

**ECOLOGY AND HABITAT PROTECTION NEEDS OF
THE SOUTHEASTERN AMERICAN KESTREL
(*FALCO SPARVERIUS PAULUS*) ON LARGE-SCALE
DEVELOPMENT SITES IN FLORIDA.**

NONGAME WILDLIFE TECHNICAL REPORT NO. 13



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SECTION 1.

LIFE HISTORY CHARACTERISTICS AND GENERAL BIOLOGY



Figure 2. Adult male American kestrel. Note the two black streaks (moustaches) on the side of the head (Photo by Brian Toland).

DESCRIPTION

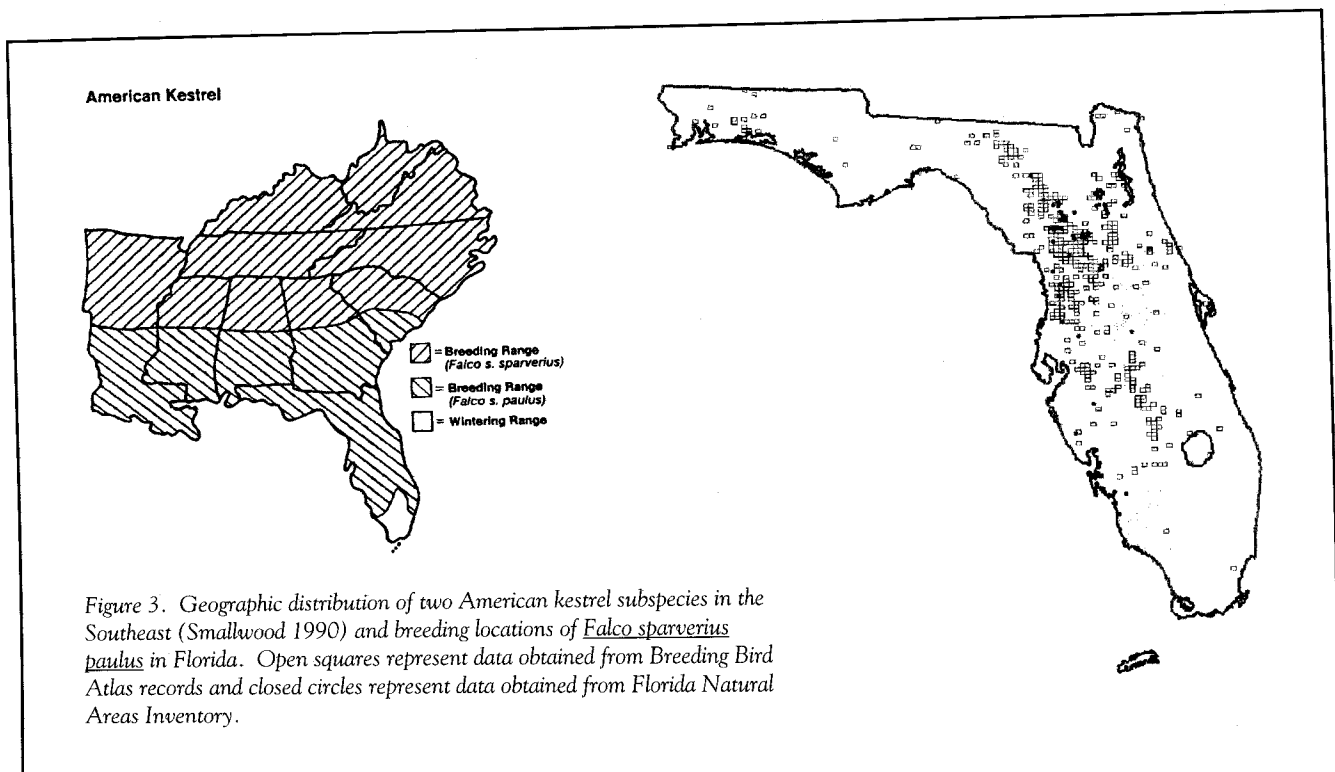
The American kestrel is the most colorful and smallest of the North American falcons. It can be identified by distinctive rufous coloration on its back and tail plumages (Bird and Palmer 1988). Both sexes have two black streaks (moustaches) on each side of the head (Figure 2) and a blue-gray patch encircling a rufous spot on the top of the head (reduced or absent in some) (Cade 1982). The southeastern kestrel is about the size of a robin, with the female larger (11.5%) than the male. The mean body weights of *F. s. paulus* are 90.8 g for males and 102.6 g for females (Layne and Smith 1992). The mean wing lengths of *F. s. paulus* are approximately 174.5 mm for the male and 181.7 mm for the female (Layne and Smith 1992). When alarmed or excited, the kestrel will give a shrill and distinctive

“killy” call in 3-6 short, rapid bursts (Wiley 1978).

The sexes are easily distinguished based on sexually dimorphic coloration. The male has blue-gray wings, a few transverse black flecks and bars on the back, and a buffy white underside with a few scattered black spots. Also, the male’s tail is unbarred except for a wide subterminal black band bordered by a narrow white tip. The female has rufous wings consistent with the coloration of the back, numerous black transverse bars across the back and tail, and a buffy white underside streaked with brown. Young birds attain an adult-like sexually dimorphic body plumage prior to fledging, a unique trait among North American raptors (Johnsgard 1990). Juvenile birds often can be differentiated from the adults for several weeks post-fledging, with the juveniles having a disproportionately shorter tail than the adults (B. Toland pers. comm.). Recently fledged kestrels also have a more conspicuous creamy tip to the tail, and have brighter plumage lacking flight feather molt during the summer and fall (J. Layne pers. comm.).

The appearance of the resident *F. s. paulus* male varies slightly from the wintering *F. s. sparverius* in the amount of spotting on the abdomen. However, the amount of spotting is highly variable, with young male *F. s. paulus* often so heavily spotted they are mistaken for females (Collopy 1989, J. Layne pers. comm.). Male *F. s. paulus* tend to have few spots, usually on the flanks under the wings, and darker buff coloration covering approximately two-thirds of the breast and abdomen, while male *F. s. sparverius* tend to have more spots, with spotting extending farther onto the abdomen and breast (Brown and Amadon 1968). In the field, females of the two subspecies are indistinguishable from one another. Both sexes of *F. s. paulus* average smaller than their northern counterparts, with the mean body mass of *F. s. paulus* about 22% (males) and 26% (females) less than that of *F. s. sparverius* (Layne and Smith 1992).

In the past, the American kestrel was frequently referred to as the “sparrowhawk.” This common name of the American kestrel was erroneously applied by the early European settlers upon their arrival in North America. Kestrels are in the family Falconidae and are



not closely related to hawks (Accipitridae), as suggested by the misleading name. The American kestrel is the only resident species of kestrel occurring in the western hemisphere.

RANGE

The American kestrel ranges throughout most of North America. The range of *F. s. sparverius* is widespread, breeding from Alaska southward through Canada and into North America, northerly and westerly of the breeding range of *F. s. paulus* (Johnsgard 1990) (Figure 3). The resident subspecies, *F. s. paulus*, has been reported breeding from southern portions of Louisiana, Mississippi, Alabama, Georgia, and South Carolina, and throughout all of Florida except the southern-most counties and the Keys (Smallwood 1990). Nesting occurs in scattered sites in the panhandle and throughout the peninsula, with the highest concentrations along the Central ridge from Highlands County to Suwannee County. In Florida, the wintering range of *F. s. sparverius* overlaps that of *F. s. paulus* (Bohall-Wood and Collopy 1986a). Year-round roadside censuses in north central Florida during 1981-82 revealed that 84% of all kestrel sightings occurred in the winter (Bohall-Wood and Collopy 1986a), a clear indication of the influence of wintering kestrels

on local populations.

The kestrel's range is thought to be limited by a combination of nest site availability, perch site availability, food supply, and suitable foraging habitat (Balgooyen 1976). The kestrel requires all of these elements in close proximity to one another. Nest site availability has drastically decreased in north central Florida due to removal of isolated longleaf pine trees from agricultural fields (Hoffman 1983). In addition, the availability of both nesting and foraging habitat has decreased in south central Florida due to conversion of longleaf pine-turkey oak (*Quercus laevis*) vegetation to citrus groves (Hoffman 1983).

DIET AND FEEDING BEHAVIOR

The major prey items of the southeastern American kestrel are insects, small rodents, reptiles, and occasionally birds (Wiley 1978). Smallwood (1987) found mostly grasshoppers, beetles, and spiders in food pellets from wild-caught wintering birds in south central Florida, with no sexual difference in diets. In north central Florida insects appear to be the main prey item throughout the year with an increase in lizards during the breeding season (Bohall-Wood and Collopy 1986b). Insects are taken more frequently in pasture areas whereas lizards are taken more often in pine-oak habi-

tat. Sources of free water are not critical to the kestrel as it obtains an adequate supply of water from the prey items it consumes (J. Layne pers. comm.).

During the breeding season kestrels may be nutritionally or energetically dependent on vertebrate prey (mostly lizards) (Smallwood 1990). By utilizing lizards, the kestrels are maximizing their energy cost-benefit ratios when feeding several young (Bohall-Wood and Collopy 1987). The importance of lizards in the diet of breeding kestrels may indicate that the presence of open woodland habitat types, where lizards are typically captured, may be a criterion in habitat selection.

