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ABSTRACT Long-billed curlews (*Numenius americanus*) are described primarily as a grassland nesting species. However, no studies to date have quantified nest habitat selection among available habitats. During a study of waterfowl nest habitat selection and success in landscapes ranging from cropland to grassland-dominated, we found 9 curlew nests of which 8 were located in active cropland within cropland-dominated landscapes. Cropland nests occurred in fall-seeded winter wheat and spring-seeded barley and nests were clumped in distribution. Four cropland nests and 1 nest in native grass pasture hatched young. Further research is needed to characterize nesting habitat selection and reproductive success for this species.

KEY WORDS Alberta, cropland, long-billed curlew, nesting habitat, *Numenius americanus,* winter wheat

Long-billed curlews (*Numenius americanus*; hereafter, curlews) are the largest North American shorebird and breeding populations were once abundant over most of the shortgrass and mixed-grass prairies of the northern Great Plains. Significant population declines since the late 1800s have been attributed to overharvest (prior to 1918) and loss of breeding habitat, particularly the loss of grasslands to cultivation (Dugger and Dugger 2002). Curlews are listed nationally in the United States as a U.S. Fish and Wildlife Service "Bird of Conservation Concern" (Fellows and Jones 2009), and in Canada they are listed as a species of "Special Concern" indicating that it may become threatened or endangered as a result of biological characteristics and identified threats (COSEWIC 2009). In Alberta, the curlew is presently found in isolated populations in the Grassland Natural Region of southeastern Alberta; breeding densities there are thought to be some of the highest within their remaining range (Hill 1998). Curlews are a "Blue List" species in Alberta, indicating that the species may be at risk of declining to non-viable population levels (Alberta Environment 2001). Despite their population status, curlews remain a relatively "underemphasized" species in studies of breeding shorebirds (Dugger and Dugger 2002: 23).

Based on surveys of territorial males and pairs, breeding curlews typically settle in landscapes characterized by large, open expanses of grassland pasture. While proximity to water is likely an important factor in settling, pairs often occur in dry grasslands (Dugger and Dugger 2002, reviewed in Dechant et al. 2003). Cultivated lands adjacent to grasslands often were used by breeding curlews, but extensively cultivated landscapes were generally avoided (Dugger and Dugger 2002, Foster-Willfong 2003, Ackerman 2007). Knopf (1994) listed curlews as a primary grassland endemic species. In systematic range-wide surveys of breeding pair habitat associations in southern Alberta, Saunders (2001) indicated that native grasslands in Alberta were preferred habitat for breeding pairs, cultivated lands were used in proportion to availability, and tame pastures were avoided. Saunders also noted that relatively large numbers of breeding curlews in Alberta occured in intensively cultivated landscapes. In a similar range-wide survey in the United States, Saalfeld et al. (2010:153) found "curlews were most frequently observed in low stature (i.e., 4–15 cm), shortgrass prairie and pasture grasslands as well as cultivated crops".

Nesting habitat is typically characterized as grazed grasslands with rare occurrences of nesting in haylands and cultivated lands (Dugger and Dugger 2002, Dechant et al. 2003, Hartman and Oring 2009). Whereas several sources indicate that curlews may nest in croplands or cultivated land (e.g., Pampush 1980, Renaud 1980), documented first-hand accounts are rare. Shackford (1994:19) found two nests in Oklahoma, both in recently plowed wheat fields that were "essentially bare except for an occasional weed or two". He further stated "this was the first confirmed nesting of curlews in a cultivated field in Oklahoma and, to the best of our knowledge, no other exists elsewhere". More recently, Foster-Willfong (2003:37) "found one nest and it was located in a crop field" and Ackerman (2007) reported one nest in spring-seeded wheat and one nest in fallow crop (of four nests found) in North Dakota. It is important to note that these reports are incidental encounters and not the result of systematic nest searching activity and therefore, the potential relative use of cropland habitat for nesting remains unknown. Our objective was to report the extent of cropland nesting by curlews from a study where a range of habitats were systematically searched for nests.

