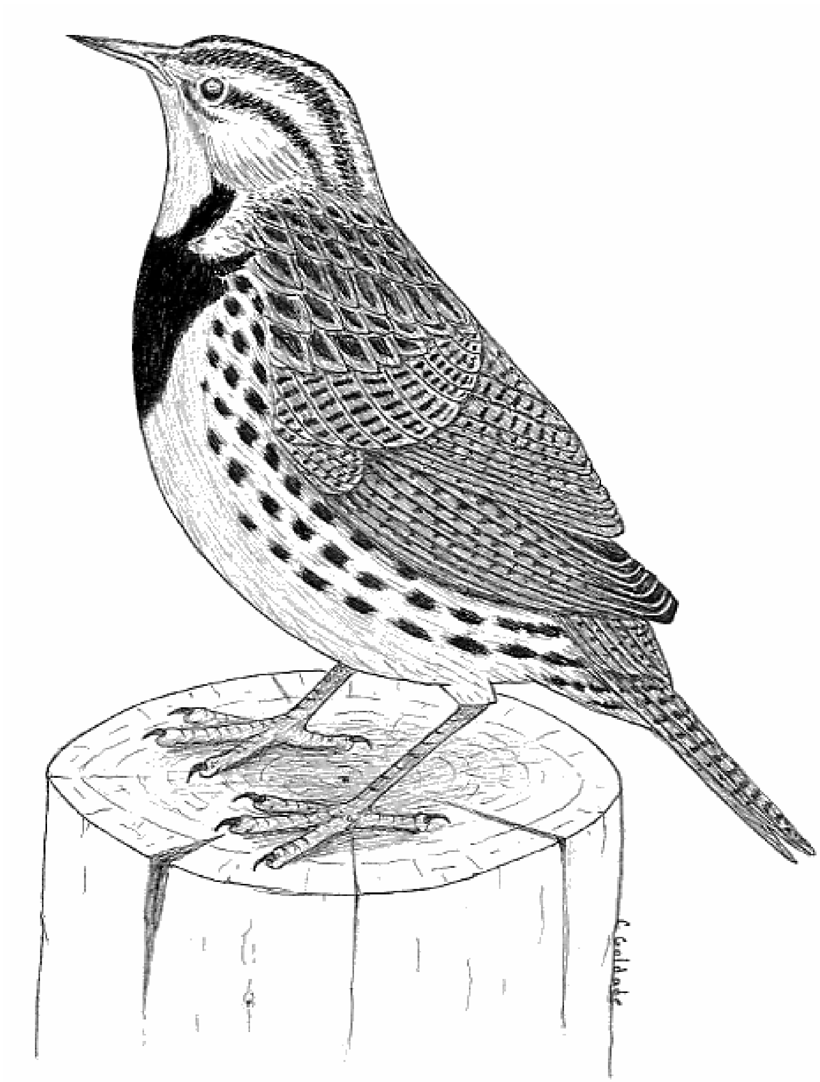
EFFECTS OF MANAGEMENT PRACTICES ON GRASSLAND BIRDS:

EASTERN MEADOWLARK



Grasslands Ecosystem Initiative
Northern Prairie Wildlife Research Center
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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

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EASTERN MEADOWLARK

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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and effects of habitat management on grassland birds were summarized from information in more than 4,000 published and unpublished papers.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.

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EASTERN MEADOWLARK

(*Sturnella magna*)

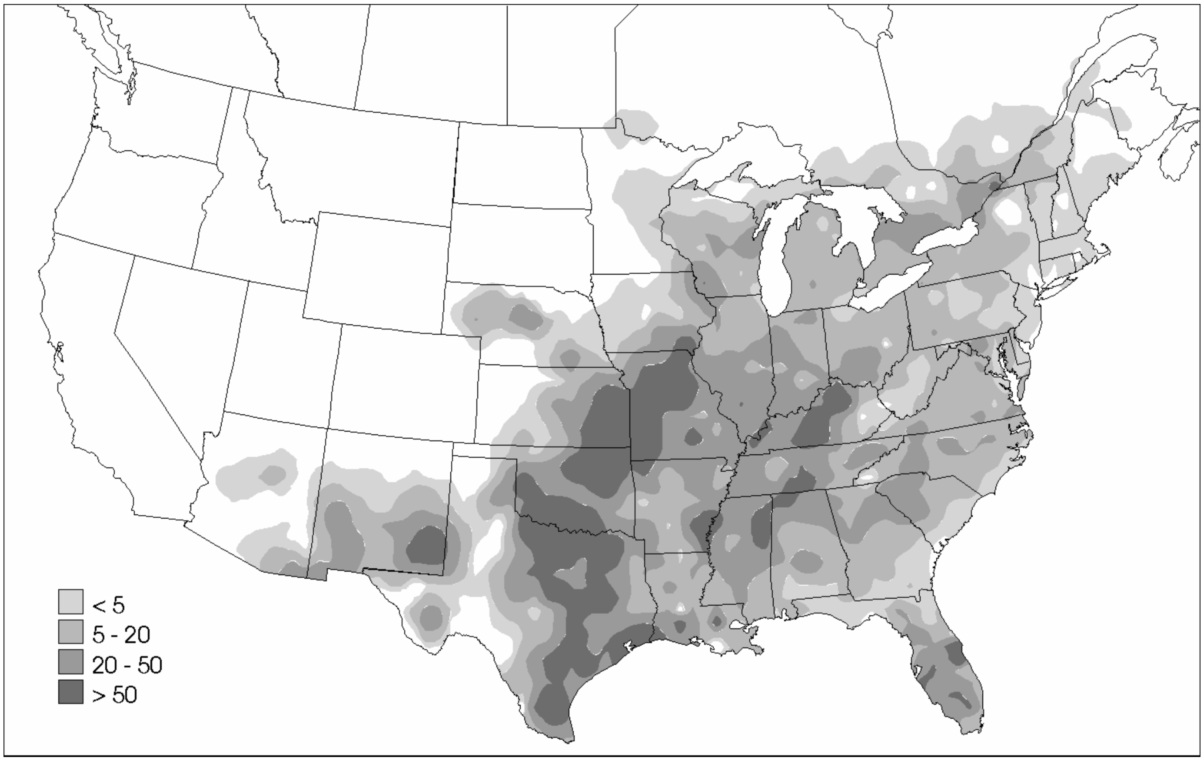

Figure. Breeding distribution of the Eastern Meadowlark in the United States and southern Canada, based on Breeding Bird Survey data, 1985-1991. Scale represents average number of individuals detected per route per year. Map from Price, J., S. Droege, and A. Price. 1995. The summer atlas of North American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

Keys to management are providing large areas of contiguous grassland of intermediate height with significant grass cover and moderate forb density.

Breeding range:

Eastern Meadowlarks breed from southern Ontario, eastern Minnesota, Iowa, extreme southwestern South Dakota, Nebraska, and extreme northeastern Colorado, east to Quebec, New Brunswick, and Nova Scotia, south throughout the eastern United States to Texas, and west to Arizona, Oklahoma, and eastcentral Kansas (National Geographic Society 1999). (See figure for the relative densities of Eastern Meadowlarks in the United States and southern Canada, based on Breeding Bird Survey data.)

Suitable habitat:

Eastern Meadowlarks prefer moderately tall grasslands with abundant litter cover, high proportion of grass, moderate to high forb density, and low coverage of woody vegetation (Wiens 1969, 1974; Roseberry and Klimstra 1970; Rotenberry and Wiens 1980; Skinner et al. 1984; Sample 1989; Bollinger 1995; Evrard and Bacon 1995; Lanyon 1995; Granfors et al. 1996; Hull et al. 1996; Klute et al. 1997). Eastern Meadowlarks utilize grasslands of various types such as tallgrass prairie (Easterla 1962, Eddleman 1974, Johnsgard 1979, Rotenberry and Wiens 1980, Zimmerman and Finck 1983, Herkert 1991*a*), semidesert grassland (Bock et al. 1986), and planted cover, such as Conservation Reserve Program (CRP) fields (Welsh and Kimmel 1991, Hull 1993, Delisle and Savidge 1995, King and Savidge 1995, Granfors et al. 1996, Hull et al. 1996, Best et al. 1997, Klute et al. 1997, Robel et al. 1998, McCoy et al. 1999, Swanson et al. 1999), dense nesting cover (Sample 1989), Waterfowl Production Areas (Niesar 1994), Wildlife Production Areas (Caito 1993), and federal Soil Bank Program fields (Roseberry and Klimstra 1970). Eastern Meadowlarks also inhabit pastures (Wiens 1969, Roseberry and Klimstra 1970, Rotenberry and Wiens 1980, Skinner et al. 1984, Kahl et al. 1985, Sample 1989, Klute 1994, Granfors et al. 1996, Klute et al. 1997), haylands (Graber and Graber 1963, Roseberry and Klimstra 1970, Kahl et al. 1985, Sample 1989, Bollinger 1995), and reclaimed surface mines (Whitmore 1980). Gross (1965) reported that Eastern Meadowlarks are found in grasslands, haylands, croplands, orchards, grassed islands among plowed fields, stubble, and pastures but are generally absent from woodland or shrubland. In Wisconsin, Eastern Meadowlarks were considered habitat generalists and were found in a variety of habitats from oldfields to wet prairies to small-grain fields (Sample 1989, Sample and Hoffman 1989, Mossman and Sample 1990). In Wisconsin and Minnesota, Faanes (1981) found Eastern Meadowlarks in hayfields, oak savannahs, overgrazed pastures, oldfields, and shrub carr wetlands. Eastern Meadowlarks were found in Wisconsin cranberry (*Vaccinium macrocarpon*) beds, but not in impoundments (Jorgensen and Nauman 1993). In Kansas and Nebraska, meadowlarks used floodplain prairie and wet meadows (Johnsgard 1979, Cink and Lowther 1989, Faanes and Lingle 1995, Helzer 1996, Helzer and Jelinski 1999). In Ontario, meadowlarks used weedy meadows surrounding a marsh (Boyer and Devitt 1961). In Arkansas, they were present in hayland and fields of burned and unburned broomsedge (*Andropogon virginicus*) but were not present in oldfields, red cedar (*Juniperus virginiana*) glades, forest edges, or forests (Shugart and James 1973).

