-12 and 5-13). This species initiated nests by early to mid-May at both colonies, but abandoned all attempts at Johnson by early June. Nest success at Rock Hill colony appeared to be relatively high (K. Molina unpubl. data). Approximately 211 pairs of Caspian Terns bred only at the Rock Hill colony (Figure 4-6, Tables 5-12 and 5-13). Caspians initiated nests by mid-May and appeared to have high nest success (K. Molina unpubl. data).

About 377 pairs of Black Skimmers nested at three sites (Figure 4-6, Tables 5-12 and 5-13). This species initiated nests by mid-June at both Rock Hill and Johnson Street. By late June, skimmers, like Gull-billed Terns, had abandoned all nest attempts at Johnson Street. In mid-July, skimmers attempted to nest on an exposed barnacle spit near Colfax Street. The colony at this site, which is contiguous with the shoreline, was depredated by dogs and abandoned by mid-August. Nesting success at the Rock Hill colony appeared to be high (K. Molina unpubl. data).

Nesting Habitat

Available nesting habitat for colonial waterbirds at the Salton Sea is concentrated near the Whitewater River mouth at the north end and along the southeast shoreline between, and including, the New and Alamo rivers. In 1999, colonial waterbirds nested at 23 sites: 21 along the shoreline and at 2 others within approximately 15 km of the Sea (Figure 4-6, Table 5-12). Of the total, 21 provided substrate suitable for arboreal nesters, whereas only 5 offered suitable habitat for obligate ground nesters (the islets in Morton Bay were unoccupied).

Colonial waterbirds used five types of nesting substrates at the Salton Sea: (1) artificial structures including the tops and cross-beams of power poles, hunt blinds, and barges; (2) flooded stands of dead snags, primarily of *Tamarix;* (3) marshes of, and river channels lined with, *Phragmites* and *Tamarix;* (4) bare earthen islets near shore; and (5) the rocky ledges and slopes of Mullet Island. Egrets and night-herons nested primarily in arboreal habitats, whereas gulls, terns, and skimmers nested exclusively on the ground. Cormorants and Great Blue Herons nested both on the ground and in trees or snags. We observed only Great Blue Heron nests on artificial structures.

Regional Perspective

The community of breeding colonial waterbirds at the Salton Sea is composed of 11 species, within three avian families, which rivals or exceeds the totals at many coastal

and interior colonies in western North America (Price et al. 1995, Parnell et al. 1988). Many of these species maintain regionally significant nesting populations at the Salton Sea. Populations of the Double-crested Cormorant (Hatch 1995), Gull-billed Tern (Parnell et al. 1995), Caspian Tern (Cuthbert and Wires in press), and Black Skimmer (Collins and Garrett 1996) may be among the largest anywhere in western North America in recent years. For the Gull-billed Tern, the Salton Sea is one of only a few sites at which the western subspecies (*S. n. vanrossemi*) breeds (Parnell et al. 1995).

Population Trends and Patterns of Site Occupancy

During the 1990s, colonial waterbird populations at the Salton Sea have been dynamic in terms of both breeding population size and colony site occupation (Shuford et al. 1999). While some populations have increased greatly, others have declined. Nesting Double-crested Cormorants began their explosive growth in 1996 with the colonization of Mullet Island (SSNWR files). This population continued to increase to over 5,000 pairs in 1999 and now forms one of the largest concentrations of breeding cormorants in the Pacific coast states north of Mexico (Carter et al. 1995). Great Blue Herons have experienced rapid growth during the last few years with the number of nesting pairs in 1999 more than twice that reported in 1998 (Shuford et al.1999, SSNWR files). The number of nesting pairs of Great, Snowy, and Cattle egrets and Black-crowned Night-Herons appear to have declined over the past several years (SSNWR files, this study). For larids that nest annually, Gull-billed Tern and Caspian Tern populations in 1999 were about 30% and 80% of their respective averages over the past several years (K. Molina unpubl. data). Populations of California Gulls and Black Skimmers increased by about 25% and 35%, respectively, over the same period (K. Molina unpubl. data). Brown Pelicans have not nested at the Salton Sea since their successful attempts in 1996. Other species not detected breeding in 1999 and with poorly understood nesting status at the Salton Sea, include the White-faced Ibis and Forster's Tern.

Although nesting colonies often shift locations at the Salton Sea, our 1999 survey results concur with information gathered in previous years (SSNWR files) indicating that the areas associated with the Whitewater, New, and Alamo rivers continue to be important focal points for colonial nesting waterbirds. During the 1990s, colonial nesting waterbirds have regularly nested at about 22 sites around the Salton Sea perimeter. In recent years, cormorants and ardeids have not established colonies at the extant sites of Lack/Lindsey, Vail Ranch and West Whitewater, and larids have not re-established nesting on the islets of Morton Bay. Cormorants bred at fewer colony sites in 1999 than in 1998, and Great Blue Herons, after deserting the New River Delta, dispersed to colonize snag stands offering marginal nesting substrate and artificial structures not previously used (SSNWR files). In 1999, Great Egrets, Cattle Egrets, and Black-crowned Night-Herons nested at fewer sites than in 1998, whereas the number of nesting sites of Snowy Egrets remained the same. Colonial ground nesters requiring bare earthen islets, such as terns and skimmers, have experienced a net loss of suitable nesting habitat from the complete erosion or vegetative overgrowth of several previously used sites (K. Molina unpubl. data). Gull-billed Terns, Caspian Terns, and Black Skimmers all have undergone recent contractions in nest site occupancy (K. Molina unpubl. data). The California Gull, a recent but now annual breeder at the Salton Sea, continues to nest at a single site, although recent observations indicate that they may be attempting to expand

to Rock Hill (Molina in press). The only nesting habitat currently managed for colonial breeding waterbirds at the Salton Sea is the set of islets at Rock Hill on the Salton Sea NWR. This site has supported large and productive colonies of terns and skimmers since 1995 (Molina 1997).

Waterbird Use of Agricultural Lands

In 1999, we recorded a minimum of 63 bird species and a total of 38,398 individuals during 12 monthly surveys of agricultural field in the northern Imperial Valley. Three species – Ring-billed Gull (12,092 individuals), Cattle Egret (10,862), and Red-winged Blackbird (4,034) – accounted for 70% of all the birds counted. Additional taxa that totaled over 100 individuals on transects were the White-faced Ibis (2,217), Snow/Ross's goose (2,025), Long-billed Curlew (1,545), Black-necked Stilt (1,055), Black Tern (686), swallow spp. (510), Killdeer (417), Laughing Gull (296), Western Meadowlark (268), Least Sandpiper (232), Black-bellied Plover (164), Whimbrel (153), Brewers Blackbird (143), American Pipit (134), Wilson's Phalarope (131), Greater Yellowlegs (123), Tree Swallow (120), Horned Lark (112), American Kestrel (110), and Yellow-headed Blackbird (100). That 14 of the 20 most abundant taxa in agricultural fields were waterbirds reaffirms the importance of this habitat to waterbirds around the Salton Sea.

Of our seven habitat classifications, 39% of all birds were in grass fields, 31% in alfalfa fields, 24% in bare fields, 5% in leaf fields, 1% in or on man-made structures, and >1% each in bulb fields or in water bodies (excluding flooded fields). In terms of behavior, 65% of all birds observed were feeding, 23% were resting, 10% were flying, and 2% engaged in other behaviors (bathing, displacement behavior, or unknown). These data document the important of these fields to foraging birds.

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Table 3-1. Seasonal status and significance of waterbirds of conservation concern at the Salton Sea, California. FT = federally threatened, FE = federally endangered, ST = state threatened, ST = state endangered, MNMC = U.S. Migratory Nongame Bird of Management Concern (USFWS 1995), BSSC = Calif. Dept. of Fish and Game Bird Species of Special Concern[a] (CDFG 1992).

Species	Special Status Designation	Seasonal Status and Significance
Brown Pelican	FE	Large non-breeding population and recent small and irregular breeding population. About 1200 died of botulism in 1996.
American White Pelican	BSSC, MNMC	Wintering population represents up to 30% of the entire North American breeding population and may exceed the size of the western breeding population. About 9,000 died of botulism in 1996.
Double-crested Cormorant	BSSC	Large wintering and breeding population. Mullet Island colony one of largest in western North America.
American Bittern	MNMC	Small wintering and, perhaps, breeding population.
Least Bittern[b]	BSSC, MNMC	Resident population of unknown size.
White-faced Ibis	BSSC, MNMC	Large wintering and small irregular breeding population. A primary wintering area in western North America.
Wood Stork	BSSC	Small and declining post-breeding population.
Fulvous Whistling-Duck	BSSC,	Small and declining breeding and wintering population.
Black Rail	ST, MNMC	Small irregular breeding population.
Yuma Clapper Rail	FE	Relatively small breeding population represents about 40% of entire U.S. population.
Greater Sandhill Crane	ST	Modest wintering population in Imperial Valley
Snowy Plover	BSSC, MNMC	Year-round resident. Largest wintering population in the interior of the U.S. and one of a handful of key breeding areas in the interior of California.
Mountain Plover	BSSC, MNMC	Winter resident. Imperial Valley population represents about 30% to 40% of the species' entire population.
Long-billed Curlew	BSSC, MNMC	Relatively large wintering population, particularly in the Imperial Valley.
Laughing Gull	BSSC	Breeder and post-breeding visitor. Breeding population has declined, now very small and irregular.
California Gull	BSSC	Primarily a winter resident and non-breeding summer resident; recently established small breeding population.
Gull-billed Tern	BSSC	Breeder and summer resident. Hosts one of few breeding populations of western subspecies.
Black Tern	BSSC, MNMC	Migrant and non-breeding summer resident. One of key migratory stopover sites in western North America.
Black Skimmer	BSSC	Breeder and summer resident. Population among the largest in western North America in recent years.

[a] List currently outdated and under revision.
[b] A population estimate of 550 individuals around the Salton Sea (Setmire et al. 1993) is unsubstantiated.

Table 4-1. Coverage of major roost sites in the Imperial Valley, California, on eight winter and fall surveys in 1999. U1 = SSNWR Unit 1, FL = Finney Lake, RL = Ramer Lake, "Keystone" duck club, DK = D and K/Mesquite duck club, OS = Ostercamp duck club, and WU = Wilderness Unlimited duck club. C = count taken, D = site dry/unsuitable, and I = site considered inactive during survey period.

	Roost Sites						
Date	U1	FL[a]	RL	KE	DK	OS	WU
27 Jan	C	I	C	C	D	C	C[b]
13 Feb	C	I	C	C	D	C	C
13 Mar	C	I	C	C	D	C	C
14 Aug	C	C[c]	C[c]	D	D	D	D
15 Sep	C	C	C	D	D	C	D
21 Oct	C	C	C	D	C	C	C
11 Nov	C	C	C	D	C	C	C
16 Dec	I[d]	I	C	D	C	C	C

[a] Finney Lake not surveyed from January to March and again in December because it appeared not to be hosting substantial numbers of roosting birds at those times.
[b] Only White-faced Ibis were counted at this site on this date.
[c] Numbers used from recount of Finney and Ramer lakes on 15 August. Observers repositioned on 15 August to ensure an accurate count after observations on 14 August indicated that after initially settling into apparent roost sites large numbers of ibis were leaving Finney and heading in the direction of Ramer.
[d] Unit 1 not surveyed in December because it appeared not to be hosting substantial numbers of roosting birds at that time.

Table 5-1. Numbers of native waterbirds recorded on four comprehensive surveys of the Salton Sea, California, and adjacent wetlands in 1999 (see Methods). Waterfowl and Eared Grebes were counted on aerial surveys at intervals that often did not coincide with comprehensive surveys (see Tables 3 and 4).

Species	22 January-5 February[a]	17-18 April	13-16 August	11-15 November
Pied-billed Grebe	25	15	47	56
Western Grebe	0[b]	379	363	714
Clark's Grebe	0[b]	340	371	222
Black Storm-Petrel	0	0	1	0
Am. White Pelican	16,697	3738	554	19,197
Brown Pelican	16	0	1995	38
Double-crested Cormorant	18,504	11,160	3023	15,179
American Bittern	0	1	2	5
Least Bittern	2	0	7	7
Great Blue Heron	1566	925	1741	1380
Great Egret	275	229	1027	958
Snowy Egret	107	350	1103	759
Cattle Egret	42	238	1213	54
Green Heron	6	8	53	8
Black-crowned Night-Heron	116	69	608	114
White-faced Ibis	361	434	205	826
Wood Stork	0	0	6	0
Clapper Rail	8	12	16	7
Virginia Rail	5	0	6	3
Sora	10	8	2	17
Common Moorhen	12	18	62	62
Black-bellied Plover	1310	575	253	1381
Pacific Golden-Plover	0	1	0	0
Snowy Plover	275	285	351	170
Semipalmated Plover	73	131	139	122
Killdeer	277	215	259	228
Black-necked Stilt	3941	3465	15,857	5938
American Avocet	7318	7001	10,037	18,800
Greater Yellowlegs	81	14	113	82
Lesser Yellowlegs	62	12	28	69
Solitary Sandpiper	0	0	1	0
Willet	1162	682	582	1531
Spotted Sandpiper	7	7	19	11
Whimbrel	0	43	31	0
Long-billed Curlew	373	33	394	1380
Marbled Godwit	1297	928	1036	1205

Table 5-1. Continued.

Species	22 January-5 February[a]	17-18 April	13-16 August	11-15 November
Ruddy Turnstone	17	44	10	0
Red Knot	0	371	1	20
Sanderling	52	249	39	37
Western Sandpiper	1573	14,700	34,394	22,526
Least Sandpiper	2006	1226	942	3773
Baird's Sandpiper	0	0	1	0
Dunlin	799	141	1	964
Stilt Sandpiper	164	1	15	206
Ruff	1	0	3	0
dowitcher spp.	6356	6492	7153	11,589
Common Snipe	24	1	2	5
Wilson's Phalarope	1	23	3065	2
Red-necked Phalarope	0	32	32	20
Red Phalarope	0	3	0	0
Laughing Gull	0	0	7	1
Franklin's Gull	0	5	0	0
Bonaparte's Gull	297	403	27	626
Heermann's Gull	0	0	1	0
Mew Gull	2	0	0	0
Ring-billed Gull	28,523	5049	4800	22,833
California Gull	6987	3293	5730	11,313
Herring Gull	7026	291	1	6900
Thayer's Gull	0	0	0	2
Lesser Black-backed Gull	0	0	0	1
Yellow-footed Gull	1	1	789	15
Western Gull	4	0	3	3
Glaucous-winged Gull	6	1	0	0
Western x Glacous-winged Gull	1	0	0	0
Gull-billed Tern	0	69	11	0
Caspian Tern	22	269	2404	44
Common Tern	0	0	6	0
Forster's Tern	0	19	1402	172
Black Tern	0	2	4011	0
Black Skimmer	0	6	777	38
Total individuals	107,790	64,007	107,132	151,613
Total species	49	55	63	54

[a] On this survey, Western and Clark's grebes were not counted in all areas and the Pied-billed Grebe, all rails, and all gulls and terns were not counted in areas 3-5.
[b] Although not counted, present and included in species total for this survey.

Table 5-2. Total numbers of waterbirds on various surveys at the Salton Sea, California, in 1999. Numbers in parentheses estimated because of a lack of surveys during particular months. See Methods for descriptions of survey protocols.

Survey Type	January	April	August	November
Comprehensive Surveys[a]	107,790	64,007	107,132	151,613
Waterfowl and Coot Surveys[b]	59,436	16,924	(5000)	67,341
Roost Counts[c]	19,687	(7500)	57,677	42,545
Totals	186,913	88,431	169,809	261,499

[a] See Table 5-1 for details.
[b] See Table 5-4 for details.
[c] See Figure 5-7 for patterns of abundance of the Cattle Egret and White-faced Ibis, which comprise the vast majority of birds at Imperial Valley roost sites in all seasons.

Table 5-3. Number of Eared Grebes (EAGR), *Aechmophorus* grebes (AECH), and Ruddy Ducks (RUDU) recorded on grouped areas of the inshore zone and two transects of the offshore zone of the Salton Sea, California, on aerial surveys in 1999. See Methods and Figures 4-3 and 4-5 for descriptions of inshore areas and offshore transects.

	19 March			28 March			29 November			17 December		
Area	EAGR	AECH	RUDU	EAGR	AECH	RUDU	EAGR	AECH	RUDU	EAGR	AECH	RUDU
Inshore												
1-2	7100	789	1235	5620	643	987	8909	66	3017	12,520	68	2555
3-5	9745	1190	1087	8345	2016	653	12,806	225	2521	46,612	464	2567
6-7	10,964	32	235	11,233	87	259	43,076	105	2452	59,397	110	3096
8-10	5755	237	937	4125	390	121	17,584	275	1620	41,965	583	2532
11	3585	24	580	2100	11	69	30,968	61	4097	31,680	230	4045
12-15	6125	2410	126	9476	1209	32	24,592	34	5171	54,261	75	5233
16-17	3045	1240	0	3555	1221	0	7242	275	2056	17,750	577	2173
18-19	902	1465	0	1107	978	0	8708	51	5453	22,124	344	7580
Offshore	340	1233	920	12,851	568	1803	18,665	416	197	35,266	1379	2899
Totals	47,561	8620	5120	58,412	7123	3924	172,550	1508	26,584	321,575	3830	32,680

Table 5-4. Numbers of waterfowl and other waterbirds counted on five aerial surveys of the Salton Sea, California, and surrounding wetlands in 1999 (see Methods and Figure 4-7). Data for 1999 courtesy of SSNWR; data for mid-winter counts 1978 to 1987 from Heitmeyer et al. (1989).

	Survey Dates 1999					mid-winter average 1978-1987
Species	8 January	9 March	3 April	27 May	18 November	
Gr. White-fronted Goose	16	0	0	0	0	0
Snow/Ross's goose	22,550	1303	30	0	4400	16,835
Canada Goose	76	0	0	0	17	3296
Gadwall	109	45	31	12	244	465
American Wigeon	1873	1997	4	0	1422	5623
Mallard	76	43	44	23	1938	389
Blue-winged/Cinnamon teal	204	239	61	51	48	242
Northern Shoveler	11,732	10,790	5404	22	13,264	12,670
Northern Pintail	5465	502	5	3	7465	14,091
Green-winged Teal	3759	4488	441	77	4227	3092
Unidentified dabbling ducks	3212	1482	440	39	0	0
Canvasback	256	111	6	0	379	1691
Redhead	117	24	10	7	266	336
Ring-necked Duck	2	4	0	0	0	110
Scaup spp.	557	3189	752	10	242	1760
Scoter spp.	0	1	0	0	10	0
Bufflehead	50	41	0	0	22	49
Common Goldeneye	5	2	0	0	0	0
Ruddy Duck	4828	15,213	7904	1493	14,655	16,269
Unidentified diving ducks	175	65	27	5	0	0
Total waterfowl	55,062	39,539	15,159	1742	48,599	76,918
Other waterbirds						
Eared Grebe	13,798	34,810	38,767	0	3370	-
Am. White Pelican	12,203	13,512	2674	0	22,706	-
Brown Pelican	415	0	0	23	154	-
American Coot	4374	4841	1765	735	18,742	-

Table 5-5. Numbers of waterfowl on ground counts of six survey areas near the southern shore of the Salton Sea, California, on dates in 1999 adjacent to or bracketing those for four aerial waterfowl surveys (see Methods).

Species	6-12 March	30 March-4 April	29 May	15-16 November
Snow/Ross's goose	2195	97	0	6688
Canada Goose	0	0	0	11
Gadwall	46	98	25	250
American Wigeon	1912	345	4	507
Mallard	5	13	65	52
Blue-winged Teal	0	0	3	0
Cinnamon Teal	213	228	55	69
Northern Shoveler	7862	3264	54	4355
Northern Pintail	40	59	13	2352
Green-winged Teal	4548	1331	25	1852
Canvasback	16	1	0	24
Redhead	5	12	203	52
Ring-necked Duck	0	1	2	17
Lesser Scaup	143	15	0	27
Surf Scoter	0	0	0	3
Bufflehead	9	3	1	9
Common Goldeneye	2	4	0	0
Ruddy Duck	1187	691	1010	2298
Totals	18,183	6162	1460	18,566

Table 5-6. Comparison of numbers of waterfowl counted for Units 1 and 2 of SSNWR and the Wister Unit of Imperial WA combined on both ground and aerial surveys in 1999.

Species	March		April		May		November	
	Ground	Air	Ground	Air	Ground	Air	Ground	Air
Snow/Ross's goose[a]	2195	1303	62	30	0	0	6688	3800
Canada Goose	0	0	0	0	0	0	10	0
Gadwall	42	41	94	11	14	9	164	40
American Wigeon	1877	1905	325	4	4	0	437	968
Mallard	5	25	13	12	64	11	34	856
Blue-winged/Cinnamon teal[b]	188	158	211	20	29	28	69	6
Northern Shoveler	3723	3675	1277	1698	54	10	2327	10,691
Northern Pintail	35	320	42	5	9	2	2201	5329
Green-winged Teal	1744	2209	817	233	25	22	454	2870
Unidentified dabbling ducks	0	337	0	17	0	2	0	0
Canvasback	16	40	1	0	0	0	21	374
Redhead	5	10	12	0	173	2	11	214
Ring-necked Duck	0	0	1	0	2	0	15	0
Scaup spp.[c]	143	1113	0	2	0	0	14	35
Bufflehead	9	25	3	0	1	0	9	0
Common Goldeneye	2	0	4	0	0	0	0	0
Ruddy Duck	637	652	356	693	374	102	1065	1306
Totals	10,621	11,813	3218	2725	749	188	13,519	26,489

[a] Because of the difficulty of identifying these two species of geese, particularly from the air, all individuals are lumped as this combined species group. Snow Geese usually vastly outnumber Ross's Geese at the Salton Sea.

[b] All teal of these species identified on ground counts were Cinnamon Teal except for one Blue-winged Teal on the May count.

[c] All scaup on ground counts were identified as Lesser Scuap.

Table 5-7. Numbers of raptors recorded on four comprehensive surveys of the Salton Sea and adjacent wetlands in 1999 (see Methods).

Species	22 January-5 February	17-18 April	13-16 August	11-15 November
Turkey Vulture	1	12	55	10
Osprey	6	11	13	17
White-tailed Kite	0	0	0	2
Bald Eagle	0	0	0	1
Northern Harrier	23	5	2	33
Sharp-shinned Hawk	0	0	0	1
Cooper's Hawk	1	0	1	4
Accipiter spp.	3	0	0	0
Red-shouldered Hawk	0	1	0	0
Red-tailed Hawk	4	0	0	17
American Kestrel	12	13	11	51
Merlin	2	0	0	4
Peregrine Falcon	3	0	2	4
Prairie Falcon	0	0	0	2
Burrowing Owl	0	2	0	0

Table 5-8. Yuma Clapper Rail numbers at wetlands around the Salton Sea, California, 24 April to 15 May 1999. Map numbers refer to locations on Figure 4-4. In general, locations are listed counterclockwise starting at the north end of the Sea. NC = not counted in that period.

Area	Map Number	Mean (±SD) Rail Numbers 1990-1998[a]	Rail Numbers 1999
Johnson St.	1	NC	0
King's Road Marsh	2	NC	0
81st Drain	3	NC	0
SSNWR Unit 1	4		
Trifolium 1 Drain	4		0
A-1 Pond	4		6
B-1 Pond	4		10
Reidman 3	4		2
Reidman 4	4		3
Bruchard Bay	4		0
New River Delta	4		0
Lack and Grumble (off refuge)	5		2
SSNWR Unit 2 and Hazard	6		
Barnacle Bar Marsh	6		2
Headquarter 'B' Pond	6		2
Union Pond	6		9
McKendry Pond	6		2
Hazard 6	6		12
Hazard 7	6		6
Hazard 8 (east)	6		2
Hazard 9 and Ditch	6		2
Hazard 10	6		6
Alamo River (east)	6		3
Alamo River (west)	6		0
SSNWR Subtotal		62 ± 33	67
Off Refuge			
Walt's Club (McDonald Rd.)	7		2
'T' Drain Marsh	8		6
Wister Unit Imperial WA			
Section C	9		27 (35)[b]
Section B	10		25 (54)[b]
Section A	11		139 (90)[b]
Wister Subtotal		248 ± 77	191 (179)
North of WisterUnit			
Bombay Marsh	12		3
Salt Creek	13	1 ± 2	0
Barnacle Beach Subtotal[c]		16 ± 10	13
Imperial Valley			
Lower Finney Lake	14	NC	3[d]
Holtville Main Drain	15	7 ± 5	5
Grand Total			279

[a] Data from Yuma Clapper Rail Recovery Team, USFWS, Phoenix, AZ.
[b] Number of rails from 12 May count, numbers in parentheses from 26 Apr count.
[c] Barnacle Beach subtotal = Lack and Grumble + Walt's Club (McDonald Rd.) + 'T' Drain Marsh + Bombay Marsh.
[d] Detected during Black Rail survey.

Table 5-9. Numbers of rails and other marsh birds detected per listening station during two periods of PRBO rail surveys in 1999; no single station was surveyed more than once in a period.

Species	24 Apr-13 May (n = 53 stations)	2-15 May (n = 42 stations)
Clapper Rail	0.32	0.33
Virginia Rail	0.17	0.00
Sora	0.11	0.00
Common Moorhen	0.04	0.12
Least Bittern	0.04	0.00
Green Heron	0.00	0.07

Table 5-10. Primary seasonal occurrence patterns of regularly occurring shorebirds at the Salton Sea, California. * = additional substantial migrant peak, ** = lower but relatively substantial winter resident population.

Year-round residents and breeders	*Primarily seasonal migrants*
Snowy Plover	Semipalmated Plover **
Killdeer	Spotted Sandpiper**
Black-necked Stilt*	Whimbrel
American Avocet *	Western Sandpiper**
	Ruddy Turnstone
Primarily winter residents	Red Knot
Black-bellied Plover	Sanderling
Mountain Plover	Short-billed Dowitcher
Greater Yellowlegs	Wilson's Phalarope
Lesser Yellowlegs	Red-necked Phalarope
Willet	
Least Sandpiper	
Dunlin	
Long-billed Dowitcher	
Stilt Sandpiper	
Marbled Godwit	
Long-billed Curlew	

Table 5-11. Numbers of Snowy Plovers counted in various areas at the Salton Sea, California, in 1999 with comparisons to prior years (data from Shuford et al. 1995). See Methods and Figure 4-3 for area boundaries.

	Breeding Season			Winter			
Area	4-12 May 1978	4-14 May 1988	21-31 May 1999	3-8 Dec 1993	1-9 Dec 1994	22-27 Jan 1999	4-15 Nov 1999
1	2	4	4	14	3	7	0
2	0	0	5	10	0	1	0
3	12	8	4	0	1	0	0
4	7	14	2	46	16	17	4
5	32	18	7	21	9	0	0
6	38	14	71	102	31	84	37
7	0	24	16	17	16	6	6
8	29	38	35	26	18	30	13
9	3	3	5	0	7	2	0
10	0	0	4	15	3	14	0
11[a]	2	7	3	3	0	18	0
12	16	17	39	10	89	90	102
13	33	11	24	0	0	3	8
14	29	26	0	13	7	2	0
15	4	1	2	0	1	1	0
16	6	0	0	0	0	0	0
17	6	0	0	0	0	0	0
18	2	0	0	5	4	0	0
21B	5	13	0	3	9	0	0
Totals	226	198	221	285	214	275	170

[a] also includes impoundments of SSNWR (Area 20A-D) not tallied separately prior to 1999.

Table 5-12. Total numbers of nesting pairs and sites occupied by colonial breeding waterbirds at the Salton Sea, California, in 1999. Totals based on peak numbers of nesting attempts adjusted for colony desertions (see Methods).

Species	Total Nesting Pairs	Number of Sites Occupied
Cormorants		
Double-crested Cormorant	5425	8
Ardeids		
Great Blue Heron	888	18
Great Egret	165	6
Snowy Egret	170	4
Black-crowned Night-Heron	102	3
Cattle Egret	6660	2
Larids		
Laughing Gull	1	1
California Gull	40	1
Gull-billed Tern	101	2
Caspian Tern	211	1
Black Skimmer	377	3
Total	14,140	

Table 5-13. Colony sites, peak number of nest attempts, period of observed nesting activity, and nesting stage for colonial waterbirds at the Salton Sea, California, in 1999. Unless otherwise noted, all censuses represent direct nest counts performed on foot or by boat. NB = nest building, I = incubation, H = hatching, and F = fledging (see Methods).

