

Breeding Success of American Kestrels Nesting in Boxes in Eastern Pennsylvania, 1987-1994

by James R. Klucsarits, Bob Robertson, and Sue Robertson

Abstract

Hawk Mountain Sanctuary has monitored the reproductive success of American Kestrels *Falco sparverius* breeding in nest boxes near the Sanctuary since 1987. From 1987 through 1994, kestrels used an average of 42% of the available nest boxes and sixty-one percent of breeding kestrels using boxes produced nestlings. There was an average of 3.7 nestlings per successful nesting attempt in 1992-1994. Hatching dates ranged from 2 May to 24 July. In 1994, 21 of 61 adult female kestrels captured at nest boxes had bred at a nest box the previous year. Sex ratios of nestling kestrels approached unity between 1992 and 1994. European Starlings *Sturnus vulgaris* were the main non-target species occupying boxes during the study period.

Since 1953, Hawk Mountain Sanctuary has been collecting data on the use of nest boxes by American Kestrels nesting near the Sanctuary (Nagy 1963; Heintzelman and Nagy 1968). Sanctuary volunteers, interns, graduate students, and staff currently monitor activity at nearly 200 boxes on farmlands in east-central Pennsylvania that surround the Sanctuary. The nest-box program was initiated with the primary goal of increasing kestrel populations locally. Other studies have illustrated how the strategic placement of nest boxes can increase the number of breeding pairs of kestrels in a given area (Hamerstrom et al. 1973; Stahlecker and Griese 1979; Toland and Elder 1987; Smallwood and Collopy 1991, 1993; Varland and Loughin 1993). Today, the nest-box program is monitoring the region's kestrel population in an attempt to provide important baseline information about the population's reproductive success and local distribution.

This paper focuses on the nest-box use, reproductive success, and nest-box fidelity of American Kestrels during the 1992-1994 breeding seasons. The site, or portions thereof, have been the focus

of several studies of nesting kestrels (Nagy 1963; Heintzelman and Nagy 1968; Apanius 1989; Rohrbaugh 1994).

Study Area and Methods

The study area consists of approximately 1500 km² of rolling, partly wooded farmland in east-central Pennsylvania. The area includes portions of northern Berks, northwestern Lehigh, and to a lesser extent southeastern Schuylkill counties, and is centered approximately 30 km north of Reading and 30 km west of Allentown, Pennsylvania.

Nest boxes, most of which have been in place since 1987, are distributed throughout the area's lower elevations. Most nest boxes are in relatively open farmland, often adjacent to meadows. Most of the boxes are mounted on trees. A few are attached to infrequently used sheds and barns. Almost all boxes are along or within 50 m of the nearest road, usually with the hole opening away from the road. All are mounted 3-6 m above the ground, and each is at least 0.5 km from its nearest neighbor.

Nest boxes are constructed of untreated pine or cedar, and measure (internally) 26 cm deep, 24 cm wide, and 33 cm high. Entrance holes are 7.6 cm in diameter, and are centered 26 cm above the floor of the box. Each box is cleaned or replaced (if damaged) in March, and the bottom is covered with wood chips (2.5-5.0 cm).

Nest boxes were checked from May until July at one-to-three week intervals, for occupancy by kestrels. Clutch initiation dates were determined by backdating the number of eggs present in incomplete clutches or by aging young (Griggs and Steenhof 1993). Clutch size was determined by counting the number of eggs or chicks during the routine visits. Brood size was recorded as the number of nestlings in the nest at the time of banding. Nestlings were banded and gender determined at approximately 17 days of age. Breeding

adults, mainly females, were captured and banded at the nest after the incubation period, or were trapped with bal-chatri traps (Berger and Mueller 1959).

A nest box was considered occupied if we found eggs in it, and was considered successful if it produced nestlings that survived to banding age. Reproductive success was calculated each year by dividing the number of boxes with banded nestlings by the number of boxes in which eggs had been laid. Productivity describes the mean number of banded nestlings per box in which eggs were laid and per successful nest. The number of boxes at which complete clutches or broods disappeared were recorded. We also recorded the number of boxes at which eggs were laid and remained in the box after nesting activity had ceased.

