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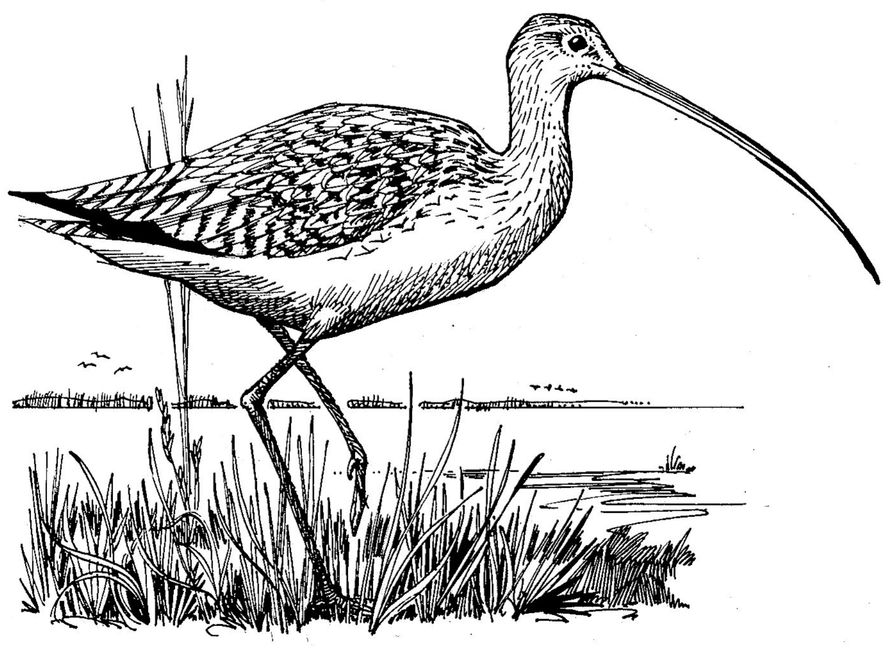
RESOURCE STATUS AND ASSESSMENT BRANCH

Population Estimate and Habitat Associations of the Long-billed Curlew *(Numenius americanus)* in Alberta



Alberta Species at Risk Report No. 25

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Population Estimate and Habitat Associations of the Long-billed Curlew *(Numenius americanus)* in Alberta

Elizabeth J. Saunders

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EXECUTIVE SUMMARY

A random stratified sample was employed within the Grassland Natural Region to estimate the population of long-billed curlews (*Numenius americanus*) in Alberta. Sample units were 32km long and 0.8km wide and most were centered along minor roads. A total of 110 sample units were surveyed for curlews between April 30th and June 8th, 2001. From these surveys a population estimate was derived: 11,942 curlew males (95% confidence interval of 9,560 – 14,323) or, assuming an equal sex ratio, 23,884 individual curlews (95% confidence interval of 19,122 – 28,646). As the Parkland Natural Region was not surveyed and there are records of curlews nesting in that region in low numbers, the total Alberta population would be slightly higher than that calculated in this study. Examination of Breeding Bird Survey data suggests that curlew populations in Alberta may be gradually declining, although this trend is not statistically significant.

A positive relationship between long-billed curlews and native grassland was found: More curlews were found in townships with the highest levels of grassland. Across all sample units the number of curlews was positively correlated with the amount of native grassland in the sample unit. Finally, where native grassland was abundant, curlews preferentially selected the native grassland over cultivated fields and tame pasture. However, curlews were also found to occur in areas with little or no native grassland.

In conjunction with the curlew surveys, data were collected on six other prairie bird species: ferruginous hawk (*Buteo regalis*), short-eared owl (*Asio flammeus*), burrowing owl (*Athene cunicularia*), upland sandpiper (*Bartramia longicauda*), loggerhead shrike (*Lanius ludovicianus*) and Sprague's pipit (*Anthus spragueii*). Weak, but potentially useful, population estimates were derived for upland sandpiper (1,194 ± 455, precision of 38%) and Sprague's pipit (11,428 ± 4683, precision of 41%).

