The Effects of Management Practices on Grassland Birds—Long-Billed Curlew (*Numenius americanus*)

Chapter G of

The Effects of Management Practices on Grassland Birds

Professional Paper 1842–G

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

Cover. Long-billed Curlew. Photgraph by David O. Lambeth, 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—Long-Billed Curlew (*Numenius americanus*)

By Jill A. Shaffer,[1] Lawrence D. Igl,[1] Douglas H. Johnson,[1] Marriah L. Sondreal,[1] Christopher M. Goldade,[1,2] Paul A. Rabie,[1,3] and Betty R. Euliss[1]

Chapter G 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[1,4]

[1]U.S. Geological Survey.

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

[3]Western Ecosystems Technology, Inc. (current).

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

Professional Paper 1842–G

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

U.S. Geological Survey, Reston, Virginia: 2019

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.

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this information product, for the most part, is in the public domain, it also may contain copyrighted materials as noted in the text. Permission to reproduce copyrighted items must be secured from the copyright owner.

Suggested citation:
Shaffer, J.A., Igl, L.D., Johnson, D.H., Sondreal, M.L., Goldade, C.M., Rabie, P.A., and Euliss, B.R., 2019, The effects of management practices on grassland birds—Long-billed Curlew (*Numenius americanus*), chap. G *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, 12 p., https://doi.org/10.3133/pp1842G.

ISSN 2330-7102 (online)

Contents

Acknowledgments iv
Capsule Statement 1
Breeding Range 1
Suitable Habitat 1
Area Requirements and Landscape Associations 5
Brood Parasitism by Cowbirds and Other Species 5
Breeding-Season Phenology and Site Fidelity 5
Species' Response to Management 6
Management Recommendations from the Literature 7
References 8

Figure

G1. Map showing breeding distribution of the Long-billed Curlew (*Numenius americanus*) in the United States and southern Canada, based on North American Breeding Bird Survey data, 2008–12 2

Table

G1. Measured values of vegetation structure and composition in Long-billed Curlew (*Numenius americanus*) breeding habitat by study 12

Conversion Factors

International System of Units to U.S. customary units

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

Abbreviations

DDE	dichlorodiphenyldichloroethylene
n.d.	no date
ppm	parts per million
spp.	species (applies to two or more species within the genus)
VOR	visual obstruction reading

Acknowledgments

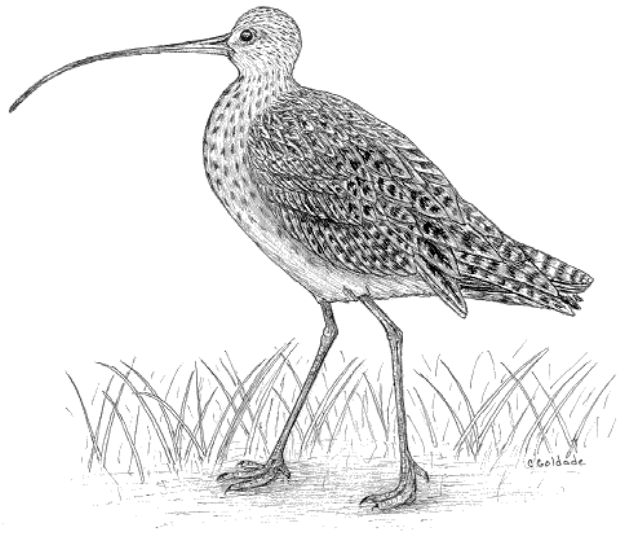
Major funding for this effort was provided by the Prairie Pothole Joint Venture, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey. Additional funding was provided by the U.S. Forest Service, The Nature Conservancy, and the Plains and Prairie Potholes Landscape Conservation Cooperative. 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, 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. We thank Christopher M. Goldade for his illustration of the Long-billed Curlew and the U.S. Geological Survey's Patuxent Wildlife Research 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 Jane E. Austin, Roland L. Redmond, and Brian A. Tangen.

The Effects of Management Practices on Grassland Birds—Long-Billed Curlew (*Numenius americanus*)

By Jill A. Shaffer,[1] Lawrence D. Igl,[1] Douglas H. Johnson,[1] Marriah L. Sondreal,[1] Christopher M. Goldade,[1,2] Paul A. Rabie,[1,3] and Betty R. Euliss[1]

Capsule Statement

Keys to Long-billed Curlew (*Numenius americanus*) management include providing large, open, level to gently rolling grasslands with short vegetation, and tailoring grazing regimes to local conditions. Long-billed Curlews have been reported to use habitats with 3–75 centimeters (cm) average vegetation height, less than or equal to 27 cm visual obstruction reading (VOR), 20–71 percent grass cover, 4–50 percent forb cover, 2–12 percent shrub cover, 7–40 percent bare ground, and less than (<) 3 cm litter depth. Descriptions of key vegetation characteristics are provided in table G1 (after the "References" section). Vernacular and scientific names of plants and animals follow the Integrated Taxonomic Information System (https://www.itis.gov).



Long-billed Curlew. Illustration by Christopher M. Goldade, U.S. Geological Survey.

Breeding Range

Long-billed Curlews breed from interior British Columbia and southern Alberta through southern Manitoba; south to central California; and east to southwestern North Dakota, central South Dakota, central Nebraska, western Kansas, northeastern New Mexico, and northern Texas (National Geographic Society, 2011). The relative densities of Long-billed Curlews in the United States and southern Canada, based on North American Breeding Bird Survey data (Sauer and others, 2014), are shown in figure G1 (not all geographic places mentioned in report are shown on figure).

Suitable Habitat

Long-billed Curlews use expansive, open, level to gently sloping or rolling grasslands with short vegetation such as shortgrass prairies or recently grazed mixed-grass prairies (Salt and Wilk, 1958; Bent, 1962; Graul, 1971; Stewart, 1975; Johnsgard, 1980; Bicak and others, 1982; Cochran and Anderson, 1987; Shackford, 1987; Eldridge, 1992; Clarke, 2006). They commonly nest in wet and dry prairies and in rangeland and occasionally nest in hayland, fallow fields, or stubble fields (Salt and Wilk, 1958; Bent, 1962; McCallum and others, 1977; Renaud, 1980; Cochran and Anderson, 1987; Shackford, 1994; Dugger and Dugger, 2002; Ackerman, 2007). Long-billed Curlews have been found nesting in cultivated land, such as fall-seeded winter wheat (*Triticum* species [spp.]) or spring-seeded barley (*Hordeum* spp.) (Devries and others, 2010), and will use cropland if native grasslands are not available (Saunders, 2001). Smith and Lomolino (2004) found a preference for shortgrass prairies with black-tailed prairie dog

[1]U.S. Geological Survey.

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

[3]Western Ecosystems Technology, Inc. (current).

