WINTER FORAGING HABITAT OF GREATER SANDHILL CRANES IN NORTHERN CALIFORNIA

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ABSTRACT: In the upper Butte basin (Butte, Colusa, Glenn, and Sutter counties) of California's Sacramento Valley, wintering Greater Sandhill Cranes select unaltered harvested rice stubble most consistently for foraging. They feed in burned and flooded rice stubble for brief periods; their use of such fields decreases dramatically by January and remains low thereafter. Few cranes forage in rice stubble disked in autumn. Recently planted winter wheat attracts large numbers of cranes from the time of planting until shortly after seedling emergence but not after early January. Disked corn stubble is used sporadically, primarily in late January and February just before cranes migrate in spring. Grazed grasslands also support cranes, mostly after the onset of winter rains. Foraging habitat for cranes in the basin is currently ample, but continuing changes in agricultural practices may result in future food shortages.

The Central Valley population is the westernmost of the five recognized populations of the Greater Sandhill Crane (*Grus canadensis tabida*) (Drewien and Lewis 1987). Birds affiliated with the Central Valley population breed from central interior British Columbia south to northeastern California and winter in California's Central Valley from near Chico, Butte County, southeast to near Delano, Tulare County (Littlefield and Thompson 1979). Cranes were studied in the valley for several winters from 1969 to 1987 (Littlefield and Thompson 1979, 1981, Pogson 1990, Pogson and Lindstedt 1991), but these studies focused primarily on the cranes' distribution, abundance, behavior, and subspecific composition. Few data were collected on winter crane foraging in relation to agriculture. To address this information gap, I studied cranes in the rice-growing region of the upper Butte basin in the northern Central Valley during the winters of 1991–92 and 1992–93. About 6000 Greater Sandhill Cranes wintered there, foraging primarily on agricultural lands while roosting and loafing on nearby wetlands; wetlands were usually on private hunting clubs, state wildlife areas, and the Llano Seco Unit of the Sacramento River National Wildlife Refuge, Butte County (Littlefield 1993).

Sandhill Cranes are omnivores, consuming invertebrates, amphibians, reptiles, small mammals and birds, eggs, and a variety of plant parts (Walkinshaw 1973); waste grains and other seeds are dominant foods in autumn and winter. Waste grains reportedly consumed include milo, wheat, corn (Walkinshaw 1973), rice (Guthery 1972), barley (Drewien and Bizeau 1974), and oats (Madsen 1967). All of these crops were grown in the upper Butte basin, but, in hectares planted, rice far exceeded all others. For example, of 33,908 ha planted to grains in Butte County in 1991, rice accounted for 84.5%, winter wheat 11.7%, barley 2.3%, and corn 1.1% (Butte County Agricultural Crop Report 1992); only two to three small plots of milo and one of oats were known planted. The large amount of rice attracted and supported the majority of wintering cranes; however, their use depended on the status of rice stubble. In this study I assessed the cranes' foraging preferences in the context of agricultural practices. My two principal objectives were to inventory crane numbers in the various foraging

habitats and to assess crane foraging preference or avoidance for specific habitats in relation to farming activities or other land-use regimes.

STUDY AREA AND METHODS

The study area extended from 6.4 km south of Chico south to the Sutter Buttes (39° 10′N, 121° 44′W), east to Highway 99, west to the Sacramento River. Cranes primarily foraged on level terrain with fertile soils, interspersed with rivers and drainage basins. Much of the area was in agricultural production; grains, alfalfa, and beans were important crops, with various orchard types in peripheral zones. Most cranes were found in the western one third of Butte County, with additional birds in northern Sutter, northeastern Colusa, and southeastern Glenn counties. On the basis of weekly mean numbers at roost sites in the winter of 1991–92, 76.6% of the cranes were in Butte, 13.7% in Sutter, and 9.7% in Colusa County, whereas in 1992-93, 79.1% were in Butte, 12.1% in Colusa, and 8.8% in Sutter County. Though few cranes roosted in Glenn County, some birds that roosted in Butte County frequently fed there.

The upper Butte basin is the northernmost region of traditional Sandhill Crane wintering in North America. The climate is Mediterranean, with cool, wet winters and hot, dry summers. Mean January temperature is 5° C (coolest month), whereas the July mean is 23° C (warmest month); fewer than 15 nights each year have temperatures below freezing (Heitmeyer et al. 1989). At Gridley, Butte County, mean annual rainfall is 513 mm (1923–1992), with most of this from November through February (Butte County Joint Water District unpubl. data). Excessive runoff from local rainfall or melting Sierra Nevada snow frequently results in lowland flooding, especially adjacent to the Sacramento River and Butte Creek. During this study, flooding was frequent in 1992–93, only minor and brief in 1991–92.

