Long-billed Curlew (*Numenius americanus*) surveys in the Nebraska Sandhills 2016 and 2023

Joel G. Jorgensen
Nongame Bird Program
Nebraska Game and Parks Commission

Stephen J. Brenner
Audubon Great Plains
Western Nebraska Field Office

The Long-billed Curlew (*Numenius americanus;* hereafter, LBCU) is the largest North American shorebird (Dugger and Dugger 2020). Formerly, the LBCU's breeding range extended as far east as Wisconsin and Illinois in the Midwest but now that range is reduced, and breeding occurs primarily in grasslands in the western Great Plains and Intermountain West (Dugger and Dugger 2020). While unregulated shooting reduced populations historically, loss of grassland and prairie habitats is the presumed source of broader population declines and long-term reduction of the LBCU's breeding range. Due to both past and ongoing declines, the LBCU is considered "highly imperiled" by the United State Shorebird Conservation Plan (USSCP 2004) and is also a Nebraska Natural Legacy Project Tier I species (Schneider et al. 2011, 2018). The species' status has led to an increased need for additional monitoring and research to understand the source of declines so that effective conservation strategies can be developed and implemented.

The Breeding Bird Survey (BBS) is arguably the most important avian monitoring program in North America (Sauer et al. 2011). The BBS shows a relatively stable annual trend of 0.05 (95% C.I.: -0.75, 0.68, n = 506 routes) for the LBCU survey-wide 1966-2019, but also indicates an annual decline of -3.50 (95% C.I.: -6.48, -0.63, n = 21 routes) in Nebraska (Sauer et al. 2020). However, BBS methods may be inadequate in tracking LBCUs because much of the species' breeding activity occurs prior to June when BBS routes are completed (Stanley and Skagen 2007). In fact, locally-breeding LBCUs outfitted with satellite transmitters are known to have migrated out of Nebraska as early as early to mid-June (NGPC, unpublished data). Recognizing that the BBS may provide incomplete information about LBCU numbers and trends, there were initiatives approximately a decade ago both range-wide (Stanley and Skagen 2007, Jones et al. 2008) and in Nebraska (McCarty et al. 2005, Gregory et al. 2012) to survey Curlews earlier in the breeding season. However, all of these efforts have been one-time surveys. While they provide valuable information about abundance, they do not provide insights about changes in abundance over time (i.e., trends).

LBCUs present an additional survey challenge because they occur at relatively low densities. Gregory et al. (2012) completed 39 routes with 40 stops each scattered over northwestern and north-central Nebraska. Routes were completed over a two-year period (2008 and 2009). Following work by Gregory et al. (2012), the Nongame Bird Program (NBP) at the Nebraska Game and Parks Commission was interested in developing a follow-up LBCU survey that could be conducted cost-effectively and at regular intervals. The NBP concluded it would not be cost-effective to simply replicate the methods used by Gregory et al. (2012). Subsequently, the NBP developed an alternative approach that would produce robust estimates of LBCU abundance but minimize the investment of time and resources needed to complete the surveys. This is achieved by conducting line transects that could be driven in a portion of the LBCU's Nebraska breeding range where Gregory et al. (2012) identified relatively high LBCU densities (Dinan and Jorgensen 2016). The first survey was completed in 2016 and a second interval was completed in 2023. Here, we provide initial results to what is intended to be a long-term monitoring program. The goal of this program is to provide reliable information about changes in LBCU abundance over time that complements traditional monitoring efforts such as the BBS.

Methods

Our general approach involves two observers completing the same survey routes using the same methods to survey LBCUs during similar periods each year of the study. We chose to have two observers survey routes each year to increase the overall number of detections but also allow for comparison between two observers within each survey year to ensure results of one observer were not biased or affected by unusual circumstances. Study design was largely developed by Dinan and Jorgensen (2016).

Study area

We used the study area defined by Dinan and Jorgensen (2016; Figure 1). The study area was defined using previously collected data to identify areas of higher LBCU density in Nebraska using interpolation in a Geographic Information System (ArcMap). The study area totaled 1,099,555 ha and includes the southern half of Sheridan County, the southwest corner of Cherry County, western Grant and Arthur counties, the northwest corner of Keith County, northern two-thirds of Garden County, far eastern Morrill and Box Butte counties. The study area largely covers an area of the Nebraska Sandhills, a grass stabilized sand dune system with numerous shallow lakes, marshes and wetlands and few developed streams (Condra 1906).

