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Wintering population of Greater Sandhill Cranes in the Okefenokee Swamp, Georgia.—Use of the Okefenokee Swamp by eastern Greater Sandhill Cranes (*Grus canadensis tabida*) as a migration stopover or wintering area was first reported by Walkinshaw (1949) and later by Cypert (1957). Patterson (1978) reviewed the migration of sandhill cranes through Georgia and the history of sightings in or near the Okefenokee Swamp. Recent estimates of the number of cranes that winter in the swamp range from 600 (Melvin 1977) to 1000 (J. Eadie *in* Patterson 1978:44). From 1985 to 1988 we conducted a population study of Greater Sandhill Cranes in the Okefenokee Swamp, Georgia, to determine: the number and distribution of cranes, the duration of winter residence by individual cranes, and their fidelity to the swamp as a wintering area during successive years.

The Okefenokee Swamp (the swamp) is a deep peat swamp-marsh complex of 1890 km^2 in southeastern Georgia. Water chemistry and biology are influenced by low pH (range = 3.8 to 4.2). The swamp is composed of a mosaic of freshwater wetland types including emergent marshes, shrub swamps, swamp forests, and lakes (Hamilton 1977). Water levels, fire, and underlying stratigraphy determine the spatial distribution of plant communities and pathways of succession (Rykiel 1977). Marshes, which are locally called prairies, occur as scattered openings in the swamp forest and cover 220 km^2 (15%) of the swamp (Cohen 1973).

The swamp exhibits a long hydroperiod, frequently extending over several years, with a normal annual amplitude of 80 cm (Rykiel 1977). Water levels are normally highest in February and reach a low point in June (Rykiel 1977).

Marshes larger than 1 km^2 were surveyed for cranes on or near the first and 15th day of each month from 1 October to 15 April (1985–88). Accessible marshes were surveyed by boat and inaccessible marshes were surveyed by helicopter or fixed-wing aircraft. Both ground and aerial surveys were systematic and designed to cover all marsh habitat. Surveys were conducted between 0800–1100 h while cranes were feeding or loafing. To minimize counting pairs or families of Florida Sandhill Cranes (*G. c. pratensis*) that are nonsocial (Bennett and Bennett, in press), we recorded only groups of ≥ 5 birds.

In 1985 and 1986, 66 cranes were captured by rocket netting (Wheeler and Lewis 1972) and individually color marked with plastic neckbands, leg bands, or both (Drewien and Bizeau 1978). Eight of these cranes were also equipped with radio transmitters (Melvin et al. 1983). Cranes were aged by examining their wing molt pattern (Nesbitt 1987) and classified as juveniles (<1 year), subadults (1–3 years), or adults (>3 years). Greater Sandhill Cranes were distinguished from Florida Sandhill Cranes on the basis of morphological measurements (Walkinshaw 1973), behavior (Bennett and Bennett, in press), and plumage coloration. Capture and tagging was conducted between 15 November and 15 December each year. Data were also collected on cranes that were color marked or radio tagged by other researchers on the breeding grounds and in Florida. Radio-tagged cranes were monitored from boats, using directional 4- and 8-element Yagi antennae. Tracking from the air was accomplished using two, 2-element "H" style directional antennae clamped to each wing strut of an airplane. Locations were obtained on radio-tagged cranes a minimum of 3 days/week. Observations of color-marked cranes were obtained from boats using 20–45× spotting scopes. Monitoring for color-marked and radio-tagged cranes began on 1 October and continued until the last cranes migrated north in early March.

