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REPRODUCTIVE PARAMETERS FOR FREE RANGING AMERICAN KESTRELS (*FALCO SPARVERIUS*) USING NEST BOXES IN MONTANA AND WYOMING

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ABSTRACT.—An average of 37 nest boxes were monitored annually for use by American Kestrels (*Falco sparverius*) in an area north of Sheridan, Wyoming, 1977–85. Of 248 occupied territories, 213 were productive with a total of 899 young fledging. During three consecutive years of the study, mean clutch size was 4.7 (N = 105, range 1–7, SE = 0.1), and the average number of chicks to hatch per clutch was 3.7 (N = 100, range 0–6, SE = 0.2). Second clutches were laid in 64.3% of the instances when first clutches failed (N = 14, SE = 0.1). Although second clutch sizes were not smaller, they were less likely to hatch than first clutches. The ratio of males to females fledged was virtually 1:1 (N = 281, SE = 0.03) over the course of this eight-year study.

Parámetros de reproducción para Halcón Cernícalo silvestre (*Falco sparverius*) usando nidos en cajas, en Montana y Wyoming

EXTRACTO.—Un promedio de 37 nidos artificiales usados por Halcones Cernícalo (*Falco sparverius*), fueron controlados anualmente en una área al norte de Sheridan, Wyoming, 1977–85. De 248 territorios ocupados, 213 fueron productivos con un total de 899 crías. Durante 3 años consecutivos de estudio, el tamaño medio de la nidada fue de 4.7 (N = 105, entre 1–7 huevos, SE [error estandard] = 0.1), y el número promedio de crías a criar por cada nido fue de 3.7 (N = 100, entre 0–6 crías, SE = 0.2). Segundos intentos de anidar fueron hechos en 64.3% del total de nidadas sin éxito (N = 14, SE = 0.1). Si bien las segundas nidadas no fueron más pequeñas, ellas tenían menos posibilidades de éxito que las primeras nidadas. En el curso de 8 años de estudio, la proporción en las crías machos vs. hembras fue virtualmente 1:1 (N = 281, SE = 0.03).

[Traducción de Eudoxio Paredes-Ruiz]

Few studies in the Northern Great Plains have consistently collected reproductive data on wild raptors (Anonymous 1979, Phillips et al. 1990). With the advent of energy development throughout much of the region, monitoring of reproductive parameters and a host of more specialized studies on raptors have been initiated (Phillips and Beske 1990). The progressive compilation and evaluation of data has led to innovative management strategies that accommodate both raptors and industry (Postovit et al. 1982, Fala et al. 1985).

Although American Kestrels (*Falco sparverius*) occasionally were found nesting in snags and in sandstone outcrops, natural nesting sites on the study area were believed to be limiting the distribution of nesting pairs. Forty-two nest boxes were constructed and situated on tracts where natural nesting sites were lacking (Dahmer et al. 1984). These boxes were monitored from 1977–85, except 1979.

Dahmer et al. (1984) showed that revegetated mined lands in Montana and Wyoming could attract and sustain breeding populations of American Kestrels provided nesting sites were available. Their research further showed that during a five-year period, reproductive rates of kestrels nesting on revegetated lands were comparable to those of kestrels nesting on native habitats. This paper presents three additional years of data, gathered between 1983–85, on reproductive rates from the same study area including clutch size, hatching success, and sex ratios. Summary reproductive data are presented here for the entire eight years. Further, I tested the hypotheses that, in a wild population where egg-removal techniques were not employed, mean clutch size of first and second clutches would be equal, and that first clutches would have hatching success equal to second clutches.

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Table 1. American Kestrel reproduction data 1977–85, from Big Horn County, Montana, and Sheridan County, Wyoming.

Year	Total Nest Boxes	Territories			Young Fledged/ Occ. Terr.	Total Young Fledged
		Occupied	Active	Productive		
1977–78 and 1980–82[a]	187	155 (149)[b]	147	129	3.7	550
1983	35	31 (30)	30	27	3.8	115
1984	36	36 (36)	36	31	3.3	117
1985	40	36 (33)	33	26	3.5	117
1977–78 and 1980–85	298	258 (248)	246	213	3.6	899

[a] Data from Dahmer et al. (1984). Nests were not monitored in 1979.
[b] The number of nests monitored for productivity is enclosed in parentheses.

