

The Effects of Management Practices on Grassland Birds— Henslow's Sparrow (*Centronyx henslowii*)

Chapter II of

The Effects of Management Practices on Grassland Birds



Professional Paper 1842—II

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Background photograph: Northern mixed-grass prairie in North Dakota, by Rick Bohn, used with permission.

The Effects of Management Practices on Grassland Birds—Henslow's Sparrow (*Centronyx henslowii*)

By James R. Herkert^{1,2}

Chapter II of

The Effects of Management Practices on Grassland Birds

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Professional Paper 1842—II

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
Area		
hectare (ha)	2.471	acre
square kilometer (km ²)	247.1	acre
hectare (ha)	0.003861	square mile (mi ²)
square kilometer (km ²)	0.3861	square mile (mi ²)

Abbreviations

BBS	Breeding Bird Survey
CRP	Conservation Reserve Program
dbh	diameter at breast height
n.d.	no date
TPP	Tallgrass Prairie Preserve

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The Effects of Management Practices on Grassland Birds—Henslow’s Sparrow (*Centronyx henslowii*)

By James R. Herkert^{1,2}

Capsule Statement

Keys to Henslow’s Sparrow (*Centronyx henslowii*) management are providing large grasslands with tall, dense, herbaceous vegetation and well-developed litter; avoiding habitat disturbances during the breeding season; and controlling plant succession. Henslow’s Sparrows have been reported to use habitats with less than or equal to (\leq) 122 centimeters (cm) average vegetation height, 25–80 cm visual obstruction reading, 35–51 percent grass cover, 10–55 percent forb cover, \leq 2 percent shrub cover, \leq 5 percent bare ground, 15–30 percent litter cover, and less than ($<$) 13 cm litter depth. The descriptions of key vegetation characteristics from the literature are provided in table III (after the “References” section). Vernacular and scientific names of plants and animals follow the Integrated Taxonomic Information System (<https://www.itis.gov>), except for the genus of the Henslow’s Sparrow, which follows the 59th Supplement to the American Ornithological Society’s Check-list of North American Birds (Chesser and others, 2018).

Breeding Range

Henslow’s Sparrows breed from southern Minnesota through Wisconsin and Michigan to southern Ontario; south to northeastern Oklahoma, Illinois, and Kentucky; and east to eastern North Carolina and New Hampshire (National Geographic Society, 2011). The relative densities of Henslow’s Sparrows in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data (Sauer and others, 2014), are shown in figure III (not all geographic places mentioned in report are shown on figure). In recent years, the species has been reported nesting north and west of the species’ historical breeding range (Igl, 2002; Shaffer and others, 2003; Kim, 2005).



Henslow’s Sparrow. Illustration by Patsy D. Renz, used with permission.

Suitable Habitat

Henslow’s Sparrows use grasslands with a well-developed litter layer, tall and dense vegetation, high coverage of standing dead residual vegetation, and generally small woody stem densities (Wiens, 1969; Robins, 1971; Skinner, 1974; Rotenberry and Wiens, 1980; Hands and others, 1989; Sample, 1989; Herkert, 1991; Hanson, 1994; Mazur, 1996; Michaels, 1997; Cully and Michaels, 2000; Scott and others, 2002). Henslow’s Sparrow habitat also generally has a large percentage of grass cover and scattered forbs for song perches (Wiens, 1969; Robins, 1971; Skinner and others, 1984; Herkert, 1994a; Winter, 1998; Scott and others, 2002).

Henslow’s Sparrows inhabit tallgrass and mixed-grass prairies and wet meadows (Hands and others, 1989; Helzer, 1996; Koford, 1997; Helzer and Jelinski, 1999; Shaffer and others, 2003; Herkert and others, 2018). The species also inhabits idle hayfields, Conservation Reserve Program (CRP) fields, and reclaimed coal mines (Graber and Graber, 1963; Bajema and others, 2001; Igl, 2002; Roth and others, 2005; Herkert, 2007; Ribic and others, 2009a; Negus and others, 2010; Ellison and others, 2013). In remnant tallgrass prairie

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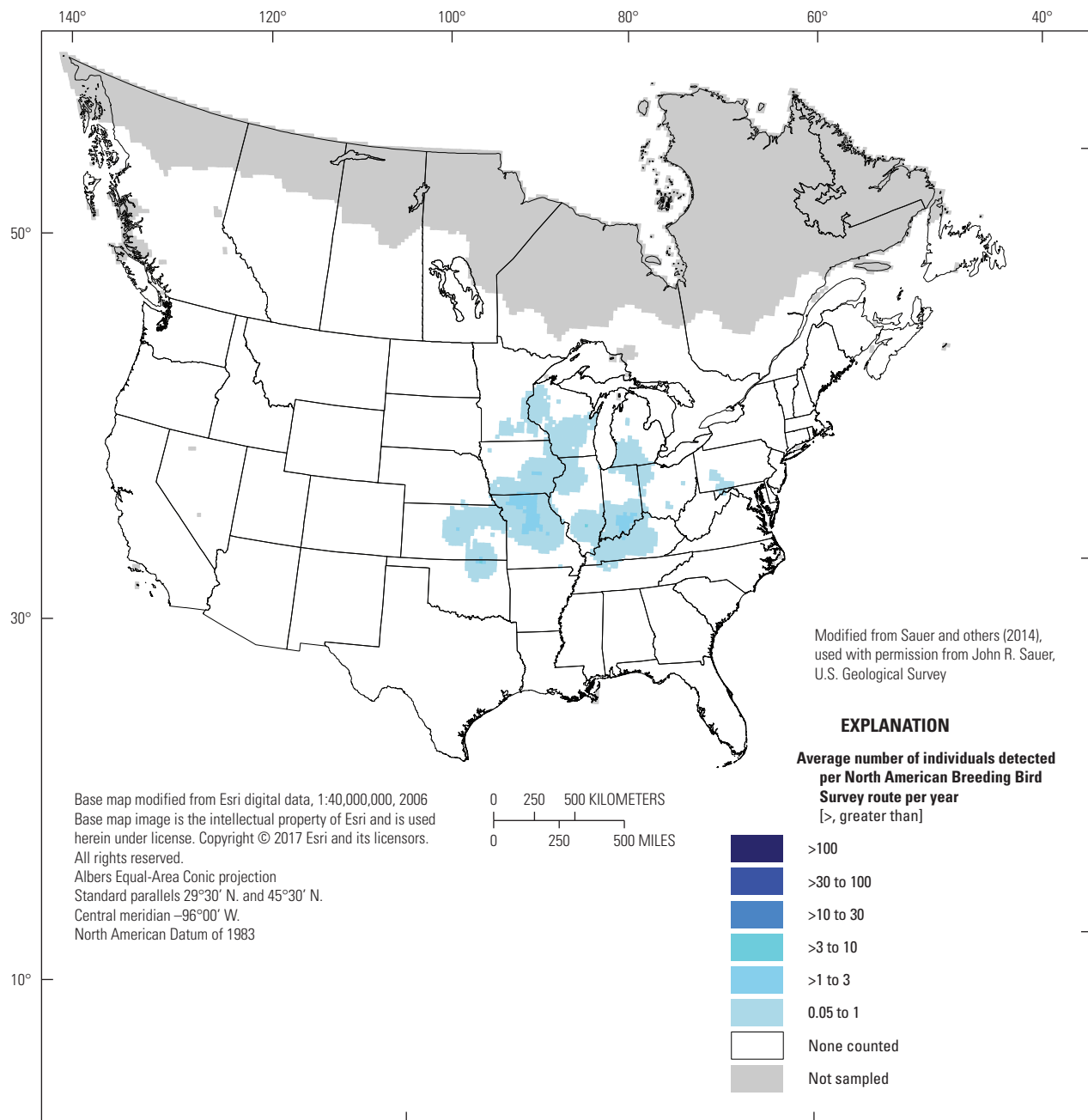