I recorded crane numbers and foraging habitats for all birds clearly viewed. Most observations were from a vehicle, through 7 × 35 binoculars or a 20× window-mounted spotting scope, but during or shortly after rain I assessed a few sites on foot. Generally I avoided this unless concealing vegetation was sufficient. Cranes are wary of people walking and frequently flew when approached within ca. 400 m; a vehicle usually did not elicit a similar response. I sometimes located foraging areas by observing or following cranes leaving roosting sites in the morning or loafing sites in the afternoon. I located most, however, by driving and scanning from public roads during morning or late afternoon when cranes were feeding. Once located, birds were counted individually, and crop type and land-use regime were recorded. Data collection was nonrandomized because of the road network and in some areas inaccessibility, thus habitat use is expressed as percentage of use (cf. Montgomery 1997). Periods of study were 30 November 1991–26 February 1992 and 18 October 1992–17 February 1993.

To assess the cranes' foraging-habitat preferences and seasonal habitat changes, I censused them weekly along a nonrandomized 77-km transect (Sutter Buttes to Nelson, Butte County) through their major use area between 23 October 1992 and 15 February 1993. I conducted 18 surveys, nine in autumn (23 October–18 December) and nine in winter (25 Decem-

ber–15 February). Agricultural types and land-use practices were recorded on both sides of the transect route at points every 0.8 km, for a total of 186 habitat-data points per census (Table 1). I conducted all censuses between 0730 and 1030 PST, with most beginning about 0745 and ending before 1000. Land-use changes along the transect were frequent in autumn, as farmers burned, flooded, plowed, or planted fields. Thus, for cranes within 1.2 km of the transect route, I calculated foraging habitat-preference indices (HPIs) weekly as percent use/percent habitat availability. Percent use was the number of cranes recorded in a specific habitat type divided by the total number of cranes tallied per census × 100; percent availability was the occurrence of a specific habitat type at data points divided by 186 data points × 100. A HPI of 1 suggests cranes were using a specific habitat type in proportion to its availability; a HPI >1 suggests use higher than expected, whereas a value <1 suggests avoidance (Hoffman 1976).

RESULTS

Seasonal Agricultural Changes

On weekly surveys along the 77-km transect route in 1992–93, as well as throughout the upper Butte basin, farming activity frequently caused habitat changes, particularly in November and December (Littlefield 1993). This was most evident for harvested rice fields, as unaltered stubble decreased from 82% on 23 October to 43% on 19 December. Alterations included stubble disking (plowing), burning, flooding, or combinations of the three (Table 2). Residual wheat stubble decreased from 100% on 30 October to 20% by 18 December; 80% of the wheat fields had been replanted by late December. Most corn stubble was disked before surveys were initiated; two corn fields were later planted with winter wheat. Cropland alteration had mostly stabilized by January. The study began too late in 1991–92 to document habitat changes, but autumn farming activities appeared similar to

Table 1 Land Uses along a 77-km Transect in the Upper Butte Basin, California, 1992–93

Land use	No. points surveyed	Percentage
Rice	77	41.4
Fallow	28	15.1
Plowed	21	11.3
Grassland	15	8.1
Orchard	13	7.0
Alfalfa	11	5.9
Marsh	9	4.8
Wheat	6	3.2
Corn	6	3.2
Total	186	100.0

Table 2 Numbers, Percentage, and Percent Change from Farming Practices in Rice-Stubble Fields at Points Surveyed in the Upper Butte Basin, Autumn 1992

Farming practice	23 October 1992	18 December 1992	Change
Unaltered	63 (82%)	33 (43%)	–39%
Burned	8 (10%)	13 (17%)	+7%
Plowed	6 (8%)	14 (18%)	+10%
Flooded	—	4 (5%)	+5%
Burned and flooded	—	5 (7%)	+7%
Burned and plowed	—	5 (7%)	+7%
Plowed and flooded	—	3 (4%)	+4%
Total	77 (100%)	77 (100%)	

those recorded in 1992–93. Several habitats (e.g., alfalfa, marsh, grassland, orchard) remained unchanged in both winters.