Eastern Meadowlarks occasionally breed in agricultural areas such as rowcrop fields (Best et al. 1997; Eastern Meadowlarks and Western Meadowlarks [*Sturnella neglecta*] combined), small-grain fields (Dambach and Good 1940, Johnsgard 1979, Sample 1989), grassed waterways (Bryan and Best 1991), farmstead shelterbelts (Yahner 1982), and herbaceous fencerows (Best and Hill 1983). In a multi-state midwestern study comparing bird use between CRP and cropland, abundance of meadowlarks (Eastern and Western meadowlarks combined) in CRP was greater than or equal to abundances in cropland in all of the six states studied (Best et al. 1997). In Indiana, Eastern Meadowlarks were more abundant in no-tillage fields (fields untilled between harvest and planting with seed planted directly into crop residue) than in conventionally tilled (fields tilled in the spring prior to planting) fields (Castrale 1985). Eastern Meadowlarks also have been found along roadsides, in orchards, golf courses, airports (Lanyon 1995), and in colonies of Gunnison's prairie dogs (*Cynomys gunnisoni*) (Clark et al. 1982).

Where populations of Eastern and Western meadowlarks are sympatric in the Great Plains, Eastern Meadowlarks are found in wet lowland areas, such as valleys and river bottoms, whereas Western Meadowlarks are found in dry uplands (Lanyon 1956*a*, 1957; Dinsmore et al. 1984). In desert grasslands, a reversal of the two species' usual ecological relationship occurs; Western Meadowlarks inhabit irrigated land and Eastern Meadowlarks inhabit arid, natural grassland (Lanyon 1962).

The Habitat Suitability Index (HSI) for Eastern Meadowlark is a model based on suspected species-habitat relationships, but cause and effect relationships are untested (Schroeder and Sousa 1982). The HSI indicated that optimal habitat contained dense grasses of moderate height (12.5-35 cm), low shrub cover (<5%; >35% was too dense), low forb cover, and adequate perches. Optimal total herbaceous (including grass) cover was >90%, whereas <20% was inadequate as nesting habitat. Optimal proportion of herbaceous cover that was grass was >80%, whereas <20% was inadequate as breeding habitat. Variation in canopy height was desirable, because ideal vegetation heights for foraging and loafing were between 10 and 30 cm. Ideal vegetation heights for nesting were between 25 and 50 cm. Optimal conditions for the species probably were met where most of the habitat was suitable for foraging and loafing. Average vegetation heights <2.5 cm or >76 cm were unsuitable. Hays and Farmer (1990) modified the HSI by eliminating distance-to-perch as a variable and adding mean height of herbaceous canopy in mid-spring (estimated by averaging pregreenup and mid-summer visual obstruction readings [VOR] and then converting VOR into height).

Although Eastern Meadowlarks inhabit both native and tame grasslands, no consistent pattern of preference between the two grassland types has been documented (Hayden 1985, Walk and Warner 1999). In Minnesota, Eastern Meadowlarks were found only in tame grasslands of Waterfowl Production Areas but not in brushy (woody vegetation ≤1.5 m tall) or native grasslands (Niesar 1994). In Illinois, Eastern Meadowlarks were found on both upland prairie and areas planted to Kentucky bluegrass (*Poa pratensis*), although densities were higher on upland prairie (Birkenholz 1973). Grass height, ground cover, and litter depth were similar in both habitats, but native prairie had higher soil moisture, more foliage cover, and greater variation in grass height than areas of Kentucky bluegrass. In another Illinois study, Eastern Meadowlarks were present in both tame and native grasslands (Walk and Warner 1999). In Missouri, Eastern Meadowlarks were found in prairie fragments as well as in pastures planted to tame grasses (Hayden 1985). In Missouri CRP fields planted either to monocultures of native switchgrass (*Panicum virgatum*) or to a mixture of tame grass species, meadowlarks (Eastern and Western meadowlarks combined) were more abundant in tame fields than in native fields, presumably due to lower vegetation height in tame fields (McCoy 1996). Likewise, in Ohio Wildlife Production Areas, Eastern Meadowlarks were more abundant in areas planted to tame grasses than in areas planted to monocultures of native switchgrass (Caito 1993). Vegetation height was lower and vegetation diversity was higher in tame WPAs than in switchgrass although no relationships between Eastern Meadowlark density and vegetation height or vegetation diversity were found. In a study of tame and native CRP fields, native prairie, and sorghum fields in Nebraska, Eastern Meadowlarks were found only in native prairie, possibly because CRP vegetation was tall and dense and did not provide adequate perch sites (King and Savidge 1995). However, in another CRP study in Nebraska, meadowlark (Eastern and Western meadowlarks combined) abundances were similar between CRP fields planted to a mixture of native grasses and CRP fields planted to tame grasses (Delisle 1995, Delisle and Savidge 1997). In Pennsylvania, there was no difference in abundance between tame and seeded native (restored) grasslands (Davies 1997). In southeastern Arizona, Eastern Meadowlarks were more abundant in areas of native grasses than areas planted to tame grasses (Bock et al. 1986, Bock and Bock 1988). Tame grasslands had significantly lower coverage of native grasses, herbs, and shrubs, and similar coverage in bare ground than in native grasslands.

The response of Eastern Meadowlarks to vegetation structure varies among studies. Wiens (1974) reported that the highest densities of Eastern Meadowlarks in tallgrass prairie occurred where vegetative heterogeneity was low. In Oklahoma, densities of Eastern Meadowlarks were higher in moderately grazed, vegetatively heterogeneous tallgrass than ungrazed, vegetatively homogeneous tallgrass (Risser et al. 1981). In Kansas, Zimmerman

(1992) reported that areas with the highest vegetative heterogeneity supported the highest densities of grassland bird species, including the Eastern Meadowlark. Also in Kansas, meadowlark (Eastern and Western meadowlarks combined) abundance was greatest in CRP fields that had the highest occurrence of forbs (Hull 1993, Hull et al. 1996). Within tallgrass prairie, abundance of Eastern Meadowlarks was positively correlated with grass and litter cover, maximum and effective vegetation height, litter depth, and total vegetation contacts (Rotenberry and Wiens 1980). Abundance was negatively correlated with percent bare ground, variation in total number of vegetation contacts, variation in litter depth, and variation in forb and shrub heights. In Illinois tallgrass, density of Eastern Meadowlarks was positively correlated with percent vegetation contacts of living vegetation and negatively correlated with grass height, total vegetation height, and total number of vegetation contacts of grasses, forbs, and dead vegetation (Herkert 1991*a*). Density was negatively correlated with total vegetation species richness, abundance of forbs and shrubs, and a structural heterogeneity index (described as either high or low variability in litter depth, vegetation height, and vegetation density). However, in Missouri, density of Eastern Meadowlarks was not influenced by vegetation characteristics (Winter 1998, Winter and Faaborg 1999). In CRP fields in Missouri, presence of meadowlarks (Eastern and Western meadowlarks combined) was negatively correlated with percent canopy cover of dead vegetation (McCoy 1996). Abundance was positively correlated with percent grass canopy cover and length of pasture/hayland edge; abundance was negatively correlated with vertical obstruction values, core area of hay within 1 km, litter cover, and core grassland area within 1 km. Core area was defined as area of grassland >50 m from a non-CRP edge. Within native and tame CRP fields in Nebraska, meadowlark (Eastern and Western meadowlarks combined) abundance was negatively correlated with litter depth (Delisle 1995, Delisle and Savidge 1997). In Minnesota, meadowlark (Eastern and Western meadowlarks combined) abundance was positively correlated to percent of land in grass cover (Kimmel et al. 1992).

In Maine, abundance was positively correlated with taller grass and low-growing (0-60 cm) shrub cover and negatively correlated with tall (60-200 cm) shrub cover (Vickery et al. 1994). In New York hayland, abundance of Eastern Meadowlarks increased linearly with field age (Bollinger 1988, 1995). Abundance was positively associated with plant-species richness and negatively associated with percent vegetation cover, vegetation patchiness, and percent cover of birdsfoot trefoil (*Lotus corniculatus*). As fields aged, plant diversity and patchiness increased whereas vegetation height decreased. In southeastern Arizona, abundance was positively correlated with shrub cover (Bock and Bock 1992).

Song perches, such as natural wood substrates or human-created posts, are used by Eastern Meadowlarks (Wiens 1969, Harrison 1977, Kahl et al. 1985). Although Eastern Meadowlarks tend to avoid areas with heavy woody invasion, they tolerate the presence of some woody vegetation and occasionally sing from woody perches (Kahl et al. 1985, Sample 1989). Perches either may be located around the periphery, or within suitable habitat, but average distance between suitable cover and perch sites should be <30 m, based on the HSI (Schroeder and Sousa 1982). Harrison (1977) reported that Eastern Meadowlarks preferred artificial perches that were 2 m tall over artificial perches that were 1.5 m tall. Vickery and Hunter (1995) reported that Eastern Meadowlarks used artificial song perches but that the additional perch sites did not increase meadowlark density. In Missouri, areas at song perches had few woody stems <2.5 cm diameter at breast height (dbh) and no woody stems ≥2.5 cm dbh, dense (>90%) ground vegetation, and moderate to dense (>65%) litter coverage (Kahl et al. 1985).