ACKNOWLEDGEMENTS

Many people participated in the long-billed curlew inventory. Richard Quinlan provided guidance and direction through this project. Field data collection was conducted by Julie Landry, Brad Downey, Brad Taylor, Ted Zuurbier, Leo Dube, Gary Erickson, Reg Russell, Richard Quinlan and Pat Young. Andy Hurly assisted with the statistical analyses. Feedback on the original survey design was provided by: Brenda Dale, Arlen Todd, Dave Prescott, Andy Hurly, Ron Bjorge and Cleve Wershler. The following people reviewed and provided valuable comments and suggestions on the draft document: Dave Prescott, Ken DeSmet, Arlen Todd, and Ron Bjorge. Several people provided their knowledge and information on curlews: Lloyd Bennett, Brenda Dale, Janna Foster, Cheri Gratto-Trevor, Gary Erickson and Al Smith. Erin Palmer provided information on the B.C. Conservation Foundation's curlew project. Canadian Forces Base Suffield provided access to the Suffield Military Base so that curlew surveys could be conducted there. Shawn Pinder conducted the GIS components of this project. Livio Fent and Lana Robinson assisted with the GIS components.

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1.0 INTRODUCTION

The long-billed curlew (*Numenius americanus*) is the largest member of the sandpiper family and although it is one of the grasslands' largest and most attention-grabbing shorebirds, surprisingly little is known about it. The curlew's distinctive down-curved bill and enchanting calls make it a notable and unforgettable part of the prairie landscape. Taverner (1934) describes the curlew as "the finest of shorebirds" and comments that it "embodies the spirit of the open range more than does any other bird".

Historically, curlew populations have declined across North American as a result of over-hunting and habitat loss (Timken 1969, Johnsgard 1981). The species has been extirpated in several states, downward trends have been documented in areas where it remains relatively common, and dramatic range reductions have occurred in southeastern Saskatchewan and southwestern Manitoba (DeSmet 1992). It is now considered extirpated in Manitoba (DeSmet 1992, Hill 1998).

In Canada the long-billed curlew is listed as a species of "special concern", meaning that it has characteristics that make it particularly sensitive to human activities or natural events (DeSmet 1992, COSEWIC 2000). In Alberta the curlew is classified as "may be at risk" (Alberta Environment 2001). The 1998 Alberta status report on the long-billed curlew recommended formal population surveys in order to better assess the current population and implement effective management (Hill 1998).

In late 2000/early 2001, a review of the relevant literature was undertaken in order to develop an appropriate method for determining a population estimate for long-billed curlews in Alberta (Saunders 2001). Based on this methodology, an inventory of long-billed curlews was carried out from April 30th to June 8th, 2001. This report summarizes the methods and results of the inventory. In addition to curlews, data were collected on six other prairie bird species: ferruginous hawk (*Buteo regalis*), short-eared owl (*Asio flammeus*), burrowing owl (*Athene cunicularia*), upland sandpiper (*Bartramia longicauda*), loggerhead shrike (*Lanius ludovicianus*) and Sprague's pipit (*Anthus spragueii*). The data for these species are also included here.

2.0 STUDY OBJECTIVES

The primary objective of the study was to estimate the population of long-billed curlews in Alberta to within ±20% (at 95% confidence limits). A secondary objective was to sample other prairie species that could be easily observed and recorded within the sampling framework designed for curlews. Finally, a third objective was to collect broad habitat information in order to better understand curlew habitat preferences in Alberta.

An inventory of curlews in Alberta was conducted for the following primary reasons:

1. Currently there are very limited existing scientific data about the long-billed curlew in Alberta. In order to better determine the status of the curlew in Alberta an estimate of the number of individuals is required. The inventory is a necessary first step towards developing and implementing management strategies for the long-billed curlew in Alberta.

2. The inventory will provide baseline data that can be used to help wildlife managers track trends in the Alberta curlew population over time.

3. The Endangered Species Conservation Committee recognized that data was deficient for the long-billed curlew, and recommended an inventory be carried out.

4. The Alberta status report on the long-billed curlew (Hill 1998) stated, “Effective management of Long-billed Curlews in Alberta relies upon the implementation of systematic population surveys”.

An accuracy of ±20% was chosen because the more precise the population estimate is, the more useful the results are. However, given the large land base contained in the Grassland Natural Region, and the small time window for surveying curlews, it was thought unlikely that a precision better than ±20% could be achieved.

