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Effects of Management Practices on Grassland Birds: Vesper Sparrow

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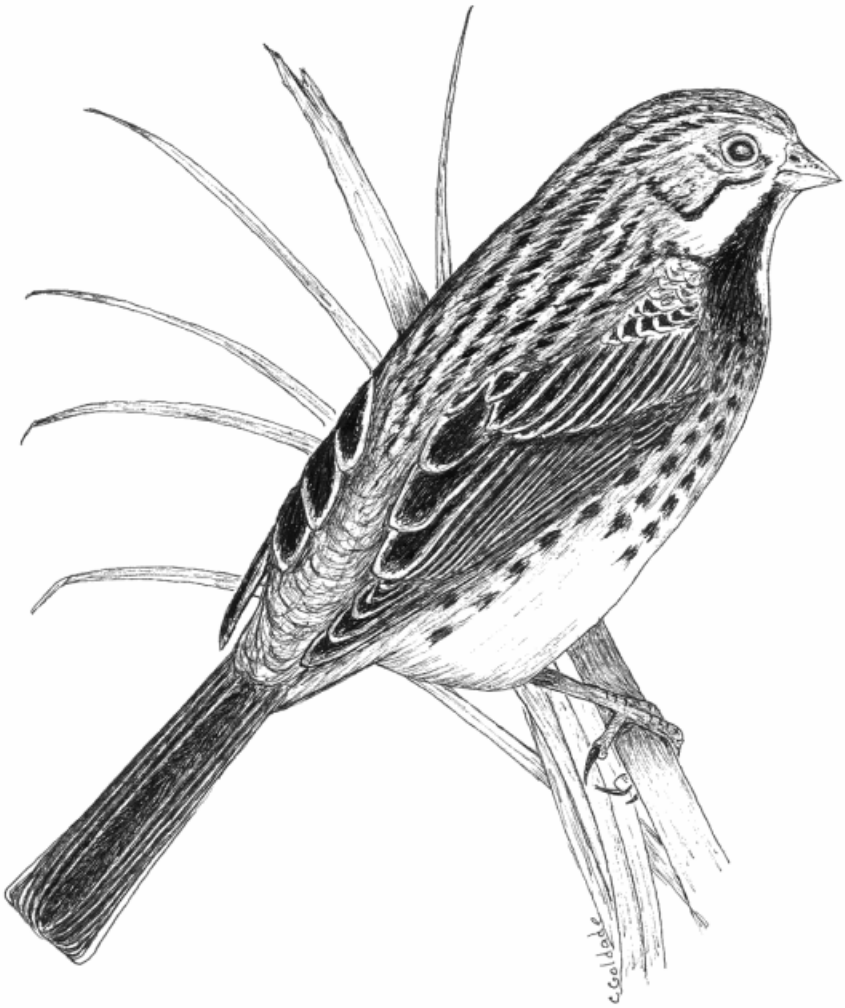
EFFECTS OF MANAGEMENT PRACTICES ON GRASSLAND BIRDS:

VESPER SPARROW



Grasslands Ecosystem Initiative
Northern Prairie Wildlife Research Center
U.S. Geological Survey
Jamestown, North Dakota 58401

This report is one in a series of literature syntheses on North American grassland birds. The need for these reports was identified by the Prairie Pothole Joint Venture (PPJV), a part of the North American Waterfowl Management Plan. The PPJV recently adopted a new goal, to stabilize or increase populations of declining grassland- and wetland-associated wildlife species in the Prairie Pothole Region. To further that objective, it is essential to understand the habitat needs of birds other than waterfowl, and how management practices affect their habitats. The focus of these reports is on management of breeding habitat, particularly in the northern Great Plains.

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Species for which syntheses are available or are in preparation:

American Bittern
Mountain Plover
Marbled Godwit
Long-billed Curlew
Willet
Wilson's Phalarope
Upland Sandpiper
Greater Prairie-Chicken
Lesser Prairie-Chicken
Northern Harrier
Swainson's Hawk
Ferruginous Hawk
Short-eared Owl
Burrowing Owl
Horned Lark
Sedge Wren
Loggerhead Shrike
Sprague's Pipit
Grasshopper Sparrow
Baird's Sparrow
Henslow's Sparrow
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow
Vesper Sparrow
Savannah Sparrow
Lark Sparrow
Field Sparrow
Clay-colored Sparrow
Chestnut-collared Longspur
McCown's Longspur
Dickcissel
Lark Bunting
Bobolink
Eastern Meadowlark
Western Meadowlark
Brown-headed Cowbird

EFFECTS OF MANAGEMENT PRACTICES ON GRASSLAND BIRDS:

VESPER SPARROW

Jill A. Dechant, Meghan F. Dinkins, Douglas H. Johnson, Lawrence D. Igl,
Christopher M. Goldade, and Betty R. Euliss

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January 2000
(revised January 2002)

ORGANIZATION AND FEATURES OF THIS SPECIES ACCOUNT

Information on the habitat requirements and effects of habitat management on grassland birds were summarized from information in more than 4,000 published and unpublished papers. A ***range map*** is provided to indicate the relative densities of the species in North America, based on Breeding Bird Survey (BBS) data. Although birds frequently are observed outside the breeding range indicated, the maps are intended to show areas where managers might concentrate their attention. It may be ineffectual to manage habitat at a site for a species that rarely occurs in an area. The species account begins with a brief ***capsule statement***, which provides the fundamental components or keys to management for the species. A section on ***breeding range*** outlines the current breeding distribution of the species in North America, including areas that could not be mapped using BBS data. The ***suitable habitat*** section describes the breeding habitat and occasionally microhabitat characteristics of the species, especially those habitats that occur in the Great Plains. Details on habitat and microhabitat requirements often provide clues to how a species will respond to a particular management practice. A ***table*** near the end of the account complements the section on suitable habitat, and lists the specific habitat characteristics for the species by individual studies. A special section on ***prey habitat*** is included for those predatory species that have more specific prey requirements. The ***area requirements*** section provides details on territory and home range sizes, minimum area requirements, and the effects of patch size, edges, and other landscape and habitat features on abundance and productivity. It may be futile to manage a small block of suitable habitat for a species that has minimum area requirements that are larger than the area being managed. The Brown-headed Cowbird (*Molothrus ater*) is an obligate brood parasite of many grassland birds. The section on ***cowbird brood parasitism*** summarizes rates of cowbird parasitism, host responses to parasitism, and factors that influence parasitism, such as nest concealment and host density. The impact of management depends, in part, upon a species' nesting phenology and biology. The section on ***breeding-season phenology and site fidelity*** includes details on spring arrival and fall departure for migratory populations in the Great Plains, peak breeding periods, the tendency to renest after nest failure or success, and the propensity to return to a previous breeding site. The duration and timing of breeding varies among regions and years. ***Species' response to management*** summarizes the current knowledge and major findings in the literature on the effects of different management practices on the species. The section on ***management recommendations*** complements the previous section and summarizes specific recommendations for habitat management provided in the literature. If management recommendations differ in different portions of the species' breeding range, recommendations are given separately by region. The ***literature cited*** contains references to published and unpublished literature on the management effects and habitat requirements of the species. This section is not meant to be a complete bibliography; a searchable, annotated bibliography of published and unpublished papers dealing with habitat needs of grassland birds and their responses to habitat management is posted at the Web site mentioned below.

This report has been downloaded from the Northern Prairie Wildlife Research Center World-Wide Web site, www.npwrc.usgs.gov/resource/literatr/grasbird/grasbird.htm. Please direct comments and suggestions to Douglas H. Johnson, Northern Prairie Wildlife Research Center, U.S. Geological Survey, 8711 37th Street SE, Jamestown, North Dakota 58401; telephone: 701-253-5539; fax: 701-253-5553; e-mail: Douglas_H_Johnson@usgs.gov.

VESPER SPARROW
(*Pooecetes gramineus*)

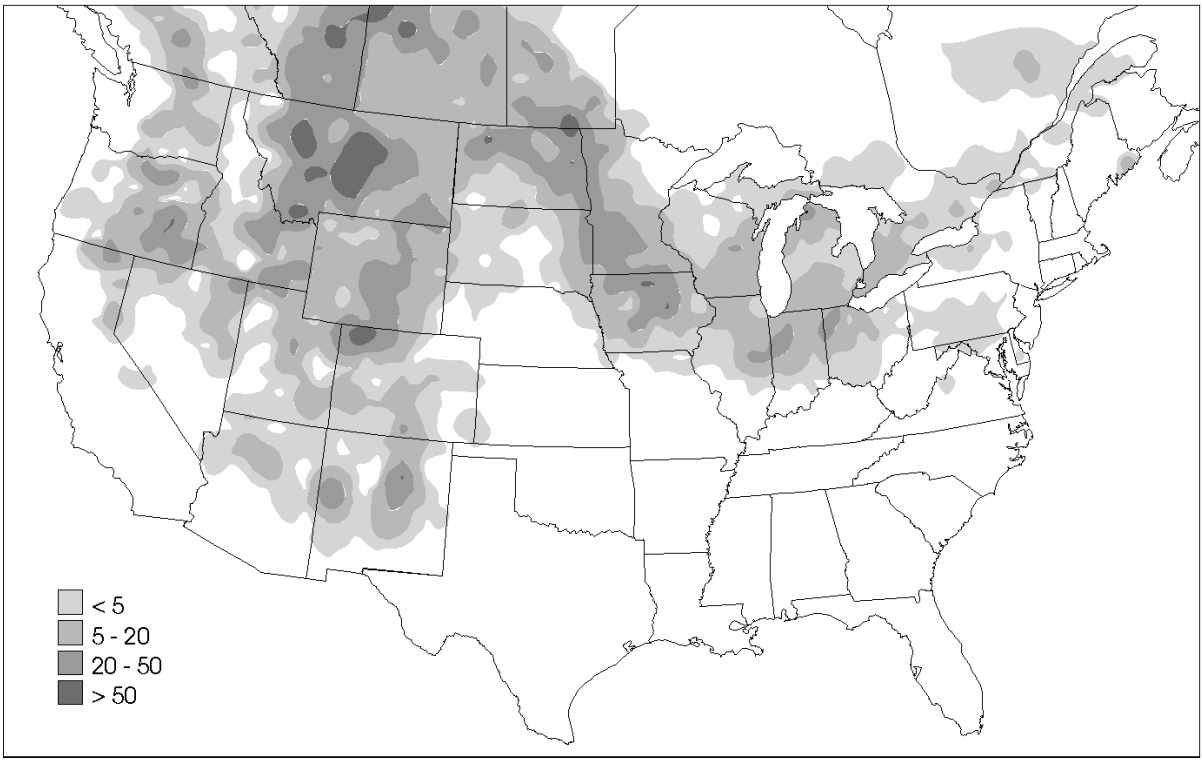

Figure. Breeding distribution of Vesper Sparrow in the United States and southern Canada, based on Breeding Bird Survey data, 1985-1991. Scale represents average number of individuals detected per route per year. Map from Price, J., S. Droege, and A. Price. 1995. The summer atlas of North American birds. Academic Press, London, England. 364 pages.

