Local and Geospatial Landscape Analysis of Habitat Use by Long-billed Curlews (*Numenius americanus*) Breeding in the United States

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ABSTRACT

Long-billed Curlew (*Numenius americanus*) populations have declined dramatically during the last 150 years mainly due to destruction and fragmentation of grasslands used during the breeding season. In this study, we examined relationships among local and landscape habitat variables with the presence/absence and number of Long-billed Curlews detected during range-wide surveys conducted throughout the United States in 2004 and 2005. Long-billed Curlews were most often observed in primary grassland habitat and secondary pasture/rangeland and shortgrass prairie habitats, with low vegetation heights (i.e., 4-15 cm). Presence/absence and number of Long-billed Curlews within local habitats was positively associated with grasslands and wetlands. Similarly, presence/absence and number of Long-billed Curlews within landscape habitats was negatively associated with evergreen forests and shrub/scrub habitats, but positively associated with hay/pasture areas. Although we confirmed the relative importance of grassland, cropland, pasture, and wetland habitats, determining local habitat selection remains difficult when dealing with such a large variety of broadly-defined habitat types and ecoregions. Our results illustrate a need to conserve a variety of habitats for Long-billed Curlews necessary for different breeding behaviors. Future studies should focus upon the degree of utilization of different habitats during the breeding season and how habitat selection patterns affect breeding success and survival.

INTRODUCTION

During the last 150 years, Long-billed Curlew (*Numenius americanus*) population size and breeding range have declined significantly, especially in the eastern portion of their range of the United States and Canada (Dugger and Dugger 2002). Currently, Long-billed Curlews are considered Highly Imperiled in both the United States and Canada shorebird conservation plans due to significant population declines and habitat losses (Donaldson et al. 2000, Brown et al. 2001). Data from the North American Breeding Bird Survey also suggest that Long-billed Curlew populations have declined throughout the western Great Plains, but increased west of the Rocky Mountains, except Utah (Peterjohn and Sauer 1999). The main cause attributed to Long-billed Curlew decline within the United States is the > 30% loss and fragmentation of Great Plains grassland habitat (Brown et al. 2001). Habitat threats to grasslands and ultimately to breeding grassland birds such as Long-billed Curlews, include conversion of native grasslands to agriculture or suburban development, introduction of nonnative plant species, particularly forbs (e.g., knapweeds [*Centaurea spp*.]), unmanaged grazing pressure, and fire suppression leading to invasion of woody plants (see Hill 1998, Cannings 1999, Dugger and Dugger 2002). Despite this apparent decrease in Long-billed Curlew populations, current breeding population estimates throughout the United States (123,500 in Morrison et al. 2007, 164,515 in 2004 and 109,533 in 2005 in Stanley and Skagen 2007, and 166,244 in 2004 and 96,276 in 2005 in Jones et al. 2008) are much larger than previously estimated using expert opinion methods (i.e., 20,000 or 55,000; see Morrison et al. 2007, Jones et al. 2008). However, identified threats to breeding populations continue and it remains important to further address breeding habitat associations and long-term population trends.

Within the United States, Long-billed Curlews breed primarily in shortgrass or mixed-grass prairie habitats of the central and western Great Plains, Great Basin, and intermontane grasslands of the western United States (Dugger and Dugger 2002). Historically, however, Long-billed Curlews bred over a much larger range, including some records in the 1800s extending into the historic tallgrass prairie grasslands of the midwestern United States (Dugger and Dugger 2002). On a local scale, nesting Long-billed Curlews utilize grasslands of low vegetation composition (Pampush and Anthony 1993) with few trees, shrubs, or tall, dense grass (Dugger and Dugger 2002). Specifically, Pampush and Anthony (1993) documented nesting Long-billed Curlews in Oregon selecting habitats with low vertical profiles and density. Long-billed Curlews have also been documented using several different grassland habitats during the breeding season including agricultural fields, tame pastures, and native grasslands for breeding or foraging throughout the breeding season (Dechant et al. 1999). Aside from the broad classification of Long-billed Curlew habitat preference, little is known about specific habitat characteristics used during different breeding behaviors (i.e., courtship, nest site selection, foraging, brood rearing, etc.) because it is often difficult to separate use based on behavior with most survey designs. Because of this, few studies have been able to determine specific habitat requirements necessary or most predictive of Long-billed Curlews during the breeding season.

As human populations expand, grassland habitats continue to be affected from the increasing pressure of agriculture and development. From 1950 to 1990, grasslands west of the Mississippi River declined by 11 million hectares; with approximately 36% grassland conversion to uses other than cropland (Conner et al. 2001). Therefore, it will become increasingly important for proactive management efforts to focus upon patterns of breeding habitat selection. Successful conservation of Long-billed Curlew populations requires detailed examination of breeding habitat(s) at local and landscape scales to develop sound management strategies under which Long-billed Curlews and humans can coexist. Our study objectives were to determine both local (field habitat data) and landscape (GIS habitat data) habitat characteristics most representative of Long-billed Curlew presence/absence and number of Long-billed Curlews detected during the arrival and pre-incubation period in breeding regions throughout the western United States.

METHODS

Survey Locations

This research was conducted as part of a range-wide survey to estimate the breeding population of Long-billed Curlews throughout the United States and Canada in 2004 and 2005 (Stanley and Skagen 2007, Jones et al. 2008). While the survey was range-wide, we only used habitat data collected in the United States; thus the following description is specific to the United States portion of the survey (Jones et al. 2008).

Long-billed Curlew survey routes were selected based upon percentage of suitable grassland habitats within each township (approximately 9,324 ha), the sampling unit for this study. All townships falling within the geographic range of breeding Long-billed Curlews (21,405 in 2004 and 20,906 in 2005) were classified into one of four strata based on % suitable habitat (i.e., elevation, area developed, water, etc.) and % grassland habitat as calculated from the National Land Cover Data (Multi-Resolution Land Characteristics Consortium; Homer et al. 2004). Strata 1-3 consisted of at least 30% suitable habitat (Stanley and Skagen 2007) and were subdivided based upon Saunders' (2001) grassland criteria (i.e., strata one = 0-5% grassland, strata two > 5-50% grassland, and strata three > 50-100% grassland). Stratum four consisted of townships that did not contain Long-billed Curlew habitat (i.e., industrial complexes, urban areas, forested, etc.); no Long-billed Curlews or any suitable habitat were found in these townships during the survey and these townships are not included in any further analyses here (Stanley and Skagen 2007). Townships within each stratum were then selected using simple random sampling without replacement for each survey year (Jones et al. 2008). Samples were allocated among three strata using estimated variances from Saunders (2001), resulting in 42, 53, and 45 townships sampled from stratum one, two, and three, respectively, in 2004 and 26, 64, and 50, townships sampled from stratum one, two, and three, respectively, in 2005. Within each selected township, a 32-km survey route, was designated along all roads (except interstate highways or roads with > 2 lanes, following Saunders 2001; Figure 1).

Survey Data Collection

Surveys were designed to correspond with the arrival and pre-incubation period of Long-billed Curlews, a time when detection probability is greatest because they are trying to attract mates, establish breeding territories, and have not yet begun incubation. Because this period varies across their geographic range, the study area was divided into temporal periods representing the average breeding period for Long-billed Curlews within a specific region. A breeding chronology map was developed by correlating First Lilac Leaf Date data (Cayan et al. 2001) with Long-billed Curlew breeding records from the literature and data from local area specialists (S. L. Jones, personal communication). Surveys were conducted from 21 March - 15 May during both years (Figure 2). All surveys began at least 30 min after sunrise and ended at least 30 min before sunset. During each survey, two observers traveled a portion of the 32-km route by vehicle, stopping at points 0.8 km apart and recording all Long-billed Curlews seen or heard during a 5 min sample window. The distance to each Long-billed Curlew seen or heard was determined by laser rangefinder or ocular estimation and grouped into three categories based upon the distance from the observer [i.e., 0 – 400 m, > 400 – 800 m, and > 800 m; because very few Long-billed Curlews were detected > 800 m away from the route (< 15% of all curlews detected, Stanley and Skagen 2007), habitat and detection of curlews > 800 m from each route are not included in this analysis.] using the double observer method (Nichols et al. 2000, Jones et al. 2008).

Field Habitat Data Collection

When a Long-billed Curlew was seen or heard along a route, the habitat immediately surrounding the individual bird (5 m radius surrounding the bird) was recorded; including vegetation height (categorized from 1-6; Table 1) and all relevant primary (Table 2), secondary (Table 3), tertiary (Table 4), and habitat condition codes (Table 4). Additionally, within a 400 m radius of each stop point (0.8 km along 32-km route), observers estimated percent cover of broad habitat classification categories (Table 2) that comprised ≥ 25% of the area by quadrants (i.e., NE, NW, SE, SW; see Appendix A for detailed description). Observers recorded up to four primary codes (Table 2) in each quadrant and all appropriate secondary codes (Table 3), tertiary codes (Table 4), and habitat conditions (Table 4) onto survey data sheets (Appendix B). All habitat data were recorded after the 5 min survey period was completed.

Curlew Habitat Data Management: Local Scale

We collated all field generated habitat data and number of curlews seen or heard for each stop along a survey route and classified each stop point as occupied (i.e., ≥ 1 Long-billed Curlew detected) or unoccupied (i.e., no Long-billed Curlews detected). We assume surveyors could accurately place heard and seen curlews within detection distances of 0-400 m and 0-800 m and therefore, did not exclude data from those that were only heard, which could potentially bias results within habitats where curlews were not easily seen. For each stop point we determined

(1) percentage of each primary habitat code (Table 2) within a 400 m radius of the stop point, (2) percentage of each secondary habitat code (Table 3) when grassland was the primary habitat, (3) percentage of each tertiary habitat code (Table 4) when grassland or cropland was the primary habitat, (4) percentage of relevant habitat condition codes (i.e., IR or DY; Table 4) when cropland was the primary habitat, (5) number of curlews seen based upon detection distance category (i.e., 0-400 m and 400-800 m; because habitat data were collected within a radius of 400 m from each stop, we used only the number of curlews seen or heard within a detection distance of 0-400 m for the local habitat portion of the study), (6) Long-billed Curlew occupancy, and (7) respective state. In some instances, primary habitat was not collected or only partially collected for a stop. In these instances, we included only stops which classified > 50% of the habitat at a stop point [487 out of 9860 stops (5%) resulted in < 50% habitat classification].

Curlew Habitat Data Management: Landscape Scale

We used GPS locations for the starting and ending points of each route to determine specific locations of each stopping point (located every 0.8 km along 32-km routes). We uploaded GPS locations for each stopping point into ArcGIS 9.2 (Environmental Systems Research Institute, Redlands, CA) and delineated routes by tracing roads along which surveys were conducted using Street Maps USA (Environmental Systems Research Institute, Redlands, CA) for use with ArcGIS 9.2. Habitat plots with radii of 400 m and 800 m were placed around routes corresponding to the estimated observation distances.

To determine any habitat association with the presence/absence or number of Long-billed Curlews seen or heard along a route, we used the 2001 National Land-Cover Data to maintain consistency among all states included in the survey, as no other data set provided universal coverage across states. These data provided relevant, standardized land cover classifications, measured in close temporal proximity to surveys. In addition, original strata classifications (i.e., % grassland) were based upon this data set, making results consistent with survey design. We determined percentage of each habitat within plots (i.e., 0-400 m and 0-800 m) around routes using Thematic Raster Summary in Hawth's Analysis Tools in ArcGIS (Beyer 2004). From this, we determined the percentage of each habitat classification within each plot for each route (see Figure 3 for example). As habitat along routes were representative of Long-billed Curlew habitat in general (Stanley and Skagen 2007), it is unlikely that any bias occurred from only sampling habitat around routes.

