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Long-Billed Curlew (*Numenius americanus*) Rangewide Survey and Monitoring Guidelines

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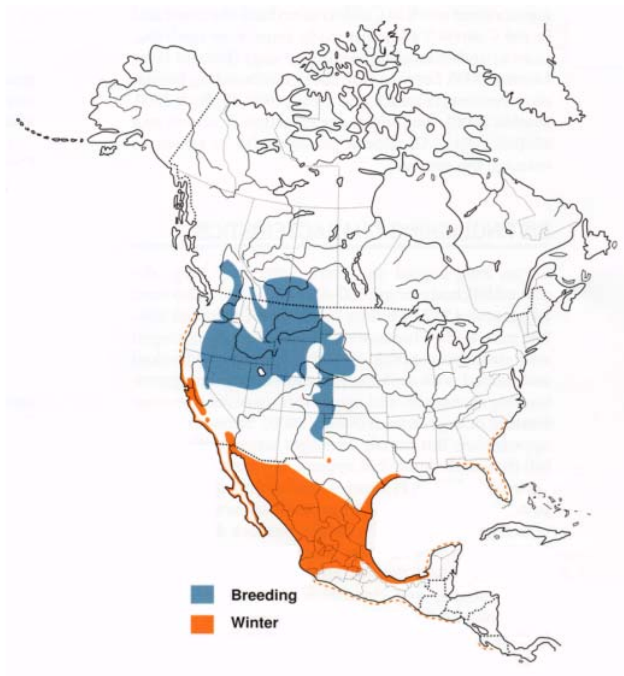
Focal Taxon

Long-billed Curlew
(*Numenius americanus*)

Breeding, migration and wintering ranges



Breeding: Long-billed Curlews (LBCUs) are found in low densities in the Great Basin, Columbia River Basin, and the shortgrass prairie region of the Great Plains.

Migration: Pacific coast and central U.S.

Wintering: California coast south of Humboldt Bay, southeast Atlantic coast from South Carolina to central Florida, occasionally North Carolina, northern and central Mexico, Baja California, and the Gulf of Mexico.

Background

LBCUs are a species of special concern throughout much of their breeding range in North America, with both the U.S. and Canadian Shorebird Plans listing them as "Highly Imperiled" (Brown et al. 2001). LBCUs are also listed in the U.S. as a Bird of Conservation Concern, at the National level, within FWS Regions 1, 2, 4 and 6, and for many Bird Conservation Regions (U.S. Fish and Wildlife Service 2002). This level of concern is due to apparent population declines, particularly in the shortgrass and mixed-grass prairie of the western Great Plains (Brown et al. 2001). Threats include habitat loss and fragmentation due to agricultural conversion (cropland and tame pasture), encroachment of woody vegetation, and urban development. For details on LBCU ecology, management, and conservation, refer to Dugger and Dugger (2002).

Breeding Bird Survey (BBS) data for LBCUs presently includes 227 survey routes rangewide, with 187 of those routes in the United States. BBS trends (1996-2002) are negative throughout much of its range, although trends are statistically significant only in FWS Region 6 (-0.2, $P = 0.03$) and FWS Region 1 (4.4, $P = 0.01$).

In general, species are considered adequately monitored by the BBS if the standard error (SE) of the estimated rangewide trend is < 0.90 and if there is no reason to believe that bias (e.g., roadside, detectability, & survey timing) is especially large (Bart and Francis *In Prep*.). Using BBS data, LBCUs have a SE of 1.10 (Bart and Frances *In Prep*.), and therefore the BBS does not adequately monitor LBCU trends. An increase in the number of BBS routes with LBCU could potentially lower the SE below the 0.90 threshold. However, since BBS routes are surveyed in June when LBCUs are largely inconspicuous (Gratto-Trevor, pers. comm.), this results in bias in BBS for LBCUs that an increase in the numbers of routes would not decrease. We believe this bias is substantial and that the BBS does not adequately reflect LBCUs trends. Our goal here is to design a monitoring scheme that provides estimates of population size and the data necessary to design a program to monitor trends in abundance rangewide.

Objectives

Objective 1 - Determine present LBCU distribution and population size rangewide during a two-year survey.