Results and Discussion

Kestrels occupied between 27% (1994) and 53% (1987, 1991) of the nest boxes each year (Table 1). Reproductive success ranged from 44% (1987) to 82% (1993) annually. Other studies of kestrels nesting in boxes have shown occupancy rates of between 27% and 88% (Smith et al. 1972; Hamerstrom et al. 1973; Balgooyen 1976; Craig and Frost 1979; Stahlecker and Griese 1979; Bloom and Hawks 1983; Wilmers 1987; Kellner and Ritchison 1988; Apanius 1989; Highhouse 1989; Wheeler 1992; Varland and Loughin 1993).

Table 2 summarizes hatching dates for kestrels nesting in boxes during the 1992-1994 breeding seasons. Mean hatch date was 30 May for all years, with the earliest hatch date of 2 May 1994, and the latest hatch date of 24 July 1992. There was no significant difference among years in hatching dates between 1992 and 1994 (Tukey's Range Test, $P > 0.05$). During the 1992-1994 seasons, clutch size averaged 4.5 per pair (Table 3). There was no significant difference with respect to average clutch size from 1992 through

1994. Annual productivity ranged from 1.9 to 3.1 nestlings per box in which eggs were laid. Productivity per box producing nestlings averaged 3.7 nestlings (Table 3). Between 1992-1994, the sex ratio of nestling kestrels approached unity (Table 4). During that time, 13 broods (9%) were all male and 14 broods (10%) were all female.

In 1993, 63 adult female kestrels were caught at their nest boxes, 32% of which were known nest-box users from 1992. Six of these females were found nesting in the same nest box as the previous year. Of the 61 adult females captured at nest sites during the 1994 season, 34% were known nest-box nesters in 1993, five of which were found nesting in the same nest box as the previous year.

European Starlings occupied 29% of the boxes in 1992, 25% of the boxes in 1993, and 19% of the boxes in 1994. Five percent of the boxes were used by starlings all three years. Overall, 31% of boxes occupied by starlings had been used by kestrels previously. In two instances, both starlings and kestrels successfully raised clutches in the same box in the same year with the kestrels nesting after the starlings fledged. Gray squirrels *Sciurus carolinensis* occupied 6% of the nest boxes; 4% of which were previously used by kestrels. Other studies have found that red squirrels *Tamiasciurus hudsonicus* may compete with kestrels for nest boxes (Balgooyen 1976; Toland and Elder 1987; Bortolotti 1994).

The number of used boxes where either eggs or nestlings disappeared ranged from 6% in 1994 to 21% in 1992. We assume that raccoons *Procyon lotor* and European Starlings were the major predators of nestlings or eggs respectively, although no direct observation of their activity was observed. Varland and Loughin (1993) suggested that starlings appear to be a factor in the disappearance of eggs and may play a role in predation. In addition, Wilmers (1987), Weitzel (1988), and Varland and Loughin (1993) have suggested that starlings can cause kestrels to abandon a nest box. Boxes where kestrel eggs were left after nesting activity had

ceased ranged from 6% in 1994 to 17% of the boxes in 1992. The possible reasons for the eggs to remain in the nest such as true abandonment, death of the parents, egg infertility, or embryonic mortality were not determined.

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Table 1. Kestrel nest-box use and reproductive success, 1987-1994, in east central Pennsylvania.

Year	1987	1988	1989	1990	1991	1992	1993	1994	8-Year Mean
Number of boxes available	117	119	118	118	129	184	178	178	143
% boxes in which eggs were laid	53	43	42	31	53	47	42	27	42
% used boxes with nestlings	44	49	53	62	67	52	82	81	61

Table 2. Hatching dates of American Kestrels, 1992-1994, in east central Pennsylvania.

Year	Earliest	Latest	Mean
1992	12 May	24 July	31 May
1993	2 May	22 July	1 June
1994	10 May	18 July	30 May

Table 3. Kestrel productivity and clutch size, 1992-1994, in east central Pennsylvania.

	1992	1993	1994
Number of occupied nests	86	74	48
Average clutch size	4.5 ± 0.8	4.7 ± 1.0	4.5 ± 1.1
Productivity per box that produced eggs	1.9 ^a ± 2.0	3.1 ^a ± 1.9	3.1 ^a ± 1.9
Productivity per box that hatched nestlings	3.6 ± 1.2	3.8 ± 1.3	3.8 ± 1.3

^{a,b} means with the same letter are not significantly different. Duncan's multiple range test ($P < 0.05$).

Table 4. Sex ratios of banded nestlings from 1992-1994 in east central Pennsylvania.

	1992	1993	1994
Number of males banded	74	119	75
Number of females banded	90	112	74
Male: female ratio	0.8:1.0	1.0:1.0	1.0:1.0