ABUNDANCE AND DISTRIBUTION OF NONGAME WATERBIRDS IN THE KLAMATH BASIN OF OREGON AND CALIFORNIA FROM COMPREHENSIVE SURVEYS IN 2003 AND 2004

W. David Shuford, Danielle L. Thomson, David M. Mauser, and John Beckstrand

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4009 Hill Road
Tulelake, CA 96134

From:

PRBO Conservation Science
3820 Cypress Dr., #11
Petaluma, CA 94954

prbo
PRBO Conservation Science

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ABSTRACT

With a tightening water supply in the Klamath Basin, against a backdrop of extensive historic habitat loss, there is a crucial need for current biological knowledge to assess how future water allocation scenarios might affect the Basin's waterbird resources, which are among the most important in the Intermountain West. To provide such information, we conducted surveys of nongame waterbirds throughout the Klamath Basin in 2003 and 2004. Estimated combined totals for the 49 and 50 species tallied in 2003 and 2004, respectively, were 62,561 and 89,799 individuals in early May, 59,392 and 52,735 in mid-June, and 87,727 and 65,465 in mid-August. These one-time counts provide minimum estimates for most species, particularly during migration when many individuals passed through the Basin both before and after our counts. Though their importance varied seasonally, grebes, pelicans and cormorants, wading birds (bitterns, herons, egrets, ibis), shorebirds, and gulls and terns were the groups accounting for the bulk of all individuals on each survey. Species or species groups with basinwide populations of >5000 individuals were the Eared Grebe (all seasons), Western Grebe (May and June), American White Pelican (May and August), White-faced Ibis (June and August), Black-necked Stilt (August), Western and Least sandpipers (May and August), Dunlin (May), Long-billed Dowitcher (May and August), and Ring-billed Gull (all seasons). Ten other species exceeded 1000 individuals in at least one season. Species ranged from being distributed over a wide array of wetlands to being concentrated at relatively few. Certain wetlands or large water bodies stood out in supplying breeding or foraging habitat for large numbers of particular species or species groups, hosting species of very limited distribution within the Klamath Basin, or supporting populations that are of regional or continental importance. Among these key sites were Clear Lake NWR, Klamath Marsh NWR, Lower Klamath NWR, Sycan Marsh, Tule Lake NWR, and Upper Klamath Lake. Other wetlands were important for supporting large colonies of one or two species or particular at-risk species.

The Klamath Basin is of regional or continental importance to breeding populations of colonial (Eared, Western, and Clark's grebes, American White Pelican, Double-crested Cormorant, Great Egret, White-faced Ibis, Ring-billed Gull, and Caspian, Forster's, and Black terns) or other waterbirds (Yellow Rail, Sandhill Crane, Black-necked Stilt) and to migrant Sandhill Cranes, shorebirds, and Black Terns. It also hosts several breeding waterbird species (Red-necked Grebe, Snowy Egret, Yellow Rail, Franklin's Gull) with disjunct populations or that reach the limit of their range in the area. Because nongame waterbirds have received little prior attention in this region, much remains to be learned about their status and ecological requirements the Klamath Basin. Thus, it would be valuable to conduct more broadscale surveys of waterbirds to assess their status and distribution over a range of climatic and habitat conditions; to focus on certain areas and species, such as Western and Clark's grebes at Upper Klamath Lake; to study the status and ecology of species prioritized for conservation at the regional or national level; and to conduct studies of the energetic requirements of important species groups, such as shorebirds, that are poorly known. Conservation of nongame waterbirds in the Klamath Basin should be coordinated with the relevant national and regional conservation plans and the Intermountain West Joint Venture, and should seek to balance the legitimate needs of both wildlife and humans. To enhance these efforts, it would be valuable to conduct a scientific evaluation of management strategies for waterbirds on all major (federal, state, private) wetlands and water bodies in the Klamath Basin. Primary goals would be to assess the effectiveness of management at the site level and to seek opportunities for better integration of management across sites to maximize the Basin's overall carrying capacity for waterbirds within the constraints of a limited water supply.

INTRODUCTION

The Upper Klamath Basin of Oregon and California hosts a wetland complex long recognized as one of the most important to wildlife in western North America. Despite extensive loss of historic wetlands, the Klamath Basin currently supports about 80% of the waterfowl in the Pacific Flyway during migration, the largest wintering population of federally threatened Bald Eagles (*Haliaeetus leucocephalus*) in the conterminous United States, and shorebird and colonial waterbird populations of regional importance (USBR 1998; Shuford 1998, 2000; Gilmer et al. 2004). Yet, heightened concern for the long-term availability of high quality water for remaining wetlands in the Klamath Basin and the impacts of potential shortages on the basin's wildlife have highlighted the paucity of information currently available on the status and habitat needs of the region's nongame waterbirds.

The U.S. Bureau of Reclamation's Klamath Project was established in 1905 with the goal of irrigating as much of the Klamath Basin below Upper Klamath Lake as was practical. From inception until 1994, Upper Klamath Lake and the Klamath River were manipulated to achieve the Project's agricultural purpose. Remaining wetlands on National Wildlife Refuges (NWR) were maintained largely via drain water deemed surplus to agricultural need. Under this scenario water availability to refuges was only an issue during years of extreme drought. A Federal Solicitor's Opinion in 1995 ruled that Project priorities were now endangered species (lakes and rivers), tribal trust (lakes and rivers), agriculture, and refuges. Because of a reduction in water availability and a low priority for remaining water, shortages to wetlands on Lower Klamath NWR, particularly in summer and fall (USBR 1998, D. Mauser pers. obs.), occur with increasing frequency. In fact, Lower Klamath NWR has experienced either shortages of water or inappropriate timing of water delivery in each of the years 2001-2003. In addition to water quantity and timing issues, water quality is often poor because of high background nutrient concentrations coupled with loss of much of the natural filtering function of riparian and wetland habitats within the watershed. Given these problems, there is a critical need to understand the basic ecology of the Basin's waterbirds so that informed water allocation decisions can be made.

Although the distribution and abundance of waterfowl within the Klamath Basin are well known from decades of study (e.g., Gilmer et al. 2004), relatively little information is available on these patterns for the many nongame waterbirds using the Basin's wetlands. Published information is available mostly for single species, such as the White-faced Ibis (*Plegadis chihi*, Taft et al. 2000); for some groups of species, such as colonial waterbirds (Shuford 1998, Shuford et al. 2001) or shorebirds (Shuford et al. 2002a), from broadscale surveys in California or the West; or from anecdotal information specific to the entire Klamath Basin (Summers 1993) or to particular wetlands within it (Stern et al. 1987). Despite this limited knowledge, the Klamath Basin is known to have been one of only four sites in the Intermountain West in 1995 holding >2000 nests of the White-faced Ibis (Earnst et al. 1998) and the foremost site in northeastern California for colonial nesting waterbirds (Shuford 1998).

To fill important data gaps relative to their conservation, in 2003 we conducted a seven-month reconnaissance survey of wetland use by nongame waterbirds in the Klamath Basin, with a particular focus on Lower Klamath NWR and Tule Lake NWR (Shuford et al. 2004). This work was patterned after similar studies conducted at the Salton Sea in 1999 to provide quantitative data on the current status and ecology of birds in that region needed to address problems with the ecosystem's health (Shuford et al. 2000, 2002b). In 2004, we built on the 2003 baseline for the Klamath Basin by again conducting comprehensive surveys of nongame waterbirds three times during the year – spring migration, breeding season, and fall migration – and by surveying colonial nesting birds at appropriate intervals from spring through late summer. Here we compare the results of the 2003 and 2004 comprehensive surveys of migrant and breeding nongame waterbirds and describe patterns of abundance and distribution of key species or species groups within the Klamath Basin. In particular, we highlight patterns that varied between years and among basin subregions and outline important gaps in the knowledge of nongame waterbirds that will need to be filled to confidently establish population and habitat objectives for waterbirds in the Klamath Basin.

STUDY AREA

The study area encompassed the key wetlands and water bodies of the Upper Klamath Basin of Oregon (Klamath and Lake counties) and California (Siskiyou and Modoc counties) (Figure 1, Appendix 1). The Upper Klamath Basin (hereafter Klamath Basin) is considered the combined watersheds of the Klamath (above Iron Gate Dam) and Lost rivers (USBR 1998).

In 2003, total precipitation in the Klamath Basin area was well below average in the winter prior to our surveys but above average in the spring of 2003 during the period most likely to affect early nesting or migrant waterbirds. Precipitation for the climate year (1 July-30 June) 2002-2003 was 49.71 and 23.80 cm (19.57 and 9.37 in) in Oregon's High Plateau and South Central drainage divisions, respectively. These figures represent 71% and 78%, respectively, of the long-term averages (n = 109 yrs) for these areas (Western Regional Climate Center; http://www.wrcc.dri.edu/divisional.html). Precipitation for spring (1 March-31 May) 2003 for these regions was 17.35 and 10.41 cm (6.83 and 4.10 in), respectively, which represents 108% and 132% of the long-term averages at that season.

In 2004, total precipitation in the region was below average in the winter prior to our surveys, extending a trend that began in the late 1990s, and generally below normal in spring 2004. Precipitation for the climate year (1 July-30 June) 2003-2004 was 57.61 and 30.96 cm (22.68 and 12.19 in) in Oregon's High Plateau and South Central drainage divisions, respectively. These figures represent 82% and 101%, respectively, of the long-term averages (n = 110 yrs) for these areas (Western Regional Climate Center; http://www.wrcc.dri.edu/divisional.html). Precipitation for spring (1 March-31 May) 2004 for these regions was 11.23 and 8.53 cm (4.42 and 3.36 in), respectively, which represents 70% and 108% of the long-term averages at that season.

METHODS

COMPREHENSIVE SURVEYS

We used comprehensive surveys to document the overall abundance, distribution, and broadscale habitat associations of most waterbirds using the Klamath Basin. In 2003 and 2004, respectively, we conducted these surveys over three relatively short periods during spring migration (1-6 May, 28 April-11 May [mostly 29 April-4 May]), mid breeding season (12-23 June, 9-16 June), and fall migration (12-19 August, 9-17 [mostly 9-13] August); see Appendices 2a-c, 3a-3c. The methods described here for 2004 are only slightly different than those used in 2003 (see Shuford et al. 2004).

Because of the large size of the area and the remoteness of many sites, we used a combination of ground, aerial, and (limited) boat surveys, varying by area (Shuford et al. 2004, Appendix 1 this report). Combining the various methods, we attempted to cover all major wetlands, lakes, reservoirs, or other water bodies that were likely to hold substantial numbers of nongame waterbirds. Although Iron Gate and Copco reservoirs are considered by some to be within the Upper Klamath Basin, we did not survey any sites on the Klamath River below Keno Dam; this probably had little effect on our results, as Iron Gate and Copco are deep-water reservoirs that generally hold relatively few waterbirds. By contrast, though some waterbirds make extensive use of irrigated agricultural fields or other upland habitats in the Klamath Basin, we did not attempt to survey these habitats on our comprehensive surveys owing to the difficulty of doing so because of the large areas involved and limited access to them. Given they have already been surveyed extensively in the Klamath Basin for decades, we did not survey waterfowl (geese, swans, ducks) or American Coots (*Fulica americana*). Because of the large number of individual sites (some refuges divided into many subunits; Figures 2 and 3), we grouped them into 18 subareas and 3 major subregions of the Klamath Basin for data analyses and presentation (see Appendices 1-5). The subregions are North (includes Klamath Marsh NWR area, Sycan Marsh, Thompson Reservoir), Central (essentially all other Oregon sites), and South (almost exclusively California sites).

Ground surveys. Project staff, collaborating biologists, and skilled volunteers conducted ground surveys with the aid of binoculars and spotting scopes; observers generally traveled by automobile or truck, all-terrain vehicle, or on foot. Key areas typically covered on the ground were Butte Valley Wildlife Area (WA), Indian Tom Lake and various nearby wetlands, Lower Klamath NWR, Tule Lake NWR, various diked wetlands around Upper Klamath Lake (Agency Lake Ranch, Running Y Resort, Williamson River Delta Preserve, Wood River Wetland), Aspen and Long lakes southwest of Upper Klamath Lake, Lake Ewauna and Klamath WA (Miller Island) along the Klamath River, small lakes or reservoirs in the Spring Lake Valley and along the Lost River to the northeast, small reservoirs or wetlands in the Yonna Valley, Circle 5 Ranch in the Langell Valley, wetlands in the Fishhole lakes area, and many reservoirs and wetlands in the Gerber/Willow Valley watershed. The number of observers participating in ground surveys was 11 in April-May, 14 in June, and 12 in August. The authors conducted all ground surveys on the Klamath Basin National Wildlife Refuges.

We instructed observers, when possible, to identify all birds to species. Groups of unidentified waterbirds fell mostly into five categories: large grebes of the genus

Aechmophorus, either Western (*A. occidentalis*) or Clark's (*A. clarkii*) grebes; yellowlegs, either Greater (*Tringa melanoleuca*) or Lesser (*T. flavipes*); small sandpipers of the genus *Calidris*, primarily Western Sandpipers (*C. mauri*), Least Sandpipers (*C. minutilla*), and Dunlin (*C. alpina*); dowitchers, either Short-billed (*Limnodromus griseus*) or (primarily) Long-billed (*L. scolopaceus*) dowitchers; phalaropes, either Wilson's (*Phalaropus tricolor*) or Red-necked (*P. lobatus*); and gulls of the genus *Larus*, mainly the Ring-billed (*L. delewarensis*) and California (*L. californicus*). 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. Still, the vast majority of these birds were likely Long-billed Dowitchers, and we treat data for dowitcher spp. as pertaining to that species. 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, and taxonomy, for all species of waterbirds recorded on surveys (Appendix 6) follows the AOU (1998) and its recent supplements.

Aerial surveys. We conducted aerial surveys of a number of large or remote (unmanaged) wetlands, lakes, and reservoirs that were not feasible to cover by other methods (see Appendix 1). The main ones generally included Round Lake, Upper Klamath Lake (shoreline, nearshore waters, and large emergent marshes), Whiteline Reservoir, Swan Lake, Alkali Lake, Klamath Marsh NWR and adjacent private lands, Thompson Reservoir, Sycan Marsh, Sprague River Valley, Gerber Reservoir, and Clear Lake NWR. When counting waterbirds, we descended to about 150 ft (45 m) above the ground and reduced air speed to about 90 knots. Two observers counted waterbirds, each looking out opposite sides of the plane. Observers included J. Beckstrand, J. Hainline, D. Mauser, and D. Shuford.

For many sites, we covered all habitat directly, but for some larger sites – Upper Klamath Marsh at Upper Klamath Lake, Klamath Marsh NWR, and Sycan Marsh – we conducted transects every 0.5 mile (0.8 km). In these instances, we estimated that the two observers looking out opposite sides of the plane could each identify and tally waterbirds out to 0.125 mi (0.25 km) and hence we covered a 0.25 mi (0.4 km) swath or half of the area surveyed. Consequently, we doubled raw counts to better estimate total numbers of birds; for birds at colonies, particularly at Upper Klamath Marsh, we used just the raw counts, as we were confident we did not miss any of these conspicuous colonies.

When counting birds on the inshore waters of Upper Klamath Lake, we flew about 0.125 mi (0.2 km) from shore with one observer counting from the plane to shore and the other counting from the plane out into the lake an equal distance. Hence, we estimated that we counted a 0.25 mi (0.4 km) strip along the shoreline. Although we judged, both from aerial and ground surveys, that waterbirds were mainly concentrated in this inshore portion of the lake, we missed an unknown proportion of birds occupying offshore waters of the lake.

We substituted numbers of waterbirds counted at individual nesting colonies from 13 May aerial photographs for the less accurate visual estimates of these colonies on the 3-4 May aerial survey that was part of the basinwide comprehensive survey.

Ground surveys of grebe ratios. To supplement the aerial surveys of Upper Klamath Lake, which formed part of the comprehensive surveys, D. Shuford conducted

ground surveys there from 8-9 May and on 9 and 17-18 June, primarily to determine the proportions of Western and Clark's grebes, which we were unable to distinguish during aerial surveys. These data were used to adjust the totals of unidentified grebes by individual shoreline survey segments.

Ratios of the two species of large grebes were obtained by taking samples by spotting scope within the 8 (of 10) shoreline survey segments that were easily accessible by vehicle or foot. Areas sampled included the portion of segment #01 (Moore Park to Howard Bay) from Moore Park north to McCormick Point, the portions of segment #02 (Howard Bay) visible looking east and north from Hwy 140 and south and west from Squaw Point, the portions of segment #03 (Eagle Ridge) looking east and north along about 2 km of shoreline north of Squaw Point and east and south from about 2 km of shoreline south of Eagle Point, the portion of segment #04 (Shoalwater and Ball bays) visible looking west into Shoalwater Bay from the dirt road along the east side of that bay, the portion of segment #6 (Agency Lake) visible looking west from various access points mainly along Modoc Point Road, segment #08 (Modoc Point south to Hank's Marsh) looking west from various access points along Hwy 97, the portion of segment #09 (Hank's Marsh) visible looking west from access points along Hwy 97, and the portion of segment #10 (Hank's Marsh south to Moore Park) visible looking west from various access roads from Sunset Beach Rd. on the west side of Cove Point south to Moore Park. Grebes (and other waterbirds) were also counted along the Upper Link River (segment #11) from the edge of Upper Klamath Lake downstream to the first dam below (south of) the bridge on Lakeshore Drive (County Rd. 630), which was not covered by the aerial survey. Grebes and other waterbirds counted on this stretch of the Link River were added to the aerial totals. Numbers of grebes from aerial surveys of segments #05 (Upper Klamath Marsh) and #07 (Agency Lake Straits to Modoc Point) were adjusted from ratios on ground counts from the closest segment of similar habitat. For #05, this was the Shoalwater Bay portion of area #04; for area #7 this was segment #08.

We also adjusted the numbers of large grebes at Gerber Reservoir on aerial surveys on 4 May, 15 June, and 12 August by ratios obtained there by D. Shuford on ground counts of portions of that reservoir on 6 May, 12 June, and 13-14 August. Because the number of identified grebes on the ground counts of Gerber in May and June, respectively, accounted for only 16% and 24% of the unidentified grebes counted on the corresponding aerial surveys, the raw numbers of identified grebes were used along with the total number of unidentifieds minus the total number of identifieds. By contrast, the number of identified grebes on the ground counts for August accounted for 96% of the unidentifieds on the corresponding aerial survey, hence the remaining unidentifieds were adjusted by the ratio of Western to Clark's on the ground counts.

Also, because it was too time consuming to separate large numbers of Western and Clark's grebes while counting all species on the ground counts at the Upper Sump (1A) of Tule Lake NWR, D. Shuford conducted surveys of the ratio of these two species at that site on other dates. We used the ratios obtained on 7 May and 15 June to adjust the large number of unidentified grebes at this site on the 3 May and 9 June comprehensive surveys, respectively.

Ground surveys also provided information on the abundance of Eared (*Podiceps nigricollis*) and Pied-billed (*Podilymbus podiceps*) grebes and a few other rare or

secretive species at Upper Klamath Lake. In May and June, when small numbers of Eared Grebes were scattered in nearshore waters, Shuford obtained ratios of that species with respect to the combined numbers of the two species of large grebes. These ratios were used to adjust numbers of Eared Grebes, which were greatly undercounted on aerial surveys, either by applying the ratios of Eared to large grebes on ground counts to adjust those from the aerial survey or, as appropriate, the higher numbers of Eared Grebes on the ground surveys were substituted for the aerial totals, despite the fact the ground surveys sampled only a portion of the Upper Klamath shoreline and hence were a minimal estimate for that species.

Pied-billed Grebes also were very difficult to see on aerial surveys. Because they generally occurred on open water only in the vicinity of emergent marshes, it was not possible to obtain representative ratios relative to large grebes from ground counts to use to adjust aerial totals. Hence, in all seasons, numbers of Pied-billed Grebes tallied on ground surveys of particular shoreline segments were substituted for the corresponding aerial totals if they exceeded them.

Boat surveys. In 2004, the only boat surveys conducted were those for colonial waterbirds by airboat at Clear Lake NWR as described below.

NESTING COLONIAL WATERBIRDS

The timing of surveys to determine the numbers of pairs of nesting colonial waterbirds varied considerably among species to accommodate differences in breeding phenology. Also, survey methods sometimes varied among sites to suit differing logistical constraints.

Grebes. Refuge biologists conducted an aerial survey on 18 July 2004 to count numbers of nests of Eared, Western, and Clark's grebes at Lower Klamath NWR and Tule Lake NWR. Because nesting can span an extended period, we supplemented these surveys with counts taken opportunistically on other May to August surveys both at these two refuges and at other sites throughout the Klamath Basin.

During the aerial flight on 14 June 2004 as part of the June comprehensive survey, the senior author took photos of a large colony of Western and Clark's grebes in the marsh at Shoalwater Bay in Upper Klamath Lake using the methods described below for photographing other colonies of other species. Unlike for other species, well-built, empty grebe nests were included in nest totals used to estimate the total number of nesting pairs at the colony. This seemed reasonable both because of the large number of broods of these grebe species seen on the lake during 9 and 17-18 June ground surveys and because the aerial photos showed some nests with incomplete clutches unattended by adults, suggesting that some empty nests would soon have been occupied by adults incubating complete clutches. Any potential overcount of nesting pairs made by counting empty nests was likely compensated for by undercounts of incubating adults not visible on aerial photos because of poor lighting or obscuring vegetation. A ground survey on 18 June 2004 was of very limited use in obtaining ratios of the two species at the Shoalwater colony as, unlike in 2003, most grebe nests were not readily visible from the dirt access road on the east side of that bay.

Pelicans and cormorants. On 13 May 2004, D. Shuford took aerial photographs of American White Pelican (*Pelecanus erythrorhynchos*) and Double-crested Cormorant

(*Phalacrocorax auritus*) colonies at Lower Klamath NWR (Sheepy Lake), Tule Lake NWR (Sump 1B), Clear Lake NWR, Upper Klamath NWR (Upper Klamath Marsh), Swan Lake, and Gerber Reservoir. At each colony, Shuford took multiple overlapping photographs with a single-lens reflex camera with a 300 mm lens while the plane circled at about 70 to 95 knots at about 120 to 150 m above the colony. This distance above the colonies provided the best possible photographs while avoiding flushing birds from their nests. We used standardized methods developed for surveying coastal seabird colonies (G. J. McChesney and H. R. Carter in litt.) to count numbers of pelicans and cormorants. This involved first sorting the photographs (slides) to obtain a subset of overlapping reference photos of the highest resolution and contrast, projecting these on a large sheet of white paper (69 x 86 cm easel), and marking nests and birds with a fine marker using identifiable landmarks as reference points to avoid double-counting. For most colonies or sub-colonies, we estimated the number of pairs of pelicans and cormorants as the number of active nests (those with incubating or brooding adults, eggs, or chicks). Because of asynchronous nesting among sub-colonies of pelicans, in some years counting is difficult in the few areas where medium- to large-sized chicks (about 3-5 weeks old; Evans and Knopf 1993, P. Moreno pers. comm.) already have gathered into crèches by the time of May surveys; this was not the case in 2004, when no crèches were evident on the 13 May photographs. We did not photograph colonies at Meiss Lake, Butte Valley WA, because we did not see any nesting activity there on our 13 May overflight. In 2004, there was no evidence of nesting by colonial birds on the Meiss Lake islands, where small numbers of pelicans and cormorants sometimes nest, as the lake level was low and islands were connected to the mainland by a landbridge (D. Van Baren *fide* K. Novick pers. comm.).

Herons and egrets. We estimated numbers of pairs of nesting herons and egrets by various methods dictated by logistical constraints. We estimated numbers of pairs of the early-nesting Great Blue Heron (*Ardea herodias*) from counts of nests from aerial photographs of colonies at Clear Lake NWR, Lower Klamath NWR (Sheepy Lake), and Upper Klamath NWR (Upper Klamath Marsh) using the techniques described above. We also counted nests of this species visually at Sycan Marsh and along the Sprague River east of the town of Beatty on aerial surveys on 15 June and 3 May, respectively; a more accurate count of the latter colony was made from the ground looking north from Highway 140 on 5 May.

We estimated heron and egret nests at a traditional colony site in tall ponderosa pines (*Pinus ponderosa*) in a portion of the Klamath Game Management Area near Squaw Point, Upper Klamath Lake, on a 3 May 2004 aerial survey of all nongame waterbirds; D. Shuford counted numbers of nests at this colony from a distance on the ground using a spotting scope on 17 June 2004.

We counted Great Egret (*Ardea alba*) nests visually at Upper Klamath Marsh on a 14 June aerial survey. At Sump 1B of Tule Lake NWR, we counted egret nests from 13 May aerial photos and independently estimated nesting numbers on the basis of a 25 June flyout count, as described below for the White-faced Ibis; numbers for these surveys were similar so we used the one from aerial photos, which provided a better vantage point by which nests and adults could be counted directly. For Unit 13 of Lower Klamath NWR, we estimated numbers of nesting egrets both from aerial surveys on 29 April and 14 June and from a flyout count on 16 June; we gauged that highest nesting numbers occurred in

June, and we again used the aerial survey tally because of the better vantage point that allowed direct estimation of nest numbers. We estimated numbers of nesting egrets in willows in Unit 1W (F-9), during the nest establishment phase, on a 29 April aerial survey; we adjusted the estimate of adult egrets by multiplying that total by 0.76, the ratio of nests to adults on the photographs of the egret colony at Sump 1B of Tule Lake NWR. Finally, we estimated the number of egrets nesting in willows along the shoreline of "The U" peninsula on aerial surveys on 29 April, 4 May, and 16 June 2004. To obtain an estimates of nesting pairs, we first took the average of the number of adults estimated on 4 May and 16 June and multiplied that figure by 0.76, the ratio of nests to adults on the photographs of the egret colony at Sump 1B of Tule Lake NWR.

We estimated numbers of Black-crowned Night-Heron (*Nycticorax nycticorax*) nests at Unit 13 of Lower Klamath NWR and at Sycan Marsh on the aerial surveys on 14 and 15 June, respectively.

White-faced Ibis. We estimated the number of pairs of nesting White-faced Ibis at five colony sites using various methods. At Unit 13 of Lower Klamath NWR and at Tule Lake NWR Sump 1B, we used dawn flyout counts on 16 and 25 June, respectively, to estimate the number of nesting pairs. As for such surveys in prior years (Taft et al. 2000), we assumed that during the incubation and early nestling periods that one member of the pair would remain at the nest while the other adult would leave the nesting area to forage elsewhere. Hence, the number of adults flying out of the colony at dawn appears to provide a reasonable estimate of the number of nesting pairs. Numbers of nesting ibis at a smaller colony at Unit 12C of Lower Klamath NWR were estimated from a 14 June aerial survey and a 16 June flyout count. The number of nests at Smokey Lake in the Sprauge River Valley and at Sycan Marsh were estimated on aerial surveys on 3 May and 15 June, respectively.