Colony and Species	Peak Number of Nest Attempts	Nesting Activity	Nesting Stage
Johnson Street			
Double-crested Cormorant	2	22 Mar to 29 Mar	I, H
Great Blue Heron	157	12 Feb to 30 Jun	I, H, F
Great Egret	26	24 May to 30 Jun	I, H
Snowy Egret	6	24 May to 30 Jun	I, H
Black-crowned Night-Heron	77	20 May to 30 Jun	I, H
Gull-billed Tern	57[a]	15 May to 11 Jun	I, H
Black Skimmer	19[a]	15 May to 11 Jun	I
Colfax Street			
Black Skimmer	46[b]	20 Jul to 23 Aug	I, H
Bombay Beach North			
Great Blue Heron	11	17 Feb to 9 Apr	I, H
Mallard Road			
Great Blue Heron	3	9 Apr to 27 Apr	I
Ibis/South Ibis Road			
Great Blue Heron	32	29 Jan to 16 Jun	NB, I, H, F
Great Egret	6[c]	27 Mar to 10 May	NB, I
Wister			
Great Blue Heron	7	2 Apr to 16 Jun	I, H, F
Mullet Island			
Double-crested Cormorant	5425[d]	22 Jan to 27 Apr	NB, I, H, F
Great Blue Heron	37[e]	1 Feb to 16 Apr	NB, I, H, F
Morton Bay			
Great Blue Heron	1	5 May to 16 Jun	I, H, F
Alamo R. Delta			
Double-crested Cormorant	106[f]	27 Apr to 16 Jun	NB, I
Great Blue Heron	108[g]	29 Jan to 27 Apr	NB, I, H, F
Great Egret	57[h]	16 Apr to 6 Jun	I
Snowy Egret	113[h]	16 Apr to 6 Jun	I
Cattle Egret	2660[h]	16 Apr to 6 Jun	NB, I
Red Hill			
Great Blue Heron	17	21 Apr to 16 Jun	NB, I, H
Rock Hill			
Laughing Gull	1	27 May to 15 Jul	I
Gull-billed Tern	44	6 May to 25 Jul	NB, I, H, F
Caspian Tern	211	6 May to 25 Jul	NB, I, H, F
Black Skimmer	377	6 May to 9 Sep	NB, I, H, F
Obsidian Butte			
California Gull	40	16 Apr to 25 Jun	NB, I, H, F
New River East			
Double-crested Cormorant	2	18 Apr to 13 Jul	NB, I, H, F
Great Blue Heron	55	14 Apr to 13 Jul	NB, I, H, F

Table 5-13. Continued.

Colony and Species	Peak Number of Nest Attempts	Nesting Activity	Nesting Stage
New River Delta			
Double-crested Cormorant	26[i, j]	2 Mar to 16 Apr	NB
Great Blue Heron	484[i, j]	2 Mar to 16 Apr	NB, I, H
Great Egret	5[i, j]	3 Apr to 16 Apr	I
New River West			
Double-crested Cormorant	2	16 Jun	I
Great Blue Heron	28	14 Apr to 16 Jul	I, H, F
Trifolium 1 West			
Great Blue Heron	114	3 Feb to 16 Jul	NB, I, H, F
Poe Road			
Double-crested Cormorant	13	28 Apr to 16 Jul	NB, I, H
Great Blue Heron	10	30 Mar to 16 Jul	NB, I, H
San Felipe Creek South			
Great Blue Heron	6	27 May to 3 Aug	I, H, F
Test Base			
Great Blue Heron	28	16 Feb to 2 Jul	NB, I, H, F
81st Avenue South			
Great Blue Heron	2	22 Mar to 30 Jun	I, H, F
76th Avenue			
Great Blue Heron	139	12 Feb to 30 Jun	NB, I, H, F
Great Egret	82	22 Mar to 30 Jun	NB, I
Snowy Egret	48	24 May to 30 Jun	I, H
Black-crowned Night-Heron	23	30 Jun	I
Ramer Lake			
Double-crested Cormorant	18[k]	6 May to 14 May	NB, I
Great Egret	51[k]	6 May to 14 May	NB, I
Westmorland Eucalyptus Grove			
Snowy Egret	3	8 Jul	F
Cattle Egret	4000	8 Jul	F
Black-crowned Night-Heron	2	8 Jul	F

[a] Nesting attempts were abandoned by 11 June, before hatching and/or fledging.

[b] Colony abandoned by 23 Aug.

[c] Colony abandoned by 10 May.

[d] Direct count derived from aerial photos taken on 19 Feb.

[e] Estimate derived from aerial photos taken on 16 Apr.

[f] Direct count derived from 27 May photos.

[g] Includes nests from all blinds in vicinity.

[h] Calculated from aerial photo counts (28 May) of adult white egrets using following ratios derived from 16 June boat survey: Great (2%), Snowy (4%), and Cattle(94%).

[i] Direct count derived from aerial photos taken on 3 Apr.

[j] Colony abandoned by 16 Apr.

[k] Colony abandoned by 16 May.

Table 5-14. Nest success for three Great Blue Heron colonies at the Salton Sea, California, in 1999.

Colony	Nests Monitored	Nests with Known Outcome	Successful Nests	% Success	Observation Period
Johnson Street	30	30	15	50	7 Mar to 15 May
76th Avenue	26	24	16	67	7 Mar to 6 May
New River East	43	43	37	86	8 May to 13 Jul

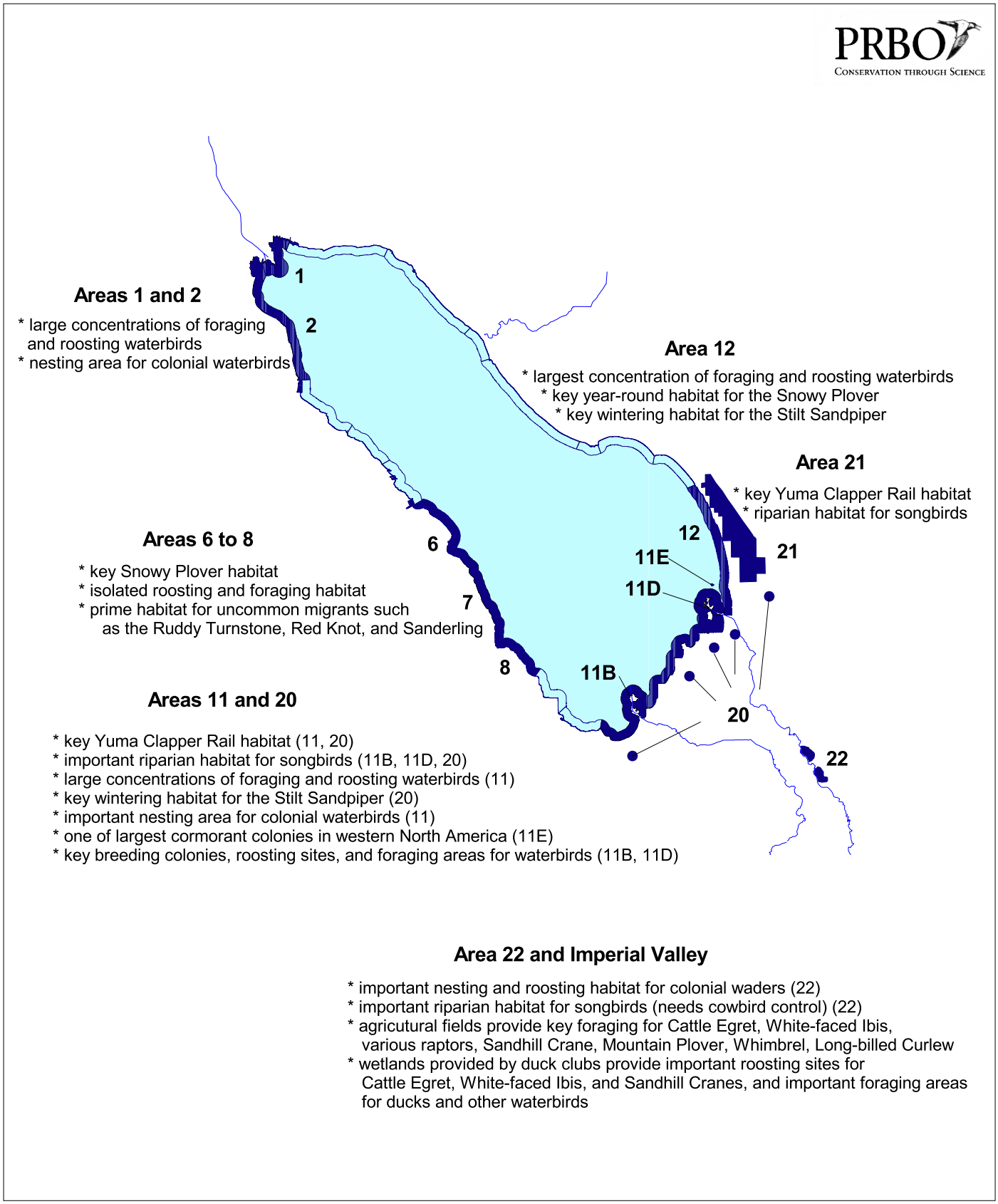

Figure 2 - 1. Areas of particular importance to birds at the Salton Sea.

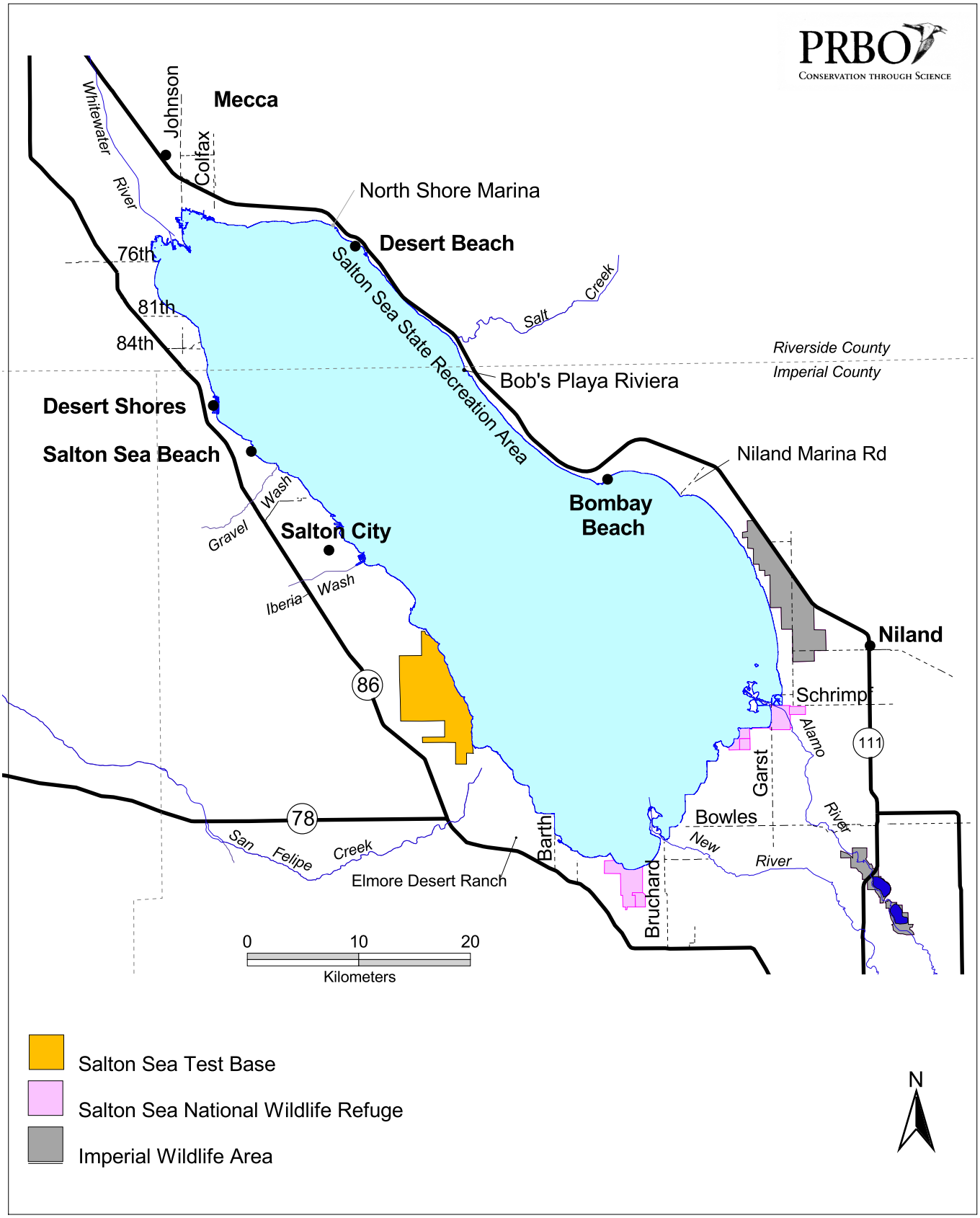

Figure 4 - 1. Overview map of the Salton Sea, California, and vicinity.

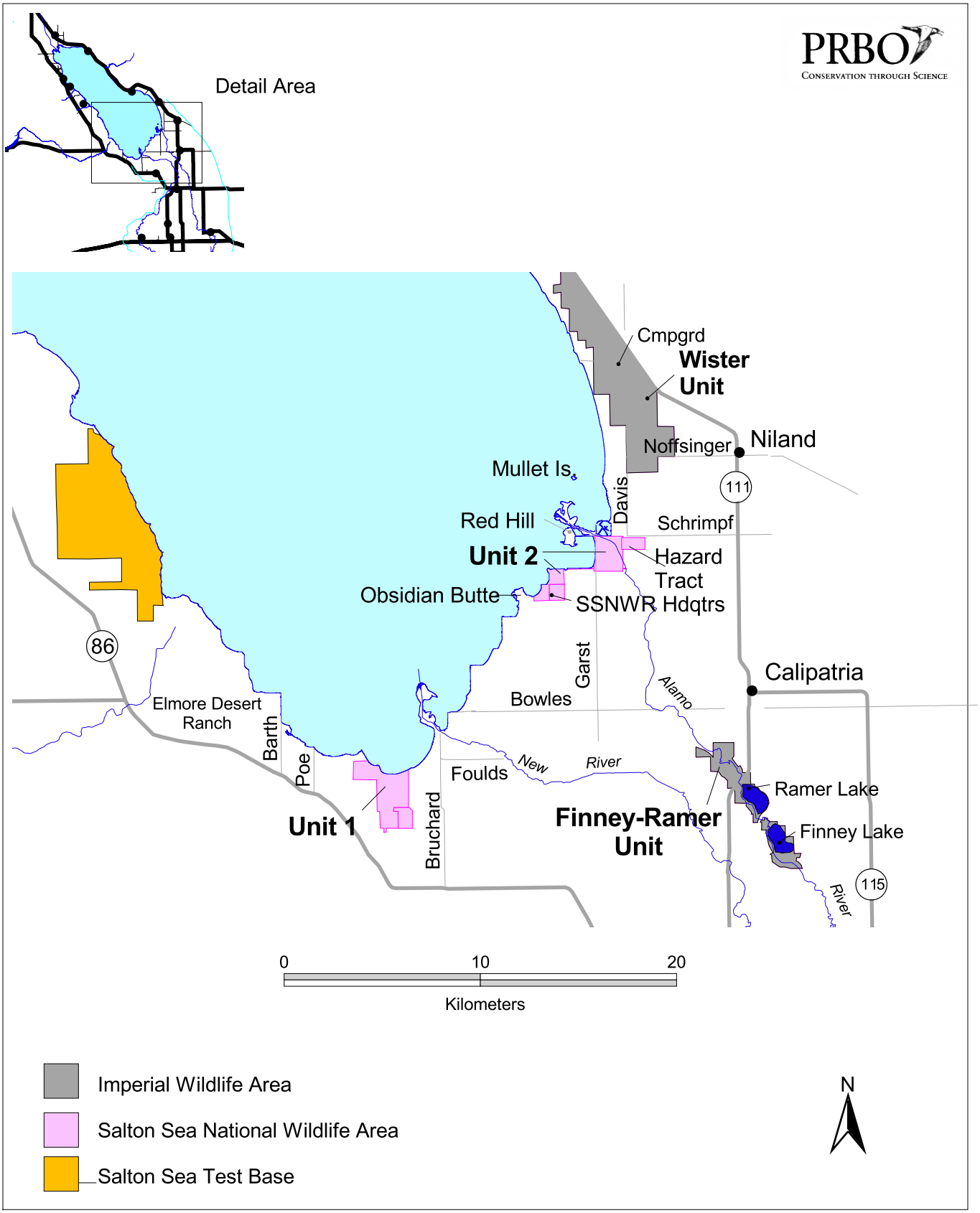

Figure 4 - 2. Map detail of the south end of the Salton Sea and adjacent portion of the Imperial Valley, California.

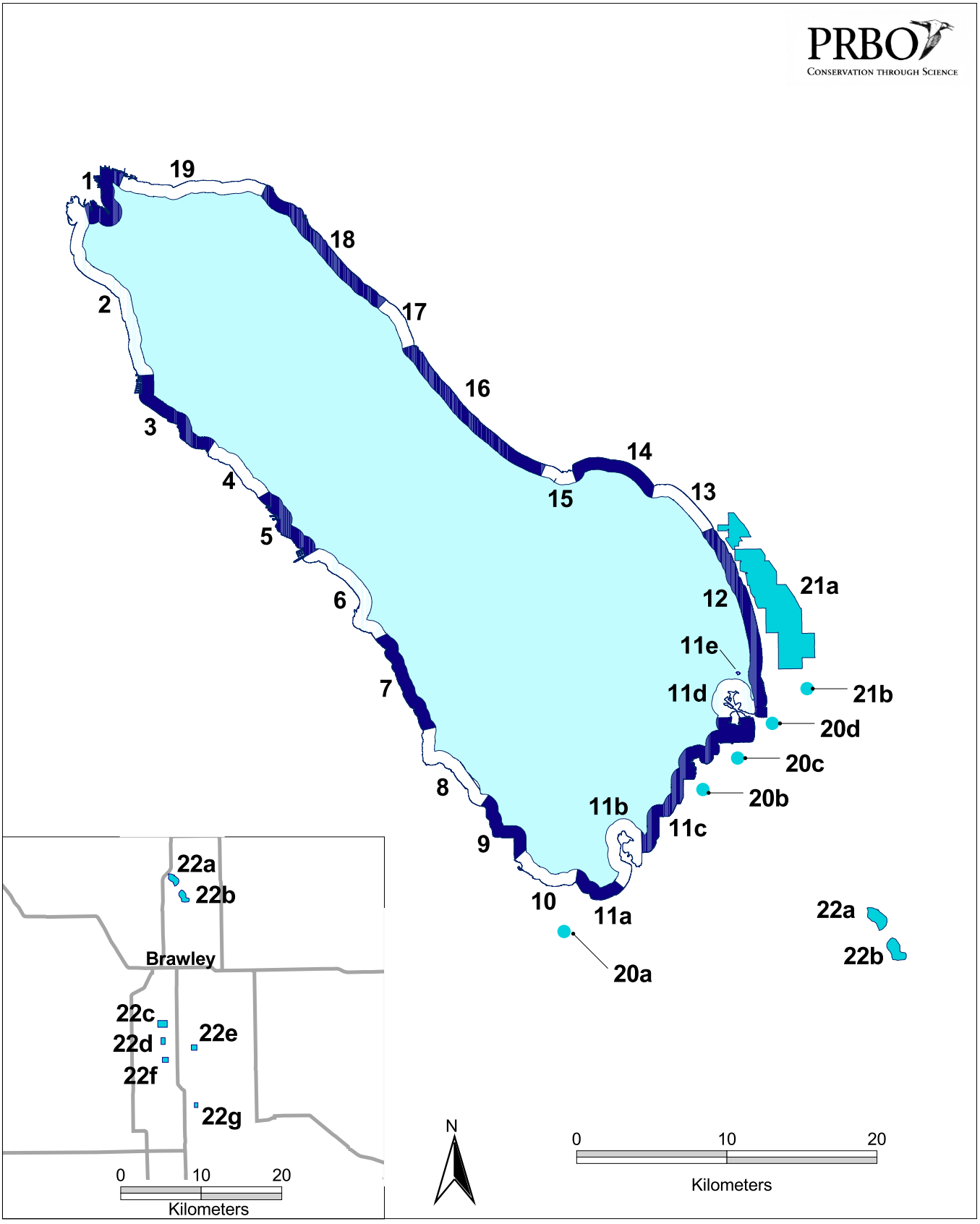

Figure 4 - 3. Numbered areas of the shoreline and inshore zone of the Salton Sea, California, and adjacent freshwater impoundments. Inset shows locations of duck clubs, near Brawley in the Imperial Valley, also used as roost sites by wading birds. See Methods for descriptions of areas and area boundaries.

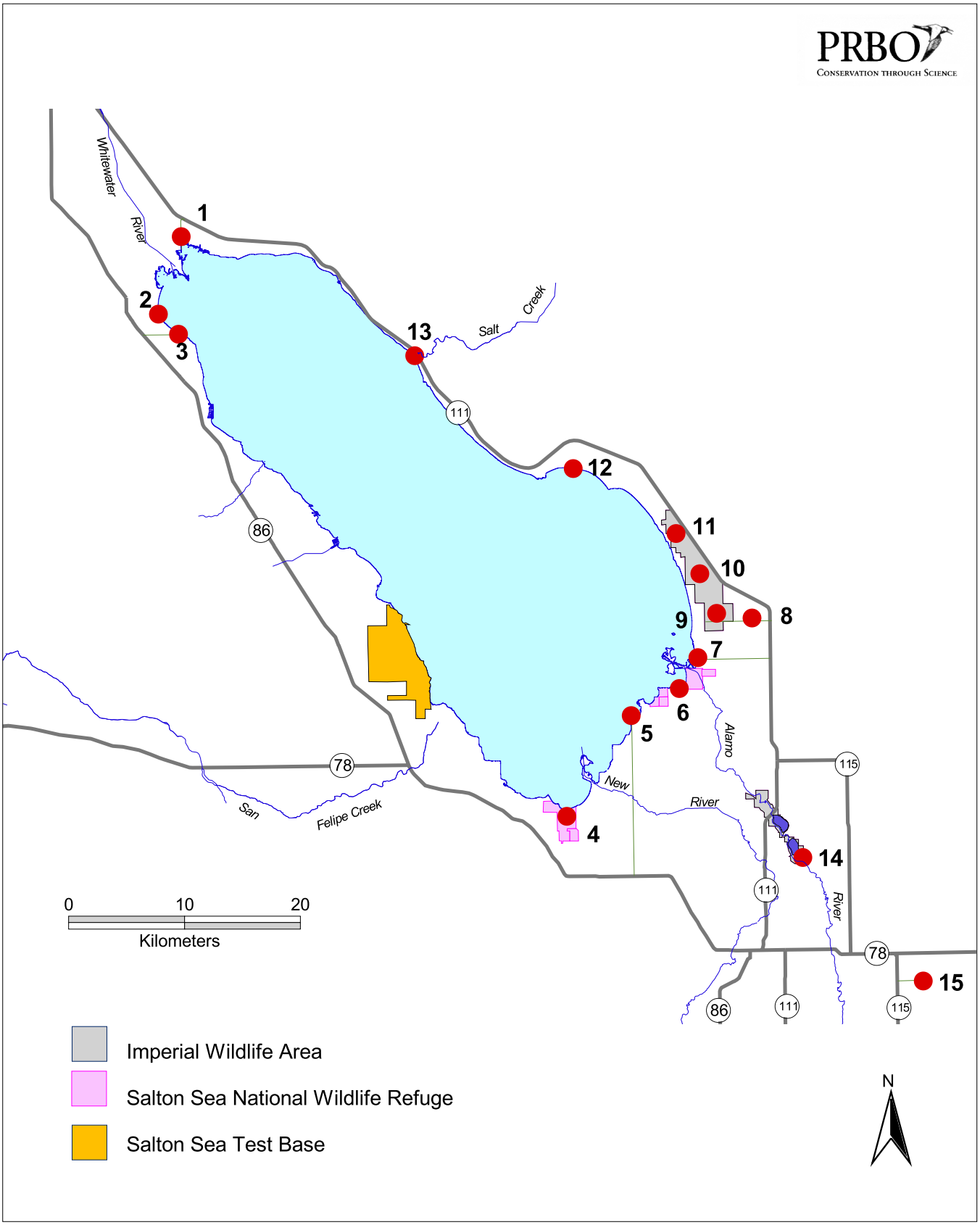

Figure 4 - 4. Distribution of Yuma Clapper Rails at the Salton Sea, California, and vicinity in 1999. See Table 5 - 8 for numbers at specific sites and for comparisons to prior years.

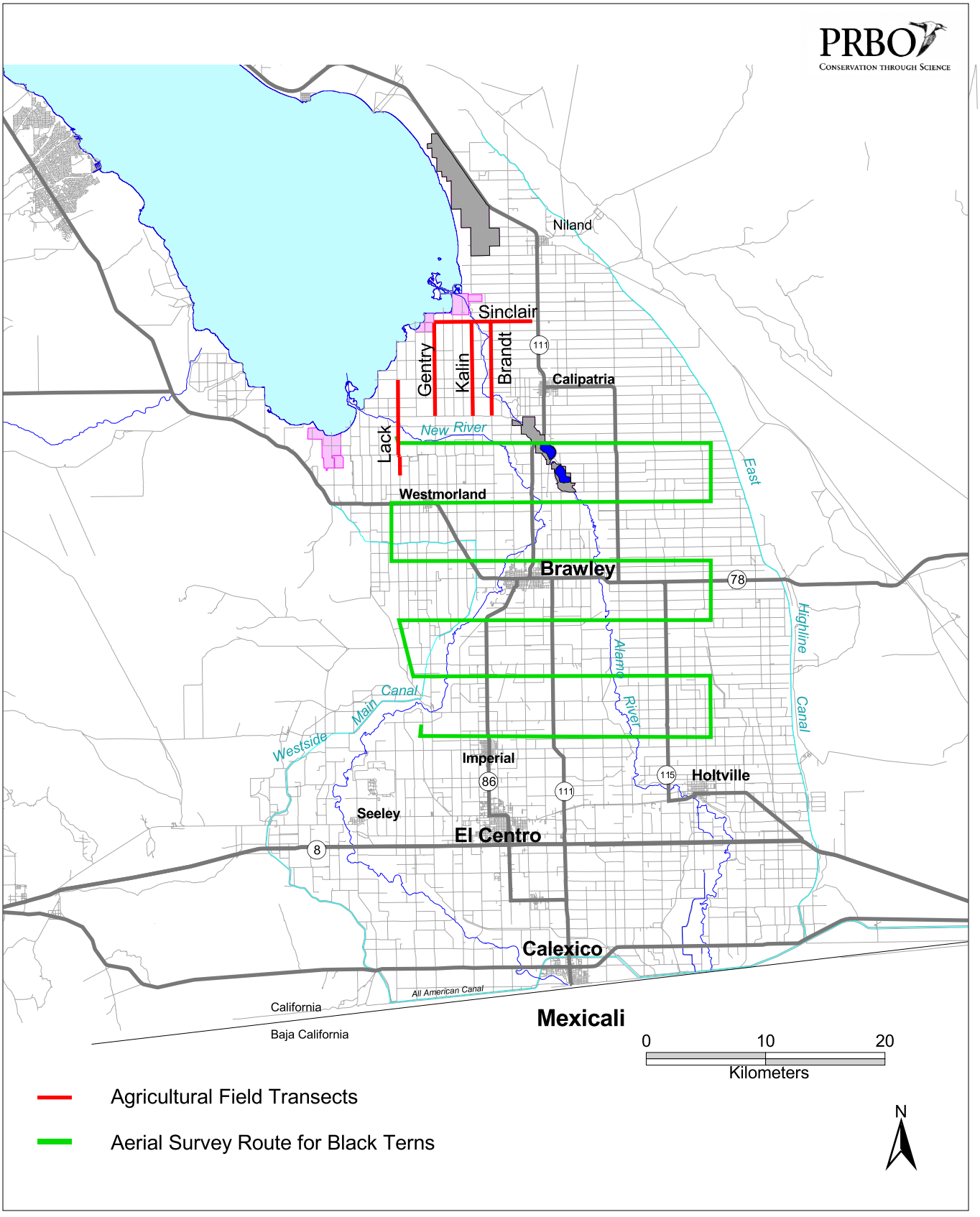

Figure 4 - 5. Overview map of the Imperial Valley, California, showing the location of roadside transects of agricultural fields and aerial survey route for Black Terns in 1999.

