THE IMPORTANCE OF AGRICULTURE TO LONG-BILLED CURLEWS IN CALIFORNIA'S CENTRAL VALLEY IN FALL

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ABSTRACT: The Long-billed Curlew (*Numenius americanus*)—a large shorebird of continental conservation concern—is a migrant and winter resident in California's Central Valley. The size of the curlew's North American breeding population has been estimated recently, but little is known about its abundance and habitat needs at migratory stopovers and wintering areas. Following two broad-scale surveys of the curlew in the central and southern portions of the Central Valley in fall in 2007 and 2008, we coordinated a survey of it throughout the valley in August 2009, recording 20,469 curlews in 195 flocks. On all three surveys, during this otherwise arid season, curlews were found primarily in irrigated alfalfa and irrigated pasture. There was a strong, positive relationship between curlew abundance by subregion of the Central Valley and the subregion's proportion of the entire valley's acreage of both alfalfa and irrigated pasture. Identifying the habitat features important to curlews at both fine and landscape scales, documenting the birds' movements (within and between seasons) in the Central Valley, and monitoring their populations is needed to aid in the conservation of this shorebird at risk.

The Long-billed Curlew (*Numenius americanus*) is a migrant and winter resident in California's Central Valley, where it concentrates primarily in agricultural lands. The U.S. Shorebird Conservation Plan categorized the Long-billed Curlew as "highly imperiled" because of population declines, low population size, and threats on the nonbreeding and breeding grounds (Brown et al. 2001). Initial rough estimates of the curlew's rangewide population size of 20,000 to 55,000 individuals, based on expert opinion (Morrison et al. 2001, Fellows and Jones 2009), have been superseded by newer estimates of about 110,000 to 165,000 individuals breeding in the United States (Stanley and Skagen 2007) and 139,000 to 183,000 in North America as a whole (Jones et al. 2008), extrapolated from a sampling of the population on the breeding grounds. Yet there is a paucity of information on the species' abundance, concentration sites, and habitat use at migratory stopovers and in its winter range, where it spends about nine months of the year.

Anecdotal evidence suggests that the vast expanses of pastures, alfalfa fields, and fields of harvested rice of the interior valleys of California are important habitats for the Long-billed Curlew during migration or winter. The first coordinated attempt to quantify its abundance across key valleys in September 2007 estimated at least 30,000 individuals: 65% in the Central Valley, 35% in the Imperial Valley, and <1% each in the Antelope Valley, San Jacinto Valley, and Carrizo Plain (Page et al. 2007). The roughly 19,000 curlews tallied in the Central Valley on that survey and another in September

2008 were mainly in its central and southern portions; in both cases, coverage was minimal in the extensive rice country of the Sacramento Valley to the north (Shuford et al. 2009).

To better document the status of the Long-billed Curlew in the Central Valley, we surveyed the entire valley on a broad scale in August 2009. Here we report on the species' abundance, distribution, and habitat-use patterns in 2009 and compare them with the patterns found on less extensive fall surveys in 2007 and 2008. We also recommend future research to inform better management practices and conservation of the Long-billed Curlew in the Central Valley.

STUDY AREA AND METHODS

Our study area was California's Central Valley (~640 km long by 64 km wide), dominated by agriculture. We divided this vast region into 121 agricultural survey areas of varying size across four subregions: the Sacramento Valley (27 areas), Delta (29), San Joaquin Basin (22), and Tulare Basin (43) (Figure 1). These subregions differ slightly from those used for previous surveys (Shuford et al. 2009; see below).

From 7 to 10 August 2009, over 100 volunteers and biologists searched 116 of the 121 areas for curlews. In addition, biologists with government agencies searched the following wetland complexes embedded within the agricultural areas: Sacramento National Wildlife Refuge (NWR), Delevan NWR, Sutter NWR, Colusa NWR, North Central Valley Wildlife Management Area (WMA; Llano Seco Unit), Upper Butte Basin Wildlife Area (WA; Howard Slough, Little Dry Creek, and Llano Seco units), Oroville WA, and Gray Lodge WA in the Sacramento Valley; Yolo Bypass WA in the Delta region; San Joaquin River NWR, San Luis NWR (Freitas, Kesterson, San Luis, East Bear Creek, and West Bear Creek units), Merced NWR (Merced, Arena Plains, and Snobird units), North Grasslands WA (China Island and Salt Slough units), Los Banos WA, Volta WA, and Grasslands WMA in the San Joaquin Basin; and Mendota WA, Kern NWR, and Pixley NWR in the Tulare Basin.

