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The Effects of Management Practices on Grassland Birds—Lark Bunting (*Calamospiza melanocorys*)

Chapter EE of

The Effects of Management Practices on Grassland Birds

Professional Paper 1842–EE

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

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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]

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The Effects of Management Practices on Grassland Birds

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

U.S. Department of the Interior
DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3939	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
hectare (ha)	2.471	acre
square kilometer (km^2)	247.1	acre
hectare (ha)	0.003861	square mile (mi^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Mass	
kilogram (kg)	2.202	pound (lb)

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

$$°F = (1.8 \times °C) + 32.$$

Abbreviations

AUM	animal unit month
BBS	Breeding Bird Survey
CRP	Conservation Reserve Program
PCP	Permanent Cover Program
spp.	species (applies to two or more species within the genus)

Acknowledgments

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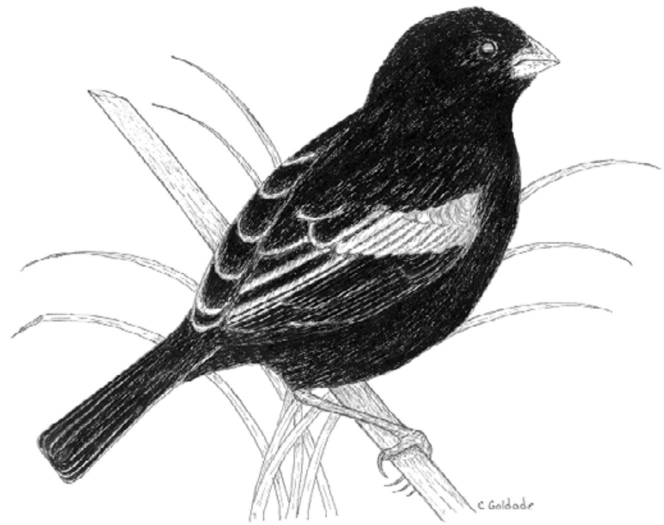
Capsule Statement

Keys to Lark Bunting (*Calamospiza melanocorys*) management include providing short vegetation with protective nest cover and tailoring grazing systems to the type of grassland. Lark Buntings have been reported to use habitats with 6–72 centimeter (cm) average vegetation height, 2–11 cm visual obstruction reading, 13–71 percent grass cover, less than or equal to (≤) 48 percent forb cover, ≤17 percent shrub cover, 10–57 percent bare ground cover, 25 percent litter cover, and ≤2 cm litter depth. The descriptions of key vegetation characteristics are provided in table EE1 (after the “References” section). Vernacular and scientific names of plants and animals follow the Integrated Taxonomic Information System (https://www.itis.gov).



Lark Bunting. Illustration by Christopher M. Goldade, used with permission.

Breeding Range

Lark Buntings breed from southern Alberta through southern Manitoba, south to western New Mexico and western Texas, and east to eastern South Dakota and northwestern Missouri (National Geographic Society, 2011). The relative densities of Lark Buntings in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data (Sauer and others, 2014), are shown in figure EE1 (not all geographic places mentioned in report are shown on figure).

Suitable Habitat

Lark Buntings use grasslands of low-to-moderate height with high vegetative cover and some bare ground (Rand, 1948; Smith and Smith, 1966; Wiens, 1970; Shane, 1972; Creighton, 1974), and often with a shrub component (Baldwin and others, 1969; With and Webb, 1993; Shane, 2020). Shrubs are especially important in savanna and sagebrush habitats (Woolfolk, 1945). Lark Buntings breed in a variety of habitats, including shortgrass, mixed-grass, and tallgrass prairies that are idle, burned, hayed, or grazed (Cameron, 1908; Rand, 1948; Smith and Smith, 1966; Baldwin and others, 1969; Wiens, 1970, 1973; Shane, 1972, 2020; Creighton, 1974; Maher, 1974; Porter and Ryder, 1974; Johnsgard, 1980; Kantrud, 1981; Dunn, 1986; With and Webb, 1993; Lueders and others, 2006; McLachlan, 2007; Greer, 2009; Lusk, 2009; Skagen and Yackel Adams, 2010; Lusk and Koper, 2013). The species also inhabits sagebrush, shrubsteppe, and desert shrub habitats (Woolfolk, 1945; Rand, 1948; Walcheck, 1970; Shane, 1972, 2020; Fautin, 1975; Stewart, 1975; Johnsgard, 1980; Johnson, 1981; Kantrud and Kologiski, 1983; Dunn, 1986). Planted cover, such as fields enrolled in the Conservation Reserve Program (CRP) and Permanent Cover Program (PCP), also provide suitable habitat (Johnson and Schwartz, 1993a, 1993b; Johnson and Igl, 1995; McMaster and Davis, 1998; McLachlan, 2007). Lark Buntings occasionally use oldfields (idle or neglected arable lands that have naturally reverted back to perennial cover), fallow fields, weedy

