USGS
science for a changing world

The Effects of Management Practices on Grassland Birds—Dickcissel (*Spiza americana*)

Chapter OO of

The Effects of Management Practices on Grassland Birds

Professional Paper 1842–OO

U.S. Department of the Interior
U.S. Geological Survey

Cover. Dickcissel. Photograph by Kiran Madura, used with permission. Background photograph: Northern mixed-grass prairie in North Dakota, by Rick Bohn, used with permission.

The Effects of Management Practices on Grassland Birds—Dickcissel (*Spiza americana*)

By Jill A. Shaffer,[1] Lawrence D. Igl,[1] Douglas H. Johnson,[1] Marriah L. Sondreal,[1] Christopher M. Goldade,[1,2] Amy L. Zimmerman,[1] and Betty R. Euliss[1]

Chapter OO of

The Effects of Management Practices on Grassland Birds

Edited by Douglas H. Johnson,[1] Lawrence D. Igl,[1] Jill A. Shaffer,[1] and John P. DeLong[1, 3]

[1]U.S. Geological Survey.

[2]South Dakota Game, Fish and Parks (current).

[3]University of Nebraska-Lincoln (current).

Professional Paper 1842–OO

U.S. Department of the Interior
U.S. Geological Survey

U.S. Geological Survey, Reston, Virginia: 2023

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment—visit https://www.usgs.gov or call 1–888–ASK–USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit https://store.usgs.gov.

Suggested citation:
Shaffer, J.A., Igl, L.D., Johnson, D.H., Sondreal, M.L., Goldade, C.M., Zimmerman, A.L., and Euliss, B.R., 2023, The effects of management practices on grassland birds—Dickcissel (*Spiza americana*), chap. OO *of* Johnson, D.H., Igl, L.D., Shaffer, J.A., and DeLong, J.P., eds., The effects of management practices on grassland birds: U.S. Geological Survey Professional Paper 1842, 47 p., https://doi.org/10.3133/pp1842OO.

ISSN 2330-7102 (online)

Contents

Figures

Tables

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	
square meter (m^2)	0.0002471	acre
hectare (ha)	2.471	acre
square kilometer (km^2)	247.1	acre
square meter (m^2)	10.76	square foot (ft^2)
hectare (ha)	0.003861	square mile (mi^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic meter (m^3)	264.2	gallon (gal)
cubic meter (m^3)	35.31	cubic foot (ft^3)
cubic meter (m^3)	1.308	cubic yard (yd^3)
cubic meter (m^3)	0.0008107	acre-foot (acre-ft)
	Mass	
kilogram (kg)	2.205	pound (lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Abbreviations

AUM	animal unit month
BBS	Breeding Bird Survey
CRP	Conservation Reserve Program
DNC	dense nesting cover
IESB	intensive early-season grazing followed by burning
PGB	patch-burn graze
SLSB	season-long grazing and annual spring burning
spp.	species (applies to two or more species within the genus)
VOR	visual obstruction reading

Acknowledgments

Major funding for this effort was provided by the Prairie Pothole Joint Venture, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey. Additional funding was provided by the U.S. Forest Service, The Nature Conservancy, and the Plains and Prairie Potholes Landscape Conservation Cooperative. We thank the following cooperators who provided access to their bibliographic files: Louis B. Best, Carl E. Bock, Brenda C. Dale, Stephen K. Davis, James J. Dinsmore, James R. Herkert, Fritz L. Knopf (deceased), Rolf R. Koford, David R.C. Prescott, Mark R. Ryan, David W. Sample, David A. Swanson, Peter D. Vickery (deceased), and John L. Zimmerman (deceased). We thank Christopher M. Goldade for his illustration of the Clay-colored Sparrow and the U.S. Geological Survey's Eastern Ecological Science Center, Laurel, Maryland, for providing the range map. We thank Courtney L. Amundson, Joel S. Brice, Rachel M. Bush, James O. Church, Shay F. Erickson, Silka L.F. Kempema, Emily C. McLean, Susana Rios, Bonnie A. Sample, and Robert O. Woodward for their assistance with various aspects of this effort. Lynn M. Hill and Keith J. Van Cleave, U.S. Geological Survey, acquired many publications for us throughout this effort, including some that were very old and obscure. Earlier versions of this account benefitted from insightful comments from Mark Fisher, Stephanie L. Jones, Richard W. Knapton, and Brian A. Tangen.

The Effects of Management Practices on Grassland Birds—Dickcissel (*Spiza americana*)

By Jill A. Shaffer,[1] Lawrence D. Igl,[1] Douglas H. Johnson,[1] Marriah L. Sondreal,[1] Christopher M. Goldade,[1,2] Amy L. Zimmerman,[1,] and Betty R. Euliss[1]

Capsule Statement

Keys to Dickcissel (*Spiza americana*) management include providing dense, moderate-to-tall vegetation, particularly with a well-developed forb component, and moderately deep litter. Dickcissels have been reported to use grassland habitats with 4–166 centimeters (cm) average vegetation height, 6–85 cm visual obstruction reading (VOR), 11–68 percent grass cover, 1–86 percent forb cover, less than or equal to (≤) 10 percent shrub cover, less than (<) 27 percent bare ground cover, <30 percent litter cover, and ≤6 cm litter depth. The descriptions of key vegetation characteristics are provided in table OO1 (after the “References” section). Vernacular and scientific names of plants and animals follow the Integrated Taxonomic Information System (https://www.itis.gov).

Dickcissel. Illustration by Christopher M. Goldade, U.S. Geological Survey.

Breeding Range

Dickcissels typically breed from northern North Dakota; south through western South Dakota, eastern Colorado, and northeastern New Mexico to southern Texas and Louisiana; and east to northern Alabama, western Tennessee, western Kentucky, western Ohio, and southern Michigan and Wisconsin (National Geographic Society, 2011). Numbers vary locally from year to year, especially outside of the core breeding range, possibly due to precipitation patterns (Mulvihill, 1988; Igl, 1991; Bateman and others, 2015). The species exhibits shifts in abundance at its range edges during drought events (Igl, 1991; Bateman and others, 2015). During some irruption years, the species’ breeding range may extend farther west, east, and north, including into southern Saskatchewan and Manitoba (National Geographic Society, 2011). The relative densities of Dickcissels in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data (Sauer and others, 2014), are shown in figure OO1 (not all geographic places mentioned in report are shown on figure).

Suitable Habitat

Dickcissels prefer grassland habitats with dense, moderate-to-tall vegetation, moderately deep litter, and a well-developed forb component (Gross, 1921a,b, 1968; Harmeson, 1972, 1974; Wiens, 1973; Harrison, 1974; Petersen, 1978; Roth, 1979; Rotenberry and Wiens, 1980; Finck, 1983, 1984; Renken, 1983; Skinner and others, 1984; Kahl and others, 1985; Frawley, 1989; Sample, 1989; Igl, 1991; Zimmerman, 1993; Delisle and Savidge, 1997; Winter, 1998; Sousa and others, 2022). Habitats with a low or moderate degree of woody vegetation are tolerated by the species, as small trees and shrubs are used as song perches and nesting substrates (Sousa and others, 2022). Dickcissels breed in a variety of habitats, including shortgrass, mixed-grass, and tallgrass prairies that are idle, burned, hayed, or grazed (Sauer, 1953; Overmire, 1963; Blankespoor, 1970; Berry, 1971; Wiens, 1973; Petersen, 1978; Roth, 1979; Rotenberry and Wiens, 1980; Skinner and others, 1984; Kahl and others, 1985; Bock and others, 1993; Zimmerman, 1993; Swengel, 1996; Winter, 1998; Jensen, 1999; Winter and Faaborg, 1999; Swengel and Swengel, 2001; Rahmig and others, 2009; Igl and others, 2018). The species

[1]U.S. Geological Survey.

[2]South Dakota Game, Fish and Parks (current).

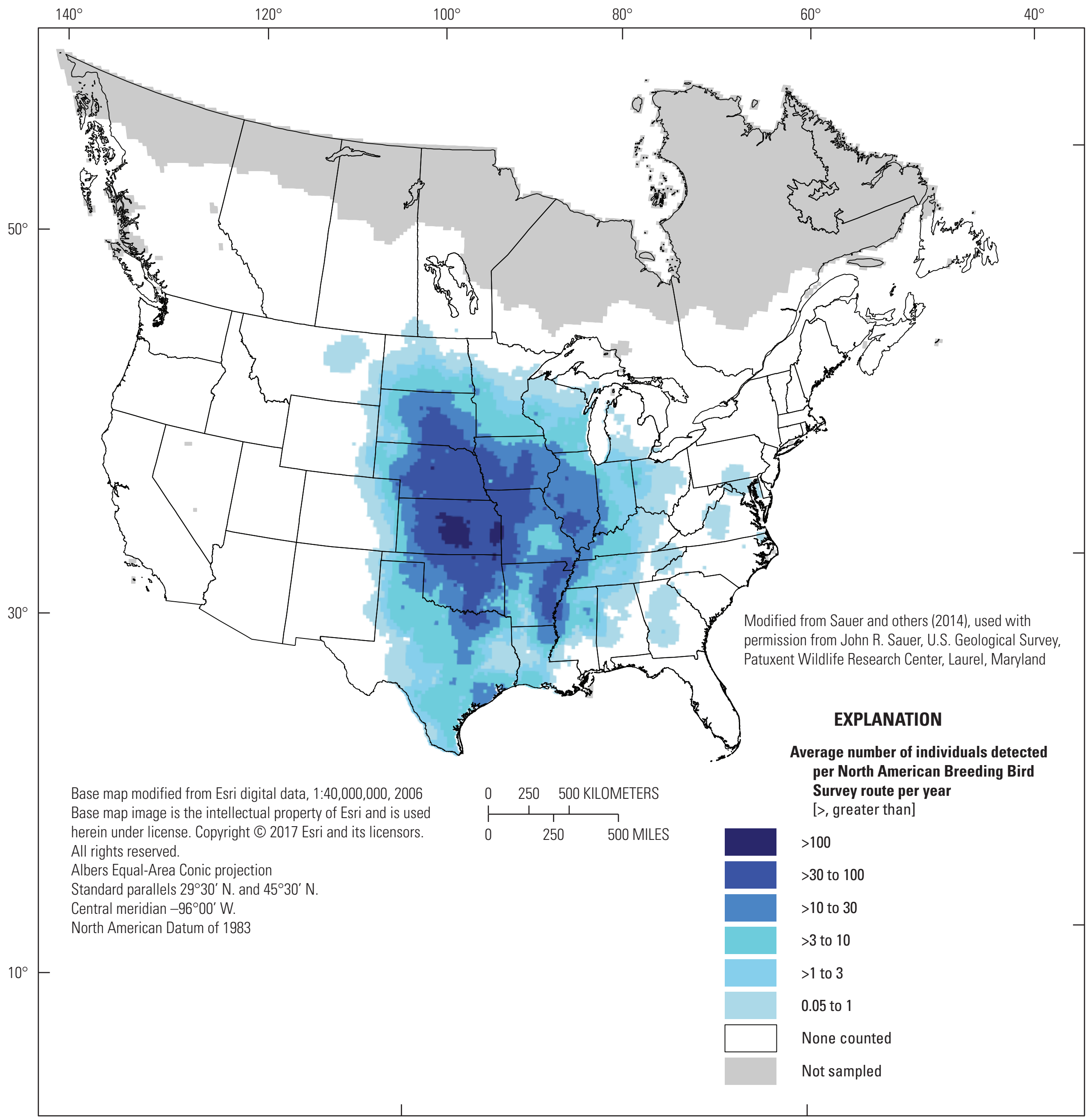

Figure 001. Breeding distribution of the Dickcissel (*Spiza americana*) in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data, 2008–12. The BBS abundance map provides only an approximation of breeding range edges.

also inhabits dry sand prairies, oak (*Quercus* species [spp.]) savannas, and oak barrens (Mabry and others, 2010; Vos and Ribic, 2011, 2013; Wood and others, 2011; Bar-Massada and others, 2012; Barrioz and others, 2013; Crosby and others, 2015; Holoubek and Jensen, 2015; McInnerney and others, 2021), as well as sand shinnery oak (*Quercus havardii*) mottes (Londe and others, 2021) and southern mixed-grass prairies encroached by eastern redcedar (*Juniperus virginiana*) (Chapman and others, 2004b).

Dickcissels occupy mesic prairies, wetlands, and river channel islands (Taber, 1947; Faanes and Lingle, 1995; Swengel, 1996; Tsai and others, 2012). In the Prairie Pothole Region, Dickcissels occasionally are associated with wetlands or wetland edges (Igl and others, 2017). In a survey of breeding birds in 1,190 wetlands throughout the Prairie Pothole Region of North Dakota and South Dakota, Dickcissels occurred in both natural and restored wetlands (Igl and others, 2017). The 11 wetlands in which Dickcissels were present were characterized as having an average of 38 percent open water, 26 percent emergent vegetation, 35 percent wet meadow, and 1 percent shore/mudflat (Igl and others, 2017).

Dickcissels frequently occupy hayland, which may be a preferred habitat over other habitats, such as wet prairies, wetlands, upland prairies, lowland forests, pastures, or cropland (Taber, 1947; Graber and Graber, 1963; Von Steen, 1965; Gross, 1968; Ducey and Miller, 1980; Faanes and Lingle, 1995). The species readily inhabits meadows and hayfields dominated by forbs such as clover (*Trifolium* spp.) and alfalfa (*Medicago sativa*) (Gross, 1921a,b, 1968; Graber and Graber, 1963; Emlen and Wiens, 1965; Monroe, 1967; Harrison, 1974; Stewart, 1975; Sealy, 1976; Ryan, 1986; Frawley, 1989; Igl, 1991; Helzer, 1996; Helzer and Jelinski, 1999; Kim and others, 2008). Dickcissels use planted grasslands, such as Conservation Reserve Program (CRP) fields, Waterfowl Production Areas, and fields of dense nesting cover (DNC) (Blankespoor, 1980; Renken and Dinsmore, 1987; Sample, 1989; Johnson and Schwartz, 1993; Johnson and Igl, 1995; King and Savidge, 1995; Hull and others, 1996; Patterson and Best, 1996; Best and others, 1997; Klute and others, 1997; Hughes and others, 1999; Fletcher and others, 2006; Igl, 2009; Reiley and Benson, 2020). Dickcissels also inhabit planted grasslands on reclaimed surface mines (DeVault and others, 2002; Scott and others, 2002; Galligan and others, 2006; Dixon and others, 2008; Graves and others, 2010). Dickcissel readily occupy oldfields (idle or neglected arable lands that have naturally reverted back to perennial cover) and weedy and brushy grasslands (Taber, 1947; Ely, 1957; Graber and Graber, 1963; Berry, 1971; Harmeson, 1972, 1974; Zimmerman, 1982; Finck, 1983; 1984; Kahl and others, 1985; Faanes and Lingle, 1995). Dickcissels often nest in strip cover or linear grassland habitats, such as road rights-of-way, hedgerows, grassed waterways, grassy habitat along cropland margins, terraces, and fencerows (Gross, 1921a,b; Meanley, 1963; Basore and others, 1986; Bryan and Best, 1991, 1994; Camp and Best, 1993, 1994; Warner, 1994; Hultquist and Best, 2001; Henningsen and Best, 2005; Cox and others, 2014; Adams and others, 2013, 2015, 2019; McCleery and others, 2015; Schulte and others, 2016). Dickcissels occasionally inhabit cropland, such as corn (*Zea mays*), soybean (*Glycine max*), wheat (*Triticum* spp.), rye (*Secale* spp.), oat (*Avena sativa*), and fallow fields, but often at lower densities than found in native prairie or planted grasslands (Emlen and Wiens, 1965; Monroe, 1967; Gross, 1921a,b, 1968; Graber and Graber, 1963; Blankespoor, 1970; Ducey and Miller, 1980; Basore and others, 1986; Johnson and Schwartz, 1993; Best and others, 1997; Igl and others, 2008; Ribic and others, 2009a; VanBeek and others, 2014).

Native and Tame Vegetation

Dickcissels use native and tame grasslands. Several researchers have compared Dickcissel use of conservation fields planted to native and tame species of grasses relative to other habitats, such as native prairies or cropland. In southern Wisconsin, Blank and others (2014) evaluated Dickcissel use of cropland and bioenergy (or biomass) plantings, including biomass grassland monocultures of warm-season grass species, grass-dominated conservation grasslands (that is, Federal, State, and nonprofit wildlife areas with greater than [>] 50 percent live vegetation cover in warm-season grass species), and forb-dominated conservation grasslands (that is, <50 percent live vegetation cover in grass species). Dickcissels were not present in cropland and occurred at low densities in forb-dominated grasslands, at moderate densities in grass-dominated grasslands, and at high densities in grass monocultures. Because these findings may seem counterintuitive, the authors explained that the fields planted as grass monocultures contained common milkweed (*Asclepias syriaca*) plants that were popular perches for Dickcissels and were adjacent to florally diverse fields attractive to avian species. The grass-dominated fields contained an average of 11 percent forbs (Blank and others, 2014). In another Wisconsin study, Dickcissel densities were significantly higher in remnant tallgrass prairies than in cool-season CRP grasslands, heavily grazed cattle pastures, grass-and-alfalfa haylands, or strip crops (that is, corn or soybeans alternated with alfalfa hayland, oats, or wheat) (Ribic and others, 2009a). The species did not occur in alfalfa haylands or strip crops and had low occurrences in pastures and CRP grasslands. In Conservation Reserve Enhancement Program fields in Illinois, Dickcissel densities were greater in sites enrolled as permanent wildlife habitat than in sites enrolled in hardwood tree planting, wetland restoration, or riparian buffer, but the species' density declined as the permanent wildlife habitat fields aged (Reiley and Benson, 2020). In central Iowa, Dickcissels were significantly more abundant in CRP fields planted to tame grass species and alfalfa than in rowcrop fields, and the species only nested within CRP grasslands (Patterson and Best, 1996). In restored grasslands in northwestern Iowa, Dickcissel densities were similar in grasslands planted to cool-season grass species and grasslands planted to warm-season grass species or to high-diversity species mixtures; density was positively related to vegetation diversity (Vogel, 2011). In conservation grasslands (that is, CRP, restored and remnant prairies, and Federal refuge lands) in western Iowa and eastern Nebraska, Dickcissel densities were higher in warm-season grasslands than in cool-season grasslands; among three levels of seeding-mixture diversity (low, medium, or high), Dickcissel density was highest in high-diversity seeding parcels and lowest in low-diversity seeding parcels (Cox and others, 2014). In Iowa roadsides planted to native or tame grass species, the species was more abundant in tame vegetation than in mixtures of native and tame vegetation (Camp and Best, 1993). In southeastern Nebraska, King and Savidge (1995) reported that Dickcissel abundance was similar among native prairies and CRP fields planted to cool-season grass species or warm-season grass species, but the authors' findings may have been confounded by haying and burning on some fields. Near a tallgrass prairie preserve in northern Illinois, Dickcissels occurred only in weedy fields adjacent to the preserve but did not occur in stands of Kentucky bluegrass (*Poa pratensis*) or tallgrass prairies (Birkenholz, 1973). In southern Illinois, Dickcissels were most abundant in grazed warm-season grasslands, followed by mowed warm-season grasslands, grazed cool-season grasslands, idle warm-season grasslands, idle cool-season grasslands, fields with annual weeds dominated by foxtail (*Setaria* spp.) and daisy fleabane (*Erigeron strigosus*), burned cool-season grasslands, hayed cool-season grasslands, and mowed cool-season grasslands (Walk and Warner, 2000). In north-central Missouri CRP fields, McCoy and others (1999) indicated that Dickcissel fecundity over 3 years was significantly lower than was necessary to support a stable population. Nest success was higher in cool-season CRP fields in the first year of the study and higher in warm-season CRP fields in the second year; abundance did not differ between the cool- and warm-season CRP fields (McCoy and others, 2001). In northern and western Missouri, Jacobs and others (2012) found that Dickcissel densities were higher in cool- and warm-season CRP grasslands than in grazed native and tame pastures and hayfields, likely because of the robust annual weeds that were present in CRP grasslands. Working in some of the same grasslands as Jacobs and others (2012), Jaster and others (2014) found no differences in daily nest survival rates of Dickcissels between warm- and cool-season grassland restorations.

Within the Kansas Flint Hills ecoregion, Dickcissels were significantly less abundant in spring-burned CRP fields that were planted to native, warm-season species of grasses than in spring-burned native pastures, but reproductive success did not differ between habitats (Klute and others, 1997). Rahmig and others (2009) reported that Dickcissel density was three times higher in unburned native-seeded CRP than in hayland or pastures. Hull and others (1996) reported that Dickcissels were common in native-seeded CRP fields and successfully nested within them. Highest abundances occurred in fields with a high frequency (greater than or equal to [≥] 60 percent) of forbs. Within grazed CRP fields west of the Kansas Flint Hills and planted to monocultures of tame yellow bluestem (*Bothriochloa ischaemum*), Dickcissels had higher abundances in expired CRP warm-season grasslands, followed by grazed native prairie and the monoculture yellow bluestem fields, but these differences were not statistically significant (Hickman and others, 2006). In north-central Oklahoma, George and others (2013) reported that Dickcissel densities were higher in grazed mixed-grass prairies than in CRP fields planted to monocultures of yellow bluestem, but these density differences were not statistically significant. In another north-central Oklahoma study, Dickcissels had higher abundances in grazed native prairie than in CRP fields seeded to yellow bluestem under various disturbances (heavily grazed, hayed, undisturbed), but these abundance differences were not statistically significant (Chapman and others, 2004a). The studies of Hickman and others (2006), George and others (2013), and Chapman and others (2004a) occurred in grazed systems, whereby grazing intensity varied among treatment types; thus, findings might be confounded by grazing (see more details in the "Species' Response to Management" section). In east-central Texas, Lituma and others (2012) reported no differences in Dickcissel abundance or nest success between tame grasslands and restored native grasslands.

Woody Vegetation

Grasslands with a woody plant component, such as woody draws and savannas, can provide nesting habitat for Dickcissels. In remnant tallgrass prairies in Minnesota, Elliott and Johnson (2017) reported that Dickcissel density peaked at about 30 percent shrub coverage. In Wisconsin, Dickcissels inhabited oak savannas (defined as 5–50 percent tree cover) and woodlands (>50 percent tree cover) dominated by bur oak (*Quercus macrocarpa*), northern pin oak (*Quercus ellipsoidalis*), northern red oak (*Quercus rubra*), white oak (*Quercus alba*), black oak (*Quercus velutina*), jack pine (*Pinus banksiana*), and black cherry *(Prunus serotina*) (Vos and Ribic, 2011, 2013; Wood and others, 2011; Bar-Massada and others, 2012). In an Iowa study of savanna and woodland bird communities, Dickcissels were restricted to restored oak savannas within an open landscape dominated by grasslands and rowcrop agriculture; Dickcissels were not found in savannas surrounded by upland deciduous forests, woodlands in open landscapes dominated by grasslands and rowcrop agriculture, or woodlands surrounded by upland deciduous forests (Mabry and others, 2010). In an Iowa study evaluating stream channelization, Dickcissel abundance was negatively related to tree species richness, tree and sapling density, tree size, and the horizontal patchiness of trees (Best and others, 1981). In the Cross Timbers ecoregion of Kansas, Holoubek and Jensen (2015) examined tolerance of bird species to varying levels of wooded habitats, including savanna (defined as 1–25 percent canopy cover), woodland (25–60 percent canopy cover) and forest (>60 percent canopy cover). Dickcissel occupancy in these habitats declined as canopy coverage per 100 meters (m) increased, which is indicative of a preference for savannas; dominant oak species were blackjack oak (*Quercus marilandica*) and post oak (*Quercus stellata*) (Holoubek and Jensen, 2015). Within southern mixed-grass prairies encroached by eastern redcedar in Oklahoma, Dickcissel abundance was negatively related to canopy coverage of eastern redcedar; abundance of grassland birds (all species) was near zero at 25 percent cover of eastern redcedar (Chapman and others, 2004b). In Texas, Dickcissels occupied post oak savanna and restored savanna but not open woodlands with dense stands of mature trees and ground cover dominated by woody regeneration (McInnerney, 2018; McInnerney and others, 2021). In Arkansas, Dickcissel densities were higher in brushy roadside borders than in open fields, and the species preferred thorny shrubs in roadsides bordering mature oat fields (Meanley, 1963).

Vegetation Structure and Composition

Importance of Forbs

The response of Dickcissels to nonwoody vegetation structure varies among studies and regions, but the species generally prefers grasslands with a high coverage of forbs (Sousa and others, 2022). A high abundance of forbs provides perches, nesting cover, nest support, and possibly increased invertebrate abundance (Blankespoor, 1970; Zimmerman, 1971; Harmeson, 1972, 1974; Birkenholz, 1973; Wiens, 1973; Skinner and others, 1984; Frawley and Best, 1991; Igl, 1991; Klute, 1994; Patterson, 1994; Patterson and Best, 1996; Winter, 1998). Several researchers have found a positive relationship between Dickcissel density and forb coverage, including Fritcher and others (2004) in mixed-grass prairies in central South Dakota, Fletcher and Koford (2002) in restored tallgrass prairies in north-central Iowa, Vogel (2011) in restored grasslands in northwestern Iowa, Delisle and Savidge (1997) in Nebraska CRP fields, and Hovick and others (2015) in burned-and-grazed tallgrass prairies in Oklahoma. In northwestern Missouri, Skinner (1974, 1975) reported that Dickcissel densities were highest with moderate amounts of forbs and were lower where forbs were either very scarce or very abundant. In moderately grazed and idle cover in southwestern Missouri, Dickcissels used moderate-to-tall vegetation with many tall forbs (Skinner and others, 1984). In Kansas oldfields, male breeding territories contained ≥50 percent coverage of forbs (Zimmerman, 1966). In burned and idle tallgrass prairies in Kansas, males with territories consisting of abundant forbs and grasses attracted more females than did males with fewer forbs and grasses in their territories (Zimmerman, 1993). In grazed mixed-grass prairies and CRP fields in north-central Oklahoma, Dickcissel density was positively related to forb coverage (George and others, 2013). In Colorado, Montana, New Mexico, Oklahoma, South Dakota, and Texas, mean habitat values for sites occupied by Dickcissels in grazed areas were 701 forb stems per square meter (m^2), 0 percent woody vegetation, and 29 percent open sky light intensity at ground level (Wiens, 1973).

High forb coverage and tall, dense vegetation also are important during the species' postfledging period (Berkeley and others, 2007; Wells and others, 2008; Jones and others, 2017). In Iowa and Nebraska, Berkeley and others (2007) examined habitat use within breeding territories by fledgling Dickcissels and concluded that fledglings required habitat similar to that used by nesting adults. High coverage of forbs was important during the postfledging period to provide shade and protection from predators. Fledgling survival was positively associated with the vertical and horizontal structure of forbs, forb density at nests, and vertical grass density on adult territories, and negatively associated with patchily distributed forbs on adult territories (Berkeley and others, 2007). In restored grasslands in central Illinois, Jones and others (2017) reported that fledgling Dickcissels used areas with denser vegetation than random locations; dense vegetation was defined as a metric that included average height, cover, and vegetation-height density values. Fledglings selected dense vegetation during 1–3 days postfledging and even denser vegetation 4–11 days postfledging after mobility increased. Fledglings were more likely to survive if they used denser vegetation at 0–3 days postfledging; no such relationship was found >3 days postfledging. Jones and others (2017) found that fledgling habitat characteristics did not differ from those preferred by females for nest sites. However, nests were in vegetation that provided more concealment than sites used by fledglings 1–3 days postfledging. In tallgrass prairies in southwestern Missouri, Wells and others (2008) found that home-range size of fledglings was influenced by variation in vegetation height; smaller home ranges had more variable vegetation heights than larger home ranges.

