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Abstract: Migrant lesser sandhill cranes (*Grus canadensis canadensis*) were monitored during 1990-2000 in northwestern Texas as flocks were arriving in autumn and departing in spring; cranes were counted as they passed over an observation point 23 km north of Sudan, Lamb County, Texas. Mean flock size was 34.5 (SD ± 32.6) in autumn and 58.2 (SD ± 45.0) in spring. Most autumn migrants (69.6%) passed in the afternoon, whereas in spring 94% migrated in the morning (1000-1200 hr). Peak period of autumn passage was in October (65%), and in spring all observations were in February-March with the peak usually in late February. For arriving cranes headwinds had little influence, but 84% departed when winds were from the southwest. Retro-migration was recorded during both migration seasons; autumn retro-migration events appeared to be associated with human disturbance south and southwest of the study site, but in February and March it was associated with weather events to the north or northeast.

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In northwestern Texas the southern high plains generally support one of the world's largest concentrations of lesser sandhill cranes (*Grus canadensis canadensis*). From mid-October through February feeding crane flocks frequent new growth winter wheat, milo, and corn stubble, and occasionally cotton fields, whereas roost sites usually are in the shallow-water areas of large saline lakes or, dependent on water availability, in small freshwater playas (Iverson et al. 1985, Haley 1983). Cranes begin leaving the wintering area in early February and most fly north to a stopover point in the North Platte River Valley of western Nebraska (Iverson et al. 1987; Folk and Tacha 1990, 1991), then northwest to breeding areas in western Alaska and northeastern Siberia (Krapu et al., 2011).

Data on cranes in northwestern Texas have been collected for several decades, but no information has been documented on local migration chronology, flock sizes, or behavior as cranes are approaching or departing the wintering area. Elsewhere in the western United States, Stahlecker (1992) discussed autumn and spring crane migration along the Rio Grande River in northern New Mexico, and Littlefield (1992) autumn migration in southeastern Oregon. For the midwestern and eastern United States, Walkinshaw (1960), DeVore (1972), and Patterson (1978) reported on spring and autumn migrant flock sizes, whereas Williams (1970) and Nesbitt (1975) discussed spring departure for migrant sandhill cranes from Florida. All of these studies involved greater sandhill cranes (*G. c. tabida*); little or no information has been documented for lesser or Canadian sandhill cranes (*G. c. rowani*). My objectives here are: 1) to summarize lesser sandhill crane migration in northwestern Texas and 2) provide information on migration behavior as cranes approached or departed northwestern Texas wintering grounds during the period 1990-2000.

METHODS

My study site was 48 km north-northeast of Muleshoe National Wildlife Refuge (MNWR), Bailey County, Texas (33°57′N, 102°47′W), or 43 km north of Bull Lake, Lamb County, Texas (33°55′N, 102°29′W); one or both of these areas are frequently important crane wintering sites depending on roosting, loafing, and feeding habitat availability and human disturbance. Autumn and spring transients were counted as crane flocks passed through a 4.8-km wide corridor at an observation point 27 km north of Sudan, Lamb County, Texas (34°18′N, 102°31′W). This 4.8-km segment was only a small fraction of an approximately 40-km wide migration corridor, but was located where cranes coming or going to MNWR converged in spring or deviated in autumn from cranes traveling from or to Bull Lake. Both MNWR and Bull Lake are located within the Muleshoe saline lake complex of southern Bailey, northern Cochran, northwestern Hockley, and southwestern Lamb

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counties, Texas (Haley 1983).

Many observations were fortuitous, as migrant cranes first were heard, then located and counted; however, there were numerous occasions when flocks were heard, but never seen. This was a particular problem when birds were migrating at high altitudes under clear skies. These were recorded as heard but not seen; cranes migrating at night were similarly recorded. On autumn days cranes were tallied at all hours, especially during heavy flights associated with strong storm systems to the north, or in spring with clearing skies and southwesterly winds after several days with unfavorable migratory conditions. *En masse* flights were observed in autumn 1990, 1993, 1997, 1999, and 2000 and in spring 1996 and 2000; no data were collected in spring 1992, and little in 1995, spring 1997, and autumn 1998. During *en masse* flights, cranes frequently passed at such rapid rates that counting individuals in all flocks were impossible, thus selected flocks were counted and others estimated. Only flocks where birds were individually counted were used in data analysis.