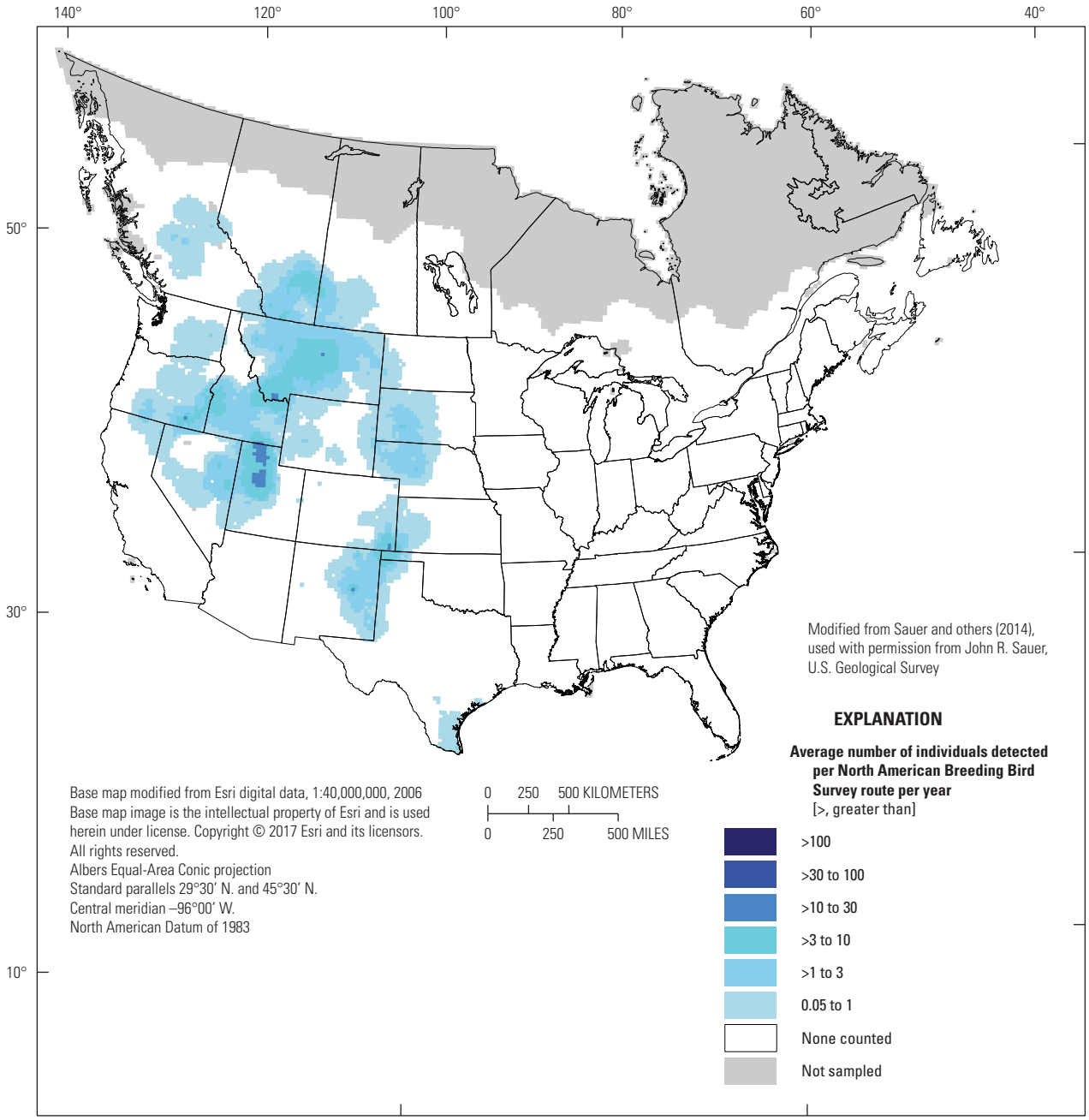


Figure G1. Breeding distribution of the Long-billed Curlew (*Numenius americanus*) in the United States and southern Canada, based on North American Breeding Bird Survey (BBS) data, 2008–12. The BBS abundance map provides only an approximation of breeding range edges.

(*Cynomys ludovicianus*) towns over shortgrass prairies without prairie dogs, fallow crop fields, scrub-sandsage, and Conservation Reserve Program grasslands. Long-billed Curlews occasionally inhabit grasslands enrolled in the Permanent Cover Program in Canada (McMaster and Davis, 1998).

Long-billed Curlews use a variety of vegetation types and prefer somewhat short vegetation. From a range-wide survey of Long-billed Curlews in the United States, Saalfed and others (2010) determined that the species preferred shortgrass prairies and rangeland, with vegetation height ranging from 4 to 15 cm, within 400 meters (m) of survey stops along roads (excluding interstate highways and roads with two or more lanes). Numbers of curlews were negatively associated with shrub or scrub habitats. Within 800 m of stops, Long-billed Curlews were positively associated with rangeland and hayland and negatively associated with evergreen forests. In Alberta, the strongest predictor of curlew numbers was the percentage of each sampling unit that was native grassland, whereas curlew numbers were negatively associated with the percentage of each sampling unit that was cultivated land

or riparian area (Saunders, 2001). In Nebraska, the species used areas in which 75 percent of the total vertical vegetation density (number of plant contacts with a thin rod inserted vertically into the canopy) was at heights <10 cm, compared to 63 percent in unused areas (Bicak, 1977). Preference for areas in which vegetation density is concentrated near ground level may be important in terms of the feeding behavior of Long-billed Curlews or their ability to see potential predators. In Colorado, the species used shortgrass and mixed-grass prairies and weedy areas more than expected based on the availability of those habitats, and they used agricultural areas (for example, cropland, stubble fields, and bare ground) less than expected; they did not use areas dominated by sand sagebrush (King, 1978). In north-central Oregon, areas of shrubs or areas of downy brome (*Bromus tectorum*) intermixed with patches of Sandberg's bluegrass (*Poa secunda*) were preferred or used in proportion to availability (Pampush, 1980; Pampush and Anthony, 1993). Areas of dense forbs, antelope bitterbrush (*Purshia tridentata*), and bunchgrasses were used in proportion to their availability or were avoided. Bunchgrass habitats used by adults for brood rearing were contiguous with downy brome areas used as nesting sites.

Long-billed Curlews forage in grasslands, cultivated fields, stubble fields, wet meadows, prairie dog colonies, and occasionally along wetland margins (Silloway, 1900; Salt and Wilk, 1958; Johnsgard, 1980; Shackford, 1987; Prescott, 1997). During the incubation period in southwestern Idaho, Long-billed Curlew prey-capture rates were higher in areas with short grass even though prey density was higher in areas with tall grass (vegetation measurements, prey densities, and prey capture rates were not given) (Bicak and others, 1982; Bicak, 1983). Prelaying female curlews in western Idaho foraged in shortgrass pastures within their territories during years when vegetation was short (3.6–9.7 cm tall) (Redmond, 1986). However, during a year when vegetation was dense and tall (12–15.7 cm tall, with areas as high as 40 cm tall) owing to abundant precipitation, curlews flew as far as 10 kilometers (km) from their territories to forage. In south-central Washington, Long-billed Curlews preferred to forage in areas with higher topographic diversity (ridges and small dunes) and higher plant species diversity than in flatter areas with more homogeneous vegetation (Allen, 1980).