Other Important Vegetation Characteristics

Other aspects of vegetation structure to which Dickcissels respond include grass and litter coverage, litter depth, vegetation height, and vegetation height-density. In Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, Texas, Wisconsin, and Wyoming, Dickcissel abundance was positively related to percentage of grass cover, percentage of litter cover, litter depth, vegetation height, and vegetation density (Rotenberry and Wiens, 1980). In Wisconsin, Dickcissel abundance was most affected by vegetation characteristics of grassland patches; specifically, Dickcissel abundance was higher in patches with taller and denser vegetation and lower proportion of litter (Vos and Ribic, 2011). In remnant tallgrass prairies in Minnesota, Elliott and Johnson (2017) reported a positive relationship between Dickcissel density and percentage cover of standing dead vegetation, grass cover, and visual obstruction; Dickcissel density increased with increasing VOR to a value of about 50 cm. The relationship between Dickcissel density and coverage of vegetation height was curvilinear; Dickcissel density peaked at about 60 cm. Dickcissel density declined with increasing percentage of bare ground and was unaffected by litter depth and percentage cover of forbs (Elliott and Johnson, 2017). In mixed-grass prairies in eastern South Dakota, Dickcissel densities were positively related to vertical height-density (that is, VOR) and negatively related to litter depth (Bakker and others, 2002). In mixed-grass prairies in central and western South Dakota, Dickcissel occurrence was positively associated with litter depth and effective leaf height (defined as the highest point on a Robel pole touched by leaves of plants or grasses), whereas densities of male Dickcissels were positively associated with grass height and negatively associated with shrub height and percentage cover of all introduced plant species (Greer, 2009). In Nebraska CRP fields, Dickcissel abundance was positively related to litter depth and visual obstruction (Delisle and Savidge, 1997). In tallgrass prairies of Nebraska and Iowa, McLaughlin and others (2014) used hierarchical model selection to explain variation in Dickcissel density and occurrence. In the occurrence model, vegetation variables did not improve explanatory power over the model that only included year. The best density model included mean vegetation height; Dickcissel densities were higher where mean vegetation was taller. In restored tallgrass prairies in north-central Iowa, Dickcissel densities were positively associated with litter depth and negatively correlated with vertical vegetation density (Fletcher and Koford, 2002). In grassed terraces in southwestern Iowa, Dickcissel abundance was positively associated with vegetation height and vertical vegetation density (Hultquist and Best, 2001). In tallgrass prairies of Iowa and Missouri, density of Dickcissels was negatively associated with litter cover (Pillsbury, 2010). In a Michigan alfalfa field, Dickcissels occupied areas of low plant diversity; low horizontal vegetation density at a height of 5 cm; and high litter coverage, vegetation height, and vertical density of vegetation (Harrison, 1974). In tallgrass prairie fragments in southwestern Missouri, Dickcissel densities increased with vegetation height (Winter, 1998). In hayed and grazed native and tame grasslands and idle CRP fields in Missouri, Dickcissel abundance increased with higher values of vegetation height-density and decreased with increasing litter depth (Jacobs and others, 2012). Predicted counts of Dickcissels increased 29 percent over the increasing range of vegetation height-density and decreased 21 percent over the increasing range of litter depth (ranges for both vegetation values were 0–60 cm). In Illinois tallgrass prairie fragments, Herkert (1991a) indicated that Dickcissel densities were positively associated with live-plant (mostly grass) richness, although Herkert (1994a) reported that Dickcissel presence was not affected by vegetation structure. In another Illinois study in tallgrass prairie fragments, Buxton and Benson (2016) found that Dickcissel densities were negatively related to visual obstruction. In Illinois CRP grasslands, Dickcissel densities were positively associated with greater plant species diversity and percentage cover of bare ground and negatively associated with total vegetation cover (Osborne and Sparling, 2013). In Kansas CRP fields, Dickcissel abundance was positively associated with vertical height-density (Hughes and others, 1999). In tallgrass prairies of Oklahoma, Dickcissel abundance increased with vegetation height, litter coverage, and litter depth (Coppedge and others, 2008; Hovick and others, 2015). In grazed mixed-grass prairies and CRP fields in north-central Oklahoma, Dickcissel density was positively related to visual obstruction and heterogeneity of vegetation structure (George and others, 2013). Within organic farm fields in the central Great Plains, Quinn and others (2012) reported that Dickcissel abundance was higher at avian survey points with greater vegetation height, lower at points with greater vegetation density, and unaffected by coverage of bare ground and total vegetation cover.

Nests and Nest Sites

General vegetation characteristics near Dickcissel nest sites include dense live vegetation, sparse bare ground cover, and occasionally a forb or woody component. In Iowa CRP fields, nest density was positively correlated with vertical height-density and total percentage canopy cover of forbs (Patterson, 1994; Patterson and Best, 1996). In Iowa grassed waterways, the probability of occurrence of Dickcissel nests was 3.9 times greater in waterways that had greater forb coverage than in waterways with lower forb coverage and 5.6 times greater in waterways with tall grass than waterways with short grass (Bryan and Best, 1994). In Nebraska CRP grasslands, maximum vegetation height was higher at unsuccessful Dickcissel nests than at successful nests (Negus and others, 2010). In Missouri tallgrass prairie fragments, Winter (1998, 1999) reported that successful nests were placed in areas with significantly greater visual obstruction, greater grass coverage, taller vegetation, and less bare ground coverage than unsuccessful nests. In the east-central portion of the Kansas Flint Hills, nest sites (that is, 0.25 m^2 around the nest) in tallgrass prairies had significantly greater live-grass height, live-forb coverage and height, and live woody-vegetation coverage and less bare ground and litter coverage than the area 1–10 m around the nests (Jensen, 1999). In the tallgrass prairies of the Flint Hills at the Konza Prairie Biological Station, Klug and others (2010) reported that Dickcissels nesting in areas of increased vegetation height but decreased shrub cover had highest nest success. In the tallgrass prairies of the Flint Hills of Kansas and Oklahoma, Frey and others (2008) examined the influence of vegetation structure and topography on daily nest survival. VOR was more important to daily nest survival than topographic position, as Dickcissels selected nest sites with higher VORs than were typically available. The use of lowlands relative to uplands shifted over the course of a nesting season; Dickcissels nested in lowlands early in the season and occupied uplands later in the season. In CRP in northeastern Kansas, Hughes (1996) found that vegetation at nest sites was characterized by higher overall vegetative volume in the canopy and lower amounts of bare ground and litter coverage than either the area immediately adjacent to the nest (within 4 m) or the field in which the nest was located. Daily nest-survival rates were positively associated with percentage of litter cover within CRP fields and were negatively associated with percentage of live and dead canopy cover (Hughes and others, 1999). In Texas, Dickcissel nests were associated with small, woody plants and were surrounded by dense grass or 0.6–0.9-m tall forbs; percentage cover of forbs on occupied sites ranged from 11 to 99 percent depending on forb height. Dickcissels also preferred lower shrub coverage, as volumes of shrubs on occupied and unoccupied sites were 9.6 and 15 cubic meters (m^3), respectively (Roth, 1979). For nests within restored post oak savannas in eastern Texas, successful nests differed from unsuccessful nests in having a higher percentage of vertical cover at 0–1 m (McInnerney, 2018). Nest sites in woody substrates had a larger diameter-at-breast-height than woody substrates at paired sites (that is, random sites that were about 25 m away and centered in structurally similar nest substrate). Nest sites also had a higher percentage cover of vertical nest strata at 0–1 m and at 2–3 m than paired sites. In another study of restored savanna in Texas, Dickcissels selected nest sites with low vegetative ground cover (that is, low visual obstruction), plenty of tall, dead forbs for perch sites and high amounts of clover and bunchgrass (Dixon, 2005). Best predictors of nest success were increasing values of nest height and vegetation height above the nest. Nest-survival rates for nests did not differ among low, medium, or high density of shrubs around the nest. In northeastern Mississippi, Dickcissel nest survival rates increased with pasture-scale VORs, with lowest VORs in grazed tame grass (for example, bermudagrass [*Cynodon dactylon*] and tall fescue [*Schedonorus arundinaceus*]), intermediate readings in grazed native warm-season grasses (Indiangrass [*Sorghastrum nutans*], little bluestem [*Schizachyrium scoparium*], and big bluestem [*Andropogon gerardii*]), and highest readings in ungrazed native warm-season grasses (Monroe and others, 2019).

Nests typically are built above the ground in grasses, forbs, shrubs, or trees, and less commonly on the ground in and under thick vegetation (Gross, 1921a,b, 1968; Overmire, 1962, 1963; Meanley, 1963; Zimmerman, 1966; Blankespoor, 1970; Eddleman, 1974; Fretwell, 1977; Frawley, 1989; Winter, 1999). Nest heights range from 0 to 2 m (Taber, 1947; Ely, 1957; Meanley, 1963; Long and others, 1965; Von Steen, 1965; Gross, 1968; Berry, 1971; Roth, 1979; Laubach, 1984; Winter, 1998; Dixon, 2005). In Nebraska, nests averaged 34 cm high in alfalfa plants and rose (*Rosa* spp.) bushes (Von Steen, 1965). In Iowa, Dickcissels placed nests in forbs (44 percent), grasses (33 percent), shrubs (11 percent), and deciduous saplings (11 percent) (Best and others, 1981). In an Illinois oldfield, Dickcissels nested in live forbs and dead vegetation; most nests were in hairy white oldfield aster (*Symphyotrichum pilosum*), but nests in dead vegetation were more productive (Harmeson, 1972, 1974). In another Illinois study, nests in trees or hedges were 0.6–1.8 m above the ground (Gross, 1968). In grasslands seeded to native grass species in Illinois, switchgrass (*Panicum virgatum*) was the most frequently occurring native species found at Dickcissel nests (it was also the most predominant species of grass) (Westemeier and Buhnerkempe, 1983). In Missouri, nests were found in individual forb plants such as leadplant (*Amorpha canescens*) and ashy sunflower (*Helianthus mollis*); nests were occasionally placed above the ground in clumps of grass or in shrubs, or on the ground in litter (Sauer, 1953; Skinner and others, 1984; Winter, 1999). Smooth brome (*Bromus inermis*) was a common nest substrate for nests found in grassed waterways in Iowa and Kansas (Blankespoor, 1970; Bryan and Best, 1991, 1994) and in road rights-of-way in Nebraska (Hergenrader, 1962). The primary forb species used as a nesting substrate in grassed waterways was alfalfa (Bryan and Best, 1994). In central Iowa CRP fields, early-season Dickcissel nests were in smooth brome, whereas late-season nests were in alfalfa or bull thistle (*Cirsium vulgare*) (Patterson and Best, 1996). In Kansas, most nests in oldfields, tallgrass prairies, waterways, and stubble fields were in forbs, followed by isolated American elm (*Ulmus americana*) saplings, thistle (*Cirsium* spp.), and grasses (Zimmerman, 1966; Blankespoor, 1970). In tallgrass pastures in Kansas, most Dickcissel nests were adjacent to patches of dogwood (*Cornus* spp.) (Fleischer, 1986). In another study in tallgrass prairie pastures, Frey and others (2008) described the main vegetation components of Dickcissel nests as consisting of grasses and forbs. In Kansas CRP fields with sparse forb coverage, nests were in solitary clumps of bunchgrasses surrounded by litter (Hughes and others, 1999). W.E. Jensen (Emporia State University, Emporia, Kansas, written commun. [n.d.]) also found that Dickcissel nests in Kansas CRP fields were most common in grass clumps of native-grass species. In Oklahoma, Dickcissels nested on the ground and in saw greenbrier (*Smilax bona-nox*) thickets within oldfields; nest heights in an oldfield ranged from 3 to 60 cm (Ely, 1957; Berry, 1971). In another Oklahoma study, trees, shrubs, and forbs were used as nesting substrates more than expected and grasses less than expected, based on availability (Overmire, 1963). Ground nests were more successful than elevated nests; as the season progressed, however, nests were built higher above the ground in trees (mostly American elm), shrubs, and forbs. In a third Oklahoma study, nests ranged from ground height to 550 cm above the ground (Reinking and others, 2009). Within tallgrass prairies in Texas, nests were most often in green milkweed (*Asclepias viridiflora*), Roemer sensitivebriar (*Mimosa roemeriana*), and eastern gamagrass (*Tripsacum dactyloides*) (Steigman, 1993). For 38 nests within restored post oak savannas in eastern Texas, 20 nests were in grass substrate, primarily little bluestem (*Schizachyrium scoparium*), and 18 were in woody substrates including post oak, hickory (*Carya* spp.), bluejack oak (*Quercus incana*), and blackjack oak (McInnerney, 2018). At another nearby restored surface mine, Dickcissels commonly nested in oaks, willow baccharis (*Baccharis salicina*), pines (*Pinus* spp.), Wilman's lovegrass (*Eragrostis superba*), switchgrass, and bushy bluestem (*Andropogon glomeratus*) (Dixon, 2005). Oaks and pines were preferred substrates, baccharis was not avoided or selected, and bunchgrasses were avoided. In Arkansas, the species nested in thorny shrubs, hawthorn (*Crataegus* spp.), common buttonbush (*Cephalanthus occidentalis*), plum trees (*Prunus* spp.), dogwood, and grasses (Meanley, 1963).

Perches

Male Dickcissels commonly sing from elevated structures. Small trees and shrubs, tall forbs, fence posts and wires, and powerlines are commonly used as song perches (Harrison and Brewer, 1979; Laubach, 1984; Kahl and others, 1985; Sousa and others, 2022). In Missouri, habitat around song perches in grasslands and oldfields had few (<350 woody stems per hectare [ha]) or no woody stems <2.5 cm diameter at breast height, no woody stems ≥2.5 cm diameter at breast height, and had dense (≥85 percent coverage) ground vegetation (Kahl and others, 1985). Harrison and Brewer (1979) added artificial song perches (wooden stakes) to an alfalfa field in Michigan to test the role of elevated perch sites in habitat selection by grassland birds; the authors concluded that changes in Dickcissel abundance throughout the breeding season seemed unrelated to the addition of elevated song perches.

Climate

Moisture conditions may influence Dickcissel distribution, abundance, and productivity during the breeding season. Irruptions and annual fluctuations in Dickcissel distribution and abundance on the breeding grounds have been linked to variation in precipitation and its effect on annual vegetation growth (Oberholser and Kinkaid, 1974; Roth, 1979; Fretwell, 1986; Mulvihill, 1988; Igl, 1991; Bateman and others, 2015). Mulvihill (1988) and Igl (1991) indicated that mowing of hayfields in the center of the species' range may contribute to opportunistic, drought-related movements to extralimital portions of the species' range. In southwestern Iowa, Igl (1991) found a positive relationship between Dickcissel densities and April soil moisture in alfalfa fields, whereas a negative relationship between April soil moisture and bird abundance was detected in Wisconsin, indicating that mechanisms influencing the annual geographic limits of distribution at the regional level may be an extension of interactions (for example, weather effects on primary and secondary resources) taking place at the local level. In the central Platte River Valley of Nebraska, Dickcissel densities were highest when moisture conditions were dry (Kim and others, 2008). In another study along the Platte River Valley of Nebraska, Rosamond and others (2020) used 9 years of capture-recapture data over an 18-year period to document that increasing precipitation was associated with a decline in Dickcissel abundance and an increase in Brown-headed Cowbird (*Molothrus ater*) abundance. Dickcissel abundance was negatively correlated to June precipitation. Dickcissel productivity was positively correlated to June–July precipitation and temperature and number of months since grazing. In Missouri, Wells and others (2008) attributed annual variation in juvenile home-range size to prolonged drought and its effect on vegetation structure and composition; home ranges were larger when average vegetation height was shorter and less variable. In Kansas, daily nest survival rate of Dickcissels was best predicted by annual mean temperature and winter season precipitation (Spahr, 2017). Daily nest survival was lower in warm years and higher with increased winter precipitation; no relationship was detected between climate variables and brood parasitism rates.

Some authors (Robbins and van Velzen, 1969; Oberholser and Kinkaid, 1974; Roth, 1979; Fretwell, 1986) have indicated that the species will nest in the extreme southern portion of its range during wet years when herbaceous vegetation is lush but bypass these southern areas during dry years when conditions are poor for nesting. In contrast, Cady and others (2019) reported that Dickcissels were more likely to colonize new areas within the southern portion of the species' range with increasing drought intensity. They reported no relationship between extinction probability and drought intensity.

Using North American BBS data, Bateman and others (2015) examined the effect of extreme weather on spatial patterns for the Dickcissel and found that drought plays an important role in the short-term changes in spatial distribution of Dickcissel breeding populations. More specifically, Dickcissel irruptions in the northern edges of its breeding range were related to drought conditions in the core of its range, indicating that birds are pushed to the edge of their breeding range when conditions in the core of the species' range are unsuitable. During drought years, Dickcissels left grassland areas and moved to locations containing a high proportion of cultivated crops (Bateman and others, 2015).

The future distribution of Dickcissels and their breeding habitat may be affected by climate-induced changes to temperature and precipitation (Langham and others, 2015). Under projected greenhouse gas emission scenarios described by the Intergovernmental Panel on Climate Change (2000), Langham and others (2015) categorized the Dickcissel as a climate-stable species, indicating that the species would retain >50 percent of its current distribution by 2050 across all Intergovernmental Panel on Climate Change scenarios, with potential for range expansion. Wilsey and others (2019) compiled avian occurrence data from 40 datasets to project climate vulnerability scores under scenarios in which global mean temperature increases 1.5, 2, or 3 degrees Celsius (ºC). Dickcissels ranked neutral in vulnerability during the breeding season under all three scenarios. Peterson (2003) modeled the effect of two scenarios—0.5 and 1 percent per year increases in carbon dioxide—on bird species whose geographical distributions were within the Great Plains, which included the Dickcissel; Peterson (2003) estimated that Dickcissels would experience breeding-range contraction and dramatic distributional movements under the two climate scenarios. Culp and others (2017) assessed the vulnerability of Dickcissels to changes in climatic factors (that is, changes in temperature and moisture) across the species' full annual cycle in the Upper Midwest and Great Lakes regions. The assessment considered factors such as background risk (that is, factors unrelated to climate change that could affect resiliency to climate change), climate change exposure (that is, exposure to temperature and moisture changes throughout the annual life cycle), and climate sensitivity and adaptability (that is, the ability of a species to physiologically and evolutionarily tolerate change). Dickcissels ranked moderate in the relative total vulnerability score (Culp and others, 2017). In South Dakota and Minnesota, Swanson and Palmer (2009) examined spring-arrival dates over a roughly 40-year period for both States and concluded that Dickcissels were arriving later in the spring in recent years. Travers and others (2015) compared historical bird data on species' spring-arrival dates in eastern North Dakota in the early to mid-20th century with dates in the early 21st century and concluded that Dickcissels were arriving later in the spring in the recent period than in the historical period.

Area Requirements and Landscape Associations

Territory Size

The male Dickcissel defends a multipurpose territory in which foraging, mating, nesting, and rearing of young occur (Sousa and others, 2022). In Kansas, mean size of male territories in tallgrass prairies ranged from 0.40 to 0.57 ha (Petersen, 1978; Finck, 1983, 1984), whereas the mean territory size in oldfields ranged from 0.15 to 0.95 ha (Zimmerman, 1966; Schartz, 1969; Petersen, 1978; Finck, 1984). The mean territory size of male Dickcissels in an Illinois oldfield ranged from 0.38 to 0.54 ha (Harmeson, 1972, 1974). The mean territory sizes in ungrazed and grazed tallgrass prairies in Oklahoma were 0.25 and 0.47 ha, respectively (Overmire, 1963). Larger territory sizes of 1.4 and 1.5 ha were reported for remnant tallgrass prairies in Iowa (Laubach, 1984) and tallgrass pastures in Oklahoma (Wiens, 1971), respectively. In Kansas, male territory sizes on an oldfield (0.14–0.17 ha) were significantly smaller than those on an unburned tallgrass prairie (0.39–0.48 ha) and a burned tallgrass prairie (0.43–0.71 ha) (Petersen, 1978). In the oldfield, males without mates had significantly smaller territories than monogamous or polygynous males, a result that also was reported by Zimmerman (1966) and Harmeson (1974). In a Missouri study of postfledging Dickcissels, average home-range size varied from 77 ha in the first year of the study to 31 and 35 ha in the next 2 years, respectively (Wells and others, 2008). These differences were related to the variability in vegetation height, with more variable heights trending towards smaller home ranges.

Area Sensitivity

In a review of area sensitivity of grassland birds, Ribic and others (2009b) concluded that Dickcissels were area sensitive, preferring larger grasslands over smaller grasslands, although some researchers have found Dickcissels to be somewhat tolerant of habitat fragmentation (Herkert, 1991a, 1991b; Herkert and others, 1993; Winter, 1998). In Wisconsin, Vos and Ribic (2013) reported that Dickcissels occurred only on prairie patches that were 48 ha or larger; patches ranged in size from 4 to 267 ha. Patch size, however, was not related to Dickcissel abundance (Vos and Ribic, 2011). In mixed-grass prairies in eastern South Dakota, Dickcissel densities were positively correlated with grassland patch area at the local level but not at the landscape level (Bakker and others, 2002). In mixed-grass prairies in central South Dakota, Greer (2009) reported a negative relationship between Dickcissel density and patch area. In fields enrolled in the Conservation Reserve Enhancement Program in Iowa, Reiley and Benson (2019) reported that Dickcissel density was positively associated with patch size. In Iowa and Nebraska tallgrass prairies, Dickcissel density and occurrence were lowest in prairies with high edge-to-interior ratios compared to sites with low ratios (McLaughlin and others, 2014). In Nebraska wet-meadow grasslands, the minimum area in which Dickcissels were found was 9 ha with a perimeter-area ratio of about 0.02 (Helzer, 1996; Helzer and Jelinski, 1999). Occurrence of Dickcissels was positively correlated with patch area and inversely correlated with perimeter-area ratio (Helzer and Jelinski, 1999). In idle tallgrass prairie fragments in Illinois, Herkert (1991a, 1994a) found no relationship between Dickcissel abundance and fragment size, and the minimum area in which Dickcissels were found was <10 ha. However, in burned tallgrass prairie fragments in Illinois, Dickcissel abundance was inversely related to area (Herkert, 1994b). In urban grasslands in the metropolitan area of Chicago, Illinois, Buxton and Benson (2016) reported that Dickcissel densities were positively related to patch size. In Illinois CRP grasslands, Dickcissel densities were positively associated with field size and negatively associated with edge-to-area ratios (Osborne and Sparling, 2013). In Missouri tallgrass prairies, Dickcissel abundance was positively related to size of prairie fragments (Swengel, 1996; Swengel and Swengel, 2001). In a second Missouri study on tallgrass prairie fragments, Dickcissel density was not influenced by fragment size, but daily nest success decreased with decreasing fragment size (Winter, 1996; Winter and Faaborg, 1999). Dickcissel densities increased as distance among grassland patches decreased (Winter, 1998). In Kansas tallgrass prairies, the abundance of Dickcissels did not differ among study sites varying in area or perimeter length (Applegate and others, 2002).

Dickcissel nest success and nest-site selection may be influenced by patch size or proximity to habitat edges. In southwestern Iowa pastures, nest survival decreased with increasing percentage cover of tall fescue at the nest site and with increasing rowcrop cover within 1 kilometer (km) of nests (Maresh Nelson and others, 2018). In Illinois, Kansas, Missouri, North Dakota, and Oklahoma, Dickcissel nest predation was negatively associated with habitat patch area (Herkert and others, 2003). In small (3–142 ha) patches of restored grasslands in southeastern Illinois, Walk and others (2010) compared Dickcissel nest survival for nests within 50 m of cropland or woodland edges to nests 50–100 m from cropland or woodland edge; daily survival rate was not related to patch size or proximity to cropland or woodland edges. Fewer Dickcissel nests were found within 100 m of wooded edges than beyond 100 m, a trend that was not observed for cropland edges (Walk and others, 2010). In northwestern Illinois CRP fields, Shew and others (2019) reported that Dickcissel nest survival decreased with increasing nest distance from non-grassland edge and with increasing field size. In southwestern Missouri tallgrass prairies, Dickcissel nests had a 9 percent probability of survival in small fragments and a 31 percent probability of survival in large fragments; prairies ranged in size from 31 to 1,084 ha (Winter, 1996; Winter and others, 2000). Nest depredation was higher <50 m from an edge habitat than >50 m from an edge (Winter and others, 2000). In Kansas tallgrass prairies, daily nest-predation rates were not related to distance from woodland or cropland edges (Jensen and Finck, 2004). Nest densities were lower in plots within 50 m of woodland edges than in plots at greater distances from woodland edges (50–100 m and >100 m), but there was no such pattern relative to cropland edges. None of 124 nests were found within 25 m of a wooded edge; mean nest distance from agricultural edges was about 44 m, and mean nest distance from woodland edges was about 70 m (Jensen, 1999; Jensen and Finck, 2004). In Kansas CRP fields, Hughes (1996) found that nest success was not significantly different between nests <50 m from a wooded edge and nests >50 m from a wooded edge. Abundance was negatively associated with the percentage of the perimeter around CRP fields that was wooded, although the authors cautioned that results may have been an artifact of sampling technique as Dickcissel use of edge habitats was not recorded (Hughes and others, 1999). On reclaimed surface mines in the post oak savanna ecoregion of eastern Texas, Dickcissels selected nest sites that were closer to brush-encroached areas and farther from wooded riparian areas and newly reclaimed areas with substantial bare ground than unoccupied random locations (Dixon, 2005; Dixon and others, 2008).

Several studies have investigated a relationship between patch size or proximity to edges and rates of parasitism by the obligate brood parasite, the Brown-headed Cowbird. In Iowa, nest parasitism rate was lower for nests with higher woodland cover within 500 m of nests and higher prevalence of woody edge, but parasitism rate was higher with higher percentage cover of woody vegetation and tall fescue at nest sites (Maresh Nelson and others, 2018). In Illinois, Kansas, Missouri, North Dakota, and Oklahoma, cowbird brood parasitism of Dickcissel nests was not associated with patch size (Herkert and others, 2003). In Illinois, Dickcissel nests located within 50 m of woody edges or other tall (>2 m) woody vegetation were more than twice as likely to be parasitized as nests >50 m from woody vegetation (J.R. Herkert, Illinois Audubon Society, Springfield, Ill., and S.K. Robinson, University of Florida, Gainesville, Florida, written commun. [n.d.]). In tallgrass prairie fragments in southwestern Missouri, the frequency of cowbird brood parasitism increased significantly with proximity to shrubby edges; frequency of brood parasitism was highest within 50 m from a shrubby edge (Winter, 1998; Winter and others, 2000). Rates of cowbird brood parasitism were not related to fragment size (Winter, 1998; Winter and others, 2000). In Kansas, brood parasitism rates were significantly higher for nests placed ≤100 m from woodland edges compared to nests placed >100 m from woodland edges (Jensen and Finck, 2004). However, parasitism rates did not differ for nests placed ≤100 m from agricultural edges than those placed >100 m from agricultural edges. In Oklahoma, Patten and others (2006) examined edge avoidance and brood parasitism in four different treatments: undisturbed, grazed, and grazed-and-burned prairies, and near roadside strips of woody vegetation. Dickcissels experienced the highest rates of brood parasitism along roadside strips, followed by burned-and-grazed, grazed, and undisturbed prairies. Brood parasitism rates were negatively related to distance from woody vegetation, with higher rates for nests within 21 m of woody vegetation than nests farther than 21 m of woody vegetation. Parasitism rates were significantly higher along country roads cut through tallgrass prairie than in roadless prairies, although there were fewer nests along roadsides than in prairies. After accounting for edge effect, presence of burning and grazing together best explained parasitism rate (Patten and others, 2006). For Dickcissels, nests placed between 50 and 150 cm above the ground and that were 75 percent concealed were parasitized more heavily than nests placed above and below this height range and more or less than 75 percent concealed (Patten and others, 2011).

Landscape Effects

Dickcissels may be influenced by characteristics of the surrounding landscape. Within organic farm fields in the central Great Plains, Quinn and others (2012) reported that Dickcissel abundance was unaffected by the percentage of grassland, woodland, or landscape vegetation heterogeneity within 5,000 m of avian survey points. Using point-count surveys collected over 4 years within the prairie landscape (Great Plains and Deserts ecoregions) of the western United States, Dreitz and others (2017) demonstrated that occupancy of Dickcissels was positively related to latitude and lands in public ownership and negatively related to the percentage of grassland and sagebrush habitats within 1-square-kilometer (km^2) survey plots. In 14 counties in eastern North Dakota and eastern South Dakota, Quamen (2008) compared Dickcissel abundance at increasing distances (1–240 m) from tree belts and in treeless grasslands to assess the species' response to edge and to evaluate changes in Dickcissel abundance after removal of the tree belts. Dickcissels avoided woody edges in 1 of 2 years; avoidance of trees was apparent as far as 240 m (that is, the farthest distance from woody edges that bird surveys were conducted). Dickcissels recolonized grasslands following tree belt removal, but their abundance remained below that observed in treeless grasslands (Quamen, 2008). In remnant tallgrass prairies in Minnesota, Elliott and Johnson (2017) reported that Dickcissel densities declined as the proportion of trees within 100 m of survey points increased up to 5 percent tree cover, and densities increased with increasing distance to the nearest tree. Remnant prairies with Dickcissels were significantly farther from trees than prairies without Dickcissels. In a study encompassing a wide range of terrestrial and aquatic habitats throughout Iowa, Harms and others (2017) reported that Dickcissel occupancy and colonization of the landscape were negatively correlated to the percentage of the landscape in woodland within 500 m of sampled sites. In mixed-grass prairies in central South Dakota, Greer (2009) reported that Dickcissel density was negatively related to the amount of grassland habitat in the landscape. In Kansas CRP fields, Dickcissel abundance was negatively associated with the amount of wooded area within 800 m of CRP fields

(Hughes and others, 1999). In western Oklahoma, species occurrence models indicated that high shrubland cover within 800 m of BBS stops was an indicator of Dickcissel occurrence (Coppedge and others, 2004).

In Wisconsin landscapes of varying amounts of grassland and forest, Dickcissel abundance increased with the area of grassland at an 800-ha scale around the 620,000-ha study site consisting of five counties (Murray and others, 2008). In agricultural areas of Iowa, abundance was negatively correlated with the amount of rowcrops and positively correlated with the amount of pasture, alfalfa hayland, herbaceous fencerow, woodland, wooded strip cover, and CRP grasslands in the landscape (Best and others, 2001). In Conservation Reserve Enhancement Program fields in Iowa, Reiley and Benson (2019) reported that Dickcissel density decreased as the percentage tree cover within a 5-m radius of survey points and the proportion of forest cover within 200 m increased. Density increased with greater proportion of restored habitat, grass cover, and cropland within 200 m. In restored grasslands and tallgrass prairies in north-central Iowa, Dickcissel density was negatively correlated with the density of grassland edge within 1 km of study sites (Fletcher and Koford, 2002). In Iowa and Missouri tallgrass prairies, Dickcissel densities were negatively associated with percentage grass cover at the 0–300-m scale, positively associated with percentage grass cover at the 300–1,000-m scale, and negatively associated with the density of wooded edges at both spatial scales (Pillsbury, 2010). In Missouri, Jacobs and others (2012) found that the best-supported models for predicting Dickcissel abundance included vegetation structure and grassland type, but also that Dickcissel abundance decreased with increasing percentage grassland cover and density of edges within 1 km of survey points. Predicted Dickcissel counts decreased 21 percent over the increasing range of percentage grassland cover (range was 0–100 percent) and decreased 39 percent over the increasing range of edge density (range was 0–140 m per ha). In Illinois CRP grasslands, Dickcissel densities were negatively associated with the percentage of forest cover and unsuitable areas (that is, urban or rural residential areas, roads, and water) within 500 m of CRP fields (Osborne and Sparling, 2013). On reclaimed surface mines in Ohio, Graves and others (2010) failed to detect an association between woody vegetation within 100 m of survey locations and Dickcissel abundance; the authors surmised that this result may be an artifact of the relatively large territory size of the Dickcissel and the researchers' use of fixed-radius surveys (within 100 m). In the Central Hardwoods Bird Conservation Region of the southern United States, Dickcissel occupancy was positively correlated with the percentage of pasture grass and pasture hay cover in the landscape and negatively correlated with the percentage and amount of deciduous forest cover in the landscape (Lituma and Buehler, 2020). Dickcissel occupancy also was negatively correlated with the mean patch perimeter-to-area ratio (that is, patch heterogeneity), indicating that the species is area sensitive and emphasizing the importance of large, homogeneous patches of grasslands for this species.

