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DISTRIBUTION AND ABUNDANCE OF SANDHILL CRANES WINTERING IN WESTERN TEXAS

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Western Texas is the major winter concentration area for most of the mid-continental population of sandhill cranes (Grus canadensis) (Lewis 1977, Buller 1979), and more than 50% of the 10-state and Canadian annual harvest occurs there (M. F. Sorenson, unpubl. rep., U.S. Fish Wildl. Serv., Laurel, Md., 1981). Data are lacking on total numbers of cranes wintering in the region, distributions, specific habitat requirements, movements, and environmental factors influencing these variables. Tacha and Vojs (1984) indicated the need for more precise information on population size to better determine the impact of hunting on sandhill cranes inhabiting mid-continental North America. Description and protection of key wintering habitats of sandhill cranes have been identified as priority management needs (Lewis 1977). To provide insight into these concerns, our objectives were to: (1) quantify the numbers and distribution of cranes wintering in the western Texas region; (2) identify key winter habitats; (3) identify environmental variables influencing the distribution and abundance of wintering cranes; and (4) describe regional movements in winter.

STUDY AREA AND METHODS

The study was conducted in a 40,000-km² area of the Southern High Plains region of western Texas containing pluvial basins (Fig. 1). The basins were geographically clustered about 35 km southwest and 45 km northwest of Lubbock, Texas. Annual precipitation averaged 43 cm; 75% fell between April and September (U.S. Dep. Commer., 1978–80). Elevation ranged from 1,000 to 1,500 m above sea level. Vegetation was characterized by shortgrass prairie.
invaded by mesquite (*Prosopis* sp.) and yucca (*Yucca* sp.). Milo and cotton farming were the principal land uses (Murfield et al. 1979a:49, 1979b:9).

Pluvial basins apparently were formed during historically wetter (pluvial) periods (e.g., Pleistocene) when pluvial streams cut through the Ogallala strata to form deep linear basins (Reeves 1966:275). Pluvial basins within the study area ranged from 0.13 to 8.6 km² (\( \bar{x} = 5.8, \) SE = 2.6) and were depressed about 10–30 m below the surrounding landscape. The semi-permanent to permanent water in the basins was supplied by precipitation runoff and freshwater springs located along the basin perimeter. Surface water in the lake basins is alkaline (pH > 7) and contains sodium sulfate salts or gypsum (Reeves 1966:271). Evaporation during dry periods forms broad expanses of crystallized salts. Low basin relief forms expansive areas of shallow water and mudflats.

Sandhill cranes roosted each night on some of the pluvial basins. Abundance was determined by counting cranes as they arrived at the roost in the evening or as they departed in the early morning. Coordinated counts on pluvial basins where cranes were known to roost were conducted weekly during January and February 1980 to determine total numbers of wintering cranes. Preliminary inspections to determine those lakes used by cranes were made in January and February 1979 and early January 1980. Weekly counts of cranes roosting on Mound and Rich lakes also were made during January and February 1979. Weekly counts during January and February 1979–81 were conducted at Muleshoe National Wildlife Refuge (NWR) and Buffalo Lake NWR by refuge personnel. Counts in Oklahoma and New Mexico were made by personnel of the respective state wildlife agencies.

Movements of individual cranes between roosts were determined using radiotelemetry (G. C. Iverson et al., unpubl. data) from transmitters attached to 10 birds captured at Rich Lake. Pluvial basins within 50 km of Rich Lake were monitored for the presence of radio-marked cranes each week during January and February 1980. Lower Paul’s Lake on Muleshoe NWR was monitored three times during February 1980. Additional regional movement data were obtained by following individual radio-marked cranes throughout the day and quantifying diurnal habitat use patterns (Iverson et al., unpubl. data).

Nineteen pluvial basins were visited within a 5-day period in February 1981 to determine: (1) the numbers of cranes present during morning or evening counts; (2) the number of flowing freshwater springs; (3) an estimate of the percentage of the basin covered by water (categories: 0%, 25%, or 50%); and (4) a percentage estimate of the surrounding land area in milo stubble. The total hectares of milo stubble within 0.8 km of county roads located 3–5 km and 11–13 km around each basin was recorded and...
expressed as a percentage of the total area along the two routes. An estimate of the basin area (km²) covered by water was determined by multiplying basin area (Reeves 1966) by the estimated percentage of water coverage of each basin.