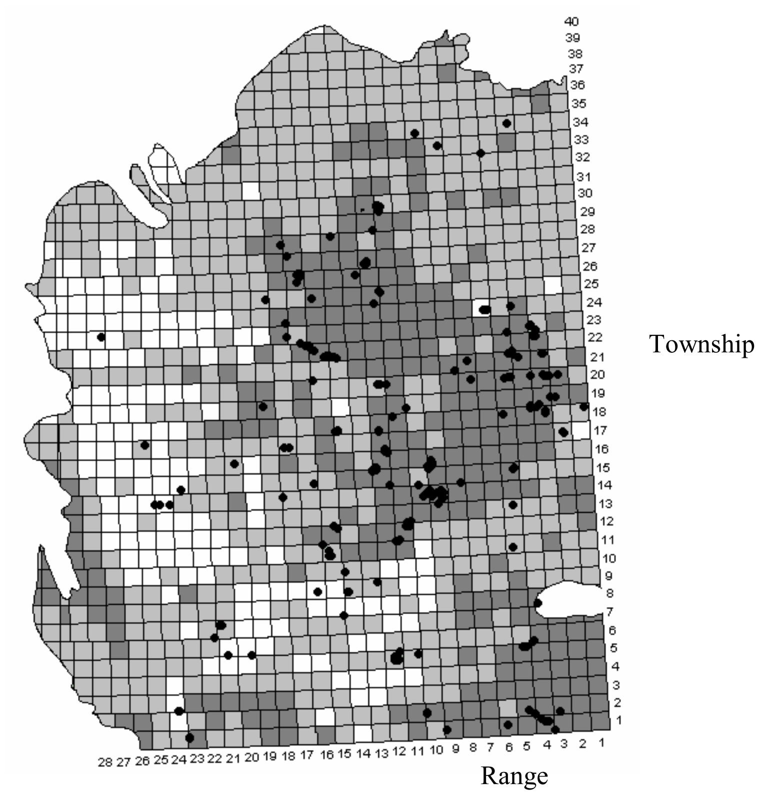
3.0 METHODS

A detailed description of the reasoning for the survey methods is provided in Saunders (2001). The methods used in the inventory are described below:

3.1 Sampling Design

In Alberta, curlews are largely restricted to the Grassland Natural Region; therefore this was established as the sampling frame for the inventory. It should be noted that some curlews occur in the Parkland Natural Region at low densities (Semenchuk 1992, D. Prescott pers. com.), obviously these birds were not included in this inventory. A random stratified sampling approach was selected, in an effort to minimize the variance in the sample and achieve a useful level of precision. Using Alberta's Native Prairie Inventory (Alberta Environmental Protection 1999), it was possible to stratify the Grassland Natural Region based on the percentage of native prairie within each township. Three strata were defined: townships with 0-5% native prairie (stratum 1), townships with 6-50% native prairie (stratum 2) and townships with 51-100% native prairie (stratum 3), Figure 1. A rationale for these strata definitions is provided in Saunders (2001).

Figure 1: Sampling strata in the Grassland Natural Region.
Note: Dots indicate curlew observations from Alberta's Biodiversity Species Observations Database (BSOD, Alberta Conservation Association and Alberta Environment 2001).



Class	Number of townships	Area	Percentage of study area
0-5%	188	17,326 square km	17%
6-50%	578	53,268 square km	53%
51-100%	326	30,044 square km	30%

3.2 Sample Units

Sample units were narrow rectangles, 32km long and 800m wide, a total of 26.5km^2 in area. This configuration was chosen because long, thin sample units reduce the chance of double-counting birds and are more appropriate for clumped populations (Krebs 1989, Saunders 2001). Sample units were established along roads and other rights-of-way as much as possible, creating a 32km route, with the sampling area extending 400m on either side.

3.3 Sample Unit Selection

Within each stratum, townships were selected randomly. Using 1:250,000 map sheets, a 32km route along minor roads was established, based on the originally selected township. The following rules were used to select the sample units:

- As much of the route as possible was in the selected township (for example, preferably at least 9.6 km of the route was in the selected township).
- The starting point of the route was the end closest to the originally selected township.
- The start point was easy for field observers to locate (for example, at an intersection or other landmark).
- Where it was not possible to locate a 32km route without running into a different stratum, the township was discarded.
- Where there were no roads in a selected township, an off-road (24km) route was established.
- Parallel routes were at least 2km apart from each other and intersecting routes were avoided as much as possible.
- Once a township was selected, it could not be selected again (i.e. sampling without replacement).

Sample units were drawn on 1:250,000 maps and copies were made for field use.