Figure II1. The breeding distribution of the Henslow's Sparrow (*Centronyx henslowii*) in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data, 2008–12. The BBS abundance map provides only an approximation of breeding range edges.

fragments and reconstructed grasslands in western Minnesota and northwestern Iowa, Ahlring and others (2019) reported that publicly owned lands supported more Henslow's Sparrows than privately owned lands.

Litter cover and vegetation height-density are important components of suitable breeding habitat for Henslow's Sparrows. In Missouri grasslands, Henslow's Sparrow abundance was higher in grasslands with greater litter depth and vegetation height-density (Jacobs and others, 2012). Predicted counts increased 68 and 50 percent over the increasing ranges

of the height of dead vegetation (0–60 cm) and vegetation height-density (0–60 cm), respectively. In Missouri and Iowa grasslands, Henslow's Sparrow densities were positively associated with percentage of litter cover and vegetation height-density (Pillsbury, 2010). In Oklahoma, Henslow's Sparrow abundance was positively associated with litter cover (Coppedge and others, 2008). In restored tallgrass prairies in Iowa, Henslow's Sparrows were not observed until 6 years after restoration (Olechnowski and others, 2009). Fields of this age had greater litter depth, vegetation height-density, and

grass cover than more recently restored fields. In reclaimed coal-mine grasslands in southwestern Indiana, male Henslow's Sparrows preferred sites with tall, dense, grass-dominated vegetation with substantial litter (Bajema and others, 2001). In southern Indiana, daily nest survival increased with the height of standing dead vegetation, although the relationship was weak (Crimmins and others, 2016).

Henslow's Sparrows will use both native and tame grasslands during the breeding season and sometimes have been reported to favor one over the other. In Wisconsin, Illinois, and Missouri, no apparent preference was indicated for either native, warm-season grasses or tame, cool-season grasses (Sample, 1989; Herkert, 1994a; Jaster and others, 2013); however, Birkenholz (1973) reported that the species was most common in native grasses and avoided a nearby field of Kentucky bluegrass (*Poa pratensis*) at one Illinois site. In Missouri, Henslow's Sparrows were more abundant in CRP grasslands planted to cool-season grasses than in fields planted to warm-season grasses (McCoy and others, 2001). In another Missouri study, Henslow's Sparrow abundance was higher in hayed native prairie than in hayed tame grasslands, warm-season or cool-season CRP fields, or grazed native or tame grasslands (Jacobs and others, 2012). Skinner (1975) did not detect Henslow's Sparrows in either tame or native Missouri hayfields.

Studies are generally inconclusive regarding the amount of woody vegetation that Henslow's Sparrows will tolerate, although studies commonly indicate that continued encroachment by woody vegetation eventually precludes use by this species (Piehler, 1987; Smith, 1992; Melde and Koford, 1996; Pruitt, 1996). Several studies have indicated that Henslow's Sparrows use areas with low density of woody vegetation (Peterson, 1983; Kahl and others, 1985; Zimmerman, 1988; Mazur, 1996; Michaels, 1997; Winter, 1998, 1999; Cully and Michaels, 2000). Henslow's Sparrow territories in Pennsylvania did not include any shrub cover (Piehler, 1987). At one site in northeastern Illinois, areas not occupied by Henslow's Sparrows had 70 percent higher densities of tall (greater than [$>$] 2 meters [m]) shrubs and trees than occupied areas (Herkert and Glass, 1999), but in another Illinois study, no relationship was detected between species occurrence and woody stem densities for shrubs <2 m tall (Herkert, 1994b). In a Minnesota study, no difference was indicated in the number of trees, shrubs, and bushes between areas used and areas not used by Henslow's Sparrows (Hanson, 1994). In Missouri, the species used grasslands that did not have woody stems >2.5 -cm diameter at breast height (dbh) and had few woody stems <2.5 -cm dbh (Kahl and others, 1985). In southwestern Missouri, dense cover of woody vegetation substantially lowered survival of Henslow's Sparrow fledglings, and fledglings avoided using areas containing woody vegetation during both their dependent and independent stages (Young and others, 2019). In another Missouri study, Henslow's Sparrow abundance decreased as shrub coverage increased (Jacobs and others, 2012). In Wisconsin, a positive correlation was detected between Henslow's Sparrow abundance and woody cover

shorter than 1 m; however, despite this positive correlation, percentage of woody cover shorter than 1 m at occupied sites was small (0.79 percent), as was total woody cover (1.69 percent) (Sample, 1989).

Elevated song perches may be an important component of suitable habitat. In Michigan, Henslow's Sparrows required available song perches (Robins, 1971). In Missouri, the species sang from dead woody vegetation <1 m tall (Kahl and others, 1985); however, in Wisconsin, Henslow's Sparrow territories did not contain posts, fence lines, or trees (Wiens, 1969).