This information will be used for the development of management and conservation strategies, which will include the development of a monitoring plan after identifying populations or ecoregions of concern. At present, population size estimates are available for only a few areas (e.g. British Columbia, Alberta, and southeast Colorado). These estimates are derived from very different methods, with large variations in reliability.

Objective 2 – Develop a plan to monitor long-term trends in population size and distribution.

Regional and rangewide trend estimates are available from the BBS from 1966 - 2002. However, since the reliability and bias associated with BBS data are unknown, LBCU may require an additional survey to monitor trends.

Methods

This proposal is for a two-year survey for Objective 1, and development of an alternate monitoring survey in Objective 2.

Objective 1:

The general approach will be to: 1) specify a spatial sampling frame covering the geographic range of LBCUs; 2) stratify sample units on the basis of factors thought to influence LBCU populations; 3) select a random sample of units from each stratum; 4) specify a unit for subsampling; and 5) collect data for population estimation. Under this nested, stratified random sampling design, adapted from Saunders (2001), it will be possible to estimate population sizes and error terms for the strata and geographic area covered by the sampling frame.

Sampling frame:

LBCUs need large, open ($\geq$ 250 m wide), contiguous patches of suitable grassland and rangeland habitats, particularly large patches of native grasslands (e.g., *Buchloe-Bouteloua* grassland) with a low vegetative profile for nesting. LBCUs rarely nest in seeded pastures, although they will use this habitat for other activities. Many other grassland types are used for nesting, and are considered suitable habitat. Close proximity to water is not critical for adults, at least not early in the breeding season. In southwest Idaho, water was within 5 - 10 km of the core nesting grounds during March and April (Redmond and Jenni 1986). Some considerations to reduce bias include that LBCUs have a broad but patchy distribution, may be semi-colonial, and generally nest in low densities (Dugger and Dugger 2002).

We will delineate the geographic range of LBCUs using GIS and combining land cover maps that identify potentially suitable nesting habitat (as described above), BBS data, and other data on LBCU occurrence (e.g. Breeding Bird Atlases). Land cover maps are available for the western United States at 30-m resolution from the National Land Cover Data (http://landcover.usgs.gov/nationallandcover.html), or at 1 km resolution for western North America from the USGS Land Cover Characteristics Database (http://edcdaac.usgs.gov/glcc/nadoc2_0.html). BBS data on LBCUs are available from the Patuxent Wildlife Research Center (http://www.mbr-pwrc.usgs.gov/bbs/). Townships falling within areas containing potentially suitable nesting habitat or where LBCUs historically have occurred will be considered the population of sample units that comprise the sampling frame.

Stratification of sample units:

The goal of stratification is to partition sample population, in this case the population of sample units (i.e., townships) comprising the sampling frame, into strata that are relatively homogeneous with respect to the variable being measured (i.e., population size). In the present case, we will use data from land cover maps, and possibly the BBS, to construct strata into which sample units can be placed *a priori*. One possible approach would be to mimic the scheme used by Saunders (2001), in which stratification was based on the percentage of native prairie and/or other suitable LBCU habitat in a township. An alternative approach would be to stratify on the basis of the existence of contiguous patches of grassland >250 m wide. We will consider these approaches and others that might better exploit the land cover and historical bird data available to us; it may be possible to post-stratify once we get on the ground and can determine what is really available.

Selection of sample units:

Sample units within each stratum will be selected using a simple random sampling approach (without replacement), where each unit has an equal probability of becoming part of the sample population. The number of sample units comprising the sample population will be constrained by the number of personnel that can be hired and distances between selected sample units. For the strata and population estimation methods used by Saunders (2001), it was estimated that a total of 412 sample units would need to be sampled to detect a 20% change in the LBCU nesting population with a power of 90% (a desirable target). As Saunders rightfully points out, however, such a target is unrealistic for LBCUs. We will attempt to maximize the precision of our LBCU population estimates by sampling as many units as possible within a season, and by optimally allocating those units among strata using estimated variances and standard statistical formulae (e.g., Cochran 1977). We will use the strata-specific variance estimates reported by Saunders (2001), if appropriate for the strata we ultimately define, or will estimate strata-specific variances using count data from BBS routes in those strata. After the first year of data are collected, the optimal allocation of units among strata will be recomputed using actual strata-specific variance estimates. A new set of sample units will be selected for surveys in year 2 to maximize information on LBCU distribution and to improve occupancy and sightability models (see below). The second year will also be necessary to quantify year effects, such as amount of rainfall.

