

**CONSERVATION ASSESSMENT FOR
GREATER SANDHILL CRANES WINTERING ON
THE COSUMNES RIVER FLOODPLAIN AND
DELTA REGIONS OF CALIFORNIA**



Prepared under contract for The Nature Conservancy, Cosumnes River Preserve

Carroll D. Littlefield, HCR 4, Box 212, Muleshoe, TX 79347

Gary L. Ivey, PO Box 6953, Bend, OR 97708

February 2000

CONSERVATION ASSESSMENT FOR GREATER SANDHILL CRANES WINTERING ON THE COSUMNES RIVER FLOODPLAIN AND DELTA REGIONS OF CALIFORNIA

Carroll D. Littlefield, HCR-4, Box 212, Muleshoe, TX 79347
Gary L. Ivey, PO Box 6953, Bend, OR 97708

INTRODUCTION

This report was prepared under contract for The Nature Conservancy's (TNC) Cosumnes River Preserve to assist with conservation planning for Greater Sandhill Cranes (*Grus canadensis tabida*) wintering on the Cosumnes River Floodplain and the Sacramento-San Joaquin Delta region. The report is organized in response to questions provided by TNC staff and addresses the importance of the habitats and habitat management of the Delta, Cosumnes River Floodplain, and surrounding farmlands to the long-term survival for the Greater Sandhill Crane.

TAXONOMIC BACKGROUND

Under the order Gruiformes, the sandhill crane (*G. canadensis*) is one of 15 species within the family Gruidae. Ten are in the genus *Grus*, whereas the other five are in three genera: *Balearica*, *Bugeramus*, and *Anthropoides*. Cranes occur on all continents except South America and Antarctica; 13 species occur only in the Old World. The Whooping (*G. americana*) and sandhill cranes are primarily North American in distribution, however, some sandhills breed in northeastern Siberia and migrate southeast to wintering areas in the southwestern United States and northern Mexico (Drewien and Lewis 1987).

In total, there are an estimated 500,000 sandhill cranes divided into six subspecies, three of which are nonmigratory and occupy ranges in the southeastern United States and Cuba: Cuban (*G. c. nesiotes*), Florida (*G. c. pratensis*), and Mississippi (*G. c. pulla*) (Ellis et al. 1996). The other three are migratory: Lesser (*G. c. canadensis*), Canadian (*G. c. rowani*), and Greater (*G. c. tabida*). Two of these subspecies, Lesser and Greater, are further divided into distinct populations. Lesser Sandhill Cranes breeding in Siberia, western and northern Alaska, and eastward to the west shore of Hudson Bay in Canada are members of the Mid-continent Population, and winter in central Kansas, Texas, New Mexico, and northern Mexico. Lessers breeding in southwestern and south-central Alaska belong to the Pacific Flyway Population, and winter primarily in the California Central Valley. The Greater Sandhill Crane is divided into five populations:

- (1). Eastern Population--breeds in the Great Lakes states and adjoining Canadian provinces and winters primarily in southern Georgia and Florida.

- (2). Prairie Population—breeds in northwestern Minnesota and southeastern Manitoba, while wintering along the Texas Gulf Coast.
- (3). Rocky Mountain Population—breeds in the Rocky Mountain states from northwestern Colorado to western Montana and winters in western New Mexico, southeastern Arizona, and northern Mexico.
- (4). Lower Colorado River Valley Population—breeding is confined mostly to northeastern Nevada and possibly extreme southeastern Oregon, and wintering in western Arizona and southeastern California.
- (5). Central Valley Population—breeds in northeastern California, central and eastern Oregon, southwestern Washington, and southern British Columbia, while wintering in the California Central Valley. The Central Valley Population is further divided into two breeding segments: the "northern" segment in British Columbia and the "southern" in Oregon, California, and Washington (Littlefield 1999).

The remaining migratory form, the Canadian Sandhill Crane, breeds in the Boreal forested regions of North America, from Quebec west and north to east-central Alaska, and south to the northern and coastal regions of British Columbia. Most migrate down the Great Plains to wintering areas along the Texas Gulf Coast (Walkinshaw 1965) and northern Mexico (Drewien et al. 1996). However, *rowani* which breed in western British Columbia and perhaps the Alaskan panhandle apparently migrate south along the Pacific Coast to wintering areas in the northern Central Valley of California (Pogson and Lindstedt 1991).

Historically, the sandhill crane was first described in 1750, based on a specimen collected somewhere along the western shore of Hudson Bay. Edwards' *Natural History* in 1750 named the type "brown and ash colour'd" crane, under the scientific name *Grus fusca canadensis* (Ridgway 1941). However, with publication of the 10th edition of *Systema Naturae* which created the binomial system of nomenclature in 1758, Linnaeus changed the scientific name to *Ardea canadensis*. The original name *Grus* was restored by Brisson in *Ornithologie* (5:374) in 1760, but the genus was briefly changed to *Megalornis* in 1921 (Oberholser 1921). By 1930 the genus name was back to *Grus*, where it has remained.

The Greater Sandhill Crane was considered a full species during the 1800s after first being described as *Ardea (Grus) mexicana*, based on a specimen collected in Mexico in 1776 (Muller *Syst. Nat. Suppl.*, p. 110). Beginning with Vieillot (*Nouv. Dict. Hist. Nat.*, xii) in 1817, *Grus mexicana* became the accepted scientific name, with the common name "Sandhill" or "Great Brown" Crane. The name *Grus mexicana* remained in existence through the early years of the 20th Century; it was not until 1918 before *mexicana* was downgraded to a subspecies (*Grus canadensis mexicana*) (Oberholser 1918). Peters (1925) replaced *mexicana* with *tabida*, but proposed *Grus* be changed to *Megalornis*. Thus, for a brief period in the 1920s the greater was known as *Megalornis canadensis tabida*. *Megalornis* did not gain acceptance, however, and by 1930 the trinomial was again changed, this time to *Grus canadensis tabida*, the scientific name in use today.

The type locality and type specimen for *Grus canadensis tabida* is based on an adult male on deposit at the Museum of Comparative Zoology (No. 72695), which was collected from the Valley of the South Fork of the Humboldt River in Nevada by Charles S. McCarthy on 19 May 1859. *Grus* is latin for crane, *canadensis* for "of Canada", and *tabida* for "waste away", referring to the subspecies status when described by Peters in 1925. The subspecies is the largest of sandhill cranes, thus the common name "greater". "Sandhill" is self-descriptive, referring to the areas where the species was seen (Gruson 1972).

1. CONSERVATION STATUS OF THE GREATER SANDHILL CRANE

On 4 February 1983 the California Fish and Game Commission voted unanimously to add the Greater Sandhill Crane to the List of Rare Animals (Section 670.5, Title 14). The California Endangered Species Act (1984) reorganized and renamed Fish and Game classifications, resulting in the Greater Sandhill Crane being classified as a State Threatened species. As a whole, the family Gruidae is one of the world's most endangered bird families, with cranes often serving as "keystone" species for conserving grasslands and wetlands around the world. Their cultural value, visibility, behavior, and attractiveness have resulted in widespread conservation efforts, drawing attention to and providing habitat protection for not only cranes, but indirectly to a large number and variety of other species which also use these same grassland and wetland ecosystems. Though sandhill cranes are by far the most abundant of the Gruidae, in general their numbers may be declining. Of the sedentary subspecies, both the Mississippi and Cuban are classified as Critically Endangered whereas the Florida Sandhill Crane is classified as Threatened. Of the migratory subspecies, the Lesser Sandhill Crane is the most abundant, numbering about 375,000. Both the Lesser and Canadian subspecies breed in remote and isolated far northern regions, thus, the two have been spared excessive human disturbance in summer, however, their wintering grounds have and continue to be extensively altered by human activity (Ellis et al. 1996), and both are legally hunted in many regions of the United States, Canada, and Mexico.

For the other migratory subspecies, the Greater Sandhill Crane, agricultural expansion, wetland drainage, and hunting in the 18th and 19th centuries led to the extirpation of the subspecies in many parts of its range, and habitat alteration has frequently been severe on its summer range in the northern United States and southern Canada (Walkinshaw 1949). Many detrimental changes have occurred on the winter range as well, especially the loss of Central Valley wetlands. We found no historical accounts of crane use for the San Joaquin-Sacramento Delta region, but birds likely began using agricultural developments after wheat farming began in the 1860s, with other crane food crops soon following. These crops have attracted and sustained cranes for over 100 years in San Joaquin and Sacramento counties.

Though food was probably not a limiting factor for cranes in the late 1800s and early 1900s, hunting surely was; market hunting between 1880 and 1915 undoubtedly had a severe impact on crane use. Even as early as the mid-1850s, cranes reportedly were always available in San Francisco markets (Newberry 1857) to replace the Christmas turkey, frequently selling for \$18 to \$20 (Heerman 1853). The Delta's proximity to San Francisco markets perhaps resulted in greater hunting pressure on birds here than elsewhere in the Central Valley. Overall, market hunting perhaps had the greatest impact on sandhill cranes breeding in the Pacific states and British

Columbia; it was not until passage of the Migratory Bird Treaty Act in 1916 before the slaughter was finally stopped (Littlefield 1999). In the 1920s, breeding populations remained low, and Dawson (1923) reported that if there were any nesting pairs left in California there were no more than six. Even in the 1930s and 1940s Garbrielson and Jewett (1940) stated the subspecies was rapidly disappearing from Oregon, and Walkinshaw (1949) estimated 150 to 200 pairs in Oregon, and only three to five nesting pairs remaining in California in 1944.

