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Effects of Management Practices on Grassland Birds: Long-Billed Curlew

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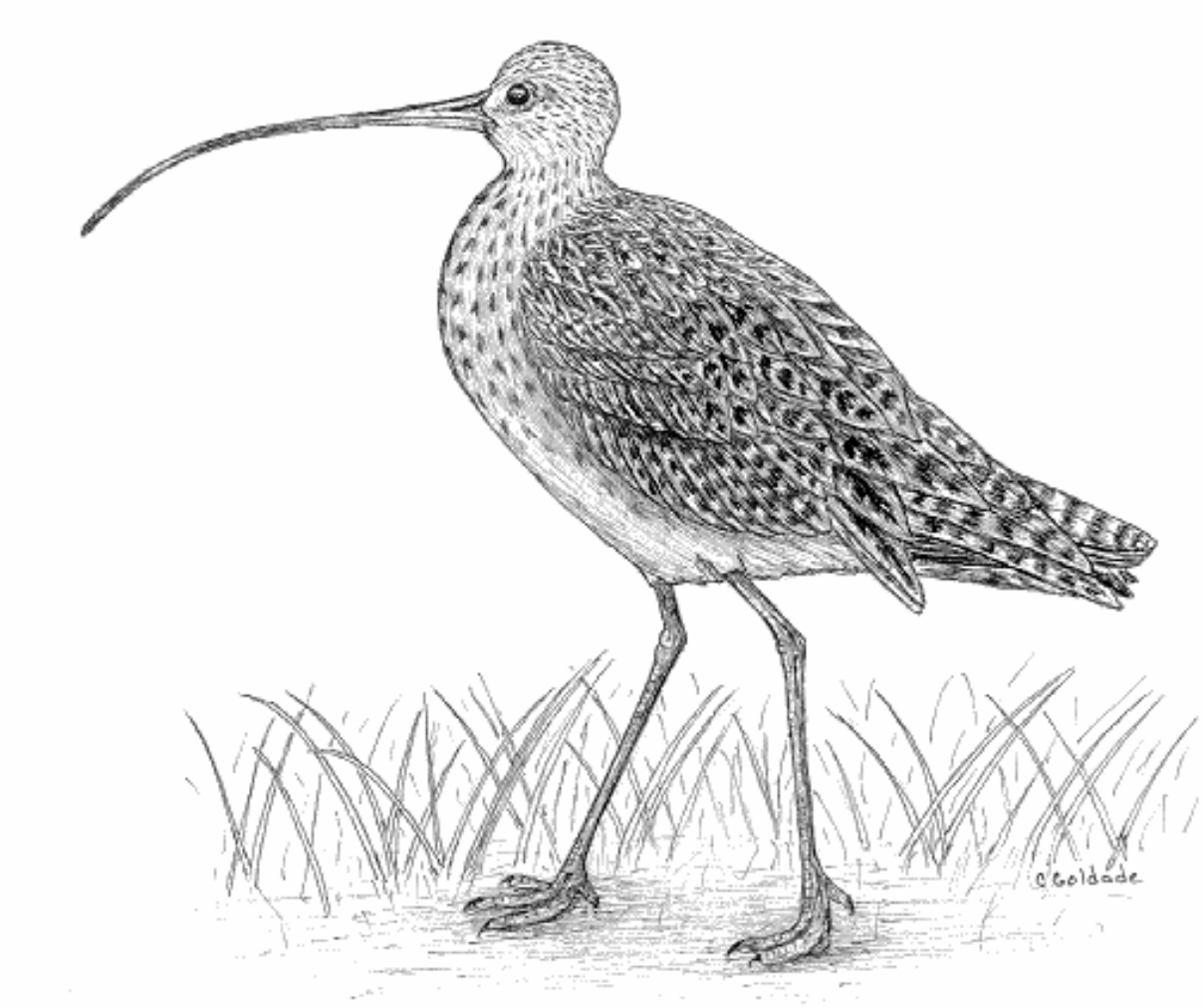
EFFECTS OF MANAGEMENT PRACTICES ON GRASSLAND BIRDS:

LONG-BILLED CURLEW



Grasslands Ecosystem Initiative
Northern Prairie Wildlife Research Center
U.S. Geological Survey
Jamestown, North Dakota 58401

This report is one in a series of literature syntheses on North American grassland birds. The need for these reports was identified by the Prairie Pothole Joint Venture (PPJV), a part of the North American Waterfowl Management Plan. The PPJV recently adopted a new goal, to stabilize or increase populations of declining grassland- and wetland-associated wildlife species in the Prairie Pothole Region. To further that objective, it is essential to understand the habitat needs of birds other than waterfowl, and how management practices affect their habitats. The focus of these reports is on management of breeding habitat, particularly in the northern Great Plains.

