

AMERICAN KESTREL DISTRIBUTION AND USE OF NEST BOXES IN THE COASTAL PLAINS OF GEORGIA

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Abstract.—Four hundred and two nest boxes were erected on the coastal plain in Georgia to establish baseline data concerning the breeding biology of the American Kestrel (*Falco sparverius*) in Georgia during 1994 and 1995. Nest box occupancy averaged 3%, although occupancy was 15% at Fort Gordon military base. Clutch size averaged 4.9, and nesting success (at least one kestrel fledged) was 62%. Overall, productivity averaged 2.7 young fledged per nest attempt, although an average of four young fledged from each successful nest. Fifty-two of 56 kestrels fledged from boxes within Fort Gordon. Small body size of the kestrels in our study suggests that the American Kestrel breeding throughout the coastal plains in Georgia could be the subspecies, *Falco sparverius paulus*.

Only 2 of 17 subspecies of American Kestrels (*Falco sparverius*) occur in the southeastern United States (White 1994). *F. s. paulus* is a non-migratory resident that breeds from Florida, north to the coastal plains of Georgia, South Carolina, Alabama, and west to Louisiana and Texas (Chapman 1928; Griffin 1939, 1940; Norris 1941; Tomkins 1942, 1948; Brown and Amadon 1968; McFarlane 1973; Hoffman and Collopy 1987, 1988; Johnsgard 1990; Layne and Smith 1992). The northern subspecies (*F. s. sparverius*) only occurs in the coastal plains of the southeastern states as a common migrant and winter resident. Its breeding range extends from western Mexico to central Alaska in the west, and through central Canada in the east (Johnsgard 1990). *F. s. paulus* adults in Florida have a 24% smaller body weight than *sparverius* (Layne and Smith 1992), and some differences in plumage also have been noted (Baird et al. 1874, Wilson and Bonaparte 1878, Chapman 1928, Brown and Amadon 1968, McFarlane 1973).

A precipitous decline in populations of the Southeastern American Kestrel resulted in the classification of *F. s. paulus* as threatened in Florida in 1978 (Stys 1993). Most studies identified the loss of suitable nesting habitat as a major factor in causing this decline (Hoffman 1983, Bohall 1984, Hoffman and Collopy 1988). Burleigh (1958) listed the "Little American Kestrel" (*F. s. paulus*) as resident within the Coastal Plains, but local in its distribution. Neither baseline population figures nor any published accounts of kestrel densities in Georgia exist, but the Breeding Bird Survey (BBS) data imply that populations have been consistently low for about the past three decades (Fuller et

al. 1987, Price et al. 1995, B. Peterjohn pers. comm.). To survey statewide kestrel populations and promote the stabilization, and the eventual increase of the American Kestrel (*F. sparverius*) in Georgia, we erected nest boxes in Georgia's coastal plains, in areas of suitable habitat. Based on previous nest box studies (Hamerstrom et al. 1973, Cely and Sorrow 1988, Loftin 1992, Wheeler 1992, Jacobs 1995, J. Smallwood pers. comm.), we assumed that if we put up boxes across the state and, resident kestrels would begin using the boxes.

STUDY AREA AND METHODS

Four hundred and two nest boxes were constructed from untreated, rough-cut cypress, pine, or cedar boards 1.3 to 2.5 cm thick (Varland and Loughin 1993, J. Smallwood, pers. comm.). The general dimensions of the boxes were $23 \times 23 \times 37.5$ cm ($1 \times w \times h$), with a 7.6 cm hole 25 cm from the bottom of the front panel. A few boxes were arranged horizontally with the opening to the nest box located on the bottom rear corner of the box, in an attempt to dissuade European Starlings (*Sturnus vulgaris*) use of the boxes.