Beginning in the 1940s in an effort to reduce coyote (*Canis latrans*) numbers, the livestock industry in the western United States devised efficient predator control methods by using toxicants. In addition, through the first half of the 20th Century several large deep-water marshes were drained and developed in Oregon to improve livestock forage. This meadow development created new crane nesting habitat in areas formerly unsuitable (Littlefield and Thompson 1979). With newly created and improved breeding habitat, plus the never-ending campaign to rid the west of coyotes, Greater Sandhill Crane breeding success improved, and the Central Valley Population had substantially increased by the end of the 1960s. However, declines of breeding cranes in portions of their range, particularly at Malheur National Wildlife Refuge (NWR), Harney County, Oregon (which supports the largest breeding flock), coupled with breeding habitat losses in both Oregon and California, resulted in the population being classified as a Washington endangered species in 1981, a U.S. Fish and Wildlife Service, Region I, sensitive species in 1982, a California threatened species in 1983, an Oregon sensitive species in 1989, and a sensitive species in British Columbia in 1993.

Presently, the Central Valley Population of Greater Sandhill Cranes is experiencing new problems. On the breeding grounds around 70% of the nesting habitat is privately owned, and agricultural practices such as installation of mechanized center-pivot irrigation systems have resulted in recent crane breeding habitat losses, as wetlands are destroyed and replaced with alfalfa or other crops (Littlefield and Thompson 1979, Herziger and Ivey 1999). Furthermore, predator control using toxicants was eliminated on public lands in 1972, resulting in increased predator populations which have been responsible for reducing crane productivity in many areas, particularly at Malheur NWR (Littlefield 1995). For 1995-1998, the recruitment rate at Malheur NWR averaged only 1.6% (Herziger and Ivey 1999); a recruitment rate of about 10% is believed necessary for population stability (C. D. Littlefield, unpubl. data).

On Central Valley wintering areas, urban sprawl and changes in agricultural crop types continues to eliminate essential Greater Sandhill Crane habitat. Cranes show a high degree of philopatry to traditional wintering sites, and do not readily shift to new areas. Throughout the valley, recent orchard and vineyard developments have encroached onto grain fields formerly used by cranes for foraging. For example, in Butte County, orchard hectares increased from 12,649 in 1959 to 29,169 (31,173-72,923 acres) in 1991, whereas corn declined from 3522 ha (8805 acres) in 1959 to 364 ha (910 acres) in 1991; wheat 12,955 ha (32,388 acres) in 1979 to 3968 ha (9920 acres) in 1991; barley from 14,980 ha (37,450 acres) in 1954 to 789 ha (1973 acres) in 1991; and rice from 44,130 ha (110,325 acres) in 1981 to 28,704 ha (71,769 acres) in 1991 (Littlefield 1993a). From the San Joaquin-Sacramento Delta south, grain crops and grasslands are also being lost through conversion to vineyards and orchards; these crops have replaced what was once important sandhill crane wintering habitat (pers. observs.).

Though several crane use-areas have been recently purchased by federal, state, and private conservation agencies, management practices have generally not specifically addressed the needs of Greater Sandhill Cranes. For example, as lands on the breeding area were acquired, predator management was totally eliminated and predation rates increased, thus creating crane reproductive "sinks". On the wintering grounds, the majority of acquisitions have been wetlands. Though these wetlands can be important as crane roosting and loafing sites, cereal grain feeding fields were generally not purchased. When they were, these fields were frequently converted to wetlands to provide recreational sites for waterfowl hunters (C. D. Littlefield, pers. observ.).

Because of the longevity and deferred breeding age of Greater Sandhill Cranes, it usually takes several years before an increased mortality factor results in a substantial decrease of breeding adults (Littlefield 1995). The impact of continual crane wintering habitat losses in the California Central Valley has not been assessed, but in the foreseeable future it is anticipated that birds will continue to crowd onto ever diminishing habitats, thus increasing the potential for epizootic events, as well as other mortality factors such as collisions with utility wires, starvation, strife, stress, and insufficient energy reserves to complete spring migration.

2. PERCENTAGE OF CENTRAL VALLEY POPULATION GREATER SANDHILL CRANES USING THE SAN JOAQUIN-SACRAMENTO DELTA, CALIFORNIA AND MAP OF USE AREAS IN THE DELTA.

No winter population surveys have been completed from the ground since the 1980s, thus, limited data are available on current Greater Sandhill Crane percentages using the San Joaquin-Sacramento Delta region. Observers conducting recent aerial surveys for midwinter waterfowl census and other purposes have counted cranes in the area, however, observers did not distinguish subspecies; consequently we did not use the data to calculate trends for Greater Sandhill Cranes. Other recent counts were conducted throughout the Flyway from 1996-1998 (Herziger and Ivey in prep), but areas were surveyed in late September and early October before many of the cranes had left their northern staging areas, and thus do not represent the importance of the Delta for wintering Greater Sandhill Cranes. These surveys recorded a range of 6-22% of greaterers in the Delta. Therefore, the most recent data to appraise the importance of the Delta is from Pogson (1990), who assessed percentages in the winters of 1983-84 and 1984-85; he recorded a peak of 5219 greaterers in January 1984. Based on the 1980s total estimate of 6000, 87% of the population would have been using the Delta, however, after extensive surveys were conducted in the Sacramento Valley in 1991-1993 (Littlefield 1993a), the population estimate was increased to 8500. Even with this higher estimate, there still would have been over 61% of the total population on the Delta in the mid-1980s, making the area one of the two most important wintering sites in California. Pogson also noted that population distribution varied seasonally among regions within the Central Valley. For example, more than half used the Sacramento Valley north of Sutter Buttes in October and November, but in December and January, only 18 and 3% used this area, respectively. Declines in the Sacramento Valley corresponded with increases on the Delta, and agriculture lands south and southwest of Thornton, San Joaquin County, became the most important Central Valley use-area in December, supporting

53% of the total population. By January 1984, 36.6% of the population were using the El Dorado Gun Club (now Woodbridge Ecological Reserve [ER]), 27.2% Staten Island, and 23.2% the Cosumnes Floodplain. This can be compared with October 1983 percentages of only 4.9% at Canal Ranch, 3.1% at E. Merlo and Sons, 7.9% at the El Dorado Gun Club, 13.6% on Staten Island, and 1% on the Cosumnes Floodplain (Pogson 1990).

In the 1970s a few surveys were conducted in these same Delta areas, except on Staten Island. Peak counts for the entire area were 994 in 1970, 997 in 1971, and 933 in 1976 (Littlefield and Thompson 1979). Most Greater Sandhill Crane use was on the El Dorado Gun Club, Canal Ranch, along Woodbridge Road, adjacent to Glasscock Road north of Highway 12, and in irrigated pastures south of Peltier Road and east of El Dorado. In total for greater in mid-January, 38.9% were on the Delta in 1970, 40.3% in 1971, and 39.6% in 1976. Several factors may have contributed to the discrepancy in Greater Sandhill Crane percentages between the 1970s and the 1980s: 1) an increase in corn hectares after 1975 perhaps attracted more birds to the Delta; 2) loss of habitat elsewhere may have attracted more birds to the Delta in the 1980s; and 3) cranes in the 1970s were not counted on Staten Island.

Although no intensive crane studies have been completed on the Delta since Pogson's study in 1983-85, Littlefield (1993a) assessed crane numbers and habitat use in the Upper Butte Basin of the Sacramento Valley in the winters of 1991-92 and 1993-94. Some movement south out of the basin was noted in both winters. This suggests that similar to the 1980s, an increase in Greater Sandhill Crane numbers occurred on the Delta after November; however, unlike the 1980s, a greater percentage of the total population was remaining in the Butte Basin (61.5% in January 1992, and 65.2% in January 1993, based on a total population of 8500). Perhaps improved habitat conditions in the Basin or degraded habitats on the Delta have contributed to fewer Greater Sandhill Cranes now shifting south in late autumn, compared with what Pogson (1990) found in the 1980s.

Based on the authors' personal experience and interviews, Greater Sandhill Crane use areas in the Delta are illustrated on Figure 1. Sandhill cranes likely use a few additional islands or tracts, but we could find no information to validate their use.