3.4 Number of Sample Units

It was not possible to determine the exact number of sample units required in advance of the surveys, although using data from other studies, an estimate of between 80 and 100 sample units was made (Saunders 2001). Calculations of the population estimate and precision were made as the data were collected, and once a precision of close to ±20% was achieved, sampling ceased. In total, 110 units were sampled, 33 in stratum 1, 41 in stratum 2 and 36 in stratum 3. Towards the end of the survey period, increased effort was put into the strata where variance was higher (strata 1 and 2) and sampling in stratum 3 was reduced, as the variance in stratum 3 was lower.

As there were 3,931 possible sample units of area 25.6km^2 in the study area, the 110 units sampled represented 2.8% of the study area. Appendix A provides a list of the sample units.

3.5 Sampling Time Frame

Surveys were conducted from the period April 30th to June 8^{th,} 2001. This corresponds to the period when curlews are on their nesting territories, conducting courtship activities, nest-building, egg-laying and incubating. Once hatching is completed, curlews tend to wander from their nesting territories and less accurate population counts are obtained (Redmond et al. 1981). Also, once brood rearing has begun, surveys tend to overestimate male density because of male mobbing behaviour (Redmond et al. 1981). It was estimated that the courtship to hatching

period extends from approximately April 25th to June 15th in Alberta (Saunders 2001). During the inventory, hatched young were first observed on May 31st. Towards the end of the survey period (June 6th - 8th), field observers felt that they were starting to see some behavioural changes. At this time, curlews were more likely to mob the observers and thus increase the probability of double-counting birds. As an adequate level of precision had been achieved by this point, surveys ceased on June 8th rather than continuing to June 15th.

3.6 Scheduling of Surveys

It was originally proposed that sample units be surveyed in a predetermined, unbiased chronological order (Saunders 2001). However this would have been very inefficient in terms of resources, as it would have greatly increased travel time and travel expenses. It also did not take into consideration weather variations. As an alternative, the sample units were clumped into clusters in similar geographic regions. A team of four field observers surveyed the sample units in a cluster in one to two days and then moved on to another cluster. As much as possible, clusters were alternated in different geographic regions (e.g. a cluster in south-eastern Alberta would be followed by a cluster in central Alberta). Strata were also sampled in an unbiased manner with regards to time of season. If there were weather problems, then the team would move to another part of the province where weather conditions were more favourable. Maintaining flexibility in scheduling meant that it was possible to maximize the number of units surveyed during the short sampling window.

3.7 Survey Methods and Protocol

3.7.1 Habitat Data Collection and Route Reconnaissance

Along each 32km route, 40 stops were established, 800m apart. Observers drove the route in advance of the curlew survey, usually the previous afternoon or evening. This reconnaissance allowed the field observer to become familiar with the route and collect general habitat information. At each stop, the observer estimated the percentage of each of the following very broad habitat categories: native grassland (grazed or ungrazed), tame pasture (irrigated or dryland), cultivated (irrigated or dryland), and riparian (lentic or lotic). An “other” category was included and was used primarily for anthropogenic features such as farmsteads, irrigation canals, industrial activity and gravel pits. The habitat data collection form is provided in Appendix B. GPS locations were also recorded at each stop and a route description form was completed (Appendix B).

3.7.2 Curlew Data Collection

Surveys were started one half hour before sunrise and took between four and six hours to complete. The observer stopped every 800m and recorded all curlews seen and heard during a five-minute count period. Observers stood in the beds of their trucks for improved visibility. Binoculars and spotting scopes were used to detect birds that were not vocalizing. The spotting scopes were particularly useful for distinguishing long-billed curlews from marbled godwits (*Limosa fedoa*) at a distance. The following information was recorded for each curlew; distance band in which the bird was first observed (0-400m, 400-800m, over 800m), compass direction, sex (where determined), age (adult versus juvenile), activity, habitat and general comments. Observers were instructed to record gender only where there was a high level of certainty (for example where both the male and female were seen together and there was an obvious

difference in bill length or where the bird was performing a male-only display such as the bounding "soft kerr-kerr" display).

Alberta's Biodiversity Species Observation Database (BSOD) codes were used for the activity classification. The curlew data collection form is included in Appendix B and BSOD activity codes are given in Appendix C. In addition to curlews, observations of six other prairie bird species were collected; upland sandpiper, ferruginous hawk, Sprague's pipit, burrowing owl, short-eared owl and loggerhead shrike. Exactly the same data were recorded for these six species as were collected for curlews. These species were selected because they are considered sensitive species, are active on their breeding grounds during the curlew survey period and in some cases there is very little existing information about them.