Climatic factors may affect the abundance of Henslow's Sparrows. From an analysis of BBS data from Minnesota, Wisconsin, Michigan, Illinois, Indiana, and Iowa, Thogmartin and others (2006) indicated that variation in annual precipitation, mean temperature during the driest season, and total warm-season precipitation were important factors affecting Henslow's Sparrow abundance. Henslow's Sparrow abundance increased as variation in annual precipitation decreased, mean temperature during the driest season decreased, and total warm season precipitation increased. In another assessment of BBS data, O'Connor and others (1999) reported a negative relationship between Henslow's Sparrow abundance and the 30-year average for July temperature. In a 6-year study in Illinois, Henslow's Sparrow abundance tended to increase in years when spring precipitation in the current year exceeded that of the preceding year and to decline in years when spring precipitation declined (Herkert and Glass, 1999). In a meta-analysis of nesting studies throughout the Henslow's Sparrow's breeding range, McCauley and others (2017) reported that nest success was sensitive to interannual variation in temperature and precipitation, resulting in elevated nest-success rates during warmer and wetter breeding seasons. Precipitation had a larger relative effect than temperature.

Henslow's Sparrow nest sites usually are well-concealed and near the ground. In Kansas, one nest was woven into dried stems 10.2 cm above the ground (Schulenberg and others, 1994). In Missouri, the species placed nests about 6–8 cm above the ground, and most nests were concealed by litter and vegetation (Winter, 1998). In Oklahoma tallgrass prairies, mean nest height was 11.8 cm above the ground (Reinking and others, 2009).

Area Requirements and Landscape Associations

Nesting territories of male Henslow's Sparrows are small (0.18–1.0 hectare [ha]) (Wiens, 1969; Robins, 1971; Piehler, 1987; O'Leary and Nyberg, 2000; Jaster and others, 2013; Young and others, 2019). In southwestern Missouri, Young and others (2019) reported that the average size (about 0.29 ha) of adult nesting territories was substantially smaller than the average size (about 1.5 ha) of areas used by dependent Henslow's Sparrow fledglings.

Grassland size has been identified as an important component of suitable habitat for Henslow's Sparrows (Bollinger, 1991, 1995; Smith and Smith, 1992; Herkert, 1994a, 1994b; Mazur, 1996; Swengel, 1996; Winter, 1996). Henslow's Sparrows are more common in large grasslands and occupy them first in spring (Mazur, 1996), but Henslow's Sparrows also have been reported nesting in small (<50 ha) grasslands (Robins, 1971; Hanson, 1994; Mazur, 1996; Winter, 1996, 1998). However, Henslow's Sparrows are more likely to be encountered, and densities may be higher, in large grassland areas than in small areas (Herkert 1994a, 1994b; Bollinger, 1995; Mazur, 1996; Swengel, 1996; Winter, 1996, 1998; Winter and Faaborg, 1999; Swengel and Swengel, 2001; Ribic and others, 2009b), and large grasslands may be needed to support viable populations (Pruitt, 1996).

In Kansas and New York, Henslow's Sparrows were observed in areas with >30 ha of contiguous grassland (Zimmerman, 1988; Smith and Smith, 1992; Mazur, 1996). In Illinois, the estimated area required for Henslow's Sparrows to be detected 50 percent of the time was >55 ha (Herkert, 1994b). In a Kansas study, the abundance of Henslow's Sparrows did not differ among six sites varying in area (mean area=36.3 ha) or perimeter length (mean perimeter length=5,323.8 m) (Applegate and others, 2002). Within reclaimed coal-mine grasslands in Indiana, Henslow's Sparrow abundance was not significantly correlated with the total area of grassland habitat or suitable Henslow's Sparrow habitat within a mine, nor with size or shape of contiguous blocks of suitable habitat within mines, although the species tended to avoid habitat edges. In the Upper Midwest, Henslow's Sparrow abundance was associated with grassland patch size (Thogmartin and others, 2006).

Few studies have investigated the effect of grassland patch size on Henslow's Sparrow nest success and other demographic parameters. In Illinois, Kansas, Oklahoma, Missouri, and North Dakota, Brown-headed Cowbird (*Molothrus ater*) parasitism of Henslow's Sparrow nests was not related to grassland patch size, but nest depredation was negatively related to grassland patch size (Herkert and others, 2003). In Missouri, nesting success did not differ with the size of tallgrass prairie fragments (Winter, 1996).

The isolation of grassland fragments also may affect the distribution and abundance of Henslow's Sparrows. In tallgrass prairie fragments in Missouri, density of Henslow's Sparrows decreased as distance between grassland patches increased (Winter, 1998). In another Missouri study, Henslow's Sparrows were absent from a 28-ha isolated prairie fragment but were present in a 16-ha fragment that was 1.6 kilometers (km) from a larger prairie where Henslow's Sparrows were present (Hayden, 1985). In tallgrass prairie patches near Chicago, Illinois, Henslow's Sparrow densities were unaffected by a gradient of urbanization (Buxton and Benson, 2016).

Henslow's Sparrows may be affected by proximity to edges. Following the removal of tree row edges in CRP fields in Wisconsin, Henslow's Sparrow densities were two to four

times higher in the CRP fields than on pretreatment or control sites, and the species nested within 50 m of removal areas where the species previously had not been recorded (Ellison and others, 2013). In Missouri, Henslow's Sparrow abundance was negatively affected by the density of edge within 1 km of survey points, such that predicted counts of Henslow's Sparrows decreased 78 percent over the increasing range of edge density (0–140 m per ha) (Jacobs and others, 2012). In another Missouri study, nest success was lower within 50 m of a shrubby edge, presumably because of increased mammalian activity and depredation of nests near edges (Winter, 1998; Winter and others, 2000). In restored grasslands in Illinois, Henslow's Sparrows were more inclined to maintain territories in the interior of fields than within 50 m of the wooded boundary (O'Leary and Nyberg, 2000). In CRP fields in Illinois, Henslow's Sparrow densities were negatively associated with field area-to-edge ratios (Osborne and Sparling, 2013). In Indiana, point-count locations >200 m from the edge of suitable habitat were more likely to be occupied than locations within 200 m from the edge of suitable habitat (Bajema and Lima, 2001); however, considering only occupied locations, Henslow's Sparrow abundance showed no tendency to be lower near habitat edges. In tallgrass prairies in Oklahoma, Henslow's Sparrows avoided nesting near roadsides, which were bordered by narrow strips of woody vegetation (Patten and others, 2006).