Prey is usually captured with the feet and killed with the beak (Johnsgard 1990), with small insects often carried in the beak (J. Layne pers. comm.). Various prey capture techniques are employed, including perch hunting, flight hunting, and hover hunting (Collopy and Koplin 1983). Males and females appear to be equal in prey capture success, with percent successful pounces of 73% and 76% for males and females, respectively (Smallwood 1987). The major-

ity of hunting time is spent in perch hunting (Collopy and Koplin 1983, Bohall 1984, Toland 1987, Gard and Bird 1990, Johnsgard 1990). Perch hunting accounted for 75.8% and 70.1% of invertebrate prey captured by female kestrels in California during two winter periods (Collopy and Koplin 1983). Perch hunting accounted for 80.5% of the time spent hunting by kestrels in north central Florida (Bohall 1984), emphasizing the importance of perch sites. The kestrel is opportunistic in perch use and frequently uses trees, utility poles and lines, and fence posts (Figure 4). Average perch height is 8.1 m (Smallwood 1990). Perch sites providing the most unobstructed view of large areas of suitable foraging habitat are preferable (Smallwood 1990). Kestrels in south central Florida usually made pounces within a 56 m radius of perch sites (Smallwood 1987). Hover hunting is employed when visibility is poor (e.g., tall vegetation). The frequency of hover hunting also increases with ambient wind speed (Smallwood 1990). During hover-hunting, kestrels hover 15-30 m above the ground for periods not usually exceeding one minute (Bird and Palmer 1988).

Most hunting occurs in open patches with short grass or sparse ground cover. The majority (97.5%) of hunting attempts occurs over substrates of grasses and weedy forbs < 25 cm in height (Smallwood 1987). Territories have a mean coverage of 52% grasses < 25 cm in height (Smallwood 1987). Hunting is most frequent in pastures, roadside berms, mown hayfields, open orchards, and lawns in parkland areas (Smallwood 1990). Open areas of short vegetation are critical foraging areas. Woody canopy is negatively correlated with the amount of suitable hunting substrate, with trees and shrubs forming a visual barrier which restricts areas available to a hunting kestrel (Smallwood 1987). However, open woodland areas (avg. 20% woody canopy cover) are readily used by wintering kestrels in Florida (Smallwood 1990). Kestrels rarely use pine plantations due to dense understory vegetation (Bohall 1984).

NEST ENVIRONMENT

Kestrels are secondary cavity nesters, and typical of most secondary cavity nesting birds, they use abandoned nest cavities excavated by woodpeckers (Raphael 1985), primarily those excavated by northern flickers (*Colaptes auratus*) or pileated woodpeckers (*Dryocopus pileatus*). However, kestrels are fairly flexible in nest site selection and are not totally dependent on any



Figure 4. Adult male American kestrel perched on a fence post (Photo by Brian Toland).

single species to provide suitable nest cavities (Hoffman 1983). They are also known to use enlarged red-headed woodpecker (*Melanerpes erythrocephalus*) cavities, but an unaltered nest opening excavated by this species is typically too small for kestrels to use (Hoffman and Collopy 1987). In many areas, the majority of "natural" nest sites used by kestrels are in abandoned or occupied buildings (Hamerstrom et al. 1973, Toland and Elder 1987).

Most tree cavities are in dead trees (snags) (Figure 5). Of 61 cavity nest sites examined in north central Florida, 59 (96.7%) were located in dead trees, of which those at an intermediate stage of decay (twigs absent, a few main limbs > 1 m in length, < 50% of the top of the tree intact, and approximately 33% of the bark left intact) were disproportionately selected (Hoffman 1983).

The majority of nest trees in north central Florida are in association with pastures or cultivated farmland (Figure 6), or within areas of longleaf pine-turkey oak woodlands, and nests occur most frequently in longleaf pine, turkey oak, or live oak (*Q. virginiana*) snags and man-made structures (Hoffman and Collopy 1987). Hoffman (1983) found a significant correlation between the density of snags with > 24 cm dbh and the density of snags with active nests or roosts in clearcuts within the Ocala National Forest. Every clearcut that had a density of large (> 24 cm dbh) snags greater than five per 40 ha had a density of active snags greater than zero.

Nest trees and cavities measured in north central Florida indicate kestrels there primarily use snags with a mean dbh of 30.45 cm and mean nest hole height of 7.25 m. Cavities used by kestrels (n=37) had a mean entrance width of 72.25 mm, a mean entrance height of 94.25 mm, a mean interior diameter of 13.35 cm, and a mean depth of 27.4 cm (Hoffman 1983). Cavity dimensions for active kestrel and pileated woodpecker nests were not significantly different, indicating the suitability and high use of pileated woodpecker cavities by kestrels.

Although the availability of natural nest sites is considered to be one of the limiting factors of kestrel distribution and abundance, kestrels readily nest in man-made boxes within a variety of habitat types (Wisconsin: Hamerstrom et al. 1973, Colorado: Stahlecker and Giese 1979, California: Bloom and Hawks 1983, West Virginia and Pennsylvania: Wilmsers 1983, Missouri: Toland and Elder 1987). In central Missouri, kestrels prefer nest boxes to natural cavities,

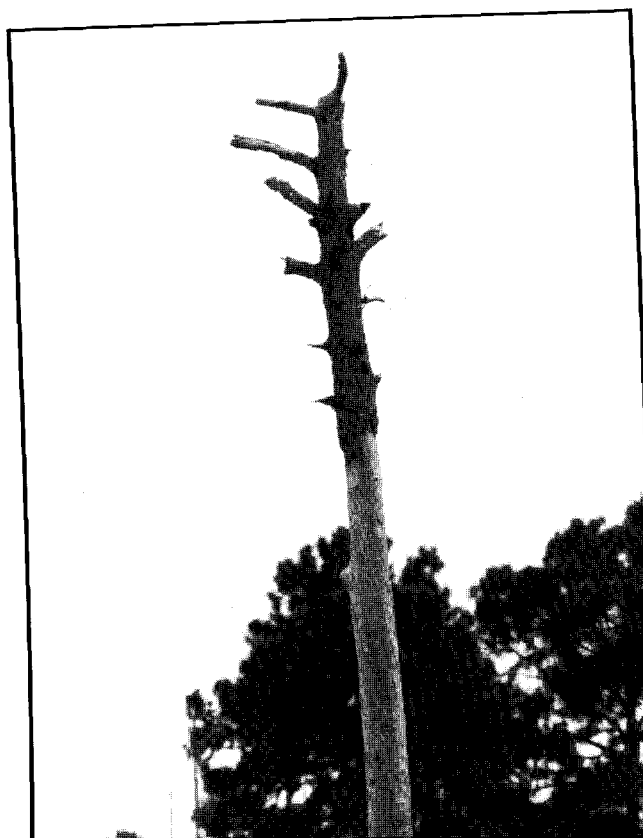


Figure 5. Active kestrel nest snag, 8 miles (12.8 km) SW of Sebring, Highlands Co., Florida (Photo by James N. Layne, Archbold Biological Station).

even when natural cavities are abundant (Toland and Elder 1987). Placement of nest boxes has increased the breeding population of kestrels in areas where nest sites were considered a limiting factor (Hamerstrom et al. 1973, Stahlecker and Giese 1979, J. Smallwood pers. comm.). Kestrels may be more apt to nest in areas with several available nest sites (boxes) (Hamerstrom et al. 1973).

Kestrels in Missouri appear to prefer nest boxes placed on utility poles and buildings to those placed on live trees, and boxes placed at a height of 7.0 m or higher are used more often than those placed 6.0 m or lower (Toland and Elder 1987). However, kestrels in north central Florida used nest boxes placed on utility poles and trees equally, with nest boxes at various heights (4.0-5.5 m) also used equally (J. Smallwood pers. comm.). Kestrels also appear to prefer nest boxes with southerly or easterly openings (Balgooyen 1976, McComb and Noble 1981, Toland and Elder 1987). In north central Florida kestrels use nest boxes with a westerly opening less than expected, but nest boxes with openings facing all other major compass directions (N, S, E, NE, NW, SE) were used equally (open-



Figure 6. Typical kestrel nest site. Nest site located 6.5 miles (10.5 km) SW of Sebring, Highlands Co., Florida (Photo by James N. Layne, Archbold Biological Station).

ings facing SW not included due to insufficient number of boxes) (J. Smallwood pers. comm.). Nest boxes within open to moderate canopy coverage and unobstructed entrances were the only nest boxes used by kestrels in a California study (Bloom and Hawks 1983). Nest boxes placed in open areas at distances greater than 50 m from woods borders are used significantly more often than boxes placed nearer woods borders (Wilmsers 1983). Unobstructed flight paths to nest boxes also are important factors in nest box use. Power line towers can be an important tool in kestrel management. Nest box placement on power line poles increased a local population in Colorado from a minimum of six pairs to at least 25 (Stahlecker and Griese 1979). Placement near wooded areas may increase use by squirrels (Toland and Elder 1987) and in farmland areas by starlings (Stahlecker and Griese 1979).

HABITAT REQUIREMENTS

The wintering migrant *F. s. sparverius* is not limited by nest site availability and only requires foraging

and roosting habitat while in Florida, allowing for more variable habitat selection. However, *F. s. paulus* often remains on or near nesting territories year-round and has a high degree of territory fidelity, using the same territory year after year (Bohall-Wood and Collopy 1986a, J. Layne pers. comm.). Although *F. s. paulus* often remains paired throughout the year, pairs may split up during the winter and reunite during the breeding season. Variability in "strength" of pair bonding during the winter months may be due to the quality of foraging habitat around a nest site (J. Layne pers. comm.). Breeding pairs remaining on nesting territories year-round suggest that intersexual competition for food during the winter is not a factor (Bohall-Wood and Collopy 1986a). Defense of nesting territories by *F. s. paulus* decreases during the winter months, often allowing winter migrants in close proximity to the nest area (Chance 1978).

In Florida, the southeastern American kestrel prefers open habitats including pastures, open longleaf pine-turkey oak sandhill communities, grasslands, and open sites within suburban and residential areas (e.g., golf courses, parks). The habitat must meet two basic criteria: 1) suitable open areas of short vegetation with scattered perch sites and an adequate prey base, and 2) suitable nest sites. Additionally, these habitat elements must be in close proximity to each other.

