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Species Profile: Southeastern American Kestrel (*Falco sparverius paulus*) on Military Installations in the Southeastern United States

by John J. Lane, Richard A. Fischer

WES

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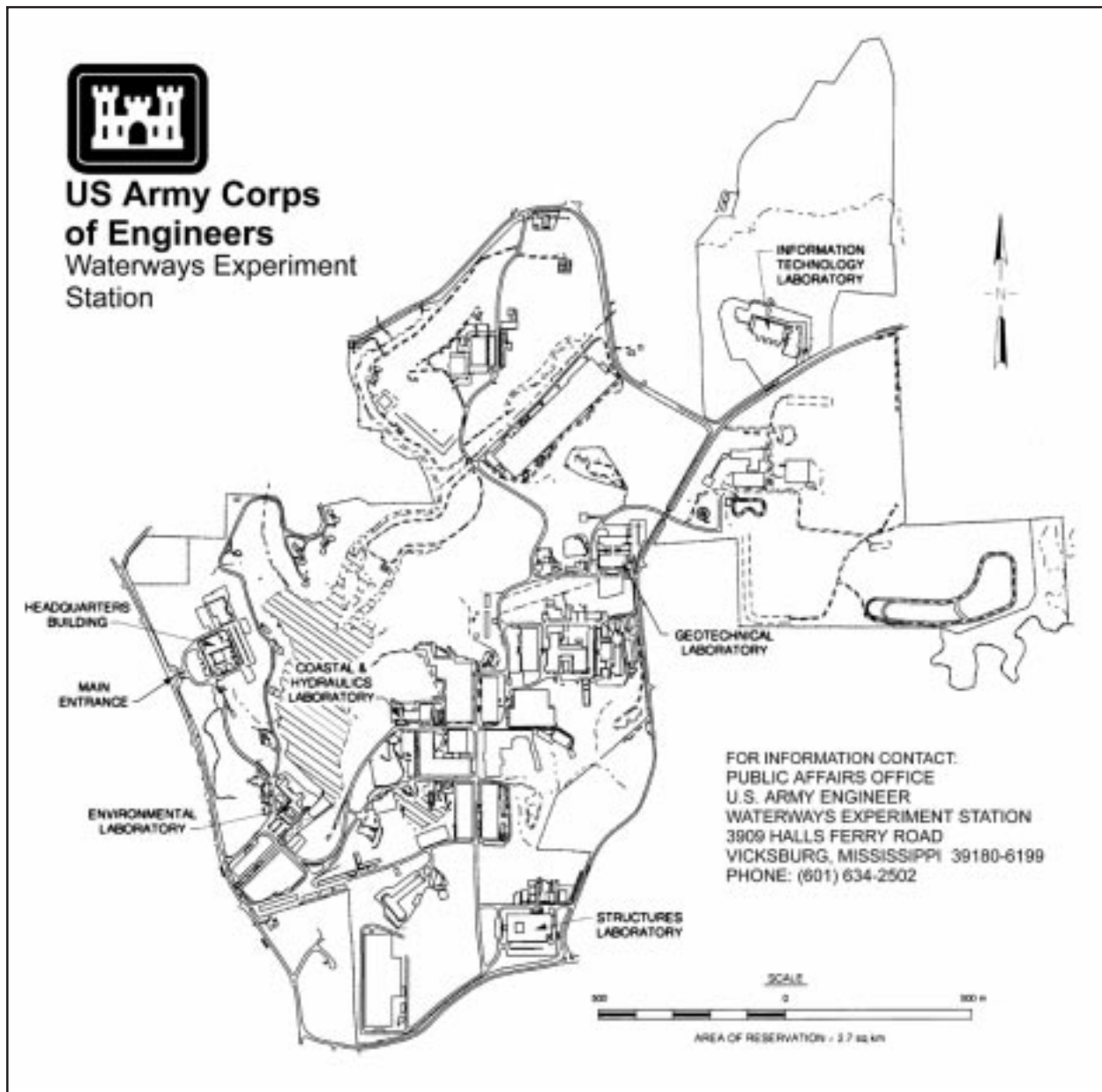
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Preface

The work described herein was authorized by the Strategic Environmental Research and Development Program (SERDP), Washington, DC. The work was performed under the SERDP study entitled “Regional Guidelines for Managing Threatened and Endangered Species Habitats.” Dr. John Harrison was Executive Director, SERDP.

This report was prepared by Mr. John J. Lane and Dr. Richard A. Fischer, Natural Resources Division (NRD), Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. Mr. Lane was employed under a Student Contract Agreement with Tennessee Technological University, Cookeville, TN, during the preparation of this report.

Report review was provided by Ms. Beth Stys, Nongame Wildlife Program, Florida Game and Fresh Water Fish Commission; Dr. Leonard A. Brennan, Director of Research, Tall Timbers Research Station, Tallahassee, FL; and Dr. Petra Bohall-Wood, West Virginia Cooperative Fish and Wildlife Research Unit, Morgantown, WV. WES technical review was provided by Mr. Chester O. Martin and Mr. Darrell Evans, EL, WES. Mr. Martin, WES, and Ms. Ann-Marie Trame, Land Management Laboratory, U.S. Army Construction Engineering Research Laboratories (CERL), Champaign, IL, were Principal Investigators for the work unit. Mr. Larry Reynolds, Ms. Tiffany Cook, and Mr. Chalin B. Street, WES, provided valuable assistance in assembling species information. Dr. Alison Hill, CERL, provided information on status of species on military installations.

This report was prepared under the general supervision of Dr. Michael F. Passmore, Chief, Stewardship Branch, NRD; Dr. Dave Tazik, Chief, NRD; and Dr. John Harrison, Director, EL.

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Species Profile: Southeastern American Kestrel

(Falco sparverius paulus)



Photo by John Smallwood

Taxonomy

Class	Aves
Order	Falconiformes
Family	Falconidae
Genus/species	<i>Falco sparverius paulus</i>
Other Common Names	American kestrel, little kestrel American sparrow hawk, little sparrow hawk, sparrow hawk, killy hawk

Description

The American kestrel (*Falco sparverius*) is the smallest and most colorful member of the family Falconidae in North America (Wiley 1978, Bird and Palmer 1988, Johnsgard 1990). The southeastern American kestrel (*F. s. paulus*) is one of two subspecies that occur in the United States (17 subspecies have been described in the Western Hemisphere) (Johnsgard 1990). Approximately the size of a robin (Wiley 1978), the southeastern American kestrel exhibits sexual size dimorphism, as do most raptors (Amadon 1975), with the female being larger (approximately 11.5 percent) than the male (Layne and Smith 1992) (Table 1).