The surveys were conducted only in suitable weather conditions. Surveys were not conducted in moderate or heavy rain or in winds greater than 25 km/hour. As it was a dry spring, rain was rarely a problem, however wind interrupted a number of surveys during the last two weeks of the survey period. If the weather turned unsuitable partway during a survey, the survey data were included in the analyses only if more than half the stops (>20) had been completed. Otherwise the route was re-surveyed on another day.

Instructions for field observers are included in Appendix D.

3.8 Field Observers and Training

A team of four field observers was hired to conduct the majority of the surveys. The project coordinator and five Fish and Wildlife Division biologists and technicians conducted additional surveys. To ensure consistency in data collection methods, all field observers attended a full day training session. The training session included: detailed instruction in the survey methods and sampling design, curlew behaviour, habitat associations, lifecycle and identification (including physical attributes and vocalizations), detailed information on the six priority incidental species (visual and aural identification, behaviour, habitat preferences) and instructions for data collection and data entry. In addition, all observers were provided with written survey instructions, background information on curlews and recordings of curlew vocalizations and those of similar species and the six priority incidental species. The relevant forms, maps, activity codes, sunrise tables and a checklist of items to take on each survey were also provided. On a separate day, the field team received instruction and practice in distance estimation. Using a range finder, observers continued to practice distance estimation after the training sessions.

3.9 Statistical Analyses

3.9.1 Population Estimate

Although all curlews observed during the surveys were recorded, only birds recorded in the 0-400m distance band were included in the analysis. The analysis was based on curlew ***males***. Where a pair was observed, this was recorded as "1". Because of the timing of the surveys (primarily during incubation), where a single bird was observed, this was assumed to be a male, as females incubate during the day. At the beginning of the survey period (from April 30th to May 8th), pairs of curlews were frequently seen together. As incubation commenced, it was

primarily males that were detected and counted. Toward the end of the survey period, some pairs were seen together again (starting on May 23rd). It is possible that the latter were failed nesters. Birds that lose their nest apparently remain on the breeding territory for approximately one week afterwards (Allen 1980). Pairs seen after May 30th may have been birds with undetected broods, as the first hatched young were recorded on May 31st.

Where only part of the sample unit was completed (i.e. between 20 and 40 stops), the number of curlew males was extrapolated to give a number per 40 stops. Out of the 110 sample units, 20 sample units (18%) were not fully completed due to weather problems. The off-road sample units were 30 stops long as this was all that could be realistically covered in one morning. There were two such off-road sample units.

Initially the data were analysed using the original three strata. However, the mean number of curlew males in stratum 1 and stratum 2 did not differ significantly from each other (see section 4.1 for results), therefore the data were analysed by combining stratum 1 and stratum 2 into one stratum, giving two strata in the sample frame, one of 0-50% native prairie and one of 51-100% native prairie.

The calculation of the mean of the whole population in the stratified sample was based on Krebs (1989) and Cochran (1977) and is described below:

The overall mean per sample unit for the entire population was estimated using:

$$x_{ST} = \frac{\sum_{h=1}^{L} N_h x_h}{N}$$

where;

x_{ST} = weighted stratified population mean per sample unit (the mean number of curlews per sample unit)

N_h = size of stratum (total number of sample units in stratum h)

h = stratum number, from 1 to L (in this case, from 1 to 3)

x_h = observed mean for stratum h (mean number of curlews observed in stratum h)

N = number of sample units in entire population = $\sum N_h$ (total number of $25.6 km^2$ sample units in the grassland natural region)

The population estimate was derived by multiplying the mean number of pairs per sample unit by the total number of sample units in the sampling frame. In this case, there are 3,931.2 sample units of $25.6 km^2$ in the Grassland Natural Region.

Next, it was necessary to calculate the variance and standard error of the stratified mean, in order to determine the precision of this population estimate.