In north central Florida, kestrels prefer open pine woodlands in association with pasture-like open areas and pastures within various plant communities (Norris 1976, Layne 1980, Bohall-Wood and Collopy 1986a). Roadside surveys conducted during the summer in north central Florida indicated kestrels were most abundant (88%) in sandhill communities associated with open areas (i.e., pastures), and of those found in agriculture/mixed hardwood areas, the majority (83%) was using pastures (Bohall-Wood and Collopy 1986a). There were no sexual differences in habitat preference or in the size of the open areas used. Most kestrels observed in sandhill communities were in open areas < 25 ha while those observed in the agriculture/hardwood areas were in open areas of 26-75 ha in size.

The sandhill community occurs on ridges and is characterized by the Chandler-Apopka soil association in northern Florida (Hoffman and Collopy 1987). Mature sandhill communities have an overstory of scattered longleaf pines and an understory of xeric oaks, particularly turkey oak; the characteristic ground cover is wiregrasses (*Aristida stricta* and *Sporobolus junceus*) (Hartman 1978). In their natural state sand-

hill communities are maintained in an open condition by frequent lightning-set ground fires. However, intensive logging of longleaf pine and suppression of fire have resulted in turkey oaks dominating many sites (Hoffman and Collopy 1987). Areas with dense understories are unsuitable kestrel foraging habitat, but may contain suitable nest sites (Figure 7). The vegetation composition on wetter sites may not produce the prey required by kestrels (Bohall 1984).

Some atypical habitats and nest sites include nests within the beams of a large electrical transformer station (Figure 8), in the roof of an equipment shed at an active business (Figure 9), and in structures at an airport (Figure 10) (J. Layne pers. comm.). Although these areas seem unusual, they all provide adequate nest sites in close proximity to suitable foraging habitat. These circumstances where the birds have adapted to high disturbance areas show how adaptable kestrels are.

There are conflicting data concerning sexual segregation of habitat by wintering migrant kestrels. Many studies have concluded that wintering migrant kestrels appear to segregate habitat use by sex (Koplin 1973, Mills 1976, Stinson et al. 1981, Cade 1982, Bohall 1984, Smith 1986, Smallwood 1987) while others have shown they do not (Bildstein 1978, Macrander 1983, Toland 1987). Habitat segregation may have evolved as a way to avoid or reduce intraspecific competition for food (Cade 1982) or may be the result of differential migration times, with one sex arriving on the wintering grounds first (Smallwood 1988). The degree of sexual habitat segregation depends on the configuration of the landscape and appears to reflect innate sex differences (J. Layne pers. comm.). Bohall (1984) found that male and female *F. s. paulus* in Florida did not exhibit a difference in habitat type, opening size, or perch preference during summer or winter. Female *F. s. paulus* did, however, show a significant shift in habitat preference from open habitats in winter to a more closed habitat in summer within longleaf pine-turkey oak communities in north central Florida (Bohall 1984). Males did not exhibit a significant shift in habitat preference between winter and summer, but male sightings in the sandhill woodlands did increase from winter to summer.

Breeding density appears to be highly variable, dependent on nest site availability and habitat type surrounding nests. In north central Florida kestrel breeding density was found to be 0.41 pairs/km² in areas of longleaf pine-turkey oak and 0.14 pairs/km² in

areas of hardwood hammock vegetation (Hoffman and Collopy 1987). A similar study found the breeding density to be 0.67 pairs/km² in areas of longleaf pine-turkey oak and 0.49 pairs/km² in areas of hardwood hammock vegetation (Bohall 1984). Differences in kestrel abundance between sandhill communities and hardwood hammocks may be attributed to differences in prey populations (Bohall-Wood and Collopy 1987). Hardwood hammock areas also may have low potential for kestrel use due to the dense cover. Pastures with isolated longleaf pine trees were the principal nesting habitat on Berry Ranch in Alachua County, with breeding densities of 1.6 and 1.4 pairs/km² during 1982 and 1983 (Hoffman and Collopy 1987). The average breeding density was 2.1 pairs/km², with about 0.5 km between nest sites, in areas of longleaf pine-turkey oak habitat on the Ordway Preserve in Putnam County, Florida (Hoffman 1983). In Mississippi, kestrels were found nesting almost colonially where there were abundant nest sites (Bird and Palmer 1988). In south-



Figure 7. Active kestrel nest snag located in an area unsuitable for foraging. Dense understory vegetation creates unsuitable substrate for kestrel foraging (Photo by James N. Layne, Archbold Biological Station).

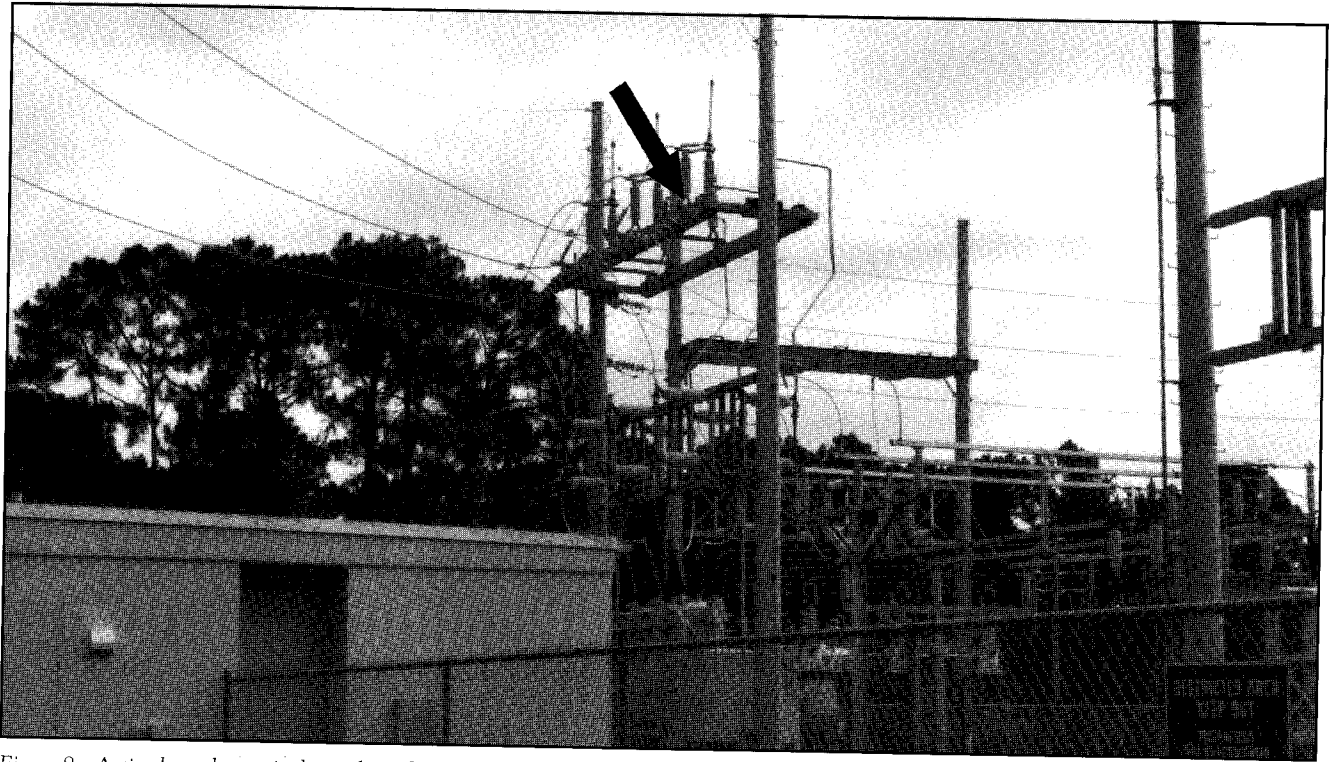


Figure 8. Active kestrel nest site located in a beam of an electrical transformer station (Photo by James N. Layne, Archbold Biological Station). Arrow indicates location of nest.

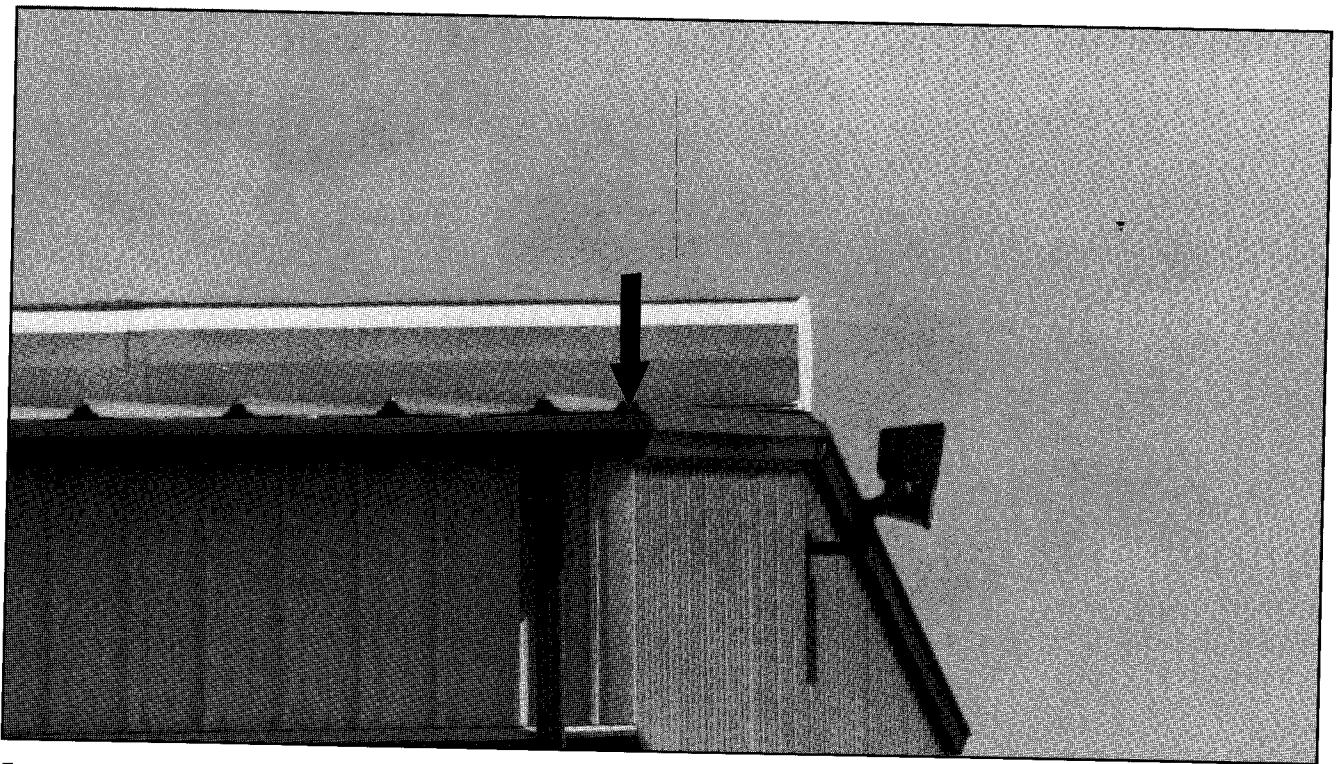


Figure 9. Active kestrel nest site located in the roof of a building at an active business (Photo by James N. Layne, Archbold Biological Station). Arrow indicates location of nest.