Observers recorded the size and location of each flock and classified the birds' habitat by crop type or other habitat, average plant height (<10 cm, 10–20 cm, >20 cm), moisture (flood irrigated, damp, dry), and field condition (tilled, growing, dormant, fallow). They also recorded the behavior (feeding, roosting, flying) of all curlews seen. We used the same protocol and survey methods as in 2007 and 2008 (Shuford et al. 2009), enabling us to make comparisons of crop use by curlews among the three years.

To evaluate the influence of the availability of key crops on curlew abundance, we obtained county crop data from the National Agricultural Statistics Service (2010). We grouped data on crop acreage and curlew abundance by four subregions of the valley (and the counties they comprise): Sacramento Valley (Glenn, Butte, Colusa, Sutter, Yuba, Placer), Delta (Yolo, Sacramento, Solano, Alameda, Contra Costa, San Joaquin), San Joaquin Basin (Stanislaus, Merced, Madera), and Tulare Basin (Fresno, Kings, Tulare, Kern). For the three of these four subregions used in Shuford et al. (2009), we modified the subregional boundaries of previous survey areas slightly to more closely match county boundaries and crop data available by county. In

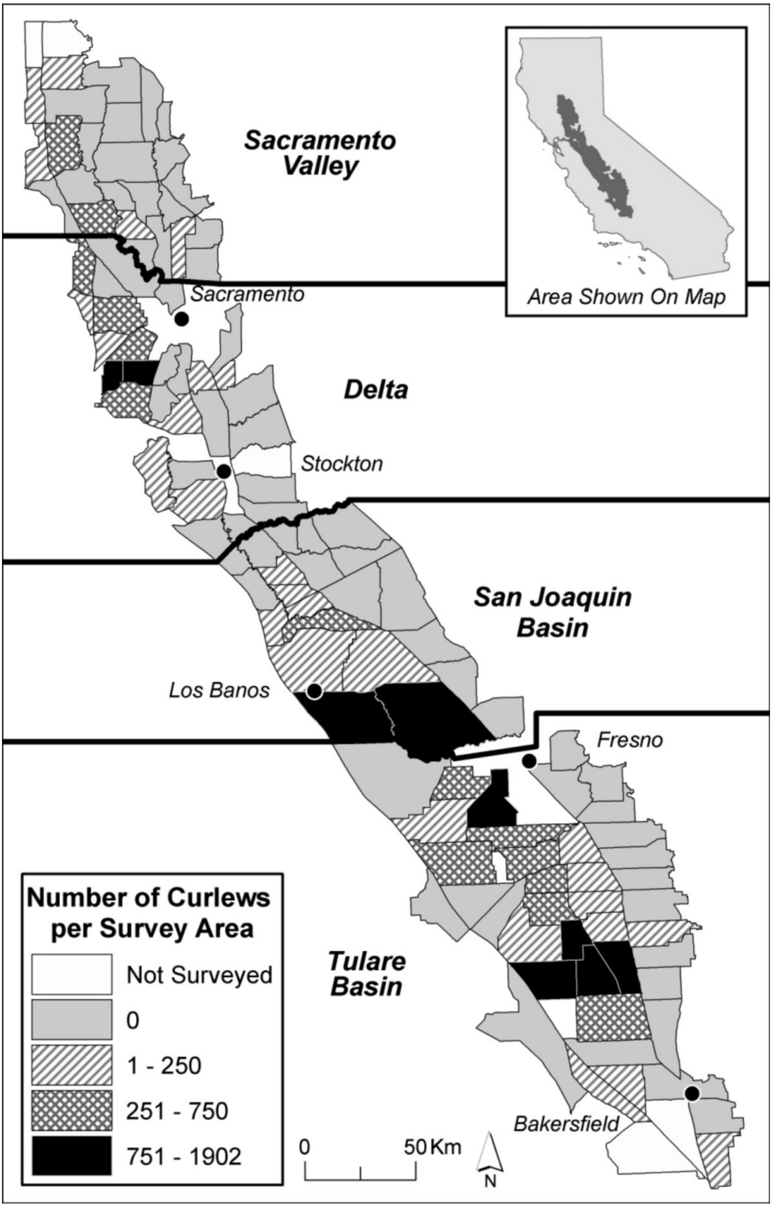

Figure 1. Patterns of abundance and distribution of the Long-billed Curlew over 121 survey areas in 4 subregions of the Central Valley in August 2009.

a few instances where agricultural survey areas included substantial parts of two counties that were in different subregions, we apportioned the number of curlews in each county to the correct subregion.