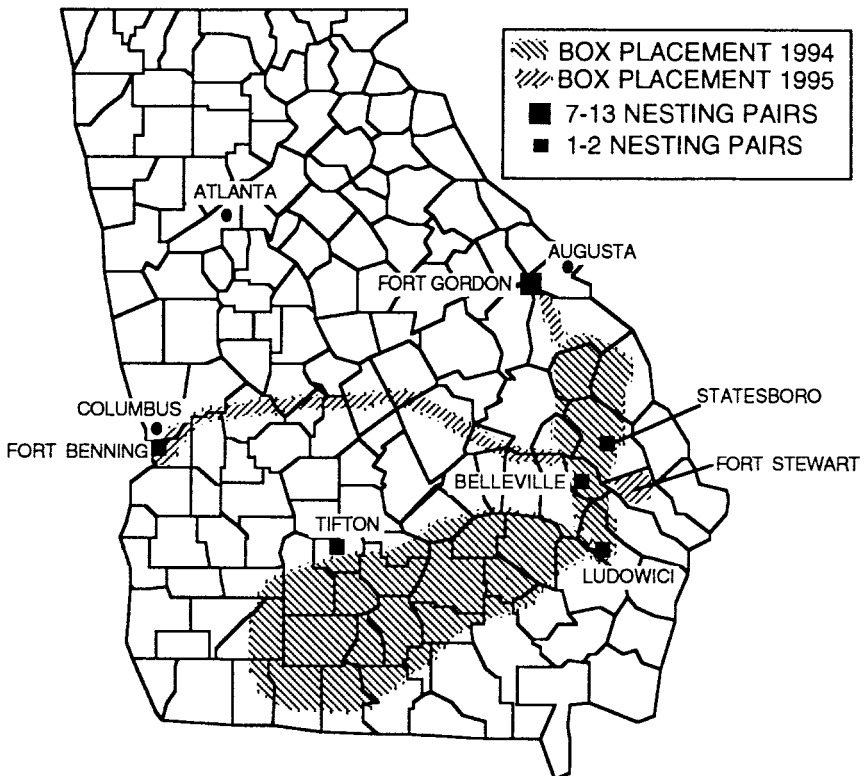


Figure 1. Southeastern American Kestrel nest-box placement and nesting locations within the coastal plain of Georgia during 1994 and 1995.

Nest boxes were erected between January and March in both years of the study. In 1994, 29 nest boxes were placed on Fort Gordon military base (Richmond County), southwest of Augusta. Also, 201 nest boxes were placed along transects extending from Girard (Burke County) south to Jesup (Wayne County), and across southern Georgia to Thomas County in southwestern Georgia (Figure 1). In 1995, 42 additional boxes were placed at Fort Gordon, and 130 other boxes were spread across other areas of the coastal plains as follows: on Interstate 16 highway signs from Statesboro to GA 96, then west to Columbus (Chatahoochee County) at Fort Benning military base; along U.S. 25 from Statesboro (Bulloch County) north to Hepzibah (Richmond County); at Joseph Kennedy Farm Correctional Institute (Toombs County); at Rogers Correctional Institute (Tattnall County); and on Fort Stewart military base (Bryan, Liberty, Long, Tattnall, and Evans Counties) (Figure 1). Most nest boxes were spaced about 0.8 km apart, except on military bases where some were placed closer together. Boxes were mounted on utility poles, or trees 4 to 5m above ground, along roadways adjacent to pastures, fallow fields, agricultural areas, and hayfields. Approximately 3 cm of pine or cedar shavings were placed in the bottom of each box (wood shavings were not used in nest boxes at Fort Gordon in 1994). Nest boxes were checked at least once a month from March through the end of July for eggs or young. Ages of young were estimated after Griggs and Steenhof (1993).

Fifteen adult kestrels were captured in the summer for banding and measurements using a bal-chatri trap. Mass was obtained with an electronic balance accurate to 0.1g, and measurements of the middle toe, middle talon, beak, and beak and cere lengths were made using digital calipers accurate to 0.01mm. Not all measurements were made on all birds handled. Permanent residency was assessed by re-trapping the summer-banded kestrels during the subsequent winter.