STUDY AREA AND METHODS

Areas surveyed included approximately 91 km^2 in both Big Horn County, Montana, and Sheridan County, Wyoming. The topography was rolling plains approximately 1200 m in elevation, transected by perennial and ephemeral drainages. Sagebrush (*Artemisia tridentata*) grassland, native grassland, and strip-mined lands reclaimed to grassland (*Agropyron* spp.) were the dominant habitat types. Riparian areas along major drainages included Cottonwood (*Populus deltoides*), Box Elder (*Acer negundo*), Green Ash (*Fraxinus pennsylvanica*), and willow (*Salix* spp.). Rocky, north facing sidehills supported Ponderosa Pine (*Pinus ponderosa*) and Rocky Mountain Juniper (*Juniperus scopulorum*).

Confusion exists with terminology used in describing parameters of raptor reproduction. I use the reproductive terminology as described by Postupalsky (1974).

Nest boxes were built and erected in locations lacking nesting sites for kestrels, as described by Dahmer et al. (1984). Boxes were monitored for reproductive status and reproductive success, clutch size, hatching success, and sex ratios of fledglings.

On occasion, wind damaged a nest box or its support pole. Boxes were not included in the total number of boxes available during a given breeding season if damage occurred to the box prior to the breeding season (prior to 1 March). If damage occurred to a nest box after 1 March, it was considered a natural stochastic event, and data were included in productivity calculations. Data from nest boxes were not included in productivity calculations if the number of young fledged was unknown. In one instance in 1983 and in three instances in 1985, boxes that were occupied were not adequately checked for complete productivity data.

Between 1 March and late June the vicinity around each box was checked for occupancy at least four times. Once occupancy was determined, boxes were checked at least every ten days to determine the status of the pair. If the pair had laid eggs, frequent box checks were made to determine clutch size, number of nestlings, and reproductive success.

Data are summarized on a yearly basis with the eight-year averages calculated using data from individual reproductive attempts. A comparison of the difference between means was made using Student's t-tests (Dixon and Massey 1983). Standard errors were calculated using the sample sizes (N) given in each case. Although some kestrels that fledged from the area returned to breed, banding data from this study documented low mate and nest site fidelity (A.H. Wheeler, unpubl.). Thus, each breeding attempt was considered an independent occurrence.

RESULTS AND DISCUSSION

Reproductive data from the first five years of the study are summarized in Table 1. During the next three breeding seasons, a maximum of 36 nest boxes were monitored annually for a total of 111 potential breeding territories (Table 1). The percentage of occupied territories was high, averaging 92.9% (range 88.6–100%, SE = 0.6) between 1983 and 1985. Of the 8 territories unoccupied during this period, 2 had lone birds in attendance. Combining data from 1977–85 with the exception of 1979 shows occupancy averaging 87.4% (N = 298, range 52.3–100%, SE = 0.9). Low occupancy occurred during the first breeding season after nest boxes were situated. Only 52.3% of nest boxes were used during the first breeding season after initial installation in 1977. Thereafter, the occupancy rate was always ≥85.0%.

Once American Kestrels found nest sites and solicited a mate, most pairs laid eggs. The percentage of occupied territories that were active between 1983 and 1985 averaged 96.2% (N = 103, range 91.7–100%, SE = 0.4), while combined data from 1977–85 yielded a slightly lower average of 95.2% (N = 258, range 84.9–100%, SE = 0.3).

The percentage of occupied territories resulting

Table 2. Clutch size and hatchability of American Kestrels 1983–85, from Big Horn County, Montana, and Sheridan County, Wyoming.