Keys to management include providing areas of dry, sparse vegetation or edge habitat between forests and fields, and providing elevated song perches.

Breeding range:

Vesper Sparrows breed from the southern Northwest Territories to southern British Columbia, throughout Alberta, all but the northeastern tip of Saskatchewan, to southern Manitoba, southern Ontario, southern Quebec, New Brunswick, Prince Edward Island, and Nova Scotia, south to central California, New Mexico, northeastern Nebraska, and northern Missouri, and east to Illinois, northern Virginia, Rhode Island, and Maine (National Geographic Society 1999). (See figure for the relative densities of Vesper Sparrows in the United States and southern Canada, based on Breeding Bird Survey data.)

Suitable habitat:

Vesper Sparrows prefer dry, open areas with short, sparse and patchy vegetation (Roberts 1932, Wiens 1969, Harrison 1974, Skinner et al. 1984, Sample 1989). However, they may be found in a variety of habitats, including shortgrass, mixed-grass, and tallgrass prairie; semidesert grasslands; sagebrush (*Artemisia*); pastures; hayland; planted cover (such as Conservation Reserve Program [CRP] fields, Permanent Cover Program [PCP] fields, and dense nesting cover

[DNC]); cropland; shrubby grasslands; oldfields; orchards; woodland edge; shelterbelts; highway rights-of-way; and jack pine (*Pinus banksiana*) barrens (Saunders 1914; Rand 1948; Batts 1958; Graber and Graber 1963; Berger 1968; Best 1972; Maher 1974; Fautin 1975; Salt and Salt 1976; Emmerich 1978; Johnsgard 1980; Faanes 1981; Yahner 1982; Sample 1989; Dhol et al. 1994; Hartley 1994*a*,*b*; Faanes and Lingle 1995; Best et al. 1997; Prescott 1997; McMaster and Davis 1998). In Colorado, Bock et al. (1999) compared the abundance of Vesper Sparrows between upland (mixed-grass prairie) and lowland (tallgrass or tame hayland) grasslands. Vesper Sparrows were significantly more abundant on upland than on lowland plots. Within grazed short- and mixed-grass prairie and shrubsteppe in Colorado, Montana, Nebraska, North Dakota, South Dakota, and Wyoming, Vesper Sparrows were most abundant in shrubsteppe (Kantrud 1982). Vesper Sparrows use transition zones between ecosystems, such as the zone between shortgrass prairie and conifer woodland in Wyoming (Finzel 1964), and the zone (parkland fringe) between mixed-grass prairie and parkland in Saskatchewan (Anstey et al. 1995). Vesper Sparrows generally use both native and tame vegetation (Anstey et al. 1995, Prescott and Murphy 1996, Sutter and Brigham 1998, Davis and Duncan 1999). In Manitoba, however, numbers of Vesper Sparrows were negatively correlated with presence of native vegetation and positively correlated with presence of tame vegetation (Wilson and Belcher 1989). They inhabit edge habitats, such as fencerows between two crop fields and edges between cropland and woodland, as well as the cropland adjacent to edge (Berger 1968, Wiens 1969, Stewart 1975, Rodenhouse 1981, Faanes 1981, Rodenhouse and Best 1983, Perritt 1987, Perritt and Best 1989, Best et al. 1990). Vesper Sparrows frequently are observed in thickets, small trees and shrubs, wooded draws, fencerows containing trees or shrubs, and areas of coarse forbs or weeds (Maher 1974, Stewart 1975, Best 1983, Faanes 1983, Arnold and Higgins 1986, Prescott et al. 1995). Vesper Sparrows have been observed in colonies of white-tailed prairie dogs (*Cynomys leucurus*) (Clark et al. 1982).

In southern Wisconsin, Vesper Sparrows were not encountered in any wet habitat or in habitats with tall, dense vegetation (Sample 1989). Density of Vesper Sparrows was significantly higher in barrens and dry prairie than in oldfields, tame grasslands, small-grain fields, corn fields, mesic prairie, planted warm-season grasses, or hayland. Density was positively correlated with percent woody cover, total number of dead stems, low density of prostrate residual vegetation, percent bare ground, and proportion of plots that were burned. Density was negatively correlated with vegetation height/density and percent cover of standing residual vegetation. In Missouri, Vesper Sparrows used short cover (35% cover at a height of 1 cm and 10% cover at a height of 25 cm) found in a heavily grazed abandoned crop field; they were not observed within idle, grazed, hayed, or burned tallgrass (Skinner et al. 1984) .

In Wyoming, the availability of sagebrush for nest cover and song perches was important for Vesper Sparrows (Fautin 1975, Schaid et al. 1983). They occurred in areas dominated by sagebrush and were absent from areas where only grass and cactus (*Opuntia*) were present (Fautin 1975). In a study examining the relationship between vegetation and bird density in montane grassland, shrubsteppe, and tallgrass, mixed-grass, and shortgrass prairie in Colorado, Kansas, Montana, Nebraska, Oklahoma, Oregon, South Dakota, Texas, Washington, Wisconsin, and Wyoming, Vesper Sparrows occurred only in shrubsteppe and montane meadow habitats (Rotenberry and Wiens 1980). They were most abundant in montane meadow in Montana. Abundance was positively correlated with forb cover and the extent of variation in height of nearest forb or shrub. In Nevada and Oregon, abundance was significantly correlated with

presence of green rabbitbrush (*Chrysothamnus viscidiflorus*), antelope bitterbrush (*Purshia tridentata*), and diversity of coverage in plant structural types (Wiens and Rotenberry 1981).

In Iowa, abundance of Vesper Sparrows in roadside vegetation was inversely related to height and vertical density of vegetation (Camp and Best 1993). Within alfalfa (*Medicago sativa*) fields, abundance appeared to be directly related to vegetation density until alfalfa reached a height of 30 cm, at which time abundance became inversely related to vegetation height and density (Frawley and Best 1991).

Quality of territories and the number of pairs using cultivated areas may be affected by availability of elevated song perches (Berger 1968, Best and Rodenhouse 1984). Perches may be any structure or vegetation higher than the nesting substrate, such as dead herbaceous plants, sagebrush, shrubs, fences, or hay bales (Berger 1968; Wiens 1969; Schaid et al. 1983; Best and Rodenhouse 1984; D. G. McMaster, Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan, pers. comm.). In Iowa, presence of song perches was the most important characteristic of preferred territories (Rodenhouse 1981). During the pre-incubation period, males used shrubs, fence posts, and fence wire within fencerows as song perches (Rodenhouse 1981, Rodenhouse and Best 1983). During incubation, males sang from within crop fields, using clods of soil or tall pieces of crop residue as perches. During the nestling stage, males sang from one or two preferred perches. By early July, males used weeds within soybean fields or corn stalks in outer rows; corn stalks were taller than fence posts and shrubs within the fencerow. In Utah, big sagebrush (*Artemisia tridentata*) was used for perching more often than Utah juniper (*Juniperus osteosperma*), Utah serviceberry (*Amelanchier utahensis*), or buckbrush (*Symphoricarpos orbiculatis*), but other shrubs, primarily Utah juniper, were used significantly more than expected based on availability (Castrale 1983). Harrison (1977) provided artificial perches of two heights, 1.5 and 2.0 m, to test whether birds preferred taller perch sites; Vesper Sparrows did not exhibit a preference for either height.

Nests are built on the ground and may be placed under dead stems, at the base of plants, near clods of soil, or near patches of bare ground where vegetation is sparse (Cameron 1908, Berger 1968). Nests may be found in dry upland prairie or in disturbed areas such as along dirt roads, in corn and alfalfa stubble, in hayland, and in grassed waterways within cropland (Roberts 1932, Berger 1968, Feist 1968, Schaid et al. 1983, Best and Rodenhouse 1984, Basore et al. 1986, Bryan and Best 1994, Camp and Best 1994, Faanes and Lingle 1995). In Montana, Vesper Sparrows nested under big sagebrush (Feist 1968, Best 1972).

Several master's theses and published studies have discussed nest location, territory characteristics, or abundance of Vesper Sparrows in agricultural settings in central Iowa. Rodenhouse (1981) studied habitat characteristics of territories encompassing fencerows that divided soybean fields and corn fields. Perritt (1987) examined the influences of weather on territory characteristics and breeding success and the relationship between habitat variables and territory size and quality. Her work also was conducted in areas where fencerows separated soybean and corn fields. Camp and Best (1991, 1994) focused on abundance and nest success of birds that nested in roadsides adjacent to rowcrop fields. Bryan and Best (1991, 1994) documented abundance and nest success of birds using grassed waterways in rowcrop fields. Waterways were in minimum-tillage corn or soybean fields. Most waterways were planted to smooth brome (*Bromus inermis*), were linear, and were connected to other forms of strip cover. Nest-site selection, nest success, and nesting density were compared between tilled fields and fields under no tillage (Basore et al. 1986). Gremaud (1983) examined the influences of litter cover; waste grain abundance; proximity of non-cultivated habitats, such as pasture and alfalfa

hayfields; and the impact of farming practices (conventional tillage, no-tillage, minimum tillage, and organic farming) on nongame bird use of rowcrop fields. Stallman and Best (1996) examined use of a strip intercropping system by Vesper Sparrows. Further details from these authors' findings may be found in the appendix later in this account. A table near the end of the account lists the specific habitat characteristics for Vesper Sparrows by study.