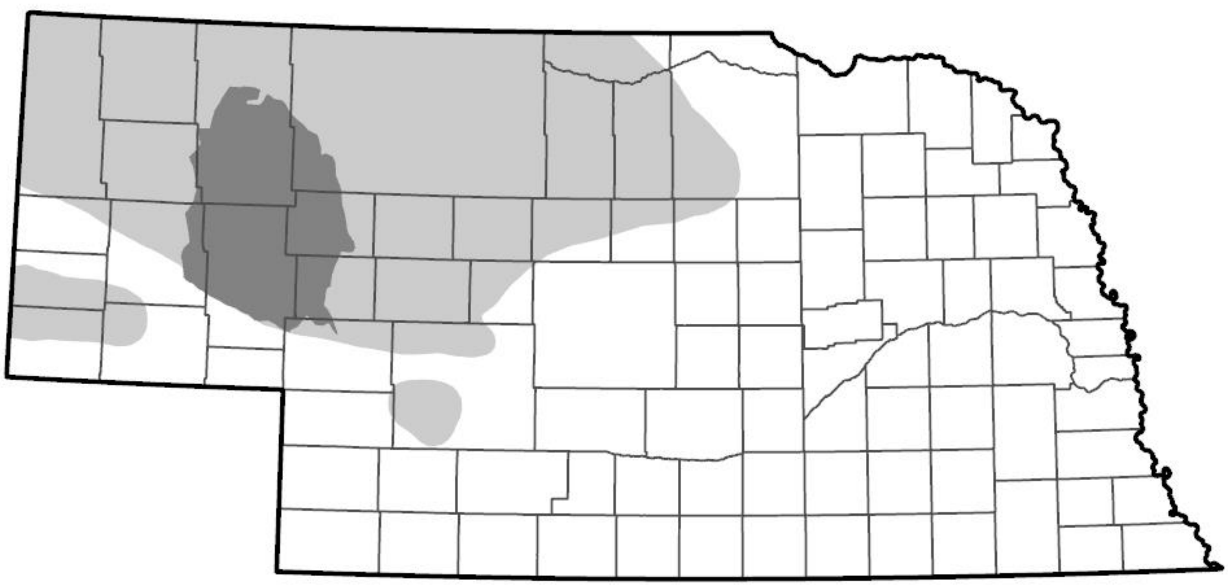

Figure 1. The study area (dark gray) within the current Long-billed Curlew breeding range (light gray) in Nebraska (Silcock and Jorgensen 2023).

Sampling Approach

We surveyed nearly all passible, public roads within our study area including highways and secondary roads. The study area is remote and has limited public roads which do not follow the Public Land Survey System, a 1 x 1 mile grid system which public roads follow over much of Nebraska. We used ArcGIS to randomly select starting points for routes (Dinan and Jorgensen 2016). We did not survey U.S. Highway 2 because of its proximity to a railroad. The proximity of the railroad and the frequency of trains greatly decreases landscape visibility on one side of the highway. Each route was surveyed as a line transect.

Access to a small number of routes changed between the first and second survey. Specifically, sections of some routes were marked as private roads or were otherwise impassible. Sections of routes that were no longer available were eliminated. LBCU detections from the 2016 survey along sections eliminated in 2023 were also excluded and were not used in comparisons between years.

Survey Methods

Surveys took place in April shortly after LBCUs arrive in Nebraska. This timing corresponds with the pre-incubation period when LBCUs are more visible, establishing nesting territories and engaging in courtship displays, and are most likely to be detected (Gregory et al. 2012). LBCUs become more secretive and less conspicuous during incubation which typically occurs in May and June (Dugger and Dugger 2020, Stanley and Skagen 2007). All surveys were conducted during daylight hours and during all weather conditions except heavy rain or snow, lightning, or wind speeds >50 km/hour.