Statistical analyses were done with JMP 3.0 (SAS Institute Inc. 1994). A z -test of the difference between two independent proportions was used to analyze differences in nest box occupancy and nesting success between Fort Gordon and all other nest boxes between and within years (Kachigan 1986). The difference in measurements between adult female and male kestrels were analyzed by a one-tailed Student's t -test. Comparisons were made between reproduction at Fort Gordon and all other nestbox sites, because of the higher population levels at Fort Gordon. All results were considered significant if a probability (P) value of 0.05 or less was obtained.

RESULTS

Overall, kestrel nest box occupancy did not differ significantly between 1994 (2%) and 1995 (4%) ($z = 1.76, P > 0.05$). Kestrels nested in 10% of 29 nest boxes inside Fort Gordon, which was significantly greater than nest-box use in the remainder of the state in 1994 (1% of 195) ($z = 3.17, P < 0.05$). In 1995, they nested in 21% of 71 nest boxes at Ft. Gordon and 0.3% of 331 other boxes monitored in 1995, also a significant difference ($z = 7.05, P < 0.05$).

Kestrels laid at least one egg in boxes 21 times during the two-year study. Thirteen (62%) of the nesting attempts were successful (fledged at least one kestrel). Nesting success (percentage of boxes in which at least one young fledged) was significantly higher in 1995 (75% of 16 boxes) than 1994 (20% of 5 boxes) ($z = 2.30, P < 0.05$). In 1994, one of three boxes used by kestrels in Fort Gordon was successful, whereas neither of the two boxes used by the same pair of kestrels in another area of the state was successful. During breeding in 1995 kestrels were

Table 1. Hatching success and sex of American Kestrel young fledged from nest boxes with complete clutches (at least 4 eggs) in the coastal plains of Georgia.

Location	Year	No. nest boxes	No. nests	No. eggs laid	No. young fledged	No. males fledged	No. females fledged
Fort Gordon	1994	29	3	13	3	3	0
	1995	71	13	67	49 ^a	23	17
Other sites	1994	201	1	5	0	0	0
	1995	331	1	4	4	1	3
Totals			18	89	56	27	20

^aNumber is greater than the total number of males and females fledged because sex was not determined before young fledged in two nest boxes.

successful in 11 of 15 (73%) nest boxes used in Fort Gordon, and one other nest box about 165 km south of Fort Gordon.

Eighty-nine eggs were laid in the 18 complete-clutch nests (minimum of 4 eggs per nest) during the two-year study, with a mean of 4.94 eggs per clutch (range = 4 to 6) (Table 1). An average of four young (range = 3 to 6) per box fledged from the 14 successful nest boxes. There were slightly more males than females fledged during the two-years of the study (Table 1). Two single-sex clutches were observed, one of three males in 1994, and one of five males in 1995.

Nests in other artificial structures also were documented during the study. In 1994 two pairs nested in buildings on Fort Gordon and fledged three and four young. A pair that nested in a house near Bellville (about 40 km southwest of Statesboro) fledged at least one young. A nest in a metal cross beam at a power substation in Statesboro was unsuccessful. Two pairs nested in buildings at Fort Gordon in 1995 and fledged at least one young each. Based on extensive field observations, no other pairs of kestrels nested at Fort Gordon or the vicinity in either 1994 or 1995. Only one other pair of kestrels (near Ludowici) was observed during numerous trips covering nearly 10,000 km throughout the coastal plains of Georgia during the study; however, we received reports of birds breeding in Tifton, and Fort Benning, near Columbus (Figure 1).

The earliest date of nest initiation was 10 April and the latest was 18 May in the known nests that fledged at least one kestrel in 1994. Of the 14 successful nests in 1995 the earliest date of nest initiation was 22 March and the latest was 15 May.