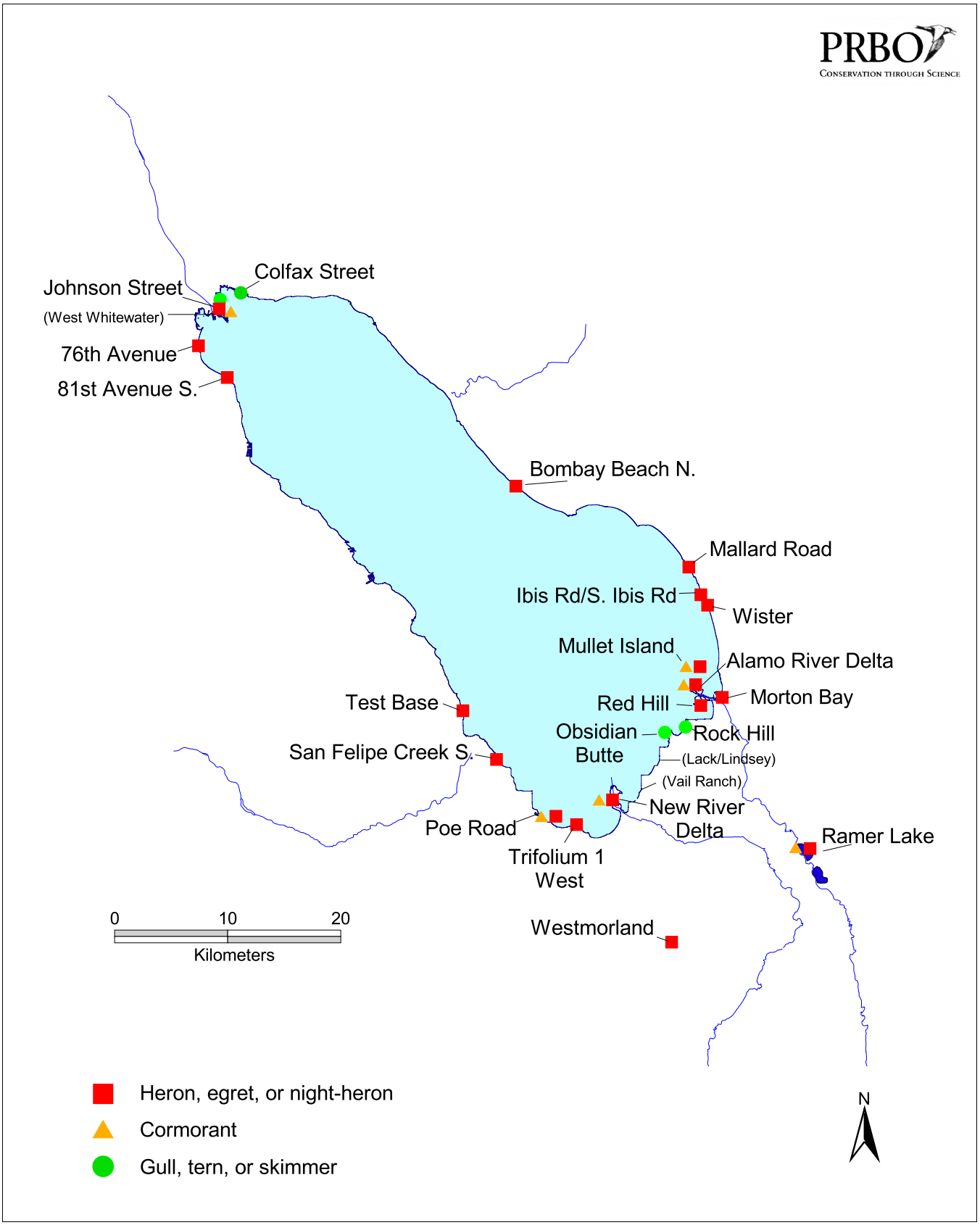

Figure 4 - 6. Location of nesting colonies of cormorants, ardeids (herons, egrets and night-herons), and larids (gulls, terns and skimmers), at the Salton Sea, California, in 1999. Arboreal sites previously used but unoccupied in 1999 are listed in parentheses. New River Delta includes three sites associated with that area (see Table 5 - 13).

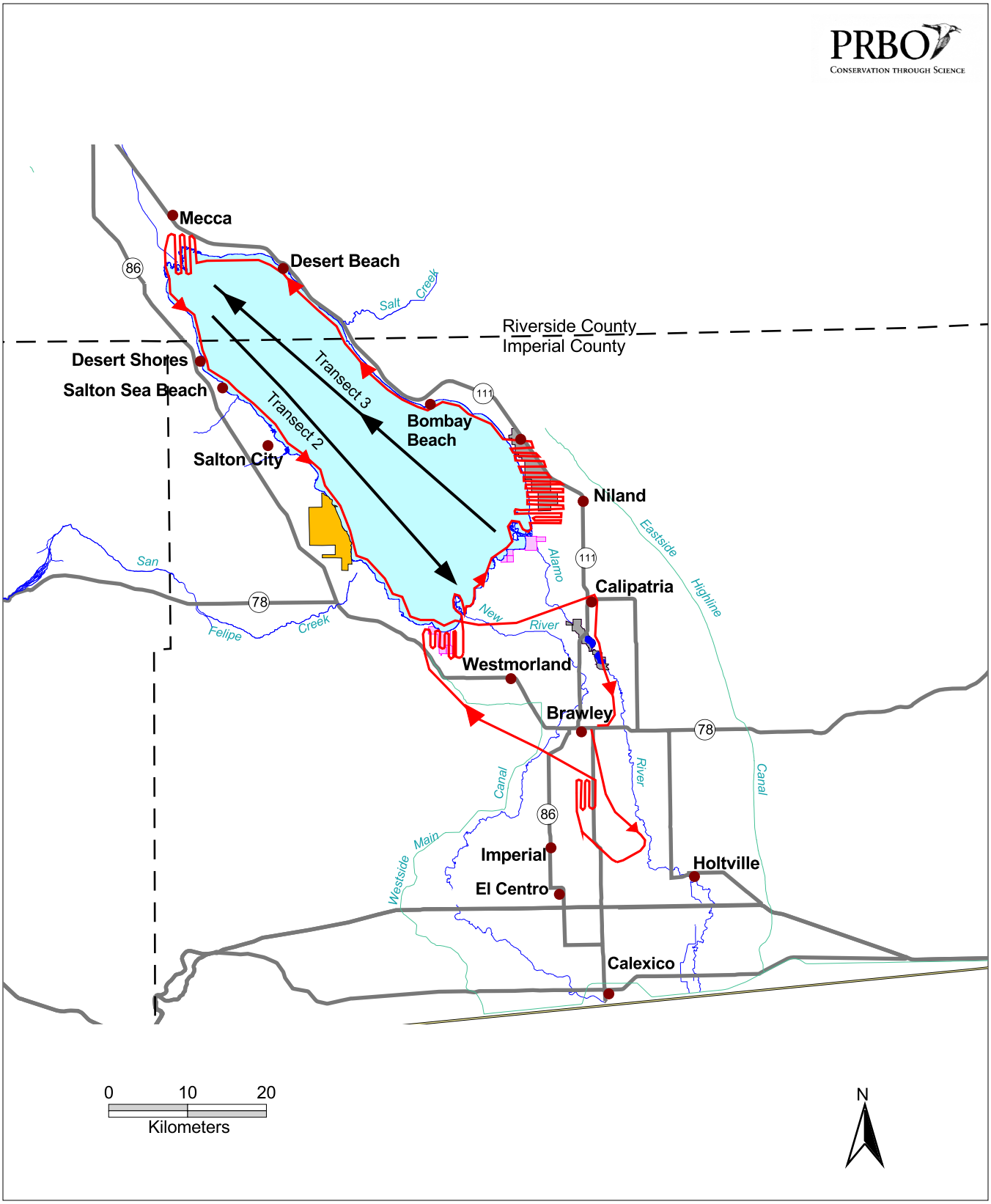

Figure 4 - 7. Aerial survey routes at the Salton Sea, California, in 1999. Aerial waterfowl surveys were initiated in the Imperial Valley then followed a counterclockwise route around the shoreline and inshore zone of the Sea, briefly interrupted by multiple transects over adjacent freshwater wetlands. Aerial surveys of pelicans and cormorants were confined to the Salton Sea but otherwise followed a nearly identical route to that of waterfowl surveys. Aerial surveys for Eared Grebes and other diving waterbirds covered a single circumnavigation of the inshore zone (transect 1) and two lengthwise transects of the offshore zone (transects 2 and 3).

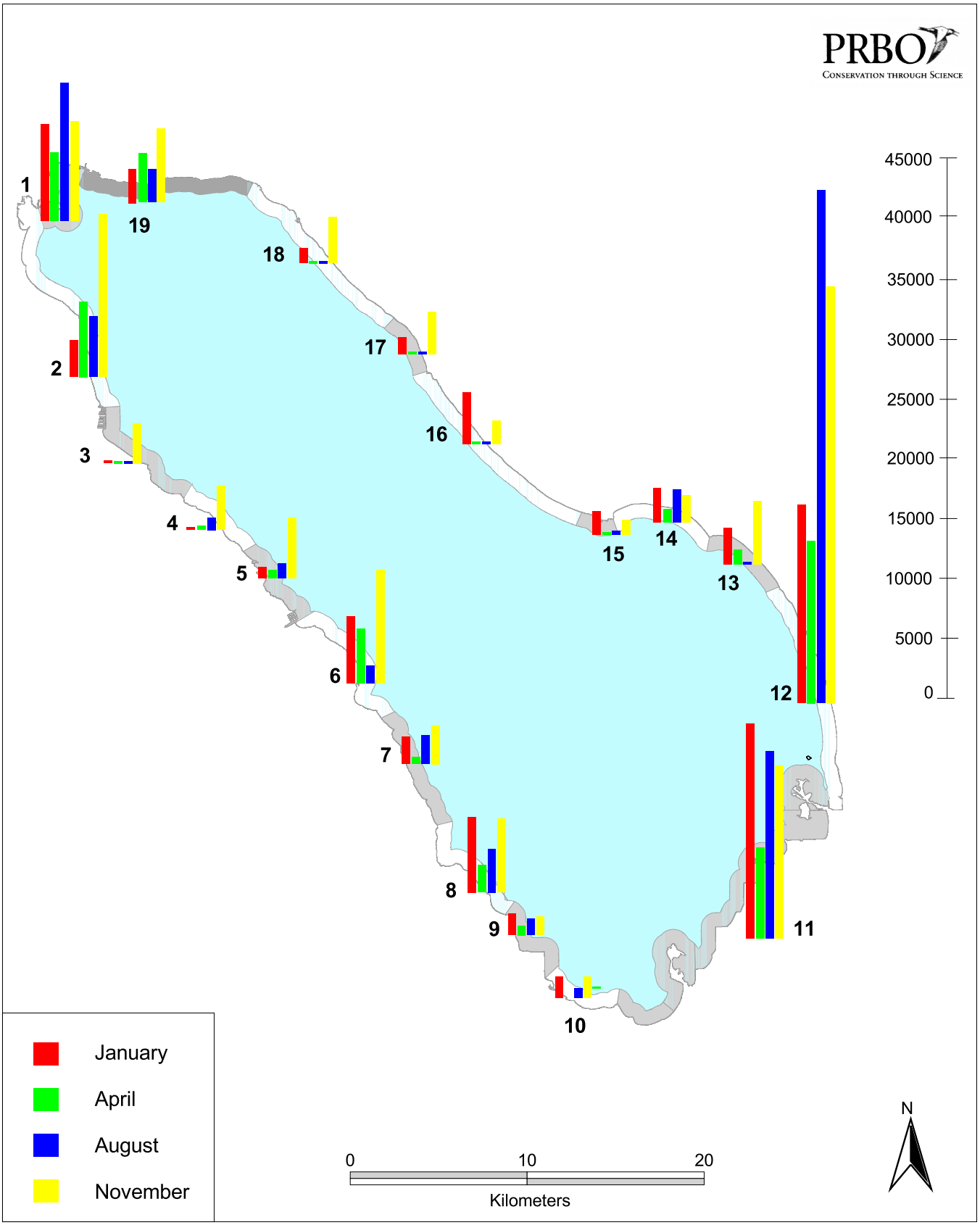

Figure 5 - 1a. Comparison of the total numbers of all waterbirds within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999.

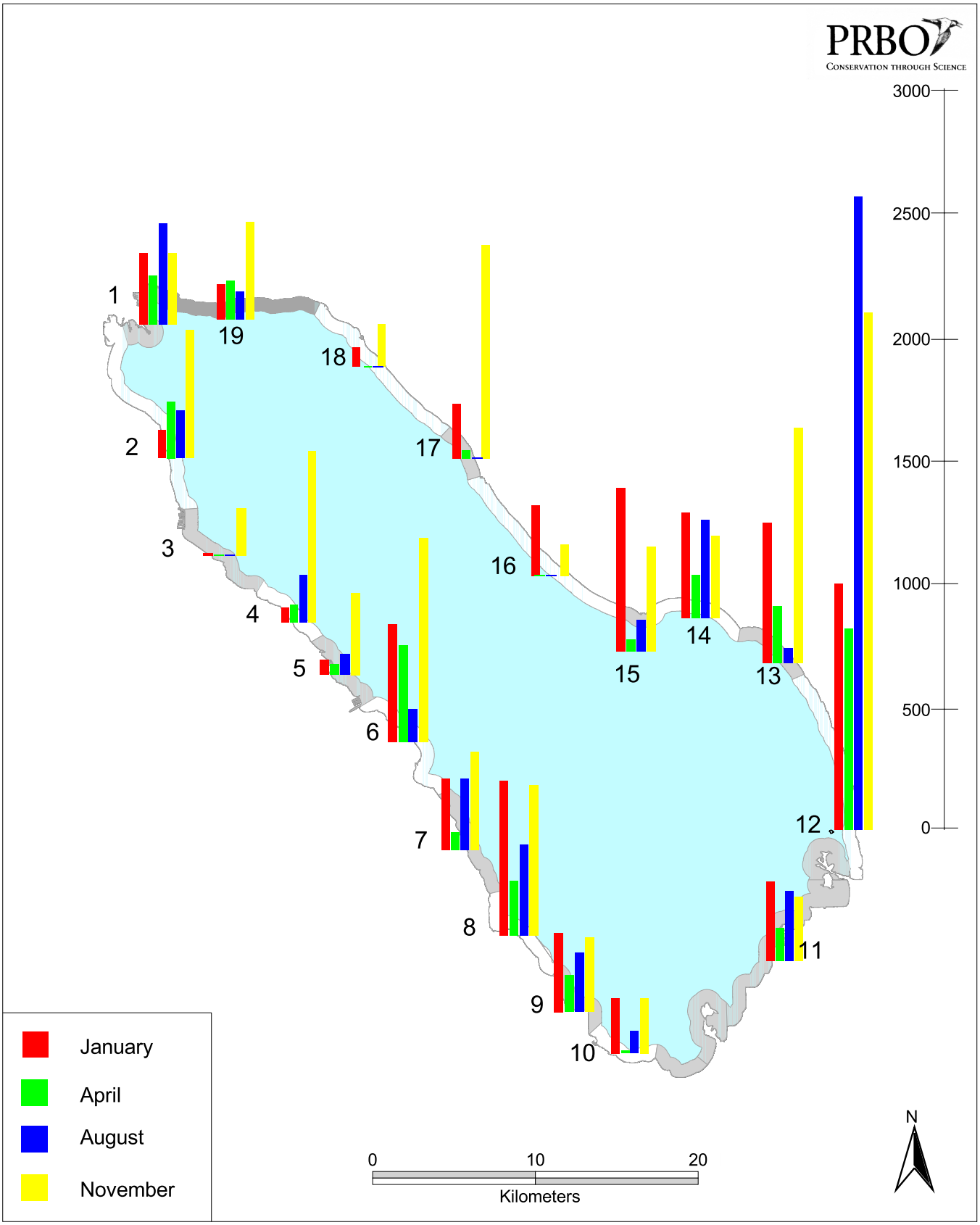

Figure 5 - 1b. Comparison of density (individuals/km) of waterbirds within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999.

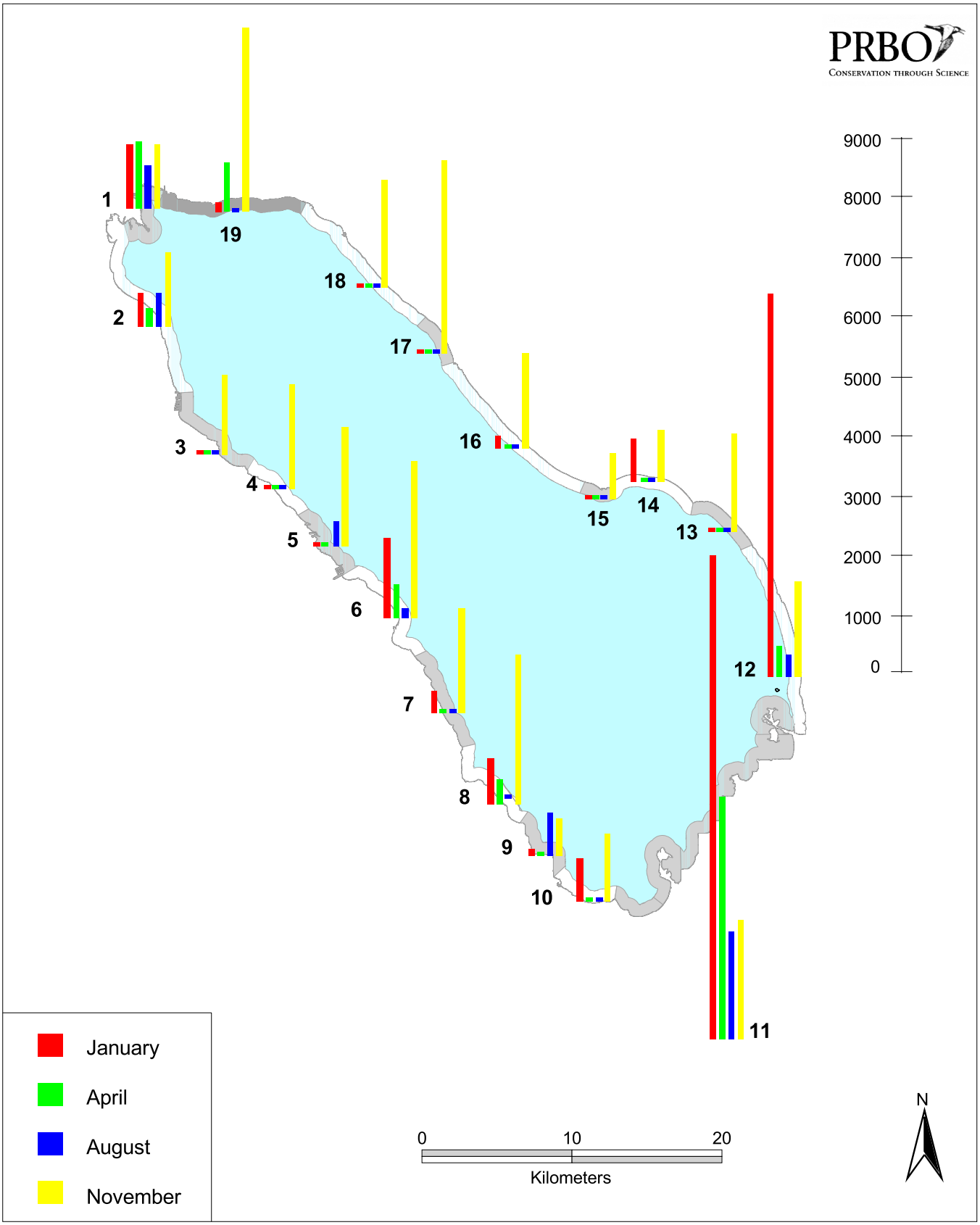

Figure 5 - 2a. Comparison of the total numbers of pelecaniformes (pelicans and cormorants) within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999.

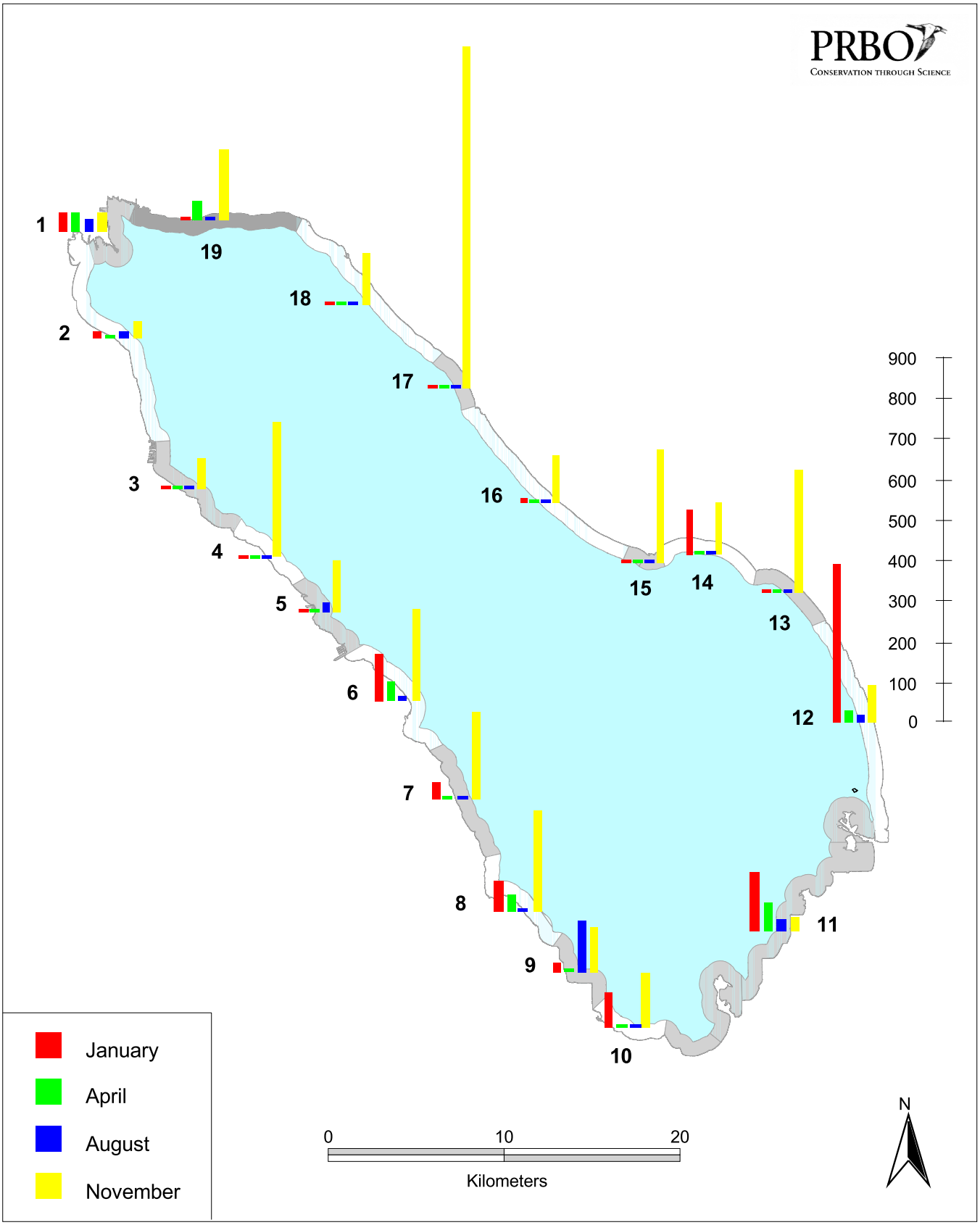

Figure 5 - 2b. Comparison of the density (individuals/km) of all pelecaniformes (pelicans and cormorants) within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999.

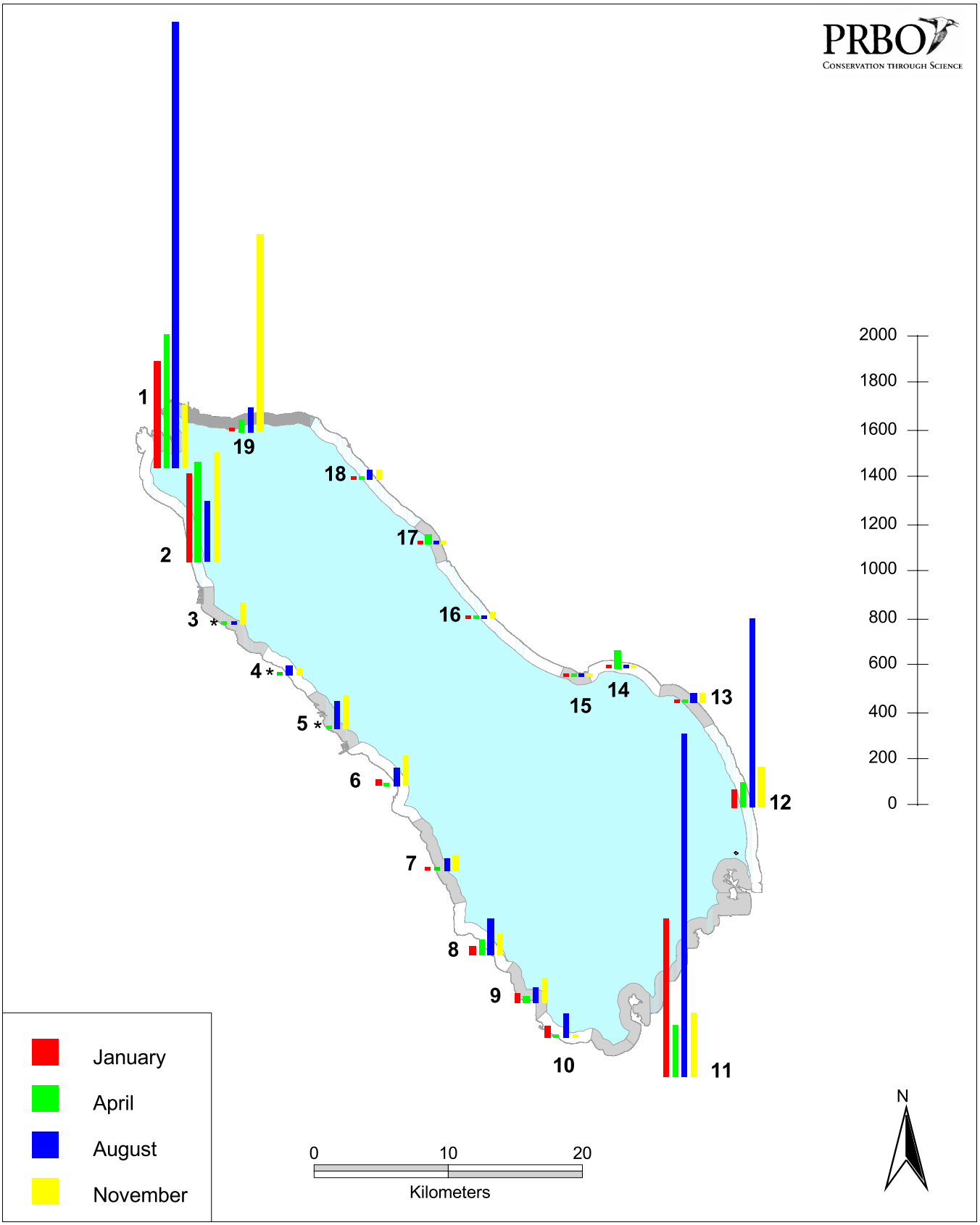

Figure 5 - 3a. Comparison of the total numbers of wading birds (herons, egrets, ibis, storks) within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999. * = no survey data for January.

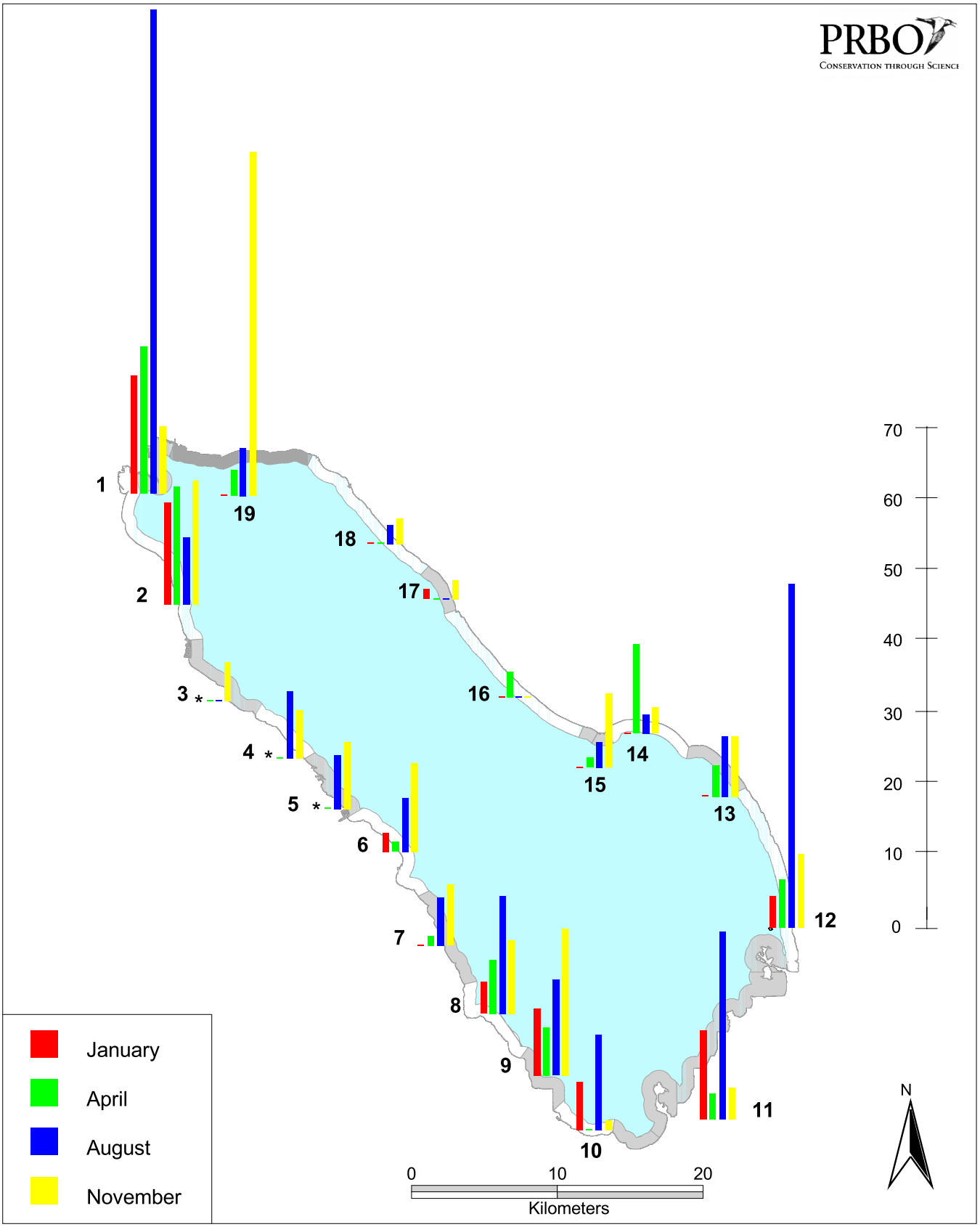

Figure 5 - 3b. Comparison of the density (individuals/km) of all wading birds (herons, egrets, ibis, storks) within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999. * = no survey data for January.