Curlews were surveyed by driving each route 16 to 32 kph and visually searching for LBCUs. When a LBCU(s) was detected, observers stopped and recorded the GPS location, whether the detection was of an individual or a cluster of individuals, the number of curlews in the cluster, and the perpendicular distance from the road to the curlew. Observers did not search for additional LBCUs while stopped; searching commenced once the observer reinitiated the line transect. Observers used laser range finders to measure the distance of each LBCU or cluster of LBCUs detected.

Analysis

We used overall LBCU counts and estimated density using Distance Sampling (Buckland et al. 2004) to compare changes in LBCU abundance between years. We compared LBCU numbers and density by year by pooling data within each year and also by comparing metrics by observer within and between each year. One observer (JGJ) conducted surveys in both survey years, while another observer (LRD) conducted surveys only in 2016 and another observer (SJB) conducted surveys only in 2023. We used Program Distance (Version 7.3; Thomas et al. 2010) to estimate density. After exploratory analysis, we used four of six models suggested by Buckland et al. (2004) which were half-normal cosine, half-normal hermite polynomial, hazard-rate cosine, and hazard-rate simple polynomial. The model(s) with the lowest AIC value was selected as the top model. Model fit was measured using goodness-of-fit tests. Results with nonsignificant P-values were considered the best fitting model.

Results

All surveys were conducted between 11-21 April 2016 and 11-14 April 2023. A total of 111 LBCUs were detected in 2016 and 91 LBCUs were detected in 2016 (Figure 2). Individual observers totaled 63 (JGJ) and 48 (LRD) LBCUs in 2016 and 47 (JGJ) and 44 (SJB) LBCUs in 2023. The best models from our analyses where data was pooled by year were hazard rate + cosine and hazard rate + simple polynomial (Table 1). The estimated density of 0.008 (95% C.I.: 0.006, 0.012) LBCUs/ha in 2016 was greater than the estimated density of 0.003 (95% C.I.: 0.002, 0.004) LBCUs/ha in 2023 (Figure 3). Estimated densities were also larger in 2016 compared to 2023 when data were analyzed by observer and year (Figure 4), although there was some overlap in confidence intervals. Total number of LBCUs calculated (estimated density x study area) in our study area were 8796 (95% C.I.: 6597, 13,195) in 2016 and 3299 (95% C.I.: 2199, 4398) in 2023.

Table 1. Model adjustments of Long-billed Curlew density data by year and by year and observer. Models are ordered by Akaike's Information Criterion (AIC). *K* is the number of parameters, ΔAIC is the AIC difference from the top model, ESW is estimated strip width, D is Density (curlews/ha), D-LCL is 95% lower confidence limit of density, D-UCL is the 95% upper confidence limit of density and CV is coefficient of variation.

2016 All Data

Model	*K*	ΔAIC*	ESW	D	D-LCL	D - UCL	CV
Hazard rate + cosine	2	-	159	0.008	0.006	0.012	0.19
Hazard rate + simple polynomial	2	-	159	0.008	0.006	0.012	0.19
Half normal + cosine	2	4.24	156	0.008	0.005	0.013	0.25
Half normal + hermite polynomial	2	4.97	158	0.008	0.005	0.013	0.25

* lowest AIC value = 1107.06

2023 All Data

Hazard rate + cosine	2	-	163	0.003	0.002	0.004	0.19
Hazard rate + simple polynomial	2	-	163	0.003	0.002	0.004	0.19
Half normal + cosine	1	1.67	156	0.003	0.002	0.005	0.18
Half normal + hermite polynomial	1	1.67	158	0.003	0.002	0.005	0.18

* lowest AIC value = 880.52

2016 JGJ

Hazard rate + cosine	2	-	162	0.005	0.003	0.008	0.22
Hazard rate + simple polynomial	2	-	148	0.005	0.003	0.008	0.22
Half normal + cosine	2	2.79	156	0.005	0.003	0.009	0.32
Half normal + hermite polynomial	1	2.89	156	0.005	0.003	0.008	0.21

