1990

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CONDITIONING OF SANDHILL CRANES DURING FALL MIGRATION

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Abstract: Body mass of adult female and male sandhill cranes (*Grus canadensis*) increased an average of 17 and 20%, respectively, from early September to late October on staging areas in central North Dakota and varied by year. Increases in body mass averaged 550 and 681 g among female and male *G. c. canadensis*, respectively, and 616 and 836 g among female and male *G. c. rowani*. Adult and juvenile *G. c. rowani* were lean at arrival, averaging 177 and 83 g of fat, respectively, and fat reserves increased to 677 and 482 g by mid-October. Fat-free dry mass increased by 12% among juveniles, reflecting substantial growth, but remained constant among adults. The importance of fall staging areas as conditioning sites for sandhill cranes, annual variation in body mass, and vulnerability of cranes to habitat loss underscore the need to monitor status of fall staging habitat in the northern plains region and to take steps to maintain suitable habitat where necessary.

J. WILDL. MANAGE. 54(2):234–238

During fall migration, midcontinent populations of 3 subspecies of sandhill crane (*G. c. canadensis*, *G. c. rowani*, and *G. c. tabida*) stop for extended periods on traditional staging areas in the northern plains region of North America before continuing southward to wintering grounds located primarily in Texas and New Mexico (Johnson and Stewart 1973, Lewis 1977, Tacha et al. 1984). Cranes that nest in central and arctic Canada, Alaska, and eastern Siberia spend most of September and October on staging areas in eastern Alberta, Saskatchewan, Manitoba, North Dakota, South Dakota, and northwestern Minnesota (Lewis 1977, Melvin and Temple 1983). In North Dakota, subspecies composition varies by site. Cranes staging in the westcentral region (McLean County) are primarily *G. c. canadensis*, whereas cranes in the

central part (Pierce and Kidder counties) are primarily *G. c. rowani* (Johnson and Stewart 1973). The fall distribution of the midcontinent population of *G. c. tabida* is centered in northwestern Minnesota, and their distribution in North Dakota is limited primarily to a small population in Kidder County (Johnson and Stewart 1973). The subpopulations of sandhill cranes that stage in Kidder and McLean counties spend winter primarily along the Texas Gulf Coast (50,000–70,000 cranes, Tacha et al. 1984) and western Texas (450,000 cranes, Iverson et al. 1985), respectively.

The significance of fall staging areas in the northern plains region as conditioning sites for the midcontinent sandhill crane population is poorly understood. The prolonged stay on these staging areas probably prepares birds physiologically for the continuation of fall migration (Melvin and Temple 1983) and possibly for winter, much as spring staging areas along the Platte and North Platte rivers physiologically prepare cranes for spring migration and reproduction (Krapu et al. 1985). However, fat levels among migrant sandhill cranes collected in Oklahoma in October 1979 were much lower than observed late in the spring staging period of the same year in Nebraska (Iverson 1981). This difference suggests, at least during some years, that cranes acquire less fat during autumn staging intervals in the Great Plains region than during spring, possibly because of less suitable foraging conditions on fall staging areas.

We address (1) patterns of body mass change among adult *G. c. canadensis* and *G. c. rowani* on staging areas in North Dakota during the fall stopover and (2) the magnitude of change in body nutrient composition of *G. c. rowani* from early to late in the fall staging period.

The North Dakota Game and Fish Department and cooperators provided measurements on hunter-shot cranes; B. A. Hanson and R. O. Woodward assisted in collecting and processing cranes, and C. R. Luna prepared the figures. D. P. Fellows gave constructive comments on an earlier draft of the manuscript.

METHODS

We obtained body mass on adult *G. c. canadensis* (n = 380) and *G. c. rowani* (n = 556) shot during fall 1965 (Madsen 1967), 1969–72 (Johnson and Stewart 1973), and 1977–87 in central North Dakota. We determined subspecies by comparing measurements of wing chord, tarsus length, and culmen length (post nares and total) with taxonomic criteria presented in Johnson and Stewart (1973). Adults were distinguished from juveniles by the lack of brown feathering on the occiput (Lewis 1979). Most cranes were shot in Burleigh, Kidder, McLean, and Pierce counties, the principal fall staging areas of sandhill cranes in the state (Johnson and Stewart 1972; U.S. Dep. Inter. 1979*a*, 1980; Melvin and Temple 1983). A few cranes (<10%) were from Benson, Bottineau, McHenry, Sheridan, and Stutsman counties, near the periphery of the major stopover sites. Cranes were weighed on a spring scale in the field to the nearest 10 g, and the sex of adults was determined by gonadal examination. The sex of juveniles was not obtained because limited development of reproductive organs prevented accurate determinations.