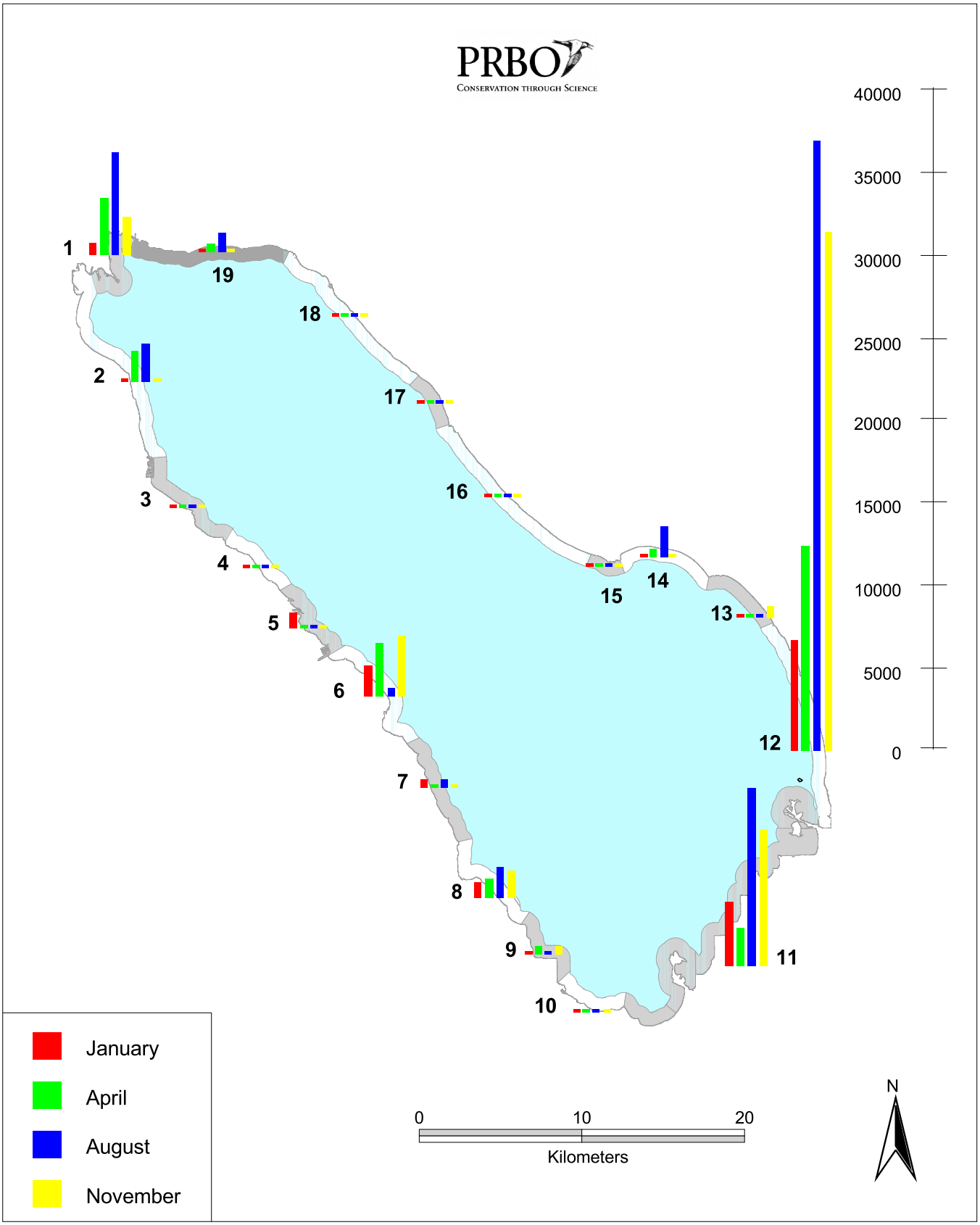

Figure 5 - 4a. Comparison of total number of all shorebirds within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999.

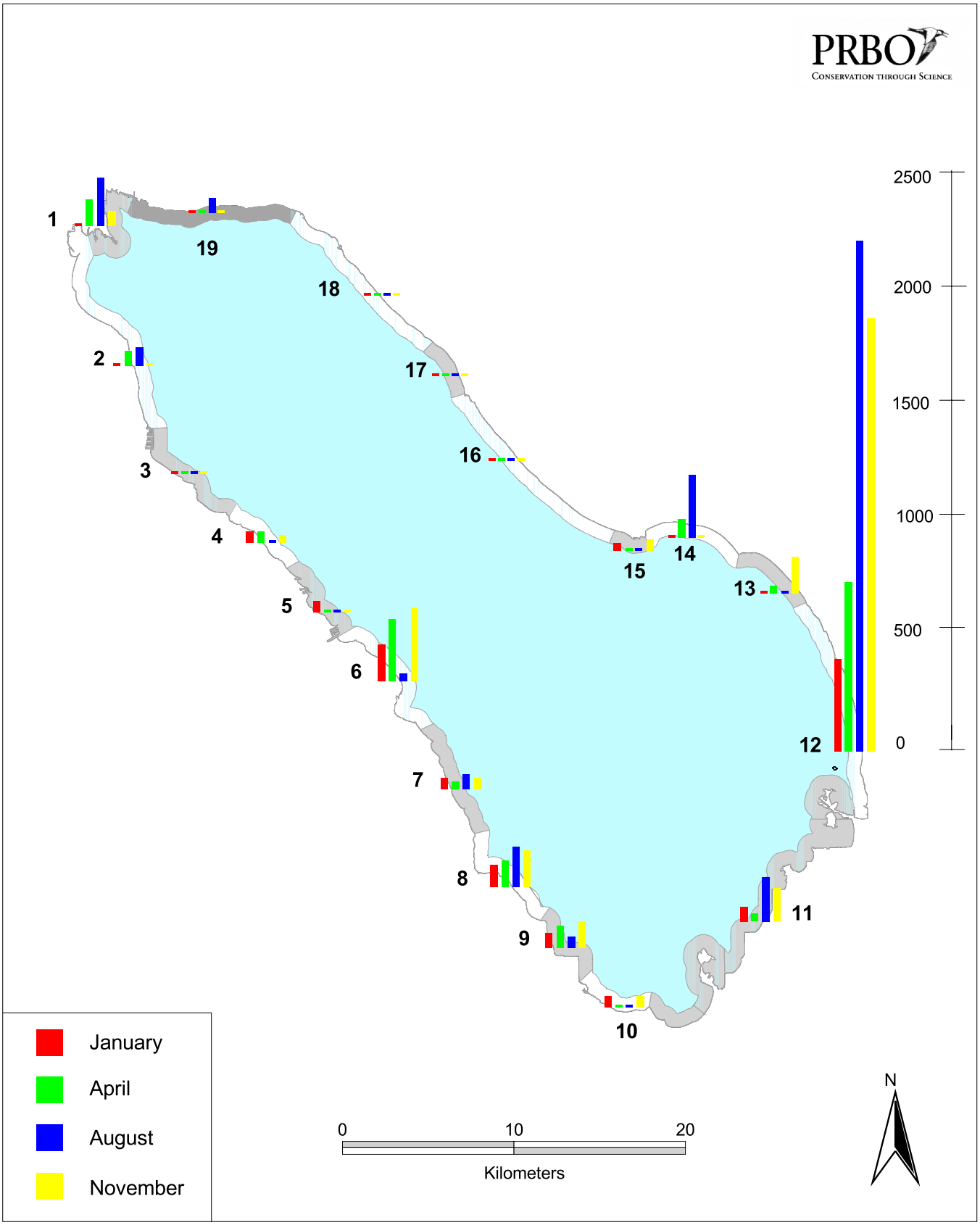

Figure 5 - 4b. Comparison of the density (individuals/km) of all shorebirds within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999.

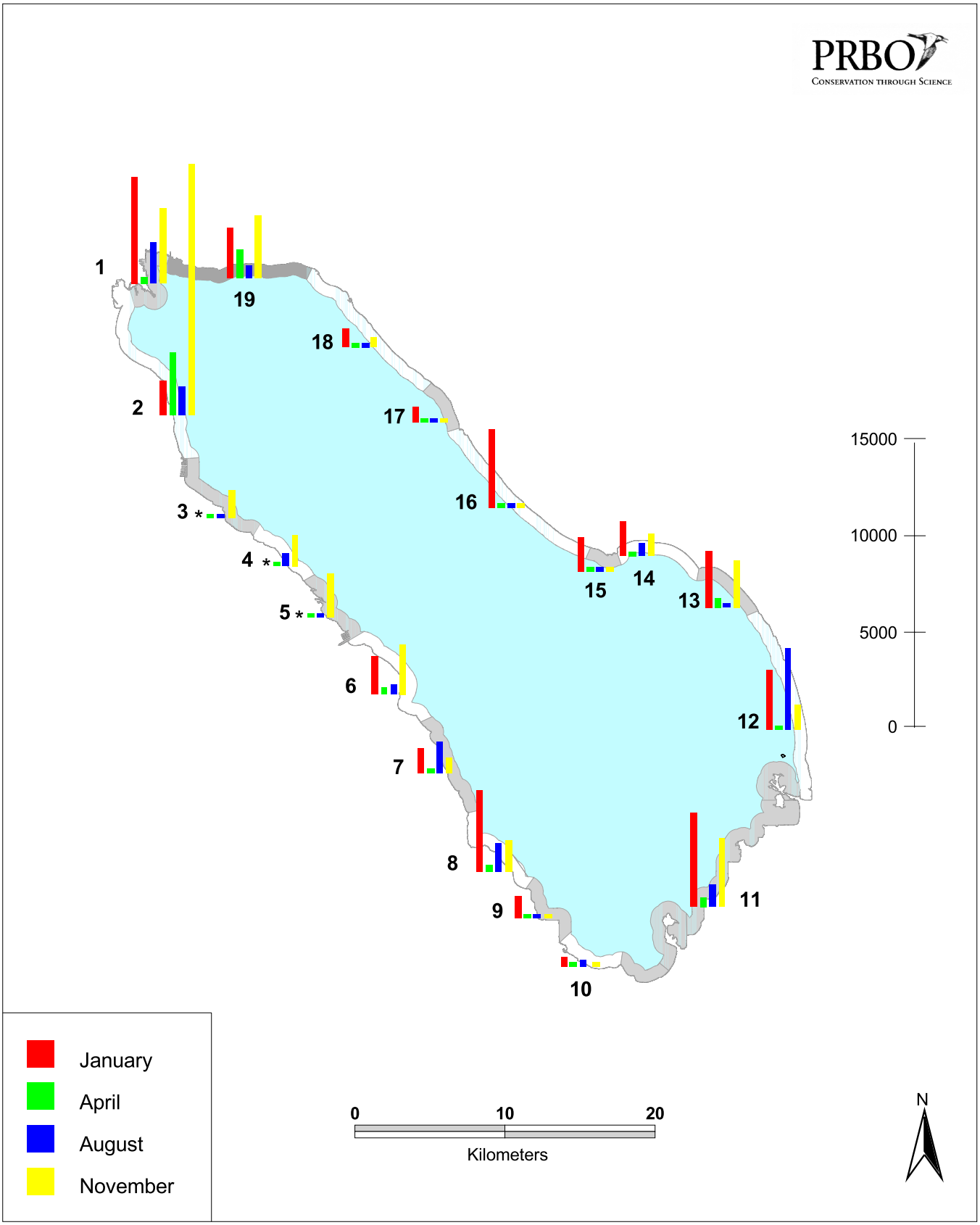

Figure 5 - 5a. Comparison of the total numbers of gulls and terns within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999. * = no survey data for January.

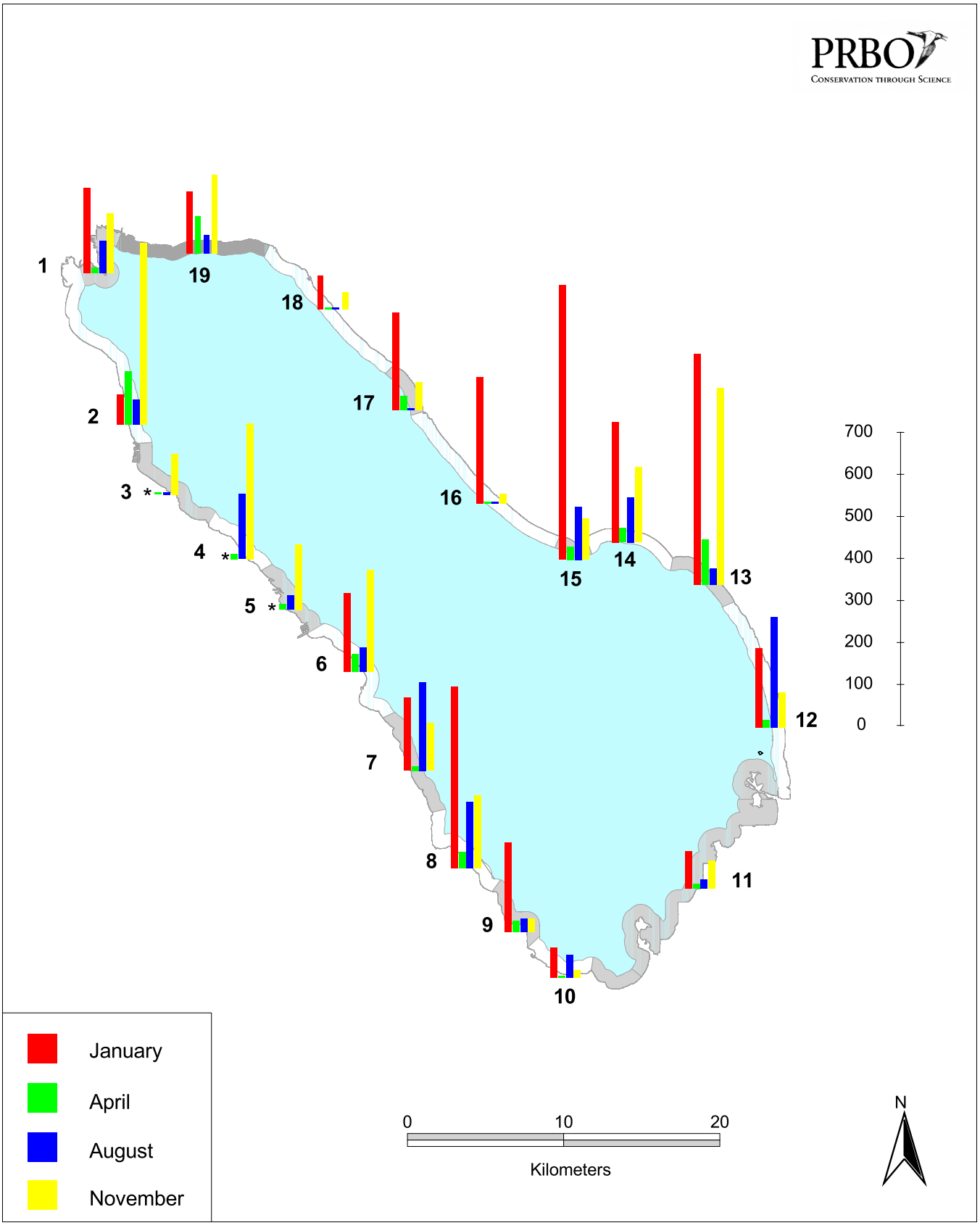

Figure 5 - 5b. Comparison of the density (individuals/km) of all gulls and terns within 19 shoreline segments for four comprehensive surveys of the Salton Sea, California, in 1999. * = no survey data for January.

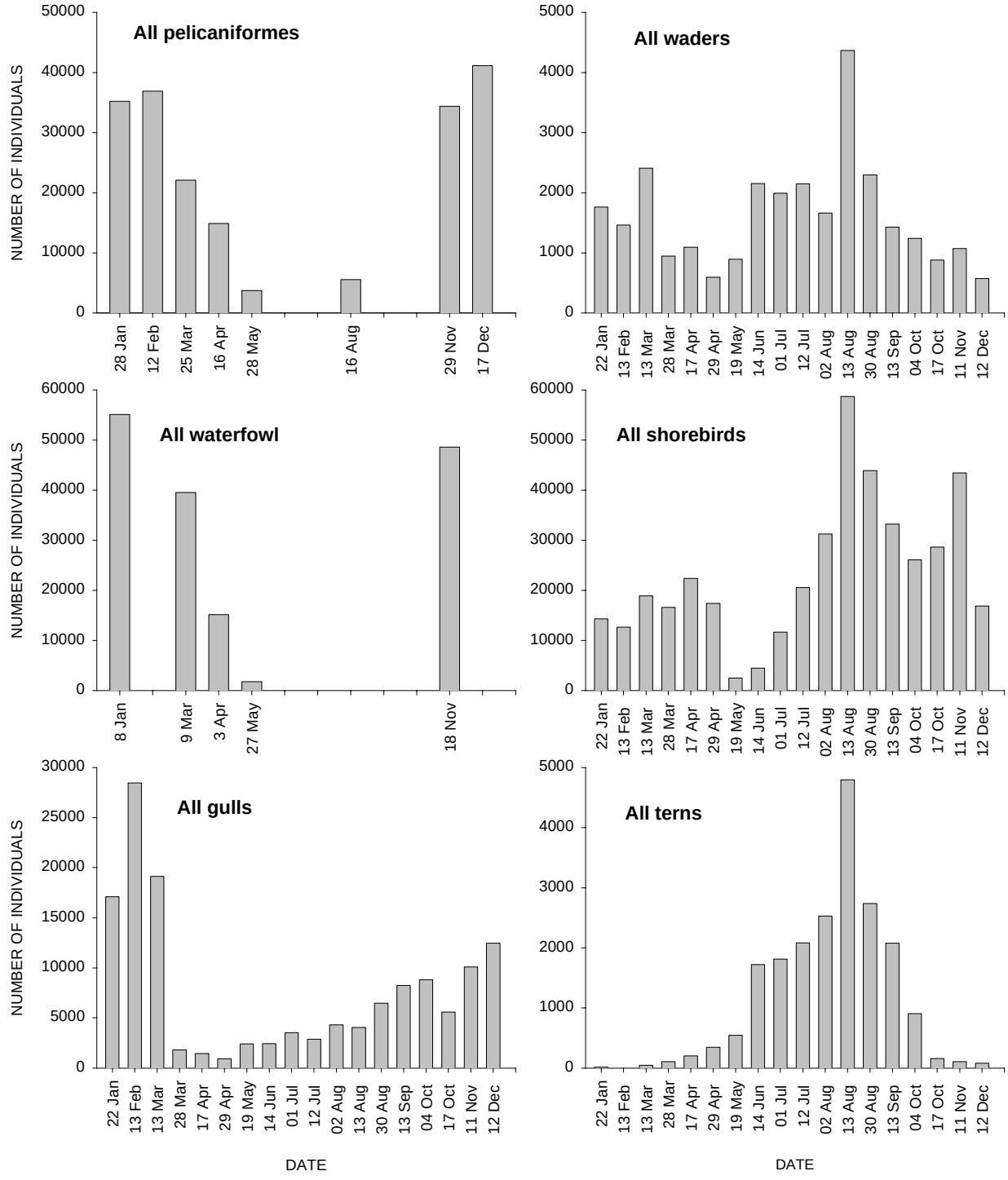

Figure 5-6a. Phenology of all pelicaniformes (pelicans and cormorants), all waders (herons, egrets, ibis, storks), all waterfowl, all shorebirds, all gulls, and all terns at the Salton Sea, California, in 1999. Data for most groups from 18 ground surveys of 5 areas of shoreline and freshwater ponds, whereas data for pelicaniformes and waterfowl from 8 and 5 aerial surveys, respectively, for the entire Sea (waterfowl surveys also covered wetlands in the Imperial Valley) (see Methods).

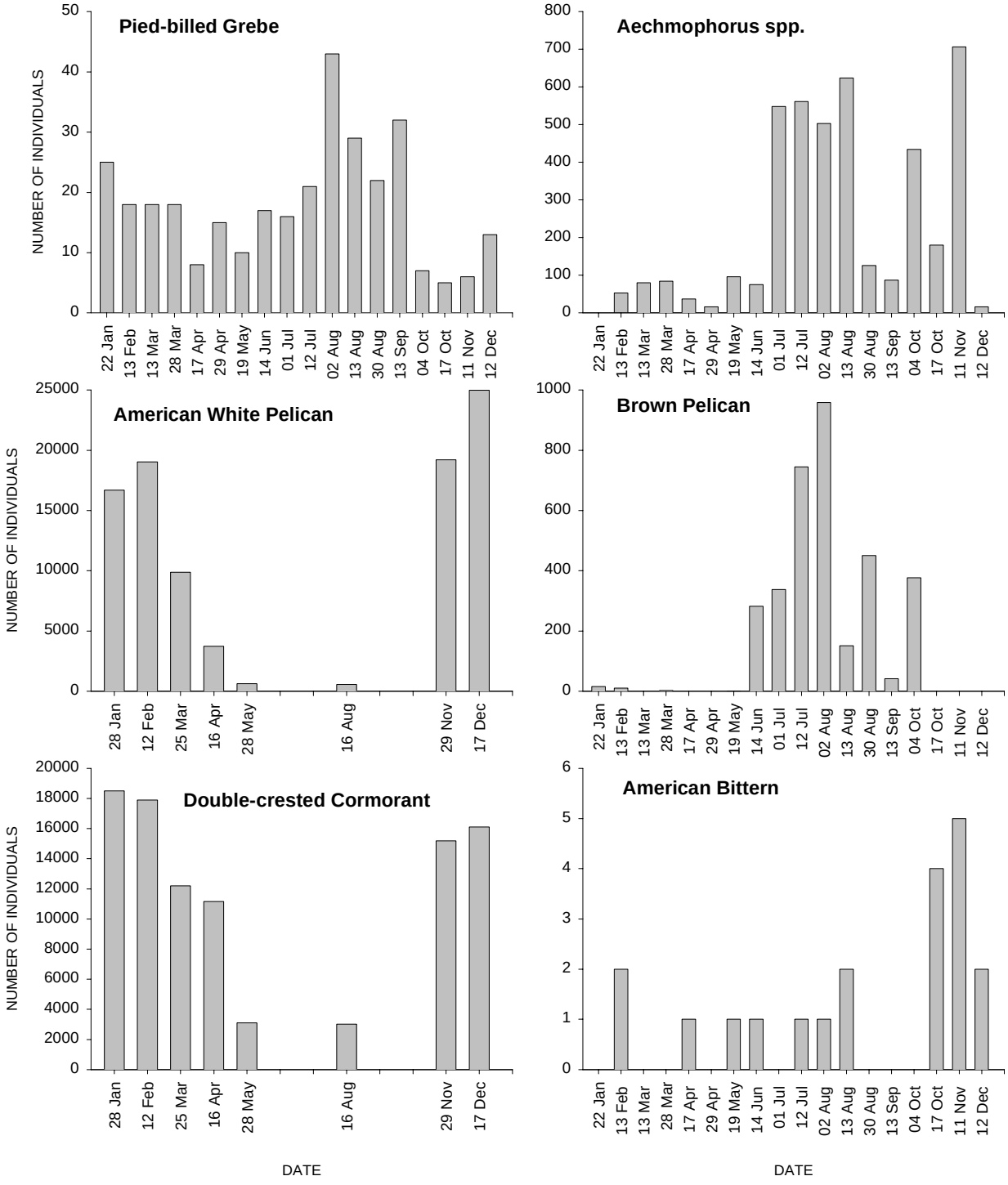

Figure 5-6b. Phenology of the Pied-billed Grebe, large grebes *(Aechmophorus* spp.), American White Pelican, Brown Pelican, Double-crested Cormorant, and American Bittern at the Salton Sea, California, in 1999. Data for American White Pelican and Double-crested Cormorant from 8 aerial surveys and for all other species from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

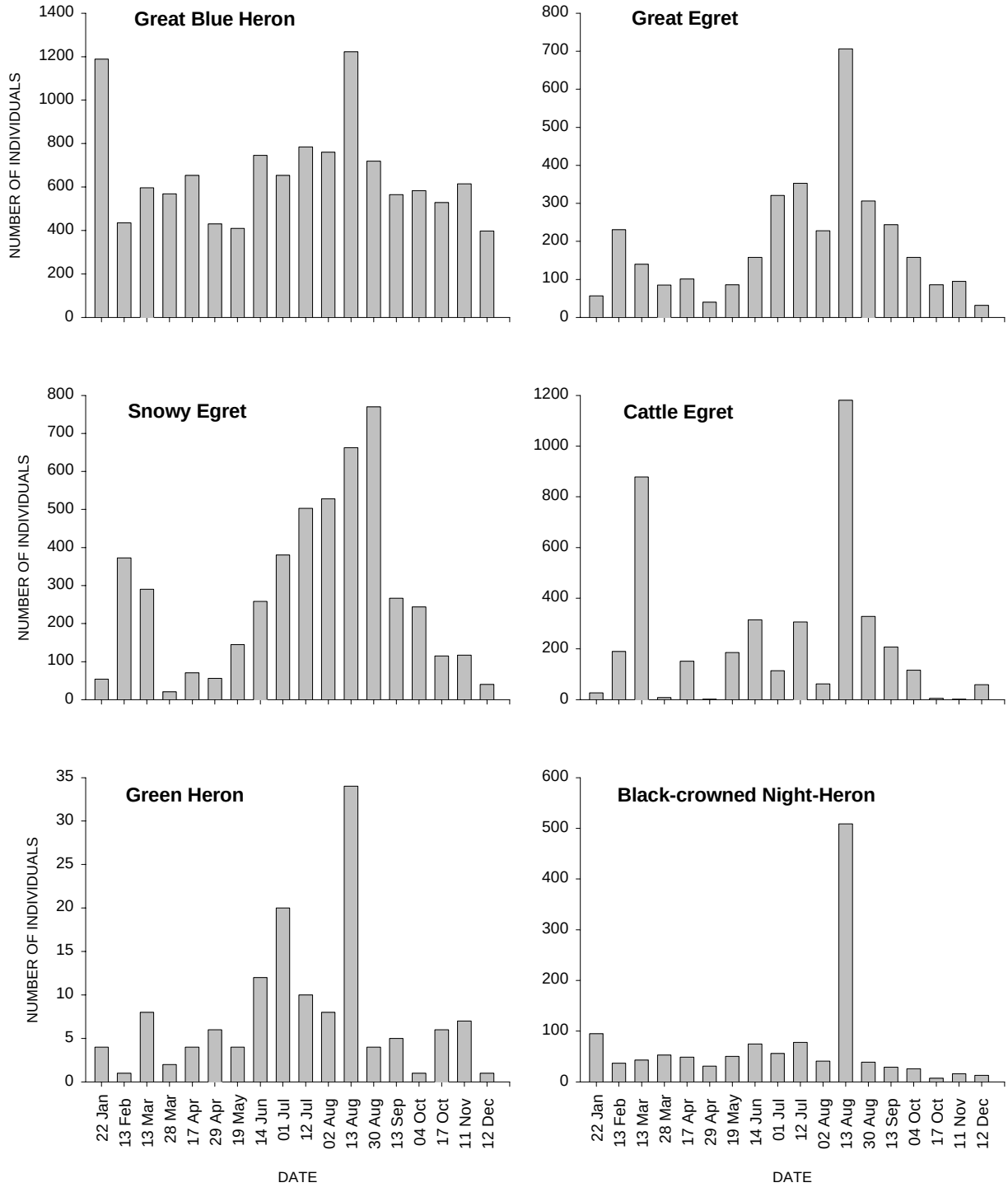

Figure 5-6c. Phenology of the Great Blue Heron, Great Egret, Snowy Egret, and Cattle Egret, Green Heron, and Black-crowned Night-Heron at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