RESULTS

An average of at least 363,000 sandhill cranes was present in western Texas during January and February 1980. The birds used nine of the pluvial basins we classified as night roosts (Table 1), but over 80% used Rich and Mound lakes near Brownfield, Texas, and Lower Paul’s Lake on Muleshoe NWR each night. A peak of 439,000 sandhill cranes was counted on 11 February 1980 during coordinated counts on nine pluvial lakes in western Texas and additional roosts in eastern New Mexico and western Oklahoma. As many as 33,000 sandhill cranes have been estimated to winter in the north-central highlands of Mexico, but these included cranes from both the mid-continent and Rocky Mountain populations (Buller 1982). An additional 25,000 (Guthery and Lewis 1979) to 60,000 cranes (R. R. George, pers. commun.) winter on the Gulf Coast of Texas and represent part of the Gulf Coast subpopulation of mid-continental sandhill cranes (Tacha et al. 1984).

The buildup of sandhill cranes in western Texas during winter continued on pluvial lakes until mid-February (Table 1). During the winters of 1978–80, the number of cranes using Lower Paul’s Lake increased significantly each year between January and mid-February (Cox and Stewart Test for Trend [Conover 1971:130], \( P < 0.06 \) for each year). There was also a significant, seasonal upward trend in numbers of cranes on Rich and Mound lakes during January and February 1979 and again in 1980 (Cox and Stewart Test for Trend, \( P < 0.01 \) both years). Major migration from the study area began in late February (Table 1).

Cranes returning to pluvial lake roosts in early evening typically landed at freshwater springs to drink, then walked to the center of the lake where they roosted for the night. Cranes were not observed to drink water from the lake basin. The birds generally roosted in shallow water to a maximum depth of about 40 cm (up to the feathered portion of the tibiotarsus) and on exposed mudflats adjoining the water.

Pluvial lakes were the only habitat type used by cranes for roosting, but not all pluvial basins were used. Cranes did not roost on pluvial basins lacking both basin water and freshwater springs (\( N = 6 \)) nor on basins with only one spring and no basin water (\( N = 4 \)). The quantity of surface water available (0–2.3 km²) in a basin was associated (\( r = 0.62, df = 18, P < 0.001 \)) with the number of cranes roosting on the lake. More cranes were counted on lakes having greater amounts of surface water (Table 2). The highly alkaline surface water in pluvial basins did not freeze and provided roosting habitat for cranes throughout the winter.

The availabilities of food and drinking water were positively associated with the number of cranes using a basin. Numbers of roosting cranes increased (\( r = 0.81, df = 18, P < 0.001 \)) as the number of freshwater springs bordering a basin increased from 0–8. There was no association (\( r = 0.39, df = 18, P > 0.15 \)) between hectares of milo stubble available and number of cranes

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**Table 1. Numbers of sandhill cranes observed during coordinated counts at selected pluvial lakes during January and February 1980 in western Texas. Blanks indicate no counts conducted.**

<table>
<thead>
<tr>
<th>Pluvial lake</th>
<th>Jan 14</th>
<th>Jan 21</th>
<th>Jan 28</th>
<th>Feb 4</th>
<th>Feb 11</th>
<th>Feb 20</th>
<th>Feb 25</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Paul’s</td>
<td>120,000</td>
<td>115,000</td>
<td>187,000</td>
<td>182,000</td>
<td>204,000</td>
<td>196,000</td>
<td>145,000</td>
<td>164,000</td>
</tr>
<tr>
<td>Mound</td>
<td>32,000</td>
<td>66,700</td>
<td>50,000</td>
<td>112,000</td>
<td>110,000</td>
<td>90,000</td>
<td>147,000</td>
<td>87,000</td>
</tr>
<tr>
<td>Rich</td>
<td>35,000</td>
<td>8,000</td>
<td>8,000</td>
<td>14,000</td>
<td>41,000</td>
<td>28,000</td>
<td>35,000</td>
<td>24,000</td>
</tr>
<tr>
<td>Skeen</td>
<td></td>
<td></td>
<td></td>
<td>26,000</td>
<td>28,000</td>
<td>15,500</td>
<td>28,000</td>
<td>23,000</td>
</tr>
<tr>
<td>Buffalo*</td>
<td>13,500</td>
<td>28,500</td>
<td>18,500</td>
<td>18,000</td>
<td>16,000</td>
<td>14,000</td>
<td>13,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Bull</td>
<td>28,000</td>
<td>18,000</td>
<td>12,000</td>
<td>10,000</td>
<td>8,000</td>
<td>5,000</td>
<td></td>
<td>3.6</td>
</tr>
<tr>
<td>Brownfield</td>
<td>14,500</td>
<td></td>
<td></td>
<td>26,000</td>
<td>10,000</td>
<td>10,000</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>15,500</td>
<td>20,000</td>
<td></td>
<td>7,000</td>
<td>12,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tahoka</td>
<td>33,000</td>
<td>18,000</td>
<td>6,000</td>
<td></td>
<td></td>
<td>4,000</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Totals</td>
<td>261,500</td>
<td>267,700</td>
<td>316,000</td>
<td>373,000</td>
<td>427,800*</td>
<td>352,400</td>
<td>357,000</td>
<td>363,000</td>
</tr>
</tbody>
</table>

*a Buffalo Lake on Buffalo Lake NWR is a freshwater reservoir.

b An additional 7,700 cranes were counted in eastern New Mexico and 4,400 were counted in Oklahoma to increase the total to 459,900.
present on a basin among all basins studied. However, among these basins having at least one freshwater spring, the number of cranes roosting on the basin increased (r = 0.65, df = 12, P < 0.025) as the amount of available milo stubble (range 0.2–12.7% of the land area) around the basin increased. A simple linear regression analysis using the interaction of number of springs and available milo stubble explained over 96% of the variation (df = 18, P < 0.001) in the number of cranes observed on the 19 pluvial basins studied.