3. GREATER SANDHILL CRANE USE ON THE COSUMNES FLOODPLAIN AND ADJACENT FARMLAND, CALIFORNIA.

Greater Sandhill Crane use on the Cosumnes Floodplain and the adjacent areas between Kammerer Road and the Mokelumne River apparently varies seasonally. Based on a Central Valley Population estimate of 6000, Pogson (1990) found 24% of the total population concentrated in the flooded riparian woodlands, meadows, and pastures on the Floodplain in late January 1984, and he also stated that even higher percentages may use the Floodplain, as some birds are departing while other are arriving (Pogson 1985). The only Cosumnes crane use noted in the early 1970s was a large number of Lesser Sandhill Cranes with a few intermixed greaters, flying toward a roost site at or near Forest Lake in the late afternoon of 20 February 1971 (C. D. Littlefield, pers. observ.). In both the 1970s and 1980s, the primary crane use area was the Delta where cranes roosted on private hunting clubs along Woodbridge Road, and when these sites

were drained after the waterfowl hunting season in mid-January, cranes apparently shifted to the Cosumnes area. Pogson (1990) noted that cranes increased on the Cosumnes between October 1983 and January 1984: 65 were counted in October; 197 in November; 238 in December; and 1390 in January; no count was made in February. Winter movements to the floodplain were also noted in late January 1985 (Pogson 1990). In early and mid-December 1999, a total of about 2000 sandhill cranes were found on the Cosumnes Floodplain, including an estimated 400 Greater Sandhill Cranes. During this period large numbers of greater were still present along Woodbridge Road and Staten Island (G. L. Ivey and C. P. Herziger, pers. observs.); this would suggest crane use patterns today are similar to the mid-1980s, but additional surveys in mid- to late January are necessary before this can be verified.

Of particular interest was the discovery of a roost site supporting about 200 greater and 50 lessers in mid-December 1999, 8.8 km (5.5 miles) NNE of Galt on Cosumnes River Preserve lands (G. L. Ivey, unpubl. observ.). Cranes in this area were observed feeding in winter wheat fields and pastures. Totals of six and 16 cranes in this area were noted on the Galt Christmas Bird Count in 1975 and 1978, respectively, though subspecies status was not reported. This suggests that perhaps crane use has recently increased in this area.

4. SIGNIFICANCE OF THE POPULATION USING THE COSUMNES FLOODPLAIN AND ADJACENT FARMLAND

Although no figures are currently available for January or early February, perhaps 20% of the total Central Valley Population may still use the Cosumnes Floodplain in late winter. However, with establishment of the Woodbridge ER and management changes to benefit cranes on Staten Island, Cosumnes crane use may have declined. Before 1985, the former El Dorado Gun Club roosting ponds were drained in January resulting in a shift of cranes to the Cosumnes Floodplain; presently these ponds are supposedly maintained through winter, and additional roosting habitat is also maintained on Staten Island. Therefore, fewer cranes may now be using the Cosumnes, as many may spend the entire winter in the vicinity of Woodbridge ER and on Staten Island. Conversely, fields that were used for feeding and loafing sites in the Delta during the 1970s and 1980s have been converted to unsuitable vineyards, thus, Cosumnes use may have increased. As more conversions occur, the Cosumnes River Preserve will likely grow in importance. The maintenance and welfare for the Delta Greater Sandhill Crane subpopulation may eventually be dependent on these protected lands, as well as any additional lands which can be acquired by fee title, easement, or agreement.

5. GREATER SANDHILL CRANE USE WITHIN THE SAN JOAQUIN - SACRAMENTO DELTA: MOST IMPORTANT ISLANDS AND TRACTS

The San Joaquin-Sacramento Delta is one of the two most important winter use-areas for the Central Valley Population of Greater Sandhill Cranes, for over 61% have been recorded on the Delta. The most important islands and tracts include Staten Island, Brack Tract (including Woodbridge ER), the remaining suitable croplands on Terminous Tract (particularly the north and east portions), Canal Ranch, and the New Hope Tract south of Walnut Grove Road. We consider

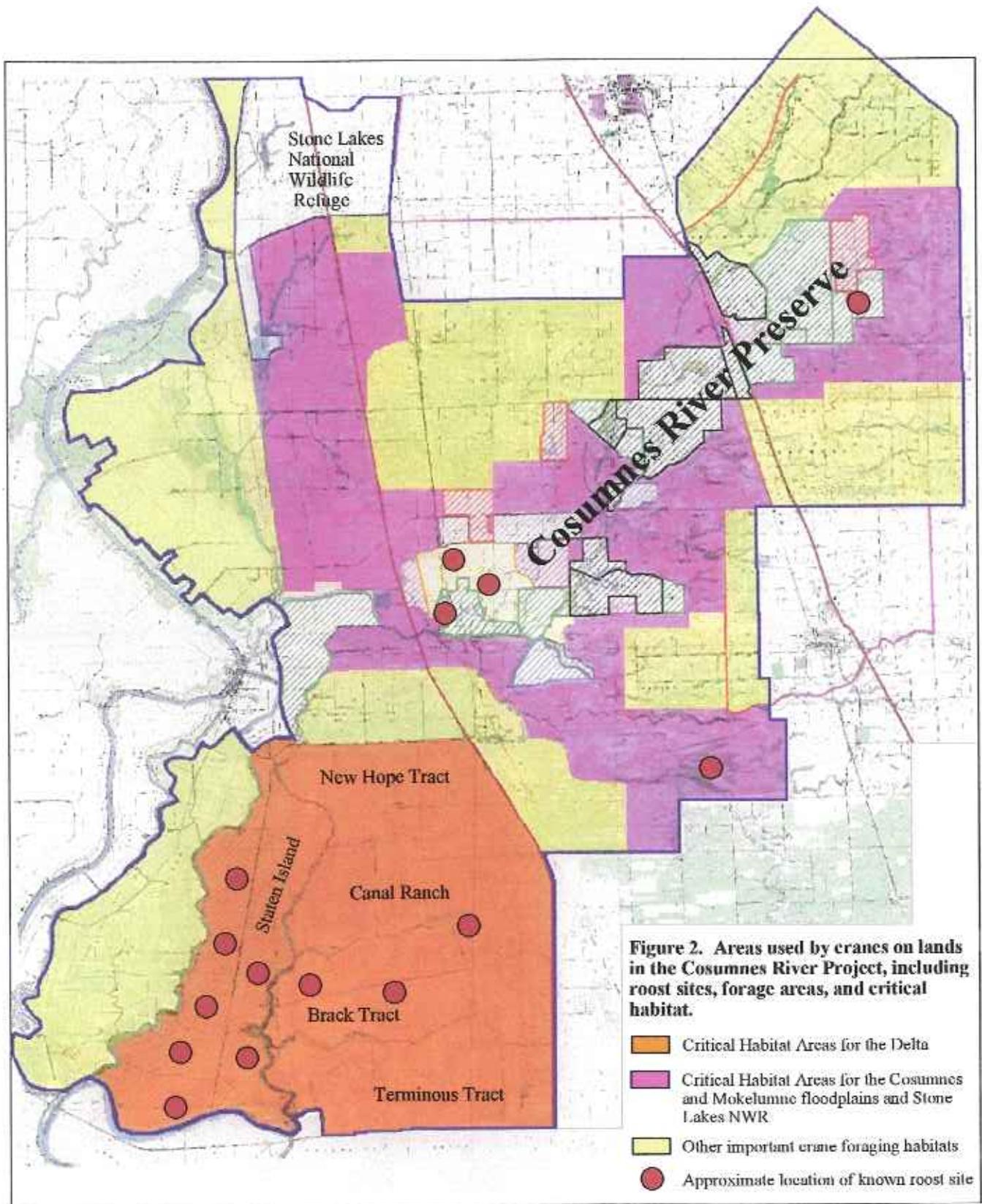
these areas critical to the conservation of Greater Sandhill Cranes (Figure 2), as they support the most consistently used roosting and feeding sites on the Delta; therefore, they should receive the highest priority in conservation plans.

Staten Island is a major Greater Sandhill Crane use area. Although no surveys were conducted there in the 1970s, the island was very important for Greater Sandhill Cranes in the 1980s; 1634 were there in January 1984 (Pogson 1990) and use was still high in both January 1998 (G. L. Ivey, pers. observ.), and December 1999 (C. P. Herziger, pers. comm.), perhaps exceeding numbers using Woodbridge ER. Staten Island was managed cooperatively with California Department of Fish and Game as a pheasant hunting area during the 1960s, discouraging crane use of the island. Beginning in the 1970s, management of the island shifted towards providing benefits to wildlife in conjunction with agricultural production, and emphasis on wildlife and cranes in particular increased through the 1980s and 1990s with the help of professional wildlife biologists (J. and S. Shanks, pers. comm.). This management program is a great success and numbers of cranes feeding and roosting on Staten Island frequently exceed those on any National Wildlife Refuge or Wildlife Area in the Sacramento or San Joaquin valleys.