Data Analyses

Local Scale.-We used resource selection functions (Manly et al. 2002) to determine field generated variable(s) within 400 m of a stop point most predictive of the presence/absence of Long-billed Curlews detected 0-400 m from a stop using a logistic regression with presence coded 1 and absence coded 0 (PROC LOGISTIC; SAS Institute, Cary, NC). We developed a candidate model set consisting of models including relevant combinations of primary habitat categories (Table 2). Correlated variables were not allowed to enter the same model. We used Akaike's Information Criterion corrected for small sample size (AIC_c) to select the best model(s) and calculated parameter likelihoods, estimates, and standard errors from model averaging. To test the goodness-of-fit of the top model, we used Hosmer and Lemeshow goodness-of-fit statistic (PROC LOGISTIC; SAS Institute, Cary, NC). We also determined secondary (Table 3), tertiary (Table 4), and habitat conditions (Table 4), when grassland or cropland was the primary habitat, that were most predictive of presence/absence of Long-billed Curlews within 0-400 m from a stop point using a logistic regression with the same methodology as above.

In addition to logistic regression, we also modeled the number of Long-billed Curlews detected 0-400 m from a stop using field generated variable(s) within 400 m of a stop point using Poisson regression (PROC GENMOD, SAS Institute, Cary, NC). We used the same candidate model set as used with logistic regression and Akaike's Information Criterion corrected for small sample size (AIC_c) to select the best model(s). We present parameter estimates, standard errors, confidence intervals, and *P*-values from the top model(s) (a model was considered a plausible model when $\Delta AIC_c < 2$). The number of Long-billed Curlews within 0-400 m from a stop point was also modeled using secondary (Table 3), tertiary (Table 4), and habitat conditions (Table 4), when grassland or cropland was the primary habitat, using Poisson regression with the same methodology as above.

Landscape Scale.- We used resource selection functions (Manly et al. 2002) to determine GIS generated variable(s) most predictive of the presence/absence of Long-billed Curlews at different distances from a route (i.e., 0-400 m and 0-800 m) and within each stratum (i.e., 1-3) with distance held constant (i.e., 0-800 m) using a logistic regression with presence coded 1 and absence coded 0 (PROC LOGISTIC; SAS Institute, Cary, NC). We developed a candidate model set consisting of models including relevant combinations of GIS generated habitat categories (Table 5). Correlated variables were not allowed to enter the same model. We used AIC_c to select the best model(s) and calculated parameter likelihoods, estimates, and standard errors from model averaging. To test the goodness-of-fit of the top model, we used Hosmer and Lemeshow goodness-of-fit statistic (PROC LOGISTIC; SAS Institute, Cary, NC). Because top models were the same despite different detection distances and plot sizes (i.e., 0-400 m and 0-800 m), we only present results from 0-800 m plots.

In addition to logistic regression, we also modeled the number of Long-billed Curlews detected at different distances from a route (i.e., 0-400 m and 0-800 m) and within each stratum (i.e., 1-3) with distance held constant (i.e., 0-800 m) using GIS generated variable(s) using Poisson regression (PROC GENMOD, SAS Institute, Cary, NC). We used the same candidate model set as for the logistic regression and AIC_c to select the best model(s). We present parameter estimates, standard errors, confidence intervals, and *P*-values from the top model(s) (a model was considered a plausible model when $\Delta\ AIC_c < 2$). Because top models were the same despite different detection distances and plot sizes (i.e., 0-400 m and 0-800 m) we only present results from 0-800 m plots.

In addition to using the 2001 National Land-Cover Data, we used the GAP Analysis Project to determine if there were any finer scale differences in habitat association with the presence/absence of Long-billed Curlews. Because each state has developed their own GAP Analysis Project, we used data from only two states to begin our investigation: Montana GAP Analysis Project (Wildlife Spatial Analysis Lab, The University of Montana) and Wyoming GAP Analysis Project (University of Wyoming, Spatial Data and Visualization Center). We used the same methodology as used when investigating the 2001 National Land-Cover Data, determining the percentage of each habitat classification within plots (i.e., 0-400 m) around routes. When using this methodology, we were unable to determine any significant differences between occupied and unoccupied points that were not explained using the 2001 National-Land Cover Data. Because the 2001 National-Land Cover Data provides relevant, standardized land cover classifications for the entire United States, measured in close temporal proximity to surveys, and the original strata classifications (i.e., % grassland) were based on this data set, we believe this data set was the most relevant and useful. Therefore, all analyses presented in this report are based on the 2001 National Land-Cover Data.

RESULTS

In 2004 and 2005, 9,860 stops along 285 routes were surveyed in the United States (139 in 2004 and 146 in 2005). There was ≥1 Long-billed Curlew detected 0-800 m from observer on 112 of these routes (60 in 2004 and 52 in 2005; Figure 1). Nearly 85% of all observations were within 800 m of observers (Figure 4, Stanley and Skagen 2007). There was ≥1 curlew 0-800 m from an observer on 14, 43, and 55 routes within stratum one, two, and three, respectively. Of the 1026 Long-billed Curlews observed within 0-800 m during 2004 and 2005, > 60% occurred in Montana, Nebraska, Oregon, and South Dakota (Table 6).

Local Scale

The majority (63%) of Long-billed Curlews detected 0-800 m from a stop were located in grassland habitat, with most occurring in shortgrass prairie (52%) and pasture grasslands (37%; Table 7). Additionally, most (71.5%) Long-billed Curlews occurred within vegetation 4-15 cm tall (Figure 5).

Using logistic regression, the best model predicting the presence of Long-billed Curlews at a distance of 0-400 m from a stop was the additive model of % grasslands and % wetlands within 0-400 m from a stop (Δ AIC_c = 0.0; AIC_w = 0.42; Table 8). The parameter likelihoods also indicate that % grasslands (likelihood = 0.62; estimate = 0.85; SE = 0.34) and % wetlands (likelihood = 0.60; estimate = 2.48; SE = 1.12) were the most important parameters to be included in the best model. The Hosmer-Lemeshow goodness-of-fit statistic ($\hat{c}$ = 0.661) indicated the data fit the model well. Similarly, Poisson regression resulted in the additive model of % grassland and % wetlands as being the top-ranked model (Δ AIC_c = 0.0; AIC_w = 0.84; Table 9), with the largest coefficient in the model associated with % wetland (positive, Table 10) followed by % grassland (positive, Table 10).

Using logistic regression, when the primary habitat was grassland, the best model of secondary habitat predicting the presence of Long-billed Curlews at a distance of 0-400 m from a stop was the model of % native prairie (Δ AIC_c = 0.0; AIC_w = 0.27; Table 11). The parameter likelihoods also indicated that % native prairie (likelihood = 0.27; estimate = -3.62; SE = 1.04) was the most important parameter to be included in the top model (Hosmer-Lemeshow goodness-of-fit statistic $\hat{c}$ = 0.570). The Poisson regression resulted in the model of % Conservation Reserve/Permanent Cover Program (Δ AIC_c = 0.0; AIC_w = 0.36; Table 12) being the top-ranked model, with the coefficient having a positive relationship to the number of curlews detected within 0-400 m of a stop (Table 13). Using logistic regression, the best model of tertiary habitat predicting the presence of Long-billed Curlews at a distance of 0-400 m from a stop was the model of % short grass (i.e., $<$ 12 cm; Δ AIC_c = 0.0; AIC_w = 0.33; Table 11). The parameter likelihoods also indicated that % short grass (likelihood = 0.33; estimate = 0.80; SE = 0.24) was the most important parameter to be included in the top model (Hosmer-Lemeshow goodness-of-fit statistic $\hat{c}$ = 0.568). The Poisson regression resulted in the model of % tall grass (i.e., $>$ 38 cm; Δ AIC_c = 0.0; AIC_w = 0.51; Table 12), being the top-ranked model, with the coefficient having a positive relationship to the number of curlews detected within 0-400 m of a stop (Table 13).

When the primary habitat was cropland, there was no top model of tertiary habitats or habitat conditions predicting the presence or number of Long-billed Curlews at a distance of 0-400 m from a stop when using either logistic or Poisson regression. In all cases, there was not sufficient evidence to reject the intercept as a plausible model (see Tables 14-16).

Landscape Scale

Using logistic regression, the best models predicting the presence of Long-billed Curlews at a distance of 0-800 m from a route was the additive model of % shrub/scrub and % evergreen forest within 0-800 m from a route (Δ AIC_c = 0.0; AIC_w = 0.24; Table 17) and the additive model of % evergreen forest, % hay, and % shrub/scrub within 0-800 m from a route (Δ AIC_c = 1.4; AIC_w = 0.22; Table 17). The parameter likelihoods also indicate that % shrub/scrub (likelihood = 0.63; estimate = -1.68; SE = 0.68), % evergreen forest (likelihood = 0.52; estimate = -4.07; SE = 2.62), and % hay (likelihood = 0.37; estimate = 0.66; SE = 0.77) were the most important parameters to be included in the best model (Hosmer-Lemeshow goodness-of-fit statistic $\hat{c}$ = 0.761). Similarly, the Poisson regression resulted in the additive model of % evergreen forest, % hay, and % shrub/scrub as the top-ranked model (Δ AIC_c = 0.0; AIC_w = 0.75; Table 18), with the largest coefficient in the model associated with % evergreen forest (negative) followed by % shrub/scrub (negative) and % hay (positive; Table 19).

Within stratum one, the first four models should be considered plausible (i.e., Δ $AIC_c < 2$; Table 20) for predicting the presence of Long-billed Curlews at a distance of 0-800 m. The parameter likelihoods indicate that % herbaceous (likelihood = 0.47; estimate = -20.15; SE = 19.25), % evergreen forest (likelihood = 0.42; estimate = -9.68; SE = 12.86), % crop (likelihood = 0.40; estimate = 1.83; SE = 1.29), and % hay (likelihood = 0.32; estimate = 3.98; SE = 3.96) were the most important parameters to be included in the best model (Hosmer-Lemeshow goodness-of-fit statistic $\hat{c}$ = 0.830). Similarly, the Poisson regression resulted in the first three models being considered plausible (i.e., Δ $AIC_c < 2$; Table 21). The greatest coefficient in all of the top three models was % herbaceous (negative, Table 22). Also note that % evergreen forest in the top model was not a significant parameter (Table 22).

Within stratum two, the first seven models should be considered plausible (Δ $AIC_c < 2$; Table 23) predicting the presence of Long-billed Curlews at a distance of 0-800 m. The parameter likelihoods indicate that % evergreen forest (likelihood = 0.28; estimate = -1.26; SE = 1.34), % shrub/scrub (likelihood = 0.26; estimate = -0.53; SE = 0.43), and % hay (likelihood = 0.26; estimate = 0.63; SE = 0.70) were most important parameters to be included in the best model (Hosmer-Lemeshow goodness-of-fit statistic $\hat{c}$ = 0.667). Similarly, the Poisson regression resulted in the additive model of % evergreen forest, % hay, and % shrub/scrub as being the top-ranked model (Δ AIC_c = 0.0; AIC_w = 0.58; Table 24), with the greatest coefficient in the model associated with % evergreen forest (negative, Table 25) followed by % shrub/scrub (negative, Table 25) and % hay (positive, Table 25).