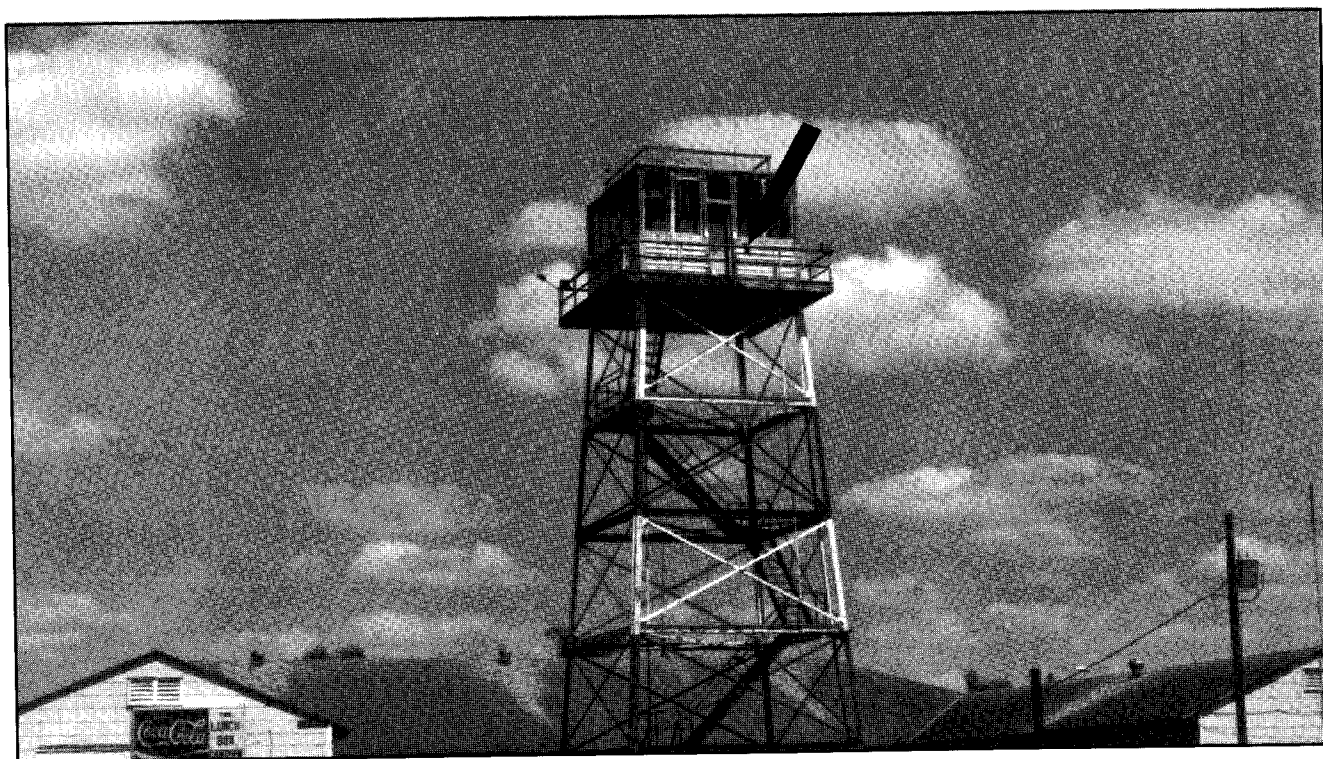


Figure 10. Active kestrel nest site located in an observation tower at an airport (Photo by James N. Layne, Archbold Biological Station). Arrow indicates location of nest.

western Quebec, territory size of breeding kestrels varied inversely with available food resources (small rodents), supporting the supposition that kestrels adjust breeding territory size in response to prey availability (Gard and Bird 1990).

Average diameter of territories for breeding pairs ranges from 0.75 km in Missouri (Toland 1983), 2.42 km in Michigan and Wyoming (Craighead and Craighead 1956), 0.82 km in Utah (Smith et al. 1972), and 0.66 km in Jamaica (Cruz 1976). The large variation in territory size may be due to differences in food and nest site availability (Bird and Palmer 1988). Hoffman (1983) found that in high quality habitat (i.e., sandhill woodlands) in Florida, kestrel territory size was approximately 50 ha (124 acres). However, in disturbed or cleared sandhill woodlands a breeding pair may require 116-317 ha (Bohall 1984, Hoffman and Collopy 1987).

Kestrels typically roost in trees or buildings that provide cover from predators. Food pellets have been recovered from nest boxes outside of the breeding season, indicating that under some circumstances kestrels roost in nest boxes (J. Smallwood pers. comm.). In Missouri during the winter, kestrels roosted in nest boxes and used the top of the nest box as a feeding platform (Toland and Elder 1987). Roost sites typi-

cally are in close proximity to available foraging and breeding areas. Roost trees close to nest sites also provide initial perch sites for fledglings (J. Layne pers. comm.). First flight attempts often end with the fledglings on the ground. The young can usually make it to the lower branches of a nearby tree.

REPRODUCTION AND BREEDING BEHAVIOR

Courtship and pair bonding in the southeastern American kestrel begin near the end of January (Bohall-Wood and Collopy 1986b). Important components of pair bonding include aerial displays, nest site selection, and courtship feeding of the female by the male (Johnsgard 1990). Pair formation is initiated by males establishing territories. Females begin associating and hunting with a territorial male, with copulation closely following (Johnsgard 1990). Kestrels are often much more visible during courtship due to the increased amount of activity and vocalizations. During the breeding season kestrels often call in either the "whine" or "chitter" (Willoughby and Cade 1964, Bird and Palmer 1988). The whine is most often heard during courtship feeding, copulation, and food begging by the female and flying young. The whine may last for 1-2 minutes. The chitter is usually associated with friendly

approach and bodily contact between males and females, as well as with nest site inspection (Willoughby and Cade 1964).

Two common aerial courtship displays are the dive-display and flutter-glide (Johnsgard 1990). In the dive-display, the male will perform a series of climbs and dives with 3-5 killy notes uttered near the peak of each ascent (Johnsgard 1990). The primary purpose of the dive-display is territory advertisement, and it is frequently exhibited directly over the female (Bird and Palmer 1988). In the flutter-glide kestrels fly slowly with quick, shallow wingbeats. Both males and females flutter-glide. Females are most frequently observed flutter-gliding when begging for food, males observed most frequently during aerial food transfer (Bird and Palmer 1988, Johnsgard 1990). Nest site selection begins with the male initiating a nest site search. Kestrels appear to be dominant over most other cavity nesting birds using similar size cavities and may evict current residents of suitable cavities (Johnsgard 1990).

Eggs are laid directly on any debris that may be present on the cavity floor; nesting material is not brought into the cavity (Wiley 1978). Egg color varies from white to a yellowish or light reddish-brown, typically blotched or mottled with gray or brown (Bird and Palmer 1988). In Florida, three to five eggs are laid mid-March to May (Wiley 1978), with incubation lasting 29-31 days (Wiley 1978, Johnsgard 1990). Both sexes incubate, but the majority of incubation is by the female (Wiley 1978, Bird and Palmer 1988, Johnsgard 1990, J. Smallwood pers. comm.). The male does most of the hunting during the incubation period and the first week following hatching (Bohall-Wood and Collopy 1986b). During incubation the male does not bring food into the nest for the female, but will land nearby and call her out (Foran et al. 1984). Hatching occurs over a period of 3-4 days with the young fledging approximately 30 days later (Wiley 1978, Johnsgard 1990, Varland et al. 1991). At hatching, the young have pink skin covered with short, silvery-white down which is soon replaced by longer white down (Bird and Palmer 1988). A week or two after the eggs hatch the female leaves the nest and begins to assist the male with feeding the young (Bohall-Wood and Collopy 1986b). The young develop very quickly, growing to their adult weight in 16-17 days (Johnsgard 1990). Sustained flight is attained 3-4 days post-fledging (B. Toland pers. comm.).

Both males and females continue bringing food to the young several weeks post-fledging (Bird and Palmer 1988). A significant increase in the rate of capture of

prey by the young occurs approximately 4-5 weeks after fledging, with the fledglings remaining social among themselves, often hunting together prior to dispersal (Varland et al. 1991).

RECRUITMENT AND MORTALITY

Mean hatching success rate has been reported as high as 89%, with an overall reproductive success rate (successful fledglings per egg) of 87.5% (Balgooyen 1976). Hatching success rate has also been reported as 78% (Heintzelman and Nagy 1968), 67% (Smith et al. 1972), and 64% (J. Smallwood pers. comm.). Sex ratio of the young at hatching is near 1:1 (Heintzelman and Nagy 1968, Porter and Wiemeyer 1972, Balgooyen 1976).