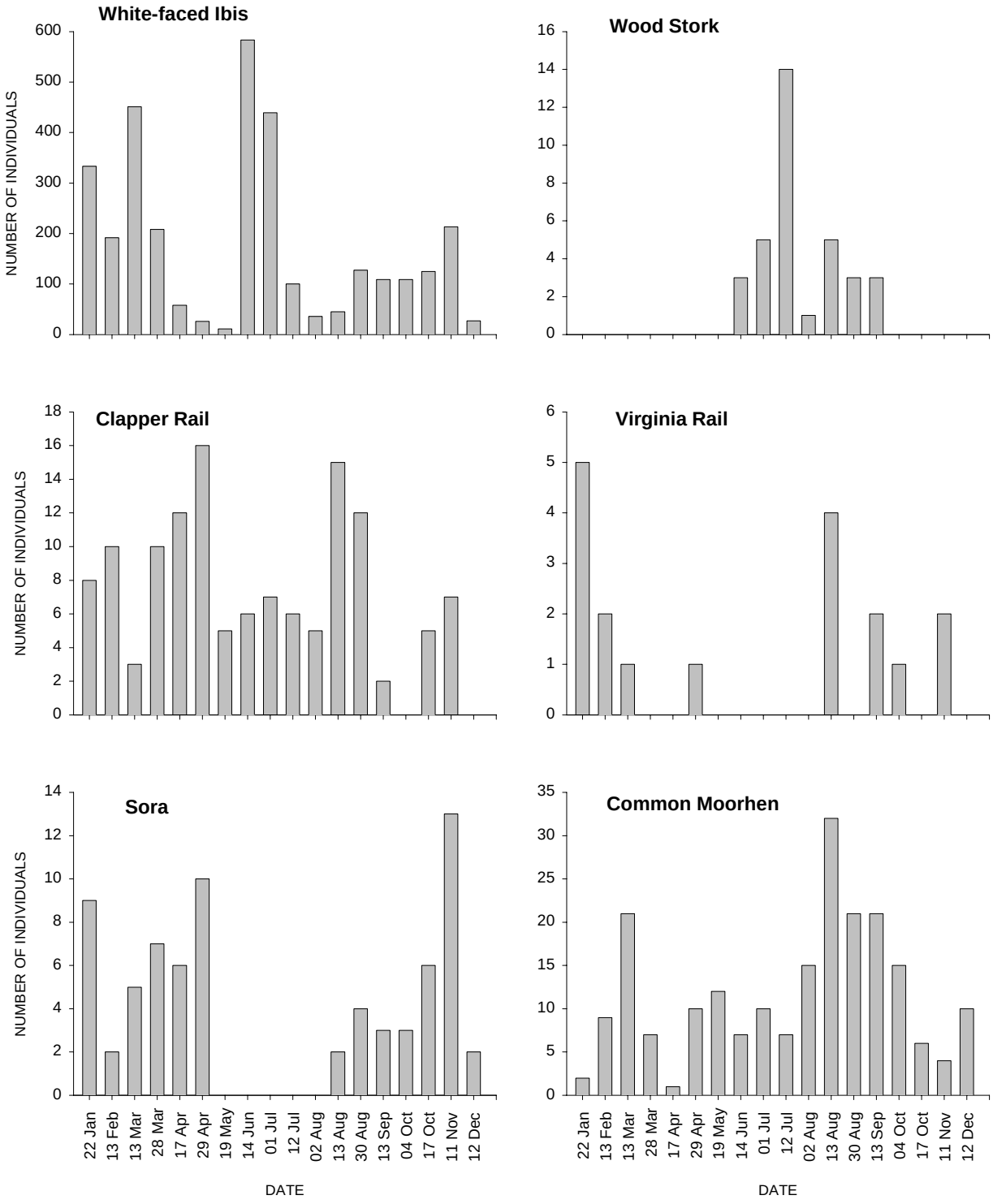

Figure 5-6d. Phenology of the White-faced Ibis, Wood Stork, and four species of rails at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

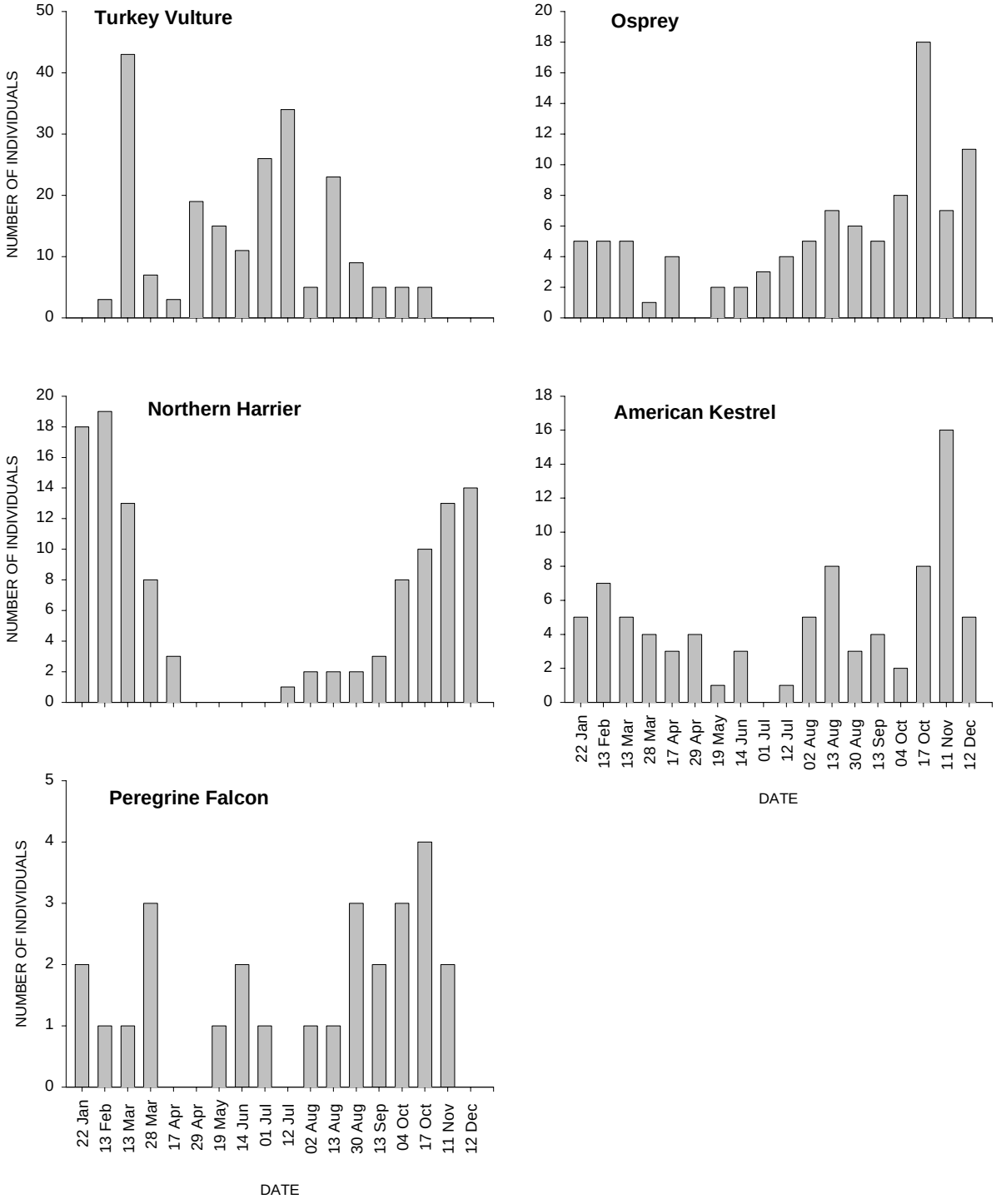

Figure 5-6e. Phenology of the Turkey Vulture, Osprey, Northern Harrier, American Kestrel, and Peregrine Falcon at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

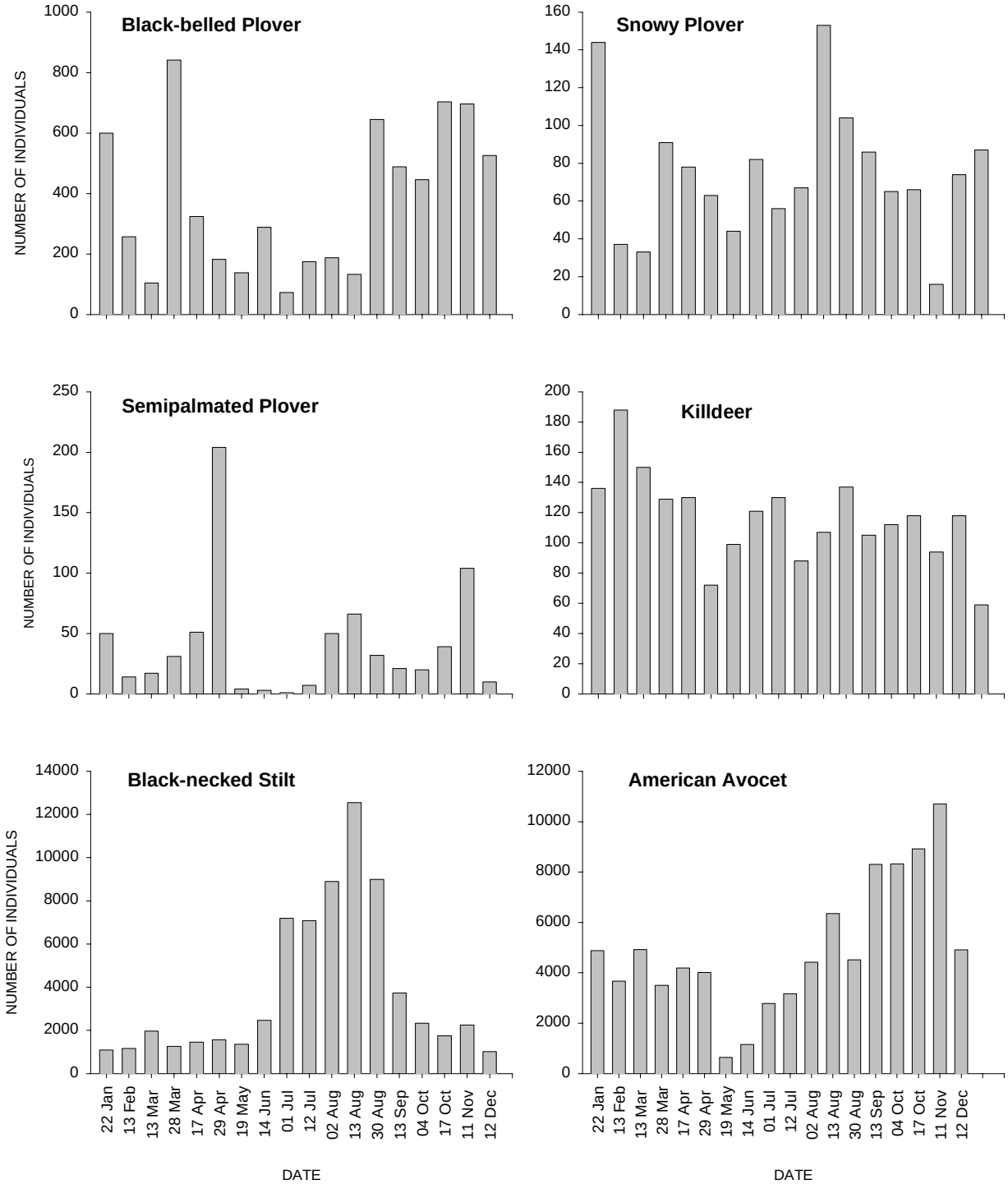

Figure 5-6f. Phenology of the Black-bellied Plover, Snowy Plover, Semipalmated Plover, Killdeer, Black-necked Stilt, and American Avocet at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods.)

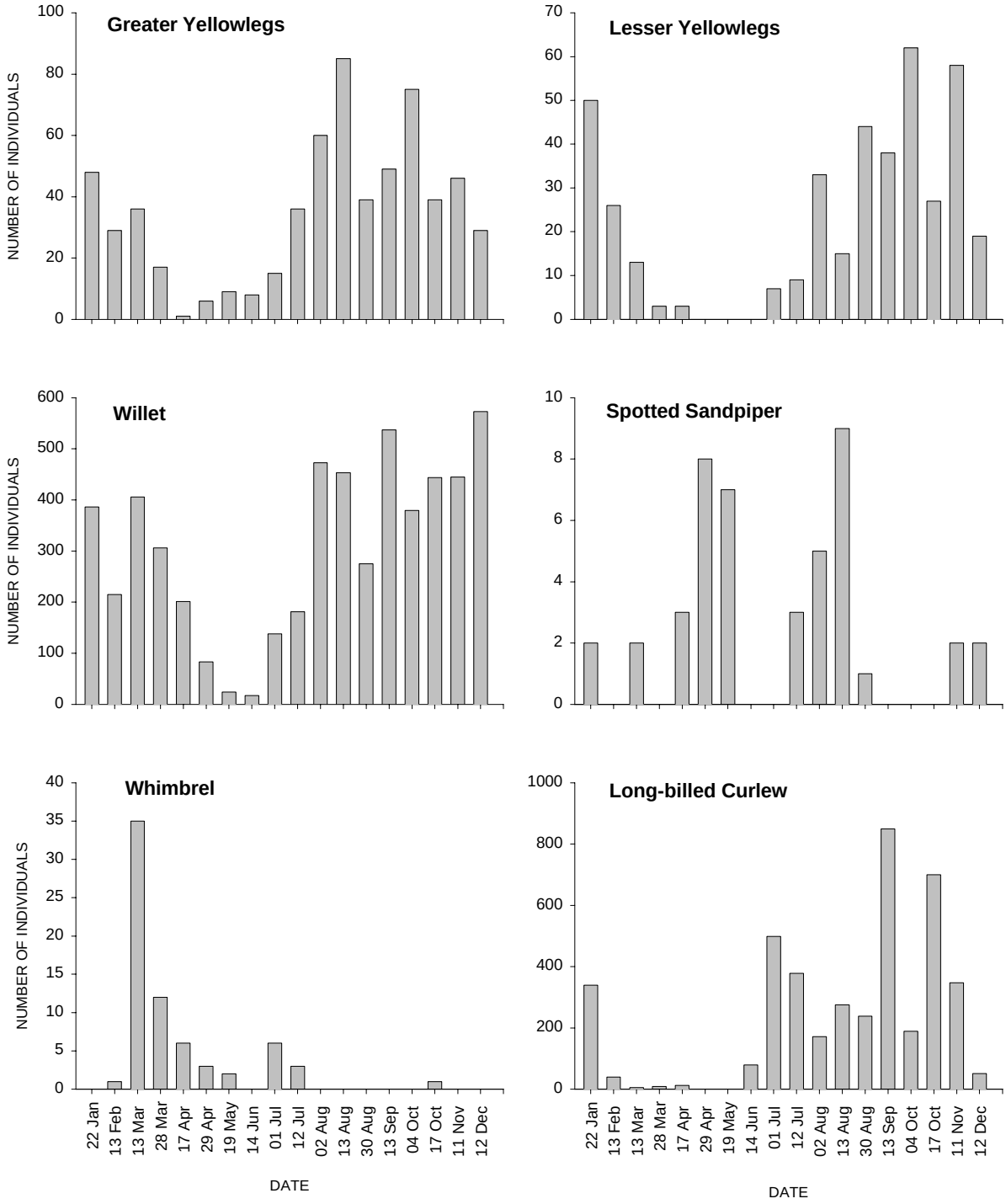

Figure 5-6g. Phenology of the Greater Yellowlegs, Lesser Yellowlegs, Willet, Spotted Sandpiper, Whimbrel, and Long-billed Curlew at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

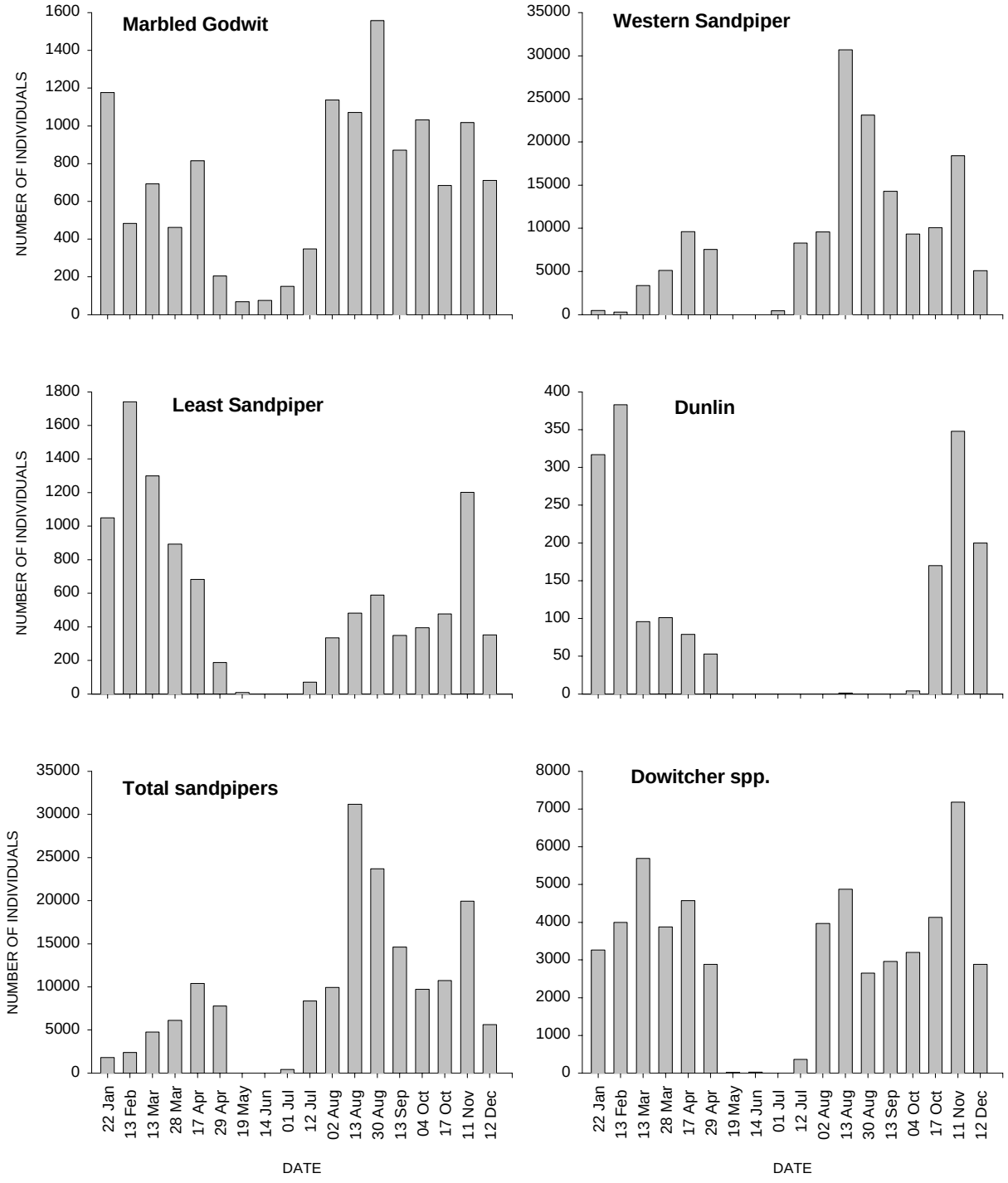

Figure 5-6h. Phenology of the Marbled Godwit, Western Sandpiper, Least Sandpiper, Dunlin, total sandpipers, and dowitcher spp. *(Limnodromus* spp.) at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

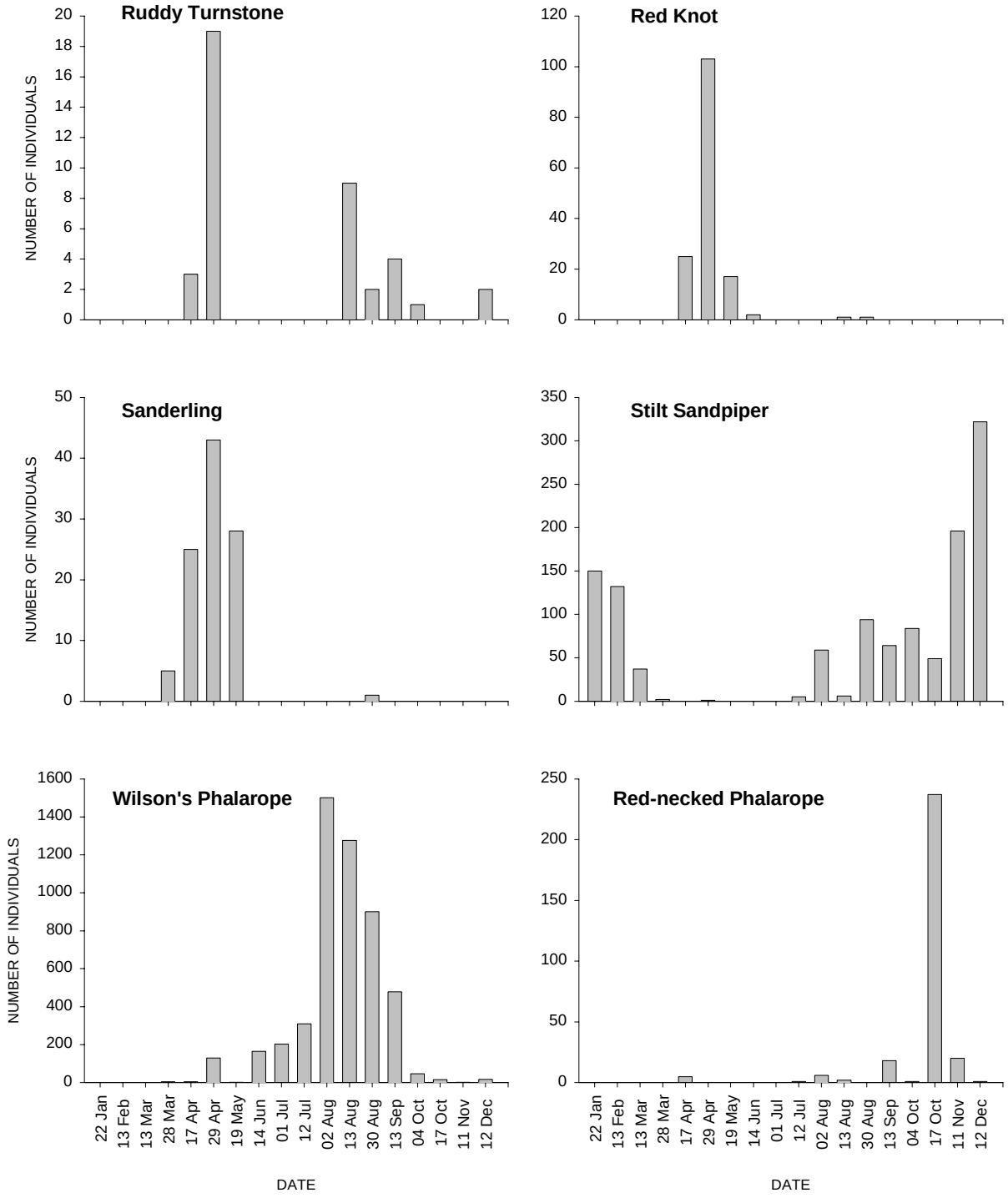

Figure 5-6i. Phenology of the Ruddy Turnstone, Red Knot, Sanderling, Stilt Sandpiper, Wilson's Phalarope, and Red-necked Phalarope at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

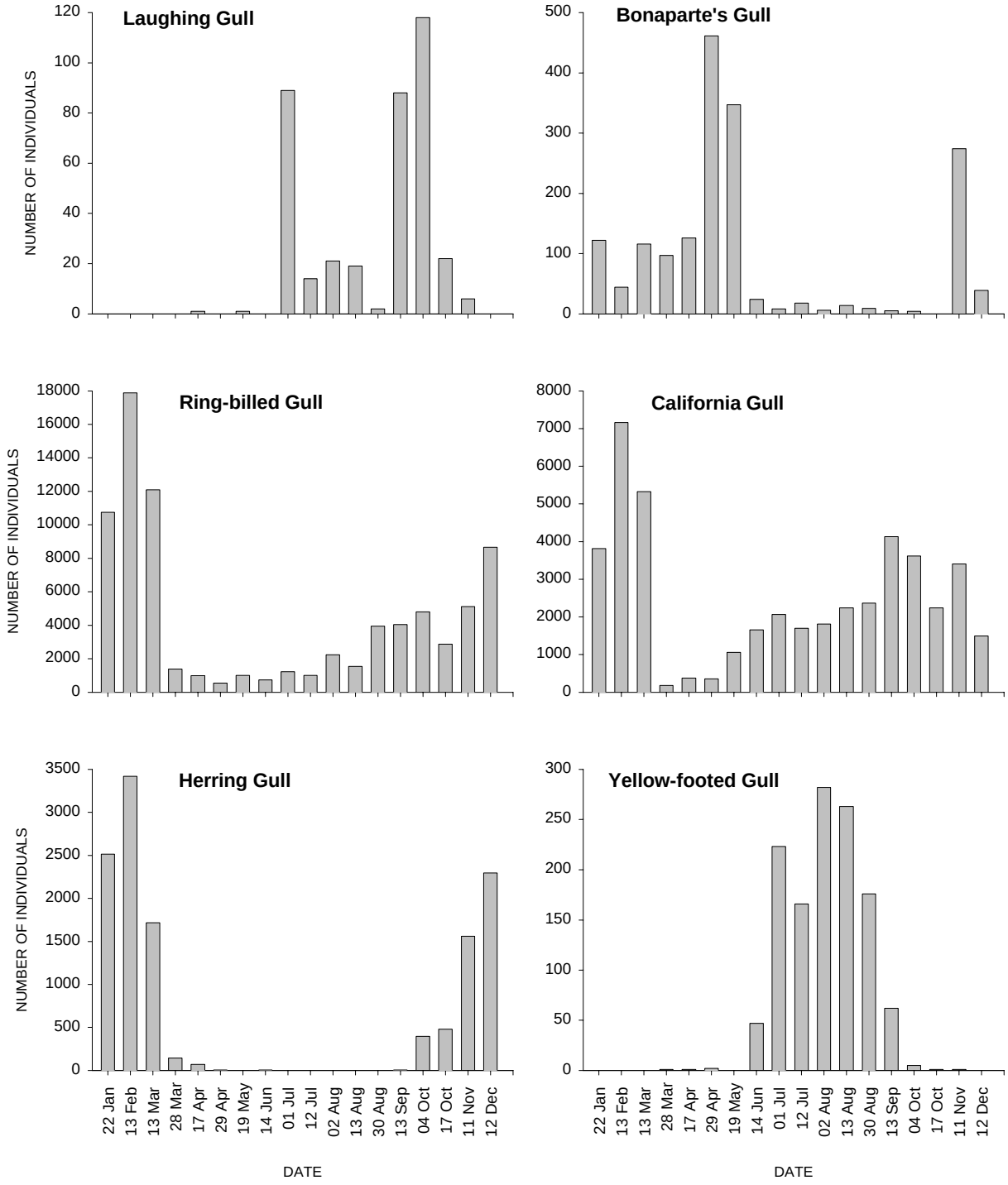

Figure 5-6j. Phenology of the Laughing Gull, Bonaparte's Gull, Ring-billed Gull, California Gull, Herring Gull, and Yellow-filled Gull at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and freshwater ponds (see Methods).

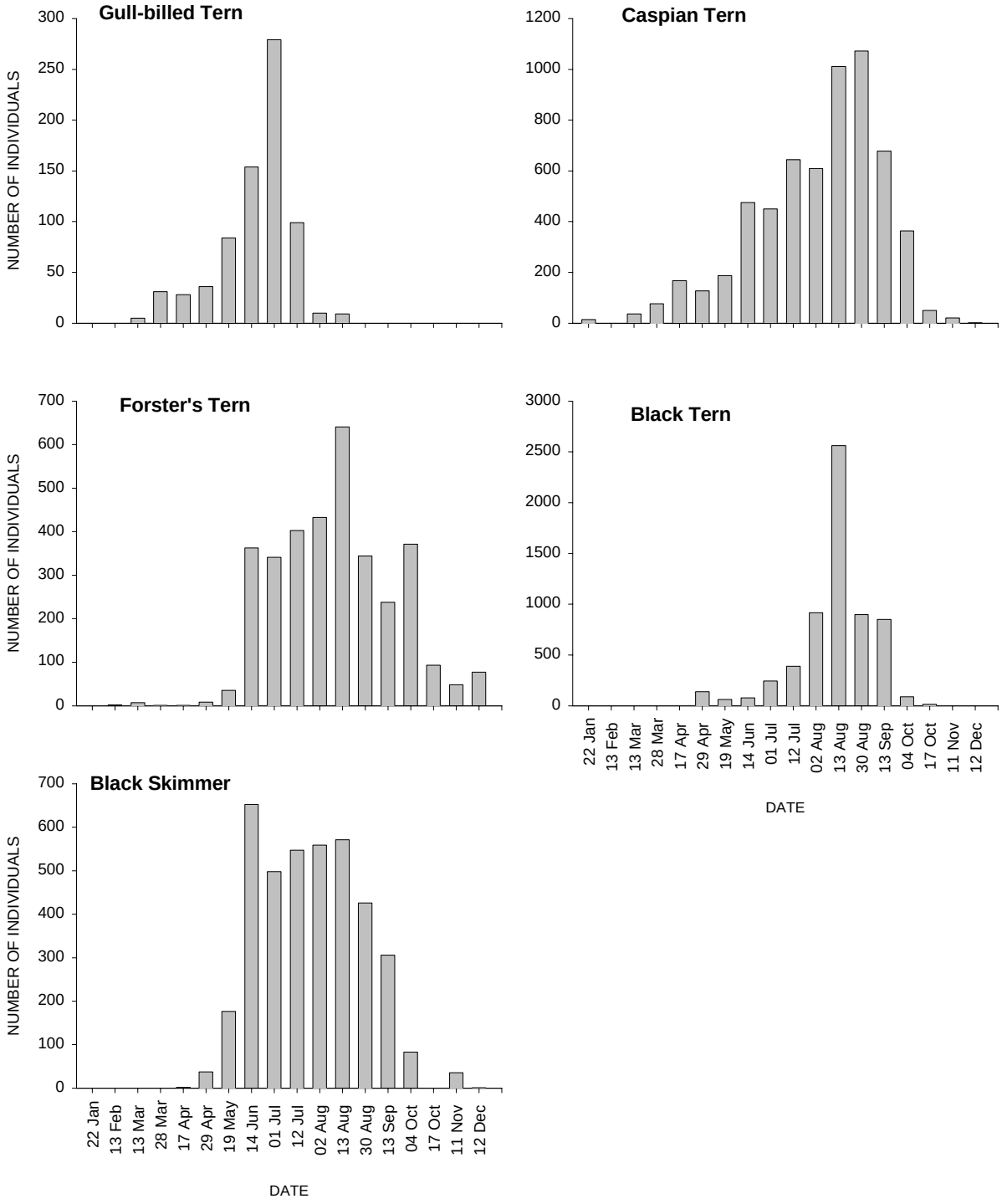

Figure 5-6k. Phenology of the Gull-billed Tern, Caspian Tern, Forster's Tern, Black Tern, and Black Skimmer at the Salton Sea, California, in 1999. Data from 18 surveys of 5 areas of shoreline and fresh-water ponds (see Methods).