Eastern Meadowlarks nest on the ground (Roseberry and Klimstra 1970, Lanyon 1995) in litter or under dense, overhanging grasses (Easterla 1962, Wiens 1969). In Kansas, nest sites (0.25 m^2 around the nest) in tallgrass hayland had significantly less bare ground than the area 1-10 m around the nest sites (Jensen 1999). In Kansas, Granfors et al. (1996) found that Eastern Meadowlarks selected nest sites with significantly greater litter cover and litter depth, a higher proportion of grass, and more structural homogeneity than available on random plots. In Wisconsin Waterfowl Production Areas, nest density was negatively correlated with spring and summer VOR (Evrard and Bacon 1995). In Illinois, average height of cover at 204 nests was 38 cm tall, with 67% of nests in cover 25-51 cm tall (Roseberry and Klimstra 1970). Presence of dead grass stems and absence of woody vegetation appeared to be important nesting habitat requirements. Few nests were found in wheat, fallow, or idle areas because of lack of good grass cover in the first two habitats and invasion of woody plants in the latter habitat. Of 307 nests, 65% were in pasture (0.5 nests/ha), 17% in hayland (0.3 nests/ha), 8% in fields enrolled in the federal Soil Bank Program (0.1 nests/ha), 7% in idle fields (0.1 nests/ha), 2% in fallow fields (0.1 nests/ha), and 1% in winter wheat (0.1 nests/ha). Under the Soil Bank Program, enrolled fields were no longer cultivated and were seeded to grasses; mowing (i.e., cutting grass) was allowed but grazing and haying (i.e., harvesting mown grasses for use as animal feed) were not allowed. Of 220 nests, 44.5% were partially concealed from above, 38.2% had full canopy coverage, and 17.3% were open from above. Path rush (*Juncus tenuis*), cheatgrass (*Bromus secalinus*), meadow fescue (*Festuca elatior*), Canada bluegrass (*Poa compressa)*, Kentucky bluegrass (*P. pratensis*), Japanese clover (*Kummerowia striata*), and Korean lespedeza (*Lespedeza stipulacea*) were commonly used in constructing the nest bowl. In Missouri, Eastern Meadowlarks nested in grasslands of short to moderate stature (about 50% cover 1 cm above ground and about 20% cover 25 cm above ground) that were moderately to heavily grazed (Skinner et al. 1984). Nests usually were located under clumps of grasses or forbs.

Roseberry and Klimstra (1970) observed that nests in Illinois were built on slopes more often than on crests of hills or in valleys. Of 350 nests, 48.9% were oriented north, northeast, or east. In Wisconsin, Wiens (1969) found that nests were oriented north and east. Similarly, in Wisconsin, Lanyon (1957) found that 55% of 64 nests were oriented north, east, or northeast. Orientation of nests was predominantly northeast and was not correlated with position within territory or location of song perches (Lanyon 1995). Lanyon (1957) attributed the orientation to the effect of prevailing winds that depressed vegetation to the north and east, an explanation also accepted by Roseberry and Klimstra (1970). A table near the end of the account lists the specific habitat characteristics for Eastern Meadowlarks by study.

Area requirements:

Eastern Meadowlarks have multipurpose territories (i.e., defended areas in which feeding, mating, and rearing of young occur) (Lanyon 1995) but prefer large grassland areas over small areas for breeding (Herkert 1994*a*,*b*; Vickery et al. 1994, O'Leary and Nyberg 2000). In Wisconsin, Wiens (1969) reported an average territory size of 2.3 ha for 18 territories. Also in Wisconsin, Lanyon (1956*b*, 1957) reported a range of 1.2-6 ha for an unspecified number of territories, with most between 2.8-3.2 ha. In Oklahoma, two territories in tallgrass pasture averaged 2.0 ha (Wiens 1971). Francq (1972) reported territory sizes ranging from 1.2 to 4.8 ha; large (size not given) territories were in open, grazed grassland with few trees and shrubs, whereas small (size not given) territories were in ungrazed grassland with lush ground cover and numerous scattered trees. In Missouri (Winter and Faaborg 1999) and New York (Bollinger

1995), Eastern Meadowlarks were not considered area sensitive because density was not influenced by patch size. In Missouri, Eastern Meadowlarks also were not found to be affected by composition of the surrounding landscape, such as edge density; distance to another patch of grassland or forest; or cover, patch size, or core area (>50 m from an edge) of grassland or forest (Winter 1998). In Illinois, however, Eastern Meadowlarks were considered moderately sensitive to habitat fragmentation (Herkert et al. 1993). Density of Eastern Meadowlarks was positively associated with area (Herkert 1991*a*). Area required for Eastern Meadowlarks was estimated at 5 ha, in which area required was defined as the "area at which a species' probability of occurrence equals 50% of its maximum" (Herkert 1994*a*). In Maine, density was positively affected by an increase in area; Eastern Meadowlarks reached <40% incidence at 500 ha in grassland barrens (Vickery et al. 1994).

For Eastern Meadowlarks, no studies have investigated a relationship between patch size and nest success or patch size and rates of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*). In Kansas, Eastern Meadowlarks that nested ≤100 m from woodland edges experienced significantly higher rates of parasitism by Brown-headed Cowbirds (Jensen 1999). Mean nest distance from agricultural edges was about 44 m, and mean nest distance from woodland edges was about 50 m. In Kansas, successful nests were not farther from edge than unsuccessful nests, but nest success was low throughout the study area (Granfors et al. 1996). Edge was defined as a fenceline, change in type of vegetation cover, road, or pond. In Nebraska, King and Savidge (1995) found no difference in abundance between landscapes composed of about 20% CRP within 23 km^2 blocks of agricultural land and landscapes composed of <5% CRP.

Brown-headed Cowbird brood parasitism:

Rates of Brown-headed Cowbird parasitism vary from 0% of 27 nests (S. D. Hull, *unpublished data*) to 70% of 40 nests (Elliott 1978). Refer to Table 1 in Shaffer et al. (2003) for rates of cowbird brood parasitism. Eastern Meadowlarks may be multiply-parasitized (Eifrig 1919, Francq 1972, Elliott 1976, Granfors 1992), and will occasionally abandon nests due to cowbird brood parasitism (Roseberry and Klimstra 1970; Elliott 1976, 1978).

Breeding-season phenology and site fidelity:

Eastern Meadowlarks occur year-round throughout most of their range (Lanyon 1995). Migrants in the northern portions of the species' range generally arrive on the breeding grounds from early January to late May and depart for the wintering grounds from early August to late December (George 1952, Batts 1958, Gross 1965, Beason 1970, Harrison 1974, Johnsgard 1980, Faanes 1981, Janssen 1987, Lanyon 1995, Kent and Dinsmore 1996).

Breeding occurs from late March to August (Lanyon 1995). Peak breeding season ranges from early May in Kansas and southern Illinois to mid-May in Wisconsin, New York, and Massachusetts (Roseberry and Klimstra 1970). The earliest recorded date of egg laying in southern Illinois was 14 April (Roseberry and Klimstra 1970). Eastern Meadowlarks often are double-brooded (Lanyon 1956*b*, 1957; Easterla 1962; Gross 1965; Wiens 1969; Roseberry and Klimstra 1970; Francq 1972; Johnsgard 1979), especially when the first nest is started early in the nesting season (Roseberry and Klimstra 1970). Unsuccessful females will attempt to renest, often many times, within a single season (Lanyon 1956*b*, 1957; Easterla 1962).

Both sexes exhibit site fidelity to previous breeding areas (Lanyon 1956*b*, 1957, 1995). Over a 3-yr period, 8 of 14 banded males returned to the area where they had been banded; only one did not return to his former territory (Lanyon 1957, 1995). None of the six males that failed to return were located in a 1.6-km zone around the study area; they were presumed to have died. Twelve of 22 banded females returned, with only three failing to return to the previous year's territory. Two of the three moved because no males occupied the territory, and one moved because the previous year's territory was now defended by a Western Meadowlark.

Eastern Meadowlarks may be polygynous (Wiens 1969; Lanyon 1957, 1995). In Ontario, Knapton (1988) found that nest success of polygynously mated females was significantly higher than monogamously mated females.

Species' response to management:

The response of Eastern Meadowlarks to prescribed fire varies across their range. In the Flint Hills of northeastern Kansas, relative abundances were not affected by burning in moist years, but may be reduced in drought years (Zimmerman 1992). Relative abundances between annually spring-burned tallgrass, tallgrass burned at less frequent intervals (interval length not given), and unburned tallgrass did not differ (Zimmerman 1993, 1997). However, there was a significant difference in mean production of young/attempted nest between burned and unburned prairie (Zimmerman 1997). In CRP fields in eastern Kansas, abundance of meadowlarks (Eastern and Western meadowlarks combined) was similar on unburned and burned CRP (Robel et al. 1998). Abundance was not significantly different between year of burn and 1 yr later, but abundance was higher in year of burn than 2-4 yr later. Also in eastern Kansas, meadowlark (Eastern and Western meadowlarks combined) abundance in tallgrass pasture was greater in CRP planted to native grasses, probably as a result of greater forb and insect abundance and lower vegetative height in pasture than in CRP (Klute 1994, Klute et al. 1997). Both CRP and native pastures were burned annually in spring. In Oklahoma, number of nests, clutch size, and number of young fledged from successful nests did not differ significantly between idle tallgrass plots and plots that were burned and/or grazed (Rohrbaugh et al. 1999). Fewer nests were found on undisturbed plots in the second and third year of the study than in the first year, possibly due to increased vegetation density caused by lack of fire or grazing. Nesting success was significantly higher on undisturbed plots in the brood-rearing period but did not vary significantly during the incubation and combined periods. In Illinois restored and native grasslands, Eastern Meadowlarks showed no preference among areas that were burned, hayed, high-mowed (stubble >30 cm tall remains on the field), or idled (Westemeier and Buhnerkempe 1983). Also in Illinois, abundances did not differ 1-3 yr postburn (Herkert 1994*b*). In Missouri, density of Eastern Meadowlarks was not affected by time since it was last burned or hayed, although density tended to be lower in areas 1 yr postburn than in areas >1 yr postburn (Winter 1998). In Wisconsin, Eastern Meadowlarks appeared on a restored prairie 3 yr after it was reseeded, which also was the year that it had been burned (Volkert 1992). In native grassland in Arizona, Eastern Meadowlarks were more abundant in unburned than in burned fields; burned fields had less grass and shrub cover and more herb cover and bare ground than unburned fields (Bock and Bock 1988). Meadowlarks preferred burned, native floodplain grasslands of sacaton grass (*Sporobolus wrightii*) over unburned grasslands; burned sacaton grasslands had significantly lower coverage of sacaton grass, no difference in coverage of other grasses, and higher herb cover and bare ground than unburned sacaton grasslands. In another Arizona study at the same study site, Eastern Meadowlark abundance was significantly lower 1 yr postfire on native grassland compared to unburned native grassland (Bock and Bock 1992). No differences in abundance between burned and unburned tame grasslands were detected. Abundance was positively correlated with shrub cover; Eastern Meadowlarks were observed singing from shrubs and probably avoided areas where fire reduced shrub coverage.