Gulls. We estimated the number of nesting pairs of Ring-billed and California gulls at Gerber Reservoir and Swan Lake on the basis of counts of gulls from aerial photos taken on 13 May 2004. At islands in Clear Lake NWR, J. Beckstrand and D. Thomson counted numbers of nesting gulls from an airboat using binoculars on 25 May 2004. Because of the difficulty of distinguishing gull nests located well back from the shore on the Clear Lake islands during the airboat survey, we estimated the numbers of nests at all sites as 0.71 of the numbers of the Ring-billed Gull and 0.72 of the California Gull, the ratios at a portion of the Clear Lake colony in 1994 at which is was easy to count both nests and adults (see Shuford and Ryan 2000). As noted above, landbridging of islands at Meiss Lake, Butte Valley WA, precluding nesting by colonial waterbirds, including Ring-billed and California gulls, which nest there in large numbers in most years.

Terns. J. Beckstrand and D. Thomson returned to the Clear Lake islands by airboat on 17 June 2004 to count numbers of Caspian Terns (*Sterna caspia*), which in this area typically start nesting about three to four weeks later than do Ring-billed and California gulls. Because the terns nest relatively close to shore, they were able to directly count both adults and nests using binoculars. Numbers of nesting Caspian Terns at Clear Lake were also estimated on aerial surveys on 14 and 16 June. As noted above, landbridging of islands at Meiss Lake, Butte Valley WA, precluding nesting by colonial waterbirds, including Caspian Terns.

At most sites we were unable to directly count nests of Forster's (*Sterna forsteri*) and Black (*Chlidonias niger*) terns. Instead, we roughly estimated the overall number of pairs of each species on the basis of counts of adults taken during a comprehensive survey of waterbirds throughout the Klamath Basin from 9-16 June 2004. We obtained lower estimates of nesting pairs by dividing the total number of adults by two and higher estimates by dividing the number of adults by the ratios (1.43 for Forster's, 1.27 for Black) of (undisturbed) adults counted to nests at various breeding areas in northeastern California in 1997 (Shuford 1998, Shuford et al. 2001).

OTHER SURVEYS

We also conducted surveys for two species that stage in large numbers at individual sites in late summer or fall, and we opted not to survey one species because of the difficulties in doing so and because prior work is sufficient to characterize its abundance and distribution in the Klamath Basin.

Rails. We did *not* attempt to conduct broadscale surveys for the Yellow Rail *(Coturnicops noveboracensis)*, a species thought extirpated from the Klamath Basin but rediscovered there in 1982 (Stern et al. 1993). Surveys for this species require specific methodology, and we judged there was little to be gained by such surveys as extensive work has been conducted on this species in the Klamath Basin in recent years (Popper and Stern 2000, Lundsten and Popper 2002).

Sandhill Cranes. Because large numbers of Sandhill Cranes (mostly Greater Sandhill Cranes, *Grus canadensis tabida*) are known to stage at Lower Klamath NWR in fall, biologists conducted ground counts of cranes at that refuge and Tule Lake NWR on 5 and 20 October and 2 and 16 November 2004. We also used counts of cranes taken on the refuge's regular aerial surveys of waterfowl in the Klamath Basin on 8 September, 6 and 21 October, and 4 and 19 November 2004.

Refuge biologists also conducted pair counts of Greater Sandhill Cranes early in the breeding season at Klamath Marsh NWR (13 April), Lower Klamath NWR (20 April), and Tule Lake NWR (21 April). Biologists counted pairs, single individuals, and groups of three or more individuals. Because single cranes at that season are considered to be foraging individuals of mated pairs (the other bird being on the nest), we estimated the number of pairs at a site as the sum of individuals and pairs counted; we estimated total cranes at a site as two times the number of estimated pairs plus the total of non-mated birds counted in groups.

Black Terns. Because Tule Lake is one of only two sites in western North America where Black Terns are known to consistently stage in large numbers in fall (Shuford 1999), D. Thomson counted numbers of that species there on 13 July 2004.

PARTIAL SURVEYS

In 2003, we used partial surveys to document the seasonal occurrence patterns of waterbirds in the Klamath Basin; we also counted numbers of the Northern Harrier *(Circus cyaneus)* and Yellow-headed Blackbird *(Xanthocephalus xanthocephalus)*, two species on the draft list of California Bird Species of Special Concern (CDFG and PRBO 2001). To this end, we selected a subset of representative units of Tule Lake NWR

(Sumps 1A and 1B) and Lower Klamath NWR (6A, 7B, 9A, 12C, and White Lake) (Figures 2 and 3). Refuge biologists surveyed all partial survey sites during each of 17 specific survey periods from late March through late October: 26 March-1 April, 14-17 April, 1-3 May, 12-14 May, 27-29 May, 4-6 June, 13-16 June, 30 June-2 July, 14-18 July, 28 July-1 August, 6-8 August, 12-15 August, 27 August-3 September, 15-22 September, 29 September-1 October, 14-15 October, and 27-30 October. The surveys of these areas in early May, mid-June, and mid-August also served as part of the comprehensive surveys in 2003. We used data from partial surveys to determine the seasonal occurrence patterns of the most numerous species.

RESULTS

SPECIES RICHNESS AND ABUNDANCE

We tallied a total of 50 species of nongame waterbirds on three comprehensive surveys of the Klamath Basin in 2004 (Table 1, Appendices 3a-c). The number of species and individuals counted, respectively, were 43 and 89,799 in late April-early May, 37 and 52,735 in mid-June, and 42 and 65,465 in mid-August. Comparable figures for 2003 were a total of 49 species overall and 45 species and 62,561 individuals in early May, 36 and 59,392 in mid-June, and 43 and 87,727 in mid-August (Table 1, Appendices 2a-c).

In both years, grebes, pelicans and cormorants, wading birds (bitterns, herons, egrets, ibis), shorebirds, and larids (gulls and terns) were the groups that combined accounted for the vast majority of all individuals on each survey. In 2004, the groups accounting for >20% of any seasonal total were grebes, shorebirds, and larids during spring migration (or early breeding season) in early May, grebes and larids during the mid breeding season in June, and shorebirds and larids during fall migration in August. In 2003, the groups accounting for >20% of any seasonal total were shorebirds and larids in early May, grebes and larids during June, and shorebirds in August. For both years, only six to eight species or species pairs in any season had estimated populations exceeding 5% of the total for all waterbirds.

In 2003 and 2004, species or species groups with basinwide populations that exceeded 5000 individuals were the Eared Grebe (all seasons), Western Grebe (May and June), American White Pelican (May and August), White-faced Ibis (June and August), Black-necked Stilt (*Himantopus mexicanus*, August), Western and Least sandpipers (May and August), Dunlin (May), Long-billed Dowitcher (May and August), and Ring-billed Gull (all seasons). An additional 10 species exceeded 1000 individuals in at least one season (Table 1).

BASINWIDE DISTRIBUTION

Overall, waterbirds were widely distributed among available habitats in the Klamath Basin, though certain subregions, subareas, and individual sites held high concentrations of many or a few species (Tables 2-4; Appendices 2a-c, 3a-c, 4a-c, 5a-c). In both 2003 and 2004, Lower Klamath NWR, Tule Lake NWR, and Upper Klamath Lake were particularly important to waterbirds. In May, June, and August, those sites, respectively,

held 25%-39%, 27%-36%, and 25%-39%, 10%-24%, 13%-15%, and 9%-14%, and 13%-15%, 20%-28%, and 28%-42% of the basinwide totals for waterbirds (Appendices 4a-c, 5a-c). Swan Lake, with 14%-19% of the waterbirds (primarily gulls) in May, was the only other site that held >10% of the basinwide total in any season.

The proportion of waterbirds found within three subregions of the Klamath Basin generally were comparable between 2003 and 2004. In both years, >30% of total waterbirds occurred in the both Central and South subregions in spring, summer, and fall (Tables 2-4). In summer and fall, the proportion in the Central subregion was higher in 2004 than in 2003 and vice versa for the South subregion.

Across all seasons in both years, the Central subregion held 70%-88% of all Western and Clark's grebes, 62%-85% of all Double-crested Cormorants, and 33%-69% of all American White Pelicans (Tables 2-4). Except in June 2003, the Central subregion also held 68%-92% of all gulls, 40%-60% of all herons and egrets, and 36%-62% of all Sandhill Cranes. Also, this subregion held 63%-81% of all Forster's Terns and 43%-52% of all Willets (*Catoptrophorus semipalmatus*) in spring and summer, about 49%-55% of all Black Terns in summer, and 47%-83% of all American Avocets (*Recurvirostra americana*) in fall.

At all seasons in both years, the South subregion held 77%-87% of all Eared Grebes, 68%-92% of all Black-necked Stilts, 50%-91% of all Caspian Terns, 50%-87% of all shorebirds combined, 39%-63% of all American White Pelicans and 39%-70% of all herons and egrets (except 25% for both in August 2003), and 40%-74% of all White-faced Ibis (except 9% in August 2004). Also, the South subregion held 82%-90% of all American Avocets and 35%-47% of all Willets from spring through summer.

Although the North subregion did not hold a high proportion of total waterbirds at any season, it held 39%-52% of all Sandhill Cranes throughout (except 14% in August 2003) and 30%-44% of all Black Terns from late spring through summer.

Patterns for particular species or species groups among the three subregions of the Klamath Basin were often strongly influenced by patterns in particular subareas or individual sites as described below.

Grebes. Lower Klamath NWR and Tule Lake NWR were the most important sites for Eared Grebes at all seasons in both 2003 and 2004, with Upper Klamath Lake a distant third (Appendices 4a-c, 5a-c). Upper Klamath Lake was by far the most important site in the Klamath Basin for Western and Clark's grebes, as it held 62%-75% of the combined total for these species in both years across all seasons. Tule Lake NWR was a distant second, never exceeding 20% of the basinwide total for these species at any season in the two years.

Western and Clark's grebes were differentially distributed within the Upper Klamath Lake system (Table 5; Shuford et al. 2004, Figure 7). Although Westerns predominated both overall and within most segments of the shoreline of Upper Klamath Lake and in Agency Lake at all seasons, Clark's accounted for a higher proportion of the total in areas with deeper water, mainly on the west and south shore of Upper Klamath Lake. Although ratios of the two species varied within areas across seasons and years, the patterns of predominance of one species over the other (or co-dominance of the two) was generally consistent in all areas. Of the 9 of 11 areas with sufficient data, Westerns consistently predominated in 5, Clark's in 2, and the two were co-dominant in 1; in the

other area, Clark's dominated in 3 of the 5 season-year combinations, Westerns in 1, and the two were co-dominant in 1 (Table 5).

Apportioning the numbers of unidentified Western and Clark's grebes on particular lake segments on aerial surveys by the ratios on ground counts of these segments and summing the segment tallies provided an estimate of the overall ratio of these respective species at Upper Klamath Lake. In 2003, ratios were 1.8:1 in May, 2.0:1 in June, and 1.5:1 in August. In 2004, ratios were about 1.5:1 in May and 1.3 in June (1.5 if numbers from aerial photo counts of the Shoalwater colony are apportioned by the ratio on the bay's open waters).

A survey for grebe ratios on Sump 1A of Tule Lake NWR on 15 June 2004 tallied 1001 Western and 156 Clark's grebes. Multiple samples all around the perimeter got 526 Western and 112 Clark's; a large, distant feeding flock in the middle of the sump consisted of roughly 475 Western and 44 Clark's.

Pelicans and cormorants. In May and June, when American White Pelicans were breeding, the highest numbers in both years were at the three sites with nesting colonies – Clear Lake NWR, Upper Klamath Lake, and Lower Klamath NWR (Appendices 4a-c, 5a-c; Table 6). In addition, pelican numbers at Tule Lake NWR and the Klamath River area each exceeded 10% of the basinwide total in June 2004. In the post-breeding period in August, pelicans shifted away from Clear Lake NWR and concentrated more at Upper Klamath Lake and Lower Klamath NWR. In both years at all seasons, Double-crested Cormorants concentrated mainly at the sites with the two largest colonies, i.e., Upper Klamath Lake and Lower Klamath NWR. The Klamath River area, not far from Upper Klamath Lake, was the only real exception to this pattern when it held 20% of the basinwide total in June 2004.

Wading birds. At all seasons in both years, herons and egrets concentrated mainly at the sites hosting nesting colonies, particularly those with the largest, i.e., Lower Klamath NWR and Upper Klamath Lake (Appendices 4a-c, 5a-c; Table 6). White-faced Ibis generally were most widespread in early May (before or during the early nest establishment phase) and in August (after breeding), and concentrated the most during the peak of the breeding season in June, particularly around the largest nesting colony at Lower Klamath NWR. Numbers remained high at Lower Klamath in August in 2003 but not in 2004. In 2004, the comprehensive survey did not record high numbers at Tule Lake NWR in June despite a large nesting colony there.

Sandhill Cranes. Sandhill Cranes were widely distributed, though over the two years only two to four sites per season held >10% of the basinwide total, with Sycan Marsh usually holding >30% (Appendices 4a-c, 5a-c).

Shorebirds. In both years, shorebirds as a whole concentrated at very few sites, particularly during migration. In spring and fall, about 80% of all shorebirds were concentrated at only 1-3 sites or subareas (Appendices 4a-c, 5a-c). Most often Lower Klamath NWR held the most migrant shorebirds, but in some seasons Tule Lake NWR (e.g., spring 2003) and managed wetlands in the Upper Klamath Lake area (e.g., fall 2004) were also very important.

During June when most shorebirds are breeding, Lower Klamath held 47%-62% of the basinwide total over the two years (Appendices 4b, 5b); the Upper Klamath Lake area was the only other area with >10% of the breeding season total. Lower Klamath held 78% and 60% of the Black-necked Stilts and 74% and 66% of the American

Avocets in June in 2003 and 2004, respectively. Overall, breeding Willets were more evenly distributed than the two aforementioned species. Although Lower Klamath was important to breeding Willets so were the Sprague River Valley and Swan Lake. Killdeer (*Charadrius vociferus*) breed in such a variety of habitats, including the borders of agricultural fields, that numbers on our surveys of wetlands and other water bodies probably represent only a small proportion of the basinwide total. Still, of the areas we surveyed, only four held >10% of the total in June: Lower Klamath NWR, Sprague River Valley, the Gerber/Willow Valley area, and the Upper Klamath Lake area.

Gulls. In both years, Ring-billed and California gulls concentrated in May and June mainly in the areas with large breeding colonies – Swan Lake, Clear Lake, and Gerber Reservoir – though the importance to gulls of Lower Klamath NWR increased from May to June (Appendices 4a-b, 5a-b; Table 6). In August, by contrast, Upper Klamath Lake held 71% and 82% of the basinwide total in 2003 and 2004, respectively (Appendices 4c, 5c).

Franklin's Gulls (*Larus pipixcan*) occurred in modest numbers only in 2003, when 56% were at Lower Klamath NWR and 41% were at Spring and Tingley lakes in May and all were at Lower Klamath NWR in June, where they appeared to be breeding. The high count in June 2004 was 10+ at or adjacent to Sump 1B of Tule Lake NWR, in the vicinity of a colony of ibis and egrets where the gulls possibly were nesting. Although only single Franklin's Gulls were recorded on the August comprehensive surveys in both 2003 and 2004, opportunistic roost counts at dusk, presumably reflecting birds returning from foraging in agricultural fields, tallied 128 and 15 (minimum count) at Lower Klamath NWR on 14 August 2003 (Unit 7B) and 10 August 2004 (Unit 11B), respectively.

Terns. At all seasons in both years, most Caspian Terns were at only two to three sites, generally at large bodies of open water or roost sites nearby (Appendices 4a-c, 5a-c). Key areas were Clear Lake NWR, Tule Lake NWR, Upper Klamath Lake, and (in August 2003 only) the Klamath River area. During the peak of breeding in June, highest numbers in both years were at Clear Lake NWR, the only nesting site (Appendices 4b, 5b; Table 6).

At all seasons in both years, most Forster's Terns concentrated at one to four sites (Appendices 4a-c, 5a-c). Key sites were the Upper Klamath Lake area, Lower Klamath NWR, Tule Lake NWR, and the Klamath River area. The Upper Klamath Lake area was the most important one during breeding in June, when in both years it held >50% of the basinwide total and Lower Klamath NWR or Tule Lake NWR were the only other sites with >10%. Tule Lake NWR stood out in having 90% and 47% of the August totals in 2003 and 2004, respectively.

For Black Terns, data on patterns of occurrence in late April to early May are unreliable because they are just returning to the Klamath Basin. Thus, higher numbers at some sites may simply reflect the fact they were surveyed a few days later than others, when more terns had returned, rather than being a true gauge of their importance at that season. During breeding in June, Black Terns were concentrated mainly in three to five of these areas: Klamath Marsh area, Sycan Marsh, Upper Klamath Lake area, Fishhole lakes area, and Lower Klamath NWR (Appendices 4b, 5b). In August, these terns were concentrated mainly at Tule Lake NWR (64%-83%) and secondarily at the Upper Klamath Lake area (11%-26%; Appendices 4c, 5c).

COLONIAL WATERBIRDS

The abundance and distribution of colonies of colonial waterbirds varied considerably among species within the Klamath Basin in 2003 and 2004 (Table 6, text below). Several sites stood out in importance for particular species of colonial waterbirds or in holding a high number of such species. The sites holding the most species of colonial waterbirds were Clear Lake NWR, Lower Klamath NWR, and Upper Klamath Marsh/Lake, but the site holding the highest numbers of breeding pairs (mainly gulls) was Swan Lake. The patterns of distribution and abundance for particular species and species groups are described below.

Grebes. A combination of focused surveys to determine the size of grebe colonies at Lower Klamath NWR and Tule Lake NWR, opportunistic counts of colonies elsewhere, and basinwide data from the comprehensive survey in June provided valuable information on the abundance and distribution of these species in the Klamath Basin.

Our 18 July 2004 estimate of Eared Grebe nests on the California refuges was about 3700. Of these, 2200 were on Tule Lake Sump 1A, 200 on Tule Lake Sump 1B, and 1300 on Lower Klamath NWR (850, 250, and 200 on Units 3A, 2, and 11C, respectively). This was considerably less than the 7397 nests estimated in 2003, of which 5296 were on Tule Lake Sump 1A and 2101 on Lower Klamath NWR (1006, 676, 314, 75, and 30 on Units 3A, 12C, 7B, 11A2, and Orem, respectively). Unit 11A2 held 412 nests on a count in mid-June 2003; the lower July count there likely reflects a reduction in active nests as hatched young moved to the water with their parents during the latter part of the month-long span between surveys.

Estimates at other sites made opportunistically on the comprehensive aerial surveys in 2004 were 40 and 200 nests at Whiteline Reservoir on 14 June and 12 August, respectively, and 220 nests at Agency Lake on 11 August. Ground counts found 42+ nests at the Orem-Sterns Unit of Lower Klamath NWR on 10 June and a small number (difficult to see) at Dog Hollow Reservoir on 13 June. In 2003, an additional 475 Eared Grebe nests were counted on a 17 June aerial survey of the Chalk Banks/The Honker Hunt Clubs on the southeast edge of Lower Klamath NWR. Although it was not possible to obtain an accurate count of nests at Agency Lake Ranch in 2003, over 900 adult Eared Grebe and many nests were observed there on a 15 June ground count (D. Shuford pers. obs.), suggesting hundreds of breeding pairs for that site. In mid-August 2003, nine nests were found both at seasonal wetlands on agricultural lands at Tule Lake NWR and at Indian Tom Lake.

Nesting Western and Clark's grebes were highly concentrated, with 62% and 75% of their combined June totals at the Upper Klamath Lake area and 20% and 12% at Tule Lake NWR in 2003 and 2004, respectively (Appendices 4b, 5b). Although it was not possible to obtain complete nest counts for the entire Klamath Basin, the available nest data shed additional light on patterns of their distribution and abundance.

Our 18 July 2004 aerial estimate of 125 nests of the Western and Clark's grebes combined on the California refuges (100 on Tule Lake Sump 1B, 25 on Tule Lake Sump 1A) was surely an undercount, as small young were first seen riding on the backs of adults of both species on Sump 1A on 15 June. On Lower Klamath NWR, ground counts found two Western Grebe nests at Unit 4C on 11 June and two Western Grebe and two Western/Clark's nests at Unit 3A on 10-11 August. The comparable estimate of numbers

of large grebes nests on the California refuges in mid-July 2003 was 673 (636 on Tule Lake Sump 1A, 37 on Lower Klamath NWR).

Although our surveys did not accurately estimate the total number of nests at Upper Klamath Lake, this site was by far the most important in the Klamath Basin to Western and Clark's grebes. The largest colony detected at Upper Klamath Lake was one of about 1388 nests at Shoalwater Bay counted from aerial photos taken on 14 June 2004. A ground count at the Shoalwater colony on 18 June detected only 13 Western Grebe nests, 10 Clark's Grebe nests, and 57 Western/Clark's Grebe nests, but the vast majority of nests were screened from view from the access road on the east side of the bay. On that date, the ratio of Western:Clark's on the bay as a whole was about 273:94 (or 2.9:1) suggesting that overall there were about 1032 nests of the Western and 356 of the Clark's; this is very similar to the ratio of these species in a sample at the Shoalwater colony of 341:121 (or 2.8:1) in 2003. In 2003, the Shoalwater Bay colony was estimated at roughly 1041 nests from aerial overview photos taken 17 June, with the ratio of nests estimated at 768 for the Western and 273 for the Clark's on the basis of a ground count sample of adults at the colony on 16 June of 341:121 for the respective species. Other substantial colonies at Upper Klamath Lake were one of about 100 nests (likely mostly Western's) at Hank's Marsh on a 17 June 2003 survey and another of unknown size in lily pads in the northeastern corner of Agency Lake on 9 June 2004; vegetation obscured many of the nests at the latter site but at least 140 Western Grebes were seen in the colony area. As described above, large numbers of Western and Clark's grebes were found on most stretches of the inshore waters of Upper Klamath Lake, suggesting that the nest estimates presented here are very minimal. This is further substantiated by the large numbers of grebe broods already on Upper Klamath Lake in mid-June as detailed below.

Small numbers of nests of large grebes were found at other scattered locales in 2004: 2 Western Grebe nests at Nuss Lake on both 9 June and 12 August, 10 Western/Clark's Grebe nests on the Klamath River between Hwy 97 and Keno on 11 August (aerial survey), and 13 Western and 6 Clark's grebe nests at Indian Tom Lake on 10 August. In 2003, additional nests were 6 of the Western and 3 of the Clark's at Indian Tom Lake on 16 August and 1 of the Western at Nuss Lake on 14 June.

Pelicans and cormorants. An estimated 726 and 3104 pairs of American White Pelicans bred at three sites each year and about 1404 and 1647 pairs of Double-crested Cormorants bred at five and six sites in the Klamath Basin in 2003 and 2004, respectively (Table 6).

Wading birds. An estimated 98 and 143 pairs of Great Blue Herons, 339 and 515 pairs of egrets (mostly Great Egrets), and 3162 and 2521 pairs of White-faced Ibis bred at 4 and 6, 5 and 6, and 4 and 5 sites, respectively, in 2003 and 2004 (Table 6).

We did not obtain estimates of the numbers of nests or pairs of the Snowy Egret (*Egretta thula*) and Black-crowned Night-Heron. Our basinwide counts in June 2003 and 2004 of 30 and 20 and 392 and 262 for these respective species (Table 1) suggest their populations are modest in size, though numbers of the night-heron, a mainly crespuscular and nocturnal species, are likely greatly underestimated.

Gulls. An estimated 7435 and 8691 pairs of Ring-billed Gulls bred at 3 and 4 sites and 3014 and 1924 pairs of California Gulls bred at 2 and 3 sites in the Klamath Basin in 2003 and 2004, respectively (Table 6). We did not obtain an accurate estimate of the number of breeding pairs of Franklin's Gulls in either year, but on the mid-June

basinwide survey of waterbirds, we counted only 5 Franklin's Gulls in 2004 versus 154 (all on Lower Klamath) in 2003. On 16 June 2004, 10 Franklin's Gulls were seen roosting or foraging at Frey's Island, Tule Lake NWR, and 2-3 more (possible some of the other 10 seen later in the day) were flycatching over the adjacent Sump 1B of Tule Lake NWR. It is possible that in 2004 these gulls were breeding in the Sump 1B marsh, which held colonies of ibis and egrets.

Terns. The single nesting colony at Clear Lake NWR had about 29 and 93 pairs of Caspian Terns in 2003 and 2004, respectively (Table 6); there were about 270 adults at or near the colony on 17 June 2004. Lacking direct counts of nests of Forster's and Black terns, we estimated the number of breeding pairs of these species on the basis of our total counts for the Klamath Basin in mid-June of 2156 and 2455 adults and 2615 and 1959 adults in 2003 and 2004, respectively (Table 1). Depending on the correction factors used (see Methods), estimates ranged from 1078-1508 and 1228-1717 pairs of Forster's Terns and 1308-2059 and 980-1542 pairs of Black Terns in 2003 and 2004, respectively.

Other Breeders

For many other nesting species in the Klamath Basin, the numbers on our mid-June comprehensive survey (Table 1) provide the best estimates of the size of their breeding populations in this area. For more secretive species – rails, bitterns, snipe – these surveys provide only an index of their abundance and only for areas covered on the ground.

For one other species, biologists gathered additional information on its breeding season abundance on the refuges:

Sandhill Cranes. In 2004, pair counts for the Greater Sandhill Crane recorded 20 individuals, 30 pairs, and 8 grouped birds for an estimated 50 pairs and 108 total cranes at Klamath Marsh NWR on 13 April; 3 individuals and 2 pairs for an estimated 5 pairs and 10 total cranes at Lower Klamath NWR on 20 April; and 1 individual for an estimated 1 pair and 2 total cranes at Tule Lake NWR on 21 April. Hence, the Klamath refuges collectively held about 56 pairs and 120 total cranes in 2004. Comparable data for 2003 were an estimated 53 pairs and 145 total cranes (Klamath Marsh NWR – 5 singles, 41 pairs, 35 grouped non-breeders; Lower Klamath NWR – 7 pairs, 4 grouped non-breeders).

Staging Migrants

On the basis of expectations from prior knowledge, refuge biologists counted large numbers of Sandhill Cranes and Black Terns staging in late summer or fall in 2003 and 2004 at traditional sites in the Klamath Basin.

Sandhill Cranes. In 2004, the highest of four aerial counts (8 Sep-4 Nov) for Lower Klamath NWR had 970 cranes on 6 November. On three of the four counts, all cranes counted in the Klamath Basin were on Lower Klamath NWR. The fourth count had the highest overall total of 1130 cranes: 730 at Lower Klamath, 330 at Alkali Lake, and 70 in the southern Langell Valley. The highest of four fall ground counts (5 Oct-16 Nov) at Lower Klamath was 1115 cranes on 5 October 2004. In 2003, the highest aerial count was 1140 cranes (all at Lower Klamath), and the highest ground count at Lower Klamath was 1047 cranes.