Population and distribution.—Greater Sandhill Cranes normally began arriving in the swamp during October. The earliest date that cranes were sighted on the ground was 27 September 1986. However, most early migrants overflew the swamp and the largest survey

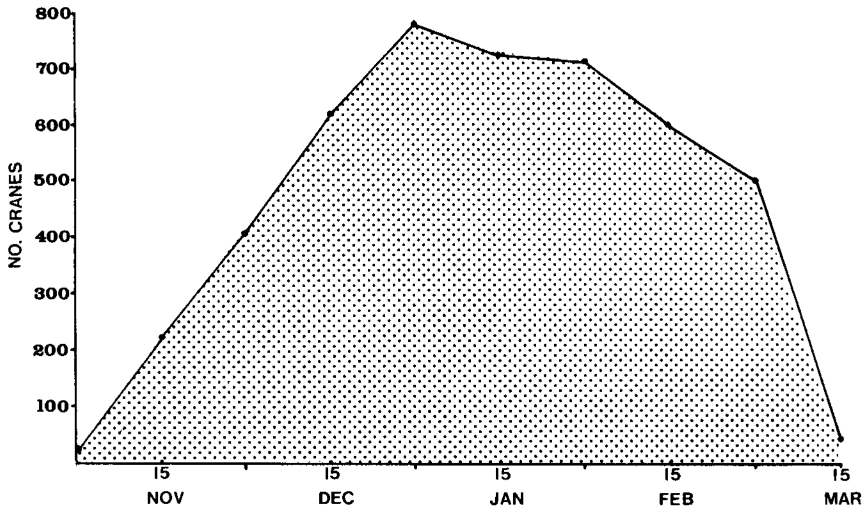

FIG. 1. Population chronology of Greater Sandhill Cranes in the Okefenokee Swamp.

count on 1 November was 31 birds. After mid-November the number of cranes steadily increased and reached a peak in early January (Fig. 1). The population remained relatively constant throughout January but slowly declined during February. Major northward migration occurred during the first week in March and by 15 March less than 50 cranes remained. A small number of cranes, primarily juveniles, remained throughout March and the latest known departure date was 11 April. In northern Florida, cranes begin their northward migration during the final week in February (Williams and Phillips 1972). The largest number of cranes sighted in the swamp was 810 on 1 January 1986. Between years, the magnitude of population peaks was relatively similar, $\bar{x} = 715$, range = 641–810. The greatest variation between years occurred during November and December. This variation probably reflected the timing of fall migration, which is often controlled by weather conditions on northern breeding and staging areas.

Greater Sandhill Cranes also wintered near Banks Lake, which is a state and federally owned swamp-marsh complex 60 km west of the swamp. The number of cranes at Banks Lake was small (60 birds), except during 1987–88 when 270 birds were present. Increased use during this season might have been in response to a managed drawdown of the lake. The distribution of cranes in the swamp was not uniform (Fig. 2). Chesser Prairie and Grand Prairie, although only 10% of the marsh habitat, accounted for 75% of the population. No cranes were observed in the 9 other prairies that comprised 44% of the available marsh. This general pattern of distribution was consistent between years. Water levels seemed to have a moderate influence on distribution. During high water conditions, cranes exhibited a greater tendency to concentrate, especially in Grand Prairie. Low water levels resulted in a wider distribution.

Habitat quality for Florida Sandhill Cranes varies widely between individual marshes in the swamp (Bennett, in press) and seemed to influence the distribution of cranes. Unlike other marshes, Grand Prairie contains extensive stands of red root (*Lacnanthes caroliniana*) which is a major food item in the winter diet of cranes (Walkinshaw 1973). Marshes that lacked red root received little or no use by cranes.