Mowing may be detrimental to Eastern Meadowlarks during the breeding season due to nest destruction. In Kansas, mowing caused nest failure and in some cases abandonment of mowed fields (Granfors 1992). Mowing destroyed 32 of 182 nests in Illinois hayfields (Roseberry and Klimstra 1970). In Michigan, Eastern Meadowlarks successfully fledged one brood before mowing occurred, but ceased breeding activities in those fields after the fields were mowed (Harrison 1974). For Eastern Meadowlarks nesting at rural Illinois airports, nest success decreased as mowing frequency and percent grass cover increased (Kershner and Bollinger 1996). Nest success increased as percentages of cover by clover (scientific name not given) and other forbs increased. Mowing was the primary disturbance responsible for low nest productivity. The authors suggested that rural airports may be ecological traps because nest density of Eastern Meadowlarks was high but nest success was low. Mowed fields continued to be used as foraging sites. In Illinois hayfields, abundance of Eastern Meadowlarks was similar between mowed and unmowed areas (Herkert 1991*a*). Mowed sites were cut 1-4 mo before 1 May, whereas unmowed sites were uncut for at least 12 mo before 1 May. In another Illinois study, Eastern Meadowlarks preferred tame hayland composed of several grass species over hayfields of red clover (*Trifolium pratense*) or alfalfa (*Medicago sativa*) (Roseberry and Klimstra 1970). Alfalfa was not used in constructing the nest bowl; red clover was used but in conjunction with fine-stemmed grasses. Meadowlarks probably nested in clover because of grass invasion that provided some nesting cover, whereas alfalfa fields did not provide good grass cover. Hays and Farmer (1990) suggested that mowing can be beneficial to meadowlark (Eastern and Western meadowlarks combined) habitat, based on the HSI. They found that across the United States, emergency mowing (due to severe drought) of CRP fields enhanced the habitat suitability for meadowlarks by causing an increase in herbaceous canopy cover and in the proportion of grasses composing the herbaceous canopy the following year. Mowing also resulted in more grass cover than in unmowed fields.

The response of Eastern Meadowlarks to grazing varies across habitats. Eastern Meadowlarks usually respond positively to moderate grazing in grasslands of taller (heights not given) vegetation but respond negatively to heavy grazing in grasslands of shorter (heights not given) vegetation (Bock et al. 1993). In Missouri, Eastern Meadowlarks were observed in grasslands of short to medium (about 50% cover 1 cm above ground and about 20% cover 25 cm above ground) stature that were moderately to heavily grazed (Skinner et al. 1984). In Missouri and Oklahoma tallgrass prairie, density of Eastern Meadowlarks increased in response to moderate grazing (Skinner 1975, Risser et al. 1981). Also in Oklahoma tallgrass prairie, birds were more abundant in moderately grazed pastures than in idle pastures (Risser et al. 1981). The authors suggested that heavy grazing would reduce meadowlark density. The ungrazed field was characterized by dense, homogeneous vegetation cover, deep litter, and few emergent forbs. The grazed field was characterized by reduced vegetation cover and litter depth, increased vegetation heterogeneity, and greater density of emergent forbs. In another Oklahoma study, meadowlarks (Eastern and Western meadowlarks combined) nested more frequently in moderately grazed tallgrass pasture than in undisturbed prairie (Smith 1940). Heavily grazed sites were not used. In Kansas, Eastern Meadowlarks were common on moderately grazed pastures with open areas and mid-height (no values given) grasses (Eddleman 1974). In southwestern Wisconsin, Eastern Meadowlark territories were observed on ungrazed pastures but not on continuously grazed or rotationally grazed pastures (Temple et al. 1999). However, two nests were found on both ungrazed and continuously grazed pastures and five nests were found on rotationally grazed pastures. Ungrazed grasslands were neither mowed or 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 Illinois, Roseberry and Klimstra (1970) found that as grazing intensity increased, bird density decreased. Heavily grazed pastures were not suitable as Eastern Meadowlark habitat. The authors examined meadowlark use of lightly grazed and severely grazed pastures, of one field that had been ungrazed for 2 yr, and of a tame hayfield. Of 200 nests, 120 (0.3 nests/ha) were found on grazed areas and 80 (2.5 nests/ha) were found on the ungrazed field. A total of 51 nests (0.3 nests/ha) were found in tame hayland. In one 16-ha tame pasture, cattle grazed vegetation to heights ranging from 2.5 to 7.6 cm. Over 3 yr, eight nests were found. During a year when grazing was less intense, vegetation was more abundant and uniformly distributed, attaining heights of 12.7 cm. Eleven nests with eggs were found that year. Nests were built in the vegetation clumps. In another tame pasture, which was heavily grazed for 2 yr, three nests were found over both years combined. The next year, grazing pressure was reduced and 13 nests were found. In the following year, the pasture was reseeded to Kentucky bluegrass and meadow fescue and 12 nests were found. In the third and fourth years, no grazing occurred and 41 and 39 nests were found, respectively. In Kansas, Francq (1972) reported that of 14 nests in a pasture, three were destroyed due to trampling by cattle.

In Texas, Eastern Meadowlark abundance was greater in moderately grazed pastures than in heavily grazed pastures in both sandy loam and clay soils (Baker and Guthery 1990). In southeastern Arizona, abundance was similar between grazed and ungrazed upland native pastures (Bock et al. 1984, Bock and Bock 1988). Grazed grasslands had significantly lower grass and shrub cover, more bare ground, and no difference in herb cover than ungrazed grasslands (Bock and Bock 1988).

In Oklahoma, mortality of eight Eastern and Western meadowlarks due to insecticides was reported (Griffin 1959). In Maine, territory density of Eastern Meadowlarks decreased, and did not recover during the 8-yr duration of Vickery's (1993) study, after lowbush blueberries (*Vaccinium angustifolium*) were sprayed with the herbicide hexazinone at a rate of 4 kg/ha. Territory density appeared to be limited by herbicide-induced reduction in graminoid cover and increased blueberry cover.

Management Recommendations:

Promote greater forb density and diversity in managed grasslands (e.g., CRP, WPAs) to improve overall habitat quality and provide food sources such as insects (Hull 1993, Klute 1994, Niesar 1994, Hull et al. 1996, Klute et al. 1997). This may be accomplished by allowing natural succession to proceed or by interseeding forb species in grassland plantings (Klute 1994, Niesar 1994).

Limit the encroachment of woody vegetation (Sample 1989, Herkert 1994*a*, Winter 1998). Remove woody vegetation within and along the periphery of grassland fragments to discourage predators that may use woody vegetation as travel corridors and to enlarge the amount of interior grassland (Winter 1998, O'Leary and Nyberg 2000).

Maintain a complex of burned and unburned habitats to provide a variety of grassland habitat types (Volkert 1992). Conduct prescribed burns in late spring on warm-season grasses to eliminate or reduce competition by cool-season grasses and weeds (Skinner 1975).

Burn prairie patches >80 ha on a rotation schedule, with 20-30% of area treated annually (Herkert 1994*b*, Winter 1998, Rohrbaugh et al. 1999). Small, isolated prairie patches should not have more than 50-60% of the total area burned at a time (Herkert 1994*b*). Where several small prairie patches are present, a rotating schedule also can be implemented to provide adjacent burned and unburned areas. Burning is preferred over haying, because vegetation recovers more quickly after burning than after haying (Winter 1998). Discourage grazing on burned grasslands to allow regrowth of herbaceous vegetation (Zimmerman 1997). However, do not completely discourage grazing because privately owned tallgrass prairie are used primarily as cattle pasture. Work to create a mosaic of burned, unburned, and grazed areas.

Burn tallgrass prairie every 3-5 yr and mow only at intervals of ≥3 yr (Westemeier and Buhnerkempe 1983). Burning is particularly recommended for areas where grazing is not used as a management tool.

Use burning as an alternative to mowing in CRP fields to periodically invigorate vegetation (Granfors 1996). Do not conduct burns annually. Reduce frequency of burning from annually to every 2-3 yr on CRP fields (Robel et al. 1998). Kimmel et al. (1992) and King and Savidge (1995) suggested conducting controlled burns on CRP fields every 3-5 yr to reduce vegetation that has become too dense. Cool burns are optimal because some bunchgrasses and forbs will remain after the burn (Granfors 1996).

Provide periodic disturbances such as haying or grazing to increase floristic and structural diversity of seeded-native CRP, making them more attractive to meadowlarks (McCoy 1996). Optimal mowing frequency may be every 3-5 yr in late summer, involving some kind of raking to reduce the litter layer (Hays and Farmer 1990). Delay burning and mowing within the breeding season to enhance suitable nesting habitat or to prevent nest destruction (Sample 1989, Bryan and Best 1991, Granfors 1992, Herkert 1994*a*, Granfors et al. 1996). If management is required to control weeds in Kansas, use spot mowing and spot spraying after 15 July to reduce nest destruction (Granfors et al. 1996, Delisle and Savidge 1997).

