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Survey of Reproduction of the Southeastern American Kestrel (Falco Sparverius Paulus) in Electrical Transmission Towers in South-Central Georgia

Pamela Lynn Maney
Georgia Southern University

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SURVEY OF REPRODUCTION OF THE SOUTHEASTERN AMERICAN KESTREL

(Falco sparverius paulus) IN ELECTRICAL TRANSMISSION TOWERS IN SOUTH-CENTRAL GEORGIA

by

PAMELA L. MANEY

(Under the Direction of John W. Parrish)

ABSTRACT

This study involved a survey of the distribution, and the reproductive biology of the rare southeastern subspecies of the American Kestrel, Falco sparverius paulus, which was found to be breeding in the hollow cross-arms of the 230 kV electrical transmission towers between the Offerman substation in the east, to Plant Mitchell (Putney), in the west, in south-central Georgia. This subspecies of the kestrel has declined in the southeastern United States by more than 80% over the last fifty years, and populations of F.s. paulus have nearly disappeared below the Fall Line in Georgia. The major factor contributing to this decline is the lack of adequate nest sites in this obligate secondary cavity nester. The current research showed this population in south-central Georgia to be the largest population of kestrels anywhere in the state of Georgia, and likely larger than any other population in the southeastern U.S., other than in central Florida, with more than two hundred-fifty nesting pairs being found in both summers of the study. The highest usage of tubular poles occurred when a second, nontubular, line ran parallel with the tubular, cross-armed line. A higher number of kestrels were observed nesting in poles that were located in farmland regions in both 2003 and 2004 than woodland or residential regions. In addition, kestrels were observed to nest in a tubular PVC-nest site, which was
erected as a possible alternative nest site should any of the tubular, cross-armed
transmission towers have to be removed in future years. Overall, this research continues
the collection of data on *F.s. paulus* in southern Georgia, and continues to provide
essential demographic data of this subspecies of concern in Georgia, as has been shown
in previous studies of this subspecies in Florida.

INDEX WORDS: Southeastern Kestrel, American Kestrel, *F.s paulus*, Electrical
Transmission Towers, Reproduction, Demographics, Nesting
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(Falco sparverius paulus) IN ELECTRICAL TRANSMISSION TOWERS IN SOUTHCENTRAL GEORGIA

by

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B.S., Georgia Southern University, 2002

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by

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Jonathan Copeland

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DEDICATION

This thesis is written in recognition of my parents, Raymond and Sally Maney, for their support and guidance growing up. They taught me to reach for higher stars and obtain the goals that I set for myself. They have encouraged me to pursue a higher education and never quit. The pride radiating from them always helped me to work hard and do my best. I know that I will always be their little girl and they will love me forever no matter what.
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Kestrels in Decline

Birds all across the world once had vast continents to range over. The numbers of birds were numerous in many instances. Within the past 250 years, more than 140 bird species have become extinct. Many birds are not endangered but suffer because humans have altered the landscape. What was once grassland habitat has now turned into farmland or urban areas. In Southern Europe, the Lesser Kestrel (*Falco naumanni*) hunts for insects in open country. Pesticide usage has killed off many of these insects, leaving the Lesser Kestrel at risk (Woodward 1997). Logging almost wiped out the Mauritius Kestrel (*Falco punctatus*), which lives on the island of Mauritius, in the Indian Ocean. The trees provided a nesting place and food supply for the kestrels. In 1974, only 6 Mauritius Kestrels were left (Woodward 1997). Kestrels are also more prone to roadside accidents due to their attraction to the mice and insects that live in the coarse grasses of along side motorways (Whitlock 1981).

Enderson (1960) thought that limited access to quality perches and roosting sites limited the abundance of wintering American Kestrels (*Falco sparverius*) in Indiana. American Kestrels tended to use areas with artificial perches more than they used natural, wood vegetation. American Kestrel perch-use was also limited by landscape type and ground cover density (Kim et al. 2003). In a recent study, it was found that the nest success of the Southeastern American Kestrel (*Falco sparverius paulus*) was positively related to cavity height (Gault et al. 2004). The decline of the Southeastern American Kestrel also may be due to the loss of longleaf pine habitat and degradation of the
remaining longleaf habitat due to fire suppression, and removal of old-growth trees and snags (Gault et al. 2004).