The distribution and abundance of Henslow's Sparrows within grasslands may be affected by characteristics in the surrounding landscape. In Missouri, Henslow's Sparrow abundance increased as percentage of grass cover within 1 km of survey points increased (Jacobs and others, 2012). In another Missouri study, Henslow's Sparrow density increased with the total area of grassland in the surrounding landscape (Winter, 1998). In a study using BBS data across the Henslow's Sparrow breeding range, Dornak and others (2013) examined resettlement behavior (that is, prevalence of occurrence, describing the consistency of resettlement over multiple years, calculated by dividing the total number of years a species was observed on a route by the total years surveyed) to past breeding sites across multiple spatial resolutions, ranging from 0.5 to 511,360 square kilometers (km²). The species was not consistently present (that is, prevalence >75 percent) at sites until the spatial resolution was 120,000 km² or greater, which suggested that Henslow's Sparrows are nomadic in successive breeding seasons across multiple scales. From an analysis of BBS data from Minnesota, Wisconsin, Michigan, Illinois, Indiana, and Iowa, Thogmartin and others (2006) determined that abundance of Henslow's Sparrow was closely associated with the interaction of grassland patch size and the proportion of forest in the landscape, with higher abundances predicted in grasslands surrounded by forest. Thogmartin and others (2006) speculated that this apparent contradiction with field-level studies could reflect the types of grasslands found in landscapes with more forests (for example, greater topographical relief, less agriculture, and more idle grasslands and CRP grasslands). In contrast, Murray and others (2008)

reported no strong relationships between Henslow's Sparrow abundance and proportions of grassland and forest in the surrounding landscape in Wisconsin. In an Indiana study on reclaimed coal-mine grasslands, Henslow's Sparrows did not respond strongly to landscape composition (Bajema and Lima, 2001). Abundance was not correlated with landscape-level variables (percentage of land cover in suitable habitat, pasture or hayfields, mature forest, shrubland, rowcrops, open water, and bare ground) in 500-m, 1,000-m, and 2,000-m radius circles of habitat patches. In the 250-m circles, abundance was negatively correlated with percentage of open water. Bajema and Lima (2001) concluded that a lack of significant effects of landscape composition on Henslow's Sparrow abundance was probably because of the large size of mine grasslands. In Illinois CRP fields, Henslow's Sparrows were positively associated with percentage of cropland within 250 m of fields and negatively associated with the percentage of forest and with percentage of unsuitable areas (urban and rural residential areas, roads, and water) within 250 m of surrounding CRP fields (Osborne and Sparling, 2013).

Brood Parasitism by Cowbirds and Other Species

Friedmann and Kiff (1985) suggested that Henslow's Sparrows may be a frequent host of the Brown-headed Cowbird in some locations; however, published records indicate that the species is an infrequent host of the Brown-headed Cowbird (Shaffer and others, 2019). Reported rates of brood parasitism by cowbirds range from 0 percent of 20 nests (Byers and others, 2017) to 9 percent of 22 nests (D. Reinking, pers. commun. [n.d.] in Winter, 1999). Rates of cowbird brood parasitism for Henslow's Sparrow are summarized in Shaffer and others (2019).

Breeding-Season Phenology and Site Fidelity

Henslow's Sparrows arrive on their breeding grounds from late March to late April and nest from May to mid-August, although nests with young have been found as late as September (Graber, 1968; Robins, 1971; Michaels, 1997; Winter, 1998). Henslow's Sparrows apparently will renest after a first nest fails, and nests found with eggs in mid-August or dependent young in September suggest that the species may be double-brooded (Graber, 1968). In southwestern Missouri, two nest initiation peaks were observed: one in late May and one in mid-June (Winter, 1999). Winter (1998) considered Henslow's Sparrows to be double-brooded based on these two distinct peaks of nest initiation. In southern Michigan, Henslow's Sparrows commonly raised two broods, and sometimes three broods, per nesting season (Robins,

1971), whereas, in Wisconsin, second broods were uncommon (Wiens, 1969). In Maryland, fledglings were found in late July, which suggested double-broodedness (Skipper, 1998).

Henslow's Sparrow populations tend to increase through the summer (Mazur, 1996; J.R. Herkert, pers. obs.), and late-arriving (after May 31) birds may use areas typically avoided by early arriving birds, such as burned or mowed areas (Skinner and others, 1984; Mazur, 1996; M. Winter, WissenLeben e.V., Raisting, Germany, written commun. [n.d.]). Fall migration begins in September, and most birds vacate the breeding grounds by late October (Graber, 1968; Robins, 1971).

Henslow's Sparrows do not use breeding areas as predictably and consistently as other grassland sparrows (Dornak, 2010), but some degree of site fidelity has been reported. In Maryland, 18.5 percent of 27 banded adult males exhibited site fidelity by returning to a prior year's breeding area (Skipper, 1998). In Ohio, 13 percent of 114 banded individuals returned to the same breeding area, with three of these returning in multiple years (Ingold and others, 2009). In Missouri grasslands, 15.6 percent of 32 males banded in 1 year were resighted using the same territories in the following year (Jaster and others, 2013).

Species' Response to Management

Periodic disturbance may be necessary to maintain suitable habitat or to improve existing habitat for Henslow's Sparrows, although disturbance reduces habitat available to Henslow's Sparrows for one or two breeding seasons following the disturbance (Zimmerman, 1988; Herkert, 1994a; Melde and Koford, 1996; Herkert and others, 2018). Henslow's Sparrows generally avoid areas that have been recently disturbed by burning, mowing, or grazing because of the removal of standing dead vegetation and litter (Eddleman, 1974; Skinner and others, 1984; Zimmerman, 1988; Volkert 1992; Herkert, 1994a). In Kansas tallgrass prairies, Henslow's Sparrow abundance was significantly higher in idle grasslands (grasslands that were not burned, hayed, or grazed), and the species was not in grasslands that were burned or hayed (Powell and Busby, 2013). Likewise, in tallgrass prairies in Oklahoma, Henslow's Sparrows nested only in undisturbed patches, avoiding burned and grazed areas (Patten and others, 2006). In an Illinois study that compared counts of birds in warm- and cool-season grasses and annual weeds with several treatment types (burning, grazing, haying, mowing, and idle or undisturbed), Henslow's Sparrows were most abundant in idle warm-season grasses (Walk and Warner, 2000). In CRP fields planted to switchgrass (*Panicum virgatum*) for bioenergy production in southwestern Wisconsin, Henslow's Sparrows were only in switchgrass fields with tall, dense vegetation with a deep litter layer and not in any fields harvested the previous year in August (Roth and others, 2005).

