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Double brooding in Red-cockaded Woodpeckers.—In 1991, seven groups of the cooperatively breeding Red-cockaded Woodpecker (*Picoides borealis*) produced second broods after successfully fledging young from first broods. These seven groups were in three different populations, five in the sandhills of North Carolina, one in the sandhills of South Carolina, and one in coastal North Carolina. No previous observation of double brooding

has been reported in this endangered species, despite intensive observations over the past 20 years over most of the range. In this note, we provide details of this unusual phenomenon.

Double brooding is common among bird species in the southeastern United States, including woodpeckers. Among other species in the same genus, the Downy Woodpecker (*P. pubescens*) may produce a second brood in this region, but the Hairy Woodpecker (*P. villosus*) is not known to be double brooded (Bent 1939). In other woodpecker genera, such as *Melanerpes* and *Sphyrapicus,* double brooding may be common (Bent 1939, Short 1982, Ingold 1987), but it occurs in only 4.9% of groups of the cooperatively-breeding Acorn Woodpecker (*M. formicivorous,* Koenig and Mumme 1987). Thus the occurrence of double brooding in Red-cockaded Woodpeckers is expected on taxonomic or geographic grounds. It is, however, somewhat unexpected on behavioral grounds, as temperate zone cooperative breeders generally are not double brooded. Indeed the species' nesting habits had been so thoroughly studied over such a long period without observation of double brooding that it frequently has been stated as fact that double brooding is not a part of the species' biology (e.g., USFWS 1985, Walters 1990).

Even in 1991, double brooding in Red-cockaded Woodpeckers was a rare phenomenon. Among 193 nesting groups monitored in the North Carolina sandhills, only five second broods were recorded (Fig. 1). In the South Carolina sandhills population, only one of six groups attempted a second brood, and in the North Carolina coastal population, only one of 42. Double brooding was discovered independently within the three populations, but was not observed in a second, nearby coastal population in North Carolina that we also monitored, nor in another South Carolina population, a Georgia population, and two Florida populations monitored by others. We think it unlikely that double brooding occurred but was overlooked in these populations in previous years, except perhaps as isolated instances. In the North Carolina Sandhills, one second brood was discovered during a normal visit to confirm group composition and another when a group was revisited because the breeding adults were observed copulating during a check for fledglings from the first nest. After these discoveries, nearly all groups that successfully fledged young by 15 June were checked for possible second broods. This indicates that if, in previous years, double brooding occurred at even the low frequency observed in 1991, normal nest monitoring procedures (described by Walters et al. 1988) and behavioral observations should have been sufficient to detect it.

The North Carolina sandhills study area (NCS) is described by Carter et al. (1983) and Walters et al. (1988), and the South Carolina sandhills population, located at the Savanna River Site (SRS) by Jackson (1984) and Gaines et al. (in press). The North Carolina coastal population is located on Croatan National Forest (CNF) and is the northernmost population of Red-cockaded Woodpeckers of even modest size.

All five second nests in NCS were successful, as was the single second nest at SRS. The sole second nest at CNF failed during the nestling stage. The number of young fledged from second nests was small (1–2) compared to the number (1–4) fledged from first nests in the same groups (Table 1). At NCS, second broods were produced by pairs that initiated their first nests relatively early in the breeding season. The five groups that produced second broods were among the first 16 to nest in the population, and four were among the first 11 to nest (Fig. 1). Birds in the northwestern quarter of the NCS study area nest slightly earlier than the other birds. Two of the groups that produced second broods were in this area, and they were among the first three groups in this area to nest. The three remaining groups that produced second broods were among the first seven outside the northwestern area to nest. Second broods were initiated 7–23 June compared to initiation dates for second attempts, by groups that failed initially, that ranged from 9 May to 19 June.

Breeding females in double-brooded groups were relatively old (4–9 yr, median 7 yr; Table 1) compared to other breeding females in the NCS population in 1991 (median age:

TABLE 1

NUMBER OF FLEDGLINGS PRODUCED IN FIRST AND SECOND BROODS OF RED-COCKADED WOODPECKERS FOR SEVEN GROUPS IN 1991

	Fledglings produced						
	First brood		Second brood		Breeder age (yrs)		Number of helpers
	Male	Female	Male	Female	Female	Male	
NCS 1	0	2	0	1	4	8	1
NCS 2	0	4	1	0	7	>7	3
NCS 3	0	3	0	1	6	7	0
NCS 4	1	2	1	0	9	5	2
NCS 5	1	1	1	1	9	5	0
CNF	1	0	failed		>3	>3	2
SRS	1	0	1	0	3	4	0