Brood Parasitism by Cowbirds and Other Species

The Dickcissel is a common host of the Brown-headed Cowbird (Shaffer and others, 2019), although rates of cowbird brood parasitism in Dickcissel nests have varied from as low as 0 percent of 21 nests (Vos and Ribic, 2013) to as high as 95 percent of 19 nests (Elliott, 1978). The species is considered a preferred and abundant cowbird host in the central Great Plains (Jensen and Cully, 2005a; Rivers and others, 2010). Dickcissel nests may be multiply parasitized (Smith, 1882; Friedmann, 1963; Zimmerman, 1966; Schartz, 1969; Elliott, 1978; Winter, 1999; Igl and Best, 2001; Igl and Johnson, 2007; Rivers and others, 2010; Maresh Nelson and others, 2018; Kraus and others, 2022; Verheijen and others, 2022), and the species has been known to abandon parasitized nests (Zimmerman, 1966; Elliott, 1978). In Illinois, Dickcissels rejected 11 percent of nine mimetic cowbird eggs experimentally added to nests (Peer and others, 2000). Cowbird parasitism may lower Dickcissel productivity in some populations (Overmire, 1963; Wiens, 1963; Schartz, 1969; Elliott, 1976; Fretwell, 1977; Zimmerman, 1982, 1983; Winter, 1998; Jensen and Cully, 2005b). In Illinois, Kansas, and Oklahoma, cowbirds parasitized 343 of 767 Dickcissel nests, and Dickcissels suffered significant costs when attempting to eject cowbird eggs (Peer and others, 2018). Acceptance of cowbird eggs lead to a loss of 1.1 host eggs or nestlings per nest, attempting to eject the cowbird egg yielded a loss of 1.8 host eggs or nestlings, and ejecting the cowbird egg resulted in a loss of 2.0 host eggs or nestlings. In Iowa grasslands, higher parasitism intensity (that is, number of cowbird eggs per parasitized nest) reduced host clutch size (Maresh Nelson and others, 2018). Parasitized nests in the nestling phase had lower nest survival than nonparasitized nests, whereas nest survival of parasitized nests and nonparasitized nests were similar during laying and incubation phases. Nests initiated later in the breeding season and nests built in areas with high territory density had lower parasitism probability (Maresh Nelson and others, 2020).

Brood parasitism rates vary regionally, and this variation may be related to cowbird and Dickcissel abundance. In Illinois, Kansas, Missouri, North Dakota, and Oklahoma, brood parasitism rates were positively correlated with Brown-headed Cowbird abundance (Herkert and others, 2003). Basili (1997) compared brood parasitism rates among multiple studies in Wisconsin, Kansas, Oklahoma, and Texas; the highest rates occurred in Kansas and the lowest rates were in Texas. Rates were positively correlated to the average number of cowbirds and the average number of Dickcissels per North American BBS route in each State. Within the Flint Hills of Kansas and Oklahoma, Jensen and Cully (2005b) reported considerable variation in frequency of cowbird parasitism, ranging from 0 to 92 percent among study areas. Parasitism frequency and intensity of Dickcissel nests were related to geographic variation in local female cowbird densities. Parasitism measures were not related to local vegetation or landscape factors, nest distance to edge, average host abundance, male Dickcissel density, nest initiation dates, or burning of prairies. Dickcissel clutch size and apparent fledging success were negatively related to parasitism frequency and intensity.

Intensity and frequency of brood parasitism by Brown-headed Cowbirds may be dependent upon Dickcissel nest densities and habitats. In Kansas and Texas, oldfields had higher nest densities but lower rates of cowbird parasitism than tallgrass prairies (Fretwell, 1977; Zimmerman, 1982, 1983). In Kansas, Rivers and others (2010) reported that the proportion of cowbird young in Dickcissel nests at Konza Prairie increased with the proportion of new Dickcissel nests and with nest initiation date, indicating that Dickcissels were consistently the preferred host for brood parasitism, despite the presence of nests of several other host species. However, in another study in tallgrass pastures in Kansas, Fleischer (1986) reported that rates of brood parasitism were not related to Dickcissel nest density but were related to nest height. Dickcissel nests that were parasitized by cowbirds were placed significantly higher (mean of 0.65 m) above the ground than unparasitized nests (mean of 0.34 m). In Missouri tallgrass prairies, there were no significant differences in vegetation measurements between parasitized and unparasitized Dickcissel nests (Winter, 1999). However, clutch size and the number of host young fledged from successful nests were significantly lower for parasitized nests. In Texas, Fretwell (1972) observed that higher rates of brood parasitism occurred in Dickcissel nests when they were placed near Red-winged Blackbird (*Agelaius phoeniceus*) nests.

Breeding-Season Phenology and Site Fidelity

In the spring, Dickcissels arrive on their breeding grounds in the central and northern Great Plains from late April to late May and depart for the wintering grounds from late August to mid-September (Gross, 1921a,b, 1968; Taber, 1947; Sauer, 1953; Schartz, 1969; Johnsgard, 1980; Faanes, 1981; Finck, 1983, 1984; Laubach, 1984; Igl, 1991; Winter, 1999). Dickcissels that breed in Texas, Oklahoma, and Arkansas arrive on the breeding grounds from mid-April to early May and depart from late July to mid-September (Meanley, 1963; Overmire, 1963; Fretwell, 1972; Roth, 1979). Renesting is common (Harmeson, 1972, 1974; Zimmerman, 1982; Winter, 1998). Multiple renesting attempts have been documented (Fletcher and others, 2006). Double-brooding is rare but has been reported in some areas (Harmeson, 1972; Bollinger and Maddox, 2000); results from a study conducted in southwestern Missouri indicated that only a single brood is produced per breeding season (Winter, 1998).

Several banding studies have reported that Dickcissels exhibit site fidelity, although attachment to former breeding areas varies considerably from one study to another (Schartz, 1969; Finck, 1984; Zimmerman and Finck, 1989; Igl, 1991; Fletcher and others, 2006). Along the Platte River Valley in Nebraska, Rosamond and others (2020) captured and marked 705 adult Dickcissels over 9 years; 50 marked adults were recaptured in a subsequent breeding season. Of the marked adults that were recaptured in a subsequent year, 70 percent occurred at the same site as initial capture and the remainder were at adjacent sites within <10 km (Rosamond and others, 2020). In Kansas, Finck (1984) indicated that 61 percent of 18 males banded in oldfields and 60 percent of 10 males banded in prairies returned in the following year. Zimmerman and Finck (1989) reported an average return rate of 49 percent for 82 male Dickcissels that were followed for 5 years but found no evidence of female site fidelity. The authors indicated that male Dickcissels were less likely to return to the study area after poor breeding success the previous year (Zimmerman and Finck 1989). In another Kansas study, Schartz (1969) demonstrated site fidelity in both males and females. Return rates for males ranged from a low of 26 percent of 23 birds to a high of 58 percent of 12 birds over 3 years. Only 4 percent of 26 females returned. At the Konza Prairie in Kansas, Sousa (2012) banded 224 adult males, 179 adult females, and 395 nestlings over 4 years; mean annual return rates over those 4 years were 33 percent for adult males and 15.5 percent for adult females. The probability that an adult male Dickcissel returned the following breeding season was positively related to his harem size the previous year but was not influenced by the proportion of nests fledged on his territory the previous year. Female Dickcissels that successfully fledged young in the previous year were no more likely to return the following year than females that were unsuccessful the previous year. Only two of the 325 nestlings that survived to fledging returned to the study sites in subsequent years; both birds were sired by the same male, but in different years. Klimkiewicz and Futcher (1987) reported that a banded male was recovered 4 years later in the same general area 5 km south of Lawrence, Kansas, in which he was banded. In a study of conformity and persistence of Dickcissel songs in northeastern Kansas, Parker and others (2022) reported lower within-season site fidelity and lower within-season survival of male Dickcissels in cropland sites relative to grassland sites; males that bred in cropland had a 19.2 percent chance of disappearing (that is, emigrating or dying) over a 14-day survey period compared to 7.2 percent chance for males that bred in grasslands.

Elsewhere in the species' breeding range, Igl (1991) reported that 1.3 percent of 76 males returned in a subsequent breeding season to regularly mowed alfalfa fields in Iowa, and Fletcher and others (2006) reported that 10 percent of 64 males and 2.9 percent of 38 females returned to restored grasslands in Iowa. In a restored grassland in Illinois, Walk and others (2004) reported that 20 percent of 25 banded female Dickcissels were recaptured or resighted in the year after banding. In tallgrass prairies in Missouri, 30.1 percent of 42 banded males returned the year following banding (Maresh Nelson and others, 2020). In CRP grasslands in Maryland, Small and others (2012) reported that 21 percent of 38 banded adult male Dickcissels, 30 percent of 20 banded adult females, and 1.7 percent of 67 banded hatch-year birds returned in a subsequent breeding season. Site fidelity of adults the following summer was not related to their nesting success or failure the previous year; however, male Dickcissels that were unsuccessful in procuring mates often did not return the following year.

Species’ Response to Management

This section evaluates the effect of management practices on Dickcissel abundance, distribution, and productivity, including such practices as burning, grazing, mowing, and discing. Also included is a discussion of how different management requirements for the maintenance of CRP grasslands, such as mid-contract management, affect Dickcissels. This section ends with an evaluation of the effects of other landscape disturbances on Dickcissels, such as urbanization and energy development.

Although recent disturbances or management in grasslands can decrease vegetation height and density below the point of suitability for Dickcissels, burning or mowing may provide Dickcissel breeding habitat by controlling succession (Igl, 1991; Zimmerman, 1992). Studies that have looked at only grazing (not in combination with burning) are few and indicate that grazing rarely provides sufficient breeding habitat (Temple and others, 1999; see also the “Grazing” section). The combination of management treatments, such as burning and grazing, can be particularly detrimental to local Dickcissel abundance, productivity, and nesting phenology (Eddleman, 1974; Zimmerman, 1997). Research that evaluates Dickcissel response to burning-only management is summarized below, followed by research on the combination of burning and grazing, and then grazing-only.

Fire

In mixed-grass and tallgrass prairies managed by the U.S. Fish and Wildlife Service in Montana, North Dakota, South Dakota, and Minnesota, Dickcissel densities were higher in tallgrass prairie units than in mixed-grass prairie units in the first growing season after burning (Igl and others, 2018). In the tallgrass prairie units, there was a linear decrease in Dickcissel densities in the growing seasons after burning. At the Konza Prairie Biological Station in the Flint Hills in northeastern Kansas, Zimmerman and Finck (1983) compared Dickcissel nest densities on spring-burned, ungrazed tallgrass prairies to oldfields. Nest densities and nest predation were higher and cowbird brood parasitism was lower in oldfields than in tallgrass prairies; daily survival rates of nests were similar in the two habitats. Dickcissel abundance was similar between burned and unburned prairies; abundance was not affected by spring burning in moist years but was reduced after burning in drought years (Zimmerman, 1992). Petersen (1978) reported that Dickcissel density and territory sizes were not significantly different between burned and unburned prairies, but densities were significantly higher and territory size significantly smaller in oldfields than in either the burned or unburned prairies. Dickcissels in burned and unburned prairies occupied “bottom” habitats (that is, areas that were parts of natural drainage systems that contained tall, dense forb coverage). Short vegetation on the burned upland prairies was not used, whereas the taller and denser vegetation on the unburned upland prairies was used. Sousa (2012) examined patterns of mating success in ungrazed tallgrass prairie plots that were burned on a variable schedule (unburned, 1-, 2-, 4-, and 10-year burn intervals) and found little evidence that burning interval influenced either the mean or the variance in Dickcissel social mating success (that is, harem size), paternity (that is, proportion of sampled young a male sired on his territory), or male phenotype (that is, tarsus length, bib size, ultraviolet hue of yellow plumage, and song frequency). Territory density was highest in annual burns, lowest in unburned watersheds, and moderate in 2- or 4-year burn intervals.

In northeastern Kansas, although not at Konza Prairie, Applegate and others (2002) reported that Dickcissels were equally abundant on spring-burned and unburned portions of an ungrazed wildlife management area. In the Smoky Hills of central Kansas, Dickcissel densities were 1.6–2 times higher in unburned idle prairie than in spring-burned idle prairie, grazed prairie (moderately stocked with cattle from May 1 to October 31 at a rate of 160 kilograms [kg] per ha or double-stocked from May 1 to July 30), or hayed prairie (cut once annually in July) (Powell and Busby, 2013). Likewise, in CRP fields planted to native grass species in Kansas, Robel and others (1998) reported that Dickcissel abundance and nest success were significantly higher on unburned than spring-burned grasslands. However, nest success was low within unburned grasslands (24.2 percent of 231 nests in unburned grasslands compared to 6.3 percent of 16 nests in burned CRP grasslands). Nest success among burned grasslands was significantly higher 1 year postburn and 3–4 years postburn than 2 years postburn (Robel and others, 1998). On southwestern Missouri tallgrass prairie preserves, Swengel (1996) examined Dickcissel use of spring-burned (March or April at intervals of 1.5–4 years), summer-hayed (late June to late July at intervals of 1–3 years), and hayed-and-burned prairies. Observation rates of Dickcissels were highest in hayed prairies, followed by burned and burned-and-hayed prairies (Swengel, 1996). Dickcissels were 1.14 times as common in hayed prairies as in burned prairies, whereas rates did not differ between hayed and burned-and-hayed prairies. Observation rates of Dickcissels were not related to the number of years since the last burn or haying (varying from 0–3 years for burns and 0–2 years for hay), although highest observation rates in hayed areas occurred 1 year after haying and, for burning, 3 years postburn (Swengel, 1996). In another study of prairie fragments in southwestern Missouri, Winter (1998) examined the effect of spring (before May 1) and summer (June 15 to August 15) burning on Dickcissel densities. Dickcissel density did not differ with time since burning during the 3 years of the study, but Dickcissel density increased with the number of years since haying (within the time frame of 6 years). In small- and medium-sized prairie fragments, density increased with time since haying but decreased in large fragments (Winter, 1998). In restored grasslands in Illinois, Dickcissels nested in all categories of burned prairie, from unburned to ≥5 years postburn; peak nest density was reached at the third year postburn (Westemeier and Buhnerkempe, 1983). Lowest nest densities were recorded 1 and 4 years postburn, with equal or nearly equal moderate densities on the unburned grassland and the 2 and ≥5 years postburn grasslands. However, higher nest densities were found in hayed than burned grasslands. In tallgrass prairie fragments in northeastern and east-central Illinois, Herkert (1994b) found no difference in Dickcissel abundance among prairies burned one, two, or three or more growing seasons since the last burn.

Fire and Grazing

Intensive Early-Season Grazing Followed by Burning in the Flint Hills of Kansas and Oklahoma

Most research on the effects of burning and grazing on Dickcissels involves the combination of burning and grazing within the same growing season and will be covered in detail below. The traditional combination of annual or biennial burning and grazing, sometimes referred to as intensive early-season grazing followed by burning (IESB), in which early cattle stocking is followed by spring burning, is a widespread practice in the tallgrass prairies throughout the Flint Hills of Kansas and Oklahoma. With and others (2008) described IESB as one head of cattle per 0.8 ha for 90 days from mid-April to mid-July. Another traditional grazing system in the Flint Hills is season-long stocking at one head per 1.6 ha for 180 days from mid-April to mid-October. Prescribed burning may begin by mid-March and is well underway by mid-April. Under the IESB and season-long grazing systems, With and others (2008) concluded that Dickcissel populations throughout the Flint Hills are declining, and the populations are not viable. Davis and others (2016) compared reproductive rates and fecundity between the IESB system and the patch-burn grazing (PBG, also known as 'pyric herbivory') system and concluded that under a range of realistic nest survival rates for grassland passerines, IESB and PBG systems were sink habitats for Dickcissels because fecundity was lower than levels necessary to maintain stable populations. The studies of With and others (2008) and Davis and others (2016) are described in detail below in their respective paragraphs. The IESB discussion will begin with local studies and expand to regionwide Flint Hills studies, ending with With and others (2008). From there, the discussion will proceed to the PBG paradigm and the conclusions of Davis and others (2016).

Locally, at the Konza Prairie Biological Station, a comparison between the abundance of Dickcissels in burned-and-grazed, unburned-and-grazed, unburned-and-ungrazed, and burned-and-ungrazed tallgrass prairies under the IESB system revealed that Dickcissels occurred in all pastures except areas that were annually burned and heavily grazed, as the species nested in dense cover such as in leadplant and buck brush (*Symphoricarpos orbiculatus*), which were removed under the burned-and-grazed treatment (Eddleman, 1974). In a related study, Zimmerman (1997) reported that Dickcissel abundance and mean productivity were lower in the burned-and-grazed areas than in the other treatments, and nesting activity was delayed compared to the other treatments. Petersen (1978) found that Dickcissels were most abundant in oldfields than any combination of burned or grazed native prairies; Dickcissels did inhabit unburned portions of prairies, particularly along natural drainages where vegetation was tall, dense, and contained forbs. Drawing upon the same historical dataset as Zimmerman (1992, 1993), but with additional years of data, Powell (2006) examined the effect of year-round American bison (*Bison bison*) grazing and prescribed burns at various intervals since the last burn. Bison were stocked at low intensity of 5 ha per animal, with the expected consumption of 25 percent of aboveground plant growth. Dickcissel abundance was affected by the number of seasons since last burn, burn frequency, and grazing treatment. For pastures on 4-year burn rotations, regardless of grazing treatment, Dickcissel abundance was lowest for the season of the burn, highest for the season after the burn, and declined in the 2-year and 3-year burn intervals to a level higher than the burn year. In ungrazed pastures, Dickcissel abundance was higher under annual burning than for those burned at 20-year intervals. Dickcissel abundance decreased with bison grazing. In grazed pastures under the 4-year rotation, grazing reduced Dickcissel abundance in the season of a burn (Powell, 2006). In the same study area, Powell (2008) also examined the effect of cattle grazing and prescribed burns. Cattle were grazed from May to early October at low intensity of 3 ha per cow-calf pairs, with the expected consumption of about 25 percent of aboveground plant growth. Frequency of spring (March 25 to May 5) burns ranged from every year to every other year or every fourth year. Dickcissel abundance was lowest during years when burns occurred and highest 1–3 years after sites had been burned (Powell, 2008). Klug and others (2010) evaluated nest-predation risk at Konza Prairie, although details on the grazing and burning systems are lacking to ascertain whether IESB was employed. The authors found that Dickcissels nested in annual burned-and-ungrazed prairie (62 of 156 nests), annual burned-and-grazed prairie (21 nests), 2-year postburned-and-ungrazed tallgrass prairie (2 nests), 2-year postburn-and-grazed prairie (6 nests), 4-year postburned-and-ungrazed prairie (31 nests), 4-year postburn-and-grazed prairie (29 nests), 20-year postburned-and-grazed prairie (1 nest), and areas of no set burning or grazing treatment (4 nests); no nests were found in 20-year postburned-and-ungrazed prairie.

Within a 50-ha tallgrass prairie pasture near the Konza Prairie Biological Station, Alexander and others (2021) examined the effect of fire on Dickcissel densities. Densities were not negatively affected by mid-summer (August) and late-summer (September) fires relative to early-spring fires (April) that were used to control sericea lespedeza (*Lespedeza cuneata*). In tallgrass prairie pastures at the Bressner Range Research Station in Woodson County, Kans., Ogden and others (2019) tested the effects of using spring burning with early-season steer grazing, followed by late-season sheep grazing (steer-sheep treatment), on sericea lespedeza vigor, grassland birds, and pollinators, and compared those results to spring burning followed by steer grazing only (steer-only treatment). Dickcissel densities were similar between the two treatments, but estimated nest survival for Dickcissels during incubation was 88 percent lower in the steer-sheep treatment than in the steer-only treatment.

Within The Nature Conservancy's Tallgrass Prairie Preserve in the Flint Hills of northeastern Oklahoma, several researchers studied the response of Dickcissels to IESB. Rohrbaugh and others (1999) reported that the number of Dickcissel nests, clutch size, and number of young fledged from successful nests did not differ significantly between disturbed plots (that is, grazed or grazed-and-burned under IESB) and undisturbed plots (that is, no fire or grazing). However, nest success was significantly lower on disturbed plots during incubation, brood-rearing, and combined phases of the nesting cycle than on idle plots. Patten and others (2006) found that cowbird densities and brood parasitism rates were higher in IESB pastures than grazed-only pastures or undisturbed prairies. Within the larger area encompassed by the Flint Hills of Kansas and Oklahoma, Rahmig and others (2009) and With and others (2008) compared Dickcissel densities on IESB pastures to CRP grasslands and hayfields. They reported that Dickcissel densities were highest in CRP grasslands and lowest in pastures and hayfields. Dickcissel densities were up to three times higher in unburned CRP grasslands than in burned and unburned native hayland, burned and unburned season-long grazed pastures (one head of cattle per 1.6 ha for 180 days, mid-April through mid-October), and IESB pastures (one head of cattle per 0.8 ha for 90 days, mid-April through mid-July) (Rahmig and others, 2009). However, Dickcissel nesting success was highest in unburned native hayland than in other treatments. With and others (2008) predicted declines of 19–29 percent per year for Dickcissels in the Flint Hills. In the Flint Hills of northeastern Kansas, Klute (1994) and Klute and others (1997) reported that Dickcissels were more abundant in annually spring-burned tallgrass prairies that were moderately grazed (2.7 ha per cow-calf pair from July to December, or 1.6 ha per steer from May to October) than in annually burned, native-seeded CRP grasslands, possibly because invertebrate prey populations were higher in the grazed areas.

Patch-Burn Grazing in the Flint Hills of Kansas and Oklahoma

In response to declining populations of grassland bird species under IESB, Fuhlendorf and Engle (2001, 2004) promoted the alternative PBG system for use in the Flint Hills and other mesic grasslands. PBG is a management strategy in which only a portion (for example, one-third) of the landscape is burned annually, and livestock preferentially graze on these burned areas, generating heterogeneity in vegetation structure and composition (Fuhlendorf and Engle, 2001, 2004). During a 3-year study in the Tallgrass Prairie Preserve, Fuhlendorf and others (2006) compared Dickcissel abundance between pastures managed under the IESB and PBG systems. Under the IESB system, pastures received annual burns from mid-April through mid-July and were stocked with cattle at 1.2 ha per 270-kg steer. Under the PBG system, plots within pastures were burned under a 3-year fire-return interval (that is, burned 0–12, 13–24, 25–36, and >36 months earlier) in either spring (March) or late summer/autumn (August–December) with cattle stocked at 1.2 ha per 270-kg steer. Dickcissel abundance was lower on PBG patches during the 0–12-month interval, and abundance was similar among pasture treatments during the 13–24- and 25–36-month intervals. Abundance was slightly higher in PBG patches that were undisturbed for >36 months than in IESB pastures. During the same years and within the same pasture units as Fuhlendorf and others (2006), Coppedge and others (2008) reported that Dickcissels were as abundant under the IESB system as under the PBG system. Overlapping in time and location with Coppedge and others (2008), Churchwell and others (2008) and Davis and others (2016) compared reproductive parameters of Dickcissels between the two grazing systems. Davis and others (2016) tested whether Dickcissel population growth rates under IESB or PBG systems were greater (source population) or lesser (sink population) than the level necessary for a stable Dickcissel population. Dickcissel fecundity (that is, the number of female young produced per female in a given season) was lower in IESB pastures than in PBG pastures, but the number of eggs laid was higher in IESB pastures and the number of young per successful nest was similar between treatments. Within PBG pastures, fecundity and percentage nest survival were lowest in patches burned 0–12 months earlier and highest in patches burned 25–36 months earlier (the interval >36 months was not evaluated). Davis and others (2016) concluded that, under a range of realistic survival rates for grassland passerines, both grazing systems were sink habitats for Dickcissels because fecundity was lower than levels necessary to maintain stable populations. Within PBG pastures, only the 25–36-month interval maintained stable or increasing populations of Dickcissels at realistic adult and juvenile survival rates. In a general statement, Churchwell and others (2008) reported that overall Dickcissel nest success was higher in

PBG pastures than IESB pastures. However, at a finer-grained level, daily nest survival and nest success were lowest in current-year PBG treatments when compared to IESB treatments and 1- and 2-year postburn PBG treatments. In general, overall cowbird brood parasitism rates were higher in IESB treatments than PBG treatments. At a finer-grained level, brood parasitism rates were much higher in current-year burn PBG treatments than in IESB treatments, and nest densities were lower. Dickcissels also tended to nest later in current-year PBG treatments and in IESB treatments than in 1- and 2-year postburn PBG treatments (Churchwell and others, 2008). Mean number of eggs and mean number of fledglings were similar between treatments (Churchwell and others, 2008). Working on the Tallgrass Prairie Preserve 7–8 years later than the previous studies, Hovick and others (2015) established seven experimental pastures with a gradient of burns and grazing, ranging from a single patch that was annually burned with spring-only (March–April) fires to eight patches assigned a fire-return interval of 1, 2, 3, or 4 years of spring-only or spring-and-summer burns (July–August). All patches were moderately grazed by cattle at 2.4 animal unit months (AUMs) per ha. Dickcissel densities were not influenced by fire-return interval or number of patches (the representation of vegetation spatial heterogeneity). Ten years after the study by Fuhlendorf and others (2006), Londe and others (2019) found that Dickcissels were common in the pastures of the Tallgrass Prairie Preserve and privately owned grasslands nearby, regardless of burning regime (spring or fall burns conducted within the past year as well as in prairies burned within the past 13–24 months and >24 months).

Additional research into PBG has been conducted beyond the Tallgrass Prairie Preserve of Oklahoma, but still within the Flint Hills. Within the Flint Hills of east-central Kansas, Erickson (2017) compared Dickcissel density on treatments of season-long grazing and annual spring burning (SLSB; 1 pasture), IESB (2 pastures), and PBG (3 pastures) over a 3-year period on private ranches. Under the SLSB system, cattle were on the pasture from late April to mid-September at stocking rates ranging from 1.6 to 2 ha per head with burns conducted from late March to early April (no burn was conducted in 1 of the 3 years). Under the PBG system, cattle were on pastures from early April to August or October at stocking rates ranging from 1.2 to 2.1 ha per head and with burns conducted from late March to mid-April. Under the IESB system, cattle were on pastures from mid-April or mid-May until mid-to-late July (although one pasture was grazed until October) at stocking rates ranging from 0.8 to 1.6 ha per head with burns conducted in early April (burns were not conducted in 2 of 3 years owing to drought-induced low fuel loads). Erickson (2017) found that Dickcissel density was highest on the SLSB pasture and lowest on the IESB pastures and the PBG pasture that received the current-year burn (and the most intensively grazed unit). Densities were moderate on the PBG pastures 1 and 2 years since fire. Nest survival was unaffected by grazing and burning treatments in the IESB and PBG systems; the SLSB system was not part of the analysis for nest survival. Parasitism rate was higher on PBG pastures than on IESB pastures. In the PBG pastures, Dickcissel nests in the 1-year-since-burn treatment had a higher clutch size than nests in the 2-years-since-burn treatment (current-year-burn treatment was not included in the analysis), regardless of whether nests were parasitized or not. Supplementing the data of Erickson (2017) with 3 additional years of data from Konza Prairie, Verheijen and others (2022) reported that few Dickcissel nests were found in recently burned pastures. Cowbird brood parasitism rates were higher at Konza Prairie than on private ranches. At Konza Prairie, parasitism rate was lower on the annually burned, ungrazed pasture compared to IESB and PBG treatments and decreased with year since last burn on PBG patches (Verheijen and others, 2022). Brood parasitism rates on private ranches were lower under the IESB system than under the PBG system; grazing system did not affect clutch size. On Konza Prairie, parasitized Dickcissel nests in the IESB pastures had more cowbird eggs than in PBG pastures or the annually burned, ungrazed treatment, whereas on the private ranches, parasitized nests contained more cowbird eggs in the PBG treatment than in the IESB treatment. Nest survival did not differ between the Konza Prairie and private ranches (Verheijen and others, 2022). Nest survival was lowest on unburned pastures and highest for the most recently burned portions of PBG units, although the differences were not statistically significant. Fledging rates per host egg were higher for unparasitized versus parasitized nests at Konza Prairie but not at private ranches. At Konza Prairie, fledging rates for parasitized nests were higher in the annually burned but ungrazed pastures than in PBG pastures but not for IESB pastures (Verheijen and others, 2022). Based on 2 years of data, Verheijen and others (2019) concluded that Dickcissel density and territory size were similar among grazing systems. Within the PBG treatments, densities were highest in the patch burned the previous year and lowest in the patch burned in the current year. Over the same span of years as Verheijen and others (2022), Spahr (2017) reported that Dickcissel daily nest survival rates did not differ among grazing and burning treatments, although highest rates were detected in the annually burned and ungrazed treatments. Cowbird brood parasitism rates were highest in IESB pastures and lowest in annually burned but ungrazed pastures. Within PBG pastures, parasitism rates were highest in the year of burn and decreased as time since burn increased.