The American Kestrel (*Falco sparverius*) is the smallest falcon found in North America. It would be the smallest falcon in the world if the Seychelles Kestrel (*Falco araea*) were not smaller. American Kestrels are widely distributed throughout the Americas. Their breeding range extends as far north as central and western Alaska, across Northern Canada, and extends south throughout North America, the Baja, into central Mexico, as well as Central and South America (Figure 1) (White 1994).

Only 2 of 17 subspecies of American Kestrels occur in southeastern United States (White 1994). *Falco sparverius paulus* is a non-migratory resident that is found breeding in South Carolina, Alabama, Louisiana, Georgia, and Florida (Chapman 1928). *F.s. paulus* is a permanent breeding resident that is found throughout the Piedmont and Coastal Plain of Georgia, and is listed by the Georgia Department of Natural Resources as a subspecies of special concern. The other subspecies is the northern subspecies (*Falco sparverius sparverius*), which possibly nests in montane, northern Georgia (Burleigh 1958, Parrish et al. 2006). *F.s. sparverius* is only found in the coastal plain of the southern half of Georgia as a common migrant and winter resident (Johnsgard 1990).

American Kestrels are obligate secondary cavity nesters. They do not add their own nesting materials to nest sites. American Kestrels require suitable nest cavities in trees or other structures, the presence of adequate prey, and open habitat for successful breeding in the United States (Johnsgard 1990). A decline in the population of *F.s. paulus* has resulted in it being declared a threatened subspecies in Florida in 1978 (Stys 1993). The losses of suitable habitat and nest sites have been found to be the two major
factors accounting for the decline in kestrel numbers (Hoffman 1983, Stys 1993). According to the Breeding Bird Survey (BBS) data, populations in Georgia have been consistently low for about the past four decades (Fuller et al. 1987, Price et al. 1995).

A number of studies have attempted to improve the reproductive success of kestrels by improving nesting success. A four-year study in Florida revealed that increases in populations occurred after nest boxes were distributed near Gainesville. Nesting success improved from the first year, when 30 young were produced, to 127 the next year, 269 the third year, and 385 the fourth year (Smallwood and Collopy 1991). In a subsequent study conducted by Breen and Parrish (1997), nestboxes were posted in Georgia’s coastal plain, in order to see if populations would eventually increase. They found low occupancy occurring during both years of the nestbox study. Those numbers were expected due to the fact that only 50 American Kestrels had been previously reported on BBS routes during the past 28 years. Also, Georgia Department of Natural Resources had reported exceptionally low numbers of kestrels in the state (B.Winn pers. comm.). However, over the past decade of further nestbox studies in Georgia, increases have occurred from 3 young fledged during the first year, to 49 fledged the second year, and an average of almost 90 nestlings that have fledged from nestboxes during each of the past seven years (Breen et al. 1995; Breen and Parrish 1996, 1997; Boyd et al. 2003; Parrish per. comm.).

**Study Species**

The American kestrel, *Falco sparverius*, is in the taxonomic classification Falconidae, Falconiformes, (family and order, respectively). It is a swallow-like falcon about the size of a jay. The kestrel is the smallest falcon found in North America, and besides the Seychelles kestrel (*Falco araea*), it is the smallest in the world (UMN 2004).
The American kestrel is the only small falcon that has a rusty-colored (rufous) back and tail. The males are brightly colored with blue-gray wings and a blue head with a rusty cap. The females have a more even tone throughout their body that is not as brightly colored. Both sexes have a mustached black-and-white face pattern (Peterson 1980). The males weigh about 103 to 120 grams. The females weigh about 126 to 166 grams. The kestrel is 19-21 centimeters in length and has an average wingspan of 50-60 centimeters (McCollough 2001, Breen 1995, Shuford 1998).

Kestrels are adaptable hunters and will take a wide variety of prey including small rodents, small birds, lizards, large insects, and earthworms. Their flexibility in diet allows them to live in many kinds of environments, ranging from busy cities to open, rural areas. Kestrels are predominately open-country birds, absent from dense woodlands unless there are clearings where they can hunt (Village 1990).