3 yr; Fig. 2). They tended to be the oldest females among those that nested early. Six of the 16 earliest nesting females were more than four years old, and four of these produced second broods. The two old females that did not produce second broods nested relatively late among these early nests and were located in the northwestern area. Four of the five females disappeared from the population and were presumed dead before the 1992 breeding season (yearly mortality for NCS females is 31.4%: Walters et al. 1988; and for females

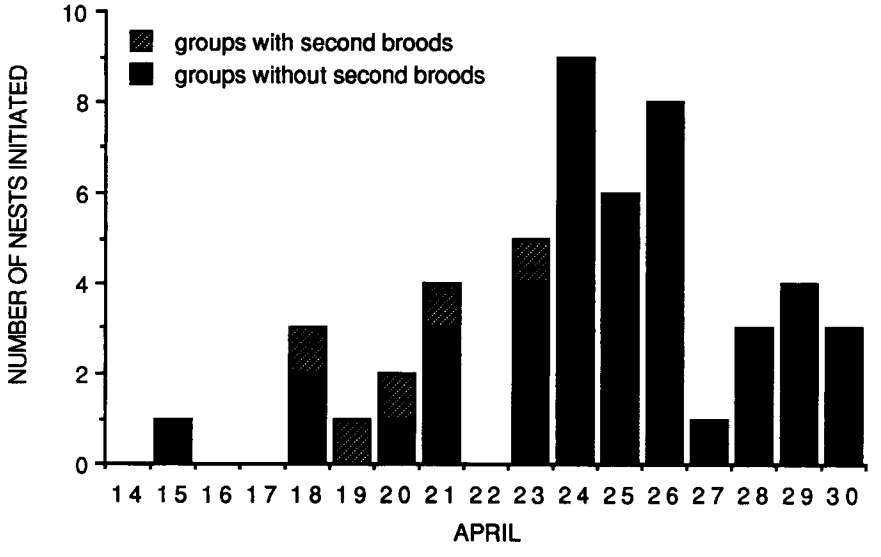

FIG. 1. Distribution of nest initiation dates for nests initiated in the North Carolina sandhills in April 1991. Initiation dates were calculated by back-dating from the date of hatching.

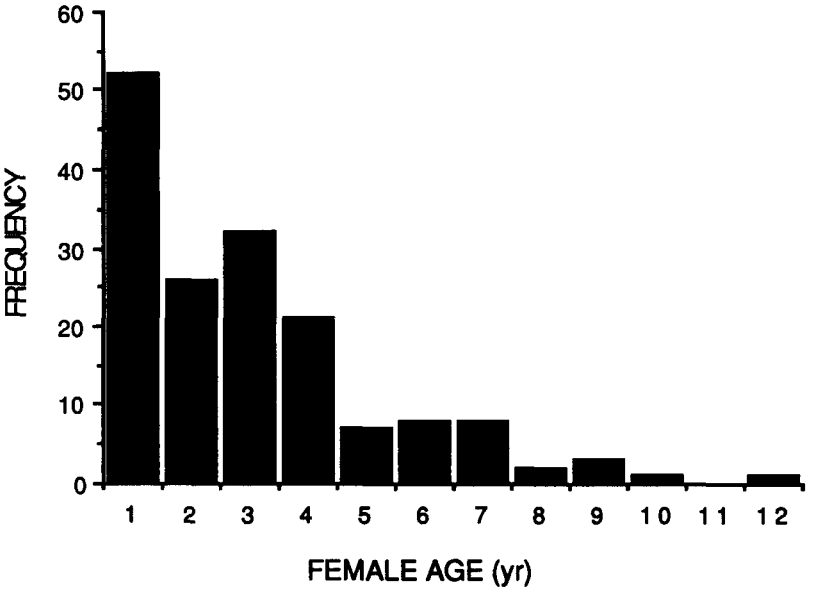

FIG. 2. Distribution of ages of breeding females in 1991 in the sandhills of North Carolina.

four years old and older is 35%; unpubl. data). Breeding males in these groups, on the other hand, were not older than average (4–7, Table 1; population median age 5 yr) and all were seen in the following season (yearly mortality for breeding males is 24%, Walters et al. 1988). Three of the NCS groups included helpers, whereas two did not (Table 1). First broods produced by these groups were female biased, whereas second broods had an even sex ratio (Table 1).

It is difficult to characterize groups that attempted second broods in the other two populations, since only one instance occurred in each. However, the characteristics of those groups (early first nest, older breeding female) are at least consistent with what was observed at NCS. Among the 41 other CNF groups, 10 nested as early as the group that attempted a second brood. Most of the breeding females at CNF were of unknown age. At SRS, the group that produced a second brood was the second of the six groups to initiate a first nest. The breeding female in this group was three years old, the median age for females in the population (Table 1).