Habitat Use

Of the nearly 70,000 habitat use-days recorded in the study, 33,870 were in the winter of 1991–92 (Table 3) and 36,201 in 1992–93 (Table 4). Harvested rice was the most frequently used habitat; 58% (n = 19,757 use-days) in 1991–92 and 72% (n = 25,953) in 1992-93. Farming practices

Table 3 Sandhill Cranes Counted per Month by Habitat in the Upper Butte Basin, 1991–1992

Habitat and status	December	January	February	Total
Rice stubble				
unaltered	2727 (18.0%)	4789 (46.5%)	2075 (26.6%)	9591 (28.3%)
burned	2516 (16.6%)	767 (7.5%)	932 (11.0%)	4215 (12.4%)
flooded	1564 (10.3%)	294 (2.7%)	107 (1.3%)	1965 (5.8%)
plowed	710 (4.7%)	259 (2.5%)	311 (3.7%)	1280 (3.8%)
burned + flooded	2271 (15.0%)	87 (0.9%)	3 (< 0.1%)	2361 (7.0%)
burned + plowed	278 (1.8%)	—	—	278 (0.8%)
plowed + flooded	47 (0.3%)	6 (0.1%)	14 (0.2%)	67 (0.2%)
Winter wheat	4528 (29.9%)	287 (2.8%)	228 (2.7%)	5043 (14.9%)
Unharvested corn	—	1795 (17.4%)	2177 (25.8%)	3972 (11.7%)
Plowed corn stubble	52 (0.3%)	862 (8.4%)	1213 (14.4%)	2127 (6.3%)
Fallow	264 (1.7%)	799 (7.8%)	822 (9.7%)	1885 (5.6%)
Grassland	179 (1.2%)	350 (3.4%)	300 (3.6%)	829 (2.5%)
Marsh	—	—	197 (2.3%)	197 (0.6%)
Alfalfa	—	—	60 (0.7%)	60 (0.2%)
Total	15,136 (44.7%)	10,295 (30.4%)	8439 (24.9%)	33,870 (100.0%)

Table 4 Sandhill Cranes Counted per Season by Habitat in the Upper Butte Basin, 1992–1993

Habitat and status	Autumn[b]	Winter[c]	Total
Rice stubble			
unaltered	7941 (37.9%)	9659 (63.4%)	17,600 (48.6%)
flooded	5343 (25.5%)	117 (0.8%)	5460 (15.1%)
burned	2035 (9.7%)	351 (2.3%)	2386 (6.6%)
plowed	15 (<0.1%)	190 (1.3%)	205 (0.6%)
burned + flooded	214 (1.0%)	—	214 (0.6%)
plowed + flooded	88 (0.4%)	—	88 (0.2%)
Wheat			
planted	2680 (12.8%)	1249 (8.2%)	3929 (10.9%)
stubble	511 (2.4%)	32 (0.2%)	543 (1.5%)
plowed stubble	106 (0.5%)	—	106 (0.3%)
Plowed corn stubble	694 (3.3%)	1990 (13.1%)	2684 (7.4%)
Grassland	998 (4.8%)	695 (4.6%)	1693 (4.7%)
Alfalfa	34 (0.2%)	324 (2.1%)	358 (1.0%)
Fallow	39 (0.2%)	304 (2.0%)	343 (1.0%)
Plowed fallow	—	197 (1.3%)	197 (0.5%)
Plowed (bare)	128 (0.6%)	37 (0.2%)	165 (0.5%)
Milo	138 (0.7%)	—	138 (0.4%)
Bean	—	77 (0.5%)	77 (0.2%)
Pasture	—	12 (< 0.1%)	12 (<0.1%)
Valley Oak	—	3 (<0.1%)	3 (<0.1%)
Total	20,964 (57.9%)	15,237 (42.1%)	36,201 (100.0%)

[a]Excludes cranes using unharvested corn in Butte County.

[b]18 October–17 December.

[c]18 December–17 February.

frequently influenced the number of cranes using a particular field. Unaltered stubble generally attracted more cranes, especially after the third week of December; 49% of all birds in rice in 1991–92 and 68% in 1992–93. Of the three methods of alteration, disking was the least preferred by cranes, and for both winters combined the cranes accrued only 1485 habitat use-days in plowed fields. On the other hand, both burning and flooding usually resulted in intensive short-term foraging, but cranes generally abandoned these sites soon after stubble was burned, or particularly after a site became flooded. By late December few cranes were foraging in burned or flooded harvested rice fields.