Table 1
Mean Measurements and Weights of Southeastern American Kestrels (Layne and Smith 1992)

Body Characteristic	Females	Males
Body weight, g	103	91
Wing length, mm	178	175
Tail length, mm	110	109
Culmen length, mm	13	12
Tarsus length, mm	34	34
Middle tow length, mm	22	21
Middle claw length, mm	9	9

The American kestrel is easily identified by two distinct black streaks (moustaches) on each side of the head that contrast with the white throat and cheeks, a blue-gray patch encircling a rufous spot on top of the head (may be reduced or absent in some), and on males, a prominent rufous coloration on the back and tail plumages (Cade 1982, Bird and Palmer 1988, Johnsgard 1990). The undersides of wings show a distinctive row of translucent spots on the trailing edge (National Geographic Society 1987). The iris is dark brown; skin, tarsi, and toes, yellowish to reddish orange; and talons, black (Wiley 1978, Johnsgard 1990). In hand, this is the only North American raptor with circular nostrils and toes entirely scutellated from base to tip (Johnsgard 1990). The voice is a shrill, high pitched, “killy” or “klee” call in three to six short, rapid bursts (Wiley 1978, Johnsgard 1990).

Sexes can be distinguished by dimorphic coloration. Females are more uniformly brown with brownish-colored wings (same as the back), buffy-white underside streaked with brown, and 9 to 11 black longitudinal bars across the back and tail. Males have blue-gray wings, a few longitudinal black flecks and bars on the back, buffy-white underside with a few scattered black spots, and an unbarred rufous tail with a wide subterminal black band bordered by a narrow white tip (Wiley 1978, Cade 1982, Johnsgard 1990).

Prior to fledging, juvenile birds attain an adultlike sexually dimorphic body plumage. They then molt again into a nearly adultlike plumage during the first winter, a unique trait among North American raptors (Cade 1982, Johnsgard 1990). However, both sexes retain juvenile wing and tail feathers until their second summer (molting them after their first breeding season). Immature males up to a year old often can be recognized by broader and more numerous black barring on the scapulars and upper back, and females

by a more poorly defined subterminal band on the tail (Johnsgard 1990). Immature birds retain a disproportionately shorter tail than adults for several weeks post-fledging (Stys 1993). Recently fledged kestrels have brighter plumage and a more conspicuous creamy tip on the tail (Stys 1993).

Similar Species

The resident southeastern American kestrel is most often confused during winter with the northern migratory subspecies, *F. s. sparverius*. *Falco s. paulus* is smaller, with a mean body mass approximately 22 percent less for males and 26 percent less for females, than that of *F. s. sparverius* (Layne and Smith 1992). Male *F. s. paulus* have darker buff coloration on about two-thirds of the breast and abdomen and fewer spots, usually on the flanks under the wings, whereas male *F. s. sparverius* have more spots, extending farther onto the abdomen and breast (Brown and Amadon 1968). However, the amount of spotting is highly variable, and a young male *F. s. paulus* often can be so heavily spotted that it can be mis-taken for a female (Collopy 1989, Stys 1993). Females of the two subspecies are generally indistinguishable from one another in the field (Stys 1993), although *F. s. sparverius* may look “chunkier” (P. Bohall-Wood, Personal Communication, 1996).

Southeastern American kestrels are occasionally confused with the smaller raptors such as the sharp-shinned hawk (*Accipiter striatus*), cooper’s hawk (*Accipiter cooperii*), and merlin (*Falco columbarius*). However, the kestrel’s smaller size, more narrow and pointed wings, and distinct coloration differentiate this falcon. Kestrels also regularly perch on utility lines (larger raptors typically perch on poles or posts), characteristically pump the tail up and down after alighting, and will hover more often than other raptors while searching for prey (Wiley 1978, Johnsgard 1990).

Status

Legal designation

Federal. The southeastern American kestrel was formerly considered a candidate (C2) subspecies for listing by the U.S. Fish and Wildlife Service (USFWS); it is no longer considered a candidate for listing but is unofficially considered a species of concern.

State. The southeastern American kestrel was listed as threatened in Florida by the Florida Game and Fresh Water Fish Commission (Wood 1996).

Military installations

See Table 2.

**Table 2
Known Status of the Southeastern American Kestrel on Military Installations**

State	Installation	Status on Installation
FL	Eglin Air Force Base (AFB)	Documented Onsite (Eglin AFB Natural Resources Management Plan 1993).
	MacDill AFB	Documented Onsite (Shelley Urbinek, Biologist, MacDill AFB, FL, Personal Communication, 1996).
	Tyndall AFB	Documented Onsite (Stephen Shea, Wildlife Biologist, Tyndall AFB, Personal Communication, 1996).
	Camp Blanding	Documented Onsite
GA	Fort Gordon	Documented Onsite
	Fort Stewart	Documented Onsite: Evidence of breeding adults but no documented nests or fledglings (Tim Beaty, Biologist, Environmental/Natural Resources Division, Fort Stewart, GA; Personal Communication, 1996).
	Fort Benning	Potential
AL	Fort Rucker	Documented Onsite: "Over-winter kestrels are common. Formerly bred throughout Alabama, but breeding birds (southeastern American kestrels) now rare in state...the status (of this subspecies) in Alabama has not been ascertained. Occurrence of a breeding population at Fort Rucker is, at best, problematic" (Mount and Diamond 1992).
	Fort McClellan; Pelham Range	Documented Onsite; "Southeastern American kestrels are rare and local in Pelham Range area, although the nonresident nominate subspecies is common in winter and on migration" (Alabama Natural Heritage Program 1994).
	Anniston Army Depot (ANAD)	"The southeastern American kestrel is rare and local on ANAD, although the nonresident nominate subspecies is common in winter and on migration. This species prefers borders of woodlands, open fields, pastures, and highway margins with scattered trees" (Godwin et al. 1994).
SC	Fort Jackson	Documented Onsite
LA	Louisiana Army Ammunition Plant	Documented Onsite

Distribution and numbers

The American kestrel is one of the most widespread and abundant falcons in North America (Cade 1982, Johnsgard 1990). *Falco s. sparverius* breeds from western and central Alaska southward through Canada and into the United States, north and west of the breeding range of *F. s. paulus*. *Falco s. sparverius* is migratory, wintering from south-central Alaska, and south into Mexico almost to Guatemala (Johnsgard 1990). *Falco s. paulus* is a nonmigratory resident of the southern Gulf coast states, now extirpated over much of its former range. Current range includes portions of east Texas, Mississippi, Alabama, South Carolina, Georgia, and Florida (except the southernmost Florida counties and the Keys) (Figure 1) (Wiley 1978, Johnsgard 1990, Smallwood 1990).