Black Terns. In 2003, counts of Black Terns at Tule Lake NWR Sump 1A were 649 on 3 July, 1906 on 17 July, 2237 on 30 July, and 1479 on 14 August. The highest count for these terns, though, was 4621 on an 18 July multi-species count at Sump 1A. In 2004, the only count of staging Black Terns recorded a total of 883 individuals at Tule Lake NWR (528 on Sump 1A, 355 on Sump 1B) on 13 July.

SEASONAL OCCURRENCE IN 2003

Species of waterbirds varied considerably in their patterns of seasonal use over the course of the late March to late October 2003 study period (Figure 4a-e). For the four species of grebes, numbers of the Eared, Western, and Clark's built up in spring, remained relatively constant through the breeding season, and dropped off in fall, the Eared earlier than the two larger grebes (Figure 4a). Numbers of the Pied-billed were relatively low early in the year but increased to highs from mid-summer through fall. Of the two pelecaniformes, the American White Pelican reached highs in mid-summer to early fall, whereas the Double-crested Cormorant did so in spring (Figure 4a).

For wading birds (herons, egrets, ibis), numbers were highest in mid-summer for the Great Egret and White-faced Ibis, in spring for the Black-crowned Night-Heron, and in the late summer and fall for the Great Blue Heron and Snowy Egret (Figures 4a,b).

Seasonal patterns of occurrence varied considerably both among breeding and migrant shorebirds (Figures 4b-d). For breeders, the Killdeer was the only species for which numbers remained relatively stable for a long stretch in summer. For other breeders, numbers were highest in spring and early summer for the American Avocet and highest in fall for the Black-necked Stilt, Willet, and Long-billed Curlew. The Spotted Sandpiper and Wilson's Phalarope showed spikes in numbers both in spring and fall. Numbers of the Wilson's Snipe, the remaining breeding shorebird, were too few in the units surveyed to warrant graphing.

Of the migrant shorebirds, yellowlegs, Western and Least sandpipers, and Long-billed Dowitcher showed narrow peaks in spring and protracted peaks in fall; numbers were higher in spring than fall for sandpipers and vice versa for yellowlegs and the dowitcher (Figures 4c,d). The Dunlin occurred almost exclusively during a relatively narrow period in spring; so few were recorded in fall that they did not show up at the scale at which they were graphed.

Patterns of occurrence were variable for gulls but less so for terns (Figures 4d,e). Franklin's Gulls occurred in the surveyed refuge units mainly during spring migration and for one brief period in July. The Bonaparte's Gull also occurred mainly as a migrant, with numbers reaching their highest in spring, dropping to lows for the summer, then increasing in fall at the time our surveys ended. Numbers of the Ring-billed and California gulls combined were highest in spring, dropped sharply in June, and then increased to moderate numbers for the rest of the fall. Number of all three species of terns reached peaks during late summer and early fall; this pattern was particularly pronounced for the Black Tern (Figure 4e).

Numbers of the Northern Harrier were low from spring through late summer then increased sharply by mid-September, remaining high when our surveys ended in late October (Figure 4e). Numbers of the Yellow-headed Blackbird were modest in the survey area except for spikes in mid-May and early August.

DISCUSSION

SURVEY LIMITATIONS

Although our surveys methods did not differ materially between years, our counts may have been slightly more accurate in 2004 than in 2003 because of the experience gained over the two-year period and because we consistently covered more small wetlands in 2004 than in 2003. Still, our methods did have limitations that varied both among sites and species as outlined below.

Given a large study area with problems of access in many areas, our comprehensive survey methods were a compromise between trying to obtain the most accurate counts at as many sites as possible while varying methods among sites to accommodate logistical constraints. As it was not possible or practical to cover many of the large, remote, or inaccessible sites on the ground, one option to insure comparable coverage would have been to survey all sites by airplane, which is typically done for waterfowl surveys of the Klamath Basin. Most waterfowl, though, are relatively large in size, tend to occur in open areas, and concentrate in flocks during the main periods of the year (fall and winter) when they are censused. By contrast, the nongame waterbirds we surveyed ranged in size from very large and conspicuous American White Pelicans down to tiny Least Sandpipers, some species are usually concealed in dense vegetation and are difficult to survey even on the ground, and many are widely spaced during the periods of our surveys. Thus we judged it was best to survey as many sites as possible on the ground and restrict aerial surveys to those sites for which this was the only reasonable option.

Fortunately, a countervailing trend of mixing survey methods overall was that of using comparable methods for most sites of similar habitat. For example, we used ground surveys for almost all of the large managed wetlands, including Lower Klamath NWR, Tule Lake NWR, Butte Valley WA, Klamath WA, Running Y Resort, Agency Lake Ranch, Wood River Wetland, Williamson River Delta Preserve, and Circle 5 Ranch. Likewise, we used aerial surveys for all the extensive, remote, or inaccessible marshes, including Upper Klamath Marsh, Hank's Marsh, Klamath Marsh NWR, Sycan Marsh, and the Sprague River Valley; for the largest lakes and reservoirs, including Upper Klamath Lake, Whiteline Reservoir, Clear Lake, Gerber Reservoir, and Thompson Reservoir; and for large sites with a mix of open water and marsh, including Swan Lake and Alkali Lake. Hence, comparisons of numbers of waterbirds would be strongest among sites with similar habitats and the same survey method. More caution should be used in making comparisons of waterbird numbers in large managed wetlands covered on the ground with those in large natural marshes covered by air. In many cases, differences in species composition and abundance are so striking among such habitats that it is clear that these differences are real even if the methods used are not strictly comparable.

It is not always obvious which method will provide the best results, as all have their strengths and weaknesses. Even within a survey category, variations in methods may produce results of differing accuracy. For example, the aerial photography surveys we conducted of most large colonies of colonial birds surely produce much more accurate estimates of colony size than would visual estimates made instantaneously from a fast-

moving plane or those taken of a colony on a large island from a compromised vantage point on a boat.

The adequacy of our survey methods also varied both among and within major species groups. In most cases, the limitations outlined below would be best addressed by future surveys focused on particular species or species groups, as the opportunities for improvement are much less in the context of comprehensive surveys designed for all species of nongame waterbirds.

Grebes. Our comprehensive survey methods were inadequate for small grebes in the areas where we relied solely on aerial counts. Pied-billed Grebes in particular were very difficult to see on aerial surveys because they occur in very low densities and are hard to pick out on small patches of open water, particularly those with scattered lily pads or other look-alike floating or emergent vegetation, or when sitting on cryptic, solitary nests. Eared Grebes generally occur in much higher densities than Pied-billed Grebes but likewise can be difficult to see from a plane when dispersed among large numbers of other waterbirds or within obscuring marsh vegetation. Hence, the potential for undercounts of both species of small grebes was highest at the large marshes – Upper Klamath Marsh and Hank's Marsh at Upper Klamath Lake, Klamath Marsh NWR, and Sycan Marsh – that we counted mainly or exclusively by plane. Large Eared Grebe colonies are conspicuous from the air, though. Conversely, we counted the abovementioned marshes during mid-June and mid-August, rather than in July, as at Lower Klamath and Tule Lake, when peak numbers of nests are likely to occur. Still, there appears to be no prior evidence of large Eared Grebe colonies at any of the abovementioned sites that we surveyed only by air. For example, this species is considered rare in summer at the 10,117-ha Sycan Marsh (Stern et al. 1987).

In addition, because coverage was incomplete during surveys of colonial nesting grebes (Eared, Western, and Clark's) in July, these surveys provide only minimal estimates of the number of nesting pairs of grebes in the basin. Still, ground and aerial surveys provided adequate information on the overall abundance and distribution of Western and Clark's grebes during May, June, and August.

Pelicans and cormorants. We appeared to underestimate the size of the populations of pelicans and cormorants that initiated breeding in the Klamath Basin in 2003 because many individuals, particularly pelicans, had abandoned their nests by the time of our aerial photography survey. Multiple counts across the season would have provided a better estimate, but this extra effort typically is not justified because it would prove useful only in such atypical years, which are not easy to predict in advance.

Wading birds. We did not obtain estimates of the number of pairs of colonial breeding Snowy Egrets and Black-crowned Night-Herons, though we did count these species on comprehensive surveys in June, which provided at least minimal estimates of their abundance and distribution in the Klamath Basin in the breeding season.

Rails. Although we did obtain density estimates for Virginia Rails and Soras at Lower Klamath and Tule Lake NWRs (Shuford et al. 2004), because of their secretive nature we were unable to estimate the overall size of their populations in the Klamath Basin.

Sandhill Cranes. The reduction in our coverage of potentially suitable habitat for staging cranes in October and November because of ongoing waterfowl hunting theoretically could have depressed our crane counts, but this likely had little effect, as

hunting tended to concentrate cranes in non-hunted areas, where coverage was nearly complete.

Breeding shorebirds. We judge that our data on several species of breeding shorebirds are of limited value for describing their patterns of proportional distribution in the Klamath Basin. Spotted Sandpipers breed extensively along streams and rivers, which we did not attempt to survey unless associated with other wetlands. Long-billed Curlews breed mainly in upland grasslands and dry meadows, which we did not survey adequately. Wilson's Snipe breed in wet meadows and other low-stature wetlands but are easily overlooked, particularly on aerial surveys. Obtaining population estimates for snipe not only would have required ground counts in all areas but also special surveys targeted to detect them when performing aerial displays, mainly during crepuscular hours. We detected higher numbers of Wilson's Phalaropes than the other hard-to-survey shorebirds mentioned but judge that we probably missed many phalaropes scattered in low densities in wet meadows and other low-stature wetlands where they can be difficult to see in vegetated areas, particularly in those surveyed by plane.

Despite regular surveys throughout the breeding season in 2003, we did not detect any nesting Snowy Plovers at White Lake on Lower Klamath NWR, where the species breeds irregularly. Although reported breeding on diked ponds in the southern portion of Lower Klamath NWR, Siskiyou County, in 1957 (Giles and Crabb 1958), in recent decades the species is known to have bred in the Klamath Basin only at White Lake on the Oregon-California border (Summers 1982). Plovers tend to nest on exposed alkali flats near water at the northwestern side of the lake in Oregon and to move south to the California portion as lake waters recede from evaporation. Summers (1982) reported that in 1982 at least 14 adult plovers raised at least eight young at White Lake. Despite efforts to locate them, no nesting plovers were seen at White Lake from 1990 to 1995 (refuge files). A few have nested since: two nests were found on the Oregon side in early June 1996 (at least one nest "produced young"), an adult with two pre-fledglings on the California side on 2 September 1997, one nest on the Oregon side in early June 1998, and two adults and a nest on the Oregon side on 26 June 2000 (refuge files).

Gulls. As noted above, we did not obtain a precise estimate of the number of breeding pairs of Franklin's Gulls because we chose not to enter and disturb the large multi-species breeding colonies with which these gulls were known, or suspected to be, associated. In hindsight, it might have been possible to obtain an accurate count of their nests using aerial photography.

SPECIES RICHNESS

We surely would have seen more species, mainly rare ones, if we had conducted more comprehensive surveys during periods of migration or over the course of many years. Still, it is clear that the Klamath Basin is host to a large variety of nongame waterbirds reflecting the diversity of wetland habitats in this area. Because of differences in coverage it is difficult to compare species richness of waterbirds in the Klamath Basin to that in other regions.

SEASONAL OCCURRENCE

Very few nongame waterbirds occur in the Klamath Basin throughout the winter, and those that do occur in much smaller numbers at that season than in spring or fall migration or in summer (Summers 1993). Hence changes in waterbird numbers from March to October reflect mainly the passage of migrants, birds concentrating to breed, or birds concentrating or dispersing after breeding. By contrast, many more species of waterfowl (geese, ducks, swans) remain in the Klamath Basin through all or most of the winter months or remain longer in the fall or return earlier in the spring than do most species of nongame waterbirds.

The season of peak occurrence in 2003 varied greatly both among waterbird species and species groups (Figure 4a-e). Although these groups also vary in their habitats needs, the patterns of use demonstrate the importance of having a large amount of suitable wetland habitat throughout the year to accommodate birds during various parts of their annual cycle. This is particularly the case if the patterns of nongame waterbirds and waterfowl are both taken into consideration.

PHENOLOGY

Although we had only anecdotal information on the phenology of migration and nesting in 2004, some patterns were evident. Spring migration seemed slightly more advanced in 2004 than in 2003, when few summer resident waterbirds had reached the northern and higher reaches of the Klamath Basin by late April to early May.

Grebes. Nesting by large grebes seemed more advanced in 2004 than in 2003. A minimum of 24 Western Grebe broods were seen on a small portion of Agency Lake sampled on 9 June 2004. Most of these were very small and riding on adults' backs but at least six broods were on the water, and at least one chick was already about one-third the size of an adult. On surveys for ratios of Western and Clark's grebes on Upper Klamath Lake proper on 17-18 June, a minimum of 374 and 333 broods were noted among the 1504 and 1215 adults of these respective species. The minimum of six and four broods (all very small chicks riding on adults' backs), respectively, among the 526 adult Western and 112 adult Clark's grebes sampled around the perimeter of Tule Lake NWR Sump 1A on 15 June 2004 were the first noted at that site in summer 2004.

Pelicans. Numbers of nesting pelicans were much higher on mid-May aerial surveys in 2004 than in 2003. Evidence of nest abandonment by pelicans was observed in 2003 (Shuford et al. 2004), which may have been a response to above average precipitation in south-central Oregon that spring (132% of average for March-May, 153% for April-May).

DISTRIBUTION AND ABUNDANCE

In both 2003 and 2004, our estimates of the overall number of nongame waterbirds using the Klamath Basin would have been higher if we had been able to survey all of the extensive agricultural habitat in the area. Certain species, particularly White-faced Ibis and Ring-billed and California gulls, forage extensively in irrigated agricultural fields. Likewise, many migrant shorebirds will use farm fields when extensive areas of shallow

water remain from irrigation or precipitation. There appears to be no information on the proportion of waterbirds that use agricultural fields versus wetlands, but irrigated fields clearly add to the diversity of habitats available to waterbirds and likely boost the carrying capacity of the area for some species.

It is difficult to explain much of the annual variation in species' abundance between years. As but one example, we have no clue why the estimate of Eared Grebes in early May was 200% higher or why that in June was 25% lower in 2004 than in 2003.

Our extensive data for 2003 and 2004 in combination with prior historical data demonstrate that the size of the populations of many species of waterbirds using the Klamath Basin are of regional or even continental importance, as outlined below.

Grebes. There is relatively little information from prior local counts or from elsewhere with which to compare the population sizes of grebes in the Klamath Basin.

The Pied-billed Grebe breeds widely in the study area. We were unable, though, to obtain a reasonable estimate of the size of its breeding population there, particularly because it is very difficult to detect on aerial surveys, which we relied on to survey many of the large marshes that are prime breeding areas.

Oregon's only consistent breeding population of the Red-necked Grebe (*Podiceps grisegena*) occurs in the vicinity of Rocky Point and Pelican Bay on Upper Klamath Lake, where the species was first detected nesting in 1945; numbers of adults usually range from 5-20 (Watkins 1988; Spencer 2003a, maximum 28). When obtaining ratios of Western and Clark's grebes from shore from Rocky Point, we recorded single Red-necked Grebes in early May and mid-June 2003 and a pair with small young in mid-June 2004. We did not make special efforts to census this species, though, which would require boat surveys. The Red-necked Grebe is on Oregon's list of Sensitive Species, category Critical (ODFW 1997). The disjunct Oregon breeding population represents only a miniscule fraction of the North American population estimate of >45,000 individuals (Jehl 2001).

The Eared Grebe, with an estimated North American population of 3.7 million, is more than 12 times more numerous than all of the continent's other grebe species combined (Jehl 2001). Although we recorded >15,000 Eared Grebes on our mid-June 2003 survey of the Klamath Basin, the nesting population is likely substantially higher. Nest counts were a minimum of 7400 on Tule Lake NWR and Lower Klamath NWR combined and 475 on adjacent duck clubs, with a large but uncounted colony at Agency Lake Ranch and many other sites not surveyed. It is likely that the region holds at least 10,000 pairs (20,000 adults). There appear to be no population estimates for Oregon, California, or the Intermountain West with which to compare the Klamath Basin numbers. Still, we know of no breeding concentrations of Eared Grebes elsewhere in California that rival those at Tule Lake and Lower Klamath. Spencer (2003b) reported counts of up to 800 nests of this species at individual sites in Oregon but provided no statewide estimate.

Although we obtained a reasonably accurate estimate of the overall numbers of Western and Clark's grebes in the Klamath Basin in the breeding season, our surveys did not provide an accurate estimate of nesting pairs because we were unable to count nests, or distinguish between the two species, at all sites. Regardless, we did identify Upper Klamath Lake as the most important site (62%-75% of basinwide total in June) for these species followed by Sump 1A of Tule Lake NWR (12%-20% of June total). Still, our

high breeding-season estimate in June 2004 of over 9800 Western and Clark's grebes in the Klamath Basin highlights the importance of this region to these grebes. If the ratios of the two species from 2004 data are reasonable accurate (see Table 1 footnote), then the roughly 6000 Westerns and 3000 Clark's represent about 5% and 15%-30% of the North American populations estimates of >120,000 and 10,000-20,000 for these respective species (Jehl 2001).

Spencer (2003c) reported a boat survey at Upper Klamath Lake from Howard Bay to Shoalwater Bay on 14 June 2002 that tallied about 1150 Western and 340 Clark's grebes; making the "reasonable assumption" that numbers in this area were representative of the entire lake, he estimated the Upper Klamath total would have been about 5000 Westerns and 1500 Clark's grebes. Given the variability we found in the numbers and ratios of the two species among various sections of the Upper Klamath shoreline (Table 5; Figure 7 in Shuford et al. 2004), it is risky to make such extrapolations on the basis of counts of a relatively small portion of the lake; Nuechterlein and Buitron (1989) also found differential distribution of the two species around Upper Klamath Lake. Still, both our complete aerial surveys and Spencer's extrapolation from a partial boat survey, show that Upper Klamath Lake is very important to both species.

Ivey (2004) reported that Tule Lake held about 17% of the combined totals of Western and Clark's grebes for 13 selected sites in California with population data for 2003 and was the second most important of these sites for these species.

Prior work at Upper Klamath Lake and Lake Ewauna indicates that Clark's Grebes tend to forage farther from shore and in deeper water than do Western Grebes (Nuechterlein 1981, Nuechterlein and Buitron 1989). More work may need to be done to investigate this apparent resource partitioning given the lack of a direct relationship between distance from shore and water depth. The deepest water at Upper Klamath Lake is in a trench along the immediate western shore of the lake with shallower water found offshore from this trench (Figure 7 in Shuford et al. 2004). Regardless, differential distribution by depth and distance from shore may compromise the use of ground surveys to obtain accurate ratios of the two species for use in estimating the population sizes of the two grebe species, as it is not possible to safely identify many grebes far from shore. It is possible that the ratios of the two species for the unidentified grebes seen offshore may be skewed disproportionately – toward the Clark's in areas where depth increases with distance from shore and toward the Western where depth decreases from shore – relative to the ratios in inshore waters where most grebes are identified to species.

Pelicans and cormorants. At least in the 1890s, up to "thousands" of American White Pelicans nested at Tule Lake (Bailey 1902, Finley 1907a) but none are known to have nested there since. Likewise, many thousands were nesting at Lower Klamath Lake, Oregon, in 1895, and nesting was observed there until at least 1915 (Finley 1907a, 1915). After the drying of Lower Klamath Lake by 1919, the regional population concentrated chiefly at Clear Lake, which likely did not hold nesting pelicans until the damning of its outflow in 1910 more than doubled the amount of open water (see Shuford and Ryan 2000, p. 147) and apparently created islands not previously available. The first account of nesting was of about 400-500 pairs (about 150 nests) in 1918 (Willett 1919). The species once bred across the length of California, but reflecting historical declines, including in the Klamath Basin (Shuford 2005), the species is considered a California Bird Species of Special Concern, Priority 1 (Remsen 1978, CDFG and PRBO 2001).

Similarly, this pelican is on Oregon's list of Sensitive Species, category Vulnerable (ODFW 1997).

American White Pelicans currently breed consistently at only three sites in the Klamath Basin: Clear Lake NWR, Sheepy Lake on Lower Klamath NWR, and Upper Klamath Marsh. The 614, 17, and 95 pairs in 2003 were below or near the low end of prior estimates for these sites, whereas the 2190, 402, and 512 pairs in 2004 were near the high end of prior estimates. The below normal numbers of nesting American White Pelicans in the Klamath Basin in 2003 likely reflected both nest abandonment during a stormy spring and a reduction in the number and extent of nesting islands at Clear Lake in response to low water levels.

The Clear Lake pelican colony typically is by far the largest in the Klamath Basin (refuge files). Numbers of pelican nests ranged from 400-2559 (ave. = 1487, SE = 207.3) at Clear Lake in 12 years from 1981-2000, from 200-695 (ave. = 423, SE = 40.9) at Sheepy Lake in 11 years from 1981-1997, and from 40-625 (ave. = 210, SE = 41.2) at Upper Klamath Marsh in 13 years from 1988-2001. In 1999 and 2000, when no pelicans nested at Sheepy Lake after high water levels led to saturation of the tule-mat nesting islands, small numbers (12-15 pairs) nested nearby on islands in Meiss Lake at Butte Valley WA (K. Novick in litt., D. Shuford unpubl. data).

The combined numbers of breeding pelicans for the three sites in the Klamath Basin in 2004 represent almost 5% of the estimated 134,000 individuals for the continental breeding population and about 16% of the estimated 37,600 in the population west of the Rockies (King and Anderson 2005).

The nesting population of Double-crested Cormorants in the Klamath Basin – 1404-1647 pairs in 2003-2004 – is of regional importance. Of 1415 pairs of cormorants tallied from nest counts in northeastern California in 1997, 94% were at three sites in the Klamath Basin refuges: Sheepy Lake (69%), Tule Lake Sump 1B (15%), and Clear Lake (9%; Shuford 1998). Likewise, the colony at Upper Klamath Marsh is typically the largest in the interior of Oregon (Matthews et al. 2003).

Wading birds. Like many colonial waterbirds in the Klamath Basin, wading birds occur at relatively few colonies (Table 6) and consequently are vulnerable to major predation or other catastrophic events. Willett (1919) noted "about one hundred nests" of the Great Blue Heron at Clear Lake in April 1918, which is equivalent to the size of the entire Klamath Basin nesting population in 2003 and about 70% of that in 2004. The Klamath Basin is one of the most important nesting areas for the Great Egret in Oregon (Herziger and Ivey 2003a) and adjacent northeastern California (D. Shuford pers. obs.). Although the Snowy Egret population of the Klamath Basin, found mainly at Lower Klamath NWR and in the Upper Klamath Lake area, is relatively small (Table 1), it appears to represent a substantial portion of the population in southeastern Oregon (Herziger and Ivey 2003b) and northeastern California (D. Shuford pers. obs.). The Snowy Egret is on Oregon's list of Sensitive Species, category Vulnerable (ODFW 1997).

The White-faced Ibis is currently the most numerous species of nesting wading bird in the Klamath Basin and one of the most concentrated (Table 6). After about 12 pairs colonized Lower Klamath NWR in 1985, the nesting population rose steadily to 3900 pairs in 1994 and has fluctuated since, reaching a low of 674 pairs in 1998 and a high of 4555 in 2001 (Figure 5). Lower Klamath was one of only four sites in the Intermountain West in 1995 holding >2000 ibis nests (Earnst et al. 1998). In all years,

ibis have nested at Lower Klamath in open stands of hardstem bulrush in early stages of succession (Taft et al. 2000, D. Mauser pers. obs.). After four years of management for marsh regeneration, a large ibis colony formed at Tule Lake NWR (Sump 1B) in 2004, representing the first known nesting at that refuge since 1962 (refuge files). We suspect that the reason the June 2004 comprehensive survey did not record high numbers at Tule Lake NWR as a whole was that birds at nests in the colony at Sump 1B were not visible from the periphery of the sump and that most ibis away from the colony were foraging either at Lower Klamath NWR or on (unsurveyed) private agricultural lands.

Data on the size of other ibis colonies in the Klamath Basin are limited. Prior irregular surveys at Sycan Marsh, Lake County, Oregon, found a colony active in 1993, inactive in 1995, and comprised of about 150 and 45 pairs in 1997 and 1999, respectively (G. Ivey in litt.). Additional small colonies were found at Wood River Wetland in 1999 (75 pairs) and at Swan Lake in 2000 (200 nests; G. Ivey in litt.).

While at Agency Lake Ranch surveying waterbirds, Shuford (2002) observed at least 13 flocks of ibis totaling about 578 individuals headed north shortly after dawn on 29 May 2001. Such flights are characteristic of ibis leaving colonies to forage, and these birds probably represented only a portion of the ibis flying out of a nesting colony, which, given the direction they were coming from, likely was in Upper Klamath Marsh. It is unclear if the colony discovered in 2003 at Smokey Lake in the Sprague River Valley is recently established or was previously overlooked because of its relatively remote location.

Large population increases in the 1980s and early 1990s at the western edge of the breeding range in the Harney Basin, Oregon, and Lower Klamath NWR, California (and in eastern Idaho) may have resulted at least in part from displacement of ibis from Great Salt Lake, Utah, by flooding in the early and mid-1980s (Ivey et al. 1988, Taylor et al. 1989) or shifting among various colonies during droughts in the late 1980s and early 1990s. The Great Basin/Intermountain West population has nearly tripled since 1985 (Earnst et al. 1998). The establishment, increase, and maintenance of the Lower Klamath ibis population was made possible by changing management practices in the early 1980s that greatly expanded the extent of early-successional emergent marshes, particularly thin stands of hardstem bulrush favored by the ibis, and summer foraging habitat (Taft et al. 2000, D. Mauser pers. obs.).

Rails. Because of their secretive nature and the special techniques needed to survey them adequately, particular across a large area, we added very limited information on the status of rails in the Klamath Basin.

The Yellow Rail is on Oregon's list of Sensitive Species, category Critical (ODFW 1997). It was known initially as a breeder in Oregon from single nest records in the Klamath Basin in 1926 at Aspen Lake and Shoalwater Bay, Upper Klamath Lake, but a lack of records from 1950 to 1980 lead ornithologist to conclude that this rail was extirpated as a breeder in both Oregon and northeastern California (Stern et al. 1993). Rediscovery of calling birds in the Fort Klamath/Wood River Valley area in 1982 catalyzed studies of the distribution and ecology of Yellow Rails throughout the Klamath Basin. Surveys have found this rail in the Klamath Basin in the Wood River Valley, Odessa Creek on the west side of Upper Klamath Lake, Klamath Marsh NWR, Sycan Marsh, and the Sprague River Valley (between Copperfield Draw and Beatty) (Stern et al. 1993, Lundsten and Popper 2002, Stern and Popper 2003). Oregon breeding habitat

for these rails consists of wet montane sedge meadows located near a cold water spring, seep, flowing creek, or in the floodplain of a river (Stern et al. 1993). Such Klamath Basin wetlands are crucial to the survival of this disjunct breeding population in Oregon.