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Species for which syntheses are available or are in preparation:

American Bittern
Mountain Plover
Marbled Godwit
Long-billed Curlew
Willet
Wilson's Phalarope
Upland Sandpiper
Greater Prairie-Chicken
Lesser Prairie-Chicken
Northern Harrier
Swainson's Hawk
Ferruginous Hawk
Short-eared Owl
Burrowing Owl
Horned Lark
Sedge Wren
Loggerhead Shrike
Sprague's Pipit
Grasshopper Sparrow
Baird's Sparrow
Henslow's Sparrow
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow
Vesper Sparrow
Savannah Sparrow
Lark Sparrow
Field Sparrow
Clay-colored Sparrow
Chestnut-collared Longspur
McCown's Longspur
Dickcissel
Lark Bunting
Bobolink
Eastern Meadowlark
Western Meadowlark
Brown-headed Cowbird

EFFECTS OF MANAGEMENT PRACTICES ON GRASSLAND BIRDS:

LONG-BILLED CURLEW

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

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October 1999
(revised January 2002)

ORGANIZATION AND FEATURES OF THIS SPECIES ACCOUNT

Information on the habitat requirements and effects of habitat management on grassland birds were summarized from information in more than 4,000 published and unpublished papers. A ***range map*** is provided to indicate the primary breeding distribution of the species in North America, based on North American Breeding Bird Survey data. The shading on the map represents the average number of individuals detected per route per year. Although birds frequently are observed outside the breeding range indicated, the maps are intended to show areas where managers might concentrate their attention. It may be ineffectual to manage habitat at a site for a species that rarely occurs in an area. The species account begins with a brief ***capsule statement***, which provides the fundamental components or keys to management for the species. A section on ***range*** outlines the current breeding distribution of the species in North America, including details on areas that could not be mapped using BBS data. The ***suitable habitat*** section describes the breeding habitat and occasionally microhabitat characteristics of the species, especially those habitats that occur in the Great Plains. Details on habitat and microhabitat requirements often provide clues to how a species will respond to a particular management practice. If habitat needs vary appreciably in different parts of the breeding range, those needs are indicated. A ***table*** near the end of the account complements the section on suitable habitat, and lists the specific habitat characteristics for the species by individual studies. The table usually provides more details than those provided within the text. A special section on ***prey habitat*** is included for those predatory species that have more specific prey requirements. For species exhibiting area sensitivity, details on minimum ***area requirements*** are provided. It may be futile to manage a small block of suitable habitat for a species that has minimum area requirements that are larger than the area being managed. The impact of management on the species depends, in part, upon a species nesting phenology, including the length of the nesting cycle and duration of the breeding season, and the tendency to renest after nest failure. ***Breeding-season phenology*** provides representative dates of spring arrival and fall departure (and occasionally peak breeding period) for the species in the Great Plains. The duration and timing of breeding will vary from region to region and from year to year. ***Species' response to management*** summarizes the current knowledge and major findings in the literature on the effects of different management practices, including burning, mowing, and grazing, on the species. The section on ***management recommendations*** complements the previous section and summarizes specific recommendations for habitat management provided in the literature. If management recommendations differ in different portions of the species' breeding range, recommendations are treated separately by region. The ***literature cited*** contains references to published and unpublished literature on the management effects and habitat requirements of the species. This section is not meant to be a complete bibliography; a searchable, annotated bibliography of published and unpublished papers dealing with habitat needs of grassland birds and their responses to habitat management is posted at the Web site mentioned below.

This report has been downloaded from the Northern Prairie Wildlife Research Center World-Wide Web site, www.npwrc.usgs.gov/resource/literatr/grasbird/grasbird.htm. It will be updated as necessary. We invite comments and suggestions. Please direct them to Douglas H. Johnson, Northern Prairie Wildlife Research Center, U.S. Geological Survey, 8711 37th Street SE, Jamestown, North Dakota 58401; telephone: 701-253-5539; fax: 701-253-5553; e-mail: Douglas_H_Johnson@usgs.gov.

LONG-BILLED CURLEW
(*Numenius americanus*)

