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# **Species Profile: Bachman's Sparrow (*Aimophila aestivalis*) on Military Installations in the Southeastern United States**

*by Wilma A. Mitchell*

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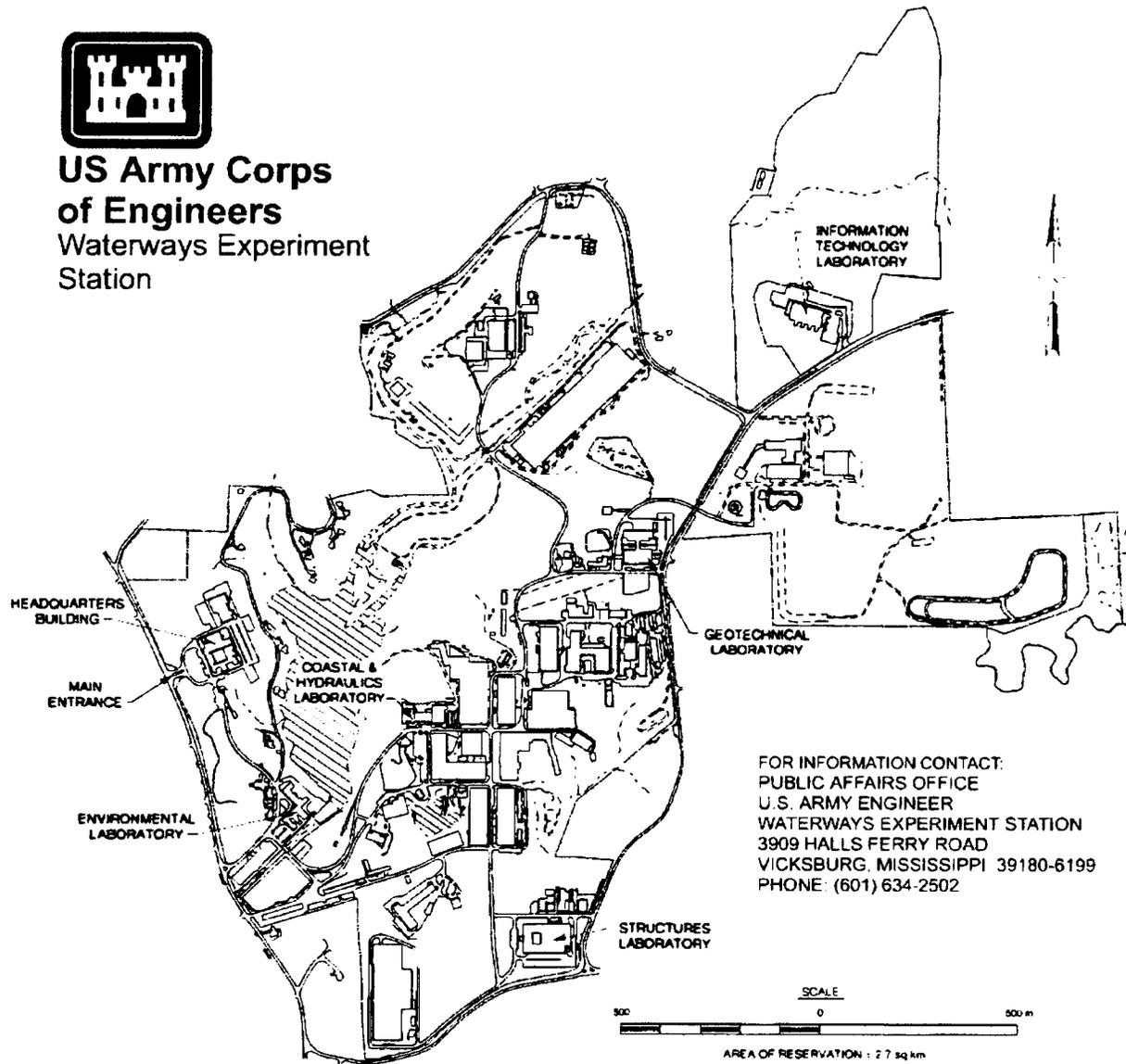
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# Preface

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The work described in this report 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." Mr. Brad Smith was Executive Director, SERDP.

This report was prepared by Dr. Wilma A. Mitchell, Natural Resources Division (NRD), Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. WES technical review was provided by Mr. Chester O. Martin and Dr. Richard A. Fischer, EL. Report review was provided by Dr. John B. Dunning, Purdue University, West Lafayette, IN, and Mr. Michael Guilfoyle, University of Southern Mississippi, Hattiesburg. Mr. Martin and Ms. Ann-Marie Trame, Land Management Laboratory, U.S. Army Construction Engineering Research Laboratories, were Principal Investigators for the work unit. Dr. Fischer managed and coordinated preparation of species profiles for this study.

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: Bachman's Sparrow

## (*Aimophila aestivalis*)

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Photograph by Fenn M. Holden, courtesy of the Florida Audubon Society, Maitland, FL.

### Taxonomy

Class . . . . .	Aves
Order . . . . .	Passeriformes
Family . . . . .	Emberizidae
Genus/species . . . . .	<i>Aimophila aestivalis</i>
Other Common Names . . . . .	Pinewoods sparrow

### Description

The Bachman's sparrow is a large sparrow with a flat forehead, large bill, and long rounded tail (National Geographic Society 1983). The adult is 14.0 to 15.9 cm (5.5 to 6.3 in.) long and weighs 18.4 to 22.6 g (0.6 to 0.8 oz) (Wolf 1977). Body plumage is gray above and heavily streaked with chestnut or dark brown on the head, neck, and back (Wolf 1977, Peterson 1980, National Geographic Society 1983, Stokes and Stokes 1996). The breast and sides of the body and head are buffy-gray, and the belly is whitish. Sub-species vary in shading from reddish brown in the western part of the range to grayish brown in the southern part (National Geographic 1983, Stokes and Stokes 1996). The head has a broad, grayish stripe above the eye and a thin dark line behind the eye; the sides of the neck are streaked with russet (Wolf 1977, Peterson 1980, National Geographic Society 1983).

Wings range from 5.5 to 6.6 cm (2.2 to 2.6 in.) in length, with dark-brown primaries and secondaries and olive-brown to fuscous tertials tipped with hazel or buff (Wolf 1977). The tail measures 6.0 to 6.6 cm (2.4 to 2.6 in.), is olive-brown or dark-brown, and is bordered with gray or olive-brown. The upper mandible is dark brown, and the lower mandible is yellowish brown. The iris is brown, and the feet and legs are pink or flesh-colored (Drilling 1985, Stokes and Stokes 1996). The adult plumage undergoes an extended body molt during spring and summer and a complete molt in autumn (LeGrand and Schneider 1992).

The juvenile has a distinctive white eye ring and streaking on the throat, breast, and sides (National Geographic Society 1983). Fledglings have heavily streaked breasts (LeGrand and Schneider 1992). Soon after fledging, birds undergo a partial molt that produces a plumage with adult body feathers and juvenile wing and tail feathers (Willoughby 1986). The breast is spotted and intermediate in appearance between the streaked fledgling and unmarked adult pattern. During the first fall, juveniles complete a full molt and become essentially indistinguishable from adults (LeGrand and Schneider 1992). Molting twice during the first 6 months is an unusual pattern that may serve to replace plumage severely worn by the abrasive habitat (Willoughby 1986).

Shy and secretive, the Bachman's sparrow may best be located and identified by its song (National Geographic Society 1983). The song consists of two parts: one clear, whistled introductory note, followed by a variable trill or warble on a different pitch. The series may be higher or lower in pitch than the introductory note, and consecutive songs usually vary between higher and lower series (LeGrand and Schneider 1992). The male sings from an open perch and may still be heard in late summer when most other songbirds have stopped seasonal singing (National Geographic Society 1983).

## Similar Species

The field sparrow (*Spizella pusilla*) and grasshopper sparrow (*Ammodramus sava-narum*) are both similar to the Bachman's sparrow. However, the field sparrow is smaller in size and has a white eye ring and smaller pink bill (Peterson 1980). The grasshopper sparrow has a light crown stripe and a sharp tail that is only about half as long as the rounded tail of the Bachman's sparrow; it inhabits meadows rather than pine savannas. The juvenile Bachman's sparrow has a white eye ring and streaked buffy breast, which give it a similar appearance to the Lincoln's sparrow (*Melospiza lincolni*); however, the latter does not breed in the South.

# Status

## Legal designation

**Federal.** The Bachman's sparrow was a candidate species (C2) for listing as either threatened or endangered by the U.S. Fish and Wildlife Service (USFWS). However, the USFWS discontinued the designation of C2 species as candidates for listing (50 CFR 17, 28 February 1996). The Bachman's sparrow is considered to be a species of concern, but more biological research and field study are needed to resolve its conservation status.

**State.** The Bachman's sparrow is listed as endangered in Indiana, Illinois, Missouri, Virginia, and Tennessee; threatened in Oklahoma and Kentucky; species of concern in North Carolina; rare (similar to threatened) in Georgia; and extirpated in Pennsylvania and Maryland (Drilling 1985). It is listed as a species of special concern in West Virginia (West Virginia Department of Natural Resources 1987). The Bachman's sparrow is considered to be potentially threatened throughout the southern United States (Dunning and Watts 1990).

## Military installations

Table 1 represents the known status of the Bachman's sparrow on military installations in the southeastern United States.