To compare curlew abundance to the availability of key crop types, we calculated the proportion of total curlews recorded in each of the four subregions in August 2009 (see Figure 1) and the proportion of the valley's acreage of both alfalfa and irrigated pasture in these subregions for the crop year of 2009. We then used Spearman rank correlations to assess the significance of these relationships at the subregion and county levels and to evaluate the effect of the size of survey areas and subregions on curlew abundance.

RESULTS

Abundance and Distribution

On the August 2009 survey, we recorded 20,469 curlews in 195 flocks in agricultural areas, and none in embedded wetland areas, of the Central Valley. Of the total, 7% were in the Sacramento Valley, 24% in the Delta, 17% in the San Joaquin Basin, and 53% in the Tulare Basin. We found curlews in 51 of 116 areas surveyed, but the birds concentrated in relatively few of these. The 23 areas that each held >250 birds and the 12 of these that held >500 birds collectively accounted for 88% and 68%, respectively, of all curlews recorded. Patterns of curlew concentration varied by subregion. With concentration gauged by the number of areas that held >250 curlews, 68% of the curlews in the Sacramento Valley were in 2 of 27 surveys areas, 94% in the Delta were in 6 of 29 areas, 86% in the San Joaquin Basin were in 3 of 22 areas, and 87% in the Tulare Basin were in 12 of 43 areas (see Figure 1). In addition, the curlews occurred mainly in the western and central portions of the Central Valley (Figure 1), extensively irrigated by flooding. There was no significant relationship between curlew abundance and the size of either individual survey areas (Spearman's $\rho = 0.09$, $P = 0.32$) or the larger subregions (Spearman's $\rho = 0.80$, $P = 0.20$).

Habitat Use

The 20,469 curlews recorded in August 2009 concentrated in just a few habitats: 91.4% were in various agricultural crops, 5.1% were roosting in wastewater, water storage, or agricultural evaporation ponds, and 3.5% were in flight. Of those in agricultural fields, 91.1% were in alfalfa, 4.7% in other hay crops, 3.4% in irrigated pasture, 0.6% in rice fields, and 0.2% in miscellaneous crops (Figure 2). The birds found roosting in various types of ponds likely had been foraging earlier in agricultural fields.

Curlews used alfalfa fields with a broad range of crop heights. Alfalfa fields with crop heights of <10 cm held 55% of all curlews, those of 10–20 cm held 38%, and those >20 cm held 7%. Use of the latter height class may have been underestimated, as curlews in tall alfalfa at times can be difficult to see.

Curlew abundance by subregion was strongly associated with the proportion of the entire valley's coverage of both alfalfa (Spearman's $\rho = 1.00$, $P < 0.001$) and irrigated pasture (Spearman's $\rho = 1.00$, $P < 0.001$) in the subregion (Figure 3). At the county level, there was also a strong relationship

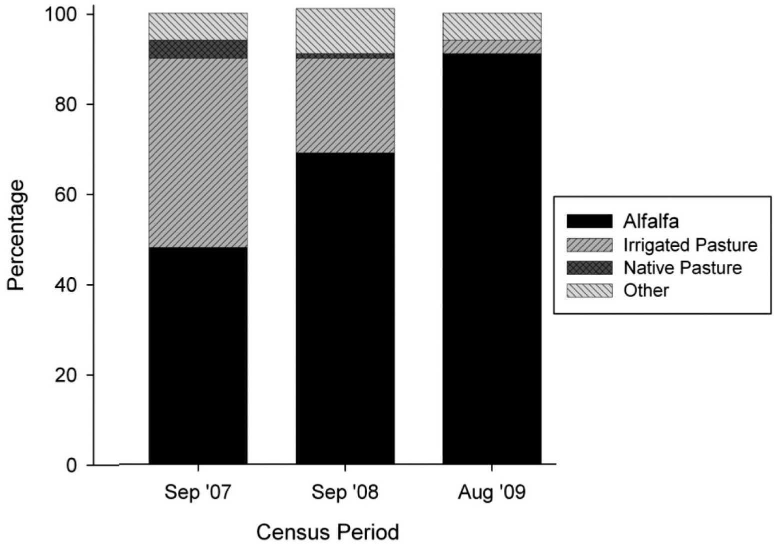

Figure 2. Percentage of curlews in various agricultural crops on three surveys of the Central Valley in fall, 2007–2009. Data for 2007 and 2008 from Shuford et al. (2009). See Methods for differences in survey coverage by year.