Within stratum three, the first six models should be considered plausible ($\Delta AIC_c < 2$; Table 26) predicting the presence of Long-billed Curlews at a distance of 0-800 m. The parameter likelihoods indicate that % evergreen forest (likelihood = 0.27; estimate = -4.74; SE = 4.64), % hay (likelihood = 0.26; estimate = -0.22; SE = 0.99), and % crop (likelihood = 0.22; estimate = 0.53; SE = 0.53) should be included in the best model (Hosmer-Lemeshow goodness-of-fit statistic $\hat{c}$ = 0.647). The Poisson regression resulted in the model of % emergent wetlands as being the top-ranked model (Δ AIC_c = 0.0; AIC_w = 0.57; Table 27), with the coefficient associated with % emergent wetlands having a positive effect on the number of curlews detected within 0-800 m of a stop (Table 28).

DISCUSSION

Our results, based upon both local and landscape habitat data collected during the United States portion of the range-wide Long-billed Curlew survey, support previous conclusions that breeding Long-billed Curlews are positively associated with % grasslands, % hay, and % wetlands but negatively associated with % evergreen forest and % shrub/scrub (Dechant et al. 1999). Overall, neither local nor landscape level habitat analyses improved the resolution of Long-billed Curlew breeding habitat selection, but substantiate consistent habitat associations at both local and landscape scales. Despite detailed analyses, at both local and landscape scales, the habitat data generated during the survey were perhaps not detailed nor specific enough to glean higher resolution habitat associations than what were previously known. Nonetheless, these analyses do substantiate the importance of maintaining grassland habitats for Long-billed Curlews throughout its breeding distribution.

Our analyses indicate that encroachment of woody vegetation into potentially suitable breeding habitats for Long-billed Curlews reduced availability of suitable nesting habitat that provides the low vegetation cover important for predator detection, feeding behavior, and intraspecific communication (Bicak et al. 1982, Dechant et al. 1999). Management practices such as controlled grazing, prescribed fire, and mowing have been recommended for maintaining habitat for Long-billed Curlews (Bicak et al. 1982, Cannings 1999, Dechant et al. 1999, Dugger and Dugger 2002). Our results also suggest that these management techniques, if done properly to reduce the amount of shrub/scrub habitat and evergreen forest habitats, and lower vegetation height, would improve breeding habitat for Long-billed Curlews.

Our results from secondary habitat (i.e., negative association with native prairies and a positive association of Conservation Reserve/Permanent Cover Program) and tertiary habitat (i.e., positive association with short grass and tall grass) when grassland was the primary habitat seem somewhat contradictory with each other and with habitat data collected in the immediate vicinity of Long-billed Curlews (i.e., higher association with low vegetation and shortgrass prairies and nonnative pastures). Despite these inconsistencies, these results still substantiate the importance of maintaining grassland habitat, regardless of type, for breeding Long-billed Curlews throughout its range. We suggest that Long-billed Curlews are using a variety of grassland habitats for breeding behaviors including foraging, nesting, and courtship. Because we were unable to determine behavior associated with the habitat of detected curlews, we cannot determine the relative importance of each used habitat.

We were unable to find any association between presence/absence or number of Long-billed Curlews per stop and tertiary habitats or habitat conditions of croplands. This is probably a result of most surveyed cropland areas (only short and medium grass heights) being suitable for feeding by Long-billed Curlews; therefore, curlews may not be selecting particular characteristics of croplands, but rather, are using available croplands in close proximity to breeding/nesting areas.

Those habitat variables most predictive of breeding Long-billed Curlews seem to vary in strength and importance among the three strata. Within strata one (0-5% grassland), we found a negative association with % herbaceous and % evergreen forest and a positive association with % crop and % hay. This indicates that in areas with little overall grassland habitat, breeding

Long-billed Curlews are selecting habitat with similar structure as preferred grassland habitats. Additionally, our results indicate that even when grassland was available, curlews are not selecting these areas. This could be due to the quality of grasslands within this stratum, where little extant grassland exists. If grassland habitats available within this stratum are small or highly fragmented, these areas may become unsuitable for breeding curlews as has been shown for numerous other grassland bird species (Herkert 1994, Helzer and Jelinski 1999). However, Long-billed Curlews were also positively associated with croplands and hay, habitat types rarely documented for breeding curlews to occur and nest in. In this study, we feel this was probably due to active foraging in bare and low stature agricultural crops. It is likely that curlews are nesting within or adjacent to these areas due to their presence during the courtship and pre-incubation period (Saunders 2001).

Within strata two (> 5-50% grassland), we found a negative association with % evergreen forest and % shrub/scrub, but a positive association with % hay. This suggests that when grassland habitat is available, but still limited, Long-billed Curlews use habitats with the same structure as grassland areas (i.e., decreased amount of evergreen forest and shrub/scrub) and also utilize hay production areas, confirming their preference for a low, grassland habitat structure.

Within strata three (> 50-100% grassland), the same habitat characteristics are predicting Long-billed Curlew presence (i.e., decreased % evergreen forest and % shrub/scrub and increased % hay). However, the Poisson regression resulted in a positive association with % emergent wetlands. Within this stratum, the amount of grassland habitat is abundant, and therefore, it appears that Long-billed Curlews are selecting habitat with the same structural composition as grasslands in conjunction with emergent wetlands. They may not be able to select for wetlands when grasslands are not abundant; such selection may affect reproduction and survival. Interestingly, Stanley and Skagen (2007) found no differences in the number of curlews/ha sampled among the three strata, indicating that Long-billed Curlews were breeding in areas with little to no grassland habitat and not differentially using areas with greater grassland habitat. In addition, in a similar study to ours, Saunders (2001) documented a large number of curlews occurring within cultivated areas during the courtship and pre-incubation periods in Alberta, Canada. Long-billed Curlews may return to the same region each year to nest, despite alterations to the habitat that decrease suitability (McCallum et al. 1977). Another possible explanation could be that Long-billed Curlews are breeding in areas other than grasslands (i.e., croplands and agricultural areas). While several studies have documented Long-billed Curlews breeding within native and tame grasslands (e.g., Dechant et al. 1999), few studies have documented Long-billed Curlews within croplands during the breeding season (Pampush 1980, Shackford 1994, Saunders 2001), with fewer documenting actual nesting within these areas (Shackford 1994). In a study in Oklahoma, Shackford (1994) found 14 Long-billed Curlew territories and two Long-billed Curlew nests within cultivated fields. Both nests in cultivated fields, however, were destroyed by human activities prior to completion. Additionally, no studies have determined the effects of nesting in these areas on breeding success, energy expenditure, survival, recruitment, and population numbers. It is possible that Long-billed Curlews successfully nest and raise young within cropland and agricultural areas, but increased mortality due to anthropogenic disturbances, predation, and energy expenditure may influence nesting success (Shackford 1994, Saunders 2001). Future research should focus upon these parameters to specifically examine the degree of nesting within cropland and agricultural areas and the long-term impacts on populations of Long-billed Curlews nesting in these habitats.

This study is one of the most comprehensive and large-scale studies determining habitat associations of breeding Long-billed Curlews in the United States. Although we confirmed the relative importance of grassland, cropland, pasture, and wetland habitats, determining local habitat selection patterns became difficult when dealing with such a large variety of habitat types and ecoregions. Focusing on Long-billed Curlew sightings during the preincubation period precluded determination of any nest site selection patterns. However, our results do illustrate a need to conserve a variety of habitats for Long-billed Curlews necessary for different behaviors. We found a positive association of Long-billed Curlews with grassland, cropland, and hay/pasture areas. We suspect that curlews are using croplands and pastures for foraging and may not necessarily be able to find adequate nest sites within these habitats. Additionally, curlews may also use a variety of grassland habitats including shortgrass prairies, pastures, and Conservation Reserve/Permanent Cover Program for breeding, nesting, and/or foraging. Therefore, by conserving a variety of habitats, Long-billed Curlews will be able to utilize different areas for different behaviors and not have to rely solely on a single habitat type for all breeding activities. Future studies, therefore, should focus upon habitat selection during the nesting period and the degree of utilization of different habitats during the breeding season. Additionally, the affect of habitat selection on breeding success and survival should also be determined to further elucidate important habitats for conservation and management of Long-billed Curlews throughout the United States.

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Table 1. Vegetation height codes and code descriptions for habitat descriptions within a 5 m radius of where a Long-billed Curlew was seen during 2004-2005 surveys for Long-billed Curlews in the United States.

Vegetation height code	Height	Height description
1	bare ground-4 cm	can see foot
2	4-10 cm	covers foot to “knee”
3	10-15 cm	up to base of belly
4	15-45 c m	up to back
5	45-65 cm	up to eye level
6	≥ 65 cm	above head

Table 2. Primary codes and code descriptions for local habitat designations during 2004-2005 surveys for breeding Long-billed Curlews in the United States.

Primary code	Code description
GRAS	grasslands
CROP	cropland, planted growing crops, post-harvest stubble
RCWS	rural cultivated woodlands, scattered farm buildings, associated grounds, shelterbelts, orchard tree farms
BARE	barren ground, plowed not yet replanted, planted not yet growing
WEED	weedy fields: former grasslands, forb dominated fields
SHRB	clumped shrubs
STEP	steppe: widely dispersed shrubs with ≥ 50% grass
WOOD	woodlands
EMWL	wetlands/wet meadows
OWWL	open water wetlands, rivers, lakes, reservoirs, irrigation canals
OTHR	urban residential, industrial, miscellaneous
NREC	not recorded, skipped
UNKN	cannot see due to topography or other visual obstructions

Table 3. Secondary codes and code descriptions for local habitat designations during 2004-2005 surveys for Long-billed Curlews in the United States.

Secondary code	Code description
Grassland	
CRPC	Conservation Reserve/Permanent Cover Program
SHTG	shortgrass prairie: blue grama (*Bouteloua gracilis*)-buffalo grass (*Buchloe dactyloides*), include cactus and small shrubs
MIXG	mixed-grass prairie: wheatgrass (*Agropyron cristatum*)-needlegrass (*Stipa spp.*)
TALG	tallgrass prairie: wheatgrass-bluestem (*Andropogon spp.)*, needlegrass
NTPA	native prairie
PAST	non-native, tame pasture/rangelands
TUND	alpine tundra, montane grasslands
Shrublands	
CACT/MTSG	cactus-*Opuntia*, cholla, etc.; mountain shrub *Cercocarpes spp*.
SALT	saltbrush-shadescale-greasewood *Atriplex-Sarcrobatus*; alakaligrass
SAGE	sagebrush *Artemisia-Agropyron*
RBBR/OAKS	rabbit brush *Chrysothamnus spp*.; oak shrub *Quercus gambelli*
WILC	highland willow carr *Salix*
YUCA	*Yucca* dominated shrubland
Woodlands	
ASPE	aspen *Populus tremuloides*
CONF	conifer forest
DECW	deciduous woodlands
MXFO	mixed deciduous-conifer woodland
RIPA	lowland riparian and hardwood bottomland *Populus-Salix-Acer*

Table 3. Continued.

Secondary code	Code description
Wetlands	
EPHW	ephemeral/temporary ponds, wetlands, low wet prairie
SPLW	semipermanent lakes and ponds, deep marsh
PLPW	permanent lakes and ponds, deep marsh
AKLW	alkali ponds and lakes, intermittent alkali
FENW	fen (alkaline) bog, wet meadow
Open wetlands	
SEWG/STOK	sewage/wastewater treatment settlement ponds, stock ponds, windmill ponds
IRCS/RIVR	irrigation canal, river
Other	
FLOT	feedlot
OILP	oil production, pipes, wells
URCP	urban residential and parks
UIND	urban industrial, downtown, commercial districts
MISC	miscellaneous: specify using codes below
BADL/ROCK	badlands; rocks

Table 4. Tertiary and habitat condition codes and code descriptions for local habitat designations during 2004-2005 surveys for Long-billed Curlews in the United States.