Specification of subsampling units:

Within each sample unit, a single 32-km route will be established using the criteria specified in Saunders (2001:4) and using suitable habitat in proportion to their availability, and points will be designated for sampling at 0.8-km intervals along the route (i.e., 40 points/route). Because any particular route represents only one of the many routes (and hence points) that could have been established, a route is best considered a subsample of size one from the sample unit. As such, it will not be possible (due to lack of replication) to use data from routes to estimate error terms for population size for sample units (i.e. error terms for population size can not be determined at the route level but data must be combined over many routes to determine population size and error terms). Moreover, because points comprising a route are not truly a random sample of the population of points existing in a sample unit, parameter estimates derived from routes may be biased. Because it is not practical or operationally feasible to randomly sample points in a township, we must assume that parameter estimates obtained from a route are representative of the sample unit itself. We believe this assumption is reasonable because the area sampled by the route represents 21.8% of the area of the township itself (more if the actual search radius exceeds the minimum 400-m radius assumed), a fairly large percentage.

Data collection on subsampling units:

The objective of this study is to estimate the population size (*N*) of LBCUs. To accomplish this, two pieces of information are required: *n*, a random variable representing the number of LBCUs counted in an area of interest, and π, the probability of detecting a LBCU in an area of interest. Then, given the count data and detection probability, population size can be estimated as $N = n/\pi$. An important point to note here is that $N = n$ only if $\pi = 1$. That is, all LBCUs must be detected in an area of interest with 100% certainty for the count to equal the true population size. Anything less then perfect detection will result in a count *n* that is, to an *unknown* degree, a biased estimate of *N*. Consequently, it is essential in surveys where population size is the parameter of interest to conduct the survey in a manner that allows detection probability (π) to be estimated.

In this study, count data from points along a route will be used to estimate the LBCU population size for the route, which as described above will be taken as the population estimate for the sample unit that contains the route. Routes will be surveyed in a manner coinciding with the relatively narrow time window (2-4 weeks) corresponding to the arrival and pre-incubation period of LBCUs, when males are most conspicuous in their aerial display flights (Redmond et al. 1981). Pilot data on Marbled Godwits (*Limosa fedoa*) and Willets (*Catoptrophorus semipalmatus*) indicate extremely low detectability rates during the incubation period, and pre-incubation surveys appear to be the most representative of how many were actually nesting in the area (Gratto-Trevor, pers. commun.). We believe that LBCUs behave similarly and LBCU surveys will be carried out during the pre-incubation period. At lower elevations and latitudes (e.g., north Texas and southwest Idaho) the survey period will begin in early March, whereas at higher elevations and latitudes (e.g., Montana's Centennial Valley), surveys will begin in early

May, and end 30 May in Canada.

Routes will be surveyed by teams of two observers who will stop at points spaced 0.8-km apart to record all LBCU seen or heard within 5 minutes. Surveys will start ½ hour before sunrise and will continue for 4 - 5 hours. Routes will be placed on secondary roads and other rights-of-way, with parallel routes a minimum of 2-km apart. If no roads are located in a selected area, a 24-km off-road route will be selected. Data on LBCUs seen or heard at a point will be collected so that detection probabilities can be estimated from the count data. Specifically, at each stop there will be a primary observer and a secondary observer, and the individuals in these roles will alternate between stops. The primary observer will be responsible for detecting LBCUs by sight or sound, determining by laser rangefinder the distance band (0 - 400 m, 400 - 800 m, >800 m) in which the LBCU occurs, and communicating this information to the secondary observer. The secondary observer will record the information, including the 1-minute time interval in which each LBCU was detected, and will record all LBCUs and the distance band that were not detected by the primary observer. The time of detection will be based on the first observation, whether the first or second observer saw it. Collecting data in this manner will allow estimation of detection probabilities and population sizes using two distinctly different methods: the double-observer approach of Nichols et al. (2000) and the removal-model approach of Farnsworth et al. (2002). Furthermore, because the data will be collected by distance band, total area sampled along a route can be calculated so the population size estimate for the route can be converted to a density estimate.