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

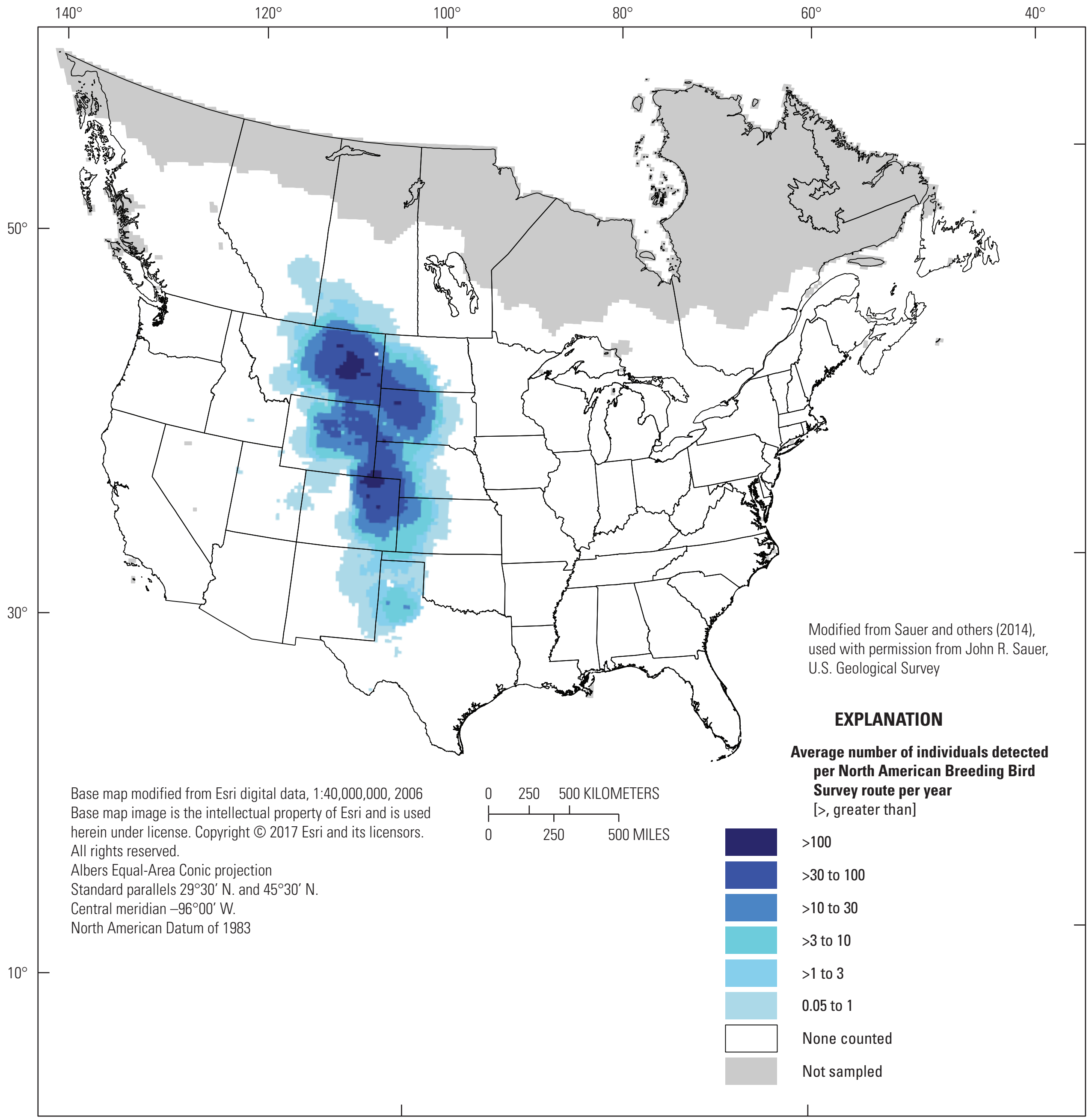

Figure EE1. The breeding distribution of the Lark Bunting (*Calamospiza melanocorys*) in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data, 2008–12. The BBS abundance map provides only an approximation of breeding range edges.

roadsides, alfalfa (*Medicago sativa*) hayfields, and cropland (Shane, 1972; Stewart, 1975; Johnsgard, 1980; Pleszczynska and Hansell, 1980; Lokemoen and Beiser, 1997; McMaster and Davis, 1998; McLachlan, 2007; Igl and others, 2008). Lark Buntings may occur within black-tailed prairie dog (*Cynomys ludovicianus*) colonies (Augustine and Baker, 2013; Ray and others, 2015; Duchardt and others, 2019).

Vegetation structure affects Lark Bunting abundance. In Saskatchewan, the abundance of Lark Buntings was positively associated with taller vegetation and reduced coverage of cow dung; abundance and reproductive success were not affected by whether a grassland was native or planted to tame species (Davis and others, 2016). In northeastern Montana, Lark Buntings preferred grasslands with shrubs (Lipsey and Naugle, 2017). Bunting abundance was positively related to maximum vegetation height and coverage of shrubs, bare ground, and small clubmoss (*Selaginella densa*). Bunting abundance was negatively related to litter depth; density of live and dead herbaceous vegetation; and coverage of grass, litter, and forbs. In South Dakota mixed-grass prairies, occurrence of Lark Buntings was positively related to the amount of bare ground and forbs and negatively associated with visual obstruction and tame grass species (Greer, 2009; Greer and others, 2016). In CRP fields in Colorado, Kansas, Nebraska, and Oklahoma, Lark Bunting occurrence was highest in fields in which less than (<) 25 percent of the grasses were taller than 15 centimeters (cm) and coverage of shrubs was between 3 and 10 percent (McLachlan, 2007). Rotenberry and Wiens (1980) determined that abundance of Lark Buntings in parts of Colorado, Kansas, Montana, Nebraska, Oklahoma, South Dakota, Texas, and Wyoming was positively correlated with litter depth.

Lark Buntings nest in mixed-grass and shortgrass prairies and areas dominated by sagebrush (*Artemisia* species [spp.]); they also use areas with tall grasses and scattered shrubs, weedy edges, retired cropland, and alfalfa or clover (*Trifolium* spp.) fields (Johnsgard, 1979, 1980; Shane, 2020). In Saskatchewan mixed-grass prairies, Lark Bunting nests were found only in lowland plots and not in upland plots (Lusk, 2009; Lusk and Koper, 2013). In another study in Saskatchewan, Lark Buntings fledged an average of 1.9 more young per nest in native pastures than in planted pastures (Davis and others, 2016). In a study in Montana, Lark Buntings were recorded only in greasewood (*Sarcobatus vermiculatus*)-sagebrush shrubland habitat and were not found in sagebrush grasslands, pine (*Pinus* spp.)-juniper (*Juniperus* spp.) woodlands, or eastern cottonwood (*Populus deltoides*) forests (Walcheck, 1970). In North Dakota, Lark Buntings preferred areas of sage flats along stream valleys or in lowland draws (Stewart, 1975); the species also used weedy roadsides, retired cropland planted to grasses and legumes, weedy fallow fields, and alfalfa hayland. In Wyoming, Lark Buntings occurred more frequently in areas dominated by sagebrush than in areas where only grass and cactus were present (Fautin, 1975). In Nebraska, Lark Buntings bred in mixed-grass and shortgrass prairies, wet meadows, and wheat (*Triticum* spp.) and alfalfa fields; Lark Buntings preferred shrub-dominated grasslands (Faanes and Lingle, 1995). In Kansas, higher nest success was reported in native grassland and alfalfa than in milo (*Sorghum* spp.) stubble fields; no young fledged from nests in seeded pasture (native or tame not specified) (Wilson, 1976).