Patch-Burn Grazing Beyond the Flint Hills

Additional research into PBG systems beyond the Flint Hills has occurred in Oklahoma, Iowa, and Missouri. In northwestern Oklahoma sand sagebrush grasslands, Doxon (2009) and Holcomb and others (2014) evaluated Dickcissel density between PBG pastures and unburned pastures grazed season-long. Dickcissel density was similar between grazing systems. Burning began 3 years before the study and was applied to study units on a 3-year interval, except for the first year of the study when a drought-induced burn ban occurred. Cattle were stocked in each pasture from early April to mid-September at a rate of 24.7 animal unit days per hectare (about 6.8 ha per steer), which is considered a light stocking rate for the region (Doxon, 2009; Holcomb and others, 2014). In State- and privately owned rangelands in the Grand River Grasslands of southern Iowa and northern Missouri, Pillsbury (2010), Pillsbury and others (2011), and Duchardt and others (2016) evaluated the response of Dickcissels to PBG treatments (that is, spatially discrete spring fires and free access by cattle at 1.7–3.1 AUMs per ha from May 1 to October 1), grazed-and-burned treatment (that is, free access by cattle and a single complete burn), and burned-only treatment (that is, single complete burn with no cattle). Dickcissel densities were highest on burned-only pastures and lowest on PBG pastures at stocking rates of 3.1 AUMs per ha (Pillsbury and others, 2011). Duchardt and others (2016) altered stocking rates within the same system to 1.7 and 2.5 AUMs per ha. They termed these stocking rates as "understocking" and "moderate," respectively, and labelled the 3.1 AUMs per ha as "overstocking." By adjusting stocking rate to moderate for 2 years on PBG pastures, Duchardt and others (2016) achieved peak diversity of obligate grassland bird species, which included the Dickcissel. Under the other two rates, avian diversity was similar among treatments. Combining years in which the stocking rate was understocked and moderate yielded Dickcissel densities that were highest on burned-only pastures, moderate on PBG pastures, and lowest on grazed-and-burned pastures (Duchardt and others, 2016).

Other Fire and Grazing Systems

A few studies have looked at Dickcissel response to burning and grazing that did not involve either the IESB or PBG systems. In northern Illinois, Herakovich and others (2021a) evaluated the effect of prescribed fire and the reintroduction of bison grazing in remnant tallgrass prairies and restored grasslands on Dickcissel detection frequency over a 3-year period. Prescribed burns were conducted during spring or fall. Bison were reintroduced to study sites 2 years before the study, and bison grazing intensity ranged from 0.74 to 1.2 AUMs per ha. The detection frequency of Dickcissels was not influenced by prescribed fire in the previous nongrowing season or with site age (that is, sites with <10 or >10 years since time of restoration, or remnant prairie with no need for restoration), although there was a slightly higher detection frequency in burned than unburned sites. The authors concluded that neither the prescribed burns nor the low stocking rate were a strong influence on detection frequency (Herakovich and others, 2021a). In western Minnesota and northwestern Iowa, Ahlering and others (2019) examined the effect of management history (time since fire or grazing), grassland type (remnant prairie or restored grassland), and land ownership (public or private ownership) on Dickcissel abundance after habitat and landscape variables had been considered. Fire and grazing history best explained additional variation in the abundance of Dickcissels. Fire was an important predictor of Dickcissel abundance (Ahlering and others, 2019). Dickcissel density was lower the year of burning and 3 years postburn, highest in grasslands 1 year postburn, and moderate at 2 and >3 years postburn. Dickcissels abundance was similar on grazed sites and ungrazed sites, which were both higher than on sites grazed the year before the survey year. Dickcissels were more common on private than on public lands, and abundance was higher on remnant prairies than reconstructed prairies (Ahlering and others, 2019).

Grazing

Little information exists on the effects of grazing-only management techniques on Dickcissels. Dickcissel response to grazing in the absence of burning is difficult to discern, given the paucity of studies, the varying factors evaluated in those studies that exist, and the differences among grazing systems and intensities. In mixed-grass and tallgrass prairies managed by the U.S. Fish and Wildlife Service in Montana, North Dakota, South Dakota, and Minnesota, Dickcissel densities were higher in tallgrass prairie units than in mixed-grass prairie units in the first growing season after grazing (Igl and others, 2018). In southwestern Wisconsin, Dickcissels were more abundant in undisturbed (that is, neither mowed nor grazed from May 15 to July 1) grasslands than in continuously grazed (that is, grazed throughout the summer at levels of 2.5–4 animals per ha) or rotationally grazed pastures (that is, stocked with 40–60 animals per ha that grazed for 1–2 days and then left undisturbed for 10–15 days before being grazed again) (Temple and others, 1999). In restored tallgrass prairies in northern Illinois, nests of Dickcissels were encountered more often in nonbison sites than in bison-grazed sites (Herakovich and others, 2021b). In southeastern Kansas, native pastures were overseeded with tall fescue in the 1940s (Johnson and Sandercock, 2010). In attempts to restore the native grassland community and reduce the viability of tall fescue, the cessation of fertilizer and introduction of winter cattle grazing were implemented. Dickcissels were more abundant in winter-grazed pastures (that is, grazed from October to April at 2.25 to 11.24 AUMs per ha) than in pastures grazed year-round (that is, grazed at 4.36 to 5.81 AUMs per ha) and fertilized in spring in alternate years; Dickcissel densities were negatively associated with the presence of cattle and positively associated with a decrease in tall fescue (Johnson and Sandercock, 2010). Coon and others (2022) studied the effect of tall fescue eradication techniques (herbicide and seeding) on Dickcissel reproduction in the Grand River Grasslands of Iowa and Missouri. Some study sites were grazed and others were ungrazed. The treatment effects varied by grazing application characterized by intensive early-season grazing (mean stocking rate of 2.8 AUMs per ha from mid-April to July 1). Compared to ungrazed sites, grazed sites had fewer nests and fewer Dickcissel males per hectare on control, sprayed, and sprayed-and-seeded plots. Twice as many nests were on the spray-and-seeded sites than control sites (Coon and others, 2022). Male Dickcissels were most abundant on spray-and-seeded sites, intermediate on sprayed sites, least abundant on controls, and nearly absent on grazed pastures regardless of herbicide treatment. The number of Dickcissel fledglings per nest followed the same pattern as male abundance. Herbicide and grazing treatments did not affect nestling-provisioning rate (Coon and others, 2022). Nearly three times as many cowbird eggs per nest were found on control sites compared to sprayed and spray-and-seeded sites. Daily nest survival was lower on control sites compared to sprayed and spray-and-seeded sites. No effect of herbicide, seeding, or grazing was detected for the presence/absence of cowbird eggs in nests, on clutch size, or on nestling mass (Coon and others, 2022). In Mississippi, Monroe and others (2016) evaluated Dickcissel response to grazing among four treatments: grazed introduced forage species (for example, bermudagrass and tall fescue); grazed monoculture of Indiangrass; grazed warm-season grass polyculture of Indiangrass, little bluestem, and big bluestem; and nongrazed polyculture of native warm-season grasses. Nest densities and productivity were consistently higher in nongrazed native warm-season pastures than in grazed tame pastures, whereas productivity in grazed native warm-season pastures was intermediate but declined between years.

Grazing of Conservation Reserve Program Grasslands

Several researchers have investigated the effect of grazing of CRP grasslands on Dickcissel abundance and reproductive success. Three studies evaluated Dickcissel abundance or density between grazed mixed-grass prairies and CRP fields planted to monocultures of tame yellow bluestem and found higher Dickcissel numbers in the native habitats than the yellow bluestem fields, but the differences were not statistically significant (Chapman and others, 2004a; Hickman and others, 2006; George and others, 2013). Within CRP fields located west of the Kansas Flint Hills ecoregion, Hickman and others (2006) compared Dickcissel abundances among grazed native prairie, former CRP grasslands that had been seeded to warm-season grasses, and CRP fields planted to monocultures of tame yellow bluestem. Native prairie was continuously or rotationally grazed at 1.37 to 1.61 AUMs per ha; expired CRP was grazed at 0.96 to 1.90 AUMs per ha; and fields of yellow bluestem were continuously or rotationally grazed at 0.26 to 6.91 AUMs per ha. In north-central Oklahoma, George and others (2013) compared Dickcissel densities and Chapman and others (2004a) compared Dickcissel abundances between grazed mixed-grass prairies and CRP fields planted to monocultures of yellow bluestem. In the study by George and others (2013), the stocking rates varied widely among native prairies and CRP fields such that grazing intensity was a relative estimate of cattle density. In the study by Chapman and others (2004a), grazing intensity was visually estimated, some CRP grasslands were not grazed or hayed, and native prairies were either not grazed or were grazed at rates that the authors describe as light-to-moderate stocking rates. In native-seeded CRP grasslands in 10 counties in central Kansas, Kraus and others (2022) evaluated the effect of 2 years of grazing on Dickcissel nest survival and probability of brood parasitism over a 3-year period; the grazing treatment represented an experimental mid-contract management option and was authorized via experimental allowance from the U.S. Department of Agriculture. Grasslands were ungrazed or grazed season-long whereby average grazing duration was 147.4 days from April 1 to October 31 with a stocking rate designed to remove 50 percent of biomass during the grazing season. Nest survival was negatively related to probability of brood parasitism and day of season and was not related to grazing or degree of nest concealment (Kraus and others, 2022). The probability of parasitism was higher and parasitized nests contained more cowbird offspring on grazed than ungrazed CRP fields under the planting regime of a minimum of two species of native grass and one species of native forb, but the probability of parasitism was lower and parasitized nests contained fewer cowbird offspring on grazed than ungrazed CRP fields under the planting regime of a minimum of 10 native grass and 10 native forb species. Dickcissel nests with more cowbird offspring contained fewer host offspring and, among successful nests, the number of cowbird offspring negatively affected the number of host young fledged (Kraus and others, 2022). In a related study to Kraus and others (2022) in native-seeded CRP grasslands across the longitudinal extent of Kansas, Wilson and others (2022) evaluated the effect of 2 years of experimental grazing on Dickcissel abundance and occurrence over a 3-year period; this study was implemented as a possible solution to improve vegetation diversity in CRP by domestic cattle as a mid-contract management. Continuous grazing was conducted for an average of 150.1 days between April and October with a stocking rate designed to remove 50 percent of biomass during the grazing season with any combination of cattle (for example, stocker males [weaned calves grazing pastures to enhance growth], female-calf pair). In western Kansas, Dickcissel abundance was higher in ungrazed than in grazed CRP grasslands over all 3 years (Wilson and others, 2022). In eastern Kansas, Dickcissel abundance also was higher in ungrazed CRP grasslands than grazed, but only when the ungrazed fields also were burned (Wilson and others, 2022). Throughout the occupied range of the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) in Colorado, Kansas, New Mexico, Oklahoma, and Texas, Pavlacky and others (2021) evaluated the effectiveness of grazing practices designed to benefit Lesser Prairie-Chickens and native- and tame-seeded CRP lands on Dickcissel densities. The authors found no effect of the grazing practices on Dickcissel density but found that density declined under both CRP-seeding mixtures relative to control sites, indicating population decline under CRP. Gary and others (2022), however, reported that management for the Lesser Prairie-Chicken serves a conservation umbrella of protection for the Dickcissel and other nontarget grassland birds, and Dickcissels were expected to receive a net conservation benefit from management for Lesser Prairie-Chicken.

Haying

Mowing can be used to prevent encroachment of woody vegetation. However, traditional hayland management that involves an early initial cutting date and one or more subsequent harvests within a growing season may be detrimental to nesting Dickcissels, as annual mowing and mowing during the breeding season result in very high rates of nest failure (Taber, 1947; Ryan, 1986; Frawley, 1989; Frawley and Best, 1991; Igl, 1991). Dickcissel productivity and annual return rates may be low in annually hayed alfalfa fields, indicating that Dickcissel populations in alfalfa fields may only be maintained by continued annual immigration from source habitats (Sealy, 1976; Igl, 1991). Igl and Johnson (2016) assessed the effects of haying on grassland birds 1–4 years after haying in 483 CRP grasslands in nine counties in four States in the northern Great Plains over a 16-year period. The Dickcissel's response to haying varied geographically but was inconsistent among the eight counties in which the species was observed. Igl and Johnson (2016) concluded that the species' irruptive tendencies during the breeding season might confound detecting a consistent management response to haying. Using North American BBS data from Minnesota, Wisconsin, and Michigan, Corace and others (2009) examined the relationship between Dickcissel population response and values from an index of mowing intensity that incorporated the date of first harvest, number of harvests, and weeks between harvests. The authors reported that Dickcissels have moderate affinity for hayfields but found no relationship between mowing intensity and the loss of pasture-hayland at a county level on population trends for Dickcissels. The effects of haying depend on the timing and frequency of the disturbance. In Michigan, Dickcissel breeding activities in hayfields were terminated following mowing (Monroe, 1967; Harrison, 1974; Harrison and Brewer, 1979). In native-seeded grasslands in Illinois, Dickcissels preferred areas that were hayed in mid-July every 2–3 years over idle areas and areas rotary-mowed in late summer or harvested for seed (also referred to as "high-mowed" as stubble heights were 30–50 cm) (Westemeier and Buhnerkempe, 1983). In Iowa alfalfa fields, Dickcissels returned to alfalfa fields after the first mowing during the breeding season, but densities never recovered to premowing levels (Frawley, 1989). Dickcissel density was highest before mowing, peaking at around 120 male territories per 100 ha in late May. Dickcissels vacated recently mowed fields, returned by the second week after mowing, but only reached about 60 male territories per 100 ha by the fifth week after mowing (Frawley, 1989; Frawley and Best, 1991). Average mowing date for the first alfalfa crop on the study plots occurred on June 7. Dickcissels returned when vegetation height was >20 cm and forb coverage reached about 60 percent (Frawley and Best, 1991). In another study in Iowa alfalfa fields, Igl (1991) noted that the variation in landowners' mowing schedules affected Dickcissel density; densities continued to increase and occasionally exceeded premowing levels if fields were left unmowed for longer in the summer. In a central Iowa study of grassed waterways planted into corn and soybean fields, Bryan and Best (1991, 1994) examined the use of grassed waterways by Dickcissels relative to the mowing schedule for the waterways. Dickcissel numbers were significantly higher on waterways during the later mowing periods (June 2–18, June 19–July 3, and July 4–22) than during the earliest mowing period (May 15–June 1). Mowing of grasslands typically occurred after July 15, when Dickcissels were at peak abundance. Of 27 nests, 4 percent were lost to mowing and another 4 percent to other mechanical means (Bryan and Best, 1994). On a military training facility in Iowa in which hayfields were planted either to tame cool-season grass species or native warm-season grass species, McMullen and Harms (2020) reported no difference in the number of detections of Dickcissels in hayfields mowed during the nesting season (mid-July) than in hayfields mowed after the nesting season (mid-August). In Missouri tallgrass prairie fragments, Dickcissel density increased with the number of years since the last haying treatment (Winter, 1998). In Arkansas, Dickcissels (combined with Field Sparrow [*Spizella pusilla*], Eastern Meadowlark [*Sturnella magna*], and Red-winged Blackbird [*Agelaius phoeniceus*]) had higher density and nest survival in unhayed and late-hayed (June 17–25) fields than in early-hayed (May 25–31) fields (Luscier and Thompson, 2009). Haying had a strong negative effect on rates of nest survival of the Dickcissel, Field Sparrow, and Red-winged Blackbird combined.

Biomass (Bioenergy) Fields

CRP fields planted to switchgrass as a biomass fuel are harvested to provide a domestic energy source; switchgrass fields for biomass fuel differ from more traditional hayfields in that the former are typically harvested after the avian breeding season (Murray and Best, 2003). In Wisconsin, Roth and others (2005) compared Dickcissel abundance over 2 years among five August-harvested switchgrass fields and five unharvested control fields. The species used unharvested CRP fields but not harvested CRP fields; the unharvested control fields had taller, denser vegetation (Roth and others, 2005). In Iowa switchgrass CRP fields, Murray and Best (2003) evaluated Dickcissel abundance and nest success among fields that were completely mowed, fields in which 60 percent was mowed in strips with alternate unmowed strips, and fields that were completely unmowed. Harvesting occurred between November and March; switchgrass was cut to a height of 9 cm with a disc mower, baled, and removed from the field. Dickcissel abundance was not significantly different among the three treatment types when years were combined, but singly, Dickcissel abundance was low during the first year of the study and higher in harvested fields than nonharvested fields during the second year of the study. Murray and others (2003) also reported no differences in Dickcissel abundance among treatment types. In Mississippi, Conkling and others (2017) studied the effects of biofuel harvests and vegetation metrics of switchgrass monocultures and native warm-season grass mixtures on Dickcissel nest success, nest density, and productivity. The researchers reported no effect of vegetation metrics (maximum vegetation height, litter depth, visual obstruction), harvest frequency, or biofuel treatment on Dickcissel nest survival, but vegetation composition and harvest frequencies influenced nest density and productivity. Native warm-season grasslands had 54–64 times more nests than switchgrass monocultures, and nest density and productivity were 10 percent greater in single-harvested fields (harvested once per year) than in double-harvested fields (harvested twice per year) (Conkling and others, 2017).

Planted Cover

Dickcissels commonly occupy other planted grasslands, such as CRP grasslands (including those not intended solely for biofuel production), DNC, Conservation Reserve Enhancement Program grasslands, grasslands restored to resemble native prairies, and reclaimed surface mines (Renken and Dinsmore, 1987; Johnson and Schwartz, 1993; Van Dyke and others, 2007; Wentworth and others, 2010). In North Dakota, Dickcissels were found only in DNC grasslands planted to alfalfa and wheatgrasses (*Agropyron* spp.) and were not on grazed or ungrazed/unburned native prairies (Renken and Dinsmore, 1987). In a South Dakota Waterfowl Production Area, Blankespoor (1980) found that Dickcissels used restored grasslands 2–4 years (the duration of the study) after grasslands were seeded to native grasses. In eastern South Dakota and western Minnesota, Dickcissel densities were similar among fields planted to cool- and warm-season mixes, native (switchgrass) and tame (intermediate wheatgrass [*Thinopyrum intermedium*]) monotypes, and native prairies (Bakker and Higgins, 2009). In central Iowa on Federal refuge lands with restored grasslands, Dickcissel abundance peaked 2–3 years after restoration of former cropland to tallgrass prairie; mean abundance was significantly higher 2 years after restoration than mean abundance 1 year after restoration (Olechnowski and others, 2009). In Iowa Waterfowl Production Areas and Wildlife Management Areas, Dickcissels readily nested in restored tallgrass prairies that were formerly rowcrops and that were embedded in a cropland-dominated landscape, but Fletcher and others (2006) projected that the population growth rate was not stable without immigration into the study sites from other areas. In eastern Nebraska and western Iowa on Federal refuge lands restored to tallgrass species, Van Dyke and others (2004, 2007) examined the effect of burning and mowing in spring on Dickcissel densities in small (3–10 ha) grassland fragments; no significant differences in densities were found between burned and unburned sites or between burned and mowed sites. In a related study, Cox and others (2014) predicted Dickcissel densities were twice as high on conservation grasslands (that is, National Wildlife Refuges, CRP grasslands, and restored and remnant prairies) than on unmanaged marginal grasslands (that is, field borders and terraces). Along the Platte River valley of south-central Nebraska, Dickcissel nest densities were three times higher in six planted grasslands that were formerly cropland than in six remnant mixed-grass prairies (Ramírez-Yáñez and others, 2011).

Using data from Best and others (1997) and the North American BBS, Herkert (2009) determined that Dickcissel population trends increased after the establishment of CRP in 12 States in the north-central United States. Johnson and Igl (1995) estimated that Dickcissels would decline by 17.1 percent if CRP grasslands in North Dakota reverted back to cropland. In Kansas, Missouri, and Nebraska, Dickcissel abundance was positively related to percentage of landscape planted to CRP practices dominated by grasses and was negatively related to patch density of tame CRP planted within 4 years, indicating a potential preference for clumped arrangements of CRP habitat (Riffell and others, 2010). Sensitivity analysis indicated that a 10 percent increase in CRP area planted to grasses was associated with a 4.09 percent increase in Dickcissel abundance; a 10 percent increase in patch density of new tame CRP grasslands was associated with a 2.02 percent decline in Dickcissel abundance. Using North American BBS data, Riffell and others (2008) assessed the potential for CRP to benefit grassland birds across seven ecological regions; Dickcissel abundance was positively related to CRP in most of the seven ecological regions that were in the model. Within the Rainwater Basin in south-central Nebraska, Hierarchical All Birds Strategy models were used to predict changes in Dickcissel abundance when rowcrops were converted to switchgrass or CRP grasslands (Uden, 2012; Uden and others, 2015). Uden and others (2015) evaluated the effect on Dickcissel abundance of four scenarios of land-use change. The first scenario was a baseline condition in which some rowcrops were converted to switchgrass under current conditions of climate, irrigation limitations, commodity prices, ethanol demand, and continuation of the CRP. The second scenario converted more rowcrops to switchgrass. The third scenario converted all CRP fields to switchgrass, and the final scenario converted all CRP fields to rowcrops (Uden and others, 2015). Dickcissel abundance increased 8–12 percent under the first scenario, increased 18–27 percent under the second scenario, and decreased 14 percent under each of the other two scenarios, indicating that replacing rowcrops with switchgrass would be beneficial to Dickcissels, whereas replacing CRP grasslands with switchgrass or rowcrops would be detrimental to Dickcissel populations (Uden, 2012; Uden and others, 2015). In another Nebraska study, Dickcissels preferred unburned and unmowed CRP fields (planted either to cool-season grasses and legumes or to warm-season native grasses) than burned and mowed CRP fields, and favored CRP fields that were characterized by tall, dense vegetation with more forbs and deeper litter (Delisle and Savidge, 1997). Dickcissels were detected in CRP fields with structurally complex vegetation; highest Dickcissel abundance occurred in two CRP fields, one of which was dominated by tall grasses, such as big bluestem, switchgrass, and Indiangrass, with few forbs present, and the other field was planted primarily to moderately dense brome (*Bromus* spp.) with patches of dense, annual forbs (Delisle and Savidge, 1997). In northwestern Oklahoma, Coppedge and others (2001) evaluated population trends for Dickcissels on threes BBS routes over a 30-year period relative to patterns of landscape change wrought by eastern redcedar encroachment into grasslands and conversion of cropland to CRP grasslands planted to Old World bluestem (*Bothriochloa* spp.) or lovegrass (*Eragrostis* spp.) species. The population trend for Dickcissels increased on the route in which the most severe redcedar encroachment was offset by increased area of CRP lands in a landscape that had the least amount of intact native grasslands within 0.4 km of BBS stops, indicating that Dickcissel use of CRP fields might be related to the matrix of land uses in the surrounding landscape.

CRP contracts often require management midway through a contract period (Kraus and others, 2022). This mid-contract management may take the form of grazing, haying, burning, disking, or interseeding. The effect of experimental mid-contract grazing management on Dickcissels was covered early in this section (Kraus and others, 2022; Wilson and others, 2022). The practices of seeding, spraying, burning, and disking will be covered here. In northeastern Nebraska, Negus and others (2010) reported that Dickcissel abundance was higher in portions of CRP fields that were disked and interseeded in the previous year than in unmanaged reference CRP fields, portions of CRP fields disked and interseeded the current year, or portions of CRP fields disked and interseeded the 2 years previously. Dickcissel nest success was 20 percent in treated fields and 10 percent in reference fields. In CRP fields in riparian corridors in Iowa, Benson and others (2011) evaluated the effect of burning and disking on Dickcissel density. Although there were no statistically significant differences in Dickcissel densities between burned or disked fields, the higher densities of Dickcissels in disked fields may indicate that disked fields are more attractive than undisked fields. In a related study, Benson and others (2013) reported that Dickcissel density increased with disking, and higher densities were found in block-shaped than in strip-shaped disked sites. Disked fields had higher forb coverage than undisked fields. In south-central Illinois, densities of Dickcissels were lowest in idle CRP fields that were primarily monotypic stands of dense, tall fescue compared to CRP fields that were either strip-disked in the fall, sprayed with glyphosate in the fall, or sprayed with glyphosate in the fall and interseeded with legumes in the spring (Osborne and Sparling, 2013). In northwestern Illinois, Shew and others (2019) examined the effects on Dickcissel nest survival of mid-contract management techniques of disking, herbicidal spray, or herbicidal spray with a forb interseeding on warm- and cool-season seeded CRP grasslands. Dickcissels had higher nest survival in warm-season CRP fields than in cool-season CRP grasslands and in those fields that had greater proportions of the field managed yearly and cumulatively (yearly percent of field treated with any form of mid-contract management technique; cumulative percent over the course of the study). In a related study, Shew and Nielsen (2021) reported that Dickcissel densities were higher in CRP fields receiving some form of annual management, compared to control fields with no management.

Cropland

Dickcissels occasionally use cropland during the breeding season. Within organic farm fields in the central Great Plains, Quinn and others (2012) reported that Dickcissel abundance was higher at avian survey points with higher percentage of alfalfa and soybeans within 50 m and unaffected by percentage of corn and small grains. Dickcissel abundance was lower as the percentage of linear patches and of blocks of woodland within 50 m increased and was unaffected by percentage of linear grassland or blocks of grassland within 50 m. In a statewide study in North Dakota, Igl and others (2008) recorded Dickcissels in low densities in cropland (defined as land used for the production of annual field crops, land under summer fallow, and land cleared for annual field crops). In South Dakota, Dickcissel abundance was 2.5 times lower in cropland and grasslands than in fallow fields (DeJong and others, 2004). In western Iowa and eastern Nebraska, Dickcissel fledglings used corn and soybean fields, restored warm-season grasslands, and wetlands; the species used habitat types in proportion to their availability (Berkeley and others, 2007). In Indiana, Iowa, Kansas, Michigan, Missouri, and Nebraska, Best and others (1997) examined Dickcissel use of CRP fields and corn, soybean, and sorghum (*Sorghum* spp.) fields; Dickcissels were more abundant within CRP fields than crop fields, and nests were most abundant in CRP fields in Kansas (Best and others, 1997). In Illinois, Dickcissels occurred in low densities in waste and fallow cropland, small grains, pasture, and corn, but the species avoided farm yards and plowed or stubble fields (Gross, 1921a,b). In Michigan, Monroe (1967) found no Dickcissels in cropland.

Linear strip cover (that is, filter strips, conservation buffers, grassed waterways and terraces, fencerows, and roadside ditches) may aid in providing habitat for Dickcissels within or adjacent to rowcrop fields and other habitats. In central Iowa rowcrops, Schulte and others (2016) examined the effectiveness in increasing avian abundance of planting strips of native perennial vegetation within rowcrops. Treatments were 100 percent rowcrop (that is, the reference or control), 10 percent of the area planted to native vegetation in one strip on the footslope, 10 percent in multiple strips on the contour, or 20 percent in multiple strips on the contour; previous land use before experimental manipulation was tame grassland. Dickcissels trended towards higher abundances in the treatments planted to native vegetation than in the rowcrop control, although the trends were not statistically significant. In southwestern Iowa, Dickcissels preferred nesting in strip cover (that is, grassed waterways and terraces, fencerows, and roadside ditches) rather than in reduced-tillage corn fields or in untilled (idle in fall and spring and containing year-round crop residue; treatments were corn-only, corn-and-sod, and corn-and-soybeans) rowcrop fields; no Dickcissel nests were found in reduced-tillage corn fields or in untilled corn-only and corn-and-soybean fields (Basore and others, 1986). In a southwestern Iowa study of avian use of grassed terrace systems in corn and soybean fields, Dickcissels were one of the most abundant species recorded on terraces (Hultquist and Best, 2001). In central Iowa, grassed waterways in corn and soybean fields were planted primarily to smooth brome to reduce erosion; Dickcissels were one of the most abundant nesting species within the waterways and the crop fields (Bryan and Best, 1991, 1994). In Iowa riparian filter strips, Dickcissels nested in strips ≤5 m wide and adjacent to corn or soybean fields but not in filter strips adjacent to woody vegetation (Henningsen and Best, 2005). Nests were more likely to be parasitized in warm-season plantings than in cool-season plantings. In Illinois, Dickcissels nested in wider tracts of strip cover, such as waterways (7–28 m wide), rather than in fencerows (1–3 m wide) (Warner, 1994). In west-central Illinois, the best predictive model to explain Dickcissel occurrence on road rights-of-way adjacent to rowcrops, houses, forested areas, and streams included the width of the right-of-way, with the probability of Dickcissel occurrence increasing considerably on road rights-of-way >24 m wide (McCleery and others, 2015). No other variables were included in the model, including forb cover, grass cover, visual obstruction, nonwoody vegetation height, vegetative biomass, average annual daily traffic, and presence of perches (McCleery and others, 2015). In Mississippi, Conover and others (2011b) evaluated Dickcissel nest densities and survival in four early-successional conservation practices: large forest blocks (6–8-year-old trees), riparian forest buffers (1–3-year-old trees), monotypic switchgrass buffer strips with no trees, and diverse forb-native grass buffer strips with no trees. Dickcissel nest densities were 3.5 times higher in large afforestation blocks than in riparian forest buffers or forb/grass strips. Dickcissels preferred buffers with diverse vegetation over monotypic switchgrass buffers. Conover and others (2011a) reported that Dickcissels nested at higher densities in wide (24–45 m wide) conservation strips of herbaceous cover planted along agriculture field margins than in narrow (about 10 m wide) conservation strips; Dickcissel nest survival was not influenced by buffer type. Adams and others (2015) found that Dickcissel densities were lower in conservation buffers bordered by woodland than in buffers bordered by grasslands. In CRP conservation grassland buffers in northeastern Mississippi, Dickcissels had lower densities in buffers adjacent to woodlands than in buffers adjacent to grasslands; Dickcissel densities in buffers that were adjacent to developed areas (for example, roads) did not differ from buffers that were adjacent to grassland habitat (Adams and others, 2015). Dickcissel densities in buffers with cropland on both sides were greater than those in buffers that bordered grasslands (Adams and others, 2015). In those same conservation buffers, Adams and others (2019) evaluated how disturbance (prescribed burning and light disking) and time since the last disturbance event influenced Dickcissel densities; Dickcissel densities did not differ in the buffers regardless of the type of disturbance or the time since disturbance. Dickcissel nest densities were greater in buffers that were burned or undisturbed than in buffers that were disked; Dickcissel nest survival was 29.7 percent during the peak nesting period (May 11–20), but disturbances did not improve nest survival (Adams and others, 2013).