After Krebs (1989), the variance of this stratified mean was calculated using:

$$\text{Variance of } x_{ST} = \sum^{L} \left[\frac{w_h^2 s_h^2}{\quad} (1 - f_h) \right]$$

$$_{h=1} \quad \lfloor \quad n_h \quad \rfloor$$

where;

w_h = stratum weight (proportion of sampling frame made up by stratum h)
s^2_h = observed variance of stratum h
n_h = sample size in stratum h (number of sampled units in stratum h)
f_h = sampling fraction in stratum h = n_h/N_h

To calculate the 95% confidence limits, it was necessary to calculate an effective number of degrees of freedom (Cochran 1977, page 95). Using the equations from Cochran 1977, 102 degrees of freedom were determined. This allowed for the calculation of a Student's *t* value that was used to calculate the confidence limits:

Confidence limits = $x_{ST} \pm t_{\alpha}$ (standard error of x_{ST})

3.9.2 Habitat Relationships

One-way ANOVA was used to assess the influence of the three strata on curlew numbers, using Tukey-Kramer tests ($\propto = 0.05$) to make multiple comparisons of means. For curlews, and for the six incidental species, there was at least some evidence of violation of the assumption of homogeneity of variances across the strata (i.e. variances were found to differ across strata). To address this, Welch ANOVAs were used, as this test does not assume homogeneity of variance across groups (SAS 2001). In addition, non-parametric Kruskal-Wallis ANOVAs were conducted. In all cases in which standard ANOVAs produced significant results the alternative tests also produced significant results. For simplicity, only the standard ANOVAs are reported here.

To look for associations between the number of curlews and habitat variables, the number of curlews observed on each sample unit was compared with the abundance of habitat types. Habitat abundance was the percentage of the sample unit composed of native grassland, tame pasture, cultivation and "other" (primarily disturbed anthropogenic habitats). Kendall's coefficient of rank correlation (τ) was used to test associations between the number of curlews and abundance of habitat on each sample unit.

Two methods were used to test whether curlews occurred in native prairie, cultivation and tame pasture in proportion to the availability of these habitat types or whether they preferentially selected some types and avoided others.

The first method was a proportional use index: The proportion of each habitat type in which curlews were actually observed was compared with the actual availability of each habitat type. For each sample unit on which at least one curlew was observed, the following steps were conducted to gain an expression of habitat preference or avoidance:

1. The proportion of curlews seen in each habitat was calculated using the data collected for individual curlew sightings (e.g. 20% of curlews were directly observed in cultivated land).

2. The proportional abundance of these habitats averaged across the 40 stops on the sample unit was calculated using the habitat data collected on the reconnaissance survey (e.g. 50% of the route was cultivated).
3. The proportional abundance was subtracted from the proportion of curlews seen in each habitat (e.g. 0.20 – 0.50 = -0.30).

Thus, over-representation of curlews in a habitat (preference) was expressed as positive numbers and under-representation (avoidance) was expressed as negative numbers.

The second method of examining habitat preference involved calculating an index of preference, called Manly's alpha, employing the calculations appropriate for a situation in which no habitat type was completely occupied by other curlews (sampling with replacement, see Krebs 1989). This index of preference compensates for differences in the relative abundance of habitats.

$$\alpha_i = \frac{r_i}{n_i} \quad \frac{1}{[(r_{ng}/n_{ng}) + (r_c/n_c) + (r_{tp}/n_{tp})]}$$

where;

α_i = Manly's alpha (preference index) for habitat i

r_i = Proportion of habitat type i selected (for each of the three habitat types: ng = native grassland, c = cultivated, tp = tame pasture)

n_i = Proportion of habitat type i available in the environment

To test the significance of the preference indices (both the proportional use test and Manly's alpha), the mean index for each habitat type was tested against the expected value of no preference (0 for the proportional test and 0.333 for Manly's alpha) using a Wilcoxon signed-rank test.

In all cases the level of statistical significance was set at p = 0.05. Values are reported as mean ± SE. The population estimate methods and habitat correlations, described above for curlews, were also used for the six incidental bird species (results are given in Section 7.0).