## Distribution and numbers

The former breeding range of the Bachman's sparrow extended from south-central Missouri through central and northeastern Illinois, central Indiana, and central Ohio to southwestern Pennsylvania and central Maryland in the east, south to the Gulf coast and south-central Florida, and west to eastern Oklahoma and Texas (Dunning 1993). However, the northern portion of the range has contracted, and this species is now generally absent (or very local) north of North Carolina, Kentucky, and Arkansas (Figure 1). It is considered accidental in New York and New Jersey (LeGrand and Schneider 1992).

The Bachman's sparrow is a permanent resident in southern States and migratory in the north (Dunning 1993). Fall migration begins in mid-to-late August with the latest known departure date being September 26 for Kentucky (Weston 1968). The species winters from southeastern North Carolina along the Atlantic coast to southern Florida and westward through the Gulf States to eastern Texas (American Ornithologists' Union (AOU) 1983, National Geographic Society 1983, Stokes and Stokes 1996). Birds are casual in winter in extreme southern Florida, especially in the Everglades National Park (Dunning 1993). Winter status of the Bachman's sparrow is uncertain because the sparrow's secretive nature, including nonvocalization, renders it difficult to inventory in winter (LeGrand and Schneider 1992).

In the early 1900s, the Bachman's sparrow expanded its range into Ohio, West Virginia, Pennsylvania, Illinois, and southern Canada, probably in response to farm abandonment and deforestation across the region (Eifrig 1915, Brooks 1938, Weston 1968). This

**Table 1**  
**Status of the Bachman's Sparrow on Military Installations in the**  
**Southeastern United States**

State	Installation	Status on Installation
AR	Little Rock Air Force Base (AFB)	Documented onsite; several individuals observed on Blackjack Drop Zone located north of the main base (Lance Peacock, Personal Communication, 1997).
	Camp Robinson	Documented onsite.
AL	Fort Rucker	Documented onsite.
	Fort McClellan; Pelham Range	Potential: "Bachman's sparrows were not detected on Pelham Range, but their occurrence is still considered likely...most suitable-looking areas are the frequently burned Large Impact and Small Arms areas" (Alabama Natrual Heritage Program 1994).
	Anniston Army Depot	Potential.
FL	Eglin AFB	Documented onsite.
	Naval Air Station Cecil Field	Documented onsite (Hank Cochran, Personal Communication, 1996).
	Avon Park Air Force Range	Documented onsite.
	Tyndall AFB	Documented onsite; nests on installation (Stephen Shea, Personal communication, 1996).
	Camp Blanding	Documented onsite.
GA	Fort Gordon	Documented onsite.
	Fort Stewart	Documented onsite: 285 localities on Fort Stewart (The Nature Conservancy 1995).
	Townsend Bombing Range (administrated by Marine Corps Air Station, Beaufort, SC)	Documented onsite (Sargent Edwin Bors, Personal communication, 1997).
	Fort Benning	Documented onsite.
	Marine Corps Logistics Base Albany	Documented onsite.
MS	Camp Shelby	Potential.
NC	Marine Corps Base Camp Lejeune	Documented onsite; 56 territories located during 1990-91 inventory (Leblond et al. 1994).
	Fort Bragg	Documented onsite.
SC	Fort Jackson	Documented onsite.
LA	Fort Polk	Documented onsite (Hart and Lester 1993).
VA	Fort Pickett	Documented onsite (Alan Dyck, Personal Communication, 1996). Thought to be extirpated from the State until 1986, when it was rediscovered in Brunswick County, not far from Fort Pickett. Some loblolly pine-grassland savannas of the Impact Area Southwest and Impact Area Southeast conservation sites provide ideal nesting habitat. These savannas and similar habitat at Fort A.P. Hill appear to be the last remaining suitable habitat for the species in the State of Virginia (Fort Pickett Natural Resources Survey).
	Fort A. P. Hill	Documented; found only in frequently burned pine savanna habitat of the controlled access area (Fort A.P. Hill Natural Resources Survey).

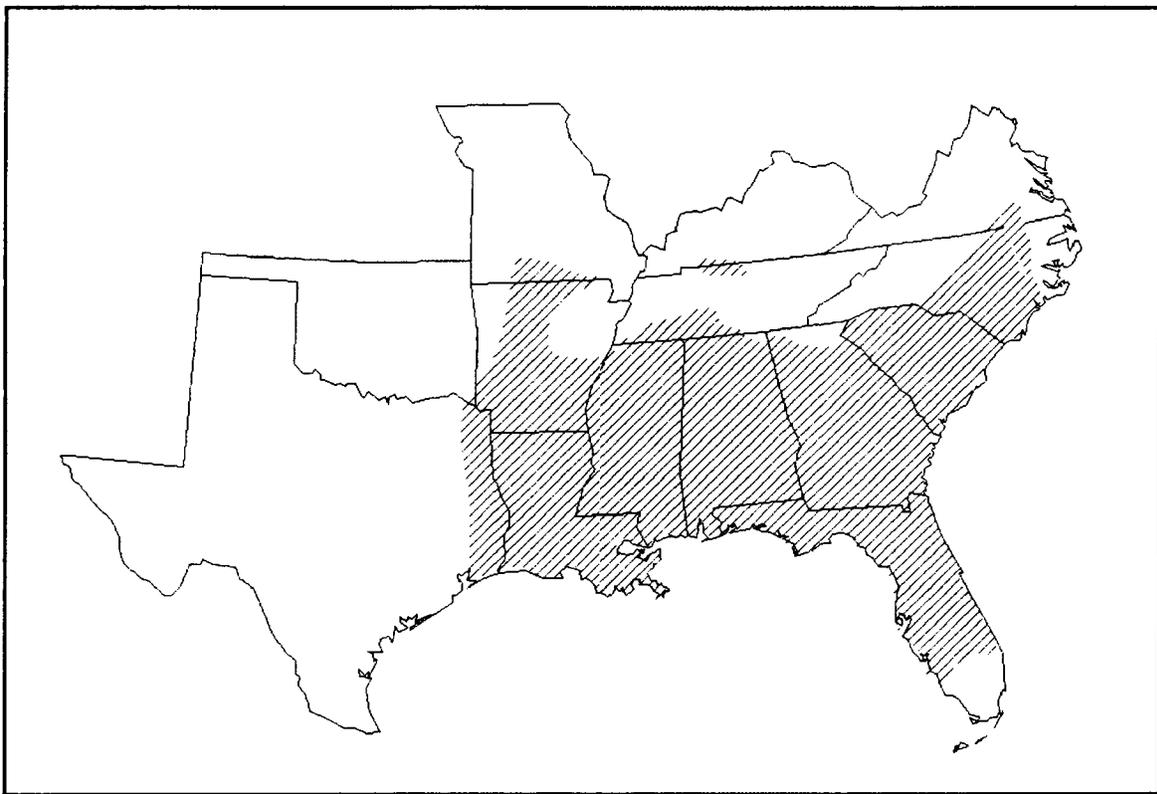


Figure 1. Distribution of the Bachman's sparrow in the southeastern United States (modified from Dunning 1993)

expansion peaked between 1915 and 1922 (Brooks 1938). Populations in these areas had begun to decline by the 1930s, and the range had contracted to its current limits by the 1970s (LeGrand and Schneider 1992). This species is nearly extirpated in the Northeast, with only a few current breeding season records from extreme southern Virginia. Data suggest that some populations in the southern part of the range may also have disappeared (Jackson 1985, Peterjohn 1987).

The Bachman's sparrow is locally distributed in many parts of its range, and much seemingly suitable habitat is not occupied (Dunning 1993). Population data for this species are limited. Hamel (1992) presented mean breeding densities of Bachman's sparrows in longleaf pine (*Pinus palustris*)—slash pine (*P. elliotii*) forests ranging from 2 birds per hectare (0.8 birds per acre) in sawtimber stands to 10 birds per hectare (4 birds per acre) in sapling/poletimber stands. McKittrick (1979) and Dunning (1993) reported much smaller densities for the Bachman's sparrow. Maximum densities of singing males in South Carolina were 4.1 to 4.8 birds per 10 ha (1.6 to 1.9 per 10 acres) in suitable habitat (Dunning 1993), whereas densities in south-central Florida were approximately 0.3 birds per 10 ha (0.12 birds per 10 acres) in small suitable patches within unsuitable habitat (McKittrick 1979).

# Life History and Ecology

## Territories

Breeding territories are used for both nesting and feeding (Dunning 1993). Territorial defense takes the form of countersinging between adjacent males for periods of 0.5 to 1 hr or longer (Dr. John Dunning, Personal Communication, 1998). Each male defends its territory by singing from an open perch (Stokes and Stokes 1996). Song perches are fairly conspicuous and are typically located in the tops of shrubs or saplings in clearcuts or old fields (Weston 1968, Dorsey 1976). In open pinewoods, song perches are commonly dead lower branches or stubs of living pine trees and range from 1.5-3 m (4.9-9.8 ft) (Meanley 1959) to 3-6 m (9.8-19.7 ft) above the ground (LeGrand and Schneider 1992). Singing occurs during all hours of the day, peaking in early morning and evening and sometimes continuing into moonlit nights (Brooks 1938). In the Northeast, singing began immediately upon arrival of males in April (Weston 1968). In the South, where birds are permanent residents, males may begin singing as early as February (Sprunt and Chamberlain 1970) and be well into the song period by March (Stoddard 1978). Singing continues into July and often into August or September (Sprunt and Chamberlain 1970, Stoddard 1978); it may even occur in October on the Mississippi coast (Toups and Jackson 1987).