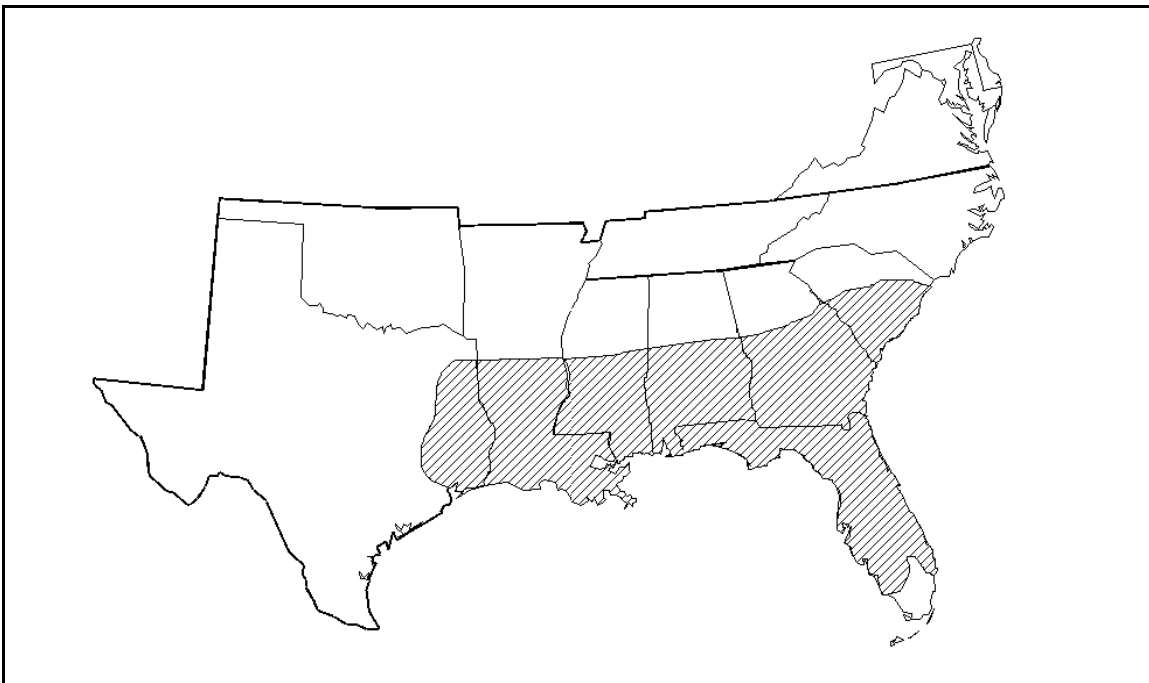


Figure 1. Distribution of southeastern American kestrels in the southeastern U.S. (after Smallwood 1990)

The ranges of the two North American subspecies overlap during winter (i.e., September to April) (Cade 1982, Bohall-Wood and Collopy 1986a, Johnsgard 1990, Smallwood 1990). Distribution of the American kestrel is believed to be limited by a combination of nest-site availability, suitable foraging habitat, perch and roost-site availability, and food supply, all of which are required in proximity (Balgooyen 1976, Cade 1982, Macrander 1983, Stys 1993).

The population of the North American kestrel is estimated at approximately 2.4 million birds (Cade 1982), and *F. s. sparverius* appears to be stable or even increasing throughout its range (Foran et al. 1984). However, populations of southeastern American kestrels in Florida have declined substantially (Kale 1971, 1980; Ogden 1971, 1972; MacFarlane 1973; Wiley 1978; Hoffman and Collopy 1988). Hoffman and Collopy (1988) found that southeastern kestrels decreased by an estimated 82 percent from early 1940 to 1981-83 in regions of north-central Florida, decreased substantially in south-central Florida, and have been extirpated from south Florida (mainly Dade County). It is also believed that kestrel numbers have declined in South Carolina and Alabama (Smallwood 1990). Although data from the USFWS Breeding Bird Survey (1966 to 1979) did not indicate any decreasing trends in southeastern American kestrel numbers in other areas (Fuller et al. 1987), little recent information has been available to assess the current population status throughout most of its range.

Species Sympatric with Southeastern American Kestrels

Raptor species that may occur in the range of the southeastern American kestrel either during winter or year-round include the Mississippi kite (*Ictinia mississippiensis*), white-tailed kite (*Elanus leucurus*), peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaeetus*), American swallow-tailed kite (*Elanoides forficatus*), northern harrier (*Circus cyaneus*), sharp-shinned hawk, cooper's hawk, red-shouldered hawk (*Buteo lineatus*), broad-winged hawk (*Buteo platypterus*), red-tailed hawk (*Buteo jamaicensis*), short-tailed hawk (*Buteo brachyurus*), and merlin (Johnsgard 1990); crested caracara (*Polyborus plancus*), crested burrowing owl (*Athene cunicularia*), Eastern screech owl (*Otus asio*), and common barn owl (*Tyto alba*) (Brian Toland, Personal Communication, 1996).

American kestrels are secondary cavity nesters, primarily using abandoned nest cavities excavated by woodpeckers (Raphael 1985). Therefore, kestrels often co-occur with northern flickers (*Colaptes auratus*), red-headed woodpeckers (*Melanerpes erythrocephalus*), and/or pileated woodpeckers (*Dryocopus pileatus*) (Stys 1993). Kestrels also frequently compete for nest sites with other cavity-nesting species such as the eastern gray squirrel (*Sciurus carolinensis*), eastern fox squirrel (*S. niger*), southern flying squirrel (*Glaucomys volans*), eastern screech owl, and common starling (*Sturnus vulgaris*) (Johnsgard 1990; Bohall-Wood, Personal Communication, 1996).

Life History and Ecology

Pair bonding in kestrels is strong and tends to be permanent (Johnsgard 1990). Southeastern American kestrel pairs often remain on or near nesting territories year-round, exhibiting a high degree of territory fidelity, often using the same territory during successive years (Bohall-Wood and Collopy 1986a). Bohall (1984) found that males and

females did not exhibit any differential use in habitat type or perch preference during summer or winter. Females did, however, show a significant shift in habitat preference from open habitats in winter to a more closed habitat in summer within longleaf pine (*Pinus palustris*)-turkey oak (*Quercus laevis*) 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 (Bohall 1984).

American kestrel territory size varies dependent upon habitat quality (e.g., prey abundance and nest-site availability) (Bird and Palmer 1988). Hoffman (1983) reported territory size was approximately 50 ha (124 acres) in sandhill woodlands, whereas in disturbed or cleared sandhill woodlands, a breeding pair may require 116 to 317 ha (287 to 783 acres) (Bohall 1984, Hoffman and Collopy 1987). Breeding densities also are highly variable, depending on nest-site availability, habitat type, and prey abundance (Bohall-Wood and Collopy 1987, Stys 1993). Hoffman and Collopy (1987) reported breeding densities of 0.41 pairs/km² (1.06 pairs/mile²) in longleaf pine-turkey oak habitats and 0.14 pairs/km² (0.36 pairs/mile²) in hardwood hammock vegetation. Bohall (1984) reported breeding densities of 0.67 pairs/km² (1.74 pairs/mile²) in longleaf pine-turkey oak habitats and 0.49 pairs/km² (1.27 pairs/mile²) in hardwood hammock vegetation.