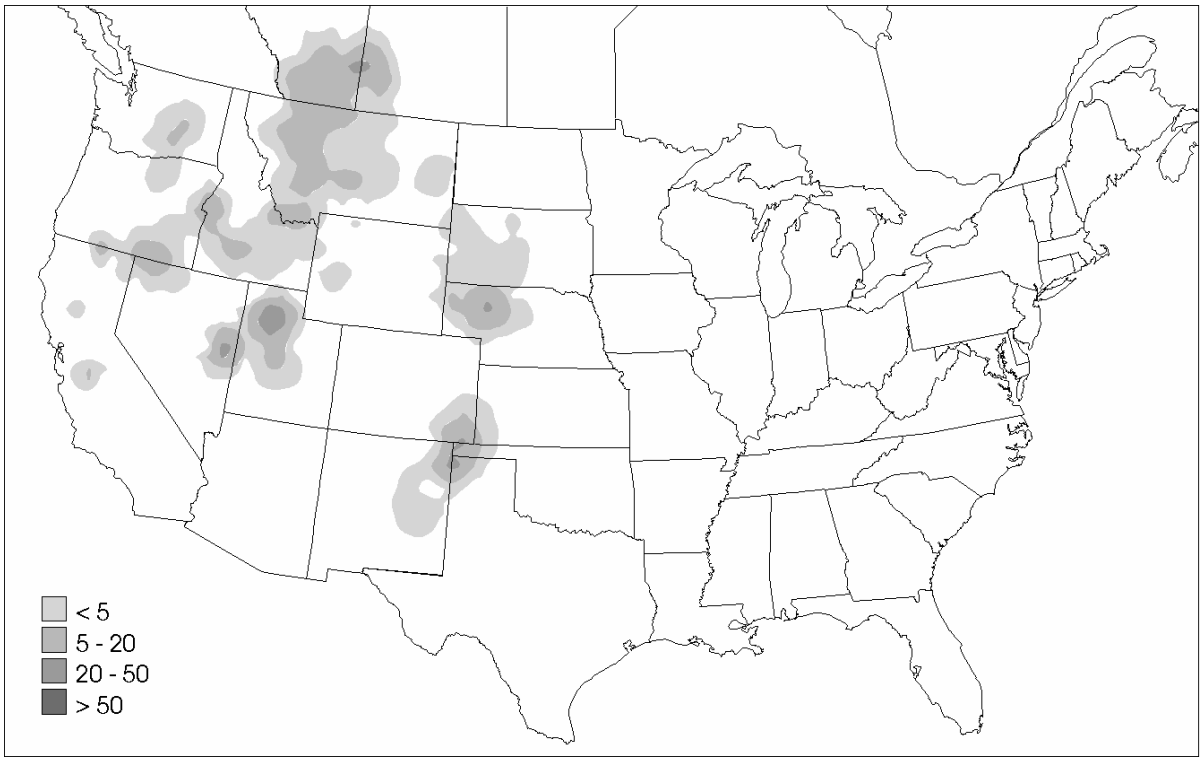

Figure. Breeding distribution of the Long-billed Curlew in the United States and southern Canada, based on Breeding Bird Survey data, 1985-1991. Scale represents average number of individuals detected per route per year. Map from Price, J., S. Droege, and A. Price, The Summer Atlas of North American Birds, Academic Press, 1995.

Keys to management include providing large, open, level to gently rolling grasslands with short vegetation, and tailoring grazing regimes to local conditions.

Breeding range:

Long-billed Curlews breed from interior British Columbia and southern Alberta through southern Manitoba, south to central California, and east to western North Dakota, central South Dakota, central Nebraska, western Kansas, northeastern New Mexico, and northern Texas (National Geographic Society 1987). (See figure for the relative densities of Long-billed Curlews in the United States and southern Canada, based on Breeding Bird Survey data.)

Suitable habitat:

Long-billed Curlews use expansive, open, level to gently sloping or rolling grasslands with short vegetation such as shortgrass or recently grazed mixed-grass prairie (Salt and Wilk 1958, Bent 1962, Graul 1971, Stewart 1975, Johnsgard 1980, Bicak et al. 1982, Cochran and Anderson 1987, Shackford 1987, Eldridge 1992). They commonly nest in both wet and dry prairie and in pastures, but rarely nest in hayland, cropland, fallow, or stubble fields (Salt and

Wilk 1958, Bent 1962, McCallum et al. 1977, Renaud 1980, Cochran and Anderson 1987, Shackford 1994).

Proximity to water may be an important factor in habitat selection (McCallum et al. 1977, Cochran and Anderson 1987, Shackford 1987). In southeastern Colorado, 41% of 63 Long-billed Curlew observations occurred within 91 m of standing water, and 68% of observations were within 403 m (McCallum et al. 1977). In southeastern Colorado and northwestern Texas, 39% of 354 curlew observations occurred within 400 m of stock ponds or irrigation facilities (King 1978). In Utah, nests often were placed near the edges of alkali flats of the Great Salt Lake (Paton and Dalton 1994). 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. However, in southeastern Alberta, Long-billed Curlews were less common on wet transects (a wet transect was defined as having wetlands intersecting the transect along >5% of its 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 (McCallum et al. 1977).

Long-billed Curlews in Colorado used shortgrass, mixed-grass, and weedy areas more than expected based on the availability of those habitats (King 1978). They used agricultural areas (cropland, stubble fields, and bare ground) less than expected based on availability and did not use areas dominated by sand sagebrush (*Artemisia filifolia*). In northcentral Oregon, areas of shrubs or areas of downy brome (*Bromus tectorum*) intermixed with patches of Sandberg's bluegrass (*Poa sandbergii*) were preferred or used in proportion to availability by Long-billed Curlews (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. If bunchgrass habitats were used by adults with broods, they always were contiguous with downy brome areas that were being used as nesting sites.