Savannas

Dickcissels readily inhabit savanna habitats. To curtail woody succession, savanna habitats often are managed with prescribed fire. The restoration and maintenance of savannas benefits Dickcissels. In northwestern Oklahoma, sand shinnery oak shrublands were maintained with primarily spring (January to March) fires and grazing conducted from April to July by cattle at moderate stocking rates (that is, 1.6 ha per AUMs). The highest relative abundance of Dickcissels occurred in intermediate times since fire (that is, 13–24 and 24–35 months postburn). These time periods equated to ecological conditions in which the sand shinnery oak community had not yet fully recovered and herbaceous species dominated (Londe and others, 2021). In eastern Texas, post oak savannas were maintained with prescribed fire on an average 3-year rotation and with herbicide treatments and mechanical treatments, such as mowing, mulching, and tree removal (McInnerney and others, 2021). Dickcissels were not detected in the year before restoration efforts on either control areas or areas slated for restoration efforts. Dickcissels occurred on the restored area 1 year after restoration but not on the control area. By the second year after restoration, Dickcissels occurred on both control and restored plots. Of 38 nests, all were in the restored or control sites, with no nests in the unrestored sites (McInnerney and others, 2021).

Pesticides

Pesticides may directly or indirectly affect Dickcissel populations. Quinn and others (2017) examined the response of grassland birds to multiple measures of agricultural change over a 40-year period along the 41st parallel within Colorado, Wyoming, Nebraska, and Iowa. Within this region and time period, total land area planted to cropland increased 40 percent, biomass yield increased 100 percent, and chemical use increased 500 percent. The abundance of Dickcissels declined with increased area farmed and with chemical use, although the latter measure was not statistically significant. Dickcissel abundance did not decline with more intensive biomass production (Quinn and others, 2017). In wheat fields treated with a mixture of toxaphene and methyl parathion in southeastern Missouri, Dickcissels showed high levels of cholinesterase inhibition activity in their brains; however, no dead or abnormally behaving birds were observed (Niethammer and Baskett, 1983). In Texas, five Dickcissels were found dead or dying in and near rice (*Oryza* spp.) fields planted with seeds treated with aldrin and Ceresan (ethylmercury chloride) (Flickinger and King, 1972). Also in Texas, over 100 birds, consisting mostly of Dickcissels and Savannah Sparrows

(*Passerculus sandwichensis*), died from feeding on planted rice that was illegally treated with carbofuran; brain cholinesterase activity was depressed between 32 and 85 percent in nearly one-half of the birds (Flickinger and others, 1986). Dickcissels may experience significant pesticide exposure on the wintering grounds, including intentional poisoning of overwintering Dickcissels to reduce crop depredation (Basili, 1997; Basili and Temple, 1999; Avery and others, 2001; Sousa and others, 2022). Such exposure can cause high levels of mortality (Sousa and others, 2022).

Urban Development

The effects of urbanization on Dickcissels during the breeding season are ambiguous. In Iowa and Nebraska tallgrass prairies, Dickcissel densities were lowest in prairies embedded in an urban landscape compared to sites with less or no urbanization (McLaughlin and others, 2014). Urbanization was defined as the percentage of land use occupied by lawn, roads, impervious surfaces, and buildings; high urbanization was 50.2 percent, moderate urbanization was 17.5 percent, and low urbanization was 3.7 percent. In patches of tallgrass prairie of varying sizes in Illinois, Dickcissel densities were unaffected by the amount of urban development within 1.6 km of point counts (Buxton and Benson, 2016). In eastern Oklahoma, Engle and others (1999) evaluated the response of Dickcissels to low-density urban sprawl in two study areas: a sparsely populated rural area and an area close to metropolitan Tulsa. Human density increased from 3 humans per km^2 in 1902 to 7 humans per km^2 in 1990 in the sparsely populated area and from 12 humans per km^2 in 1902 to 44 humans per km^2 in 1990 in the high human density area. Dickcissel abundance increased in the low human density area between 1902 and 1990, with the prediction to increase as more deciduous forest is cleared; abundances remained stable in high human density area (Boren and others, 1999; Engle and others, 1999). In tallgrass prairies of Oklahoma, Dickcissel abundance increased with proximity to roads (that is, any graveled or improved surface at least 2 m wide) (Coppedge and others, 2008). In tallgrass prairies of Missouri, Dickcissel nest success was unaffected by distance to roads (that is, two-lane paved country roads 7 m wide or wider) (Winter and others, 2000). In restored post oak savannas in eastern Texas, Dickcissel nest success was negatively related to distance to nearest maintained road (McInnerney, 2018). Successful nests were farther from a road (no descriptions of road characteristics were provided by the authors; median value for eight nests was 257 m) compared to unsuccessful nests (median value for 13 nests was 60 m). On reclaimed surface mines in eastern Texas, Dixon and others (2008) detected no relationship between the location of Dickcissel nests and nest success to distance from roads; cowbird brood parasitism was more likely to occur in nests near roads (no descriptions of road characteristics were provided by the authors).

Energy Development

Energy development may affect Dickcissel distribution and abundance. Beston and others (2016) developed a prioritization system to identify avian species (428 species evaluated) most likely to experience population declines in the United States from wind facilities based on the species' current conservation status and the species' expected risk from wind turbines. The Dickcissel scored a 3.92 out of nine (nine indicating highest likelihood of decline), and Beston and others (2016) estimated that 7.32 percent of the Dickcissel breeding population in the United States is exposed to wind facilities. Wulff and others (2016) examined diurnal flight heights of Dickcissels and determined that the species' mean flight height was 6.8 m, which is outside of the rotor-swept zone (32–124 m) of wind turbine blades; Wulff and others (2016) concluded that the Dickcissel was not at risk of turbine collisions. Loss and others (2013) reviewed published and unpublished reports on collision mortality at monopole wind turbines (that is, with a solid tower rather than a lattice tower) in the contiguous United States; one Dickcissel mortality was reported at one wind facility. Erickson and others (2014) compiled data from 116 studies on small-passerine fatalities caused by collisions with turbines at wind-energy facilities in the United States and Canada; 0.005 percent of the continental population of Dickcissels was estimated to annually suffer mortality from collisions with wind turbines. Hatchett and others (2013) reported that proximity to wind turbines did not affect Dickcissel nest density. In Oklahoma, Londe and others (2019) found no evidence that Dickcissel abundance was affected by distance to conventional oil wells (that is, grid-powered pump jacks) in tallgrass prairies under any of three time-since-fire burning schedules. Dickcissels did not appear to avoid major gravel roadways (that is, county roads that were wide enough [>8 m] for two lanes of traffic) in current-year burns, with highest abundances occurring nearer to roads in current-year burns. Dickcissels showed no response to roads in prairies 13–24 months postburn and >24 months postburn. Between August 1992 and June 2005, remains of 172 bird species were identified in oil pits (fluid-filled pits and tanks that store waste fluids from oil production) in the United States; remains of three Dickcissels were recovered in oil pits in Texas (Trail, 2006).

Management Recommendations from the Literature

Grassland Protection and Restoration

Throughout the Dickcissel's breeding range, the protection, maintenance, and restoration of large tracts of grassland habitat that support stands of tall, dense grasses and forbs will benefit Dickcissel adults and fledglings (Helzer and Jelinski, 1999; Herkert and others, 2003; Berkeley and others, 2007; Uden and others, 2015; Jones and others, 2017; Lituma and Buehler, 2020; Sousa and others, 2022). Habitats such as grasslands restored under the CRP and unburned tallgrass prairie hayfields may be especially beneficial in maintaining Dickcissel populations (With and others, 2008; Rahmig and others, 2009; Jacobs and others, 2012; Uden and others, 2015). Oldfields are a preferred habitat for Dickcissels in some portions of their range; thus, allowing cropland to revert to oldfield status would benefit Dickcissels in those regions (Harmeson, 1974; Zimmerman, 1982; Zimmerman and Finck, 1983).

Grassland patch area and configuration are important factors in decisions about what grasslands to protect, maintain, or restore (Helzer and Jelinski, 1999; McLaughlin and others, 2014). Several researchers have recommended that consideration and prioritization for future grassland restorations under the CRP include the matrix of land uses in the surrounding landscape (Coppedge and others, 2004; Osborne and Sparling, 2013; Shew and others, 2019), and that fields that are smaller in size and surrounded by large proportions of forested land receive less consideration for enrollment than larger fields not surrounded by forest (Osborne and Sparling, 2013; Shew and others, 2019). Other considerations include the ratio of perimeter to area (Helzer and Jelinski, 1999). Fletcher and others (2006) indicated that increasing grassland patch size and the total area of grasslands in the landscape may ameliorate the negative impact of nest predation. Where feasible, removal of woody vegetation around grassland field edges may help redistribute movement patterns of mammalian nest predators, reduce predator abundance, and help to create connections for Dickcissels between small and isolated grassland fragments (Winter and others, 2000). Klug and others (2010) recommended targeted removal of shrubs and trees or reducing shrub cover to ≤5 percent of the total area within grasslands to mediate nest-predation risk. This value was the average shrub cover recorded at successful Dickcissel nests, whereas an average of 10 percent shrub cover was recorded at depredated nests. However, Klug and others (2010) provided the caveat that the effect of shrub removal on predator communities is unknown and could affect predator species meriting their own conservation actions; thus, more research into this suggestion is warranted. Patten and others (2006) recommended removal of woody vegetation along roads to help reduce brood parasitism rates in grasslands near roads. Jensen and Finck (2004) indicated that prairies dissected solely by cropland might provide more suitable Dickcissel habitat than prairies dissected by woodland, and Walk and others (2010) stated that Dickcissels might be more tolerant of grassland-cropland edges than grassland-woodland edges. However, Maresh Nelson and others (2018) reported that woodland cover and wooded-edge prevalence were associated with reduced parasitism risk for Dickcissel nests in Missouri pastures; the researchers cautioned that converting nearby crop fields to grassland or applying management actions at the patch level—such as controlling woody cover—might be more effective in reducing parasitism than avoiding the acquisition of conservation sites near woodlands. Quamen (2008) recommended that resource managers remove tree belts from grasslands where conservation of Dickcissels and other native grassland songbirds is a primary management objective. Given that grassland bird abundance is lower within 220 m of a woody edge, Quamen (2008) extrapolated that one tree belt on an average-sized (87 ha) Federal tract of land in North Dakota would reduce habitat benefits for grassland birds on 25 percent of Federal public lands.

In urban or highly agricultural landscapes, the only existing grasslands may be small patches (Ribic and others, 2009a; Walk and others, 2010; McLaughlin and others, 2014; Buxton and Benson, 2016). Bakker and others (2002) and Greer (2009) emphasized the importance of conserving remaining small grassland patches embedded within landscapes with a high proportion of grassland habitat. Van Dyke and others (2004, 2007) recommended managing small grassland fragments for the benefit of a few bird species, as the patches may be too small to support large numbers of birds. Maintaining small grassland patches may be challenging if the encroachment of invasive plant species is an issue or if treatment options such as burning are infeasible because of proximity to urban or suburban areas (McLaughlin and others, 2014).

In areas where fragmentation is high because of urbanization and agriculture, or where unchecked vegetation succession eventually degrades Dickcissel habitats (for example, savannas, barrens, parkland), public lands protect imperiled habitats upon which Dickcissels rely; examples include the Fort McCoy Military Installation for oak savanna (Vos and Ribic, 2013) and the Boyer Chute National Wildlife Refuge (Berkeley and others, 2007) for grasslands. Federal policies that protect grassland types on public land, such as the dry sand prairies of Wisconsin and tallgrass prairies in Kansas found on military installations, may be key to preserving rare habitats inhabited by Dickcissels (Vos and Ribic, 2011, 2013; Powell and Busby, 2013; McMullen and Harms, 2020). Privately owned lands (especially pastureland generally referred to as “working lands”) can provide habitat and protect native ecosystems, as over 70 percent of the United States is held in private ownership (Ciuzio and others, 2013). Conservation partnerships among Federal, State, and Tribal agencies; nongovernmental organizations; and private landowners result in programs like grassbanks. Gripne (2005) described a grassbank as a conservation tool that exchanges the value of a given amount of forage for conservation benefits. Dickcissels benefit from grassbanks for the grassland habitat protected and in some cases, the higher abundances on private grasslands than public lands (Ahlering and others, 2019).

Public/private partnerships also create new grasslands, with a common example being the CRP (Klute, 1994). Federal landowner incentive programs like the CRP can provide valuable conservation benefits to a myriad of wildlife, and the effectiveness of this program in providing breeding habitat for the Dickcissel has been well established (Herkert, 2009). Former coal mines that are eligible for reclamation may be good targets for grassland creation and preservation, as they often are large (>2,000 ha), owned by a single entity, and are not desirable for agricultural uses (Galligan and others, 2006). Blank and others (2014) reported that newer programs to create grasslands as sources for bioenergy create habitat for Dickcissels that is more preferred than corn fields; thus, incentives to convert grasslands to corn fields would be detrimental to the species (Blank and others, 2014; Uden and others, 2015). Blank and others (2014) indicated that creating bioenergy grasslands in a landscape of other grassland parcels maximizes the benefit to Dickcissels. Blank and others (2014) also indicated that the timing of biomass harvests to minimize nest loss will be an important consideration. A mid-August harvest could allow for at least 90 percent of Dickcissel nests to fledge (Basili, 1997; Roth and others, 2005). Decreasing herbicide use on bioenergy fields would increase forb abundance, which would benefit Dickcissels (Murray and Best, 2003). Incorporating a diverse mixture of forbs into biofuel grasslands or interspersing plots of switchgrass and native warm-season grasses in the landscape to increase biodiversity may provide adequate biomass for biofuel production and improve habitat for Dickcissels and other grassland nesting birds (Conkling and other, 2017).

Fire and Grazing

Maintenance of existing rangelands and grasslands includes preventing the encroachment of invasive plant species and woody vegetation (Zimmerman, 1992). Combination treatments, such as grazing and burning, are frequently applied in certain areas such as the tallgrass prairies; however, several researchers have found combination treatments to be detrimental to the stability of local Dickcissel populations and recommend against conducting combination treatments on the same grassland (Eddleman, 1974; Swengel, 1996; Zimmerman, 1997). Several authors have concluded that the combination burn-and-graze treatment, especially the annual burning followed by grazing (for example, the IESB system), is detrimental to Dickcissel populations, particularly in the Flint Hills where it is commonly applied (Fuhlendorf and others, 2006; Patten and others, 2006; Powell, 2006, 2008; With and others, 2008; Davis and others, 2016). Davis and others (2016) further concluded that the PBG system in the Flint Hills also served as a sink habitat under certain realistic population-dynamic scenarios.

A synthesis of the recommendations of grazing systems on Dickcissels is challenging given the geographical extent over which systems, particularly the PBG system, has been conducted, extending from Iowa to Missouri, Kansas, and Oklahoma. Caution is merited when considering general statements about advantages of one grazing system over another, as variation in stocking rates exists among individual livestock producers and among studies (Pillsbury and others, 2011)—one example is the alteration of stocking rates by Duchardt and others (2016) based on results of Pillsbury and others (2011)—as well as differences in fire-return intervals (annually under IESB versus the typical 3-year fire-return interval among patches under PBG) (Pillsbury and others, 2011). Researchers may present overall results that indicate that one system is advantageous over another, but finer-grained, among-treatment differences may yield more subtle results. For example, although overall Dickcissel productivity (daily nest survival and nest success) was higher in PBG pastures than in IESB pastures, nest survival and nest success were lowest in current-year PBG patches when compared against IESB pastures and 1- and 2-year PBG pastures (Churchwell and others, 2008). Despite these caveats, a general synthesis and compilation of management recommendations has been attempted, although discrete and detailed recommendations from researchers are uncommon. Pillsbury and others (2011) stressed that a too-high stocking rate may result in vegetation structural heterogeneity other than expected, and that annual readjustments to stocking rates may be necessary to maintain sufficient residual biomass. Maintaining stocking rates at levels common to the ranching community, and even substantial reductions below these levels, may still be insufficient to achieve vegetation heterogeneity that supports avian diversity, especially if other factors such as fragmentation also are affecting habitat use by birds (Pillsbury and others, 2011). Achieving an optimal stocking rate in smaller, more fragmented pastures may be more challenging than in larger pastures (Pillsbury and others, 2011; Duchardt and others, 2016). To achieve high avian diversity, Duchardt and others (2016) adjusted stocking rates from the study of Pillsbury and others (2011), thus highlighting the challenges of identifying a stocking rate to achieve desired avian results. Coppedge and others (2008) cautioned that increasing overall avian diversity may not be the most desirable goal if grassland endemic species of conservation concern are missing. Pillsbury and others (2011) concluded that the stark reductions in livestock stocking rate that would have created heterogeneity would best be achieved on public lands and recreational private lands where revenues from livestock production would be of secondary importance. Dickcissels exhibited no response in density to fire-return intervals or number of PBG patches in the experimental manipulations of Hovick and others (2015); thus, their suggestion of a 3–4-year fire-return interval in PBG systems may not apply to Dickcissels. Davis and others (2016) called for additional research into how grazing and fire intensity, patch-burn area, and fire pattern affect habitat structure for grassland birds.

Grazing systems may affect cowbird abundance and brood parasitism rates. For example, in the Flint Hills, cowbird densities and brood parasitism rates were higher in IESB pastures than grazed-only or idle pastures (Patten and others, 2006). Additionally, Churchwell and others (2008) reported that overall brood parasitism rates were higher on IESB pastures than PBG pastures, but Erickson (2017) found that Dickcissel parasitism rates were higher on PBG than IESB pastures. By evaluating between-year differences, Churchwell and others (2008) found that parasitism rates in current-year burn patches were much higher than in IESB pastures, even though nest densities were lower. In light of the above examples, Patten and others (2006) cautioned that decoupling the effect of grazing from the effect of burning on parasitism rates would be challenging in the Flint Hills.

With and others (2008) evaluated scenarios in which the current land use throughout the Flint Hills was altered, including one scenario in which the total grazed area burned was reduced by 50 percent; the Dickcissel rate of decline was only marginally affected under this scenario. Because such widespread alterations also would likely affect other factors, such as types and abundance of predators and nest-predation rates, With and others (2008) offered no recommendations on management scenarios related to burning and grazing. With and others (2008) and Rahmig and others (2009) recommended increasing hay production in the tallgrass prairies of the Flint Hills, as nest success was found to be high in this habitat and the native warm-season grasses in the Flint Hills are mowed later (mid-July) than elsewhere in the Midwest, enabling birds to complete at least one nesting attempt (With and others, 2008). With and others (2008) further examined scenarios under which perennial grassland cover was restored under the CRP, and both they and Rahmig and others (2009) found that Dickcissels were common in this habitat, although nest success was low, indicating that increasing the CRP in the Flint Hills may have only nominal positive effects on Dickcissels.

Burning alone or grazing alone might be more beneficial to Dickcissels than the combination of the two treatments (Powell, 2008). Studies indicate that grasslands that are treated with burning-only management have similar or higher Dickcissel densities than PBG systems (Pillsbury and others, 2011; Holcomb and others, 2014; Duchardt and others, 2016). A mosaic of sites, such as sites that incorporate idle, burned-only, or moderately grazed-only patches, provide dense herbaceous vegetation preferred by Dickcissels (Zimmerman, 1997). Using prescribed burning in a rotational system (for example, not burning more than 20–30 percent of a prairie fragment annually) can provide a mosaic of habitats that will accommodate the habitat needs of several grassland bird species, including the Dickcissel (Winter, 1998; Rohrbaugh and others, 1999; Churchwell and others, 2008). Zimmerman (1992) supplied some climate-related guidelines to burning-only treatments in tallgrass prairies; namely, burning in wet years likely will not impact Dickcissel abundance, but burning in drought years likely will cause a reduction in abundance. Refraining from burning certain prairie areas, such as "bottom" habitats that are part of natural drainage systems, may provide nesting habitat for Dickcissels within larger burned grassland units (Petersen, 1978). Powell and Busby (2013) found higher Dickcissel densities in unburned than in annually burned prairies, and Robel and others (1998) found higher Dickcissel abundances in unburned than annually burned CRP grasslands, but these researchers agreed that some frequency of burning was necessary to curtail woodland advancement. Although Powell and Busby (2013) suggested a burning interval of 3–4 years and Robel and others (1998) an interval of 2–3 years, they acknowledged that these were untested suggestions. Powell (2008) indicated that a 1–3-year fire-return interval might be more appropriate for Dickcissels, although other grassland bird species might prefer a longer interval, such as 4 years, or a shorter interval, such as 2 years. Alexander and others (2021) concluded that prescribed burning during August or September provided an inexpensive means to control seed-based and vegetative propagation of sericea lespedeza while improving forb diversity, habitat for native pollinators, and overall ecosystem health without decreasing the value of grasslands for livestock grazing or Dickcissels and other grassland nesting birds. In the tallgrass prairie fragments in which Winter (1998) worked in Missouri, prairies were treated with a rotational system of burning or haying in alternate years or sometimes even twice within a year (spring-burned and summer-hayed), with 30–50 percent of patches being managed each time. Winter (1998) indicated that these practices are too frequent and suggested researching the effect of less-frequent management on Dickcissel abundance and productivity. Herkert (1994b) provided general suggestions, not specific to Dickcissel findings, to conduct prescribed burns on prairie fragments >80 ha in a rotation of 20–30 percent of the area annually, with smaller prairie fragments receiving burns on 50–60 percent of the area. Westemeier and Buhnerkempe (1983) suggested high mowing (above 30 cm) in conjunction with prescribed burning at 3- to 5-year intervals, but not annual burning. Haying may be desirable, but not more than once in 3 years.

Management Timing

Dickcissel nests and their young are vulnerable to management disturbances (for example, haying; Frawley, 1989, Frawley and Best, 1991) during the breeding season. Degradation of grasslands through intensive management (too-frequent fire or intensive grazing) or neglect (fire suppression) may decrease Dickcissel breeding habitat and reduce nest success through increased woody vegetation and increased rates of nest predation (Klug and others, 2010). Delaying mowing until after the peak nesting period (that is, until after mid-August) may improve Dickcissel productivity (Gross, 1921a,b, 1968; Harrison, 1974; Harrison and Brewer, 1979; Bryan and Best, 1991; Frawley and Best, 1991; Herkert, 1994b; Zimmerman, 1997; Roth and others, 2005). Researchers who have studied fledgling behavior recommended that management activities occur in early spring (that is, several weeks before the species' arrival on the breeding grounds) or in late fall or winter (Hughes, 1996; Jones and others, 2017) because fledgling Dickcissels have limited mobility and remain dependent on their parents for several weeks after leaving the nest (Berkeley and others, 2007).

Planted Cover

In CRP fields receiving grazing as a form of mid-contract management, Kraus and others (2022) recommended applying grazing efforts in conjunction with long-term monitoring, given the ambiguous results to Dickcissel productivity from grazing during the primary nesting season. Additional research is warranted to study the long-term, delayed effects of grazing and the effects of different seeding mixtures and age since establishment on nest survival. For CRP fields planted to monocultures, such as yellow bluestem, more research into avian productivity is warranted, as yellow bluestem fields had lower avian and plant diversity and lower food biomass than native prairies (Chapman and others, 2004a; Hickman and others, 2006; George and others, 2013), all of which could affect factors such as avian nest success and source-sink dynamics. In brome-dominated CRP fields receiving disking and interseeding as a form of mid-contract management, annual management is merited (Negus and others, 2010). Annual rotations of disking and interseeding, such as one-fourth of each field annually, creates variation in vegetation structure and floristic diversity (Negus and others, 2010; Shew and others, 2019). Negus and others (2010) indicated that disking and interseeding legumes may be more effective at increasing avian diversity when used in conjunction with other practices such as herbicide application, burning, haying, or grazing, but that these combinations need to be evaluated. Benson and others (2013) suggested that disking is favorable to Dickcissels because of the increase in forb cover; Dickcissels seemed to prefer block-shaped disked areas over strip-shaped disked areas.

Cropland

Agricultural areas may be enhanced for Dickcissels by establishing grassed waterways and grass terraces within cropland fields and grassy filter strips along cropland field edges, as Dickcissels are among the most common species in these habitats (Bryan and Best, 1991, 1994; Hultquist and Best, 2001; Henningsen and Best, 2005; Schulte and others, 2016). Bryan and Best (1991, 1994) provided several recommendations for increasing the utility of grassed waterways to Dickcissels. These recommendations included delaying the mowing of grassed waterways until late August or early September to avoid peak nesting period and to increase Dickcissel nest success, but not delaying the mowing past September to allow sufficient vegetation regrowth for winter and spring cover. Mowing at heights of 15–30 cm facilitates sufficient regrowth for winter and spring cover. Annual mowing is discouraged to allow unmowed areas to serve as refugia and to counteract disturbances in other mowed habitats, such as hayfields and roadways, that are mowed annually. Fall burning is discouraged. Weed control could occur through spot herbicide spraying or spot mowing. However, as Dickcissels nest in some forbs that may be considered weeds, these nesting substrates should be maintained unless they are noxious weeds. Interseeding grass with a legume, such as alfalfa, also provides a nesting substrate (Bryan and Best, 1991, 1994). Henningsen and Best (2005) advised that woody vegetation near filter strips adjacent to streams be controlled or eliminated or, alternatively, filter-strip establishment should be prioritized for areas distant from wooded stream banks. Hultquist and Best (2001) differentiated between terrace types and recommended converting older grassed backslope terraces (the front slopes of which have a cropland component) to narrow-base terraces (which consist of all grass), to increase grassland coverage. Planting narrow-base terraces with a diversity of plant species, rather than a monoculture, also may promote avian diversity (Hultquist and Best, 2001). In prairie strips consisting of a diverse assemblage of native plant species planted within annual rowcrops, Schulte and others (2016) noted an increase in bird abundance, species richness, and diversity. McCleery and others (2015) reported that wider road rights-of-way with thicker and taller vegetation and low traffic volume provided the best available conditions for grassland bird communities in roadsides adjacent to agricultural crops. Reducing mowing and the frequency of mowing on road rights-of-way may enhance nesting success for Dickcissels and other grassland birds while reducing management costs for road rights-of-way (McCleery and others, 2015). Adams and others (2015) recommended avoiding grassland buffer establishment along woodland edges to maximize the potential of buffers supporting Dickcissels and other grassland birds; the quality of the buffers for grassland birds could be enhanced if buffers are established along grasslands, pastures, and hayland. Although Dickcissel nest survival did not vary in relation to disturbance type (burning versus disking), Adams and others (2013) recommended managing early successional herbaceous buffers with prescribed burning because Dickcissel nest densities were greater in burned buffers compared to those that were disked.

Savannas

Within savanna habitats, removal or control of trees may be necessary to curtail succession to woodland or forest. A rotational fire schedule for sand shinnery oak shrublands may benefit Dickcissel, as the species reached highest abundance 2–3 years after burning (Londe and others, 2021). Protection of existing oak shrublands also is important, as the reestablishment of extirpated populations is difficult and expensive (Londe and others, 2021). Thinning of trees may be necessary to prevent succession to woodlands (Holoubek and Jensen, 2015). In Kansas, Holoubek and Jensen (2015) recommended that savannas undergoing succession to forests should be thinned to <25 percent canopy coverage, or <200 trees per ha. Although not providing goals for canopy coverage reductions for grasslands encroached by eastern redcedar, Chapman and others (2004b) emphasized the early prevention of tree encroachment, as increases in redcedar coverage appears to cause a decrease in the variation of grassland bird abundance. McInnerney and others (2021) suggested that the basis for future restoration activities hinge on the proximity to other restored or remnant savannas, so that source populations of targeted avian species are available, and on consideration of the size of restoration area. In restored savanna in Texas, Dixon (2005) suggested that restored areas be improved by planting more bunchgrasses, tall forbs (including clover), and oaks, all of which were preferred nesting substrates associated with higher nest survival rates for Dickcissels.

References

Adams, H.L., Burger, L.W., Jr., and Riffell, S., 2013, Disturbance and landscape effects on avian nests in agricultural conservation buffers: The Journal of Wildlife Management, v. 77, no. 6, p. 1213–1220. [Also available at https://doi.org/10.1002/jwmg.568.]

Adams, H.L., Burger, L.W., Jr., and Riffell, S., 2015, Edge effects on avian diversity and density of native grass conservation buffers: The Open Ornithology Journal, v. 8, p. 1–9. [Also available at https://doi.org/10.2174/1874453201508010001.]

Adams, H.L., Burger, L.W., Jr., and Riffell, S., 2019, Influence of disturbance on avian communities in agricultural conservation buffers in Mississippi, USA: The Open Ornithology Journal, v. 12, p. 16–29. [Also available at https://doi.org/10.2174/1874453201912000016.]

Ahlering, M.A., Johnson, D.H., and Elliott, L.H., 2019, Land ownership and use influence grassland bird abundance: The Journal of Wildlife Management, v. 83, no. 2, p. 343–355. [Also available at https://doi.org/10.1002/jwmg.21590.]

Alexander, J.A., Fick, W.H., Ogden, S.B., Haukos, D.A., Lemmon, J., Gatson, G.A., and Olson, K.C., 2021, Effects of prescribed fire timing on vigor of the invasive forb sericea lespedeza (*Lespedeza cuneata*), total forage biomass accumulation, plant-community composition, and native fauna on tallgrass prairie in the Kansas Flint Hills: Translational Animal Science, v. 5, no. 2, txab079. [Also available at https://doi.org/10.1093/tas/txab079.]

Applegate, R.D., Flock, B.E., and Horak, G.J., 2002, Spring burning and grassland area—Effects on Henslow's Sparrow (*Ammodramus henslowii* [Audubon]) and Dickcissel (*Spiza americana* [Gmelin]) in eastern Kansas, USA: Natural Areas Journal, v. 22, no. 2, p. 160–162.