Kestrels are monogamous, and are highly territorial around the nest. Breeding pairs are usually spaced some distance apart, but the separation can vary considerably. Pairs occasionally breed in small groups or colonies (Village 1990). For up to six weeks before the eggs are laid, the females mate with two or three males. Once she settles with one mate, the pair copulates frequently until time to lay the eggs (McCollough 2001). Three to seven eggs are laid at a time (UMN 2004). The lightly streaked eggs are white, cream, or pale brown with an average size of 35 x 29mm. The female mostly incubates the eggs, with the male relieving the female several times per day. Usually 30 days after the eggs are laid, they will hatch with about three to seven young. The female begs for food from the male during incubation, and during the first week after the young are hatched. The female feeds the young for about two weeks, then the chicks beg for food from both males and females (McCollough 2001). The nestlings grow at a rapid rate.
reaching adult weights after two and a half weeks (Breen and Parrish 1997, Shuford 1997, UMN 2004). The young birds will fledge from the nest about a month after hatching. The family will stay as a unit for some time (McCollough 2001). If the first nest fails, the kestrels will usually attempt to renest. They have been reported to raise two broods per year in some of the southern states (Breen and Parrish 1995, UMN 2004). Under natural conditions, the survival rate of chicks is about 50%, however, in better conditions, such as human-provided nesting boxes, the rate is usually higher (McCollough 2001).

230 kV Electrical Transmission Towers in South-central Georgia

A large numbers of kestrels were recently discovered nesting in the hollow, tubular cross-arms of 230 kV electrical transmission towers (Figure 2) in south-central Georgia, between Pierce Co., in the east, to Dougherty Co., in the west (Snow and Parrish 2002). Preliminary summer surveys showed at least 50 pairs of southeastern kestrels were nesting in the transmission towers (Snow and Parrish 2003). Based on those results, it was apparent that those nesting sites were maintaining not only the largest single population of kestrels in Georgia, but also all of southeastern United States, with the exception of Florida. It was considered possible that more than 100 pairs of kestrels were nesting in those transmission towers. However, the towers have been in place for more than 50 years and safety issues have become a concern due to rusting of the towers. A number of rusted-out towers have already been replaced. The replacement towers possess lattice (non-tubular) cross-arms and do not provide any nesting cavities (Figure 3). Therefore, it was considered crucial to conduct a thorough investigation to determine
the total number of tubular, cross-armed transmission towers used as nesting sites by the kestrels.

Objectives

The purpose of this study was to provide further data on the Southeastern American Kestrel for the continuing ten-year study of the demographics of *F.s. paulus* in southeastern Georgia, by collecting data on the numbers and breeding sites of *F.s. paulus* in the tubular, cross-armed transmission towers in the south-central region of Georgia. The transmission towers actually used were monitored in order to determine the extent of use of each tower by nesting kestrels. Since tubular cross-arms were being replaced with nontubular structures due to rusting, various types of alternative nest structures were placed on towers and observed for nesting kestrels. This study should document that the tubular, cross-armed transmission towers benefit the kestrel by providing suitable nesting cavities, and that a sizeable population of kestrels exists in south-central Georgia.
CHAPTER 2
MATERIALS AND METHODS

Study Site

*F. s. paulus* is a resident in the southern half of the state of Georgia, but it is rather local in its distribution, and nowhere common (Burleigh 1958, Breen and Parrish 1997). This study was conducted in south-central Georgia, between Putney and Offerman (Dougherty Co. and Pierce Co., respectively), Georgia (Figure 4). Putney is in the western part and Offerman is in the eastern part of Georgia (Figure 5). The towers run as a single line, then are accompanied by a second, nontubular line in the middle three-fifths, and then turn back into a single line again. The single line has a rights-of-way of about 30m and the double line has a rights-of-way of about 60m.

The power lines run through a variety of landscapes. The three main types are farmland, residential areas, and woodlands (Figure 6). The farmland has open fields of crops with occasional human activities such as plowing, cultivating, or harvesting of the crops. The residential areas consist of one or more houses in close proximity to the lines and where daily human activities exist (Figure 6). The woodlands have little nearby human development and consist of a border of trees on the sides of the rights-of-ways (Figure 6). There is about 0.2 km between towers (about 5 transmission towers per km). The tubular cross-arms have a diameter of about 15.2 cm at the openings and expand to about 25 cm in the middle, are approximately 12 m in length, and most are more than 30 m high (Figure 7).
Data Collection

Observations of kestrels at the towers were made monthly from March to August in both 2003 and 2004. The main focus of the study was to determine the exact transmission towers in use during each of those months for both years.