Long-billed Curlews in Nebraska used areas in which 75% of the total vertical vegetation density (number of plant contacts with a thin rod inserted vertically into the canopy) was found at heights <10 cm, compared to 63% in non-use 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 the Oklahoma Panhandle, curlews were usually observed in areas with clay loam soils on 0-1% slopes (Shackford 1987).

Curlews forage in grasslands, cultivated fields, stubble fields, wet meadows, prairie dog (*Cynomys*) colonies, and occasionally along wetland margins (Silloway 1900, Salt and Wilk 1958, Johnsgard 1980, Shackford 1987). During the incubation period in southwestern Idaho, Long-billed Curlew's prey-capture rate was higher in areas with short grass even though prey density was higher in areas with tall grass (vegetation measurements, prey densities, and capture rates were not given) (Bicak et al. 1982, Bicak 1983). Pre-laying female curlews in western Idaho foraged in shortgrass pasture 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) due to abundant precipitation, curlews flew as far as 10 km from their territories to forage. In southcentral 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). Although breeding density also was higher in topographically diverse areas, most nests

were placed on relatively flat ground (neither the proportion of nests nor the slope of the ground was given).

In the Platte River Valley of Nebraska, Long-billed Curlews nested at higher densities in wet meadows than in upland prairie (Faanes and Lingle 1995). Within the sandhill grasslands of Nebraska, 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 (Bicak 1977). Curlews in Nebraska also nested on upland slopes of native vegetation near moist meadows that were used for foraging (Johnsgard 1980). In North Dakota, Long-billed Curlews nested on grazed mixed-grass and on shortgrass prairie (Stewart 1975). Curlews preferred gently rolling terrain with gravelly soils. Long-billed Curlews in central Montana nested on dry portions of the mixed-grass prairie, which were elevated above their surroundings and located near wet meadows (Silloway 1900). Grassy floodplains adjoining a creek provided nesting habitat in southeastern Colorado (Davis 1949).

In northern Utah, Long-billed Curlew nests were found in irrigated and non-irrigated 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 saltwort (*Salicornia rubra*) (Forsythe 1972).

Of 21 nests in southeastern Washington, 71% were in areas dominated by a mixture of downy brome and Sandberg's bluegrass and 29% were in areas dominated by downy brome alone (Allen 1980). All areas with downy brome and Sandberg's bluegrass were used for nesting, whereas there were areas which were not used for nesting that contained only downy brome. Preference for areas dominated by the two plant species was attributed to a lower percent coverage of live (7%) and dead (65%) downy brome in those areas than in areas dominated by downy brome alone (live: 14%; dead: 92%). Plant communities dominated by downy brome but containing substantial amounts of tumbling mustard (*Sisymbrium altissimum*), as well as other grass communities (e.g., wheatgrass [*Agropyron* spp.] communities), were not used for nesting. In northcentral 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 northcentral 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 vs. 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 vs. 0.2 contacts/5 cm height increment) in the 25-50 cm height increment, and shrubs with lower total vertical density (0.02 vs. 0.05 contacts/5 cm height increment). Nest density within study areas was negatively correlated with vegetation height and vertical density; nest density was positively correlated with percent 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 predators were more dense or nests were more vulnerable in those habitats. In Wyoming, hayfields and pastures with nests had lower percent grass cover (mean of 20 vs. 32%), had greater forb cover (mean of 16 vs. 4%), and were drier (45 vs. 3% of random locations characterized as 'dry') than hayfields and pastures that had no nests (Cochran and Anderson 1987).

Although Long-billed Curlews select nest sites in areas with short vegetation, vegetation within 3-6 m of the nest may be taller than vegetation in the surrounding habitat patch (Cochran

and Anderson 1987, Paton and Dalton 1994). In Utah, habitat patches containing nests had shorter vegetation (mean of 5.6 cm) than random habitat patches (mean of 9.0 cm), and more bare ground 6-15 m from the nest (mean of 34-36%) than random patches (mean of 38-39%) (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 (mean of 4.9-5.5 cm) from the nest and there was less bare ground <3 m from the nest (mean of 18%) than ≥6 m from the nest (mean of 28-39%). In Wyoming, nest sites were characterized by less bare ground and higher percent cover of grasses (values were not given) than random sites within hayfields and pastures that contained nests (Cochran and Anderson 1987).

Nests often are located near cowpies or other conspicuous objects, possibly for concealment (Silloway 1900, Bent 1962, King 1978, Johnsgard 1979, Allen 1980, Cochran and Anderson 1987). Additionally, nests often occur on hummocks, possibly to improve visibility of predators and to prevent flooding in otherwise level fields (Cochran and Anderson 1987). Of 59 nests in southcentral Washington, 37% were 30-100 cm from an object (e.g., big sagebrush [*Artemisia tridentata*] branches, rocks, dirt mounds, horse manure, metal cans, bunchgrasses), 31% were ≤30 cm from an object, 27% were immediately adjacent to an object, and only 5% were >100 cm from an object (Allen 1980). Big sagebrush, antelope bitterbrush, trees, dried tumbleweeds (*Salsola*), dirt mounds, rocks, tree stumps, and fences were used as perches.