Allow moderate grazing where the average height of currently grazed grassland vegetation is 20.3-30.4 cm to enhance both avian species and plant height diversity (Skinner 1975, Skinner et al. 1984). To maintain plant vigor, do not graze warm-season grasses to <25 cm tall during the growing season in tallgrass prairie. Use a rotational system of grazing on two or more grazing units to provide a diversity of plant heights.

Grazing management decisions that attempt to benefit Eastern Meadowlark populations also must consider soil-type/grazing interactions (Baker and Guthery 1990). In Texas, grazing intensity had little effect on the structure of ground cover on clay soils; however, on sandy soils, reduced grazing intensity increased vegetation cover. Amount of bare ground varied according to whether soils were moderately or heavily grazed.

Discourage birds from attempting to nest at small, rural airports in Illinois as airports are population sinks (Kershner and Bollinger 1996). This can be accomplished by lowering the cutter height and mowing more frequently. Few birds nested at vegetation heights of 3.8 cm.

Table. Eastern Meadowlark habitat characteristics.

Author(s)	**Location(s)**	**Habitat(s) Studied***	**Species-specific Habitat Characteristics**
Baker and Guthery 1990	Texas	Shortgrass pasture	Abundance was greater during the summer in moderately grazed shortgrass pasture than in heavily grazed shortgrass pasture
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	Abundance was greater in CRP than in cropland; present in all CRP management types (abundance between management types not compared)
Birkenholz 1973	Illinois	Idle, idle tallgrass, idle tame, wetland, wet meadow	Preferred tallgrass prairie to stands of Kentucky bluegrass (*Poa pratensis*), but were present in both habitats; grass height (51 cm), ground cover (100%), and litter depth (10 cm) were similar in both habitats, but native prairie had higher values for soil moisture (60% versus 40%), foliage cover at 31 cm (60% versus 30%), and variation in grass height (standard deviation of 5.5 versus 3.4) than areas of Kentucky bluegrass
Bock and Bock 1988	Arizona	Burned semidesert grassland, idle semidesert grassland, idle tame, semidesert grassland	Abundance was greater in areas of native grasses than in tame grasses, greater in unburned than in burned upland native grassland, and not different between grazed

		pasture	and ungrazed upland native pastures; burned fields had less grass and shrub cover and more herb cover and bare ground than unburned fields; grazed grasslands had significantly lower grass and shrub cover, more bare ground, and no difference in herb cover than ungrazed grasslands; preferred burned, native floodplain grasslands of sacaton grass (*Sporobolus wrightii*) over unburned grasslands; burned sacaton grasslands had significantly lower coverage of sacaton grass, similar coverage of other grasses, and higher herb cover and bare ground than unburned sacaton grasslands
Bock and Bock 1992	Arizona	Burned semidesert grassland, burned tame, idle semidesert grassland, idle tame	Abundance was positively correlated with shrub cover; abundance significantly decreased 1 yr postfire in burned native fields but not in unburned native fields, and abundance was nonsignificantly higher 2-4 yr postburn in burned tame grasses than unburned tame grasses
Bock et al. 1986	Arizona	Idle semidesert grassland, idle tame	Abundance was greater in native semidesert grassland than in areas planted to tame Lehmann lovegrass (*Eragrostis lehmanniana*) and weeping lovegrass (*E. curvula*)
Bock et al. 1984	Arizona	Idle semidesert grassland, semidesert grassland pasture	Abundance did not differ between grazed and ungrazed plots despite differences in vegetative characteristics between habitats
Bollinger 1988, 1995	New York	Tame hayland	Abundance increased linearly with field age; as fields aged, litter cover, plant diversity, and

			vegetation patchiness increased, whereas total plant cover, legume cover, and vegetation height decreased; abundance was positively associated with plant species richness and negatively associated with percent vegetation cover, vegetation patchiness, and percent birdsfoot trefoil (*Lotus corniculatus*) cover; mean values for fields with meadowlarks was 61.7% total cover, 1.2% birdsfoot trefoil cover, and 17.7 cm vegetation height; preferred short, sparse, patchy, grass-dominated vegetation with high litter cover
Caito 1993	Ohio	Cropland, Wildlife Production Area (burned seeded-native, idle seeded-native, idle tame, tame hayland)	Abundance was greater in stands of tame grasses than in monocultures of native switchgrass (*Panicum virgatum*); vegetation height was shorter in tame stands but vegetation diversity was greater than in switchgrass stands; in 18 WPAs, mean vegetation height over 3 mo (May, June, and July) in areas planted to tame grasses was 54 cm compared to 115 cm in areas planted to switchgrass; Shannon-Wiener diversity index in tame stands was 1.70 compared to 1.12 in switchgrass stands
Castrale 1985	Indiana	Cropland	Were more abundant in no-tillage fields (fields untilled between harvest and planting with seed planted directly into crop residue) than in conventionally tilled (fields tilled in the spring prior to planting) fields; one nest was found in a no-tillage field
Davies 1997	Pennsylvania	Seeded-native hayland,	No difference in abundance was detected

		seeded-native pasture, tame hayland, tame pasture	between cool- and warm-season grass stands; Eastern Meadowlarks were found only on fields >1.4 ha
Delisle 1995, Delisle and Savidge 1997	Nebraska	CRP (burned seeded-native, idle seeded-native, idle tame, seeded-native hayland, tame hayland)	Abundances were similar among CRP treatments; abundance was negatively correlated with litter depth (litter depth ranged from 1.9 to 2.4 cm); visual obstruction readings (VOR), live vegetation height, and dead vegetation height were significantly lower in July in tame CRP than in native CRP; values for VOR and live and dead vegetation height in tame CRP were 48 cm, 48 cm, and 20 cm, respectively, whereas values in native CRP were 88 cm, 78 cm, and 61 cm, respectively
Eddleman 1974	Kansas	Burned tallgrass, burned tallgrass pasture, idle tallgrass, tallgrass pasture, wet meadow	Were common on moderately grazed pastures with open areas and mid-height (no values given) grasses
Evrard and Bacon 1995	Wisconsin	Idle tallgrass, idle tame	Nest densities were negatively correlated with VOR; ranges for VOR, vegetation height, and litter depth in the two fields in which nests were found were 6.4-47.4 cm, 28.8-87.1 cm, and 2-6.4 cm, respectively; ranges for VOR, vegetation height, and litter depth in the two fields in which nests were not found were 23.3-76.8 cm, 85.7-105 cm, and 1.7-4.1 cm, respectively
Granfors 1992, Granfors et al. 1996	Kansas	Burned tallgrass pasture, CRP (idle seeded-native,	Nest success and number of young fledged did not differ among habitat types; selected nest

		seeded-native hayland), tallgrass pasture	sites with greater grass cover, litter cover, and structural homogeneity than on random plots; overall, nests were characterized by 69% herbaceous cover, 38 cm herbaceous height, and 23 cm VOR; nests in rangeland were characterized by 46% grass cover, 5% residual cover, 78% litter cover, and 3.1 cm litter depth; nests in CRP were characterized by 57% grass cover, 10% residual cover, 77% litter cover, and 2.7 cm litter depth; no significant differences were found between parasitized and unparasitized nests in any vegetation variables
Harrison 1974	Michigan	Tame hayland	Mean vegetation measurements on territories were 65% litter cover, 57 cm vegetation height, vertical density of 13 vegetation contacts on a metal rod (diameter of rod not given), horizontal density at 5 cm of 13 vegetation contacts (contacts on a 1-m long rod inserted horizontally through the vegetation at a height of 5 cm), and 1.4 vegetation contacts/cm^2
Harrison 1977	Michigan	Tame hayland	Selected taller (2 m) perch sites over shorter (1.5 m) perch sites
Hays and Farmer 1990	Not given	CRP (idle seeded-native, idle tame, seeded-native hayland, tame hayland)	Based on the Habitat Suitability Index (HSI), which is a model based on untested species-habitat relationships, emergency mowing (haying due to severe drought) of CRP fields appeared to enhance the habitat suitability for meadowlarks by causing an increase in the herbaceous canopy cover and in the proportion

			of grasses composing the herbaceous canopy in the following year; mowing also resulted in more grass cover than in unmowed fields
Herkert 1991*a*	Illinois	Burned seeded-native, burned tallgrass, cropland, idle seeded-native, idle tallgrass, idle tame, tame hayland	Univariate analysis: density was positively correlated with percent live contacts and fragment area; density was negatively correlated with mean grass height, mean vegetation height, and total number of contacts of live grasses, forbs, and residual vegetation. Multivariate analysis: density was negatively correlated with total vegetation richness, forb and shrub abundance, and vegetation heterogeneity
Herkert 1994*a*	Illinois	Idle seeded-native, idle tallgrass, idle tame	Occurrence was positively influenced by size of grassland fragment and areas dominated by live vegetation; avoided areas with high mean grass height
Herkert 1994*b*	Illinois	Burned seeded-native, burned tallgrass	Density did not differ among three burn treatments (1, 2, and 3 yr postburn)
Hull 1993, Hull et al. 1996	Kansas	CRP (burned seeded-native, idle seeded-native)	Abundance was greatest in CRP fields that had the highest (61%) occurrence of forbs than in fields with medium (50%) or low (21%) occurrence of forbs
Jensen 1999	Kansas	Burned tallgrass, burned tallgrass pasture, cropland, tallgrass hayland, tallgrass pasture, woodland edge	Nested in tallgrass hayland; nest sites (0.25 m^2 around the nest) had significantly less bare ground than the area 1-10 m around the nests; mean vegetation variables at the nest site were 55% live grass cover (41 cm average height), 5% standing dead grass cover (13 cm average