Area requirements:

In Montana, average size of 60 territories was 1.65 ha (Reed 1986). Seven territories ranged in size from 0.29 to 3.04 ha (Reed 1985). In montane pasture in Montana, average territory size of three males was 1.96 ha (Wiens 1971). In southern Wisconsin, average size of five territories in dry areas with sparse vegetation was 0.88 ha (Wiens 1969). Average size of 42 territories located along fencerows between and adjacent to corn and soybean fields in Iowa was 2.3 ha; territories ranged in size from 1.8 to 3.2 ha (Rodenhouse 1981, Rodenhouse and Best 1983). Of 37 territories in corn and soybean fields in the same geographical location as Rodenhouse (1981), Perritt (1987) reported an average territory size of 3.05 ha one year and 3.57 ha another year. Size of territories ranged from 1.60 to 8.19 ha. Within a 5.6-ha uncultivated field in Michigan, Vesper Sparrows established from 8 to12 territories per yr over a period of 8 yr, with all available habitat occupied; average territory size per year varied from 0.48 to 0.72 ha (F. C. Evans, *unpublished data*, *in* Berger 1968: 869). In tallgrass prairie fragments in Illinois, Vesper Sparrows were encountered on small (<10 ha) sites but were not encountered on a single 650-ha site (Herkert 1991*a*,*b*). Abundance within burned prairie was not affected by area (Herkert 1994). In Maine, abundance of Vesper Sparrows was positively correlated with increasing area and habitat patchiness; Vesper Sparrows reached 50% incidence at 20 ha in grassland barrens (Vickery et al. 1994).

No studies have investigated a relationship between patch size and Vesper Sparrow nest success or patch size and rates of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*). In Saskatchewan, McMaster et al. (1999) examined the influence on nest success of several landscape features, including area of the study site, area of the study site (vegetation within study site was hayland) plus contiguous perennial grassland (referred to as the grass patch), grass-patch edge density, and grass-patch shape. None of the features significantly affected nest success. The authors also found that parasitized nests were closer to field edges than were unparasitized nests. Berger (1968) believed there was a relationship between parasitism and proximity to woody vegetation: in general, parasitized nests were in fields bordering woodlots or thickets, whereas non-parasitized nests were not near woody vegetation. In Colorado, Bock et al. (1999) compared the abundance of Vesper Sparrows between interior and edge locations. Edge was defined as the interface between suburban development and upland or lowland habitat, and interior locations were 200 m from edge. Vesper Sparrows were significantly more abundant on interior plots than on edge plots.

Brown-headed Cowbird brood parasitism:

The Vesper Sparrow is a fairly common host of the Brown-headed Cowbird and is known to rear cowbird young (Friedmann 1963). Parasitism rates vary from 0% of 10 nests (Frawley 1989) to 61% of 41 nests (Stallman and Best 1996). Refer to Table 1 in Shaffer et al. (2003) for rates of cowbird brood parasitism. In southern Saskatchewan, parasitized nests had smaller clutch sizes, hatched fewer eggs, fledged fewer host young per nest, and hatched fewer host young per successful nest than did unparasitized nests (McMaster et al. 1999). Parasitized nests

were not significantly closer to perches or significantly less concealed than unparasitized nests. Multiple parasitism occasionally occurs; Cameron (1908) found a nest that contained three cowbird eggs and three host eggs.

Breeding-season phenology and site fidelity:

In Nebraska, Vesper Sparrows arrive on the breeding grounds from early March to late May and depart from mid-August to late November (Johnsgard 1980). In Iowa, Vesper Sparrows arrive from mid-March to mid-April and depart by mid-October (Rodenhouse and Best 1983, Kent and Dinsmore 1996). Females begin arriving within a week of the arrival of the first males. Vesper Sparrows arrive in Michigan in late March and depart from late October to early November (George 1952, Batts 1958). They arrive in Minnesota from late March to mid-May and depart from late August to late October (Berger 1968, Janssen 1987, Harrison 1974, Faanes 1981). They arrive in Montana in late April (Cameron 1908). In Saskatchewan, they arrive from mid-April to early May and depart from September to early October (Maher 1973, 1974; Knapton 1979). Peak breeding season in North Dakota is late May to mid-July (Stewart 1975).

Three studies in Michigan found that Vesper Sparrows may be double- or even triple-brooded. George (1952) reported one case of double-brooding. F. C. Evans (*in* Berger 1968:874) found that 45% of 29 females raised two broods and one female raised three broods. Harrison (1974) reported that breeding pairs in Michigan alfalfa fields were double-brooded. Renesting after initial clutch has been destroyed also has been recorded (George 1952).

Of 24 adults banded in Michigan, 46% returned to the study area where they had been banded (George 1952). One pair mated for two consecutive breeding seasons. None of 45 banded nestlings were seen in subsequent breeding seasons. A male Vesper Sparrow returned to the same nesting territory for four consecutive years; for two of those years, he paired with the same banded mate (L. H. Walkinshaw *in* Berger 1968:878). Also in Michigan, a banded adult was recaptured 6 yr later at the site where it was banded (Klimkiewicz and Futcher 1987). Of 26 male and 11 female Vesper Sparrows banded in Iowa, four males and two females returned to the same fencerows that they had used in the previous year (Best and Rodenhouse 1984). Two of the four returning males returned to the same territories they had occupied the previous year.

Species' response to management:

In Saskatchewan, density of Vesper Sparrows was higher in one mixed-grass prairie site 1 yr postburn and lower 2 and 3 yr postburn than in an unburned mixed-grass site (Pylypec 1991). Vesper Sparrows appeared on a restored prairie the third year after it was reseeded, which also was the year it was burned (Volkert 1992). They were most abundant 2 yr postburn and declined 3-5 yr postburn. In Iowa, Vesper Sparrows were more abundant in burned roadsides than in unburned roadsides (Camp and Best 1993). Abundance was inversely related to height and vertical density of vegetation in roadsides. In Illinois, Vesper Sparrows were most abundant in the first growing season postburn, were absent the second growing season postburn, and were uncommon the third growing season postburn (Herkert 1994). In Wyoming sagebrush, no significant differences were observed in the abundance of Vesper Sparrows among grazed areas that were burned 7-9 yr previous to the study, areas that were treated 20-22 yr previous to the study with 2,4-D to remove sagebrush, and areas that were untreated (Kerley and Anderson 1995). Also in Wyoming sagebrush, McGee (1976) reported that Vesper Sparrows used spring-burned areas 1-3 yr postburn and the unburned control. They occupied an area of sagebrush before it was burned in the fall, but were absent during 1-2 yr postburn growing seasons. In

southeastern Idaho, Vesper Sparrows were present in sagebrush 3-4 yr postburn but were absent from the same area before it was burned and 1-2 yr postburn (Petersen and Best 1987). In Utah, density of Vesper Sparrows was similar between sagebrush areas that had been plowed and seeded to grasses 17 yr before the study and areas that had been burned 4 yr before the study (Castrale 1982). Vesper Sparrows were not present within areas in which sagebrush was removed by chaining, followed by seeding to grasses.

Within aspen parkland in Alberta, Vesper Sparrows were present in delayed-mowed hayfields and were absent from conventional hayland (Prescott et al. 1995). Delayed-mowed hayfields were planted to tame grasses and were cut once during the previous summer, after 15 July, whereas conventional hayfields were subject to conventional cutting regimes. In Saskatchewan, Vesper Sparrows were detected more often in tame hayland than in native pasture, tame pasture, or cropland (Anstey et al. 1995, Davis et al. 1997). In southern Saskatchewan hayfields, the number of pairs was not affected by amount of cropland or wetland within 1.6 km of study areas (McMaster et al. 1999). Nest success for both the incubation and nestling periods combined was not related to the proportion of wetland or cropland in study areas. In North Dakota, Vesper Sparrows avoided native hayland mowed the previous year (Kantrud 1981). In Iowa, Vesper Sparrows were six times more likely to nest in mowed grassed waterways than in unmowed grassed waterways (Bryan and Best 1994). However, they nested only in the longest waterways (>609 m), compared with waterways that were 60-304 m or 305-609 m long. The effects of mowing on Vesper Sparrows in alfalfa fields were examined by Frawley and Best (1991). Densities of birds were recorded before mowing, 2 wk after mowing, and 4 wk after mowing. Densities of Vesper Sparrows did not differ before and after mowing. In contrast, in Saskatchewan, clutch initiations were higher in late July and early August, after mowing, than in June, when hayland was unmowed and vegetation was thick and tall (McMaster et al. 1999). In southern Michigan, Vesper Sparrows nested in hayfields but avoided thick stands of hay (George 1952). Populations were not reduced markedly by mowing. Also in Michigan, Vesper Sparrows continued breeding activities following mowing of an alfalfa field in late June (Harrison 1974). Breeding was terminated after the second mowing in early August, but Vesper Sparrows may have successfully fledged young before the second mowing occurred.