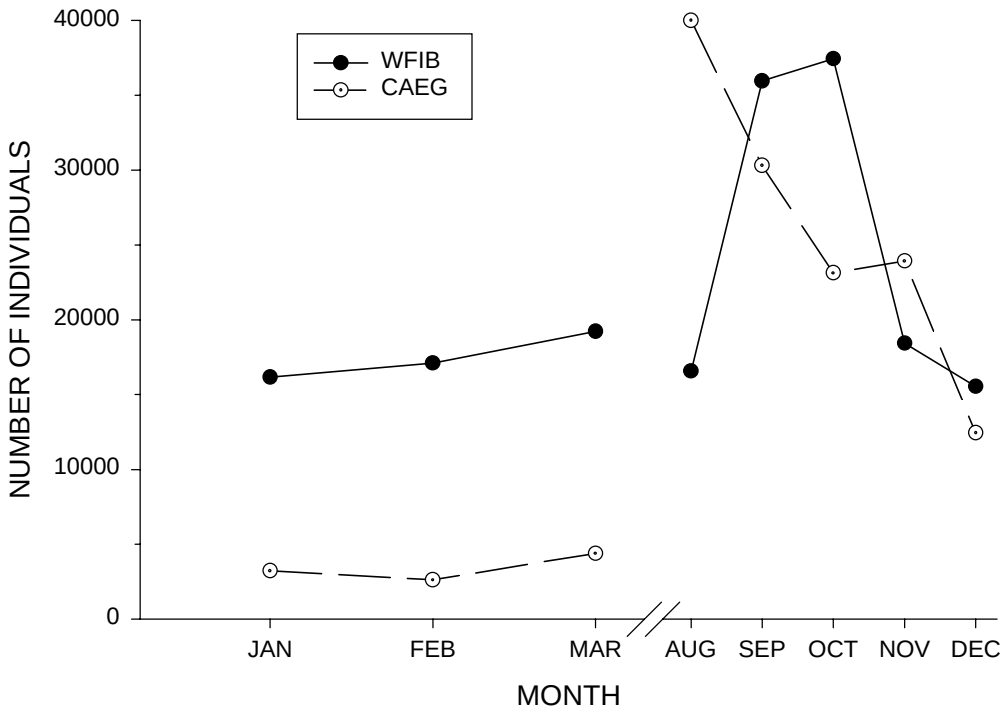

Figure 5-7. Numbers of Cattle Egrets and White-faced Ibis on monthly counts at night-time roost sites in the Imperial Valley, California, in 1999.

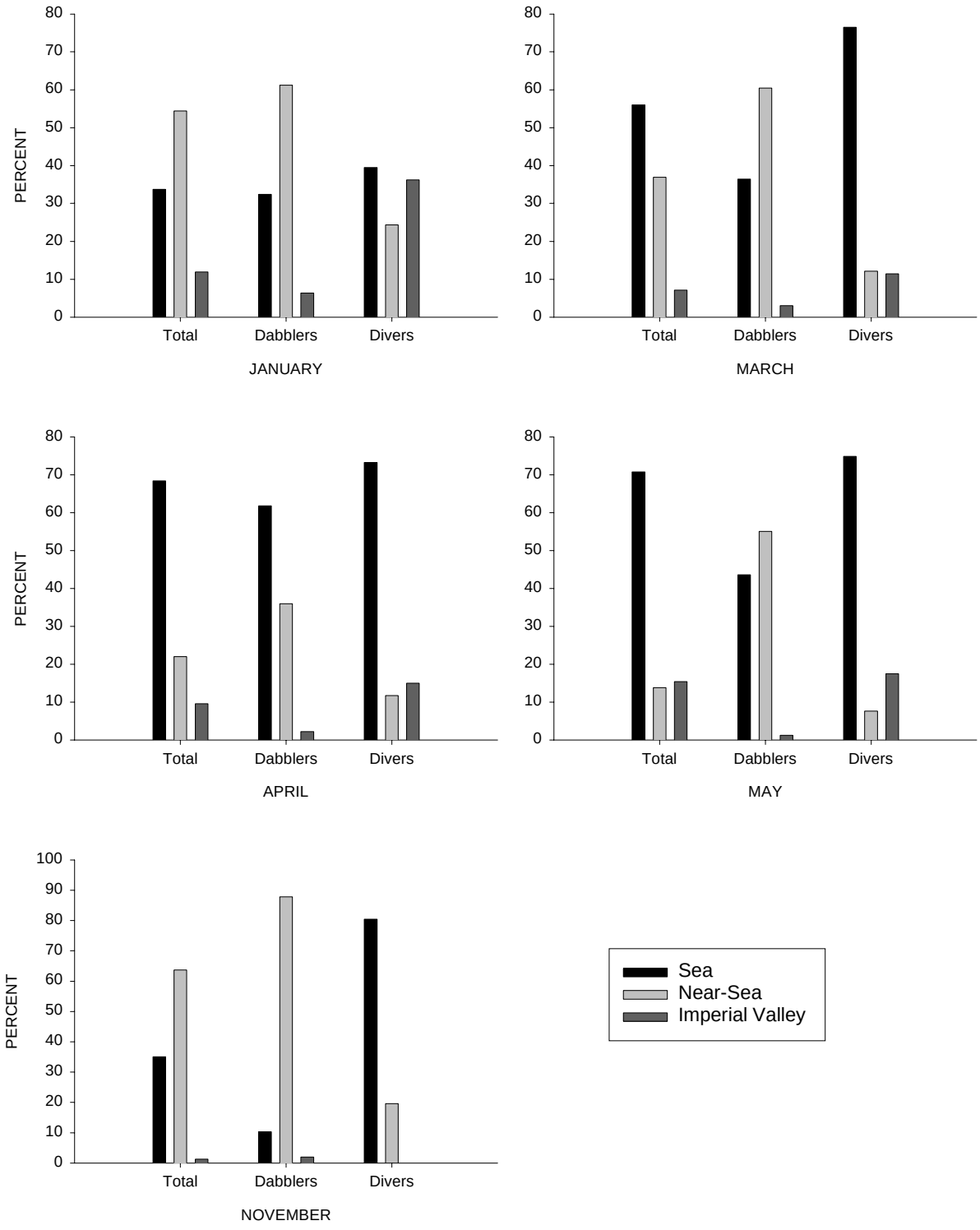

Figure 5-8. Percent of total numbers of all ducks, dabbling ducks, and diving ducks on the inshore waters of the Salton Sea, near-Sea freshwater impoundments, and Imperial Valley duck clubs and reservoirs from aerial surveys in 1999. Data courtesy of SSNWR.

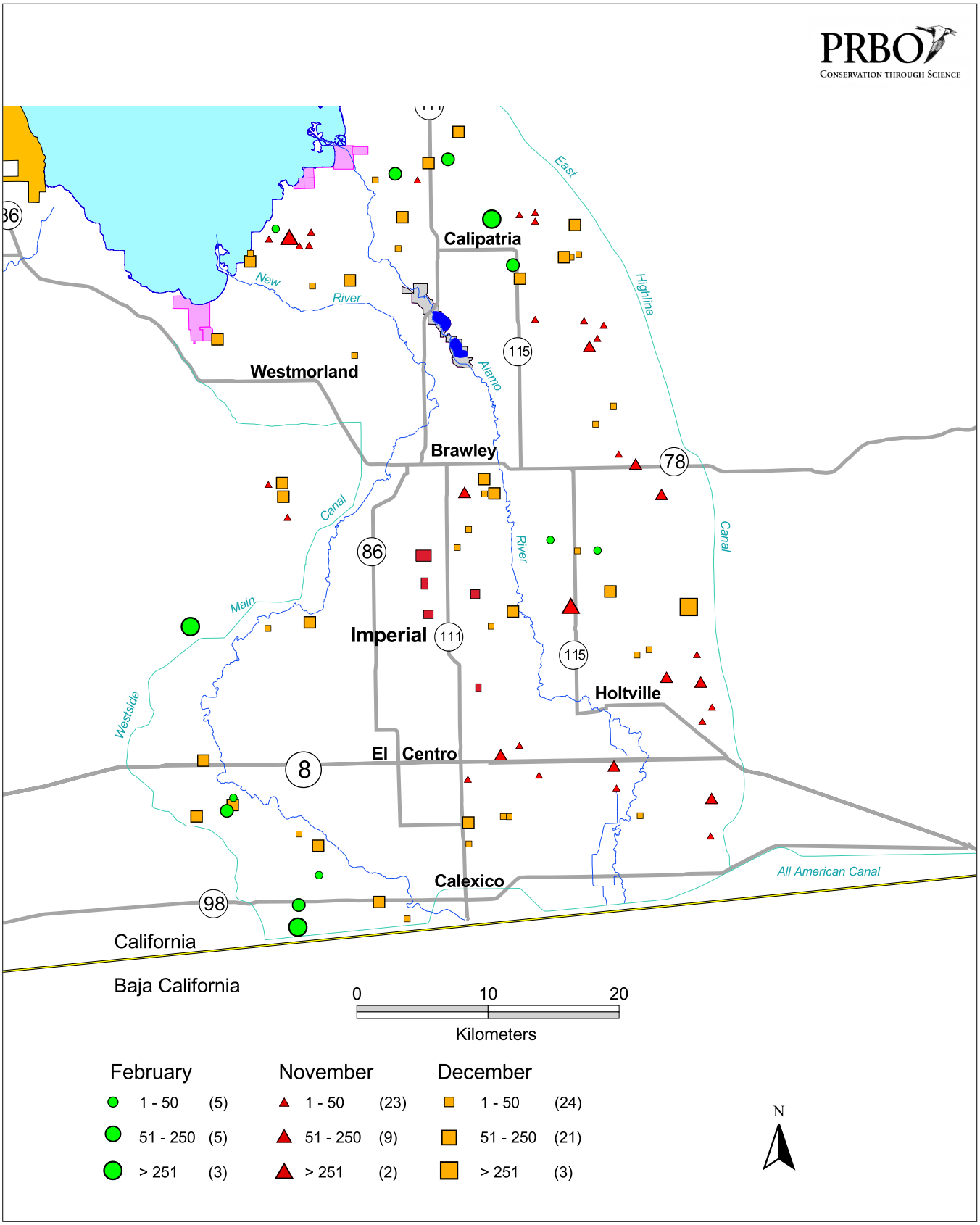

Figure 5 - 9. Distribution and relative size of Mountain Plover flocks on three surveys of the Imperial Valley, California, in 1999.

Appendix A

List of Common and Scientific Bird Names

GAVIIFORMES
GAVIIDAE
Common Loon *Gavia immer*
PODICIPEDIFORMES
PODICIPEDIDAE
Pied-billed Grebe *Podilymbus podiceps*
Eared Grebe *Podiceps nigricollis*
Western Grebe *Aechmophorus occidentalis*
Clark's Grebe *Aechmophorus clarkii*
PROCELLARIFORMES
HYDROBATIDAE
Black Storm-Petrel *Oceanodroma melania*
PELECANIFORMES
PELECANIDAE
American White Pelican *Pelecanus erythrorhynchos*
Brown Pelican *Pelecanus occidentalis*
PHALACROCORACIDAE
Double-crested Cormorant *Phalacrocorax auritus*
CICONIIFORMES
ARDEIDAE
American Bittern *Botaurus lentiginosus*
Least Bittern *Ixobrychus exilis*
Great Blue Heron *Ardea herodias*
Great Egret *Ardea alba*
Snowy Egret *Egretta thula*
Tricolored Heron *Egretta tricolor*
Cattle Egret *Bubulcus ibis*
Green Heron *Butorides virescens*
Black-crowned Night-Heron *Nycticorax nycticorax*
THRESKIORNITHIDAE
White-faced Ibis *Plegadis chihi*
CICONIIDAE
Wood Stork *Mycteria americana*
CATHARTIDAE
Turkey Vulture *Cathartes aura*
ANSERIFORMES
ANATIDAE
Fulvous Whistling-Duck *Dendrocygna bicolor*
Greater White-fronted Goose *Anser albifrons*
Snow Goose *Chen caerulescens*
Ross's Goose *Chen rossii*
Canada Goose *Branta canadensis*
Brant *Branta bernicla*
Wood Duck *Aix sponsa*
Gadwall *Anas strepera*
American Wigeon *Anas americana*
Mallard *Anas platyrhynchos*
Blue-winged Teal *Anas discors*
Cinnamon Teal *Anas cyanoptera*
Northern Shoveler *Anas clypeata*
Northern Pintail *Anas acuta*
Green-winged Teal *Anas crecca*
Canvasback *Aythya valisineria*
Redhead *Aythya americana*
Ring-necked Duck *Aythya collaris*
Greater Scaup *Aythya marila*
Lesser Scaup *Aythya affinis*
Surf Scoter *Melanitta perspicillata*
White-winged Scoter *Melanitta fusca*
Black Scoter *Melanitta nigra*
Bufflehead *Bucephala albeola*
Common Goldeneye *Bucephala clangula*
Common Merganser *Mergus merganser*
Red-breasted Merganser *Mergus serrator*
Ruddy Duck *Oxyura jamaicensis*
FALCONIFORMES
ACCIPITRIDAE
Osprey *Pandion haliaetus*
White-tailed Kite *Elanus leucurus*
Bald Eagle *Haliaeetus leucocephalus*
Northern Harrier *Circus cyaneus*
Sharp-shinned Hawk *Accipiter striatus*
Cooper's Hawk *Accipiter cooperii*
Red-shouldered Hawk *Buteo lineatus*
Swainson's Hawk *Buteo swainsoni*
Red-tailed Hawk *Buteo jamaicensis*
FALCONIDAE
American Kestrel *Falco sparverius*
Merlin *Falco columbarius*
Peregrine Falcon *Falco peregrinus*
Prairie Falcon *Falco mexicanus*
GRUIFORMES
RALLIDAE
Black Rail *Laterallus jamaicensis*
Yuma Clapper Rail *Rallus longirostris yumanensis*
Virginia Rail *Rallus limicola*
Sora *Porzana carolina*
Common Moorhen *Gallinula chloropus*
American Coot *Fulica americana*
GRUIDAE
Sandhill Crane *Grus canadensis*
CHARADRIIFORMES
CHARADRIIDAE
Black-bellied Plover *Pluvialis squatarola*
American Golden-Plover *Pluvialis dominica*
Pacific Golden-Plover *Pluvialis fulva*
Snowy Plover *Charadrius alexandrinus*
Semipalmated Plover *Charadrius semipalmatus*
Killdeer *Charadrius vociferus*
Mountain Plover *Charadrius montanus*
RECURVIROSTRIDAE
Black-necked Stilt *Himantopus mexicanus*

Appendix A. Continued.

American Avocet *Recurvirostra americana*
SCOLOPACIDAE
Greater Yellowlegs *Tringa melanoleuca*
Lesser Yellowlegs *Tringa flavipes*
Solitary Sandpiper *Tringa solitaria*
Willet *Catoptrophorus semipalmatus*
Spotted Sandpiper *Actitis macularia*
Whimbrel *Numenius phaeopus*
Long-billed Curlew *Numenius americanus*
Marbled Godwit *Limosa fedoa*
Ruddy Turnstone *Arenaria interpres*
Black Turnstone *Arenaria melanocephala*
Red Knot *Calidris canutus*
Sanderling *Calidris alba*
Western Sandpiper *Calidris mauri*
Least Sandpiper *Calidris minutilla*
Baird's Sandpiper *Calidris bairdii*
Dunlin *Calidris alpina*
Stilt Sandpiper *Calidris himantopus*
Ruff *Philomachus pugnax*
Short-billed Dowitcher *Limnodromus griseus*
Long-billed Dowitcher *Limnodromus scolopaceus*
Common Snipe *Gallinago gallinago*
Wilson's Phalarope *Phalaropus tricolor*
Red-necked Phalarope *Phalaropus lobatus*
Red Phalarope *Phalaropus fulicaria*

LARIDAE
Laughing Gull *Larus atricilla*
Franklin's Gull *Larus pipixcan*
Bonaparte's Gull *Larus philadelphia*
Heermann's Gull *Larus heermanni*
Mew Gull *Larus canus*
Ring-billed Gull *Larus delawarensis*
California Gull *Larus californicus*
Herring Gull *Larus argentatus*
Thayer's Gull *Larus thayeri*
Lesser Black-backed Gull *Larus fuscus*
Yellow-footed Gull *Larus livens*
Western Gull *Larus occidentalis*
Glaucous-winged Gull *Larus glaucescens*
Gull-billed Tern *Sterna nilotica*
Caspian *Tern Sterna caspia*
Common Tern *Sterna hirundo*
Forster's Tern *Sterna forsteri*
Least Tern *Sterna antillarum*
Black Tern *Chlidonias niger*
Black Skimmer *Rynchops niger*
STRIGIDAE
Burrowing Owl *Athene cunicularia*

Appendix B-1. Numbers of waterbirds and raptors on a comprehensive survey of the Salton Sea, California, and vicinity in January 1999. See Methods for survey protocol and Figure 4-3 for locations of numbered areas.

Species	1	2	3	4	5	6	7	8	9	10	11	11e	12	13	14	15	16	17	18	19	20	21	22C	22E	22F	22G	Total
Pied-billed Grebe											1											24					25
American White Pelican	492	14		2	22	1385	203	509	77	509	6235		6289	6	763	2	158	0		31		0					16697
Brown Pelican							1				15																16
Double-crested Cormorant	645	621	60			2	193	290	102	256	1907	13859	199		15		104		55	196							18504
Least Bittern	2																										2
Great Blue Heron	414	165				35	6	47	45	59	596		81					6			103	9					1566
Great Egret	19	161					2				17								1		3	72					275
Snowy Egret	11	39					1				4		4						1		16	31					107
Cattle Egret											27											15					42
Green Heron	4	1																				1					6
Black-crowned Night-Heron	7	1					3	6	12	2	40		1					3			9	32					116
White-faced Ibis	2	16								1			2								294	46					361
Turkey Vulture																						1					1
Osprey	1										2		1								1		1				6
Northern Harrier								1			5		3	1							6	5	1			1	23
Copper's Hawk																						1					1
accipiter spp.											1										2						3
Red-tailed Hawk									1													2	1				4
American Kestrel			2					1	3		1		1								2	2					12
Merlin													2														2
Peregrine Falcon									1		1		1														3
Clapper Rail																						8					8
Virginia Rail	3							1														1					5
Sora	2							1			2											5					10
Common Moorhen	1	4								2									2		1	2					12
Black-bellied Plover	33	20	14	38	104	66	42	55	16	21	391		150	17	1	33	1		15		8			284		1	1310
Snowy Plover	7	1		17		84	6	30	2	14	17		90	3	2	1			1								275
Semipalmated Plover	2				3	6		6		7	14		29			6											73
Killdeer	10	5	5	11	15	1	4	36	8	18	24		35	3	6	5		3	8		48	27				5	277
Black-necked Stilt	144	59	201	215	565	490	159	138	57	68	301		510	38	96	92	23	10	106		238	197	28	28	44	134	3941

Appendix B-1. Continued.

Species	1	2	3	4	5	6	7	8	9	10	11	11e	12	13	14	15	16	17	18	19	20	21	22C	22E	22F	22G	Total
American Avocet	400	34	1	25	55	413	3	188	103	143	1446		1964	93	70	1					1171	882	14	152	17	143	7318
Greater Yellowlegs	10	5	1	2	2		4	2	4	1	12				1				1		20	11		1	1	3	81
Lesser Yellowlegs	4	3	2	5			2				2		1								38	5					62
Willet	52	25	5	4	126	139	125	144	181	116	63		44		11	5					122						1162
Spotted Sandpiper			1	3	1						2																7
Long-billed Curlew											252		64								24	33					373
Marbled Godwit	88	28			13	14	6	19	3	22	917		96								21	70					1297
Ruddy Turnstone						17																					17
Sanderling						52																					52
Western Sandpiper	2				4	379	129	82	21	9	69		859	3								16					1573
Least Sandpiper	90	19		27	93	177	77	69	26	55	352		400	3	16	14		6	17		161	271	6	31	13	83	2006
Dunlin	4				6	206	19	214	1	7	37		257								1	39		8			799
Stilt Sandpiper						5	1						120								30	1		1		6	164
Ruff																					1						1
dowitcher spp.	104	27	1	8	70	22	2	222	7	9	325		2243	1	27	6					1025	1345	20	229		663	6356
Common Snipe	1																				2	17				4	24
Wilson's Phalarope																					1						1
Bonaparte's Gull						77							98									122					297
Mew Gull													1				1										2
Ring-billed Gull	2716	920				1440	907	3066	1103	592	3382		2552	1933	1271	1477	2829	600	825	1897	802	211					28523
California Gull	2673	932				205	230	406			595		106	389	230	195	453	50	157	361	5						6987
Herring Gull	248	81				448	316	899	139	26	958		408	705	482	219	849	250	181	416	106	295					7026
Yellow-footed Gull						1																					1
Western Gull											3		1														4
Western X Glaucous-winged Gull																			1								1
Glaucous-winged Gull						1							2	1		1	1										6
Caspian Tern	12	5									2		1	1							1						22
flamingo spp.						3																					3
Total	8203	3186	293	357	1079	5668	2441	6432	1912	1937	18018	13859	16615	3197	2991	2057	4419	928	1371	2901	4262	3799	71	734	75	1043	107848

Appendix B-2. Numbers of waterbirds and raptors on a comprehensive survey of the Salton Sea, California, and vicinity in April 1999. See Methods for survey protocol and Figure 4-3 for locations of numbered areas.

Species	1	2	3	4	5	6	7	8	9	10	11	11e	12	13	14	15	16	17	18	19	20	21	22A	22B	22C	22G	Total
Pied-billed Grebe	1	3							1					1								7	1			1	15
Western Grebe	30	16				28	1	1					2	155	143					1			2				379
Clark's Grebe		27				27		1			5		3	167	105			2		3							340
American White Pelican	535	2	0	0	0	611	20	274	2	1	1407		280	17	1	0	4	0	0	512	0	72					3738
Double-crested Cormorant	627	344	0	3	3	13	91	195	81	34	2730	6053	303	59	21	0	98	0	44	364	26	71					11160
American Bittern																						1					1
Great Blue Heron	485	68	1	4	2	19	13	70	30		58		91	23	15	4	1		4	12	6	16	3				925
Great Egret	67	47					1	5	3		11		15	3	2				1	21	3	9	39	2			229
Snowy Egret	10	240					3	1	5		3		3	1	2				4	14	4	52	1		1	6	350
Cattle Egret		75							3		150									6		2				2	238
Green Heron		2		1							2					1						2					8
Black-crowned Night-Heron	23	6						2			9		3	1	4					8		13					69
White-faced Ibis		7											1		64		50		11	1	5	52				243	434
Turkey Vulture	1	3							1	2			2	2								1					12
Osprey	3	4							1		1									1	1						11
Northern Harrier		1																				3				1	5
Red-shouldered Hawk		1																									1
American Kestrel	1	4			1					2	1				1					1		2					13
Clapper Rail																						12					12
Sora	4							2					1													1	8
Common Moorhen	1	8																		4			4			1	18
Black-bellied Plover	38	8	1	16	32		33	39	5	4	161		99	6	19	12			6	14					1	81	575
Pacific Golden- Plover																	1										1
Snowy Plover	8			3		73	13	52	2	3	4		59	11	14	19	13			4		6			1		285
Semipalmated Plover	17	8		1	1	8	6	7	1	2	11		31	5	2	5	12			3		11					131
Killdeer	9	12	2	5	3	1		25	4	1	23		17	4	11	2		8	4	5	11	54	3	2	2	7	215
Black-necked Stilt	222	380	18	123	107	505	90	147	102	18	284		689	56	133	10	8	23	42	85	95	229			7	92	3465
American Avocet	1448	580	2	86	79	1012	39	108	22		702		1865	55	170	2				165	79	324			1	262	7001
Greater Yellowlegs		3		3	1		1			1				1	1					1	1				1		14
Lesser Yellowlegs	1			1					2											3	1	2				2	12
Willet	39	155	5	10	44	131	27	53	25	13	71		49	11	13	1	2		4	19	9					1	682

Appendix B-2. Continued.

Species	1	2	3	4	5	6	7	8	9	10	11	11e	12	13	14	15	16	17	18	19	20	21	22A	22B	22C	22G	Total
Spotted Sandpiper											2						1		1	1	1					1	7
Whimbrel	1	16		3		5		1	1					3						5		4			2	2	43
Long-billed Curlew		4				2	1	10	8		3			5													33
Marbled Godwit	24	48			2	26		16			383		400				3			23		3					928
Ruddy Turnstone				4		37		3																			44
Red Knot				13	143	179	8	25	2	1																	371
Sanderling	1			11		202	2	24								7	2										249
Western Sandpiper	1021	290	9	45	64	1142	132	587	298	43	278		7435	92	191	45	15		3	42	529	1333	1		1044	61	14700
Least Sandpiper	161	85		1	5	12		40	18		90		21	40	11		13		2	27	82	454	1		74	89	1226
Dunlin	22	17		1		25	5	44	2	2	3		12		2		1			3		2					141
Stilt Sandpiper															1												1
dowitcher spp.	568	520		10	24	55	54	189	115	11	557		1887	14	56		2	4	8	217	580	1350				271	6492
Common Snipe									1																		1
Wilson's Phalarope				17										1	1						4						23
Red-necked Phalarope						9	18						5														32
Red Phalarope													3														3
Franklin's Gull															4											1	5
Bonaparte's Gull	5		5	10	23	3		8	4		90		94	2	18	3			61	2	74				1		403
Ring-billed Gull	258	1875		27	81	279	10	247	139	23	168		254	446	161	68	15	108	27	850	3	3	1		3	3	5049
California Gull	128	1480	6	40	127	132	86	107	3	3	196			121	37		9	27	20	770					1		3293
Herring Gull	4	15			28	92	4	48	9	1	30		3	21	14	15				7							291
Yellow-footed Gull								1																			1
Glaucous-winged Gull													1														1
Gull-billed Tern	2	3					5	6	16		15		3	2		3			2	8		4					69
Caspian Tern	27	28		2	1	9	5	12			128		9	14	5	7	3	2	2	14					1		269
Forster's Tern	1	8											2		6	1	1										19
Black Tern											2																2
Black Skimmer	2																			4							6
Burrowing Owl									2																		2
flamingo spp.													4														4
Total	5795	6393	49	440	771	4637	668	2350	908	165	7578	6053	13646	1339	1228	205	254	174	246	3220	1514	4094	56	4	1140	1128	64055

Appendix B-3. Numbers of waterbirds and raptors on a comprehensive survey of the Salton Sea, California, and vicinity in August 1999. See Methods for survey protocol and Figure 4-3 for locations of numbered areas.

Species	1	2	3	4	5	6	7	8	9	10	11	11e	12	13	14	15	16	17	18	19	20	21	22A	22B	Total
Pied-billed Grebe											7		8			1				1	2	12	6	10	47
Western Grebe	146	19									44		121							7			18	8	363
Clark's Grebe	176	41									86		56							8			3	1	371
Black Storm-Petrel													1												1
American White Pelican	19										309	106	120												554
Brown Pelican	12	3	62	29	403	212	50	14	548	41	328	20	263		3	5				2					1995
Double-crested Cormorant	728	589	28	13	44	1	15	8	230	75	1216	20	32						1	1	19	3			3023
American Bittern																						2			2
Least Bittern		1														2	1							3	7
Great Blue Heron	620	48	2	10	44	73	52	121	18	17	305		236	40	10	2	3	1	19	38	27	49		6	1741
Great Egret	288	65			4	1		23	23	7	122		313	1	2					42	76	44	8	8	1027
Snowy Egret	191	120	2		52	17	6	21	34	13	198		218	1	5	1			5	19	82	15	95	8	1103
Cattle Egret	417	22									761		2								7	4			1213
Green Heron	2	1	1								17					8	1			3	8	8	2	2	53
Black-crowned Night-Heron	363	9			6	4		3	5	18	69		31	6	1				24	11	16	40	1	1	608
White-faced Ibis	30	5		43	19					63	1		1							6	1	36			205
Wood Stork													2									4			6
Turkey Vulture	1	3						6			1		13	11								20			55
Osprey	2	1							1	1	4							1		2	1				13
Northern Harrier																						2			2
Cooper's Hawk						1																			1
American Kestrel		2												1							5	3			11
Peregrine Falcon													2												2
Clapper Rail														1							1	14			16
Virginia Rail	3												2								1				6
Sora	1																					1			2
Common Moorhen	1	3			2						20				1	1				1	7	8	11	7	62
Black-bellied Plover	32	48		1	9	7	8	7	4	11	66		15	1	9	2			2	17	14				253
Snowy Plover		8	2	3		90	10	8		12	4		209		2	2				1					351
Semipalmated Plover	4	12			1			5		4	27		62							4	11	9			139
Killdeer	12	19		7	4	6		11	3	7	31		34	5		2	2		14	13	28	52	9		259
Black-necked Stilt	2436	450	15	70	184	307	416	924	350	76	4559		4186	27	41	17	10	13	23	225	1266	201	5	56	15857
American Avocet	44	430				3		601		16	1354		5557	2	255					185	1370	220			10037
Greater Yellowlegs	22	9			2	7	1	2		1	5		7		2					3	24	28			113

Appendix B-3. Continued.