The Henslow's Sparrow is adapted to tallgrass prairie that has not been recently disturbed (Reinking and others, 2000;

Patten and others, 2006) and generally are absent from areas during the first growing season following a prescribed fire (Eddleman, 1974; Hayden, 1985; Zimmerman, 1988; Clawson, 1991; Herkert, 1994a; Patten and others, 2006). In Wisconsin, Henslow's Sparrows were most abundant on a restored tallgrass prairie 2–3 years postburn (Volkert, 1992). After one-half of the prairie was burned a second time, Henslow's Sparrows occupied only the unburned portion. In Illinois, Henslow's Sparrow densities were usually 20–50 percent lower in areas during the second growing season postburn than densities in areas three or more growing seasons postburn (Herkert, 1994a; Herkert and Glass, 1999). No differences in densities were indicated among 3, 4, or 5 growing seasons postburn (Herkert and Glass, 1999). In tallgrass prairies in Missouri, Henslow's Sparrow densities were reduced in the first growing season postburn, but no difference in density was indicated two to four growing seasons postburn (Swengel, 1996; Winter, 1998). Henslow's Sparrows used tallgrass prairies that had been burned in the same spring later in the breeding season (late June through July) after vegetation became tall and dense enough to provide nesting cover (Winter, 1998, 1999). Nests in areas burned the same spring were placed close to the ground within large clumps of grass. Crimmins and others (2016) reported only nominal support to suggest that time since burn affected nest survival in Indiana tallgrass prairies.

In Kansas and Oklahoma, Henslow's Sparrows avoided nesting in spring-burned tallgrass prairies (Reinking and Hendricks, 1993; Schulenberg and others, 1994). In another Kansas study, Henslow's Sparrows were less abundant on spring-burned than unburned tallgrass prairies (Applegate and others, 2002). In the Konza Prairie Biological Station of Kansas, Henslow's Sparrows were absent on annually burned tallgrass prairies (Zimmerman, 1997) and were present in higher numbers on areas that had been burned 2–3 growing seasons previously than on areas burned <2 growing seasons or more than 4 growing seasons previously (Michaels, 1997). In more recent studies at Konza Prairie, Henslow's Sparrows were either absent or uncommon during the year of a burn in annually burned and 4-year postburn watershed management units; abundance was higher 2–3 years postburn than 4 years postburn (Powell 2006, 2008). On the Tallgrass Prairie Preserve (TPP) in Oklahoma, Henslow's Sparrows were absent in tallgrass prairie patches that were burned annually and in patches that had been burned within 12 months of surveys; abundance increased with time since last burn in patches that were burned at varying intervals to promote vegetation heterogeneity (Fuhlendorf and others, 2006). Coppedge and others (2008) reported similar results, also at TPP, as Henslow's Sparrows were absent from annually burned tallgrass pastures that were entirely burned and routinely observed on patch-burned tallgrass pastures (two of six patches burned in spring and fall of each year on a 3-year fire-return interval). To examine the interaction of fire and grazing, Hovick and others (2015) selected seven experimental pastures on TPP with varying levels of patchiness ranging from annually

burned with spring-only fires to a 4-year fire-return interval. Henslow's Sparrow density increased as fire-return interval increased, was unrelated to number of patches and hence increasing heterogeneity, was positively related to coverage of grass and litter and to litter depth and vegetation height, and negatively related to forb coverage. Working on TPP and on private ranches, Reinking and others (2000) reported that Henslow's Sparrows were absent on areas burned <2 years before surveys, but Henslow's Sparrows were present in areas 2, 3, and >3 years postburn, where vegetation height and density were higher than on recently burned areas. In addition, all nests were found in areas that had not been burned for at least 3 years. Patten and others (2006) determined that nests in grazed pastures managed with prescribed fire on TPP and private ranches experienced higher rates of brood parasitism than nests in idle prairies.

In restored grasslands in Iowa and Missouri, Pillsbury (2010) evaluated the effect of three treatments on Henslow's Sparrow territory density. Those treatments were patch-burn grazing (a portion of each site was left unburned during both years of the study and cattle had free access, resulting in patches <1 year postfire, 1–2 years postfire, and >2 years postfire), a complete burn before the second study year and no access by cattle, and an idle treatment. No change was indicated in territory density before and after treatment for the patch-burn and idled treatments, but a significant decline in abundance was indicated in the completely burned treatments. This decline was strongly correlated to reduced litter coverage. Although no change was indicated in territory density in the patch-burned sites, site occupancy was low initially and so Pillsbury (2010) recommended additional study before advocating for the increased use of this treatment. In a Missouri study evaluating patch-burn grazing, Henslow's Sparrow densities were lowest in the spring immediately following a burn, largest 1 year after a burn, and then declined 2 years after a burn; these results were statistically nonsignificant (Stropel, 2009). In the first year after a burn, Henslow's Sparrow densities were significantly higher on control areas (burned only) than on grazed areas. In southwestern Missouri, fledgling survival was negatively associated with cover of winged sumac (*Rhus copallinum*) and positively associated with years since last burn (Young and others, 2019).

The timing of mowing during the previous year may affect whether Henslow's Sparrows occupy a particular field in the subsequent growing season. In Illinois, mowing tended to reduce Henslow's Sparrow abundance but not eliminate their presence in the growing season immediately following mowing (Herkert, 1994a). In New York, fields mowed late the previous year were avoided at the beginning of the breeding season, but some were occupied later in the season once vegetation had recovered (Mazur, 1996). In another New York study, Henslow's Sparrows bred in pastures that had been mowed in late July to August 1–6 years earlier (Smith and Smith, 1992). Henslow's Sparrows continue nesting late (that is, August) into the summer (Potter, 1915; Reinking and Hendricks, 1993) and abandon fields once the fields are

mowed (George, 1952; Graber, 1968; Hayden, 1985). In Missouri tallgrass prairie fragments, Henslow's Sparrow densities were lower in areas hayed the previous year than those hayed 2 years earlier (Winter, 1998). In Wisconsin CRP fields planted to switchgrass, Henslow's Sparrows were only observed in unharvested fields (Roth and others, 2005). In reclaimed grasslands in Indiana, the species avoided intensively hayed areas (Bajema and others, 2001), and in reclaimed coal-mine grasslands in Ohio, Henslow's Sparrows were present only in unmowed fields (Ingold, 2002). Within the same grasslands in Ohio, of 114 Henslow's Sparrows captured over 7 years, 87 percent were captured and banded in unmowed areas and 13 percent in mowed areas (that is, typically individuals nesting later in the season after grass had recovered from an early season mowing). Birds banded in unmowed fields returned to unmowed fields in subsequent years, but no birds banded in mowed fields returned to fields that had been mowed the previous year (Ingold and others, 2009).