Reproduction and development

Southeastern American kestrels begin courtship and pair-bonding during late January (Bohall-Wood and Collopy 1986b). Pair formation is initiated by the male establishing a territory and the female associating and hunting with the territorial male. Males often select the same territory that was used the previous year, which probably encourages re-pairing with the same female. Important components of pair formation and pair-bonding include aerial courtship displays, courtship feeding of the female by the male, mutual perching, copulation, and the nest-site search (Johnsgard 1990).

Common aerial courtship displays include the “dive-display” and “flutter-glide” (Willoughby and Cade 1964, Bird and Palmer 1988, Johnsgard 1990). During the dive-display, the male performs a series of climbs and dives with three to five killy notes uttered near the apex of each ascent. The dive consists of a vertical drop of 10 to 20 m (33 to 66 ft) and frequently occurs directly above the perched female (Johnsgard 1990). The primary purpose of the dive-display is territory advertisement (Bird and Palmer 1988). During the flutter-glide, performed by both males and females, the birds fly slowly with quick, shallow wing beats. Males are observed most frequently flutter-gliding during aerial food transfer and females when begging for food (Willoughby and Cade 1964, Bird and Palmer 1988, Johnsgard 1990). Courtship feeding also occurs while birds are perched, with the male vocalizing whines and chitters while holding food in front of the female’s beak (Johnsgard 1990).

Copulation occurs concurrent with or slightly prior to the female associating and hunting with a territorial male (Johnsgard 1990). Promiscuous matings are fairly common as females move about among territories of two or more males prior to forming monogamous pair bonds. Pairing appears to be completed when the female associates exclusively with a single male on his territory (Balgooyen 1976).

The first stage of the nesting phase begins with the male initiating a nest-site search (nest-site characteristics are described under Habitat Requirements). Final choice and occupation of the nest site follows. Kestrels are apparently dominant over most other cavity-nesting species and may even evict current residents (Johnsgard 1990). South-eastern American kestrels lay three to five eggs from mid-March to late-May (Wiley 1978). Eggs are deposited directly on any debris present on the cavity floor; no nesting material is brought into the cavity (Wiley 1978). Egg color ranges from white to light reddish-brown, and they typically are mottled with gray or brown (Bird and Palmer 1988).

The incubation period lasts 29 to 31 days. The female does the majority of the incubation (Wiley 1978, Johnsgard 1990), but Balgooyen (1976) estimated 15 to 20 percent of total incubation was performed by the male. During incubation and the first week following hatching, the male does most of the hunting (Bohall-Wood and Collopy 1986b). Hatching occurs over a period of 3 to 4 days (Wiley 1978, Johnsgard 1990). The young are pink skinned and covered with short, silvery down (Bird and Palmer 1988). The female leaves the nest 1 to 2 weeks after the eggs hatch and assists the male with feeding the young (Bohall-Wood and Collopy 1986b). The young grow rapidly, attaining their adult weight in 16 to 17 days (Johnsgard 1990). Fledging occurs at 29 to 31 days, with siblings thereafter forming a social unit, often hunting together until dispersal (Balgooyen 1976, Johnsgard 1990). The male and female continue bringing food to the young for several weeks post-fledging (Bird and Palmer 1988).

Mean hatching success rates of American kestrels have been reported to range from 64 to 89 percent (Heintzelman and Nagy 1968, Smith et al. 1972, Balgooyen 1976, Stys 1993). Sex ratio of the young at hatching is near 1:1 (Heintzelman and Nagy 1968, Porter and Wiemeyer 1972, Balgooyen 1976). Due to efficient parental defense, there is a high fledgling survival rate (Johnsgard 1990). Fledging success rates of 98 percent (Balgooyen 1976) and 78 percent (Smith et al. 1972) have been reported. Renesting following initial clutch loss, especially for early nesters, occurs frequently (Toland 1985, Bowman 1986). Kestrels also can successfully rear two broods in a single season. Double brooding has been reported in Florida (Howell 1932), Missouri (Toland 1985), southern California and Tennessee (Cade 1982), and speculated to have occurred in Colorado (Stahlecker and Griese 1977) and Oklahoma (Black 1979, Sutton 1979). Toland (1985) reported 11.8 per-cent (1982) and 33 percent (1983) double brooding in a Missouri population, with second clutches averaging slightly smaller than initial clutches, and hatching success rates of 86 and 73 percent, respectively. Double brooding appears to be influenced, in part, by food availability and weather conditions (Newton 1979). Yearlings of both sexes are capable of breeding (Bird and Palmer 1988).

Food habits and foraging

The American kestrel is a generalized predator, feeding on insects, small rodents, reptiles, amphibians, and occasionally small birds (Wiley 1978, Cade 1982, Bohall 1984) (Figure 2). In Florida, Bohall (1984) found that southeastern American kestrel diets consisted predominantly of invertebrates (96.8 percent). Identifiable prey items included grasshoppers (Orthoptera), worms (Annelida), dragonflies (Odonata), beetles (Coleoptera), caterpillars (Lepidoptera), flies (Diptera), and spiders (Arachnida). Vertebrate prey items included primarily lizards and a small number of frogs and passerine birds. Bohall (1984) also found that males captured more vertebrate prey items (94 percent captured during the breeding season), primarily lizards than did females. Smallwood (1987) found remains of arthropods (primarily grasshoppers, beetles, and spiders) exclusively in food pellets collected from kestrels captured during winter in Florida; there was no sexual difference in the diet. Insects are captured most often in open pasturelike habitats, and lizards are taken most often in pine-oak habitat (Stys 1993). Kestrels obtain an adequate supply of water from the prey items consumed and therefore do not require a free source of water (Bartholomew and Cade 1956).



Figure 2. American kestrel feeding on a house sparrow (photo courtesy of Florida Agricultural Information Retrieval System, University of Florida)

Kestrels apparently are able to capture insects more readily than other prey items. However, during the breeding season kestrels may be nutritionally or energetically dependent on vertebrate prey (mainly lizards) (Bohall-Wood and Collopy 1987; Smallwood 1990). When feeding several young, kestrels predominantly feed on lizards (Bohall-Wood and Collopy 1987). The importance of lizards in the diet of breeding kestrels may indicate that open-woodland habitat types, where lizards are typically captured, may be an important aspect of habitat selection (Bohall-Wood and Collopy 1987).