			height), 11% forb cover, 26 cm live forb height, 0.1% live woody cover, 0.4 cm woody height, 9% bare soil, 19% litter cover, and 0% rock cover
Kahl et al. 1985	Missouri	Burned tallgrass, cropland, idle, idle tallgrass, tallgrass hayland, tallgrass pasture, woodland, woodland edge	Observed in grasslands and avoided areas with heavy woody invasion such as oldfields; perch locations were characterized by few woody stems <2.5 cm diameter at breast height (dbh), no woody stems $\geq$2.5 cm dbh, dense ground vegetation (>90%) and intermediate to dense litter coverage (>65%); woody vegetation or stakes were used as song perches
Kershner and Bollinger 1996	Illinois	Tame hayland	Nest success decreased as mowing frequency and percent grass cover increased, whereas nest success increased as percentages of cover by clover (scientific name not given) and other forbs increased; nest sites were characterized by 83.5% grass cover, 11% forb cover, 5.4% clover cover, and 0% bare ground; nest sites had more dead grass (33% of grass cover) and less bare ground than non-nest sites, which had 4.2% bare ground; small (3-1200 ha) airport habitats may be ecological traps
King and Savidge 1995	Nebraska	Burned tallgrass, cropland, CRP (burned seeded-native, idle seeded-native, idle tame, tame hayland), idle tallgrass, tallgrass hayland	Density did not differ between landscapes with 20% CRP within 23 km^2 blocks of agricultural land and landscapes with 5% CRP; were present only on tallgrass sites; may have been absent from other habitats because vegetation was too tall and dense and lacked perch sites; in June, maximum vegetation height and VOR in prairie ranged from 33 to 49 cm and 22 to

			25 cm, respectively, compared to 66 to156 cm and 24 to 78 cm in CRP fields
Klute 1994, Klute et al. 1997	Kansas	Burned tallgrass pasture, CRP (burned seeded-native)	Were more abundant in grazed pastures than in CRP; pastures had lower vegetative height, higher forb canopy cover, and higher insect biomass than CRP
Lanyon 1957	Wisconsin	Idle tallgrass	Of 64 nests, 55% were oriented toward the north, east, or northeast
McCoy 1996	Missouri	Cropland, CRP (idle seeded-native, idle tame)	Were more abundant in tame CRP than in native CRP or cropland; tame CRP had significantly shorter and less dense vegetation than native CRP; VOR and maximum live vegetation height in July in tame CRP were 71 cm and 76 cm, respectively, compared to 107 cm for both measurements in native CRP
Niesar 1994	South Dakota	Waterfowl Production Area (idle mixed-grass, idle tame), wetland, woodland	Observed only in WPAs composed of tame grass and not in WPAs composed of native grass nor in wetland or woodland
Risser et al. 1981	Oklahoma	Idle tallgrass, tallgrass pasture	Densities were higher in moderately grazed, vegetatively heterogeneous tallgrass than in ungrazed, vegetatively homogeneous tallgrass
Robel et al. 1998	Kansas	CRP (burned seeded-native)	Abundance increased as number of years since last prescribed fire increased
Roseberry and Klimstra 1970	Illinois	Cropland, tame hayland, tame pasture	Of 220 nests, 44.5% were partially concealed from above, 38.2% had full canopy coverage, and 17.3% were open from above, although concealment varied as the breeding season

			progressed; at 204 nests, cover ranged from 5 to 76 cm tall, with an average of 38 cm; 66.6% of 204 nests were in cover 25-51 cm tall; of 853 plant occurrences in 406 nests, 96.5% were grasses or grass-like forms (*Juncus* or legumes); of 350 nests, 48.9% were located in north, northeast, or east orientations; nest density was inversely related to grazing intensity; absence of woody stems and presence of dead grass stems at ground level were prerequisites for nesting
Rotenberry and Wiens 1980	Colorado, Kansas, Montana, Nebraska, Oklahoma, Oregon, South Dakota, Texas, Washington, Wisconsin, Wyoming	Idle mixed-grass, idle shortgrass, idle shrubsteppe, idle tallgrass, montane meadow	Occurred only in tallgrass habitat; abundance was positively correlated with percent grass cover, percent litter cover, litter depth, and total vegetation contacts, maximum vegetation height, and effective vegetation height; abundance was negatively correlated with percent bare ground and amount of variation in forb and shrub heights, litter depth, and vegetation contacts
Sample 1989	Wisconsin	Burned tallgrass, cropland, dense nesting cover (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 positively correlated with percent cover of standing vegetation, prostrate residual vegetation, woody cover, total number of dead stems, and plant species richness; density was negatively correlated with maximum vegetation height and height/density; used areas had average values of 4% woody cover, 74% herbaceous cover, 20% litter cover, 5% bare ground, 66 cm maximum vegetation height, and 20 cm vegetation height/density

Schroeder and Sousa 1982	Rangewide	Grassland, hayland, pasture	According to the HSI, optimal habitat contains dense grasses of moderate height (12.5-35 cm.) with low shrub cover (<5%; >35% is too dense), low forb cover, and adequate perches; optimal total herbaceous (including grass) cover is >90%, whereas <20% is inadequate; optimal proportion of herbaceous cover that is grass is >80%, whereas <20% is inadequate; variation in canopy height is desirable, because ideal vegetation heights for foraging and loafing are between 10 and 30 cm; ideal vegetation heights for nesting are between 25 and 50 cm; optimal conditions are probably met when most of the habitat is suitable for foraging and loafing; average vegetation heights <2.5 cm or >76 cm are unsuitable as nesting habitat
Shugart and James 1973	Arkansas	Burned tame, idle, idle tame, tame hayland, woodland, woodland edge	Were present in hayland and fields of burned and unburned broomsedge (*Andropogon virginicus*) but were not present in oldfields, red cedar (*Juniperus virginiana*) glades, forest edge, or forest
Skinner 1975	Missouri	Idle tallgrass, idle tame, tallgrass hayland, tallgrass pasture, tame hayland, tame pasture	Were present in all management treatments: idle, hayed, combined for seed, and grazed at four intensities (0-10.2 cm high, 10.2-20.3 cm, 20.3-30.4 cm, and >30.4 cm); density was highest in moderately grazed fields (10.2-30.4 cm tall)
Skinner et al. 1984	Missouri	Burned tallgrass, idle tallgrass, tallgrass hayland, tallgrass pasture, tame	Abundance was highest in grasslands that were short (about 50% cover 1 cm above ground) to medium (about 20% cover 25 cm

		pasture	above ground) in height and that were moderately to heavily grazed; nested in short to medium cover under grass or forb clumps
Smith 1940	Oklahoma	Idle mixed-grass, mixed-grass pasture	Preferred nesting in moderately grazed pastures over nesting in undisturbed prairie; although heavily grazed sites were not used for nesting, they were used as foraging sites, due to high abundances of grasshoppers (*Orthoptera*)
Vickery 1993, Vickery et al. 1994	Maine	Eastern grassland-barren: burned, mowed, and/or sprayed with herbicides	Density was positively correlated with increasing area, high grass cover, and cover of low-growing (0-60 cm) shrubs; density was negatively correlated with cover of tall (60-200 cm) shrubs; densities decreased following burning; densities also decreased after herbicide spraying and did not recover during the 8-yr study
Vickery and Hunter 1995	Maine	Burned eastern grassland-barren, idle eastern grassland-barren	Artificial song perches did not affect territory density
Volkert 1992	Wisconsin	Burned tallgrass (restored), idle tallgrass (restored)	Were present on a restored prairie 3 yr after it was reseeded, which also was the year it was burned
Walk and Warner 1999	Illinois	Tallgrass: burned, hayland, idle, and/or pasture; tame: burned, hayland, idle, and/or pasture	Were present in burned, hayed, idle, or grazed tame or native grasslands
Welsh and Kimmel 1991	Minnesota	CRP (idle seeded-native/tame), seeded-	Occurred in landscapes with varying amounts of planted cover, from 0% to $\geq$18% cover

		native/tame hayland	within 23.4-km^2 study sites
Westemeier and Buhnerkempe 1983	Illinois	Burned tallgrass, idle seeded-native, tallgrass hayland	Nest densities were not different among areas that were burned, hayed, high-mowed (stubble >30 cm remains on the field), or idle
Wiens 1969	Wisconsin	Idle pasture, tame pasture	Used large grassy fields with elevated song perches and some litter; occupied territories had lower vertical vegetation density, mean effective vegetation height, and litter depth but had greater forb density than unoccupied areas; territories had 96% grass cover, 30% forb cover, 3% bare ground and 41% vegetation cover with an effective vegetation height of <5 cm; of 12 territories, mean distance from territory boundary to woods was 165.8 m, to fence line was 11.6 m, and to cultivated field was 45.8 m; 67% of territories included posts, 67% included fence lines, 33% wire bales or tangles, and 58% trees
Winter 1998. Winter and Faaborg 1999	Missouri	Burned tallgrass, idle tallgrass, tallgrass hayland	Density was not influenced by patch size, vegetation characteristics, time since an area was last burned or hayed, or by surrounding landscape; nesting success was not related to patch size
Zimmerman 1993	Kansas	Burned tallgrass, idle tallgrass	Abundance was similar between annually burned and unburned grassland

*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.

LITERATURE CITED

Baker, D. L., and F. S. Guthery. 1990. Effects of continuous grazing on habitat and density of ground-foraging birds in south Texas. Journal of Range Management 43:2-5.

Batts, H. L., Jr. 1958. The distribution and population of nesting birds on a farm in southern Michigan. Jack-Pine Warbler 36:131-149.

Beason, R. C. 1970. The annual cycle of the Prairie Horned Lark in west central Illinois. M.S. thesis. Western Illinois University, Macomb, Illinois. 160 pages.

Best, L. B., H. Campa, III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, Jr., and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. Wildlife Society Bulletin 25:864-877.