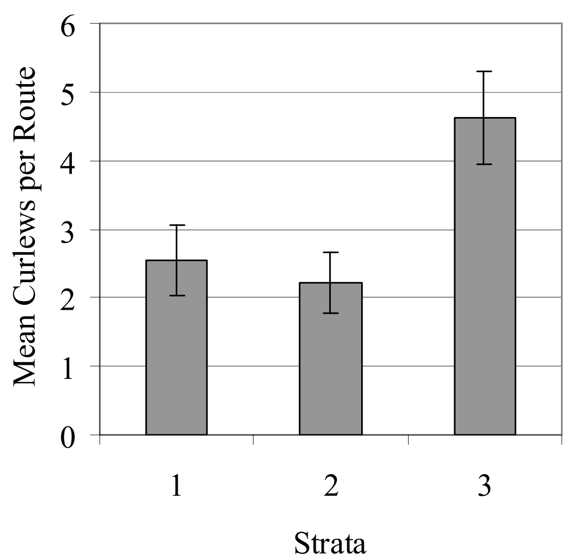
4.0 RESULTS

A total of 543 individual long-billed curlews were observed over the course of the 110 curlew surveys. Of these, 128 curlews were observed in stratum 1 (0-5% native prairie), 144 were observed in stratum 2 (6-50% native prairie) and 271 were observed in stratum 3 (51-100% native prairie). Of the 110 sample units, curlews were observed within the 400m distance band on 78 (71%) of the sample units. In stratum 1, curlews were observed on 67% of sample units. In stratum 2, curlews were observed on 68% of sample units. In stratum 3, curlews were observed on 78% of the sample units. Out of all of the curlew observations, 399 were recorded as unidentified gender, 95 were positively identified as males and 49 were positively identified as females.

4.1 Population Estimate

The mean number of curlews observed per sample unit varied significantly with stratum ($F_{2,107}$ = 5.72, P = 0.0043, Figure 2). The number of curlews per sample unit in stratum 3 (4.63 ± 0.68) was significantly higher than in stratum 1 (2.55 ± 0.51) and stratum 2 (2.21± 0.44), but the numbers in stratum 1 and 2 did not differ significantly from each other and thus could be combined together for estimating total population size.

Figure 2: Mean number of curlews per stratum.



The overall mean number of curlew males per sample unit (25.6km^2) was 3.04 ± 0.31, resulting in an estimate of 11,942 ± 2,381 curlew males for the Grassland Natural Region in Alberta. This is a precision of 19.94% or between 9,560 and 14,323 curlew males (95% confidence interval).

Assuming that the curlew population has an even sex ratio, this population estimate translates to 23,884 ± 4,762 individual curlews. Although there is no reason to assume a skewed sex ratio in the overall curlew population, there is evidence from other regions that there may be more

males than females present on the breeding grounds because young males may return to the breeding grounds a year or two before young females (see discussion for details).

Thus, it is possible that in the Alberta population estimate, some unpaired males were included in the survey and therefore it is not necessarily appropriate to assume an even sex ratio and double the results to gain a total population estimate. It should be noted that if there was a skewed sex ratio in the Alberta curlew population, as a result of some proportion of the young males returning earlier, the females still exist as part of the population, even though they are not in Alberta. Table 1 shows the population estimates based on differing assumptions regarding the curlew sex ratio.

Table 1: Implications for the curlew population estimate assuming alternative sex ratios

	Assumption		
	Even sex ratio, all males were paired	25% of males were unpaired	Extreme situation, only 50% of males were paired
Population estimate	23,884 ± 4,762	20,898 ± 4,180	17,913± 3,583

Again, it should be noted that the few curlews that nest in the Parkland Natural Region are not included in this population estimate. Thus, the total Alberta curlew population would be expected to be slightly larger than is estimated here.