Large variability in territory size exists throughout the range of the Bachman's sparrow. The average territory size has been reported as 5.1 ha (12.5 acres) in central Florida (McKittrick 1979), 2.5 ha (6.2 acres) in Arkansas (Haggerty 1986), 0.81 ha (2.1 acres) in southeastern Texas (Wolf 1977), 0.62 ha (1.53 acres) in Missouri (Hardin et al. 1982), and 0.6 ha (1.5 acres) in Ohio (Hicks in Brooks 1938). Differences in habitat composition may contribute to variability in territory sizes (McKittrick 1979, Stober 1996). Stober (1996) found that territories in 2-year-old and 4-year-old pine regeneration stands were approximately 2.2 ha (5.4 acres) and 2.9 ha (7.2 acres), respectively, whereas mean territory size in mature pine stands was approximately 4.8 ha (11.8 acres). The variation in territory sizes may also result from differences in the survey techniques used for estimating territories (Dr. John Dunning, Personal Communication, 1998). Studies based only on the distribution of singing males generally yield smaller estimates than those in which both males and females are surveyed. From a spotmapping survey of male singing posts, Stober (1996) estimated mean territory size as 0.93 ha (2.3 acres) compared with 3.12 ha (7.7 acres) estimated from radiotelemetry. Males use only a small part of their territories for singing posts; therefore, surveys based only on singing males is likely to underestimate territory size.

## Reproduction and development

Dates for nesting vary greatly because of the 10-degree latitude span in breeding distribution. Nesting generally extends from late April through July and peaks during May (Hamel 1992); however, it continues through August in South Carolina (Weston 1968) and Georgia (Stoddard 1978). Nests with eggs have been found from April 25 to July 5 in Texas (Oberholser 1974), from May 11 to July 20 in Tennessee (Weston 1968), and

from April 21 to August 31 in Georgia (Burleigh 1958). Nest-building begins about 2 months after initiation of male territorial singing (Hardin et al. 1982) and is performed entirely by the female (Weston 1968).

The Bachman's sparrow is a ground nester that raises one or two broods of young per breeding season (Johnsgard 1979, Stokes and Stokes 1996). Field observations have suggested that three broods may sometimes occur in southern portions of its range (Burleigh 1958, Sprunt and Chamberlain 1970, Potter et al. 1980). However, Stober (1996) was the first to document a pair attempting a third brood. Clutches consist of 3 to 5 eggs (Hamel 1992, Stokes and Stokes 1996) with an average clutch size of 3.9 (Haggerty 1988) to 4.0 (McNair 1987) eggs. Haggerty (1988) found that clutches laid during the first half of the breeding season were significantly larger ( $x = 4.1$ ) than those laid during the second half ( $x = 3.7$ ) ( $P = 0.01$ ).

The eggs are entirely white with mean dimensions of 19.8 by 15.6 mm (0.8 by 0.6 in.) (Haggerty 1988). One egg is laid each day, and incubation begins when the last egg has been laid. Incubation lasts from 12 to 14 days and is done entirely by the female (Meanley 1959, Sprunt and Chamberlain 1970, Haggerty 1988). Both parents contribute substantially to nestling care (Emlen and Oring 1977, Haggerty 1992). When feeding nestlings, adults usually do not fly directly to and from the nest but approach and leave it through the surrounding vegetation (Brooks 1938), walking on the ground as far as 15 m (50 ft) (Hardin and Probasco 1983). To distract intruders, the female will feign injury by dragging a wing and fluttering along the ground like a killdeer (*Charadrius vociferus*) (Gainer 1921, Brooks 1938).

The young fledge in 9 to 11 days (Haggerty 1988, Stokes and Stokes 1996). The fledgling period, the time between fledging and independence, lasts for approximately 25 days (Haggerty 1988). Adults still feed the young after fledging, and young follow the foraging parents on the ground. Males have been known to continue caring for fledglings while females begin a second brood. The length of a successful nesting cycle (period between laying of first egg to fledging last young) is approximately 51 days.

Data on reproductive success of the Bachman's sparrow are limited. In Arkansas, Haggerty (1988) found that the average number of nests per breeding season was approximately three and the average production of young was approximately one fledgling per nesting attempt, or three fledglings per pair per breeding season. Nesting success, defined as a nest that fledges at least one young, was not significantly different between first and second halves of the breeding season, old fields and pine forest tracts, or large-brood and small-brood nests.

### **Food habits**

The Bachman's sparrow forages entirely on the ground (Allaire and Fisher 1975, Stokes and Stokes 1996) in dense grasses, palmettos, or shrubs (Hamel 1992), and often near stumps or fallen logs (Imhof 1976). Sparrows forage independently or in pairs, moving slowly and searching the ground with thorough and deliberate foraging techniques

(Allaire and Fisher 1975). In the breeding season, peak feeding occurs during the first 5 hr after sunrise and the last 2 hr before sunset. Winter feeding is more irregular and continues throughout daylight hours.

Food habits of the Bachman's sparrow have been difficult to determine because of the bird's secretive nature (LeGrand and Schneider 1992). It is both insectivorous and granivorous, feeding on insects and on small seeds that have fallen to the ground. Analyses of stomach contents from eastern Texas showed that diets during all seasons were predominantly grass seeds, chiefly those of panicums (*Panicum* spp.); other grasses that contributed small amounts were crabgrass (*Digitaria* sp.), bristle grass (*Setaria* sp.), and *Triodia* sp. (Allaire and Fisher 1975). In central Louisiana, major dietary components were panicums, dropseed (*Sporobolus* spp.), and beetles; seeds of longleaf and loblolly (*P. taeda*) pines also contributed to winter diet (Meanley 1959).

In some parts of its range, the Bachman's sparrow appears to be primarily insectivorous (Sprunt and Chamberlain 1970, Oberholser 1974, Imhof 1976). Arthropods, chiefly insects, were the components of Bachman's sparrow diets in Alabama studies (Howell 1924, Imhof 1976). The stomach contents of 10 birds consisted of 58-percent animal matter and 42-percent vegetable matter (Howell 1924). Insects comprising the diet were chiefly beetles (Coleoptera), true bugs (Hemiptera), and grasshoppers and crickets (Orthoptera). Other arthropods that contributed to the diet were millipedes and spiders (Imhof 1976). Seed components were from grasses, sedges, wood sorrel (*Oxalis* spp.), and Indian strawberry (*Duchesnea indica*).

### **Predation/parasitism**

Nest predators include snakes (Brooks 1938, Weston 1968) and American crows (*Corvus brachyrhynchos*) (Weston 1968). In southwestern Virginia, 10 of 12 nests observed were destroyed by American crows (Weston 1968). In Arkansas, Haggerty (1988) reported that 95 percent of 38 nest failures were caused by predation and 5 percent were caused by brown-headed cowbird (*Molothrus ater*) parasitism. Of 35 eggs lost, 7 (20 percent) were removed by cowbirds, and 28 (80 percent) were destroyed by depredation. Of 115 nestlings lost, 78 percent were killed by unknown predators, 6 percent were killed by snakes, and 4 percent were killed by an unidentified mammal.

## **Habitat Requirements**

### **Nesting habitat**

Historically, the Bachman's sparrow was most common in mature longleaf pine forests of the southeastern United States (Stoddard 1978, Haggerty 1986, Dunning 1993). Dunning (1993) referred to this species as "an enigmatic resident of the mature pine woods and open habitats" of the South. It is currently a year-round resident in pine savannas of the southeastern coastal plain. These communities are characterized by an open overstory of longleaf pine and a ground cover of perennial grasses and forbs interspersed with deciduous oaks (*Quercus* spp.) (Platt et al. 1988, Myers 1990).

Vegetation is predominantly old-growth pines (>80 years) (Ehrlich et al. 1992) with small hardwood stands bordering drainage systems (Meanley 1959). Ground cover is usually dominated by grasses such as bluestems (*Andropogon* spp.) and wiregrass (*Aristida stricta*) (Dunning 1993). Typical forbs associated with pine savannas are goldenrods (*Solidago* spp.), asters (*Aster* spp.), thoroughworts (*Eupatorium* spp.), and blazing stars (*Liatris* spp.) (Mitchell 1980). Scattered shrub species include wax myrtle (*Myrica cerifera*), sumacs (*Rhus* spp.), post oak (*Q. stellata*), blackjack oak (*Q. marilandica*), and black gum (*Nyssa sylvatica*) (Meanley 1959).

In eastern Texas, the dominant habitat type in which Bachman's sparrows nest is mixed loblolly and shortleaf (*P. echinata*) pine forest (Allaire and Fisher 1975). In the north-central States, sparrows breed in hilly areas with dense herbaceous vegetation and scattered trees; these areas are usually located adjacent to forests in the northern part of the range and within forests in the southern part of the range (Hands et al. 1989). Nesting also occurs in the Missouri glades, which are natural openings overlying stony, shallow limestone soils in the oak-hickory forests of south-central Missouri (Probasco 1978). Little bluestem (*A. scoparius*) commonly dominates the glades, but woody species such as smoke tree (*Cotinus obovatus*) and eastern red cedar (*Juniperus virginiana*) can become important components (Evans and Kirkman 1981). Predominant grasses in areas preferred by the Bachman's sparrow are little bluestem, big bluestem (*A. gerardi*), side oats grama (*Bouteloua curtipendula*), switch grass (*Panicum virgatum*), and baldgrasses (*Sporobolus* spp.). Forb species include prairie clovers (*Petalostemum* spp.), indigo (*Indigofera* spp.), black-eyed susan (*Rudbeckia hirta*), and coneflowers (*Rudbeckia* spp.). Hardin et al. (1982) found that little bluestem comprised 40 to 60 percent of glade cover; forbs averaged 20 percent cover; and shrubs and trees averaged 4 percent or less cover.