Tertiary/Habitat code	Code description
Grassland/Cropland tertiary code	
SHRT	short grass, < 12 cm
MEDM	mid grass, 12-38cm
TALL	tall grass, > 38cm
Management tools	
GRAZ	grazed (cattle present, fresh piles)
BURN	burned (presence of ash or soot, black ground)
MCUT	mechanically cut: mowed, hayed
IR	irrigated grassland, cropland, etc.
DY	dryland cropland, tame pastures
LOGD	logged
Invasive species	
INVA	invasive species: grasses (cheat grass, Kentucky blue-grass) and other weeds (knapweed, thistle)
Burrowing mammals	
PDOG	prairie dog
RQSQ	Richardson's ground squirrel
13LSQ	13-lined ground squirrel
AC	active
IA	inactive

Table 5. Habitat codes and code descriptions for landscape habitat classifications using the 2001 National Land Cover Dataset (Multi-Resolution Land Characteristics Consortium; see Homer et al. 2004; definitions accessed from <http://www.mrlc.gov/nlcd_definitions.php>) for 2004-2005 surveys for Long-billed Curlews in the United States.

Habitat code	Code description
BARN	Barren land - areas where vegetation accounts for < 15% of total cover.
CROP	Cultivated crops - areas dominated (> 20%) by crop vegetation.
DECD	Deciduous forest- areas dominated (> 20%) by trees > 5 m tall, with > 75 % of tree species shedding foliage.
DEVL	Developed - areas with a mixture of constructed materials and vegetation.
EMRG	Emergent herbaceous wetlands - areas dominated (> 80%) by perennial herbaceous vegetation and substrate periodically saturated or covered with water.
EVGR	Evergreen forest - areas dominated (> 20%) by trees > 5 m tall, with > 75 % of tree species maintaining leaves year round.
HAY	Pasture/hay - areas dominated (> 20%) by grasses and/or legumes planted for livestock grazing or production of seed or hay crops.
HERB	Grasslands/herbaceous - areas dominated (> 80%) by grammanoid or herbaceous vegetation.
MIXD	Mixed forest - areas dominated (> 20%) by trees > 5 m tall, with neither deciduous nor evergreen species comprising > 75 % of total tree cover.
SHRB	Shrub/scrub - areas dominated by shrubs (> 20%) < 5 m tall.
WATR	Open water - areas of open water, with < 25% cover of vegetation or soil.
WDWT	Woody wetlands - areas dominated (> 20%) by forest or shrubland vegetation and soil or substrate is periodically saturated with or covered with water.

Table 6. Percent occurrence of Long-billed Curlews observed within United States within 0-400 m and 400-800 m from survey routes during 2004-2005 surveys.

State	# Routes	Frequency 0-400 m	Percent 0-400 m	Frequency 400-800 m	Percent 400-800 m
California	3	0	0.0	0	0.0
Colorado	21	6	0.9	5	1.3
Idaho	19	37	5.8	12	3.1
Kansas	8	11	1.7	7	1.8
Montana	52	177	27.8	64	16.5
North Dakota	8	8	1.3	0	0.0
Nebraska	18	82	12.9	52	13.4
New Mexico	11	34	5.3	61	15.7
Nevada	36	12	1.9	0	0.0
Oklahoma	7	30	4.7	16	4.1
Oregon	30	80	12.6	46	11.8
South Dakota	14	99	15.5	27	6.9
Texas	5	9	1.4	80	20.6
Utah	7	3	0.5	2	0.5
Washington	19	21	3.3	12	3.1
Wyoming	27	28	4.4	5	1.3
Total	285	637	100.0	389	100.0

Table 7. Percent occurrence of Long-billed Curlews observed within habitat codes within 0-400 m and 400-800 m from survey routes in the United States during 2004-2005 surveys.

Primary/Secondary habitat codes	Frequency 0-400 m	Percent 0-400 m	Frequency 400-800 m	Percent 400-800 m
BARE	10	2.1	2	0.7
CROP	91	19.0	75	27.9
IR	12	38.7	9	69.2
DY	19	61.2	4	30.7
Total	31	100.0	13	100.0
EMWL	7	1.5	5	1.9
GRAS	319	66.6	152	56.5
CRPC	4	2.5	2	2.5
NTPA	12	7.5	0	0.0
PAST	51	32.1	38	47.5
SHTG	87	54.7	37	46.3
TALL	5	3.1	3	3.8
Total	159	100.0	80	100.0
SHRT	94	75.8	45	81.8
MEDM	30	24.2	10	18.2
Total	124	100.0	55	100.0
OTHR	3	0.6	0	0.0
OWWL	6	1.3	0	0.0
RCWS	1	0.2	0	0.0
SHRB	7	1.5	7	2.6
STEP	29	6.1	23	8.6
WEED	6	1.3	4	1.5
WOOD	0	0.0	1	0.4
Total	479	100.0	269	100.0

Table 8. Model results of primary habitat categories from local habitat analysis from logistic regression predicting presence/absence of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EMWL + % GRAS	3	0.00	0.42
% GRAS	2	15.15	0.20
% EMWL + % SHRB	3	18.58	0.17
% SHRB	2	30.14	0.09
% WOOD	2	34.82	0.07
% EMWL + % STEP	3	79.06	0.01
% EMWL	2	82.02	0.01
% STEP	2	90.96	0.00
% CROP	2	91.30	0.00
% OTHR	2	92.20	0.00
Intercept	1	94.04	0.00
% RCWS	2	95.62	0.00
% WEED	2	95.89	0.00
% BARE	2	95.91	0.00
% OWWL	2	95.94	0.00

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 9. Model results of primary habitat categories from local habitat analysis from Poisson regression predicting number of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EMWL + % GRAS	3	0.00	0.84
% GRAS	2	37.14	0.13
% EMWL + % SHRB	3	75.98	0.02
% SHRB	2	102.44	0.01
% WOOD	2	124.86	0.00
% EMWL + % STEP	3	187.32	0.00
% EMWL	2	203.24	0.00
% STEP	2	215.54	0.00
% OTHR	2	219.82	0.00
% CROP	2	227.22	0.00
% RCWS	2	230.02	0.00
% OWWL	2	230.32	0.00
% BARE	2	230.98	0.00
Intercept	1	231.86	0.00
% WEED	2	233.86	0.00

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 10. Characteristics of the top-ranked model from local habitat analysis from Poisson regression predicting number of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Variable	Estimate	SE	Wald 95% CI		Chi-square	*P*
Intercept	-3.461	0.074	-3.6061	-3.316	2187.82	<0.001
% EMWL	4.033	0.453	3.145	4.920	79.32	<0.001
% GRAS	1.534	0.108	1.323	1.745	203.02	<0.001
Scale	1.000	0.000	1.000	1.000		

Table11. Model results of secondary and tertiary grassland habitat categories from local habitat analysis from logistic regression predicting presence/absence of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
Secondary grassland habitat			
% NTPA	2	0.00	0.27
% CRPC	2	8.80	0.17
% MIXG	2	15.33	0.13
% PAST	2	16.53	0.12
% TALG	2	18.64	0.11
Intercept	1	19.03	0.10
% SHTG	2	20.39	0.10
Tertiary grassland habitat			
% SHRT	2	0.00	0.33
% TALL	2	5.53	0.25
Intercept	1	8.15	0.22
% MEDM	2	10.05	0.20

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 12. Model results of secondary and tertiary grassland habitat categories from local habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
Secondary grassland habitat			
% CRPC	2	0.00	0.36
% NTPA	2	8.24	0.24
% MIXG	2	20.00	0.13
% PAST	2	27.41	0.09
% TALG	2	32.34	0.07
Intercept	1	35.28	0.06
% SHTG	2	37.20	0.06
Tertiary grassland habitat			
% TALL	2	0.00	0.51
% SHRT	2	15.22	0.24
Intercept	1	27.61	0.13
% MEDM	2	29.62	0.12

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 13. Characteristics of the top-ranked model of secondary and tertiary grassland habitat categories from local habitat analysis from Poisson regression predicting number of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Variable	Estimate	SE	Wald 95% CI		Chi-square	*P*
Secondary grassland habitat						
Intercept	-2.500	0.058	-2.614	-2.386	1842.27	<0.001
% CRPC	1.466	0.208	1.059	1.872	49.82	<0.001
Scale	1.000	0.000	1.000	1.000		
Tertiary grassland habitat						
Intercept	-2.439	0.056	-2.549	-2.328	1872.38	<0.001
% TALL	1.450	0.234	0.992	1.908	38.52	<0.001
Scale	1.000	0.000	1.000	1.000		

Table 14. Model results of tertiary and habitat condition of cropland habitat categories from local habitat analysis from logistic regression predicting presence/absence of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
Tertiary cropland habitat			
% MEDM	2	0.00	0.35
% SHRT	2	1.00	0.33
Intercept	1	2.17	0.31
Cropland habitat conditions			
% IR	2	0.00	0.34
% DY	2	0.59	0.33
Intercept	1	1.04	0.33

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 15. Model results of tertiary and habitat condition of cropland habitat categories from local habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
Tertiary cropland habitat			
% MEDM	2	0.00	0.42
% SHRT	2	4.08	0.34
Intercept	1	11.54	0.24
Cropland habitat conditions			
Intercept	1	0.00	0.35
% DY	2	1.06	0.33
% IR	2	1.62	0.32

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 16. Characteristics of the top-ranked model of tertiary and habitat condition of cropland habitat categories from local habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-400 m from survey routes in the United States during 2004-2005 surveys.

Variable	Estimate	SE	Wald 95% CI		Chi-square	*P*
Tertiary cropland habitat						
Intercept	-0.535	0.238	-1.002	-0.069	5.05	0.025
% MEDM	-3.918	1.335	-6.535	-1.301	8.61	0.003
Scale	1.000	0.000	1.000	1.000		
Cropland habitat conditions						
Intercept	-2.488	0.088	-2.661	-2.314	792.02	<0.001
Scale	1.000	0.000	1.000	1.000		

Table 17. Model results from landscape habitat analysis from logistic regression predicting presence/absence of Long-billed Curlews 0-800 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EVGR + % SHRB	3	0.00	0.24
% EVRG + % HAY + % SHRB	4	1.35	0.22
% CROP + % HERB	3	10.93	0.14
% SHRB	2	20.48	0.08
% HAY + % SHRB	3	20.91	0.08
% HERB	2	31.89	0.05
% EVGR + % HAY	3	43.21	0.03
% EVGR	2	43.28	0.03
% CROP + % HAY	3	49.38	0.02
% CROP	2	50.32	0.02
% DECD	2	59.18	0.01
% HAY	2	62.03	0.01
Intercept	1	63.29	0.01
% WDWT	2	64.06	0.01
% MIXD	2	64.44	0.01
% EMRG	2	64.71	0.01
% DEVL	2	64.84	0.01
% WATR	2	65.12	0.01
% BARN	2	65.22	0.01

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 18. Model results from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EVGR + % HAY + % SHRB	4	0.00	0.75
% EVGR + % SHRB	3	22.42	0.25
% HAY + % SHRB	3	170.81	0.00
% SHRB	2	202.08	0.00
% CROP + % HERB	3	217.26	0.00
% EVGR + % HAY	3	412.05	0.00
% EVGR	2	449.07	0.00
% HERB	2	452.99	0.00
% CROP + % HAY	3	534.74	0.00
% CROP	2	583.00	0.00
% EMRG	2	604.91	0.00
% DECD	2	624.47	0.00
% HAY	2	648.31	0.00
% MIXD	2	676.10	0.00
% WATR	2	684.18	0.00
% DEVL	2	692.08	0.00
Intercept	1	694.72	0.00
% WDWT	2	694.83	0.00
% BARN	2	696.72	0.00

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 19. Characteristics of the top-ranked model from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes in the United States during 2004-2005 surveys.