The effects of burning, mowing, grazing, and idling on occurrence of birds were evaluated in southwestern Missouri; Vesper Sparrows were most common in a heavily grazed former crop field (Skinner et al. 1984). In Michigan, Vesper Sparrows avoided permanent pasture and pastures in hayfields (George 1952). In southwestern Wisconsin, Vesper Sparrows were more abundant in continuously grazed pastures than in rotationally grazed pastures or in ungrazed pastures (Temple et al. 1999). Ungrazed grasslands were neither mowed nor grazed from 15 May to 1 July. Continuously grazed sites were grazed throughout the summer at levels of 2.5-4 animals/ha. Rotationally grazed pastures, stocked with 40-60 animals/ha, were grazed for 1-2 d and then left undisturbed for 10-15 d before being grazed again; pastures averaged 5 ha. All sites were composed of 50-75% cool-season grasses, 7-27% legumes, and 8-23% forbs. In aspen parkland in southern Alberta, Vesper Sparrows occurred in low numbers in early-season tame pastures (grazed from late April to mid-June), early-season native pastures (grazed in early summer), and deferred-grazed native pastures (grazed after 15 July), and were not present in continuously grazed native pastures (Prescott and Wagner 1996). In aspen parkland in central Alberta, Vesper Sparrows were common in both native and tame pasture (Prescott and Murphy 1996). They were found in native pasture on areas with moderate cover diversity and with uniformly short grass. In tame pasture, they used areas with moderate amounts of herbaceous

biomass, moderate to low variation in herbaceous height, and moderate to high proportion of forbs relative to grasses. In Saskatchewan, no significant difference in abundance of Vesper Sparrows was detected between lightly grazed mixed-grass prairie and lightly grazed crested wheatgrass (*Agropyron cristatum*) (Sutter and Brigham 1998). Vesper Sparrows were equally frequent in native pastures as in three types of tame pastures (Davis and Duncan 1999). The three types were pure stands of crested wheatgrass; mixed stands of crested wheatgrass, smooth brome, and bluegrass (*Poa* spp.); and stands of crested wheatgrass and alfalfa. Occurrence was negatively associated with vegetation height and clubmoss (*Selaginella densa*). Vesper Sparrows were detected as frequently in native mixed-grass pasture as in tame pasture (Anstey et al. 1995, Davis et al. 1997). Anstey et al. (1995) found that abundance in mixed-grass pasture was positively associated with forbs and broad-leaved grasses $\leq$10 cm tall and with shrubs 20-100 cm tall; abundance was negatively associated with broad-leaved grasses 20-100 cm tall. Frequency of occurrence of Vesper Sparrows in native pasture was unaffected by grazing intensity. Heavy grazing was characterized by the removal of virtually all litter and plant material, coverages of >20% bare soil and >40% clubmoss, and the presence of small plants with poor vigor. Light grazing was characterized by little or no evidence of grazing, coverages of <10% bare soil and <10% clubmoss, and the presence of robust and vigorous plants, abundant litter, and plant material. Moderately grazed pastures had characteristics intermediate between the other two types. In aspen parkland, Vesper Sparrows were most abundant in deferred-grazed tame and native grasslands, followed by idle native grassland, continuously grazed native grassland, delayed-mowed hayfields, brush/shrub, idle tame grassland, tame pasture, continuously grazed native parkland, tame DNC, and idle native parkland (Prescott et al. 1995). They did not occur in idle deciduous upland, conventional hayfields, cropland, native DNC, shelterbelts, or saline or fresh wetlands.

The effects of grazing on short- and mixed-grass prairie and shrubsteppe were examined in Colorado, Montana, Nebraska, North Dakota, South Dakota, and Wyoming (Kantrud and Kologiski 1982, 1983). Densities of Vesper Sparrows were highest on moderately grazed borollic aridisols (characterized by 20 cm average vegetation height and 17% bare soil) and lightly grazed ustic aridisols (characterized by 23 cm average vegetation height and 9% bare soil), located in shrubsteppe/grassland habitat. They were least common on typic and aridic ustolls, regardless of grazing intensity. Areas with highest densities of Vesper Sparrows also had above-average abundance of wheatgrasses (*Agropyron* spp.), Junegrass (*Koeleria pyramidata*), fringed sagewort (*Artemisia frigida*), and big sagebrush.

Vesper Sparrows are not common in planted cover (Johnson and Schwartz 1993, Prescott et al. 1995, Best et al. 1997). In Iowa, Vesper Sparrows were more common in rowcrops than in CRP, although they nested in both habitats (Patterson 1994). Best et al. (1997) reported that Vesper Sparrows were uncommon in CRP in Indiana, Iowa, and Michigan and were not encountered in Kansas, Missouri, or Nebraska. They were abundant and frequently nested in rowcrops. In Minnesota, Montana, North Dakota, and South Dakota, Vesper Sparrows were more common in cropland than in CRP (Johnson and Schwartz 1993, Johnson and Igl 1995). In eastcentral Saskatchewan, Vesper Sparrows were present in DNC as well as in idle native grasslands and wheat fields (Hartley 1994*a*,*b*). Dale (1993) reported that Vesper Sparrows were uncommon in tame DNC, fairly common in low nesting cover of creeping red fescue (*Festuca rubra*) and Kentucky bluegrass (*Poa pratensis*), and absent from fallow cropland. Also in Saskatchewan, Vesper Sparrows were more abundant in cropland on organic farmland than on conventional or minimum-tillage farmland or in DNC (Shutler et al. 2000). Presence of Vesper

Sparrows was negatively related to number of wetlands within 2.8 km^2 of point counts. Vesper Sparrows were observed in wetlands or wetland margins within all farmland types and within DNC; presence was positively related to percent woody vegetation around wetland margin. In Alberta, Vesper Sparrows were present in low abundance on 1-, 3-, and 4-yr-old tame DNC but were not present in native DNC or cropland (Prescott et al. 1995, Prescott and Murphy 1999). In Manitoba, Vesper Sparrows were present in idle mixed-grass prairie but were not present in DNC planted to native species or to tame species (Dhol et al. 1994). In contrast to the above findings, Vesper Sparrows in southern Canada occurred significantly more frequently in PCP than in cropland (McMaster and Davis 1998). PCP is a Canadian program that pays farmers to seed highly erodible land to perennial grassland cover; it differs from CRP in the United States in that haying and grazing are allowed annually in PCP. Presence of Vesper Sparrows was influenced by the amount of grassland surrounding PCP sites; frequency of occurrence was higher in sites surrounded more by grasslands than by sites surrounded by cropland, wetland, woodland, or human settlement. There was no significant difference in frequency of occurrence between PCP sites that were hayed and those that were grazed.

Although Vesper Sparrows nest in cropland (Rodenhouse and Best 1983, Patterson and Best 1996, Best et al. 1997), nesting success may be low. Rodenhouse and Best (1983) found that only 29% of 45 nests in Iowa rowcrops were successful. The first nests of the breeding season were destroyed by seedbed preparation or planting. About 50% of nests built later in the breeding season, when nests were placed in rowcrops, were destroyed by other mechanical operations. Only 2% of 41 nests was successful in Iowa fields where strip intercropping (i.e., planting rowcrops, legumes, and small grains in a series of adjacent, narrow strips) was used (Stallman and Best 1996). No active nests survived mechanical field operations. Based on roadside censuses in Alberta, Vesper Sparrows were significantly more common at census stops where land use was a mix of cultivation and grazed pastures than at grazed or undisturbed (i.e., where mowing, grazing, or cultivation did not occur) stops; they also were significantly more common at grazed stops than at undisturbed stops (Owens and Myres 1973). In Iowa, nest densities were higher in no-tillage corn and soybean fields and in strip cover than in corn fields that were tilled (Basore et al. 1986). Although tillage does not always lead to nest destruction, nest losses were primarily from agricultural operations or from depredation (Rodenhouse 1981, Best and Rodenhouse 1984). Rodenhouse and Best (1983) suggested that adoption of no-tillage practices would enhance Vesper Sparrow production because a decrease in tillage operations would decrease the number of nests destroyed by tillage. Furthermore, retention of crop residue on fields would increase nesting success by affecting nest placement and/or concealment. The authors also suggested that fencerow removal would reduce the use of corn and soybean fields by Vesper Sparrows. Densities of breeding Vesper Sparrows possibly could be increased by increasing the proportion of herbaceous-shrubby fencerows in a section. Best and Hill (1983) found that Vesper Sparrows inhabited fencerows that contained only herbaceous vegetation, fencerows of scattered trees and shrubs, or fencerows of continuous trees and shrubs. In a comparison of nesting activity in minimum-tillage, conventional tillage, and organic farms in North Dakota, Vesper Sparrows mainly used conventionally tilled fields; conventional was defined as involving fall and spring tillage and pesticides (Lokemoen and Beiser 1997).

The effects of grasshopper (Orthoptera) control methods (malathion, carbaryl, and *Nosema locustae* bait, a biological control agent for grasshoppers) on Vesper Sparrow density were evaluated in Colorado, Idaho, North Dakota, Utah, and Wyoming (George et al. 1995). Density did not decline 10 and 21 d after treatment (all treatments combined). In North Dakota,

brain levels of acetylcholinesterase (AChe) in Vesper Sparrows did not differ between areas treated with carbaryl bait and untreated areas (George et al. 1992). Carbaryl is an AChe-inhibiting chemical. In Montana and Wyoming, numbers of Vesper Sparrows did not decline significantly from application rates of 140, 210, or 280 g/ha of BAYGON* (*o*-isopropoxyphenyl methylcarbamate; McEwen et al. 1972). Numbers of Vesper Sparrows did decline significantly on areas in Montana sprayed with 441 and 672 g/ha applications of fenitrothion. In sagebrush/grassland habitat of Montana, the effect of various degrees of sagebrush removal on Vesper Sparrow abundance was examined (Best 1972). Sagebrush was killed by aerial spraying with 2,4-D. The five treatments involved areas that were rendered devoid of live sagebrush, areas in which sagebrush was killed only in alternate strips 30.48 m wide (strip spray), areas in which sagebrush was only partially killed (partial spray), a control (no spraying), and a control in which grazing occurred. Both strip spray and partial spray reduced live sagebrush by about 50%. The biggest change in abundance of Vesper Sparrows occurred on the grazed control plot, where numbers of breeding Vesper Sparrows dropped 30% (from 25 birds to 17.5 birds) in 2 yr. Indirect effects of spraying on abundance of Vesper Sparrows were not obvious. Dominant plant and animal species consumed by Vesper Sparrows were similar between sprayed and unsprayed areas, but the amount of those species consumed between sprayed and unsprayed areas differed.