Bachman's sparrows occur in other open habitats with adequate ground cover, such as young pine woodlands, old fields, and early successional clearcuts (Evans and Kirkman 1981, Hardin and Probasco 1983, Dunning and Watts 1990, Gobris 1992, Dunning et al. 1995). Typical vegetation is similar to the herbaceous layer of open pine forests, especially longleaf pine savannas (Ehrlich et al. 1992). Principal plant species are bluestems, goldenrods, asters, fleabanes (*Erigeron* spp.), and other composites, along with some woody species that include greenbriers (*Smilax* spp.), blackberry (*Rubus* spp.), sumacs, crabapple (*Malus augustifolia*), hawthorne (*Crataegus* spp.), and flowering dogwood (*Cornus florida*) (Brooks 1938, Evans and Kirkman 1981). Shrubs and small trees characteristic of a site may also be present, such as oaks, hickories, pines, black cherry (*Prunus serotina*), and sassafras (*Sassafras albidum*) (Evans and Kirkman 1981).

Other typical nesting sites in open habitats include abandoned pastures, roadcuts, utility rows, and clearcuts, which provide suitable habitat for 1 to 7 years after replanting (Dunning and Watts 1990). Bachman's sparrows use abandoned farmlands left uncultivated for several years, particularly in the Piedmont (Dorsey 1976). They nest in grassy patches where understory shrub intrusion is limited by poor soils, fire, or other disturbance, such as the dry grassy edges of seasonal ponds (McKittrick 1979) and borders of cultivated fields (Oberholser 1974). In Georgia and Texas, Bachman's sparrows have

adapted to tung (*Aleurites fordii*) groves (Weston 1968, Oberholser 1974) that provide leguminous cover crops with abundant insect prey (Stoddard 1978).

The nest site is almost always on the ground, usually at the base of an overhanging grass clump, small shrub, or pine seedling (Dunning 1993). Nests are particularly associated with clumps of little bluestem (Hardin et al. 1982) or wiregrass (Hardin et al. 1982, Meanley 1988) and are frequently located under palmetto (*Serenoa* spp.) in coastal areas (Weston 1968, Imhof 1976). The female builds the nest, with the male following closely after her during nest construction (Dunning 1993). She places the nest in a small depression after clearing away leaf litter and digging a scrape at the nest site (Haggerty 1986). Size of nest scrapes in Arkansas averaged 1 cm (0.4 in.) in depth at the center, 10.4 cm (4.1 in.) in length, and 9.1 cm (3.6 in.) in width.

The nest is made of dry grasses, forbs, and rootlets and lined with fine grasses and horse hair (Dunning 1993); panicums are frequently used as the primary grasses (Hoyt 1945, Nicholson 1976, Meanley 1989). One nest from North Carolina was composed of 1,035 pieces of plant material, which was mostly panicum grasses (Meanley 1989). The nest may be an open, cup-shaped structure (Tyler and Lyle 1934, Brooks 1938, Stoddard 1978, Haggerty 1986). However, the cup of most nests is covered with a domed roof that is usually woven into overhanging vegetation (Gainer 1921, Laskey 1942, Burleigh 1958, Sprunt and Chamberlain 1970, Imhof 1976, Nicholson 1976, Stoddard 1978, Potter et al. 1980, Hardin et al. 1982, Haggerty 1986, Meanley 1988). In Arkansas, 66 of 71 nests had domes or partial domes, while only 5 nests were open cups (Haggerty 1986). Mean dimensions of Arkansas nests were 15.0 cm (6.0 in.) in outside length, 12.8 cm (5.0 in.) in outside width, and 10.1 cm (4.0 in.) in height; mean weight was 13.7 g (0.5 oz).

The nest opening is usually oriented away from direct sun. Haggerty (1986) found the mean direction of orientation to be NNE in Arkansas. Nests in Texas have been reported to face west (Johnsgard 1979), and a nest found in Croatan National Forest, North Carolina, was facing east (Meanley 1988). There is little ground vegetation 30 to 40 cm (12 to 16 in.) in front of the nest opening (Wolf 1977, Haggerty 1986), and a hidden passageway, or tunnel, often extends outward from the nest (Sprunt and Chamberlain 1970, Potter et al. 1980). A new nest is built for each subsequent nesting attempt (Dunning 1993).

### **Wintering habitat**

Migratory and resident Bachman's sparrows winter primarily in longleaf pine forests of the South (LeGrand and Schneider 1992). Wintering habitat of the Bachman's sparrow is similar to its breeding habitat and composed mostly of thick grassy cover. The habitat is usually open pinewoods or bluestem fields (Weston 1968, Sprunt and Chamberlain 1970). However, wintering birds have been found in riparian habitat and sometimes along saltwater shores of coastal woodlands (Weston 1968). Winter habitat criteria have not been well defined because Bachman's sparrows are difficult to detect unless males are singing (Dunning 1993).

## Habitat Assessment

Existing or potential nesting areas on an installation should be assessed to determine habitat suitability for the Bachman's sparrow. Characteristics of vegetation structure to be measured include percent total cover, density and height of herbaceous vegetation and shrubs, and plant species composition. In wooded areas, forest inventory methods should be applied to determine characteristics such as tree density, height, and basal area, all of which affect the quality and quantity of savanna grasses and shrubs. Potential for song perches can be ascertained by determining the availability of dead lower branches or stubs of living pine trees up to 6 m (20 ft) above the ground. Sampling should be conducted in spring when birds would be using nesting habitat.

Point sampling along line transects is an effective method for sampling herbaceous vegetation. Herkert (1994) used it to sample midwestern grassland vegetation at 40 randomly located sites within each bird census transect. He passed a 0.6-cm- (0.25-in.-) diam metal rod vertically through the vegetation and counted the number of contacts by different vegetation types, including dead plant material, in successive 25-cm (10-in.) intervals of height. Other variations of point sampling include the technique described by Zimmerman (1988) for assessing vegetation in the Henslow's sparrow habitat, which is similar to that of Bachman's sparrows.

Hardin et al. (1982) used plot sampling along transects to survey vegetation where Bachman's sparrows nested in limestone glades of Missouri. Grasses, forbs, and woody plants less than 1 m (3.3 ft) tall were sampled within 30- by 65-cm (12- by 26-in.) quadrats spaced 5 m (16 ft) along transects that crossed the territory at 10-m (33-ft) intervals. Herbaceous cover was estimated for each quadrat and recorded by the Daubenmire (1959) ranking method. Territories were marked with a 20- by 20-m (65.6- by 65.6-ft) grid to sample shrubs, defined as woody species taller than 1 m (3.3 ft) and less than 8-cm (3-in.) diam at breast height (dbh). At each intersection point, percent shrub cover was estimated in a circle 4 m (13 ft) in diameter. Trees, woody plants greater than 8-cm (3-in.) dbh, were measured for height, crown width, and dbh by using a randomly located 10- by 10-m (33- by 33-ft) plot on each territory.

In South Carolina pine stands and clearcuts, Dunning and Watts (1990) quantified vegetation characteristics of Bachman's sparrow habitat by measuring vegetation volumes at 200 points within each plot of 10 to 20 ha (25 to 50 acres). Vegetation was measured in the first 4-m (13-ft) layers above ground by using the pole method described by Mills et al. (1989). All vegetation was recorded within a series of 0.1-m- (0.3-ft-) radius cylindrical volumes centered around a pole marked in 0.1- and 1.0-m (0.3- and 3-ft) sections. At each of 200 points was recorded the number of 0.1-m (0.3-ft) volumes that contained vegetation in each 1-m (3-ft) layer above ground, and the plant was identified in each case. The species of all tree saplings and shrubs that entered the sample space were recorded. All other plants were classified as ferns, grasses, forbs, vines, or dead vegetation. Data were analyzed using Principle Components Analysis, which is described more fully in Dunning and Watts (1990).

Canopy cover can be estimated with an ocular tube in mature stands or those providing considerable canopy. Engstrom et al. (1984) used ocular-tube sightings to determine canopy cover of hardwood saplings approximately 5 m (16 ft) tall and pines about 30 m (100 ft) tall.

Although specific parameters of wintering habitat have not been described for the Bachman's sparrow, longleaf pine savannas and other known nesting areas on southeastern military installations should be surveyed to determine their possible use as winter habitat. Vegetation attributes can be measured by applying the same techniques given above for sampling nesting habitat. Sampling should be done in midwinter when sparrows would most likely be using the habitat.

## **Inventory and Monitoring**

Ideally, existing and potential habitat for the Bachman's sparrow should be censused every year. At least one breeding census should be conducted to collect baseline information, and known populations should be monitored regularly for breeding activity in subsequent years. The best time to census Bachman's sparrows is at the height of the breeding season in May and/or June (Probasco 1978, Dunning and Watts 1990). Although males sing throughout the day (Stoddard 1978), most censuses are conducted between sunrise and 10:00 a.m. (Probasco 1978, Dunning and Watts 1990). Collection of nest success data such as clutch size, number of young produced, and causes of nest failure will increase the baseline data for this species.