Kestrels employ a variety of prey capture techniques including perch hunting, hawking flights, hover hunting, and foraging on foot (Balgooyen 1976, Collopy and Koplín 1983, Johnsgard 1990). Prey items are typically captured with the feet and killed with the beak, although small insects are often captured and carried with the beak

(Johnsgard 1990, Stys 1993). Prey capture success rates between males and females appear to be equal with percent successful pounces of 73 and 76 percent, respectively (Smallwood 1987). Balgooyen (1976) reported that kestrels hunted nearly all day long in California, whereas other studies have indicated hunting activity peaks in morning and evening (Johnsgard 1990). Prey abundance, weather, and activity pattern variations probably influence the periodicity of kestrel foraging in various locations (Johnsgard 1990).

Perch hunting accounts for the majority of time spent hunting (Balgooyen 1976, Collopy and Koplín 1983, Bohall 1984, Toland 1987, Gard and Bird 1990, Johnsgard 1990). Bohall (1984) reported that perch hunting accounted for 81 percent of time spent hunting in north-central Florida, and Balgooyen (1976) reported that in California perch hunting accounted for nearly all hunting time (>97 percent), indicating the importance of perch sites. Hover hunting is employed when visibility is poor or in areas lacking perch sites. The frequency of hover hunting also increases with ambient wind speed (Balgooyen 1976, Smallwood 1990). Kestrels hover 15 to 30 m (50 to 100 ft) above ground for periods usually not exceeding 1 min (Bird and Palmer 1988) and dive head-first when capturing mammals, compared with feet-first when capturing insects (Balgooyen 1976). Cade (1982) reported observing kestrels foraging on foot for worms that were exposed on the surface during wet conditions.

Other

Mortality of kestrels is highest during the first year of life (approximately 69 percent); for each successive year, survival is approximately 50 percent (Brown and Amadon 1968, Henny 1972). Analyses of banding data for American kestrel indicated that life expectancy is approximately 15 months (Bond 1943); out of 558 recoveries of banded birds, only 15 birds lived >4 years (Terres 1991). Reports of nestling mortality are few; however, mortality of nestlings to snakes and fire ants have occurred in north-central Florida (Stys 1993). Humans appear to be the kestrel's greatest enemy, with most banded birds recovered having been shot (Terres 1991). Additionally, Layne (1982) reported collisions with motor vehicles responsible for 52 percent of birds found killed, injured, or incapacitated in Florida. Mammalian and avian predators also are potential factors influencing nest success rates and juvenile and adult survival rates (Stys 1993).

Habitat Requirements

The American kestrel occurs in a variety of habitat types, but is primarily an open-habitat bird (Wiley 1978, Cade 1982, Johnsgard 1990). Southeastern American kestrels are found in various plant communities associated with open pasturelike areas that include snags (dead trees). These birds prefer open longleaf pine-turkey oak sandhill communities, agricultural/mixed hardwood communities, pine flatwoods, old-growth slash pine (*P. elliotii*), grasslands, pastures, open sites within suburban and sparse

residential areas (e.g., golf courses, parks), edges of river bottoms, and along coastal regions (Norris 1976, Wiley 1978, Layne 1980, Bohall 1984, Bohall-Wood and Collopy 1986a).

Kestrel habitat must include three basic components: (a) an adequate amount of open pasturelike area of short vegetation with scattered perch sites (i.e., foraging habitat), (b) an adequate prey base, and (c) suitable nest sites. These habitat components must be located close to each other and well interspersed (Balgooyen 1976, Johnsgard 1990, Stys 1993). Characteristics of selected habitats frequently used by southeastern kestrels are described below.

In Florida, longleaf pine-turkey oak sandhill communities occur on ridges and are characterized by the Chandler-Apopka soil series (Hoffman and Collopy 1987). Longleaf pines form a scattered overstory and xeric oaks, primarily turkey oak, are small understory trees. Ground cover characteristically is scattered wiregrass (*Aristida stricta* and *Sporobolus junceus*) with numerous areas of bare sand. The deep, sandy soils are moderately to extremely well drained. Open areas include agricultural fields and pasture (Bohall-Wood and Collopy 1986a).

Agricultural/mixed hardwood communities (in Florida) are characterized by natural hardwood stands on deep, well-drained, moderately rich soils. These sites are dominated by shade-tolerant hardwoods such as southern magnolia (*Magnolia grandiflora*), laurel oak (*Q. laurifolia*), and live oak (*Q. virginiana*). The major component of this community is agricultural areas, because most natural hardwood areas have been converted to agricultural production (Bohall-Wood and Collopy 1986a).

Pine flatwoods (in North Florida) are characterized by natural or planted stands of various pine species, primarily slash and longleaf pine. Understory varies from grasses and low shrubs to tall shrubs and small trees, dependent upon timing and intensity of fires. This community also is interspersed with small tracts of other habitat types, particularly bald cypress (*Taxodium distichum*) dome wetlands. Soils are generally poorly drained. Open areas include agricultural fields, pastures, or clear cuts (Bohall-Wood and Collopy 1986a).

Foraging habitat

Kestrels hunt most frequently in areas having short grass or sparse ground cover and high perch sites, including pastures, roadside berms, mown hayfields, open orchards, and lawns in parkland areas (Smallwood 1987, 1990). Smallwood (1987) reported that most hunting attempts (97.5 percent) occurred over substrates of grasses and weedy forbs <25 cm in height. Kestrels readily hunt in open woodlands, especially during winter (Smallwood 1990). However, woody canopy cover is negatively correlated with suitable hunting substrate, with trees and shrubs forming a visual barrier restricting available

hunting sites (Smallwood 1987). Smallwood (1987) reported that wintering kestrels most often used woodland areas averaging 20-percent woody canopy cover. Bohall (1984) reported that kestrels rarely used pine plantations because of the dense understory vegetation.

Perch sites are an important component of kestrel foraging habitat. Kestrels are opportunistic in perch-site use, frequently using trees, utility poles and lines, and fence posts. Perch sites that provide the most unobstructed view of the greatest area of the foraging habitat are preferred (Smallwood 1990). Smallwood (1987, 1990) reported an average perch height of 8.1 m (26.5 ft), and pounces were usually made within a 56-m (184-ft) radius of perch sites.

Nest sites

Kestrels are secondary cavity nesters, using abandoned nest cavities excavated by woodpeckers (Raphael 1985), primarily northern flickers or pileated woodpeckers. However, kestrels are not dependent on any single cavity nesting species to provide suitable nest sites (Hoffman 1983). In north-central Florida, kestrels frequently nest in longleaf pine, and occasionally in turkey oak and live oak. Turkey oak snags may be alternate nest sites in Florida, especially as longleaf pine decreases in abundance (Hoffman and Collopy 1987). Longleaf pine trees used for nesting in Florida typically are >22.7 cm (9 in.) diam at breast height (DBH) and 6.7 m (22 ft) tall (Bohall-Wood et al. 1996). In some areas, the majority of nest sites may be located in abandoned or occupied buildings (Hamerstrom et al. 1973, Toland and Elder 1987) or in telephone poles (B. Toland, Personal Communication).