Best, L. B., and B. J. Hill. 1983. Fencerows are for the birds. Iowa Bird Life 53:16-21.

Birkenholz, D. E. 1973. Habitat relationships of grassland birds at Goose Lake Prairie Nature Preserve. Pages 63-66 *in* L. C. Hulbert, editor. Third Midwest Prairie Conference Proceedings. Kansas State University, Manhattan, Kansas.

Bock, C. E., and J. H. Bock. 1988. Grassland birds in southeastern Arizona: impacts of fire, grazing, and alien vegetation. Pages 43-58 *in* P. D. Goriup, editor. Ecology and conservation of grassland birds. International Council for Bird Preservation Publication 7.

Bock, C. E., and J. H. Bock. 1992. Response of birds to wildfire in native versus exotic Arizona grassland. Southwestern Naturalist 37:73-81.

Bock, C. E., J. H. Bock, K. L. Jepson, and J. C. Ortega. 1986. Ecological effects of planting African love-grasses in Arizona. National Geographic Research 2:456-463.

Bock, C. E., J. H. Bock, W. R. Kenney, and V. M. Hawthorne. 1984. Responses of birds, rodents, and vegetation to livestock exclosure in a semidesert grassland site. Journal of Range Management 37:239-242.

Bock, C. E., V. A. Saab, T. D. Rich, and D. S. Dobkin. 1993. Effects of livestock grazing on Neotropical migratory landbirds in western North America. Pages 296-309 *in* D. M. Finch and P. W. Stangel, editors. Status and management of Neotropical migratory birds. U.S.D.A. Forest Service, General Technical Report RM-229.

Bollinger, E. K. 1988. Breeding dispersion and reproductive success of Bobolinks in an agricultural landscape. Ph.D. dissertation. Cornell University, Ithaca, New York. 189 pages.

Bollinger, E. K. 1995. Successional changes and habitat selection in hayfield bird communities. Auk 112:720-730.

Boyer, G. F., and O. E. Devitt. 1961. A significant increase in the birds of Luther Marsh, Ontario, following freshwater impoundment. Canadian Field-Naturalist 75:225-237.

Bryan, G. G., and L. B. Best. 1991. Bird abundance and species richness in grassed waterways in Iowa rowcrop fields. American Midland Naturalist 126:90-102.

Caito, J. L. 1993. Avian diversity on restored grasslands in northwest Ohio. M.S. thesis. Ohio State University, Columbus, Ohio. 136 pages.

Castrale, J. S. 1985. Responses of wildlife to various tillage conditions. Transactions of the North American Wildlife and Natural Resources Conference 50:142-149.

Cink, C. L., and P. E. Lowther. 1989. Breeding bird populations of a floodplain tallgrass prairie in Kansas. Pages 259-262 *in* T. B. Bragg and J. Stubbendieck, editors. Proceedings of the Eleventh North American Prairie Conference. University of Nebraska Printing, Lincoln, Nebraska.

Clark, T. W., T. W. Campbell III, D. G. Socha, and D. E. Cassey. 1982. Prairie dog colony attributes and associated vertebrate species. Great Basin Naturalist 42:572-582.

Dambach, C. A., and E. E. Good. 1940. The effect of certain land use practices on populations of breeding birds in southwestern Ohio. Journal of Wildlife Management 4:63-76.

Davies, S. E. 1997. The effects of the reestablishment of warm-season grasses on grassland bird communities in farmlands of southwestern Pennsylvania. M.S. thesis. University of Pennsylvania, California, Pennsylvania. 47 pages.

Delisle, J. M. 1995. Avian use of fields enrolled in the Conservation Reserve Program in southeast Nebraska. M.S. thesis. University of Nebraska, Lincoln, Nebraska. 38 pages.

Delisle, J. M., and J. A. Savidge. 1997. Avian use and vegetation characteristics of Conservation Reserve Program fields. Journal of Wildlife Management 61:318-325.

Dinsmore, J. J., T. H. Kent, D. Koenig, P. C. Peterson, and D. M. Roosa. 1984. Iowa birds. Iowa State University Press, Ames, Iowa. 356 pages.

Easterla, D. A. 1962. Avifauna of Tucker Prairie. M.A. thesis. University of Missouri, Columbia, Missouri. 144 pages.

Eddleman, W. R. 1974. The effects of burning and grazing on bird populations in native prairie in the Kansas Flint Hills. Unpublished report, National Science Foundation-Undergraduate Research Program. Kansas State University, Manhattan, Kansas. 33 pages.

Eifrig, C. W. 1919. Notes on birds of the Chicago area and its immediate vicinity. Auk 36:513-524.

Elliott, P. F. 1976. The role of community factors in cowbird-host interactions. Ph.D. dissertation. Kansas State University, Manhattan, Kansas. 62 pages.

Elliott, P. F. 1978. Cowbird parasitism in the Kansas tall grass prairie. Auk 95:161-167.

Evrard, J. O., and B. R. Bacon. 1995. Bird nest densities in managed grasslands. Passenger Pigeon 57:89-95.

Faanes, C. A. 1981. Birds of the St. Croix River Valley: Minnesota and Wisconsin. U.S. Fish and Wildlife Service, Washington, D.C. North American Fauna 73. 196 pages.

Faanes, C. A., and G. R. Lingle. 1995. Breeding birds of the Platte River Valley of Nebraska. Jamestown, ND: Northern Prairie Wildlife Research Center home page. http://www.npwrc.usgs.gov/resource/distr/birds/platte/platte.htm (Version 02SEP99).

Francq, G. E. 1972. Parental care of the Eastern Meadowlark (*Sturnella magna*). M.S. thesis. Kansas State Teachers College, Emporia, Kansas. 45 pages.

George, J. L. 1952. The birds on a southern Michigan farm. Ph.D. dissertation. University of Michigan, Ann Arbor, Michigan. 413 pages.

Graber, R. R., and J. W. Graber. 1963. A comparative study of bird populations in Illinois, 1906-1909 and 1956-1958. Illinois Natural History Survey Bulletin 28:383-528.

Granfors, D. A. 1992. The impact of the Conservation Reserve Program on Eastern Meadowlark production and validation of the Eastern Meadowlark Habitat Suitability Index model. M.S. thesis. Texas Technical University, Lubbock, Texas. 98 pages.

Granfors, D. A., K. E. Church, and L. M. Smith. 1996. Eastern Meadowlark nesting in rangelands and Conservation Reserve Program fields in Kansas. Journal of Field Ornithology 67:222-235.

Griffin, D. N. 1959. The poisoning of meadowlarks with insecticides. Wilson Bulletin 71:193.

Gross, A. O. 1965. Eastern Meadowlark. Pages 53-80 *in* Life histories of North American blackbirds, orioles, tanagers, and allies. Dover Publications, Inc., New York, New York.

Harrison, K. G. 1974. Aspects of habitat selection in grassland birds. M.S. thesis. Western Michigan University, Kalamazoo, Michigan. 82 pages.

Harrison, K. G. 1977. Perch height selection of grassland birds. Wilson Bulletin 89:486-487.

Hayden, T. J. 1985. Minimum area requirements of some breeding bird species in fragmented habitats in Missouri. M.A. thesis. University of Missouri, Columbia, Missouri. 148 pages.

Hays, R. L., and A. H. Farmer. 1990. Effects of the CRP on wildlife habitat: emergency haying in the Midwest and pine plantings in the Southeast. Transactions of the North American Wildlife and Natural Resources Conference 55:30-39.

Helzer, C. J. 1996. The effects of wet meadow fragmentation on grassland birds. M.S. thesis. University of Nebraska, Lincoln, Nebraska. 65 pages.

Helzer, C. J., and D. E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications 9:1448-1458.

Herkert, J. R. 1991*a*. An ecological study of the breeding birds of grassland habitats within Illinois. Ph.D. dissertation. University of Illinois, Urbana, Illinois. 112 pages.

Herkert, J. R. 1991*b*. Study suggests increases in restored prairie fragments to conserve breeding bird communities. Restoration and Management Notes 9:107.

Herkert, J. R. 1994*a*. The effects of habitat fragmentation on midwestern grassland bird communities. Ecological Applications 4:461-471.

Herkert, J. R. 1994*b*. Breeding bird communities of midwestern prairie fragments: the effects of prescribed burning and habitat-area. Natural Areas Journal 14:128-135.

Herkert, J. R., R. E. Szafoni, V. M. Kleen, and J. E. Schwegman. 1993. Habitat establishment, enhancement and management for forest and grassland birds in Illinois. Illinois Department of Conservation, Division of Natural Heritage, Natural Heritage Technical Publication 1, Springfield, Illinois. 20 pages.

Hull, S. D. 1993. Avian, invertebrate and forb abundance in Conservation Reserve Program fields in northeast Kansas, with notes on avian behavior. M.S. thesis. Kansas State University, Manhattan, Kansas. 141 pages.

Hull, S. D., R. J. Robel, and K. E. Kemp. 1996. Summer avian abundance, invertebrate biomass, and forbs in Kansas CRP. Prairie Naturalist 28:1-12.

Janssen, R. B. 1987. Birds in Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 352 pages.

Jensen, W. E. 1999. Nesting habitat and responses to habitat edges of three grassland passerine species. M.S. thesis. Emporia State University, Emporia, Kansas. 58 pages.

Johnsgard, P. A. 1979. Birds of the Great Plains. University of Nebraska Press, Lincoln, Nebraska. 539 pages.

Johnsgard, P. A. 1980. A preliminary list of the birds of Nebraska and adjacent Plains states. University of Nebraska, Lincoln, Nebraska. 156 pages.

Jorgensen, E. E., and L. E. Nauman. 1993. Bird distribution in wetlands associated with commercial cranberry production. Passenger Pigeon 55:289-298.

Kahl, R. B., T. S. Baskett, J. A. Ellis, and J. N. Burroughs. 1985. Characteristics of summer habitats of selected nongame birds in Missouri. Research Bulletin 1056. University of Missouri, Columbia, Missouri. 155 pages.