Variable	Estimate	SE	Wald 95% CI		Chi-square	*P*
Intercept	1.937	0.041	1.858	2.017	2283.57	<0.001
% EVGR	-13.555	2.408	-18.274	-8.836	31.69	<0.001
% HAY	1.645	0.311	1.035	2.255	27.91	<0.001
% SHRB	-2.403	0.146	-2.690	-2.116	269.78	<0.001
Scale	1.000	0.000	1.000	1.000		

Table 20. Model results from landscape habitat analysis from logistic regression predicting presence/absence of Long-billed Curlews 0-800 m from survey routes within stratum 1 (0-5% grassland) in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EVGR + % HERB + % SHRB	4	0.00	0.06
% HERB + % SHRB	3	0.07	0.06
% CROP + % HERB	3	1.02	0.06
% CROP + % HAY + % HERB	4	1.92	0.06
% CROP + % EVGR + % HERB	4	2.67	0.05
% CROP + % EVGR + % HAY + % HERB	5	3.65	0.05
% CROP + % HAY	3	5.74	0.05
% CROP	2	5.88	0.05
% CROP + % EVGR + % HAY	4	5.95	0.05
% CROP + % EVGR	3	5.96	0.04
% EVGR + % SHRB	3	7.63	0.04
% SHRB	2	8.55	0.04
% HAY + % HERB	3	11.21	0.03
% EVGR + % HAY + % HERB	4	12.13	0.03
% HERB	2	13.03	0.03
% EVGR + % HERB	3	13.57	0.03
% DEVL	2	13.60	0.03
% HAY	2	14.00	0.03
% EVGR + % HAY	3	14.48	0.03
% DECD	2	15.68	0.03
% EMRG	2	16.21	0.03
Intercept	1	16.64	0.03
% EVGR	2	16.85	0.03
% WDWT	2	17.08	0.03
% BARN	2	18.11	0.02

Table 20. Continued.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% WATR	2	18.80	0.02

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 21. Model results from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes within stratum 1 (0-5% grassland) in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EVGR + % HERB + % SHRB	4	0.00	0.13
% CROP + % HAY + % HERB	4	0.23	0.13
% HERB + % SHRB	3	1.00	0.12
% CROP + % EVGR + % HAY + % HERB	5	2.30	0.11
% CROP + % HERB	3	7.20	0.09
% CROP + % EVGR + % HERB	4	8.86	0.08
% CROP + % HAY	3	10.87	0.07
% CROP + % EVGR + % HAY	4	12.27	0.07
% CROP	2	20.33	0.05
% CROP + % EVGR	3	21.24	0.04
% EVGR + % SHRB	3	25.77	0.04
% SHRB	2	28.23	0.03
% EMRG	2	65.56	0.00
% HAY + % HERB	3	67.01	0.00
% EVGR + % HAY + % HERB	4	67.11	0.00
% DEVL	2	67.71	0.00
% DECD	2	71.09	0.00
% EVGR + % HERB	3	77.81	0.00
% HERB	2	78.84	0.00
% HAY	2	82.50	0.00
% EVGR + % HAY	3	82.56	0.00
% WDWT	2	94.42	0.00
% EVGR	2	97.43	0.00
Intercept	1	98.56	0.00
% BARN	2	98.93	0.00

Table 21. Continued.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% WATR	2	100.70	0.00
% MIXD	2	100.71	0.00

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 22. Characteristics of the top-ranked models from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes within stratum 1 (0-5% grassland) in the United States during 2004-2005 surveys.

Variable	Estimate	SE	Wald 95% CI		Chi-square	*P*
Top-ranked model						
Intercept	2.265	0.174	1.925	2.605	170.44	<0.001
% EVGR	-4.174	3.282	-10.607	2.259	1.62	0.204
% HERB	-16.652	5.979	-28.372	-4.933	7.76	0.005
% SHRB	-2.693	0.302	-3.286	-2.101	79.41	<0.001
Scale	1.000	0.000	1.000	1.000		
Second-ranked model						
Intercept	-0.355	0.213	-0.772	0.063	2.77	0.096
% CROP	2.680	0.308	2.076	3.284	75.67	<0.001
% HAY	4.672	1.385	1.957	7.388	11.37	0.001
% HERB	-14.045	6.043	-25.890	-2.201	5.40	0.020
Scale	1.000	0.000	1.000	1.000		
Third-ranked model						
Intercept	2.227	0.175	1.885	2.569	162.66	<0.001
% HERB	-17.878	6.202	-30.034	-5.722	8.31	0.004
% SHRB	-2.725	0.306	-3.324	-2.125	79.38	<0.001
Scale	1.000	0.000	1.000	1.000		

Table 23. Model results from landscape habitat analysis from logistic regression predicting presence/absence of Long-billed Curlews 0-800 m from survey routes within stratum 2 (> 5-50% grassland) in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EVGR + % SHRB	3	0.00	0.07
% SHRB	2	0.63	0.07
% EVGR + % HAY + % SHRB	4	1.18	0.06
% CROP + % HERB	3	1.44	0.06
% HAY + % SHRB	3	1.50	0.06
% EVGR + % HERB	3	1.79	0.06
% HERB	2	2.00	0.06
% DECD	2	5.76	0.05
% CROP + % HAY	3	7.83	0.05
% CROP	2	8.17	0.05
% WATR	2	8.37	0.04
% EVGR	2	8.97	0.04
% EVGR + % HAY	3	9.52	0.04
Intercept	1	9.65	0.04
% HAY	2	9.89	0.04
% BARN	2	10.34	0.04
% WDWT	2	10.36	0.04
% MIXD	2	10.79	0.04
% EMRG	2	11.29	0.04
% DEVL	2	11.54	0.04

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 24. Model results from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes within stratum 2 (> 5-50% grassland) in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EVGR + % HAY + % SHRB	4	0.00	0.58
% EVGR + % SHRB	3	18.67	0.23
% EVGR + % HERB	3	33.76	0.11
% HAY + % SHRB	3	52.73	0.04
% CROP + % HERB	3	69.61	0.02
% SHRB	2	75.42	0.01
% HERB	2	96.90	0.00
% EVGR + % HAY	3	109.41	0.00
% DECD	2	119.99	0.00
% BARN	2	131.59	0.00
% EVGR	2	134.39	0.00
% CROP + % HAY	3	149.22	0.00
% WATR	2	184.08	0.00
% HAY	2	186.00	0.00
% CROP	2	186.38	0.00
% MIXD	2	191.28	0.00
% WDWT	2	207.96	0.00
% DEVL	2	208.74	0.00
% EMRG	2	213.45	0.00
Intercept	1	213.98	0.00

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 25. Characteristics of the top-ranked model from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes within stratum 2 (> 5-50% grassland) in the United States during 2004-2005 surveys.

Variable	Estimate	SE	Wald 95% CI		Chi-square	*P*
Intercept	1.772	0.066	1.642	1.902	712.99	<0.001
% EVGR	-13.425	3.372	-20.034	-6.815	15.85	<0.001
% HAY	1.851	0.376	1.113	2.589	24.18	<0.001
% SHRB	-1.810	0.194	-2.190	-1.431	87.30	<0.001
Scale	1.000	0.000	1.000	1.000		

Table 26. Model results from landscape habitat analysis from logistic regression predicting presence/absence of Long-billed Curlews 0-800 m from survey routes within stratum 3 (> 50-100% grassland) in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% SHRB	2	0.00	0.06
% BARN	2	1.09	0.06
% CROP + % EVGR	3	1.26	0.06
% CROP	2	1.51	0.06
% WATR	2	1.53	0.06
% EVGR	2	1.57	0.06
% HAY + % SHRB	3	2.04	0.06
Intercept	1	3.04	0.05
% CROP + % EVGR + % HAY	4	3.46	0.05
% CROP + % HAY	3	3.62	0.05
% EVGR + % HAY	3	3.69	0.05
% EVGR + % HERB	3	3.72	0.05
% MIXD	2	4.19	0.05
% WDWT	2	4.36	0.05
% DECD	2	4.54	0.05
% EMRG	2	4.61	0.05
% DEVL	2	4.69	0.05
% HERB	2	5.05	0.05
% HAY	2	5.07	0.05

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 27. Model results from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes within stratum 3 (> 50-100% grassland) in the United States during 2004-2005 surveys.

Model	No. parameters	ΔAIC_c [a]	AIC_w [b]
% EMRG	2	0.00	0.57
% SHRB	2	25.04	0.16
% HAY + % SHRB	3	26.02	0.15
% CROP + % EVGR + % HAY	4	58.69	0.03
% CROP + % EVGR	3	62.96	0.02
% EVGR + % HAY	3	75.84	0.01
% EVGR + % HERB	3	75.99	0.01
% EVGR	2	79.34	0.01
% CROP + % HAY	3	91.11	0.01
% CROP	2	93.48	0.01
% WATR	2	104.72	0.00
% DECD	2	112.02	0.00
% BARN	2	112.02	0.00
% DEVL	2	115.67	0.00
% HAY	2	122.25	0.00
Intercept	1	122.96	0.00
% HERB	2	124.00	0.00
% WDWT	2	124.54	0.00
% MIXD	2	125.04	0.00

[a] Difference between model's Akaike's Information Criterion corrected for small sample size and the lowest AIC_c value

[b] AIC_c relative weight attributed to model

Table 28. Characteristics of the top-ranked model from landscape habitat analysis from Poisson regression predicting the number of Long-billed Curlews 0-800 m from survey routes within stratum 3 (> 50-100% grassland) in the United States during 2004-2005 surveys.