In Wyoming shrubsteppe, there was no significant difference in the mean number of Vesper Sparrows among areas that were treated with 2,4-D 20-22 yr before the study and that were grazed at the time of the study compared with areas that were unsprayed and also grazed, and areas that were burned 7-9 yr earlier and grazed (Kerley and Anderson 1995). Grazing intensity was higher on herbicide-treated plots than on untreated plots and higher on burned than on untreated plots. Grazing intensity was not different between herbicide-treated plots and burned plots. In a Texas study examining the effects on avian density of discing, spraying of 2,4,5-T about 14 yr prior to the study, and construction of brush shelters, grassland sparrows, as a group, were more abundant in the treated than untreated areas; effects on particular species, such as Vesper Sparrow, composing the group of grassland sparrows, were not examined (Gruver and Guthery 1986). In Ontario corn fields, the mean number of Vesper Sparrows did not differ between pre- and post-applications of the granular insecticides fonofos and terbufos, which are used to control corn rootworm (*Diabrotica* spp.), or between treated fields and control fields (Knapton and Mineau 1995).

The effects of mine reclamation on densities of breeding Vesper Sparrows were examined in South Dakota and Wyoming (Schaid et al. 1983). A single unmined area of grass and big sagebrush was selected as a control. Dominant native grass species were western wheatgrass (*Pascopyrum smithii*), Junegrass, buffalo grass (*Buchloe dactyloides*), and blue grama (*Bouteloua gracilis*). Bluegrass, brome grass (*Bromus* spp.), green needlegrass (*Stipa viridula*), and foxtail barley (*Hordeum jubatum*) also were widespread on the area. Treatments were unreclaimed bentonite clay spoils and reclaimed mine areas. The unreclaimed area consisted of numerous bentonite spoils and mine pits with remnants of unmined grass/sagebrush habitat between the spoils and pits. Reclaimed areas had been recontoured and revegetated mostly with native grasses (green needlegrass and wheatgrasses [*Agropyron* spp.]) although

*References to chemical trade names does not imply endorsement of commercial products by the Federal Government.

some areas were planted to crested wheatgrass. Reclamation occurred 3-10 yr prior to the study. No remnants of the original grass/sagebrush habitat existed on the reclaimed area. Vesper Sparrows were among the most common breeding species in the grass/sagebrush area. Vesper Sparrow density was significantly greater on the control than on the two mining treatments, and density was similar between the two mined treatments. Lack of sagebrush in the mined treatments may have accounted for lower density of Vesper Sparrows. The authors speculated that Vesper Sparrows that did occur in reclaimed spoil areas probably were attracted to the seed of green needlegrass for food.

In Colorado, the influence of recreational trails on avian abundance was evaluated in mixed-grass prairie (Miller et al. 1998). Vesper Sparrows were significantly more abundant along control transects, which were placed in blocks of mixed-grass prairie without trails, than along trails. In a Saskatchewan study that examined whether the abundance of grassland birds differed between roadsides and trailsides, abundance of Vesper Sparrows was significantly higher along roadsides than along trailsides (Sutter et al. 2000). Roads were defined as traveling surfaces with adjacent drainage ditches planted to smooth brome and ending with a fence 11-18 m from the traveling surface. Trails were defined as a single pair of wheel ruts visually indistinct from surrounding habitat in terms of plant structure and composition. Habitat along roads and trails were parcels of lightly to moderately grazed native prairie >256 ha.

Management Recommendations:

If sagebrush must be controlled by burning or chaining, do so in the spring before breeding territories are established or in late summer or early fall after birds have left the area (Castrale 1982). Treat large areas in small blocks over several years. Leave some sagebrush to serve as perches.

Burn or mow roadsides every 3-5 yr to maintain vegetation quality (Camp and Best 1993). To reduce nest losses, mow roadsides only in early spring or late summer (Camp and Best 1994). Encourage farmers to retain fence lines along roadsides, especially in areas where forbs are sparse, to serve as perches (Camp and Best 1993, 1994).

Delay spraying pesticides and mowing in CRP until after July to avoid the peak nesting period (Patterson 1994).

Delay mowing grassed waterways in cropfields until late August to avoid disturbing nesting birds (Bryan and Best 1994). Waterways may serve as refuges because other haylands are mowed earlier in the season. Mow every 3-4 yr to maintain grass vigor. Do not burn waterways in the fall. Burning would have to be delayed until after fall harvest, which would preclude any regrowth of the vegetation. Encourage the growth of forbs in waterways.

Maintain fencerows adjacent to cropland (Rodenhouse and Best 1983). Removal may reduce the use of corn and soybean fields by Vesper Sparrows. Near cropland, increase the proportion of fencerows that consist of both herbaceous and shrubby vegetation (Rodenhouse 1981, Rodenhouse and Best 1983).

To increase productivity of Vesper Sparrows in crop fields, leave more corn residue and reduce the number of mechanical field operations (Rodenhouse 1981). Low nesting success early in the breeding season was mostly attributed to nest destruction by mechanical field operations such as seedbed preparation with a rotary hoe or cultivation. Adopt no-tillage practices to enhance Vesper Sparrow productivity (Rodenhouse and Best 1983). A decrease in tillage operations would decrease the number of nests destroyed by tillage. Retention of crop residue on fields may increase nesting success by providing more nest concealment cover.
Reduced-tillage farming provides more foraging opportunities than conventional-tillage methods (Rodenhouse and Best 1994). Use no-tillage or minimum-tillage methods to retain crop residue and waste grain on the surface of fields for birds to use (Gremaud 1983). However, the use of herbicides in no-tillage or minimum-tillage practices decreases weed-seed density.

If a system of strip intercropping must be used, decrease the number of passes made by farm machinery through strips or increase time between passes to 3.5 wk to allow the completion of nesting cycles (Stallman and Best 1996). As an alternative to mechanical means of weed control, apply herbicides minimally by spot spraying.

Limit pesticide use in areas where Vesper Sparrows forage (Rodenhouse and Best 1994). Use only rapidly degrading chemicals of low toxicity at the lowest rates possible (McEwen et al. 1972). Avoid pest outbreaks by maintaining range in good condition. Overgrazed and drought-affected areas tend to be more prone to insect outbreaks.

Plant shrubs on recontoured and reseeded strip mines to make reclaimed areas more attractive to Vesper Sparrows (Schaid et al. 1983). To facilitate the expansion of shrubby areas, maintain areas of shrubs along roadsides, between mine spoils, and around equipment and storage buildings during mining and reclamation operations.

Table. Vesper Sparrow habitat characteristics.

Author(s)	**Location(s)**	**Habitat(s) Studied***	**Species-specific Habitat Characteristics**
Anstey et al. 1995	Saskatchewan	Cropland, mixed-grass pasture, tame hayland, tame pasture	Were detected most often in parkland fringe grassland and equally frequently in native pasture as in tame pasture; were detected less frequently in cropland than in hayland and more frequently in hayland than in native or tame pasture; frequency of occurrence was unaffected by grazing intensity; abundance was positively associated with forbs and broad-leaved grasses ≤10 cm tall and with shrubs 20-100 cm tall; abundance was negatively associated with broad-leaved grasses 20-100 cm tall
Arnold and Higgins 1986	North Dakota	Mixed-grass hayland, mixed-grass pasture	Were found in shrubby transects of western snowberry (*Symphoricarpos occidentalis*) and silverberry (*Elaeagnus commutata*)
Basore et al. 1986	Iowa	Cropland, idle	Nested in corn planted into sod residue (former pasture or hayland), corn planted into corn residue, soybeans planted into corn residue, tilled corn, and strip cover; nest densities were higher in strip cover than in no-tillage corn; in no-tillage fields, nest sites were in areas with less residue than that found in the field overall
Berger 1968	Rangewide	Cropland, woodland	Used extensive cultivated tracts, such as those planted to hay, wheat, or corn; favorite song perches near woods were branches ≥7.6 m above ground along the edge of the woods; in treeless areas, perches were dead weeds, fences, shrubs, or any structure or vegetation higher than nesting substrate; nested on the ground, near patches of bare ground, or where vegetation was short and sparse; nests were placed at the base of plants, near dirt clods, or under prostrate, dead stems

Best 1972	Montana	Shortgrass pasture, shrubsteppe	Nested on the ground beneath relatively short (14 to 34.3 cm in height) big sagebrush (*Artemisia tridentata*) plants, which averaged 0.033 m^3 in volume when alive, 0.033 m^3 when partially dead, and 0.024 m^3 when completely dead; grass concealment of nests was greater at nest sites where sagebrush was dead, either because Vesper Sparrows preferred this or because there was an overall increase in grass coverage in sprayed areas; grass species associated with sagebrush were western wheatgrass (*Pascopyrum smithii*), bluebunch wheatgrass (*Pseudoroegneria spicata*), green needlegrass *(Stipa viridula*), and Junegrass (*Koeleria cristata*)
Best 1983	Iowa	Cropland, idle	Were abundant during spring and summer in herbaceous fencerows, in fencerows with scattered trees or shrubs, and in fencerows of continuous trees or shrubs
Best et al. 1997	Indiana, Iowa, Kansas, Michigan, Missouri, Nebraska	Conservation Reserve Program (CRP; burned seeded-native, burned seeded-native/tame; burned tame, idle seeded-native, idle seeded-native/tame, idle tame, seeded-native/tame hayland, tame hayland), cropland	Frequently nested in rowcrops; were present in CRP in low abundances
Best and Hill 1983	Iowa	Cropland	Occurred in all types of fencerows (fencerows containing herbaceous vegetation, scattered trees and shrubs, or continuous trees and shrubs); found in cropland areas
Best and Rodenhouse	Iowa	Cropland, idle	Territories occurred along fencerows and extended no more than 80 m into the crop field on both sides of the fencerow;