* lowest AIC value = 628.37

2016 LRD

Hazard rate + cosine	2	-	158	0.003	0.003	0.005	0.21
Hazard rate + simple polynomial	2	-	158	0.003	0.003	0.005	0.21
Half normal + cosine	1	1.00	147	0.003	0.003	0.005	0.23
Half normal + hermite polynomial	1	1.00	147	0.003	0.003	0.005	0.23

* lowest AIC value = 481.61

2023 JGJ

Hazard rate + cosine	2	-	144	0.002	0.001	0.003	0.30
Hazard rate + simple polynomial	2	-	144	0.002	0.001	0.003	0.30
Half normal + cosine	1	1.67	129	0.002	0.001	0.004	0.30
Half normal + hermite polynomial	1	1.67	129	0.002	0.001	0.004	0.30

* lowest AIC value = 445.79

2023 SJB

Half normal + cosine	1	-	201	0.001	0.001	0.002	0.30
Half normal + hermite polynomial	1	-	201	0.001	0.001	0.002	0.30
Hazard rate + cosine	2	1.95	198	0.001	0.000	0.003	0.45
Hazard rate + simple polynomial	2	1.95	198	0.001	0.000	0.003	0.45

* lowest AIC value = 445.79

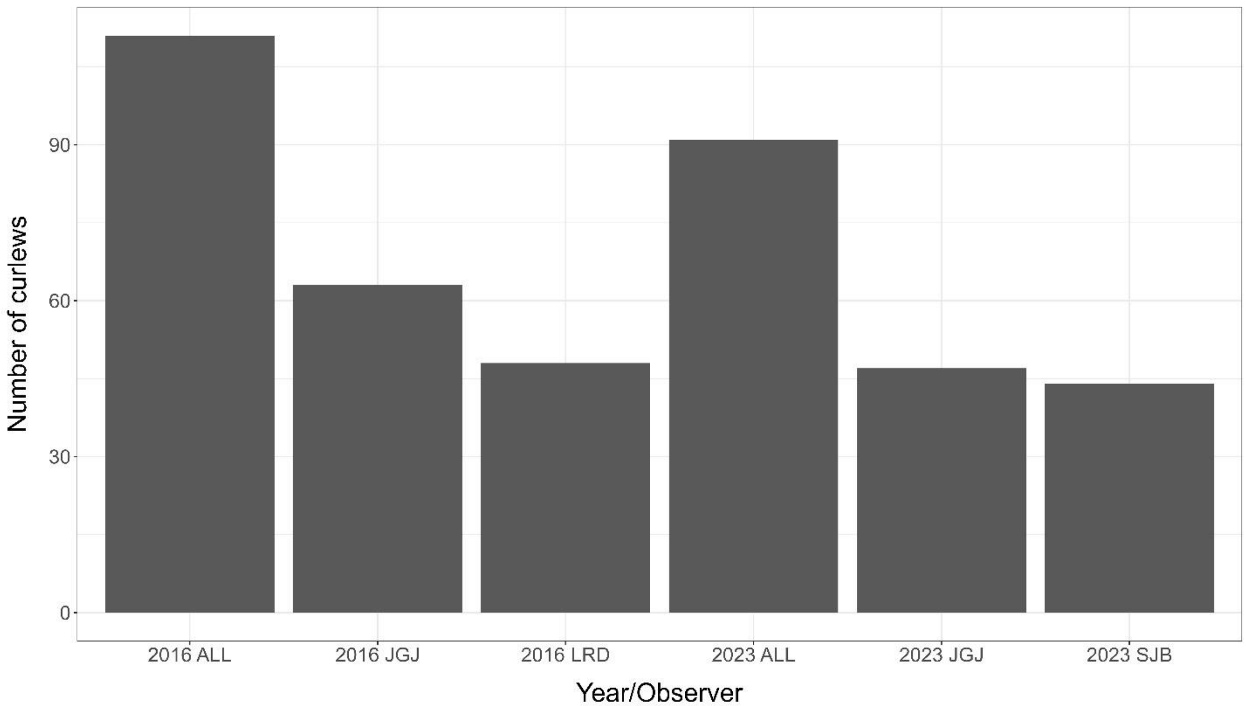

Figure 2. Total number of Long-billed Curlews detected by year by both observers (ALL) and total number detected by observer by year.