Lark Buntings often build nests under protective vegetation, including tall grasses, forbs, low shrubs, and cacti (Whittle, 1922; Woolfolk, 1945; Baumgarten, 1968; Baldwin and others, 1969; Creighton, 1971; Shane, 1972, 2020; Stewart, 1975; Wilson, 1976; Pleszczynska, 1977, 1978; Johnsgard, 1979), and Yackel Adams and others (2006) reported that radio-marked Lark Bunting fledglings used shrubs, grasses, cacti, forbs, fences, and trees for protective cover. In Saskatchewan, nests were placed under western snowberry (*Symphoricarpos occidentalis*) (Smith and Smith, 1966). In Montana, nests were in weedy areas beneath tumble ringwing (*Cycloloma atriplicifolium*) (Whittle, 1922) and under sagebrush (Woolfolk, 1945). In South Dakota, nests were under plants such as alfalfa, fringed sagewort (*Artemisia frigida*), plains pricklypear cactus (*Opuntia polyacantha*), and soapweed yucca (*Yucca glauca*) (Pleszczynska, 1977). In Colorado, Lark Buntings were associated with slimspike three-awn (*Aristida longespica*), fourwing saltbush (*Atriplex canescens*), and rabbitbrush (*Chrysothamnus* spp., *Ericameria* spp.) (Baldwin and others, 1969; Creighton, 1974). In Oklahoma, Lark Buntings nested among grama grasses (*Bouteloua* spp.), buffalograss (*Bouteloua dactyloides*), yucca (*Yucca* spp.), sand sagebrush (*Artemisia filifolia*), and various forb species (Dunn, 1986).

Strong (1971) and Pleszczynska (1977, 1978) indicated that the presence of protective cover may be a factor in reproductive success. However, Lusk (2009) found no effect of vegetation structure on daily nest survival in Saskatchewan mixed-grass prairies but did find that the location of nest sites was positively related to increasing vegetation density and litter depth. In another Saskatchewan study, nests in mixed-grass pasture were placed on the ground in vegetation 18 to 61 cm tall (Smith and Smith, 1966). Mean height of vegetation around ground nests in Colorado (Baldwin and others, 1969), Kansas (Shane, 1972), and Utah (Johnson, 1981) ranged from 15 to 28 cm. In Colorado, Skagen and Yackel Adams (2010) reported that nest survival increased with increasing vegetation height. In sand sagebrush grasslands in Kansas, areas in which nests were found had fewer and shorter sand sagebrush plants and had higher percent forb cover (mean of 48.2 percent) than areas where nests were not present (Shane, 1972). Average vegetation height at nest sites was 25.2 cm. Successful nests (those with young present 6 days after hatching) were adjacent to tall (mean of 30.6 cm) overall vegetation and tall (mean of 41.9 cm) forbs.

Vegetative cover may provide protection for nests from inclement weather and concealment from nest predators (Woolfolk, 1945; Baumgarten, 1968; Baldwin and others, 1969; Strong, 1971; Creighton, 1974; Pleszczynska, 1977, 1978; With and Webb, 1993; Shane, 2020), as well as provide open views in one or more directions (Baldwin and others, 1969; Shane, 1972; Wilson, 1976). In Kansas, Lark Buntings oriented nests adjacent to protective vegetation that allowed access to morning sunlight, adequate ventilation, and afternoon shade (Shane, 1974, 2020). In Colorado shortgrass pastures, most nests were placed on the northern side of protective vegetation (With and Webb, 1993). In other studies, nests were placed on the east or southeast side of protective vegetation (Baldwin and others, 1969; Creighton, 1971; Pleszczynska, 1977).

Time of season may affect selection of nesting habitat. In Kansas, Lark Buntings used stubble fields for nesting during the early part of the breeding season and used native grassland on hillsides, where vegetation was sparser, later in the breeding season (Wilson, 1976).

Seasonal moisture levels and summer temperatures may affect the occurrence and survivability of Lark Buntings, but, as Niemuth and others (2017) stated, the biological meaning of climate variables in models characterizing bird-environment relationships is unclear; climate variables are likely correlates of other factors (for example, plant community composition, primary and secondary productivity) that more directly affect species occurrence, likely in concert with other factors such as soils and landform. In an assessment of BBS data for the conterminous United States, O'Connor and others (1999) reported a negative relationship between Lark Bunting abundance and mean annual precipitation. Wilson and others (2018) analyzed BBS data over a 48-year period to examine whether Lark Bunting breeding distribution shifted relative to changes in a drought index modeled at 1-month and 48-month time scales based on the month of May. Lark Buntings exhibited high interannual variability but small overall variation in distribution, with the distribution centroid of the bunting population shifting only 100 kilometers over 48 years. Lark Buntings exhibited contrasting responses to 1-month versus 48-month drought conditions in that buntings responded favorably to wet spring conditions in the short term but preferred drier conditions over the long term (Wilson and others, 2018). Currie and Venne (2017) analyzed BBS data over a 32-year period to examine whether Lark Bunting breeding distribution shifted relative to changes in breeding-season temperature and concluded that the species was not responding to temperature change. 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). Lark Buntings ranked low in vulnerability during the breeding season at a 1.5 ºC increase, moderate at 2 ºC, and high at 3 ºC.

Using a combination of BBS, eBird (https://www.ebird.org; Sullivan and others, 2009), and point-count data, Nixon and others (2016) modeled the impact of future climate change scenarios on Lark Bunting breeding distribution along the boreal forest-prairie ecotone in Alberta and predicted that buntings would shift gradually northward within the next 80 years, with the potential for expansion of suitable breeding habitat. Peterson (2003) modeled the impact of two climate scenarios—0.5 and 1 percent per year increases in carbon dioxide—on bird species whose geographical distributions were exclusively within the Great Plains, which included the Lark Bunting; Peterson (2003) estimated that Lark Buntings would experience a breeding-range contraction and dramatic distributional movements under the two climate scenarios. Using BBS data for seven States that constitute the northern Great Plains, Niemuth and others (2017) developed spatially explicit models of Lark Bunting distribution from a suite of candidate predictor variables that characterized landscape, weather and climate, bird activity and detectability, topography, and survey structure. The occurrence of Lark Buntings exhibited a nonlinear relationship with mean long-term (30-year) precipitation and mean January temperature. Lark Bunting occurrence was negatively associated with current-year precipitation anomaly, defined as the subtraction of current-year March–June precipitation from the long-term mean to create a variable reflecting the deviation in precipitation for this time period (N.D. Niemuth, Habitat and Population Evaluation Team, U.S. Fish and Wildlife Service, written commun., March 20, 2018).