Sandhill Cranes. Counts of both breeding and fall-staging Greater Sandhill Cranes on federal refuges were similar in 2003 and 2004 and did not alter prior assessments of the regional importance of the Klamath Basin to these populations. The Klamath Basin supported about 20% of the 1223 breeding crane pairs in Oregon and California in 1986-1988 (Littlefield et al. 1994) and about 18% of the 1616 pairs in 1999-2000 (Ivey and Herziger 2000, 2001). The Klamath Basin held some of the most important breeding areas in Oregon (Sycan Marsh, Klamath Marsh-Klamath Marsh NWR, Klamath River floodplain) and California (Lower Klamath NWR).

The 2003-2004 counts added to the long-term data showing Lower Klamath NWR is one of the most important sites for staging Greater Sandhill Cranes during fall migration from mid-September to mid-November, when over 1500 cranes have been counted on a single day (Figure 6). Given the total size of the (wintering) Central Valley Population (CVP) of Greater Sandhill Cranes is unlikely to exceed 10,000 individuals (Ivey and Herziger 2003), the peak counts at Lower Klamath represent about 15% of the entire CVP. Given that hundreds of these cranes breed to the south and east of Lower Klamath, and hence may not pass through Lower Klamath in fall migration, and that the single-day peak counts in fall do not account for turnover of birds, the proportion of CVP cranes that use Lower Klamath in fall is likely much higher.

Shorebirds. The Klamath Basin is of at least regional importance to migrating shorebirds. Numbers of shorebirds in the California portion of the Klamath Basin (exclusive of Butte Valley WA) on Pacific Flyway Project surveys from 1990 to 1995 ranged from 2906-28,367 (n = 6 yrs, median 6616) in spring and from 325-2622 (n = 6 yrs, median 2021) in fall (Shuford et al. 2002a). In 2003 and 2004, we estimated, respectively, about 27,000 and 34,000 shorebirds in the entire Klamath Basin in early May and 47,000 and 24,000 in mid-August (Table 1). The higher numbers in these years than in the early 1990s appear to be attributable to several factors: coverage of the Oregon portion of the basin in 2003 and 2004, recent creation of shallow-water wetlands around Upper Klamath Lake at Agency Lake Ranch, Williamson River Delta Preserve, and Wood River Wetland, and changing management at some sites. Examples of the latter are for Tule Lake Sump 1B, where spring drawdowns have attracted large numbers of shorebirds (11,406 in 2003), and at Wood River Wetland, where shallow water at the time of the August 2004 count attracted 5746 shorebirds, representing almost 24% of the basinwide total. A count of Sump 1B on 27 April 2001 estimated at total of about 19,961 shorebirds; species each contributing over 5% of the total were Western Sandpiper (39%), Least Sandpiper (7%), Dunlin (37%), and Long-billed Dowitcher (11%) (D. Shuford unpubl. data).

Numbers of some breeding shorebirds in the Klamath Basin are also of at least regional importance. Comparing numbers on our surveys in June 2003 and 2004 (Table 1) to those reported from 10 other “key shorebird areas of the Intermountain West” profiled by Oring et al. (2000), the Klamath Basin had the second highest numbers of breeding Black-necked Stilts after Great Salt Lake. The population of breeding Black-necked Stilts in the Klamath Basin represents about 2% of the estimated North American population of 150,000 individuals (Morrison et al. 2000). Although the Klamath Basin is less important to the

American Avocet, numbers of breeding avocets there exceed those at a few of the "key shorebird areas of the Intermountain West" (Oring et al. 2000)

Gulls. Although most gulls counted on June comprehensive surveys were concentrated near breeding colonies some were not. For example, the large numbers of gulls at Lower Klamath NWR in June 2003 were mainly roosting in bare or recently sprouted agricultural fields. Patterns of concentration would have been more accurately reflected if we had conducted surveys of the extensive areas of private agricultural land where many gulls forage.

By the post-breeding period in August, about 70%-80% of gulls basinwide were concentrated at Upper Klamath Lake, apparently to take advantage of fish kills. Such die-offs often occur during periods of poor water quality (high ammonia, low dissolved oxygen, high pH), found annually during late summer in this increasingly hypereutrophic lake, in response to the dynamics of the dominant (blue-green) algae *Aphanizomenon flos-aquae* (Perkins et al. 2000). Fish kills of variable magnitude have been noted since the late 1880s but have occurred more frequently in recent years (Perkins et al. 2000); usually concentrations of gulls and other fish eating birds increase in kind (M. Buettner in litt.). Affected fish are mainly large chub (*Gila* sp.) and adults of the federally endangered Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers (Perkins et al. 2000). Water quality in Upper Klamath Lake was especially poor in late July and early August 2003 (M. Buettner pers. comm.).

The nesting gull populations in the Klamath Basin are of regional significance. For the three years between 1994-1997 when data were available on the size of all major colonies of the Ring-billed Gull in California, the Klamath Basin sites (Meiss Lake/Butte Valley WA, Lower Klamath NWR, Clear Lake NWR) held 56% to 59% of the statewide breeding population (Shuford and Ryan 2000).

The breeding season of 2003 and 2004 were unusual for gulls in the Klamath Basin. A large colony that typically forms at Meiss Lake, Butte Valley WA, was inactive because water levels were too low to maintain isolation of nesting islands (K. Novick pers. comm.). From 1994-1999, the numbers of breeding pairs of the Ring-billed Gull at Meiss Lake ranged from 2525-4087 (median 3332) and of the California from 327-2956 (median 2009; Shuford and Ryan 2000). Low water levels at Clear Lake NWR reduced the number and combined size of nesting islands, and correspondingly the 738 and 729 pairs of Ring-billed and 1182 and 701 pairs of California gulls (Table 6) in 2003 and 2004, respectively, were less than usual. From 1994-2000, numbers of nesting pairs of these respective species ranged from 1739-3922 (median 2942) and 432-1769 (median 1345; Shuford and Ryan 2000). A small colony of gulls at Unit 6A of Lower Klamath NWR was inactive in 2003 and held 35 pairs of Ring-billed Gulls in 2004. Surveys of Unit 6A from 1994-1998 and in 2000, found 6-96 (median 48) pairs of California Gulls; the 48 pairs of the Ring-billed in 2000 is the only documentation of that species nesting there in this period (refuge files). Also, a colony at Sheepy Lake, which held 178 and 79 pairs of California Gulls in 1994 and 1997, respectively, is not known to have been active since (refuge files, this study). Shuford and Ryan (2000) provided additional data on the historical size of gull colonies in the California portion of the Klamath Basin, including former colonies at Tule Lake and Tule Lake NWR.

By contrast, Oregon gull colonies reported for the first time in the literature in 2003 at Swan Lake and Gerber Reservoir were also active in 2004 (Table 6). The Swan

Lake colony with 5673 and 6604 pairs of the Ring-billed and 1832 and 1160 pairs of the California in 2003 and 2004, respectively, was by far the largest gull colony in the Klamath Basin in this period (Table 6). We since have learned that G. Ivey (in litt.) made an estimate of about 150 Ring-billed Gull nests at Swan Lake during an aerial survey for cranes in 2000. It is unclear if the Swan Lake and Gerber colonies were active in prior years but went unreported because of their remote locations or if nesting is irregular, perhaps depending on varying local conditions or the shifting from other sites where conditions are sometimes inhospitable or suboptimal, as was the case at Meiss and Clear lakes, respectively, in 2003 and 2004.

The history of gull breeding in the Oregon portion of the Klamath Basin is sketchy. The only prior well documented account of breeding in this area is Finley's (1907b) detailed description of a Ring-billed and California gull colony of "at least five hundred pairs" nesting on tule-mat islands in Lower Klamath Lake in 1905 before it was drained. Gabrielson and Jewett (1940) reported "one or more" colonies of the California Gull at Upper Klamath Lake and another at Spring Lake. They noted the Ring-billed Gull occurred in "each of the great colonies of California Gulls in … the Klamath Basin" yet identified only Spring Lake as a specific colony site of the Ring-billed. F. Newton (in Conover 1983) reported both gull species "breeding" at Upper Klamath Lake in 1979 but provided no estimate of the colony size or its location at the lake. Gilligan et al. (1994) reported that "in recent years over 2000 pairs" of California Gulls have nested in the Klamath Basin, Klamath County, but they provided no actual colony location(s). Similarly, they indicated that the California is joined by the Ring-billed at Klamath County colonies but provided no estimate of the size of the latter species' population in this region. Butler (2003) cited Conover (1983) and Gilligan et al. (1994) together for the estimate of 2000 pairs of nesting California Gulls at Upper Klamath Lake, Klamath County, during the early 1990s, though the former author identified only the colony site and the latter only the population estimate.

The Franklin's Gull was very rarely seen in the Klamath Basin in the 1970s and early 1980s (R. Ekstrom in litt.) but has since increased both as a migrant and breeder. Through the early 1990s high counts of migrants were in the single digits, typically <5. The highest annual double-digit counts from 1995 to 2003 include the following (all observations by R. Ekstrom in litt.): 27, 13 June 1995, Lower Klamath NWR; 15, 31 May 1996, Lower Klamath (Unit 4B); 51, 8 July 2000, Lower Klamath (Unit 4C); 21, 28 May 2001, Tule Lake NWR (Sump 1B); 53, 5 May 2002, Tule Lake NWR (49 in Modoc Co. fields); and 30, 7 September 2002, Lower Klamath NWR (Unit 7B). Numbers of Franklin's Gulls in the Klamath Basin from spring through fall 2003 were unprecedented (R. Ekstrom, K. Spencer pers. comm.). High counts during migratory periods in 2003 were 260 on 10 May at Tule Lake NWR (Sump 1B), Siskiyou County, California (R. Ekstrom in litt.); 153 on 28 April near Merrill and 55 on 11 May near Henley High School, both Klamath County, Oregon (Spencer 2003d); and 128 on 14 August at Lower Klamath NWR (Unit 7B) (D. Shuford pers. obs.). These and other records for the Klamath Basin (Table 1, D. Shuford pers. obs.) indicated that many hundreds of Franklin's Gulls migrated through, or to, the Klamath Basin in 2003.

The Franklin's Gull was first documented breeding in the Klamath Basin in 1990 at Lower Klamath NWR (Summers 1993, Burger and Gochfeld 1994), and small numbers have been present in summer in most years since. The 154 recorded on the mid-

June 2003 comprehensive (Table 1) is also unprecedented for the Klamath Basin for the breeding season.

The unusual numbers of Franklin's Gulls in the Klamath Basin during migration and in the breeding season in 2003 were not repeated in 2004.

Terns. The Caspian Tern currently breeds in the Klamath Basin mainly at Clear Lake NWR. The population estimates of about 29 and 93 nesting pairs in 2003 and 2004, respectively, are atypically low for this site, which is among the most important to the species in interior of the West (Shuford and Craig 2002). There appears to have been no ornithological exploration of Clear Lake before the damming of its outflow in 1910 eliminated most marshland and greatly increased the extent of open water. Refuge biologists have estimated numbers of nesting pairs of Caspian Terns at Clear Lake NWR since at least 1952; in most years through the mid-1970s, numbers of nesting pairs were <160 but from 1977 to the present mostly in the 200-300 range (Shuford and Craig 2002). From 1997-2001, the number of nesting pairs at Clear Lake ranged from 68-242 (median 180). Islands occupied vary with lake level, and the terns usually nest in association with other colonial waterbirds, such as Ring-billed and California gulls and American White Pelicans. Inactive in 2003 and 2004 (K. Novick pers. comm.), a much smaller colony forms irregularly on islands in Meiss Lake, Butte Valley WA, where from 1997-2001 the number of pairs ranged from 0-27 (median 19). Caspian Terns nest there on low-lying islands in association with Ring-billed and California gulls.

Caspian Terns nested at Lower Klamath Lake before it was drained (Finley 1907c, 1915). Chapman (1908) described a colony there of 300 terns nesting with cormorants on a tule-mat island in 1906. Gabrielson and Jewett (1940) noted that after the draining of Lower Klamath Lake that the only remaining colony "in late years" in Klamath County, Oregon, was one of 20-50 pairs at Spring Lake. Subsequently, refuge biologists estimated nests at Lower Klamath NWR, California, in at least 1955 (15), 1970 (20), 1972 (27), and 1976 (20); terns nested on tule-mat islands with pelicans and cormorants (Shuford and Craig 2002). At Tule Lake, Bailey (1902) observed a feeding flock of about 500 Caspian Terns along the shoreline in July 1899 but did not visit the nesting island(s) or estimate breeding pairs. Refuge biologists estimated numbers of nests in colonies on islands in Sump 1B of Tule Lake NWR at least in 1952 (80), 1953 (14), 1955 (3), and 1962 (19) (Shuford and Craig 2002).

The location and size of nesting colonies of the Forster's Tern in the Klamath Basin are poorly documented. Important breeding sites in at least some years are Agency Lake Ranch, Butte Valley WA, Chalk Banks/The Honker Hunt Clubs, Lower Klamath NWR, Tule Lake NWR, Upper Klamath NWR (Upper Klamath Marsh, Hank's Marsh) (Shuford 1998, this study). Other known or suspected breeding sites are Aspen Lake, Clear Lake NWR, Gerber Reservoir, Klamath Marsh NWR, Klamath WA (Miller Island), Lake Ewauna, Ness Lake, Round Lake, Soloman Flat, Swan Lake, Sycan Marsh, Thompson Reservoir, Williamson River Delta Preserve, and Wood River Wetland. The 2156-2455 Forster's Terns we counted in the Klamath Basin in June is about 4%-5% of the estimated North American population of 47,000-51,500 breeders (Kushlan et al. 2002).

The status of breeding Black Terns in the Klamath Basin has been poorly known until recently, but there still are few population estimates for specific sites. Key breeding areas include Agency Lake Ranch, Klamath Marsh NWR, Lower Klamath NWR, Sycan

Marsh, and Upper Klamath NWR (Upper Klamath Marsh, Hank's Marsh) (Shuford 1999, Shuford et al. 2001, Stern 2003, Alexander et al. 2004, this study). From 1982 to 1984, Sycan Marsh, held about 200 to 400 pairs (M. Stern in Shuford 1999). Other known or suspected breeding sites are Adobe Flat, Agency Lake, Alkali Lake, Antelope Reservoir, Aspen Lake, Barnes Valley, Bear Valley, Butte Valley National Grasslands, Butte Valley WA, Chalk Banks/The Honker Hunt Clubs, De Vaul Lake, Dog Hollow Reservoir, Dry Prairie, Gerber Reservoir potholes, Kilgore Reservoir, Long Lake, Noble Reservoir, Round Lake, Smokey Lake, Soloman Flat, Sprague River Floodplain, Squaw Flat, Swan Lake, Upper Midway Reservoir, Wood River Wetland, and Yonna Valley wetlands. This list is likely incomplete, and terns do not nest at all sites every year.

Tule Lake NWR is one of only two areas in western North America where large numbers of Black Terns are know to consistently stage during fall migration, the other being the Salton Sea (Shuford 1999, Shuford et al. 2001). Black Terns appear to be attracted to the large numbers of damselflies at Tule Lake at this season (D. Mauser pers. obs.). Malheur Lake, Oregon, also can serve as an important staging area when water depths are "normal" in fall; up to 6000 Black Terns have congregated there "in the past" (Littlefield 1990). Our high count in this study was about 4621 individuals at Tule Lake Sump 1A on 18 July 2003. From 1949 to 1977, estimated peak counts of Black Terns at Tule Lake NWR from July to early September ranged from 2000 to 19,000 (n = 17 yrs, median 5000), documenting it as an extremely important post-breeding or migratory stopover for the species (Shuford et al. 2001). Estimates of tern numbers at Tule Lake, 15 July to 4 August 1997, ranged from 1000 to 6000. In five years from 1958 to 1972, peak counts at Lower Klamath NWR in August exceeded 1000 (max. = 9000, Klamath Basin NWR files); large numbers have not been reported there in recent years.

Overall Historic Changes

Although it is beyond the scope of this report to catalogue the details of what is known of wetland loss in the Klamath Basin and its effects on waterbirds, still a few comments are in order. Among the greatest losses to waterbirds in the Klamath Basin were the draining of Lower Klamath and Tule lakes. Historically, Lower Klamath Lake consisted of about 22,267 ha of marsh and 12,146 ha of open water (Akins 1970). Lower Klamath Lake was then intermediate between an undrained basin and a thoroughly drained floodplain as water flowed seasonally either from the Klamath River to the lake or vice versa (Weddell 2000). A large reclamation project begun in 1906 had cut off all water from the Klamath River by 1917, and subsequently it took about five years for most of the lake's waters to evaporate. Currently, Lower Klamath NWR has 8907 ha of wetlands; 4858 to 6478 ha are seasonally flooded and 2024 to 3644 ha are permanently flooded marshes (USBR 1998). Historically, Tule Lake fluctuated in size from about 22,267 to 44,534 ha between extremes of dry and wet cycles (Akins 1970), but today consists of only 5263 ha of return-flow permanent sumps within Tule Lake NWR (USBR 1998). In contrast to Lower Klamath, Tule Lake was primarily an evaporative basin, which received water from the Klamath River via Lost River Slough only in extremely wet periods, though apparently high rates of seepage into the Lava Beds kept Tule Lake waters relatively fresh (Abney 1964). Drainage of Tule Lake was facilitated by a dam at the outflow of Clear Lake, which greatly increased the open water of that lake but drowned a 2000-ha

marsh, and diversion of the Lost River into the Klamath River by means of a canal (Akins 1970). Drainage of the Basin's lakes and marshes was controversial at the time and protested by conservationists to little avail (Foster 2002).

The effects on waterbirds of these dramatic changes to the Klamath Basin wetlands are only sketchily known, as partially described in the accounts of losses of major nesting colonies at Lower Klamath and Tule lakes, but overall must have been profound. Wetland restoration and intensive management on state and federal refuges and some private preserves have offset these losses to some degree but all rely on sufficient water in an over-allocated basin. The best and most efficient use of this water for wildlife remains to be documented and negotiated among interested parties.

AREAS CURRENTLY IMPORTANT TO NONGAME WATERBIRDS

Today all of the wetlands in the Klamath Basin are important both individually and collectively to waterbirds. Still, certain wetlands or large water bodies stand out in supplying breeding or foraging habitat for large numbers of particular species or species groups, hosting species of very limited distribution within the Klamath Basin, or supporting populations that are of regional or continental importance. Among the region's wetlands that are particularly notable for one or more of these reasons are Clear Lake NWR, Klamath Marsh NWR and associated wetlands, Lower Klamath NWR, Sycan Marsh, Tule Lake NWR, and Upper Klamath Lake and associated wetlands.

Clear Lake is among the basin's most important sites for colonial waterbirds, as it hosts at least seven such species, the largest of only two colonies of American White Pelicans in California, and the Klamath Basin's main colony of Caspian Terns. Klamath Marsh is particularly important to breeding Yellow Rails, Greater Sandhill Cranes, and Black Terns. Lower Klamath NWR stands out for hosting high numbers of waterbirds overall, large numbers of migrant and breeding shorebirds, important colonies of the Eared Grebe, American White Pelican (California's other breeding colony), Great Egret, White-faced Ibis (largest in Klamath Basin, one of largest in Intermountain West), Franklin's Gull (only one in the Klamath Basin), and Forster's and Black terns. Sycan Marsh is a key area for breeding White-faced Ibis, Greater Sandhill Cranes, and Black Terns. Tule Lake NWR is very important to breeding Eared, Western, and Clark's grebes, migrant shorebirds, and fall staging Black Terns. Upper Klamath Lake hosts the Klamath Basin's largest populations of Western and Clark's grebes at all season's, which also are of continental importance, and other important nesting colonies of the American White Pelican (one of three basin colonies), Double-crested Cormorant (basin's largest in 2003 and 2004), and Forster's and Black terns.

Other wetlands are important for supporting large colonies of one or two species (e.g., Swan Lake, Gerber Reservoir for gulls) or are key to certain non-colonial at-risk species (e.g., Wood River Valley for the Yellow Rail), yet many species depend on a wide array of wetlands (or associated uplands) within the Klamath Basin and are not particularly concentrated at any of them (e.g., breeding Long-billed Curlews [*Numenius americanus*] and Wilson's Phalaropes).

Because we conducted surveys throughout the Klamath Basin during only two years, we may have over- or underestimated the importance of some sites for the long-term conservation of waterbirds. For example, because of dry conditions in 2003 and

2004 Meiss Lake at Butte Valley WA did not support large colonies of Ring-billed and California gulls or a small colony of Caspian Terns, which it does in most years. Fortunately, for some species, particularly colonial breeders, there are additional data upon which to evaluate various sites' importance to waterbirds.

FUTURE PROSPECTS AND RESEARCH NEEDS

Given the Klamath Basin serves as such an important area for breeding and migratory species, any further impacts to its wetlands are likely to be felt by bird populations spanning two international borders. The tightening water supply in the Klamath Basin has prodded members of Congress, agency personnel, and interest groups to begin discussing long-term solutions to the Basin's water supply issues. It will be crucial to assess how future water allocation scenarios might affect the Basin's abundant waterbird resources so that potential impacts of decisions can reasonably be estimated or mitigated. To do so, however, will require adequate and current biological knowledge.

Because nongame waterbirds in the past have received much less attention than waterfowl, much remains to be learned about their status and ecological requirements in the Klamath Basin. It would be valuable to conduct more broadscale surveys of waterbirds throughout the basin to build upon the knowledge gained in 2003 and 2004 by assessing their distribution, abundance, and habitat use over a range of climatic and habitat conditions. It also would be valuable to look more closely at certain areas and species. In particular, there is a need to better document the importance of Upper Klamath Lake to Western and Clark's grebes. Studies are needed to refine information on the size of their overall populations and colonies, their relative distribution around the lake, and their rates of breeding productivity. Also better information is needed on the status and habitat requirements of species that have been prioritized for conservation at the regional or national level (e.g., Long-billed Curlew; Brown et al. 2001, USFWS 2002). It also would be valuable to do focused studies of the energetic requirements of important species groups, such as shorebirds (e.g., Loesch et al. 2000), to build upon what is currently known for waterfowl.

Conservation efforts for nongame waterbirds in the Klamath Basin should be coordinated both with the U.S. Shorebird Conservation Plan (Brown et al. 2001) and the North American Waterbird Conservation Plan (Kushlan et al. 2002) and, particularly, the respective regional shorebird (Oring et al. 2000) and waterbird (Ivey and Herziger 2006) conservation plans for the Intermountain West, which encompasses the Klamath Basin. Implementation of these regional plans is most likely to be effective through the Intermountain West Joint Venture and the support of the state, federal, nongovernmental, and private partners of which it is comprised. To enhance these efforts, it would be valuable to conduct a scientific evaluation of management strategies for waterbirds on all major (federal, state, private) wetlands and water bodies in the Klamath Basin. Primary goals would be to assess the effectiveness of management at the site level and to seek opportunities for better integration of management across sites to maximize the Basin's overall carrying capacity for waterbirds within the constraints of a limited water supply.

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Table 1 NUMBERS OF NONGAME WATERBIRDS RECORDED ON THREE COMPREHENSIVE SURVEYS OF THE KLAMATH BASIN, OREGON AND CALIFORNIA, IN 2003 AND 2004 (SEE METHODS)

Species	1-6 May 2003	28 Apr-4 May 2004	12-23 June 2003	9-16 June 2004	12-19 Aug 2003	9-13 Aug 2004
Common Loon	1	1	0	0	0	0
Pied-billed Grebe	105	180	178	189	453	891
Horned Grebe	6	3	2	2	0	0
Red-necked Grebe	1	0	1	3	0	0
Eared Grebe	5391	11,978	15,273	11,361	4263	5443
Western Grebe	3065	5479	3493	5029[a]	2679	831
Clark's Grebe	1482	3339	1458	2769[a]	1579	88
Aechmophorus spp.	274	1168	1590	2023[a]	1592	5440
Am. White Pelican	2747	6295	3775	3452	5355	4798
Double-cr. Cormorant	2186	2521	2736	1832	1638	1694
American Bittern	3	7	13	14	7	2
Great Blue Heron	207	204	216	213	288	235
Great Egret	686	423	925	785	1594	1398
Snowy Egret	18	5	30	20	88	28
Green Heron	0	0	0	1	2	4
Black-cr. Night-Heron	153	122	392	262	280	207
White-faced Ibis	955	1905	5789	4102	5187	5319
Virginia Rail	5	7	6	5	8	10
Sora	6	3	10	24	10	29
Sandhill Crane	270	224	277	208	169	336
Black-bellied Plover	506	164	0	0	1	2
Snowy Plover	9	0	0	0	1	0
Semipalmated Plover	76	93	0	1	14	25
Killdeer	249	519	575	659	1457	825
Black-necked Stilt	2451	2747	3298	2571	5176	4682
American Avocet	1345	2273	1998	1790	1675	890
Greater Yellowlegs	53	38	3	0	113	95
Lesser Yellowlegs	4	14	1	0	39	9
yellowlegs spp.	49	9	0	2	88	54
Solitary Sandpiper	0	1	0	0	1	3
Willet	560	564	523	625	27	7
Spotted Sandpiper	9	55	45	82	42	108
Whimbrel	0	0	2	0	0	0
Long-billed Curlew	36	59	107	86	110	2
Marbled Godwit	3	35	0	0	14	0
Red Knot	20	0	0	0	0	0
Western Sandpiper	383	2113	0	0	2234	1062
Least Sandpiper	1104	1959	0	0	1116	500
Western/Least	13,096	7327	0	2	4991	2325
Baird's Sandpiper	0	0	0	0	6	5
Dunlin	3428	9479	0	0	0	2
Western/Least/Dunlin	406	290	0	0	0	0

Table 1 *(Continued)*

Species	1-6 May 2003	28 Apr-4 May 2004	12-23 June 2003	9-16 June 2004	12-19 Aug 2003	9-13 Aug 2004
dowitcher spp.	2938	5265[b]	11	0	26,779	10,165
Wilson's Snipe	10	15	25	18	28	27
Wilson's Phalarope	33	643	531	822	2350	1503
Red-necked Phalarope	17	0	0	5	510	901
phalarope spp.	14	164	190	205	160	910
Franklin's Gull	107	6	154	5	1	1
Bonaparte's Gull	328	74	95	46	399	2
Ring-billed Gull	11,616	13,293	4345	1719	4749	3017
California Gull	4349	2863	1858	417	540	34
gull spp.	385	3041	4358	6569	6904	8752
Caspian Tern	159	429	338	403	579	407
Forster's Tern	391	1761	2156	2455	600	979
Black Tern	866	642	2615	1959	1831	1418
Total individuals	62,561	89,799	59,392	52,735	87,727	65,465
Total species	45	43	36	37	43	42

[a] If the 1432 unidentified large grebes counted from 14 June 2004 aerial photos of the Shoalwater Bay colony at Upper Klamath Lake (included in the 2023 *Aechmophorus* spp. here) are apportioned by the ratio of Western:Clark's on that bay as a whole of 273:94 (or 2.9:1) on 18 June then the basinwide totals would be 6094 Western Grebes, 3136 Clark's, and 591 Western/Clark's; the validity of such an apportionment is further supported by a comparable ratio at the Shoalwater colony of 341:121 (or 2.8:1) in 2003.