Avery, M.L., Tillman, E.A., and Laukert, C.C., 2001, Evaluation of chemical repellents for reducing crop damage by Dickcissels in Venezuela: International Journal of Pest Management, v. 47, no. 4, p. 311–314. [Also available at https://doi.org/10.1080/09670870110065235.]

Bakker, K.K., and Higgins, K.F., 2009, Planted grasslands and native sod prairie—Equivalent habitat for grassland birds?: Western North American Naturalist, v. 69, no. 2, p. 235–242. [Also available at https://doi.org/10.3398/064.069.0212.]

Bakker, K.K., Naugle, D.E., and Higgins, K.F., 2002, Incorporating landscape attributes into models for migratory grassland bird conservation: Conservation Biology, v. 16, no. 6, p. 1638–1646. [Also available at https://doi.org/10.1046/j.1523-1739.2002.01328.x.]

Bar-Massada, A., Wood, E.M., Pidgeon, A.M., and Radeloff, V.C., 2012, Complex effects of scale on the relationships of landscape pattern versus avian species richness and community structure in a woodland savanna mosaic: Ecography, v. 35, no. 5, p. 393–411. [Also available at https://doi.org/10.1111/j.1600-0587.2011.07097.x.]

Barrioz, S., Keyser, P., Buckley, D., Buehler, D., and Harper, C., 2013, Vegetation and avian response to oak savanna restoration in the Mid-South USA: American Midland Naturalist, v. 169, no. 1, p. 194–213. [Also available at https://doi.org/10.1674/0003-0031-169.1.194.]

Basili, G.D., 1997, Continental-scale ecology and conservation of Dickcissels: Madison, Wis., University of Wisconsin, Ph.D. Dissertation, 151 p.

Basili, G.D., and Temple, S.A., 1999, Dickcissels and crop damage in Venezuela—Defining the problem with ecological models: Ecological Applications, v. 9, no. 2, p. 732–739. [Also available in http://doi.org/10.1890/1051-0761(1999)009%5B0732:DACDIV%5D2.0.CO;2.]

Basore, N.S., Best, L.B., and Wooley, J.B., 1986, Bird nesting in Iowa no-tillage and tilled cropland: The Journal of Wildlife Management, v. 50, no. 1, p. 19–28. [Also available at https://doi.org/10.2307/3801482.]

Bateman, B.L., Pidgeon, A.M., Radeloff, V.C., Allstadt, A.J., Akcakaya, H.R., Thogmartin, W.E., Vavrus, S.J., and Heglund, P.J., 2015, The importance of range edges for an irruptive species during extreme weather events: Landscape Ecology, v. 30, no. 6, p. 1095–1110. [Also available at https://doi.org/10.1007/s10980-015-0212-6.]

Benson, T.J., Dinsmore, J.J., and Hohman, W.L., 2011, Short-term effects of burning and disking on songbird use of conservation easements: American Midland Naturalist, v. 165, no. 2, p. 257–273. [Also available at https://doi.org/10.1674/0003-0031-165.2.257.]

Benson, T.J., Dinsmore, J.J., and Hohman, W.L., 2013, Soil disturbances increase songbird use of monotypic re-established grasslands: Wildlife Society Bulletin, v. 37, no. 4, p. 725–732. [Also available at https://doi.org/10.1002/wsb.302.]

Berkeley, L.I., McCarty, J.P., and Wolfenbarger, L.L., 2007, Postfledging survival and movement in Dickcissels (*Spiza americana*)—Implications for habitat management and conservation: The Auk, v. 124, no. 2, p. 396–409. [Also available at https://doi.org/10.1642/0004-8038(2007)124[396:PSAMID]2.0.CO;2.]

Berry, G.A., 1971, The nesting biology of the Dickcissel (*Spiza americana*) in north central Oklahoma: Stillwater, Okla., Oklahoma State University, Master's Thesis, 27 p.

Best, L.B., Bergin, T.M., and Freemark, K.E., 2001, Influence of landscape composition on bird use of rowcrop fields: The Journal of Wildlife Management, v. 65, no. 3, p. 442–449. [Also available at https://doi.org/10.2307/3803096.]

Best, L.B., Campa, H., III, Kemp, K.E., Robel, R.J., Ryan, M.R., Savidge, J.A., Weeks, H.P., Jr., and Winterstein, S.R., 1997, Bird abundance and nesting in CRP fields and cropland in the Midwest—A regional approach: Wildlife Society Bulletin, v. 25, no. 4, p. 864–877.

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

Beston, J.A., Diffendorfer, J.E., Loss, S.R., and Johnson, D.H., 2016, Prioritizing avian species for their risk of population level consequences from wind energy development: PLoS One, v. 11, no. 3, p. e0150813. [Also available at https://doi.org/10.1371/journal.pone.0150813.]

Birkenholz, D.E., 1973, Habitat relationships of grassland birds at Goose Lake Prairie Nature Preserve, *in* Hulbert, L.C., ed., Proceedings of the third Midwest Prairie Conference: Manhattan, Kans., Kansas State University, p. 63–66.

Blank, P.J., Sample, D.W., Williams, C.L., and Turner, M.G., 2014, Bird communities and biomass yields in potential bioenergy grasslands: PLoS One, v. 9, no. 10, p. e109989. [Also available at https://doi.org/10.1371/journal.pone.0109989.]

Blankespoor, G.W., 1970, The significance of nest and nest site microclimate for the Dickcissel, *Spiza americana*: Manhattan, Kans., Kansas State University, Ph.D. Dissertation, 184 p.

Blankespoor, G.W., 1980, Prairie restoration—Effects on nongame birds: The Journal of Wildlife Management, v. 44, no. 3, p. 667–672. [Also available at https://doi.org/10.2307/3808015.]

Bock, C.E., Saab, V.A., Rich, T.D., and Dobkin, D.S., 1993, Effects of livestock grazing on Neotropical migratory landbirds in western North America, *in* Finch, D.M., and Stangel, P.W., eds., Status and management of Neotropical migratory birds: Fort Collins, Colo., U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229, p. 296–309.

Bollinger, E.K., and Maddox, J.D., 2000, A double-brooded Dickcissel: Prairie Naturalist, v. 32, no. 4, p. 253–254.

Boren, J.C., Engle, D.M., Palmer, M.W., Masters, R.E., and Criner, T., 1999, Land use change effects on breeding bird community composition: Journal of Range Management, v. 52, no. 5, p. 420–430. [Also available at https://doi.org/10.2307/4003767.]

Bryan, G.G., and Best, L.B., 1991, Bird abundance and species richness in grassed waterways in Iowa rowcrop fields: American Midland Naturalist, v. 126, no. 1, p. 90–102. [Also available at https://doi.org/10.2307/2426153.]

Bryan, G.G., and Best, L.B., 1994, Avian nest density and success in grassed waterways in Iowa rowcrop fields: Wildlife Society Bulletin, v. 22, no. 4, p. 583–592.

Buxton, V.L., and Benson, T.J., 2016, Conservation-priority grassland bird response to urban landcover and habitat fragmentation: Urban Ecosystems, v. 19, no. 2, p. 599–613. [Also available at https://doi.org/10.1007/s11252-016-0527-3.]

Cady, S.M., O'Connell, T.J., Loss, S.R., Jaffe, N.E., and Davis, C.A., 2019, Species-specific and temporal scale-dependent responses of birds to drought: Global Change Biology, v. 25, no. 8, p. 2691–2702. [Also available at https://doi.org/10.1111/gcb.14668.]

Camp, M., and Best, L.B., 1993, Bird abundance and species richness in roadsides adjacent to Iowa rowcrop fields: Wildlife Society Bulletin, v. 21, no. 3, p. 315–325.

Camp, M., and Best, L.B., 1994, Nest density and nesting success of birds in roadsides adjacent to rowcrop fields: American Midland Naturalist, v. 131, no. 2, p. 347–358. [Also available at https://doi.org/10.2307/2426260.]

Chapman, R.N., Engle, D.M., Masters, R.E., and Leslie, D.M., Jr., 2004a, Grassland vegetation and bird communities in the southern Great Plains of North America: Agriculture, Ecosystems and Environment, v. 104, no. 3, p. 577–585. [Also available at https://doi.org/10.1016/j.agee.2004.01.026.]

Chapman, R.N., Engle, D.M., Masters, R.E., and Leslie, D.M., Jr., 2004b, Tree invasion constrains the influence of herbaceous structure in grassland bird habitats: Ecoscience, v. 11, no. 1, p. 55–63. [Also available at https://doi.org/10.1080/11956860.2004.11682809.]

Churchwell, R.T., Davis, C.A., Fuhlendorf, S.D., and Engle, D.M., 2008, Effects of patch-burn management on Dickcissel nest success in a tallgrass prairie: The Journal of Wildlife Management, v. 72, no. 7, p. 1596–1604. [Also available at https://doi.org/10.2193/2007-365.]

Ciuzio, E., Hohman, W.L., Martin, B., Smith, M.D., Stephens, S., Strong, A.M., and Vercauteren, T., 2013, Opportunities and challenges to implementing bird conservation on private lands: Wildlife Society Bulletin, v. 37, no. 2, p. 267–277. [Also available at https://doi.org/10.1002/wsb.266.]

Conkling, T.J., Belant, J.L., DeVault, T.L., and Martin, J.A., 2017, Effects of crop type and harvest on nest survival and productivity of Dickcissels in semi-natural grasslands: Agriculture, Ecosystems and Environment, v. 240, p. 224–232. [Also available at https://doi.org/10.1016/j.agee.2017.01.028.]

Conover, R.R., Burger, W.B., Jr., and Linder, E.T., 2011a, Grassland bird nest ecology and survival in upland habitat buffers near wooded edges: Wildlife Society Bulletin, v. 35, no. 4, p. 353–361. [Also available in https://doi.org/10.1002/wsb.87.]

Conover, R.R., Dinsmore, S.J., and Burger, W.B., Jr., 2011b, Effects of conservation practices on bird nest density and survival in intensive agriculture: Agriculture, Ecosystems & Environment, v. 141, nos. 1–2, p. 126–132. [Also available at https://doi.org/10.1016/j.agee.2011.02.022.]

Coon, J.J., Maresh Nelson, S.B., Bradley, I.A., Rola, K.E., and Miller, J.R., 2022, Increased abundance and productivity of a grassland bird after experimental control of invasive tall fescue: Restoration Ecology, v. 30, no. 8, p. e13709. [Also available at https://doi.org/10.1111/rec.13709.]

Coppedge, B.R., Engle, D.M., Masters, R.E., and Gregory, M., 2001, Avian response to landscape change in fragmented southern Great Plains grasslands: Ecological Applications, v. 11, no. 1, p. 47–59. [Also available at https://doi.org/10.1890/1051-0761(2001)011[0047:ARTLCI]2.0.CO;2.]

Coppedge, B.R., Engle, D.M., Masters, R.E., and Gregory, M.S., 2004, Predicting juniper encroachment and CRP effects on avian community dynamics in southern mixed-grass prairie, USA: Biological Conservation, v. 115, no. 3, p. 431–441. [Also available at https://doi.org/10.1016/S0006-3207(03)00160-5.]

Coppedge, B.R., Fuhlendorf, S.D., Harrell, W.C., and Engle, D.M., 2008, Avian community response to vegetation and structural features in grasslands managed with fire and grazing: Biological Conservation, v. 141, no. 5, p. 1196–1203. [Also available at https://doi.org/10.1016/j.biocon.2008.02.015.]

Corace, R.G., III, Flaspohler, D.J., and Shartell, L.M., 2009, Geographical patterns in openland cover and hayfield mowing in the Upper Great Lakes region—Implications for grassland bird conservation: Landscape Ecology, v. 24, no. 3, p. 309–323. [Also available at https://doi.org/10.1007/s10980-008-9306-8.]

Cox, A.W., Wolfenbarger, L.L., Berkeley, L.I., Engberg, S.E., Janousek, W.M., Klug, P.E., Rider, N.L., and McCarty, J.P., 2014, Grassland bird communities on conservation and marginal grasslands in an agricultural landscape: Agriculture, Ecosystems and Environment, v. 193, p. 53–59. [Also available at https://doi.org/10.1016/j.agee.2014.04.026.]

Crosby, A.D., Elmore, R.D., Leslie, D.M., Jr., and Will, R.E., 2015, Looking beyond rare species as umbrella species—Northern Bobwhites (*Colinus virginianus*) and the conservation of grassland and shrubland birds: Biological Conservation, v. 186, p. 233–240. [Also available at https://doi.org/10.1016/j.biocon.2015.03.018.]

Culp, L.A., Cohen, E.B., Scarpignato, A.L., Thogmartin, W.E., and Marra, P.P., 2017, Full annual cycle climate change vulnerability assessment for migratory birds: Ecosphere, v. 8, no. 3, p. e01565. [Also available at https://doi.org/10.1002/ecs2.1565.]

Davis, C.A., Churchwell, R.T., Fuhlendorf, S.D., Engle, D.M., and Hovick, T.J., 2016, Effect of pyric herbivory on source-sink dynamics in grassland birds: Journal of Applied Ecology, v. 53, no. 4, p. 1004–1012. [Also available at https://doi.org/10.1111/1365-2664.12641.]

DeJong, J.R., Naugle, D.E., Bakker, K.K., Quamen, F.R., and Higgins, K.F., 2004, Impacts of agricultural tillage on grassland birds in western South Dakota, *in* Egan, D., and Harrington, J.A., eds., Proceedings of the nineteenth North American prairie conference: Madison, Wis., University of Wisconsin, p. 76–80.

Delisle, J.M., and Savidge, J.A., 1997, Avian use and vegetation characteristics of Conservation Reserve Program fields: The Journal of Wildlife Management, v. 61, no. 2, p. 318–325. [Also available at https://doi.org/10.2307/3802587.]

DeVault, T.L., Scott, P.E., Bajema, R.A., and Lima, S.L., 2002, Breeding bird communities of reclaimed coal-mine grasslands in the American Midwest: Journal of Field Ornithology, v. 73, no. 3, p. 268–275. [Also available at https://doi.org/10.1648/0273-8570-73.3.268.]

Dixon, T.P., 2005, Nesting ecology of Dickcissels on reclaimed surface-mined lands in Freestone County, Texas: College Station, Texas A&M University, Master's Thesis, 67 p.

Dixon, T.P., Lopez, R.R., Peterson, M.J., McCleery, R.A., and Silvy, N.J., 2008, Field-level spatial factors, associated edges, and Dickcissel nesting ecology on reclaimed lands in Texas: Landscape and Urban Planning, v. 86, no. 1, p. 60–65. [Also available at https://doi.org/10.1016/j.landurbplan.2008.01.001.]

Doxon, E.D., 2009, Nesting and feeding ecology of grassland birds in mixed-grass prairie managed with patch-burn techniques: Stillwater, Okla., Oklahoma State University, Ph.D. Dissertation, 273 p.

Dreitz, V.J., Stinson, L.T., Hahn, B.A., Tack, J.D., and Lukacs, P.M., 2017, A large-scale perspective for managing prairie avifauna assemblages across the western US—Influences of habitat, land ownership and latitude: PeerJ, v. 5, p. e2879. [Also available at https://doi.org/10.7717/peerj.2879.]

Ducey, J., and Miller, L., 1980, Birds of an agricultural community: Nebraska Bird Review, v. 48, no. 3, p. 58–68.

Duchardt, C.J., Miller, J.R., Debinski, D.M., and Engle, D.M., 2016, Adapting the fire-grazing interaction to small pastures in a fragmented landscape for grassland bird conservation: Range Ecology and Management, v. 69, no. 4, p. 300–309. [Also available at https://doi.org/10.1016/j.rama.2016.03.005.]

Eddleman, W.R., 1974, The effects of burning and grazing on bird populations in native prairie in the Kansas Flint Hills: Manhattan, Kans., Kansas State University, National Science Foundation-Undergraduate Research Program, Participation Project Report, 33 p.

Elliott, L.H., and Johnson, D.H., 2017, Local-scale habitat associations of grassland birds in southwestern Minnesota: American Midland Naturalist, v. 178, no. 2, p. 165–188. [Also available at https://doi.org/10.1674/0003-0031-178.2.165.]

Elliott, P.F., 1976, The role of community factors in cowbird-host interactions: Manhattan, Kans., Kansas State University, Ph.D. Dissertation, 62 p.

Elliott, P.F., 1978, Cowbird parasitism in the Kansas tall grass prairie: The Auk, v. 95, no. 1, p. 161–167. [Also available at https://doi.org/10.2307/4085507.]

Ely, C.A., 1957, Comparative nesting success of certain south-central Oklahoma birds: Norman, Okla., University of Oklahoma, Master's Thesis, 74 p.

Emlen, J.T., and Wiens, J.A., 1965, The Dickcissel invasion of 1964 in southern Wisconsin: The Passenger Pigeon, v. 27, no. 2, p. 51–59.

Engle, D.M., Griner, T.L., Boren, J.C., Masters, R.E., and Gregory, M.S., 1999, Response of breeding birds in the Great Plains to low density urban sprawl: Great Plains Research, v. 9, no. 1, p. 55–73.

Erickson, A.N., 2017, Responses of grassland birds to patch-burn grazing in the Flint Hills of Kansas: Manhattan, Kans., Kansas State University, Master's Thesis, 71 p.

Erickson, W.P., Wolfe, M.M., Bay, K.J., Johnson, D.H., and Gehring, J.L., 2014, A comprehensive analysis of small-passerine fatalities from collision with turbines at wind energy facilities: PLoS One, v. 9, no. 9, p. e107491. [Also available at https://doi.org/10.1371/journal.pone.0107491.]

Faanes, C.A., 1981, Birds of the St. Croix River Valley—Minnesota and Wisconsin: Washington, D.C., U.S. Fish and Wildlife Service, North American Fauna, no. 73, 196 p. [Also available at https://doi.org/10.3996/nafa.73.0001.]

Faanes, C.A., and Lingle, G.R., 1995, Breeding birds of the Platte River Valley of Nebraska: Jamestown, N. Dak., U.S. Geological Survey, Northern Prairie Wildlife Research Center, 412 p.

Finck, E.J., 1983, Male behavior, territory quality and female choice in the Dickcissel (*Spiza americana*): Manhattan, Kans., Kansas State University, Ph.D. Dissertation, 79 p.

Finck, E.J., 1984, Male Dickcissel behavior in primary and secondary habitats: The Wilson Bulletin, v. 96, no. 4, p. 672–680.

Fleischer, R.C., 1986, Brood parasitism by Brown-headed Cowbirds in a simple host community in eastern Kansas: Kansas Ornithological Society Bulletin, v. 37, no. 2, p. 21–29.

Fletcher, R.J., Jr., and Koford, R.R., 2002, Habitat and landscape associations of breeding birds in native and restored grasslands: The Journal of Wildlife Management, v. 66, no. 4, p. 1011–1022. [Also available at https://doi.org/10.2307/3802933.]

Fletcher, R.J., Koford, R.R., and Seaman, D.A., 2006, Critical demographic parameters for declining songbirds breeding in restored grasslands: The Journal of Wildlife Management, v. 70, no. 1, p. 145–157. [Also available at https://doi.org/10.2193/0022-541X(2006)70%5B145:CDPFDS%5D2.0.CO;2.]

Flickinger, E.L., and King, K.A., 1972, Some effects of aldrin-treated rice on Gulf Coast wildlife: The Journal of Wildlife Management, v. 36, no. 3, p. 706–727. [Also available at https://doi.org/10.2307/3799422.]

Flickinger, E.L., Mitchell, C.A., White, D.H., and Kolbe, E.J., 1986, Bird poisoning from misuse of carbamate Furadan in a Texas rice field: Wildlife Society Bulletin, v. 14, no. 1, p. 59–62.

Frawley, B.J., 1989, The dynamics of nongame bird breeding ecology in Iowa alfalfa fields: Ames, Iowa, Iowa State University, Master's Thesis, 94 p. [Also available at https://doi.org/10.31274/rtd-180813-13196.]

Frawley, B.J., and Best, L.B., 1991, Effects of mowing on breeding bird abundance and species composition in alfalfa fields: Wildlife Society Bulletin, v. 19, no. 2, p. 135–142.

Fretwell, S.D., 1972, Ecological studies of Dickcissels in Texas: Bulletin of the Texas Ornithological Society, v. 5, p. 22–23.

Fretwell, S.D., 1977, Is the Dickcissel a threatened species?: American Birds, v. 31, no. 5, p. 923–932.

Fretwell, S., 1986, Distribution and abundance of the Dickcissel: Current Ornithology, v. 4, p. 211–242.

Frey, C.M., Jensen, W.E., and With, K.A., 2008, Topographic patterns of nest placement and habitat quality for grassland birds in tallgrass prairie: American Midland Naturalist, v. 160, no. 1, p. 220–234. [Also available at https://doi.org/10.1674/0003-0031(2008)160%5B220:TPONPA%5D2.0.CO;2.]

Friedmann, H., 1963, Host relations of the parasitic cowbirds: Washington, D.C., Smithsonian Institution, U.S. National Museum, Bulletin 233, 276 p. [Also available at https://doi.org/10.5479/si.03629236.233.]

Fritcher, S.C., Rumble, M.A., and Flake, L.D., 2004, Grassland bird densities in seral stages of mixed-grass prairie: Journal of Range Management, v. 57, no. 4, p. 351–357. [Also available at https://doi.org/10.2307/4003858.]

Fuhlendorf, S.D., and Engle, D.M., 2001, Restoring heterogeneity on rangelands—Ecosystem management based on evolutionary grazing patterns: BioScience, v. 51, no. 8, p. 625–632. [Also available at https://doi.org/10.1641/0006-3568(2001)051[0625:RHOREM]2.0.CO;2.]

Fuhlendorf, S.D., and Engle, D.M., 2004, Application of the fire-grazing interaction to restore a shifting mosaic on tallgrass prairie: Journal of Applied Ecology, v. 41, no. 4, p. 604–614. [Also available at https://doi.org/10.1111/j.0021-8901.2004.00937.x.]

Fuhlendorf, S.D., Harrell, W.C., Engle, D.M., Hamilton, R.G., Davis, C.A., and Leslie, D.M., Jr., 2006, Should heterogeneity be the basis for conservation? Grassland bird response to fire and grazing: Ecological Applications, v. 16, no. 5, p. 1706–1716. [Also available at https://doi.org/10.1890/1051-0761(2006)016%5B1706:SHBTBF%5D2.0.CO;2.]

Galligan, E.W., DeVault, T.L., and Lima, S.L., 2006, Nesting success of grassland and savanna birds on reclaimed surface coal mines of the midwestern United States: The Wilson Journal of Ornithology, v. 118, no. 4, p. 537–546. [Also available at https://doi.org/10.1676/05-086.1.]

Gary, D.M., Mougey, K., McIntyre, N.E., and Griffis-Kyle, K.L., 2022, Species as conservation umbrellas—A case study with Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) in the southern Great Plains of North America: Global Ecology and Conservation, v. 38, p. e02256. [Also available at https://doi.org/10.1016/j.gecco.2022.e02256.]

George, A.D., O'Connell, T.J., Hickman, K.R., and Leslie, D.M., 2013, Food availability in exotic grasslands—A potential mechanism for depauperate breeding assemblages: The Wilson Journal of Ornithology, v. 125, no. 3, p. 526–533. [Also available at https://doi.org/10.1676/13-003.1.]

Graber, R.R., and Graber, J.W., 1963, A comparative study of bird populations in Illinois, 1906–1909 and 1956–1958: Illinois Natural History Survey Bulletin, v. 28, nos. 1–3, p. 383–528. [Also available at https://doi.org/10.21900/j.inhs.v28.169.]

Graves, B.M., Rodewald, A.D., and Hull, S.D., 2010, Influence of woody vegetation on grassland birds within reclaimed surface mines: The Wilson Journal of Ornithology, v. 122, no. 4, p. 646–654. [Also available in https://doi.org/10.1676/09-101.1.]

Greer, M.J., 2009, An evaluation of habitat use and requirements for grassland bird species of greatest conservation need in central and western South Dakota: Brookings, S. Dak., South Dakota State University, Master's Thesis, 158 p.

Gripne, S.L., 2005, Grassbanks—Bartering for conservation: Rangelands, v. 27, no. 1, p. 24–38. [Also available at https://doi.org/10.2111/1551-501X(2005)27<24:GBFC>2.0.CO;2.]

Gross, A.O., 1921a, The Dickcissel (*Spiza americana*) of the Illinois prairies: The Auk, v. 38, no. 1, p. 1–26. [Also available at https://doi.org/10.2307/4074023.]

Gross, A.O., 1921b, The Dickcissel (*Spiza americana*) of the Illinois prairies: The Auk, v. 38, no. 2, p. 163–184. [Also available at https://doi.org/10.2307/4073881.]

Gross, A.O., 1968, Dickcissel (*Spiza americana*), *in* Austin, O.L., Jr., ed., Life histories of North American cardinals, grosbeaks, towhees, finches, sparrows, and allies. Order Passeriformes—Family Fringillidae. Part one—Genera *Richmondena* through *Pipilo*: New York, N.Y., Dover Publications, Inc., p. 158–191. [Also available at https://doi.org/10.5479/si.03629236.237.1.]

Harmeson, J.P., 1972, Breeding ecology of the Dickcissel: Urbana, Ill., University of Illinois, Master's Thesis, 26 p.

Harmeson, J.P., 1974, Breeding ecology of the Dickcissel: The Auk, v. 91, no. 2, p. 348–359.

Harms, T.M., Murphy, K.T., Lyu, X., Patterson, S.S., Kinkead, K.E., Dinsmore, S.J., and Frese, P.W., 2017, Using landscape habitat associations to prioritize areas of conservation action for terrestrial birds: PLoS One, v. 12, no. 3, p. e0173041. [Also available at https://doi.org/10.1371/journal.pone.0173041.]

Harrison, K.G., 1974, Aspects of habitat selection in grassland birds: Kalamazoo, Mich., Western Michigan University, Master's Thesis, 82 p.

Harrison, K.G., and Brewer, R., 1979, The role of elevated perch sites and mowing in the distribution of grassland and savanna birds: The Jack-Pine Warbler, v. 57, no. 4, p. 179–183.

Hatchett, E.S., Hale, A.M., Bennett, V.J., and Karsten, K.B., 2013, Wind turbines do not negatively affect nest success in Dickcissel (*Spiza americana*): The Auk, v. 130, no. 3, p. 520–528. [Also available at https://doi.org/10.1525/auk.2013.12187.]

Helzer, C.J., 1996, The effects of wet meadow fragmentation on grassland birds: Lincoln, Nebr., University of Nebraska, Master's Thesis, 65 p.

Helzer, C.J., and Jelinski, D.E., 1999, The relative importance of patch area and perimeter-area ratio to grassland breeding birds: Ecological Applications, v. 9, no. 4, p. 1448–1458. [Also available at https://doi.org/10.2307/2641409.]

Henningsen, J.C., and Best, L.B., 2005, Grassland bird use of riparian filter strips in southeast Iowa: The Journal of Wildlife Management, v. 69, no. 1, p. 198–210. [Also available at https://doi.org/10.2193/0022-541x(2005)069<0198:gbuorf>2.0.co;2.]

Herakovich, H., Barber, N.A., and Jones, H.P., 2021a, Assessing the impacts of prescribed fire and bison disturbance on birds using bioaccoustic recorders: American Midland Naturalist, v. 186, no. 2, p. 245–262. [Also available at https://doi.org/10.1674/0003-0031-186.2.245.]

Herakovich, H., Whelan, C.J., Barber, N.A., and Jones, H.P., 2021b, Impacts of a recent bison reintroduction on grassland bird nests and potential mechanisms for these effects: Natural Areas Journal, v. 41, no. 2, p. 93–103. [Also available at https://doi.org/10.3375/043.041.0204.]

Hergenrader, G.L., 1962, The incidence of nest parasitism by Brown-headed Cowbird (*Molothrus ater*) on roadside nesting birds in Nebraska: The Auk, v. 79, no. 1, p. 85–88. [Also available at https://doi.org/10.2307/4082452.]

Herkert, J.R., 1991a, An ecological study of the breeding birds of grassland habitats within Illinois: Urbana, Ill., University of Illinois, Ph.D. Dissertation, 112 p.

Herkert, J.R., 1991b, Study suggests increases in restored prairie fragments to conserve breeding bird communities: Restoration and Management Notes, v. 9, no. 2, p. 107.

Herkert, J.R., 1994a, The effects of habitat fragmentation on midwestern grassland bird communities: Ecological Applications, v. 4, no. 3, p. 461–471. [Also available at https://doi.org/10.2307/1941950.]

Herkert, J.R., 1994b, Breeding bird communities of midwestern prairie fragments—The effects of prescribed burning and habitat-area: Natural Areas Journal, v. 14, no. 2, p. 128–135.

Herkert, J.R., 2009, Response of bird populations to farmland set-aside programs: Conservation Biology, v. 23, no. 4, p. 1036–1040. [Also available at https://doi.org/10.1111/j.1523-1739.2009.01234.x.]

Herkert, J.R., Reinking, D.L., Wiedenfeld, D.A., Winter, M., Zimmerman, J.L., Jensen, W.E., Finck, E.J., Koford, R.R., Wolfe, D.H., Sherrod, S.K., Jenkins, M.A., Faaborg, J., and Robinson, S.K., 2003, Effects of prairie fragmentation on the nest success of breeding birds in the midcontinental United States: Conservation Biology, v. 17, no. 2, p. 587–594. [Also available at https://doi.org/10.1046/j.1523-1739.2003.01418.x.]

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

Hickman, K.R., Farley, G.H., Channell, R., and Steier, J.E., 2006, Effects of Old World bluestem (*Bothriochloa ischaemum*) on food availability and avian community composition within the mixed-grass prairie: The Southwestern Naturalist, v. 51, no. 4, p. 524–530. [Also available at https://doi.org/10.1894/0038-4909(2006)51[524:EOOWBB]2.0.CO;2.]