For about 2 to 3 weeks, generally in November and December, recently planted winter wheat was an important but temporary localized food source. In December 1991, 29.9% of the total use was in wheat, but in January and February this figure declined to only 2.8% and 2.7%, respectively (Table 3). Harvested disked corn was third in importance in both winters. Few cranes were noted using corn in November and December, but beginning in January waste corn consumption increased. Birds continued to feed on corn

until they migrated in February. Also, a flooded unharvested 15-ha corn plot on a state wildlife area in Butte County was used daily between 8 January and 25 February 1992 by a mean of 493 cranes (range 398–599). In addition to croplands, cranes fed on Rancho Llano Seco grasslands (ca. 16 km SW of Chico) during and after rain. These cattle-grazed ranges had cranes more frequently in the wetter winter of 1992–93 (1692 use-days) than in the drier winter of 1991–92 (829 use-days).

Cranes generally used the same habitat types in both winters, but there were exceptions. For example, more cranes were found in alfalfa in 1993 (e.g., 262 on 9 February), 77 used a harvested Colusa County bean field in January 1993, and three spent several consecutive days feeding beneath a large Valley Oak (*Quercus lobata*) in Sutter County in February 1993, apparently consuming acorns. However, in both winters, grazed grasslands, harvested rice, recently planted winter wheat, and disked corn stubble provided the majority of crane foraging habitat.

Foraging-Habitat Preferences

Of the 36,201 total crane habitat use-days tallied in 1992–93, 14,678 (40.6%) were along the 77-km transect survey route and were used to calculate weekly HPIs. Of those along the transect, 7207 were in autumn, 7471 in winter. The mean count on the nine autumn censuses was 801, standard deviation (SD) 385, range 312–1596, whereas the mean for the nine winter censuses was 827, SD 317, range 457–1498; the mean for all counts was 815 (SD 342). As throughout the upper Butte basin, unaltered harvested rice stubble was the habitat used most consistently, but burned and flooded rice stubble, recently planted winter wheat, disked corn stubble, and cattle-grazed grasslands were also important; however, crane foraging in these habitats was inconsistent. The HPI in unaltered and burned rice stubble was generally high in autumn (Table 5), but unaltered rice stubble was the principal foraging habitat in winter (Table 6). Flooded harvested rice had a higher-than-expected proportion of foraging cranes between 4 and 13 November 1992 (HPI 5.87), after which its rating dropped precipitously. The HPI for burned rice stubble that was subsequently flooded also demonstrated a similar but brief crane-foraging response. Rice stubble disked shortly after harvest was strongly avoided, reaching its highest HPI of only 0.16 in February; however, a figure of 20.4 (Table 5) was recorded from one disked field being flooded on 13 November 1992. After 13 November, however, no cranes were noted there. Though rice was the most consistently used crop overall, the highest rating for any habitat type was on newly planted winter wheat on 19 (HPI 51.36) and 26 November (HPI 33.36), but this type was little used after early January.

DISCUSSION

The upper Butte basin frequently supports up to 70% of the Central Valley crane population in winter, and it is also an important stopover for cranes migrating to or from wintering regions further south (Pogson and Lindstedt 1991). My study implies that waste rice in harvested fields is these cranes' most important food. Though other agricultural types (particularly recently

Table 5 Weekly Habitat-Preference Indices[a] for Sandhill Cranes along a 77-km Transect through the Upper Butte Basin, 23 October–18 December 1992

Habitat	23 Oct	30 Oct	4 Nov	13 Nov	19 Nov	26 Nov	4 Dec	11 Dec	18 Dec
Rice stubble									
unaltered	1.05	2.22	2.27	0.79	1.02	0.25	0.56	2.36	2.57
burned	1.23	5.44	2.77	5.32	2.51	0.61	5.34	3.91	1.28
flooded	—	—	1.43	5.87	0.18	—	—	—	—
plowed	—	—	—	—	0.09	—	—	—	—
burned + flooded	—	—	—	—	—	—	9.63	—	0.78
plowed + flooded	—	—	—	20.40	—	0.55	1.25	—	—
Wheat									
stubble	13.61	—	—	—	—	—	—	—	—
planted	—	—	—	—	51.36	33.36	13.09	—	11.56
Corn (plowed)	—	—	2.03	6.97	—	10.31	—	—	3.19
Plowed (bare)	1.42	—	—	0.03	—	—	—	—	—
Grassland	—	—	0.78	0.21	0.04	2.54	1.49	3.83	1.85
Alfalfa	0.80	0.22	—	—	—	—	—	—	—
No. cranes	643	312	523	596	630	1596	896	852	1157

[a]Percent use/percent availability.