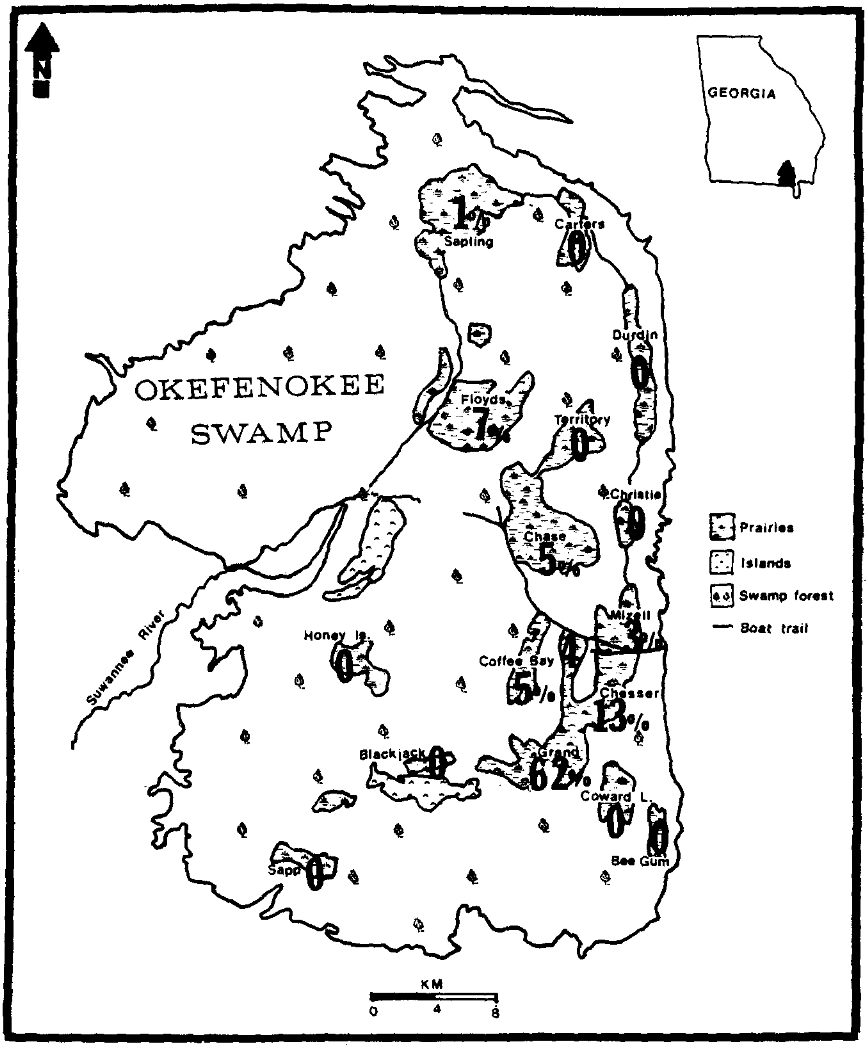

FIG. 2. Distribution of Greater Sandhill Cranes wintering in the Okefenokee Swamp, 1985–1986.

Melvin (1977) and J. Eadie (*in* Patterson 1978) suggested that the crane population in the swamp was larger than they estimated. Because cranes concentrate in several southeastern marshes that are readily accessible by boat, the birds give a misleading impression of their overall abundance in the swamp. The size of the eastern Greater Sandhill Crane population was estimated at 22,300 birds in fall 1987 (L. Schuman pers. comm.). Based on that estimate, the swamp supports approximately 3.5% of the population and is of relatively minor significance as a wintering area.