Kestrels can successfully rear two broods within a single breeding season. Food availability and weather conditions appear to determine, in part, whether a kestrel pair will attempt to raise two broods (Newton 1979). Double brooding has been reported in Florida (Howell 1932) and speculated to have occurred in Colorado (Stahlecker and Griese 1977) and Oklahoma (Black 1979, Sutton 1979). Toland (1985) found that 11.8% (1982) and 33% (1983) of a color-marked population under study in Missouri had double broods, with the average size of second clutches slightly smaller than initial clutches, and hatching success of 86% and 73% for initial and second clutches, respectively. In addition, early nesters whose initial nests were unsuccessful can successfully reneest, and in one case 82% reneested in their original territories (Bowman 1986). Early nesting kestrels have better nesting success as measured by a greater probability of raising a second brood, laying replacement clutches, and a higher mean number of young fledged per pair (Toland 1985). Henny (1972) estimated that each breeding female must produce 2.88 young per year for a population to remain stable. Yearling birds of both sexes are capable of breeding (Bird and Palmer 1988).

Dispersal of young from nest sites occurs 23-24 days after fledging (Varland et al. 1991). Dispersal occurs gradually, with the young wandering farther and farther from nest sites over a period of several weeks (Harb 1988). Adult birds near Archbold Biological Station did not show any signs of aggression toward their young at the time of dispersal, suggesting that the kestrels do not "drive off" or "lure" their young away from the nest site (Harb 1988). During post fledging wanderings, microhabitat may influence movement and ultimate dispersal direction (Harb 1988). Estimates based on a

very limited data set from south central Florida revealed dispersal distances of 8.05-9.65 km, with one juvenile dispersing about 29 km (J. Layne pers. comm.). Habitat suitability and availability probably are two of the major factors in determining how far kestrels will disperse.

Reports of nestling mortality are few; however, mortality of nestlings to snakes and fire ants have occurred in north central Florida (J. Smallwood pers. comm.). Chances of mortality are highest during the first year of life (about 69%) and survival rate is about 50:50 for each year thereafter (Brown and Amadon 1968, Henny 1972). Layne (1982) found motor vehicles to be the cause in 52% of birds found killed, injured, or incapacitated. Mammalian and avian predators are potential factors influencing nest success rates and juvenile and adult survival rates.

SECTION 2.

DETERMINING LOCAL POPULATION SIZE AND HABITAT QUALITY

INTRODUCTION

The procedures detailed in this section are for use in determining the significance of an area to southeastern American kestrels. If kestrels are found foraging or nesting on site, then habitat protection measures for kestrels typically are recommended. The first step in determining the importance of a site to kestrels is to map all potential kestrel habitat. If a site contains at least 50 ha of potential kestrel habitat, then surveys should be conducted to determine the extent of kestrel use of the site. Roadside surveys supplemented with foot surveys are prescribed to determine presence and location of kestrels occurring on site. If kestrels are found on the site, then further surveys should be conducted to locate any kestrel nests that may be present. Recommendations concerning habitat protection procedures, based on the amount of suitable kestrel habitat found on the site and on the type of kestrel use of the area as determined through surveys, are found in Section 3.

HABITAT INVENTORY AND MAPPING

The primary objective of the procedures described below is to develop a vegetation map of the proposed site with all plant communities used or potentially used by kestrels delineated. Plant communities should be mapped on aerial photographs (1 inch = 200 ft), and a summary table of number of ha (acres) of each habitat type on site should be prepared. Habitat types should follow the *Florida Land Use, Cover and Forms Classification System* (Florida Department of Transportation 1985).

The following classes may be potential kestrel habitat (number in parenthesis represents designation in the classification system):

Recreational land (180), improved pasture (211), unimproved pasture (212), woodland pasture (213), specialty farms (250), other open lands (260), herbaceous rangeland (310), coniferous forest (4101), pine flatwoods

(4111), longleaf-xeric oak (4121), pine-mesic oak (4141), xeric oak (4211), hardwood-conifer mixed (4341), mixed hardwood (4381), forest regeneration areas (443), rural land in transition without positive indicators of intended activity (741), burned areas (745).

Kestrel use of a site can also be divided into two broad categories based on the structural characteristics of the vegetation. To further define potential kestrel use of a site, the following habitat types should be mapped as an overlay on the map of potential habitat types listed above.

Type I Habitat: Upland plant communities with less than 10% canopy closure and with at least 60% herbaceous ground cover of less than 25 cm in height.

Type II Habitat: Open woodland communities with greater than 10% but less than 25% canopy closure and with at least 60% herbaceous ground cover less than 25 cm in height.

SURVEYING FOR KESTRELS

The primary objective of the procedures described below is to determine the number of southeastern American kestrels or kestrel pairs on the proposed development site. Secondary objectives include mapping locations of kestrel sightings and obtaining locations of active and potential nest sites. The most effective survey technique for kestrels involves the use of roadside transects supplemented with foot transects as necessary. Roadside transects should meet the following criteria:

- (1) The transect routes should pass through all potential kestrel habitats present on the site.

- (2) The habitat along road transects should be open enough to allow sighting of individual birds at considerable distances.

Foot surveys should be utilized in areas where visibility from the road is limited, areas that are inaccessible by roads, or habitat areas that are underrepresented by road transects. Additionally, foot surveys should be used to locate nest sites.

Survey design

If there is an extensive road network on a proposed development site, random selection of road transects is preferable; however road transects should be placed so that all potential kestrel habitat is surveyed. The distance between transects should be spaced according to the limits on visibility imposed by vegetation and terrain. On sites with limited roads, the surveys should be supplemented with foot surveys. Foot surveys should be conducted in those areas unsuitable for, or inaccessible by, road transects. Field personnel should establish parallel line transects spaced so that all areas that qualify as Type I or Type II habitat are surveyed. Transect length and distances between transects will vary with size of the area, topography, and vegetative structure. All transects should be marked on a map of the area and, if necessary, identified by numbering individual transects.

Surveys must be carried out during the spring and summer (i.e., April-August). Surveys outside this time-frame would over-estimate the number of resident kestrels on site due to inclusion of wintering kestrels. Conducting surveys early in the breeding season may enhance the ability to sight kestrels, which should be conspicuously involved in courtship behavior. Surveys should be conducted during the morning hours, from sunrise to 3-4 hours past, on calm, clear days. A driving speed of 10-25 mi/hour is recommended, varying in response to terrain, road condition, or visibility. High traffic roads which would prohibit slow driving or frequent stopping should be avoided. The same individual(s) should conduct all surveys to eliminate observer bias. Direction of travel along transects should be reversed on alternate surveys to eliminate direction of travel bias. Surveys should be conducted 6-8 times with 4-7 days between each.

Equipment required to complete kestrel surveys and nest site surveys includes:

- (1) Vehicle.
- (2) Binoculars and spotting scope.
- (3) Map
- (4) Rangefinder.
- (5) Compass.

Survey Protocol

Location of kestrels—Surveyors conducting road transects should observe both sides of the road, looking for kestrels perched on fencerows, telephone poles and lines, and trees, and for kestrels flying or hovering. When a kestrel is sighted the observer should stop the vehicle and record the location (both by odometer reading and on the map). Binoculars and spotting scopes should be used to verify identification. The specific habitat category for each kestrel observed should be recorded at the point where the kestrel was first observed. The perpendicular distance from the center of the road to the kestrel should be measured (rangefinder) and plotted on the map. An attempt should be made to identify the sex of the kestrel. If the kestrel leaves or moves to a new location while being observed, the flight direction and possibly the location where the kestrel lands should be noted. Behavior and vocalizations should be noted, especially behavior that would indicate courtship or nesting.

Surveyors on foot transects should walk transects at a steady pace. Often birds will silently flush before being observed as surveyors approach a territory. The surveyor should look for and record signs of kestrel activity (e.g., prey remains, feathers at plucking sites, white feces stains accumulated at perches or roosts). The surveyor should also look for potential nest sites while conducting foot surveys. Potential nest sites include dead or dying trees, dead limbs on trees, and buildings. Locations of kestrels, possible kestrel activity, and potential nest sites should be recorded on a map (compass direction and distance from a permanent landmark). Habitat type and use should be recorded for kestrel sightings. Binoculars should be used to identify and possibly determine the sex of the birds. Upon completion of all transects, surveys for nest sites should begin.



Figure 11. Active kestrel nest site located in an ivy covered snag (Photo by James N. Layne, Archbold Biological Station).

Location of nest sites—Although potential nest site areas can be identified from road surveys, foot surveys will be needed in most instances for locating actual nests. Behavior and vocalizations are clues to stages of the reproductive cycle and can aid in the location of nests. The surveyor should return to areas where kestrels were repeatedly located; or where kestrel pairs were observed; or where kestrels were exhibiting courtship, breeding, or territorial defense behavior during the roadside transects (or foot transects if they were necessary). If the kestrel(s) are in sight upon arriving in an area, the surveyor should observe the bird for signs of courtship, nesting behavior and vocalizations, and look for kestrel nest sites in snags, old woodpecker cavities, and buildings. Although longleaf pine snags are the most frequently used nest tree, surveyors should examine possible nest sites in all types of trees (i.e., species and stages of decay) (Figure 11). Kestrels are known to nest in a variety of places and nothing should be overlooked. Nest site location should be recorded (plotted on map with record of compass direction and distance from a permanent landmark) upon nest site

confirmation. Location of a nest site can be confirmed by observing the use of a cavity or nest structure by kestrels, the presence of a pair of kestrels exhibiting courtship and reproductive behavior in the vicinity of possible nest sites, or presence of nestling or fledgling kestrels at a nest site. Measurements at the nest should include tree species, stage of decay, and nest tree health. If the nest is in a man-made structure, the type of structure, physical state of the structure (e.g., occupied, abandoned, falling over), and location of the nest within or on the structure should be recorded.

Locations of snags observed on road and foot surveys should be plotted on the area map. All structures (man-made and natural) which qualify as suitable perch sites also should be recorded and plotted on the area map.