Habitat characteristics of the landscape surrounding nest sites also influence Long-billed Curlew populations (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 with more vegetative cover (e.g., 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). Use of areas with tall, dense vegetation in the Texas Panhandle and northcentral 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). A table near the end of the account lists the specific habitat characteristics for Long-billed Curlews by study.

Area requirements:

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 et al. 1982). Territory size averaged about 14 ha in the most densely populated areas, and an unoccupied buffer zone of 300-500 m existed around the edge of suitable habitat (Redmond et al. 1981). In southeastern Washington, areas with diverse topography and habitat (shrubby areas near the nest sites) supported smaller (6-8 ha) curlew territories than did open, flat, less diverse habitat, which supported larger (20 ha) territories (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 suggested that the existing territories may have already reached a minimum size.

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

Brown-headed Cowbird brood parasitism:

No known records of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) exist.

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 et al. 1981, Bicak et al. 1982, Paton and Dalton 1994). In some areas, fall departure may begin as early as June or July (Maher 1973, King 1978, Allen 1980), 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 southcentral Washington (Allen 1980). The second nest also was depredated following completion of the clutch. Historically occupied sites are reused by curlews every year, and some individual birds may reuse the same territories from year to year (McCallum et al. 1977; Allen 1980; Redmond and Jenni 1982,1986).

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 following a fall range fire, there was a 30% increase in the estimated curlew breeding density in western Idaho (Redmond and Jenni 1986).

Haying can be used to provide the short vegetation preferred by nesting curlews, but should be timed so that short vegetation is available early in the season and active nests are not damaged (Cochran and Anderson 1987). In northcentral 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). In Wyoming hay meadows, cowpies from fall- and winter-pastured cattle were scattered with branches, logs, or harrows (Cochran and Anderson 1987). This practice, termed "dragging," was detrimental because curlews often built nests near cowpies. The practice generally has declined since the 1960's but still can be common locally.

Grazing can be beneficial if it provides suitably short vegetation, particularly during the pre-laying period (Bicak et al. 1982, Cochran and Anderson 1987). Timing and intensity of grazing treatments should be adjusted according to local climate and habitat characteristics (Bicak et al. 1982, Bock et al. 1993). Curlew response to grazing over large areas of mixed-grass and shortgrass prairie was variable, but response to grazing in shrubsteppe habitats was negative (Bock et al. 1993). In Nebraska, curlews were present on grazed areas and were absent from ungrazed areas (Cole and Sharpe 1976). Long-billed Curlews in southern Alberta used only continuously grazed mixed-grass pasture and were absent from mixed-grass pasture grazed in early summer, spring-grazed tame pasture, and deferred-grazed (grazed after 15 July) mixed-grass pasture (Prescott et al. 1993). In southwestern Idaho, areas grazed by sheep alone or sheep

and cattle had higher densities of curlews than did areas grazed by cattle alone (Bicak et al. 1982). Pastures that included sheep in the grazing regime had more area of short grass (32% of area sampled <10 cm tall) than areas grazed by cattle alone (19% of area sampled <10 cm tall). Curlew density was negatively correlated with height and vertical density of vegetation. Height of vegetation was negatively correlated with grazing intensity and with animal stocking rates. Sheep 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. However, Sugden (1933) cautioned that sheep are more likely to trample nests than cattle. In northwestern South Dakota, Long-billed Curlews were seen either in pastures with cattle or in unoccupied pasture; no curlews were observed in pastures with sheep (Timken 1969). In Idaho, neither cattle nor sheep could graze dense stands of perennial wheatgrasses, such as crested wheatgrass (*Agropyron cristatum*), to a height that was usable by curlews (Bicak et al. 1982). Long-billed Curlews preferred recently grazed areas and did not use areas that had not been grazed for >1 yr. Rotational and deferred grazing may provide suitable habitat, but year-long grazing was not recommended. 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). Of 119 nests in western Idaho, 4.2% were lost to trampling by livestock (Redmond and Jenni 1986).

Long-billed Curlews prefer grazed prairie, but will forage and occasionally even nest in cropland, including fallow fields, forage crops, and grain crops (McCallum et al. 1977, Pampush 1980, Renaud 1980, Cochran and Anderson 1987, Pampush and Anthony 1993). However, Renaud (1980) reported that curlews avoided large cultivated areas in Saskatchewan. In the Platte River Valley of Nebraska, conversion of upland prairie 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 pasture and cropland, which often was planted to wheat (Shackford 1987). In Alberta, Long-billed Curlews were more common in areas of mixed-grass prairie than in cultivated areas (Owens and Myres 1973). In central South Dakota, Long-billed Curlew adults were observed in a bare, disced field (Spomer 1981). The only two nests found in cropland during a 3-yr 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 due to disturbance by mechanical field operations.