Nests often are located near cow dung or other conspicuous objects, possibly for concealment (Silloway, 1900; Bent, 1962; King, 1978; Johnsgard, 1979; Allen, 1980; Cochran and Anderson, 1987; Clarke, 2006). Additionally, nests often are placed on hummocks greater than or equal to 2.5 cm above the immediate surroundings, possibly to improve visibility of predators and to prevent flooding in otherwise level fields (Cochran and Anderson, 1987).

In North Dakota mixed-grass and shortgrass prairies, Long-billed Curlews prefer gently rolling terrain with gravelly soils (Stewart, 1975). In central Montana, Long-billed Curlews nested on dry portions of mixed-grass prairies, which were elevated above their surroundings and located near wet meadows (Silloway, 1900). Long-billed Curlews in Nebraska nest on upland slopes of native vegetation near moist meadows that are used for foraging (Johnsgard, 1980). Grassy flood plains adjoining a creek provided nesting habitat in southeastern Colorado (Davis, 1949). In the Oklahoma Panhandle, Long-billed Curlews usually were observed in areas with clay loam soils on <1 percent slopes (Shackford, 1987). In northern Utah, Long-billed Curlew nests were found in irrigated and nonirrigated grass pastures and on alkali flats (Sugden, 1933; Forsythe, 1972; Paton and Dalton, 1994). Nests in that area were built in bunchgrasses, clumps of sedges (*Carex* spp.), stands of inland saltgrass (*Distichlis spicata*), or red saltwort (*Salicornia rubra*) (Forsythe, 1972). In south-central Washington, Long-billed Curlew breeding density was higher in topographically diverse areas, although most nests were placed on somewhat flat ground (neither the proportion of nests nor the slope of the ground was given) (Allen, 1980). Of 59 nests, 37 percent were 30–100 cm from an object (for example, big sagebrush (*Artemisia tridentata*) branches, rocks, dirt mounds, horse manure, metal cans, bunchgrasses), 31 percent were less than or equal to 30 cm from an object, 27 percent were immediately adjacent to an object, and only 5 percent were greater than 100 cm from an object (Allen, 1980). Big sagebrush, antelope bitterbrush, trees, dried tumbleweeds (*Salsola* spp.), dirt mounds, rocks, tree stumps, and fences were used as perches.

Vegetation composition and structure play an important role in nest selection. In 1 of 2 years in South Dakota grazed mixed-grass prairies, Clarke (2006) found no difference among nest sites, brood points, and random points for VOR; coverage of grasses, forbs, and bare ground; and distance to water. Long-billed Curlews selected nest sites similar to random points, with an average of 55 percent grass cover, 47 percent forb cover, and an average VOR of 27 cm. The plant species around nest sites ranged from an average height of 10 to 45 cm. In the second year, nest sites were in shorter vegetation with lower VORs than random points (Clarke, 2006). Nest sites had lower shrub coverage than random points, and slope was steeper at random points than at nest sites. In the second year, nest sites had lower VOR, more bare ground, and less forb coverage than in the previous year, whereas brood points also had lower VOR and grass and forb coverage, but more bare ground. Daily nest survival rates were positively related to average VORs taken at nest sites. Daily nest survival rate was higher at nest sites dominated by forb cover than at nest sites dominated by grass cover. Distance to the nearest manure pile was shorter from nest sites than from random points.

At Crescent Lake National Wildlife Refuge in Nebraska, Gregory and others (2011) found strong evidence for a negative effect of large-scale VOR (mean of 16 samples within 2–25 m from nests) on nest survival, and a weak but negative effect of small-scale VOR (mean of 4 samples within 2 m of nest) and forb cover on nest survival. Bare ground had a weak but positive influence on nest survival. Grass cover, litter cover, vegetation depth, and height of tallest vegetation had no influence. In Wyoming, nest sites within hayfields and pastures were characterized by less bare ground and higher percentage

cover of grasses (values were not given) than random sites (Cochran and Anderson, 1987). Hayfields and pastures with nests had lower percentage of grass cover (mean of 20 compared to 32 percent), greater forb cover (mean of 16 compared to 4 percent), and were drier (45 compared to 3 percent of random locations characterized as "dry") than hayfields and pastures without nests. In Colorado and Texas, mean vegetation height was 11 cm centered at seven nests and 20.6 cm at 3 m from nests (King, 1978).

In Utah, 10 habitat patches containing nests had shorter vegetation (mean of 5.6 cm) than random habitat patches (mean of 9.0 cm) and had more bare ground 6–15 m from the nest (mean of 34–36 percent) than random patches (mean of 38–39 percent) (Paton and Dalton, 1994). At nest sites, however, vegetation <3 m from the nest was taller (mean of 6.5 cm) than vegetation 6–15 m from the nest (mean of 4.9–5.5 cm). Percentage of bare ground <3 m from the nest was lower (mean of 18 percent) than greater than or equal to 6 m from the nest (mean of 28–39 percent). In north-central Oregon, several vegetation variables differed between nesting areas and non-nesting areas (Pampush, 1980; Pampush and Anthony, 1993). Compared to non-nesting areas, nesting areas had shorter vegetation (24 compared to 29 cm at non-nesting areas), grass with less variation in height, total vegetation with less variation in height, grass with higher vertical density (0.8 compared to 0.2 contacts per 5-cm height increment) in the 25–50-cm height increment, and shrubs with lower total vertical density (0.02 compared to 0.05 contacts per 5-cm height increment). Nest density within study areas was negatively correlated with vegetation height and vertical density; nest density was positively correlated with percentage cover of bare ground and with the evenness of forb height. Depredation of eggs and chicks was high in habitats other than downy brome, possibly indicating that predator densities were higher or nests were more vulnerable in those habitats.

Exotic or invasive vegetation may reduce or improve habitat quality, depending on plant species and region (Dugger and Dugger, 2002). In South Dakota, nest sites dominated by yellow sweet clover (*Melilotus officinalis*), junegrass (*Koeleria macrantha*), green needlegrass (*Nassella viridula*), and buffalograss (*Bouteloua dactyloides*) had 100-percent daily nest survival rate, whereas survival rates were lower at nest sites dominated by Japanese brome (*Bromus japonicus*) and western wheatgrass (*Pascopyrum smithii*) (Clarke, 2006). American vetch (*Vicia americana*), junegrass, and buffalograss represented a higher proportion of species composition at nest sites than at random points. In southeastern Washington, 71 percent of 21 nests were in areas dominated by a mixture of downy brome and Sandberg's bluegrass and 29 percent were in areas dominated by downy brome alone (Allen, 1980). Nearly all areas containing downy brome and Sandberg's bluegrass were used for nesting, whereas areas containing solely downy brome were not always used for nesting. Allen (1980) attributed preference for areas dominated by the two plant species to a lower percentage cover of live (7 percent) and dead (65 percent) downy brome in those areas than in areas dominated by downy brome alone (live: 14 percent; dead: 92 percent). Plant communities dominated by downy brome but containing substantial amounts of tumbleweed mustard (*Sisymbrium altissimum*), as well as other grass communities (for example, wheatgrass communities), were not used for nesting. In north-central Oregon, mean nest density was highest in downy brome and Sandberg's bluegrass, followed by bunchgrasses, dense forbs and shrubs, and antelope bitterbrush (Pampush, 1980; Pampush and Anthony, 1993). In Colorado and Texas, six of seven nests were in areas dominated by buffalograss and blue grama (*Bouteloua gracilis*), and one nest was in an area dominated by sand dropseed (*Sporobolus cryptandrus*) (King, 1978).

