2002

Effects of Management Practices on Grassland Birds: Western Meadowlark

Jill A. Dechant

Marriah L. Sondreal

Douglas H. Johnson
USGS, Douglas_H_Johnson@usgs.gov

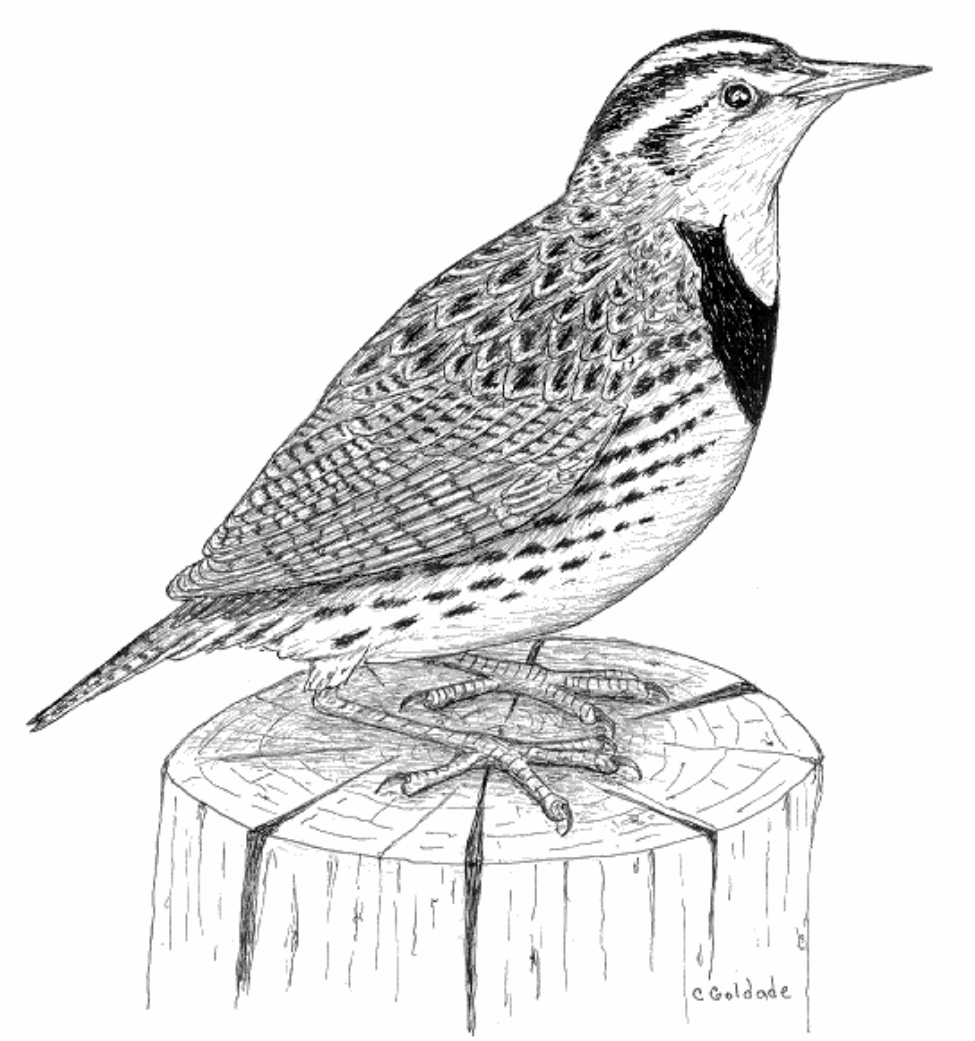
Lawrence D. Igl
USGS, ligl@usgs.gov

Christopher M. Goldade

See next page for additional authors

EFFECTS OF MANAGEMENT PRACTICES ON GRASSLAND BIRDS:

WESTERN MEADOWLARK



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.

Suggested citation:

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, A. L. Zimmerman, and B. R. Euliss. 1999 (revised 2002). Effects of management practices on grassland birds: Western Meadowlark. Northern Prairie Wildlife Research Center, Jamestown, ND. 33 pages.

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:

WESTERN MEADOWLARK

Jill A. Dechant, Marriah L. Sondreal, Douglas H. Johnson, Lawrence D. Igl,
Christopher M. Goldade, Amy L. Zimmerman, and Betty R. Euliss

Series Coordinator: Douglas H. Johnson
Series Assistant Coordinator: Lawrence D. Igl

Reviewers: Brian J. Frawley and Wesley E. Lanyon

Range Map: Jeff T. Price

Cover Art: Christopher M. Goldade

Major Funding: Prairie Pothole Joint Venture, U.S. Fish and Wildlife Service
U.S. Geological Survey

Funding also provided by: U.S. Forest Service
The Nature Conservancy

Collaborators:

Louis B. Best, Iowa State University
Carl E. Bock, University of Colorado
Brenda C. Dale, Canadian Wildlife Service
Stephen K. Davis, Saskatchewan Wetland Conservation Corporation
James J. Dinsmore, Iowa State University
James K. Herkert, Illinois Endangered Species Protection Board
Fritz L. Knopf, Midcontinent Ecological Science Center
Rolf R. Koford, Iowa Cooperative Fish and Wildlife Research Unit
David R. C. Prescott, Alberta NAWMP Centre
Mark R. Ryan, University of Missouri
David W. Sample, Wisconsin Department of Natural Resources
David A. Swanson, Ohio Division of Wildlife
Peter D. Vickery, Massachusetts Audubon Society
John L. Zimmerman (retired), Kansas State University

May 1999
(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.

 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.

WESTERN MEADOWLARK
(*Sturnella neglecta*)

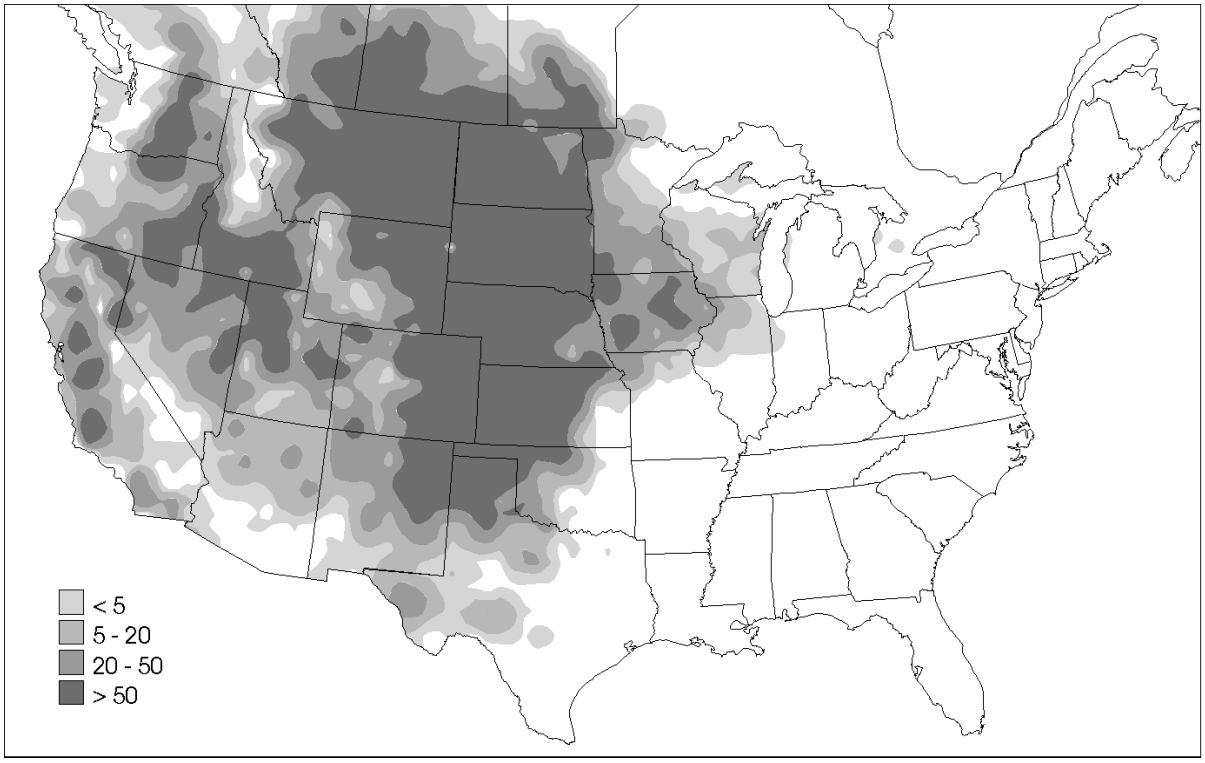


Figure. Breeding distribution of the Western Meadowlark in the United States and southern Canada, based on Breeding Bird Survey data, 1985-1991. Scale represents average number of individuals detected per route per year. Map from Price, J., S. Droege, and A. Price. 1995. The summer atlas of North American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

Keys to management include providing a variety of grassland types and heights, sparse woody cover, and high forb and grass cover.