1984			pairing success was significantly related to the number of shrub groups and the amount of crop residue within territories; elevated perches enhanced territory preference and affected territory location
Best et al. 1990	Illinois, Iowa	Cropland, edge, idle, idle tame, woodland	Were observed in corn fields, woodland/cropland edge, and grassland/cropland edge
Bock et al. 1999	Colorado	Idle mixed-grass, idle tallgrass, mixed-grass pasture, tallgrass pasture, tame hayland	Were more abundant on interior plots than on edge plots and in upland habitat than in lowland habitat; edge was defined as the interface between suburban development and upland or lowland habitat, and interior locations were 200 m from edge; upland grasslands were mixed-grass prairie and lowland grasslands were tallgrass prairie or tame hayland
Bryan and Best 1991, 1994	Iowa	Cropland, idle tame, tame hayland	Were commonly observed in cropland; nests were found in grassed waterways; nested only in the longest (>609 m) waterways compared to shorter (60-304 m and 305-609 m) waterways; occurrence of nests was six times more likely in completely mowed grassed waterways than unmowed grassed waterways
Cameron 1908	Montana	Idle shortgrass, idle shrubsteppe	Nested among sagebrush
Camp and Best 1993	Iowa	Burned seeded-native tallgrass/tame, burned tame, cropland, idle seeded-native tallgrass/tame, idle tame	Were commonly observed along roadsides and in rowcrops; were more abundant in burned than unburned roadsides; abundance was inversely related to height and vertical density of vegetation in roadsides
Camp and Best 1994	Iowa	Burned seeded-native tallgrass/tame, burned	Nested in short, roadside vegetation; nest density was positively correlated with amount of bare ground and

		tame, cropland, idle seeded-native tallgrass/tame, idle tame	negatively correlated with vegetation height and a vegetation vertical density index; vegetation at nest sites averaged 4.1 vertical density, 32.5 cm maximum height, 52.1% grass cover, 13.3% forb cover and 31.2% bare ground; vegetation 1 m from nest sites averaged 5.1 vertical density, 20.7 cm maximum height, 40.0% grass cover, 3.2% forb cover, and 55.0% bare ground; most nests were located on the foreslope (defined as the slope of the roadside between the road and the bottom of the ditch) where mowing and gravel kept the vegetation short
Castrale 1982	Utah	Shrubsteppe	Average values of characteristics of nest sites in sagebrush (*Artemisia*)/grassland sites were 0 cm nest height, 49 cm shrub height, 233 cm^2 shrub cover, 208 cm^3 shrub volume, and 4767 shrubs/ha
Castrale 1983	Utah	Shrubsteppe	Perched primarily on big sagebrush but Utah juniper (*Juniperus osteosperma*) was used significantly more than expected based on availability; also perched on forbs and fences; average measurements of perch sites based on 86 perches were 101.2 cm perch height, 928 cm^2 perch cover, 3778 cm^2 volume, 143.1 cm intershrub distance, and 11.9 shrubs/30 m^2 (density based on sample size of 73); height and cover of song perches were significantly higher than nearest shrubs; no preference was exhibited for live over dead shrubs
Clark et al. 1982	Colorado, New Mexico, Utah	Colonies of burrowing mammals, idle shortgrass	Were present on white-tailed prairie dog (*Cynomus leucurus*) towns
Dale 1984	Saskatchewan	Idle mixed-grass, mixed-grass pasture	Were uncommon on grazed as well as on ungrazed grassland
Dale 1993	Saskatchewan	Dense nesting cover	Were common in short grass, uncommon in DNC, and

		(DNC; idle tame), idle, low nesting cover: idle tame	absent from fallow cropland
Davis and Duncan 1999	Saskatchewan	Mixed-grass pasture, tame pasture	Were equally frequent in native pastures as in tame pastures; occurrence was negatively associated with vegetation height and clubmoss (*Selaginella densa*)
Davis et al. 1997	Saskatchewan	Cropland, hayland, mixed-grass pasture, tame pasture	Were most abundant in hayland and least abundant in cropland; found in equal abundance in tame pastures and in native pastures
Dhol et al. 1994	Manitoba	DNC (idle seeded-native, idle tame), idle mixed-grass	Found only in idle native grasslands; absent from both native and tame DNC
Emmerich 1978	South Dakota	Woodland	Were found in tree claims (nonlinear plantings of trees ≥2.1 ha not planted in rows) and single-row windbreaks (single row of shrubs and/or trees that were at least 2 m tall and 100 m long); were not found in riparian woodlands (woodlands were ≥20 m wide and were ≥250 m long along the shore of a permanent stream); tree claims were dense stands of trees, ungrazed to heavily grazed, with a sparse to dense shrub layer, and many dead trees; single-row windbreaks ranged from young, shrub-height trees to mature trees with a scant to dense shrub understory
Faanes 1981	Minnesota, Wisconsin	Cropland, idle, idle tallgrass/tame, shrub carr, tame hayland, tame pasture, wet meadow, wetland, woodland	Used edge habitats such as fencerows along agricultural fields and retired cropland near woodland; used highway rights-of-way, oldfields, brushy areas, and occasionally jack pine (*Pinus banksiana*) barrens
Faanes 1983	North Dakota	Idle mixed-grass,	Commonly nested in wooded draws and upland native

		mixed-grass pasture, woodland	prairie
Faanes and Lingle 1995	Nebraska	Cropland, idle mixed-grass, idle shortgrass, idle tallgrass, pasture, tame hayland, wet meadow, wetland, woodland	Nested in domestic hayland and upland prairie
Fautin 1975	Wyoming	Shrubsteppe	Occurred in areas where sagebrush was present but not in areas with only grass and cactus (*Opuntia*)
Feist 1968	Montana	Sagebrush, shortgrass pasture	Nested on the ground under big sagebrush; average height of big sagebrush at 11 nest sites was 32.8 cm with a range from 15 to 41 cm; percent canopy coverage averaged 14.5% with a range from 3 to 32%; plants with the highest coverage and percent frequency of occurrence around nests were western wheatgrass, bluebunch wheatgrass, and blue grama (*Bouteloua gracilis*); frequency of occurrence of bare ground ranged from 98 to100% and coverage ranged from 16 to 48%
Finzel 1964	Wyoming	Mixed-grass pasture, shortgrass pasture, woodland	Used grassland/conifer transition area
Frawley 1989, Frawley and Best 1991	Iowa	Tame hayland	Occurred at low densities both before and after mowing; abundance appeared to be positively related to vegetation density until alfalfa (*Medicago sativa*) reached 30 cm tall, at which time abundance became inversely related to vegetation height and density; average measurements in territories before mowing were 16% bare ground, 12% grass coverage, 75% forb coverage, and average height of

			49 cm; average measurements before second mowing were 14% bare ground, 11% grass coverage, 76% forb coverage, and average height of 44 cm
George 1952	Michigan	Cropland, hayland, pasture, woodland edge	Nested in hayfields, avoided permanent pasture and hayfield pasture, which was apparently too barren; avoided thick hayland; populations were not reduced markedly by mowing
Graber and Graber 1963	Illinois	Cropland, hayland, idle, tame pasture, wetland, woodland	Were observed in all grassland and hay habitats; fallow, small-grain, soybean, corn, and plowed fields; shrubbery of all types; and orchards; highest densities were in shrubby areas of fencerows and roadsides and in red clover (*Trifolium pratense*) fields
Gremaud 1983	Iowa	Cropland, tame hayland, tame pasture, woodland	No significant difference in abundance between rowcrop and herbaceous habitats was detected; abundance was significantly correlated with percent litter cover in corn stubble; abundance was not correlated with percent litter cover in soybean stubble, to waste corn abundance, to weed seed density, or to distance to pasture or brushy habitats; abundance increased as distance to woodlots and to alfalfa haylands increased
Harrison 1974	Michigan	Tame hayland	Occupied areas of low litter and low vegetation density; territories were located in xeric, sparsely vegetated areas; continued breeding activities following mowing in late June, but breeding was terminated after the second mowing in early August; used mowed field for foraging; areas used by Vesper Sparrows were characterized by 51.3% litter cover, 51.2 cm vegetation height, 63% light intensity, 48 vegetation contacts/cm at 5 cm high, and 122 vegetation contacts/cm^2
Hartley 1994*a*,*b*	Saskatchewan	Cropland, DNC (idle	Were present in DNC, native grassland, and wheat fields

		seeded-native, idle seeded-native/tame, idle tame, idle tame hayland), idle mixed-grass	
Herkert 1994	Illinois	Burned seeded-native, burned tallgrass	Were most abundant first growing season postburn
Johnsgard 1980	Nebraska	Cropland, idle, idle mixed-grass, idle shortgrass, idle tallgrass, tame hayland, wet meadow	Used idle fields, prairie edges, and areas where grassland was mixed with scattered shrubs or low trees
Johnson and Schwartz 1993, Johnson and Igl 1995	Minnesota, Montana, North Dakota, South Dakota	Cropland, CRP (idle seeded-native, idle tame)	Were more common in cropland than CRP
Kantrud 1981	North Dakota	Mixed-grass hayland, mixed-grass pasture	Density was about equal among heavily, moderately, and lightly grazed areas; avoided hayland that was mowed the previous year
Kantrud and Kologiski 1982	Colorado, Montana, Nebraska North Dakota, South Dakota, Wyoming	Mixed-grass pasture, shortgrass pasture, shrubsteppe	Were common on typic and aridic boroll soils and on borollic and ustic aridisol soils; were not common on typic and aridic ustoll soils; densities were highest on moderately grazed (20 cm average vegetation height and 17% bare soil) borollic aridisol soils and lightly grazed (23 cm average vegetation height and 9% bare soil) ustic aridisol soils; plots that had the highest number of Vesper Sparrows also contained above-average abundance of wheatgrass, Junegrass, fringed sagewort (*Artemisia frigida*), and big sagebrush