In the shortgrass steppes of Colorado, Conrey and others (2016) examined the effect of heat, drought, and precipitation on the likelihood of bird species fledging at least one young. Lark Bunting was included with Chestnut-collared Longspur (*Calcarius ornatus*) and Western Meadowlark (*Sturnella neglecta)* in the guild of species nesting in taller grasses interspersed with forbs and low shrubs. The authors concluded that the likelihood for a nest from this guild fledging at least one young was reduced under conditions of drought, high summer temperatures, and storms. Scenarios in which temperature increased by 3 ºC and precipitation decreased by two additional dry days resulted in nest success being halved compared to its current average value. In another Colorado study, Skagen and Yackel Adams (2012) determined that Lark Bunting clutch size, nest survival, and productivity positively covaried with seasonal precipitation. Relatively intense daily precipitation events temporarily depressed daily nest survival, and nest survival was positively associated with average temperatures during the breeding season. At future scenarios with average mean temperature increases of 2 and 3 ºC during the breeding season, the number of young produced per 100 nests increased with increasing temperatures (because of increases in nest survival) but declined with reductions in precipitation. Higher temperatures with no accompanying change in precipitation led to 4–6 percent smaller clutches, 31–50 percent higher daily nest survival, and 5–8 percent lower productivity. These changes yielded 22–32 percent additional young per 100 nests, corresponding to a rise in fecundity from 0.72 to 0.88–0.95. However, under scenarios of rising temperatures and declines in seasonal precipitation, clutch size, daily nest survival, and productivity all declined by 12–14, 27–40, and 7–10 percent, at 2–3 ºC increases, respectively. The number of young per 100 nests declined by 36–46 percent and fecundity declined to 0.39–0.46 (Skagen and Yackel Adams, 2012). In a third Colorado study, Yackel Adams and others (2006) reported that bunting density during a year of normal precipitation was similar to a year of mild drought conditions, but that density was markedly lower during a severe drought. Drought had no effect on daily nest survival, number of young fledged per successful nest, or mass of young at fledging but did have a strong negative effect on post-fledging survival. Nestling size varied more widely during the drought, suggestive of differential feeding of nestlings, and the smallest fledglings had lower survival during the drought. Breeding also terminated 2 weeks earlier during the drought year, possibly because of low food availability (Yackel Adams and others, 2006).

Area Requirements and Landscape Associations

The size of Lark Bunting territories in north-central Colorado was 0.5–1.1 hectares (ha) (Wiens, 1970, 1971; Finch and others, 1987). In South Dakota, territory size averaged about

0.2 ha in idle mixed-grass prairie and alfalfa fields (Pleszczynska, 1977). However, territory size may be difficult to measure for this species because male Lark Buntings communally display within other males' territories (Finch and others, 1987), which has led some observers to believe that territoriality does not exist in the Lark Bunting (Shane, 2020). Territoriality in male Lark Buntings differs from that of other North American grassland songbirds and has been described as having three phases: (1) the preterritorial phase, which occurs during the first few weeks of spring arrival and involves small groups of males performing communal flight displays; (2) the territorial or mate-attraction phase, which involves mostly solitary males confining their activities to a circumscribed area; and (3) the mated phase, in which males are less aggressive toward conspecific males (Taylor and Ashe, 1976; Shane, 2020). Adults with fledglings remain within 1,600 meters (m) (typically within 800 m) of the natal area up to 3 weeks after fledging (Yackel Adams and others, 2001, 2006).

Lark Buntings may be area sensitive, preferring larger grasslands over smaller grasslands. Although the species usually is associated with large areas of contiguous grassland in the northern Great Plains, Johnson and Igl (2001) did not detect any preference for large patches of grasslands, using Lark Bunting abundance and occurrence data from CRP grasslands. In shortgrass prairies in Colorado, Skagen and others (2005) reported that nest survival decreased with increasing size of grassland patch. Three variables (patch size, distance from edge, and vegetation structure) were included in models of nest success, but only patch size best explained daily nest survival. Of 36 nests, 12 were within 50 m of the edges between shortgrass prairies and agricultural fields, which were fewer than expected if nest distribution was random or uniform relative to habitat edges. For the Lark Bunting, no studies have investigated a relationship between patch size and rates of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*).

The abundance of Lark Buntings may be affected by characteristics of the surrounding landscape. Within the Prairie Pothole Region of Canada, Fedy and others (2018) examined the influence of grassland, cropland, shrubland, woodland, and wetland habitats at four scales (400; 800; 1,600; and 3,200 m within BBS stops) on the relative probability of occurrence of Lark Buntings. The best model for predicting occurrence indicated the species' preference for landscapes consisting of tame grasslands and other perennial cropland grown for hay, pasture, or seed within 1,600 m, as well as for a combination of native and tame grassland and an abundance of wetland basins within 3,200 m; the model indicated avoidance of landscapes with shrubland and woodland within 3,200 m (Fedy and others, 2018). Within native pasture, tame pasture, and tame hayland in Saskatchewan, Lark Bunting abundance declined when the amount of native pasture within 1,600 m around each study plot was <20 percent and increased when landscape matrices consisted of 60–80 percent cropland (Davis and others, 2016). The authors indicated that these results were difficult to explain but may be related to the amount of competing habitat surrounding tame and native pastures; males may nest at greater densities in pastures surrounded by cropland, whereas males may nest at lower densities in pastures surrounded by other grasslands because of more nesting opportunities in the surrounding landscape (Davis and others, 2016). Niemuth and others (2017) investigated the relationship between Lark Bunting occurrence and land use within 3,200 m of BBS points throughout the northern Great Plains; occurrence was positively associated with percent coverage of grasslands (native and tame) and shrubland and was negatively associated with percent coverage of emergent wetlands, open water, forest, and developed land. Occurrence also was negatively related to the number of disjunct patches of grassland, wetlands, and forest in the landscape, which is a measure of habitat fragmentation. Lark Bunting occurrence exhibited a quadratic relationship with the amount of cropland in the landscape, indicating that intermediate values of cropland coverage best explained the species' distribution. Using point-count surveys collected over 4 years throughout the northern Great Plains, Dreitz and others (2017) demonstrated that occupancy of Lark Buntings was positively related to latitude and to the percentage of grassland and sagebrush habitat within 1-square-kilometer (km^2) survey plots and negatively related to lands in public ownership. Green and others (2019) collected breeding-season occurrence data throughout the western Great Plains of the United States to create a species distribution model for Lark Bunting that examined local occupancy, extinction, and colonization in relation to annual variation in habitat conditions. Bunting occupancy within 1-km^2 grid cells was higher in grids with more grassland coverage. Extinction (defined as the probability that a grid occupied in 1 year is not occupied in the next year) decreased with increasing grassland cover and with higher than average vegetation greenness (as measured by a Normalized Difference Vegetation Index). Colonization (defined as the probability that a grid not occupied in 1 year is occupied in the next year) increased with increasing shrubland and grassland cover. Buntings were widely distributed across the landscape and were locally prevalent, with high turnover rate, but turnover rate was lowest in areas with high grassland coverage (Green and others, 2019). Using data from 16,728 point-count surveys in the northern Great Plains, Correll and others (2019) quantified the relationship between grassland habitat specialism and species population trends; the authors determined that species with high specialism rankings, such as the Lark Bunting, are more likely to experience declining population trends.