Breeding range:

Western Meadowlarks breed from southern British Columbia through central Alberta, Saskatchewan, and southern Manitoba, to southern Ontario, south to southern California, western Texas, and Iowa, and east from northwestern Louisiana and western Arkansas, through Illinois and Indiana, to western Ohio (National Geographic Society 1987). (See figure for the relative densities of Western Meadowlarks in the United States and southern Canada, based on Breeding Bird Survey data.)

Suitable habitat:

Western Meadowlarks use a variety of grassland types from shrubsteppe and shortgrass prairie to mixed-grass and tallgrass prairie (Bent 1965, Walcheck 1970, Maher 1974, Stewart 1975, Salt and Salt 1976, Dale 1983, Laubach 1984, Bock and Bock 1987, Renken and Dinsmore 1987, Lanyon 1994, Bock et al. 1995). In the Great Plains, Western Meadowlarks use a wide range of vegetation heights and densities, although they avoid extremely sparse or tall

cover (Dale 1983, Patterson 1994, Patterson and Best 1996). They prefer high forb and grass cover, low to moderate litter cover, and little or no woody cover (Sample 1989, Kimmel et al. 1992, Anstey et al. 1995, Hull et al. 1996, Madden 1996). In shrubsteppe and desert grasslands, they prefer mesic areas; low shrub cover and density; patchiness in vegetative structure and in heights of forbs and shrubs; and high coverage of grass, forb, and litter (Lanyon 1962, Rotenberry and Wiens 1980, Wiens and Rotenberry 1981, Wiens et al. 1987, McAdoo et al. 1989, Knick and Rotenberry 1995). In general, Western Meadowlarks prefer open, treeless areas (Salt and Salt 1976, Sample 1989, Johnson 1997), although a few shrubs may be used as song perches (Knick and Rotenberry 1995).

Suitable habitats are found in idle native and idle tame grasslands (including fields of planted cover, such as Conservation Reserve Program [CRP] fields, Permanent Cover Program [PCP] fields, and dense nesting cover [DNC]), native and tame pastures and hayland (Graber and Graber 1963; Smith and Smith 1966; Giezentanner 1970; Maher 1973, 1974; Stewart 1975; Salt and Salt 1976; Johnsgard 1979, 1980; Ducey and Miller 1980; Kantrud 1981; Kantrud and Kologiski 1982; Faanes 1983; Laubach 1984; Renken and Dinsmore 1987; Frawley and Best 1991; Dhol et al. 1994; Hartley 1994; Klute 1994; Anstey et al. 1995; Berthelsen and Smith 1995; Bock et al. 1995; Faanes and Lingle 1995; King and Savidge 1995; Prescott et al. 1995; Skeel et al. 1995; Sutter 1996; Delisle and Savidge 1997; Klute et al. 1997; Prescott 1997; Koford 1999; Davis and Duncan 1999). Western Meadowlarks also inhabit road rights-of-way, field edges, cropland, retired cropland, wet meadows, pine (*Pinus*) foothills, mountain meadows, orchards, windbreaks, riparian areas, and to a limited extent, wet areas on shortgrass prairie and sagebrush (*Artemisia*)-dominated plains (Hergenrader 1962, Bent 1965, Strong 1971, Stewart 1975, Salt and Salt 1976, Johnsgard 1979, Ducey and Miller 1980, Stauffer and Best 1980, Faanes 1983, Basore et al. 1986, Cable et al. 1992, Camp and Best 1993, Hartley 1994, Lanyon 1994, Faanes and Lingle 1995, Prescott 1997). In Colorado, Bock et al. (1999) compared the abundance of Western Meadowlarks between upland (mixed-grass prairie) and lowland (tallgrass prairie or tame hayland) grasslands. Western Meadowlarks were significantly more abundant on upland than on lowland plots.

Where populations of Western and Eastern meadowlarks are sympatric in the Great Plains, Western Meadowlarks are found in dry uplands whereas Eastern Meadowlarks are found in wet lowland areas, such as valleys and river bottoms, (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).

Within mixed-grass areas in North Dakota, abundance of Western Meadowlarks was positively associated with percent grass cover, litter depth, and density of low-growing shrubs (western snowberry [*Symphoricarpos occidentalis*] and silverberry [*Elaeagnus commutata*]) (Schneider 1998). In mixed-grass prairie in North Dakota, the density of Western Meadowlarks was positively correlated with maximum and average vegetation heights, and negatively correlated with shrub coverage (Georgee and McEwen 1991). When vegetation variables were grouped and analyzed in combination, Western Meadowlark density was positively correlated with vertical density of vegetation and grass cover, and negatively correlated with vertical heterogeneity (diversity of vegetation) and litter cover. In riparian areas in Iowa, density was positively associated with grass cover and the cover of all life forms combined; life forms were defined as grass-like vegetation, forbs, shrubs, deciduous and evergreen trees, and vines (Best et al. 1981). The density of Western Meadowlarks was negatively associated with sapling and tree

richness, the horizontal patchiness of trees, and forb cover. In crested wheatgrass (*Agropyron cristatum*) pastures in Saskatchewan, Western Meadowlark abundance was positively correlated with litter depth and the number of plant contacts from 0 to 10 cm from the ground (Sutter and Brigham 1998). Numbers of Western Meadowlarks were higher in areas with high percent grass and sedge cover and high maximum vegetation height than in areas with high litter depth and number of plant contacts >10 cm tall. In mixed-grass pastures, Western Meadowlark density was negatively correlated with maximum vegetation height and the number of plant contacts <10 cm. Numbers of Western Meadowlarks were higher in areas with high percent grass and sedge cover and high maximum vegetation height than in areas with high litter depth and number of plant contacts >10 cm tall.

In Nebraska, meadowlarks (Eastern Meadowlarks [*Sturnella magna*] and Western Meadowlarks combined) were equally abundant in idle fields planted to native grasses and in idle fields planted to tame grasses (Delisle and Savidge 1997). In Saskatchewan, Western Meadowlarks occurred with equal frequency in native pastures and tame pastures (Anstey et al. 1995, Sutter 1996, Davis and Duncan 1999). In Manitoba and Alberta, however, Western Meadowlarks preferred native grasses to tame grasses (Wilson and Belcher 1989, Dhol et al. 1994, Prescott and Murphy 1996). Western Meadowlarks nested in grassed waterways planted to smooth brome (*Bromus inermis*) in Iowa rowcrop fields (Bryan and Best 1991).

Western Meadowlarks occasionally nest in no-tillage cropland (Basore et al. 1986). In Iowa, Western Meadowlarks preferred untilled fields of corn and soybeans rather than tilled fields (Basore et al. 1986). Untilled fields were idle in the fall and spring and contained year-round crop residue. Specifically, Western Meadowlarks preferred nesting in fields where corn was planted into sod residue over fields where corn or soybeans were planted into corn residue (Basore et al. 1986). In wheat-stubble fields, the tightly woven nest of Western Meadowlarks often protected eggs from rolling out during tillage with undercutter blades (Rodgers 1983). A table near the end of the account lists the specific habitat characteristics for Western Meadowlarks by study.

Area requirements:

Estimates of male territory size are 3-13 ha within tallgrass prairie (Kendeigh 1941, Lanyon 1956*b*, Laubach 1984), 2-7 ha within short- and mixed-grass prairies (Wiens 1970, 1971; Schaeff and Picman 1988), 2 ha in tame pastures in Wisconsin (Wiens 1969), and 3 ha in alfalfa (*Medicago sativa*) fields and surrounding edges in Iowa (Frawley and Best 1991). In idle shrubsteppe and shrubsteppe pasture, the estimated territory sizes for male Western Meadowlarks were 2.2 ha and 2.3 ha, respectively (Wiens 1971). In Colorado, male Western Meadowlarks had a mean territory size of 1.2 ha (Aweida 1995). Herkert et al. (1993) suggested that Western Meadowlarks were moderately sensitive to habitat fragmentation. In Nebraska, the minimum area in which Western Meadowlarks were found was 5 ha, with a perimeter-area ratio of about 0.025 (Helzer 1996, Helzer and Jelinski 1999). Occurrence of Western Meadowlarks was positively correlated with patch area and inversely correlated with perimeter-area ratio (Helzer and Jelinski 1999). In Idaho shrubsteppe, no relationship was found between occupancy of an area and patch size (Knick and Rotenberry 1995).

In Minnesota tallgrass prairie, nest depredation and Brown-headed Cowbird (*Molothrus ater*) brood parasitism decreased farther from woody edges, and nest depredation rates were lower on large (130-486 ha) than on small (16-32 ha) grasslands (Johnson and Temple 1990). The probability of encountering Western Meadowlark nests was highest on large fragments near

forest edges; however, nest productivity was highest for nests far from forest edges in areas 1 yr postburn (Johnson and Temple 1986). In Saskatchewan, cowbird brood parasitism rates for Western Meadowlarks were negatively associated with area; 700-1600 ha would be required to reduce brood parasitism by 50% (SWCC 1997). In Colorado, Bock et al. (1999) compared the abundance of Western Meadowlarks 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. Western Meadowlarks were significantly more abundant on interior plots than on edge plots.