The El Dorado Gun Club and adjacent fields along Woodbridge Road on Brack Tract were the most important Delta crane use-areas in the 1970s and 1980s, and use has remained high through 1999. Located south of Woodbridge Road, the 57 ha (143 acre) El Dorado Gun Club was purchased by the California Department of Fish and Game in 1985. Now known as the Woodbridge Ecological Reserve, the property had been managed as a duck hunting club from as early as 1927. Historically, the site was flooded in winter, drained in late January, and cattle grazed in summer. The club was checked and leveed with four major ponds; the principle water source originated from Sycamore Slough. Greater Sandhill Cranes have used these ponds and associated uplands for roosting and loafing, respectively, for at least 30 years. A few willows and extensive blackberry (*Rubus ursinus*) brambles are on the east and along portions of the north boundary, whereas upland habitats are vegetated with grasses and forbs. In spring and summer the site is dry; pond bottoms in summer are largely covered with grasses, clovers, and patches of knotweed (*Polygnum* sp.) (Calif. Dept. of Fish and Game Management Plan for Woodbridge Ecological Reserve 1986). Reflooded in autumn, this wetland has perhaps been one of the key habitat features which has attracted cranes to the area. Though other roost sites are used, certainly the most consistent has been this former duck club, and it remains a primary roost site in the area. The shallows and uplands are also frequently used by Greater Sandhill Cranes for mid-day loafing, and to some extent foraging bouts. If shallow and open water are maintained between 5 September and 30 March, the Woodbridge ER should continue to be one of the principal crane use-areas, providing surrounding feeding habitat remains unchanged.

Also, in 1971 some feeding use was noted in a barley field 3.2 km (2 miles) west-northwest of El Dorado (now Cortopassi Farms property). Corn was limited in the area, however, several fields west of El Dorado had been planted in 1975, and the majority of observed cranes were using these fields for both feeding and loafing purposes in late January 1976.

Other tracts and islands which also receive substantial use by Greater Sandhill Cranes include Terminous, Canal Ranch, and New Hope. In the 1970s newly planted barley fields on the Canal Ranch attracted cranes, and on the Terminous Tract about 400 cranes were noted on 20 February



1971. Another important use area used to be the irrigated pastures south of Peltier Road. These grasslands received extensive use in the 1970s, as birds which fed in the early morning on the Canal Ranch flew about 1.6 km (1 mile) east-southeast to loaf in pastures on the Thompson-Folger Ranch; in mid-afternoon they returned to the dry fields of the Canal Ranch to resume feeding. However, much of Thompson-Folger Ranch has been lost because of conversions to vineyards. Croplands on the Terminous Tract are primarily still intact and cranes still use the area, however, the expansion of Tower Park Marina and RV Park and related increasing recreational activities there are effecting crane use of the tract. There are pockets of heavy crane use, but use at these spots are threatened from water-related recreation activities, as the state sponsors a public houseboat dock, picnic area, and fishing access along the levee on Sycamore Slough. Also, Highway 12 is designated as a recreation corridor, and heavy traffic and recreational disturbance causes cranes to avoid the south and west portions of Terminous Tract (J. and S. Shanks, pers. comm.).

Though apparently minor, Pogson (1990) also found additional crane use on Bouldin and Empire tracts, on King Island, Grand and Tyler islands in the 1980s. Small numbers of cranes also use Ryer Island (J. and S. Shanks, pers. comm.); Brannan, Twitchell and Bradford islands (J. Strahan, pers. comm.); Venice and Mandeville islands, and Webb, Holland and Palm tracts (D. Gifford, pers. comm.) (see Figure 1).

6. NATIONAL SIGNIFICANCE OF THE DELTA

An estimated 62,600 Greater Sandhill Cranes presently exist in the world, mostly in two of the five populations. The Eastern has been estimated at 29,400 birds (47%), whereas the Rocky Mountain contains some 19,500 (31.2%), (R. C. Drewien, pers. comm). About 78% of all Greater Sandhill Cranes occur in these two populations. For the other three, the Lower Colorado River Valley Population has around 2200 (3.5%), the Prairie Population 3000 (4.8%), and an estimated 8500 (13.6%) are in the Central Valley Population. About 14% of the world's greaterers are in the Pacific states, with 13.6% wintering in the California Central Valley. Within the valley, there are two major use-areas: the Sacramento Valley to the north and the San Joaquin-Sacramento Delta to the south. Though numbers vary, after November more than 5000 have been counted in the Delta region. Smaller wintering groups also occur in Stanislaus, Merced, and Delano counties. Based on total world numbers, the percentage of Greater Sandhill Cranes using the Delta peaks at around 8.3%; on the Cosumnes Floodplain, 2.2% have been recorded.

7. HABITATS USED BY GREATER SANDHILL CRANES IN THE DELTA AND COSUMNES FLOODPLAIN

Wintering Greater Sandhill Cranes are generally found in agricultural regions which have extensive cereal and other small grain crops; associated wetlands are used for roosting and loafing. Cranes generally leave roosting locations in early morning, then fly to nearby grainfields where they feed until mid-morning. In mid-day birds usually loaf and occasionally feed in pastures, alfalfa fields, along canals, levees, ditches, rice-checks, and dikes, or use the shorelines and shallows of ponds, lakes, or other wetlands. Most return to grainfields in mid-afternoon,

where they feed until early evening before flying back to shallow water bodies where they spend the night standing in shallow, open water. Though roosts are usually within 2-4 km (1-2.5 miles) of feeding fields, cranes will use sites at greater distances; most grain fields on the Delta are within 4 km (2.5 miles) of nocturnal roost sites. An exception, however, is when cranes feed on the Canal Ranch and roost on the Cosumnes Floodplain, a distance of about 8 km (5 miles).

In migration or winter, sandhill cranes have been recorded consuming corn, wheat, barley, rye, oats, milo and rice (pers. observs.). With the exception of rye and milo, these crops are listed by the agricultural commission as crops grown in San Joaquin County (Curry and Rademacher 1998), with corn having the most hectares. Cranes have also been recorded on native grasslands, and prefer open sites with growing green vegetation. They often flip cattle dung pads, a rich source for invertebrate food. They will hunt mice in taller vegetation, but generally avoid heavy cover which might conceal predators. These grasslands, as well as irrigated pastures and alfalfa fields are used as loafing and feeding sites, with foods generally consisting of invertebrates, small vertebrates, and green plant material. Such food items are rich sources of protein and calcium, nutrients essential for daily maintenance requirements (Reinecke and Krapu 1986).

The presence of secure roost sites is key to the use of an area by sandhill cranes. The most consistently used roost site has been the ponds along Woodbridge Road on Woodbridge ER; however, between 22-25 January 1976, birds were not using the site to any extent, instead roosting on what is now Cortopassi Farms property. Cortopassi Farms was still being used as a roost in 1999. Also, on 8 February 1970 cranes were noted using a roost site north of Woodbridge Road which is now included within Woodbridge ER. The other major roosting area has been Staten Island, where cranes regularly shift roost sites as different fields are successionaly flooded through the winter period. Additional roost sites include: in the vicinity of Forest Lake east of Thornton on 20 February 1971; on the Cosumnes River Preserve (Rude 1989), and in Pond 1, Lost Slough East, Barn Pond, and Rice Field 4 (Cosumnes Preserve, unpubl. data) and north of Galt, Sacramento County, east of Highway 99 in December 1999 (Figure 2).

The adequacy of Delta crane habitats is presently unknown, but overall in San Joaquin County, food is perhaps not a limiting factor. For example, in 1998 there were still 141 ha (353 acres) of barley, 25,158 ha (62,895 acres) of corn, 592 ha (1480 acres) of oats, 1900 ha (4750 acres) of rice, 15,984 ha (39,960 acres) of wheat, 25,118 ha (62,795 acres) of alfalfa, and 9407 ha (23,518 acres) of irrigated pasture (Curry and Rademacher 1998). However, these crops may not be available to cranes as many are outside the species' traditional use areas and cranes are highly philopatric to wintering sites and do not readily shift to new areas. Also, urban expansion in Sacramento County is rapidly replacing agricultural lands, and this loss could limit the crane carrying capacity on the Cosumnes Floodplain in the future. Data on area of wetlands were unavailable.

8. LANDSCAPE FEATURES

Sandhill cranes need a variety of habitats to acquire the nutrients necessary to survive the winter period, as well as to store energy reserves for spring migration. Essential habitat components include grain crops for obtaining sufficient carbohydrates, and grasslands, pastures,

or alfalfa for obtaining protein, calcium, and other essential nutrients. Another essential habitat component is favorable roosting sites secure from disturbance and in close proximity to fields. In addition, another important element is the availability of small gravel for grit.

For most of the 20th Century, Greater Sandhill Cranes have been primarily dependent on waste grains for winter survival in California. Cranes formerly relied on a variety of natural food plants on the two million or so wetland hectares in pristine California; however, since the arrival of Europeans during the mid-1800s (Heitmeyer et al. 1989) more than 95% of these wetlands have been modified, or in most cases destroyed (Gilmer et al. 1982). Of the remaining 115,000 ha (287,500 acres) in the Central Valley, two-thirds are privately owned and managed for waterfowl hunting, whereas the other one-third is mostly divided among several state and federal agencies (Heitmeyer et al. 1989). Many of these governmental lands are also used for waterfowl hunting. With so few wetlands remaining, and these frequently unavailable to cranes because of hunter disturbance and the potential mortality threat, few natural sites remain available, thus the majority of crane foraging now occurs on agricultural fields.