Grazing affects Henslow's Sparrow distribution and abundance; moderately to heavily grazed areas generally are not used by Henslow's Sparrows (Peterson, 1983; Skinner and others, 1984; Zimmerman, 1988; Bajema and others, 2001; J.R. Herkert, pers. obs.). Henslow's Sparrows have been reported to occupy areas that are lightly grazed (Skinner and others, 1984; Swengel, 1996). In Missouri, Henslow's Sparrow densities were highest on lightly grazed (vegetation height >30.4 cm) pastures, followed by idle pastures; the species was not found on heavily grazed (vegetation height ≤10.2 cm) pastures (Skinner, 1975). In New York, Henslow's Sparrows were found on lightly grazed pastures occupied annually by cattle from May 15 to October 15 (Smith and Smith, 1992). These pastures also had been mowed in late July to August in the previous year.

At Konza Prairie in Kansas, Henslow's Sparrows were not encountered until grazing had been discontinued for 2 years (Zimmerman and Finck, 1983). In another study at Konza Prairie in Kansas, Henslow's Sparrows were absent from pastures that were annually burned and grazed by bison (*Bison bison*); the species was absent the year of the burn and grazing nearly eliminated the species from pastures until 2 years postburn (Powell, 2006). In Kansas grasslands, Henslow's Sparrows were present on native prairie and winter-grazed pastures (that is, grazed in winter for 4 or more years) but were not found in pastures that had been grazed year-round (Johnson and Sandercock, 2010). Johnson and Sandercock (2010) speculated that Henslow's Sparrows might have preferred the winter-grazed pastures over the year-round grazed pastures because of the lack of cattle disturbance during the breeding season or because of differences in vegetation structure between the two grazing treatments. In southwestern Wisconsin, Henslow's Sparrows were nearly equally abundant in rotationally grazed pastures (stocked with 40–60 animals per ha, grazed for 1–2 days, then left undisturbed for 10–15 days before being grazed again), continuously grazed pastures (grazed throughout the summer

at levels of 2.5–4.0 animals per ha), and ungrazed pastures (neither mowed nor grazed from May 15 to July 1) (Temple and others, 1999).

Planted grasslands, such as CRP fields, are an important habitat for Henslow's Sparrows. In a multi-State study using BBS data, Herkert (2007) determined that CRP enrollment was positively correlated with an increased population trend for Henslow's Sparrows. In a Wisconsin study evaluating land usage, Henslow's Sparrows were 10–20 times more abundant within CRP grasslands and remnant prairie patches than in pastures and hayfields; the species was absent from strip crops (Ribic and others, 2009a). In Nebraska, Henslow's Sparrow abundance was higher in CRP fields idled for more than 10 years than in CRP fields managed with disking and seeding (Negus and others, 2010). In Illinois CRP fields, Henslow's Sparrow densities were negatively associated with glyphosate-sprayed fields; the species had much higher densities on fields that were sprayed with glyphosate and then seeded with legumes (Osborne and Sparling, 2013). The sprayed-and-seeded fields provided the standing residual vegetation preferred by the species.

Energy development may negatively impact Henslow's Sparrow distribution and abundance. In Oklahoma, Henslow's Sparrow abundance increased linearly up to 500 m from conventional oil wells (that is, grid-powered pump jacks) in tallgrass prairies that were 13–24 months post-fire and greater than 24 months post-fire (Londe and others, 2019). The species did not respond to major gravel roadways (that is, county roads that were wide enough [≥8 m] for two lanes of traffic). Beston and others (2016) developed a prioritization system to identify avian species most likely to experience population declines in the United States from wind facilities based on their current conservation status and their expected risk from wind turbines. The Henslow's Sparrow was among 40 species (of 428 species evaluated) with an average priority score of at least a four or above out of nine; 4.67 percent of the Henslow's Sparrow breeding population in the United States are exposed to wind facilities.

Management Recommendations from the Literature

Henslow's Sparrows are affected by local vegetation structure and composition and by landscape structure and composition (Herkert, 1994a, 1994b; Winter, 1996; Bajema and Lima, 2001). Several studies have indicated that the Henslow's Sparrow is area sensitive, preferring large grasslands over small grasslands (Bollinger, 1991, 1995; Smith and Smith, 1992; Herkert, 1994a, 1994b; Mazur, 1996; Swengel, 1996; Winter, 1996), which emphasizes the importance of protecting and maintaining large areas of suitable habitat that can support breeding populations of Henslow's Sparrows (Zimmerman, 1988; Smith and Smith, 1992; Mazur, 1996). Where

contiguous management units are not available, maintaining a complex of smaller units of suitable grasslands may facilitate colonization of Henslow's Sparrows from nearby occupied habitat (Mazur, 1996). Restoring or planting grasslands near small prairie fragments allows small prairie fragments to support higher densities of Henslow's Sparrows (Winter, 1998).

The size and vegetation structure of restored grasslands may be more important to Henslow's Sparrows than plant species composition (Jaster and others, 2013). Herkert and others (1993) recommended restoring grasslands that are larger than 50 ha and preferably >100 ha. Providing dense and moderately tall grassy vegetation is important (Smith, 1992). Former coal mines, if planted to tall, dense grasses with deep litter, can provide quality habitat for Henslow's Sparrows (Bajema and others, 2001), especially if disturbances such as early season mowing are used sparingly or not at all (Ingold and others, 2009).