Adults and broods move to habitats surrounding nest sites for cover, shade, and food (Maher, 1973; King, 1978; Allen, 1980; Pampush, 1980; Pampush and Anthony, 1993). After eggs hatch, adults and broods continue to forage in shortgrass and mixed-grass habitats, but they increase their use of areas that have more vegetative cover (for example, cropland, stubble fields, and weedy areas) (Maher, 1973, 1974; King, 1978; Allen, 1980; Pampush, 1980; Pampush and Anthony, 1993), particularly if vegetation is sparse at the nest site (Maher, 1974). In South Dakota, brood habitat contained a greater proportion of sixweeks fescue (*Vulpia octoflora*), Indianwheat (*Plantago* spp.), junegrass, and American vetch than random points in 1 year and a greater proportion of creeping spikerush (*Eleocharis palustris*) and water than random points in another year (Clarke, 2006). Use of areas with tall, dense vegetation in the Texas Panhandle and north-central Oregon may have provided chicks with an important source of shade or concealment cover (King, 1978; Pampush, 1980; Pampush and Anthony, 1993). In central South Dakota, Long-billed Curlews with chicks were reported in grass that was 18 cm tall (Spomer, 1981). In Oklahoma, Long-billed Curlews with young were observed in cultivated fields, shortgrass prairie, and tame grassland (Shackford, 1994).

Proximity to water may be an important factor in habitat selection (Bent, 1962; McCallum and others, 1977; Cochran and Anderson, 1987; Shackford, 1987). From a range-wide survey of Long-billed Curlews in the United States, Saalfed and others (2010) determined that numbers of Long-billed Curlews were positively associated with wetland habitats within 400 m of survey stops along roadsides. In South Dakota, both nest sites and brood locations were within 500 m of the nearest water source (Clarke, 2006). During a dry year, broods used habitats consisting of a greater proportion of water than random points, and broods were located almost 200 m closer to water than in a year of average precipitation. In the Platte River Valley of Nebraska, Long-billed Curlews nested at higher densities in wet meadows than in upland prairies (Faanes and Lingle, 1995). Within the Nebraska sandhills at Crescent Lake National Wildlife Refuge and surrounding grasslands, proximity of mixed-grass uplands to wet meadows was the most important criterion in nest-site selection (Bicak, 1977). Wet meadows were used for feeding, loafing, and fledging young and were aggressively defended. In southeastern

Colorado, 41 percent of 63 Long-billed Curlew observations were within 91 m of standing water, and 68 percent of observations were within 403 m of water (McCallum and others, 1977). In southeastern Colorado and northwestern Texas, 39 percent of 354 curlew observations occurred within 400 m of stock ponds or irrigation facilities (King, 1978). Shackford (1987) suggested that a drop in the water table in the panhandle of Oklahoma caused Long-billed Curlews to favor areas near irrigated fields over upland, shortgrass sites. In Utah, nests often were placed near the edges of alkali flats of the Great Salt Lake (Paton and Dalton, 1994). In southeastern Alberta, Long-billed Curlews were less common on wet transects (defined as having wetlands intersecting transects along greater than 5 percent of their length) than on dry transects (Gratto-Trevor, 1999). Because curlews are known to return to the same area to nest each year, regardless of whether water is still available, curlews may be found nesting far from water if water sources have disappeared between breeding seasons (McCallum and others, 1977). In Alberta, Sliwinski and Koper (2012) found that Long-billed Curlew abundance decreased by 25 percent within 0.31 km of wetland edges, possibly because vegetation density was highest near wetlands.

Seasonal moisture levels may affect the abundance, distribution, and brood-survival rates of Long-billed Curlews. In an assessment of North American Breeding Bird Survey data for the conterminous United States, O'Connor and others (1999) reported a negative relationship between Long-billed Curlew abundance and the mean annual precipitation and the 30-year average of January temperature. Hartman (2008) evaluated the influence of precipitation on brood and chick daily survival rate in northeastern Nevada. The cumulative precipitation from October of the previous year through May of the current year was included as a variable in analyses because it corresponded to the period of greatest precipitation and time during which snowpack used to irrigate Nevada hayfields in the current year accumulated in the nearby mountains. Brood survival rate was slightly greater in years with higher winter precipitation, and individual chick daily survival rate was greater in wet years.

Area Requirements and Landscape Associations

Territory size is highly variable across the species' breeding range (De Smet, 1992). In southwestern Idaho, curlew densities were positively correlated with size of the management unit and with amount of area within the management unit that contained vegetation <10 cm tall (Bicak and others, 1982). Territory size averaged about 14 hectares (ha) in the most densely populated areas, and there was an unoccupied buffer zone of 300–500 m around the edge of suitable habitat (Redmond and others, 1981). In southeastern Washington, areas with diverse topography and habitat (shrubby areas near the nest sites) supported smaller curlew territories (6–8 ha) than did open, flat, less diverse habitat, which supported larger territories (20 ha) (Allen, 1980). An increase in the breeding population between years did not result in the reduction of territory size, but rather resulted in an increased use of marginal habitat. Allen (1980) indicated that the existing territories may have already reached a minimum size. In South Dakota, the average 95-percent home range for five territories in 1 year ranged from 70 to 490 ha and ranged from 52 to 100 ha for the brood-rearing period; in the second year, the 95-percent home range for 13 territories ranged from 115 to 2,910 ha (Clarke, 2006).

After eggs hatch, adults and their broods often leave the nesting area. In southern Saskatchewan, one pair of adults with a brood was recorded more than 6.5 km from the nest site 6 days after hatching (Maher, 1974; Sadler and Maher, 1976).

Little information exists about the effect of habitat fragmentation on Long-billed Curlews. Although Long-billed Curlews prefer large expanses of grasslands, the effects of fragmentation on curlews has been poorly studied but is considered a potential threat to breeding populations (Sedgwick, 2006). In Alberta, Sliwinski and Koper (2012) found no effect of road or cropland edges on curlew abundance. In British Columbia, Ohanjanian (1992) determined that breeding Long-billed Curlews used only grassland areas that were greater than 250 m.

Brood Parasitism by Cowbirds and Other Species

No known records of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) exist (Shaffer and others, 2019). Long-billed Curlews and Willets (*Tringa semipalmata*) will occasionally parasitize each other's nests (Sugden, 1933; Bent, 1962; Dugger and Dugger, 2002).