Most nest cavities are located in snags (dead trees). Hoffman (1983) reported that kestrels disproportionately used nest cavities in dead trees in an intermediate stage of decay (twigs absent, a few main limbs >1 m (33 ft) in length, <50 percent of the treetop intact, and approximately 33 percent of the bark left intact). Most nest trees in north-central Florida were associated with pastures or cultivated farmland or within longleaf pine-turkey oak woodlands. Nests most frequently occurred in longleaf pine, turkey oak, or live oak snags (Hoffman and Collopy 1987).

Measurements of nest trees and cavities in north-central Florida by Hoffman (1983) indicated kestrels used snags with a mean DBH of 30.5 cm (12 in.) and mean nest hole height of 7.3 m (24 ft). Cavities had a mean entrance width of 7.2 cm (2.8 in.), mean entrance height of 9.4 cm (3.7 in.), mean interior diameter of 13.4 cm (5.3 in.), and mean depth of 27.4 cm (10.8 in.).

Although the availability of natural nest sites is considered to be a factor limiting the distribution and abundance of kestrel populations (Bohall-Wood, Personal Communication, 1996), kestrels will readily nest in man-made boxes (Hamerstrom et al. 1973, Stahlecker and Griese 1977, Bloom and Hawks 1983, Wilmers 1983, Toland and Elder

1987). Toland and Elder (1987) reported that kestrels preferred nest boxes to natural cavities, even when natural cavities were abundant.

Kestrels in Missouri appeared to prefer nest boxes placed on utility poles and buildings to those placed on live trees. Boxes placed at a height of 7 m (23 ft) or higher are used more often than those placed 6 m (19.7 ft) 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 to 5.5 m (13.1 to 18 ft)) also used equally (Smallwood 1990). Kestrels also appeared to prefer nest boxes with southerly or easterly openings (Balgooyen 1976, McComb and Noble 1981, Toland and Elder 1987). In north-central Florida kestrels used nest boxes facing all cardinal directions equally except those facing west (Smallwood 1990).

Impacts and Cause of Decline

The long-term decline of the southeastern American kestrel population in Florida appears to be the result of human-induced habitat modifications (Hoffman 1983, Bohall 1984, Hoffman and Collopy 1988). Hoffman and Collopy (1988) reported that population declines in north-central Florida were the result of decreased nest-site availability caused by the removal of isolated longleaf pine trees from row-crops, residential development, and timber production. In south-central Florida, population declines were attributed to conversion of longleaf pine-turkey oak vegetation to citrus groves, which reduced the availability of both nesting and foraging habitat (Hoffman and Collopy 1988). The extirpation of the southeastern American kestrel from south Florida is believed to be a result of the cutting of virgin slash pine forest and modification of the pine forest understory in response to clearing and fire suppression (Hoffman and Collopy 1988).

Management and Protection

The procedures detailed in this section were developed by Petra Bohall-Wood and published with the Florida Game and Fresh Water Fish Commission, Nongame Wildlife Program by Stys (1993). This information was used to determine habitat protection needs of the southeastern American kestrel on large-scale development sites in Florida. These procedures are applicable to the assessment and protection of kestrel habitat on military installations. Assessment of potential kestrel habitat, survey for kestrels within these habitats, and preservation and management of this habitat are necessary procedures to maintain or enhance southeastern American kestrel populations.

Procedures for protecting kestrel habitat

Preservation of critical kestrel habitat (i.e., foraging and nesting) can be accomplished by onsite habitat protection and/or offsite mitigation. Habitat protection is recommended when (a) kestrels are nesting and foraging on a site, (b) kestrels are nesting onsite but foraging offsite, and (c) kestrels are nesting offsite but foraging onsite. Onsite habitat protection is recommended when the site contains ≥ 50 ha (124 acres) of suitable foraging habitat. If a site contains < 50 ha of suitable foraging habitat, then offsite habitat compensation also can be pursued.

An onsite habitat protection area is defined as the amount of properly managed suitable habitat required by a breeding pair of southeastern American kestrels (i.e., 50 ha). The protection area must include an adequate number of perch sites (i.e., 1 perch site per 2 ha (1 per 5 acres)) to provide suitable foraging habitat and an adequate number of potential nest sites (i.e., 1 site per 10 ha (1 site per 25 acres)). Artificial perch sites and nest sites may be incorporated within a protection area to provide suitable habitat. Offsite habitat mitigation techniques are discussed by Stys (1993).

Kestrels nesting and foraging onsite. Onsite habitat protection is recommended when an active kestrel nest is located on a site that contains ≥ 50 ha of suitable foraging habitat within 0.5 km (0.3 miles) of the nest site. The habitat protection area should include 50 ha of suitable foraging habitat and a 150-m (492-ft) radius buffer zone around the nest site. The protection area can be any configuration that maximizes the area containing the highest quality habitat and the greatest number of kestrel sightings as possible. Five nest boxes should be erected and perch sites maintained at a density of 1 per 2 ha (1 per 5 acres) within the protection area.

Kestrels nesting onsite and foraging offsite. If a site contains an active kestrel nest and < 10 ha (25 acres) of suitable foraging habitat within 0.5 km of the nest site, either onsite habitat protection or offsite compensation is recommended. Onsite habitat protection should include a 150-m (492-ft) radius buffer zone around the nest site, and two nest boxes should be erected within the buffer zone.

Kestrels nesting offsite and foraging onsite. If kestrels are nesting offsite but foraging onsite, two methods may be used to determine size of the habitat protection area. The habitat protection area can be determined as either (a) the amount of suitable foraging habitat within 0.5 km of kestrel observations determined from initial surveys or (b) the amount of suitable foraging habitat located in the onsite kestrel use area determined by surveys along a grid of transects.

If ≥ 50 ha of suitable kestrel habitat exists onsite within 0.5 km of initial kestrel observations or within the onsite kestrel use area, onsite habitat protection is recommended. The habitat protection area should consist of 50 ha of suitable foraging habitat and include the greatest number of kestrel observations as possible. Five nest

boxes should be erected and perch sites maintained at a density of 0.5 sites per hectare within the protection area.

If >15 ha (37 acres) but <50 ha of suitable kestrel habitat exists onsite within 0.5 km of initial kestrel observations or within the onsite kestrel use area, onsite habitat protection or offsite compensation is recommended. Onsite habitat protection should include available suitable foraging habitat up to 49 ha, within 0.5 km of initial kestrel observations or within the onsite kestrel use area and include the greatest number of kestrel observations as possible. Nest boxes should be erected at a density of 1 box per 10 ha (minimum of two) and perch sites maintained at a density of 0.5 sites per hectare within the protection area.