Kent, T. H., and J. J. Dinsmore. 1996. Birds in Iowa. Published by the authors, Iowa City and Ames, Iowa. 391 pages.

Kershner, E. L., and E. K. Bollinger. 1996. Reproductive success of grassland birds at east-central Illinois airports. American Midland Naturalist 136:358-366.

Kimmel, R. O., A. H. Berner, R. J. Welsh, B. S. Haroldson, and S. B. Malchow. 1992. Population responses of Grey Partridge (*Perdix perdix*), Ring-necked Pheasant (*Phasianus colchicus*), and meadowlarks (*Sturnella* spp.) to farm programs in Minnesota. Gibier Faune Sauvage 9:797-806.

King, J. W., and J. A. Savidge. 1995. Effects of the Conservation Reserve Program on wildlife in southeast Nebraska. Wildlife Society Bulletin 23:377-385.

Klute, D. S. 1994. Avian community structure, reproductive success, vegetative structure, and food availability in burned Conservation Reserve Program fields and grazed pastures in northeastern Kansas. M.S. thesis. Kansas State University, Manhattan, Kansas. 168 pages.

Klute, D. S., R. J. Robel, and K. E. Kemp. 1997. Will conversion of Conservation Reserve Program (CRP) lands to pasture be detrimental for grassland birds in Kansas? American Midland Naturalist 137:206-212.

Knapton, R. W. 1988. Nesting success is higher for polygynously mated females than for monogamously mated females in the Eastern Meadowlark. Auk 105:325-329.

Lanyon, W. E. 1956*a*. Ecological aspects of the sympatric distribution of meadowlarks in the north-central states. Ecology 37:98-103.

Lanyon, W. E. 1956*b*. Territory in the meadowlarks, genus *Sturnella*. Ibis 98:485-489.

Lanyon, W. E. 1957. The comparative biology of the meadowlarks (*Sturnella*) in Wisconsin. Publications of the Nuttall Ornithological Club, Number 1. Cambridge, Massachusetts. 67 pages.

Lanyon, W. E. 1962. Species limits and distribution of meadowlarks of the desert grassland. Auk 79:183-207.

Lanyon, W. E. 1995. Eastern Meadowlark (*Sturnella magna*). A. Poole and F. Gill, editors. The birds of North America, No. 160. The Academy of Natural Sciences, Philadelphia, Pennsylvania; The American Ornithologists' Union, Washington, D.C.

McCoy, T. D. 1996. Avian abundance, composition, and reproductive success on Conservation Reserve Program fields in northern Missouri. M.S. thesis. University of Missouri, Columbia, Missouri. 104 pages.

McCoy, T. D., M. R. Ryan, E. W. Kurzejeski, and L. W. Burger, Jr. 1999. Conservation Reserve Program: source or sink habitat for grassland birds in Missouri? Journal of Wildlife Management 63:530-538.

Mossman, M. J., and D. W. Sample. 1990. Birds of Wisconsin sedge meadows. Passenger Pigeon 52:39-55.

National Geographic Society. 1999. Field guide to the birds of North America, third edition. National Geographic Society, Washington, D.C. 480 pages.

Niesar, S. L. 1994. Vertebrated richness of Waterfowl Production Areas in the Prairie Pothole region of Minnesota. M.S. thesis. South Dakota State University, Brookings, South Dakota. 104 pages.

O'Leary, C. H., and D. W. Nyberg. 2000. Treelines between fields reduce the density of grassland birds. Natural Areas Journal 20:243-249.

Risser, P. G., E. C. Birney, H. D. Blocker, S. W. May, W. J. Parton, and J. A. Weins. 1981. The true prairie ecosystem. U.S. International Biological Program Synthesis Series, No. 16. Hutchinson Ross Publishing Company, Stroudsburg, Pennsylvania. 557 pages.

Robel, R. J., J. P. Hughes, S. D. Hull, K. E. Kemp, and D. S. Klute. 1998. Spring burning: resulting avian abundance and nesting in Kansas CRP. Journal of Range Management 51:132-138.

Rohrbaugh, R. W. Jr., D. L. Reinking, D. H. Wolfe, S. K. Sherrod, and M. A. Jenkins. 1999. Effects of prescribed burning and grazing on nesting and reproductive success of three grassland passerine species in tallgrass prairie. Pages 165-170 *in* P. D. Vickery and J. R. Herkert, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

Roseberry, J. L., and W. D. Klimstra. 1970. The nesting ecology and reproductive performance of the Eastern Meadowlark. Wilson Bulletin 82:243-267.

Rotenberry, J. T., and J. A. Wiens. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: a multivariate analysis. Ecology 61:1228-1250.

Sample, D. W. 1989. Grassland birds in southern Wisconsin: habitat preference, population trends, and response to land use changes. M.S. thesis. University of Wisconsin, Madison, Wisconsin. 588 pages.

Sample, D. W., and R. M. Hoffman. 1989. Birds of dry-mesic and dry prairies in Wisconsin. Passenger Pigeon 51:195-208.

Schroeder, R. L., and P. J. Sousa. 1982. Habitat Suitability Index: Eastern Meadowlark. FWS/OBS 82/10. U.S. Fish and Wildlife Service. 9 pages.

Shaffer, J. A., C. M. Goldade, M. F. Dinkins, D. H. Johnson, L. D. Igl, and B. R. Euliss. 2003. Brown-headed Cowbirds in grasslands: their habitats, hosts, and response to management. Prairie Naturalist 35:146-186.

Shugart, H. H., and D. James. 1973. Ecological succession of breeding bird populations in northwestern Arkansas. Auk 90:62-77.

Skinner, R. M. 1975. Grassland use patterns and prairie bird populations in Missouri. Pages 171-180 *in* M. K. Wali, editor. Prairie: a multiple view. University of North Dakota Press, Grand Forks, North Dakota.

Skinner, R. M., T. S. Baskett, and M. D. Blendon. 1984. Bird habitat on Missouri prairies.Terrestrial Series 14. Missouri Department of Conservation, Jefferson City, Missouri. 37 pages.

Smith, C. C. 1940. The effect of overgrazing and erosion upon the biota of the mixed-grass prairie of Oklahoma. Ecology 21:381-397.

Swanson, D. A., D. P. Scott, and D. L. Risley. 1999. Wildlife benefits of the Conservation Reserve Program in Ohio. Journal of Soil and Water Conservation 54:390-394.

Temple, S. A., B. M. Fevold, L. K. Paine, D. J. Undersander, and D. W. Sample. 1999. Nesting birds and grazing cattle: accommodating both on midwestern pastures. Pages 196-202 *in* P. D. Vickery and J. R. Herkert, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

Vickery, P. D. 1993. Habitat selection of grassland birds in Maine. Ph.D. dissertation. University of Maine, Orono, Maine. 124 pages.

Vickery, P. D., and M. L. Hunter, Jr. 1995. Do artificial song-perches affect habitat use by grassland birds in Maine? American Midland Naturalist 133:164-169.

Vickery, P. D., M. L. Hunter, and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8:1087-1097.

Volkert, W. K. 1992. Response of grassland birds to a large-scale prairie planting project. Passenger Pigeon 54:190-196.

Walk, J. W., and R. E. Warner. 1999. Effects of habitat area on the occurrence of grassland birds in Illinois. American Midland Naturalist 141:339-344.

Welsh, R. J., and R. O. Kimmel. 1991. Impacts of the federal conservation reserve and reinvest in Minnesota programs on abundance of ring-necked pheasants, gray partridge, and meadowlarks. Pages 16-22 *in* Minnesota Department of Natural Resources, Population Research Unit Report.

Westemeier, R. L., and J. E. Buhnerkempe. 1983. Responses of nesting wildlife to prairie grass management in prairie chicken sanctuaries in Illinois. Pages 36-46 *in* R. Brewer, editor. Proceedings of the Eighth North American Prairie Conference. Western Michigan University, Kalamazoo, Michigan.

Whitmore, R. C. 1980. Reclaimed surface mines as avian habitat islands in the eastern forest. American Birds 34:13-14.

Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithological Monographs 8:1-93.

Wiens, J. A. 1971. Avian ecology and distribution in the comprehensive network, 1970. U.S. International Biological Program, Grassland Biome Technical Report 77. Colorado State University, Fort Collins, Colorado. 49 pages.

Wiens, J. A. 1974. Habitat heterogeneity and avian community structure in North American grasslands. American Midland Naturalist 91:195-213.

Winter, M. 1998. Effect of habitat fragmentation on grassland-nesting birds in southwestern Missouri. Ph.D. dissertation. University of Missouri, Columbia, Missouri. 215 pages.

Winter, M., and J. Faaborg. 1999. Patterns of area sensitivity in grassland-nesting birds. Conservation Biology 13:1424-1436.

Yahner, R. H. 1982. Avian nest densities and nest-site selection in farmstead shelterbelts. Wilson Bulletin 94:156-175.

Zimmerman, J. L. 1992. Density-independent factors affecting the avian diversity of the tallgrass prairie community. Wilson Bulletin 104:85-94.

Zimmerman, J. L. 1993. Birds of Konza: the avian ecology of the tallgrass prairie. University of Kansas Press, Lawrence, Kansas. 186 pages.

Zimmerman, J. L. 1997. Avian community responses to fire, grazing, and drought in the tallgrass prairie. Pages 167-180 *in* F. L. Knopf and F. B. Samson, editors. Ecology and conservation of Great Plains vertebrates. Springer-Verlag, New York, New York.

Zimmerman, J. L., and E. J. Finck. 1983. Success in a secondary habitat: the Dickcissel in the tallgrass prairie. Pages 47-49 *in* R. Brewer, editor. Proceedings of the eighth North American Prairie Conference. Western Michigan University, Kalamazoo, Michigan.