STUDY AREA

Our study was conducted near the town of Hussar, Alberta (51° 2' 27" N, 112° 40' 57" W; Fig. 1). This area is within the Moist Mixed Grassland Ecoregion of southern

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Alberta and is characterized by flat to hummocky or kettled topography formed by deposition of lacustrine deposits and glacial till (Ecological Stratification Working Group 1995). Wetlands, in the form of prairie potholes, comprised approximately 7.6% of the area (J. Devries unpublished data). The regional climate was cold continental with a mean annual temperature of 4.1°C (January–July range: −8.9 – 16.2 °C) and a mean annual precipitation of 320 mm (at Calgary; Environment Canada 2000). Primary land uses in the area included cropland (predominantly for cereal grain and oil-seed production), and introduced and native grassland pasture and hayland for beef cattle.

Native grasslands were dominated by spear grass (*Stipa comata*), western porcupine grass (*S.curtiseta*), western wheat grass (*Agropyron smithii*), northern wheatgrass (*A. dasystachyum*), June grass (*Koeleria macrantha*), western snowberry (*Symphoricarpos occidentalis*), and prickly rose (*Rosa acicularis*; Alberta Environmental Protection 1997). Tame grasslands and haylands typically were seeded to alfalfa (*Medicago* spp.) in combination with crested wheatgrass (*A. cristatum*), smooth brome (*Bromus inermis*), or Russian wild rye (*Elymus junceus*). Approximately 99 and 92% of native and tame grasslands, respectively, were used as pasture and generally provided sparse cover throughout the nesting season. Haylands provided sparse cover early in the season but dense cover by early June. Idle native and tame grasslands provided dense cover throughout the nesting season. Croplands included standing stubble of cereal crops (e.g., wheat, barley) and canola or bare dirt (previous year's fallow land). All cropland provided sparse nesting cover early in the nesting season although winter wheat became relatively tall and dense by early June (Devries et al. 2008).