Methods used to inventory the Bachman's sparrow include territory mapping (Hardin 1977, Hardin et al. 1982) and time-area counts (Probasco 1978; Dunning and Watts 1990, 1991). In the Missouri glades, Probasco (1978) established four 0.10-ha (0.25-acre) plots in each cover type and collected data on bird activity and frequency during 30-min observation periods divided into 5-min intervals. In another study, singing males were located in glades by observers listening for birds or playing a recording of the male Bachman's sparrow song and listening for a response (Hardin et al. 1982). Activities and locations of territorial males were recorded at 5-min intervals over a 3-hr period. After at least 10 locations were recorded for each male, an outline of the territory was drawn and area was calculated.

Dunning and Watts (1990, 1991) and Dunning et al. (1995) censused Bachman's sparrows in clearcuts and various-aged stands in Georgia and South Carolina with slight modifications to the sampling technique each season. The first counts were conducted at each of six marked reference points within plots of 10 to 20 ha (25 to 50 acres) (Dunning and Watts 1990). All birds seen or heard during 3-min count intervals were recorded. After the initial count, taped Bachman's sparrow songs were played for 1.5-min intervals, and all responses were recorded in the following 1.5 min. During the next breeding season, the technique was modified so that each observer spent 20 min in each stand, playing taped songs every 1 to 2 min and listening for responses (Dunning and Watts 1991).

All plots were surveyed twice in each of these studies. Taped recordings were helpful in counting Bachman's sparrows, as territorial males respond by flying to an exposed perch and matching songs with the recording (Dunning et al. 1995).

This census technique was further modified so that a single observer could survey the clearcuts by walking a line transect on a path that carried the observer within 30 m (100 ft) of all points in each stand (Dunning et al. 1995). Singing males are easily detectable within 30 m, so the entire area of each stand was surveyed. The observer alternated playing tape-recorded songs and listening for male responses. All sparrow observations (including nonsinging females and fledglings) were recorded on a map of the study sites, and density data were calculated as the average number of singing males per hectare. Following the initial procedure described in the paragraph above, observers conducted point counts from six locations within each study plot; sparrow locations were mapped as well as recorded.

## Impacts and Causes of Decline

Although subject to population fluctuations over time and space, the Bachman's sparrow experienced the greatest decline from the 1930s to the 1960s (Dunning 1993). However, decline had become more evident by the 1970s (LeGrand and Schneider 1992), and this species has been on the National Audubon Society's Blue List since 1972 (Tate 1986). Reasons for the sparrow's decline are not obvious, but most authors attribute it to habitat loss resulting from changes in timber management and agricultural land-use practices (Brooks 1938, Oberholser 1974, Dorsey 1976, Haggerty 1986, Dunning and Watts 1990, Ehrlich et al. 1992, LeGrand and Schneider 1992, Dunning 1993).

### Habitat loss

The pronounced decline following northward expansion of the Bachman's sparrow during the early part of the century was most likely a response to successional changes on abandoned farmland (Haggerty 1986). By the 1980s, there was little abandoned farmland compared with the acreage left idle in the early decades of the century (Odum 1987). Such farmland eventually converts to woodland and thus becomes unsuitable for Bachman's sparrows.

Regional populations declined in the South as mature forest stands were harvested (Oberholser 1974, Hunter 1990, Ehrlich et al. 1992, Dunning 1993). Commercial timber management has resulted in the conversion of natural stands of longleaf and loblolly pines with savanna understory to densely stocked monocultures of loblolly and shortleaf pine (Hunter 1990). Young pine plantations provide suitable habitat for Bachman's sparrows for a few years during early successional stages, but become unsuitable within 4 to 7 years after replanting (Dunning 1993). The Bachman's sparrow can exist over long periods of time in naturally occurring, open longleaf pine savannas that are maintained by frequent fire (LeGrand and Schneider 1992). However, commercial timber is generally harvested under a 30- to 40-year rotation so that few areas become old enough

to consistently support ground cover and understory conditions suitable for Bachman's sparrow habitat (Ehrlich et al. 1992, Dunning 1993).

Fire exclusion has contributed significantly to habitat loss for the Bachman's sparrow (Oberholser 1974, Hunter 1990, LeGrand and Schneider 1992). Historically, wildfires could burn for days and cover thousands of acres of land to keep shrub and understory layers under control, thus promoting development of a dense grass and forb stage in old-growth forests (LeGrand and Schneider 1992). However, the spread of human populations into more wooded areas has dictated the need for fire-suppression policies, and management of forests by prescribed burning has become increasingly more difficult. In the absence of natural fire or active management, grassy habitats are rapidly supplanted by hardwood brush and rendered unsuitable for Bachman's sparrows (Dunning and Watts 1990). During a 15-year study in northwest Florida, avian species adapted to open habitats disappeared within 5 years after fire exclusion (Engstrom et al. 1984). Suppression of natural fire is also causing loss of suitable habitat in the western part of the Bachman's sparrow range, where sparrows inhabit open stands of hardwoods, such as oak savanna (LeGrand and Schneider 1992). Although cutting and thinning forests can create suitable habitat, openings must be maintained by burning to prevent woody vegetation from dominating the understory (Hardin 1977, Haggerty 1986).

Habitat fragmentation may have contributed to the decline of the Bachman's sparrow. Research by Dunning et al. (1995) suggested that landscape distributions of suitable habitat may affect regional populations. Field surveys conducted in regions where suitable habitat patches were isolated from potential sources of dispersing birds showed that isolated patches were less likely to be colonized than nonisolated patches. Computer simulation models suggested that the Bachman's sparrow may become locally extinct in landscapes where suitable habitat consists only of isolated patches of early successional vegetation (Pulliam et al. 1992).

### **Other impacts**

Although interspecific competition, cowbird parasitism, predation, and diseases may influence local populations of Bachman's sparrows, available data do not support any of these factors as significant contributors to the overall decline of this species. The field sparrow has a niche similar to that of the Bachman's sparrow (Hardin et al. 1982, Haggerty 1986); however, the latter is a ground feeder, whereas the field sparrow usually feeds in shrubs and saplings and less often on the ground (Allaire and Fisher 1975). Cowbirds parasitize Bachman's sparrow nests but are usually not significant in nest failure (Mengel 1965, Haggerty 1988). In Arkansas, Haggerty (1986, 1988) found that predation caused 55 to 95 percent of nest losses, whereas cowbird parasitism accounted for only 5 percent. Although ectoparasites have been reported on Bachman's sparrows (Peters 1936), it seems unlikely that parasites have contributed to their decline.

### **Military training**

Training activities on military installations can impact the habitat of Bachman's sparrows (Trame 1997). Mechanized training can alter natural plant communities

through impacts resulting in soil erosion, and intensive use of tactical land vehicles (both tracked and wheeled) can cause extensive soil disturbance. These training activities can also disrupt nesting by the physical destruction of nests. Bivouacs, which involve a combination of vehicle and nonmechanized trampling, represent a serious source of soil compaction and related impacts. Upland soils with high sand content will not suffer a great deal of compaction, and frequently used bivouac sites may retain ground cover and pine regeneration if soils are resistant to compaction. However, sustained high levels of trampling can ultimately eliminate vegetation and potential nesting habitat.

Military training can impact native communities by fragmenting the fuel sources needed to carry fire over large areas (Trame 1997). Native ground covers, especially grasses, are essential fuel sources that allow large areas to burn. As unburned areas undergo a change in plant succession, sites become increasingly shaded through time, and the natural community is ultimately lost. However, training activities may result in potentially beneficial effects to natural habitats. The most beneficial effect is the reintroduction of fire resulting from activities such as live arms firing and use of incendiary devices. Frequency of ignition on military installations, especially in high hazard impact areas, often produces a fire regime over large areas at a frequency that resembles presettlement natural fire return intervals. This encourages a mosaic burn pattern and enhances conditions for fire-adapted species, especially those associated with longleaf pine savannas and other open habitats (Gulf Engineers and Consultants, Inc., and Geo-Marine 1994, LeBlond et al. 1994).

## **Management and Protection**

### **Recovery**

There is no recovery plan for the Bachman's sparrow because it is not Federally listed, but application of current knowledge can provide protection for population reestablishment. Recovery of this species requires the maintenance of numerous stable and protected populations where suitable habitat remains within its historical range. Land protection through acquisition, easement, and registry programs are means of ensuring that large tracts of suitable habitats are adequately preserved for Bachman's sparrows, but these are not usually viable alternatives for military installations. Therefore, the focus for restoring Bachman's sparrow populations must be on management of large areas of natural communities (pine savannas, prairies, limestone glades, mature hardwood forests) where existing management practices can be modified to accommodate nesting habitat needs (LeGrand and Schneider 1992). Emphasis should be placed on avoiding habitat fragmentation during management applications, since isolated habitat patches do not provide an adequate resource base for population maintenance (Pulliam et al. 1992, Dunning et al. 1995). Restoration of the species in the Northeast may require reintroduction of sparrows to suitable habitat. However, the Bachman's sparrow should be able to recover in the central and southern portions of its range if existing and restored breeding habitats are properly managed.

## Management procedures

Management of public lands offers the best opportunity to protect and restore the longleaf pine ecosystem, which is the Bachman's sparrow's primary habitat. On national forests and military installations, efforts are often driven by management for the endangered red-cockaded woodpecker (*Picoides borealis*), a species that is also endemic to the longleaf pine forests of the southeastern United States. The red-cockaded woodpecker (RCW) uses mature forests with an open midstory (Liu et al. 1995), and RCW management encourages development of old-growth forests (Ehrlich et al. 1992). Dunning and Watts (1990) suggested that management practices producing suitable habitat for the RCW would probably provide habitat for Bachman's sparrows. Brennan et al. (1995) and Wilson et al. (1995) found that Bachman's sparrows were more abundant in areas managed for RCWs than in areas not managed for them, and the majority of Bachman's sparrows found during surveys at Camp Lejeune, NC, were within 100 m (328 ft) of an RCW colony (LeBlond et al. 1994). Therefore, rehabilitation and restoration of the longleaf pine ecosystem as part of RCW management on military installations will likely benefit Bachman's sparrows.