Species	1	2	3	4	5	6	7	8	9	10	11	11e	12	13	14	15	16	17	18	19	20	21	22A	22B	Total
Lesser Yellowlegs	1	1									1		10							1	1	13			28
Solitary Sandpiper															1										1
Willet	81	27			6	10	18	34	14	9	223		37		2					16	105				582
Spotted Sandpiper	3	2		1				1		2	2		1		1					1	1	2	2		19
Whimbrel		31																							31
Long-billed Curlew		2									333		4	1							54				394
Marbled Godwit	58	44				1		3	2	5	409		462	6	8	4				3	31				1036
Ruddy Turnstone					1			1			3										5				10
Red Knot								1																	1
Sanderling						14							25												39
Western Sandpiper	3702	730		13	6	166	52	274		2	3331		21611	27	697					480	2173	1130			34394
Least Sandpiper	6	24		4	3	26		2		3	27		206	4		3				2	330	296	6		942
Baird's Sandpiper																					1				1
Dunlin								1																	1
Stilt Sandpiper													10		2						3				15
Ruff													2								1				3
dowitcher spp.	16	566						99	9	6	547		3589		690					85	1248	285	13		7153
Common Snipe																						2			2
Wilson's Phalarope		165		53	18		99	18	1		23		961	9	320					315	1082	1			3065
Red-necked Phalarope													25							5	2				32
Laughing Gull		1									1				1						4				7
Bonaparte's Gull											15									1	11				27
Heermann's Gull							1																		1
Ring-billed Gull	296	850	71	46	177	134	347	151	137	125	388		929	133	90	27			26	320	313	240			4800
California Gull	1076	475	45	723	254	313	240	695			334		817	60	350	100			13	210	23	2			5730
Herring Gull	1																								1
Yellow-footed Gull	8	14		1	9	23	25	42	22	10	201		360	5	7		20	6	30	2	4				789
Western Gull													3												3
Gull-billed Tern	4																			2	4	1			11
Caspian Tern	476	190	9	56	40	88	96	150	15	34	146		210	34	301	237	1	1	25	65	220	10			2404
Common Tern			1		5																				6
Forster's Tern	213	70	7	13	48	90	161	99	7	166	69		272			6	2			55	115		5	4	1402
Black Tern	142	52			13	50	881	490	15	143	140		1790	1						34	235		23	2	4011
Black Skimmer	14	3			4					12	8		10							180	546				777
flamingo spp.													6												6
Total	11647	5155	245	1086	1358	1644	2478	3815	1438	879	15735	146	42831	376	2801	420	40	22	182	2366	9478	2757	207	116	107222

Appendix B-4. Numbers of waterbirds and raptors on a comprehensive survey of the Salton Sea, California, and vicinity in November 1999. See Methods for survey protocol and Figure 4-3 for locations of numbered areas.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22A	22B	22D	22E	22F	22G	Total
Pied-billed Grebe												2								3	1	17	33					56
Western Grebe	448	12	48	5	5			1	8	10	16	64		9	12	15			4	1	3	27	26					714
Clark's Grebe	157	8	2			5					11	8		5	1				19			1	5					222
American White Pelican	246	604	843	790	892	1423	846	2134	567	673	510	456	1132	498	759	967	2154	1012	1846		694							19197[a]
Brown Pelican		6		4	18	3							4	3														38
Double-crested Cormorant	869	678	546	984	1126	1245	978	432	106	512	1533	1213	561	431	71	678	1121	823	1269		0							15179[b]
American Bittern																					5							5
Least Bittern		1													3					1	2							7
Great Blue Heron	238	72	50	9	80	148	18	82	113	13	186	138	35	19	11	7	10	29	54	19	36		8	4		1		1380
Great Egret	28	225	21	1	5		58	14	3	1	23	20	13	6	2	1		11	450	4	29	8	14	12	1	7	1	958
Snowy Egret	5	175	21	26	14			11	1		59	23		1	16	6		10	300	25	28	9	8	17		4		759
Cattle Egret									1	1	2								50									54
Green Heron	1										5				1						1							8
Black-crowned Night-Heron	9		13		61		1				8							2	1	4	2	3	8	2				114
White-faced Ibis	2	4								1	5	5							1	42	316					450		826
Turkey Vulture																									10			10
Osprey	3	1	1	1					3	1	2								1	2	1						1	17
White-tailed Kite																					2							2
Bald Eagle																					1							1
Northern Harrier	1								2	2	1	2			1					6	9	2	2		2		3	33
Sharp-shinned Hawk																						1						1
Cooper's Hawk																		1				2		1				4
Red-tailed Hawk																		1		4	4		1		5		2	17
American Kestrel	1	11			2				8	2	2	1				1			4	4	9				6			51
Merlin												2								2								4
Peregrine Falcon										1	1	1													1			4
Prairie Falcon									1				1															2
Clapper Rail												1								2	4							7
Virginia Rail																				2	1							3
Sora	3										2	3								2	6		1					17
Common Moorhen		13									3				1				5	1		34	5					62
Black-bellied Plover	32	14	6	9	15	69	38	17	16	4	456	202	12	2	6	10	5	3	4	4				450	7			1381
Snowy Plover				4		37	6	13				102	8															170
Semipalmated Plover	12			7		4	6				14	77	1							1								122
Killdeer	7	12	3	4	4			5	9	2	28	42	5	2	4		4	13	7	12	61			1			3	228
Black-necked Stilt	458	133	146	132	350	666	195	246	92	144	361	811	370	29	89	14	21	119	8	278	459		1	745			71	5938

Appendix B-4. Continued.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22A	22B	22D	22E	22F	22G	Total
American Avocet	1354	270	7	4	11	791	26	748	165	89	4576	5257	210		5				82	916	388			3901				18800
Greater Yellowlegs		6	4	4	3						10	3	1		1				1	7	38			1	2		1	82
Lesser Yellowlegs			4	3							4									24	33				1			69
Willet	9	5	4	17	25	579	63	227	38	84	109	116	52	76	25	2	9	2		87				2				1531
Spotted Sandpiper					2															2		3	1	3				11
Long-billed Curlew									131		57	290									2			900				1380
Marbled Godwit	65	27				116	2	88	1		795	110												1				1205
Red Knot						19				1																		20
Sanderling						37																						37
Western Sandpiper	325	16	8	43	76	977	119	244	192	142	793	16684	266	14	4	6	6	1	3	1250	959			105	284		9	22526
Least Sandpiper	9	51	21	2	29	190	10	25	69		229	800		5	39	4	4		17	192	320	45	9	263	1200	3	237	3773
Dunlin	78	4		3		290	39	69	19	20	27	179	15	3					2	38	10			46	122			964
Stilt Sandpiper												88								108	5			5				206
dowitcher spp.	52	32			7	177	1	96	14	33	900	6691	71						16	465	1375	8	17	504	1119	1	10	11589
Common Snipe																					1		2				2	5
Wilson's Phalarope																				2								2
Red-necked Phalarope																				20								20
Laughing Gull																							1					1
Bonaparte's Gull	250	4		166	48	68		1			12	43	2	13				7		7		5						626
Ring-billed Gull	1492	7000	885	748	586	1230	411	1222	180	157	1532	1052	2118	443	127	157	165	315	2500	226	5	220	24	38				22833
California Gull	1690	3750	518	7	1209	266	146	373		4	1308	91	119	140	67	210	100	253	850	64		111	19	18				11313
Herring Gull	590	550	266	813	596	1253	387	180	11	3	840	207	329	645	92			2	35	37		55		9				6900
Thayer's Gull		1									1																	2
Lesser Black-backed Gull											1																	1
Yellow-footed Gull									1		1						2	11										15
Western Gull			1		1						1																	3
Caspian Tern	6		1						3		8	9	3	3					2	3	1		5					44
Forster's Tern	2	38	19		6	1		3	8	10	27	18	2		7			6	7	8	4	2	4					172
Black Skimmer	3					2					33																	38
Total	8445	13723	3438	3786	5171	9596	3350	6231	1762	1910	14492	34811	5330	2347	1344	2078	3601	2621	7538	3875	4815	553	194	7028	2760	466	340	151759

[a] Total also includes 151 pelicans observed in offshore waters of the Sea on an aerial survey.
[b] Total also includes three cormorants observed in offshore waters of the Sea on an aerial survey.

Appendix C

Landbird Migration Monitoring at the Salton Sea: 1999 Field Season

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Abstract

Waterbird and shorebird use of the Salton Sea has been studied in detail, however there is limited and mostly anecdotal information on landbird migration through the area. In 1999, the Point Reyes Bird Observatory systematically surveyed landbirds at the Salton Sea to determine the use of its desert riparian habitats as migratory stopover sites. Using constant-effort mist-netting, point count surveys, and area search surveys, we assessed the diversity and abundance of birds in these habitats. During spring we surveyed four riparian sites along the north, south and eastern shores of the Sea. In fall we surveyed five riparian sites and one residential site all on the eastern shore of the Sea. Using constant-effort mist-netting, we caught a total of 1,542 individuals of 48 species at overall rates of 137.1 and 345.3 birds per 100 net hours in April and May, respectively. Less than 1% of the birds we caught were hatch-year birds. During fall, we caught a total of 892 individuals of 47 species at overall rates of 73.4 and 64.6 birds per 100 net hours in September and October, respectively. Hatch-year birds accounted for 45% of all total captures. During spring, we caught Wilson's Warblers (Wilsonia pusilla) at an overall rate of 82.8 birds per 100 net hours, which accounted for 39% of all captures. More Wilson's warblers were caught at the Salton Sea during spring migration than at any other mist-netting site in California. The abundance of neotropical migrants recorded during spring and fall, provides evidence that the area is used extensively by migrating passerines, including 11 species of statewide concern in riparian habitats. The high use of the Salton Sea and its environs by landbirds during migration suggests the need for effective management and restoration of desert riparian habitats.

Introduction

In 1999, the Point Reyes Bird Observatory (PRBO) surveyed landbirds of the Salton Sea to assess the use of riparian habitats during spring and fall migration as both a migratory stopover and a dispersal corridor. The area was known to be used by a variety of waterbirds during migration, but there was limited information on use by landbirds, including California Partners in Flight (CPIF) Priority Riparian Species (RHJV 1998).

Stopover ecology has become an important topic in recent studies due to an increased awareness of population declines of migratory landbirds (Moore 2000, Robbins et al. 1989, Askins et al. 1990, Finch and Stangel 1993).

Riparian habitat comprises less than one percent of land in the West, yet is one of the most productive habitats, supporting a large diversity of aquatic and terrestrial wildlife (Knopf et al. 1988). Desert riparian has been exploited and degraded by conversion to agriculture, water management practices, urbanization, and recreation (Knopf et al. 1988, Finch and Yong 2000). A further threat has been the introduction of exotic plant species that have displaced native vegetation (Knopf et al. 1988, Hunter et al. 1988). The disproportionate importance of western riparian habitat to these and other bird populations has been well-documented (Kreuper 1993, Saab and Rich 1997).

Here we describe patterns of species richness, diversity, seasonal occurrence, and habitat use of landbirds in riparian habitats around the Salton Sea in 1999. Additionally, we make recommendations for future monitoring of landbirds in this area.

Methods

Study Sites

Study sites differed for the spring and fall migration periods. During spring, we established study sites in desert riparian habitat at the Wister Unit of the Imperial Wildlife Area and on the New, Alamo, and Whitewater rivers (Figure C-1). In fall we established study sites at the Salton Sea National Wildlife Refuge (SSNWR) Headquarters, the Wister Unit, the Finney-Ramer Unit of the Imperial Wildlife Area, the East Highline Canal, and in the town of Niland, California (Figure C-1). All fall sites are classified as riparian habitat, with the exception of Niland, which is residential with numerous exotic species (Table C-1).

Desert riparian habitat included a mixture of Fremont cottonwood *(Populus fremontii*), blue palo verde (*Cercidium floridum*), mesquite (*Prosopsis* spp.), desert fan palm (*Washingtonia filifera*), and willow (*Salix* spp.). Many riparian areas have been invaded by exotic saltcedar (*Tamarix* spp.), now the dominant species. In addition, other exotics such as eucalyptus (*Eucalyptus* spp.), date palms (*Phoenix* spp.), and various fruit trees are pervasive in the residential area.

Constant Effort Mist-netting

Mist-net stations run in spring and fall followed the protocol outlined in Ralph et al. (1993). In sum we ran an array of 10, 30-mm-mesh nets, three days per week. We placed nets at least 10 m apart within contiguous and homogenous habitat where available. In spring we opened nets 15 minutes after local sunrise and checked them every 30 minutes for 5 hours. In fall we placed nets in the shade of vegetation and opened them at sunrise rather than the usual 15 minutes after sunrise. Nets were also closed early on various dates because of wind and rain and to avoid the stress of high temperatures on the large number of birds being caught.

During spring, P. Capitolo and Z. Smith operated a constant effort mist-net station for 723.5 net hours on 23 dates from 6 April to 26 May at the Wister Unit of the Imperial Wildlife Area (Figure C-1). During fall, M. Flannery and S. Guers operated a constant effort mist-net station for 1211 net hours on 25 dates between 3 September and 29 October at the SSNWR headquarters. We abandoned the spring mist-net station at Wister because of conflicts with hunting seasons in the fall.

During both seasons, we banded each captured bird with a numbered USGS-BRD aluminum leg-band and identified all individuals to species, age, and, when possible, sex. We also recorded the birds' wing length, degree of skull ossification, fat score, molt presence and pattern, flight feather condition, and weight. We took measurements following guidelines in Pyle (1997). On several occasions when large numbers of birds were caught, certain data, such as molt presence and flight feather condition, were not recorded to minimize processing time. Recaptured birds were processed again if the interval between captures was at least one hour.

Point Counts

The protocol for conducting point counts followed Ralph et al. (1993, 1995). Along the Whitewater, Alamo, and New rivers and within the Wister Unit of the Imperial Wildlife Area (Figure C-1), we set up point count transects, each with a series of point count stations 250 m apart. Of 88 total point count stations, the Whitewater River held 25, the Alamo River 14, the New River 25, and the Wister Unit 24. We conducted point counts on each transect once per month. Counts lasted five minutes, during which we recorded all birds seen or heard. Birds detected within a 50-m radius of the point were recorded separately from those detected farther away and from those flying overhead. We also recorded the type of detection, i.e., song, visual, or call. We began each series of point counts within one-half hour after local sunrise and completed them within four hours after sunrise.

Area Searches

During the fall, we established area search plots at six sites: the Wister Unit, Finney and Ramer lakes, SSNWR headquarters, the East Highline Canal, and the town of Niland (Figure C-1). Our area search protocol followed Ralph et al. (1993), with modifications to accommodate local conditions. Most sites had three plots and were surveyed once every other week. The SSNWR headquarters and the Wister Unit had four plots each and were surveyed once every week. Area searches lasted 20 minutes during which all individual birds observed were counted. During area searches observers may move around the plot and actively seek out birds that may be quiet or hidden and may otherwise go undetected using other survey techniques.

Statistical Analysis

Although a variety of landbirds and waterbirds were recorded on point counts and area searches, we restricted our analyses to species of passerines (songbirds) and near-passerines (hummingbirds, woodpeckers, and doves). We included in a species list but eliminated from analyses birds that are not adequately surveyed with the point count and area search methods, which includes swallows, swifts, crows, ravens, quail, raptors, and owls. Individuals not identified to species were excluded from all analyses except for abundance estimates.

Using mist-net data, we calculated the following:

(1) Productivity indices – hatch-year to after hatch-year ratio.

(2) Standardized capture rates - birds per 100 net hours.

Using point count and area search data, we calculated the following indices:

(1) Species richness – the total number of species detected within 50 m of all point count stations at a given site or within each area search plot. Mean species richness was calculated as the number of species detected by plot.

(2) Relative abundance – the mean number of individuals detected per station or plot, determined by dividing the total number of individuals detected within each plot or transect by the number of stations and the number of visits.

(3) Species diversity – a measure of ecological diversity based on the number of species detected weighted by the number of individuals of each species. Mean species diversity was calculated by plot. A high score indicates high ecological (species) diversity. Species diversity was measured using a modification of the Shannon-Wiener index (also called Shannon-Weaver index or just Shannon index; Krebs 1989). We used a

transformation of the usual Shannon-Weiner index (symbolized H′). This transformed index, which was introduced by MacArther (1965), is N_1, where $N_1 = 2^{H'}$. The advantage of N_1 over H′ (the original Shannon-Wiener metric) is that N_1 is measured in terms of species, whereas H′ is measured in terms of bits of information, and thus the former is more easily interpretable.

Results

Mist-net Data

During spring, we captured 1542 individuals of 48 species at overall rates of 137.1 birds per 100 net hours in April and 345.3 in May. Capture rates varied both by age and time of season. We captured 0.2 new hatch-year birds per 100 net hours in April and 1.1 in May. By contrast, capture rates for new after hatch-year birds were 136.7 birds per 100 net hours in April versus 344.0 in May.

Neotropical migrants accounted for a large proportion of the total captures. The five most numerous migrants combined account for 70% of all captures: Wilson's Warbler 39%, Orange-crowned Warbler 12%, Warbling Vireo 9%, Yellow Warbler 6%, and Audubon's Warbler 4% (see Tables for scientific names).

In spring, we captured 10 CPIF Priority Riparian Species: Willow Flycatcher, Warbling Vireo, Swainson's Thrush, Yellow Warbler, Wilson's Warbler, Common Yellowthroat, Yellow-breasted Chat, Song Sparrow, Black-headed Grosbeak, and Blue Grosbeak.

During fall, we captured 892 individuals of 47 species at overall rates of 73.4 birds per 100 net hours in September and 64.6 in October. Ten taxa – Willow Flycatcher, Verdin, Orange-crowned Warbler, Audubon's Warbler, MacGillivray's Warbler, Wilson's Warbler, Common Yellowthroat, Abert's Towhee, and Gambel's White-crowned Sparrow – accounted for 71% of all captures. The capture rates of new hatch-year birds were 36.9 and 26.9 per 100 net hours for September and October, respectively, whereas the respective rates for new after hatch-year birds were 33.9 and 17.5 per 100 net hours.

In fall, we caught eight CPIF Priority Riparian Species: Willow Flycatcher, Warbling Vireo, Yellow Warbler, Wilson's Warbler, Common Yellowthroat, Yellow-breasted Chat, Song Sparrow, and Blue Grosbeak.

The majority of CPIF Priority Riparian Species were caught during migration or dispersal through the area. During spring, we caught 4 hatch-year birds, less than 1% of the total individuals captured. All hatch-year captures were Song Sparrows of the resident breeding race *Melospiza melodia saltonis* (Table C-2). In contrast, during fall, hatch-year birds accounted for 45% of total captures, after hatch-year birds 35%, and birds of unknown age 20%.

In fall, productivity ratios (HY/AHY birds) varied considerably among species caught in mist-nets (Table C-3). Species such as Willow Flycatcher and Audubon's Warbler showed high young/adult ratios of 8.7 and 2.5, respectively. Species with high capture rates, such as the Wilson's Warbler, Yellow Warbler, Orange-crowned Warbler, and Warbling Vireo, showed ratios of 1.0.

Patterns of seasonal occurrence varied considerably both between seasons and among species (Figures C-2 and C-3). Among the most numerous migrants we caught, capture rates

were similar in spring and fall for the Willow Flycatcher and Audubon's Warbler and much greater in spring than fall for the Warbling Vireo, Yellow Warbler, Orange-crowned Warbler and Wilson's Warbler. The latter pattern was particularly striking for the Wilson's Warbler, which we caught at a rate of 300 birds per 100 net hours on the peak date of 11 May in spring versus 8.4 birds per 100 net hours on the peak date of 17 September in fall. This is the highest rate of capture of spring migrant Wilson's warblers in California. Periods of peak passage were most staggered in spring, when the Audubon's Warbler reached peak numbers in early April, Orange-crowned Warbler in late April, Warbling Vireo in early May, Wilson's Warbler in mid-May, and Yellow Warbler and Willow Flycatcher in mid- to late May. By contrast, most fall migrants reached peak numbers in mid- to late September, except for the Audubon's Warbler, which was most numerous in mid- to late October.

Point Counts

We recorded a total of 55 species of landbirds within 50 m of point count stations surveyed in April and May (Table C-4). Species diversity ranged from 22.2 at the Wister Unit to 13.9 at the Alamo River, and relative abundance ranged from 8.5 at the Whitewater River to 6.5 at the Alamo River (Table C-5). Species richness ranged from 25 at the Alamo River to 39 at the Wister Unit (Table C-5).

Area Searches

We recorded a total of 63 species of passerines during censuses of 20 area search plots in September and October (Table C-6). Species diversity ranged from 20.2 at the Wister Unit to 10.4 at Niland. Relative abundance ranged from 79.7 Niland to 18.0 at Finney Lake. Species richness ranged from 32 at Niland to 18 at Ramer Lake (Table C-7).

Mean species diversity varied across habitats. Within habitats with at least three plots surveyed, diversity ranged from 12.0 in residential areas to 17.8 in mesquite habitat. Mean species richness ranged from 26.6 in mesquite to 21.7 in saltcedar. Relative abundance varied from 23.0 in saltcedar-dominated habitat to 43.3 in mesquite-dominated habitat (Table C-8).

Discussion

Data collected during both spring and fall migration indicate that the Salton Sea contains habitats that support a diverse landbird community. Many resident and neotropical migrant species use these areas, including 11 CPIF Priority Riparian Species. The high number of neotropical migrants caught in mist-nets during spring, 70% of all new captures, provides further evidence that the area is used by migrating passerines.

Wilson's Warblers are using the Salton Sea extensively in the spring, as evidenced by their overall capture rate of 82.8 birds per 100 net hours, representing 39% of all captures. The migrational pattern of higher use in spring than fall at the Salton Sea is similar to that observed at Coyote Creek Riparian Station in Alviso, California (Otahal 1995). Wilson's Warbler abundance, however, was much higher at the Salton Sea (peak of 300 birds/100 net hrs on 11 May 1999) than at Coyote Creek (peak of 20 birds/100 net hrs on 16 May 16 1991; Otahal 1995).

The differences in young/adult ratios among the species we caught in fall indicate variability in the migration patterns of hatch-year and after hatch-year birds. For example, more hatch-year than after hatch-year (9:1) Willow Flycatchers, a CPIF Priority Riparian Species, use the Salton Sea as a migratory stopover site. Stopover sites for refueling during migration are especially important for hatch-year Willow Flycatchers (Yong and Finch 1997). The abundance of hatch-year Willow Flycatchers at the Salton Sea in fall suggests that this area is an important stopover site for this species.

Studies show that bird populations during the breeding season have lower species richness and lower total density in saltcedar-dominated habitat than in native habitats (Anderson and Ohmart 1984, Hunter et al. 1988). Little information exists on use of non-native habitats during migration. Of the 20 area search plots we surveyed at the Salton Sea, 8 were dominated by saltcedar. We recorded lower species diversity within these plots compared to those with native vegetation.

Further study is needed to fully understand the importance of the Salton Sea and its environs to migrating landbirds. Lack of information on habitat use by birds during migration has prevented the development of comprehensive strategies for their protection along migration routes, including identification of high priority habitat types and specific sites critical to long-term persistence of those species (Petit 2000). Year-round, long-term monitoring efforts, such as constant-effort mist-netting and nest monitoring, should be established. These data could be used to document temporal variability in patterns of occurrence of migrants and in productivity rates of breeding birds and to identify habitat features important to various riparian birds.

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Table C-1. Songbird census techniques and habitat types at the Salton Sea, California, in 1999. Habitat types follow Sawyer and Keeler-Wolf (1995). SC = saltcedar, MX = mixed species, ME = mesquite, PV = blue palo verde, RE = residential.

Study Site	Habitat Type	Census Techniques		
		Point Count	Area Search	Mist Net
Alamo River	SC	X		
East Highline Canal	SC, MX	X		
Finney Lake	SC, MX		X	
New River	SC	X		
Niland	RE		X	
SSNWR Headquarters	ME, MX, PV		X	X
Ramer Lake	SC, MX		X	
Whitewater River	SC	X		
Wister Unit	SC, MX, ME	X	X	X

Table C-2. Productivity indices (hatch-year to after hatch-year ratios) for all species caught at the Wister Unit banding site at the Salton Sea, California, 6 April to 26 May 1999. AHY = after hatch-year captures, HY = hatch-year captures, U = birds of unknown age.

Species	AHY	HY	U	Ratio HY/AHY
Least Bittern *Ixobrychus exilis*	1	0	0	0.0
Sharp-shinned Hawk *Accipiter striatus*	1	0	0	0.0
Common Ground-Dove *Columbina passerina*	2	0	0	0.0
Rufous Hummingbird *Selasphorus rufus*	1	0	0	0.0
Western Wood-Pewee *Contopus sordidulus*	4	0	0	0.0
Willow Flycatcher *Empidonax traillii*	16	0	0	0.0
"Western" Flycatcher *Empidonax difficilis/occidentalis*	37	0	0	0.0
Hammond's Flycatcher *Empidonax hammondii*	7	0	0	0.0
Black Phoebe *Sayornis nigricans*	1	0	0	0.0
Ash-throated Flycatcher *Myiarchus cinerascens*	2	0	0	0.0
Western Kingbird *Tyrannus verticalis*	5	0	0	0.0
Cassin's Vireo *Vireo cassinii*	5	0	0	0.0
Warbling Vireo *Vireo gilvus*	136	0	0	0.0
Verdin *Auriparus flaviceps*	11	0	0	0.0
House Wren *Troglodytes aedon*	1	0	0	0.0
Marsh Wren *Cistothorus palustris*	24	0	0	0.0
Ruby-crowned Kinglet *Regulus calendula*	17	0	0	0.0
Blue-gray Gnatcatcher *Polioptila caerulea*	3	0	0	0.0
Black-tailed Gnatcatcher *Polioptila melanura*	5	0	0	0.0
Swainson's Thrush *Catharus ustulatus*	27	0	0	0.0
Hermit Thrush *Catharus guttatus*	5	0	0	0.0
Orange-crowned Warbler *Vermivora celata*	184	0	0	0.0
Nashville Warbler *Vermivora ruficapilla*	31	0	0	0.0
Yellow Warbler *Dendroica petechia*	86	0	0	0.0
Audubon's Warbler *Dendroica coronata auduboni*	61	0	0	0.0
Black-throated Gray Warbler *Dendroica nigrescens*	10	0	0	0.0
Townsend's Warbler *Dendroica townsendi*	17	0	0	0.0
Hermit Warbler *Dendroica occidentalis*	2	0	0	0.0
Western Palm Warbler *Dendroica palmarum palmarum*	1	0	0	0.0
MacGillivray's Warbler *Oporonis tolmiei*	30	0	0	0.0
Common Yellowthroat *Geothlypis trichas*	63	0	1	0.0
Wilson's Warbler *Wilsonia pusilla*	599	0	0	0.0
Yellow-breasted Chat *Icteria virens*	8	0	0	0.0
Western Tanager *Piranga ludoviciana*	36	0	0	0.0
Abert's Towhee *Pipilo aberti*	8	0	0	0.0
Chipping Sparrow *Spizella passerina*	1	0	0	0.0
Sage Sparrow *Amphispiza belli*	1	0	0	0.0
Song Sparrow *Melospiza melodia*	45	4	0	0.1
Lincoln's Sparrow *Melospiza lincolnii*	11	0	0	0.0

Table C-2. Continued.

Species	AHY	HY	U	Ratio HY/AHY
Swamp Sparrow *Melospiza georgiana*	1	0	0	0.0
Gambel's White-crowned Sparrow Zonotrichia leucophrys gambelii	5	0	0	0.0
Mountain White-crowned Sparrow *Zonotrichia l. oriantha*	2	0	0	0.0
Black-headed Grosbeak *Pheucticus melanocephalus*	4	0	0	0.0
Blue Grosbeak *Guiraca caerulea*	3	0	0	0.0
Lazuli Bunting *Passerina amoena*	7	0	0	0.0
Brown-headed Cowbird *Molothrus ater*	6	0	0	0.0
Bullock's Oriole *Icterus bullockii*	4	0	0	0.0
House Finch *Carpodacus mexicanus*	2	0	0	0.0
Lesser Goldfinch *Carduelis psaltria*	1	0	0	0.0

Table C-3. Productivity indices (hatch-year to after hatch-year ratios) for all species caught at the SSNWR Headquarters banding site at the Salton Sea, California, 3 September to 29 October 1999. AHY = after hatch-year captures, HY = hatch-year captures, U = birds of unknown age.