Variable	Estimate	SE	Wald 95% CI		Chi-square	*P*
Intercept	1.590	0.052	1.488	1.691	937.58	<0.001
% EMRG	14.876	1.111	12.698	17.054	179.20	<0.001
Scale	1.000	0.000	1.000	1.000		

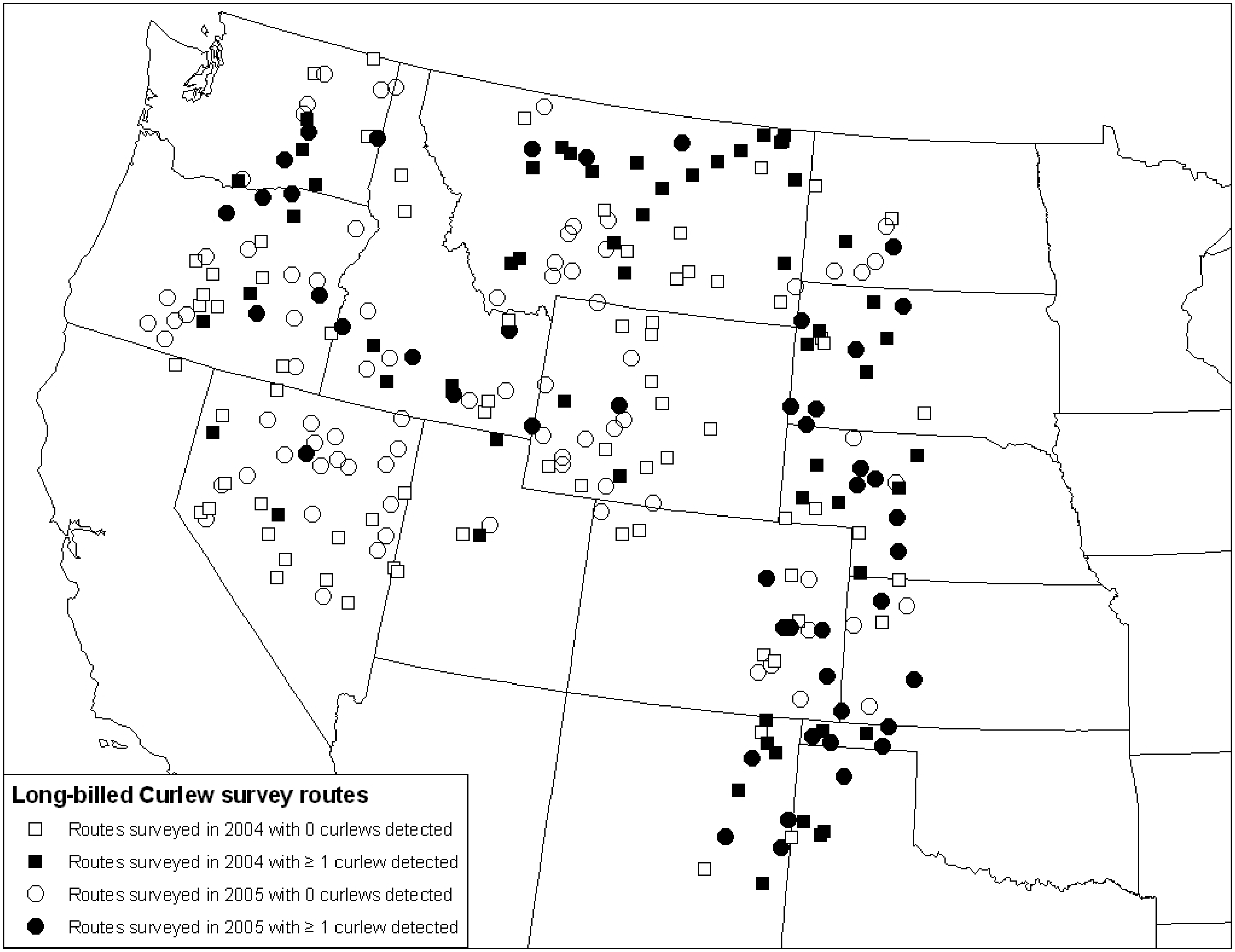
Figure 1. Location of Long-billed Curlew survey routes with and without curlews detected in the United States during 2004-2005 surveys.

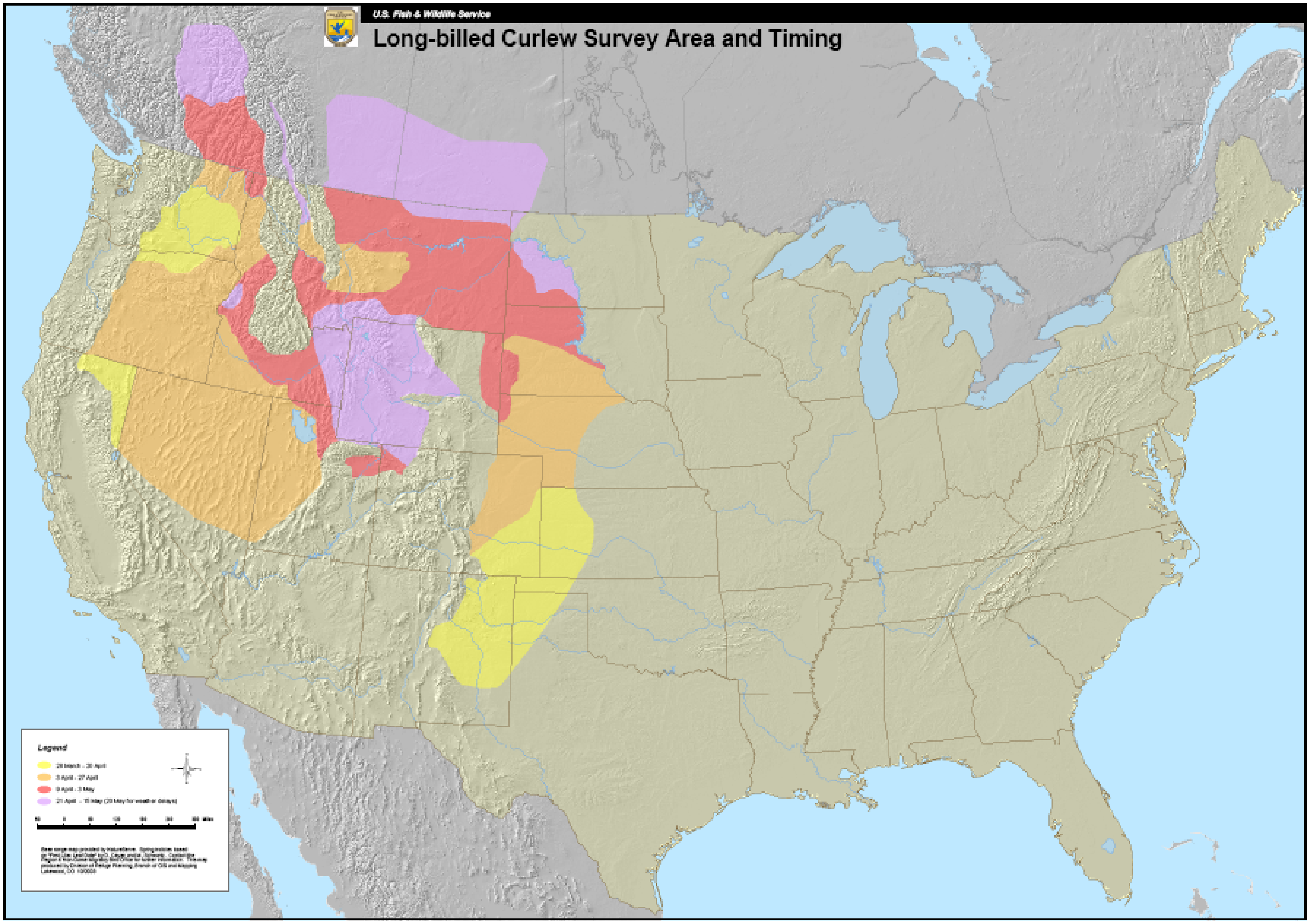
Figure 2. Timing of Long-billed Curlew surveys conducted in the United States during 2004-2005 surveys. Figure accessed from <http://www.fws.gov/mountain-prairie/species/birds/longbilled_curlew/curlew_040505.pdf>.

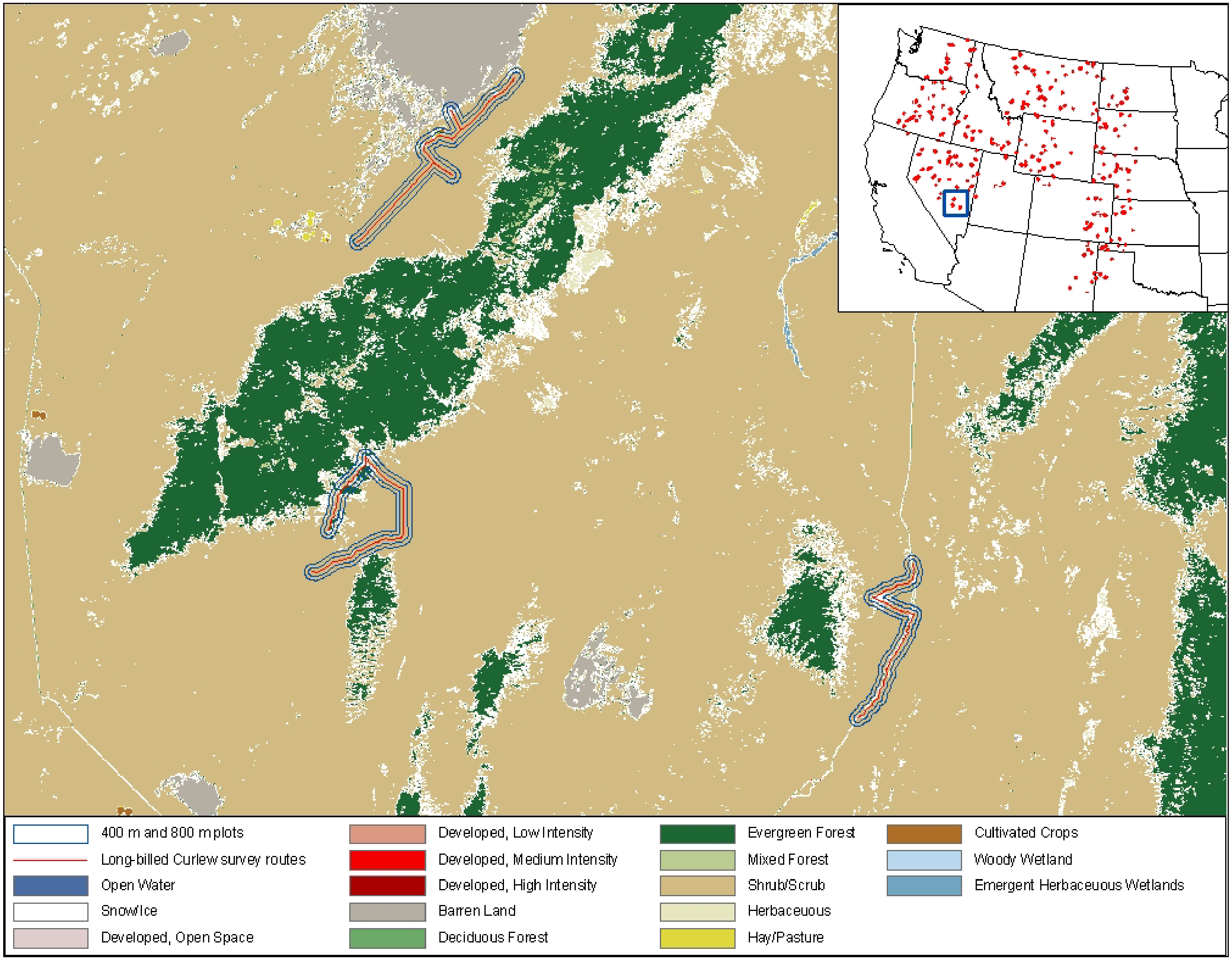
Figure 3. Example of habitat classifications along Long-billed Curlew routes within 0-400 m and 0-800 m plots within the United States during 2004-2005 surveys.