Holcomb, E.D., Davis, C.A., and Fuhlendorf, S.D., 2014, Patch-burn management—Implications for conservation of avian communities in fire-dependent sagebrush ecosystems: The Journal of Wildlife Management, v. 78, no. 5, p. 848–856. [Also available at https://doi.org/10.1002/jwmg.723.]

Holoubek, N.S., and Jensen, W.E., 2015, Avian occupancy varies with habitat structure in oak savanna of the south-central United States: The Journal of Wildlife Management, v. 79, no. 3, p. 458–468. [Also available at https://doi.org/10.1002/jwmg.849.]

Hovick, T.J., Elmore, R.D., Fuhlendorf, S.D., Engle, D.M., and Hamilton, R.G., 2015, Spatial heterogeneity increases diversity and stability in grassland bird communities: Ecological Applications, v. 25, no. 3, p. 662–672. [Also available at https://doi.org/10.1890/14-1067.1.]

Hughes, J.P., 1996, The effect of vegetative structure and landscape composition on avian abundance and reproductive success in CRP fields in northeastern Kansas: Manhattan, Kans., Kansas State University, Master's Thesis, 194 p.

Hughes, J.P., Robel, R.J., Kemp, K.E., and Zimmerman, J.L., 1999, Effects of habitat on Dickcissel abundance and nest success in Conservation Reserve Program fields in Kansas: The Journal of Wildlife Management, v. 63, no. 2, p. 523–529. [Also available at https://doi.org/10.2307/3802638.]

Hull, S.D., Robel, R.J., and Kemp, K.E., 1996, Summer avian abundance, invertebrate biomass, and forbs in Kansas CRP: Prairie Naturalist, v. 28, no. 1, p. 1–12.

Hultquist, J.M., and Best, L.B., 2001, Bird use of terraces in Iowa rowcrop fields: American Midland Naturalist, v. 145, no. 2, p. 275–287. [Also available at https://doi.org/10.1674/0003-0031(2001)145[0275:BUOTII]2.0.CO;2.]

Igl, L.D., 1991, The role of climate and mowing on Dickcissel (*Spiza americana*) movements, distribution and abundance: Ames, Iowa, Iowa State University, Master's Thesis, 54 p. [Also available at https://doi.org/10.31274/rtd-180813-8122.]

Igl, L.D., 2009, Breeding bird use of grasslands enrolled in the Conservation Reserve Program in the northern Great Plains: Fargo, N. Dak., North Dakota State University, Ph.D. Dissertation, 199 p.

Igl, L.D., and Best, L.B., 2001, On the rarity of food provisioning by male Dickcissels: Prairie Naturalist, v. 33, no. 2, p. 111–118.

Igl, L.D., and Johnson, D.H., 2007, Brown-headed Cowbird, *Molothrus ater*, parasitism and abundance in the northern Great Plains: Canadian Field-Naturalist, v. 121, no. 3, p. 239–255. [Also available at https://doi.org/10.22621/cfn.v121i3.471.]

Igl, L.D., and Johnson, D.H., 2016, Effects of haying on breeding birds in CRP grasslands: The Journal of Wildlife Management, v. 80, no. 7, p. 1189–1204. [Also available at https://doi.org/10.1002/jwmg.21119.]

Igl, L.D., Johnson, D.H., and Kantrud, H.A., 2008, A historical perspective—Changes in grassland breeding bird densities within major habitats in North Dakota between 1967 and 1992–1993, *in* Springer, J.T., and Springer, E.C., eds., Prairie invaders—Proceedings of the twentieth North American Prairie Conference: Kearney, Nebr., University of Nebraska, p. 275–295.

Igl, L.D., Newton, W.E., Grant, T.A., and Dixon, C.S., 2018, Adaptive management in native grasslands managed by the U.S. Fish and Wildlife Service—Implications for grassland birds: U.S. Geological Survey Open-File Report 2018–1152, 61 p. [Also available at https://doi.org/10.3133/ofr20181152.]

Igl, L.D., Shaffer, J.A., Johnson, D.H., and Buhl, D.A., 2017, The influence of local- and landscape-level factors on wetland breeding birds in the Prairie Pothole Region of North and South Dakota: U.S. Geological Survey Open-File Report 2017–1096, 65 p. [Also available at https://doi.org/10.3133/ofr20171096.]

Intergovernmental Panel on Climate Change, 2000, IPCC special report—Emissions scenarios: United Kingdom, accessed May 2020 at https://www.ipcc.ch/site/assets/uploads/2018/03/sres-en.pdf.

Jacobs, R.B., Thompson, F.R., III, Koford, R.R., La Sorte, F.A., Woodward, H.D., and Fitzgerald, J.A., 2012, Habitat and landscape effects on abundance of Missouri's grassland birds: The Journal of Wildlife Management, v. 76, no. 2, p. 372–381. [Also available at https://doi.org/10.1002/jwmg.264.]

Jaster, L., Jensen, W.E., and Forbes, A.R., 2014, Nest survival of grassland birds in warm- and cool-season grassland restorations: American Midland Naturalist, v. 171, no. 2, p. 246–257. [Also available at https://doi.org/10.1674/0003-0031-171.2.246.]

Jensen, W.E., 1999, Nesting habitat and responses to habitat edges of three grassland passerine species: Emporia, Kans., Emporia State University, Master's Thesis, 58 p.

Jensen, W.E., and Cully, J.F., Jr., 2005a, Density-dependent habitat selection by Brown-headed Cowbirds (*Molothrus ater*) in tallgrass prairie: Oecologia, v. 142, no. 1, p. 136–149. [Also available at https://doi.org/10.1007/s00442-004-1709-x.]

Jensen, W.E., and Cully, J.F., Jr., 2005b, Geographic variation in Brown-headed Cowbird (*Molothrus ater*) parasitism on Dickcissels (*Spiza americana*) in Great Plains tallgrass prairie: The Auk, v. 122, no. 2, p. 648–660. [Also available at https://doi.org/10.1642/0004-8038(2005)122%5B0648:GVIBCM%5D2.0.CO;2.]

Jensen, W.E., and Finck, E.J., 2004, Edge effects on nesting Dickcissels (*Spiza americana*) in relation to edge type of remnant tallgrass prairie in Kansas: American Midland Naturalist, v. 151, no. 1, p. 192–199. [Also available at https://doi.org/10.1674/0003-0031(2004)151%5B0192:EEONDS%5D2.0.CO;2.]

Johnsgard, P.A., 1980, A preliminary list of the birds of Nebraska and adjacent Plains States: Lincoln, Nebr., University of Nebraska, 156 p.

Johnson, D.H., and Igl, L.D., 1995, Contributions of the Conservation Reserve Program to populations of breeding birds in North Dakota: The Wilson Bulletin, v. 107, no. 4, p. 709–718.

Johnson, D.H., and Schwartz, M.D., 1993, The Conservation Reserve Program—Habitat for grassland birds: Great Plains Research, v. 3, no. 2, p. 273–295.

Johnson, T.N., and Sandercock, B.K., 2010, Restoring tall-grass prairie and grassland bird populations in tall fescue pastures with winter grazing: Rangeland Ecology and Management, v. 63, no. 6, p. 679–688. [Also available at https://doi.org/10.2111/REM-D-09-00076.1.]

Jones, T.M., Brawn, J.D., and Ward, M.P., 2017, Post-fledging habitat use in the Dickcissel: The Condor, v. 119, no. 3, p. 497–504. [Also available at https://doi.org/10.1650/CONDOR-17-21.1.]

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

Kim, D.H., Newton, W.E., Lingle, G.R., and Chavez-Ramirez, F., 2008, Influence of grazing and available moisture on breeding densities of grassland birds in the central Platte River Valley, Nebraska: The Wilson Journal of Ornithology, v. 120, no. 4, p. 820–829. [Also available at https://doi.org/10.1676/07-153.1.]

King, J.W., and Savidge, J.A., 1995, Effects of the Conservation Reserve Program on wildlife in southeast Nebraska: Wildlife Society Bulletin, v. 23, no. 3, p. 377–385.

Klimkiewicz, M.K., and Futcher, A.G., 1987, Longevity records of North American birds—Coerebinae through Estrildidae: Journal of Field Ornithology, v. 58, no. 3, p. 318–333.

Klug, P.E., Jackrel, S.L., and With, K.A., 2010, Linking snake habitat use to nest predation risk in grassland birds—The dangers of shrub cover: Oecologia, v. 162, no. 3, p. 803–813. [Also available at https://doi.org/10.1007/s00442-009-1549-9.]

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: Manhattan, Kans., Kansas State University, Master's Thesis, 168 p.

Klute, D.S., Robel, R.J., and Kemp, K.E., 1997, Will conversion of Conservation Reserve Program (CRP) lands to pasture be detrimental for grassland birds in Kansas?: American Midland Naturalist, v. 137, no. 2, p. 206–212. [Also available at https://doi.org/10.2307/2426840.]

Kraus, H.M., Jensen, W.E., Houseman, G.R., Jameson, M.L., Reichenborn, M.M., Watson, D.F., and Kjaer, E.L., 2022, Cattle grazing in CRP grasslands during the nesting season—Effects on avian reproduction: The Journal of Wildlife Management, v. 86, no. 2, p. e22152. [Also available at https://doi.org/10.1002/jwmg.22152.]

Langham, G.M., Schuetz, J.G., Distler, T., Soykan, C.U., and Wilsey, C., 2015, Conservation status of North American birds in the face of future climate change: PLoS One, v. 10, no. 9, p. e0135350. [Also available at https://doi.org/10.1371/journal.pone.0135350.]

Laubach, R., 1984, Breeding birds of Sheeder Prairie Preserve, west-central Iowa: Proceedings of the Iowa Academy of Science, v. 91, no. 4, p. 153–163.

Lituma, C.M., and Buehler, D.A., 2020, Cost-share conservation practices have mixed effects on priority grassland and shrubland breeding bird occupancy in the Central Hardwoods Bird Conservation Region, USA: Biological Conservation, v. 244, article 108510. [Also available at https://doi.org/10.1016/j.biocon.2020.108510.]

Lituma, C.M., Morrison, M.L., and Whiteside, J.D., 2012, Restoration of grasslands and nesting success of Dickcissels (*Spiza americana*): The Southwestern Naturalist, v. 57, no. 2, p. 138–143. [Also available at https://doi.org/10.1894/0038-4909-57.2.138.]

Londe, D.W., Carroll, J.M., Elmore, R.D., Davis, C.A., and Fuhlendorf, S.D., 2021, Avifauna assemblages in sand shinnery oak shrublands managed with prescribed fire: Rangeland Ecology and Management, v. 79, no. 1, p. 164–174. [Also available at https://doi.org/10.1016/j.rama.2021.08.009.]

Londe, D.W., Fuhlendorf, S.D., Elmore, R.D., and Davis, C.A., 2019, Landscape heterogeneity influences the response of grassland birds to energy development: Wildlife Biology, v. 2019, no. 1, p. 1–11. [Also available at https://doi.org/10.2981/wlb.00523.]

Long, C.A., Long, C.F., Knops, J., and Matulionis, D.H., 1965, Reproduction in the Dickcissel: The Wilson Bulletin, v. 77, no. 3, p. 251–256.

Loss, S.R., Will, T., and Marra, P.P., 2013, Estimates of bird collision mortality at wind facilities in the contiguous United States: Biological Conservation, v. 168, p. 201–209. [Also available at https://doi.org/10.1016/j.biocon.2013.10.007.]

Luscier, J.D., and Thompson, W.L., 2009, Short-term responses of breeding birds of grassland and early successional habitat to timing of haying in northwestern Arkansas: The Condor, v. 111, no. 3, p. 538–544. [Also available at https://doi.org/10.1525/cond.2009.080019.]

Mabry, C.M., Brudvig, L.A., and Atwell, R.C., 2010, The confluence of landscape context and site-level management in determining midwestern savanna and woodland breeding bird communities: Forest Ecology and Management, v. 260, no. 1, p. 42–51. [Also available at https://doi.org/10.1016/j.foreco.2010.03.028.]

Maresh Nelson, S.B., Coon, J.J., Duchardt, C.J., Miller, J.R., Debinski, D.M., and Schacht, W.H., 2018, Contrasting impacts of invasive plants and human-altered landscape context on nest survival and brood parasitism of a grassland bird: Landscape Ecology, v. 33, no. 10, p. 1799–1813. [Also available at https://doi.org/10.1007/s10980-018-0703-3.]

Maresh Nelson, S.B., Coon, J.J., and Miller, J.R., 2020, Do habitat preferences improve fitness? Context-specific adaptive habitat selection by a grassland songbird: Oecologia, v. 193, no. 1, p. 15–26. [Also available at https://doi.org/10.1007/s00442-020-04626-8.]

McCleery, R.A., Holdorf, A.R., Hubbard, L.L., and Peer, B.D., 2015, Maximizing the wildlife conservation value of road right-of-ways [sic] in an agriculturally dominated landscape: PLoS One, v. 10, no. 3, p. e0120375. [Also available at https://doi.org/10.1371/journal.pone.0120375.]

McCoy, T.D., Ryan, M.R., and Kurzejeski, E.W., 2001, Grassland bird conservation—CP1 vs. CP2 plantings in Conservation Reserve Program fields in Missouri: American Midland Naturalist, v. 145, no. 1, p. 1–17. [Also available at https://doi.org/10.1674/0003-0031(2001)145%5B0001:GBCCVC%5D2.0.CO;2.]

McCoy, T.D., Ryan, M.R., Kurzejeski, E.W., and Burger, L.W., Jr., 1999, Conservation reserve program—Source or sink habitat for grassland birds in Missouri?: The Journal of Wildlife Management, v. 63, no. 2, p. 530–538. [Also available at https://doi.org/10.2307/3802639.]

McInnerney, C., 2018, Breeding bird responses to post oak savanna restoration seven years post management in eastern Texas: Nacogdoches, Texas, Stephen F. Austin State University Master's Thesis, 120 p.

McInnerney, C., Comer, C.E., Oswald, B., Masse, R.J., and Schalk, C.M., 2021, Avian responses to vegetation changes from post oak savanna restoration efforts in eastern Texas: Journal of Fish and Wildlife Management, v. 12, no. 1, p. 61–69. [Also available at https://doi.org/10.3996/JFWM-20-028.]

McLaughlin, M.E., Janousek, W.M., McCarty, J.P., and Wolfenbarger, L.L., 2014, Effects of urbanization on site occupancy and density of grassland birds in tallgrass prairie fragments: Journal of Field Ornithology, v. 85, no. 3, p. 258–273. [Also available at https://doi.org/10.1111/jofo.12066.]

McMullen, C., and Harms, T.M., 2020, Impact of delayed mowing on restoring populations of grassland birds of conservation concern: Ecological Restoration, v. 38, no. 2, p. 77–82. [Also available at https://doi.org/10.3368/er.38.2.77.]

Meanley, B., 1963, Nesting ecology and habits of the Dickcissel on the Arkansas Grand Prairie: The Wilson Bulletin, v. 75, no. 3, p. 280.

Monroe, A.P., Burger, L.W., and Martin, J.A., 2019, Pasture-scale vegetation predicts Dickcissel nest-site selection and success in native and exotic grass pastures: The Condor, v. 121, no. 3, p. 1–14. [Also available at https://doi.org/10.1093/condor/duz027.]

Monroe, A.P., Chandler, R.B., Burger, L.W., Jr., and Martin, J.A., 2016, Converting exotic forages to native warm-season grass can increase avian productivity in beef production systems: Agriculture, Ecosystems and Environment, v. 233, p. 85–93. [Also available at https://doi.org/10.1016/j.agee.2016.08.024.]

Monroe, B.L., Jr., 1967, Dickcissel populations in southwestern Michigan: The Jack-Pine Warbler, v. 45, no. 4, p. 124–127.

Mulvihill, R.S., 1988, The occurrence of Dickcissels (*Spiza americana*) in western Pennsylvania during the 1988 nesting season—Its possible bearing on the species' unusual history in eastern North America: Pennsylvania Birds, v. 2, no. 3, p. 83–87.

Murray, L.D., and Best, L.B., 2003, Short-term bird response to harvesting switchgrass for biomass in Iowa: The Journal of Wildlife Management, v. 67, no. 3, p. 611–621. [Also available at https://doi.org/10.2307/3802718.]

Murray, L.D., Best, L.B., Jacobsen, T.J., and Braster, J.L., 2003, Potential effects on grassland birds of converting marginal cropland to switchgrass biomass production: Biomass and Bioenergy, v. 25, no. 2, p. 167–175. [Also available at https://doi.org/10.1016/S0961-9534(02)00187-3.]

Murray, L.D., Ribic, C.A., and Thogmartin, W.E., 2008, Relationship of obligate grassland birds to landscape structure in Wisconsin: The Journal of Wildlife Management, v. 72, no. 2, p. 463–467. [Also available at https://doi.org/10.2193/2006-556.]

National Geographic Society, 2011, Field guide to the birds of North America (6th ed.): Washington, D.C., National Geographic Society, 576 p.

Negus, L.P., Davis, C.A., and Wessel, S.E., 2010, Avian response to mid-contract management of Conservation Reserve Program fields: American Midland Naturalist, v. 164, no. 2, p. 296–310. [Also available at https://doi.org/10.1674/0003-0031-164.2.296.]

Niethammer, K.R., and Baskett, T.S., 1983, Cholinesterase inhibition of birds inhabiting wheat fields treated with methyl parathion and toxaphene: Environmental Contamination and Toxicology, v. 12, no. 4, p. 471–475. [Also available at https://doi.org/10.1007/BF01057591.]

Oberholser, H.C., and Kinkaid, E.B., Jr., 1974, The birdlife of Texas: Austin, Tex., University of Texas Press, 1069 p.

Ogden, S., Haukos, D.A., Olson, K.C., Lemmon, J., Alexander, J., and Gatson, G.A., 2019, Grassland bird and butterfly responses to sericea lespedeza control via late-season grazing pressure: American Midland Naturalist, v. 181, no. 2, p. 147–169. [Also available at https://doi.org/10.1674/0003-0031-181.2.147.]

Olechnowski, B.F.M., Debinski, D.M., Drobney, P., Viste-Sparkman, K., and Reed, W.T., 2009, Changes in vegetation structure through time in a restored tallgrass prairie ecosystem and implications for avian diversity and community composition: Ecological Restoration, v. 27, no. 4, p. 449–457. [Also available at https://doi.org/10.3368/er.27.4.449.]

Osborne, D.C., and Sparling, D.W., 2013, Multi-scale associations of grassland birds in response to cost-share management of Conservation Reserve Program fields in Illinois: The Journal of Wildlife Management, v. 77, no. 5, p. 920–930. [Also available at https://doi.org/10.1002/jwmg.553.]

Overmire, T.G., 1962, Nesting of the Dickcissel in Oklahoma: The Auk, v. 79, no. 1, p. 115–116. [Also available at https://doi.org/10.2307/4082463.]

Overmire, T.G., 1963, The effects of grazing upon habitat utilization of the Dickcissel (*Spiza americana*) and Bell's Vireo (*Vireo bellii*) in north central Oklahoma: Stillwater, Okla., Oklahoma State University, Ph.D. Dissertation, 57 p.

Parker, T.H., Sousa, B., Leu, S.T., Edmondson, S., Foo, C., Strauss, A., Kahl, H., Ballinger, K., Ross, E., Ruse, M.G., Sandsten, M., Verheijen, B.H.F., and Jensen, W., 2022, Cultural conformity and persistence in Dickcissel song are higher in locations in which males show high site fidelity: Ornithology, v. 139, no. 1, p. 1–17. [Also available at https://doi.org/10.1093/ornithology/ukab061.]

Patten, M.A., Reinking, D.L., and Wolfe, D.H., 2011, Hierarchical cues in brood parasite nest selection: Journal of Ornithology, v. 152, no. 3, p. 521–532. [Also available at https://doi.org/10.1007/s10336-010-0608-7.]

Patten, M.A., Shochat, E., Reinking, D.L., Wolfe, D.H., and Sherrod, S.K., 2006, Habitat edge, land management, and rates of brood parasitism in tallgrass prairie: Ecological Applications, v. 16, no. 2, p. 687–695. [Also available at https://doi.org/10.1890/1051-0761(2006)016%5B0687:HELMAR%5D2.0.CO;2.]

Patterson, M.P., 1994, Bird species abundance, composition, and vegetation characteristics, and bird productivity in Conservation Reserve Program land in central Iowa: Ames, Iowa, Iowa State University, Master's Thesis, 54 p.

Patterson, M.P., and Best, L.B., 1996, Bird abundance and nesting success in Iowa CRP fields—The importance of vegetation structure and composition: American Midland Naturalist, v. 135, no. 1, p. 153–167. [Also available at https://doi.org/10.2307/2426881.]

Pavlacky, D.C., Jr., Hagen, C.A., Bartuszevige, A.M., Iovanna, R., George, T.L., and Naugle, D.E., 2021, Scaling up private land conservation to meet recovery goals for grassland birds: Conservation Biology, v. 35, no. 5, p. 1564–1574. [Also available at https://doi.org/10.1111/cobi.13731.]

Peer, B.D., McCleery, R.A., and Jensen, W.E., 2018, Resistance is futile—Prohibitive costs of egg ejection in an obligate avian brood parasite host: Animal Behaviour, v. 144, p. 45–51. [Also available at https://doi.org/10.1016/j.anbehav.2018.08.002.]

Peer, B.D., Robinson, S.K., and Herkert, J.R., 2000, Egg rejection by cowbird hosts in grasslands: The Auk, v. 117, no. 4, p. 892–901. [Also available at https://doi.org/10.2307/4089628.]

Petersen, K.L., 1978, Habitat distribution and territoriality in the Dickcissel and Red-winged Blackbird: Manhattan, Kans., Kansas State University, National Science Foundation-Undergraduate Research Program, Participation Project Report, 37 p.

Peterson, A.T., 2003, Projected climate change effects on Rocky Mountain and Great Plains birds—Generalities of biodiversity consequences: Global Change Biology, v. 9, no. 5, p. 647–655. [Also available at https://doi.org/10.1046/j.1365-2486.2003.00616.x.]

Pillsbury, F.C., 2010, Grassland bird responses to a fire-grazing interaction in a fragmented landscape: Ames, Iowa, Iowa State University, Ph.D. Dissertation, 114 p. [Also available at https://doi.org/10.31274/etd-180810-1612.]

Pillsbury, F.C., Miller, J.R., Debinski, D.M., and Engle, D.M., 2011, Another tool in the toolbox? Using fire and grazing to promote bird diversity in highly fragmented landscapes: Ecosphere, v. 2, no. 3, article 28. [Also available at https://doi.org/10.1890/ES10-00154.1.]

Powell, A.F.L.A., 2006, Effects of prescribed burns and bison (*Bos bison*) grazing on breeding bird abundance in tallgrass prairie: The Auk, v. 123, no. 1, p. 183–197. [Also available at https://doi.org/10.1642/0004-8038(2006)123%5B0183:EOPBAB%5D2.0.CO;2.]

Powell, A.F.L.A., 2008, Responses of breeding birds in tallgrass prairie to fire and cattle grazing: Journal of Field Ornithology, v. 79, no. 1, p. 41–52. [Also available at https://doi.org/10.1111/j.1557-9263.2008.00144.x.]

Powell, A.F.L.A., and Busby, W.H., 2013, Effects of grassland management on breeding birds at the western edge of the tallgrass prairie ecosystem in Kansas: Natural Areas Journal, v. 33, no. 2, p. 130–138. [Also available at https://doi.org/10.3375/043.033.0202.]

Quamen, F.R., 2008, A landscape approach to grassland bird conservation in the Prairie Pothole Region of the northern Great Plains: Missoula, Mont., University of Montana, Ph.D. Dissertation, 149 p.

Quinn, J.E., Awada, T., Trinidade, F., Fulginiti, L., and Perrin, R., 2017, Combining habitat loss and agricultural intensification improves our understanding of drivers of change in avian abundance in a North American cropland anthrome: Ecology and Evolution, v. 7, no. 3, p. 803–814. [Also available at https://doi.org/10.1002/ece3.2670.]

Quinn, J.E., Brandle, J.R., and Johnson, R.J., 2012, The effects of land sparing and wildlife-friendly practices on grassland bird abundance within organic farmlands: Agriculture, Ecosystems and Environment, v. 161, p. 10–16. [Also available from https://doi.org/10.1016/j.agee.2012.07.021.]

Rahmig, C.J., Jensen, W.E., and With, K.A., 2009, Grassland bird responses to land management in the largest remaining tallgrass prairie: Conservation Biology, v. 23, no. 4, p. 420–432. [Also available at https://doi.org/10.1111/j.1523-1739.2008.01118.x.]

Ramírez-Yáñez, L.E., Chávez-Ramírez, F., Kim, D.H., and Heredia-Pineda, F., 2011, Grassland bird nesting on restored and remnant prairies in south central Nebraska: Ecological Restoration, v. 29, no. 1–2, p. 8–10. [Also available at https://doi.org/10.3368/er.29.1-2.8.]

Reiley, B.M., and Benson, T.J., 2019, Differential effects of landscape composition and patch size on avian habitat use of restored fields in agriculturally fragmented landscapes: Agriculture, Ecosystems and Environment, v. 274, p. 41–51. [Also available at https://doi.org/10.1016/j.agee.2018.12.017.]

Reiley, B.M., and Benson, T.J., 2020, Does conservation practice and site age influence vegetation structure and avian abundance in restored fields?: Wildlife Society Bulletin, v. 44, no. 4, p. 684–694. [Also available at https://doi.org/10.1002/wsb.1131.]

Reinking, D.L., Wolfe, D.H., and Sherrod, S.K., 2009, Nest monitoring, point counts, and habitat of tallgrass prairie breeding birds of northeastern Oklahoma, 1992–1996: Oklahoma Biological Survey, v. 9, no. 1, p. 1–12.

Renken, R.B., 1983, Breeding bird communities and bird-habitat associations on North Dakota waterfowl production areas of three habitat types: Ames, Iowa, Iowa State University, Master’s Thesis, 90 p.

Renken, R.B., and Dinsmore, J.J., 1987, Nongame bird communities on managed grasslands in North Dakota: Canadian Field-Naturalist, v. 101, no. 4, p. 551–557.

Ribic, C.A., Guzy, M.J., and Sample, D.W., 2009a, Grassland bird use of remnant prairie and Conservation Reserve Program fields in an agricultural landscape in Wisconsin: American Midland Naturalist, v. 161, no. 1, p. 110–122. [Also available at https://doi.org/10.1674/0003-0031-161.1.110.]

Ribic, C.A., Koford, R.R., Herkert, J.R., Johnson, D.H., Niemuth, N.D., Naugle, D.E., Bakker, K.K., Sample, D.W., and Renfrew, R.B., 2009b, Area sensitivity in North American grassland birds—Patterns and processes: The Auk, v. 126, no. 2, p. 233–244. [Also available at https://doi.org/10.1525/auk.2009.1409.]

Riffell, S., Scognamillo, D., and Burger, L.W., 2008, Effects of the Conservation Reserve Program on Northern Bobwhite and grassland birds: Environmental Monitoring and Assessment, v. 146, nos. 1–3, p. 309–323. [Also available at https://doi.org/10.1007/s10661-007-0082-8.]

Riffell, S., Scognamillo, D., Burger, L.W., Jr., and Bucholtz, S., 2010, Broad-scale relations between Conservation Reserve Program and grassland birds—Do cover type, configuration, and contract age matter?: The Open Ornithology Journal, v. 3, p. 112–123. [Also available at https://doi.org/10.2174/1874453201003010112.]

Rivers, J.W., Jensen, W.E., Kosciuch, K.L., and Rothstein, S.I., 2010, Community-level patterns of host use by the Brown-headed Cowbird (*Molothrus ater*), a generalist brood parasite: The Auk, v. 127, no. 2, p. 263–273. [Also available at https://doi.org/10.1525/auk.2009.09053.]

Robbins, C.S., and van Velzen, W.T., 1969, The Breeding Bird Survey, 1967 and 1968: Washington, D.C., U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Special Scientific Report-Wildlife No. 124, 102 p.

Robel, R.J., Briggs, J.N., Dayton, A.D., and Hulbert, L.C., 1970, Relationships between visual obstruction measurements and weight of grassland vegetation: Journal of Range Management, v. 23, no. 4, p. 295–297. [Also available at https://doi.org/10.2307/3896225.]

Robel, R.J., Hughes, J.P., Hull, S.D., Kemp, K.E., and Klute, D.S., 1998, Spring burning—Resulting avian abundance and nesting in Kansas CRP: Journal of Range Management, v. 51, no. 2, p. 132–138. [Also available at https://doi.org/10.2307/4003197.]

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

Rosamond, K.M., Goded, S., Soultan, A., Kaplan, R.H., Glass, A., Kim, D.H., and Arcilla, N., 2020, Not singing in the rain—Linking migratory songbird declines with increasing precipitation and brood parasitism vulnerability: Frontiers in Ecology and Evolution, v. 8, article 536769. [Also available at https://doi.org/10.3389/fevo.2020.536769.]

Rotenberry, J.T., and Wiens, J.A., 1980, Habitat structure, patchiness, and avian communities in North American steppe vegetation—A multivariate analysis: Ecology, v. 61, no. 5, p. 1228–1250. [Also available at https://doi.org/10.2307/1936840.]

Roth, A.M., Sample, D.W., Ribic, C.A., Paine, L., Undersander, D.J., and Bartelt, G.A., 2005, Grassland bird response to harvesting switchgrass as a biomass energy crop: Biomass and Bioenergy, v. 28, no. 5, p. 490–498. [Also available at https://doi.org/10.1016/j.biombioe.2004.11.001.]

Roth, R.R., 1979, Vegetation as a determinant in avian ecology: Proceedings of the Welder Wildlife Foundation symposium, v. 1, p. 162–174.

Ryan, M.R., 1986, Nongame management in grassland and agricultural ecosystems, *in* Hale, J.B., Best, L.B., and Clawson, R.L., eds., Management of nongame wildlife in the Midwest—A developing art: Chelsea, Mich., BookCrafters, North Central Section of The Wildlife Society, p. 117–136.