DETERMINATION OF KESTREL HABITAT USE ON SITES THAT LACK NESTS

If kestrels are sighted on a proposed development site, but an active nest site is not located, then it can be assumed that the kestrel(s) are nesting off site and utilizing on-site habitat for foraging. In this situation the on-site kestrel observations will most likely be in close proximity to the boundary of the site. If this situation occurs, kestrel habitat use should be determined using one of the two methods outlined below. However, if the kestrel observations from the initial surveys are not within 0.5 km of suitable foraging habitat on site, then further surveys and habitat protection generally are not recommended.

The first method for determining the habitat used by kestrels for foraging is to simply identify all suitable kestrel foraging habitat on site within 0.5 km of the locations of kestrel sightings from initial surveys. The amount, up to 50 ha, of suitable kestrel foraging habitat delineated in this manner should serve as the on-site habitat protection area if on-site habitat protection is pursued.

The second method for determining the habitat used by kestrels for foraging is creation of an on-site kestrel use area map. This method should be used when it is necessary or desirable to determine the size of the kestrel use area more accurately than is possible by simply mapping all suitable forage habitat within 0.5 km of initial kestrel sightings. The on-site kestrel use area should be determined by intensively surveying the area for new kestrel sightings. The surveyors

should return to the on-site area(s) where the kestrels were observed during initial surveys. Foot surveys should be conducted throughout suitable foraging habitat in the areas of initial kestrel sightings. Foot transects should be established in a grid at 100 m intervals (Figure 12). Stakes with flagging should be placed at 100 m intervals to mark transect lines. Direction of travel along the transects should be alternated between surveys. For example, surveyors should follow the north-south transects for the first survey and the east-west transects on the following survey, alternating direction until all surveys are complete (Figure 12). All kestrel sightings should be plotted on the area map. Surveys should be conducted 6-8 times. Surveys should be completed following the same seasonal, time of day, and weather condition restrictions that apply to the initial surveys.

Upon completion of surveys, the on-site kestrel use area should be delineated. The outermost perched kestrel sighting locations should be used in delineating the boundary. The on-site kestrel use area should encompass all suitable habitat 60 m beyond these outermost sighting locations (Figure 12). The delineated on-site kestrel use area should serve as the habitat protection area if on-site habitat protection is pursued.

SURVEY REPORT

A final report, including data sheets and maps, should be provided to review and regulatory agencies. A data sheet should be filled out for each survey conducted and should include the following information:

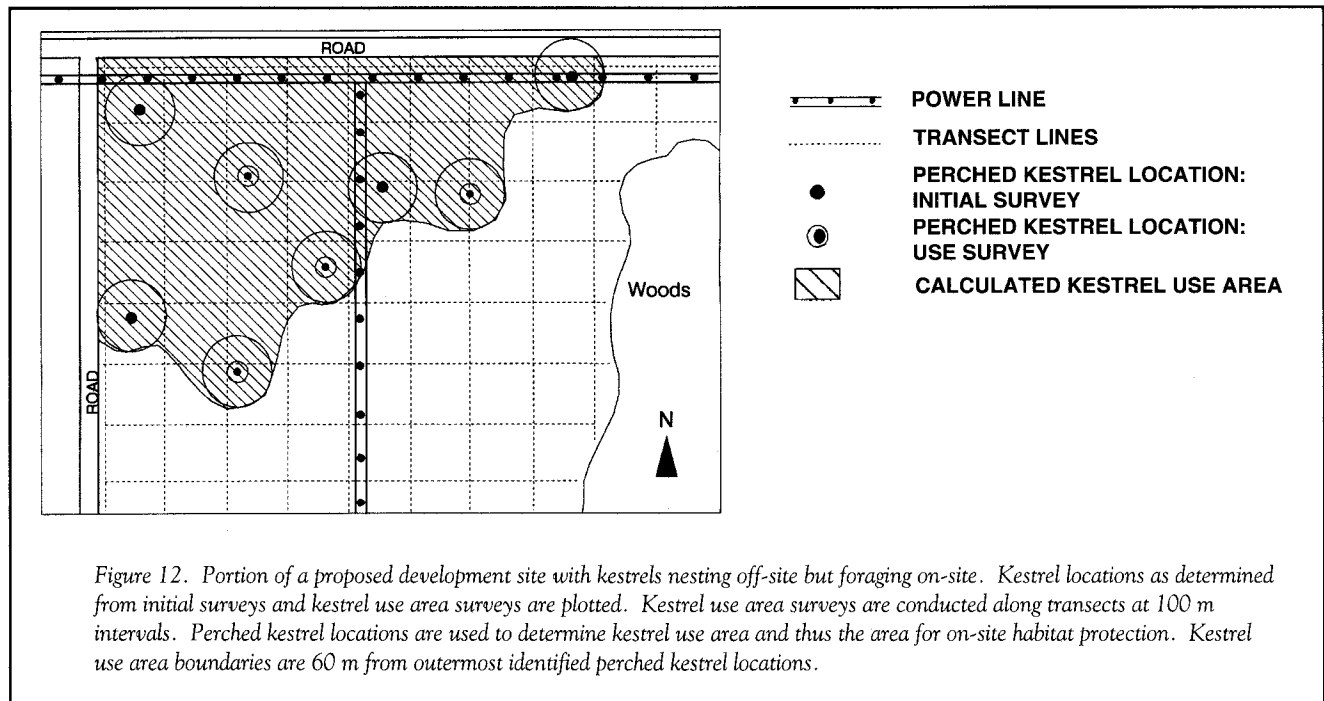
1. Date, starting and ending time, and starting and ending odometer readings of each survey conducted.
2. Weather conditions during each survey, including average temperature, wind speed and direction, precipitation, and percent cloud cover.
3. Direction of travel and beginning and ending points of transects.
4. Odometer reading at each sighting location.
5. Sex of bird, bird activity and behavior, single

bird or possible pair.

6. Nest site information including type of structure (natural or man-made); physical state of the structure; and tree species and stage of decay for those nests located in a tree.

The aerial photograph should include:

1. The vegetative characteristics of the entire area of interest.
2. Boundaries and locations of Type I and Type II kestrel habitat.
3. Locations of transect lines.
4. Locations of all kestrels sighted while conducting the surveys.
5. Locations of nest sites.
6. Boundaries of the kestrel use area, including sighting locations and nest sites.



SECTION 3.

PROCEDURES FOR IMPLEMENTING PRESERVATION MEASURES

PRESERVATION RECOMMENDATIONS

Preservation of habitat (foraging and nesting) critical to the survival and maintenance of kestrels can be accomplished by on-site habitat protection as well as off-site mitigative compensation. Habitat protection in either event is recommended when 1) kestrels are both nesting and foraging on site, 2) kestrels are nesting on site but foraging off site, and 3) kestrels are nesting off site but foraging on site. In most situations, on-site habitat protection is preferable, rather than off-site compensation for habitat loss. Exclusive on-site habitat protection is recommended whenever the required acreage for the habitat protection area(s) is < 25% of all developable uplands on site and the site contains at least 50 ha of suitable foraging habitat. On-site protection or off-site compensation may be pursued when less than 50 ha of suitable foraging habitat is located on site. Off-site mitigation techniques are discussed in further detail in Section 4.

The on-site habitat protection area (50 ha) is the amount of properly managed suitable habitat required by a breeding pair of southeastern American kestrels. However, for suitable foraging habitat to be available, adequate perch sites must be left on the protection area or provided. A density of 0.5 perch sites/ha provides an adequate coverage of an area for kestrels perch hunting. Most prey capture pounces area made within a 56 m radius of perch sites. Nest boxes at a density of 1/10 ha will provide needed alternative nest sites. Nest box placement and perch site maintenance should follow procedures described in MANAGING PROTECTION AREAS later in this section. If the plans for the proposed development call for destruction or relocation of a kestrel nest (active or inactive), actual removal of the nest site must be accomplished outside of the breeding season and with a permit issued pursuant to Rule 39-27.002(2), Florida Administrative Code, and Title 50, Code of Federal Regulations.

Kestrels nesting and foraging on site

If an active kestrel nest is located on site and at least 50 ha of suitable foraging habitat is within 0.5 km

of the nest site, then on-site habitat protection is recommended. The habitat protection area should contain a 150 m radius buffer zone around the active nest site and 50 ha of suitable foraging habitat. The habitat protection area should include as many kestrel sighting locations as possible. Five nest boxes should be placed in the habitat protection area, and perch sites should be maintained at a density of 0.5/ha.

If an active kestrel nest is located on site and 10-49 ha of suitable foraging habitat is within 0.5 km of the nest site, then either on-site habitat protection or off-site compensation is recommended. An on-site habitat protection area should include a 150 m radius buffer zone around the nest site and all suitable foraging habitat within 0.5 km of the nest site, up to 49 ha. Nest boxes should be placed in the habitat protection area at a density of 1/10 ha, and perch sites should be maintained at a density of 0.5/ha. Off-site compensation should include the purchase of land in an amount equal to the total acreage that would have been required for the nest site buffer zone and all available suitable foraging habitat within 0.5 km of the nest site, up to 49 ha. The acquired land must include habitat suitable for kestrel use and must be a part of an existing mitigation park or contiguous with other publicly owned land.

Kestrels nesting on site and foraging off site

If the site contains an active kestrel nest and less than 10 ha of suitable foraging habitat within 0.5 km of the active nest site, then either on-site habitat protection of the nest site or off-site compensation is recommended. If on-site protection is pursued, then the habitat protection area should provide a 150 m radius buffer zone around each nest site, and two nest boxes should be placed within the nest site buffer zone. If off-site mitigation is pursued, then compensation should include the purchase of land in an amount equal to that required for the nest site buffer zone.