Brown-headed Cowbird brood parasitism:

Rates of Brown-headed Cowbird parasitism vary from 7% of 29 nests (Hill 1976) to 46% of 24 nests (De Smet 1992). Refer to Table 1 in Shaffer et al. (2003) for rates of cowbird brood parasitism. Western Meadowlarks may be multiply-parasitized (Silloway 1917, Knapton 1979, SWCC 1997, Davis and Sealy 2000). In southern Saskatchewan, distance to cowbird perch sites and amount of concealment cover were not significantly different between parasitized and unparasitized nests (S. K. Davis, Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan, *unpublished data*).

Breeding-season phenology and site fidelity:

In the northern Great Plains, Western Meadowlarks arrive on the breeding grounds from mid-March to mid-May and depart from mid-October to mid-November (Cameron 1907; Bent 1965; Maher 1973, 1974; Stewart 1975; Salt and Salt 1976; Knapton 1979; Dinsmore et al. 1984; Laubach 1984; Lanyon 1994). In Nebraska, Western Meadowlarks arrive from early February to mid-March and depart from mid-October to mid-November; some meadowlarks may overwinter (Johnsgard 1980). Peak breeding season in North Dakota is from early May to mid-July (Stewart 1975). Female Western Meadowlarks that successfully raise their first brood will attempt to raise a second brood (Cameron 1907; Lanyon 1956*b*, 1994; Bent 1965; Strong 1971), and may attempt to renest if their first nest fails (Lanyon 1956*b*, 1994; Maher 1973).

Between-year site fidelity for breeding territories has been recorded in Wisconsin (Lanyon 1956*b*) and Saskatchewan (Dale 1983). Both sexes exhibit site fidelity to previous breeding areas (Lanyon 1956*b*, 1957, 1995). Over a 3-yr period, 12 of 21 banded males and 10 of 19 banded females returned to the area where they had been banded (Lanyon 1957). Only one male and one female did not return to their respective, former territory; they did, however, breed on adjacent territories. In Colorado, a banded adult was recaptured 6 yr later at the site where it was banded (Klimkiewicz and Futcher 1987).

Species' response to management:

Densities of Western Meadowlarks are low immediately following burning, but increase a few years postburn, probably in response to recovery of vegetation and absence of woody vegetation (Johnson 1997). Densities declined by 5 yr postburn. In the northern Great Plains, Western Meadowlark densities in prairie generally declined 1-2 yr postburn, but peaked 2-4 yr postburn (Forde et al. 1984, Pylypec 1991). However, in northern North Dakota, Western Meadowlark density peaked 1-3 yr postburn (Madden 1996). In one Saskatchewan field, densities 3 yr postburn were comparable to unburned areas (Pylypec 1991). In northern North Dakota, Western Meadowlarks were absent from unburned, native mixed-grass areas, but were present in areas subjected to repeated (e.g., every 3 yr) burning; prairies in which the last burn

was >80 yr ago did not attract Western Meadowlarks (Madden 1996, Madden et al. 1999). Abundance was highest in grasslands that had been burned four times in the previous 15 yr, compared to unburned areas and areas burned one to two times in the previous 15 yr. In South Dakota, use of native pastures burned in the spring increased during June and July to the extent that abundance was significantly higher in burned than in unburned prairie in July, and abundance was significantly higher in July than June in the burned prairie (Huber and Steuter 1984). In Nebraska, Western Meadowlarks were more abundant in pastures grazed by cattle than in a pasture grazed by American bison (*Bison bison*) and burned (Griebel et al. 1998). Within Idaho shrubsteppe, densities were higher 1-3 yr postburn than preburn; densities leveled off about 4 yr postburn (Petersen and Best 1987). In Montana, abundance was higher in burned than in unburned shrubsteppe (Bock and Bock 1987). Within burned areas, occupied sites contained significantly less grass and herbaceous cover than was available in the burned areas as a whole. Numbers of Western Meadowlarks in Wyoming shrubsteppe were significantly higher in untreated (i.e., unburned and not sprayed with herbicides) shrubsteppe than in burned shrubsteppe; no differences were detected between sprayed and burned areas or between sprayed and untreated areas (Kerley and Anderson 1995). Untreated areas contained higher shrub density, higher percent shrub cover, and taller shrubs than treated areas. Grazing intensity also was lower on untreated areas.

On native grasslands in North Dakota, Western Meadowlark density was highest in hayland mowed the previous year compared to grasslands under light, moderate, or heavy grazing (Kantrud 1981). In Saskatchewan, Western Meadowlarks consistently were found in annually mowed hayfields, and occasionally were found in periodically mowed (mowed some years, idled during other years) fields, but were most abundant in idle native grasslands (Dale et al. 1997). In southern Saskatchewan hayfields, number of pairs was not affected by amount of cropland or wetland within 1.6 km of study areas (McMaster et al. 1999). In Iowa alfalfa fields, density did not differ between unmowed fields and fields mowed in early June and again in mid-July, but territories were not entirely within alfalfa fields (Frawley and Best 1991). Western Meadowlarks nested in both first and second alfalfa crops; nest success was low due mainly to depredation (Frawley 1989). In Nebraska, Western Meadowlarks nesting in hayfields were unsuccessful because of disturbance caused by mowing (Ducey and Miller 1980). Emergency haying (haying due to severe drought) of CRP fields in the Midwest resulted in an increase in the herbaceous canopy cover and an increase in the proportion of grasses composing the herbaceous canopy in the following year (Hays and Farmer 1990); these vegetative changes were favored by meadowlarks (Eastern and Western meadowlarks combined).

Western Meadowlarks usually respond positively to light to moderate grazing and negatively to heavy grazing (Giezentanner 1970, Kantrud and Kologiski 1982, Bock et al. 1993), although they also may exhibit no response to grazing (Karasiuk et al. 1977, Renken 1983, Messmer 1990). In North Dakota, Western Meadowlarks preferred grazed fields over DNC, but showed no response to grazing intensities or to short-duration (involved a system of pastures rotated through a grazing schedule of about 1 wk grazed and 1 mo ungrazed, repeated throughout the season), twice-over rotation (involved grazing a number of pastures twice per season, with about a 2-mo rest in between grazing), or season-long (involved leaving cattle on the same pasture all season) grazing systems (Renken 1983; Messmer 1985, 1990). In mixed-grass prairie in South Dakota, Western Meadowlarks were more abundant in ungrazed areas than grazed areas (Wiens 1973). In Alberta, Western Meadowlark frequencies of occurrence did not differ significantly among four grazing treatments: early-season tame (grazed from late April to mid-

June), early-season native (grazed in early summer), deferred-grazed native (grazed after 15 July), and continuously grazed native (Dale and McKeating 1996, Prescott and Wagner 1996). Western Meadowlarks in Saskatchewan were equally abundant in grazed and ungrazed areas (Dale 1984). However, in another Saskatchewan study, Western Meadowlark density was three times higher in ungrazed than grazed grassland, although the species was common in both (Maher 1973, 1974). Western Meadowlarks in Alberta bred in both idle and grazed areas and tolerated any intensity of grazing (from light to heavy grazing), especially if some shrubs remained; they were abundant on mowed and cultivated areas as well (Owens and Myres 1973). In Alberta aspen parkland, Western Meadowlark abundance was greater in idle mixed-grass prairie than in continuously grazed prairie, although Western Meadowlarks were common in both (Prescott et al. 1995). In shortgrass pasture of Colorado, Western Meadowlarks nested in lightly to moderately summer- or winter-grazed shortgrass pastures, heavily winter-grazed pastures, and avoided heavily summer-grazed pastures (Giezentanner 1970, Porter and Ryder 1974, Wiens 1973, Ryder 1980). In Oklahoma, meadowlarks (Eastern and Western meadowlarks combined) nested more frequently in moderately grazed tallgrass pasture than in undisturbed prairie (Smith 1940). In southwestern Wisconsin, Western Meadowlarks were nearly equally abundant in rotationally grazed pastures, continuously grazed pastures, and ungrazed pastures (Temple et al. 1999). 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. Within shortgrass pastures of Arizona, Western Meadowlarks were absent from heavily grazed pastures where sheep had unlimited grazing access; they were common in moderately grazed pastures where sheep were kept at carrying capacity and where erosion by floodwater was controlled (Monson 1941). In Idaho, Western Meadowlarks nested in low numbers in ungrazed areas of big sagebrush (*Artemisia tridentata*) or crested wheatgrass, and did not nest in grazed areas of these habitats (Reynolds and Trost 1980). In Saskatchewan, Western Meadowlarks were common in lightly grazed crested wheatgrass (Sutter and Brigham 1998).

