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RECRUITMENT AND SOCIALLY-SPECIFIC FLOCKING TENDENCIES OF EASTERN SANDHILL CRANES

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Nest-sites of Sandhill Cranes (*Grus canadensis*) are widely dispersed and difficult to find. Consequently, annual recruitment (percentage of juveniles) is most easily assessed at concentration areas during winter and migration (Drewien 1973, Lewis 1979). Miller and Hatfield (1974) asserted that counts of flying cranes leaving and returning to roosts gave the least biased estimates of age ratios. Percentages of juveniles in ground counts of cranes on roosts or in feeding fields were lower than in counts of flying cranes near roosts. This difference was attributed to tendency of adults with young to feed away from main flocks and hence be overlooked and undercounted, whereas all social classes of cranes used primary roosts and would be counted during morning and evening feeding flights. Buller (1979) argued that combining all counts of feeding, flying and roosting cranes provided more realistic estimates of annual recruitment. He noted that proportions of young among cranes remaining on refuges during the day were less than among cranes that left refuges to feed.

Young cranes, one or two per family, remain with their parents throughout their first year of life. Although many Greater Sandhill Cranes (*G. c. tabida*) may pair as 2 year olds (Drewien 1973), successful nesting probably does not occur until the third or fourth year (Walkinshaw 1965). Flocks at concentration areas during winter and migration appear to be loosely organized assemblages of smaller groups of one to seven cranes (Miller and Stephen 1966). These groups consist of families or "nonbreeders," which are unsuccessful, or pre-nesting pairs and unmated subadults. The purpose of this study was to investigate differential habitat use and flocking tendencies of family groups vs nonbreeders at an Indiana staging area, and to assess current annual recruitment in the eastern population of Greater Sandhill Cranes. This population breeds in the Lake States and southern Canada, and winters from central Florida north to the Okefenokee Swamp in southern Georgia.

STUDY AREA AND METHODS

The Jasper-Pulaski Fish and Wildlife Area (JPFWA) is 60 km south of Lake Michigan in the sandy lacustrine plain of northwestern Indiana (Jasper and Pulaski counties). Physiography, vegetation, and management history of the area were described by Lovvorn and Kirkpatrick (1981). JPFWA is the primary staging site of the eastern population of Greater Sandhill Cranes, and up to 13,000 cranes may be there simultaneously in fall. Fall roosts are shallow impoundments, often with wooded peripheries, within the refuge area. Cranes forage in agricultural fields surrounding JPFWA and in the Goose Pasture, a 243-ha refuge feeding field planted in winter wheat, corn and buckwheat. Agricultural fields are continuous and homogeneous in physical aspect, and significant physical boundaries between fields often are lacking. Percentages of cover types available to cranes in fall were roughly 53% corn, 30% soybeans, 3% winter wheat, and 14% fallow and pasture areas. Cranes typically will not feed in corn or soybean fields outside a refuge until after harvesting.

Juvenile (hatching year) Sandhill Cranes are best distinguished from older cranes by characteristic rust-colored plumage on the forehead, occiput and nape; whereas "adult" (after hatching year) cranes have mouse-gray plumage on the occiput and nape, and red, unfeathered skin on the forehead. Lewis (1979) provided details on field discrimination of adults and juveniles. Walkinshaw (1973:84) reported that a captive Greater Sandhill Crane hatched 11 May molted into plumage "quite similar" to that of adults by mid-October. Average hatching dates for 'greaters' passing through JPFWA vary from 10–28 May in southeastern and central Wisconsin to around 24 May in upper-peninsula Michigan and east-central Minnesota (Johnson 1976, Howard 1977, Bennett 1978, Walkinshaw 1978), although northern extent of the range in Canada is unknown. These dates suggest that some juveniles at JPFWA may not be distinguishable from adults after October. However, careful attention to progress of molt indicated that most juveniles could be identified through the second week in November.