Kantrud and Kologiski 1983	Colorado, Montana, Nebraska North Dakota, South Dakota, Wyoming	Mixed-grass pasture, shortgrass pasture, shrubsteppe	Densities were high in shrubsteppe/grassland and shrubsteppe habitats
Lokemoen and Beiser 1997	North Dakota	Cropland, idle	Second most frequently observed species in conventional-tillage (spring and fall tillage and pesticide use), minimum-tillage, and organic fields in fallow, sunflower, and wheat fields; nested mainly in conventional-tillage fields
Maher 1974	Saskatchewan	Cropland, idle mixed-grass, mixed-grass pasture, tame hayland, woodland	Common summer resident in brushy habitats; uncommon on grasslands
McGee 1976	Wyoming	Burned shrubsteppe, shrubsteppe	Present on control and on spring-burned area 1-3 yr postburn; were present on fall-burned area before the area was burned but not 2 yr postburn
McMaster and Davis 1998	Alberta, Manitoba, Saskatchewan	Cropland, Permanent Cover Program (PCP; idle tame, tame hayland, tame pasture)	Occurred significantly more frequently in PCP than in cropland; frequency of occurrence was higher in PCP sites surrounded by grasslands than in PCP sites surrounded by cropland, wetland, woodland, or human settlement; no significant difference in frequency of occurrence between PCP sites that were hayed and those that were grazed
McMaster et al. 1999	Saskatchewan	Hayland, PCP (tame hayland)	Amount of cropland or wetland within 1.6 km of study areas, area of hayland, area of hayland plus contiguous perennial grassland (referred to as the grass patch), grass patch edge density, and grass patch shape and complexity did not affect number of indicated pairs or nest success

Owens and Myres 1973	Alberta	Cropland, idle mixed-grass, mixed-grass hayland, mixed-grass pasture	Were more common on roadside censuses along cultivated land (66% cultivated, 30% rough fescue (*Festuca scabrella*) pasture, and 4% tame grassland) than censuses along native grassland (99% native rough fescue, 1% cultivated); significantly more common in censuses near cultivated land than in censuses near pastures or near cultivated and grazed areas, and at censuses near pasture than censuses near undisturbed (unmowed $\geq$3 yr) areas
Patterson 1994, Patterson and Best 1996	Iowa	Cropland, CRP (idle tame, tame hayland)	Nested in both rowcrop and CRP fields but were more common in rowcrops
Perritt 1987, Perritt and Best 1989	Iowa	Cropland	Based on 74 territories found in 2 yr, territories were characterized by mean values of 3.31 ha territory size, 196 m fencerow length, 216 m territory width perpendicular to a fencerow, 1412 m^2 nonproductive area, 1.2 nonproductive areas, 3.3 cultivations, and 55% of the territory planted in soybeans; territory size was negatively correlated to percentage of territory planted to soybeans and positively correlated to territory width perpendicular to the fencerow and to length of the fencerow; male Vesper Sparrows appeared to adjust the length of fencerow relative to fencerow width and height such that fencerow volume was relatively constant (405 to 588 m^3)
Petersen and Best 1987	Idaho	Burned shrubsteppe, idle shrubsteppe	Were present 3-4 yr postburn but were absent preburn
Prescott 1997	Alberta	Cropland, hayland, mixed-grass pasture, shrubland, tame	Were present in sandhill grasslands, tame pastures, hayfields, coulees, badlands, mixed-grass, planted croplands, upland shrub, fallow croplands, riparian shrub,

		pasture, woodland	and shelterbelts
Prescott and Murphy 1996	Alberta	Mixed-grass pasture, tame pasture	Were common in both tame and native pastures; in native pasture, appeared in areas with moderate cover diversity and short grass; in tame pasture, appeared in areas with moderate amounts of herbaceous biomass, moderate to low variation in herbaceous height, and moderate to high proportion of forbs relative to grasses; in tame pastures, highest abundance was at moderate variation in herbaceous height
Prescott and Murphy 1999	Alberta	Cropland, DNC (idle seeded-native/tame)	Were present in low abundance on 1-, 3-, and 4-yr-old DNC fields and were absent in cropland
Prescott et al. 1995	Alberta	Cropland, DNC (idle seeded-native, idle tame), idle mixed-grass, idle parkland, idle tame, mixed-grass pasture, parkland pasture, tame hayland, tame pasture, wetland, woodland	Were most abundant in deferred grazed tame and native grasslands, followed by idle native grassland, continuously grazed native grassland, delayed haylands, shrub, idle tame grassland, tame pasture, continuously grazed native parkland, tame DNC, and idle native parkland; were absent from idle deciduous upland, conventional hayfields, cropland, native DNC, shelterbelts, and saline or fresh wetlands
Prescott and Wagner 1996	Alberta	Mixed-grass pasture, tame pasture	Found in low occurrence in tame pasture, early-season grazed native pasture, and deferred-grazed native pasture, absent from continuously grazed native pasture
Pylypec 1991	Saskatchewan	Burned mixed-grass, idle mixed-grass	Preferred area 1 yr postburn over unburned area
Rand 1948	Alberta	Cropland, idle shortgrass, shortgrass pasture	Were common in open, arid, closely-grazed shortgrass prairie
			Were observed in short, dense vegetation with a high

Reed 1986	Montana	Not given	percentage of ground cover; mean values for 52 sampling points within territories were 20 cm vegetation height, 351% ground cover (cumulative percent cover where maximum was 400%), 145% grass cover, 206% forb cover, 4 contacts (vertical vegetation density), and 90 cm height of nearest perch
Roberts 1932	Minnesota	Cropland, idle tallgrass, woodland	Were common in open, dry uplands, either native or cultivated, as well as in cleared forest areas that had been burned, cut, or that were created by windfall
Rodenhouse 1981, Rodenhouse and Best 1983	Iowa	Cropland	Territories were located linearly along fencerows and included areas of cropland adjacent to the fencerows but rarely extended >80 m into fields; 42 territories were characterized by an average of 3.7 shrub groups per territory, 0.7 washes, 0.5 weedy areas, 0.4 grassy waterways, 164 m fencerow length, 377 m^2 fencerow coverage, 400 m^2 coverage of washes, 1700 m^2 coverage of nonproductive areas, 700 kg/ha soybean residue before planting, 500 kg/ha soybean residue after planting, 2400 kg/ha corn residue before planting, 900 kg/ha corn residue after planting, and 2.34 ha territory size; use of perch sites and nest placement changed seasonally
Rotenberry and Wiens 1980	Colorado, Kansas, Montana, Nebraska, Oklahoma, Oregon, South Dakota, Texas, Washington, Wisconsin,	Idle mixed-grass, idle shortgrass, idle shrubsteppe, idle tallgrass, montane meadow	Abundance was positively correlated with forb cover and amount of variation in height of nearest forb or shrub

	Wyoming		
Salt and Salt 1976	Alberta	Cropland, idle, idle grassland, parkland, pasture	Nested on ground in grass nests lined with hair and fine grass; Vesper Sparrow originally nested on shortgrass prairie but have adapted to cultivation and settlement; stubble was avoided for everything except feeding; used grass patches by roads, under fence lines, or on coulee slopes; in parklands or woodlands, Vesper Sparrows occurred in extensive meadows or pastures where grass was not too tall or thick and used aspen (*Populus*) trees, fence posts, and fence lines for perches
Sample 1989	Wisconsin	Burned tallgrass, cropland, DNC (idle seeded-native, idle tame), idle, idle seeded-native, idle tallgrass, idle tallgrass/tame, idle tame, tame hayland, tame pasture, tame savanna pasture, wet meadow, wet-meadow pasture	Density was significantly greater in barrens than in any other habitat; preferred dry habitats with short, sparse, and patchy vegetation; used areas with an average of 3% woody cover, 68% herbaceous cover, 16% litter cover, 13% bare ground, 62 cm maximum vegetation height and 21 cm vegetation height/density; density was positively correlated with percent woody cover, percent bare ground, total number of dead stems, low density of prostrate residual vegetation, and proportion of burned plots; density was negatively correlated with height/density and percent standing residual vegetation
Saunders 1914	Montana	Idle shortgrass, montane meadow, woodland	Were abundant on prairies and mountain meadows
Schaid et al. 1983	South Dakota, Wyoming	Shrubsteppe	Density was significantly greater in unmined grass/sagebrush areas than in unreclaimed or reclaimed mining sites, and density was similar between the two mined treatments; lack of sagebrush in the mined sites may have accounted for lower density; nested on the ground under big sagebrush in grass/sagebrush and unreclaimed

			site, but did not nest on the reclaimed site probably because of lack of shrubs; used sagebrush for song perches; percent frequency of occurrence of big sagebrush was a statistically significant variable explaining variation in Vesper Sparrow densities in the unreclaimed sites; percent frequency of occurrence of green needlegrass was a statistically significant variable explaining variation in Vesper Sparrow densities in the reclaimed sites, probably because Vesper Sparrows foraged on seeds of green needlegrass; surface area of water, litter, percent frequency of occurrence of Junegrass, and average height of vegetation were positively associated with variation in Vesper Sparrow densities in unmined areas, whereas percent frequency of occurrence of forbs, shrubs and Japanese brome (*Bromus japonicus*) were negatively associated with variation in Vesper Sparrow densities in unmined areas
Shutler et al. 2000	Saskatchewan	Cropland, DNC (idle seeded-native, idle seeded-tame), wetland	Were more abundant in cropland on organic farmland than on conventional or minimum-tillage farmland or in DNC; presence was negatively related to number of wetlands within 2.8 km^2 of point counts; were detected in wetlands or wetland margins within all farmland types and within DNC; presence was positively related to percent woody vegetation around wetland margin
Skinner et al. 1984	Missouri	Burned tallgrass, idle tallgrass, tallgrass hayland, tallgrass pasture, tame pasture	Used short cover (35% cover at 1 cm and 10% cover at 25 cm); were most common in heavily grazed oldfields
Stewart 1975	North Dakota	Cropland, grassland edge, woodland edge	Were common along field and prairie edges and along shelterbelts and weedy fencerows in cropland areas; occurred in thickets, scattered small trees and shrubs, patches of coarse forbs and/or weeds contiguous with tracts