planted winter wheat and disked corn stubble) were used sporadically in localized areas, waste rice was consumed consistently from October through February. Alteration of stubble, however, commonly reduced the quantity of rice available to cranes. Disking shortly after harvest was highly detrimental, and as a consequence birds generally shunned plowed fields. Burning of rice stubble usually resulted in intensive short-term use, but burned fields regularly attracted large numbers of geese, ducks, and blackbirds that rapidly depleted the food. Furthermore, Miller et al. (1989) found that burned stubble contains on average 276 kg/ha of waste rice, 30% less than the 388 kg/ha in unburned fields. Cranes were also attracted to rice stubble as it was being flooded but generally avoided fields once waste grains were inundated. Thus cranes, unlike geese and ducks, appear highly inefficient at locating submerged seeds.

Cranes foraged heavily in winter wheat at times. Harvested fields were used briefly in late October, but once wheat planting commenced use of stubble generally ceased. Cranes fed on new wheat from planting until shortly after emergence; once seedlings grew to about 5 cm use decreased. Hoffman (1976) noted a similar response in Michigan, with cranes usually avoiding fields when seedlings reach heights of 5–10 cm. Disked corn stubble also attracted cranes at times, but corn was limited on the study area. Disked corn was preferred, and no cranes were noted in standing stubble, but most fields had been plowed before surveys were initiated in late October. In contrast, in Indiana Lovvorn and Kirkpatrick (1982) found that cranes avoid plowed corn stubble in autumn, preferring instead stubble that had not been altered. Except for rice, wheat, and corn, cranes rarely used other crops in the upper Butte basin but did frequent cattle-grazed grasslands

Table 6 Weekly Habitat-Preference Indices[a] for Sandhill Cranes along a 77-km Transect through the Upper Butte Basin, 25 December 1992–15 February 1993

Habitat	25 Dec	31 Dec	7 Jan	14 Jan	21 Jan	28 Jan	3 Feb	8 Feb	15 Feb
Rice stubble									
unaltered	1.61	3.09	2.34	5.13	3.77	5.37	5.00	2.31	3.15
burned	0.21	2.13	0.84	0.61	0.64	0.03	0.61	-	0.04
flooded	—	—	—	—	0.59	—	—	—	—
plowed	—	—	—	0.08	—	—	0.15	1.16	0.18
Wheat (planted)	12.01	1.09	12.41	—	—	—	—	—	0.27
Corn (plowed)	15.05	—	—	0.18	—	—	3.46	2.64	18.86
Plowed (bare)	—	—	—	0.14	—	—	—	—	—
Grassland	1.26	3.46	2.61	0.53	3.58	0.91	0.10	1.62	—
Alfalfa	—	—	0.92	—	—	—	—	6.46	—
Fallow	0.01	—	—	0.94	—	—	—	0.14	0.16
No. cranes	859	457	579	1438	507	860	1136	687	948

[a]Percent use/percent availability.

during and after periods of rain. These grasslands were perhaps an important source for macroinvertebrates, providing essential proteins, calcium, and other nutrients generally not found in grains (Reinecke and Krapu 1986).

Sandhill Cranes have had a long history in the upper Butte basin, with the earliest account dating to 1828 (McGowan 1961), but historical crane foraging habitats were not documented. Perhaps acorns were an important pre-agriculture food; acorns have been reported in the diets of Sandhill Cranes elsewhere (Walkinshaw 1953, Guthery 1972). Substantial forests of Valley Oak once bordered most northern California rivers and sinks, and until 1849 these forests were virtually unaltered by people (Thompson 1980). Only scattered remnants of these once extensive woodlands currently persist. Before extensive European settlement, luxuriant grasses and forbs reportedly covered much of the upper Butte basin (Anderson 1992). Thus, before the 1850s, a mosaic of riparian systems, oak woodlands, grasses, and forbs likely created a diversity of high-quality habitat. By the 1860s, however, much of the original vegetation had been replaced with wheat, with rice introduced in 1912 (Willson 1979). Therefore, except during occasional droughts or floods, food has perhaps never been a limiting factor for cranes wintering in the upper Butte basin. However, changes in land use (e. g., conversion from grain crops to orchards and vineyards, and increased autumn disking, flooding, and burning of rice stubble) have eliminated or degraded the cranes' foraging habitat and will continue to do so. These changes, plus the spiraling costs of rice production and termination of government subsides to producers of rice and other grains, may result in food shortages for the cranes in the near future, at least in some portions of California's Central Valley.

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