Between 13 October and 14 November 1980, a roughly 500-km^2 area centered on JPFWA was surveyed daily from a truck and numbers of juveniles and adults in all aggregations of two or more cranes were recorded. A few counts were made with a 15–60× spotting scope, but most were made at 80× with a window-mounted Questar telescope. Surveys began after 08:30 EST, and lasted until all flocks had been examined or until heat distortions prevented accurate counts. Outside the JPFWA refuge, only counts in which distance, vegetation, lighting and crane activity permitted age classification of all flock members were used for analyses. In the Goose Pasture, however, large numbers of cranes present (up to 4700) and large size of the field (243 ha) at times allowed only samples of age ratios.

During 9–21 October 1979 and 4–17 October 1980, cranes arriving at and departing roosts were characterized as to group size and age composition, and time of arrival or departure. Counts were made with 10 × 50 binoculars from blinds built about 14 m above ground in trees. Families could be distinguished when breaking away from arriving groups just before landing, or before merging with departing groups just after taking flight (Lynch and Singleton 1964, Buller 1979). In most cases, age classification of cranes arriving at roosts was possible until over 90% of the cranes had arrived. Darkness occasionally prevented age discrimination of the last 10–15% of arrivals. Although some cranes probably arrived at or departed roosts during the night, comparisons of evening counts with counts the following mornings indicated such changes were small. Two roosts, Miller Ditch 1 and West Ringneck, were monitored in 1979; and four roosts, Miller Ditch 2 and 3, West Ringneck and West Lake, were monitored in 1980. Water regimes and vegetation at these roosts were described by Lovvorn and Kirkpatrick (1981). Counts of age ratios at roosts were curtailed in late October, when opening of waterfowl hunting season disrupted normal roosting patterns.

RESULTS

Highly significant differences in age ratios of cranes at different roosts were found in both 1979 and 1980 (Table 1). Consistently lower proportions of young were counted in the Miller Ditch roosts, which were separated only by narrow bands of trees, than in West Ringneck and West Lake, which were grouped together 1.6 km away from Miller Ditch. Age ratios

TABLE 1

RESULTS OF RECRUITMENT SURVEYS OF SANDHILL CRANES ARRIVING AT OR DEPARTING ROOSTS, JASPER-PULASKI FISH AND WILDLIFE AREA, 9–21 OCT. 1979 AND 4–17 OCT. 1980

Roost	Year	N	Cranes/count $\bar{x}$ SD	Cranes/count Range	% juv.[a] $\bar{x}$	% juv.[a] SD[b]
Miller Ditch 1	1979	4326	541 ± 275	160–901	11.2	0.2
Miller Ditch 2	1980	3162	395 ± 151	234–621	11.5[c]	0.1
Miller Ditch 3	1980	4322	617 ± 272	149–1029	9.7[c]	0.8
West Ringneck	1979	2702	270 ± 103	135–496	22.4	1.2
	1980	2386	298 ± 215	26–581	19.0[c,d]	2.7
West Lake	1980	4632	926 ± 169	705–1067	15.5[c]	0.4
Total	1979	7028	390 ± 236	135–901	13.4	0.3
Total	1980	14,502	518 ± 301	26–1067	11.9[d]	0.2

[a] (Juveniles/total cranes) × 100.
[b] Weighted by numbers of cranes in each count.
[c] Different from other 1980 roosts, F-test, $P < 0.001$.
[d] Different from 1979, t-test, $P < 0.001$.

at Miller Ditch 1 and 2 and at West Ringneck were similar between years. Overall age ratio was greater in 1979 than in 1980, possibly owing to bias of fewer roosts monitored in 1979.

Water level fluctuations made area of suitable roosting substrate highly dynamic and difficult to measure. Hence, no attempt was made to relate age ratios to numbers of cranes present relative to available substrate. Nevertheless, age ratios were correlated with total cranes counted at roosts during arrival or departure periods ($r^2 = -0.24$, $P < 0.001$). Age ratios also diverged between roosts with progress of arrival period (Fig. 1), suggesting that factors affecting roost preferences of family groups vs nonbreeders became more pronounced as more cranes arrived. Average brood sizes and percent nonbreeders were 1.22 young/pair and 59% in 1979, and 1.16 young/pair and 65% in 1980.