Recommendations for managing red-cockaded habitat are found in "Environmental Assessment of Army-Wide Management Guidelines for the Red-cockaded Woodpecker" (U.S. Army Construction Engineering Research Laboratories (USACERL) 1994). Effective management techniques for both RCWs and Bachman's sparrows are those that open longleaf pine midstory, which will aid in establishing and maintaining herbaceous vegetation for food and foraging cover. These techniques include (a) prescribed burning, (b) pine thinning and hardwood control, (c) brush clearing and fuel removal within buffer areas surrounding cavity trees, (d) longleaf pine regeneration, and (e) erosion control.

**Prescribed burning.** Regular prescribed fire, the primary tool for managing RCW habitat, is the key to developing and maintaining the dense herbaceous understory preferred by Bachman's sparrows (Plentovich et al. 1998). Longleaf pines resist fire (Chapman 1932, Myers 1990), and regular burning prevents hardwoods from outcompeting both shade-intolerant pines and the diverse understory of forbs and grasses (Lewis and Harshbarger 1976). Platt et al. (1988) maintained that longleaf pine is a keystone species and that influencing a fire regime conducive to its reproduction also influences composition and abundance of other species within the habitat.

Because fire historically occurred in the southeastern pine forests at intervals of approximately 3 to 5 years (Chapman 1932, Krusac et al. 1995), burn management is usually conducted on a 3- to 5-year rotation (Dunning and Watts 1990). A 3-year burn schedule is preferable to longer rotations because sparrow densities decrease 3 years after burning (Johnson and Landers 1982, Dunning and Watts 1990, Gobris 1992). Engstrom et al. (1984) found that Bachman's sparrows had disappeared from Florida loblolly and slash pine forests within 5 years of fire exclusion. Before the massive timber destruction resulting from Hurricane Hugo, the U.S. Department of Agriculture Forest Service burned all forest compartments on a 3- to 5-year rotation at the Francis Marion National Forest,

South Carolina, where much of the forest was managed for RCW colonies (Dunning and Watts 1990).

It is recommended that burning be conducted during the growing season to kill young hardwoods (Glitzenstein et al. 1995), increase growth of grass-stage longleaf pines in the understory (Robbins and Myers 1992), and stimulate development of a dense cover of herbaceous vegetation (Platt et al. 1991, Waldrop et al. 1992). Natural fire breaks, such as topographic features and wetland boundaries, should be used for controlling fire, since natural breaks more closely mimic natural ecosystem processes than do artificial fire controls (USACERL 1994). Use of heavy equipment to construct berms or fire lanes should be minimized to avoid negative impacts to ground-layer vegetation and soil stability.

Plentovich et al. (1998) suggested that any treatment for midstory control should include frequent burning. The more intensive treatments are at risk of being lost if the area is not burned frequently enough to prevent reestablishment of hardwoods (Escano 1995). In forests where fire has been suppressed for many years, prescribed burns of low intensity may not kill larger hardwoods (Waldrop et al. 1992), and a dense midstory may reduce herbaceous ground cover so much that fire intensity will not be great enough to kill oaks (Platt et al. 1991). In this case, large-scale midstory removal is necessary before fire becomes an effective management tool (Krusac et al. 1995).

**Pine thinning and hardwood control.** It may be possible to manage habitat for the Bachman's sparrow by thinning pine habitats and controlling hardwoods by other means than burning. These methods can have the same effect as burning by opening the forest to create an abundance and variety of plants, especially those associated with early stages of plant succession. Dunning and Watts (1990) found that an infrequently burned mature pine stand was occupied by Bachman's sparrows when an open understory was maintained by cutting saplings and girdling older deciduous trees. Selective cutting of overcrowded stands produces an open parklike aspect approximating optimum habitat for the Bachman's sparrow (Meanley 1959). Thinning pine plantations to basal areas found in mature stands will allow Bachman's sparrows to use 45- to 60-year-old stands (Haggerty 1986). Liu et al. (1995) suggested the incorporation of both thinning and prescribed burning into forest management of young pine stands to create suitable habitat for Bachman's sparrows.

Clearcuts may be used on some sites to provide habitat for Bachman's sparrows for several years. LeGrand and Schneider (1992) recommended that clearcuts be at least 75 ha (185 acres) in size and preferably square, rectangular, or circular in shape, as sparrows seldom use narrow clearings, such as power lines. However, Dunning and Watts (1990) found that Bachman's sparrows at the Savannah River Site, South Carolina, most commonly used clearcuts of 10 to 20 ha (25 to 50 acres) and also occupied power line rights-of-way (Dr. John B. Dunning, Personal Communication, 1998). A burned clearcut can remain suitable for Bachman's sparrows for 5 to 10 years, but 1 to 2 years may be required for cover reestablishment after clearing (with or without fire) (LeGrand and Schneider 1992). In about 10 years, saplings become too dense for clearcuts to be used by sparrows (Dunning and Watts 1990).

Use of hardwood and pine thinning guidelines for RCW habitat (USACERL 1994) should benefit Bachman's sparrows by promoting the maintenance of open, parklike stands of mature pine-oak forest. Other strategies for hardwood control include the manual removal of hardwoods from around cavity trees, manual removal of hardwoods over extensive areas, and herbicide applications to hardwoods (Jackson 1986, Krusac et al. 1995). Chemical and mechanical methods of hardwood control should employ best management practices to avoid soil disturbance, destruction of ground-layer vegetation, and nontarget effects of herbicides (USACERL 1994). Hardwood control should be avoided during nesting periods.

**Longleaf pine regeneration.** Reestablishment of longleaf pine and regeneration of existing pine stands potentially increase available habitats for Bachman's sparrows. Clear or partial cutting of pine forests, followed by burning and direct seeding or planting, provides optimum habitat for these sparrows (Meanley 1959, Haggerty 1986). Nesting habitat can be maintained for longer use if pines are planted less densely (Haggerty 1986). Hunter (1990) recommended that trees be spaced at least 6 to 7 m (20 to 25 ft) apart. Cleared areas planted with longleaf pine are suitable to the Bachman's sparrow for longer periods of time than those planted with loblolly pine.

Site preparation techniques affect the initial suitability of habitat for Bachman's sparrows (Dunning 1993). Techniques that do not destroy all ground vegetation, such as burning prior to replanting, generally allow quick colonization of a site, whereas techniques that destroy virtually all ground vegetation (e.g., disking, wind-rowing, and roller-chopping) result in delayed colonization by sparrows until the vegetation has recovered (Dunning and Watts 1990). A technique called drumchopping is used by foresters to reduce the amount of aboveground vegetation and debris before planting. Dunning and Watts (1990) found that drumchopping resulted in low, dense shrubs, whereas clear-cuts that were not drumchopped had tall shrubs and standing dead timber that created exposed song perches. Areas cleared by burning appear to be preferred by sparrows over areas cleared by mechanical means (Hunter 1990).

**Erosion control.** Concerted efforts to reduce and prevent soil erosion within RCW Habitat Management Units (HMUs) would have a beneficial effect on Bachman's sparrow habitats by maintaining the integrity of the herbaceous layer of vegetation (USACERL 1994). Use of native vegetation should be used wherever possible, and nonnative species should be avoided. Mechanical means of erosion control should maintain the natural contours of the surrounding topography to ensure the integrity of natural hydrologic processes.

**Training restrictions.** Restrictions on training activities within RCW HMUs should benefit the Bachman's sparrow in areas where they minimize disturbance to vegetation and soils (USACERL 1994). Vehicular traffic on roadways should be monitored to reduce soil erosion, and off-road traffic should be prohibited because it is highly deleterious to ground cover, soil structure, and hydrologic patterns. If off-road traffic is unavoidable, it should be prohibited from areas supporting known breeding populations of Bachman's sparrows.

## Cautions

Management practices involving extractive land uses should be applied with caution. For example, pine straw raking has been shown to destroy ground-layer vegetation and longleaf pine seedlings and to cause or exacerbate erosion problems (USACERL 1994). Over a long period of time, removal of pine straw fuels may also alter fire regimes, which in turn would have negative impacts on the Bachman's sparrow. Timber harvest that shifts forest stands toward longer rotations and replaces offsite pines and hardwoods with longleaf pine should restore natural fire, hydrologic, and dynamics in plant communities. Forest management should minimize adverse impacts to wiregrass and other herbaceous ground-layer species. No extractive land uses should be permitted during the breeding season.

Managers should be aware that management practices for RCWs may not always benefit Bachman's sparrows because habitat requirements of the two species are not identical (Liu et al. 1995). Studies at Eglin Air Force Base, FL (Plentovich et al. 1998) showed that areas suitable for RCWs were not always suitable for Bachman's sparrows. RCWs appear more tolerant of a hardwood midstory and do not require a dense ground cover of grasses and forbs. Manual removal of midstory hardwoods from around cavity trees does not always produce sufficient open areas for Bachman's sparrows. Large-scale midstory removal creates an open midstory and prevents hardwoods from encroaching on RCW cavities but does not have the same effects on understory as fire (Platt et al. 1988). Prescribed burning must also be used to promote development of appropriate ground cover for Bachman's sparrows (Plentovich et al. 1998).