In North Dakota, abundance of Western Meadowlarks was higher in CRP than in Waterfowl Production Areas (tracts of grassland and wetland managed by the U. S. Fish and Wildlife Service to provide nesting and brood-rearing habitat for waterfowl) (Koford 1999). In Minnesota, they were absent from CRP and only one Western Meadowlark was recorded in WPA. In Iowa, Western Meadowlarks were abundant in CRP planted to tame grasses and legumes; abundance in CRP was positively correlated with vertical patchiness and negatively correlated with vertical vegetation cover (Patterson 1994, Patterson and Best 1996). Western Meadowlarks nested in CRP, but not in rowcrops (Patterson 1994). In Nebraska, there was no difference in meadowlark (Eastern and Western meadowlarks combined) abundance between agricultural landscapes with 20% CRP land and landscapes with <5% CRP, or between areas dominated by warm- or cool-season grasses (King and Savidge 1995, Delisle and Savidge 1997). In Kansas, meadowlarks (Eastern and Western meadowlarks combined) were more abundant in moderately grazed, annually burned tallgrass prairie than in native, annually burned CRP, possibly because invertebrate prey was more common in the grazed areas (Klute 1994). Six nests were found in pastures, and none in CRP (Klute et al. 1997). Western Meadowlarks were not common within Kansas native CRP, but the highest abundances occurred in fields with a high ($\geq$60%) frequency of occurrence of forbs (Hull et al. 1996). Nest density within native or

tame CRP fields in Texas did not differ by cover type (blue grama [*Bouteloua gracilis*]/sideoats grama [*Bouteloua curtipendula*], blue grama/Kleingrass [*Panicum coloratum*], and blue grama/Turkestan bluestem [*Andropogon ischaemum*]) (Berthelsen and Smith 1995).

In southern Canada, Western Meadowlarks occurred more frequently in PCP grasslands than in cropland (McMaster and Davis 1998). PCP was a Canadian program that paid farmers to seed highly erodible land to perennial grassland cover; it differed from CRP in the United States in that haying and grazing were allowed annually in PCP. In North Dakota, Western Meadowlark density was higher in grazed native prairie than in DNC planted to alfalfa and wheatgrass (*Agropyron* spp.); they also were found in formerly grazed fields that had been idle for 1 yr (Renken 1983, Renken and Dinsmore 1987). Western Meadowlark density was negatively correlated with vegetation height and forb cover (Renken 1983). In Saskatchewan, Western Meadowlarks were more common in idle native grasslands than in wheat or DNC (both native and tame) (Hartley 1994). In Manitoba, Western Meadowlarks were more abundant in idle native grasslands than native DNC (Dhol et al. 1994).

In South Dakota, few Western Meadowlarks occupied retired fields of corn or soybeans that were restored to native grasses (Blankespoor 1980). A 2-yr drought in combination with 1 yr of grazing on restored fields caused a decrease in effective plant height and in vertical and horizontal plant density; these vegetative changes were favored by Western Meadowlarks (Blankespoor 1980). In Iowa, Western Meadowlarks preferred no-tillage fields (idle in the fall and spring, and containing crop residue throughout the year) of corn or soybeans over conventionally-tilled fields (Basore et al. 1986). Western Meadowlarks were present in low numbers, and no nests were detected, in strip-intercropped fields (i.e., planting rowcrops, legumes, and small grains in a series of adjacent, narrow strips) (Stallman and Best 1996).

The effects of grasshopper (Orthoptera) control methods (malathion, carbaryl in oil, carbaryl bait, and *Nosema locustae* bait, a biological control agent) on Western Meadowlark density were evaluated in Colorado, Idaho, North Dakota, Utah, and Wyoming (George et al. 1995). Density declined 10 and 21 d post-treatment (all treatments combined), probably due to a reduction in insect prey. At the Pawnee National Grassland in Colorado, malathion and toxaphene were applied at rates of 0.6 kg/ha and 1.1 kg/ha, respectively (McEwen and Ells 1975). Western Meadowlarks suffered mortalities in grasslands that received toxaphene applications. In New Mexico, toxaphene applied at 1.1 kg/ha caused mortality and decline in numbers. No effects were observed from applications of 448 g/ha carbaryl or 476 g/ha malathion. Numbers declined significantly on guthion-treated plots at the 280 g/ha application. In North Dakota, brain levels of acetylcholinesterase (AChe) in Western Meadowlarks did not differ between areas treated with carbaryl bait and untreated areas (George et al. 1992). Carbaryl is an AChe-inhibiting chemical. In Wyoming, Western Meadowlark mortality was observed after fenthion, a chemical used to control mosquitoes (Culicidae), was aerially applied at a rate of 47 g/ha to an irrigated meadow (DeWeese et al. 1983). Mortality of eight Eastern and Western meadowlarks due to insecticides was reported in Oklahoma (Griffin 1959). In Montana, numbers of Western Meadowlarks were unaffected by application rates of 175 g/ha of BAY 77488* (phenylglyoxylonitrile oxime 0,0-diethyl phosphorothioate) (McEwen et al. 1972). Rates of 322 and 651 g/ha caused significant declines between pre- and post-spray censuses. Numbers

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

declined significantly on areas sprayed with 441 and 672 g/ha applications of fenitrothion. In Wyoming, diazinon applied at 350-560 g/ha caused mortality and significant declines in numbers. No significant declines were caused by Mobam* (benzo [b]thien-4-yl methylcarbamate) applied at 210 g/ha. In Montana and Wyoming, numbers did not decline significantly with the 140 g/ha rate of Baygon* (*o*-isopropoxyphenyl methylcarbamate) but did decline at 210 and 280 g/ha rates.

In a Colorado study examining the influence of recreational trails on the density of songbirds in mixed-grass prairie, Western Meadowlarks were significantly more abundant along control transects than along recreational trails (Miller et al. 1998). Abundance increased with increasing distance from trails. In a Saskatchewan study that examined whether the abundance of grassland birds differed between roadsides and trailsides, abundance of Western Meadowlarks was not significantly different along trailsides than along roadsides (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:

Avoid disturbance (burning, mowing, grazing, tilling, and chemical spraying) during the breeding season (Messmer 1985, Frawley 1989, Lanyon 1994, Patterson 1994, Patterson and Best 1996, Dale et al. 1997). Spray weeds on a spot-by-spot basis, and delay spraying until after the peak breeding season (Patterson 1994, Patterson and Best 1996, Delisle and Savidge 1997).

Protect large, native grassland areas and wet meadows from conversion to agricultural production; management of native grasslands can be accomplished through burning, mowing, and grazing (Kantrud 1981, Faanes and Lingle 1995, Helzer 1996, Prescott and Murphy 1996). Continue the Conservation Reserve Program to preserve nesting habitat in the Great Plains (Bock et al. 1993, Klute 1994, Patterson 1994, Patterson and Best 1996). Shape, as well as area, of management units must be taken into consideration; perimeter-area ratio strongly influenced occurrence of Western Meadowlarks in Nebraska (Helzer and Jelinski 1999).

Provide large blocks of grassland to reduce brood parasitism by Brown-headed Cowbirds, to reduce nest depredation (Johnson and Temple 1990, Klute 1994, Davis and Sealy 2000), and to decrease amount of edge adjacent to suburban development (Bock et al. 1999).

Place any trails near forest or grassland edges to limit the fragmentation of large blocks of habitat (Miller et al. 1998).

Treat (burn, graze, or mow) portions of large areas on a rotational schedule to provide a mosaic of successional stages (Renken and Dinsmore 1987, Madden 1996, Prescott and Murphy 1996, Dale et al. 1997, Johnson 1997). Treat small, isolated areas as part of a larger mosaic, ensuring a variety of successional stages (Renken and Dinsmore 1987, Madden 1996, Johnson 1997).

In mixed-grass prairie, conduct prescribed burns at varying intervals of time (2-3 yr, 4-7 yr, or 8-10 yr) to provide a mosaic of successional stages (Madden 1996). In tallgrass prairie, burn CRP fields every 3-5 yr to reduce dense vegetation (King and Savidge 1995).

Burn or mow road rights-of-way in blocks on a 3-5 yr rotational basis to maintain vegetation quality (Camp and Best 1993).

Control encroachment of woody vegetation (Faanes and Lingle 1995, Prescott and Murphy 1996). In order to increase nest productivity in tallgrass prairie fragments, remove woody vegetation to reduce edges and burn at least every 3 yr (Johnson and Temple 1990).

Mow hayfields in late summer (after 15 July) on a 3-5 yr rotational basis to maintain grass quality and improve habitat for the following year (Dale et al. 1997). Mowing of CRP fields should not be done more than every 3-5 yr, should be done in late summer, and should be followed by raking to reduce and loosen litter (Hays and Farmer 1990).

On CRP fields that have been seeded to tallgrass species, use grazing to improve the breeding habitat by reducing vegetation height, and by increasing canopy and forb coverage and invertebrate biomass (Klute 1994). Within shortgrass prairie, protect dry areas from grazing, and graze wet areas to increase species diversity and patchiness (Ryder 1980). Graze tame pastures in the spring to allow native pastures to recover from grazing; this improves habitat in the native pastures for Western Meadowlarks (Prescott and Wagner 1996). Increase the amount of public rangeland from which livestock are excluded, especially in the National Grasslands (Bock et al. 1993).

To avoid destroying nests and nestlings, undercut wheat stubble in the spring instead of using surface tillage (Rodgers 1983). In wheat-stubble fields, the tightly woven nest of Western Meadowlarks often protected eggs from rolling out during tillage with undercutter blades.

When pest management is required, use only rapidly degrading chemicals of low toxicity at the lowest application 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.