Eight kestrels were banded as nestlings at Fort Gordon military base and 15 adults (one in Evans County and 14 at Fort Gordon) were captured and banded in 1994. Four kestrels (one juvenile and three

adults) banded at Fort Gordon in the summer of 1994 were re-trapped there between January and February 1995, two within 100 m of their original capture-sites.

Adult females were significantly heavier ($t = 1.77, P < 0.05$; Table 2) and also had significantly larger combined beak and cere lengths than males ($t = 1.92, P < 0.05$; Table 2). Females also had slightly longer beaks, middle toes, and middle claws, but the differences were not significant (Table 2). Nestling kestrels were divided into five age groups. The mass of the females was significantly greater than the males at all five stages between two and four weeks of age (two-tailed t -test, $P < 0.05$; Table 3).

In addition to the American Kestrel, 10 other species of cavity-nesting birds used the nest boxes during the two-year study (Breen 1995). Starlings nested in all of the boxes with the entrance hole on the bottom rear of the box.

DISCUSSION

Availability of suitable nest cavities in trees or other structures, the presence of adequate prey, and open habitat seem to be the most important factors for successful breeding of American Kestrels in the United States (Balgooyen 1976, Johnsgard 1990). In the southern coastal plains, particularly in Florida, nest sites seem to be the major limiting factor for Southeastern American Kestrels (*F. s. paulus*) (Bohall-Wood and Collopy 1986, Loftin 1992).

Compared to other kestrel nest-box programs in the United States (Stahlecker and Griese 1979, Wilmers 1982, Varland and Loughin 1993), nest box occupancy by kestrels in our study area was exceptionally low in both years of the study (2 to 4%). Low occupancy was expected, because only 50 American Kestrels had been reported on more than 1100 BBS routes run in Georgia during the past 28 years (B. Peterjohn pers. comm.), and recent surveys by wildlife biologists at the Georgia Department of Natural Resources had indicated exceptionally low numbers of kestrels in the state (B. Winn pers. comm.).

The nesting success (62%) of kestrels over the two years of our study was within the range found in other nest box studies in North America (20 to 83%) (Hamerstrom et al. 1973, Stahlecker and Griese 1979, Toland and Elder 1987, Varland and Loughin 1993, Jacobs 1995). The absence of wood chips in the 1994 nest boxes at Fort Gordon likely accounts for the fact that all of the eggs cracked in the two unsuccessful boxes. The eggs were laid on top of a partially-built starling nest in the one successful nest on the base that year. The earliest and latest egg laying date for the kestrels nesting in our study are similar to those reported for *F. s. paulus* in Florida (Loftin 1992, J. Smallwood pers. comm.) and South Carolina (Cely and Sorrow 1988), and the av-

Table 2. Size comparisons of adult American Kestrels (*Falco sparverius*) trapped in the Georgia coastal plains during the spring and summer of 1994 and 1995.

	Male				Female			
	n	Mean	SE	Range	n	Mean	SE	Range
Mass (g) [*]	9	97.1	1.62	88.0-104.2	6	102.0	1.98	95.1-107.5
Beak and cere (mm) [*]	8	14.6	0.44	11.5-15.8	6	15.9	0.51	14.7-17.3
Beak (mm)	8	11.3	0.36	8.8-12.6	6	12.3	0.42	10.9-12.9
Middle toe (mm)	9	20.2	0.41	17.4-21.3	6	20.8	0.50	19.4-22.7
Middle talon (mm)	9	9.1	0.34	6.1-9.6	6	9.3	0.42	7.8-10.5

^{*}Females significantly ($P < 0.05$) larger than males (one-tailed t -test).

Table 3. Mass of male and female nestling American Kestrels banded in south Georgia. Females were significantly larger than males ($P < 0.05$, two-tailed t -test) at all age intervals.