[b] Includes both Long-billed (mainly) and Short-billed dowitchers.

Table 2 PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING SPRING MIGRATION (LATE APRIL-EARLY MAY)

	North Subregion		Central Subregion		South Subregion	
Species or Group	2003	2004	2003	2004	2003	2004
Eared Grebe	2.0	0.5	20.6	19.5	77.4	80.0
Western/Clark's grebes	0.7	2.5	87.5	78.0	11.8	19.5
Am. White Pelican	0.3	0.2	51.5	38.6	48.2	61.3
Double-cr. Cormorant	0.0	1.6	68.9	67.4	31.1	31.0
Herons and Egrets (all)	3.6	0.3	40.3	42.0	56.1	57.7
White-faced Ibis	31.4	20.9	28.2	22.8	40.4	56.3
Sandhill Crane	50.4	39.3	43.3	44.6	6.3	16.1
Black-necked Stilt	0.0	1.1	7.7	19.7	92.3	79.2
American Avocet	0.2	0.2	17.5	15.8	82.2	84.1
Willet	13.0	10.3	49.3	42.7	37.7	47.0
Shorebirds (all)	2.2	1.4	11.6	11.4	86.2	87.1
Gulls (all)	0.0	0.3	76.6	80.8	23.4	18.9
Caspian Tern	0.0	1.2	38.4	7.7	61.6	91.1
Forster's Tern	0.0	6.2	80.6	65.2	19.4	28.5
Black Tern	0.0	43.9	36.8	52.0	63.2	4.0
Waterbirds (all)	1.9	2.0	41.2	40.3	56.9	57.7

Table 3 PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING THE BREEDING SEASON (MID-JUNE)

	North Subregion		Central Subregion		South Subregion	
Species or Group	2003	2004	2003	2004	2003	2004
Eared Grebe	0.4	0.0	14.0	12.5	85.6	87.4
Western/Clark's grebes	1.2	0.5	70.2	82.9	28.6	16.5
Am. White Pelican	3.7	3.9	33.4	57.0	62.9	39.1
Double-cr. Cormorant	0.1	0.4	76.4	67.1	23.5	32.5
Herons and Egrets (all)	1.3	6.1	28.8	47.7	69.9	46.2
White-faced Ibis	16.9	25.2	9.1	16.1	73.9	58.7
Sandhill Crane	51.6	44.7	28.2	39.9	20.2	15.4
Black-necked Stilt	0.9	0.2	12.7	28.5	86.4	71.3
American Avocet	0.0	0.0	10.2	16.5	89.8	83.5
Willet	13.2	12.2	52.2	45.8	34.6	42.1
Shorebirds (all)	5.1	5.3	20.9	34.4	74.0	60.4
Gulls (all)	0.0	0.1	38.9	67.5	61.1	32.4
Caspian Tern	0.0	0.0	38.8	22.1	61.2	77.9
Forster's Tern	2.6	3.7	62.8	67.9	34.6	28.3
Black Tern	30.5	30.1	49.4	54.6	20.1	15.4
Waterbirds (all)	4.5	4.7	33.3	48.1	62.3	47.3

Table 4 PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING FALL MIGRATION (MID-AUGUST)

	North Subregion		Central Subregion		South Subregion	
Species or Group	2003	2004	2003	2004	2003	2004
Eared Grebe	0.0	0.0	20.5	17.2	79.5	82.8
Western/Clark's grebes	0.4	0.4	73.4	74.3	26.3	25.3
Am. White Pelican	6.3	0.0	68.6	49.7	25.1	44.6
Double-cr. Cormorant	2.3	2.5	62.3	85.2	35.3	12.1
Herons and Egrets (all)	15.1	1.2	59.6	53.8	25.3	38.8
White-faced Ibis	19.2	60.8	27.0	29.3	53.8	9.0
Sandhill Crane	13.6	40.5	62.1	36.3	24.3	19.9
Black-necked Stilt	1.5	0.0	16.7	30.9	81.9	67.8
American Avocet	0.0	0.0	46.8	83.0	53.2	16.7
Willet[a]	–	–	–	–	–	–
Shorebirds (all)	2.9	1.2	18.0	47.0	79.0	49.7
Gulls (all)	2.2	1.0	83.1	91.5	14.8	7.4
Caspian Tern	3.1	0.0	47.2	31.4	49.7	68.1
Forster's Tern	0.0	0.4	2.5	40.7	97.5	58.9
Black Tern	1.4	4.7	14.7	31.6	83.9	63.8
Waterbirds (all)	3.9	6.0	36.9	54.2	59.1	38.3

[a] Most Willets have departed by August such that remaining numbers are too few to use for proportional analysis.

Table 5 SAMPLED RATIOS OF WESTERN GREBES AND CLARK'S GREBES IN 11 AREAS WITHIN THE UPPER KLAMATH LAKE SYSTEM, 2003 AND 2004[a]

	MAY						JUNE						AUGUST		
	2003			2004			2003			2004			2003		
Survey Areas	WEGR	CLGR	ratio	WEGR	CLGR	ratio	WEGR	CLGR	ratio	WEGR	CLGR	ratio	WEGR	CLGR	ratio
01 – Moore Park to Howard Bay	95	127	0.7:1	141	219	0.6:1	51	70	0.7:1	86	161	0.5:1	43	106	0.4:1
02 – Howard Bay	246	126	2.0:1	348	201	1.7:1	158	66	2.4:1	364	145	2.5:1	142	95	1.5:1
03 – Squaw Point to Eagle Point (Eagle Ridge)	353	331	1.1:1	211	335	0.6:1	321	490	0.6:1	214	412	0.5:1	371	212	1.8:1
04 – Shoalwater and Ball bays	147	17	8.6:1	278	72	3.9:1	144	91	1.6:1	273	94	2.9:1	393	213	1.8:1
05 –Upper Klamath Marsh	3[b]	0[b]	–	12[b]	0[b]	–	4[b]	1[b]	–	17[b]	0[b]	–	6[b]	0[b]	–
06 –Agency Straits and Agency Lake	97	1	97:1	115	0	115:0	156	1	155:1	444	4	111:1	208	0	208:0
07 –Agency Straits to Modoc Pt. At Hwy 97	–[b]	–[b]	–	22[b]	0[b]	–	–[b]	–[b]	–	–[b]	–[b]	–	–[b]	–[b]	–
08 – Modoc Point at Hwy 97 S to Hanks Marsh	87	2	44:1	198	21	9.4:1	189	37	5.1:1	364	161	2.3:1	278	85	3.3:1
09 – Hanks Marsh	75	1	75:1	52	16	8.7:1	16	4	–	48	6	8.0:1	0	0	–
10 – Hanks Marsh S to Moore Park	18	56	0.3:1	82	118	0.7:1	41	66	0.6:1	61	155	0.4:1	81	168	0.5:1
11 – Upper Link River	–	–	–	107	104	1:1	54	55	1:1	77	81	1:1	0	0	–

[a] Ratios obtained from ground counts at various access points in each area; no counts conducted in area 11 in May 2003 and no counts at all in August 2004 (see Methods).

[b] Very small sample sizes or no data from areas 05 and 07 because of very limited access.

Table 6 ESTIMATED NUMBERS OF NESTING PAIRS OF CERTAIN COLONIAL WATERBIRDS IN THE KLAMATH BASIN IN 2003 AND 2004

Site	Species[a]															
	AWPE		DCCO		GBHE		EGRE		WFIB		RBGU		CAGU		CATE	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Upper Klamath NWR, Upper Klamath Marsh	95[b]	512[b]	840[b]	999[b]	15[b]	11[b]	75[c]	18[c]	0	0	0	0	0	0	0	0
Klamath Game Mgmt. Area, Squaw Point	0	0	0	0	35[d]	51[d]	5[d]	2[d]	0	0	0	0	0	0	0	0
Swan Lake	0	0	43[b]	38[b]	0	0	0	0	0	0	5673[e]	6604[e]	1832[e]	1160[e]	0	0
Sycan Marsh	0	0	0	0	0	15[c]	0	0	200[c]	200[c]	0	0	0	0	0	0
Sprague River Valley																
Smokey Lake	0	0	0	0	0	0	0	0	100[c]	160[c]	0	0	0	0	0	0
E of Beatty	0	0	0	0	0	16[d]	0	0	0	0	0	0	0	0	0	0
Gerber Reservoir	0	0	0	6[b]	0	0	0	0	0	0	1024[e]	1323[e]	0	63[e]	0	0
Lower Klamath NWR																
Sheepy Lake	17[b]	402[b]	371[b]	458[b]	14[b]	6[b]	0	0	0	0	0	0	0	0	0	0
Unit 1W	0	0	0	0	0	0	0	38[c]	0	0	0	0	0	0	0	0
Unit 6A	0	0	0	0	0	0	0	0	0	0	0	35[d]	0	0	0	0
Unit 8B	0	0	0	0	0	0	0	0	50[d]	0	0	0	0	0	0	0
Unit 12C	0	0	0	0	0	0	0	0	0	59[f]	0	0	0	0	0	0
Unit 13A	0	0	0	0	0	0	185[f]	400[c]	2812[f]	1063[f]	0	0	0	0	0	0
Tule Lake NWR																
Sump 1A	0	0	56[b]	0	0	0	72[g]	0	0	0	0	0	0	0	0	0
Sump 1B	0	0	0	30[b]	0	0	0	19[b]	0	1039[f]	0	0	0	0	0	0
Clear Lake NWR	614[b]	2190[b]	94[b]	116[b]	34[b]	44[b]	2[b]	38[c]	0	0	738[e]	729[e]	1182[e]	701[e]	29[g]	93[g]
Total Numbers Pairs	726	3104	1404	1647	98	143	339	515	3162	2521	7435	8691	3014	1924	29	93
Total Numbers Sites	3	3	5	6	4	6	5	6	4	5	3	4	2	3	1	1

[a] Species codes: AWPE, American White Pelican; DCCO, Double-crested Cormorant; GBHE, Great Blue Heron; EGRE, Great (mainly) and Snowy egrets; WFIB, White-faced Ibis; RBGU, Ring-billed Gull; CAGU, California Gull; CATE, Caspian Tern.
[b] Counts of nests from aerial photographs of colonies: 12 May in 2003, 13 May in 2004.
[c] Visual estimate of nests or adults at colony on aerial survey; adults at Unit 1W, Lower Klamath NWR and Clear Lake NWR converted to pair estimate (see Methods).
[d] Nests counted from the ground.
[e] Number of pairs estimated from counts of adults adjusted by the ratios of adults to nests from prior ground counts (see Methods); counts of adults at Swan Lake and Gerber Reservoir from aerial photos on 12 May and 13 May and at Clear Lake from airboat survey on 21 May and 25 May in 2003 and 2004, respectively.
[f] Estimated from dawn flyout counts (see Methods).
[g] Direct count of nests from an airboat.

Appendix 1 KLAMATH BASIN SURVEY AREAS FOR NONGAME WATERBIRDS (METHODS OF COVERAGE IN 2004).

NORTH SUBREGION

Klamath Marsh area (all sites by air all surveys, except Loosely covered only in May)
- Klamath Marsh NWR
  - Big Wocus Bay
  - Little Wocus Bay
  - Loosely Tract
  - S of Spring Unit to Military Crossing area
  - Spring Unit
- E of Spring Unit
- Soloman Flat
- Williamson River South (L. Wocus to south of Soloman Flat)

Thompson Reservoir (by ground in May, by air in June and August)
- Thompson Reservoir

Sycan Marsh (by air all surveys)
- Sycan Marsh

CENTRAL SUBREGION

Upper Klamath Lake area (Areas #1-10 by air all surveys; all others by ground except Agency Lake Ranch by air in August and UKL #11 not covered in August)
- Agency Lake Ranch
- Running Y wetlands
- Upper Klamath Lake #1: Moore Park to Howard Bay
- Upper Klamath Lake #2: Howard Bay
- Upper Klamath Lake #3: Eagle Ridge
- Upper Klamath Lake #4: Shoalwater and Ball bays
- Upper Klamath Lake #5: Upper Klamath Marsh
- Upper Klamath Lake #6: Agency Lake and Straits
- Upper Klamath Lake #7: Agency Lake Straits to Modoc Point
- Upper Klamath Lake #8: Modoc Point to Hank's Marsh
- Upper Klamath Lake #9: Hank's Marsh
- Upper Klamath Lake #10: Hank's Marsh to Moore Park
- Upper Klamath Lake #11: Upper Link River
- Williamson River Delta Preserve
- Wood River Wetland

Sprague River Valley (all sites by air all surveys except as noted)
- Sprague River Floodplain (area 1; confined flat open area E of Chiloquin)
- Sprague River Floodplain (area 2; next open area E to town of Sprague River)
- Sprague River Floodplain (area 3; town of Sprague River to just E of Beatty)
  - Cordelia Flat
  - Muckney Lake
  - Smokey Lake
  - Wild Billy Lake

Appendix 1 *(Continued)*

Sprague River Valley *(Continued)*

Sprague River Floodplain (area 4; E of Beatty to E end of Sprague River Valley)

Campbell Reservoir
Devil Lake (by ground all surveys)
Hyde Reservoir
Oberchain Reservoir

Aspen Lake area

Aspen Lake (by ground May and June; by air in August)
Long Lake (by ground May and June; by air in August)
Round Lake (by air all surveys)

Klamath River area

Klamath WA (Miller Island; by ground all surveys)
Klamath River (Keno north to Hwy 97 bridge; by air all surveys)
Lake Ewauna (and Klamath R. south to Hwy 97 bridge; by ground all surveys)

Spring Lake area (by ground on all surveys)

Ness Lake (aka Nuss Lake)
Spring Lakes (Spring and Little Spring lakes)
Tingley Lakes (North and South)
Wilson Reservoir

Swan Lake area (by air all surveys)

Swan Lake
Whiteline Reservoir

Yonna Valley area

Alkali Lake (by ground in May, by air in June and August)
Short Lake (by air May only)
Yonna Valley miscellaneous (by ground all surveys)

Langell Valley

Circle 5 Ranch (by ground all surveys)
Langell Valley miscellaneous (by ground June only)

Gerber/Willow Valley area (by ground all surveys except as noted)

Alkali Spring
Antelope Reservoir
Big Adobe Reservoir
Boggs Lake (by air all surveys)
Bumphead Reservoir
Copeland Reservoir (by air all surveys)
De Vaul Lake
Dog Hollow Reservoir
Dry Prairie (by air all surveys)
Gerber Reservoir (by air all surveys)
Gerber Reservoir Potholes
Kilgore Reservoir
Noble Reservoir
Mallory Reservoir (by air all surveys)

Appendix 1 *(Continued)*

Gerber/Willow Valley area *(Continued)*

Round Valley Reservoir
Sherman Potter Reservoir (by ground August only)
Threemile Reservoir (by air May only)
Upper Midway Reservoir
Willow Valley Reservoir

Fishhole lakes area (by ground all surveys except at noted)

Adobe Flat
Barnes Valley (by air all surveys)
Bear Valley
Little Squaw Flat
Little Squaw Flat Reservoir
Middle Fishhole and Lower Fishhole
Squaw Flat

SOUTH SUBREGION (almost all in California)

Butte Valley

Butte Valley WA (by ground all surveys)

Lower Klamath NWR (few sites in OR in *italic*; by ground all surveys except Unit 2 (part) by air). Units: 1E (1-8), 1W (9-10), 2, 3A, 3B, 4A, 4B, 4C, 4D, 4E, 4F, 4G, 5A, 5B, 6A, 6B1, 6B2, 6C, 7A, 7B, 8A, 8B, 9A, 9B, 9C, 9D, 10A, 10B, 11A1, 11A2, 11B, 11C, 12A, 12B, 12C, 13A, 13B, Canals, *East Area K*, *West Area K*, Miller Lake, Orem, Sheepy East, Sheepy West, Sterns, White Lake (*part OR*).

Lower Klamath area private (by ground all surveys except when dry; site in OR in *italic*)

Alkali lakes W end Stateline Hwy
Chalk Banks/The Honker Hunt Clubs
Indian Tom Lake
Marsh Island Ranch
Miller Lake (OR)
private wetlands along Sheepy Creek and Dorris-Brownell Roads
private wetlands W of US 97 and N of Dorris

Tule Lake NWR (by ground all surveys)

"D Blind" Wetlands (Lots 8357-8362; dry August)
Discovery Marsh (Headquarters Wetlands)
Frey's Island
Lot 6
Lower Sump (1B)
Upper Sump (1A)

Clear Lake (by air all surveys)

Clear Lake NWR

Appendix 2a NUMBERS OF NONGAME WATERBIRDS ON A COMPREHENSIVE SURVEY OF THE KLAMATH BASIN, 1-6 MAY 2003. SEE SHUFORD ET AL. (2004) FOR DESCRIPTIONS OF SURVEY PROTOCOL AND AREAS SURVEYED.

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Common Loon	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Pied-billed Grebe	0	0	0	55	0	3	2	0	0	0	0	0	2	39	1	3	0	**105**
Horned Grebe	0	0	0	2	0	0	0	0	0	0	0	0	0	0	4	0	0	**6**
Red-necked Grebe	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Eared Grebe	72	7	30	760	0	4	59	19	200	35	0	35	35	3036	64	1033	2	**5391**
Western Grebe	0	0	0	2307	0	0	140	6	0	0	0	243	0	162	38	169	0	**3065**
Clark's Grebe	0	0	0	1291	0	0	66	2	0	0	0	41	0	24	31	27	0	**1482**
Aechmophorus spp.	5	31	0	0	6	1	0	95	16	3	0	0	0	28	0	71	18	**274**
Am. White Pelican	8	1	0	764	37	11	212	98	52	132	92	17	0	306	7	116	894	**2747**
Double-cr. Cormorant	1	0	0	1311	6	0	111	9	67	2	0	0	0	458	16	87	118	**2186**
American Bittern	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	**3**
Great Blue Heron	27	1	0	91	7	2	2	0	0	2	1	1	0	24	0	4	45	**207**
Great Egret	0	0	10	214	0	3	26	8	0	8	0	0	0	248	4	162	3	**686**
Snowy Egret	0	0	0	8	0	0	1	0	0	0	0	0	0	7	0	1	1	**18**
Black-cr. Night-Heron	0	0	0	50	1	0	2	2	0	0	0	0	2	77	1	18	0	**153**
White-faced Ibis	0	0	300	17	50	0	0	0	100	2	100	0	29	198	3	148	8	**955**
Virginia Rail	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	**5**
Sora	0	0	0	1	0	0	0	0	0	0	0	0	0	5	0	0	0	**6**
Sandhill Crane	56	0	80	30	1	11	8	0	47	6	10	4	1	16	0	0	0	**270**
Black-bellied Plover	0	0	0	16	0	0	0	0	0	0	0	0	0	490	0	0	0	**506**
Snowy Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	**9**
Semipalmated Plover	0	0	0	7	0	5	0	0	0	0	2	0	0	56	0	6	0	**76**
Killdeer	14	6	0	17	25	8	4	2	6	25	25	20	8	67	5	10	7	**249**
Black-necked Stilt	0	0	0	48	4	0	38	10	4	82	3	0	48	2006	10	198	0	**2451**
American Avocet	3	0	0	20	0	0	4	3	50	148	11	0	101	906	35	61	3	**1345**
Greater Yellowlegs	42	1	0	1	0	0	1	1	0	0	4	0	0	2	0	1	0	**53**
Lesser Yellowlegs	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	**4**
yellowlegs spp.	0	0	20	0	11	0	0	0	2	6	3	0	6	1	0	0	0	**49**

Appendix 2a *(Continued)*

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Willet	11	2	60	0	38	0	0	1	144	26	48	19	41	144	12	4	10	**560**
Spotted Sandpiper	0	0	0	0	3	0	1	0	0	0	0	2	0	0	1	0	2	**9**
Long-billed Curlew	0	0	0	0	0	0	0	0	0	2	0	0	0	32	0	0	2	**36**
Marbled Godwit	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	**3**
Red Knot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	**20**
Western Sandpiper	0	0	0	9	0	0	0	2	0	0	4	0	0	222	0	146	0	**383**
Least Sandpiper	0	0	0	218	0	0	0	79	0	17	52	0	0	530	0	208	0	**1104**
Western/Least	30	0	300	0	30	12	80	0	430	66	200	0	295	608	0	11045	0	**13096**
Western/Least/Dunlin	50	4	0	0	20	0	0	0	0	150	182	0	0	0	0	0	0	**406**
Dunlin	25	0	0	3	0	0	0	0	0	0	2	0	0	3378	0	20	0	**3428**
dowitcher spp.	15	0	0	15	0	0	0	0	0	526	25	0	184	1659	0	514	0	**2938**
Wilson's Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	**10**
Wilson's Phalarope	0	0	0	0	0	0	0	0	4	0	0	0	0	29	0	0	0	**33**
Red-necked Phalarope	0	0	0	14	0	0	0	0	0	0	0	0	0	3	0	0	0	**17**
phalarope spp.	0	0	0	0	2	0	0	0	8	2	2	0	0	0	0	0	0	**14**
Franklin's Gull	0	0	0	2	0	0	0	44	0	0	0	0	0	60	0	1	0	**107**
Bonaparte's Gull	0	5	0	132	3	0	49	0	0	2	2	2	0	7	0	126	0	**328**
Ring-billed Gull	0	0	0	17	0	0	30	49	7995	20	120	1442	241	98	0	636	968	**11616**
California Gull	0	0	0	3	0	0	0	0	2545	0	7	11	263	8	0	0	1512	**4349**
gull spp.	0	0	0	84	4	7	100	0	178	2	0	4	0	6	0	0	0	**385**
Caspian Tern	0	0	0	47	0	1	4	2	0	0	1	6	0	7	0	47	44	**159**
Forster's Tern	0	0	0	193	0	14	44	33	9	14	5	3	5	39	2	30	0	**391**
Black Tern	0	0	0	299	0	20	0	0	0	0	0	0	0	547	0	0	0	**866**
Area Total	**359**	**59**	**800**	**8049**	**248**	**102**	**1054**	**465**	**11857**	**1279**	**902**	**1850**	**1261**	**15563**	**234**	**14912**	**3637**	

Appendix 2b NUMBERS OF NONGAME WATERBIRDS ON A COMPREHENSIVE SURVEY OF THE KLAMATH BASIN, 12-23 JUNE 2003. SEE SHUFORD ET AL. (2004) FOR DESCRIPTIONS OF SURVEY PROTOCOL AND AREAS SURVEYED.

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Pied-billed Grebe	16	0	0	81	1	1	4	1	0	0	0	4	1	2	54	6	7	0	**178**
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	**2**
Red-necked Grebe	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Eared Grebe	43	5	10	1156	0	0	0	958	0	8	0	19	0	15	6803	1074	5182	0	**15273**
Western Grebe	12	0	0	2713	7	0	120	14	0	0	1	88	0	0	402	38	98	0	**3493**
Clark's Grebe	0	0	0	1326	1	0	30	1	0	0	0	47	0	0	27	12	14	0	**1458**
Aechmophorus spp.	34	30	0	0	57	0	0	74	0	0	0	113	0	0	0	0	1218	64	**1590**
Am. White Pelican	54	30	56	920	112	1	62	23	18	42	23	52	6	150	512	4	322	1388	**3775**
Double-cr. Cormorant	2	0	0	1868	2	0	205	6	0	0	0	9	0	0	414	16	4	210	**2736**
American Bittern	0	0	0	0	0	3	0	0	0	0	1	0	0	0	9	0	0	0	**13**
Great Blue Heron	11	0	6	95	17	0	6	2	0	2	2	0	0	1	22	3	3	46	**216**
Great Egret	0	0	0	191	0	0	41	3	1	35	10	0	0	2	542	32	64	4	**925**
Snowy Egret	0	0	0	0	0	0	0	0	0	0	0	0	0	1	29	0	0	0	**30**
Black-cr. Night-Heron	2	0	2	27	0	0	17	0	0	0	1	0	0	4	321	16	2	0	**392**
White-faced Ibis	47	0	934	148	326	0	9	0	0	45	0	0	0	0	3830	368	82	0	**5789**
Virginia Rail	1	0	0	1	0	0	0	0	0	0	1	0	1	0	2	0	0	0	**6**
Sora	5	0	0	2	0	0	0	0	0	0	0	0	1	0	2	0	0	0	**10**
Sandhill Crane	44	1	98	23	6	4	6	0	17	6	4	2	10	12	40	4	0	0	**277**
Killdeer	43	15	10	74	104	12	15	6	13	24	13	30	10	17	117	34	9	29	**575**
Black-necked Stilt	31	0	0	382	0	0	10	8	0	6	12	1	0	65	2577	8	187	11	**3298**
American Avocet	0	0	0	131	0	0	10	7	24	10	22	0	0	109	1478	34	144	29	**1998**
Greater Yellowlegs	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	**3**
Lesser Yellowlegs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**

Appendix 2b *(Continued)*

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Willet	33	6	30	0	144	0	0	1	84	10	5	18	11	13	121	19	2	26	**523**
Spotted Sandpiper	2	2	0	10	12	0	0	0	0	0	1	7	2	0	3	2	1	3	**45**
Whimbrel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	**2**
Long-billed Curlew	12	0	14	0	0	0	0	0	2	0	0	0	0	0	79	0	0	0	**107**
dowitcher spp.	0	0	0	9	0	0	2	0	0	0	0	0	0	0	0	0	0	0	**11**
Wilson's Snipe	1	0	0	4	0	3	0	0	0	0	0	0	6	0	7	4	0	0	**25**
Wilson's Phalarope	23	6	44	127	4	0	0	9	0	16	16	3	22	69	153	33	6	0	**531**
phalarope spp.	29	2	70	1	30	0	0	0	3	41	0	0	0	0	0	5	0	9	**190**
Franklin's Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	154	0	0	0	**154**
Bonaparte's Gull	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	59	0	**95**
Ring-billed Gull	0	0	0	26	4	0	200	0	1	0	0	1444	0	0	1417	0	233	1020	**4345**
California Gull	0	0	0	81	0	0	0	0	2	0	0	0	0	76	163	0	2	1534	**1858**
gull spp.	0	0	0	129	132	0	305	3	1809	28	0	0	0	0	1031	0	0	921	**4358**
Caspian Tern	0	0	0	102	18	1	5	3	0	0	2	0	0	0	2	1	30	174	**338**
Forster's Tern	46	4	6	1246	8	21	52	16	5	1	4	2	0	39	344	127	221	14	**2156**
Black Tern	643	0	154	908	14	83	2	0	0	11	0	73	201	1	463	62	0	0	**2615**
Area Total	**1134**	**101**	**1434**	**11818**	**999**	**129**	**1101**	**1135**	**1979**	**285**	**118**	**1912**	**273**	**577**	**21123**	**1902**	**7890**	**5482**	

Appendix 2c NUMBERS OF NONGAME WATERBIRDS ON A COMPREHENSIVE SURVEY OF THE KLAMATH BASIN, 12-19 AUGUST 2003. SEE SHUFORD ET AL. (2004) FOR DESCRIPTIONS OF SURVEY PROTOCOL AND AREAS SURVEYED.