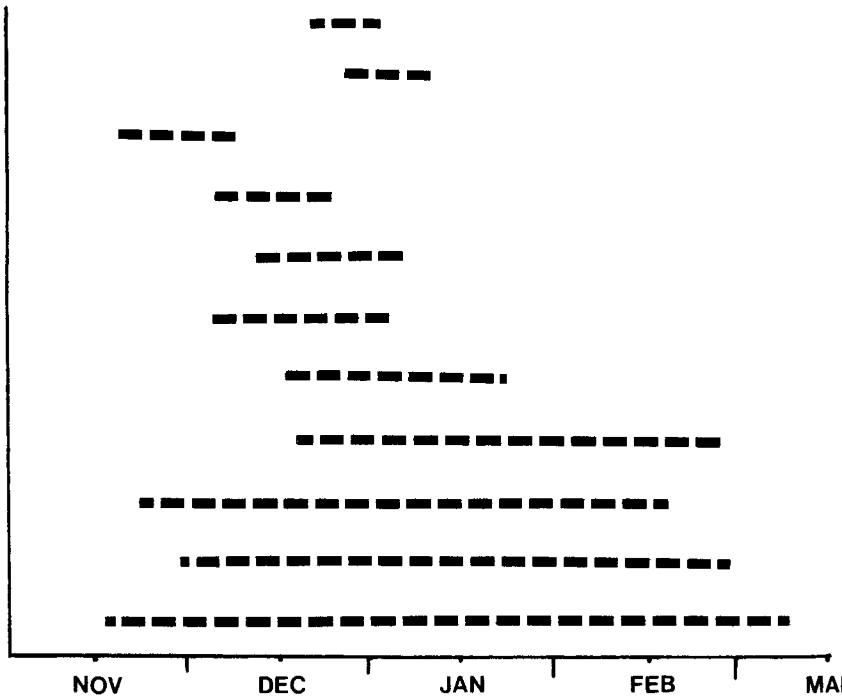

FIG. 3. Arrival and departure dates, and length of winter residence by 11 radio-tagged Greater Sandhill Cranes in the Okefenokee Swamp, 1986–1988.

Duration of winter use.—The mean length of time that 11 radio-tagged cranes remained in the swamp from the date of their arrival was 38 days, range = 10–106 days (Fig. 3). Of these cranes, 3 (27%) remained in the swamp from November until spring migration in late February. Of 47 cranes that were color-tagged by 15 December 1985, only 18 (38%) were sighted in the swamp after 1 February 1986.

We made no effort to locate cranes that left the Okefenokee Swamp and moved to wintering areas in Florida or elsewhere. However, observations were received from cooperators in Florida. A crane tagged 4 December 1985 in the swamp was sighted on 14 January 1986 near Gainesville, Florida, by S. Nesbitt. A radio-tagged crane that arrived in the swamp on 1 December 1986 and remained for 30 days was located near Orange Lake, Florida, on 4 January 1987 by R. Urbanek, and a second crane that arrived in the swamp on 25 December 1987 and remained for 17 days was located in central Florida on 13 January.

The tendency for cranes to remain in the swamp did not appear to be related to their arrival date. Cranes arriving in late December were just as likely to continue their migration southward as those arriving in early November. However, of 42 color-tagged cranes that were in the swamp after 14 January, 34 (81%) stayed for the remainder of the winter.

Movement between marshes was common for cranes that wintered in the swamp. Intra-swamp movements by tagged cranes were most common in mid-winter and were normally southward toward Grand Prairie. However, dispersal out of Grand Prairie was uncommon, which resulted in a growing concentration of cranes in this prairie throughout the winter. Of 47 cranes tagged in Grand Prairie, 43 (91%) remained in Grand Prairie until they eventually left the swamp.

Analysis of our data indicates the crane population that winters in the swamp has a high rate of turnover. Many cranes that arrive in November and December continue their migration southward after spending 1 to 6 weeks in the swamp. Cranes that leave are often replaced by later migrants from the breeding grounds or from wintering areas in Georgia and Florida. Because of this exchange, the winter population in the swamp remains relatively constant. The high population turnover in the swamp during November and December might be due to its position in the migration corridor. Most cranes destined for Florida pass over or near the swamp, and many use it as a stopover area. This northernmost wintering area for cranes commonly experiences sub-freezing temperatures. A possible weather-induced migration was observed in January, 1985 when −10° C overnight temperatures kept the marshes frozen for 3 days. Some cranes abandoned the swamp in December 1986 following heavy rainfall. Feeding and roosting habitat availability in the swamp is influenced by water levels (Bennett, in press). Under high water levels, competition for feeding sites intensifies.

Wintering site fidelity.—Return rates for radio-tagged and color-marked birds were combined because many of the radio transmitters failed while cranes were on the breeding grounds. Greater Sandhill Cranes sighted in the swamp at least once were considered returnees even if they later traveled to wintering areas in Florida. Eleven of 32 (34%) color-tagged cranes that wintered in the swamp during 1986–87 returned in 1987–88. However, approximately 130 cranes (16% of the population) wintered in marshes with limited accessibility and not all of these cranes could be examined for leg bands. Assuming that the ratio of tagged to untagged cranes was similar in this group, the actual return rate may have been 41%. The tendency for cranes to return to the swamp did not seem to be related to their known length of stay during the previous winter. Return rates for cranes that spent all of the previous winter in the swamp and those that spent ≤30 days did not differ significantly ($P > 0.05$, $N = 10$). Conversely, several radio-tagged cranes that spent ≤30 days in the swamp during 1986–87 before continuing south returned and spent the entire winter in 1987–88. Cranes that did not return the following winter were sighted in Florida at locations 130–360 km south of the swamp.