In Alberta, Saskatchewan, and Manitoba, Long-billed Curlews were present on grasslands enrolled in the Permanent Cover Program (PCP) (McMaster and Davis 1998). PCP was a Canadian program that paid farmers to seed highly erodible land to perennial grassland cover; it differed from CRP in the United States in that haying and grazing were allowed annually in PCP.

Pesticides can be detrimental to Long-billed Curlews (Blus et al. 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 and another of chlordane poisoning. The third, a female, may have sustained lethal injuries as a result of

impairment from poisoning. Seven eggs collected in the same region all contained low concentrations of dichlorodiphenyltrichloroethane (DDT) metabolites, and some (numbers not given) contained low concentrations of polychlorinated biphenyls and chlordane metabolites. The authors suggested that concentrations of contaminants in the eggs were too low to influence the reproductive success of Long-billed Curlews substantially.

Management Recommendations:

Prevent conversion of upland prairie to cropland (Faanes and Lingle 1995).

Protect breeding habitat of curlews 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).

Habitat areas need to be $\geq$3 times as large as a Long-billed Curlew territory, which averages about 14 ha, in order for curlews to use them, because of an unoccupied buffer strip 300-500 m wide around the edge of suitable habitat (Redmond et al. 1981).

Tall, dense residual vegetation should be removed before the pre-laying period (March to April) so that adults do not have to leave their territories to forage (Redmond 1986; R. L. Redmond, University of Montana, Missoula, Montana, pers. comm.). Removal of residual vegetation is especially important after years of above-normal precipitation. Haying and grazing can be used to provide the short vegetation and reduced vertical plant density preferred by nesting curlews, but should be timed so that short vegetation is available early in the season (Cochran and Anderson 1987). In southwestern Idaho, curlews avoided areas that had not been grazed within the past year (Bicak et al. 1982).

Burn areas where fire will improve habitat by reducing shrub coverage and increasing habitat openness (Redmond and Jenni 1986, Pampush and Anthony 1993). During the breeding season following a fall range fire in western Idaho, the estimated curlew breeding density increased 30% (Redmond and Jenni 1986).

Adjust timing and intensity of grazing treatment according to environmental factors (Bicak et al. 1982, Cochran and Anderson 1987, Bock et al. 1993).

Avoid grazing during the incubation period; in Wyoming, nests in areas that were grazed during incubation had lower hatching success rates than nests in other areas (Cochran and Anderson 1987).

In westcentral Wyoming, do not drag hayfields to break up cowpies; Long-billed Curlews prefer to nest near cowpies (Cochran and Anderson 1987). However, in Idaho, curlews did not show a preference for nesting near cowpies, and R. L. Redmond (pers. comm.), suggested that dragging

may be acceptable if it occurs after the breeding season when eggs or chicks are no longer vulnerable.

Table. Long-billed Curlew habitat characteristics.

Author(s)	**Location(s)**	**Habitat(s) Studied***	**Species-specific Habitat Characteristics**
Allen 1980	Washington	Cropland, shrubsteppe	Preferred to forage in dune and ridge areas where topographic and vegetational diversity were high; most nests were on relatively flat ground; of 59 nests, 5% were >100 cm from an object, 37% were 30-100 cm from an object, 31% were ≤30 cm from an object, and 27% abutted an object (e.g., big sagebrush [*Artemisia tridentata*] limbs, rocks, dirt mounds, horse manure, metal cans, bunchgrasses); preferred to nest (71% of 21 nests) in areas dominated by downy brome (*Bromus tectorum*) and Sandberg's bluegrass (*Poa sandbergii*) rather than in areas dominated by downy brome alone (29% of nests); did not nest in stands of downy brome containing substantial amounts of tumbling mustard (*Sisymbrium altissimum*), nor in areas dominated by wheatgrasses (*Agropyron* spp.); mean vegetation values at nest sites in downy brome/Sandberg's bluegrass were <10 cm downy brome height, 20 cm Sandberg's bluegrass height, 6.7% coverage of live downy brome, 65% coverage of dead downy brome, 17% coverage of live Sandberg's bluegrass, and 4.6% coverage of dead Sandberg's bluegrass; mean coverage values at nest sites in areas dominated by downy brome were 14% coverage of live downy brome and 92% coverage of dead downy brome
Bent 1962	Rangewide	Idle mixed-grass, idle shortgrass, mixed-grass pasture, shortgrass pasture	Required large, open prairie expanses; nested on grazed rangeland and in damp, grassy hollows or slopes near bodies of water
Bicak 1977	Nebraska	Mixed-grass hayland,	Areas used by curlews had 75% of total vertical vegetation density <10 cm high, compared to 63% in non-use areas;