Sample, D.W., 1989, Grassland birds in southern Wisconsin—Habitat preference, population trends, and response to land use changes: Madison, Wis., University of Wisconsin, Master's Thesis, 588 p.

Sauer, G.C., 1953, Dickcissel study: Bluebird, v. 20, no. 1, p. 12–16.

Sauer, J.R., Hines, J.E., Fallon, J.E., Pardieck, K.L., Ziolkowski, D.J., Jr., and Link, W.A., 2014, The North American Breeding Bird Survey, results and analysis 1966–2012 (ver. 02.19.2014): Laurel, Md., U.S. Geological Survey, Patuxent Wildlife Research Center, accessed November 2022 at https://www.mbr-pwrc.usgs.gov/bbs/bbs2012.html.

Schartz, R.L., 1969, A time budget of the male Dickcissel (*Spiza americana*): Manhattan, Kans., Kansas State University, Master's Thesis, 57 p.

Schulte, L.A., MacDonald, A.L., Niemi, J.B., and Helmers, M.J., 2016, Prairie strips as a mechanism to promote land sharing by birds in industrial agricultural landscapes: Agriculture, Ecosystems and Environment, v. 220, p. 55–63. [Also available at https://doi.org/10.1016/j.agee.2016.01.007.]

Scott, P.E., DeVault, T.L., Bajema, R.A., and Lima, S.L., 2002, Grassland vegetation and bird abundances on reclaimed midwestern coal mines: Wildlife Society Bulletin, v. 30, no. 4, p. 1006–1014.

Sealy, S.G., 1976, The 1973 Dickcissel invasion of southern Manitoba: Canadian Field-Naturalist, v. 90, no. 4, p. 464–466.

Shaffer, J.A., Igl, L.D., and Johnson, D.H., 2019, The effects of management practices on grassland birds—Rates of Brown-headed Cowbird *(Molothrus ater*) parasitism in nests of North American grassland birds, chap. PP *of* Johnson, D.H., Igl, L.D., Shaffer, J.A., and DeLong, J.P., eds., The effects of management practices on grassland birds: U.S. Geological Survey Professional Paper 1842, 24 p., accessed March 2021 at https://doi.org/10.3133/pp1842PP.

Shew, J.J., and Nielsen, C.K., 2021, Differential effects of policy-based management on obligate and facultative grassland birds: Agriculture, Ecosystems and Environment, v. 319, article 107411. [Also available at https://doi.org/10.1016/j.agee.2021.107411.]

Shew, J.J., Nielsen, C.K., and Sparling, D.W., 2019, Finer-scale habitat predicts nest survival in grassland birds more than management and landscape—A multi-scale perspective: Journal of Applied Ecology, v. 56, no. 4, p. 929–945. [Also available at https://doi.org/10.1111/1365-2664.13317.]

Skinner, R.M., 1974, Grassland use patterns and prairie bird populations in Missouri: Columbia, Mo., University of Missouri, Master's Thesis, 53 p.

Skinner, R.M., 1975, Grassland use patterns and prairie bird populations in Missouri, *in* Wali, M.K., ed., Prairie—A multiple view: Grand Forks, N. Dak., University of North Dakota Press, p. 171–180.

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

Small, D.M., Gimpel, M.E., and Gill, D.E., 2012, Site fidelity and natal philopatry in Dickcissels: Northeastern Naturalist, v. 19, no. 1, p. 123–129. [Also available at https://doi.org/10.1656/045.019.0110.]

Smith, P., Jr., 1882, Eggs in a set: Ornithologist and Oologist, v. 7, p. 182.

Sousa, B.F., 2012, Ecology of mating patterns and sexual selection in Dickcissels breeding in managed prairie: Lexington, Ky., University of Kentucky, Ph.D. Dissertation, 166 p.

Sousa, B.F., Temple, S.A., and Basili, G.D., 2022, Dickcissel (*Spiza americana*) (ver. 2.0), *in* Schulenberg, T.S., and Keeney, B.K., eds. The birds of the world: Ithaca, N.Y., Cornell Lab of Ornithology, accessed October 2022 at https://birdsoftheworld.org/bow/species/dickci/cur/introduction. [Also available at https://doi.org/10.2173/bow.dickci.02.]

Spahr, L.A., 2017, The interactive effects of annual climatic variability and rangeland management on the reproductive success of Dickcissels (*Spiza americana*): Lynchburg, Va., Liberty University, Honor's Thesis, 38 p.

Steigman, K.L., 1993, Nesting ecology of the Dickcissel (*Spiza americana*) on a tallgrass prairie relict in north central Texas: Denton, Tex., University of North Texas, Ph.D. Dissertation, 133 p.

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

Swanson, D.L., and Palmer, J.S., 2009, Spring migration phenology of birds in the Northern Prairie region is correlated with local climate change: Journal of Field Ornithology, v. 80, no. 4, p. 351–363. [Also available at https://doi.org/10.1111/j.1557-9263.2009.00241.x.]

Swengel, S.R., 1996, Management responses of three species of declining sparrows in tallgrass prairie: Bird Conservation International, v. 6, no. 3, p. 241–253. [Also available at https://doi.org/10.1017/S0959270900003130.]

Swengel, S.R., and Swengel, A.B., 2001, Relative effects of litter and management on grassland bird abundance in Missouri, USA: Bird Conservation International, v. 11, no. 2, p. 113–128. [Also available at https://doi.org/10.1017/S095927090100020X.]

Taber, R.D., 1947, The Dickcissel in Wisconsin: The Passenger Pigeon, v. 9, no. 2, p. 39–46.

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

Trail, P.W., 2006, Avian mortality at oil pits in the United States—A review of the problem and efforts for its solution: Environmental Management, v. 38, no. 4, p. 532–544. [Also available at https://doi.org/10.1007/s00267-005-0201-7.]

Travers, S.E., Marquardt, B., Zerr, N.J., Finch, J.B., Boche, M.J., Wilk, R., and Burdick, S.C., 2015, Climate change and shifting arrival dates of migratory birds over a century in the northern Great Plains: The Wilson Journal of Ornithology, v. 127, no. 1, p. 43–51. [Also available at https://doi.org/10.1676/14-033.1.]

Tsai, J.-S., Venne, L.S., Smith, L.M., McMurry, S.T., and Haukos, D.A., 2012, Influence of local and landscape characteristics on avian richness and density in wet playas of the southern Great Plains, USA: Wetlands, v. 32, no. 4, p. 605–618. [Also available at https://doi.org/10.1007/s13157-012-0280-1.]

Uden, D.R., 2012, Agricultural landuse change impacts on bioenergy production, avifauna, and water use in Nebraska's Rainwater Basin: Lincoln, Nebr., University of Nebraska, Master's Thesis, 250 p.

Uden, D.R., Allen, C.R., Mitchell, R.B., McCoy, T.D., and Guan, Q., 2015, Predicted avian responses to bioenergy development scenarios in an intensive agricultural landscape: Global Change Biology. Bioenergy, v. 7, no. 4, p. 717–726. [Also available at https://doi.org/10.1111/gcbb.12157.]

VanBeek, K.R., Brawn, J.D., and Ward, M.P., 2014, Does no-till soybean farming provide any benefits for birds?: Agriculture, Ecosystems and Environment, v. 185, p. 59–64. [Also available at https://doi.org/10.1016/j.agee.2013.12.007.]

Van Dyke, F., Schmeling, J.D., Starkenburg, S., Yoo, S.H., and Stewart, P.W., 2007, Responses of plant and bird communities to prescribed burning in tallgrass prairies: Biodiversity and Conservation, v. 16, no. 4, p. 827–839. [Also available at https://doi.org/10.1007/s10531-006-9107-9.]

Van Dyke, F., Van Kley, S.E., Page, C.E., and Van Beek, J.G., 2004, Restoration efforts for plant and bird communities in tallgrass prairies using prescribed burning and mowing: Restoration Ecology, v. 12, no. 4, p. 575–585. [Also available at https://doi.org/10.1111/j.1061-2971.2004.00352.x.]

Verheijen, B.H.F., Clipp, H.L., Bartolo, A.J., Jensen, W.E., and Sandercock, B.K., 2019, Effects of patch-burn grazing on breeding density and territory size of Dickcissels: Avian Conservation and Ecology, v. 14, no. 1, article 7. [Also available at https://doi.org/10.5751/ACE-01343-140107.]

Verheijen, B.H.F., Erickson, A.N., Boyle, W.A., Leveritte, K.S., Sojka, J.L., Spahr, L.A., Williams, E.J., Winnicki, S.K., and Sandercock, B.K., 2022, Predation, parasitism, and drought counteract the benefits of patch-burn grazing for the reproductive success of grassland songbirds: Ornithological Applications, v. 124, no. 2, p. 1–22. [Also available at https://doi.org/10.1093/ornithapp/duab066.]

Vogel, J.A., 2011, Grassland bird response to enhanced vegetation diversity in restoration planting in the Spring Run Complex of northwestern Iowa: Ames, Iowa, Iowa State University, Ph.D. Dissertation, 161 p. [Also available at https://doi.org/10.31274/etd-180810-5173.]

Von Steen, D.A., 1965, A study of nesting Dickcissels in Nebraska: Nebraska Bird Review, v. 33, no. 2, p. 22–24.

Vos, S.M., and Ribic, C.A., 2011, Grassland bird use of oak barrens and dry prairies in Wisconsin: Natural Areas Journal, v. 31, no. 1, p. 26–33. [Also available at https://doi.org/10.3375/043.031.0104.]

Vos, S.M., and Ribic, C.A., 2013, Nesting success of grassland birds in oak barrens and dry prairies in west central Wisconsin: Northeastern Naturalist, v. 20, no. 1, p. 131–142. [Also available at https://doi.org/10.1656/045.020.0110.]

Walk, J.W., Kershner, E.L., Benson, T.J., and Warner, R.E., 2010, Nesting success of grassland birds in small patches in an agricultural landscape: The Auk, v. 127, no. 2, p. 328–334. [Also available at https://doi.org/10.1525/auk.2009.09180.]

Walk, J.W., and Warner, R.E., 2000, Grassland management for the conservation of songbirds in the midwestern USA: Biological Conservation, v. 94, no. 2, p. 165–172. [Also available at https://doi.org/10.1016/S0006-3207(99)00182-2.]

Walk, J.W., Wentworth, K., Kershner, E.L., Bollinger, E.K., and Warner, R.E., 2004, Renesting decisions and annual fecundity of female Dickcissels (*Spiza americana*) in Illinois: The Auk, v. 121, no. 4, p. 1250–1261.

Warner, R.E., 1994, Agricultural land use and grassland habitat in Illinois—Future shock for midwestern birds?: Conservation Biology, v. 8, no. 1, p. 147–156. [Also available at https://doi.org/10.1046/j.1523-1739.1994.08010147.x.]

Wells, K.M.S., Millspaugh, J.J., Ryan, M.R., and Hubbard, M.W., 2008, Factors affecting home range size and movements of post-fledging grassland birds: The Wilson Journal of Ornithology, v. 120, no. 1, p. 120–130. [Also available at https://doi.org/10.1676/06-117.1.]

Wentworth, K.L., Brittingham, M.C., and Wilson, A.M., 2010, Conservation Reserve Enhancement Program fields—Benefits for grassland shrub-shrub species: Journal of Soil and Water Conservation, v. 65, no. 1, p. 50–60. [Also available at https://doi.org/10.2489/jswc.65.1.50.]

Westemeier, R.L., and Buhnerkempe, J.E., 1983, Responses of nesting wildlife to prairie grass management in prairie chicken sanctuaries in Illinois, *in* Brewer, R., ed. Proceedings of the eighth North American Prairie Conference: Kalamazoo, Mich., Western Michigan University, p. 36–46.

Wiens, J.A., 1963, Aspects of cowbird parasitism in southern Oklahoma: The Wilson Bulletin, v. 75, no. 2, p. 130–139.

Wiens, J.A., 1969, An approach to the study of ecological relationships among grassland birds: Ornithological Monographs, no. 8, p. 1–93. [Also available at https://doi.org/10.2307/40166677.]

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

Wiens, J.A., 1973, Pattern and process in grassland bird communities: Ecological Monographs, v. 43, no. 2, p. 237–270. [Also available at https://doi.org/10.2307/1942196.]

Wilsey, C., Taylor, L., Bateman, B., Jensen, C., Michel, N., Panjabi, A., and Langham, G., 2019, Climate policy action needed to reduce vulnerability of conservation-reliant grassland birds in North America: Conservation Science and Practice, v. 1, no. 4, p. e21. [Also available at https://doi.org/10.1111/csp2.21.]

Wilson, B.S., Jensen, W.E., Houseman, G.R., Jameson, M.L., Reichenborn, M.M., Watson, D.F., Morphew, A.R., and Kjaer, E.L., 2022, Cattle grazing in CRP grasslands during the nesting season—Effects on avian abundance and diversity: The Journal of Wildlife Management, v. 86, no. 2, p. e22188. [Also available at https://doi.org/10.1002/jwmg.22188.]

Winter, M., 1996, How does fragmentation affect grassland birds in southwestern Missouri prairies?: Missouri Prairie Journal, v. 17, p. 15–18.

Winter, M., 1998, Effect of habitat fragmentation on grassland-nesting birds in southwestern Missouri: Columbia, Mo., University of Missouri, Ph.D. Dissertation, 215 p.

Winter, M., 1999, Nesting biology of Dickcissels and Henslow's Sparrows in Missouri prairie fragments: The Wilson Bulletin, v. 111, no. 4, p. 515–527.

Winter, M., and Faaborg, J., 1999, Patterns of area sensitivity in grassland-nesting birds: Conservation Biology, v. 13, no. 6, p. 1424–1436. [Also available at https://doi.org/10.1046/j.1523-1739.1999.98430.x.]

Winter, M., Johnson, D.H., and Faaborg, J., 2000, Evidence of edge effects on multiple levels in tallgrass prairie: The Condor, v. 102, no. 2, p. 256–266. [Also available at https://doi.org/10.1650/0010-5422(2000)102[0256:EFEEOM]2.0.CO;2.]

With, K.A., King, A.W., and Jensen, W.E., 2008, Remaining large grasslands may not be sufficient to prevent grassland bird declines: Biological Conservation, v. 141, no. 12, p. 3152–3167. [Also available at https://doi.org/10.1016/j.biocon.2008.09.025.]

Wood, E.M., Pidgeon, A.M., Gratton, C., and Wilder, T.T., 2011, Effects of oak barrens habitat management for Karner blue butterfly (*Lycaeides samuelis*) on the avian community: Biological Conservation, v. 144, no. 12, p. 3117–3126. [Also available at https://doi.org/10.1016/j.biocon.2011.10.010.]

Wulff, S.J., Butler, M.J., and Ballard, W.B., 2016, Assessment of diurnal wind turbine collision risk for grassland birds on the southern Great Plains: Journal of Fish and Wildlife Management, v. 7, no. 1, p. 129–140. [Also available at https://doi.org/10.3996/042015-JFWM-031.]

Zimmerman, J.L., 1966, Polygyny in the Dickcissel: The Auk, v. 83, no. 4, p. 534–546. [Also available at https://doi.org/10.2307/4083148.]

Zimmerman, J.L., 1971, The territory and its density dependent effect in *Spiza americana*: The Auk, v. 88, no. 3, p. 591–612.

Zimmerman, J.L., 1982, Nesting success of Dickcissels (*Spiza americana*) in preferred and less preferred habitats: The Auk, v. 99, no. 2, p. 292–298.

Zimmerman, J.L., 1983, Cowbird parasitism of Dickcissels in different habitats and at different nest densities: The Wilson Bulletin, v. 95, no. 1, p. 7–22.

Zimmerman, J.L., 1992, Density-independent factors affecting the avian diversity of the tallgrass prairie community: The Wilson Bulletin, v. 104, no. 1, p. 85–94.

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

Zimmerman, J.L., 1997, Avian community responses to fire, grazing, and drought in the tallgrass prairie, *in* Knopf, F.L., and Samson, F.B., eds., Ecology and conservation of Great Plains vertebrates: New York, N.Y., Springer-Verlag, p. 167–180. [Also available at https://doi.org/10.1007/978-1-4757-2703-6_7.]

Zimmerman, J.L., and Finck, E.J., 1983, Success in a secondary habitat—The Dickcissel in the tallgrass prairie, *in* Brewer, R., ed., Proceedings of the eighth North American Prairie Conference: Kalamazoo, Mich., Western Michigan University, p. 47–49.

Zimmerman, J.L., and Finck, E.J., 1989, Philopatry and correlates of territory fidelity in male Dickcissels: North American Bird Bander, v. 14, no. 3, p. 83–85.

Table 001. Measured values of vegetation structure and composition in Dickcissel (*Spiza americana*) 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; m, meter; CRP, Conservation Reserve Program; <, less than; DNC, dense nesting cover; >, greater than]

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)
Alexander and others, 2021 (nests)	Kansas	Tallgrass prairie	Burned, grazed	--	--	35.8	35.8	--	2.0	1.7	--
Alexander and others, 2021 (5 m from nest)	Kansas	Tallgrass prairie	Burned, grazed	--	--	54.2	28.4	--	6.4	3.2	--
Bakker and Higgins, 2009	Minnesota, South Dakota	Tallgrass prairie	--	96[a]	20[b]	--	--	--	--	--	2.6
Bakker and Higgins, 2009	Minnesota, South Dakota	Tame grassland	Seeded to intermediate wheatgrass (*Thinopyrum intermedium*)	135[a]	36[b]	--	--	--	--	--	3.1
Bakker and Higgins, 2009	Minnesota, South Dakota	Tame grassland	Seeded to switchgrass (*Panicum virgatum*)	107[a]	37[b]	--	--	--	--	--	1.6
Bakker and Higgins, 2009	Minnesota, South Dakota	Tame grassland	Cool-season seeding mixture	124[a]	36[b]	--	--	--	--	--	3.4
Bakker and Higgins, 2009	Minnesota, South Dakota	Tame grassland	Warm-season seeding mixture	166[a]	27[b]	--	--	--	--	--	4.1
Chapman and others, 2004a	Oklahoma	Mixed-grass prairie	Grazed	--	48.7[b]	--	--	--	--	--	--
Chapman and others, 2004a	Oklahoma	Tame grassland (CRP)	Seeded to yellow bluestem (*Bothriochloa ischaemum*), grazed	--	39.6[b]	--	--	--	--	--	--
Churchwell and others, 2008[c]	Oklahoma	Tallgrass prairie	Grazed, annual complete burn	32	--	51.4	43.3	--	2.9	1.5	--
Churchwell and others, 2008[c]	Oklahoma	Tallgrass prairie	Grazed, current-year patch burn	25	--	33.3	41.2	--	16	0.6	--
Churchwell and others, 2008[c]	Oklahoma	Tallgrass prairie	Grazed, 1-year post-burn patch burn	36	--	60.1	35.3	--	0.9	35.4	--
Churchwell and others, 2008[c]	Oklahoma	Tallgrass prairie	Grazed, 2-years post-burn patch burn	44	--	74.5	23	--	0.1	61.6	--

Table 001. Measured values of vegetation structure and composition in Dickcissel (*Spiza americana*) 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.—Continued

[cm, centimeter; %, percent; --, no data; m, meter; CRP, Conservation Reserve Program; <, less than; DNC, dense nesting cover; >, greater than]

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)
Fletcher and Koford, 2002	Iowa	Tallgrass prairie	--	91.7	--	45.6	33.4	--	0.9	9.9	3.4
Fletcher and Koford, 2002	Iowa	Restored grassland	Cool- and warm-season seeding mixture	91.6	--	51.8	20.6	--	3.6	13.7	2.5
Frawley, 1989 (territories)	Iowa	Tame grassland	Before first mowing	51	--	11	86	--	7	--	--
Frawley, 1989 (territories)	Iowa	Tame grassland	Before second mowing	49	--	16	78	--	9	--	--
Frey and others, 2008 (nests)	Kansas, Oklahoma	Tallgrass prairie	Intensively early grazed and burned	--	25–27[b,d]	--	--	--	--	--	--
Frey and others, 2008 (nests)	Kansas, Oklahoma	Tallgrass prairie	Season-long grazed and burned	--	26.6–29.2[b,d]	--	--	--	--	--	--
Frey and others, 2008 (nests)	Kansas, Oklahoma	Tallgrass prairie	Season-long grazed and unburned	--	32.1–39.3[b,d]	--	--	--	--	--	--
Fritcher and others, 2004[c,e]	South Dakota	Mixed-grass prairie	Grazed	26.6–51.8	5.8–17[b]	85.7–91.6	18.0–26.1	--	1.8–12.9	80.7–94.6	0.9–3.1
Fuhlendorf and others, 2006[f]	Oklahoma	Tallgrass prairie	Annual complete burn and grazed	14.7	--	63	18	--	20.3	8	--
Fuhlendorf and others, 2006[f]	Oklahoma	Tallgrass prairie	Patch-burn and grazed	21.7	--	55.7	19	--	14.7	50.3	--
George and others, 2013	Oklahoma	Mixed-grass prairie	Grazed	75.6	39.2[b]	57.3	12.8	--	26.9	12.8	--
George and others, 2013	Oklahoma	Tame grassland (CRP)	Yellow bluestem, grazed, hayed	62.3	28.8[b]	61.5	1.4	--	26.2	5.3	--
Greer, 2009[c]	South Dakota	Mixed-grass prairie	Multiple	15[a]	85[b]	56.8	18.8	1.4	7.8	15.6	1.7
Harrison, 1974 (territories)	Michigan	Tame grassland	Hayed	56.9	--	--	--	--	--	--	--
Hickman and others, 2006	Kansas	Mixed-grass prairie	Grazed	31.7	--	54	38.1	--	--	--	1.2
Hickman and others, 2006	Kansas	Tame grassland (former CRP)	Warm-season seeding mixture, grazed	31.9	--	68	13.9	--	--	--	3.3
Hickman and others, 2006	Kansas	Tame grassland	Seeded to yellow bluestem, grazed	29.6	--	42.5	21.2	--	--	--	1

Table 001. Measured values of vegetation structure and composition in Dickcissel (*Spiza americana*) 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.—Continued

[cm, centimeter; %, percent; --, no data; m, meter; CRP, Conservation Reserve Program; <, less than; DNC, dense nesting cover; >, greater than]

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)
Hughes, 1996[c] (nests)	Kansas	Tame grassland (CRP)	Warm-season seeding mixture	73	82.2[b]	88.3	2.9	0.8	9.2	29.2	0.5
Hughes, 1996[c] (nest vicinity)	Kansas	Tame grassland (CRP)	Warm-season seeding mixture	63.1	74.8[b]	78.9	3.6	0.2	15.9	50.1	0.5
Jensen, 1999 (nests)	Kansas	Tallgrass prairie	Multiple	6.1–41[g]	--	47.6	26.8	4.9	8.5	9.1	--
Jensen, 1999 (nest vicinity)	Kansas	Tallgrass prairie	Multiple	3.8–37.2[g]	--	48.2	16.4	1.7	15.3	16.3	--
Jones and others, 2017[h] (postfledgling locations)	Illinois	Tame grassland	Cool- and warm-season seeding mixture, multiple	63.5	45.8[b]	--	--	--	--	--	--
Jones and others, 2017[h] (nest locations)	Illinois	Tame grassland	Cool- and warm-season seeding mixture, multiple	54.8	39.5[b]	--	--	--	--	--	--
Klug and others, 2010 (successful nests)[c]	Kansas	Tallgrass prairie	Burned, grazed	77.6	--	44.4	35.3	5.8	12.4	47.1	--
Klug and others, 2010 (unsuccessful nests)[c]	Kansas	Tallgrass prairie	Burned, grazed	72.1	--	46.0	33.9	9.4	10.8	45.5	--
McCoy and others, 2001[c]	Missouri	Tame grassland (CRP)	Cool-season seeding mixture	--	51[b]	46	33	1	12	75	2.6
McCoy and others, 2001[c]	Missouri	Tame grassland (CRP)	Warm-season seeding mixture	--	80[b]	54	27	<1	11	74	2.2
Murray and Best, 2003	Iowa	Tame grassland (CRP)	Total-harvested switchgrass	80.9	71[b]	51.6	19.6	0.4	5	23.2	1.9
Murray and Best, 2003	Iowa	Tame grassland (CRP)	Strip-harvested switchgrass	81.7	75[b]	53.3	17.5	0.1	2.8	29.6	3.5
Murray and Best, 2003	Iowa	Tame grassland (CRP)	Unharvested switchgrass	78.1	71[b]	32.9	25.4	2.1	2.9	22.9	5.5
Negus and others, 2010[c]	Nebraska	Tame grassland (CRP)	Cool-season seeding mixture; disked and interseeded	65.7	35.8[b]	41.8	23.8	--	14.5	25.2	1.7
Negus and others, 2010[c]	Nebraska	Tame grassland (CRP)	Cool-season seeding mixture; idle	55.9	29.4[b]	63.9	1.4	--	1.4	39.3	3.1

Table 001. Measured values of vegetation structure and composition in Dickcissel (*Spiza americana*) 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.—Continued

[cm, centimeter; %, percent; --, no data; m, meter; CRP, Conservation Reserve Program; <, less than; DNC, dense nesting cover; >, greater than]

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)
Ogden and others, 2019 (nests)[c]	Kansas	Tallgrass prairie	Steer or steer-sheep grazed	85.7	33.4[b]	42	50	--	5	4	2
Ogden and others, 2019 (5 m from nests)[c]	Kansas	Tallgrass prairie	Steer or steer-sheep grazed	65.6	23.1[b]	52	30	--	16	7	2.3
Osborne and Sparling, 2013[c]	Illinois	Tame grassland (CRP)	Idle	--	56.5[b]	47.4	23.3	--	8.5	--	6
Osborne and Sparling, 2013[c]	Illinois	Tame grassland (CRP)	Disked	--	52[b]	47.7	22.5	--	16.1	--	5.4
Osborne and Sparling, 2013[c]	Illinois	Tame grassland (CRP)	Glyphosate-sprayed	--	56.7[b]	23.8	37.5	--	12.9	--	4.1
Osborne and Sparling, 2013[c]	Illinois	Tame grassland (CRP)	Glyphosate-sprayed and seeded	--	53.7[a]	29.3	31.3	--	15.5	--	3.6
Patterson and Best, 1996 (nests)	Iowa	Tame grassland (CRP)	Cool-season seeding mixture; multiple	98	67[b]	48	54	--	--	--	--
Petersen, 1978	Kansas	Oldfield, tallgrass prairie	Burned, unburned	94.7–110	--	--	--	--	--	--	--
Pillsbury, 2010[c]	Iowa, Missouri	Tallgrass prairie	Multiple	--	44.6[b]	21.7	24.8	2.3	--	32.1	--
Renken, 1983[i]	North Dakota	Tame grassland (DNC)	Idle, grazed	--	20[b]	76.3	27.1	0.3	0	100	4.7
Roth and others, 2005	Wisconsin	Tame grassland	Unharvested switchgrass	--	50[b]	--	34.4	--	--	--	5.3
Sample, 1989	Wisconsin	Multiple	--	62.9	19[b]	--	74[j]	0.7	9.4	12.5	--
Vogel, 2011	Iowa	Tame grassland	Cool-season grassland	--	34.9[b]	60.3	2.7	0.03	2.7	30.3	2.2
Vogel, 2011	Iowa	Tame grassland	Young warm-season grassland	--	22[b]	42.8	15	0	24.6	15.9	0.4
Vogel, 2011	Iowa	Tame grassland	Older warm-season grassland	--	44.3[b]	49.6	13.3	0.2	5.5	28.3	2.4
Vogel, 2011	Iowa	Tame grassland	High-diversity grassland	--	42.7[b]	32.1	33.4	0.1	18.5	13.8	1
Wiens, 1973[i]	Oklahoma	Tallgrass prairie	Grazed	20.5[k]	13.5[l]	100	25	0	0	74	1.6
Winter, 1999 (successful nests)	Missouri	Tallgrass prairie	Burned, hayed	49	29.6[b]	56	26	4	4	11	2
Winter, 1999 (unsuccessful nests)	Missouri	Tallgrass prairie	Burned, hayed	44	26[b]	51	27	5	6	11	2

Table 001. Measured values of vegetation structure and composition in Dickcissel (*Spiza americana*) 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.—Continued

[cm, centimeter; %, percent; --, no data; m, meter; CRP, Conservation Reserve Program; <, less than; DNC, dense nesting cover; >, greater than]

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)
Zimmerman, 1966 (territories of mated males)	Kansas	Oldfield	Idle	--	120[l]	--	>20	--	--	--	--
Zimmerman, 1966 (territories of bachelor males)	Kansas	Oldfield	Idle	--	45[l]	--	--	--	--	--	--
Zimmerman, 1971 (territories)	Kansas	Multiple	Multiple	50–150	--	--	--	--	--	--	--

[a]Mean grass height.

[b]Visual obstruction reading (Robel and others, 1970).

[c]The sum of the percentage is >100%, based on methods described by the authors.

[d]Range of averages among three topographic positions.

[e]Range of averages among seral stages within study area.

[f]The sum of the percentage is >100%, based on the modified point-quadrat technique as described by the authors.

[g]These values represent a range of average heights that encompass live grass, dead grass, live forb, and woody plants.

[h]Average among three postfledgling age categories.

[i]The sum of the percentage is >100%, based on the modified point-quadrat technique of Wiens (1969).

[j]Herbaceous vegetation cover.

[k]Emergent vegetation height.

[l]Effective vegetation height.

For more information about this publication, contact:
Director, USGS Northern Prairie Wildlife Research Center
8711 37th Street Southeast
Jamestown, ND 58401
701–253–5500

For additional information, visit: https://www.usgs.gov/centers/npwrc

Publishing support provided by the
Rolla Publishing Service Center

Shaffer and others—**The Effects of Management Practices on Grassland Birds—Dickcissel (*Spiza americana*)**—Professional Paper 1842–OO

ISSN 2330-7102 (online)
https://doi.org/10.3133/pp1842OO