In NCS, older females generally nest earlier in the season than do first year females and early nests are less likely to fail than later ones (LaBranche and Walters, unpubl. data). When early nests fail, renesting often occurs, but the last date at which renesting may be initiated varies greatly among years, occurring in early June in some years, but not until mid-July in others. The percentage of groups with failed nests that attempt renesting has varied from 7 to 48% between 1980 and 1991. At CNF this percentage has varied from 0 to 40% in the three years it has been studied (1989–1991). Another aspect of reproductive biology that varies from year to year is the percentage of groups nesting. Each year some groups do not attempt even a first nest. Usually these groups have a young breeding male

(Walters 1990). The proportion of groups that did not nest has varied from 4 to 20% in NCS, and from 5 to 12% at CNF.

The proportion of groups nesting and the likelihood of renesting are independent aspects of nesting effort. For both aspects, nesting effort was great in 1991. At NCS, both percentage of groups nesting and probability of renesting were the second highest levels observed between 1980–1991. Only one other year, 1984, was comparable, but there is no evidence (based on winter censuses and presence of unbanded helpers in 1985) to suggest that double brooding occurred. On CNF, both percentage of groups nesting and probability of renesting were by far the highest levels observed during the three years the population has been studied. Annual variation in reproductive parameters, such as these nesting effort parameters, appears to be highly correlated among populations within the Carolinas. For example, in 1991 the coastal North Carolina population at Camp LeJeune also experienced the highest proportion of groups nesting and greatest frequency of renesting observed in six years of study (96% and 40% respectively, compared to previous ranges of 81–93% and 0–33%). It appears that in this species the upper extreme of effort includes occasional double brooding, but that this level is not reached in most years. In NCS, double brooding may have occurred but been overlooked in 1984 and perhaps 1987, but otherwise during the years since 1980, nesting effort has not approached the level at which double brooding might be expected to occur. The two coastal populations had not reached these levels at all previously during the period 1986–1990. We have not noticed obvious differences in weather between years of high effort and years of low effort. The only unusual characteristic of the 1991 breeding season that we can discern is that it followed two successive mild winters.

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Direct use of wings by foraging woodpeckers.—Wing use in food-gathering activities has not been observed frequently in birds; the direct use of wings in foraging appears to be quite rare. We define direct wing use as the use of wings in behaviors directly involved in food item "capture" and retention. In contrast, indirect wing use is characterized by the use of wings in behaviors related to, but not directly involved in, food item capture. Here we describe direct use of wings by four species of woodpeckers. These observations, combined with scattered references to similar behavior in other woodpecker species (MacRoberts and MacRoberts 1976, Jackson 1983), bring the total number of woodpecker species in which direct use of wings has been observed thus far to six. We discuss these observations in the context of general patterns of wing use in avian foraging, as well as with respect to speculated evolutionary pathways to avian flight, some of which hypothesize foraging as a function of the avian "proto-wing".

We observed direct wing use in foraging by free-ranging woodpeckers during a series of experiments examining tradeoffs between foraging behavior and vigilance. Experiments were conducted by the senior author in a mature 20-ha deciduous woodlot in western Vigo County, Indiana, from January through March 1993. Woodpeckers had free access to 1-m long sassafras (*Sassafras albidum*) logs. In each log, 1-cm diameter holes were drilled at 5-cm intervals; these holes were filled with purified beef fat before each experimental session. The beef fat provided an essentially non-depleting food resource for the birds (Lima 1992). Logs were aligned 1.5 m apart and were presented in one of four possible pair-wise combinations of diameter (1.5 and 20 cm) and orientation (horizontal and vertical). Approximately 35 h of observations were videotaped from a house through a camouflaged window at a 10-m distance in March 1993. A filming session began at dawn and lasted for approximately 100 min. Behavior was recorded at the equivalent of 30 frames/sec. Woodpecker species foraging on experimental logs were Downy Woodpeckers (*Picoides pubescens*), Hairy Woodpeckers (*P. villosus*), Red-bellied Woodpeckers (*Melanerpes carolinus*), Red-headed Woodpeckers (*M. erythrocephalus*), Pileated Woodpeckers (*Dryocopus pileatus*), and Northern Flickers (*Colaptes auratus*). Other species feeding on the logs were Carolina Chickadees (*Parus carolinensis*), Tufted Titmice (*P. bicolor*), White-breasted Nuthatches (*Sitta carolinensis*), and Carolina Wrens (*Thryothorus ludovicianus*).

"Wing-catching" of food items was observed in Downy, Hairy, Red-bellied, and Pileated woodpeckers. Wing-catching refers to the extension of a wing to prevent a food item (in