Breeding-Season Phenology and Site Fidelity

Long-billed Curlews arrive on the breeding grounds from about mid-March through May and depart for the wintering grounds from August to October (Silloway, 1900; Sugden, 1933; Salt and Wilk, 1958; Bent, 1962; Maher, 1974; Stewart, 1975; Allen, 1980; Pampush, 1980; Renaud, 1980; Redmond and others, 1981; Bicak and others, 1982; Paton and Dalton, 1994; Saunders, 2001; Clarke, 2006). In some areas, fall departure may begin as early as June or July (Maher, 1973; King, 1978; Allen, 1980; Clarke, 2006; Page and others, 2014), especially by unsuccessful breeders (Allen, 1980; Paton and Dalton, 1994). Peak breeding season in North Dakota is early May through early June (Stewart, 1975). A single renesting attempt following depredation of a first clutch was observed in south-central Washington (Allen, 1980). The

second nest also was depredated following completion of the clutch. Clarke (2006) reported that one of four radio-marked pairs with a failed first nesting attempt renested in 1 year; the second nest was placed 332 m from the original nest. Six of 13 pairs renested in a second year, with two of those renesting twice, and renest distance ranged from 0.9 to 6 km from the original nest. In Nevada rangeland and hayfields, Hartman and Oring (2009) reported a high proportion of renesting after initial nest attempts, but no cases of double brooding.

Historically occupied sites are reused by curlews every year, and some individual birds may reuse the same territories from year to year (McCallum and others, 1977; Allen, 1980; Redmond and Jenni, 1982, 1986; Cannings, 1999). In South Dakota, 15 of 26 radio-marked adults returned to their breeding site of the previous year; nests were placed 0.1 to 1.1 km from previous nest sites (Clarke, 2006).

Species' Response to Management

Burning can improve habitat for Long-billed Curlews by removing shrubs and increasing habitat openness (Pampush and Anthony, 1993). During the breeding season after a fall range fire, there was a 30-percent increase in the estimated curlew breeding density in western Idaho (Redmond and Jenni, 1986). However, in central South Dakota mixed-grass prairies, curlew density did not differ between fall-burned and unburned pastures (Clarke, 2006).

Haying can be used to provide the short vegetation preferred by nesting curlews (Cochran and Anderson, 1987). In Nevada, hayfields provide suitable habitat for nesting Long-billed Curlews by providing optimal brood-rearing habitat that results in high chick survival (Hartman, 2008). Long-billed Curlews preferred nesting in tame hayfields and open rangeland more so than in shrub-desert rangeland (Hartman and Oring, 2009). Hayfields were irrigated from melting snow, grazed with as many as 4 cattle per ha until early May, and then hayed in mid- to late July; rangeland and shrub-desert plots received low-intensity cattle grazing of <0.25 cattle per ha (Hartman, 2008). Mammal predation accounted for most nest failures, but raking of irrigated hayfields, trampling by cattle, cattle-induced nest abandonment, and flooding owing to irrigation also contributed to nest failures. No chicks were lost to mowing or other ranching activities (Hartman, 2008). Broods that hatched in rangeland moved to hayfields within days of hatching, and no chick mortality was attributed to agricultural activity (Hartman and Oring, 2009).

In Wyoming hay meadows, ranchers traditionally scattered cow dung from fall- and winter-pastured cattle using branches, logs, or harrows (Cochran and Anderson, 1987). This practice, termed "dragging," was detrimental to nesting birds because curlews often built nests near cow dung. The practice generally has declined since the 1960s but still can be common locally. In north-central Oregon, alfalfa (*Medicago sativa*) fields were used for foraging as long as vegetation remained <30 cm tall (Pampush, 1980; Pampush and Anthony, 1993). In Alberta, however, Long-billed Curlews did not use haylands (Prescott, 1997).

Grazing can be beneficial if it provides suitably short vegetation, particularly during the prelaying period (Bicak and others, 1982; Cochran and Anderson, 1987). In Colorado, Montana, Nebraska, North Dakota, South Dakota, and Wyoming, Long-billed Curlews preferred lightly grazed areas with aridic ustoll and aridic borollic soils and heavily grazed areas with typic ustoll soils (Kantrud and Kologiski, 1982). In southern Alberta, Long-billed Curlews used only continuously grazed mixed-grass pastures and were absent from mixed-grass pastures grazed in early summer, spring-grazed tame pastures, and deferred-grazed (grazed after July 15) mixed-grass pastures (Prescott and others, 1993). In Nebraska, curlews were present on grazed areas and were absent from ungrazed areas (Cole and Sharpe, 1976). In Colorado, curlew response to grazing over large areas of mixed-grass and shortgrass prairies was variable, but response to grazing in shrubsteppe habitats was negative (Bock and others, 1993). In Wyoming, nests in areas that were grazed during the incubation period had lower hatching success rates than nests in ungrazed areas (Cochran and Anderson, 1987).

In central South Dakota mixed-grass prairies, curlew density was not related to American bison (*Bison bison*) or cattle density (densities ranged from 0 to 223 bison per square kilometer [km^2] and from 0 to 42 cattle per km^2), and there was no difference in curlew densities between pastures grazed by bison, by cattle, or ungrazed pastures (Clarke, 2006). However, risk of nest trampling was dependent on livestock density. In 1 year, 3 of 15 nests were trampled by bison, with nest trampling starting at a bison density of 218 bison per km^2. In the second year, 5 of 27 nests were trampled by bison, and 3 of 27 nests were trampled by cattle, with nest trampling starting at 77 bison per km^2 and 33 cattle per km^2. Daily nest survival rates were negatively related to density of bison grazed in pastures containing nests. Sugden (1933) cautioned that sheep are more likely to trample nests than cattle. Of 119 nests in western Idaho, 4.2 percent were lost to trampling by livestock (Redmond and Jenni, 1986). Of 25 nests that failed owing to ranching operations in Nevada, such as from raking and trampling, 18 were in irrigated hayfields (Hartman, 2008). Ten nests were trampled by cattle: 7 of 94 nests in hayfields and 3 of 30 nests in rangeland.

In southwestern Idaho, Long-billed Curlews preferred recently grazed areas and avoided areas that had not been grazed within the past year (Bicak and others, 1982). Rotational and deferred grazing may provide suitable habitat, but year-long grazing was not recommended. Areas grazed by sheep alone or sheep and cattle had higher densities of curlews than did areas grazed by cattle alone. Pastures that included sheep in the grazing regime had more area of short grass (32 percent of area sampled <10 cm tall) than pastures grazed by cattle alone (19 percent of area sampled <10 cm tall). Curlew density was negatively correlated with height and vertical density of vegetation, and height of vegetation was negatively

correlated with grazing intensity and animal stocking rates. Sheep, however, were less likely than cattle to follow established routes through the grassland, and thus sheep trampled and reduced the amount of dead vegetation to a greater extent than did cattle. Neither cattle nor sheep could graze dense stands of perennial wheatgrasses, such as crested wheatgrass (*Agropyron cristatum*), to a height that was suitable to curlews. In northwestern South Dakota, Long-billed Curlews were seen in pastures with cattle as well as in unoccupied pastures, but no curlews were observed in pastures with sheep (Timken, 1969).