		mixed-grass pasture	proximity of nest sites to foraging meadows was more important in nest site selection than vegetation characteristics
Bicak et al. 1982	Idaho	Shortgrass/tame pasture, tame pasture	Used areas of short, recently grazed vegetation; curlew density was positively correlated with size of management unit, annual total animal unit months, and area of vegetation <10 cm tall; areas grazed by sheep alone or by sheep and cattle had more area of short grass (32% of area sampled was <10 cm tall) and higher densities of curlews than did areas grazed by cattle alone (19% of area sampled was <10 cm tall); did not use areas that had not been grazed for >1 yr
Cochran and Anderson 1987	Wyoming	Shortgrass hayland, shortgrass pasture, tame hayland, tame pasture, woodland	Preferred irrigated native hayland and pasture over tame hayland and pasture; nested in pastures and hayfields that had lower mean percent grass cover (20 vs. 32%), higher mean percent forb cover (16 vs. 3.5%), and were drier (45 vs. 3% of random locations characterized as 'dry') than unused pastures and hayfields; within pastures and hayfields containing nests, nest sites had less bare ground and higher percent cover of grasses (values not given) than random sites; preferred to nest on hummocks ≥2.5 cm above the immediate surroundings; percent coverages in native hayland and pasture were 24% grass, 24% sedge (*Carex*), 23% bare ground, 9.9% rush (*Juncus*), 7.8% forbs, and 0.8% moss (Latin name not given)
Cole and Sharpe 1976	Nebraska	Idle, pasture	Were present on areas that were grazed, and absent from idle areas
Faanes and Lingle 1995	Nebraska	Idle mixed-grass, idle shortgrass, idle tallgrass, wet meadow	Nested at higher densities in wet meadow than in upland prairie
		Shrubsteppe,	Nests were found in irrigated and non-irrigated grass pastures

Forsythe 1972	Utah	shrubsteppe pasture	and salt flats; nests were built in bunchgrasses, clumps of sedges (*Carex* spp.), and stands of inland saltgrass (*Distichlis spicata*), or saltwort (*Salicornia rubra*)
Gratto-Trevor 1999	Alberta	Shortgrass pasture, wetland	Were more common on dry transects (a dry transect was defined as intersecting wetlands along ≤5% of its length) than on wet transects
Graul 1971	Colorado	Shortgrass	Nested in shortgrass prairie at the edge of a valley and near a hill; nest was lined with buffalo grass (*Buchloe* sp.) and lichen (*Parmelia molliuscula*); vegetation surrounding the nest was buffalo grass, blue grama (*Bouteloua gracilis*), and plains prickly pear (*Opuntia polyacantha*)
Johnsgard 1979, 1980	Colorado, Kansas, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas	Cropland, idle mixed-grass, idle shortgrass, idle tallgrass, mixed-grass pasture, tallgrass pasture, tame hayland, wet meadow	Nested on shortgrass plains on gently rolling terrain or on upland prairie slopes; in the sandhill grasslands region, close proximity to wet meadows was important in nest-site selection; nests frequently were placed next to cowpies; used wet meadows as foraging areas
Kantrud and Kologiski 1982	Colorado, Montana, Nebraska, North Dakota, South Dakota, Wyoming	Mixed-grass pasture, shortgrass pasture, shrubsteppe	Preferred lightly grazed areas with aridic ustoll and aridic borollic soils, and heavily grazed areas with typic ustoll soils; plants that were more common than average within nesting habitat included clubmoss (*Selaginella densa*), blue grama, fringed sagewort (*Artemisia frigida*), and golden aster (*Chrysopsis villosa*); other common plants within breeding habitat included bluebunch wheatgrass (*Pseudoroegneria spicata*), prairie sandreed (*Calamovilfa longifolia*), and Idaho fescue (*Festuca idahoensis*)
	Colorado,	Cropland, idle,	Six of seven nests were in areas dominated by buffalo grass

King 1978	Texas	mixed-grass pasture, sand-sage grassland, shortgrass pasture	(*Buchloe dactyloides*) and blue grama; one nest was in an area dominated by sand dropseed (*Sporobolus cryptandrus*); six of seven nests were within 20 cm of a cowpie; mean vegetation height at nests was 11 cm; mean vegetation cover at nests was 72%; at 3 m from nests, mean vegetation height was 20.6 cm; did not use areas dominated by sand sagebrush (*Artemisia filifolia*) for nesting or foraging; 39% of curlew observations occurred within 400 m of standing water (irrigation, stockponds); used shortgrass, mixed-grass, and weedy areas in slightly greater proportions (75% of 354 observations) than their availability (67% of the landscape); use of areas with high structural diversity increased following hatching of eggs
McCallum et al. 1977	Colorado	Idle, mixed-grass, shortgrass	Preferred to nest in shortgrass prairie; occasionally nested in fallow fields; 41% of 63 curlew observations were ≤91 m from water and 68% were ≤403 m from water; avoided tall (measurements not provided) vegetation
McMaster and Davis 1998	Alberta, Manitoba, Saskatchewan	Cropland, Permanent Cover Program (PCP; idle tame, tame hayland, tame pasture)	Present in both cropland and PCP grassland; PCP cover included combinations of wheatgrasses, brome (*Bromus* spp.), and alfalfa (*Medicago* spp.)
Owens and Myres 1973	Alberta	Cropland, idle mixed-grass, mixed-grass hayland, mixed-grass pasture	Were more common in areas of mixed-grass than in cultivated areas
Pampush 1980, Pampush and Anthony 1993	Oregon	Cropland, idle, idle shortgrass, idle tame, shortgrass/tame pasture, shrubsteppe,	Highest mean densities of nests occurred in areas of downy brome with patches of Sandberg's bluegrass intermixed; avoided areas of antelope bitterbrush (*Purshia tridentata*) and areas with dense forbs; nest density was negatively correlated