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Pied-billed Grebe	0	0	0	110	1	0	9	35	0	1	0	30	0	0	208	11	48	0	**453**
Eared Grebe	0	0	0	779	4	0	0	39	0	0	0	54	0	0	1836	118	1433	0	**4263**
Western Grebe	0	0	0	2222	0	0	3	23	0	0	0	58	0	0	248	41	84	0	**2679**
Clark's Grebe	0	0	0	1521	0	0	0	2	0	0	0	31	0	0	11	11	3	0	**1579**
Aechmophorus spp.	1	22	0	0	8	0	286	130	0	0	0	7	0	0	12	0	1109	17	**1592**
Am. White Pelican	300	40	0	2886	57	0	277	193	0	125	0	107	27	0	852	0	354	137	**5355**
Double-cr. Cormorant	0	38	0	868	1	2	63	41	0	0	0	46	0	0	382	0	109	88	**1638**
American Bittern	0	0	0	2	0	1	0	0	0	0	0	0	0	0	3	0	1	0	**7**
Great Blue Heron	24	7	18	99	17	6	23	2	1	9	3	19	2	4	19	3	8	24	**288**
Great Egret	283	0	0	780	10	6	116	18	0	63	0	21	0	0	161	2	134	0	**1594**
Snowy Egret	0	0	0	30	0	0	4	0	0	0	0	0	0	0	40	0	14	0	**88**
Green Heron	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	**2**
Black-cr. Night-Heron	7	0	3	4	0	2	106	0	0	0	0	0	0	7	141	0	8	2	**280**
White-faced Ibis	158	5	831	599	293	32	1	14	27	376	18	2	41	0	2104	0	638	48	**5187**
Virginia Rail	0	0	0	2	0	1	0	0	0	2	0	0	0	0	3	0	0	0	**8**
Sora	0	0	0	5	0	1	0	0	0	1	0	0	0	0	0	0	3	0	**10**
Sandhill Crane	0	0	23	5	4	8	4	0	0	16	66	0	2	13	24	2	2	0	**169**
Black-bellied Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**
Snowy Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**
Semipalmated Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	2	0	**14**
Killdeer	98	10	6	144	124	30	10	4	53	52	3	132	19	5	555	25	19	168	**1457**
Black-necked Stilt	73	0	4	640	0	0	11	0	0	169	41	1	0	0	2045	32	2133	27	**5176**
American Avocet	0	0	0	256	0	0	1	0	0	527	0	0	0	0	528	0	219	144	**1675**
Greater Yellowlegs	0	0	0	29	0	0	1	2	0	0	2	4	0	0	59	8	8	0	**113**
Lesser Yellowlegs	0	0	0	14	0	0	0	0	0	1	0	0	0	0	20	0	4	0	**39**
yellowlegs spp.	48	0	12	5	8	0	3	0	0	0	0	2	0	0	0	0	6	4	**88**

Appendix 2c *(Continued)*

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Solitary Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
Willet	0	0	1	0	0	0	0	0	0	2	0	0	0	0	19	0	0	5	**27**
Spotted Sandpiper	0	2	0	0	7	1	8	0	0	0	0	16	0	0	2	5	0	1	**42**
Long-billed Curlew	0	0	0	0	0	0	0	0	0	0	16	0	0	0	93	0	0	1	**110**
Marbled Godwit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	1	0	**14**
Western Sandpiper	0	0	0	616	0	0	5	0	0	36	0	31	0	9	1362	0	175	0	**2234**
Least Sandpiper	0	0	0	110	0	0	15	0	0	7	0	11	0	0	561	0	412	0	**1116**
Western/Least	531	275	8	290	87	1	0	0	35	280	3	400	0	0	43	0	3	3035	**4991**
Baird's Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	**6**
dowitcher spp.	235	0	0	3240	35	0	0	0	15	232	8	85	0	0	20967	0	1954	8	**26779**
Wilson's Snipe	0	0	0	13	5	0	0	0	0	0	0	1	3	0	1	0	5	0	**28**
Wilson's Phalarope	31	0	0	204	12	0	0	0	5	176	42	9	0	0	1189	0	682	0	**2350**
Red-necked Phalarope	0	0	0	20	0	0	0	0	0	9	0	0	0	0	200	0	281	0	**510**
phalarope spp.	40	10	0	0	16	0	0	0	0	55	0	0	2	0	0	0	0	37	**160**
Franklin's Gull	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Bonaparte's Gull	0	0	0	283	0	0	0	0	0	0	0	0	0	0	69	0	1	46	**399**
Ring-billed Gull	0	0	0	3323	1	2	759	82	0	6	10	7	0	0	350	20	170	19	**4749**
California Gull	0	0	0	522	0	0	3	3	0	0	0	0	0	0	3	5	4	0	**540**
gull spp.	16	181	75	4834	22	0	345	35	9	90	13	113	0	0	4	420	79	668	**6904**
Caspian Tern	18	0	0	174	1	0	92	0	0	0	0	6	0	0	13	8	220	47	**579**
Forster's Tern	0	0	0	9	0	1	4	1	0	0	0	0	0	0	7	0	541	37	**600**
Black Tern	0	0	25	203	15	2	0	31	0	1	0	6	11	0	11	0	1526	0	**1831**
Area Total	**1863**	**590**	**1006**	**24842**	**728**	**97**	**2150**	**655**	**145**	**2236**	**225**	**1199**	**107**	**38**	**34181**	**711**	**12395**	**4563**	

Appendix 3a NUMBERS OF NONGAME WATERBIRDS ON A COMPREHENSIVE SURVEY OF THE KLAMATH BASIN, 28 APRIL-11 MAY (MOSTLY 29 APR-4 MAY) 2004. SEE METHODS FOR SURVEY PROTOCOL AND APPENDIX 1 AND FIGURE 1 FOR DESCRIPTIONS OF VARIOUS SURVEY AREAS.

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Common Loon	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Pied-billed Grebe	15	3	0	66	0	0	2	0	2	3	0	21	2	2	37	4	23	0	**180**
Horned Grebe	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	**3**
Eared Grebe	10	52	0	1748	2	0	0	272	60	93	2	117	42	3	4435	121	5021	0	**11978**
Western Grebe	0	147	4	3695	0	0	1	18	0	6	0	144	0	0	364	49	1051	0	**5479**
Clark's Grebe	0	2	0	2923	0	0	4	3	0	8	0	47	0	0	34	19	299	0	**3339**
Aechmophorus spp.	16	80	0	0	6	0	305	129	1	14	0	489	0	0	6	1	43	78	**1168**
Am. White Pelican	6	5	0	1894	71	0	153	143	10	16	0	140	1	2	613	3	383	2855	**6295**
Double-cr. Cormorant	0	40	0	1426	0	0	108	83	45	0	0	38	0	1	521	21	105	133	**2521**
American Bittern	0	0	0	0	0	2	0	0	0	0	0	0	0	1	4	0	0	0	**7**
Great Blue Heron	2	0	0	108	19	0	3	1	0	5	0	1	0	0	12	2	0	51	**204**
Great Egret	0	0	0	47	1	0	56	6	0	0	0	0	0	0	169	2	78	64	**423**
Snowy Egret	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	**5**
Black-cr. Night-Heron	0	0	0	25	0	0	46	0	0	0	0	0	0	3	38	2	8	0	**122**
White-faced Ibis	195	0	204	10	301	0	34	0	54	0	35	0	0	0	992	22	58	0	**1905**
Virginia Rail	0	0	0	2	0	0	0	0	0	1	0	0	0	0	4	0	0	0	**7**
Sora	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	**3**
Sandhill Crane	20	0	68	33	9	1	7	2	7	14	0	11	16	18	15	2	1	0	**224**
Black-bellied Plover	0	0	0	0	0	0	0	7	0	12	0	0	0	5	135	0	5	0	**164**
Semipalmated Plover	0	0	0	17	0	0	0	0	0	19	0	0	0	0	55	2	0	0	**93**
Killdeer	8	12	0	62	21	9	13	7	6	102	5	78	34	16	73	53	13	7	**519**
Black-necked Stilt	15	0	14	166	1	0	25	10	109	189	37	3	2	58	1860	173	79	6	**2747**
American Avocet	2	0	2	28	0	0	14	5	57	215	35	0	4	32	1809	35	20	15	**2273**
Greater Yellowlegs	0	0	0	18	0	0	0	0	0	1	0	0	0	11	7	1	0	0	**38**
Lesser Yellowlegs	0	0	0	1	0	0	0	0	0	0	0	0	0	0	13	0	0	0	**14**
yellowlegs spp.	0	0	0	1	3	0	0	0	3	0	0	0	0	0	0	2	0	0	**9**

Appendix 3a *(Continued)*

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Solitary Sandpiper	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Willet	17	3	38	0	29	0	0	3	39	42	14	72	42	40	176	34	0	15	**564**
Spotted Sandpiper	2	6	0	0	8	0	15	0	3	0	0	9	1	0	0	2	8	1	**55**
Long-billed Curlew	1	0	16	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	**59**
Marbled Godwit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	**35**
Western Sandpiper	0	0	0	101	0	0	0	2	0	184	2	0	0	50	1744	30	0	0	**2113**
Least Sandpiper	0	0	0	89	0	0	0	37	0	208	0	0	0	100	1222	303	0	0	**1959**
Western/Least	0	0	0	0	0	0	0	0	0	0	2	0	0	460	6615	95	155	0	**7327**
Western/Least/Dunlin	10	0	194	0	5	0	0	0	15	0	0	40	0	0	0	0	0	26	**290**
Dunlin	0	0	0	14	0	0	0	0	0	163	0	0	0	0	9295	0	7	0	**9479**
dowitcher spp.	0	0	0	1	0	0	25	315	212	462	0	0	0	0	3205	162	883	0	**5265**
Wilson's Snipe	0	0	0	4	0	0	0	0	0	0	0	0	1	1	2	7	0	0	**15**
Wilson's Phalarope	6	0	6	34	0	0	0	0	11	170	30	54	54	4	189	52	33	0	**643**
phalarope spp.	0	0	136	0	5	0	23	0	0	0	0	0	0	0	0	0	0	0	**164**
Franklin's Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	**6**
Bonaparte's Gull	0	0	0	3	0	0	4	0	0	1	0	0	12	0	54	0	0	0	**74**
Ring-billed Gull	0	20	0	69	0	0	263	24	9302	24	6	1867	29	90	531	0	41	1027	**13293**
California Gull	0	0	0	0	0	0	148	0	1611	24	0	88	12	0	6	0	0	974	**2863**
gull spp.	2	0	34	220	120	4	820	0	828	1	0	31	68	0	264	0	209	440	**3041**
Caspian Tern	0	5	0	8	2	6	3	0	0	12	0	2	0	0	30	0	253	108	**429**
Forster's Tern	88	10	12	785	9	31	166	10	41	87	0	20	0	12	164	36	255	35	**1761**
Black Tern	79	9	194	89	0	40	0	0	0	0	0	10	195	0	0	0	26	0	**642**
Area Total	**494**	**394**	**922**	**13691**	**612**	**93**	**2238**	**1077**	**12416**	**2076**	**168**	**3284**	**515**	**909**	**34778**	**1236**	**9061**	**5835**	

Appendix 3b NUMBERS OF NONGAME WATERBIRDS ON A COMPREHENSIVE SURVEY OF THE KLAMATH BASIN, 9-16 JUNE 2004. SEE METHODS FOR SURVEY PROTOCOL AND APPENDIX 1 AND FIGURE 1 FOR DESCRIPTIONS OF VARIOUS SURVEY AREAS.

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Pied-billed Grebe	0	0	0	76	0	1	4	16	0	2	0	9	1	0	44	5	31	0	**189**
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	**2**
Red-necked Grebe	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Eared Grebe	4	0	0	704	2	2	0	553	54	0	0	29	80	6	5491	96	4340	0	**11361**
Western Grebe	3	6	0	3447	26	0	4	7	0	0	0	188	0	0	248	35	1065	0	**5029**
Clark's Grebe	0	0	0	2475	0	0	0	0	0	0	0	96	0	0	27	14	157	0	**2769**
Aechmophorus spp.	9	36	0	1432	5	0	203	58	12	8	0	184	0	0	34	1	0	41	**2023**
Am. White Pelican	98	15	20	1131	110	4	376	71	4	127	0	145	0	18	420	20	529	364	**3452**
Double-cr. Cormorant	0	7	0	751	2	0	360	70	24	0	0	22	0	0	474	1	38	83	**1832**
American Bittern	0	0	0	8	0	2	0	0	0	0	0	0	0	2	1	0	1	0	**14**
Great Blue Heron	4	0	18	134	26	1	2	0	0	3	0	2	0	0	16	1	0	6	**213**
Great Egret	1	0	2	279	2	0	40	6	3	32	0	4	0	1	269	20	86	40	**785**
Snowy Egret	0	0	0	3	0	0	0	1	0	0	0	0	0	0	15	0	1	0	**20**
Green Heron	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
Black-cr. Night-Heron	4	0	50	45	0	0	18	6	0	0	0	0	0	5	100	3	31	0	**262**
White-faced Ibis	84	0	948	500	8	0	4	0	121	28	0	0	0	0	2082	0	327	0	**4102**
Virginia Rail	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	**5**
Sora	0	0	0	13	0	0	0	0	0	0	0	0	1	2	8	0	0	0	**24**
Sandhill Crane	11	0	82	25	12	1	5	1	8	2	9	6	14	9	21	0	2	0	**208**
Semipalmated Plover	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Killdeer	16	14	12	108	58	13	9	9	5	29	18	93	4	11	144	47	28	41	**659**
Black-necked Stilt	1	0	4	611	10	0	14	10	17	53	15	4	0	18	1529	52	230	3	**2571**
American Avocet	0	0	0	188	1	0	24	16	2	57	8	0	0	106	1178	12	188	10	**1790**
yellowlegs spp.	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**

Appendix 3b *(Continued)*

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley area	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Willet	22	2	52	0	106	0	0	3	70	33	6	54	14	34	196	17	1	15	**625**
Spotted Sandpiper	6	4	0	19	21	0	3	4	0	0	4	14	1	0	2	2	0	2	**82**
Long-billed Curlew	1	0	16	0	3	0	0	0	0	0	1	0	0	0	65	0	0	0	**86**
Western/Least	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	**2**
Wilson's Snipe	0	0	0	13	0	0	0	1	0	0	0	1	2	0	1	0	0	0	**18**
Wilson's Phalarope	13	2	72	303	21	0	0	2	9	27	115	31	24	35	101	57	8	2	**822**
Red-necked Phalarope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	**5**
phalarope spp.	21	2	102	1	2	0	0	0	34	24	0	15	1	0	3	0	0	0	**205**
Franklin's Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	**5**
Bonaparte's Gull	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**46**
Ring-billed Gull	0	1	0	173	2	0	106	5	6	6	0	2	11	5	555	19	819	9	**1719**
California Gull	0	0	0	2	0	0	21	21	0	0	0	0	0	0	240	16	117	0	**417**
gull spp.	3	7	2	221	132	0	54	7	4014	185	57	836	0	63	185	0	0	803	**6569**
Caspian Tern	0	0	0	69	1	0	10	2	1	2	0	4	0	0	11	2	11	290	**403**
Forster's Tern	40	24	28	1334	6	50	77	21	75	2	0	103	0	0	590	6	91	8	**2455**
Black Tern	379	0	210	593	23	110	3	0	16	31	0	98	195	0	301	0	0	0	**1959**
Area Total	**720**	**120**	**1618**	**14709**	**581**	**184**	**1337**	**891**	**4475**	**651**	**233**	**1940**	**350**	**315**	**14365**	**426**	**8103**	**1717**	

Appendix 3c NUMBERS OF NONGAME WATERBIRDS ON A COMPREHENSIVE SURVEY OF THE KLAMATH BASIN, 9-17 (MOSTLY 9-13) AUGUST 2004. SEE METHODS FOR SURVEY PROTOCOL AND APPENDIX 1 AND FIGURE 1 FOR DESCRIPTIONS OF VARIOUS SURVEY AREAS.

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Pied-billed Grebe	0	0	0	39	0	0	4	78	0	3	8	45	7	0	324	9	374	0	**891**
Eared Grebe	0	0	0	341	5	0	1	323	200	0	0	66	0	0	2168	4	2335	0	**5443**
Western Grebe	0	0	0	283	0	0	0	23	0	0	0	133	0	0	266	60	51	15	**831**
Clark's Grebe	0	0	0	0	0	0	0	2	0	0	0	52	0	0	18	14	2	0	**88**
Aechmophorus spp.	0	26	0	3804	23	0	236	167	0	0	0	1	0	0	22	0	1158	3	**5440**
Am. White Pelican	275	0	0	1761	56	0	188	139	0	49	2	174	15	0	1507	42	120	470	**4798**
Double-cr. Cormorant	2	41	2	1183	2	0	157	51	0	0	0	51	0	0	168	1	28	8	**1694**
American Bittern	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Great Blue Heron	29	8	12	84	16	2	3	4	2	6	1	10	1	7	25	1	4	20	**235**
Great Egret	88	0	0	545	49	0	27	20	3	51	12	7	6	1	528	12	40	9	**1398**
Snowy Egret	0	0	0	1	0	0	0	0	0	0	0	0	0	0	22	0	5	0	**28**
Green Heron	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	**4**
Black-cr. Night-Heron	0	0	0	137	0	0	16	1	0	0	0	0	0	13	30	0	9	1	**207**
White-faced Ibis	47	170	3064	883	0	0	3	4	36	598	14	4	19	4	355	42	76	0	**5319**
Virginia Rail	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4	1	1	0	**10**
Sora	0	0	0	9	0	0	0	0	0	1	0	0	0	0	1	0	18	0	**29**
Sandhill Crane	11	0	136	10	10	0	9	3	0	13	69	2	6	36	31	0	0	0	**336**
Black-bellied Plover	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Semipalmated Plover	0	0	0	0	4	0	0	0	0	0	0	0	0	0	21	0	0	0	**25**
Killdeer	33	0	0	88	72	4	17	13	17	7	0	248	3	0	65	144	5	109	**825**
Black-necked Stilt	61	0	0	901	48	0	10	12	106	364	6	0	0	30	3030	83	28	3	**4682**
American Avocet	2	0	0	141	0	0	20	0	225	353	0	0	0	9	121	0	2	17	**890**
Greater Yellowlegs	0	0	0	1	0	0	0	1	0	17	0	15	0	0	26	35	0	0	**95**
Lesser Yellowlegs	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	1	0	0	**9**
yellowlegs spp.	0	15	0	35	1	0	0	0	2	0	0	0	0	0	1	0	0	0	**54**

Appendix 3c *(Continued)*

Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR	KLAMATH BASIN TOTAL
Solitary Sandpiper	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	**3**
Willet	1	0	0	1	0	0	0	1	2	0	0	0	0	0	1	0	0	1	**7**
Spotted Sandpiper	1	2	0	15	11	0	16	3	0	0	0	42	0	0	3	8	3	4	**108**
Long-billed Curlew	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Western Sandpiper	0	0	0	978	0	0	0	0	0	0	0	26	0	0	58	0	0	0	**1062**
Least Sandpiper	0	0	0	104	3	0	0	1	0	1	0	46	0	0	325	20	0	0	**500**
Western/Least	325	210	0	302	200	0	0	0	205	125	0	329	20	0	120	0	0	489	**2325**
Baird's Sandpiper	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	**5**
Dunlin	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**2**
dowitcher spp.	25	0	0	5027	24	0	0	0	0	72	0	56	0	28	4895	0	8	30	**10165**
Wilson's Snipe	0	0	0	17	0	0	0	1	0	0	0	7	0	0	2	0	0	0	**27**
Wilson's Phalarope	0	0	0	127	2	0	0	0	4	8	31	11	1	0	1302	1	16	0	**1503**
Red-necked Phalarope	0	0	0	355	0	0	0	0	0	0	0	0	0	0	546	0	0	0	**901**
phalarope spp.	65	50	12	142	50	0	40	0	154	15	0	0	0	0	282	0	0	100	**910**
Franklin's Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**
Bonaparte's Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	**2**
Ring-billed Gull	0	0	0	2023	0	0	339	73	0	8	6	42	2	0	225	4	184	111	**3017**
California Gull	0	0	0	0	0	0	0	0	0	1	0	8	0	5	3	5	0	12	**34**
gull spp.	7	117	6	7722	32	0	283	0	60	124	0	84	0	0	36	4	5	272	**8752**
Caspian Tern	2	0	0	111	0	0	7	3	0	0	0	7	0	0	25	5	143	104	**407**
Forster's Tern	0	0	4	117	0	1	192	61	0	0	0	27	0	0	62	0	464	51	**979**
Black Tern	0	0	66	363	0	0	47	36	0	2	0	0	0	0	4	0	900	0	**1418**
Area Total	**974**	**639**	**3306**	**27659**	**608**	**7**	**1616**	**1022**	**1016**	**1818**	**149**	**1500**	**80**	**133**	**16631**	**498**	**5980**	**1829**	

Appendix 4a PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN 18 SUBAREAS OF THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING SPRING MIGRATION (LATE APRIL-EARLY MAY) IN 2003.

	North Subregion			Central Subregion										South Subregion				
Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area[a]	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR
Eared Grebe	1.3	0.1	0.6	14.1	0.0	0.1	1.1	0.4	3.7	0.6	0.0	0.6	x	0.6	56.3	1.2	19.2	0.0
Western/Clark's grebes	0.1	0.6	0.0	74.6	0.1	0.0	4.3	2.1	0.3	0.1	0.0	5.9	x	0.0	4.4	1.4	5.5	0.4
Am. White Pelican	0.3	0.0	0.0	27.8	1.3	0.4	7.7	3.6	1.9	4.8	3.3	0.6	x	0.0	11.1	0.3	4.2	32.5
Double-cr. Cormorant	0.0	0.0	0.0	60.0	0.3	0.0	5.1	0.4	3.1	0.1	0.0	0.0	x	0.0	21.0	0.7	4.0	5.4
Herons and Egrets (all)	2.5	0.1	0.9	34.0	0.7	0.5	2.9	0.9	0.0	0.9	0.2	0.1	x	0.2	33.6	0.5	17.3	4.6
White-faced Ibis	0.0	0.0	31.4	1.8	5.2	0.0	0.0	0.0	10.5	0.2	10.5	0.0	x	3.0	20.7	0.3	15.5	0.8
Sandhill Crane	20.7	0.0	29.6	11.1	0.4	4.1	3.0	0.0	17.4	2.2	3.7	1.5	x	0.4	5.9	0.0	0.0	0.0
Black-necked Stilt	0.0	0.0	0.0	2.0	0.2	0.0	1.6	0.4	0.2	3.3	0.1	0.0	x	2.0	81.8	0.4	8.1	0.0
American Avocet	0.2	0.0	0.0	1.5	0.0	0.0	0.3	0.2	3.7	11.0	0.8	0.0	x	7.5	67.4	2.6	4.5	0.2
Willet	2.0	0.4	10.7	0.0	6.8	0.0	0.0	0.2	25.7	4.6	8.6	3.4	x	7.3	25.7	2.1	0.7	1.8
Shorebirds (all)	0.7	0.0	1.4	1.4	0.5	0.1	0.7	0.4	2.4	3.9	2.1	0.2	x	2.5	37.8	0.2	45.5	0.1
Gulls (all)	0.0	0.0	0.0	1.4	0.0	0.0	1.1	0.6	63.9	0.1	0.8	8.7	x	3.0	1.1	0.0	4.5	14.8
Caspian Tern	0.0	0.0	0.0	29.6	0.0	0.6	2.5	1.3	0.0	0.0	0.6	3.8	x	0.0	4.4	0.0	29.6	27.7
Forster's Tern	0.0	0.0	0.0	49.4	0.0	3.6	11.3	8.4	2.3	3.6	1.3	0.8	x	1.3	10.0	0.5	7.7	0.0
Black Tern	0.0	0.0	0.0	34.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	x	0.0	63.2	0.0	0.0	0.0
Waterbirds (all)	0.6	0.1	1.3	12.9	0.4	0.2	1.7	0.7	18.9	2.0	1.4	3.0	x	2.0	24.8	0.4	23.8	5.8

[a] x = area not surveyed.

Appendix 4b PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN 18 SUBAREAS OF THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING THE BREEDING SEASON (MID-JUNE) IN 2003.

	North Subregion			Central Subregion										South Subregion				
Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR
Eared Grebe	0.3	0.0	0.1	7.6	0.0	0.0	0.0	6.3	0.0	0.1	0.0	0.1	0.0	0.1	44.5	7.0	33.9	0.0
Western/Clark's grebes	0.7	0.5	0.0	61.7	1.0	0.0	2.3	1.4	0.0	0.0	0.0	3.8	0.0	0.0	6.6	0.8	20.3	1.0
Am. White Pelican	1.4	0.8	1.5	24.4	3.0	0.0	1.6	0.6	0.5	1.1	0.6	1.4	0.2	4.0	13.6	0.1	8.5	36.8
Double-cr. Cormorant	0.1	0.0	0.0	68.3	0.1	0.0	7.5	0.2	0.0	0.0	0.0	0.3	0.0	0.0	15.1	0.6	0.1	7.7
Herons and Egrets (all)	0.8	0.0	0.5	19.9	1.1	0.2	4.1	0.3	0.1	2.3	0.9	0.0	0.0	0.5	58.6	3.2	4.4	3.2
White-faced Ibis	0.8	0.0	16.1	2.6	5.6	0.0	0.2	0.0	0.0	0.8	0.0	0.0	0.0	0.0	66.2	6.4	1.4	0.0
Sandhill Crane	15.9	0.4	35.4	8.3	2.2	1.4	2.2	0.0	6.1	2.2	1.4	0.7	3.6	4.3	14.4	1.4	0.0	0.0
Black-necked Stilt	0.9	0.0	0.0	11.6	0.0	0.0	0.3	0.2	0.0	0.2	0.4	0.0	0.0	2.0	78.1	0.2	5.7	0.3
American Avocet	0.0	0.0	0.0	6.6	0.0	0.0	0.5	0.4	1.2	0.5	1.1	0.0	0.0	5.5	74.0	1.7	7.2	1.5
Willet	6.3	1.1	5.7	0.0	27.5	0.0	0.0	0.2	16.1	1.9	1.0	3.4	2.1	2.5	23.1	3.6	0.4	5.0
Shorebirds (all)	2.4	0.4	2.3	10.1	4.0	0.2	0.5	0.4	1.7	1.5	0.9	0.8	0.7	3.7	62.1	1.9	4.8	1.5
Gulls (all)	0.0	0.0	0.0	2.5	1.3	0.0	4.7	0.0	16.8	0.3	0.0	13.4	0.0	0.7	25.6	0.0	2.7	32.1
Caspian Tern	0.0	0.0	0.0	30.2	5.3	0.3	1.5	0.9	0.0	0.0	0.6	0.0	0.0	0.0	0.6	0.3	8.9	51.5
Forster's Tern	2.1	0.2	0.3	57.8	0.4	1.0	2.4	0.7	0.2	0.0	0.2	0.1	0.0	1.8	16.0	5.9	10.3	0.6
Black Tern	24.6	0.0	5.9	34.7	0.5	3.2	0.1	0.0	0.0	0.4	0.0	2.8	7.7	0.0	17.7	2.4	0.0	0.0
Waterbirds (all)	1.9	0.2	2.4	19.9	1.7	0.2	1.9	1.9	3.3	0.5	0.2	3.2	0.5	1.0	35.6	3.2	13.3	9.2

Appendix 4c PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN 18 SUBAREAS OF THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING FALL MIGRATION (MID-AUGUST) IN 2003.