The detection probability (π) can be decomposed into the product ψp , where ψ is the probability a LBCU is present in an area and p is the probability a LBCU is detected in an area *given* it is present. In large-scale monitoring studies it is often of interest to construct a model for ψ using habitat or other covariates, so that model can be used to predict the probability an animal occupies a particular area based on habitat (or other covariates) alone. This "occupancy model" can then be used to adjust rangewide population size estimates. The model could also be used as planning tool for future monitoring activities, and to identify potentially important areas for management activities. It is common to model ψ using logistic regression; however, this approach assumes that sample units are correctly classified as occupied or unoccupied. Unfortunately, when the conditional detection probability p is less than 1, this assumption is violated because there will exist occupied sample units that are classified as unoccupied because the LBCUs present went undetected. Modeling p as a function of weather, habitat, observer, or other covariates is likewise often of interest in monitoring studies. The resulting "sightability model" for p can then be used to identify the best times for surveying or to adjust population size estimates to account for variable sightability conditions.

MacKenzie et al. (2002) offer a solution to the problem of estimating ψ when $p < 1$. They constructed a model that allows joint estimation of ψ and p, and allows these parameters to be modeled as functions of covariates. This allows the possibility of constructing a robust occupancy model for ψ as well as a sightability model for p, both of which can be exploited for planning, research, and management. In this study, assuming sufficient personnel resources and adequate travel funds, a small subset of units from our stratified random sample may be selected for multiple visits (approximately 5 visits/sample unit) so that ψ and p can be modeled using the MacKenzie et al. (2002) approach. Covariates for modeling ψ should be time-constant and site-specific, and might include things such as % native grassland (grazed and ungrazed), % tame pasture, % cultivated (irrigated or dryland), % other dominant grassland and rangeland species present (e.g. cheat grass, *Bromus secalinus*) and distance to other features (e.g., riparian, farmsteads, irrigation canals, industrial activity, gravel pits), distance and type of nearest water; and vegetation structure and composition. Covariates for modeling p will include things such as time of day, precipitation, wind speed, and observer.

Statistical Analysis:

Population size and density estimates for sample units will be combined to obtain point and error estimates for strata and the entire geographic range using the standard formulae of sampling theory (Cochran 1977). If data can be obtained to estimate ψ and p under the MacKenzie et al. (2002) model, occupancy and sightability models will be constructed and used to adjust point estimates.

Objective 2:

The general approach to accomplishing Objective 2 will be to use the information obtained from Objective 1 to determine the priority and need for continuing monitoring to promote the conservation of LBCU. The data gathered in the rangewide survey (in Objective 1) will be used to further evaluate the need for supplemental monitoring and the geographic priorities for this monitoring. After this evaluation, the data from Objective 1 could be used to design a long-term monitoring program.

Implementation

Implementation of this survey will use existing resources, volunteers, and agency biologists, along with the new funding received to hire new personnel. Many state and federal biologists, in both the U.S. and Canada, have expressed an interest in cooperating with the project, and would be interested in conducting routes in their states and provinces. A minimum of four biologists will be needed to complete the surveys, coordinate the volunteers and state biologists, analyze the data, and complete the reports (Redmond and Jones 2002). This project was selected for implementation by the FWS Region 6 Science Support Team for funding in FY03/04 (Redmond and Jones 2002) and the survey will occur in 1 Mar – 30 May, 2004 and 2005.

Many state and provincial natural resources agencies have expressed an interest in estimating LBCU population numbers for their state. We will work with them to establish the sample sizes required to achieve this goal, and will identify sample units in their jurisdiction that were not selected for the rangewide survey so they can survey those routes. Some volunteers, particularly in the more populous states, could be used for a number of surveys. In the event cooperators and volunteers are only able to collect count data from routes, estimated detection probabilities and sightability models from other routes could be used to adjust those data to yield population size estimates.

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Photo by Doug Backlund