Kestrels nesting off site and foraging on site

If the site contains foraging habitat for kestrel(s)

nesting off site, either of two methods may be used to determine the size of the habitat protection area. The on-site kestrel habitat protection area should consist of either (1) the amount of suitable kestrel foraging habitat within 0.5 km of kestrel sightings determined from initial surveys or (2) the amount of suitable kestrel foraging habitat located within the on-site kestrel use area as defined by detailed surveys along a grid of transects (described in Section 2: DETERMINATION OF KESTREL HABITAT USE ON SITES THAT LACK NESTS).

If there is at least 50 ha of suitable kestrel habitat located on site within 0.5 km of initial kestrel sightings or within the on-site kestrel use area, then on-site habitat protection is recommended. The on-site habitat protection area should contain 50 ha of suitable foraging habitat and should include as many kestrel sighting locations as possible. Five nest boxes should be provided within the habitat protection area, and perch sites should be maintained at a density of 0.5/ha. Off-site compensation should only be considered in unusual circumstances or when the habitat protection area would consume more than 25% of all developable uplands on site. If the habitat protection area would consume more than 25% of all developable uplands on site, then off-site mitigation should include the purchase of land in an amount equal to 25% of all developable uplands on site. Otherwise, off-site compensation should include the purchase of land in an amount equal to the acreage required for the habitat protection area. The acquired land must contain suitable kestrel habitat and must either be part of an existing mitigation park or be contiguous with land already in public ownership.

If the amount of on-site suitable kestrel habitat located within 0.5 km of initial sightings or the amount of suitable kestrel habitat within the on-site kestrel use area is greater than 15 ha but less than 50 ha, then either on-site habitat protection or off-site compensation is recommended. If on-site protection is pursued, then the habitat protection area should include all available suitable foraging habitat, up to 49 ha, either within 0.5 km of initial kestrel sightings or within the on-site kestrel use area. The habitat protection area should include as many of the kestrel sighting locations as possible. Nest boxes should be provided at a density of 1/10 ha with a minimum of two nest boxes within the protection area. Perch sites should be maintained at a density of 0.5/ha. If off-site mitigation is pursued, then compensation should include the

purchase of land in an amount equal to the acreage required for the habitat protection area. The acquired land must include suitable kestrel habitat and must either be part of an existing mitigation park or be contiguous with other parcels of publicly owned land.

If the amount of on-site suitable kestrel habitat within 0.5 km of initial sightings or the amount of suitable kestrel habitat within the on-site kestrel use area is less than 15 ha (37 acres), then protection of habitat for kestrels is generally not recommended. However, these areas should be considered for protection if open, natural areas or green spaces are required within the development site.

PROTECTION AREA SIZE AND CONFIGURATION

Active nest sites should be protected by a 150 m radius buffer zone encircling the nest site. If the nest site is located within an area of suitable foraging habitat, the 150 m buffer zone area should be included within the habitat protection area. The nest site does not necessarily need to be in the center of the protection area, but the 150 m buffer zone should be maintained. If the nest site buffer zone is not contiguous with suitable foraging habitat, a protection area of suitable foraging habitat could be established separately from the nest site buffer zone, but not farther than 0.5 km from the nest site. If the nest site occurs off site, then the habitat protection area should be located based on on-site kestrel habitat use (section 2: DETERMINATION OF KESTREL HABITAT USE ON SITES THAT LACK NEST SITES).

Whenever possible, the area designated as the habitat protection area should be a single, contiguous block of land, generally in the shape of a circle, square, or rectangle, unless other designs maximize the area containing high quality habitat. If suitable kestrel foraging habitat occurs in a disjunct pattern, then the individual areas may be protected separately. However, if the habitat protection area is to be composed of several disjunct areas, then the total acreage for the habitat protection area should include all available suitable foraging habitat within 0.5 km of the nest site, or within the kestrel use areas. Furthermore, development in the areas between the kestrel protection zones should not form a physical barrier which may inhibit kestrels from traveling from one protected area of foraging habitat to another. Situations in which disjunct areas of foraging habitat are to be used to meet

the requirements of the habitat protection area should be reviewed on a case by case basis.

Either Type I or Type II habitat is suitable for the habitat protection area. However, if both Type I and Type II habitat occur within 0.5 km of the active nest site, then Type II habitat is preferred. If available, Type II habitat should comprise at least 20% of the habitat protection area. Proximate boundaries of the protection area should encompass as many of the kestrel observation locations as possible, except under special circumstances (e.g., overlap with a gopher tortoise colony).

Dead or dying trees > 24 cm dbh should be retained within the habitat protection area at a density of at least 1 tree/8 ha. These trees will provide future nest sites as well as perch sites. If this density cannot be attained or maintained, strategically situated live trees should be retained (i.e., those that are isolated and surrounded by foraging habitat). Perch sites at a density of 0.5/ha should be maintained or created.

If there are more than 50 ha of suitable foraging habitat in close proximity to an active nest site, the habitat protection area should be selected based on: (1) the highest quality habitat, (2) habitat known to contain other listed species (e.g., gopher tortoise), (3) areas as near as possible to protected natural habitat areas, (4) areas as near as possible to off-site undeveloped lands that are expected to remain undeveloped.

OTHER MANAGEMENT CONSIDERATIONS

Overlap of kestrel habitat and gopher tortoise habitat

Some proposed development sites will contain both kestrels and gopher tortoises, and in such instances the habitat protection needs of both of these species may be incorporated into a single habitat protection area. There are several options available, depending on the location and type of habitat found in each species' use area. The *Ecology and Habitat Protection Needs of Gopher Tortoise (*Gopherus polyphemus*) Populations Found on Lands Slated for Large-Scale Development in Florida* (Cox et al. 1987) should be consulted for information on gopher tortoise habitat requirements and preservation recommendations. If kestrels and gopher tortoises have overlapping habitat use areas and the habitat is suitable for both species, then the gopher tortoise colony may be included within the kestrel habitat protection area. If a gopher tortoise

colony occurs on habitat that appears to be suitable kestrel foraging habitat and is located in close proximity to the active kestrel nest site but kestrels are not observed within this area, then the kestrel habitat protection area should be situated so as to include the gopher tortoise colony. A habitat protection area designed to protect both kestrels and gopher tortoises should (1) provide 50 ha (125 acres) of suitable kestrel foraging habitat, (2) provide 150 m radius buffer zones around the kestrel nest sites, (3) provide adequate perch sites for kestrels, and (4) include adequate habitat (acreage and type) to maintain gopher tortoises based on the recommendations of Cox et al (1987). If a gopher tortoise protection area occurs on habitat unsuitable for kestrel foraging habitat, and management to alter it for use by kestrels would be detrimental to gopher tortoise management, then both species need separate habitat protection areas. Similarly, if a kestrel protection area occurs on habitat unsuitable for a gopher tortoise habitat protection area and management to render it suitable for gopher tortoise use would be detrimental to use by kestrels, then both species need separate habitat protection areas.

Removal/Relocation of a kestrel nest

If a site contains an active kestrel nest, and project plans call for clearing of land on which the nest site is located, and off-site compensation is pursued to mitigate impacts on kestrels, then appropriate procedures must be followed in order to remove the nest site. Permits must first be obtained from the Florida Game and Fresh Water Fish Commission pursuant to Rule 39-27.002(2), Florida Administrative Code, and from the U.S. Fish and Wildlife Service. Typically such permits do not allow for destruction or relocation of nests during the breeding season. In addition, if a proposed development site contains a kestrel nest and on-site habitat protection is pursued, but the nest is located in a structure which is scheduled for removal (e.g., abandoned building), then a permit must be obtained from the Florida Game and Fresh Water Fish Commission. Such permits typically require that alternative nest sites be installed in the vicinity of the original active nest site prior to removal. If an active kestrel nest is located in a man-made structure and the structure is not scheduled to be removed, then the nest site should not be disturbed and nest boxes should be placed around the structure to provide alternative nest sites if the structure is in poor condition or is slated for

removal at a later date.

When the on-site habitat protection consists only of a 150 m radius buffer zone around an active kestrel nest site (i.e., the proposed development site contains an active nest but less than 10 ha of suitable foraging habitat on site), and it can later be documented that the kestrels have not nested in the habitat protection area for two consecutive breeding seasons, then the habitat protection area may be developed and the nest site may be removed.

INTEGRATING PROTECTION AREAS INTO THE DEVELOPMENT COMMUNITY

Kestrels are frequent residents of suburban areas and are tolerant of human activities. Some developed areas can even enhance or create suitable kestrel foraging habitat. If such areas are maintained properly and nest sites are available or provided, these areas may be included as part of the habitat protection area. Some possible developed areas that may be included as part of a kestrel habitat protection area are: (1) small airports, (2) horse stables, (3) golf courses, (4) parks, and (5) power line rights-of-way. Developed lands that are proposed for inclusion in a kestrel habitat protection area must meet all the criteria for suitable kestrel habitat (i.e., suitable foraging habitat; active, potential, and alternative nest sites; and 0.5 perch sites per hectare), and they must be within or contiguous to the habitat protection area. High use areas (e.g., airport terminal, riding arena, golf clubhouse, playground) should be located as far as possible from nest sites and will not count towards the goal of providing a habitat protection area of 50 ha. If the kestrel habitat overlaps with existing developed areas (e.g., power line rights-of-way), and this area can be managed and maintained as kestrel foraging habitat, then it may be included in the habitat protection area and will contribute toward the goal of providing a habitat protection area of 50 ha. If management of the developed area to be incorporated as part of the kestrel habitat protection area includes practices (e.g., pesticide use) that would directly or indirectly cause sickness, reduced reproductive capability, death, or reduced amounts of available prey, then these areas should NOT be included as part of the habitat protection area. Consultation with a habitat specialist is recommended if chemical treatment is planned for any area being considered for inclusion as a portion of the

kestrel habitat protection area.

Other developed land may contain suitable kestrel foraging habitat, but should not be included as part of the protection area and will not count toward the required protection area. Areas of possible suitable foraging habitat that should NOT be incorporated into a habitat protection area include: (1) residential lawns, (2) isolated narrow grassy strips along roads, and (3) areas adjacent to high traffic roads. Low traffic roads may transect a protection area, but they should not count toward the required acreage of suitable foraging habitat.