Table. Western Meadowlark 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	Occurred in native and tame pastures with equal frequency; abundance was positively associated with narrow-leaved grasses ≤10 cm tall and negatively associated with shrubs 20-100 cm tall
Basore et al. 1986	Iowa	Cropland, idle	Preferred to nest in untilled fields (idle in fall and spring and containing crop residue throughout the year) in which corn had been planted into sod residue, rather than in tilled fields or strip cover
Berthelsen and Smith 1995	Texas	Conservation Reserve Program (CRP; idle seeded-native, idle seeded-native/tame), cropland	Nested in CRP planted to blue grama (*Bouteloua gracilis*)/sideoats grama (*Bouteloua curtipendula*), blue grama/Kleingrass (*Panicum coloratum*), and blue grama/Turkestan bluestem (*Andropogon ischaemum*); density of meadowlarks was equal in all CRP cover types
Best et al. 1981	Iowa	Idle, woodland, woodland edge	Observed in herbaceous vegetation and woodland edge; density was negatively associated with sapling and tree species richness, horizontal patchiness of trees, and forb cover; density was positively associated with grass cover and the total of all life forms (life forms were defined as grass-like vegetation, forbs, shrubs, deciduous and evergreen trees, and vines) combined
Blankespoor 1980	South Dakota	Idle seeded-native, seeded-native pasture	Nested in areas with low vertical and horizontal plant density and effective plant height, and high vegetation evenness, caused by drought and grazing
Bock and Bock 1987	Montana	Burned shrubsteppe, idle shrubsteppe	Used burned and idle shrubsteppe; within burned site, used areas with significantly less grass and forb cover

			than occurred in random plots
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	Iowa	Cropland, idle tame, tame hayland	Nested in grassed waterways planted to smooth brome (*Bromus inermis*) in rowcrop fields
Cameron 1907	Montana	Idle shortgrass, idle shrubsteppe	Nested under sagebrush (*Artemisia*) or in grass clumps
Camp and Best 1993	Iowa	Burned seeded-native tallgrass/tame, burned tame, cropland, idle seeded-native tallgrass/tame, idle tame	Were common along road rights-of-way composed of grasses and sparse forbs; were uncommon in rowcrops
Dale 1983	Saskatchewan	Idle mixed-grass, mixed-grass pasture	Used open grassland areas with a range of vegetation heights and densities; avoided sparsely vegetated areas; avoided areas with extremely tall, dense cover
Dale 1984	Saskatchewan	Idle mixed-grass, mixed-grass pasture	No difference in density was found between grazed and idle areas
Dale et al. 1997	Saskatchewan	Idle mixed-grass, idle tame, tame hayland	Preferred native grassland to tame hayland; were more common in annually mowed hayland than in periodically mowed hayland (mowed in some years, idled during others)
Dale and McKeating 1996	Alberta,	Cropland, dense nesting	Exhibited no difference in abundance between areas

	Saskatchewan	cover (DNC; idle seeded-native, idle tame), hayland, mixed-grass pasture, tame pasture	subjected to complementary grazing (early-season grazing on crested wheatgrass [*Agropyron cristatum*], with cattle rotated through several native-grassland paddocks for the remainder of the summer) and areas subjected to season-long grazing
Davis and Duncan 1999	Saskatchewan	Mixed-grass pasture, tame pasture	Occurred in native and tame pastures with equal abundance; abundance was positively associated with needlegrass (*Stipa* spp.) and was negatively associated with Junegrass (*Koeleria pyramidata*)
Delisle and Savidge 1997	Nebraska	CRP (burned seeded-native, idle seeded-native, idle tame, seeded-native hayland, tame hayland)	Exhibited no difference in abundance between agricultural areas dominated by warm- or cool-season grasses; abundance was negatively correlated with litter depth
Dhol et al. 1994	Manitoba	DNC (idle seeded-native, idle tame), idle mixed-grass	Were more abundant and productive in mixed-grass prairie than native DNC (western wheatgrass [*Pascopyrum smithii*], thick-spike wheatgrass [*Agropyron dasystachyum*], streambank wheatgrass [*Agropyron riparium*], slender wheatgrass [*Agropyron caninum*], green needlegrass [*Stipa viridula*], big bluestem [*Andropogon gerardii*], switchgrass [*Panicum virgatum*], and purple prairie clover [*Dalea purpurea*]); were absent from tame DNC (tall wheatgrass [*Agropyron elongatum*], intermediate wheatgrass [*Agropyron intermedium*], slender wheatgrass, and alfalfa [*Medicago sativa*])
Ducey and Miller 1980	Nebraska	Cropland, idle, mixed-grass pasture, tame hayland	Nested in road rights-of-way, hayland, and pastures; nests in hayland were destroyed by mowing

Faanes and Lingle 1995	Nebraska	Cropland, idle mixed-grass, idle shortgrass, idle tallgrass, pasture, tame hayland, wetland, wet meadow, woodland	Highest densities were found in upland native prairie, followed by wet meadow, tame hayland, cropland, woodland, and river channel islands; densities were 6.5 times higher in native grasslands than in corn fields
Forde et al. 1984	South Dakota	Burned mixed-grass/tame, idle mixed-grass/tame	Density did not significantly decrease after burning, but began to increase 2-3 yr postburn
Frawley 1989, Frawley and Best 1991	Iowa	Tame hayland	Meadowlarks that hold territories that are only partially within alfalfa fields may be unaffected by mowing
George and McEwen 1991	North Dakota	Idle mixed-grass	Density was positively correlated with maximum vegetation height and average vegetation height, and was negatively correlated with shrub coverage; density also was negatively correlated with decreasing vertical density of vegetation and grass cover, and increasing vertical heterogeneity (variation in maximum height), shrub cover, and litter cover
Giezentanner 1970	Colorado	Cropland, hayland, idle, shortgrass pasture	Avoided heavily summer-grazed shortgrass pastures; preferred to nest in lightly to moderately summer- and winter-grazed areas; also nested in heavily winter-grazed areas
Hartley 1994	Saskatchewan	Cropland, DNC (idle seeded-native, idle seeded-native/tame, idle tame, idle tame hayland), idle mixed-grass	Preferred idle mixed-grass, but also nested in areas planted to DNC or wheat
Hull et al. 1996	Kansas	CRP (burned seeded-native, idle seeded-	Were uncommon in native CRP; highest abundance was

		native)	in fields with a high frequency of occurrence of forbs
Johnson 1997	North Dakota	Burned mixed-grass, burned tame, idle mixed-grass	Avoided recently burned areas; preferred grasslands 2-4 yr postburn; avoided grasslands 5 yr postburn
Kantrud 1981	North Dakota	Mixed-grass hayland, mixed-grass pasture	Preferred areas that were mowed the previous year
Kantrud and Kologiski 1982	Colorado, Montana, Nebraska North Dakota, South Dakota, Wyoming	Mixed-grass pasture, shortgrass pasture, shrubsteppe	Occurred in highest densities in areas with moderately grazed, typic ustoll soils; average percent bare ground on these soils was 8%, and average vegetation height was 23 cm; densities on lightly and moderately grazed areas were significantly higher than on heavily grazed areas; heavily grazed, aridic soils had an average of 17-25% bare ground and 8-10 cm average vegetation height
Kimmel et al. 1992	Minnesota	CRP (idle seeded-native/tame, seeded-native/tame hayland)	Abundance was positively correlated with percent of land in grassland cover
King and Savidge 1995	Nebraska	Burned tallgrass, cropland, CRP (burned seeded-native, idle seeded-native, idle tame, tame hayland), idle tallgrass, tallgrass hayland	Used CRP, tallgrass prairie, and cropland; no difference in abundance was found between landscapes with 20% CRP land and landscapes with <5% CRP land
Klute 1994, Klute et al. 1997	Kansas	Burned tallgrass pasture, CRP (burned seeded-native)	Preferred grazed pastures to CRP fields, possibly due to greater numbers of insect prey in pastures
Knick and Rotenberry	Idaho	Shrubsteppe	Occupancy increased dramatically where grasslands had

1995			sparse shrub cover (although shrubs were used as song perches); occupancy of an area was unrelated to landscape attributes (e.g., patch size)
Koford 1999	Minnesota, North Dakota	CRP (idle tame), Waterfowl Production Area (WPA; burned, hayland, idle native, idle native/tame, idle seeded-native, idle tame)	In North Dakota, were more abundant in CRP than in WPA; in Minnesota, were absent from CRP and only one meadowlark was recorded in WPA
Madden 1996	North Dakota	Burned mixed-grass, burned tame, idle mixed-grass, idle tame	Occupied areas had significantly higher frequencies of Kentucky bluegrass (*Poa pratensis*)/native grass (4.6%) and forb cover (32%), and significantly lower shrub cover (17%) and frequency of western snowberry (*Symphoricarpos occidentalis*) and silverberry (*Elaeagnus commutata*) shrubs (0.1%) compared to unoccupied areas; visual obstruction was lower (16 cm) on occupied areas than unoccupied areas (21 cm); best predictors of occurrence were high forb and grass cover
Maher 1973	Saskatchewan	Burned mixed-grass, idle mixed-grass, mixed-grass hayland, mixed-grass pasture	Density was three times greater in ungrazed grasslands as in grazed grasslands
Maher 1974	Saskatchewan	Cropland, idle mixed-grass, mixed-grass pasture, tame hayland, woodland	Were common in grazed and ungrazed plots, but densities were higher in ungrazed plots
McAdoo et al. 1989	Nevada	Shrubsteppe pasture, tame pasture	Abundance was negatively correlated with shrub density and positively correlated with percent herbaceous cover