Kestrels were located using a Bushnell spotting scope (30X by 60mm). The transmission towers where kestrels were sighted were used to determine nesting locations and nesting success rates. The number of individuals at each tower and the sex of each kestrel were recorded for each month. The presence of other species of birds was also recorded for each month. Since kestrels are dominant birds, no other species would coexist with them in the tower. The amount of observation time spent at each location varied depending on the activity at that particular time, but generally ranged between 20 to 30 minutes. Observations at the towers were often replicated between stops, since previously viewed towers could again be observed at adjacent stops. The type of landscape surrounding the pole and whether the pole was in the single- or double-lined section was recorded.

Statistical Analysis

Statistical analyses were done using JMP 3.0 (SAS Institute Inc. 1994). A Chi-square test was used to determine if there were a significant difference between the usage of single- and double-lined poles. The Chi-square was also used to determine if the usage of poles in different landscapes were significant. A G-test was used to analyze whether the pole arrangement (single or double-lined) and landscape types were independent of each other. All results were considered significant if a probability (P) value of 0.05 or less was obtained.
CHAPTER 3

RESULTS

Overall, the kestrels were found nesting in more poles than was expected from the preliminary summer survey. There was a significantly higher usage of poles in the double-lined section than the single-lined section (in 2003, $\chi^2=35.05$, d.f. = 1, $p=0.05$; in 2004, $\chi^2=29.85$, d.f. = 1, $p=0.05$). There also was a significant difference in landscape type in 2003 ($\chi^2=6.2$, d.f. = 2, and $p=0.05$), but not a significant difference in 2004 ($\chi^2=2.74$, d.f. = 2, and $p=0.05$). The number of kestrels inhabiting poles in each line type (single and double-lined) varied within the different landscapes ($g=22.781$, d.f. = 2, $p=0.000$).

The average monthly number of male and female Kestrels observed corresponded with expectations of what should occur during their breeding season. Male numbers were low in March as males searched for food to feed the female (Johnsgard 1990) in order to maintain the pair bond between each pair (Figure 9, Figure 10, Figure 11). Females were high in number during March because that is when they began laying eggs in both years, and because it is most likely that the females protected the nest sites at the transmission towers, until incubation began. The number of females observed in April decreased as females began incubating eggs inside the tubular, cross-arms for the 30-day incubation period. On the other hand, male observations in April increased as males brought food to the incubating females. Females became more frequent again in May, as the eggs hatched, and they contributed to feeding the hatchlings. Both males and females fed the fledglings by foraging in the areas surrounding the tower, therefore, they were not observed as frequently in June. During July and August, several fledglings juveniles
were present on the towers, as well as the adult males and females (Figure 9, Figure 10, Figure 11).

Male and female kestrels were observed at least twice between March and June at 274 of the transmission towers in 2003, and at 296 of the transmission towers in 2004 (Table 1). The highest usage of tubular poles occurred when a second, nontubular, line ran parallel with the tubular, cross-armed line, between Alma and Tifton. The usage by nesting kestrels averaged about 152 towers (84%) along the Alma to Tifton transect for the two years of the study (Table 1). The Tifton to Sumner transect also had tubular cross-armed transmission towers with a second line (nontubular) running parallel to it. Kestrels used only 38 of the tubular, cross-armed transmission towers, however, that total represented all (100%) of the useable towers along that transect in both summers (Table 1). Nearly 88% of the towers used by kestrels in 2003, were reused for nesting in 2004.

The lowest use of the transmission towers, during both years of the study, occurred where the line runs alone on the eastern end of the transect. In the eastern end, from Offerman to Alma, an average of 35 (52%) of the usable towers had nesting kestrels (Table 1). The western end, from Sumner to Putney, which also consisted of a solitary line of tubular, cross-armed towers, exhibited a similar situation. However, the western end had a higher average of about 60 poles (72%) that were used for nest sites by the kestrels during the two-year study (Table 1). There were significantly fewer towers used where the line was solitary, on both the eastern and western ends (in 2003, $\chi^2=35.05$, d.f. = 1, p=0.05; in 2004, $\chi^2=29.85$, d.f. = 1, p = 0.05), than when there was a second, nontubular, line adjacent to the tubular, cross-armed towers (Figure 12).
Farmland sites with towers had the highest number of kestrels using poles for nesting in both 2003 and 2004. In 2003, the woodland and residential regions had the exact same number of kestrels present (n= 77) (Figure 13). In 2004, the woodland region (n= 97) had more kestrels present than the rural region (n = 82). The results of a Chi-squared test revealed that there was a significantly greater usage of farmland poles by kestrels than for woodland and rural regions in 2003 ($\chi^2 = 6.2$, d.f.= 2, and $p= 0.05$) (Figure 13). However, in 2004, there were no significant habitat usage differences according to the Chi-squared test ($\chi^2 =2.74$, d.f.= 2, and $p> 0.05$). Based on G-test results, the number of kestrels inhabiting poles in each line type (single and double-lined) varied within the different landscapes ($g=22.781$, d.f.= 2, $p= 0.001$) (Figure 14). A greater number of kestrels occurred when the second, nontubular, line ran parallel with the tubular, cross-armed line thru farmland (n= 103) and residential areas (n= 71). However in the woodlands, the single line (n= 59) had only five more nesting kestrels than the double-line (n= 54) (Figure 14).
CHAPTER 4