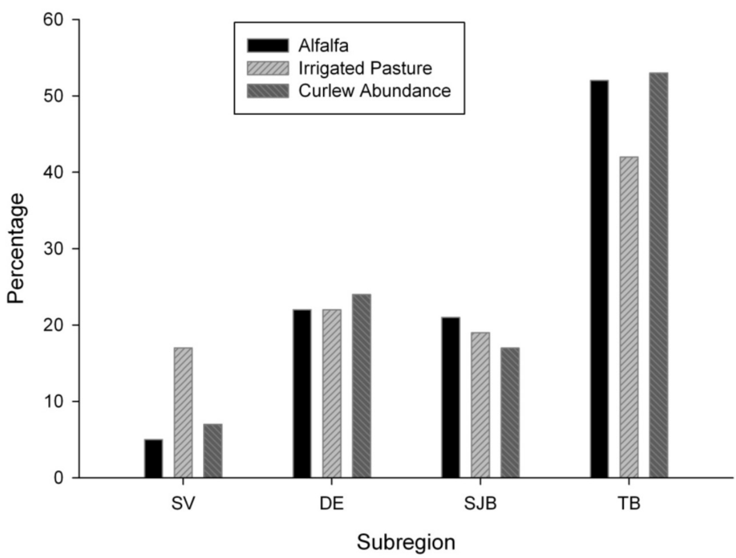

Figure 3. Proportion of the total harvested acres of alfalfa and irrigated pasture in the Central Valley in the 2009 crop year within four subregions of the valley and the proportion of Long-billed Curlews counted in those subregions in August 2009 (see Methods). SV, Sacramento Valley; DE, Delta; SJB, San Joaquin Basin; TB, Tulare Basin. Crop data from NASS (2010).

between curlew abundance and the extent of alfalfa (Spearman's $\rho = 0.74$, $P < 0.001$) in the county; the county-level relationship was not significant for irrigated pasture (Spearman's $\rho = 0.28$, $P = 0.25$) but it was for the combined coverage of alfalfa and irrigated pasture (Spearman's $\rho = 0.62$, $P < 0.01$).

DISCUSSION

Survey Challenges

The curlew's behavior and patterns of habitat use may affect the accuracy of counts. As some curlews equipped with radio transmitters move >30 km within the Central Valley every day (K. Sesser unpubl. data), there is a strong likelihood that we may have either under- or overcounted curlews in particular survey areas as birds moved within or among them. The issue of movement was exacerbated by the overall survey lasting several days. Also, our ability to locate birds in early fall may have been enhanced by the heavy reliance of foraging curlews on two crops—irrigated alfalfa and pastures—during this driest time of the year. Similarly, the tendency of these large birds to gather in big flocks, their conspicuousness in flight, and their loud flight calls all make them easy to detect. On balance, we judge that the count of about 20,500 curlews underestimated the number in the Central Valley in August 2009. Although we asked observers to drive all roads through potential curlew habitat in their survey areas, this was not always possible, and not all available habitat was visible from the roads that were driven.

Patterns of Abundance

Variation in patterns of curlew abundance at various geographic and time scales appears to reflect primarily the extent of suitable habitat and, in some cases, the extent of its coverage on surveys. The 20,469 curlews recorded in August 2009, when we surveyed 116 of 121 agricultural areas in the entire Central Valley, was only modestly higher than the 19,063 in September 2007 and 18,775 in September 2008, when we surveyed 55 and 41, respectively, of 88 agricultural areas in the central and southern Central Valley (Shuford et al. 2009). The small differences among surveys likely reflect the curlew's limited use of the Sacramento Valley in August and September. Despite the vastly greater coverage of the Sacramento Valley in August 2009 than in the prior two Septembers, we found only 1398 individuals there in 2009, all in agricultural areas, versus 3204 and 1658, respectively, in 2007 and 2008, when all were in embedded wetlands. It also may be that we covered some of the best areas for curlews in the central and southern Central Valley in 2007 and 2008 such that increased coverage in those regions in 2009 did not change the totals substantially. Possibly, curlew numbers had not reached their seasonal peak in the valley by the time of our August survey, but multi-year coastal surveys show curlews begin returning to central California by late June and the numbers reaching their winter plateau by early August (Shuford et al. 1989). Other notable patterns of abundance are detailed below by subregion.