Age interval (days)	Male			Female		
	n	Mean	SE	n	Mean	SE
14-16	3	85.2	6.5	2	108.7	7.7
17-19	7	105.0	3.5	5	115.8	2.2
20-22	10	114.1	0.9	4	124.5	0.9
23-25	5	108.7	2.8	9	118.7	1.7
26-28	2	103.7	2.8	3	116.2	3.3

erage clutch size was similar to other nest-box studies (Loftin 1992, Varland and Loughin 1993).

It became apparent after the first year's observations that there were more kestrels nesting at Fort Gordon military base than there were throughout the rest of the state. Small numbers of kestrels have apparently nested in old barracks and other buildings at Fort Gordon for over 20 years (Denton 1975). Unfortunately, most of those structures were removed at the end of 1995. We believe that 11 pairs of kestrels that bred at Fort Gordon in 1995 were probably derived from the 1994 stock and not from immigrating birds, because we extensively surveyed the base and surrounding areas for nesting activity in 1994. Jacobs (1995) reported 7 of 10 kestrels returned to breed within 35 km of their hatching site even in migratory kestrels (*F. s. sparverius*). Three other reports of kestrels nesting in Georgia (Figure 1) were far south of Fort Gordon.

The re-trapping of four summer-banded kestrels at Fort Gordon the following winter is indicative of a year-round resident population. Also, recorded masses, middle toe and claw lengths (Table 2) are essentially the same as the size-ranges of *F. s. paulus* in Florida (Layne and Smith 1992, J. Smallwood pers. comm.). Resident status and small size indicate that the kestrels breeding in our areas are *F. s. paulus*. This is further supported by the fact that we have counted more than 200 kestrels in Bulloch County during the winter (Halas and Parrish, unpublished), but have had only a single pair present during the summer. Presumably, the winter birds were mostly *F. s. sparverius*, since summer *paulus* kestrels appeared to disperse no more than about 40 km from their breeding areas in the early fall after reproduction was complete (Breen 1995).

All 26 confirmed kestrel nest sites in nest boxes and other artificial structures were located in sandhill habitats that dominate the coastal plains. Fort Gordon, where most of the kestrels nested, lies on the upper edge of the fall line of the coastal plains and is dominated by sand-

hill communities made up of scrub oaks and various pines. This propensity for sandhill nest sites is identical to *F. s. paulus* breeding preferences in Florida, where kestrels nest in longleaf pine (*Pinus palustris*) - turkey oak (*Quercus lacevis*) sandhill communities (Bohallowood and Collopy 1987, Loftin 1992). Kestrels breeding in the coastal plains of South Carolina also have been reported to prefer sandhill communities (Cely and Sorrow 1988). All but a few of the nest sites at Fort Gordon are associated with the contonement area that is dominated by buildings, parade grounds and other open areas. The more remote nest boxes are situated near open small-firearm ranges. Several firearm ranges were closed by the base biologist to reduce interference with reproducing kestrels when boxes near those areas were used during the study.

Burleigh (1958) listed 11 counties in the coastal plains (Appling, Baker, Ben Hill, Burke, Camden, Charlton, Chatham, Long, Screven, Thomas, and Washington) where kestrels had been found in the summer in Georgia. Denton (1975) first reported breeding kestrels at Fort Gordon (Richmond County). We observed kestrels during the summer in only one of those counties (Long County), and four others not listed by Burleigh (1958) during the two years of our study (Breen et al. 1995). Through the 1997 nesting season, we have personally observed kestrels nesting in the following coastal plains counties: Appling, Bulloch, Columbia, Evans, Long, Richmond, and Tatnall (Breen et al. 1995, Shuford and Parrish unpubl.). We have received reports of single, kestrel nests also in Bryan, Clarke, Chatahoochee, Floyd, Fulton, Glynn, Tift, and Turner counties to date (Shuford and Parrish unpubl.). No further reports are available from the Georgia Breeding Bird Atlas studies (T. Schneider pers. comm.). It is apparent from our studies that the exceptionally low populations of the American Kestrel on the coastal plains appear to warrant its listing as threatened in Georgia.

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