Species	AHY	HY	U	Ratio HY/AHY
Cooper's Hawk *Accipiter cooperii*	1	0	0	0.0
American Kestrel *Falco sparverius*	1	0	0	0.0
Common Ground-Dove *Columbina passerina*	2	0	2	0.0
Lesser Nighthawk *Chordeiles acutipennis*	0	1	0	-
Anna's Hummingbird *Calypte anna*	1	0	0	0.0
Willow Flycatcher *Empidonax traillii*	4	35	0	8.7
Western Flycatcher *Empidonax difficilis*	1	3	0	3.0
Black Phoebe *Sayornis nigricans*	7	4	0	0.6
Say's Phoebe *Sayornis saya*	2	0	0	0.0
Ash-throated Flycatcher *Myiarchus cinerascens*	1	2	1	2.0
Loggerhead Shrike *Lanius ludovicianus*	1	0	1	0.0
Plumbeous Vireo *Vireo plumbeus*	0	1	0	-
Warbling Vireo *Vireo gilvus*	1	1	0	1.0
Verdin *Auriparus flaviceps*	9	8	5	0.9
Cactus Wren *Campylorhynchus brunneicapillus*	0	1	0	-
Bewick's Wren *Thryomanes bewickii*	0	4	2	-
House Wren *Troglodytes aedon*	0	1	1	-
Marsh Wren *Cistothorus palustris*	0	1	0	-
Ruby-crowned Kinglet *Regulus calendula*	3	2	5	0.7
Blue-gray Gnatcatcher *Polioptila caerulea*	1	1	3	1.0
Black-tailed Gnatcatcher *Polioptila melanura*	0	1	0	-
Hermit Thrush *Catharus guttatus*	1	4	0	4.0
Northern Mockingbird *Mimus polyglottos*	2	3	1	1.5
Orange-crowned Warbler *Vermivora celata*	54	58	33	1.1
Nashville Warbler *Vermivora ruficapilla*	2	3	0	1.5
Yellow Warbler *Dendroica petechia*	59	58	3	1.0
Audubon's Warbler *Dendroica coronata auduboni*	30	76	62	2.5
Black-throated Gray Warbler *Dendroica nigrescens*	0	4	0	-
Townsend's Warbler *Dendroica townsendi*	0	1	0	-
American Redstart *Setophaga ruticilla*	1	1	0	1.0
MacGillivray's Warbler *Oporonis tolmiei*	15	8	1	0.5
Common Yellowthroat *Geothlypis trichas*	16	36	10	2.3
Wilson's Warbler *Wilsonia pusilla*	27	18	0	0.7

Table C-3. Continued.

Species	AHY	HY	U	Ratio HY/AHY
Western Tanager *Piranga ludoviciana*	0	2	0	-
Green-tailed Towhee *Pipilo chlorurus*	1	0	0	0.0
Abert's Towhee *Pipilo aberti*	17	1	8	.1
Chipping Sparrow *Spizella passerina*	0	2	0	-
Brewer's Sparrow *Spizella breweri*	1	2	0	2.0
Savannah Sparrow *Passerculus sandwichensis*	0	1	0	-
Song Sparrow *Melospiza melodia*	1	0	0	0.0
Lincoln's Sparrow *Melospiza lincolnii*	9	6	1	0.7
Gambel's White-crowned Sparrow *Zonotrichia leucophrys gambelii*	36	23	0	0.6
Mountain White-crowned Sparrow *Zonotrichia l. oriantha*	5	0	0	0.0
Oregon Junco *Junco hyemalis oreganus*	0	2	1	-
Blue Grosbeak *Guiraca caerulea*	1	3	0	3.0
Red-winged Blackbird *Agelaius phoeniceus*	2	2	0	1.0
Hooded Oriole *Icterus cucullatus*	0	1	0	-
House Finch *Carpodacus mexicanus*	2	0	1	0.0
House Sparrow *Passer domesticus*	0	1	0	-

Table C-4. Numbers of all species detected within 50 m of all point count stations by site at the Salton Sea, California, 8 April to 13 May 1999.

Species	Alamo River	New River	Whitewater River	Wister Unit
Cooper's Hawk *Accipiter cooperii*	0	0	1	0
American Kestrel *Falco sparverius*	0	1	0	0
Ring-necked Pheasant *Phasianus colchicus*	0	2	0	0
Gambel's Quail *Callipepla gambelii*	0	0	7	0
White-winged Dove *Zenaida asiatica*	0	2	0	3
Mourning Dove *Zenaida macroura*	5	49	6	20
Common Ground-Dove *Columbina passerina*	3	0	0	1
Lesser Nighthawk *Chordeiles acutipennis*	0	0	0	1
Black-chinned Hummingbird *Archilochus alexandri*	0	0	1	0
Ladder-backed Woodpecker *Picoides scalaris*	0	0	2	1
Western Wood-Pewee *Contopus sordidulus*	2	0	0	6
Willow Flycatcher *Empidonax traillii*	0	0	0	1
Hammond's Flycatcher *Empidonax hammondii*	0	0	0	1
“Western” Flycatcher *Empidonax difficilis/occidentalis*	0	2	1	1
Empidonax spp.	0	1	0	3
Black Phoebe *Sayornis nigricans*	0	3	0	7
Ash-throated Flycatcher *Myiarchus cinerascens*	0	4	1	3
Western Kingbird *Tyrranus verticalis*	5	7	2	14
Warbling Vireo *Vireo gilvus*	4	4	8	19
Tree Swallow *Tachycineta bicolor*	0	16	0	0
Northern Rough-winged Swallow *Stelgidopteryx serripennis*	0	36	20	1
Cliff Swallow *Petrochelidon pyrrhonota*	0	0	0	4
Barn Swallow *Hirundo rustica*	0	23	1	8
Verdin *Auriparus flaviceps*	8	29	34	17
Bewick's Wren *Thryomanes bewickii*	0	0	6	0
House Wren *Troglodtyes aedon*	0	0	0	2
Marsh Wren *Cistothorus palustris*	30	25	17	36
Ruby-crowned Kinglet *Regulus calendula*	1	3	3	0
Blue-gray Gnatcatcher *Polioptila caerulea*	0	1	3	0
Black-tailed Gnatcatcher *Polioptila melanura*	0	0	19	10
Swainson's Thrush *Catharus ustulatus*	1	0	0	1
Hermit Thrush *Catharus guttatus*	0	1	0	0
Northern Mockingbird *Mimus polyglottos*	0	0	0	1
Crissal Thrasher *Toxostoma crissale*	0	0	1	0
European Starling *Sturnus vulgaris*	0	0	0	7
Orange-crowned Warbler *Vermivora celata*	12	34	53	14
Nashville Warbler *Vermivora ruficapilla*	1	4	8	3
Yellow Warbler *Dendroica petechia*	2	2	4	6
Yellow-rumped Warbler *Dendroica coronata*	5	1	19	4
Myrtle Warbler *Dendroica c. coronata*	1	0	0	0
Audubon's Warbler *Dendroica c. auduboni*	8	44	62	10
Black-throated Gray Warbler *Dendroica nigrescens*	1	2	4	2
Townsend's Warbler *Dendroica townsendi*	3	1	0	1

Table C-4. Continued.

Species	Alamo River	New River	Whitewater River	Wister Unit
Common Yellowthroat *Geothlypis trichas*	20	15	41	20
Wilson's Warbler *Wilsonia pusilla*	9	14	15	23
Western Tanager *Piranga ludoviciana*	3	4	2	7
Green-tailed Towhee *Piplio chlorurus*	1	0	0	0
Abert's Towhee *Pipilo aberti*	2	14	18	20
Chipping Sparrow *Spizella passerina*	0	0	1	0
Brewer's Sparrow *Spizella breweri*	0	3	1	0
Black-throated Sparrow *Amphispiza bilineata*	0	1	0	0
Savannah Sparrow *Passerculus sandwichensis*	0	3	0	0
Song Sparrow *Melospiza melodia*	21	51	23	44
Lincoln's Sparrow *Melospiza lincolnii*	1	0	3	1
White-crowned Sparrow *Zonotrichia leucophrys*	0	21	7	4
Black-headed Grosbeak *Pheucticus melanocephalus*	0	3	0	3
Blue Grosbeak *Guiraca caerulea*	0	0	2	3
Lazuli Bunting *Passerina amoena*	1	3	1	3
Red-winged Blackbird *Agelaius phoeniceus*	0	12	0	2
Western Meadowlark *Sturnella neglecta*	0	4	0	0
Yellow-headed Blackbird *Xanthocephalus xanthocephalus*	0	1	0	0
Great-tailed Grackle *Quiscalus mexicanus*	2	4	5	2
Brown-headed Cowbird *Molothrus ater*	29	17	33	35
Bullock's Oriole *Icterus bullockii*	0	1	4	3
House Finch *Carpodacus mexicanus*	0	0	11	0
Lesser Goldfinch *Carduelis psaltria*	0	0	1	0
American Goldfinch *Carduelis tristis*	0	0	1	0
House Sparrow *Passer domesticus*	0	0	2	0

Table C-5. Species richness, diversity, and relative abundance for all point count transects surveyed at the Salton Sea, California, 8 April to 14 May 1999. All detections within 50 m of observer.

Transect	Number of Points	Species Richness	Relative Abundance	Diversity (N_1)
Alamo River	14	25	6.5	13.9
New River	25	38	7.9	18.9
Whitewater River	25	37	8.5	17.4
Wister Unit	24	39	7.6	22.2

Table C-6. Summary of all species detected during area searches at the Salton Sea, California, 7 September to 26 October 1999.

Species	Finney Lake	Highline Canal	Refuge Hdqrtrs	Niland	Ramer Lake	Wister Unit
Turkey Vulture *Cathartes aura*	0	1	0	0	0	0
Osprey *Pandion haliaetus*	0	1	1	0	0	1
Northern Harrier *Circus cyaneus*	0	1	3	1	1	2
Cooper's Hawk *Accipiter cooperii*	0	0	1	0	0	2
American Kestrel *Falco sparverius*	4	3	9	8	3	3
Ring-necked Pheasant *Phasianus colchicus*	0	0	0	0	0	1
Gambel's Quail *Callipepla gambelii*	7	10	4	6	0	0
Rock Dove *Columba livia*	0	0	0	14	0	1
Mourning Dove *Zenaida macroura*	4	2	74	12	1	5
Inca Dove *Columbina inca*	0	0	1	3	0	0
Common Ground-Dove *Columbina passerina*	8	18	96	35	10	25
Greater Roadrunner *Geococcyx californianus*	1	3	1	0	1	1
Barn Owl *Tyto alba*	0	0	0	0	0	1
Great Horned Owl *Bubo virginianus*	0	0	0	0	0	3
Lesser Nighthawk *Chordeiles acutipennis*	6	1	0	0	0	0
swift spp. *Chaetura* spp.	0	0	2	0	0	0
Black-chinned Hummingbird *Archilochus alexandri*	0	0	0	8	0	0
Anna's Hummingbird *Calypte anna*	0	0	1	7	0	0
hummingbird spp.	0	0	2	13	0	0
Ladder-backed Woodpecker *Picoides scalaris*	6	1	0	3	1	9
Northern Flicker *Colaptes auratus*	0	0	0	1	0	1
Red-shafted Flicker *Colaptes a. cafer*	0	0	2	0	0	0
Western Wood-Pewee *Contopus sordidulus*	0	0	0	2	0	0
Willow Flycatcher *Empidonax traillii*	2	0	7	0	0	1
"Western" Flycatcher *Empidonax difficilis/occidentalis*	1	0	0	2	0	3
Empidonax spp.	0	0	4	1	4	3
Black Phoebe *Sayornis nigricans*	10	10	42	6	25	38
Say's Phoebe *Sayornis saya*	0	2	8	1	2	4
Ash-throated Flycatcher *Myiarchus cinerascens*	0	0	0	1	0	0
Western Kingbird *Tyrannus verticalis*	1	0	0	0	0	0
Loggerhead Shrike *Lanius ludovicianus*	0	0	3	0	0	9
Warbling Vireo *Vireo gilvus*	0	0	4	1	0	4
Tree Swallow *Tachycineta bicolor*	5	0	1	0	2	0
Barn Swallow *Hirundo rustica*	9	8	5	8	5	5
Verdin *Auriparus flaviceps*	35	8	126	33	27	80
Cactus Wren *Campylorhynchus brunneicapillus*	3	0	1	1	2	3
Bewick's Wren *Thryomanes bewickii*	0	0	4	0	0	2
House Wren *Troglodytes aedon*	3	0	8	1	0	9
Marsh Wren *Cistothorus palustris*	9	0	2	2	11	38
Ruby-crowned Kinglet *Regulus calendula*	0	5	9	0	4	26
Blue-gray Gnatcatcher *Polioptila caerulea*	4	2	6	0	0	8
Black-tailed Gnatcatcher *Polioptila melanura*	9	1	7	0	1	8
gnatcatcher spp. *Polioptila* spp.	0	2	9	1	7	5

Table C-6. Continued.

Species	Finney Lake	Highline Canal	Refuge Hdqtrs	Niland	Ramer Lake	Wister Unit
Hermit Thrush *Catharus guttatus*	0	0	0	0	0	1
Gray Catbird *Dumetella carolinensis*	0	1	0	0	0	0
Northern Mockingbird *Mimus polyglottos*	6	2	35	53	4	9
European Starling *Sturnus vulgaris*	6	0	37	115	27	6
American Pipit *Anthus rubescens*	0	0	3	0	0	0
Phainopepla *Phainopepla nitens*	2	0	1	2	0	0
Orange-crowned Warbler *Vermivora celata*	12	4	59	0	8	107
Nashville Warbler *Vermivora ruficapilla*	1	0	1	0	2	12
Yellow Warbler *Dendroica petechia*	1	0	54	4	1	33
Yellow-rumped Warbler *Dendroica coronata*	0	1	35	0	5	11
Audubon's Warbler *Dendroica c .auduboni*	12	12	75	9	5	34
Black-throated Gray Warbler *Dendroica nigrescens*	0	0	3	0	0	2
Townsend's Warbler *Dendroica townsendi*	0	0	0	0	0	1
American Redstart *Setophaga ruticilla*	0	0	0	0	0	4
MacGillivray's Warbler *Oporonis tolmiei*	1	0	0	2	1	10
Common Yellowthroat *Geothlypis trichas*	9	15	25	4	6	68
Wilson' Warbler *Wilsonia pusilla*	0	0	11	4	2	31
Yellow-breasted Chat *Icteria virens*	0	0	1	0	0	1
Western Tanager *Piranga ludoviciana*	0	0	2	2	0	1
Green-tailed Towhee *Pipilo chlorurus*	0	0	0	0	0	1
Abert's Towhee *Pipilo aberti*	15	13	78	1	4	52
Chipping Sparrow *Spizella passerina*	0	3	0	0	0	2
Brewer's Sparrow *Spizella breweri*	0	3	0	0	0	0
Vesper Sparrow *Pooecetes gramineus*	0	15	0	0	0	0
Savannah Sparrow *Passerculus sandwichensis*	2	1	0	0	0	0
Song Sparrow *Melospiza melodia*	2	4	5	0	9	41
Lincoln's Sparrow *Melospiza lincolnii*	0	4	2	3	0	0
Gambel's White-crowned Sparrow *Zonotrichia leucophrys gambelii*	18	6	76	48	5	20
White-crowned Sparrow *Zonotrichia leucophrys*	2	9	46	0	23	22
Dark-eyed Junco *Junco hyemalis*	0	0	0	0	0	1
Oregon Junco *Junco h. oreganus*	1	1	1	0	0	0
sparrow spp.	0	0	2	0	0	0
Black-headed Grosbeak *Pheucticus melanocephalus*	1	0	2	0	0	1
Blue Grosbeak *Guiraca caerulea*	0	0	4	0	1	0
Red-winged Blackbird *Agelaius phoeniceus*	0	5	36	0	13	8
Western Meadowlark *Sturnella neglecta*	0	7	10	1	2	3
Brewer's Blackbird *Euphagus cyanocephalus*	0	0	3	0	0	0
Great-tailed Grackle *Quiscalus mexicanus*	1	1	2	21	21	33
Brown-headed Cowbird *Molothrus ater*	3	0	8	0	4	5
House Finch *Carpodacus mexicanus*	12	9	37	44	0	46
Lesser Goldfinch *Carduelis psaltria*	0	0	2	3	0	12
House Sparrow *Passer domesticus*	0	0	49	110	0	0

Table C-7. Species richness, relative abundance, and species diversity for 20 area search plots at the Salton Sea, California, 7 September to 26 October 1999. Habitat types follow (Sawyer and Keeler-Wolf 1995). SC = saltcedar, MX = mixed species, ME = mesquite, PV = blue palo verde, RE = residential.

Site	Habitat Type	Plot	Species Richness	Relative Abundance	Diversity (N_1)
Finney Lake	SC	1	22	26.3	16.2
	SC	2	20	18.0	13.8
	MX	3	25	32.6	18.9
East Highline Canal	MX	1	16	35.0	12.0
	SC	2	20	28.5	16.2
	SC	3	24	30.0	17.8
Refuge Headquarters	ME	1	28	46.0	18.1
	ME	2	27	47.0	16.6
	MX	3	26	58.6	15.2
	PV	4	20	28.6	18.8
Niland	RE	1	24	79.7	12.4
	RE	2	32	58.6	13.3
	RE	3	19	53.3	10.4
Ramer Lake	SC	1	22	26.3	15.4
	SC	2	18	18.3	12.8
	MX	3	21	35.0	10.8
Wister Unit	SC	1	27	28.3	18.0
	MX	2	28	37.7	20.2
	ME	3	25	36.6	18.8
	SC	4	21	28.0	14.6

Table C-8. Species richness, relative abundance, and species diversity by habitat type from area searches at the Salton Sea, California, September and October 1999. Habitat classification follows Sawyer and Keeler-Wolf (1995).

Habitat	Number of Plots	Mean Species Richness	Relative Abundance	Mean Diversity (N_1)
Mesquite series	3	26.7	43.3	17.8
Blue palo verde series	1	20.0	28.7	13.8
Mixed mesquite/Palo verde	5	23.2	37.5	15.4
Tamarisk series	8	21.7	23.0	15.6
Residential	3	25.0	63.9	12.0

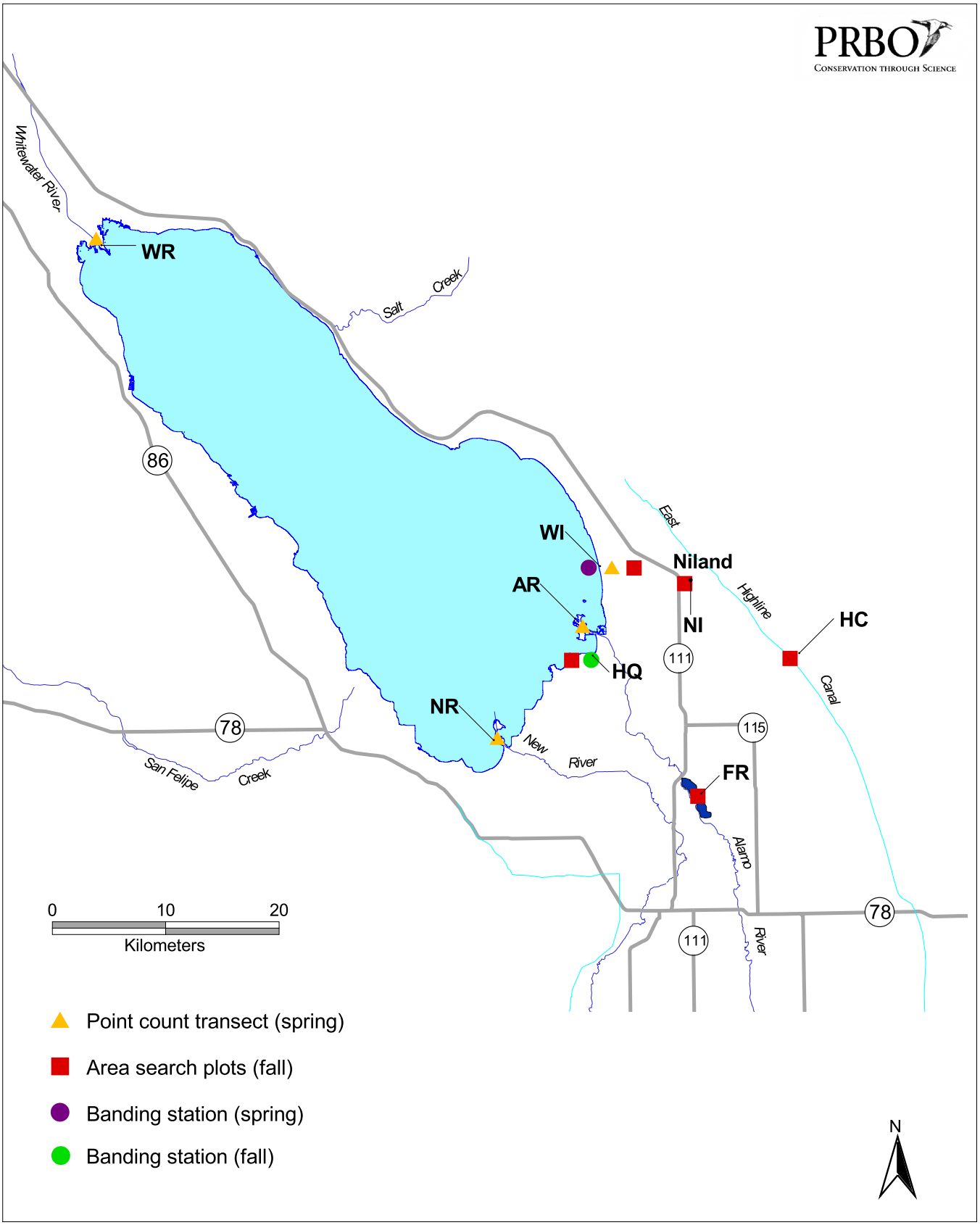

Figure C - 1. Locations of point count transects, area search plots, and banding stations for landbirds at the Salton Sea, California, and vicinity in 1999. AR = Alamo River, FR = Finney-Ramer Unit of Imperial WA, HC = East Highline Canal, HQ = Salton Sea NWR Headquarters, NI = Niland, NR = New River, WI = Wister Unit of Imperial WA, and WR = Whitewater River.

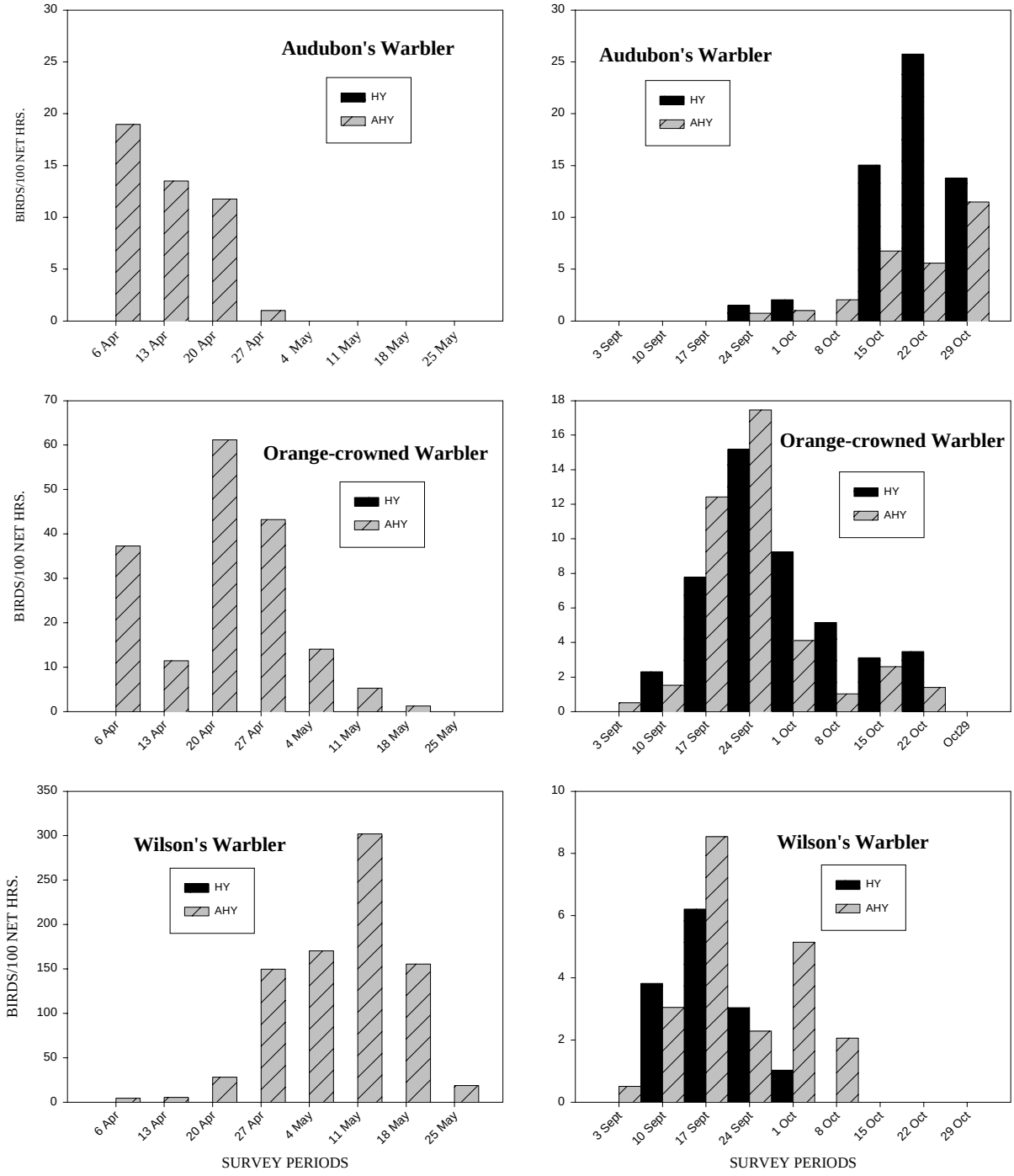

Figure C-2. Phenology of the Audubon's Warbler, Orange-crowned Warbler, and Wilson's Warbler at the Salton Sea, California, in spring and fall 1999.

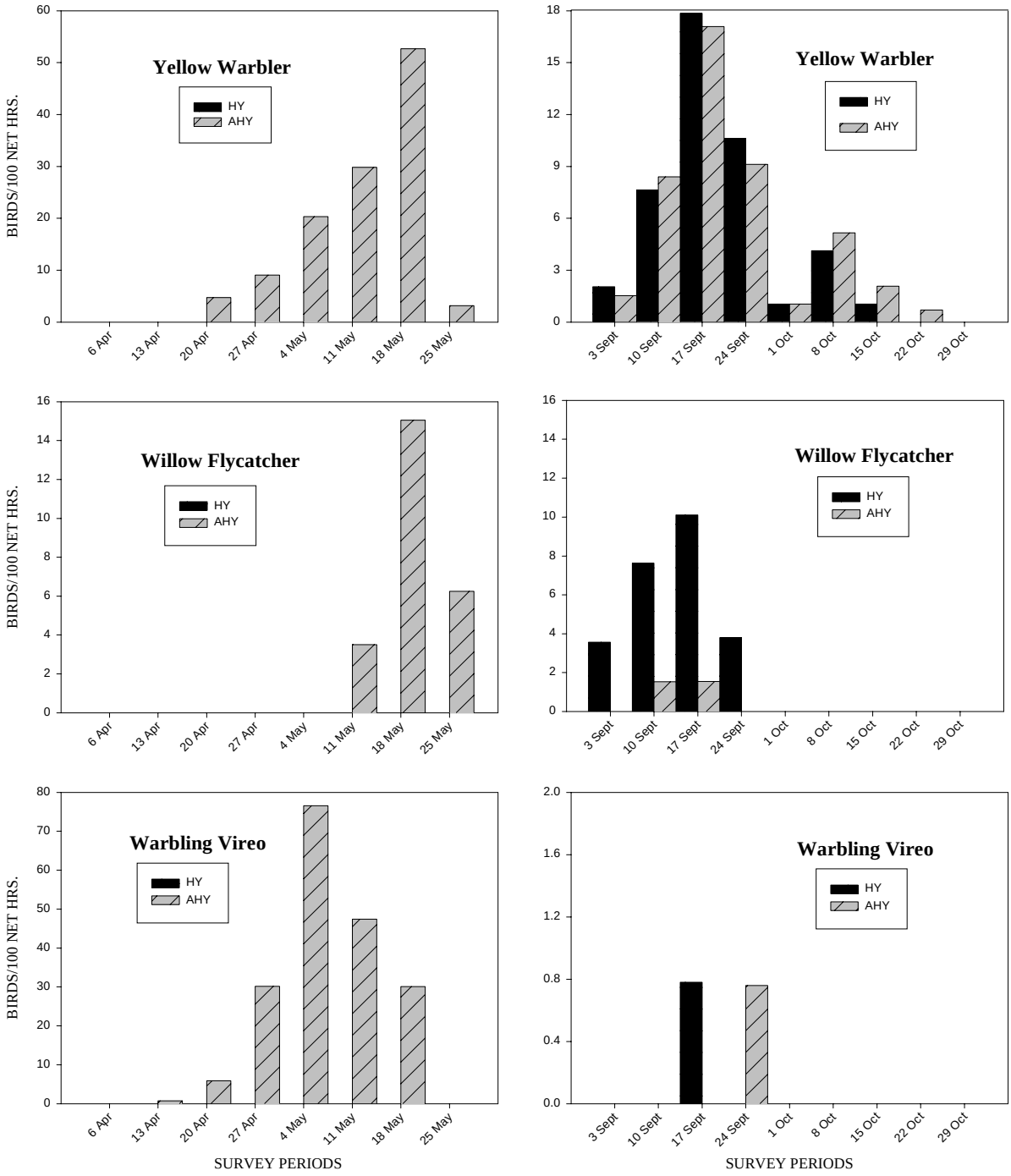

Figure C-3. Phenology of the Yellow Warbler, Willow Flycatcher, and Warbling Vireo at the Salton Sea, California, in spring and fall 1999.