If <15 ha of suitable kestrel habitat exists onsite within 0.5 km of initial kestrel observations or within the onsite kestrel use area, protection of habitat for kestrels may not be warranted.

Managing kestrel habitat (from Stys 1993; Bohall-Wood et al. 1996)

Once a kestrel habitat protection area has been determined, the area should be managed to provide optimum habitat conditions.

Foraging habitat. At least 60 percent of the ground cover within a habitat protection area should be maintained at a height of <25 cm (10 in.) by periodic mowing or burning. Mowing strips on a rotational basis creates an interspersion of dense vegetation and open areas that will provide an optimal combination of prey numbers and availability. Burning on a 2- to 3-year rotation will probably maintain suitable foraging habitat; however, the required burning frequency will vary depending on vegetation type and density.

Nest sites. Disturbance inside the nest-site buffer zone should be minimized during the courtship, breeding, and nesting period (i.e., January to August). A snag management program also should be initiated to promote natural nesting cavities. Existing snags and other large, live trees should be retained in and near pastures and fields, which will provide current and future nesting and perching sites. Live trees will eventually die, which ensures future cavity availability as existing snags eventually fall. Approximately five trees per hectare (two trees per acre) are needed to support the woodpecker populations that excavate the cavities needed by kestrels. If too few natural snags are available, they can be created by selecting approximately five trees per hectare (especially pines) >25.4 cm (10 in.) DBH and cutting off the tops with a chainsaw 10 m (33 ft) from the ground.

Nest boxes can be erected and placed at a density of one per 10 ha within habitat protection areas or areas that have a declining availability of natural cavities (See Figure 3 for kestrel nest box design). Roadsides and power line rights-of-way also are excellent sites for nest boxes; these areas often have abundant insect and lizard

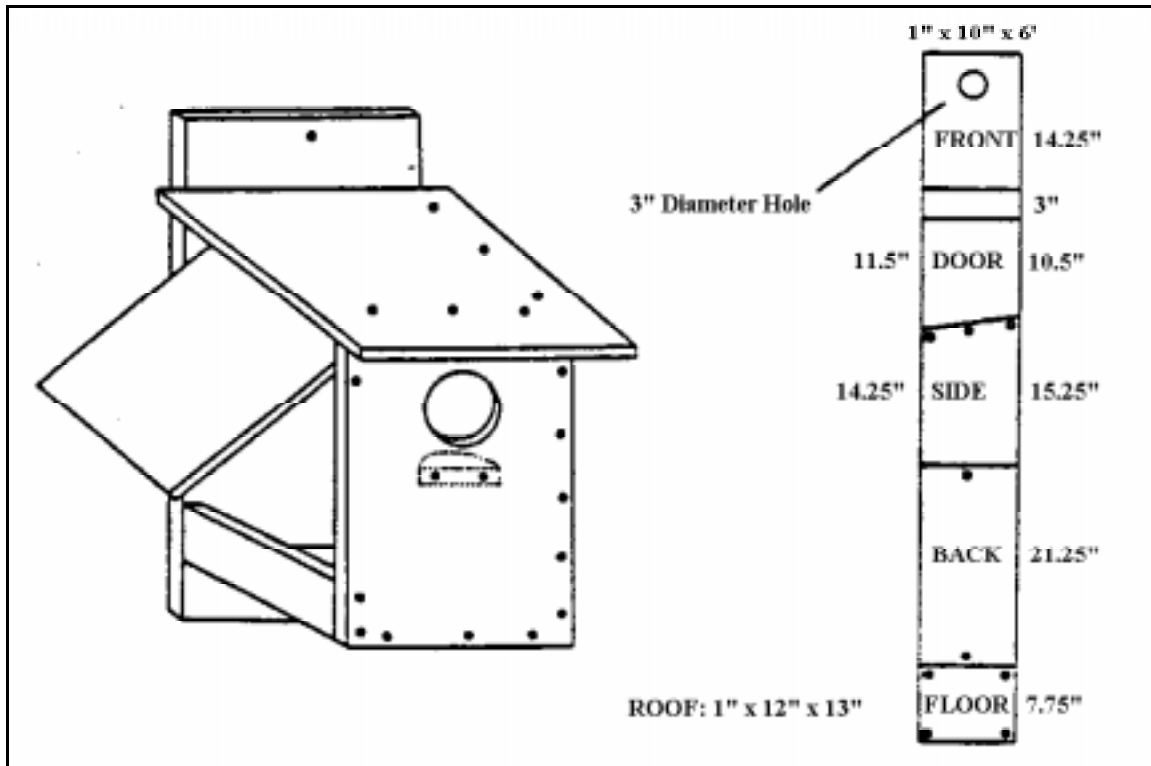


Figure 3. Kestrel nest box design (One-inch-thick wood is recommended. Two nails at the top of one side panel act as hinges to swing the side open for cleaning. A single nail is used at the bottom to secure the side shut. Half of the entrance cut-out can be used as an inside perch by attaching it with a screw to the inside of the box (from Stys 1993))

populations, but pesticide use should always be avoided in these areas. Although nest boxes can provide nest sites for kestrels in areas lacking natural cavities, predation and parasitism can increase after boxes are installed. Nest boxes must be maintained, and upkeep may be more labor-intensive than initiating a snag management program. Maintenance of nest boxes should include two inspections per year, replacement of missing or damaged boxes, and in some cases, removal of nontarget species (e.g., European starlings). One inspection should be performed prior to the breeding season (i.e., December).

Nest boxes should be in place by December and erected with the following considerations:

- a. Approximately 4 to 7 m (13 to 23 ft) high.
- b. Placed on poles, utility poles, snags, or live trees.
- c. Close to a roost tree.
- d. Opening should face a southerly to easterly direction.
- e. Entrance should be unobstructed with a clear flight path.
- f. In an open area at a distance >50 m from a forest edge.

Dr. Leonard Brennan (Personal Communication, 1996) stressed that nest boxes should not be installed and then forgotten. He suggested that nest boxes should be used as a monitoring tool to assess breeding success, productivity, and some demographic parameters of kestrels.

Perch sites. Perch sites are a critical habitat component due to the predominance of perch hunting by kestrels (Balgooyen 1976, Bohall 1984); consequently, the availability and density of perch sites directly influence foraging habitat quality (Stys 1993). Perch-sites include trees, utility poles and lines (each 112 m (367 ft) length of utility line equals one perch site), and fence posts. Perch-site density should be 0.5 perch sites per hectare (1 per 5 acres) on the protection area. If adequate perch sites are not available, artificial perch sites (poles approximately 7 to 10 m (23 to 33 ft) high) should be erected and maintained throughout the protection area to increase the amount of available foraging habitat (Stys 1993).