Henslow's Sparrows are tolerant of low densities of woody vegetation (for example, short-statured shrubs), but Henslow's Sparrow occurrence and abundance commonly decline with increasing encroachment or coverage of woody vegetation (Peterson, 1983; Kahl and others, 1985; Pehler, 1987; Zimmerman, 1988; Mazur, 1996; Pruitt, 1996; Melde and Koford, 1996; Michaels, 1997; Winter, 1998, 1999; Cully and Michaels, 2000; Young and others, 2019). Discouraging encroachment of woody vegetation and avoiding shrub and tree plantings in suitable Henslow's Sparrow habitat will be beneficial to Henslow's Sparrows. Removal of woody vegetation within and along the periphery of grassland fragments and roadsides may discourage predators that use woody vegetation as travel corridors, enlarge the amount of interior grassland, and create more usable nesting habitat (Winter, 1998; O'Leary and Nyberg, 2000; Patten and others, 2006; Ellison and others, 2013; Young and others, 2019). Removal of woody vegetation may be necessary when woody vegetation becomes taller than the fully grown herbaceous vegetation (Smith, 1992; Herkert and others, 1993; Mazur, 1996). Henslow's Sparrows avoid wooded roadsides, and Patten and others (2006) indicated that Henslow's Sparrows and other grassland birds would benefit from refraining from planting woody vegetation along roads adjacent to suitable grassland habitat and removing woody vegetation along roads.

To reduce disturbance to nesting birds, the timing of management treatments (for example, mowing or prescribed burning) within a year is an important consideration. Management treatments that are completed before the birds arrive in the spring or after the young have fledged will reduce or avoid treatment-related destruction of nests (Smith, 1992; Hanson, 1994; Mazur, 1996; Winter, 1998; Roth and others, 2005). Herkert and others (1993) and Winter (1998) recommended that prescribed fires should be completed in early spring (March to early April) or late fall (October and November). Winter (1998) also cautioned against over-management of tallgrass prairies; Henslow's Sparrows in Missouri tallgrass prairies were able to use spring-burned areas later in the nesting season once vegetation had recovered. In these prairies,

prescribed fires in the spring (before May 1) had a less severe impact than haying in the summer (June 15–August 15) because of rapid recovery of vegetation after burning and less chance for nest destruction.

In large grasslands or in multiple grasslands within a landscape, rotating management disturbances among management units or grasslands across years will ensure the availability of some suitable habitat during each breeding season (Zimmerman, 1988; Herkert, 1994a; Melde and Koford, 1996); however, burning, mowing, or otherwise disturbing an entire area in one breeding season may reduce the available suitable habitat for one or two growing seasons following the disturbance (Herkert and others, 1993, 2018; Hanson, 1994; Melde and Koford, 1996; Fuhlendorf and others, 2006; Coppedge and others, 2008; Pillsbury, 2010; Powell and Busby, 2013). In Kansas, Zimmerman (1988) suggested implementing a rotational burning program in which three to four adjacent tracts of prairie are alternately burned on a 3- to 4-year cycle; based on incidental observations of the presence or absence of Henslow's Sparrow, Zimmerman (1988) indicated that each patch should be at least 30 ha. Herkert (1994a) also recommended that management units should be at least 20–30 ha, if possible. In Missouri grasslands, burning one-third to one-half of a management area annually may maintain suitable habitat (Clawson, 1991; Pillsbury, 2010). Henslow's Sparrows were absent from annually burned pastures but were present in patch-burned pastures with a 3-year burn interval (Fuhlendorf and others, 2006; Coppedge and others, 2008). In New York, burning once every 5–6 years or mowing every 4–5 years may allow vegetation to recover between disturbances to provide suitable habitat while keeping succession in check (Mazur, 1996). Young and others (2019) recommended providing a mosaic of burned, unburned, and lightly grazed areas that provide adequate nesting habitat for Henslow's Sparrows while accounting for relatively short fledgling movements.

Reinking and others (2000) suggested that moderate grazing and burning at intervals >3 years (to control woody vegetation invasion) are compatible with the habitat needs of the species in Oklahoma tallgrass prairies but recommended avoiding annual burning and intensive grazing that limit the creation of late-stage grasslands required by the species. Although Henslow's Sparrows do not use recently burned grasslands, Patten and others (2006) suggested that occasional prescribed fires may be necessary to curtail wood encroachment in Henslow's Sparrow habitats; however, after accounting for the effects of wooded roadside edges, Patten and others (2006) determined that grazing after annual spring burns in Oklahoma tallgrass prairies increased the probability of brood parasitism by Brown-headed Cowbirds.

Many nests and fledglings are destroyed by mowing during the breeding season, and M. Winter (WissenLeben e.V., Raisting, Germany, written commun. [n.d.]) recommended delaying mowing in areas with nesting Henslow's Sparrows until after the breeding season (about August 15). Mowing in early August may destroy nests of late-nesting Henslow's Sparrows (Potter, 1915). Late summer haying can be used

to provide the amount of litter cover preferred by Henslow's Sparrows without the possibility of destroying nests or removing too much litter (Ingold and others, 2009; Jacobs and others, 2012). Mowing fields on a rotational basis also will provide adequate habitat (Roth and others, 2005). Swengel (1996) recommended implementing conservation haying (one annual cut after mid-July) on a 2- to 3-year rotation.

To support breeding populations of Henslow's Sparrows, Skinner (1982) and Skinner and others (1984) recommended providing idle or lightly grazed grasslands. Light grazing was defined as grazing pressure that left more than 40 percent vegetative cover at 25 cm.

Continuation of the CRP and other long-term cropland retirement programs may be important to maintain stable populations of Henslow's Sparrows (Herkert, 2007). For mid-contract management in CRP fields, Negus and others (2010) recommended leaving some fields idle or using a rotation schedule in which some patches remain untreated in some years. Glyphosate treatment for mid-contract management of CRP fields is detrimental to Henslow's Sparrows, as glyphosate treatment leaves no standing residual vegetation, but glyphosate treatment followed by drill-seeding of legumes provides ground cover structure suitable for Henslow's Sparrows (Osborne and Sparling, 2013).

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Table II1. Measured values of vegetation structure and composition in Henslow's Sparrow (*Centronyx henslowii*) breeding habitat by study. The parenthetical descriptors following authorship and year in the "Study" column indicate that the vegetation measurements were taken in locations or under conditions specified in the descriptor; no descriptor implies that measurements were taken within the general study area.