In South Dakota mixed-grass prairies, occurrence and density of Lark Bunting were positively associated with the amount of grassland surrounding the patch within 3,200 m; occurrence also was positively associated with the amount of grassland at 1,600 m (Greer, 2009; Greer and others, 2016). Probability of occurrence for Lark Buntings was <10 percent when the surrounding landscape contained <40 percent grass within 3,200 m but increased to 50 percent when grassland habitat occupied greater than (>) 90 percent of the surrounding landscape (Greer and others, 2016). In Colorado, Kansas, Nebraska, and Oklahoma, Lark Bunting occurrence was negatively related to the amount of woodland at all spatial scales examined (300; 600; 1,200; and 2,400 m), to shrubland at the 300- and 600-m scales, and to the number of land-cover patches at the 1,200- and 2,400-m scales (McLachlan, 2007).

Brood Parasitism by Cowbirds and Other Species

Rates of cowbird brood parasitism for Lark Bunting are summarized in Shaffer and others (2019). Generally, Lark Bunting nests are parasitized infrequently by Brown-headed Cowbirds; however, they may be common hosts in local situations (Friedmann, 1963; Friedmann and others, 1977). Because of the Lark Bunting's irruptive behavior, in some years it may occur in areas of higher frequencies of cowbird parasitism (for example, Koford and others, 2000). Parasitism rates vary from 0 percent of 30 nests (Shane, 2020) to 61 percent of 23 nests (Koford and others, 2000). Lark Bunting nests may be multiply parasitized (Allen, 1874; Knapton, 1979; Davis and Sealy, 2000; Igl and Johnson, 2007). In Kansas, Lark Buntings were considered unimportant hosts because of loss of nests to farming operations, ejection of cowbird eggs, and desertion of parasitized nests by adults (Hill, 1976). Furthermore, in Saskatchewan (Lusk, 2009), Manitoba (Davis, 1994; Davis and Sealy, 2000), and Kansas (Wilson, 1976), Lark Buntings with parasitized nests failed to fledge any Brown-headed Cowbird young. In Saskatchewan, Sealy (1999) reported that of nine Brown-headed Cowbird eggs found in five nests, seven eggs were accepted, and two eggs were buried in the nest lining. Seven other nests contained cowbirds in the nestling stage. Of five experimentally parasitized nests, cowbird eggs were accepted in four nests. The cowbird egg disappeared within 24 hours from the fifth nest, which was naturally parasitized 3 days after the experimental egg disappeared. The naturally laid cowbird egg hatched.

Breeding-Season Phenology and Site Fidelity

The breeding season extends from early May to early August, although Lark Buntings still may be present on the breeding grounds in the fall (Cameron, 1908; Baumgarten, 1968; Giezentanner and Ryder, 1969; Creighton, 1971; Maher, 1974; Wilson, 1976; Knapton, 1979; Johnson, 1981; Skagen and Yackel Adams, 2010; Shane, 2020). In Kansas, males arrived on the breeding grounds earlier than females and acquired territories (Shane, 2020). In North Dakota, peak breeding occurs from early June to early August (Stewart, 1975). Strong (1971) reported that Lark Buntings produced single broods; however, Langdon (1933) and Shane (2020) indicated that Lark Buntings were sometimes double-brooded. In the Pawnee National Grassland in Colorado, Yackel Adams and others (2007) reported that seven of 27 females that successfully fledged young from their initial nest produced a second nest.

Lark Buntings usually renest after loss of their initial nest (Shane, 2020). Yackel Adams and others (2007) reported that 27 of 39 females that failed in their initial nesting attempt remained in the area to renest; renesting attempts typically were in the proximity (average 199 m) of the initial nest. Seventeen of the 27 second nests failed, and 37 percent of the 27 females renested a third time.

Lark Buntings may exhibit site fidelity (Shane, 2020). In Colorado, a male bunting was recaptured 3 years later in the same general area in which he was banded (Klimkiewicz and Futcher, 1987). In a second Colorado study, two birds were recaptured in the same location in which they were banded the previous year, and a female returned the 2 years following banding to within 0.8 kilometer of where she was initially banded (Ryder, 1972).

Species' Response to Management

Management for the Lark Bunting and monitoring the species' response to management may be difficult on the periphery of the species' breeding range, as Lark Buntings fluctuate locally in numbers from year to year because of their irruptive behavior and shifts in distribution and abundance (Hibbard, 1965; Baumgarten, 1968; Wilson, 1976; Shane, 2020). This behavior may be related to annual variation in precipitation and fluctuating habitat conditions (Tout, 1902; Yackel Adams and others, 2006; Wilson and others, 2018).