Habitat Assessment Techniques

An assessment of potential kestrel habitat should be conducted on installations potentially harboring southeastern American kestrels. The primary objective should be to develop a vegetation map detailing all plant communities used or potentially used by kestrels. Plant communities should be plotted on aerial photographs, and a summary table detailing the number of hectares of each habitat type prepared (Stys 1993).

Potential kestrel habitat also can be delineated based on two broad categories of structural characteristics of the vegetation. The following habitat types should be plotted as an overlay on the map of potential kestrel habitats to further define potential kestrel habitat: Type I Habitat, upland plant communities with <10-percent canopy closure and with ≥ 60 -percent herbaceous ground cover of <25 cm in height, and Type II Habitat, open-woodland communities with canopy closure between 10 and 25 percent and ≥ 60 -percent herbaceous ground cover of <25 cm in height (Stys 1993).

Inventory and Monitoring (See Stys (1993))

Surveys of kestrels within potential habitat should be conducted periodically to document the species presence/absence on installations and to gain a better understanding of distribution, ecology, and habitat use by the species on the installation. The most effective census method for kestrels consists of roadside transects supplemented with foot transects as required. Roadside transects should intersect all potential kestrel habitat present on a site, and habitat along transect routes should be open enough to allow observation of individual birds at considerable distances. Foot surveys should be implemented in areas of limited visibility from road transects, areas inaccessible by road,

or habitats underrepresented by road transects. Foot surveys should also be used to locate nest sites. Required equipment for kestrel surveys includes a vehicle, binoculars and spotting scope, map, rangefinder, and a compass (Stys 1993).

Survey design

If an extensive network of roads exists on a site, random selection of road transects is preferred. Transect length and distance between transects are determined by area size and visibility restrictions imposed by vegetation and topography. All transects should be marked on a map and individually numbered (Stys 1993).

Surveys must be performed during the spring and summer (i.e., April to August). Surveys conducted outside this period could include migrating or wintering birds from northern populations and would, consequently, overestimate the number of resident kestrels. Surveys conducted during spring may enhance the ability to sight kestrels, which are more conspicuous when performing courtship behaviors. Surveys should be performed during the morning for 3 to 4 hours beginning at sunrise, on calm, clear days. Driving speeds of 10 to 25 mph, altered in response to road conditions, topography, and visibility, are recommended. Surveys should be conducted six to eight times with a 4- to 7-day break between each survey. Direction of travel should be reversed along transects on alternate days to eliminate bias. When possible, the same individual should conduct all surveys to eliminate observer bias (Stys 1993).

Survey protocol

Location of kestrels. Personnel performing surveys by road transects should observe both sides of the road, searching for kestrels perched on fence rows, utility lines and poles, and trees, and kestrels in flight. When a kestrel is sighted, the vehicle should be stopped, and binoculars and/or a spotting scope should be used to verify identification and an attempt made to identify sex. Behavior and vocalizations should be noted, especially courtship or nesting behavior. The observation location, determined by odometer reading and map location and including the perpendicular distance from the center of the road to the kestrel measured with a rangefinder, should be plotted on a map. If the kestrel moves during the observation, flight direction and possible new location should be recorded. Habitat type should also be recorded for kestrel observations. Surveyors should also look for potential nest sites, which include dead or dying trees, dead limbs on trees, and buildings, and record the locations (Stys 1993).

Personnel performing transect surveys on foot should walk at a steady, consistent pace. Kestrels often will silently flush as their territory is approached before being observed. When a kestrel is sighted, binoculars should be used to verify identification and an attempt made to determine sex. Signs of kestrel activity (e.g., prey remains, pellets, feathers at plucking sites, white feces stains accumulated at perches or roosts) should also be recorded. Surveyors should also look for potential nest sites. Locations of

kestrels, possible kestrel activity, and potential nest sites should be determined (compass direction and distance from a permanent landmark) and plotted on a map. Habitat type also should be recorded for kestrel observations (Stys 1993).

Location of nest sites. Potential nest sites can be identified from road surveys, but foot surveys are required in most situations to locate actual nests. Nest surveys should be performed in areas where kestrels were repeatedly located, where kestrel pairs were observed or where kestrel pairs exhibited courtship, breeding, or territorial defense behavior during road or foot transects. When kestrels are sighted during nest searches, the surveyor should observe the bird for signs of courtship, nesting behavior, and vocalizations and search for kestrel nest sites in snags, cavities, and buildings. Active nest-site location can be confirmed by observing use of the nest site by kestrels, presence of a pair of kestrels exhibiting courtship and reproductive behavior in the vicinity, or presence of nestling or fledgling kestrels. Nest-site location should be plotted on a map. Nest-site measurements also should be recorded and include tree species, stage of decay, and nest tree health. If the nest is located in a man-made structure, the structure type, physical state of the structure, and nest-site location within the structure should be recorded (Stys 1993).

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12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The southeastern American kestrel (<i>Falco sparverius paulus</i>) is one of two subspecies of kestrels that occur in the United States. It is a former candidate for listing as Threatened or Endangered by the U.S. Fish and Wildlife Service. The southeastern subspecies is a nonmigratory resident of the southern Gulf Coast States, now extirpated over much of its former range. Current range includes portions of east Texas, Mississippi, Alabama, South Carolina, Georgia, and Florida. Southeastern American kestrels prefer open longleaf pine-turkey oak sandhill communities, agricultural/mixed hardwood communities, pine flatwoods, old-growth slash pine, and grasslands and pastures. They have been documented on several military installations in the Southeast. This report is one of a series of "Species Profiles" being developed for threatened, endangered, and sensitive species inhabiting southeastern United States plant communities. The work is being conducted as part of the Department of Defense (DoD) Strategic Environmental Research and Development Program (SERDP). The report is designed to supplement information provided in plant community management reports for major United States plant communities found on military installations. Information provided on the southeastern American kestrel includes status, life history and ecology, habitat requirements, impacts and cause of decline, management and protection, and inventory and monitoring.			
14. SUBJECT TERMS DoD installations Management techniques SERDP		15. NUMBER OF PAGES 28	
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13. (Concluded).

c. Of the improvement plans tested, the channel and sand trap configuration of Plan 14 appeared to be optimal with respect to all wave conditions from all directions. Navigation conditions in the entrance will be improved, and the plan will have no negative impact on the existing structures or the spit between the south breakwater and the groin.

d. Sediment tracer tests indicated that sediment moving in the predominant northerly direction will deposit in the deepened entrance channel and sand trap area of Plan 14 as desired, and material moving in the southerly direction will deposit in the deepened entrance channel.

e. The -30-ft entrance channel of Plan 15 will result in similar wave conditions for operational and extreme waves as the -40-ft channel of Plan 14, which would be acceptable with regard to entrance conditions and would have no negative impact on the breakwaters and spit area.