Sacramento Valley. The limited availability of habitats suitable for the curlew in the Sacramento Valley at the time of fall surveys likely explains much of the patterns of abundance observed. The extent of alfalfa and irrigated pasture in the Sacramento Valley is much less than in other subregions of the Central Valley (Figure 3), and the roughly 200,000 ha of cultivated rice fields, a habitat curlews also use in the Sacramento Valley (Elphick and Oring 1998), are not very suitable for them in late summer and early fall. At this time, the rice plants are dense and tall, and fields are drained just prior to harvest, which typically occurs from late August to mid-October. The limited use of rice in early fall is illustrated by our August 2009 survey, when we covered much of the rice-growing region of the Sacramento Valley but found only 116 curlews in rice fields, all in one survey area.

Flooded wetlands in the Sacramento Valley also contribute to the extent of habitat for curlews, particularly for roosting. Our August 2009 survey, however, was at the seasonal nadir of available water on managed wetlands there, and we did not record any curlews on the many managed wetlands that were surveyed across this region. By contrast, many wetlands begin to be flooded in September for use by early migrating ducks. Greater availability of flooded wetlands may explain why we found use by roosting curlews in September 2007 and 2008 but not in August 2009.

Delta. Large numbers of curlews concentrated in the Delta in southern Yolo and northern Solano counties on all surveys, especially in September. On the basis of survey areas each with >250 curlews as a gauge of concentration, 8874 curlews were in 5 areas, 9080 were in 5 areas, and 4538 were in 6 areas in September 2007, September 2008, and August 2009, respectively. Four to five adjacent survey areas in Yolo and Solano counties held 86–100% of these curlews on the three surveys.

San Joaquin Basin. Moderate to large numbers of curlews were concentrated in this region on all surveys. On the basis of survey areas with >250 curlews, 5024 curlews were in 6 areas, 2111 were in 4 areas, and 2978 were in 3 areas in September 2007, September 2008, and August 2009, respectively. The specific areas that held large numbers of curlews were not as consistent from survey to survey as they were in the Delta (Shuford et al. 2009; Figure 1).

Tulare Basin. Because coverage of the three broad-scale surveys was inconsistent, it is difficult to evaluate the patterns of curlew concentration in this subregion. When coverage was nearly complete in August 2009, the 12 areas that each held >250 curlews, collectively accounting for 9385 individuals, were widely distributed across the basin. Over all surveys there was some indication of concentration in Kings and Tulare counties (Shuford et al. 2009; Figure 1), but more surveys with adequate coverage are needed to confirm this pattern.

Patterns of Habitat Use

The curlew's strong affinity for foraging in irrigated alfalfa and pasture is demonstrated by the strong relationship between its abundance by subregion of the Central Valley and the proportion of the entire valley's coverage of both alfalfa and irrigated pasture in each subregion (Figure 3). At a finer level, there was also a strong relationship between curlew abundance by county and the extent of alfalfa but not the extent of irrigated pasture. This may be because over 90% of curlews in agricultural fields in August 2009 were in alfalfa.

The curlew's relative use of crops likely varies from year to year. Alfalfa, for example, accounted for 91% of the curlews in agricultural fields in August 2009 versus 48% in September 2007 and 69% in September 2008 (Figure 2). Another crop important to curlews in fall was irrigated pasture, which accounted for 42% of curlews in September 2007 and 21% in September 2008. Similarly, K. Sessser (unpubl. data) found that 10 curlews tagged with radio transmitters made significant use of alfalfa and grasslands (irrigated and native pasture combined) in the Central Valley from June to October.

As they do patterns of abundance, seasonal changes in habitat suitability also may explain differences in the curlew's habitat use across years and seasons. The greater use of alfalfa in August than in September (Figure 2) may reflect a decrease in irrigation of that crop toward the end of its growing season. In the San Joaquin Valley, irrigation of alfalfa decreases substantially by late September because of cessation or reduction of water deliveries to farmers, shifting of irrigation to higher-value crops when water is scarce, and a lessened need to irrigate alfalfa as cooler day and night temperatures reduce plant growth and evapotranspiration rates (H. Calvillo pers. comm.). In some cases farmers cease irrigating alfalfa fields to avoid crop losses. The risk of early rains in October spoiling the harvested alfalfa left in the field to cure before it is baled may not justify irrigating another crop in September (anonymous farmer pers. comm.). Use of irrigated pasture was greater in September than in August, but it is unclear if irrigation of pastures extends on average later in the season than for alfalfa.