			of cropland, hayland, or open prairie; nested on ground in sparse to fairly dense herbaceous vegetation
Sutter and Brigham 1998	Saskatchewan	Mixed-grass pasture, tame pasture	Abundance did not significantly differ between native mixed-grass and crested wheatgrass (*Agropyron cristatum*)
Sutter et al. 2000	Saskatchewan	Mixed-grass pasture	Abundance in mixed-grass prairie was twice as high along roadsides than along trailsides
Volkert 1992	Wisconsin	Burned tallgrass (restored), idle tallgrass (restored)	Occurred after a burn in an area that had been reseeded 3 yr previously; reached highest abundance the next year but declined to zero by the 5th yr postburn
Whitmore 1979	West Virginia	Idle tame	Territories upon spring arrival were characterized by 17% basal area cover of grass, 6% forb cover, 53% litter cover, 44% bare ground, 1 cm litter depth, 8 cm forb height, and 26 cm effective vegetation height; territories during peak breeding season were characterized by 6% basal area cover of grass, 14% forb cover, 56% litter cover, 44% bare ground, 1 cm litter depth, and 14 cm forb height
Wiens 1969	Wisconsin	Idle pasture, tame pasture	Observed in dry, upland pasture with sparse grass and forb cover; average territory size of five territories was 0.88 ha; all territories were along fence lines and were characterized by 96% grass cover, 30% forb cover, and 3% bare ground; for 5 territories, mean distance from territory boundary to woods was 246 m, to fence line was 0 m, and to cultivated field was 69 m; all territories contained fence posts and fence lines
Wiens and Rotenberry 1981	Nevada, Oregon	Idle shrubsteppe	Density was positively and significantly correlated with diversity of coverage in plant structural types; abundance was positively and significantly correlated with cover of green rabbitbrush (*Chrysothamnus viscidiflorus*) and antelope bitterbrush (*Purshia tridentata*)

Wilson and Belcher 1989	Manitoba	Idle mixed-grass, idle tame	Abundance was positively correlated with tame vegetation and negatively correlated with native vegetation
Wray and Whitmore 1979	West Virginia	Idle tame	Successful nest sites were characterized by higher vertical vegetation density, more litter cover, and less bare ground than unsuccessful nest sites
Yahner 1982	Minnesota	Woodland	Were most common in the midstory and ground strata of shelterbelts; no tree or shrub preference was observed

* In an effort to standardize terminology among studies, various descriptors were used to denote the management or type of habitat. "Idle" used as a modifier (e.g., idle tallgrass) denotes undisturbed or unmanaged (e.g., not burned, mowed, or grazed) areas. "Idle" by itself denotes unmanaged areas in which the plant species were not mentioned. Examples of "idle" habitats include weedy or fallow areas (e.g., oldfields), fencerows, grassed waterways, terraces, ditches, and road rights-of-way. "Tame" denotes introduced plant species (e.g., smooth brome [*Bromus inermis*]) that are not native to North American prairies. "Hayland" refers to any habitat that was mowed, regardless of whether the resulting cut vegetation was removed. "Burned" includes habitats that were burned intentionally or accidentally or those burned by natural forces (e.g., lightning). In situations where there are two or more descriptors (e.g., idle tame hayland), the first descriptor modifies the following descriptors. For example, idle tame hayland is habitat that is usually mowed annually but happened to be undisturbed during the year of the study.

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Appendix 1. Summary of Vesper Sparrow use of agricultural habitats in Iowa.

Territory characteristics for Vesper Sparrows inhabiting fence rows between cropland were examined in Iowa (Rodenhouse 1981, Best and Rodenhouse 1984, Perritt 1987, Perritt and Best 1989). Territories were located linearly along fence rows and included areas of the cropland adjacent to the fence rows; only one territory studied did not include a fence row (Rodenhouse 1981). Centers of fields were rarely used by Vesper Sparrows because territories did not extend >80 m into fields. Paired males had more shrub groups (one or more shrubs or saplings forming a contiguous canopy) and more corn residue within their territories than did unpaired males. Males that arrived earlier in the breeding season had more shrubs in their territories and greater fence row coverage than those arriving later in the season. Only along herbaceous fence rows were portions of fence rows unoccupied by Vesper Sparrows, as opposed to fence rows with shrubs or saplings. Preferred territories had structurally diverse vegetation and high plant species richness. Of eight territories without a successful nest, six did not contain a wash (eroded areas in watercourses caused by cultivation); 11 territories with two successful nests contained an average of 1.1 washes (Best and Rodenhouse 1984). No territory preference, however, was exhibited for washes, perhaps because they did not exist at the time of territory selection for most Vesper Sparrows. During the last month of the breeding season, washes provided the only open habitat and were used heavily for nesting. Perritt (1987) found that there were fewer cultivations in territories with one successful nest and more cultivations in territories with no or two successful nests. Nest success may have been influenced by the interaction between number of cultivations and the type of crop planted within territories. Territories of pairs with no or one successful nest contained 50% soybean and 50% corn. Territories of pairs with two successful nests contained a higher proportion of soybeans, possibly because canopy closure occurred later in soybeans than in corn. The most successful breeding pairs experienced frequent disturbance from cultivation early in the breeding season but were able to overcome this because of the amount of soybeans in the territories. Territory size was smallest in territories with two successful nests than in territories with no or one successful nest. Territory size was negatively correlated with percentage of territory planted to soybeans and positively correlated with territory width perpendicular to the fence row.

Rodenhouse (1981) found that nest placement changed seasonally. Before spring tillage, Vesper Sparrows built nests near clumps of crop residue and within fields with high amounts of crop residue. On plowed fields with little residue, nesting sites were scarce until plants developed (Rodenhouse and Best 1983). After spring tillage operations, which destroyed some of the initial nests, subsequent nests were placed on the side of the fence row that was not the most recently tilled. After plants grew to 10 cm tall, nests were placed at the base of the growing plants. About 50% of the nests survived subsequent field operations. Later in the season, when the crop canopy had closed, nests were placed in washes. As the breeding season progressed and crop fields became more heavily vegetated, washes provided the only open areas for nesting. Early nests (initiated before 23 May) were placed closer to nonproductive areas (i.e., grassed waterways, washes, and weedy areas) than mid-season nests (initiated between 23 May and 19 June) that were built after initial nests had been destroyed (Rodenhouse and Best 1983). Insect populations may have been higher in nonproductive areas than in either fence rows or crops early in the breeding season, whereas the insect community was developing in cropland later in the breeding season. Also, the probability increased that a mid-season nest would be destroyed the closer the nest was to a nonproductive area (Rodenhouse 1981). This did not hold true for parasitized nests. Late nests (initiated after 19 June) were placed close to nonproductive areas,

particularly fence rows and washes (Rodenhouse and Best 1983). Nests were usually in soybean fields because soybean plants concealed some nests and provided cover for adults approaching the nests, which were on sparsely vegetated areas.

Perritt and Best (1989) reported that reproductive success was greater in a wet year than in a dry year because of fewer cultivations and a longer breeding season due to late canopy closure and presence of more nonproductive areas. However, reproductive success may still not have been high enough to maintain a stable population. Under average climatic conditions, reproductive success was less than replacement rate (Rodenhouse and Best 1983). Low nesting success before mid-June was mostly attributed to nest destruction by agricultural field operations such as seedbed preparation, use of a rotary hoe for weed control after planting, or by cultivation. Through 15 June, 21% of 29 nests were successful in corn and soybean fields; after that date, 44% of 16 nests were successful. Through 15 June, 17% of 29 nests were parasitized; 0 of 16 nests were parasitized after 15 June. Overall, of 45 nests, 11% were parasitized, 27% were destroyed by farm implements, 29% were destroyed by depredation, and 4% were destroyed by weather (Rodenhouse and Best 1983).

Throughout the breeding season, Vesper Sparrows foraged in or near uncropped or weedy areas within their territories (Rodenhouse and Best 1994). In April and May, 68% of 1055 foraging observations occurred in or within 1 m of an uncropped or weedy area. In June, foraging occurred in corn fields and in washes; crops concealed bird movement. In July and early August, half of 1996 observations occurred in or <6 m from uncropped or weedy areas. Large areas within cropped areas, especially those areas >50 m from an uncropped or weedy area, were avoided. There were no differences in foraging patterns between males and females. Throughout the breeding season, pairs preferred to forage in fields with the most crop residue. The authors theorized that Vesper Sparrows preferred areas with more remaining residue because these fields had higher song perches, more concealment cover, and contained more arthropods.

Nest densities were higher in strip cover than in fields of no-tillage corn or tilled corn (Basore et al. 1986). Strip cover consisted of waterways, terraces, fence rows, and roadside ditches. In no-tillage fields, Vesper Sparrows chose nest sites with less residue than that found in the field overall. Vesper Sparrows also nested along gravel roads situated between corn and/or soybean fields (Camp and Best 1994). Of seven nests, all were located on the foreslope (defined as the slope of the roadside between the road and the bottom of the ditch) where mowing and gravel kept the vegetation short. Nest densities were positively correlated with amount of bare ground and negatively correlated with vegetation density and vegetation height.

Stallman and Best (1996) investigated a system of strip intercropping, in which rowcrops, legumes, and small grains are planted in a series of adjacent, narrow strips. Vesper Sparrows preferred nesting in corn or soybean strips over oat strips. They placed nests under clumps of vegetation or crop residue. All nests in corn strips were placed under weeds, whereas there appeared no preference for nest location in soybean strips. Territories were in areas with elevated song perches and abundant food. About 40% of the nests were located >80 m from fencerows.

Gremaud (1983) found that although abundance was similar in corn, soybean, and alfalfa stubble in one year, abundance was significantly higher in alfalfa stubble than in corn or soybean stubble the following year. Abundance was significantly correlated with percent litter cover in corn stubble. Abundance was not correlated with percent litter cover in soybean stubble, waste

corn abundance, weed seed density, or distance to pasture or brushy habitats; abundance increased as distance to woodlots and to alfalfa haylands increased.