Age had a major influence on winter site fidelity. The return rate for adult cranes was 2.4× greater than that of subadults. Among subadults, those banded as juveniles the year before exhibited the lowest return rate. Only 1 of 14 (7%) juveniles returned to winter in the swamp the following year. Subadults comprised 53% of our tagged sample, and this might have reduced the overall return rate. In 1986–87 and 1987–88, R. Urbanek (pers. comm.) observed an 84% return rate of adult cranes wintering at specific sites in Florida and Georgia.

Although the number of cranes that wintered in the swamp was relatively constant between years, the low return rate suggests that this is not a discrete wintering population. Less than 50% of the population exhibited loyalty to the swamp as a wintering area. Many migratory bird species return in subsequent winters to the area in which they spent their initial winter (Crissey 1965, Nichols et al. 1983). Ralph and Mewaldt (1975) discussed the possible benefits associated with returning to the same wintering area each year, such as familiarity with the distribution of food resources and roost sites. However, Lensink (1964) and Bellrose and Crompton (1970) contended that waterfowl may winter in different areas depending on such factors as weather conditions and food availability. In Florida, Wenner and Nesbitt (1987) found that Greater Sandhill Cranes moved between wintering areas in response to habitat conditions. The swamp might be less attractive to cranes than sites in Florida that offer greater access to upland agricultural croplands and pasture. In addition, high water levels in the swamp often limit the availability of marsh habitat to cranes in winter (Bennett, in press).

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Nest habitat and nesting success of Lesser Golden-Plovers.—Many birds, especially ground-nesters with no aggressive nest defense, use camouflage for nest protection (e.g., Lack, Ecological adaptations for breeding in birds. Methuen, London, 1968). At Churchill, Manitoba, I found Lesser Golden-Plovers (*Pluvialis dominica*) frequently nesting on lichen heath. Their nests appeared far more difficult to see on the variegated lichen substrate than on nesting habitat covered by other vegetation (Fig. 1). At Churchill, scattered trees on the tundra may be used as lookout posts by avian predators and provide cover for surprise-attacking ground predators (Stroud et al., Wader Study Group Bull. 46:25–28, 1986). I examined whether habitat and distance to nearest tree affected nest survival and nest-site selection.

I studied plovers in a 3.75 km^2 area about 24 km east of Churchill town. I found 23 golden-plover nests. Two nests were excluded from calculations, one because it contained 8 eggs (probably laid by two females) and thus was highly conspicuous even with an incubating bird (the eggs in this nest were eventually depredated, one by one), and another that was deserted for an unknown reason. Twenty of the nests were found during the three first days of the field work (starting 24 June). Four of the nests were found during egg laying, the other ones immediately after laying of the last egg as judged from water flotation.

Nests were visited at 1–4 day intervals during incubation, some of them more than once daily during hatching. On average, hatching took 77 h from pipping until the chick was dry (± 30 h [SD]; N = 32 eggs, 10 nests). Eggs that disappeared between two nest visits were therefore counted as robbed. After predation, one (female) or both birds disappeared from their territory (10 of the birds were individually color banded).

At each nest the 3–4 most dominant plants (from % coverage) within a radius of 1 m were recorded and habitat was classified according to the most dominant component (usually covering >60%). The distance from each nest to the nearest tree (>1 m tall; most trees were 2–4 m tall) was measured. Occurrence of the various habitats in the study area was established from parallel transects across the area, 150 m apart. At each 150th pace I classified vegetation by the same procedure as I used at nest sites and measured distance to the nearest tree. Habitat availability is based on 96 point samples throughout the study area. Distances