Future Research

There is still much to be learned from additional broad-scale surveys of curlews. It would be valuable to survey the entire Central Valley in winter to see if substantial numbers of curlews winter in Sacramento Valley rice fields and in grasslands of the foothills or smaller interior valleys adjacent to the Central Valley. Such seasonal shifts are suggested by numbers much lower in winter than in fall in the Solano County portion of the Delta (Shuford et al. 2009), fall movements of some radio-tagged curlews from the Delta to other areas of the Central Valley (K. Sesser unpubl. data), the shifting of some curlews from various habitats on the valley floor in fall to native grasslands in foothills on either side of the Central Valley in winter (K. Sesser unpubl. data), and anecdotal evidence of curlew numbers increasing substantially from fall to winter in the Carrizo Plain (Shuford et al. 2009), a large valley in the dry inner Coast Ranges west of the southern San Joaquin Valley. Given the substantial annual variation in winter rainfall, standardized surveys at some sites from fall through winter in both wet and dry years should reveal seasonal changes in curlew use and whether patterns of use vary much with climatic conditions.

Because of the difficulty of surveying large regions comprehensively and repeatedly, ensuring the conservation of the Long-billed Curlew will require more focused population monitoring. It will likely need to rely on volunteer-based ground surveys to sample potential habitat, as aerial surveys are unlikely to prove fruitful—curlews often fly well before the approach of a plane (D. Shuford and G. Page pers. obs.). Monitoring of curlews via counts at nighttime roosts, where they often congregate in large numbers (Shuford et al. 2009), may also be worth exploring.

Although curlews clearly use flood-irrigated alfalfa fields and pastures, native pastures after the onset of seasonal rains, and rice fields flooded in winter, it would be valuable to understand the finer features of these habitats that favor use by curlews and their preferred prey (e.g., optimal plant densities and heights, depth and period of flooding, soil moisture and penetrability). If conditions favorable for curlews are also ones that enhance crop yields, it might be possible to devise a program of economic incentives for farmers to maintain crops and management practices that benefit them and curlews. Further, it would be instructive to assess the landscape features that affect curlew abundance, such as whether within a circumscribed area the acreage of a favored crop must exceed a threshold before curlews occupy it, or if the proximity of crop types or wetlands enhances their value to curlews out of proportion to the combined acreages of these habitats.

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LITERATURE CITED

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

Elphick, C. S., and Oring, L. W. 1998. Winter management of Californian rice fields for waterbirds. J. Appl. Ecol. 35:95–108.

Fellows, S. D., and Jones, S. L. 2009. Status assessment and conservation action plan for the Long-billed Curlew (*Numenius americanus*). Biol. Tech. Publ. FWS/BTP-R6012-2009. U.S. Fish and Wildl. Serv., Washington, DC.

Jones, S. L., Nations, C. S., Fellows S. D., and McDonald, L. L. 2008. Breeding abundance and distribution of Long-billed Curlews (*Numenius americanus*) in North America. Waterbirds 31:1–14.

Morrison, R. I. G., Gill, R. E., Jr., Harrington, B. A., Skagen, S. K., Page, G. W., Gratto-Trevor, C. L., and Haig, S. M. 2001. Estimates of shorebird populations in North America. Canadian Wildl. Serv. Occas. Paper 104. Environment Canada, Ottawa.

National Agricultural Statistics Service (NASS). 2010. County agricultural commissioners' data 2009. NASS California Field Office, P.O. Box 1258, Sacramento, CA 95812; www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/Detail/index.asp.

Page, G. W., Shuford, W. D., Langham, G. M., and Molina, K. C. 2007. Results of the 13–16 September 2007 survey for Long-billed Curlews in interior valleys of California. A report of PRBO Conservation Science, Audubon California, and the Natural History Museum of Los Angeles County. Available from PRBO Conservation Science, 3820 Cypress Drive #11, Petaluma, CA 94954.

Shuford, W. D., Langham, G. M., Page, G. W., and Hickey, C. 2009. Distribution, abundance, and habitat use of Long-billed Curlews in California's Central Valley from broad-scale surveys in 2007 and 2008. Central Valley Bird Club Bull. 12:29–44.

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

Stanley, T. R., and Skagen, S. K. 2007. Estimating the breeding population of Long-billed Curlew in the United States. J.Wildl.Mgmt.71:2556–2564.

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