Historical crane use on the San Joaquin-Sacramento Delta is unknown, and it was not until the late 1960s before any information became available, long after most wetlands had been drained and extensive agriculture developed. Though barley seemed to be the important crane food crop in the late 1960s and early 1970s, production has declined dramatically. By the mid-1970s corn production had increased; in January 1976, most Greater Sandhill Cranes were foraging in harvested corn stubble, and for the past 25 years waste corn has been the principle carbohydrate food source for cranes wintering on the delta. In contrast, in the other major Greater Sandhill Crane wintering region, waste rice provides the bulk of the winter food consumed: north of Sutter Buttes, in the Sacramento Valley, 71.4% of crane use was in rice fields, of which 59.3% was in unaltered rice stubble, 16.2% in flooded stubble, and 14.4% in burned stubble. Autumn tilled rice stubble had infrequent use (3.3%), as did burned-flooded (5.6%) and tilled-flooded (0.3%). Even with limited corn hectares in the Sacramento Valley, most cranes changed their diet from rice to corn beginning in January, with use continuing until birds migrated in February (Littlefield 1993a, 1993b). Though rice contains sufficient quantities of five essential amino acids, corn has only one (Buckley 1989), but corn is rich in carbohydrates, an energy source necessary for fat deposition and consequent migration (Reinecke and Krapu 1986).

On their wintering grounds, Greater Sandhill Cranes frequently associate with grasslands, particularly after the onset of winter rains. Foods consumed generally consist of invertebrates and green plant material. In Butte County, the winter livestock-grazed grasslands of Rancho Llano Seco were the fourth ranked feeding type, only surpassed by rice, newly planted winter wheat, and corn (Littlefield 1993a). No crane foraging was noted on Llano Seco grasslands not being grazed by cattle. This was likely because extensive and dense stands of residual yellow starthistle (*Centaurea solstitialis*) were interspersed among grasses; shortly after cattle entered, decadent starthistle disappeared. In Nebraska, Krapu et al. (1984) also noted more use in pastures grazed by livestock, with 89 to 98% of the cranes using grasslands grazed by cattle, whereas only 1-8% used mowed meadows, and 1% burned meadows. Food obtained in grasslands, as well as along grassy borders around cultivated fields, on dikes, levees, rice-checks, islands, subirrigated uplands, and other moist-soil sites, are essential for acquiring high quality protein foods

(invertebrates). Reincke and Krapu (1986) found that along the Platte River in Nebraska, cranes devoted as much time obtaining 3% of their diet of invertebrates in alfalfa and pastures as they did in obtaining 97% of their diet of carbohydrates in corn fields. In addition to obtaining high quality protein food, these same sites are used for loafing.

Seasonal wetlands are another important landscape feature. Cranes loaf and forage in these habitats and they are an important source of invertebrates and other high-protein foods. Pogson (1985) stated that when temperatures exceeded 60°F in the Central Valley cranes returned to flooded areas, spending as much as 6-8 hours in wetlands. On these warm days, foraging in grain fields is limited to the early morning and late afternoon. A similar pattern was noted at Bosque del Apache NWR in New Mexico, a major sandhill crane wintering area of the Central Flyway (J. P. Taylor, pers. comm.). Pogson also noted that cranes would more likely use flooded non-cultivated lands (native meadows, grasslands, pastures, etc.) than flooded cultivated lands, because high-quality protein foods were more available in non-cultivated areas.

Cranes roost at night standing in open water areas of wetlands or flooded agricultural fields. They will tolerate emergent vegetation along the periphery, but will rarely use roosts with heavy emergent cover. Winter roosts in Texas and Oklahoma had little submergent vegetation (Lewis 1976), whereas in the Great Lakes states cranes spent the night in water bodies containing heavy submergent growth (Bennett 1978, Lovvorn and Kirkpatrick 1981); generally cranes use ponds with little turbidity. In the California Central Valley after the onset of winter rains, cranes frequently roost in shallow rain water pools in a variety of sites, including fallow fields, harvested grain fields, and pastures. Nocturnal roost sites vary in size; for example, at Malheur NWR roosts have varied from 0.5 to 120 ha (1-300 acres), with water depths rarely exceeding 20 cm (8 inches); average depth was 11.7 cm (4.5 inches) (range 4-22.4 cm [1.5-9 inches]) (Littlefield 1986). Depths on the Little Dry Creek Unit of the Upper Butte Basin Wildlife Area (WA) in Butte County, California, ranged from 8.7-17.3 cm (4-7 inches); cranes abandoned sites when depths reached 20.2-28.8 cm (8-11 inches) (Littlefield 1993b). Depths at the roost on El Dorado Gun Club averaged 8.2 cm (3 inches) and ranged from 5.2-11.9 cm (2-4.5 inches) in November 1969 (C. D. Littlefield unpubl data).

Grit sites are a Greater Sandhill Crane habitat component which have generally not been considered in management decisions. Grit is particularly essential for cranes feeding predominately on waste grains, especially corn and rice. Frequently birds leave grain fields or roost sites and fly to nearby rocky uplands; there they spend considerable time gleaning and consuming small stones. In the Central Valley, birds have been noted obtaining grit on the rocky slopes of Sutter Buttes, as well as off graveled roads along Butte Creek in Butte County, and C. P. Herziger (pers. comm.) reported cranes "snacking" off the gravel roads of Staten Island in 1999, a common occurrence there (J. and S. Shanks, pers. comm.). Gizzard contents of a juvenile greater illegally shot near Merced NWR, Merced County on 11 December 1969 contained over 800 small pebbles; pebble sizes ranged from 1.0 x 0.6 to 7.2 x 4.9 mm, and consisted of both quartz (66%), and sedimentary (33%) rocks (C. D. Littlefield, unpubl. data). Though Delta cranes are perhaps not lacking grit, in Sutter County birds have been noted flying up to 8 km (5 miles) to obtain grit (C. D. Littlefield, pers. observ.). In a landscape dominated by deep and fertile soils, grit may be a limiting factor, however, within the Delta sufficient quantities are presumably provided by road-surfacing and other graveling projects.

9. WHAT LAND USES ARE RESTRICTING THE HABITAT AVAILABLE TO CRANES.

Cranes are intolerant of urbanization and excessive human disturbance. Recreational uses such as hunting, golfing, or off-road vehicle use generally discourage crane use. Permanent crops such as orchards and vineyards eliminate crane foraging sites. Some crops such as asparagus and sugar beets are not used by sandhill cranes, but others may receive some use, even tomatoes (S. Shanks, pers. comm.), potatoes, and cotton.

Land use changes are presently the most serious factor threatening sandhill cranes wintering in California. As orchard developments have encroached onto crane use-areas in the Sacramento Valley, so too have vineyards encroached onto crane use-areas on the Delta. Greater Sandhill Crane habitat is entirely lost when lands are converted from grasslands and grains to orchards and vineyards. In Sacramento County, for example, hectares planted with vineyards have more than doubled in just the past 3 years; presently there are 2656 ha of fruit-bearing vines and 2764 non-bearing (Estuary 8: October 1999). In San Joaquin County, vineyard hectares increased from 18,745 in 1991 to 31,093 in 1998 (46,863-77,733 acres) (San Joaquin County Agricultural Reports). Formerly important crane use-areas on the Delta have already been destroyed, particularly adjacent to Peltier Road; however, in other areas grain croplands have remained mostly intact. Unfortunately, a shift from rice, corn, other row crops, and pastures to vineyards is continuing at a rapid rate; unless this trend is curtailed, little crane habitat may soon exist on the Delta. Conversion has perhaps been accelerated in recent years by the spiraling cost of grain production, loss of government subsidies, reduced exports, excessive national surpluses, and subsequently, lower commodity prices. If not for the capital outlay and time required for investment recovery, considerably more of the Delta would have likely already been lost to vineyard development. Continued low market values for grain crops will cause conversion to other crops which are of little value to Greater Sandhill Cranes.

Declining grain crops are a major concern. These crops have consistently been planted in the Delta region since the onset of agricultural development, but some are now less abundant than in the recent past. For example, barley which was used extensively by cranes in the 1960s and 1970s (and probably long before) has declined in hectares planted. In the last decade, barley dwindled from 3036 ha (7590 acres) in San Joaquin County in 1991 to only 145 ha (363 acres) in 1998 and sorghum (milo) dropped from 159 ha (398 acres) in 1991 to 0 in 1998 (Worthen and Gritz 1991, Curry and Rademacher 1998). Irrigated pastures have also decreased, from 10,769 ha (26,923 acres) in 1990 to 9676 ha (24,190 acres) in 1998, including losses of important Greater Sandhill Crane feeding and loafing sites adjacent to Peltier Road. However, corn hectares have remained little changed in San Joaquin County through the 1990s: corn increased from 16,300 (40,750 acres) in 1969-71 to 28,100 (70,250 acres) in 1980-82 (Pogson 1990), and 25,870 ha (64,675 acres) in 1998 (Curry and Rademacher 1998). Yearly variation in grain crop hectares frequently reflect variation in market value; prices have been and continue to be low, and if low prices persist, crane food shortages may be anticipated, particularly for grains such as corn.

10A. HOW SHOULD PUBLIC AND PRIVATE LANDS BE BETTER MANAGED TO SUPPORT CRANES?