Managers should not depend only on RCW management to provide suitable habitat for Bachman's sparrows. Old fields, clearcuts, and other open areas with dense herbaceous cover, as well as mature forests, should be managed for this species. Simulation models developed by Liu et al. (1995) indicated that sole dependence on RCW-management strategies may cause local Bachman's sparrow populations to decrease substantially over the short term (10 years). However, simulation results were specific to that particular landscape, which was dominated by middle-aged forest (30 to 40 years). Different population trajectories would be expected in landscapes with other habitat distributions.

## Research Needs

Research needs for the Bachman's sparrow include the following: (a) determination of mortality and reproductive success rates; (b) determination of winter habitat use and requirements; (c) further studies on effects of habitat fragmentation on Bachman's sparrow populations; (d) determination of the effects of prescribed burning regimes on development of suitable habitat for Bachman's sparrows; (e) evaluation of the appropriate size, shape, and juxtaposition of restored pine stands compared with presettlement fire-induced landscape mosaic (Wilson et al. 1995); and (f) further studies on the compatibility of management strategies for both the RCW and Bachman's sparrow.

## Literature Cited

- Alabama Natural Heritage Program. 1994. Natural Heritage Inventory of Fort McClellan, Pelham Range: Federal endangered, threatened, candidate species and State-listed species. Alabama Natural Heritage Program, Alabama Department of Conservation and Natural Resources, State Lands Division, Montgomery, AL.
- Allaire, P. N., and C. D. Fisher. 1975. Feeding ecology of three resident sympatric sparrows in eastern Texas. *Auk* 92:260-269.
- American Ornithologists' Union. 1983. Checklist of North American birds. Sixth edition. Allen Press, Inc., Lawrence, Kansas. 877 pp.
- Brennan, L. A., J. L. Cooper, K. E. Lucas, B. D. Leopold, and G. A. Hurst. 1995. Assessing the influence of red-cockaded woodpecker colony site management on non-target forest vertebrates in loblolly pine forests of Mississippi: Study design and preliminary results. Pages 309-319 *In* D. L. Kulhavy, R. G. Hooper, and R. Costa, ed. Red-cockaded woodpecker: Recovery, ecology and management. Center for Applied Studies in Forestry, College of Forestry, Stephen F. Austin State University, Nacogdoches, TX. 551 pp.
- Brooks, M. 1938. Bachman's sparrow in the north-central portion of its range. *Wilson Bulletin* 50:86-109.
- Burleigh, T. D. 1958. Georgia birds. University of Oklahoma Press, Norman. 746 pp.
- Chapman, H. H. 1932. Is the longleaf type a climax? *Ecology* 13:328-334.
- Daubenmire, R. 1959. A canopy-coverage method of vegetation analysis. *Northwest Scientist* 33:43-64.
- Dorsey, G. A. 1976. Bachman's sparrow: Songs and behavior. *The Oriole* 41:52-56.
- Drilling, N. E. 1985. *Aimophila aestivalis*. Element Stewardship Abstract. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN.
- Dunning, J. B., Jr. 1993. Bachman's sparrow. Pages 1-16 *In* A. Poole, P. Stettenheim, and F. Gill, ed. *The Birds of North America*, No. 38. Academy of Natural Sciences, Philadelphia, and the American Ornithologists' Union, Washington, DC.
- Dunning, J. B., Jr., R. Borgella, Jr., K. Clements, and G. K. Meffe. 1995. Patch isolation, corridor effects, and colonization by a resident sparrow in a managed pine woodland. *Conservation Biology* 9:542-550.
- Dunning, J. B., Jr., and B. D. Watts. 1990. Regional differences in habitat occupancy by Bachman's sparrow. *Auk* 107:463-472.

- Dunning, J. B., Jr., and B. D. Watts. 1991. Habitat occupancy by Bachman's sparrow in the Francis Marion National Forest before and after Hurricane Hugo. *Auk* 108:723-725.
- Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1992. Birds in jeopardy: The imperiled and extinct birds of the United States and Canada, including Hawaii and Puerto Rico. Stanford University Press, Stanford, CA. 259 pp.
- Eifrig, G. 1915. Bachman's sparrow near Chicago, Illinois. *Auk* 32:496-497.
- Emlen, S. T., and L. W. Oring. 1977. Ecology, sexual selection, and the evolution of mating systems. *Science* 197:215-223.
- Engstrom, R. T., R. L. Crawford, and W. W. Baker. 1984. Breeding bird populations in relation to changing fire exclusion: A 15-year study. *Wilson Bulletin* 96:437-450.
- Escano, R. E. F. 1995. Red-cockaded woodpecker extinction or recovery: Summary of status and management on our National Forests. Pages 28-35 *In* D. L. Kulhavy, R. G. Hooper, and R. Costa, ed. Red-cockaded woodpecker: Recovery, ecology and management. Center for Applied Studies in Forestry, College of Forestry, Stephen F. Austin State University, Nacogdoches, TX. 551 pp.
- Evans, K. E., and R. A. Kirkman. 1981. Guide to bird habitats of the Ozark Plateau. USDA Forest Service, General Technical Report NC-68. 79 pp.
- Gainer, A. F. 1921. Nesting of Bachman's sparrow. *Wilson Bulletin* 33:3-4.
- Glitzenstein, J. S., W. J. Platt, and D. R. Streng. 1995. Effects of fire regime and habitat on tree dynamics in north Florida longleaf pine savannas. *Ecological Monographs* 65:441-476.
- Gobris, N. M. 1992. Habitat occupancy during the breeding season by Bachman's sparrow at Piedmont National Wildlife Refuge in central Georgia. M.S. thesis, University of Georgia, Athens.
- Gulf Engineers and Consultants, Inc., and Geo-Marine, Inc. 1994. Rare, threatened, and endangered species survey and their habitat at Fort Benning, Georgia. Final report, Contract No. DACW21-89-0016. Baton Rouge, LA.
- Haggerty, T. M. 1986. Reproductive ecology of Bachman's sparrow (*Aimophila aestivalis*) in central Arkansas. Ph.D. dissertation, University of Arkansas, Fayetteville.
- Haggerty, T. M. 1988. Aspects of the breeding biology and productivity of Bachman's sparrow in central Arkansas. *Wilson Bulletin* 100:247-255.

- Haggerty, T. M. 1992. Effects of nestling age and brood size on nestling care in the Bachman's sparrow (*Aimophila aestivalis*). *American Midland Naturalist* 128:115-125.
- Hamel, P. B. 1992. The land manager's guide to the birds of the South. The Nature Conservancy, Southeastern Region, Chapel Hill, NC. 437 pp.
- Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status of the Bachman's sparrow in the northcentral United States. Missouri Cooperative Fish and Wildlife Research Unit report. 11 pp.
- Hardin, K. I. 1977. Bachman's sparrow on southern Missouri glades. M.S. thesis, University of Missouri, Columbia. 111 pp.
- Hardin, K. I., T. S. Baskett, and K. E. Evans. 1982. Habitat of Bachman's sparrows breeding on Missouri glades. *Wilson Bulletin* 94:208-212.
- Hardin, K. I., and G. E. Probasco. 1983. The habitat characteristics and life requirements of Bachman's sparrow. *Birding* 15:189-197.
- Hart, B. L., and G. D. Lester. 1993. Natural communities and sensitive species assessment on Fort Polk Military Reservation, Louisiana. Final report submitted to Department of the Army Corps of Engineers, Memphis, TN, by The Nature Conservancy, Arlington, VA.
- Herkert, J. R. 1994. The effects of habitat fragmentation on midwestern grassland bird communities. *Ecological Applications* 4:461-171.
- Howell, A. H. 1924. Birds of Alabama. Department of Game and Fish of Alabama and U.S. Department of Agriculture, Bureau of Biological Survey, Montgomery. 384 pp.
- Hoyt, J. S. Y. 1945. Nesting of Bachman's sparrow near Memphis. *Migrant* 16:1-2.
- Hunter, W. C. 1990. Handbook for nongame bird management and monitoring in the Southeast Region. U.S. Fish and Wildlife Service, Southeast Region, Atlanta, GA.
- Imhof, T. A. 1976. Alabama Birds. Second edition. University Alabama, Tuscaloosa. 445 pp.
- Jackson, J. A. 1985. The nesting 1985 season. *American Birds* 39:926.
- Jackson, J. A. 1986. Biopolitics, management of Federal lands, and the conservation of the red-cockaded woodpecker. *American Birds* 40:1162-1168.
- Johnsgard, P. A. 1979. Birds of the Great Plains. University of Nebraska Press, Lincoln. 539 pp.