DISCUSSION

The present study of the demographics of Southeastern American Kestrels in south-central Georgia indicates that between 274 and 296 pairs of kestrels are nesting inside the tubular, cross-armed transmission towers every year. These figures indicate that these nest sites are housing the largest known kestrel population in the state of Georgia (Breen and Parrish 1997), and most likely the largest population of southeastern kestrels in the southeastern Coastal Plain, except Florida (Smallwood and Collopy 1991).

The transmission lines provide high perches, which kestrels, that spend a lot of time sitting and hunting, prefer. Any structure that is moderately inaccessible to mammalian predators, reasonably sheltered, and can hold eggs, is probably a potential site of high utility for kestrels. These conditions, along with their flexibility in diet, allow kestrels to be able to inhabit a wide variety of environments, including human-made structures (Village 1990).

Even though no significant difference was found, the percentage of kestrels nesting in each type of landscape was expected. Kestrels are predominately open-country birds, absent from dense woodlands unless there are clearings where they can hunt (Village 1990). Since the single line, with right of ways of about 30m, runs mainly through pine forest, and residential areas with human habitation, a small number of kestrels were found along the towers where the line is solitary (Table 1, Figure 14). That type of habitat provides insufficient hunting opportunities for kestrels. When the single line went through farmlands and pastures, an increase in nesting kestrels was observed (Table 1, Figure 14). The middle section of the transect contained a second line that
paralleled the tubular, cross-armed tower. Having a 60m right of way (ROW), gave the kestrels a place to nest in spite of the fact that the transmission towers ran through some areas of dense woodlands. The additional ROW space also provided a larger hunting ground for prey. Kestrels were found to be nesting in only about 60% of the towers in which there was a single line of poles, but they nested in more than 85% of the towers with a double lines of poles (Table 1).

Since the tubular transmission towers were erected around the 1950s, some of the tubular cross-arms have rusted beyond repair. They have been replaced with nontubular structures, leaving the kestrels without nesting sites. This problem is being addressed by placing various types of alternative nest sites when the tubular cross-arms are being replaced. An alternative nest structure was placed on tower number 87 in the fall of 2003 after a new substation was built nearby (Figure 8). The alternative nest structure was constructed from UV-resistant PVC tubing, with a diameter of about 30.5 cm. The PVC tube was about 91 cm long, and had a 7.6 cm diameter hole cut into one of the caps placed over each of the ends of the PVC tubing (Figure 8). The inside of the tube was filled with a layer of pine-straw, since kestrels do not add nest materials to their nest sites. A pair of kestrels fledged young using the PVC-tube nest-site in 2004. None of the other variously-shaped PVC tubes or nest boxes that were put up on non-tubular, cross-armed towers in the spring of 2004 were used by Southeastern American Kestrels. Since the structures were put up late in the spring nesting season, they may have not been put up early enough to be attractive to kestrels as nest sites. The structures will potentially be used in subsequent summers. Kestrels successfully nested in six out of eight nest boxes that were put up in late spring near the Butler substation in central Georgia, where
identical, tubular, cross-armed transmission towers had been removed earlier in the spring of 2004 (Parrish pers. comm.). The use of those boxes suggests that kestrels will use alternative structures when they are desperate for available nest sites. Therefore, it is imperative to continue to observe the new alternative structures in 2005 and beyond, in order to determine the best type of alternative nest sites, which might provide suitable nest sites for the kestrels, during and after the removal of any of the tubular, cross-armed transmission towers in future years.