Overall age ratio for ground counts in fields in 1980 was essentially the same as for combined roost counts (Table 2). Lower proportions of young were found among cranes remaining in the Goose Pasture during the day than among cranes leaving the refuge to feed. Considerable variation in daily totals apparently resulted from daily differences in numbers of nonbreeders remaining in the Goose Pasture. When large flocks, with high proportions of nonbreeders, remained in the Goose Pasture, age ratios outside the refuge were inflated. Because cranes in the Goose Pasture were undersampled when flock sizes there were large, age ratios from combined field and refuge counts over-reflected changing ratios outside the refuge.

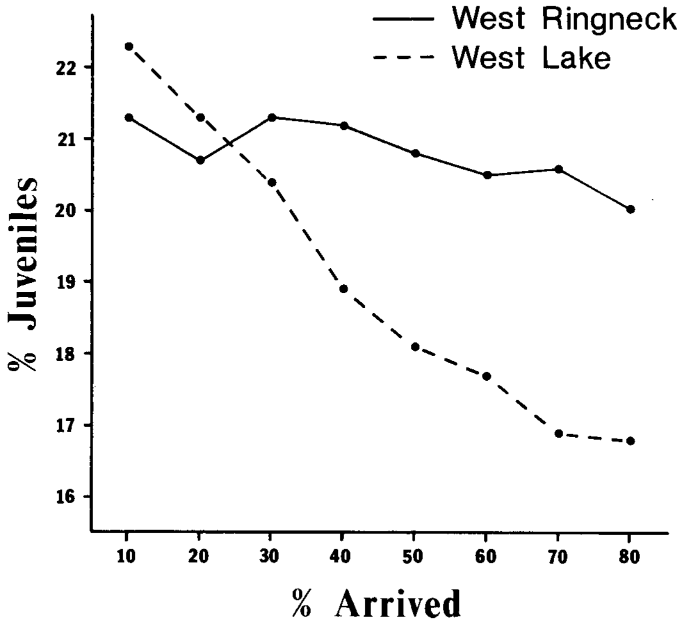

FIG. 1. Mean percentages of juveniles among Sandhill Cranes having arrived at West Ringneck and West Lake roosts at different stages of five arrival periods, Jasper-Pulaski Fish and Wildlife Area, October 1980.

TABLE 2

RESULTS OF RECRUITMENT SURVEYS OF SANDHILL CRANES IN FIELDS, JASPER-PULASKI FISH AND WILDLIFE AREA, FALL 1980

		% juv.[a]				Mean flock size off refuge	
		Off refuge	Goose Pasture	Daily totals			
Date	N	$\bar{x}$ SD[b]	$\bar{x}$ SD[b]	$\bar{x}$ SD[b]	Range		Staging numbers[c]
Oct. 13–20	13,333	11.8 ± 0.7	7.6[d] ± 0.7	10.9 ± 0.2	9.8–13.8	110	9500
Oct. 26–31	19,627	12.3 ± 0.6	9.8[d] ± 1.8	11.9 ± 0.5	9.8–14.2	162	10,900
Nov. 2–7	9795	13.9 ± 0.6	11.7[d] ± 1.0	13.1 ± 0.1	12.3–14.3	108	9900
Nov. 8–14	15,867	15.9 ± 1.1	10.2[d] ± 0.7	13.0 ± 0.4	10.2–14.2	145	8200
Total	58,622	13.1 ± 0.8	10.0[d] ± 0.9	12.2 ± 0.5	9.8–14.3	133	—

[a] (Juveniles/total cranes) × 100.
[b] Weighted by numbers of cranes counted each day.
[c] Midpoint for period extrapolated from weekly counts.
[d] Different from off refuge, t-test, $P < 0.005$.