- Johnson, A. S., and J. L. Landers. 1982. Habitat relationships of summer resident birds in slash pine flatwoods. *Journal of Wildlife Management* 46:416-428.
- Krusac, D. L., J. M. Dabney, and J. J. Petrick. 1995. An ecological approach to recovering the red-cockaded woodpecker on southern National Forests. Pages 61-66 *In* D. L. Kulhavy, R. G. Hooper, and R. Costa, ed. *Red-cockaded woodpecker: Recovery, ecology and management*. Center for Applied Studies in Forestry, College of Forestry, Stephen F. Austin State University, Nacogdoches, TX. 551 pp.
- Laskey, A. R. 1942. Nesting observations for 1942 a la bird banding. *Migrant* 13:36-38.
- LeBlond, R. J., J. O. Fussell, and A. L. Braswell. 1994. Inventory of the rare species, natural communities, and critical areas of the Camp Lejeune Marine Corps Base, North Carolina. North Carolina Natural Heritage Program, Department of Environment, Health, and Natural Resources, Raleigh, NC.
- LeGrand, H. E., and K. J. Schneider. 1992. Bachman's sparrow, *Aimophila aestivalis*. Pages 299-313 *In* K. J. Schneider and D. M. Pence, ed. *Migratory nongame birds of management concern in the Northeast*. U.S. Fish and Wildlife Service, Newton Corner, MA. 400 pp.
- Lewis, C. E., and T. J. Harshbarger. 1976. Shrub and herbaceous vegetation after 20 years of prescribed burning in the South Carolina coastal plain. *Journal of Range Management* 29:13-18.
- Liu, J., J. B. Dunning, Jr., and H. R. Pulliam. 1995. Potential effects of a forest management plan on Bachman's sparrows (*Aimophila aestivalis*): Linking a spatially explicit model with GIS. *Conservation Biology* 9:62-75.
- McKittrick, M. C. 1979. Territory size and density of Bachman's sparrow in south central Florida. *Florida Field Naturalist* 7:33-34.
- McNair, D. A. 1987. Egg data slips - are they useful for information on egg-laying dates and clutch size? *Condor* 89:369-376.
- Meanley, B. 1959. Notes on Bachman's sparrow in central Louisiana. *Auk* 76:232-234.
- Meanley, B. 1988. Notes on Bachman's sparrow in the Croatan National Forest. *Chat* 52:2-3.
- Meanley, B. 1989. Unique shape of a Bachman's sparrow nest. *Chat* 53:12-13.
- Mengel, R. M. 1965. The birds of Kentucky. Ornithological Monograph No. 3. American Ornithologists' Union, Washington, DC. 581 pp.

- Mills, G. S., J. B. Dunning, and J. M. Bates. 1989. Effects of urbanization on breeding bird community structure in southwestern desert habitats. *Condor* 91:416-428.
- Mitchell, W. A. 1980. Evaluation of white-tailed deer and cattle diets in two southeastern pine forests. Ph.D. dissertation, Mississippi State University, Mississippi State. 236 pp.
- Myers, R. L. 1990. Scrub and high pine. Pages 150-193 *In* R. L. Myers and J. J. Ewel, ed. *Ecosystems of Florida*. University of Central Florida Press, Orlando.
- National Geographic Society. 1983. *Field Guide to the Birds of North America*. National Geographic Society, Washington, DC. 464 pp.
- Nicholson, C. P. 1976. The Bachman's sparrow in Tennessee. *Migrant* 47:53-60.
- Oberholser, H. C. 1974. *The bird life of Texas*. Vol. 2. University of Texas Press, Austin. 538 pp.
- Odum, E. 1987. *The Georgia landscape: A changing resource*. Institute of Ecology, University of Georgia, Athens. 88 pp.
- Peterjohn, B. G. 1987. The nesting 1987 season. *American Birds* 41:144.
- Peters, H. S. 1936. A list of external parasites from birds of the eastern part of the United States. *Bird-Banding* 7:9-27.
- Peterson, R. T. 1980. *A field guide to the birds east of the Rockies*. 4th edition. Houghton Mifflin Company, Boston. 384 pp.
- Platt, W. J., G. W. Evans, and M. M. Davis. 1988. Effects of fire season on flowering of forbs and shrubs in longleaf pine forests. *Oecologia* 76:353-363.
- Platt, W. J., J. S. Glitzenstein, and D. R. Streng. 1991. Evaluating pyrogenicity and its effects on vegetation in longleaf pine savannas. *Proceedings of Tall Timbers Fire Ecology Conference* 17:143-161.
- Plentovich, S., J. W. Tucker, Jr., N. R. Holler, and G. E. Hill. 1998. Enhancing Bachman's sparrow habitat via management of red-cockaded woodpeckers. *Journal of Wildlife Management* 62:347-354.
- Potter, E. F., J. F. Parnell, and R. P. Teulings. 1980. *Birds of the Carolinas*. University North Carolina Press, Chapel Hill. 408 pp.
- Probasco, G. E. 1978. Bird habitat - woody plant relations on Missouri limestone glades. Pages 107-109 *In* D. C. Glenn-Lewin and R. Q. Landers, ed. *Proceedings of the fifth Midwest Prairie Conference*. Iowa State University, Ames. 230 pp.

- Pulliam, H. R., J. B. Dunning, and J. Liu. 1992. Population dynamics in complex landscapes: A case study. *Ecological Applications* 2:165-177.
- Robbins, L. E., and R. L. Myers. 1992. Seasonal effects of prescribed burning in Florida: A review. Tall Timbers Research Miscellaneous Publication 8.
- Sprunt, A., and E. B. Chamberlain. 1970. South Carolina bird life. Second edition. University of South Carolina Press, Columbia. 655 pp.
- Stober, J. 1996. Territory dynamics and basic biology of the Bachman's Sparrow (*Aimophila aestivalis*) at the Savannah River Site, South Carolina. M.S. thesis, University of Georgia, Athens. 108 pp.
- Stoddard, H. L., Sr. 1978. Birds of Grady County, Georgia. Bulletin Tall Timbers Research Station 21:1-175.
- Stokes, D., and L. Stokes. 1996. Stokes field guide to birds: Eastern region. Little, Brown and Company, Boston and New York. 471 pp.
- Tate, J., Jr. 1986. The blue list for 1986. *American Birds* 40:227-236.
- The Nature Conservancy. 1995. Fort Stewart Inventory, Final Report. U.S. Department of Defense, Department of the Army, Headquarters 24th Mechanized Division, Fort Stewart, GA.
- Toups, J. A., and J. A. Jackson. 1987. Birds and birding on the Mississippi Coast. University Press of Mississippi, Jackson. 303 pp.
- Trame, A. 1997. Known and potential impacts of maneuver training, especially physical disturbance, on threatened and endangered species. USACERL Technical Report 97/70. U.S. Army Construction Engineering Research Laboratories, Champaign, IL.
- Tyler, B. P., and R. B. Lyle. 1934. A Bachman's sparrow nest. *Migrant* 5:31.
- U.S. Army Construction Engineering Research Laboratories (USACERL). 1994. Environmental assessment of Army-wide management guidelines for the red-cockaded woodpecker. USACERL Special Report EN-94/04. 52 pp. and appendices.
- Waldrop, T. A., D. L. White, and S. M. Jones. 1992. Fire regimes for pine-grassland communities in the southeastern United States. *Forest Ecology and Management* 47:195-210.
- Weston, F. M. 1968. Bachman's sparrow. Pages 956-975 *In* A. C. Bent, ed. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows and allies. Part 2. U.S. National Museum Bulletin 237:603-1248.

- West Virginia Department of Natural Resources. 1987. Vertebrate species of concern in West Virginia. West Virginia Department of Natural Resources, Special report, Charleston.
- Willoughby, E. J. 1986. An unusual sequence of molts and plumages in Cassin's and Bachman's sparrows. *Condor* 88:461-172.
- Wilson, C. W., R. E. Masters, and G. A. Bukenhofer. 1995. Breeding bird response to pine-grassland community restoration for red-cockaded woodpeckers. *Journal of Wildlife Management* 59:56-67.
- Wolf, L. L. 1977. Species relationships in the avian genus *Aimophila*. American Ornithological Union, Ornithological Monographs No. 23, Washington, DC. 220 pp.
- Zimmerman, J. L. 1988. Breeding season habitat selection by the Henslow's sparrow (*Ammodramus henslowii*) in Kansas. *Wilson Bulletin* 100:17-24.

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Bors, Sargent Edwin E. 1997. Chief Game Warden, MCAS, Beaufort, SC. ATTN: NREAO, MCAS Beaufort, P.O. Box 55001, Beaufort, SC 29904-5001.

Cochran, Hank. 1996. Natural Resources Manager, P.O. Box 108, Naval Air Station, Cecil Field, FL 33215. (904) 778-5451

Dunning, John B. 1998. Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN 47907-1159. (765) 494-3565

Dyck, Alan. 1996. Natural Resources Manager, Fort Pickett, Blackstone, VA 23824-5000.

Peacock, Lance. 1997. The Nature Conservancy, Arkansas. (501) 663-6699 ext. 30.

Shea, Stephen. 1996. Wildlife biologist, 325 CES/CEN, 119 Alabama Avenue, Tyndall Air Force Base, FL. (904) 283-2641.

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<b>13. ABSTRACT (Maximum 200 words)</b> The Bachman's sparrow ( <i>Aimophila aestivalis</i> ) is a small ground-nesting sparrow that is endemic to the southeastern United States. The former breeding range extended into the midwestern and northeastern States but has contracted to its current general limits of North Carolina, Kentucky, and central Arkansas. Birds winter along the lower Coastal Plain from North Carolina to eastern Texas and south Florida. The Bachman's sparrow is considered to be a species of special concern, as its population has declined significantly since the 1930s. This species is most common in longleaf pine ( <i>Pinus palustris</i> ) savannas, which are characterized by an open overstory and a ground cover of perennial grasses and forbs interspersed with a few shrubs; it also occurs in other open habitat types with early successional vegetation. Bachman's sparrows have been documented on at least 19 installations in the Southeast. This report is one of a series of Species Profiles being developed for threatened, endangered, and sensitive species inhabiting plant communities in the southeastern United States. 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 <div style="text-align: right;">(Continued)</div>			
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found on military installations. Information provided on the Henslow's sparrow includes status, life history and ecology, habitat requirements, impacts and causes of decline, habitat assessment techniques, inventory and monitoring, and management and protection.