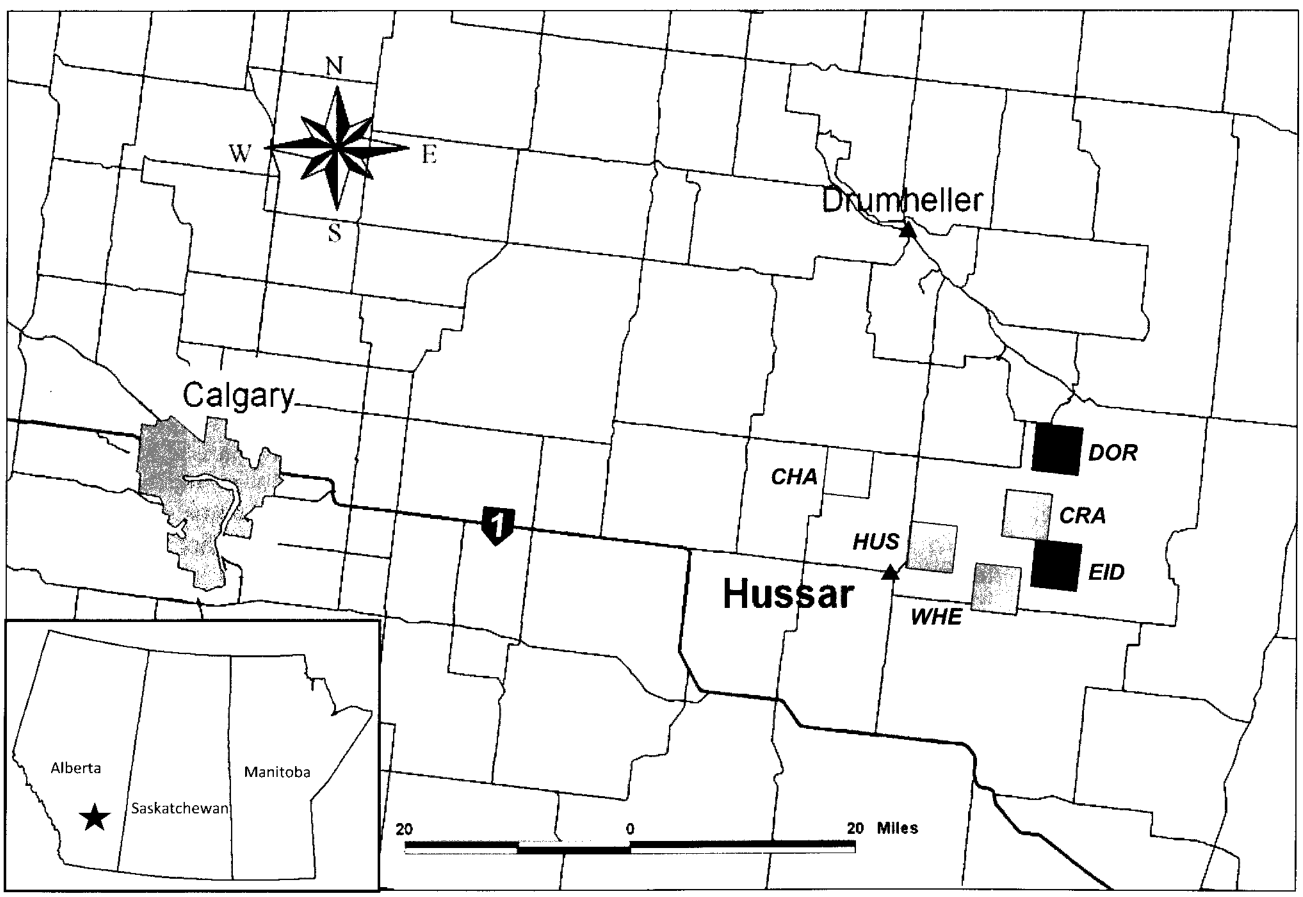

Figure 1. Location of 6, 41km^2 study sites containing habitats searched for waterfowl and shorebird nests near Hussar, Alberta, 2007. Light-gray sites contain <40% grassland cover (CHA, CRA, HUS, WHE), and dark-gray sites contain >60% grassland cover (DOR, EID). CHA = Chancellor, CRA = Crawling Valley, HUS = Hussar, WHE = Wheatland, DOR = Dorothy, and EID = Eastern Irrigation District study sites.

METHODS

We conducted nest searches for waterfowl and shorebirds during April–June 2007 and we sampled most nesting habitats available. Our study examined the influence of landscape composition on waterfowl nesting; hence, we selected 6, 6.4 x 6.4-km (41 km^2) landscapes of which 2 represented high (>60%) levels of grassland cover (i.e., tame and native grassland and hayland), and 4 represented low (<40%) levels of grassland cover. Our study sites were 41 km^2 in size because previous research indicated that grassland amount at this scale affected waterfowl nest survival (Stephens et al. 2005). The 6 study sites were a stratified random sample from 2,000 random sites generated in ArcMap and stratified by land use as determined from classified Landsat-TM data (Agriculture and Agri-Food Canada 2001). The 2 high-grassland site replicates were dominated by intact native prairie with minimal cropland (Dorothy [DOR] and Eastern Irrigation District [EID]), 2 low-grassland replicates were composed of tame and native pastures and hayland with some spring-seeded cropland (Hussar [HUS] and Crawling Valley [CRA]), and the remaining 2 low-grassland replicates were dominated by spring-seeded cropland (Chancellor [CHA] and Wheatland [WHE]; Table 1, Fig. 1).

Because use of cropland habitat, especially winter wheat, for nesting was of interest, we contracted seeding of 111–124 ha of winter wheat (473 ha total) on the 4 low grassland sites (i.e., CHA, HUS, WHE, CRA) during September 2006. Agreements with landowners ensured that we could nest search these areas as well as an equal area of their spring-seeded cropland and/or chemical fallow cropland. Exact location of crop fields within the study site was constrained by landowner willingness to be involved in our study. Because we could not nest search entire study sites, we identified other habitats of interest (native grassland, tame [seeded] grassland, hayland) on all quarter sections (65 ha legal subdivisions) within a study site and we randomly selected a minimum of 2 quarters containing each habitat for nest searching. We searched non-flooded wetland vegetation on all quarters.

Table 1. Study sites, location, percent of study sites in grassland and cropland, and habitat area (ha) systematically searched for waterfowl and shorebird nests in southern Alberta, 2007.