Cranes responded each year to the quality of habitat on each basin. For example, Buffalo Lake was used by an average of 19,000 cranes in 1980 (Table 1). However, the lake was drained the following year (A. Jones, pers. commun.) and was not used by cranes during 1981. Conversely, Baileyboro was used by cranes in 1981 but not during the winter of 1980, probably due to the absence of basin water in 1980.

Radio-marked cranes roosted on two to four (x̄ = 3) individual pluvial lakes in the area southwest of Lubbock during January and February 1980. The birds averaged 4.1 changes (range one to nine) of roost location during the same period. Radio-marked cranes remained in the study area an average of 43 days (range 14–59) after radio attachment in early January 1980. Their movements were greatest during January when cranes were dispersing from Rich Lake following banding. Comparatively fewer movements between roost sites were recorded in February prior to migration when most birds were located on the same or nearby (within 9–11 km) lake throughout February. Mound, Rich, and Tahoka were the principal lakes used by radio-marked cranes in the area southwest of Lubbock.

<table>
<thead>
<tr>
<th>Basin</th>
<th>N springs</th>
<th>% Milo</th>
<th>Basin area (km²)</th>
<th>Surface water (km²)</th>
<th>N cranes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Paul’s</td>
<td>8</td>
<td>15.7</td>
<td>3.4</td>
<td>1.70</td>
<td>187,000</td>
</tr>
<tr>
<td>Mound</td>
<td>4</td>
<td>2.5</td>
<td>4.5</td>
<td>2.25</td>
<td>20,000</td>
</tr>
<tr>
<td>Rich</td>
<td>5</td>
<td>2.5</td>
<td>2.1</td>
<td>1.05</td>
<td>21,000</td>
</tr>
<tr>
<td>Bull</td>
<td>4</td>
<td>6.8</td>
<td>2.5</td>
<td>0.58</td>
<td>20,000</td>
</tr>
<tr>
<td>Baileyboro</td>
<td>2</td>
<td>13.7</td>
<td>0.8</td>
<td>0.20</td>
<td>16,000</td>
</tr>
<tr>
<td>Brownfield</td>
<td>1</td>
<td>0.5</td>
<td>0.8</td>
<td>0.20</td>
<td>2,000</td>
</tr>
<tr>
<td>Silver</td>
<td>2</td>
<td>7.1</td>
<td>0.7</td>
<td>0.18</td>
<td>6,000</td>
</tr>
<tr>
<td>Tahoka</td>
<td>2</td>
<td>0.2</td>
<td>1.7</td>
<td>0.43</td>
<td>1,000</td>
</tr>
<tr>
<td>Skeen</td>
<td>2</td>
<td>0.2</td>
<td>0.5</td>
<td>0.13</td>
<td>1,000</td>
</tr>
</tbody>
</table>

### MANAGEMENT IMPLICATIONS

Sandhill cranes concentrated on a limited number of highly saline pluvial lakes in western Texas during winter. A peak of 427,000 cranes was counted on nine lakes in mid-February 1980. This peak was the highest recorded for western Texas and exceeded previous published estimates of the entire mid-contintental population by almost 30% (Lewis 1977, 1979). This more recent population estimate is a valuable asset to sandhill crane harvest management (Tacha and Vols 1984). Total numbers of cranes wintering in the region increased from early January until the onset of spring migration in mid- to late February 1980. This buildup of wintering cranes may have resulted from an influx into the region by cranes wintering in Mexico (Buller 1982) and southwestern Texas and eastern and southern New Mexico (Lewis 1977).