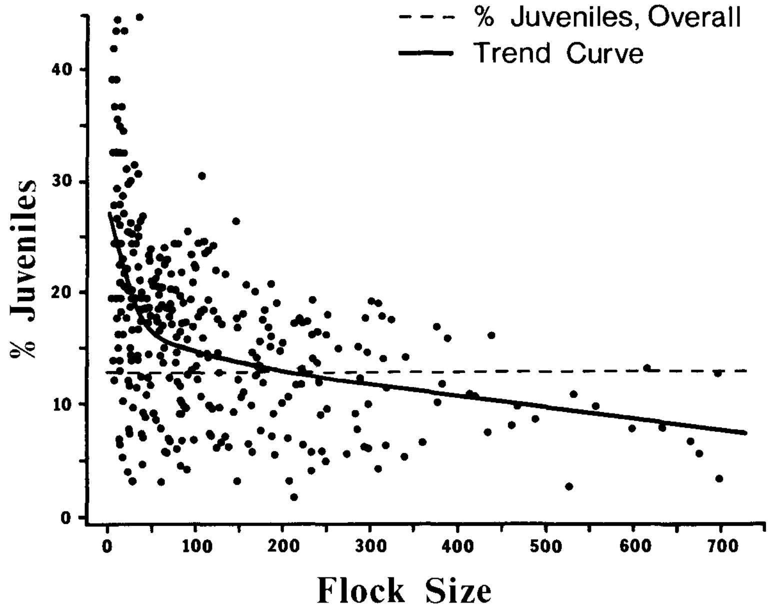

FIG. 2. Relationship between percentage of juveniles and flock sizes of Sandhill Cranes outside the refuge, and percentage of juveniles for the total off-refuge sample, Jasper-Pulaski Fish and Wildlife Area, October–November 1980.

The curve in Fig. 2 was constructed piecewise by linear and nonlinear least squares regressions over intervals of homogeneous variances. The plot indicates that variability and magnitude of age ratios declined as flock sizes increased. Comparing the curve with overall age ratio suggests that sampling primarily flocks of <150 cranes could cause substantial overestimates of annual recruitment.

DISCUSSION

Protection from predators and enhanced foraging efficiency are foremost among sundry hypotheses for adaptive value of bird flocks (Moriarty 1976). Observed flock sizes may result from individuals balancing costs and benefits of flocking behavior. Lovvorn and Kirkpatrick (1982b) found that previous crane use of a field both within and between years was the best predictor of where large crane flocks occurred at JPFWA in fall. This site fidelity was essentially independent of crop type, distance from roosts, or weather, and appeared to result from regimes of human disturbance. The continuous, homogeneous nature of agricultural land in northwestern Indiana argues against enhanced food-finding as a basis for flocking in fall, although historically food may have been more patchy. Cranes leave their roosts in small groups and join flocks upon reaching feeding fields (Miller and Stephen 1966, this study). Cranes apparently continue to join such flocks until foraging competition or social tensions offset disturbance-avoiding benefits of joining large flocks in consistently undisturbed fields. In such repeatedly used fields, food in fact may have been much reduced.

Among survival benefits of avian family cohesion are enhanced feeding time for juveniles while adults remain alert, and social dominance over non-family individuals (Prevett and MacInnes 1980). Juvenile cranes spend more time actively foraging and less time watching the surrounding area than adults (Miller and Hatfield 1974). Maintenance of higher foraging rates of juveniles may require larger foraging areas, possibly resulting in more frequent aggressive interactions for families in large flocks. Families are consistently dominant over nonbreeders, but avoidance behavior may require less energy than aggressive behavior, causing families to seek better foraging conditions by avoiding large flocks.