		Area searched						
Study site	% grassland, cropland[a]	Native grass	Tame grass	Hayland	Spring-crop / Chemical fallow	Winter wheat	Wetland	Total area searched
Chancellor	21, 68	72.6	15.8	0.0	234.1	110.0	7.2	439.7
Crawling Valley	31, 55	182.4	127.5	24.7	203.0	118.3	3.7	659.6
Dorothy	61, 29	243.3	115.3	114.8	52.2	0.0	2.8	528.4
E. Irrigation District	94, 0	304.9	0.6	0.0	0.0	0.0	4.7	310.2
Hussar	41, 52	191.8	95.4	0.0	160.9	120.7	4.3	573.1
Wheatland	4, 87	0.0	4.9	50.0	235.4	124.0	4.7	419.0
Total area searched		995.0	359.5	189.5	885.6	473.0	27.4	2,930.0

[a] Percent grassland (native and tame grassland and hayland) and cropland (annually cultivated lands) within the 41-km^2 study site boundaries reflecting criteria used to select sites.

We found nests using all-terrain vehicle (ATV) cable-chain drags (Higgins et al. 1977) and ATV rope drags (2.5-cm diameter rope used in growing cropland), by walking and dragging a rope between 2 observers, or by walking and striking the vegetation with willow switches ('beat-outs'). We conducted 4 nest searches on each quarter section beginning approximately 26 April, 15 May, 3 June and 27 June. We conducted searches between 0730 and 1300 MST each day. We searched all habitats including croplands but excluded trees and flooded wetland vegetation. When a nest was discovered, we identified the nest habitat, species, number of eggs in the nest, and incubation status. We recorded nest locations using a Global Positioning System (GPS; Garmin Model 76) for later analyses in a Geographic Information System (GIS; ArcMap, ESRI, Redlands, California, USA), and marked with a willow stake 4 m north of the nest. Following discovery, we checked nests every 7–10 days to track number of eggs and incubation status until final nest fate was determined (hatched, destroyed, or abandoned). For shorebird nests, we determined incubation status by flotation in water (C. Gratto-Trevor, Environment Canada, personal communication; Liebezeit et al. 2007). In the absence of evidence of curlew chicks, we determined nest fate based on condition of the nest bowl (tiny shell chips from pipping, flattened nest bowl; C. L. Gratto-Trevor, Environment Canada, personal communication).

To characterize the landscape surrounding nests, we used classified Landsat-TM digital landcover (Agriculture and Agri-Food Canada 2008) in ArcMap to estimate the percent grassland (all types) within a composite 1.6-km radius buffer landscape (hereafter, landscape) around curlew nests at each study site. We used classified landcover as well to estimate mean distance from cropland nests to the nearest large (>65 ha) patch of grazed grassland.

RESULTS

We searched a total of 2,930 ha of 6 habitats of which 1,544 ha were grassland types (native/tame pastures and haylands), and 1,386 ha were cropland types (spring-seeded wheat and barley, chemical fallow, and winter wheat; Table 1). We found 9 curlew nests; 3 each on the CHA and CRA sites (low-grassland), 2 on WHE (low-grassland), and 1 on EID (high-grassland). Eight of 9 nests were in active cropland, including 5 in winter wheat and 3 in spring-seeded barley. The remaining nest was in native grassland pasture (Table 2). Nests in winter wheat were distributed among 2 fields; 3 nests in one 126-ha field and 2 nests in one 124-ha field. The 3 nests in spring-seeded barley also were together in 1, 125-ha field. The nest in native prairie was 1,560 m into a large contiguous block of native grassland pasture (i.e., > 41 km^2 in size) that comprised the EID site. All nests were concurrently active and hence represented separate breeding females. Distances among 3 nests in winter wheat were 805, 780, and 395 m in 1 field and 340 m between 2 nests in the other. Distances among nests in the spring-seeded barley field were 910, 640, and 540 m.

Percent grassland comprised approximately 99, 16, 7, and <1% of the landscape surrounding nests at the EID, CRA, CHA, and WHE study sites, respectively. Median distance from cropland nests to the nearest large block of grazed grassland was 1,475 m (range: 690–3,270 m). We were able to estimate incubation for 6 nests and these were backdated to initiation dates between 8 May and 27 May (Table 2). Seven of 8 nests for which we determined full clutch contained 4 eggs and the remaining nest contained 3 eggs (Table 2). Five of the nests hatched and the remainder were presumed lost to predation.