	North Subregion			Central Subregion										South Subregion				
Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR
Eared Grebe	0.0	0.0	0.0	18.3	0.1	0.0	0.0	0.9	0.0	0.0	0.0	1.3	0.0	0.0	43.1	2.8	33.6	0.0
Western/Clark's grebes	0.0	0.4	0.0	64.0	0.1	0.0	4.9	2.6	0.0	0.0	0.0	1.6	0.0	0.0	4.6	0.9	20.4	0.3
Am. White Pelican	5.6	0.7	0.0	53.9	1.1	0.0	5.2	3.6	0.0	2.3	0.0	2.0	0.5	0.0	15.9	0.0	6.6	2.6
Double-cr. Cormorant	0.0	2.3	0.0	53.0	0.1	0.1	3.8	2.5	0.0	0.0	0.0	2.8	0.0	0.0	23.3	0.0	6.7	5.4
Herons and Egrets (all)	13.9	0.3	0.9	40.5	1.2	0.7	11.1	0.9	0.0	3.2	0.1	1.8	0.1	0.5	16.1	0.2	7.3	1.2
White-faced Ibis	3.0	0.1	16.0	11.5	5.6	0.6	0.0	0.3	0.5	7.2	0.3	0.0	0.8	0.0	40.6	0.0	12.3	0.9
Sandhill Crane	0.0	0.0	13.6	3.0	2.4	4.7	2.4	0.0	0.0	9.5	39.1	0.0	1.2	7.7	14.2	1.2	1.2	0.0
Black-necked Stilt	1.4	0.0	0.1	12.4	0.0	0.0	0.2	0.0	0.0	3.3	0.8	0.0	0.0	0.0	39.5	0.6	41.2	0.5
American Avocet	0.0	0.0	0.0	15.3	0.0	0.0	0.1	0.0	0.0	31.5	0.0	0.0	0.0	0.0	31.5	0.0	13.1	8.6
Willet	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	70.4	0.0	0.0	18.5
Shorebirds (all)	2.2	0.6	0.1	11.9	0.6	0.1	0.1	0.0	0.2	3.3	0.2	1.5	0.1	0.0	59.0	0.1	12.6	7.3
Gulls (all)	0.1	1.4	0.6	71.2	0.2	0.0	8.8	1.0	0.1	0.8	0.2	1.0	0.0	0.0	3.4	3.5	2.0	5.8
Caspian Tern	3.1	0.0	0.0	30.1	0.2	0.0	15.9	0.0	0.0	0.0	0.0	1.0	0.0	0.0	2.2	1.4	38.0	8.1
Forster's Tern	0.0	0.0	0.0	1.5	0.0	0.2	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	90.2	6.2
Black Tern	0.0	0.0	1.4	11.1	0.8	0.1	0.0	1.7	0.0	0.1	0.0	0.3	0.6	0.0	0.6	0.0	83.3	0.0
Waterbirds (all)	2.1	0.7	1.1	28.3	0.8	0.1	2.5	0.7	0.2	2.5	0.3	1.4	0.1	0.0	39.0	0.8	14.1	5.2

Appendix 5a PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN 18 SUBAREAS OF THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING SPRING MIGRATION (LATE APRIL-EARLY MAY) IN 2004.

	North Subregion			Central Subregion										South Subregion				
Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR
Eared Grebe	0.1	0.4	0.0	14.6	0.0	0.0	0.0	2.3	0.5	0.8	0.0	1.0	0.4	0.0	37.0	1.0	41.9	0.0
Western/Clark's grebes	0.2	2.3	0.0	66.3	0.1	0.0	3.1	1.5	0.0	0.3	0.0	6.8	0.0	0.0	4.0	0.7	13.9	0.8
Am. White Pelican	0.1	0.1	0.0	30.1	1.1	0.0	2.4	2.3	0.2	0.3	0.0	2.2	0.0	0.0	9.7	0.0	6.1	45.4
Double-cr. Cormorant	0.0	1.6	0.0	56.6	0.0	0.0	4.3	3.3	1.8	0.0	0.0	1.5	0.0	0.0	20.7	0.8	4.2	5.3
Herons and Egrets (all)	0.3	0.0	0.0	23.7	2.6	0.3	13.8	0.9	0.0	0.7	0.0	0.1	0.0	0.5	29.6	0.8	11.7	15.1
White-faced Ibis	10.2	0.0	10.7	0.5	15.8	0.0	1.8	0.0	2.8	0.0	1.8	0.0	0.0	0.0	52.1	1.2	3.0	0.0
Sandhill Crane	8.9	0.0	30.4	14.7	4.0	0.4	3.1	0.9	3.1	6.3	0.0	4.9	7.1	8.0	6.7	0.9	0.4	0.0
Black-necked Stilt	0.5	0.0	0.5	6.0	0.0	0.0	0.9	0.4	4.0	6.9	1.3	0.1	0.1	2.1	67.7	6.3	2.9	0.2
American Avocet	0.1	0.0	0.1	1.2	0.0	0.0	0.6	0.2	2.5	9.5	1.5	0.0	0.2	1.4	79.6	1.5	0.9	0.7
Willet	3.0	0.5	6.7	0.0	5.1	0.0	0.0	0.5	6.9	7.4	2.5	12.8	7.4	7.1	31.2	6.0	0.0	2.7
Shorebirds (all)	0.2	0.1	1.2	1.6	0.2	0.0	0.3	1.1	1.3	5.2	0.4	0.8	0.4	2.3	78.3	2.8	3.6	0.2
Gulls (all)	0.0	0.1	0.2	1.5	0.6	0.0	6.4	0.1	60.9	0.3	0.0	10.3	0.6	0.5	4.5	0.0	1.3	12.7
Caspian Tern	0.0	1.2	0.0	1.9	0.5	1.4	0.7	0.0	0.0	2.8	0.0	0.5	0.0	0.0	7.0	0.0	59.0	25.2
Forster's Tern	5.0	0.6	0.7	44.6	0.5	1.8	9.4	0.6	2.3	4.9	0.0	1.1	0.0	0.7	9.3	2.0	14.5	2.0
Black Tern	12.3	1.4	30.2	13.9	0.0	6.2	0.0	0.0	0.0	0.0	0.0	1.6	30.4	0.0	0.0	0.0	4.0	0.0
Waterbirds (all)	0.6	0.4	1.0	15.2	0.7	0.1	2.5	1.2	13.8	2.3	0.2	3.7	0.6	1.0	38.7	1.4	10.1	6.5

Appendix 5b PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN 18 SUBAREAS OF THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING THE BREEDING SEASON (MID-JUNE) IN 2004.

	North Subregion			Central Subregion										South Subregion				
Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR
Eared Grebe	0.0	0.0	0.0	6.2	0.0	0.0	0.0	4.9	0.5	0.0	0.0	0.3	0.7	0.1	48.3	0.8	38.2	0.0
Western/Clark's grebes	0.1	0.4	0.0	74.9	0.3	0.0	2.1	0.7	0.1	0.1	0.0	4.8	0.0	0.0	3.1	0.5	12.4	0.4
Am. White Pelican	2.8	0.4	0.6	32.8	3.2	0.1	10.9	2.1	0.1	3.7	0.0	4.2	0.0	0.5	12.2	0.6	15.3	10.5
Double-cr. Cormorant	0.0	0.4	0.0	41.0	0.1	0.0	19.7	3.8	1.3	0.0	0.0	1.2	0.0	0.0	25.9	0.1	2.1	4.5
Herons and Egrets (all)	0.7	0.0	5.4	36.2	2.2	0.2	4.6	1.1	0.2	2.7	0.0	0.5	0.0	0.6	31.0	1.9	9.2	3.6
White-faced Ibis	2.0	0.0	23.1	12.2	0.2	0.0	0.1	0.0	2.9	0.7	0.0	0.0	0.0	0.0	50.8	0.0	8.0	0.0
Sandhill Crane	5.3	0.0	39.4	12.0	5.8	0.5	2.4	0.5	3.8	1.0	4.3	2.9	6.7	4.3	10.1	0.0	1.0	0.0
Black-necked Stilt	0.0	0.0	0.2	23.8	0.4	0.0	0.5	0.4	0.7	2.1	0.6	0.2	0.0	0.7	59.5	2.0	8.9	0.1
American Avocet	0.0	0.0	0.0	10.5	0.1	0.0	1.3	0.9	0.1	3.2	0.4	0.0	0.0	5.9	65.8	0.7	10.5	0.6
Willet	3.5	0.3	8.3	0.0	17.0	0.0	0.0	0.5	11.2	5.3	1.0	8.6	2.2	5.4	31.4	2.7	0.2	2.4
Shorebirds (all)	1.2	0.3	3.8	18.1	3.3	0.2	0.7	0.7	2.0	3.2	2.4	3.1	0.7	3.0	47.0	2.7	6.6	1.1
Gulls (all)	0.0	0.1	0.0	5.0	1.5	0.0	2.1	0.4	45.9	2.2	0.7	9.6	0.1	0.8	11.2	0.4	10.7	9.3
Caspian Tern	0.0	0.0	0.0	17.1	0.2	0.0	2.5	0.5	0.2	0.5	0.0	1.0	0.0	0.0	2.7	0.5	2.7	72.0
Forster's Tern	1.6	1.0	1.1	54.3	0.2	2.0	3.1	0.9	3.1	0.1	0.0	4.2	0.0	0.0	24.0	0.2	3.7	0.3
Black Tern	19.3	0.0	10.7	30.3	1.2	5.6	0.2	0.0	0.8	1.6	0.0	5.0	10.0	0.0	15.4	0.0	0.0	0.0
Waterbirds (all)	1.4	0.2	3.1	27.9	1.1	0.3	2.5	1.7	8.5	1.2	0.4	3.7	0.7	0.6	27.2	0.8	15.4	3.3

Appendix 5c PERCENT OCCURRENCE OF KEY SPECIES AND SPECIES GROUPS OF WATERBIRDS WITHIN 18 SUBAREAS OF THREE SUBREGIONS OF THE KLAMATH BASIN (SEE APPENDIX 1) DURING FALL MIGRATION (MID-AUGUST) IN 2004.

	North Subregion			Central Subregion										South Subregion				
Species	Klamath Marsh area	Thompson Reservoir	Sycan Marsh	Upper Klamath Lake area	Sprague River Valley	Aspen Lake area	Klamath River area	Spring Lake area	Swan Lake area	Yonna Valley area	Langell Valley	Gerber/Willow Valley	Fishhole lakes area	Butte Valley	Lower Klamath NWR	Lower Klamath (private)	Tule Lake NWR	Clear Lake NWR
Eared Grebe	0.0	0.0	0.0	6.3	0.1	0.0	0.0	5.9	3.7	0.0	0.0	1.2	0.0	0.0	39.8	0.1	42.9	0.0
Western/Clark's grebes	0.0	0.4	0.0	64.3	0.4	0.0	3.7	3.0	0.0	0.0	0.0	2.9	0.0	0.0	4.8	1.2	19.0	0.3
Am. White Pelican	5.7	0.0	0.0	36.7	1.2	0.0	3.9	2.9	0.0	1.0	0.0	3.6	0.3	0.0	31.4	0.9	2.5	9.8
Double-cr. Cormorant	0.1	2.4	0.1	69.8	0.1	0.0	9.3	3.0	0.0	0.0	0.0	3.0	0.0	0.0	9.9	0.1	1.7	0.5
Herons and Egrets (all)	6.2	0.4	0.7	41.0	3.5	0.1	2.5	1.4	0.3	3.0	0.7	0.9	0.4	1.1	32.3	0.7	3.1	1.6
White-faced Ibis	0.9	3.2	57.6	16.6	0.0	0.0	0.1	0.1	0.7	11.2	0.3	0.1	0.4	0.1	6.7	0.8	1.4	0.0
Sandhill Crane	3.3	0.0	40.5	3.0	3.0	0.0	2.7	0.9	0.0	3.9	20.5	0.6	1.8	10.7	9.2	0.0	0.0	0.0
Black-necked Stilt	1.3	0.0	0.0	19.2	1.0	0.0	0.2	0.3	2.3	7.8	0.1	0.0	0.0	0.6	64.7	1.8	0.6	0.1
American Avocet	0.2	0.0	0.0	15.8	0.0	0.0	2.2	0.0	25.3	39.7	0.0	0.0	0.0	1.0	13.6	0.0	0.2	1.9
Willet	14.3	0.0	0.0	14.3	0.0	0.0	0.0	14.3	28.6	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	14.3
Shorebirds (all)	2.1	1.1	0.1	34.2	1.7	0.0	0.4	0.1	3.0	4.0	0.2	3.3	0.1	0.3	44.8	1.2	0.3	3.1
Gulls (all)	0.1	1.0	0.1	82.5	0.3	0.0	5.3	0.6	0.5	1.1	0.1	1.1	0.0	0.0	2.2	0.1	1.6	3.3
Caspian Tern	0.5	0.0	0.0	27.3	0.0	0.0	1.7	0.7	0.0	0.0	0.0	1.7	0.0	0.0	6.1	1.2	35.1	25.6
Forster's Tern	0.0	0.0	0.4	12.0	0.0	0.1	19.6	6.2	0.0	0.0	0.0	2.8	0.0	0.0	6.3	0.0	47.4	5.2
Black Tern	0.0	0.0	4.7	25.6	0.0	0.0	3.3	2.5	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.0	63.5	0.0
Waterbirds (all)	1.5	1.0	5.1	42.3	0.9	0.0	2.5	1.6	1.6	2.8	0.2	2.3	0.1	0.2	25.4	0.8	9.1	2.8

Appendix 6 LIST OF COMMON AND SCIENTIFIC NAMES OF BIRDS RECORDED ON SURVEYS OF NONGAME WATERBIRDS IN THE KLAMATH BASIN IN 2003 AND 2004.

GAVIIFORMES
GAVIIDAE
Common Loon *Gavia immer*
PODICIPEDIFORMES
PODICIPEDIDAE
Pied-billed Grebe *Podilymbus podiceps*
Horned Grebe *Podiceps auritus*
Red-necked Grebe *Podiceps grisegena*
Eared Grebe *Podiceps nigricollis*
Western Grebe *Aechmophorus occidentalis*
Clark's Grebe *Aechmophorus clarkii*
PELECANIFORMES
PELECANIDAE
American White Pelican *Pelecanus erythrorhynchos*
PHALACROCORACIDAE
Double-crested Cormorant *Phalacrocorax auritus*
CICONIIFORMES
ARDEIDAE
American Bittern *Botaurus lentiginosus*
Great Blue Heron *Ardea herodias*
Great Egret *Ardea alba*
Snowy Egret *Egretta thula*
Green Heron *Butorides virescens*
Black-crowned Night-Heron *Nycticorax nycticorax*
THRESKIORNITHIDAE
White-faced Ibis *Plegadis chihi*
GRUIFORMES
RALLIDAE
Virginia Rail *Rallus limicola*
Sora *Porzana carolina*
GRUIDAE
Sandhill Crane *Grus canadensis*
CHARADRIIFORMES
CHARADRIIDAE
Black-bellied Plover *Pluvialis squatarola*
Snowy Plover *Charadrius alexandrinus*
Semipalmated Plover *Charadrius semipalmatus*
Killdeer *Charadrius vociferus*
RECURVIROSTRIDAE
Black-necked Stilt *Himantopus mexicanus*
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*
Red Knot *Calidris canutus*
Western Sandpiper *Calidris mauri*
Least Sandpiper *Calidris minutilla*
Baird's Sandpiper *Calidris bairdii*
Dunlin *Calidris alpina*
Short-billed Dowitcher *Limnodromus griseus*
Long-billed Dowitcher *Limnodromus scolopaceus*
Wilson's Snipe *Gallinago delicata*
Wilson's Phalarope *Phalaropus tricolor*
Red-necked Phalarope *Phalaropus lobatus*
LARIDAE
Franklin's Gull *Larus pipixcan*
Bonaparte's Gull *Larus philadelphia*
Ring-billed Gull *Larus delawarensis*
California Gull *Larus californicus*
Caspian Tern *Sterna caspia*
Forster's Tern *Sterna forsteri*
Black Tern *Chlidonias niger*

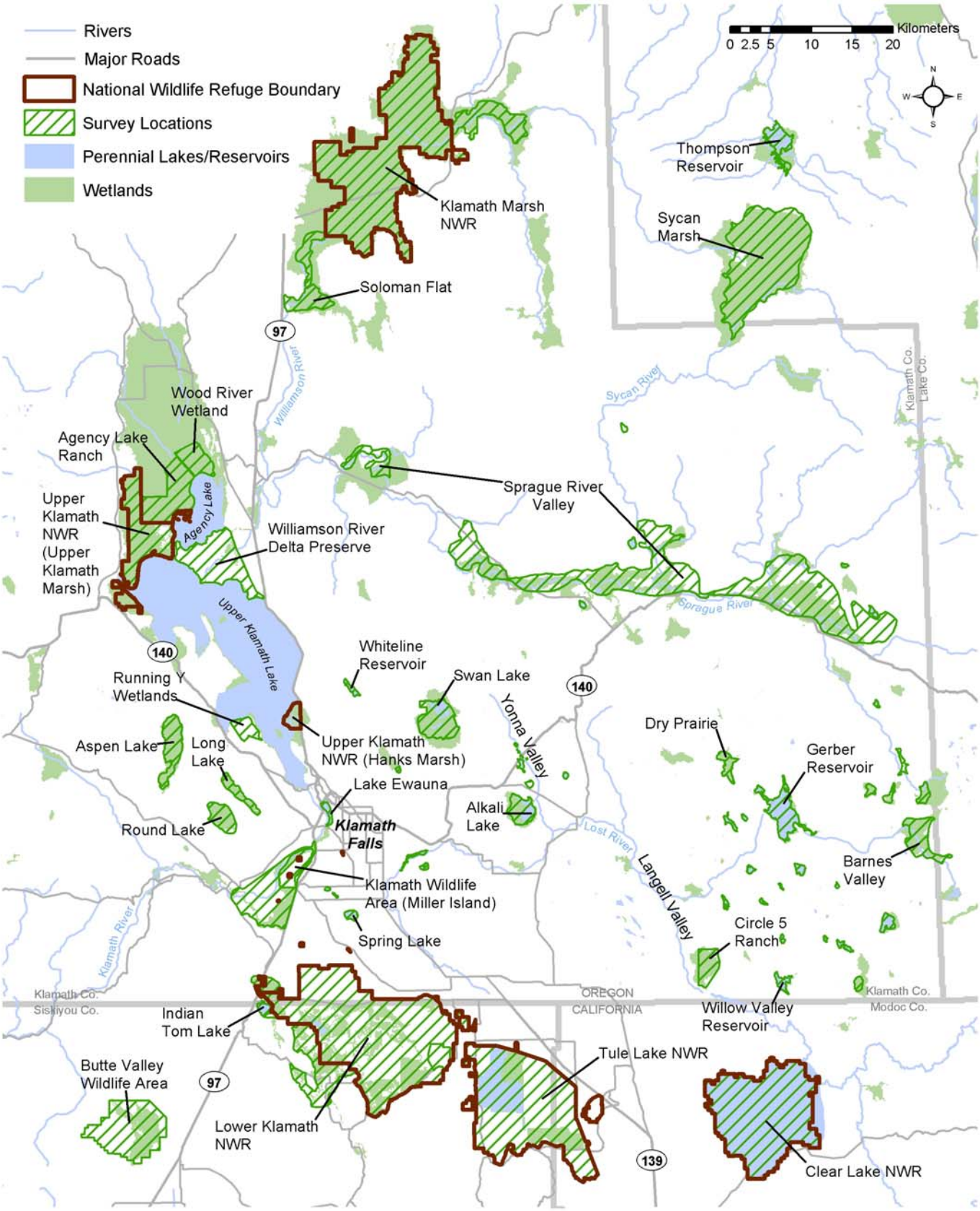

Figure 1. Key wetlands in the Klamath Basin study area. See Appendix 1 for groupings of wetlands for analysis and a list of all sites within each grouping.

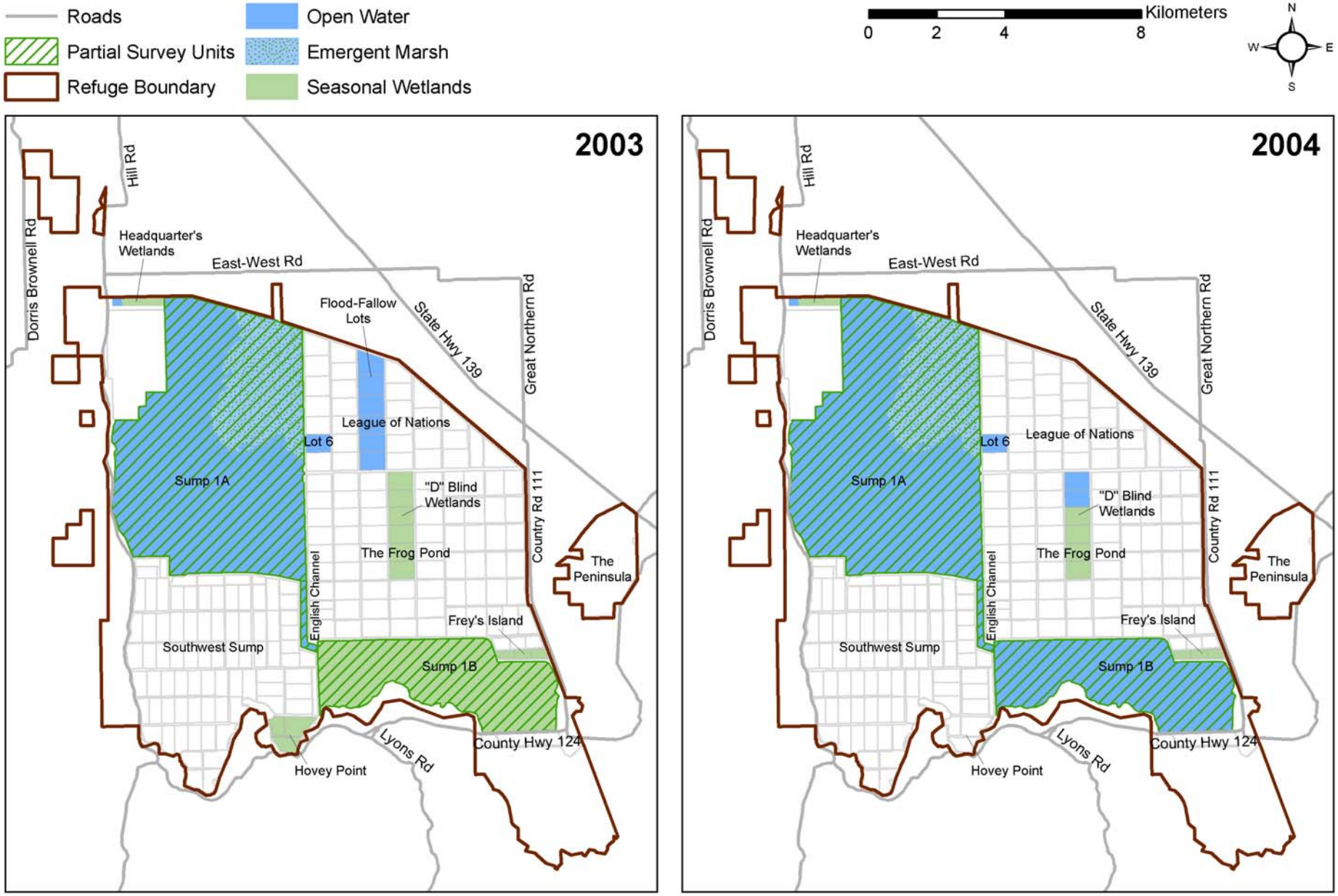

Figure 2. Tule Lake National Wildlife Refuge showing wetland habitats censused on comprehensive surveys in 2003 and 2004 and the (highlighted) subset of these also censused more frequently as partial survey areas in 2003 only (see Methods); Sump 1A includes the English Channel.

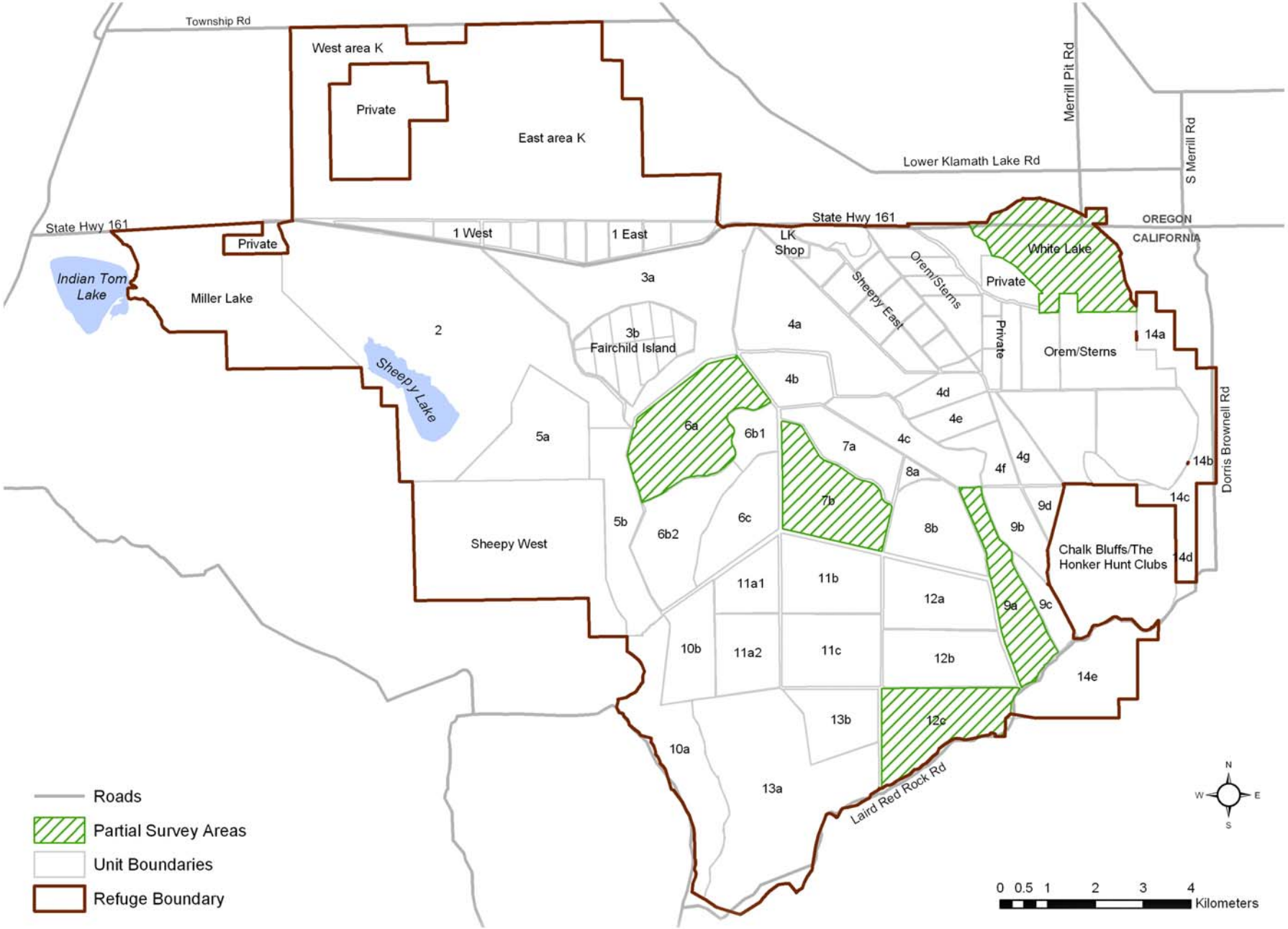

Figure 3. Lower Klamath National Wildlife Refuge showing all named and numbered wetland units censused on comprehensive surveys in 2003 and 2004 and the (highlighted) subset of these also censused more frequently as partial survey areas in 2003 only (see Methods).