McMaster and Davis 1998	Alberta, Manitoba, Saskatchewan	Cropland, Permanent Cover Program (PCP; idle tame, tame hayland, tame pasture)	Occurred more frequently in PCP fields than in cropland
McMaster et al. 1999	Saskatchewan	Hayland, PCP (tame hayland)	Amount of cropland or wetland within 1.6 km of study areas did not affect number of indicated pairs
Messmer 1985	North Dakota	Idle mixed-grass/tame, mixed-grass/tame pasture	Used grazed areas more than idle areas
Messmer 1990	North Dakota	Idle mixed-grass/tame, mixed-grass/tame hayland, mixed-grass/tame pasture, wet-meadow pasture	No significant difference in density was found between short duration (involved a system of pastures rotated through a grazing schedule of about 1 wk grazed and 1 mo ungrazed, repeated throughout the season), twice-over rotation (pastures grazed twice per season, with about a 2-mo rest in between grazing), or season-long (cattle remained on the same pasture all season) grazing systems
Miller et al. 1998	Colorado	Idle mixed-grass, woodland	Were significantly more abundant in areas where no trails existed than in areas near trails; abundance increased with increasing distance from trails
Monson 1941	Arizona	Shortgrass pasture	Were absent from heavily grazed areas and present on moderately grazed areas
Owens and Myres 1973	Alberta	Cropland, idle mixed-grass, mixed-grass hayland, mixed-grass pasture	Nested in idle and grazed areas; were common in wheat fields; tolerated light or heavy grazing if shrubs were present
Patterson 1994, Patterson and Best 1996	Iowa	Cropland, CRP (idle tame, tame hayland)	Preferred CRP over cropland; abundance was positively correlated with vertical patchiness and negatively

			correlated with vertical vegetation cover; spot mowing may increase use of CRP fields by providing open areas; average nest-site vegetation measurements were 31 cm vertical density (Robel pole), 53 cm live vegetation height, 67% grass cover, 39% forb cover, and 58% total canopy cover
Petersen and Best 1987	Idaho	Burned shrubsteppe, idle shrubsteppe	Were present both preburn and postburn, although densities were higher postburn; densities increased 1-3 yr postburn, and leveled off 4 yr postburn; densities remained constant on unburned shrubsteppe
Prescott and Murphy 1996	Alberta	Mixed-grass pasture, tame pasture	Preferred native grasses to tame grasses
Pylypec 1991	Saskatchewan	Burned mixed-grass, idle mixed-grass	Were less abundant on burned than unburned mixed-grass 2 yr postburn, but increased to equal abundances by 3 yr postburn
Renken 1983, Renken and Dinsmore 1987	North Dakota	DNC (idle tame), idle mixed-grass, mixed-grass pasture	Used idle and grazed native prairie, DNC planted to alfalfa and wheatgrass (*Agropyron* spp.), and areas in first year of rest after grazing, but preferred grazed areas; density was negatively correlated with vegetation height and forb cover
Reynolds and Trost 1980	Idaho	Idle shrubsteppe, idle tame, shrubsteppe pasture, tame pasture	Nested in ungrazed areas of big sagebrush (*Artemisia tridentata*) and crested wheatgrass, but not in grazed treatments
Rotenberry and Wiens 1980	Colorado, Kansas, Montana, Nebraska, Oklahoma, Oregon,	Idle mixed-grass, idle shortgrass, idle shrubsteppe, idle tallgrass, montane meadow	Abundance was positively correlated with the amount of variation in forb and shrub heights; abundance was negatively correlated with the amount of variation in height of nearest forb or shrub

	South Dakota, Texas, Washington, Wisconsin, Wyoming		
Ryder 1980	Colorado	Shortgrass pasture	Preferred lightly summer-grazed or winter-grazed shortgrass pastures; also were found on heavily winter-grazed pastures
Salt and Salt 1976	Alberta	Cropland, idle, idle grassland, parkland, pasture	Nested in pastures, idle grasslands, and road rights-of-way; foraged in cropland
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	Preferred treeless areas with short vegetation and high amounts of medium-density, prostrate residual cover; density was negatively correlated with maximum vegetation height and height/density; used areas had average values of 0.7% woody cover, 81% herbaceous cover, 14% litter cover, 5% bare ground, 44 cm maximum vegetation height, and 8 cm 100% vertical visual obstruction
Schneider 1998	North Dakota	Mixed-grass pasture, tame pasture, wet-meadow pasture	Abundance was positively associated with percent grass cover, litter depth, and density of low-growing shrubs (western snowberry and silverberry)
Smith and Smith 1966	Saskatchewan	Mixed-grass pasture	Three nests were on the ground and hidden in grasses 23 to 36 cm tall
Stauffer and Best 1980	Iowa	Hayland, idle, pasture, woodland, woodland	Were intolerant of habitat alteration; pastures and haylands were preferred over woody areas, thus removal of woody vegetation was beneficial; density

		edge	was positively correlated with species richness of grasses and of all vegetative life-forms combined; density was negatively correlated with sapling/tree richness, horizontal patchiness of trees, and forb species richness
Stewart 1975	North Dakota	Idle, idle mixed-grass, idle tallgrass, idle tame, tame hayland, wet meadow	Used mixed-grass and tallgrass prairie, wet meadows, tame haylands, idle tame grasslands, weedy field borders, retired cropland, and road rights-of-way
Strong 1971	Colorado	Idle, shortgrass pasture	Nested in tall grasses in disturbed areas such as road rights-of-way; preferred lightly to moderately grazed grassland for nesting
Sutter 1996	Saskatchewan	Idle mixed-grass, mixed-grass pasture, tame pasture	Within a moderately moist site with introduced vegetation, abundance was positively correlated with litter cover; within a moderately moist site with native vegetation, abundance was positively correlated with horizontal heterogeneity (variation in grass and sedge [*Carex*] cover); within a more arid site with introduced vegetation, abundance was positively correlated with litter depth; within a more arid site with native vegetation, abundance was negatively correlated with maximum vegetation height
Sutter and Brigham 1998	Saskatchewan	Mixed-grass pasture, tame pasture	Were common in lightly grazed crested wheatgrass; in this habitat, abundance was positively correlated with litter depth and the number of plant contacts from 0 to 10 cm from the ground; numbers of Western Meadowlarks were higher in areas with high percent grass and sedge cover and high maximum vegetation height than in areas with high litter depth and number of plant contacts >10 cm tall; in mixed-grass pastures,

			abundance was negatively correlated with maximum vegetation height and the number of plant contacts <10 cm tall; numbers of Western Meadowlarks were higher in areas with high percent grass and sedge cover and high maximum vegetation height than in areas with high litter depth and number of plant contacts >10 cm tall
Sutter et al. 2000	Saskatchewan	Mixed-grass pasture	Abundance in mixed-grass prairie was not significantly different along roadsides than along trailsides
Walcheck 1970	Montana	Shrubsteppe, woodland	Were found in areas with herbaceous and grass cover and widely dispersed shrubs; four nests were found next to plains prickly pear cactus (*Opuntia polyacantha*)
Wiens and Rotenberry 1981	Nevada, Oregon	Idle shrubsteppe	Density was positively correlated with grass, shrub, and litter cover, total vegetative cover, litter depth, and vertical vegetation structure (mean maximum height and number of plant contacts); density was negatively correlated with percent bare ground, dead vegetative cover, and horizontal heterogeneity (variation in maximum height of plant contacts and total number of plant contacts over the entire transect area); abundance was positively correlated with big sagebrush and increasing grass coverage; abundance was negatively correlated with increasing rockiness, dead vegetation coverage, and shrub diversity
Wilson and Belcher 1989	Manitoba	Idle mixed-grass, idle tame	Abundance was positively correlated with little bluestem (*Schizachyrium scoparium*); abundance was higher in mixed-grass than in tame 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

Anstey, D. A., S. K. Davis, D. C. Duncan, and M. Skeel. 1995. Distribution and habitat requirements of eight grassland songbird species in southern Saskatchewan. Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan. 11 pages.

Aweida, M. K. 1995. Repertoires, territory size and mate attraction in Western Meadowlarks. Condor 97:1080-1083.

Basore, N. S., L. B. Best, and J. B. Wooley. 1986. Bird nesting in Iowa no-tillage and tilled cropland. Journal of Wildlife Management 50:19-28.

Bent, A. C. 1965. Life histories of North American blackbirds, orioles, tanagers, and allies. Dover Publications, Inc., New York, New York. 549 pages.

Berthelsen, P. S., and L. M. Smith. 1995. Nongame bird nesting on CRP lands in Texas Southern High Plains. Journal of Soil and Water Conservation 50:672-675.