Although it was not an issue studied in the current project, a number of recent studies have examined the effects of electromagnetic fields (EMF) on American Kestrels. Fernie and Bird (1999a) found that both short- and long-term exposure of captive kestrels to EMF affected melatonin levels, and advanced the onset of molt and increased body mass in males. Melatonin levels were suppressed at 42 days, but elevated after 70 days of EMF exposure in male kestrels (Fernie and Bird 1999a). Melatonin levels were also suppressed in long-term exposure in fledglings (Fernie and Bird 1999b). EMF exposure also increased nestling and fledgling weights (Fernie and Bird 2000). Oxidative stress was elevated by one season of EMF exposure in male kestrels as well (Fernie and Bird 2001). Further studies will be necessary to determine if kestrels nesting in the transmission towers in south-central Georgia are similarly affected by high EMF exposure. Certainly, the fact that reproduction was similar in both years (Table 1) implies that EMF exposure is not preventing the kestrels in Georgia from maintaining recruitment levels high enough to sustain the population being exposed to those high levels of EMF.
Table 1. Southeastern American Kestrel use of tubular, cross-armed transmission towers as nest-sites along an 80km transect from Offerman to Putney, Georgia, in the summer of 2003 and 2004. The tower transects consist of a single line on both the eastern (Offerman to Alma) and western ends of the transect (Sumner to Putney), but has a second parallel (nontubular) line between Alma and Sumner, Georgia.

<table>
<thead>
<tr>
<th>Transect</th>
<th>Usable/Total poles</th>
<th>Poles used ’03 (%)</th>
<th>Poles used ’04 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offerman to Alma (single line)</td>
<td>66/93</td>
<td>32 (48%)</td>
<td>38 (57%)</td>
</tr>
<tr>
<td>Alma to Tifton (double line)</td>
<td>182/241</td>
<td>148 (81%)</td>
<td>157 (86%)</td>
</tr>
<tr>
<td>Tifton to Sumner (double line)</td>
<td>38/43</td>
<td>38 (100%)</td>
<td>38 (100%)</td>
</tr>
<tr>
<td>Sumner to Putney (single line)</td>
<td>82/94</td>
<td>56 (68%)</td>
<td>63 (77%)</td>
</tr>
<tr>
<td>TOTALS</td>
<td>368/470</td>
<td>274 (74%)</td>
<td>296 (80%)</td>
</tr>
</tbody>
</table>
Figure 1. A recent Breeding Bird Survey map of the summer distribution of the American Kestrel, *Falco sparverius*, in Canada and the United States.
Figure 2. A 230 kV electrical transmission tower in south-central Georgia.

Figure 3. A PVC replacement nest site on a tower which possess lattice (non-tubular) cross-arms which previously did not provide any nesting cavities.
Figure 4. The map of where the study was conducted in south-central Georgia, between Putney and Offerman (Dougherty Co. and Pierce Co., respectively), Georgia.
Figure 5. A close-up map of where the study was conducted in south-central Georgia, showing both Putney (west end) and Offerman (east end).
Figure 6. The three main types of landscapes that the power lines run through are:

a) farmland, b) residential areas, and c) woodlands.
Figure 7. A close-up of the hollow, tubular cross-arms of 230 kV electrical transmission towers.

Figure 8. An example of an alternative nest structure placed on towers when the tubular cross-arms are being replaced.
Figure 9. Monthly totals of male Southeastern American Kestrels observed at individual transmission towers in south-central Georgia in 2003 and 2004.
Figure 10. Monthly totals of female Southeastern American Kestrels observed at individual transmission towers in south-central Georgia in 2003 and 2004.
Figure 11. Average monthly totals of male and female Southeastern American Kestrels observed at individual transmission towers in south-central Georgia in both 2003 and 2004.
Figure 12. Comparison of how single- and double-lined power poles affect the number of poles used by Southeastern American Kestrels in 2003 and 2004 (in 2003, $\chi^2=35.05$, d.f.= 1, p=0.05; in 2004, $\chi^2=29.85$, d.f.= 1, p= 0.05).
Figure 13. A comparison of number of poles used by Southeastern American Kestrels in 2003 and 2004 for three different landscape types (woodlands, rural, and farmland) (in 2003, $\chi^2 = 6.2$, d.f. = 2, and p = 0.05; in 2004, $\chi^2 = 2.74$, d.f. = 2, and p > 0.05).
Figure 14. Average number of poles occupied by nesting kestrels, for 2003 and 2004, in different landscapes located within the single and the double-lined sections (g=22.781, d.f.= 2, p= 0.001).
LITERATURE CITED