Little information is available on the effects of burning on Lark Buntings. In south-central Montana, Lark Buntings avoided burned areas where brush cover had been eliminated (Bock and Bock, 1987). In Nebraska, Lark Buntings were present in pastures that were both grazed by American bison (*Bison bison*) and burned; they were not present in areas grazed by cattle (Griebel and others, 1998). In a study evaluating patch-burn management in shortgrass steppe in Colorado, Lark Buntings were 2–3 times less abundant on 1–3 year-old burned areas compared to unburned controls (Augustine and Derner, 2015). Patch-burn grazing management under moderate livestock stocking rates (0.6 animal unit month [AUM] per ha) reduced Lark Bunting abundance, as habitats that had taller vegetation structure preferred by the species were less likely to occur with patch burning. Lark Bunting densities increased as time since burning increased. Skagen and others (2018) expanded on the experimental study by Augustine and Derner (2015) and determined that patch-burn grazing also affected the distribution of nesting effort by Lark Buntings, but the direction of the effects depended on weather patterns; patch-burn grazing management and drought had significant negative effects on Lark Bunting reproduction. Skagen and others (2018) indicated that the value of retaining tall-structured vegetation in unburned and lightly or ungrazed areas to provide habitat for Lark Buntings during droughts may be negated by the species' large-scale shifts in abundance during those periods.

The effects of mowing during the breeding season are not well known for the Lark Bunting but likely include lower productivity because of destruction of nests (Davis and others, 2016). In Saskatchewan, Lark Buntings were found in native and tame pastures but not in annually mowed hayfields (Davis and others, 2016). However, in another Saskatchewan study, Lark Buntings nested only in planted haylands and rarely used native grasslands (Maher, 1974). In North Dakota, the species avoided haylands that were mowed the previous year (Kantrud, 1981). 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 Lark Bunting's response to haying varied geographically but was inconsistent among the five 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.

Grazing effects on Lark Buntings vary depending on grassland type and grazing intensity. Based on a habitat suitability model, Finch and others (1987) suggested that allowing heavy grazing in vegetation taller than 30 cm would provide suitable habitat for breeding Lark Buntings. In mixed-grass prairies in Saskatchewan, stocking rates (0.25–0.54 AUM per ha) within lightly and moderately grazed pastures did not affect nest success in either year of a 2-year study (Lusk, 2009; Lusk and Koper, 2013). In Montana grasslands dominated by Wyoming big sagebrush (*Artemisia tridentata* subspecies *wyomingensis*) and intermixed with western wheatgrass (*Pascopyrum smithii*), needle and thread (*Hesperostipa comata*), blue grama (*Bouteloua gracilis*), and junegrass (*Koeleria macrantha*), Golding and Dreitz (2017) reported that Lark Buntings were more abundant in areas with season-long grazing (continuous grazing during growing season) than areas with rest-rotation grazing (alternating 2–3 month grazing periods, followed by 15–18 months of rest). In Montana mixed-grass prairies, nest densities did not differ between grazed and ungrazed sites, but more Lark Buntings were detected on point counts in ungrazed sites than grazed sites in 1 of 2 years (Logan, 2001). There were no differences in clutch size or the number of young fledged per successful nest between grazed and ungrazed plots, but the number of young fledged per nest attempt was greater in ungrazed plots than in grazed plots in 1 of 2 years. Nestling period daily survival rates in both years and incubation period daily survival rates in 1 of 2 years were higher on ungrazed than on grazed plots (Logan, 2001).

In mixed-grass prairies in North Dakota, Lark Bunting densities were highest in moderately grazed areas (Kantrud, 1981). In another North Dakota study in mixed-grass prairies, the Lark Bunting was among the most common species on plots that were heavily grazed (0.74–1.76 AUMs per ha) by cattle and were absent from plots that were lightly grazed (0.28–0.31 AUM per ha) by bison (Lueders and others, 2006). In that same study, Lark Bunting density decreased with distance from livestock water developments (Fontaine and others, 2004). Vegetation height-density and litter depth increased and cow dung coverage and vegetation structural variability decreased with distance from water, presumably because of reduced grazing pressure. In South Dakota mixed-grass prairies, Lark Buntings selected areas of moderate-to-heavily grazed pastures with low vegetation densities and high coverage of bare ground (Greer 2009). In the Nebraska Sandhills, Kempema (2007) examined the effect of duration of grazing systems on Lark Bunting density. Average grazing duration and intensity during the growing season (May 1–September 30) were a rotation of 3 days of grazing at 1.4 AUMs per ha for the short-duration system, 23 days at 1.3 AUMs per ha for the medium-duration system, and 78 days at 1.4 AUMs per ha for the long-duration system. Lark Bunting density was highest on the short-duration system and lowest on the long-duration system.

In shortgrass prairies, heavy grazing often is detrimental to Lark Buntings because it increases bare ground cover, reduces vegetation height, and removes protective nesting cover (Rand, 1948; Ryder, 1980; Bock and others, 1993). In shortgrass prairies and shrubsteppe habitats in north-central Colorado, lightly to moderately grazed areas were preferred over heavily grazed areas (Giezentanner, 1970; Strong, 1971; Porter and Ryder, 1974; Ryder, 1980; Bock and others, 1993). Lark Buntings preferred nesting in pastures that were lightly grazed in the summer, followed by pastures that were heavily or moderately grazed in winter, and pastures that were moderately grazed in summer; they were absent from pastures that were heavily grazed in summer (Giezentanner and Ryder, 1969; Giezentanner, 1970; Wiens, 1970, 1973). With and Webb (1993) reported Lark Buntings nesting in moderately grazed shortgrass prairies in Colorado. In another Colorado study, Davis and others (2020) reported no differences in the densities of Lark Buntings between the traditional system of continuous, season-long grazing and a system of rest-rotational, multi-pasture grazing. Both grazing systems had stocking rates ranging from 0.61 to 0.70 AUM per ha, but the rest-rotational system also incorporated periods when grazing was not applied and periods when grazing was intensively applied. Although grazing did not impact bunting density, year and ecological site (that is, a distinctive soil and plant community) did; Lark Buntings were more abundant during years of high precipitation and less abundant during years of average precipitation, and buntings were more abundant in loamy and sandy plains ecological sites than in salt flats (Davis and others, 2020). In Colorado, Montana, Nebraska, North Dakota, South Dakota, and Wyoming, densities of Lark Buntings were lowest on heavily grazed, warm, dry ustic aridisol soils; densities were unaffected by grazing on cool, moist, typic boroll soils (Kantrud and Kologiski, 1982). Densities were highest on heavily grazed, warm, moist, typic ustoll soils and on moderately or heavily grazed, cool, moderate-to-dry, aridic boroll soils and borollic aridisol soils.