Best, L. B., D. F. Stauffer, A. R. Geier, K. L. Varland, J. P. Vogler, R. B. Dahlgren, and R. Q. Landers. 1981. Effects of habitat alterations on riparian plant and animal communities in Iowa. U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-81/26. 55 pages.

Blankespoor, G. W. 1980. Prairie restoration: effects on nongame birds. Journal of Wildlife Management 44:667-672.

Bock, C. E., and J. H. Bock. 1987. Avian habitat occupancy following fire in a Montana shrubsteppe. Prairie Naturalist 19:153-158.

Bock, C. E., J. H. Bock, and B. C. Bennett. 1995. The avifauna of remnant tallgrass prairie near Boulder, Colorado. Prairie Naturalist 27:147-157.

Bock, C. E., J. H. Bock, and B. C. Bennett. 1999. Songbird abundance in grasslands at a suburban interface on the Colorado High Plains. Pages 131-136 *in* P. D. Vickery and J. R. Herkert, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

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.

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.

Cable, T. T., R. L. Schroeder, V. Brack, Jr., and P. S. Cook. 1992. Summer bird use of Kansas windbreaks. Prairie Naturalist 24:175-184.

Cameron, E. S. 1907. The birds of Custer and Dawson counties, Montana. Auk 24:241-270 and 389-406.

Camp, M., and L. B. Best. 1993. Bird abundance and species richness in roadsides adjacent to Iowa rowcrop fields. Wildlife Society Bulletin 21:315-325.

Dale, B. C. 1983. Habitat relationships of seven species of passerine birds at Last Mountain Lake, Saskatchewan. M.S. thesis. University of Regina, Regina, Saskatchewan. 119 pages.

Dale, B. C. 1984. Birds of grazed and ungrazed grasslands in Saskatchewan. Blue Jay 42:102-105.

Dale, B. C., P. A. Martin, and P. S. Taylor. 1997. Effects of hay management regimes on songbirds in Saskatchewan. Wildlife Society Bulletin 25:616-626.

Dale, B. C., and G. McKeating. 1996. Finding common ground-the nongame evaluation of the North American Waterfowl Management Plan in Canada. Pages 258-265 *in* J. T. Ratti, editor. Proceedings of the seventh International Waterfowl Symposium.

Davis, S. K., and D. C. Duncan. 1999. Grassland songbird occurrence in native and crested wheatgrass pastures of southern Saskatchewan. Pages 211-218 *in* J. Herkert and P. Vickery, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

Davis, S. K., and S. G. Sealy. 2000. Cowbird parasitism and nest predation in fragmented grasslands of southwestern Manitoba. Pages 220-228 *in* J. N. M. Smith, T. L. Cook, S. I. Rothstein, S. K. Robinson, and S. G. Sealy, editors. Ecology and management of cowbirds and their hosts. University of Texas Press, Austin, Texas.

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.

De Smet, K. D. 1992. Manitoba's threatened and endangered grassland birds: 1991 update and five-year summary. Manuscript report 92-03, Manitoba Natural Resources, Winnipeg, Manitoba. 77 pages.

DeWeese, L. R., C. Lowell, L. A. S. McEwen, and R. D. Deblinger. 1983. Effects on birds of fenthion aerial application for mosquito control. Journal of Economic Entomology 76:906-911.

Dhol, S., J. Horton, and R. E. Jones. 1994. 1994 non-waterfowl evaluation of Manitoba’s North American Waterfowl Management Plan. Unpublished report. Wildlife Branch, Manitoba Department of Natural Resources, Winnipeg, Manitoba. 12 pages.

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.

Ducey, J., and L. Miller. 1980. Birds of an agricultural community. Nebraska Bird Review 48:58-68.

Faanes, C. 1983. Breeding birds of wooded draws in western North Dakota. Prairie Naturalist 15:173-187.

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 16JUL97).

Forde, J. E., N. F. Sloan, and D. A. Shown. 1984. Grassland habitat management using prescribed burning in Wind Cave National Park, South Dakota. Prairie Naturalist 16:97-110.

Frawley, B. J. 1989. The dynamics of nongame bird breeding ecology in Iowa alfalfa fields. M.S. thesis. Iowa State University, Ames, Iowa. 94 pages.

Frawley, B. J., and L. B. Best. 1991. Effects of mowing on breeding bird abundance and species composition in alfalfa fields. Wildlife Society Bulletin 19:135-142.

George, T. L., and L. C. McEwen. 1991. Relationships between bird density, vegetation characteristics, and grasshopper density in mixed-grass prairie of western North Dakota. Pages 465-475 *in* D. R. McCullough and R. H. Barrett, editors. Wildlife 2001: populations. Elsevier Science Publishers LTD, Essex, England.

George, T. L., L. C. McEwen, and A. Fowler. 1992. Effects of a carbaryl bait treatment on nontarget wildlife. Environmental Entomology 21:1239-1247.

George, T. L., L. C. McEwen, and B. E. Peterson. 1995. Effects of grasshopper control programs on rangeland breeding bird populations. Journal of Range Management 48:336-342.

Giezentanner, J. B. 1970. Avian distribution and population fluctuations on the shortgrass prairie on north central Colorado. M.S. thesis. Colorado State University, Fort Collins, Colorado. 113 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.

Griebel, R. L., S. L. Winter, and A. A. Steuter. 1998. Grassland birds and habitat structure in sandhills prairie management using cattle or bison plus fire. Great Plains Research 8:255-268.

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

Hartley, M. J. 1994. Passerine abundance and productivity indices in grasslands managed for waterfowl nesting cover. Transactions of the North American Wildlife and Natural Resources Conference 59:322-327.

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.

Hergenrader, G. L. 1962. The incidence of nest parasitism by Brown-headed Cowbird (*Molothrus ater*) on roadside nesting birds in Nebraska. Auk 79:85-88.

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.

Hill, R. A. 1976. Host-parasite relationships of the Brown-headed Cowbird in a prairie habitat of west-central Kansas. Wilson Bulletin 88:555-565.

Huber, G. E., and A. A. Steuter. 1984. Vegetation profile and grassland bird response to spring burning. Prairie Naturalist 16:55-61.

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.

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.

Johnson, D. H. 1997. Effects of fire on bird populations in mixed-grass prairie. Pages 181-206 *in* F. L. Knopf and F. B. Samson, editors. Ecology and conservation of Great Plains vertebrates. Springer-Verlag, New York, New York.

Johnson, R. G., and S. A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies. Pages 245-249 *in* J. Verner, M. L. Morrison, and C. J. Ralph, editors. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, Wisconsin.

Johnson, R. G., and S. A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. Journal of Wildlife Management 54:106-111.

Kantrud, H. A. 1981. Grazing intensity effects on the breeding avifauna of North Dakota native grasslands. Canadian Field-Naturalist 95:404-417.

Kantrud, H. A., and R. L. Kologiski. 1982. Effects of soils and grazing on breeding birds of uncultivated upland grasslands of the northern Great Plains. U.S. Fish and Wildlife Service, Wildlife Research Report 15. 33 pages.

Karasiuk, D., H. Vriend, J. G. Stelfox, and J. R. McGillis. 1977. Avifauna: study results from Suffield, 1976. Pages 33-44 *in* J. G. Stelfox, editor. Effects of livestock grazing on mixed prairie range and wildlife within PFRA pastures, Suffield Military Reserve.

Kendeigh, S. C. 1941. Birds of a prairie community. Condor 43:165-174.

Kerley, L. L., and S. H. Anderson. 1995. Songbird responses to sagebrush removal in a high elevation sagebrush steppe ecosystem. Prairie Naturalist 27:129-146.

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.

Klimkiewicz, M. K. and A. G. Futcher. 1987. Longevity records of North American birds: Coerebinae through Estrildidae. Journal of Field Ornithology 58:318-333.

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. 1979. Birds of the Gainsborough-Lyleton region. Saskatchewan Natural History Society Special Publication 10. 72 pages.

Knick, S. T., and J. T. Rotenberry. 1995. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. Conservation Biology 9:1059-1071.

Koford, R. R. 1999. Density and fledging success of grassland birds in Conservation Reserve Program fields in North Dakota and west-central Minnesota. Pages 187-195 *in* P. D. Vickery and J. R. Herkert, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

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. 1994. Western Meadowlark (*Sturnella neglecta*). *In* A. Poole and F. Gill, editors. The birds of North America, No. 104. The Academy of Natural Sciences, Philadelphia, Pennsylvania; The American Ornithologists' Union, Washington, D.C.

Laubach, R. 1984. Breeding birds of Sheeder Prairie Preserve, west-central Iowa. Proceedings of the Iowa Academy of Science 91:153-163.

Madden, E. M. 1996. Passerine communities and bird-habitat relationships on prescribe-burned, mixed-grass prairie in North Dakota. M.S. thesis. Montana State University, Bozeman, Montana. 153 pages.

Madden, E. M., A. J. Hansen, and R. K. Murphy. 1999. Influence of prescribed fire history on habitat and abundance of passerine birds in northern mixed-grass prairie. Canadian Field-Naturalist 113:627-640.