A separate sample of 20 adult and 14 juvenile *G. c. rowani* was obtained in Kidder County in 1978 and 1984 to compare body composition from early to late in the fall staging period. Cranes were shot during 2 periods—after arrival (late Aug–mid-Sep), and before departure (mid-Oct). A maximum of 1 adult and 1 juvenile was collected per flock. Specimens were tagged and were weighed wet at the laboratory to the nearest 1 g on a beam balance. Feathers were plucked, gizzard and esophageal contents were removed, sex was determined by gonadal examination, and birds were reweighed to the nearest 1 g. Each bird was double-bagged in plastic and stored frozen until prepared for chemical analysis. Carcass composition of fat, protein, water, and ash was measured with whole carcass homogenate (Horwitz 1975). Fat content was determined by Soxhlet extraction for 6 hours using petroleum ether and with duplicate analyses for each specimen. Protein determination was by the Kjeldahl method. Statistical analyses were made with SAS (SAS Inst., Inc. 1985) procedure GLM.

RESULTS

Body Mass

Body masses of adult male *G. c. canadensis* were 3,406 ± 52 (SE) g during 1–10 September and increased to 4,087 ± 89 g by 21–30 October (Fig. 1). Adult male *G. c. rowani* mass increased from 4,169 ± 27 g to 5,005 ± 111 g during the same period (Fig. 1). Adult females exhibited similar patterns in mass gains, with female *G.*

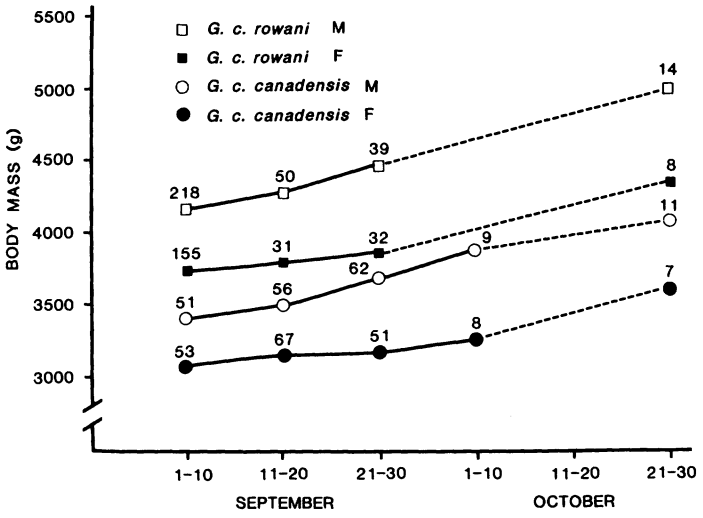

Fig. 1. Body mass curves of adult male and female *G. c. rowani* and *G. c. canadensis* by 10-day intervals during fall in central North Dakota. Dashed lines represent time intervals where sample size was ≤5 cranes.

c. canadensis changing from 3,074 ± 41 g during 1–10 September to 3,624 ± 34 g by 21–30 October, whereas adult female *G. c. rowani* increased from 3,735 ± 26 g to 4,351 ± 121 g during the fall. Mass gains of *G. c. canadensis* from early September to late October averaged 20% for adult males and 18% for adult females, whereas mass gains of *G. c. rowani* averaged 20% for adult males and 17% for adult females. Rates of mass gain differed by sex (ANOVA, $P < 0.002$), but not by subspecies ($P > 0.10$). Body mass of juvenile *G. c. rowani* collected for carcass composition analyses increased 20% from 3,380 ± 459 g ($n = 4$) in early September to 4,053 ± 277 g ($n = 11$) in mid-October.

Above and beyond the variation associated with subspecies, sex, and time period, mass of adult cranes also varied among years (ANOVA, $P < 0.0001$). Much of the annual variation was caused by higher mass in the early years of the study (Fig. 2). Mass tended to decrease beginning in 1977, when the hunting season in North Dakota shifted from November to September. Even during the 1977–87 period, some annual variation in mass of cranes was evident, suggesting the influence of other environmental factors.

Carcass Composition

Adult and juvenile *G. c. rowani* arriving in central North Dakota in late August and early September were lean (Fig. 3). Percentages of fat, protein, and ash did not differ between the sexes among adults ($P > 0.10$). Mean fat levels among adults increased from 177 ± 11 g to 677 ± 59 g. Fat levels of juveniles increased from 83 ± 23 g in late August through mid-September to 482 ± 32 g in mid-October. Fat content as a percentage of total body mass increased from 4 to 14% among adults and from 2 to 12% among juveniles. The estimated daily rate of fat gain for *G. c. rowani* was 10.1 ± 1.4 g ($n = 20$) among adults and 8.0 ± 1.0 g ($n = 14$) among juveniles during the fall staging interval. Fat-free mass of adults remained constant (978 vs. 981 g), whereas juveniles increased by 12% (from 740 to 829 g).

DISCUSSION

G. c. rowani and *G. c. canadensis* subpopulations staging during fall in central North Dakota undergo major gains in body mass and fat content from early September to late October, after which most depart from the state. Sandhill cranes probably exhibit similar patterns of body mass and fat gain on other fall staging areas in the northern plains region. At Last Mountain Lake, Saskatchewan, the fat content (expressed as a percentage of dry tissue mass) in sandhill crane carcasses increased 3-fold from mid-August to late September 1981 (Tacha et al. 1985). Cereal grains are the principal foods taken in fall in North Dakota (Madsen 1967) and Saskatchewan (Tacha et al. 1985), and are the primary source of nutrients for fat synthesis.