Lark Buntings are common in PCP and CRP grasslands (Johnson and Schwartz, 1993a, 1993b; Johnson and Igl, 1995; McMaster and Davis, 1998). In aspen (*Populus* spp.) parklands in Alberta, Saskatchewan, and Manitoba, Lark Buntings were more common in PCP grasslands than in cropland; frequency of occurrence did not differ between hayed and grazed PCP sites (McMaster and Davis, 1998). In portions of Montana, North Dakota, and South Dakota, Lark Buntings were abundant in native and tame CRP grasslands, although they were less common in areas with a high percentage cover of grasses and legumes (Johnson and Schwartz, 1993a, 1993b). In North Dakota, Johnson and Igl (1995) reported that the Lark Bunting was more common in CRP grasslands than in cropland and projected that the species' statewide population would decline by 17 percent if the CRP was terminated and grasslands enrolled in the program were returned to cultivation. In Colorado, Kansas, Nebraska, and Oklahoma, Lark Buntings were significantly more abundant in CRP fields and shortgrass prairies than in dryland agriculture fields; no significant difference in abundance occurred between CRP fields and shortgrass prairies (McLachlan, 2007).

Lark Buntings may use agricultural fields during the breeding season (Lokemoen and Beiser, 1997; Igl and others, 2008), but Quinn and others (2017) demonstrated that Lark Bunting populations fare poorly in intensely agricultural landscapes. In Nebraska, Lark Buntings occasionally nested in cropland (Faanes and Lingle, 1995). The highest breeding densities occurred in wheat and wheat stubble (22 pairs per km^2), followed by shortgrass and mixed-grass prairies (15.7 pairs per km^2), alfalfa fields (3.2 pairs per km^2), and wet meadows (1 pair per km^2). Although the highest breeding densities were in wheat and wheat stubble, Faanes and Lingle (1995) noted that nests in that habitat may have been destroyed by frequent disturbances. In North Dakota, Lark Buntings nested in minimum-tillage cropland (Lokemoen and Beiser, 1997). Minimum tillage was defined as seeding into untilled or moderately tilled plant residue; weeds in crop fields were controlled by herbicides. Lark Buntings did not nest in conventionally tilled cropland. Conventional tillage was defined as tillage in spring and fall, with use of herbicides and tillage to control weeds. Quinn and others (2017) reported that Lark Bunting populations decreased across a recent 42-year period within 41 counties within the Corn Belt of Iowa, Nebraska, Colorado, and Wyoming. During this period, total area planted to cropland agriculture, biomass yield of crops, and chemical use increased 40, 100, and 500 percent, respectively. Lark Bunting abundance sharply declined as chemical use and the total area farmed increased.

In shortgrass prairies in Wyoming, diazinon applications for grasshopper (Acrididae) control resulted in population declines and mortalities of Lark Buntings (McEwen and others, 1972). At the Pawnee National Grassland in Colorado, malathion and toxaphene were applied at rates of 0.6 kilogram (kg) per ha and 1.1 kg per ha, respectively (McEwen and Ells, 1975). Densities of Lark Buntings were higher in untreated grasslands than in grasslands treated with malathion or toxaphene.

There is limited information on the effects of energy development on Lark Buntings. 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 (Trail, 2006). Meadowlarks (*Sturnella* spp.) and the Lark Bunting were the two most common species recovered from oil pits; remains of 140 Lark Buntings were identified in oil pits in California, Colorado, Illinois, Indiana, Kansas, Michigan, Nebraska, and Texas. 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 Lark Bunting scored a 1.89 out of nine, and Beston and others (2016) estimated that 3.36 percent of the Lark Bunting breeding population in the United States may be exposed to wind facilities. 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 Lark Bunting mortality was reported at one wind facility. Keinath and Kauffman (2014) indicated that Lark Buntings were among the top 20 of 156 ranked species of conservation concern for exposure to wind, oil, and gas developments in Wyoming.

Management Recommendations from the Literature

Conservation of native rangeland is important in maintaining populations and high reproductive success of Lark Buntings (Davis and others, 2016; Greer and others, 2016). The continuation of agricultural set-aside programs, such as the CRP, is also critical as a source of suitable habitat (Johnson and Igl, 1995, 2001; McLachlan, 2007). The removal and minimization of invasive plants species would be most beneficial in landscapes with existing native grasslands (Greer and others, 2016). Although large grassland areas are important for the conservation of Lark Buntings and their habitat (Greer and others, 2016; Shane, 2020), small patches may have value as well (Skagen and others, 2005), especially those with tall-structured vegetation (Skagen and others, 2018). However, Quinn and others (2017) cautioned that conservation efforts focused on local remnant or restored patches, without consideration of the matrix of land uses within the surrounding landscapes, may be counterproductive, especially in landscapes dominated by intense agriculture. Dreitz and others (2017) recommended conserving sagebrush habitats for the benefit of Lark Bunting populations.

Human activity near nest sites during the breeding season may lower productivity, and caution should be exercised around nest sites (Creighton, 1971). For example, mammalian predators, such as thirteen-lined ground squirrels (*Ictidomys tridecemlineatus*), may follow researchers' scent trails to nests.

The management of Lark Buntings presents challenges owing to the species' irruptive nature, characterized by high interannual variability in local population numbers (Wilson and others, 2018; Shane, 2020). Lark Buntings may be impacted equally or more strongly by precipitation levels than management treatments, including for abundance (Yackel Adams and others, 2006; Augustine and Derner, 2015; Davis and others, 2020) and nest success (Skagen and Yackel Adams, 2012; Conrey and others, 2016). For example, Davis and others (2020) demonstrated that year and ecological-site characteristics affected Lark Bunting density more than did grazing management. Management objectives may be unsuccessful if managers fail to account for the unique soil and plant-community characteristics and the annual variation in climate variables of the landscape under management consideration (Davis and others, 2020).