Long-billed Curlews prefer grazed prairies but will forage and occasionally even nest in cropland, including fallow fields, forage crops, and grain crops (McCallum and others, 1977; Pampush, 1980; Renaud, 1980; Cochran and Anderson, 1987; Pampush and Anthony, 1993; Saunders, 2001; Devries and others, 2010). However, Renaud (1980) reported that Long-billed Curlews avoided large cultivated areas in Saskatchewan. In the Platte River Valley of Nebraska, conversion of upland prairies to cropland had a negative impact on curlews through the destruction of nesting habitat (Faanes and Lingle, 1995). Long-billed Curlews in the Oklahoma Panhandle frequently used areas with a mix of shortgrass pastures and cropland, which often was planted to wheat (Shackford, 1987). In Alberta, Long-billed Curlews were more common in mixed-grass prairies than in cultivated areas (Owens and Myres, 1973). In central South Dakota, Long-billed Curlew adults were observed in a bare, disked field (Spomer, 1981). The only two nests found in cropland during a 3-year Oklahoma study were destroyed by agricultural operations (Shackford, 1994). Researchers suggested that Long-billed Curlews may experience better nesting success in wheat fields than in fields that are being prepared for plowing. Cochran and Anderson (1987) suggested that, although hayfields in Wyoming that had been cultivated may provide suitable vegetation and bare ground, they lacked elevated mounds and hummocks preferred for nesting. Nests in hayfields and pastures that were fertilized had lower success rates than nests in unfertilized fields, presumably because of disturbances caused by mechanical field operations.

Pesticides can be detrimental to Long-billed Curlews (Blus and others, 1985). Three Long-billed Curlews suffering convulsions or displaying erratic behavior were collected in northeastern Oregon. One male curlew appeared to have died of dieldrin poisoning (5.9 parts per million (ppm) tissue fresh weight) and another of chlordane poisoning (4.8 ppm fresh weight heptachlor epoxide and 4.4 ppm fresh weight oxychlordane). The third, a female, may have sustained lethal injuries as a result of impairment from poisoning (2.2 ppm fresh weight heptachlor epoxide and 2.7 ppm fresh weight oxychlordane). Seven eggs collected in the same region all contained 4.26 ppm fresh weight of dichlorodiphenyldichloroethylene (DDE), and some (numbers not given) contained low concentrations of polychlorinated biphenyls and chlordane metabolites. Blus and others (1985) suggested that concentrations of contaminants in the eggs were too low to influence the reproductive success of Long-billed Curlews substantially. Peakall (1976) reported that one individual from Alberta had 14 ppm wet weight of DDE and 0.05 ppm of polychlorinated biphenyls.

Management Recommendations from the Literature

Preventing conversion of upland prairie to cropland is important in maintaining suitable habitat for Long-billed Curlews during the breeding season (Faanes and Lingle, 1995). To maintain healthy breeding populations, Saalfed and others (2010) emphasized the importance of providing grassland habitats of short stature, free of woody plants, and embedded in a landscape dominated by other grasslands. Habitat areas need to be at least three times as large as a Long-billed Curlew territory, which averages about 14 ha, because the species requires an unoccupied buffer strip 300–500 m wide around the boundary of a territory (Redmond and others, 1981).

Tall, dense residual vegetation should be removed before the prelaying period (March to April) so that adults do not have to leave their territories to forage (Redmond, 1986; R.L. Redmond, University of Montana, written commun. [n.d.]). Removal of residual vegetation from previous growing seasons is especially important after years of above-normal precipitation. Burning may improve habitat in some areas by reducing shrub coverage and increasing habitat openness (Redmond and Jenni, 1986; Pampush and Anthony, 1993). Haying and grazing can be used to provide the short vegetation and reduced vertical plant density preferred by nesting curlews, but these disturbances should be timed so that short vegetation is available early in the season and active nests are not destroyed (Cochran and Anderson, 1987).

In west-central Wyoming, it is not advisable to drag hayfields to break up cow dung; Long-billed Curlews prefer to nest near cow dung (Cochran and Anderson, 1987). However, in Idaho, curlews did not show a preference for nesting near cow dung, and R.L. Redmond (University of Montana, written commun. [n.d.]) suggested that dragging may be acceptable if it occurs after the breeding season when eggs or chicks are no longer vulnerable. Hayfields in Nevada have high conservation value because they provide optimal brood-rearing habitat and thus, high productivity (Hartman and Oring, 2009). The practice of irrigation may be necessary to create the vegetation growth needed for brood-rearing habitat, yet may cause some nests to be flooded, so care must be taken (Hartman, 2008). In Nevada, land raking should be completed before the peak of nest initiation, which is late April (Hartman, 2008). Removing cattle from hayfields earlier than mid-April might alleviate some nest failures caused by cattle trampling and disturbance. Coyote control may be the single best factor in increasing curlew populations. In Nevada hayfields, predation, especially by large mammalian predators such as coyotes, was the greatest cause of nest failure (Hartman and Oring, 2009). In the

final year of the study, nest success (52 percent) was more than twice the average from the previous 3 years after the removal of six coyotes from one of the focal ranches.

Grazing is beneficial in providing the short vegetative structure preferred by Long-billed Curlews, although timing and intensity of grazing treatments may need to be adjusted to environmental conditions and biological factors (Bicak and others, 1982; Cochran and Anderson, 1987; Bock and others, 1993; Clarke, 2006). For northern mixed-grass prairies, Clarke (2006) recommended reducing grazing pressure from April 10 to June 25 to reduce nest trampling by livestock. This recommendation may mean reducing cattle density below 33 cattle per km^2 and bison density below 220 bison per km^2, and, during years of drought or following a fire, reducing bison density below 77 bison per km^2. Grazing during the curlew incubation period should be avoided; in Wyoming, nests in areas that were grazed during incubation had lower hatching success rates than nests in other areas (Cochran and Anderson, 1987). Native grasslands need grazing to provide shorter cover for broods, but not too short so as to limit use for escape cover and shade; moderate grazing provides the patchy vertical distributions required for chicks to survive (Clarke, 2006). Rotational and deferred grazing may provide suitable habitat, but year-long grazing is not recommended (Bicak and others, 1982).

Curlews may nest in cropland, and where they have been known to do so, agricultural producers can incorporate fall-seeded crops, such as winter wheat and fall rye (*Secale* spp.), into their rotations to provide cropland habitats with reduced disturbances for nesting curlews (Devries and others, 2010).

Breeding habitat and nesting curlews should be protected from detrimental human activities, such as vehicular use, researcher disturbance, and shooting (Sugden, 1933; Redmond and Jenni, 1986). In Saskatchewan, abandonment of breeding sites by Long-billed Curlews was attributed to researcher disturbance (Maher, 1973, 1974).

References

Ackerman, D.S., 2007, Distribution, abundance, and habitat associations of the Long-billed curlew in southwestern North Dakota: Grand Forks, N. Dak., University of North Dakota, Master's Thesis, 80 p.

Allen, J.N., 1980, The ecology and behavior of the Long-billed Curlew in southeastern Washington: Wildlife Monographs No. 73, p. 3–67.

Bent, A.C., 1962, Long-billed Curlew (*Numenius americanus*), *in* Bent, A.C., ed., Life histories of North American shorebirds. Order Limicolae. Part 2: New York, N.Y., Dover Publications, Inc., p. 97–108. [Also available at https://doi.org/10.5479/si.03629236.146.i.]

Bicak, T.K., 1977, Some eco-ethological aspects of a breeding population of Long-billed Curlews (*Numenius americanus*) in Nebraska: Omaha, Nebr., University of Nebraska, Master's Thesis, 42 p.

Bicak, T.K., 1983, Vegetative interference—A factor affecting Long-billed Curlew (*Numenius americanus*) foraging success: Wader Study Group Bulletin, v. 39, p. 57.