Moreover, negative relation of age ratio with flock size also held for cranes on roosts, where foraging efficiency was no longer pertinent. Although early arrivals at roosts were primarily families whose juveniles often foraged actively, most foraging soon ceased as more cranes arrived (Lovvorn and Kirkpatrick 1981). It appeared that many families landed first in West Lake, but later in the arrival period moved to nearby West Ringneck as numbers of cranes in West Lake became large (Fig. 1, Table 1). Much aggression was evident during roost arrival periods, and cranes landing within 2 m of other cranes on the ground were almost invariably pecked at by the previous arrivals. Nevertheless, cranes at given roosts typically aggregated into single roosting clusters, within which quite uniform individual distances were maintained, while leaving substantial areas of suitable roosting substrate unoccupied. These behaviors suggested that advantages of flocking, presumably related to predator detection and avoidance, were strong, and that density of roosting cranes was less of a limiting influence to families than absolute flock size. Prevett and MacInnes (1980) noted that members of Snow Goose (*Anser caerulescens*) families were more easily separated during migration when concentrated in large flocks on refuges. Family members often became separated in the confusion when large numbers of birds flushed simultaneously. Such risks of separation may influence crane families to avoid larger flocks when feeding or roosting, regardless of quality or quantity of substrate.

Sandhill Cranes nesting in southern Michigan, which form <10% of the estimated eastern population and probably do not pass through JPFWA (Lovvorn and Kirkpatrick 1982a), had an average recruitment of 19.4% during 1952–1958 (Walkinshaw et al. 1960) and 14.0% in 1971–1973 (Walkinshaw and Hoffman 1974). Crane age ratios at JPFWA were about 13%

(N [of cranes counted] = 525) in 1976 (Crete 1980), 10.3% (N = 4861) (Crete 1980) to 11.3% (N = 9894) (Bennett 1978) in 1977 and about 12% in 1980 (this study). Current annual recruitment of the eastern population of Greater Sandhill Cranes apparently is 10–13%. Drewien (1973) suggested that recruitment of 13–14% among Greater Sandhill Cranes at Grays Lake, Bonneville Co., Idaho, characterized an increasing, expanding population; whereas the population in southeastern Oregon was considered stable with recruitment of 8–10% (Littlefield and Ryder 1968). Age ratios suggest that the recently growing population in the Lake States and southern Canada (Lovvorn and Kirkpatrick 1982a) may be approaching stability at least in some portions of the range.

Age ratios must be interpreted with care, however. High proportions of young could result from scarcity of subadults in adult plumage, whereas low ratios could result from exceptional production 1–3 years earlier (Prevett and MacInnes 1980). Data on brood sizes obtainable through counts at roosts allow inferences concerning age structure as well as annual recruitment. Trends in proportions of nonbreeders could not be evaluated in this study, as average brood sizes were not determined in previous investigations at JPFWA.

Age ratio data must be collected in light of potential sampling bias. Fluctuations in numbers of nonbreeders remaining in refuge feeding fields where complete counts are not feasible may cause marked variability in observed age ratios. This phenomenon necessitates repeated sampling on different days in the same area. Roost counts should include samples from different roosts, and ground counts in fields should not favor small flocks even though they are more easily and accurately counted.

SUMMARY

Annual recruitment and differential flocking tendencies of family group vs nonbreeding Sandhill Cranes (*Grus canadensis*) were studied at the Jasper-Pulaski Fish and Wildlife Area, Indiana, in the autumns of 1979 and 1980. Highly significant differences in age ratios of cranes at different roosts were found in both years. Age ratios at roosts were negatively correlated with total cranes counted during arrival or departure periods. Age ratios at different roosts diverged with progress of arrival period, suggesting that factors affecting roost preferences of family groups vs nonbreeders became more pronounced as more cranes arrived.

Overall age ratio for ground counts in fields in 1980 was essentially the same as for combined roost counts. Total age ratios in fields showed considerable daily variation. This variation apparently resulted from daily differences in numbers of nonbreeders remaining in refuge fields, where large flocks were undersampled. Outside the refuge, variability and magnitude of flock age ratios declined as flock sizes increased.

Current annual recruitment of the eastern population of Greater Sandhill Cranes is probably 10–13%. Age ratios must be interpreted carefully, relative to inferred population structure and potential bias in sampling procedures.

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