		tame hayland	with vegetation height and vertical density; foraged in fallow fields and alfalfa (*Medicago sativa*) as long as vegetation was <30 cm tall; compared to non-nest areas, nest areas were associated with shorter vegetation (24 cm vs. 29 cm at non-nest areas), grass with less variation in height, total vegetation with less variation in height, grass with higher vertical density (0.8 contacts vs. 0.2 contacts/5 cm height increment) in the 25-50 cm height increment, and shrubs with lower total vertical density (0.02 contacts vs. 0.05 contacts/5 cm height increment)
Paton and Dalton 1994	Utah	Shrubsteppe pasture, wetland	Habitat patches containing nests had shorter vegetation (mean of 5.6 cm) than random habitat patches (mean of 9.0 cm), and more bare ground 6-15 m from the nest (mean of 34-36%) than random patches (mean of 38-39%); at nest sites, 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) and there was less bare ground <3 m from the nest (mean of 18%) than ≥6 m from the nest (mean of 28-39%)
Prescott 1997	Alberta	Cropland, hayland, idle, idle mixed-grass pasture, shrubland, tame pasture, woodland	Occurred (in decreasing order of abundance) in mixed-grass, mixed-grass within sandhills areas, planted cropland, and hayfields; were absent from fallow cropland, stubble fields, riparian areas, upland shrubland, and upland areas of deciduous trees
Prescott et al. 1993	Alberta	Mixed-grass pasture, tame pasture, wetland, wetland (restored)	Were present only in continuously grazed mixed-grass pasture; absent from early summer-grazed mixed-grass pasture, spring-grazed tame pasture, and deferred-grazed (grazed after 15 July) mixed-grass pasture
Redmond 1986	Idaho	Cropland, shortgrass pasture	Nested in shortgrass pasture; foraged in shortgrass pasture when vegetation was sparse (3.6 to 9.7 cm tall) but traveled up to 10 km from nesting sites to forage in agricultural areas when

			vegetation was dense (12 to 15.7 cm tall with areas 40 cm tall) due to abundant precipitation
Shackford 1987	Oklahoma	Colonies of burrowing mammals, cropland, idle, shortgrass pasture	Used native pastures near cultivated fields (mostly planted to wheat); areas that were used had clay loam soils on 0-1% slopes; curlews with young foraged in prairie dog (*Cynomys*) colonies
Shackford 1994	Oklahoma	Cropland, shortgrass, tame	Curlews were observed in cropland, in shortgrass prairie, and in tame grassland; two nests were found in cultivated fields
Stewart 1975	North Dakota	Idle shortgrass, mixed-grass pasture	Used shortgrass prairie and mixed-grass pasture; some areas of shortgrass prairie that were used had prickly pear cactus (*Opuntia*) and an open shrub layer composed of big sagebrush and silver sagebrush (*Artemisia cana*); preferred gently rolling terrain with gravelly soils
Sugden 1933	Utah	Pasture, wetland	Preferred flat, open country of alkali flats and wetlands around the Great Salt Lake
Timken 1969	South Dakota	Pasture	Curlews were noted in idle pasture and in cattle pasture, but not in sheep pasture

*In an effort to standardize terminology among studies, various descriptors were used to denote the management or type of habitat. "Idle" used as a modifier (e.g., idle tallgrass) denotes undisturbed or unmanaged (e.g., not burned, mowed, or grazed) areas. "Idle" by itself denotes unmanaged areas in which the plant species were not mentioned. Examples of "idle" habitats include weedy or fallow areas (e.g., oldfields), fencerows, grassed waterways, terraces, ditches, and road rights-of-way. "Tame" denotes introduced plant species (e.g., smooth brome [*Bromus inermis*]) that are not native to North American prairies. "Hayland" refers to any habitat that was mowed, regardless of whether the resulting cut vegetation was removed. "Burned" includes habitats that were burned intentionally or accidentally or those burned by natural forces (e.g., lightning). In situations where there are two or more descriptors (e.g., idle tame hayland), the first descriptor modifies the following descriptors. For example, idle tame hayland is habitat that is usually mowed annually but happened to be undisturbed during the year of the study.

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