Wetland Management

Seasonal wetlands: As much as possible, shallow seasonal wetlands should be restored in native habitat areas of the Cosumnes and Mokelumne floodplains to provide wetland foraging, loafing and roosting areas for sandhill cranes. Restoring natural drainages to vernal pool areas and other natural wetlands would benefit cranes and other wildlife, and well as native flora. These wetlands should be managed for early seral vegetation, and to mimic the natural hydrologic patterns in the region, with flooding occurring during the wet season (November through April). However, some wetlands (especially roost sites) should be flooded by early September for use by cranes in early fall.

- Restoration of natural wetland basins should be a priority in native grassland and oak savannah habitats.
- Where possible, natural drainage inflows should be restored to wetland basins; otherwise water delivery should primarily mimic natural hydrologic cycles, except that some managed areas should be flooded in early September for fall crane use.
- Wetland vegetation should be maintained in early seral stages in managed wetlands to encourage more crane use. Dense stands of emergent vegetation or other heavy cover generally discourage crane use.

Roost sites: Woodbridge ER and Staten Island provide excellent wetland roosting sites, but to avoid overcrowding and the subsequent potential for disease outbreaks, additional roosting wetlands need to be developed within the Cosumnes River Project area. Roost site development will also help disperse cranes, increasing their options for finding new feeding areas. Agricultural fields may be flooded to create suitable roost habitat where there appears to be adequate dry grain fields nearby to meet the foraging needs of cranes. In the culture of winter wheat, temporary roost sites could be provided during pre-irrigation (see Cropland Management discussion). Though not usually considered in crane management or recovery plans, grit sites are an important component of crane habitat, and can be provided in association with roosting sites. Provision of grit is particularly important when cranes are feeding in organic soils on large grains such as corn or rice. Small gravel from riverine deposits is recommended when a road or surfacing project is considered, and it would be beneficial to spread gravel along shores of roosting and loafing ponds as well. We recommend the following considerations for roost site management:

- To reduce crane crowding and lessen the potential for disease outbreaks, newly created wetland roost sites should be widely dispersed and be maintained with flowing water to reduce potential for epizootic events.
- New roosting wetlands should be designed with sloping banks which allow cranes to walk onto the site from adjacent uplands.

- Encroaching coarse emergents such as cattails and tall bulrushes should be controlled if they begin expanding into open water crane use-areas. Though emergents provide concealment and thermal cover, they should be restricted to roost site fringes; birds prefer shallow and open water, thus encroaching emergents can result in abandonment.
- To prevent over-crowding, roost sites need to be at least 8 ha (20 acres) in size; we recommend even larger wetlands of 40 ha (100 acres) or more to provide additional security and benefit to cranes and a variety of other wetland species.
- Water levels should be managed to provide extensive areas at depths ranging from 8-20 cm (3-8 inches).
- Water should be maintained in wetlands from early September though at least mid-March.
- Spreading of small gravel along roads, bare shoreline areas, or on islands will provide grit sources for cranes.
- The Delta is well known for disease outbreaks, particularly avian cholera (*Pasteurella multocida*), and roost sites need to be monitored to detect disease outbreaks. If an outbreak is detected, dead birds should be retrieved in coordination with the California Department of Fish and Game, and the site should be immediately drained.
- Human disturbance around roost sites should be minimized by positioning new roosts at least 0.4 km (0.25 mile) from heavy traffic, areas open to hunting, or other disturbing factors. Public uses around roost sites (i.e. wildlife watching and photography) should be carefully regulated to prevent disturbance to roosting birds.

Cropland Management

For fee title lands, management should consider ways to maximize the amount and availability of food for cranes. For lease lands, leases should specify crane compatible crop types. Farmers should also be encouraged to use crop management practices as outlined below to benefit cranes.

Food plots: A portion of fee title croplands should be dedicated to food plots for sandhill cranes and planted with grain crops such as corn, milo, wheat or rice. Corn plots could be planted and left unharvested and standing. Approximately 60 ha (150 acres) of experimental unharvested corn plots received extensive crane use on the Little Dry Creek Unit of the Upper Butte Basin WA; over 3400 greaterers were feeding in these plots in January 1993 (Littlefield 1993b), and a nearby flooded unharvested plot also accrued high use in January 1992. A similar management strategy has been successful at Merced NWR (K. Sande, pers. comm.), and at Bosque del Apache NWR (J. P. Taylor, pers. comm.). At Bosque del Apache NWR, individual cranes generally consume about 340 g (0.75 lb) of corn, geese 227 g (0.50 lb), and ducks 114 g (0.25 lb) daily. Based on these estimates, the amount of corn to be planted annually could be

calculated based on predicted yields and the projected number of cranes, geese and ducks which are to be supported for 6 months (J. P. Taylor, pers. comm.). Also at Bosque del Apache NWR, standing corn is mowed or dragged down to encourage use by cranes and waterfowl, however, because of California's Mediterranean climate, we recommend leaving unharvested corn standing to prevent fungal contamination of corn kernels. Though it may take time before cranes discover plots, after a few birds begin feeding in standing corn it is usually only a short time before others join these feeding groups. Therefore, a few agricultural fields which presently exist within the Cosumnes River Project should be planted, with corn remaining unmanipulated through early March. This will provide an opportunity for cranes to establish a tradition for feeding in standing corn. Should agricultural lands in the Delta be acquired, portions of these could also be left unharvested. Such sites provide an abundance of food, and persist through the winter period. Although corn plots would likely be most attractive to Greater Sandhill Cranes, corn is limited in its nutritional value, therefore it is important to additionally provide grasslands, pastures, or alfalfa within 2 km. Other grain crop types would provide similar benefits. We recommend the following considerations for grain plots:

- Provision of about 50 ha (125 acres) of unharvested grain plots of about 8-12 ha (20-30 acres each) would provide an opportunity for a substantial increase in crane use. These should be established at dispersed historic cropland locations on fee title lands.
- Food plots should not be harvested, with plants left standing into March.

Harvested croplands: For fee title and easement croplands which are harvested, practices which maximize the availability of waste grain will benefit cranes. Fields should not be heavily disced or plowed, as these practices bury much of the waste grain, making it unavailable to cranes and other wildlife. For example, a corn field along New Hope Road (Department of Water Resources property) was disced heavily when observed in December 1999 (G. L. Ivey, pers. observ.), and although it was being used by a flock of 17 cranes, more cranes would likely have been using this site if it had been left as corn stubble after harvest. For rice, the practice of flooding and rolling rice fields is not conducive for sandhill crane use. Although cranes use these fields heavily as they are being flooded, use is of short duration as much of the waste grain is rapidly consumed by waterfowl and other birds. Cranes visually surface-glean for waste grain, thus flooding prevents birds from locating seeds once stubble is inundated. Birds do, however, occasionally feed on invertebrates by probing along field edges or on associated subirrigated upland, and flooded rice patties (cells) are also sometimes used as roosting and loafing sites. In the Sacramento Valley, unaltered harvested rice stubble was the most consistently used crane habitat in the early 1990s (Littlefield 1993a), and alteration by burning, flooding, or autumn plowing frequently resulted in infrequent crane use. Generally burning attracted cranes as waste rice was exposed, but use was of short duration, as geese, ducks, and blackbirds were also attracted, rapidly depleting the food source. By far, the most detrimental practice is autumn rice stubble plowing; generally cranes abandon rice fields shortly after autumn tilling. Winter wheat can also provide great benefits to cranes, as harvested fields can be flooded early to provide roost and loafing areas for the first arrivals in September, and new wheat planted in late fall attracts large numbers of cranes to feed on the planted seed bed until the emerged wheat grows to about six inches. By using a successional pattern of cropping, the birds can always have some new

forage areas developing (J. and S. Shanks, pers. comm.). We recommend the following considerations for grainfield management for harvested croplands:

- For harvested corn fields, shallow discing of corn stubble in autumn to remove residual stubble as well as remove kernels from cobs will improve accessibility to waste seeds. Alternatively, operators could lower the corn headers on the harvesters and cut low enough that the cranes would readily use the waste corn without the light discing.
- To maintain availability of waste grain, no additional tilling of corn or other grain fields is recommended until March.
- To maximize food availability to cranes, harvested rice fields should be left dry and unmanipulated until March.
- Winter wheat can provide multiple benefits to cranes; flooding harvested fields for pre-irrigation of the next crop in September provides wetland roost areas, and wheat fields planted in succession in late fall and early winter provide a sustained source of grain and new green sprouts for crane foraging through most of the winter period.

Grassland Management

Wintering Greater Sandhill Cranes generally obtain protein-rich foods by soil-probing in irrigated pastures or other grasslands, but birds usually avoid these lands when vegetation exceeds 25 cm (10 inches). In addition, cranes frequently overturn cattle dung pads, feeding on the associated invertebrates beneath. Therefore, at the onset of autumn rains, some grassland sites within the Cosumnes River Project should be winter grazed by cattle to provide short vegetation and open situations. These grazed sites may become increasingly important, as irrigated pastures on private lands are disappearing. We recommend the following considerations for grassland management:

- Manage 20-40 percent of grasslands in the project area with cattle grazing to provide foraging sites for sandhill cranes.
- In the Delta, the sides of levees should be managed for short vegetation. Cranes often use levees as daytime loafing and feeding areas.
- An alternative to grazing would be autumn burning to provide green plant foods for crane foraging.
- For irrigated pastures, irrigation should begin in September on some sites, with pastures sporadically irrigated throughout the winter period to promote new green growth for cranes.