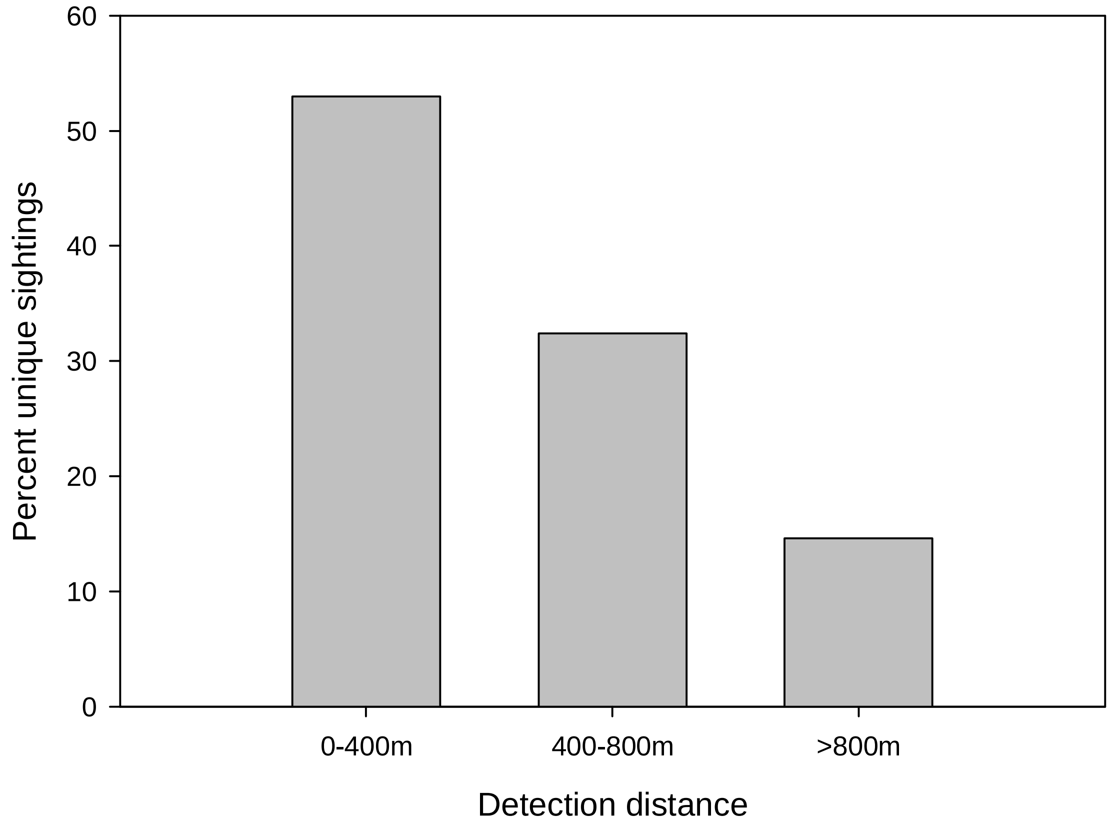
Figure 4. Percent occurrence of Long-billed Curlews observed within 3 detection distance categories in the United States during 2004-2005 surveys.

Figure 5. Percent occurrence of Long-billed Curlews observed within 6 plant height categories where an individual was detected within 0-400 m and 400-800 m from survey routes in the United States during the 2004-2005 surveys.

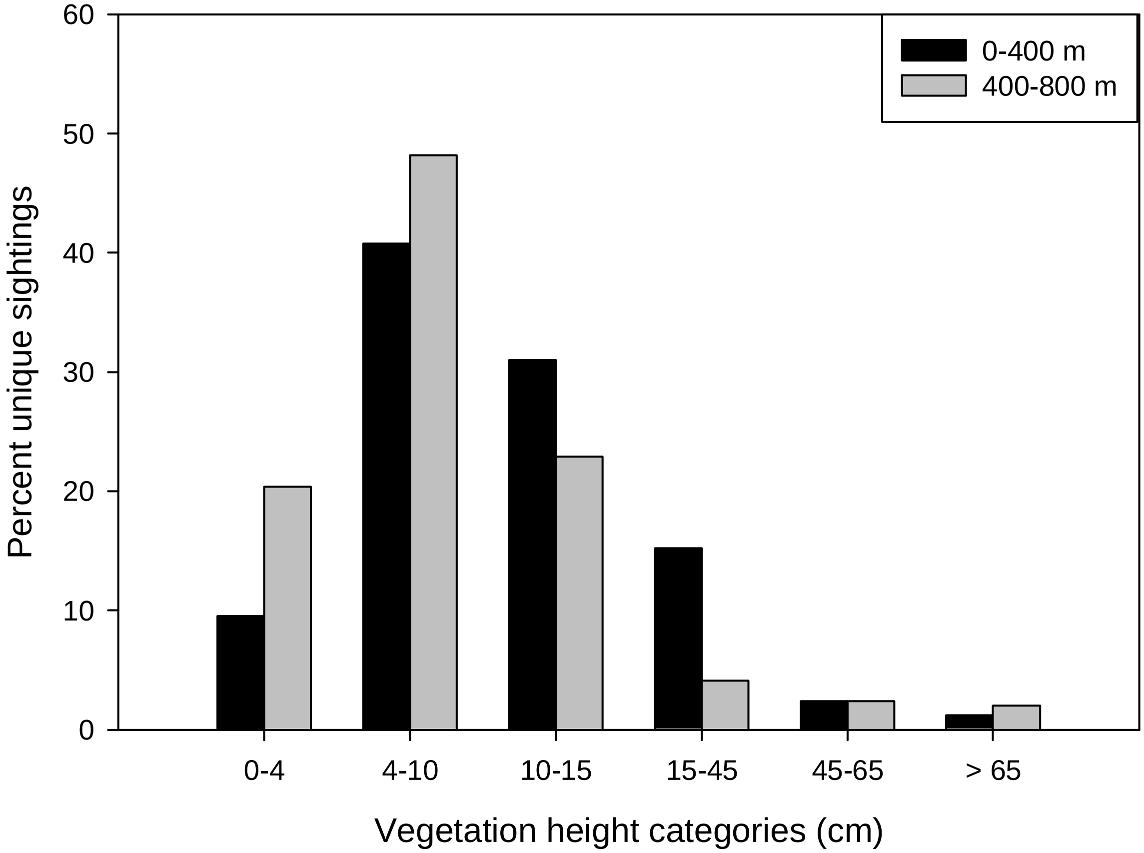

Long-billed Curlew survey routes
Routes surveyed in 2004 with 0 curlews detected
Routes surveyed in 2004 with ≥ 1 curlew detected
Routes surveyed in 2005 with 0 curlews detected
Routes surveyed in 2005 with ≥ 1 curlew detected


U.S. Fish & Wildlife Service
Long-billed Curlew Survey Area and Timing
Legend


400 m and 800 m plots
Long-billed Curlew survey routes
Open Water
Snow/Ice
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub/Scrub
Herbaceuous
Hay/Pasture
Cultivated Crops
Woody Wetland
Emergent Herbaceuous Wetlands



60
50
40
30
20
10
0
Percent unique sightings
0-400m
400-800m
>800m
Detection distance



60
50
40
30
20
10
0
Percent unique sightings
0-400 m
400-800 m
0-4
4-10
10-15
15-45
45-65
> 65
Vegetation height categories (cm)

Appendix A

Detailed Explanation of Habitat Codes Used During the 2004-2005 Range-Wide Survey for Breeding Long-Billed Curlews in the United States

Habitat Codes Explained

Observers will need to be able to identify the broad habitat classifications below. They will be used on the survey data sheet to estimate the immediate habitat the LBCU is using (5 m radius around the LBCU) and on the habitat data sheet to estimate the habitat found all four quadrants around the stop point (400 m radius around the stop point).

Habitat data should be taken after the 5 minute survey period has been completed. Make all observations from the stop point; do not walk into the field. The collection of the data is not intensive and should not take more than 2 minutes/stop. Look at each quadrant (NE, SE, SW, and NW) separately. For the landscape characteristics which contain $\geq$ 25% of any of the classifications, include up to four primary codes. Designate the percentage (25-100%) of each classification. Total percentages in each quadrant should not equal more than 100%. However, the total may be less than 100% if there are primary habitat types which do not comprise at least 25% of a quadrant total.

Primary Codes: These can be completed even if you do not know anything about individual plant species. There are 13 primary codes:

Grasslands: Use the primary code **GRAS** for any grasslands. Secondary and tertiary codes as well as habitat condition codes will be used to further describe the type of grassland and are extremely important to include.

Rural Developments: Use the code **RCWS** to indicate a farmstead, scattered farm buildings or buildings associated with farming and or ranching operations, orchard/tree farms (regardless of species), shelterbelts, etc.

Cultivated: **CROP** indicates planted growing crops and post-harvest stubble. For cropland which has been plowed but not planted or planted but nothing is above ground, classify it as **BARE**. Please use habitat condition codes where appropriate.

Weedy Fields: In many areas former croplands and grasslands which have been plowed have become "weedy". Use the code **WEED** to indicate a field which is a forb-dominated grassland or cropland. Please use tertiary codes and habitat condition codes where appropriate.

Shrublands: Use one of two codes for the primary classification of the basic structures of shrublands: if shrubs are clumped and there is less than 49% grass within the area use **SHRB**. For an area in which grass makes up at least 50% of the cover and the shrubs are widely dispersed classify it as steppe (**STEP**). Please use secondary codes and habitat condition codes where appropriate.

Woodlands: Any noncultivated area with naturally occurring trees is classified as woodland (**WOOD**). Use the codes under Rural Developments, Cultivated, or Other to indicate treed areas that are either associated with rural or urban development. Please use secondary codes and habitat condition codes where appropriate.

Water: There are three primary codes to use for water habitats found in the quadrants. Wet meadows, ephemeral, temporary, semipermanent, alkali wetlands, bogs, and marshes are all shallow water areas and should be coded **EMWL**. Reservoirs, lakes, rivers and large, deep open water wetlands and irrigation canals should be classified as open water areas, **OWWL**. In the case of stock ponds and tanks, sewage treatment ponds, and windmills indicate their presence as **STOK**. Please use secondary codes and habitat condition codes where appropriate.

Other: Urban residential and industrial areas as well as miscellaneous areas such as rock piles, cemeteries, etc. can be classified as **OTHR**.

Unknown: In the event that topography or other visual obstructions prevent classification of habitat, use **UNKN**.

Secondary Codes: Where more details can be quickly gathered please use the following classifications. These can be used to augment the primary codes where appropriate. There are illustrations of several of the key species in Appendix C. In many cases the identification of these species may be difficult especially during early season surveys where warm season grass seedheads have not yet appeared.

Grasslands: Native prairie (**NTPA**) consists of native grassland species including forbs and shrub species. This is a broad category but covers all nonbroken grasslands with native species. Planted pasture and rangelands (**PAST**) consist of many non-native species commonly crested wheatgrass (*Agropyron cristatum*). Conservation Reserve Program (U.S.) and Permanent Cover Program (Canada) grasslands (**CRPC**) can be either planted in native or non-native species. They may be indicated by a sign stating they are part of the CR/PC program. Shortgrass prairies (**SHTG**) consist of grass species such as grama (*Bouteloua*), needle (*Stipa*), wheatgrass (*Agropyron*), fescue (*Festuca*), and buffalo (*Buchloe*) and are often interspersed with cactus (*Opuntia spp*.), yucca (*Yucca*), forbs and small shrubs. Tallgrass prairies (**TALG**) consist of species of grasses such as bluestem (*Andropogon*), switch (*Panicum*), Indian (*Sorghastrum*), needle (*Stipa*), and wheatgrass (*Agropyron*), many forbs (especially Asteraceae and Fabaceae) and even trees. Mixed-grass prairies (**MIXG**) show a combination of both tall- and shortgrass prairie species. Alpine tundra and montane grasslands (**TUND**) are found in high elevation areas generally over 7000' (2100 m). Please include tertiary codes and habitat conditions where appropriate.

Shrublands:

Shrublands can be dominated by sagebrush (**SAGE**) *Artemisia spp*. and wheatgrasses *Agropyron spp*. Communities of saltbrush (*Atriplex spp.*) and greasewood (*Sarcobatus vermiculatus*) should be designated **SALT**. Designate oak (*Quercus gambelli*) shrublands as **OAKS**. Mountain shrubland communities dominated by mountain mahogany species (*Cercocarpus spp*.) are designated **MTSG**. Highland willow carr areas are dominated by willow (*Salix spp.*) and designated **WILC**. Please include habitat condition codes where appropriate.