	First Clutches		Second Clutches	
Year	Eggs $\bar{x} \pm$ SE Range (N)	Hatchlings $\bar{x} \pm$ SE Range (N)	Eggs $\bar{x} \pm$ SE Range (N)	Hatchlings $\bar{x} \pm$ SE Range (N)
1983	5.0 ± 0.1	4.2 ± 0.3	5.0 ± 1.0	1.5 ± 1.5
	3–7 (28)	0–6 (26)	4–6 (2)	0–3 (2)
1984	4.5 ± 0.2	3.2 ± 0.4	4.4 ± 0.4	3.4 ± 0.7
	1–6 (35)	0–5 (35)	3–5 (5)	2–5 (5)
1985	4.8 ± 0.2	4.2 ± 0.3	3.0 ± 2.0	0.0
	1–6 (33)	0–6 (30)	1–5 (2)	0 (2)
1983–85	4.8 ± 0.1	3.8 ± 0.2	4.2 ± 0.5	2.2 ± 0.7
	1–7 (96)	0–6 (91)	1–6 (9)	0–5 (9)

in fledglings varied from year to year. The 1983–85 average was 85.0% (N = 99, range 78.8–90.0%, SE = 0.6), while the eight-year average was slightly higher (87.6%, N = 248, range 78.8–93.3%, SE = 0.5). Kestrels averaged 3.5 fledglings per occupied territory (N = 99, range 3.3–3.8, SE = 0.03) for 1983–85 with a mean of 4.2 young per active territory (N = 97, range 1–6, SE = 0.04). Long-term productivity averaged 3.6 fledglings per occupied territory (N = 248, range 3.2–4.1, SE = 0.02) with a mean brood size of 4.2 young per active territory (N = 213, range 1–6, SE = 0.02).

Clutch size ranged from 1–7 eggs from which 0–6 chicks hatched (Table 2). Only one 7-egg clutch was found during all years of this study. This female laid a second clutch of 6 eggs after the first clutch failed. Willoughby and Cade (1964) and Heintzelman and Nagy (1968) reported clutch sizes within the range of 1–6 eggs as have Roest (1957) and Smith et al. (1972). Evidence from egg-removal experiments suggests the American Kestrel is an indeterminate layer (Porter and Wiemeyer 1972, Porter 1974). Eggs were not removed from nest boxes by the researcher during this study, but data from this particular pair of birds supports this concept.

During all three years, some American Kestrel pairs laid a second clutch after their first clutch failed. Severe weather including low temperatures, high precipitation, and high winds apparently caused some nest failures. Data on clutch sizes and hatching success are segregated into first or second clutches (Table 2). In 9 of 14 instances where the first clutch failed, kestrels laid a second clutch. This illustrates the need for rechecking nest sites after the initial clutch fails in order to generate accurate productivity estimates.

Willoughby and Cade (1964) reported an average clutch of 3.7 eggs for 12 captive pairs. Heintzelman and Nagy (1968), studying 13 wild pairs using nest boxes, reported a slightly larger mean clutch size ($\bar{x}$ = 4.2). Neither team mentions second clutches in the papers cited here. Combining data from both first and second clutches from nest boxes on this study area, the mean clutch size was 4.7 eggs (N = 105, SE = 0.1). First clutches averaged 4.8 eggs (N = 97, range 1–7, SE = 0.1), while second clutches did not differ significantly in size ($\bar{x}$ = 4.2, N = 9, range 1–6, SE = 0.5, t = 2.26, $P > 0.05$).

The average number of chicks hatched per clutch from all clutches monitored was 3.7 (N = 100, range 0–6, SE = 0.2). Hatching success of first clutches ($\bar{x}$ = 3.8, N = 91, SE = 0.2), however, was significantly greater than that of second clutches ($\bar{x}$ = 2.2, N = 9, SE = 0.7, t = 2.26, $P < 0.05$). Of 453 eggs from 97 clutches, 81.2% (368 young) hatched. Of 421 eggs from first clutches, 82.7% hatched while only 62.5% of 32 second clutch eggs hatched. Standard errors for both clutch size and hatching success were significantly greater for second clutches. Hatchability of eggs on this study area was higher than the rate reported by Heintzelman and Nagy (1968) for Pennsylvania where 78% of 55 eggs hatched from 13 clutches.

Despite the observation that eggs from second clutches were less likely to hatch, the percentage of chicks hatching from second clutches that survived to fledging (90.0%, $N = 20$) was similar to the percentage of chicks from first clutches (91.3%, $N = 346$).

Sex ratios of fledgling American Kestrels varied from the extreme of 5 females from a clutch of 5 eggs to an even count of males and females. The ratio of female to male fledglings over the course of the eight-year study was not significantly different from 1 to 1 ($N = 281$, males = 141, females = 140, SE = 0.03).

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