Hazards to cranes

Utility wires are a major crane mortality factor in the California Central Valley, particularly as birds leave roost sites on foggy mornings. Radio and television towers pose a collision threat to cranes as well. Wire fences also have resulted in crane mortality; there are numerous records of cranes dying after collisions or entanglements. We recommend the following considerations for reduction of hazards to cranes:

- Utility wires are highly hazardous to cranes, thus, all non-essential transmission lines should be removed. Ideally, essential lines should be buried, otherwise, they should be equipped with orange spheres or yellow spiral line-markers (Brown and Drewien 1995), especially near roost sites or where crossing major flight corridors.
- Any proposed utility corridor through crane use-areas should be vigorously opposed.
- If possible, existing towers should be removed from crane use-areas, and permits should not be renewed after expiration. No new towers should be permitted.
- Unnecessary fences should be removed. Where fences are needed for management, temporary barbless or electric fencing should be considered. If permanent fencing is necessary, wires should be kept tight to prevent entanglement. Top wires on existing fences should be replaced with smooth wire to reduce injury or death to cranes and other wildlife.

Public Use/Disturbance

Disturbance to cranes from operational activities or from public use should be kept to a minimum. Disturbed cranes forced into unnecessary flights expend vital energy needed for winter survival and migration. We recommend the following considerations regarding minimizing disturbance to cranes:

- Operational activities such as construction projects, irrigation, and wildlife censuses should be conducted with consideration for minimal disturbance to cranes. For example, choosing the appropriate time of day to manipulate irrigation water or census birds would limit disturbance to cranes in sensitive areas. It would be best to conduct construction projects outside the crane wintering period.
- Public use such as birdwatching and photography should be restricted to designated areas to limit disturbance near important crane use-areas and especially roost sites.
- No hunting should be allowed within 0.4 km (0.25 miles) of crane roost sites and other use-areas, and where possible, human access should be restricted. Waterfowl hunting within major crane use-areas should be prohibited, particularly at or near roost sites. Not only creating disturbances during shooting hours, hunters entering pond edges in the pre-dawn hours will frequently cause cranes to leave a roost in total darkness. Such disturbances not

only disrupt birds, but also dramatically increases the potential for collisions with utility wires or other obstructions. Only one pre-dawn disruption is usually necessary before cranes abandon a site. In addition, on rare occasions cranes have been accidentally shot and killed by hunters, particularly in the early morning and during periods with limited visibility.

- Shelterbelt areas of trees and shrubs should be planted as a buffer to reduce disturbance from hunting and other public uses.

10B. WHERE SHOULD MANAGEMENT BE FOCUSED TO SUPPORT CRANES?

Project activities should urgently address preserving essential habitats and land uses in critical habitat areas of the Delta as indicated on Figure 2. A priority to acquire agricultural lands between Thornton and Highway 12 on the east and Staten Island on the west should be initiated and vigorously pursued; acquisition by agreements, easements, or fee title is essential. Within this area the majority of Delta Greater Sandhill Crane use has been and continues to occur, particularly in the agricultural fields on Staten Island and adjacent to Woodbridge Road from the Woodbridge ER westward. Croplands and pastures in the Terminous Tract and on the Canal Ranch should be acquired as they become available. In addition, it is extremely important to protect and perpetuate crane use-areas on Staten Island. Corn production, and to some extent, livestock grazing of pastures should continue on lands acquired. Secondly, critical habitat within the Cosumnes and Mokelumne floodplains, and the Stone Lakes NWR area (Figure 2) should be secured. If these areas are acquired or protected, virtually the entire winter range of the Delta Greater Sandhill Crane subpopulation will be secure, at least from the severe habitat degradation which is presently occurring. Until the privately owned lands between Thornton and Highway 12 and west through Staten Island can be secured for crane conservation, the majority of Delta sandhill crane habitat will remain in jeopardy.

Staten Island

Staten Island is one of the most important sites for Greater Sandhill Cranes on the Delta; under single ownership, it is currently managed for both wildlife and agriculture. Although Staten Island is currently secure, it may not be in the future. Proposals to use the island for flood relief, coupled with economic issues, may soon change land use on the island and could eliminate its value to cranes. Crane use would probably not change if the island were flooded on a frequency of no more than once in ten years; however, cranes would likely abandon the site if it were flooded on a more frequent basis. If political pressure pushes for flooding Staten Island, TNC should lobby for a lower flooding frequency.

M & T Staten Ranch owners are sympathetic to the needs of cranes and other wildlife, and would prefer to continue management for these dual objectives. However, private agricultural lands must remain profitable, and low grain values currently threaten the future of current management practices. While the opportunity still exists, TNC and other conservation agencies should consider options to maintain this privately-managed conservation endeavor by negotiating a fair level of compensation for its continuance.

An agreement with M & T Staten Ranch in the form of a perpetual easement to continue crane management activities is needed. Assuming an arrangement could be reached with M & T Staten Ranch to secure conservation efforts on the island, management for cranes could be improved by developing the southern one-third into an independent unit with separate water control and delivery facilities. Funds for construction of a major dike to divide the southern from the northern segment would allow for intensive and improved management on the lands presently used by Greater Sandhill Cranes. This would help resolve the conflict between keeping the whole island dry for crop harvest and the need to provide flooded roost sites for early arriving cranes. Perhaps this project could be funded collaboratively with a North American Wetlands Conservation Act Grant through the Central Valley Joint Venture.

Remaining Delta Critical Habitat Areas

For the other islands and tracts marked within the critical habitat area, any remaining cropland which has not been converted to vineyards should be secured through easements, cooperative agreements, or fee title. Of particular importance is the crane roosting habitat on Cortopassi Farms. Easements should restrict farming to crops used by cranes (e.g., grains, irrigated pastures, alfalfa, etc). Incentives should also be offered to maintain flooded areas for roost sites.

Cosumnes Floodplain and Stone Lakes NWR areas

Although the importance of the Cosumnes Floodplain to Greater Sandhill Cranes is secondary to the Delta, it is still an important area. Its significance will likely increase in the future as habitat losses on the Delta and in other Central Valley locations will perhaps result in a crane shift to new wintering areas. Rapid urban expansion toward Stone Lakes NWR and the Cosumnes is a cause for concern. Sufficient favorable agricultural (non-orchard/vineyard) and natural lands should be protected for the future needs of sandhill cranes. Within the boundary provided on Figure 2, remaining critical habitat areas should be secured through easements, cooperative agreements, or fee title. Within the critical area, properties should be prioritized for conservation based on their proximity to known or potential roost sites, and properties currently in grain crops, natural grassland, irrigated pasture, or alfalfa should receive priority over other crop types.

11. SANDHILL CRANE ROOST SITES AND FORAGE AREAS IN THE REGION AROUND THE COSUMNES RIVER PRESERVE, STONE LAKES NWR, AND STATEN ISLAND.

Known sandhill crane roost sites and foraging areas are illustrated in Figure 2. Foraging areas are shaded in color on the map, however, due to the broad scale, these bounds include a few residential sites and some orchards and vineyards which are not crane foraging habitat. Roost sites regularly shift on Staten Island, as new water is applied and withdrawn from different agricultural fields, thus mapped sites are approximate.

12. CRITICAL HABITAT FOR THE GREATER SANDHILL CRANES IN THE STUDY AREA.

Figure 2 illustrates areas we consider to be critical habitat for Greater Sandhill Cranes.

13. RISK ASSESSMENT.

Of the above recommendations, the majority are common sense strategies which will benefit Greater Sandhill Cranes; however, based on past experience, a serious problem sometimes arises after lands are acquired by governmental agencies or conservation organizations. This has been particularly evident when agricultural croplands important for Greater Sandhill Crane foraging were purchased and subsequently converted to wetlands. These wetlands became vegetated with undesirable annual forbs (e.g., slender aster, *Aster alexis*), were not flooded until mid-October, and were subsequently used for public hunting. Although wetlands are desirable, these management practices were detrimental to crane foraging. Acquiring suitable lands, then dramatically altering the habitat is not sound crane management. We recommend that lands within critical habitat areas currently in grain production, should remain in grain production. After acquisition, land use and management practices should remain compatible with the needs of cranes.

If Staten Island and other critical areas are secured and maintained under current conditions, we estimate that 80% of the current Greater Sandhill Crane use could be maintained on the Delta. Recommendations presented here for securing and maintaining habitat on the Cosumnes Floodplain and in the Stone Lakes NWR region should ensure maintenance of at least 90% of the current Greater Sandhill Crane use. Additionally, with focused land management crane use could be increased significantly beyond current levels. To demonstrate the potential for this kind of management, we cite an example from Bosque del Apache NWR, where a wintering population of 11,000 sandhill cranes is maintained on 2080 ha (5,137 acres) of intensively managed habitat (Taylor 1999). Of these hectares, most are managed wetlands; about 405 ha (1,000 acres) are maintained as cropland, including about 122 ha (300 acres) of unharvested corn and about 283 ha (700 acres) of alfalfa.