Table 2. Characteristics of nine long-billed curlew nests found during systematic nest searches in southern Alberta, 2007.

Nest	Study site	Nest habitat[a]	Nest initiation date	Full clutch	Exposure days	Fate
LBCU01	CRA	Barley	8-May	4	22	Hatched
LBCU02	CHA	Winter Wheat	8-May	4	20	Hatched
LBCU03	CHA	Winter Wheat		4	11	Destroyed
LBCU04	CHA	Winter Wheat			4	Destroyed
LBCU05	CRA	Barley		3	13	Destroyed
LBCU06	CRA	Barley	13-May	4	27	Hatched
LBCU07	WHE	Winter Wheat	13-May	4	13	Hatched
LBCU08	WHE	Winter Wheat	13-May	4	4	Destroyed
LBCU09	EID	Native Grass	27-May	4	3	Hatched

[a] Barley was seeded on 2 May 2007; winter wheat was seeded in September 2006. Blank cells represent no data.

DISCUSSION

Dechant et al. (2003) and Fellows and Jones (2009:8) report that curlews "nested in the simplest, most open habitat available". Saunders (2001) speculated that, based on the presence of pairs and courtship activity in intensively cropped landscapes, nesting in croplands was likely. Moreover, early spring croplands with standing stubble from previous year's crop may provide the open, sparsely vegetated structure preferred by nesting curlews (Saunders 2001).

Our study is the first to report a higher proportion of curlew nests in croplands when compared to previous research. Despite opportunities to nest in nearby expanses of grazed native grasslands, most (8 of 9) curlew nests we observed were in cropland. Saalfeld et al. (2010) indicated that in landscapes with 0–5% grassland, curlew tended to avoid grassland fragments and speculated that minimum breeding area requirements may make these unsuitable breeding habitats. Because we only searched a relatively small set of landscapes within the curlew range in Alberta, we are limited in our inference regarding nest habitat selection. Observed use of croplands in our study could easily result from a unique concurrence of curlews and highly cropped landscapes.

In our study, curlews initiated nests in spring-seeded cropland 6 days after seeding operations had occurred in early May and hence avoided disturbances which would have destroyed established nests. This may have been an artifact of suitable weather for early crop seeding in 2007; nests would commonly be at risk in this habitat in many years when seeding occurs well into May. In contrast, winter wheat is seeded in August-September and remains relatively undisturbed through the following breeding season prior to harvest. Lack of a seeding disturbance in winter wheat could enhance both initial nest success and renesting success relative to croplands cultivated during spring (Hartman and Oring 2004, Devries et al. 2008). Nest success is a primary factor determining the population growth potential of many bird species and is often a vital rate targeted by conservation efforts (e.g., Hoekman et al. 2002, Mattson and Cooper 2007).

The clumped distribution of nests in our sample is striking and supports the observation of Allen (1980) and Saunders (2001) that curlews tend to occur, and may nest, in loose social aggregates. This attribute also may enhance the risks or benefits to a nesting population when making habitat selection decisions. Curlew are known for vigorous defense of nests and young (Dugger and Dugger 2002) and the effectiveness of this behavior is likely enhanced if nests are semi-colonial (e.g., Berg 1996). When nests are aggregated in cropland, however, the benefit of this behavior may be lower, and risk higher, if cultivation is the primary source of nest destruction.

Our study was not designed to examine curlew breeding habitat association or nest habitat selection; however, our observations suggest that nesting of curlews in croplands may be more common than previously believed. Given low nest success reported for birds nesting in croplands (Lokemoen and Beiser 1997, Best 1986, Devries et al. 2008), the extent and implications of this behavior to curlew population demography requires further study.

MANAGEMENT IMPLICATIONS

Conservation planning and habitat management for the curlew requires that nesting habits and habitats are well understood, and plausible conservation options are available. We recommend that where curlew and highly cropped landscapes overlap, agricultural producers incorporate fall-seeded crops into their rotations to potentially reduce disturbance of nesting curlew. Fall-seeded crops such as winter wheat and fall rye are examples of low disturbance crops already being planted in the region.

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