A comparison of rate of fat gain among *G. c.*

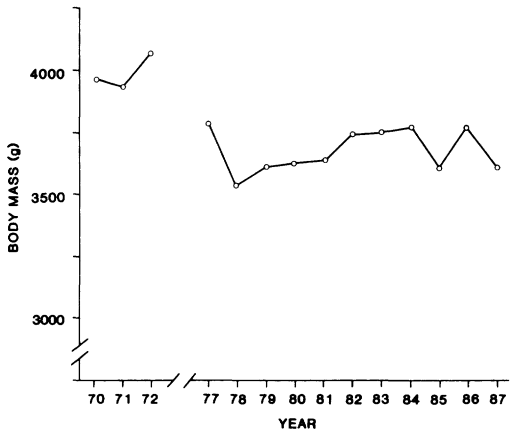

Fig. 2. Population marginal means (least-squares means) of body mass of sandhill cranes in central North Dakota, 1970–87. Population marginal means are the averages expected if there had been equal numbers of cranes in all categories of subspecies, sex, and time period.

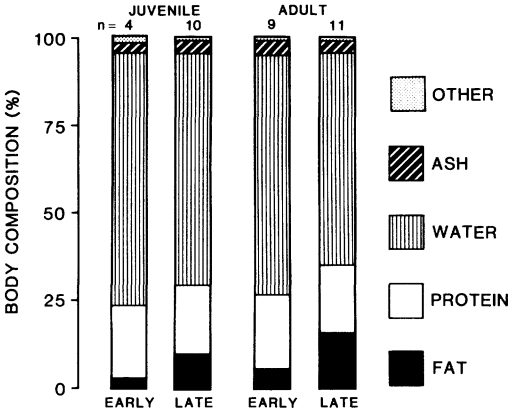

Fig. 3. Body composition of juvenile and adult sandhill cranes collected during early fall (21 Aug–12 Sep) and late fall (16–18 Oct) in central North Dakota.

rowani staging in North Dakota during fall and in Nebraska during spring suggests fat is acquired more rapidly in spring. The estimated daily rate of fat gain by adult *G. c. rowani* in North Dakota (10.1 ± 1.4 g, $n = 20$) was 38% less ($P = 0.088$, t-test) than the 16.3 ± 2.6 g ($n = 34$) in Nebraska (G. L. Krapu, U.S. Fish Wildl. Serv., unpubl. data). Causes for the slower daily rate of fat gain in fall are unknown but greater disturbance during the fall hunting season might be a contributing factor. The change in average body mass prior to 1977 versus 1977 and after coincided with a shift in hunting seasons from November to September. Earlier hunting resulted in greater hunter activity and probably reduced the time available for cranes to forage and rest. Although the daily rate of fat gain was lower among *G. c. rowani* in North Dakota, fat levels at departure were similar in North Dakota and Nebraska because sandhill cranes stayed longer in North Dakota.

Annual variation in body mass of sandhill cranes in North Dakota suggests that the rate of fattening is sensitive to local environmental conditions. Widely dispersed, suitable staging habitat must be maintained so cranes can adjust their fall distribution in response to hunting pressure, food, and roost-site availability. Staging during fall in North Dakota presently is restricted primarily to areas having large shallow alkali lakes with soft bottoms (Soine 1982) where cranes roost at night. Daylight hours are spent mostly on surrounding agricultural lands (Melvin and Temple 1983). Formerly, cranes staged extensively in the Missouri River Valley of North and South Dakota, but most of their roosting habitat was inundated with the filling of several mainstem reservoirs (Buller and Boeker 1965). Alkali lakes are relatively secure from conversion to cropland in the northern Great Plains because high salt concentrations make these sites poorly suited for agricultural production (Stewart and Kantrud 1971). However, alkali lakes can be altered in other ways that reduce or eliminate their value as crane roosting habitat. For example, some alkali lakes have been drained for construction of irrigation canals (U.S. Dep. Inter. 1979*b*), and proposals have been advanced to freshen and deepen others, currently supporting major crane roosts, to enhance their value for recreation (U.S. Dep. Inter. 1979*b*). Pumping groundwater for irrigation from aquifers that discharge into alkali lakes can lower the water table and thereby diminish or eliminate the surface waters (Winter 1988), causing loss of crane roosting habitat. Sandhill cranes also are displaced by human disturbance in the vicinity of their roosts (Krapu et al. 1984). Because most of the remaining sandhill crane roosts in the northern Great Plains are vulnerable to various forms of human activity, we propose that sandhill crane use of fall staging areas be regularly monitored and reported to help reduce further habitat loss.

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Received 10 November 1988.
Accepted 11 October 1989.
Associate Editors: Leslie/Baldassarre.