If properly protected and managed, the Delta region will continue to be one of the most important Greater Sandhill Crane wintering use-areas in California. Crane use has been increasing in the region in recent years (Table 1), as more Lesser Sandhill Cranes are now using the San Joaquin County. As habitat continues to be lost in the Central Valley, cranes are becoming more concentrated, thus active management becomes increasingly important; however, preferred and adequate habitat has to be available before active management can be accomplished. Efforts presently underway on the Cosumnes River Floodplain and Delta will hopefully be in time to prevent further losses of essential habitat in a region known to be important for Greater Sandhill Cranes. Restoration, acquisition, and maintenance of grasslands, pastures, wetlands, and grain croplands will ensure that cranes will have the essential components necessary, but management must be continuous, sound, and not interrupted. The worse case scenario is that if the Cosumnes River Project were unable to secure sufficient amounts of the recommended lands in a timely fashion, and unable to ensure continued suitable crane roosting and foraging habitats, habitat

losses to undesirable crops and urbanization would continue. Thus, many cranes would be forced to relocate to other areas. The carrying capacity of the wintering grounds would be further reduced, ultimately leading to a significant decline in the Greater Sandhill Crane population. The loss of cranes would also mean the loss of an array of the other wildlife species which share the lands used by cranes.

Table 1. Late December sandhill crane numbers recorded during the Stockton, California Christmas Bird Count in the Woodbridge area, 1968-1997 (counts unavailable for 1979, 1993 and 1996).

Year	Number	Year	Number
1968	1762	1983	2912
1969	3107	1984	9334
1970	1310	1985	2015
1971	2173	1986	9547
1972	2763	1987	10,189
1973	2194	1988	8986
1974	989	1989	8480
1975	2175	1990	8918
1976	6028	1991	15,811
1977	4720	1992	21,900
1978	3949	1994	6558
1980	1765	1995	17,862
1981	4512	1997	13,304
1982	10,113		

LITERATURE CITED

- Bennett, A. J. 1978. Ecology and status of Greater Sandhill Cranes in southeastern Wisconsin. M. S. Thesis, Univ. of Wisconsin, Stevens Point, WI.
- Brown, W. M. and R. C. Drewien. 1995. Marking powerlines to reduce crane and waterfowl collision mortality. *Wildl. Soc. Bull.* 23(2):217-227.
- Buckley, C. E. 1989. The nutritional quality of selected rowcrop and moist-soil seeds for Canada Geese. M. S. Thesis, Univ. of Missouri, Columbia, MO.
- Curry, D. and D. Rademacher. 1998. 1998 annual crop report. San Joaquin County Agric. Comm., Stockton, CA.
- Dawson, W. L. 1923. The birds of California. South Moulton Co., San Diego, Los Angeles, San Francisco, CA.
- Drewien, R. C. and J. C. Lewis. 1987. Status and distribution of cranes in North America. Pages 469-477 in *Proc. 1983 Int. Crane Workshop* (G. W. Archibald and R. F. Pasquier, eds). Dist. by Int. Crane Foundation, Baraboo, WI.
- Drewien, R. C., W. M. Brown, and D. S. Benning. 1996. Distribution and abundance of sandhill cranes in Mexico. *J. Wildl. Manage.* 60: 270-285.
- Ellis, D. H., G. F. Gee, and C. M. Mirande. 1996. Cranes: their biology, husbandry, and conservation. Hancock House Publishers, Blaine, WA.
- Gabrielson, I. N. and S. G. Jewett. 1940. Birds of Oregon. Oregon State Coll., Corvallis, OR.
- Gilmer, D. S., M. R. Miller, R. D. Bauer, and J. R. LeDonne. 1982. California's Central Valley wintering waterfowl: concerns and challenges. *Trans. No. Amer. Wildl. Nat. Res. Conf.* 47: 441-452.
- Gruson, E. S. 1972. Words for birds. Quadrangle Books, Inc., New York, NY.
- Heerman, A. L. 1853. Report upon birds collected on the survey. Part 4, Number 2, pages 29-80 in Report on explorations in California for railroad routes. Pub. with Vol. 10 U. S. Pacific R.R. Survey, Wash. D. C.
- Heitmeyer, M. E., D. P. Connelly, and R. L. Pederson. 1989. The Central, Imperial, and Coachella valleys of California. Pages 475-506 in *Habitat management for migrating and wintering waterfowl in North America* (L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds). Texas Tech. Univ. Press, Lubbock, TX.
- Herziger, C. P. and G. L. Ivey. 1999. Progress report: Status and distribution of breeding Greater Sandhill Cranes in Oregon, 1999 results. Ducks Unlimited, Inc., Ranch Cordova, CA.

- Herziger, C. P. and G. L. Ivey. In prep. Important fall staging areas for Greater Sandhill Cranes in Washington, Oregon and northern California.
- Krapu, G. L., D. E. Facey, E. K. Fritzell, and D. H. Johnson. 1984. Habitat use by migrant sandhill cranes in Nebraska. *J. Wildl. Manage.* 48: 407-417.
- Lewis, J. C. 1976. Roost habitat and roosting behavior of sandhill cranes. Pp. 93-104 *in Proc. Int. Crane Workshop* (J. C. Lewis, ed.). Oklahoma State Univ. Pub. and Print. Stillwater, OK.
- Littlefield, C. D. 1986. Autumn sandhill crane habitat use in southeast Oregon. *Wilson Bull.* 98: 131-137.
- Littlefield, C. D. 1993a. Greater Sandhill Crane assessment in the Upper Butte Basin, California 1991-1993. California Dept. of Fish and Game, Rancho Cordova, CA.
- Littlefield, C. D. 1993b. Annual assessment and monitoring report for Greater Sandhill Cranes and other threatened and endangered species on the Little Dry Creek Unit, California. California Dept. of Fish and Game, Rancho Cordova, CA.
- Littlefield, C. D. 1995. Demographics of a declining flock of Greater Sandhill Cranes in Oregon. *Wilson Bull.* 107: 667-674
- Littlefield C. D. 1999. The coastal segment of the Pacific Flyway Population of Lesser Sandhill Cranes (*Grus canadensis canadensis*). Perkins Coie, LLP, Seattle, WA.
- Littlefield, C. D. and S. P. Thompson. 1979. Distribution and status of the Central Valley Population of Greater Sandhill Cranes. Pp. 113-120 *in Proc. 1978 Crane Workshop* (J. C. Lewis, ed.). Colorado State Univ. Printing Service, Fort Collins, CO.
- Lovvorn, J. R. and C. M. Kirkpatrick. 1981. Roosting behavior and habitat of migrant Greater Sandhill Cranes. *J. Wildl. Manage.* 45: 842-857.
- Newberry, J. S. 1857. Report upon birds. Pp. 73-110 *in Reports of explorations and surveys for a railroad from the Mississippi River to the Pacific Ocean.* Vol. 6, Pt. 4, No. 2, Chapt. 2, Wash. D. C.
- Oberholser, H. C. 1918. Third annual list of proposed changes in the A. O. U. Check-list of North American Birds. *Auk* 35: 200-217.
- Oberholser, H. C. 1921. Notes on North American birds. *Auk* 38: 79-82.
- Peters, J. L. 1925. Notes on the taxonomy of *Ardea canadensis* Linné. *Auk* 42: 120-122.
- Pogson, T. H. 1985. Letter to L. Frank Goodson dated 10 June 1985. Cosumnes River Preserve files. Cosumnes River Preserve, Galt, CA.

- Pogson, T. H. 1990. Distribution, abundance, and behavior of Greater Sandhill Cranes, *Grus canadensis tabida*, wintering in California's Central Valley. M. S. Thesis, Univ. of Alaska, Fairbanks, AK.
- Pogson, T. H. and S. M. Lindstedt. 1991. Distribution and abundance of large sandhill cranes, *Grus canadensis*, wintering in California's Central Valley. *Condor* 93: 266-278.
- Reinecke, K. J. and G. L. Krapu. 1986. Feeding ecology of sandhill cranes during spring migration in Nebraska. *J. Wildl. Manage.* 50: 71-79.
- Ridgway, R. 1941. The birds of North and Middle America. Part IX, U. S. Nat. Hist. Mus. Bull. 50, Wash., D. C.
- Rude, L. 1989. Sunrise over Cosumnes. *Ducks Unlimited March-April*: 50-57.
- Taylor, J. P. 1999. A Plan for the Management of waterfowl, sandhill cranes, and other migratory birds in the Middle Rio Grande Valley of New Mexico. Unpublished report. Bosque del Apache National Wildlife Refuge, Socorro, NM.
- Walkinshaw, L. H. 1949. The sandhill cranes. *Cranbrook Institute of Science Bull.* 29, Bloomfield Hills, MI.
- Walkinshaw, L. H. 1965. A new sandhill crane from central Canada. *Can. Field-Nat.* 79: 181-184.
- Worthen, M. and W. J. Gritz. 1991. 1991 annual crop report. San Joaquin County Agric. Comm., Stockton, CA.