Fires that remove all brush cover should be avoided, particularly in areas where the Lark Bunting is largely associated with shrubs (Woolfolk, 1945; Bock and Bock, 1987; Dreitz and others, 2017). Lark Buntings avoided burned areas in Montana shrubsteppe after wildfire removed all brush (Bock and Bock, 1987). Patch-burn grazing management in shortgrass prairies did not enhance habitat for Lark Buntings, as the tall vegetation preferred by this species was removed (Augustine and Derner, 2015). Despite annual fluctuations in precipitation, Lark Buntings preferred unburned grasslands. To benefit Lark Buntings, Augustine and Derner (2015) recommended alternative management strategies to patch-burn grazing, such as periodic rest from livestock grazing in areas not burned for >3 years. Skagen and others (2018) suggested employing a diversity of management strategies, including patch-burn grazing, but patch-burn grazing should be applied only on a portion of the landscape.

Delaying mowing of hayfields until after the species' breeding season may prevent destruction of nests (Davis and others, 2016). In some areas, hayland may be an important habitat for Lark Buntings; hayland was preferred over uncultivated grassland in Saskatchewan (Maher, 1974), and in Kansas, Lark Buntings had higher nest success in alfalfa fields than in stubble fields (Wilson, 1976).

The implementation of grazing treatments may need to be tailored to grassland type and to topoedaphic and precipitation conditions, as Lark Buntings may respond more strongly to soil type and precipitation than to grazing system (Lipsey and Naugle, 2017; Davis and others, 2020). In mixed-grass prairies, low-to-moderate grazing that allows for some tall, dense vegetation to remain will be beneficial to Lark Buntings (Lusk and Koper, 2013). Allowing heavy grazing in vegetation >30 cm tall may provide the shorter, sparser habitat preferred by Lark Buntings (Finch and others, 1987). Shortgrass habitats should not be heavily grazed during the summer (Giezentanner, 1970; Wiens, 1973; Ryder, 1980). Giezentanner (1970) and Ryder (1980) recommended light summer grazing or grazing during winter, provided that vegetative cover and height are not greatly reduced. In sagebrush grasslands, Golding and Dreitz (2017) indicated that a single grazing system (such as season-long grazing) can be used to alter the abundance of an individual songbird species (such as the Lark Bunting) but a mosaic of numerous grazing systems will maintain ecological functions and the abundance and distribution of the entire songbird community.

In cultivated areas, disking and other mechanized disturbances may destroy nests and cause adult Lark Buntings to abandon nesting areas (Wilson, 1976; Faanes and Lingle, 1995). In North Dakota, Lark Buntings nested in cropland that was under minimum tillage (Lokemoen and Beiser, 1997). No-tillage or minimum tillage was recommended as an alternative to fall cultivation.

Maintaining rangeland in good condition may reduce the risk of pest outbreaks and the need for pest management involving chemical control (McEwen and others, 1972). When pest management is required, McEwen and others (1972) recommended using only rapidly degrading chemicals of low toxicity to nontarget organisms and to apply them at the lowest application rates possible.

To make oil production waste fluids inaccessible to Lark Buntings and other birds, Trail (2006) recommended replacing open oil pits with closed tanks or other closed containment systems. If open pits are retained, Trail (2006) recommended increased netting to exclude wildlife. To be effective, netting should be sturdy and supported by a steel frame to provide complete enclosure and should be maintained and monitored to ensure that it remains effective under all conditions.

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Table EE1. Measured values of vegetation structure and composition in Lark Bunting (*Calamospiza melanocorys*) 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; >, greater than; spp., species (applies to two or more species within the genus)]

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)
Baldwin and others, 1969 (nests)	Colorado	Shortgrass prairie	Grazed	15–28	--	--	--	--	--	--	--
Creighton, 1974	Colorado	Mixed-grass prairie	Grazed	13.4	--	71	7	2	10	--	--
Greer, 2009[a]	South Dakota	Mixed-grass prairie	Multiple	72[b]	8[c]	50.8	23.7	1.4	14.2	12.4	0.8
Johnson, 1981 (nests)	Utah	Desert shrub	--	24	--	--	--	--	--	--	--
Logan, 2001 (nests)	Montana	Mixed-grass prairie	Grazed	19.2[b]	6.9[c]	--	--	--	--	--	--
Logan, 2001 (nests)	Montana	Mixed-grass prairie	Ungrazed	25.8[b]	10.5[c]	--	--	--	--	--	--
Logan, 2001	Montana	Mixed-grass prairie	Grazed	12.4[b]	2.2[c]	13.4	2.8	10.7	56.8	--	0.4
Logan, 2001	Montana	Mixed-grass prairie	Ungrazed	15.1[b]	3.4[c]	17.7	3.3	7.3	44.8	--	0.6
Lueders and others, 2006	North Dakota	Mixed-grass prairie	Cattle-grazed	--	7[c]	35.3[d]	11.7	0.4	22.4	24.6	1.2
Lusk, 2009[e] (nests)	Saskatchewan	Mixed-grass prairie	Grazed, ungrazed	--	--	28.4	1.2	13.5	0.1	37.2	2.1
Shane, 1972	Kansas	Multiple	Multiple	23.3	--	--	48.2	--	--	--	--
Shane, 1972 (nests)	Kansas	Multiple	Multiple	25.2	--	--	--	--	--	--	--
Smith and Smith, 1966 (nests)	Saskatchewan	Mixed-grass prairie	Grazed	18–61	--	--	--	--	--	--	--
Walcheck, 1970	Montana	Greasewood-sagebrush shrubland	--	--	--	24	25	17	20	--	--
Wiens, 1970[e] (territories)	Colorado	Shortgrass prairie	Summer-grazed	--	0.6[f]	70	0	0	30	16.3	0.2
Wiens, 1970[e] (territories)	Colorado	Shortgrass prairie	Winter-grazed	--	0.9[f]	79.5	4.5	2.5	14.5	25.7	0.3
Wiens, 1973[e]	Colorado	Shortgrass prairie	Heavy winter-grazing intensity	8.1[g]	0.5[f]	82	6	2	16	24	0.3
Yackel Adams and others, 2006[h]	Colorado	Shortgrass prairie	Grazed	5.7–10.5[b]	--	42.9–56.9	0.8–7.5	--	--	--	--

[a]The sum of the percentages is >100%, based on methods described by the author.

[b]Grass height.

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

[d]Grass and sedge (*Carex* spp.) combined.

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

[f]Effective vegetation height.

[g]Emergent vegetation height.

[h]The range of averages represent averages of 3 years, including 1 year of normal precipitation, 1 year of mild drought, and 1 year of severe drought.

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