[cm, centimeter; %, percent; --, no data; <, less than; CRP, Conservation Reserve Program; >, greater than; spp., species]

Study	State or province	Habitat	Management practice or treatment	Vegetation height (cm)	Vegetation height-density (cm)	Grass cover (%)	Forb cover (%)	Shrub cover (%)	Bare ground cover (%)	Litter cover (%)	Litter depth (cm)
Bajema and others, 2001 ^a	Indiana	Reclaimed mine grassland	--	93.2	32.3 ^b	68.1	24	--	--	79.1	5.4
Birkenholz, 1973	Illinois	Tallgrass prairie	--	<61	--	--	--	--	--	--	--
Eddleman, 1974	Kansas	Tallgrass prairie	Idle	60–122	--	--	--	--	--	--	--
Fuhlendorf and others, 2006 ^c	Oklahoma	Tallgrass prairie	Annual complete burn and grazed	14.7	--	63	18	--	20.3	8	--
Fuhlendorf and others, 2006 ^c	Oklahoma	Tallgrass prairie	Patch burn and grazed	21.7	--	55.7	19	--	14.7	50.3	--
Hanson, 1994 (territories)	Minnesota	Tallgrass prairie, tame grassland	--	59.4 ^d	--	--	--	--	--	--	7.1
Herkert, 1994a	Illinois	Multiple	--	49.3	--	--	--	--	--	--	3.1
Jaster and others, 2013 ^e	Missouri	Tame grassland	Cool-season seeding mixture	--	32.7 ^b	41.2	22.8	1.0	39.3	60.2	1.2
Jaster and others, 2013 ^e	Missouri	Restored native grassland	Warm-season seeding mixture	--	39.2 ^b	33.6	28.6	5.8	32.3	64.6	1.8
Kahl and others, 1985 (territories)	Missouri	Multiple	Multiple	20–40	--	--	--	--	--	--	--
McCoy and others, 2001 ^e	Missouri	Tame grassland (CRP)	Cool-season seeding mixture	--	51 ^b	46	33	1	12	75	2.6
McCoy and others, 2001 ^e	Missouri	Tame grassland (CRP)	Warm-season seeding mixture	--	80 ^b	54	27	<1	11	74	2.2
Negus and others, 2010 ^e (nests)	Nebraska	Tame grassland (CRP)	Disked and interseeded	65.7	35.8 ^b	41.8	23.8	--	14.5	25.2	1.7
Negus and others, 2010 ^e (nests)	Nebraska	Tame grassland (CRP)	Idle	55.9	29.4 ^b	63.9	1.4	--	1.4	39.3	3.1
Osborne and Sparling, 2013 ^e	Illinois	Tame grassland (CRP)	Idle	--	56.5 ^b	47.4	23.3	--	8.5	--	6.0
Osborne and Sparling, 2013 ^e	Illinois	Tame grassland (CRP)	Disked	--	52.0 ^b	47.7	22.5	--	16.1	--	5.4
Osborne and Sparling, 2013 ^e	Illinois	Tame grassland (CRP)	Glyphosate-sprayed	--	56.7 ^b	23.8	37.5	--	12.9	--	4.1
Osborne and Sparling, 2013 ^e	Illinois	Tame grassland (CRP)	Glyphosate-sprayed and seeded	--	53.7 ^b	29.3	31.3	--	15.5	--	3.6

Table III. Measured values of vegetation structure and composition in Henslow's Sparrow (*Centronyx henslowii*) breeding habitat by study. The parenthetical descriptors following authorship and year in the "Study" column indicate that the vegetation measurements were taken in locations or under conditions specified in the descriptor; no descriptor implies that measurements were taken within the general study area.

[cm, centimeter; %, percent; --, no data; <, less than; CRP, Conservation Reserve Program; >, greater than; spp., species]

Study	State or province	Habitat	Management practice or treatment	Vegetation height (cm)	Vegetation height-density (cm)	Grass cover (%)	Forb cover (%)	Shrub cover (%)	Bare ground cover (%)	Litter cover (%)	Litter depth (cm)
Piehler, 1987 ^c (territories)	Pennsylvania	Reclaimed mine grassland	--	102.2	117.3 ^f	--	8.8	0	2.1	97.9	6.0
Pillsbury, 2010 ^e	Iowa, Missouri	Restored native grassland	Multiple	--	44.6 ^b	21.7	24.8	2.3	--	32.1	--
Pillsbury, 2010 ^e (territories)	Iowa, Missouri	Restored native grassland	Patch-burned and grazed	--	29.5 ^b	--	--	--	--	56.2	--
Pillsbury, 2010 ^e (territories)	Iowa, Missouri	Restored native grassland	Burned	--	47 ^b	--	--	--	--	52.4	--
Pillsbury, 2010 ^e (territories)	Iowa, Missouri	Restored native grassland	Idle	--	44 ^b	--	--	--	--	75.8	--
Powell and Busby, 2013	Kansas	Tallgrass prairie	Unburned idle	93 ^d	--	--	--	--	--	--	12.5
Powell and Busby, 2013	Kansas	Tallgrass prairie	Grazed	74 ^d	--	--	--	--	--	--	9.4
Reinking and others, 2000	Oklahoma	Tallgrass prairie	Burned and grazed	71.3–88.3	--	--	--	--	--	--	--
Roth and others, 2005	Wisconsin	Tame grassland (CRP)	Idle	--	46.0 ^b	--	32.5	--	--	--	6.3
Sample, 1989	Wisconsin	Multiple	--	88.1	40.4 ^b	--	74.1 ^g	1.7	1.5	14.5	--
Schulenberg and others, 1994 (nests)	Kansas	Tallgrass prairie	--	--	--	35 ^h	20	--	5	30	<2
Skinner, 1974	Missouri	Tallgrass prairie	Multiple	>48	--	--	--	--	--	--	--
Skinner and others, 1984	Missouri	Tallgrass prairie	Multiple	--	--	--	10–55	--	--	--	--
Wiens, 1969 ^c (territories)	Wisconsin	Tame grassland	Multiple	--	--	97	20	--	1	--	--
Winter, 1998, 1999 (nests)	Missouri	Tallgrass prairie	Burned and hayed	43	25.4 ^b	51	19	2	0.6	27	3.3

^aThe sum of the percentages is >100% because litter cover was estimated separately from canopy cover.

^bVisual obstruction reading (Robel and others, 1970).

^cThe sum of the percentages is >100%, based on the modified point-quadrant technique as described by the author(s).

^dStanding dead vegetation height.

^eThe sum of the percentages is >100%, based on methods described by the author(s).

^fEffective vegetation height.

^gHerbaceous vegetation cover.

^hCover of little bluestem (*Schizachyrium scoparium*) and sedges (*Carex* spp.) combined.

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