Woodlands:

Conifer (**CONF**) forests are natural wooded areas composed of *Pinus*, *Psuedotsuga*, *Abies*, *Picea*, *Larix*, *Juniperus*, and/or *Tsuga*. Lowland riparian and hardwood bottomlands (**RIPA**) are streamside woodlands dominated by *Populus*, *Salix* and *Acer* species. **ASPE** consist of aspen (*Populus tremoides*) stands. Deciduous woodlands (**DECW**) are composed of other deciduous forests not classified above. Use the code **MXFO** for mixed woodlands of both deciduous and coniferous species. Please include habitat condition codes where appropriate.

Wetlands:
Where it is possible, please distinguish between ephemeral/temporary ponds and low wet prairies (**EPHW**) and semipermanent lakes and ponds, and shallow marshes (**SPLW**). Differences in vegetation will be your biggest key. Alkali ponds and lakes and intermittent alkali areas, as determined by salt deposits, should be designated **AKLW**, whether or not they are dry or wet. Permanent lakes and ponds as well as deep marshes should be coded **PLPW**. Fen areas can be designated **FENW**. Reservoirs, rivers, lakes and other open water areas are designated by **OWWL** as a primary code and do not require a secondary code.

Other:
Urban residential, park areas and urban cemeteries (**URCP**) and urban industrial, down town and commercial districts (**UIND**) could be encountered along the survey routes. **ROCK** designates bare rock, rock piles, rock quarries, and rock cliffs. **FLOT** designates feed lots. **OILP** can be used to designate areas with oil development and include oil pumps, pipelines, buildings and machinery associated with the extraction, storage and shipment of petroleum products. **HPLT** designates high tension power lines and poles, communication towers, and other structures associated with the electric or communication services. A miscellaneous (**MISC**) code is also provided for coding of any other structures which do not fit into any of the other classifications.

Tertiary Codes: These codes apply to grassland foliage structure. Look only at the height of grass foliage, as it is now. Indicate if the grass is **SHRT** (short < 5"), **MEDM** (medium 5-15") or **TALL** (tall > 15") in height. In this case do not include seedheads in your estimation. You do not need to know the species of grasses--this is just a measurement of height.

Habitat Conditions:
Management tools: Grasslands, croplands, and shrublands may be treated in several ways. Indicate if fields are irrigated (**IR**-center pivot or other mechanical watering device is present, evidence of water on field that is clearly not from natural precipitation) or dryland (**DY**). Indicate if irrigated based on observed irrigation systems, whether or not currently irrigating. If there are cattle in the quadrant or there is evidence of recent cattle grazing as indicated by fresh cow pies or other cues, please indicate **GRAZ** after the primary code. If the quadrant has recently been burned as indicated by black ground or the presence of ash or soot indicate **BURN**. If fields have been hayed or mowed or otherwise mechanically cut indicate with **MCUT**.

Invasive species: If you find invasive species indicate **INVA** and include the species and estimate the % in the quadrant. We will define an "invasive species" as one that is a) non-native (alien) to the ecosystem under consideration and b) causes or is likely to cause economic or environmental harm or harm to human health (www.invasivespecies.gov). Some of the more common species may include cheat grass/downy brome (*Bromus tectorum*), Kentucky blue-grass (*Poa pratensis*), thistles, knapweeds, leafy spurge, salt cedar, Russian olive, pepperweeds, mustards, and whitetops. There are several illustrations of different species in Appendix C.

Burrowing mammals: If the quadrant includes a prairie dog, Richardson's ground squirrels, or other burrowing mammal town please indicate **PDOG** or **RGSQ** (note if other species) and indicate if the town is active (**AC**) or inactive (**IA**) and a rough number of mounds seen within the quadrant. A town is considered active if burrowing mammals are present or if there are fresh signs of activity (fresh diggings, fresh droppings, vegetation is clipped, etc.). A town is considered inactive if it is overgrown or there is no sign of any of the burrows being used. You do not have to distinguish between active and inactive burrows, this is just a measurement of the activity of the town as a whole.

Appendix B

Example Field Habitat Data Collection Sheet Used During 2004-2005 Range-Wide Survey for

Breeding Long-Billed Curlews in the United States

Long-billed Curlew Range-wide Monitoring Habitat Data Sheet

Page No. 1 of 3

Survey Route Number/Name: WY 51132 Savery

Observer A: John L. Doe (JLD)

Date: 24 April 2005

Observer B: Petunia M. Flower (PMF)

Stop #	GPS Reading (zone-easting-northing)	Topo % Hab Visible	Habitat Classification by Quadrant			
			NE	SE	SW	NW
1	13 T 0272981-4623822	R-100%	100% GRAS-SHRT-GRAZ	50% CROP-winterwheat-DY	50% CROP-corn-IR 50% BARE	100% GRAS-SHRT
				50% BARE		
2	13 T 0272200-4623854	F-100%	100% GRAS-SHTG-SHRT-PDOG-IA#34	100% GRAS-SHTG-SHRT-PDOG-AC#12	100% GRAS-CRPC-TALL	75% RCWS 25% OWWL-sewage
3	13 T 0271456-4623965	F-100%	100% SHRB-SAGE	100% WOOD-CONF	100% OTHR-ROCK	100% WEED-GRAZ
4	13 T 0271032-4624011	R-80%	25% GRAS-NTPA-MEDM	75% GRAS-PAST-SHRT-GRAZ	100% OTHR-URCP-SHRT-MCUT-IR-	100%WOOD-DECW
			75% UNKN	25% WOOD-RIPA-GRAZ	cemetery	
5	13 T 0270654-4624821	F-100%	75% GRAS-SHTG-SHRT	65% CROP-DY 35% BARE-IR	100% GRAS-NTPA-SHRT-MCUT-HPLT-	100% CROP-MCUT
			25% EMWL-SPLW	OILPx2	windmills x 15	
6	13 T 0270001-4624901	F-100%	100% GRAS-TALG-MEDM-HPLT	95% OTHR-FLOT	95% RCWS	75% BARE-GRAZ 25% STOK
7	0269925-4625023	F-100%	100% GRAS-PAST-TALL	50% BARE-DY 25% WOOD-ASPE	75% CROP-DY 25% EMWL-EPHW	100%EMWL-AKLW-dry
				25% EMWL-SPLW		
8	0269125-4625035	R-100%	66% STEP 25% WOOD-OAKS	75% SHRB-SALT 25% SHRB-SAGE	100% BARE-BURN evidence of burned PJ	100%WEED-MEDM-INVA-cheatgrass 75%
	etc.					
37	0265996-462598	F-100%	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ
38	0265789-4626015	F-100%	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% CROP-DY
39	0265013-4626118	R-100%	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ
40	13 T 0264762-4626138	F-100%	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ	100% GRAS-PAST-SHRT-GRAZ

Survey route information is put on the sheet:

State and number of route (nearest town optional for cross reference). Observer A will be John Doe and he will be the primary observer for the odd numbered stops. Petunia M. Flower will be the primary observer for the even numbered stops and is designated Observer B. Record the date in day month year format.

GPS coordinates: please use UTM units as described under "equipment calibration" in the "Instructions to Observers for Conducting Long-billed Curlew Surveys 2005". Please use the format "zone easting-northing".

Stop 1: NE quadrant is a grazed area (you see fresh cow patties) in short grass but you can't tell which grass species are present or if it is a tame or native prairie; the SE and SW quadrants are both equally planted and freshly plowed fields, the SE planted in winter wheat and the SW is an irrigated corn field; NW quadrant has grass less than 5" tall, again, you can't tell the species and there is no evidence of recent grazing. The topography is rolling but you can see the entire survey area.

Stop 2: NE quadrant has buffalo grass and some small shrubs and you see 34 prairie dog burrows, none of which look as though they are being used (no dogs, no fresh diggings, grown over), the height of the grass is less than 5"; SE quadrant looks like the NE quadrant but with 12 burrows and prairie dogs running around on it; SW quadrant has a Conservation Reserve Program sign and tall grass; NW quadrant has a farmstead with buildings and shelterbelt which covers about 3/4 of the area and a sewage lagoon covering the rest. The topography is flat and you can see the entire survey area.

Stop 3: NE quadrant is covered with sagebrush; SE quadrant is covered in pinyon-juniper; SW quadrant is bare rock; NW quadrant looks like a crop field which has been allowed to go wild--you see lots of forbs and some grass, and there are cattle present. The topography is flat and you can see the entire survey area.

Stop 4: NE quadrant cannot all be seen because most of it is behind a hill, the 25% you can see is a native prairie about 8 inches high; SE quadrant is a pasture land with grass about 3" tall, an unfenced riparian area going through the center of it and horses within the quadrant; SW is a cemetery with mowed grass and an irrigation system; NW quadrant is a mix of deciduous trees. The topography is rolling and you estimate that about 20% of the survey area is not visible.

Stop 5: NE quadrant has a wetland within a grassland, you recognize wheatgrass, needlegrass, and several native shortgrass species; SE quadrant has a planted crop, recently plowed areas and 2 oil pumps; SW quadrant is a windfarm, essentially a mowed native prairie with several windmills on it; NW quadrant is a harvested hay field with the previous year's stubble left on it. The topography is flat and you can see the entire survey area.

Stop 6: NE quadrant is a big bluestem prairie, most of which are about 12 inches tall, there are also electric lines running across the quadrant; SE quadrant is dominated by a feedlot; SW quadrant has buildings associated with the feedlot; NW quadrant is a bare field with evidence of cattle and several stock ponds. The topography is flat and you can see the entire survey area.

Stop 7: NE quadrant is a grassy field and you can see ridges where it was obviously plowed at one time, the grass is now about two feet tall; SE quadrant has pockets of aspen trees growing around wetland areas, between the trees it has been plowed for crops; SW quadrant has wetland areas without trees and has a crop which has just sprouted; NW quadrant has a dry wetland with heavy salt deposits around it leading you to believe it is an alkali wetland when there is water. The topography is flat and you can see the entire survey area.

Stop 8: NE is a hilly area with an equal amount of grass and shrub equally dispersed and several pockets of shrub oak; SE quadrant is a mixture of saltbrush, greasewood and sagebrush; SW quadrant looks like it was once a pinyon juniper covered mountainside but it has recently been burned and there is nothing growing on it now; NW quadrant is a weedy field with lots of 7 inch high cheat grass. The topography is rolling but you can see the entire survey area and you can see the entire survey area.

Stop 37: all four quadrants are non-native rangeland that are short in stature and grazed. The topography is flat and you can see the entire survey area.

Stop 38: NE, SE, and SW are non-native rangelands, short in stature and grazed; NW quadrant is a dryland cultivated field. The topography is flat and you can see the entire survey area.

Stop 39: all four quadrants are non-native rangeland that are short in stature and grazed. The topography is rolling but you can see the entire survey area.

Stop 40: all four quadrants are non-native rangeland that are short in stature and grazed. The topography is flat and you can see the entire survey area.

At the end of the survey make sure all supplemental pages are numbered consecutively beginning with 1. Put the total number of pages (X) at the top of the first page (Page No. 1 of X). The GPS reading at the start of the survey should be the same on both the Survey Data Form and stop #1 of the Habitat Data Form. The GPS reading at the end of the survey should be the same on both the Survey Data Form and stop #40 (or what ever the last number of stops was) of the Habitat Data Form.