Bicak, T.K., Redmond, R.L., and Jenni, D.A., 1982, Effects of grazing on Long-billed Curlew (*Numenius americanus*) breeding behavior and ecology in southwestern Idaho, *in* Peek, J.M., and Dalke, P.D., eds., Proceedings of the Wildlife-Livestock Relationships Symposium: Moscow, Idaho, University of Idaho, Forest, Wildlife and Range Experiment Station, p. 74–85.

Blus, L.J., Henny, C.J., and Krynitsky, A.J., 1985, Organochlorine-induced mortality and residues in Long-billed Curlews from Oregon: The Condor, v. 87, no. 4, p. 563–565. [Also available at https://dx.doi.org/10.2307/1367968.]

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.

Cannings, R.J., 1999, Status of the Long-billed Curlew in British Columbia: Victoria, British Columbia, Ministry of Environment, Lands and Parks, Wildlife Working Report No. WR-96, 14 p.

Clarke, J.N., 2006, Reproductive ecology of Long-billed Curlews breeding in grazed landscapes of western South Dakota: Brookings, S. Dak., South Dakota State University, Master's Thesis, 94 p.

Cochran, J.F., and Anderson, S.H., 1987, Comparison of habitat attributes at sites of stable and declining Long-billed Curlew populations: The Great Basin Naturalist, v. 47, no. 3, p. 459–466.

Cole, T., and Sharpe, R.S., 1976, The effects of grazing management on a sandhills prairie community. III. Breeding bird density and diversity: Proceedings of the Nebraska Academy of Science Affiliated Society, v. 86, p. 12.

Davis, W.B., 1949, Long-billed Curlew breeding in Colorado: The Auk, v. 66, no. 2, p. 202. [Also available at https://dx.doi.org/10.2307/4080458.]

De Smet, K.D., 1992, COSEWIC status report on the Long-billed Curlew *Numenius americanus* in Canada: Ottawa, Ontario, Committee on the Status of Endangered Wildlife in Canada, 33 p.

Devries, J.H., Rimer, S.O., and Walsh, E.M., 2010, Cropland nesting by Long-billed Curlews in southern Alberta: Prairie Naturalist, v. 42, no. 3–4, p. 123–129.

Dugger, B.D., and Dugger, K.M., 2002, Long-billed Curlew (*Numenius americanus*) (ver. 2.0), *in* Poole, A.F., and Gill, F.B., eds., The birds of North America: Ithaca, N.Y., Cornell Lab of Ornithology, accessed July 2019 at https://birdsna.org/Species-Account/bna/species/lobcur. [Also available at https://doi.org/10.2173/bna.628.]

Eldridge, J., 1992, Management of habitat for breeding and migrating shorebirds in the Midwest: Washington, D.C., U.S. Fish and Wildlife Service, Leaflet 13.2.14, 6 p.

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.

Forsythe, D.M., 1972, Observations on the nesting biology of the Long-billed Curlew: The Great Basin Naturalist, v. 32, no. 2, p. 88–90.

Gratto-Trevor, C., 1999, Use of managed and natural wetlands by upland breeding shorebirds in southern Alberta, *in* Proceedings of the fifth Prairie Conservation and Endangered Species Conference: Edmonton, Alberta, Provincial Museum of Alberta, Natural History Occasional Paper, no. 24, p. 252–259.

Graul, W.D., 1971, Observations at a Long-billed Curlew nest: The Auk, v. 88, no. 1, p. 182–184. [Also available at https://dx.doi.org/10.2307/4083988.]

Gregory, C.J., Dinsmore, S.J., Powell, L.A., and Jorgenson, J.G., 2011, Nest survival of Long-billed Curlew in Nebraska: Wader Study Group Bulletin, v. 118, no. 2, p. 109–113.

Hartman, C.A., 2008, Behavioral ecology and population biology of Long-billed Curlews (*Numenius americanus*) in northeastern Nevada: Reno, Nev., University of Nevada, Ph.D. Dissertation, 191 p.

Hartman, C.A., and Oring, L.W., 2009, Reproductive success of Long-billed Curlews (*Numenius americanus*) in northeastern Nevada hay fields: The Auk, v. 126, no. 2, p. 420–430. [Also available at https://dx.doi.org/10.1525/auk.2009.08062.]

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

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

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

King, R., 1978, Habitat use and related behaviors of breeding Long-billed Curlews: Fort Collins, Colo., Colorado State University, Master's Thesis, 69 p.

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

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

McCallum, D.A., Graul, W.D., and Zaccagnini, R., 1977, The breeding status of the Long-billed Curlew in Colorado: The Auk, v. 94, no. 3, p. 599–601.

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

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

O'Connor, R.J., Jones, M.T., Boone, R.B., and Lauber, T.B., 1999, Linking continental climate, land use, and land patterns with grassland bird distribution across the conterminous United States, *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. 45–59.

Ohanjanian, I.A., 1992, Numbers, distribution and habitat dynamics of Long-billed Curlews in East Kootenay: Cranbrook, British Columbia, Ministry of Environment, Wildlife Branch, 41 p.

Owens, R.A., and Myres, M.T., 1973, Effects of agriculture upon populations of native passerine birds of an Alberta fescue grassland: Canadian Journal of Zoology, v. 51, no. 7, p. 697–713. [Also available at https://dx.doi.org/10.1139/z73-104.]

Page, G.W., Warnock, N., Tibbitts, T.L., Jorgensen, D., Hartman, C.A., and Stenzel, L.E., 2014, Annual migratory patterns of Long-billed Curlews in the American West: The Condor, v. 116, no. 1, p. 50–61. [Also available at https://dx.doi.org/10.1650/CONDOR-12-185-R2.1.]

Pampush, G.J., 1980, Breeding chronology, habitat utilization and nest-site selection of the Long-billed Curlew in north-central Oregon: Corvallis, Oreg., Oregon State University, Master's Thesis, 49 p.

Pampush, G.J., and Anthony, R.G., 1993, Nest success, habitat utilization and nest-site selection of Long-billed Curlews in the Columbia Basin, Oregon: The Condor, v. 95, no. 4, p. 957–967. [Also available at https://dx.doi.org/10.2307/1369431.]

Paton, P.W.C., and Dalton, J., 1994, Breeding ecology of Long-billed Curlews at Great Salt Lake, Utah: The Great Basin Naturalist, v. 54, no. 1, p. 79–85.

Peakall, D.B., 1976, The Peregrine Falcon (*Falco peregrinus*) and pesticides: Canadian Field-Naturalist, v. 90, no. 3, p. 301–307.

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

Prescott, D.R.C., Arbuckle, R., Goddard, B., and Murphy, A., 1993, Methods for the monitoring and assessment of avian communities on NAWMP landscapes in Alberta, and 1993 results: Edmonton, Alberta, Alberta NAWMP Centre, NAWMP-007, 48 p.

Redmond, R.L., 1986, Egg size and laying date of Long-billed Curlews (*Numenius americanus*)—Implications for female reproductive tactics: Oikos, v. 46, no. 3, p. 330–338. [Also available at https://dx.doi.org/10.2307/3565831.]