Maher, W. J. 1973. Matador Project: Birds I. Population dynamics. Canadian Committee for the International Biological Programme, Matador Project, Technical Report 34. University of Saskatchewan, Saskatoon, Saskatchewan. 56 pages.

Maher, W. J. 1974. Matador Project: Birds II. Avifauna of the Matador area. Canadian Committee for the International Biological Programme, Matador Project, Technical Report 58. University of Saskatchewan, Saskatoon, Saskatchewan. 31 pages.

McAdoo, J. K., W. S. Longland, and R. A. Evans. 1989. Nongame bird community responses to sagebrush invasion of crested wheatgrass seedings. Journal of Wildlife Management 53:494-502.

McEwen, L. C., and J. O. Ells. 1975. Field ecology investigations of the effects of selected pesticides on wildlife populations. U.S. International Biological Program, Grassland Biome Technical Report 289. Colorado State University, Fort Collins, Colorado. 36 pages.

McEwen, L. C., C. E. Knittle, and M. L. Richmond. 1972. Wildlife effects from grasshopper insecticides sprayed on short-grass range. Journal of Range Management 25:188-194.

McMaster, D. G., and S. K. Davis. 1998. Non-game evaluation of the Permanent Cover Program. Unpublished report. Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan. 75+ pages.

McMaster, D. G., J. H. Devries, and S. K. Davis. 1999. An integrated evaluation of cropland conversion in the Missouri Coteau of Saskatchewan: productivity of pintail and other grassland birds. Unpublished report. Saskatchewan Wetland Conservation Corporation,

Regina, Saskatchewan; Institute for Wetland and Waterfowl Research, Oak Hammock Marsh, Manitoba; Ducks Unlimited Canada, Oak Hammock Marsh, Manitoba.

Messmer, T. A. 1985. Effects of specialized grazing systems on upland nesting birds in southcentral North Dakota. M.S. thesis. North Dakota State University, Fargo, North Dakota. 112 pages.

Messmer, T. A. 1990. Influence of grazing treatments on nongame birds and vegetation structure in south central North Dakota. Ph.D. dissertation. North Dakota State University, Fargo, North Dakota. 164 pages.

Miller, S. G., R. L. Knight, and C. K. Miller. 1998. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Monson, G. 1941. The effect of revegetation on the small bird population in Arizona. Journal of Wildlife Management 5:395-397.

National Geographic Society. 1987. Field guide to the birds of North America, second edition. National Geographic Society, Washington, D.C. 464 pages.

Owens, R. A., and M. T. Myres. 1973. Effects of agriculture upon populations of native passerine birds of an Alberta fescue grassland. Canadian Journal of Zoology 51:697-713.

Patterson, M. P. 1994. Bird species abundance, composition, and vegetation characteristics, and bird productivity in Conservation Reserve Program land in central Iowa. M.S. thesis. Iowa State University, Ames, Iowa. 54 pages.

Patterson, M. P., and L. B. Best. 1996. Bird abundance and nesting success in Iowa CRP fields: the importance of vegetation structure and composition. American Midland Naturalist 135:153-167.

Petersen, K. L., and L. B. Best. 1987. Effects of prescribed burning on nongame birds in a sagebrush community. Wildlife Society Bulletin 15:317-329.

Porter, D. K., and R. A. Ryder. 1974. Avian density and productivity studies and analyses on the Pawnee Site in 1972. U.S. International Biological Program, Grassland Biome Technical Report 252. Colorado State University, Fort Collins, Colorado. 77 pages.

Prescott, D. R. C. 1997. Avian communities and NAWMP habitat priorities in the northern prairie biome of Alberta. NAWMP-029. Land Stewardship Centre of Canada, St. Albert, Alberta. 41 pages.

Prescott, D. R. C., and A. J. Murphy. 1996. Habitat associations of grassland birds on native and tame pastures of the aspen parkland in Alberta. NAWMP-021. Alberta NAWMP Centre, Edmonton, Alberta. 36 pages.

Prescott, D. R. C., A. J. Murphy, and E. Ewaschuk. 1995. An avian community approach to determining biodiversity values of NAWMP habitats in the aspen parkland of Alberta. NAWMP-012. Alberta NAWMP Centre, Edmonton, Alberta. 58 pages.

Prescott, D. R. C., and G. M. Wagner. 1996. Avian responses to implementation of a complementary/rotational grazing system by the North American Waterfowl Management Plan in southern Alberta: the Medicine Wheel Project. NAWMP-018. Alberta NAWMP Centre, Edmonton, Alberta. 24 pages.

Pylypec, B. 1991. Impacts of fire on bird populations in a fescue prairie. Canadian Field-Naturalist 105:346-349.

Renken, R. B. 1983. Breeding bird communities and bird-habitat associations on North Dakota waterfowl production areas of three habitat types. M.S. thesis. Iowa State University, Ames, Iowa. 90 pages.

Renken, R. B., and J. J. Dinsmore. 1987. Nongame bird communities on managed grasslands in North Dakota. Canadian Field-Naturalist 101:551-557.

Reynolds, T. D., and C. H. Trost. 1980. The response of native vertebrate populations to crested wheatgrass planting and grazing by sheep. Journal of Range Management 33:122-125.

Rodgers, R. D. 1983. Reducing wildlife losses to tillage in fallow wheat fields. Wildlife Society Bulletin 11:31-38.

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.

Ryder, R. A. 1980. Effects of grazing on bird habitats. Pages 51-66 *in* R. M. DeGraff and N. G. Tilghman, editors. Management of western forests and grasslands for nongame birds, U.S.D.A. Forest Service, General Technical Report INT-86.

Salt, W. R., and J. R. Salt. 1976. The birds of Alberta. Hurtig Publishers, Edmonton, Alberta. 498 pages.

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.

Saskatchewan Wetland Conservation Corporation (SWCC). 1997. Grassland bird conservation through Saskatchewan's native prairie stewardship program. Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan. 25 pages.

Schaeff, C., and J. Picman. 1988. Destruction of eggs by Western Meadowlarks. Condor 90:935-937.

Schneider, N. A. 1998. Passerine use of grasslands managed with two grazing regimes on the Missouri Coteau in North Dakota. M.S. thesis. South Dakota State University, Brookings, South Dakota. 94 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.

Silloway, P. M. 1917. Some nesting birds of the Judith Basin, Montana, No. 2. Oologist 34:42-45.

Skeel, M. A., D. C. Duncan, and S. D. Davis. 1995. Abundance and distribution of Baird's Sparrows in Saskatchewan. Saskatchewan Wetland Conservation Corporation, Regina, Saskatchewan. 13+ 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.

Smith, H., and J. Smith. 1966. A breeding bird survey on uncultivated grassland at Regina. Blue Jay 24:129-131.

Stallman, H. R., and L. B. Best. 1996. Bird use of an experimental strip intercropping system in northeast Iowa. Journal of Wildlife Management 60:354-362.

Stauffer, D. F., and L. B. Best. 1980. Habitat selection by birds of riparian communities: evaluating effects of habitat alterations. Journal of Wildlife Management 44:1-15.

Stewart, R. E. 1975. Breeding birds of North Dakota. Tri-College Center for Environmental Studies, Fargo, North Dakota. 295 pages.

Strong, M. A. 1971. Avian productivity on the shortgrass prairie of northcentral Colorado. M.S. thesis. Colorado State University, Fort Collins, Colorado. 70 pages.

Sutter, G. C. 1996. Habitat selection and prairie drought in relation to grassland bird community structure and the nesting ecology of Sprague's Pipit, *Anthus spragueii*. Ph.D. dissertation. University of Regina, Regina, Saskatchewan. 144 pages.

Sutter, G. C. and R. M. Brigham. 1998. Avifaunal and habitat changes resulting from conversion of native prairie to crested wheatgrass: patterns at songbird community and species levels. Canadian Journal of Zoology 76:869-875.

Sutter, G. C., S. K. Davis, and D. C. Duncan. 2000. Grassland songbird abundance along roads and trails in southern Saskatchewan. Journal of Field Ornithology 71:110-116.

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.

Walcheck, K. C. 1970. Nesting bird ecology of four plant communities in the Missouri River breaks, Montana. Wilson Bulletin 82:370-382.

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

Wiens, J. A. 1970. Avian populations and patterns of habitat occupancy at the Pawnee site, 1968-1969. U.S. International Biological Program, Grassland Biome Technical Report 63. Colorado State University, Fort Collins, Colorado. 57 pages.

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. 1973. Pattern and process in grassland bird communities. Ecological Monographs 43:237-270.

Wiens, J. A., and J. T. Rotenberry. 1981. Habitat associations and community structure in shrubsteppe environments. Ecological Monographs 51:21-41.

Wiens, J. A., J. T. Rotenberry, and B. Van Horne. 1987. Habitat occupancy patterns of North American shrubsteppe birds: the effect of spatial scale. Oikos 48:132-147.

Wilson, S. D., and J. W. Belcher. 1989. Plant and bird communities of native prairie and introduced Eurasian vegetation in Manitoba, Canada. Conservation Biology 3:39-44.