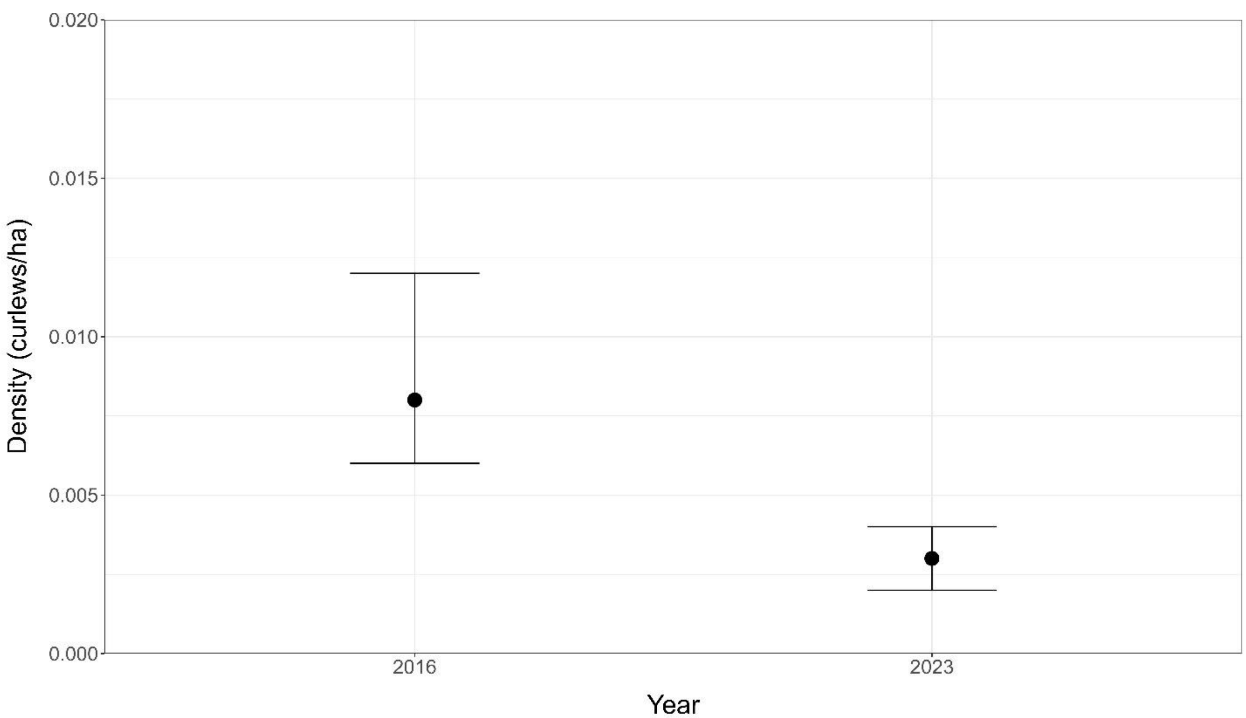

Figure 3. Long-billed Curlew estimated density in the Sandhills study area by year. Points represent mean density estimate and error bars represent 95% lower and upper confidence limits.