Redmond, R.L., Bicak, T.K., and Jenni, D.A., 1981, An evaluation of breeding season census techniques for Long-billed Curlews (*Numenius americanus*), *in* Ralph, C.J., and Scott, J.M., eds., Estimating numbers of terrestrial birds: Studies in Avian Biology, v. 6, p. 197–201.

Redmond, R.L., and Jenni, D.A., 1982, Natal philopatry and breeding area fidelity of Long-billed Curlews (*Numenius americanus*)—Patterns and evolutionary consequences: Behavioral Ecology and Sociobiology, v. 10, no. 4, p. 277–279. [Also available at https://dx.doi.org/10.1007/BF00302817.]

Redmond, R.L., and Jenni, D.A., 1986, Population ecology of the Long-billed Curlew (*Numenius americanus*) in western Idaho: The Auk, v. 103, no. 4, p. 755–767.

Renaud, W.E., 1980, The Long-billed Curlew in Saskatchewan—Status and distribution: Blue Jay, v. 38, no. 4, p. 221–237.

Saalfed, S.T., Conway, W.C., Haukos, D.A., Rice, M., Jones, S.L., and Fellows, S.D., 2010, Multiscale habitat selection by Long-billed Curlews (*Numenius americanus*) breeding in the United States: Waterbirds, v. 33, no. 2, p. 148–161. [Also available at https://doi.org/10.1675/063.033.0203.]

Sadler, D.A., and Maher, W.J., 1976, Notes on the Long-billed Curlew in Saskatchewan: The Auk, v. 93, no. 2, p. 382–384.

Salt, W.R., and Wilk, A.L., 1958, The birds of Alberta: Edmonton, Alberta, Department of Economic Affairs, 295 p.

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 July 2019 at https://www.mbr-pwrc.usgs.gov/bbs/bbs2012.shtml.

Saunders, E.J., 2001, Population estimate and habitat associations of the Long-billed Curlew (*Numenius americanus*) in Alberta: Edmonton, Alberta, Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 25, 65 p.

Sedgwick, J.A., 2006, Long-billed Curlew (*Numenius americanus*)—A technical conservation assessment: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region, 56 p.

Shackford, J.S., 1987, Nesting distribution and population census of Golden Eagles, Prairie Falcons, Mountain Plovers, and Long-billed Curlews in Cimarron County, Oklahoma: Bartlesville, Okla., George Miksch Sutton Avian Research Center Inc., 28 p.

Shackford, J.S., 1994, Nesting of Long-billed Curlews on cultivated fields: Bulletin of the Oklahoma Ornithological Society, v. 27, no. 3, p. 17–20.

Shaffer, J.A., Igl, L.D., Goldade, C.M., Dinkins, M.F., Johnson, D.H., and Euliss, B.R., 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 July 2019 at https://doi.org/10.3133/pp1842PP.

Silloway, P.M., 1900, Notes on the Long-billed Curlew: The Condor, v. 2, no. 4, p. 79–82. [Also available at https://dx.doi.org/10.2307/1361045.]

Sliwinski, M.S., and Koper, N., 2012, Grassland bird response to three edge types in a fragmented mixed-grass prairie: Avian Conservation & Ecology, v. 7, no. 2, 6. [Also available at https://dx.doi.org/10.5751/ACE-00534-070206.]

Smith, G.A., and Lomolino, M.V., 2004, Black-tailed prairie dogs and the structure of avian communities on the short-grass plains: Oecologia, v. 138, no. 4, p. 592–602. [Also available at https://dx.doi.org/10.1007/s00442-003-1465-3.]

Spomer, R., 1981, Long-billed Curlews and Sprague's Pipits near Pierre: South Dakota Bird Notes, v. 33, no. 4, p. 78.

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

Sugden, J.W., 1933, Range restriction of the Long-billed Curlew: The Condor, v. 35, no. 1, p. 3–9. [Also available at https://dx.doi.org/10.2307/1363458.]

Timken, R.L., 1969, Notes on the Long-billed Curlew: The Auk, v. 86, no. 4, p. 750–751. [Also available at https://dx.doi.org/10.2307/4083466.]

Table G1. Measured values of vegetation structure and composition in Long-billed Curlew (*Numenius americanus*) breeding habitat by study. The parenthetical descriptors following authorship and year in the "Study" column indicate that the vegetation measurements were taken in locations or under conditions specified in the descriptor; no descriptor implies that measurements were taken within the general study area.

[cm, centimeter; %, percent; --, no data; ≤, less than or equal to; <, less 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)
Ackerman, 2007 (nests)	North Dakota	Mixed-grass prairie, tame grassland	--	2.8–13.1	7.4–10	--	--	--	--	--	0.1–0.5
Allen, 1980 (nests)	Washington	Tame grassland	Idle	≤20[a]	--	--	--	--	--	--	--
Bicak and others, 1982	Idaho	Shortgrass prairie, tame grassland	Grazed	<10	--	--	--	--	--	--	--
Clarke, 2006[b] (nests)	South Dakota	Mixed-grass prairie	Grazed	13	10.2–27.0	45.6–55.1	10.8–46.9	0–0.03	8.5–36.2	--	--
Clarke, 2006[b] (broods)	South Dakota	Mixed-grass prairie	Grazed	12	10.4–20.3	34.6–59.4	5.3–10.8	0.1–1.1	16.1–53.2	--	--
Cochran and Anderson, 1987 (study plots)	Wyoming	Tame grassland	Multiple	--	--	71.4[c]	10.1	--	9.3	--	--
Cochran and Anderson, 1987 (study plots)	Wyoming	Shortgrass prairie	Multiple	--	--	57.9[c]	7.8	--	22.7	--	--
Cochran and Anderson, 1987 (nest fields)	Wyoming	Shortgrass prairie, tame grassland	Multiple	--	--	19.9	15.5	--	--	--	--
Cochran and Anderson, 1987 (nests)	Wyoming	Shortgrass prairie, tame grassland	Multiple	--	--	61	--	--	7	--	--
Gregory and others, 2011 (nests)	Nebraska	Mixed-grass prairie	--	5–75	0.5–6.8	--	--	--	--	--	0–2.3
King, 1978 (nests)	Colorado, Texas	Multiple	Grazed	11	--	--	--	--	--	--	--
Pampush, 1980	Oregon	Multiple	Grazed	25–33	--	30–53	4–20	2–12	26–40	--	--
Paton and Dalton, 1994 (nests)	Utah	Multiple	--	6.5	--	--	--	--	18	--	--
Redmond, 1986	Idaho	Shortgrass prairie	Grazed	3.6–15.7	--	--	--	--	--	--	--
Spomer, 1981 (broods)	South Dakota	Mixed-grass prairie	--	18[d]	--	--	--	--	--	--	--

[a]Height of Sandberg's bluegrass (*Poa secunda*) and downy brome (*Bromus tectorum*).

[b]The sum of the percentages is greater than 100%, based on methods described by the authors.

[c]Value includes grasses, sedges (*Carex* spp.), and rushes (*Juncus* spp.).

[d]Grass 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—Long-Billed Curlew (*Numenius americanus*)**—Professional Paper 1842–G

ISSN 2330-7102 (online)
https://doi.org/10.3133/pp1842G