MANAGING PROTECTION AREAS

Foraging areas

A minimum of 60% of the ground cover within habitat protection areas should be maintained at a height of < 25 cm by periodic mowing or burning. If mowing is used, rotational mowing of strips creates an interspersed dense vegetation and open areas which may more closely approach an optimal combination of prey numbers and availability. Burning on a 2-3 year rotation should maintain suitable foraging substrate; however, needed frequency of burning will depend on the type and density of vegetation on the site. Developed areas included as part of kestrel habitat protection areas should be maintained similarly.

Nest sites

Disturbance within the nest site buffer zone should be prohibited during the courtship, breeding, and nesting period (i.e., January - August). One nest box (Figure 13) per 10 ha should be erected within habitat protection areas. Maintenance of the nest boxes should include two routine maintenance checks per year, replacement of missing or damaged nest boxes, and removal of non-target species. One of the maintenance checks should be prior to the breeding season (i.e., December).

The nest boxes should be erected as near optimum conditions as possible and be in place by December. Several factors to consider in nest box placement include:

- (1) Place the nest box approximately 7 meters high.
- (2) Place the nest box on poles, snags, or live trees (or on utility poles if proper authorization has been

received).

- (3) Place nest box in close proximity to a roost tree.
- (4) The nest box opening should face a southerly to easterly direction.
- (5) The entrance of the nest box should be unobstructed with a clear flight path.
- (6) The nest box should be placed in an open area at a distance greater than 50 m from a forest edge.
- (7) If a live tree must be used as the support structure, then there should be 4.5-6.0 m between the nest box and the lowest branch on the tree.

Roost sites in close proximity to the nest site provide both cover from predators and initial perch sites for fledglings. If a tree (live or dead) is used as a nest box support structure, the health status of the tree also should be monitored during the nest box maintenance checks. If the tree becomes unsuitable (e.g., decayed) for a nest box structure, the nest box should be relocated to a nearby suitable structure (tree or pole). The nest box should only be relocated during the non-reproductive season (September-December). Removal or relocation of a nest box that has been used by kestrels requires a permit from Florida Game and Fresh Water Fish Commission and United States Fish and Wildlife Service.

Perch sites

The availability and density of perch sites directly influences the quality of foraging habitat. With the majority of their hunting accomplished by pouncing on prey from perch sites, the kestrel's ability to successfully capture prey can be severely reduced without adequate perch sites. Kestrels make most of their prey capture pounces within a 56 m radius of a perch site (Smallwood 1987). The overall density of perch sites (natural or man-made) for the protection area should be 0.5 perch sites/ha. If adequate perch sites do not exist on the protection area, perch sites should be erected and maintained. If man-made perch sites are required, then poles approximately 7-10 m high should be used for additional perch sites. The poles should be placed throughout the protection area wherever natural perch sites are lacking. Perch sites

should be regularly distributed throughout the protection area to increase the amount of available foraging area. Power lines and poles provide excellent perch sites for kestrels and qualify as suitable perch sites for the protection area. Each 112 m length of power line will count as 1 perch site.

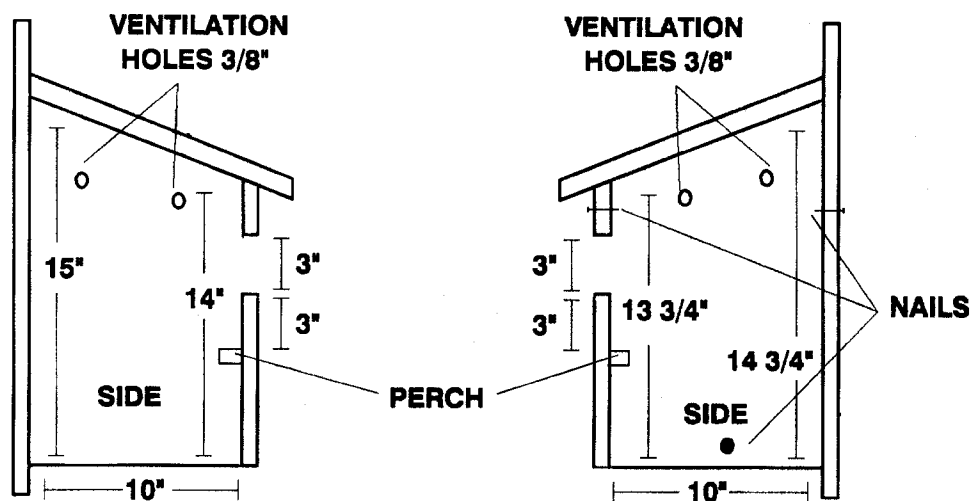
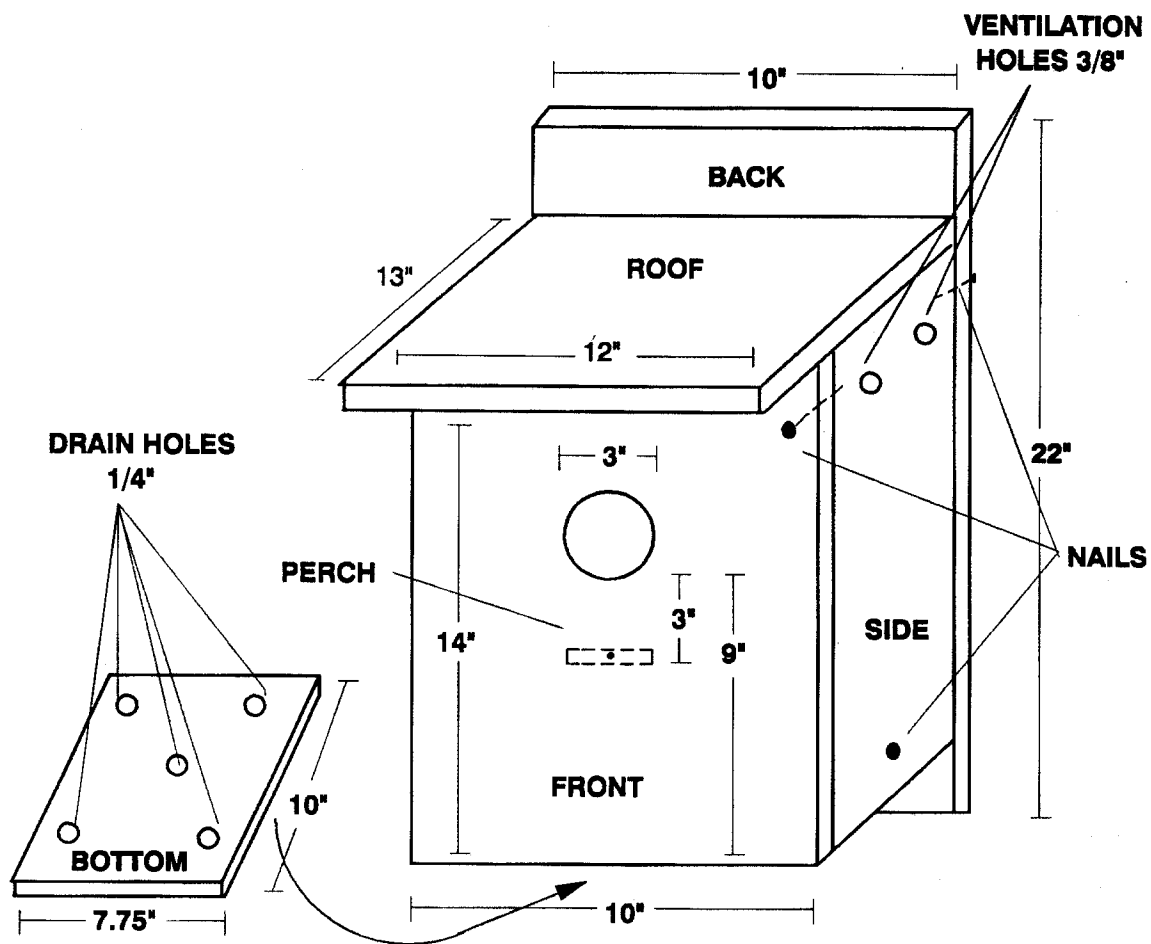


Figure 13. Kestrel nest box design. Half of the entrance cut-out is used for an inside perch, attached with a screw. Two nails at the top of one side panel act as hinges to swing the side open for cleaning. A single nail is used at the bottom to secure the side shut. Use 1 inch thick wood for construction.

SECTION 4.

ALTERNATIVE PROTECTION AND MITIGATION TECHNIQUES

Off-site compensation is recommended if a development site is smaller than the required acreage for the habitat protection area. If the kestrel habitat protection area would consume more than 25% of all developable uplands on a site, then either on-site protection or off-site compensation may be considered. Off-site mitigation should include the purchase of land in an amount equal to 25% of all developable uplands on site. If the habitat protection area would consume more than 25% of all developable uplands on a site but the types of land use proposed for the development are suitable for inclusion in a kestrel habitat protection area (see Section 3), then on-site protection is recommended. In cases where active kestrel nest(s) are present on sites that qualify for off-site mitigation, appropriate procedures to minimize direct harm or stress to the kestrel must be followed.

OFF-SITE MITIGATION

Off-site mitigation may consist of a purchase of land consisting of suitable kestrel habitat within a mitigation park. The amount of land purchased within the mitigation park should be equal in area to that required for a habitat protection area for each breeding pair of kestrels located on site. The land purchased should contain suitable foraging habitat, adequate perch sites, and alternative natural nest sites or nest boxes. A second off-site option requires the purchase of land adjacent to and contiguous with public lands where management is compatible with kestrels. The purchased land should be donated to the agency that holds title to the public lands. The area purchased should consist of an amount of suitable foraging habitat equal to what would have been required for the habitat protection area. The applicant must provide a one-time management action to optimize forage value and erect kestrel nest boxes at a density of 1/10 ha in the off-site mitigation area.

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