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Nesting success and incubation behavior of American Kestrels in central Kentucky.—

Previous studies of the nesting success and incubation behavior of American Kestrels (*Falco sparverius*) reported that nest failure generally occurred before hatching and that 74–100% of hatchlings fledged (Hamerstrom et al. 1973, Balgooyen 1976, Craig and Trost 1979, Bloom and Hawks 1983, Coonan 1986, Bowman and Bird 1985). Male kestrels typically do 0–20% of all incubating (Willoughby and Cade 1964, Balgooyen 1976, Rudolph 1982, Wilmers et al. 1985). In the present study, we describe nesting success and incubation behavior of American Kestrels over three years in central Kentucky. This population has substantially lower nesting success and much more incubation by males than other populations described in the literature.

Breeding kestrels were observed during 1983, 1984, and 1987 on the Central Kentucky Wildlife Management Area (CKWMA) located 17 km SSE of Richmond, Madison County, Kentucky. Eleven nests were studied in nest boxes located on barns. Nest height ranged from 4 to 7 m. A removable door was placed at the back of each nest box so that contents could be checked from within the barn. It was often possible to observe kestrels through cracks in the doors without disturbing them. Nest boxes were checked for eggs or young no more than once per day. Date, time, and the sex of incubating birds were noted during each visit. Incubation by male and female kestrels was quantified by tallying the number of times each sex was observed incubating during 1983. Such incubation was assumed to begin only after clutches were complete.

Average clutch size for the three years ($N = 10$ clutches) was 4.2 eggs (mode = 4, $SD = 0.91$) (Table 1). Fifteen of 43 (34%) eggs failed to hatch (Table 1). One of these contained a fully developed embryo, and 14 were lost to predators. Nine eggs were lost from 4 nests between consecutive observations. At a fifth nest, 5 eggs were lost over a period of 7 days. Of 28 kestrel eggs that hatched, 12 young (43%) fledged from 3 nests (Table 1). Of 16 kestrels that hatched but did not fledge, one died (probably from an infection), while 15 were killed by predators. Thus, overall fledging success for three years was 12 fledglings from 43 eggs laid (28%) or 1.1 fledglings/active nest. In 1983, 2 of 5 nests were successful, yielding 9 fledglings (1.8 fledglings/active nest), in 1984, none of the 4 active nests produced fledglings, and in 1987, 1 of 2 nests was successful and produced 3 young (1.5 fledglings/active nest). Additionally, two adult females were found dead; one below a nest from which 4 eggs had disappeared, and the other within a nest from which 1 of 4 young was missing. Matted feathers on each female's head and neck may be an indication that snakes had tried to swallow them.

Incubation by individual males accounted for from 0% to 60% of total incubation ($\bar{x} = 32\%$). Males were not recorded incubating at two nests ($N = 5$ and 4 observations, respectively) while at three other nests males were recorded incubating in 3 of 5, 2 of 5, and 4 of 9 observations, respectively. Males performed 47% of the incubation (9/19 observations) for pairs in which males were observed incubating. Although incubation by male kestrels was common in 1983, they were never observed brooding ($N = 15$ observations of brooding adults).

Nesting success of American Kestrels in central Kentucky was lower than that published elsewhere. Unlike other studies, where nest failure typically occurred prior to hatching, mortality in the present study occurred both before and after hatching. This difference in nesting success probably was due to predation on both eggs and young by black rat snakes (*Elaphe obsoleta*) which are known predators of cavity-nesting birds. A black rat snake was observed consuming several nestling European Starlings (*Sturnus vulgaris*) from a nest box subsequently used by kestrels. In another case, a black rat snake was found inside a nest

TABLE 1
 NESTING SUCCESS AND NEST INITIATION OF AMERICAN KESTRELS
 ON THE CENTRAL KENTUCKY WILDLIFE MANAGEMENT AREA
 FOR 1983, 1984, AND 1987

Year	Nest box	First egg laid ^a	Clutch size	Number hatched	Number fledged
1983	1	2 April	5	5	4
	2	12 March	5	5	5
	3	14 May	4	3	0
	5	5 April	5	0	0
	6	26 May	4	4	0
Mean			4.6	3.4	1.8
1984	1	22 April	4	0	0
	2	25 April	5	5	0
	5	6 June	1	0	0
	6	30 May	4	0	0
Mean			4.3 ^b	1.2	0
1987	2	—	4	4	3
	3	—	2	2	0
Mean			3	3	1.5
Overall mean			3.8 ^b	2.5	1.1

^a Back calculated using an interegg laying interval of 2 days for nests that contained >1 egg when first encountered.

^b Based on completed clutches.

box from which two kestrels were missing. This seems to be the first instance where snakes have been found to be a major cause of nest failure in American Kestrels. The CKWMA may represent marginal breeding habitat for American Kestrels due to predation by black rat snakes on eggs and nestlings. Such predation totally eliminated kestrel reproduction during 1984, while in 1985 and 1986 no kestrels attempted to breed on the area.

In central Kentucky, male kestrels played an important role in incubation during 1983, perhaps because of food scarcity (Rudolph 1982). Packham (1985) suggested that incubation by male European Kestrels (*F. tinnunculus*) also was more important during years of food scarcity. Tall grass on the CKWMA may have protected prey, and one of two nests in which males apparently did not incubate was located on the edge of a large mowed area. Although male incubation was not recorded at one other nest, this male did enter his nest on two occasions after the incubating female flushed. In each case, he remained in the nest box for approximately 15 min.

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Sexual dimorphism in the voice of the Greater Shearwater.—Typically active at their colonies after dark, burrowing petrels may use calls to convey information given by visual signals in other diurnal seabirds. Recent studies of these calls have revealed that there is sexual dimorphism in some species (e.g., Little Shearwater [*Puffinus assimilis*], James and Robertson 1985a), and the call provides an immediate label of the bird's sex. In other species (e.g., White-chinned Petrel [*Procellaria aequinoctialis*], Brooke 1986), the sexes share two calls, one for sexual advertisement and another probably serving to discourage intrusion into the breeding burrow. Various intermediate vocal systems have also been described. For example in the British Storm-Petrel (*Hydrobates pelagicus*), the two sexes share a call, but in addition the male utters a sex-specific call (James 1984). However, the factors which dispose species to adopt a specific vocal system are not yet clear. The Manx Shearwater (*P. puffinus*) (Brooke 1978a) and the Little Shearwater (James and Robertson 1985a) have a marked sexual dimorphism in their calls. In both species the male call has a ringing quality lacking in the female, and sonograms of these calls are also distinct (Brooke 1978a, James and Robertson 1985a) so that human subjects, asked to assign a particular sonogram to the male or to the female group, may be 100% successful (Brooke 1978a). The closely related Cory's Shearwater (*Calonectris diomedea*) has an equally distinct sexual call dimorphism (Wink et al. 1982). The present note reports on dimorphism of the calls of Greater Shearwaters (*Puffinus gravis*).

Study area and methods.—The study was carried out in 1986 on Gough Island (40°21'S, 9°53'W) and Nightingale Island (37°24'S, 12°28'W), 420 km to the NNW, in the South Atlantic. The study period included the first two weeks of November, during the laying