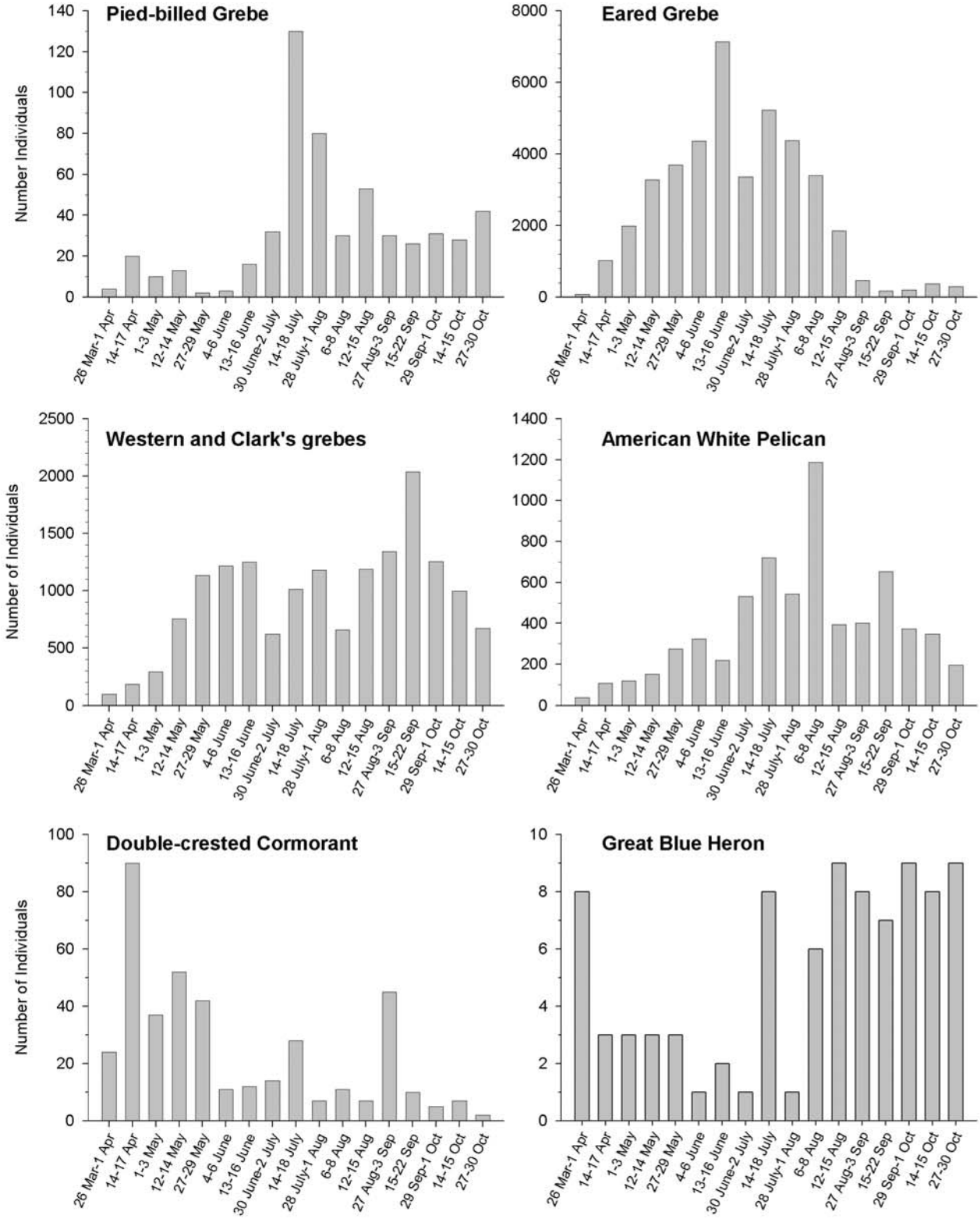

Figure 4a. Phenology of the Pied-billed Grebe, Eared Grebe, Western and Clark's grebes, American White Pelican, Double-crested Cormorant, and Great Blue Heron in the Klamath Basin from late March to late October 2003. Data from 17 surveys of five units of Lower Klamath NWR (6A, 7B, 9A, 12C, White Lake) and two units of Tule Lake NWR (1A, 1B).

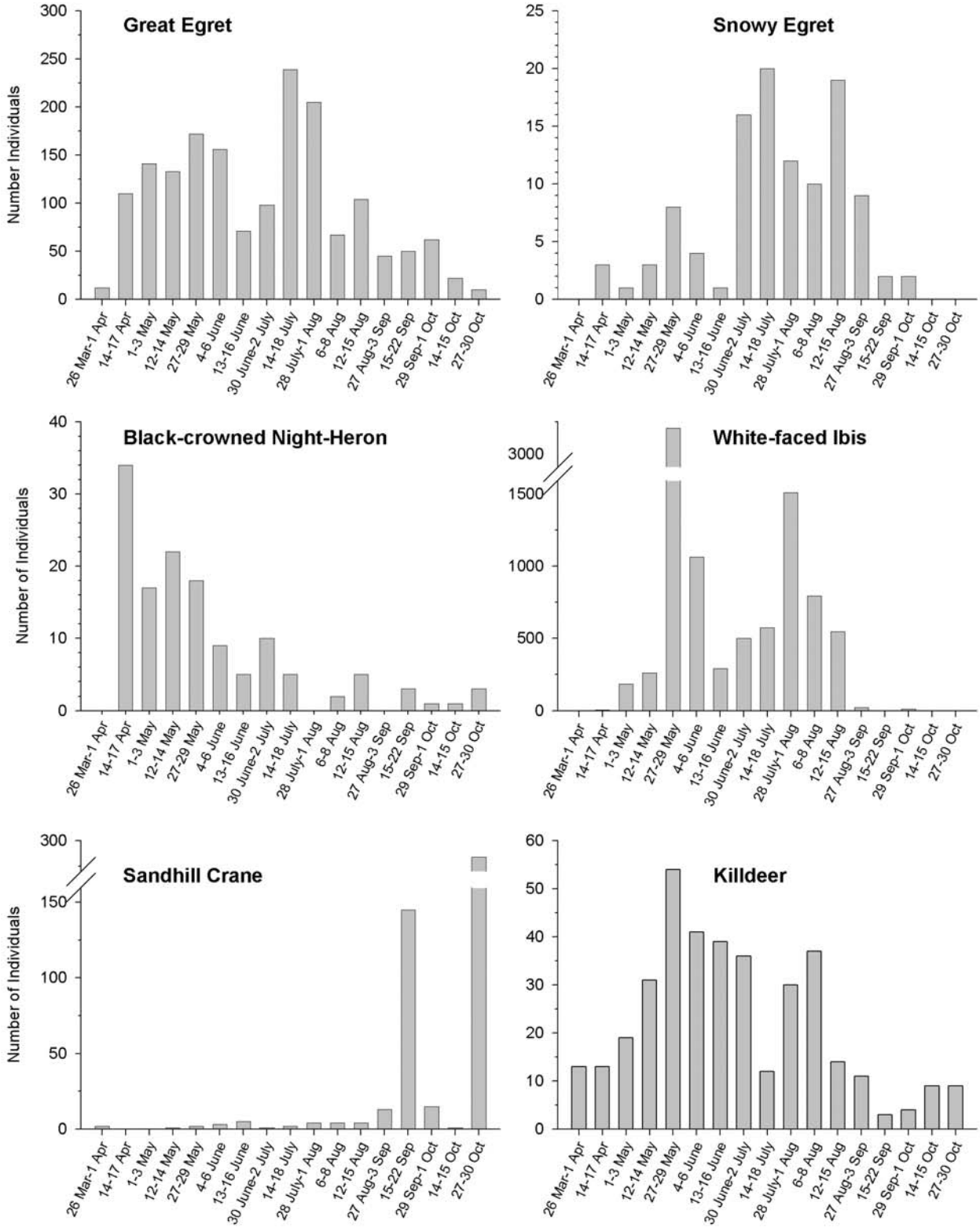

Figure 4b. Phenology of the Great Egret, Snowy Egret, Black-crowned Night-Heron, White-faced Ibis, Sandhill Crane, and Killdeer in the Klamath Basin from late March to late October 2003. Data from 17 surveys of five units of Lower Klamath NWR (6A, 7B, 9A, 12C, White Lake) and two units of Tule Lake NWR (1A, 1B).

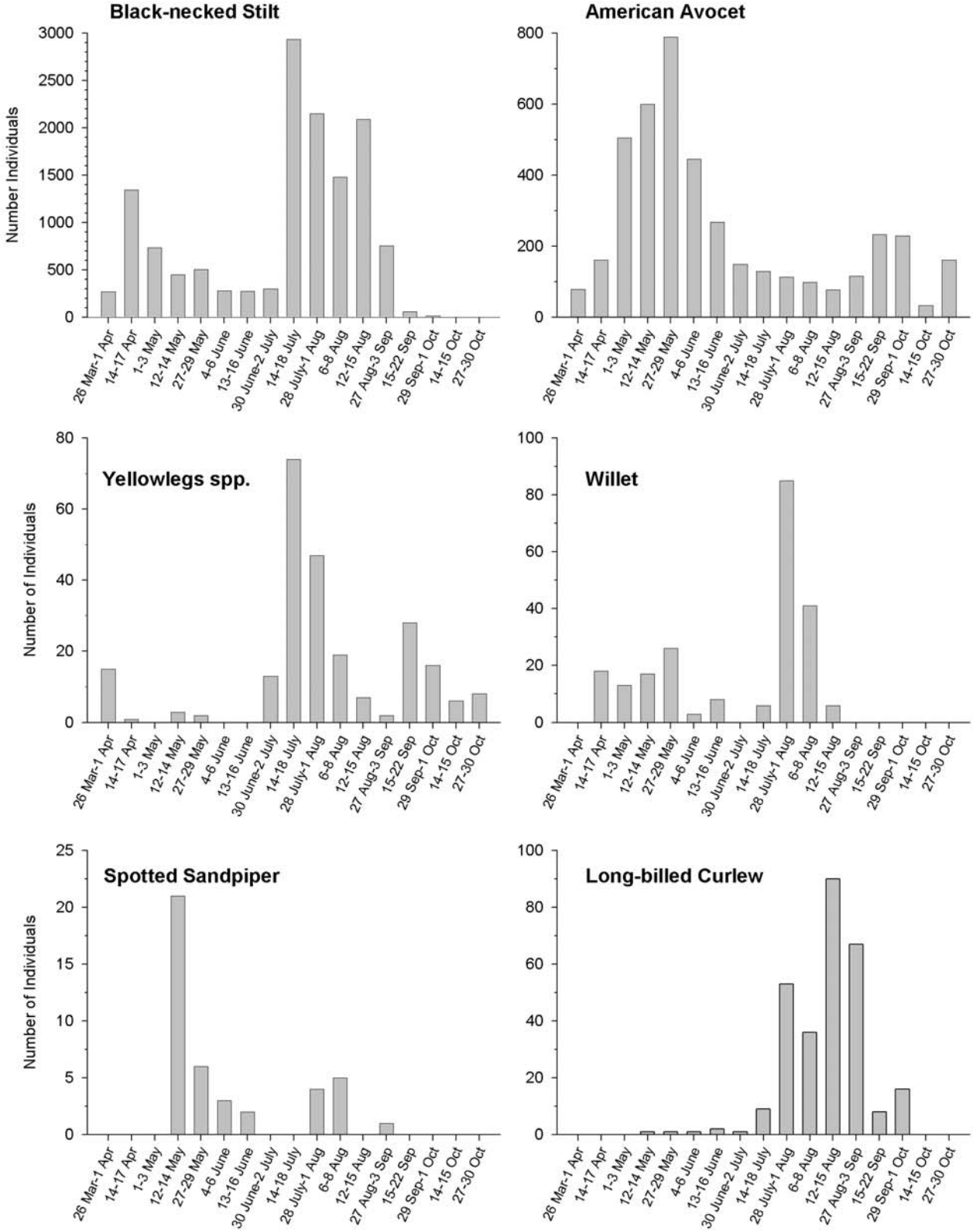

Figure 4c. Phenology of the Black-necked Stilt, American Avocet, yellowlegs, Willet, Spotted Sandpiper, and Long-billed Curlew in the Klamath Basin from late March to late October 2003. Data from 17 surveys of five units of Lower Klamath NWR (6A, 7B, 9A, 12C, White Lake) and two units of Tule Lake NWR (1A, 1B).

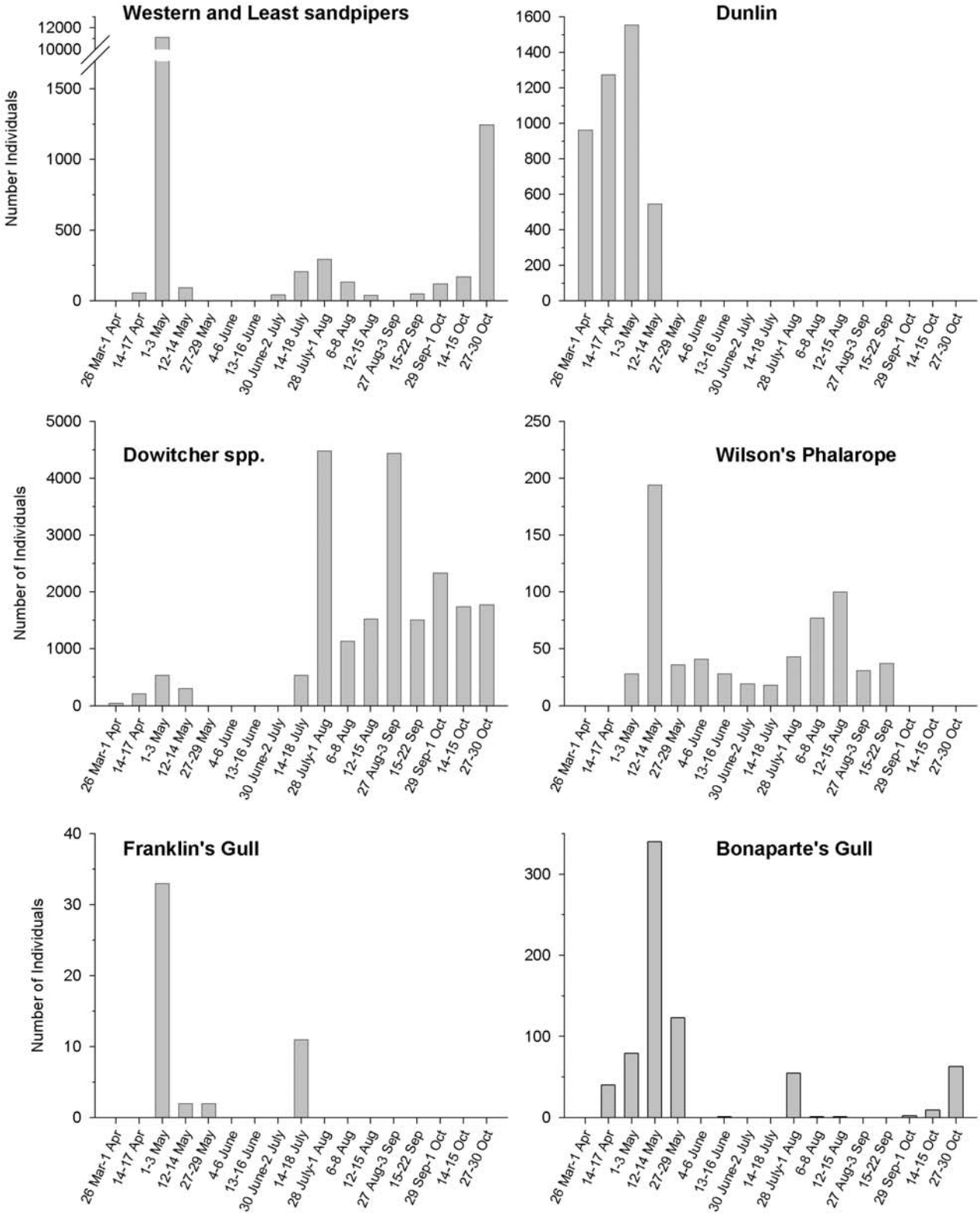

Figure 4d. Phenology of the Western and Least sandpipers, Dunlin, dowitchers, Wilson's Phalarope, Franklin's Gull, and Bonaparte's Gull in the Klamath Basin from late March to late October 2003. Data from 17 surveys of five units of Lower Klamath NWR (6A, 7B, 9A, 12C, White Lake) and two units of Tule Lake NWR (1A, 1B).

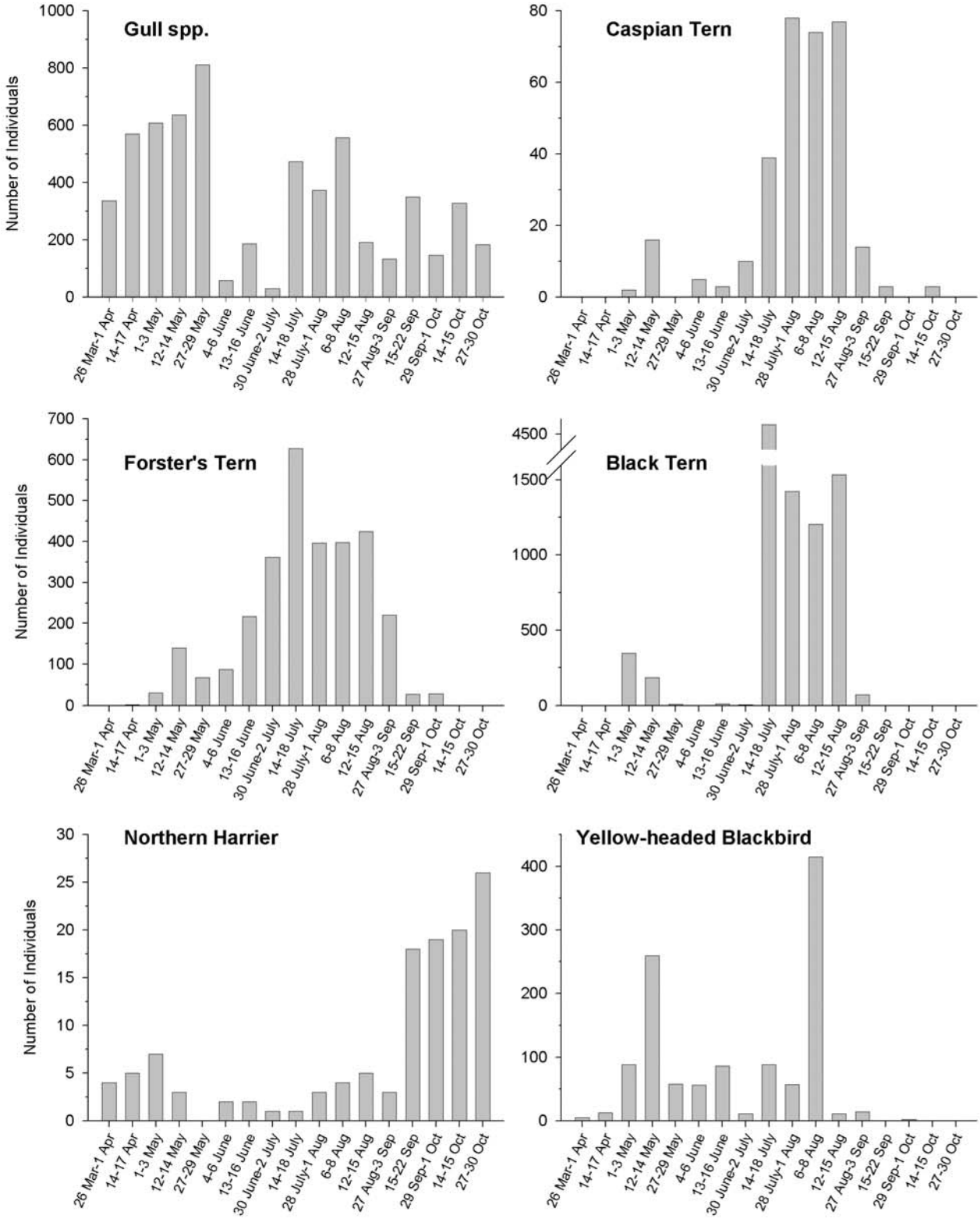

Figure 4e. Phenology of gulls (Ring-billed and California), Caspian Tern, Forster's Tern, Black Tern, Northern Harrier, and Yellow-headed Blackbird in the Klamath Basin from late March to late October 2003. Data from 17 surveys of five units of Lower Klamath NWR (6A, 7B, 9A, 12C, White Lake) and two units of Tule Lake NWR (1A, 1B).

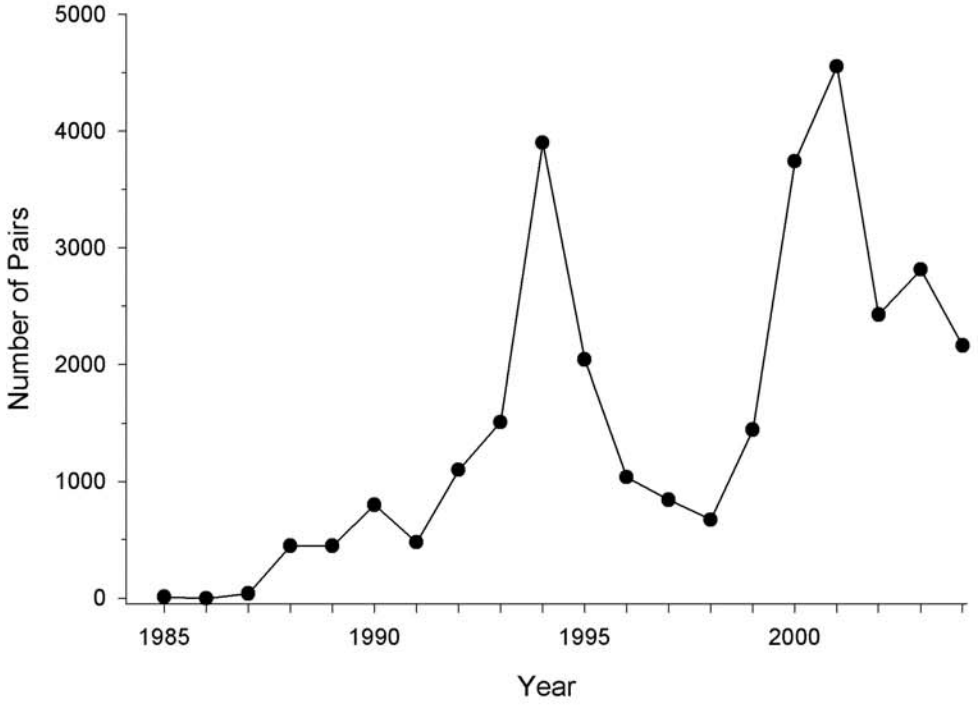

Figure 5. Numbers of pairs of nesting White-faced Ibis at Lower Klamath NWR, 1985 to 2003, and Lower Klamath NWR and Tule Lake NWR combined in 2004, estimated mainly from flyout counts of ibis leaving colonies at dawn (see Methods).

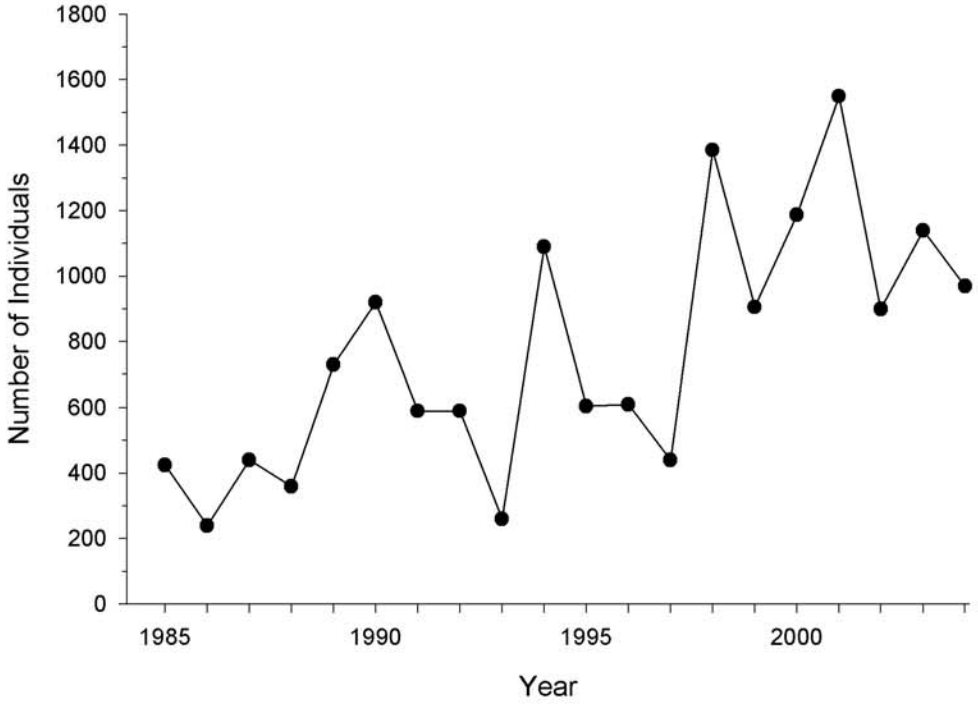

Figure 6. High counts of staging Sandhill Cranes at Lower Klamath NWR in fall, 1985 to 2004, from aerial surveys typcially conducted two to three times a month starting in early September (see Methods). Dates of high counts in all years have ranged from 22 September to 6 November.