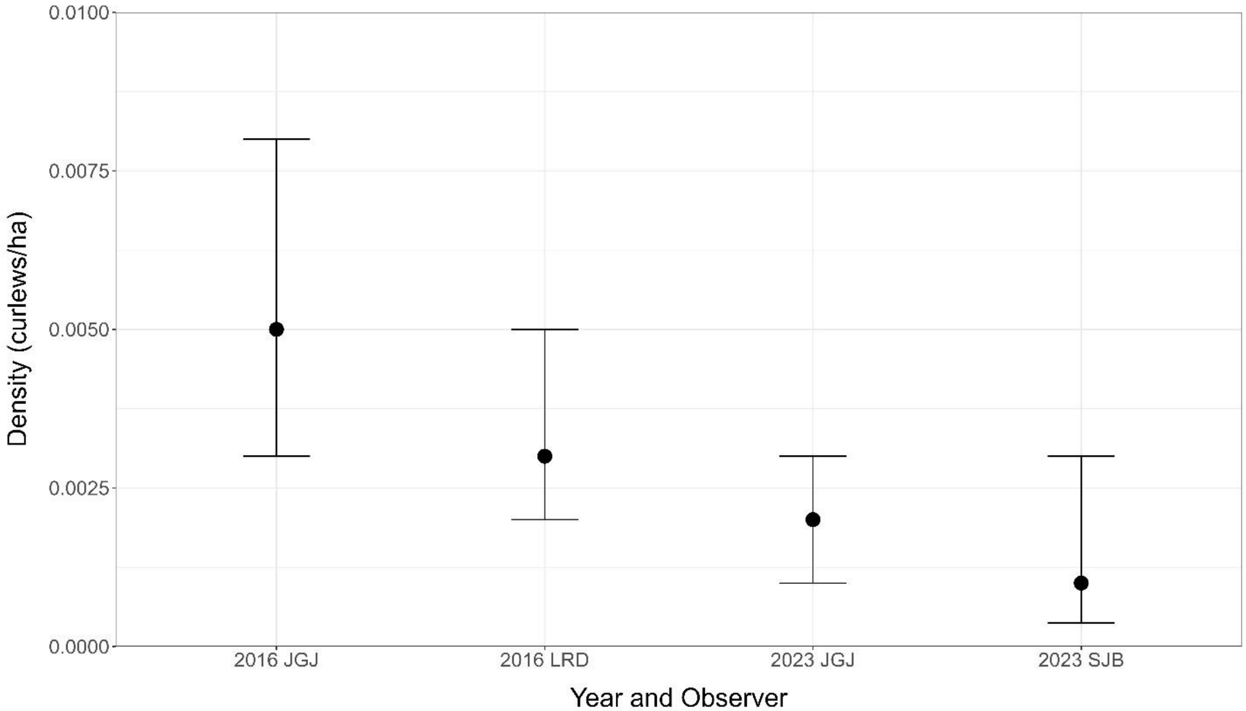

Figure 4. Long-billed Curlew estimated density in the Sandhills study area by year and observer. Points represent mean density estimate and error bars represent 95% lower and upper confidence limits.

Discussion

In 2023, we completed the second iteration of what is intended to be a long-term monitoring program focused on a species of high conservation concern, the LBCU. Limited inferences can be made at this juncture because surveys have only been conducted at two intervals. Even though density estimates show a marked decline in LBCUs in our study area since 2016, we believe it is premature to draw any conclusions about LBCU trends from this study. As our surveys occur early in the breeding season, annual variation in temperature and precipitation during the winter and early spring prior to the surveys could have a large impact on our detections and estimates. The winter of 2022-2023 saw above average snowfall totals and low temperatures across the region. North-central and western regions of the contiguous United States were also colder than average during March 2023 but were much warmer than average in 2016 (NOAA 2023). Thus, weather and climate patterns differences between the two survey years could have delayed the arrival or breeding of LBCUs in our study area. A third iteration of the survey will be especially important and will provide a greater perspective if LBCUs are, in fact, declining sharply in what is recognized as the core area of the species' abundance in Nebraska (Gregory et al. 2012).

The approach we used has shown be a cost-effective means to resolve a monitoring challenge of a species that occurs at low densities and is not ideally suited for the BBS. Both observers were able to complete all routes during a four-day period in 2023. We also believe there is value to having two observers complete all survey routes during the same year. However, years when only one observer is available to complete the surveys will also provide useful data. If additional portions of routes become inaccessible over time, this may present additional challenges, especially if LBCU numbers decrease and fewer are detected over time.

The second iteration of this survey was intended to be completed in 2020 but was delayed because of the COVID-19 pandemic. We believe iterations should be conducted every 3-6 years. However, the frequency of surveys can be adjusted as additional information is collected and incorporated into the body of knowledge of this monitoring program. Survey frequency may increase if it is shown that LBCUs are declining. In fact, it may be reasonable and prudent to move up the next iteration sooner rather than later because of the markedly lower density estimates observed in 2023 compared to 2016.

Acknowledgements

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Sandhills prairie in the study area