Weather conditions were recorded on most days when cranes were observed, as was direction birds were traveling and time of passage. Cranes were counted with 7× binoculars as flocks were in forward-flight; unless small, it was impossible to count individuals in a spiraling flock. I counted alone. Transients traveling to or from wintering areas southwest of northwestern Texas could not be differentiated and were included.

RESULTS AND DISCUSSION

Northwest Texas Annual Crane Chronology

Mean autumn arrival at the study site was 3 October (SD ± 5.6 days, n = 10 years). Peak of autumn passage usually occurred between 15 October and 5 November, with the latest known migrants on 21 December 1998. In spring, if habitat was available to the north in Castro County (west of Dimmitt), pre-migratory cranes begin congregating in mid-January, but it was not until February before sandhill cranes reached their greatest abundance (e.g., 30,150 were present on 20 February 2000). Lesser sandhill cranes have been seen leaving northwestern Texas as early as 8 February, but mean earliest spring departure during this study was 16 February. Mean late departure date was 24 March (SD ± 15.1 days, n = 10 yrs), and the latest date was a flock heard on 21 April 1993.

Larger Canadian sandhill cranes occasionally were among some southwestern-bound lesser sandhill crane flocks in October, but generally the subspecies did not winter; the majority of *G. c. rowani* likely continued on to northern Mexico, southeastern Arizona, and western New Mexico. Canadian sandhill cranes mostly by-passed the study area in spring, perhaps migrating north up the Rio Grande Valley of New Mexico (Drewien et al 1996).

Autumn Migration

During 1990-2000, 618 autumn crane flocks ranging in numbers from 2 to 269 were assessed. For 21,648 cranes individually tallied, mean flock size was 34.5 (SD ± 32.6); 15 additional birds were traveling alone. For 19,570 cranes with known arrival times, 2 were observed between 0800 and 0900 hours (all times standard); 272 (1.4%, 0900-1000 hr); 1,223 (6.3%, 1000-1100 hr); 1,437 (7.3%, 1100-1200 hr); 2,556 (13.1%, 1200-1300 hr); 2,693 (13.8%, 1300-1400 hr); 2,784 (14.2%, 1400-1500 hr); 3,157 (16.1%, 1500-1600 hr); and 2,434 (12.4%, 1600-1800 hr). Cranes continued to migrate during late afternoon and near or after sunset; 1,968 (10.1%) were recorded from 1800 to 1900 hours and 1,044 (5.3%) from 1900 to 2000 hours.

Only 170 (0.9%) cranes were noted migrating in September. Most migrated in October (12,724, 65%) and November (6,443, 32.9%). Few cranes migrated in December (233, 1.2%). The greatest proportion of migrating cranes were recorded between 1200-1300 hours in September (52.4%), 1500-1600 hours in October (19.7%), and 1300-1400 hours (20.9%) and 1400-1500 hours (20.5%) in November. All migrating cranes in December were recorded between 1400 and 1500 hours.

For 16,796 individuals, 6,176 (36.8%) were traveling south toward Bull Lake and 10,162 (60.5%) southwest toward MNWR. In addition, 458 (2.7%) changed travel direction from south to southeast along their migration corridor. Perhaps these cranes had strayed off course and were correcting to reach their traditional wintering grounds at the Brownfield saline lakes complex, east and southeast of Brownfield, Terry County, Texas.

Headwinds had little influence on arriving cranes in autumn. For 21,736 cranes assessed, 12,092 (55.6%) arrived against headwinds from the southwest quadrate, 7,462 (34.3%) with winds from the northeast quadrate, 1,930 (8.9%) from the northwest quadrate, and 252

(1.2%) from the southeast quadrate. Strong southwesterly winds (32-48 km/hr) frequently resulted in birds making little forward progress, and occasionally migrants were laterally displaced; on 24 October 1997, 18 were attempting to fly southwest against 32-56 km/hour west-southwest winds. When first observed, the flock was 1.6 km north-northwest of the observation point, but after 5 minutes it was 3.2 km southeast, still trying to go southwest.