The combination of saline pluvial lakes, fresh drinking water, and milo stubble represented the major elements affecting the distribution and abundance of sandhill cranes wintering in western Texas. The birds roosted nightly on pluvial lakes and departed in early morning for feeding and loafing in nearby milo and cotton stubble fields (Iverson et al., unpubl. data). Freshwater springs bordering pluvial basins provided essential drinking water in the semiarid region. Ephemeral playa lakes were unreliable as alternative sources of freshwater in 1980; only 1 of 94 monitored playas contained water (Iverson et al., unpubl. data). Annual rainfall during this study was above the 50-year average (U.S. Dep. Commer. 1930–80) indicating that playa lakes may be even less important in years of below-average rainfall. This further emphasizes the importance of the freshwater springs as a source of drinking water for wintering cranes. Milo was the primary food item consumed by cranes during winter (Iverson et al. 1982), and milo stubble abundance was a secondary factor that influenced selection and use of pluvial lake roost sites. The distribution and availability of milo stubble around Rich Lake strongly influenced the distribution and movements of cranes roosting on that lake (Iverson et al., unpubl. data). Knowledge of the interrelationship of these three essential environmental variables provides a valuable management tool and a basis for habitat manipulation to influence the distribution and abundance of wintering sandhill cranes.
Wintering concentrations of about 90% of mid-continental sandhill cranes roosting on nine lakes in western Texas (over 80% on three lakes) poses a threat to the welfare of the population. Potential disease outbreaks or other natural disasters such as hail storms (Hefebower and Klett 1980) associated with large concentrations of cranes should preclude any greater concentrations on these lakes, especially Lower Paul's Lake where over 200,000 cranes congregate. The first outbreak of fowl cholera in waterfowl in the U.S. occurred on Muleshoe NWR (Quortrup et al. 1946), and recurring periodic winter outbreaks have continued since (Rosen 1971). Sandhill crane mortality attributed to avian cholera has been documented (Rosen 1972, Wobeser and Brand 1982). During the winter of 1979, 15 cranes were found dead on Lower Paul's Lake following a confirmed cholera outbreak among wintering waterfowl (A. Jones, pers. commun.). The susceptibility of large concentrations of cranes in the Platte River Valley to fowl cholera has been discussed (Krapu and Pearson 1982). Dispersal of large concentrations of cranes from selected pluvial lake roosts in western Texas by manipulation of roost water, fresh drinking water, or milo stubble availability may become desirable.

Suitable pluvial lake roosts, freshwater springs bordering the pluvial lakes used for roosts, and milo stubble were available to cranes on a combination of public (Muleshoe NWR) and private lands in western Texas. However, Lower Paul’s Lake, as the only major pluvial lake roost currently protected and managed by a public natural resource agency, cannot and should not become the single focal point for the more than 400,000 wintering sandhill cranes. Since pluvial lakes appear to be critical habitat for a majority of the mid-continental population of sandhill cranes wintering in western Texas, easements to protect lakes used by large numbers of cranes (e.g., Mound and Rich) are minimally desirable to prevent adverse habitat alterations. Modifications that eliminate large expanses of shallow water or mudflats, disrupt freshwater flows, or change water salinity and thereby affect the freezing point may discourage continued use by cranes. Evidence indicates that the pluvial lakes constitute a scarce natural resource critical as wintering habitat for sandhill cranes and thereby deserve greater public protection.

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LITERATURE CITED


ROSEN, M. R. 1971. Avian cholera. Pages 59–74 in
THE EFFECTS OF FOREST MANAGEMENT ON CAVITY-NESTING BIRDS IN NORTHWESTERN WASHINGTON

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Abstract: Population characteristics and nest-site preferences of 11 species of cavity-nesting birds were studied in the Olympic National Forest (ONF) of northwestern Washington in the spring and summer of 1979–80. We characterized breeding populations in four different forest successional stages where either high or low densities of snags occurred. Species richness (N = 13 vs. N = 9), densities (P < 0.01), and diversities (P < 0.01) of cavity-nesting birds increased with increasing snag densities. Active cavity-nests were five times more numerous on the 1980 plots (Snag Plots) than the 1979 plots (Clean Plots). Snag densities on the Snag Plots varied from 13.8/ha in a clear-cut to 97.1/ha in 25-50-year-old second-growth stand. Clean Plots contained from 0.5 snags/ha in a clear-cut to 37.3/ha in old-growth. Hairy woodpeckers (Picoides villosus), a primary cavity-nester, selected western hemlock (Tsuga heterophylla) snags for nest sites. In contrast, broken-topped Douglas-fir (Pseudotsuga menziesii) snags were preferred by secondary cavity-nesters. The average diameter at breast height (dbh) for active nest trees was substantially greater than the mean dbh for sampled snags in the ONF. Snags appear to be a limiting factor for breeding cavity-nesting bird populations. We discuss management recommendations for cavity-nesting birds in the ONF.

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The rapid harvesting of old-growth and shortening of harvest rotation cycles in the Pacific Northwest western hemlock–Douglas-fir forests disrupt avifauna. Several authors have shown that snag removal during intensive forest management is highly detrimental to cavity-nesting birds (Balda 1975, Thomas et al. 1976, Evans and Conner 1979, Short 1979). Snag removal eliminates nest and roost sites that are crucial for successful breeding and overwinter survival. Although specific nest-site character-

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