For 21,625 autumn transients, 11,538 (53.4%) arrived under clear skies, 9,095 (42.1%) under partly cloudy skies, and 992 (4.6%) under overcast skies. For those migrating when skies were partly cloudy, 6,336 (69.7%) arrived at high altitudes under high, thin cirrus clouds.

En masse flights frequently occurred when weather conditions were mild (e.g., 67 flocks totaling 1,931 cranes passed over between 0930 and 1842 hours on 16 October 1990 when the maximum temperature reached 27° C, with 16-32 km/hr southwest winds), whereas other flights were associated with arctic frontal systems. On 25 October 1993, 1,991 cranes in 50 flocks passed over shortly before the arrival of an arctic system which eventually lowered the temperature to -11° C on 29 October. A total of 556 cranes migrated on 18 October 1999 after snow the previous day, and 1,314 rapidly migrated south to southwest between 0900 and 1604 hours on 6 November before 18 cm of snow, accompanied by 16-32 km/hour north winds, occurred the next day. Also, after morning snow on 18 November 2000, 12 flocks totaling 530 individuals migrated between 1400 and 1432 hours. On 1 occasion, when minimum temperature dropped to -7° C, 17 cranes, together with a chevron of 855 snow geese (*Chen caerulescens*), were rapidly flying south-southwest perhaps after their roost site had become frozen on 12 December 1998.

Cranes were occasionally heard migrating at night. For example, flocks passed 1.5 hours after sunset on 28 October 1991 as an arctic frontal system arrived, and others were heard during the nights of 9 October 1994 and at 2330 hours on 30 October 1994, apparently associated with the passage of Pacific frontal systems.

Spring Migration

A total of 311 flocks ranging in size from 2 to 309 were assessed during spring migration. For 16,479 cranes counted, mean flock size was 58.2 (SD ± 45.0); all were migrating in February and March. Time of passage was recorded for 14,673 birds; only 93 (0.6%) were noted between 0800 and 0900 hours and 521 (3.6%) between 0900 and 1000 hours. Most cranes migrated between 1000 and 1100 hours (54.0%) and 1100 and 1200 hours (39.4%). Only 350 (2.4%) were observed after 1300 hours and 23 (0.2%) as late as 1400-1500 hours. Most migrated between 1000 and 1200 hours in February and between 1000 and 1100 hours in March.

From a sample of 13,010 cranes, direction of travel was north or northeast. North from Bull Lake 2,890 (22.2%) were tallied, whereas 10,120 (77.8%) were flying from MNWR or points further southwest. None were noted migrating from the southeast.

Unlike in autumn, wind direction was an important factor during spring migration. For 28,012 spring transients, 23,565 (84%) left with winds from the southwest. 3,147 (11.2%) with south winds, 780 (2.8%) with northeast winds, and 520 (1.9%) with northwest winds.

Nearly as many cranes departed under partly cloudy (high cirrus, 92.9%) as clear skies (48.0% vs. 51.9%, respectively). Only 992 (4.6%) migrated when skies were overcast. Spring *en masse* flights generally occurred with southwesterly winds and increasing temperatures after a period of unsettled weather (e.g., cold, overcast, northerly winds, precipitation).

Retro-migration

Cranes observed retro-migrating in autumn seemed to be associated with hunting disturbance near Bull Lake or MNWR (e.g., 1,187 flew NNE between 0832 and 1100 hr on 23 November 1997). On the other hand, spring retro-migration usually was associated with late winter storm systems and sudden cold fronts. Examples include 198 cranes that flew southwest between 1725 and 1745 hours on 7 March 1991 after a frontal system the previous day dropped the morning minimum to -5° C, and sleet on 28 February 2001, with 8-16 km/hour northeasterly winds, apparently provided the stimulus for 212 to return on 1 March at 1600 hours. In March 1998, blizzard conditions and extreme cold (-26° C) and snow (20 cm) occurred in Nebraska (Craig 2001); perhaps 113 southwest bound cranes passing over the Texas study site between 1325 and 1708 hours on 9 March were associated with this storm. Other retro-migration events also seemed related to late winter storms. Thus, retro-migration in autumn

generally appeared to be associated with human disturbance to the south and southwest, whereas retro-migration in spring was associated with weather events to the north and northeast.

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