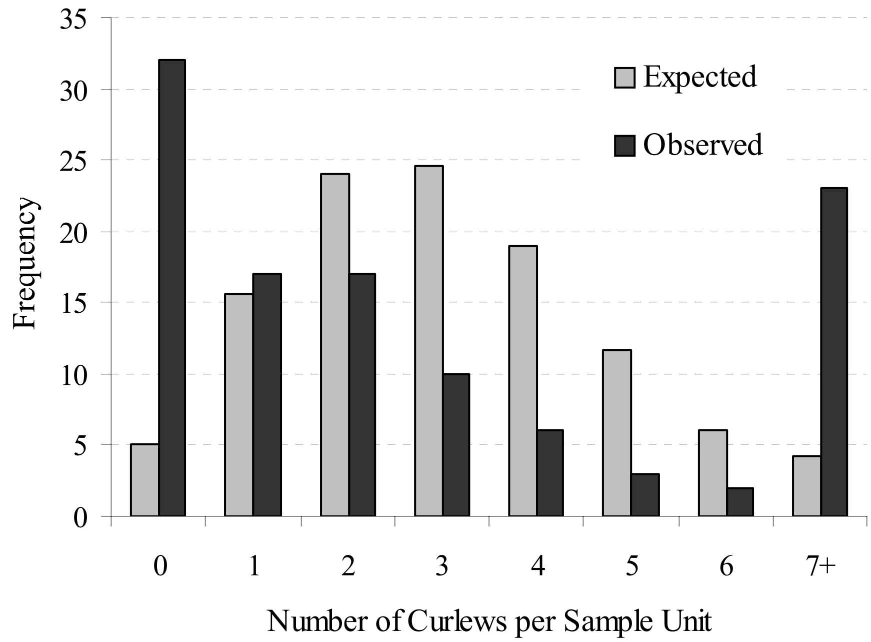
4.2 Geographical Patterns

As the sample units were selected randomly rather than systematically, it is difficult to draw significant conclusions regarding geographical trends in curlew distribution in Alberta. However there are some patterns that can be reported here: Because the survey was not systematic, we cannot accurately map densities or concentrations of curlews (e.g. there may be a concentration in an area that was not surveyed as a result of the random survey design). However there are a few areas where concentrations of birds are apparent: In the area bounded by Stavely to the north-west, Vauxhaul to the north-east, Fort Macleod to the south-west and Lethbridge to the south-east there were seven stratum 1 sample units. The mean number of curlews per sample unit in this area was 5.8 ± 1.0, which is considerably higher than the mean for the entire study area (3.04 ± 0.31) and also higher than the mean for stratum 3 (4.63 ± 0.68). This is particularly surprising because all of the sample units in this area are in stratum 1 and it is an area of intense cultivation (the mean amount of native grassland across these seven sample units is 2.9%). Another concentration lies in the area bounded by highway 875 (near Hays) to the west, the Red Deer River to the north, South Saskatchewan River to the east and Medicine Hat to the south. In this area there were twelve stratum 3 sample units and one stratum 2 sample unit. The mean number of curlews per sample unit in this area was 5.4 ± 1.1. The three sample units in the extreme south of the province, along the US border also had above average counts (mean of 9.5 ± 1.6). These three routes were located between Del Bonita and the Milk River Natural Area.

Despite the inability to map curlew densities, it is apparent that curlew densities must vary considerably across the Grassland Natural Region. On the scale of the sample units, curlews

were clustered or aggregated. If curlews were distributed randomly then the frequency distribution of curlews per sample unit would be distributed according to the Poisson distribution and the index of dispersion (variance/mean) would be approximately 1.0 (Krebs 1989). In this case, the index of dispersion was 3.87 and the frequency distribution of observed curlews per sample unit was skewed towards more routes with 0 curlews than expected and more routes with seven or more curlews than expected (χ^2=307.2, p<0.001, df=6, Figure 3).

Figure 3: Frequency distribution of curlews per route.



4.3 Habitat Results

The broad habitat information collected for each sample unit enables some basic investigation of long-billed curlew habitat preferences. There are three levels at which these relationships can be examined: at the strata level, at the sample unit level and at the individual curlew sighting level.

Figures 4 to 6 summarize the results of the habitat data collected for each sample unit in each of the three strata.

Figure 4: Average proportion of each broad habitat type for Stratum 1 (based on habitat data collected on 31 sample units).

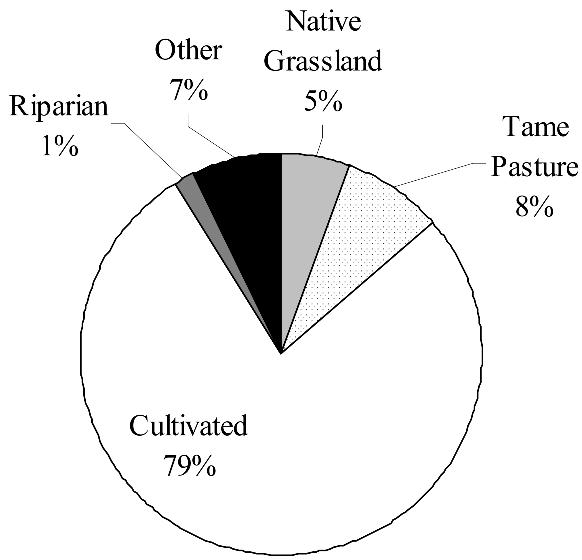


Figure 5: Average proportion of each broad habitat type for Stratum 2 (based on habitat data collected on 41 sample units).

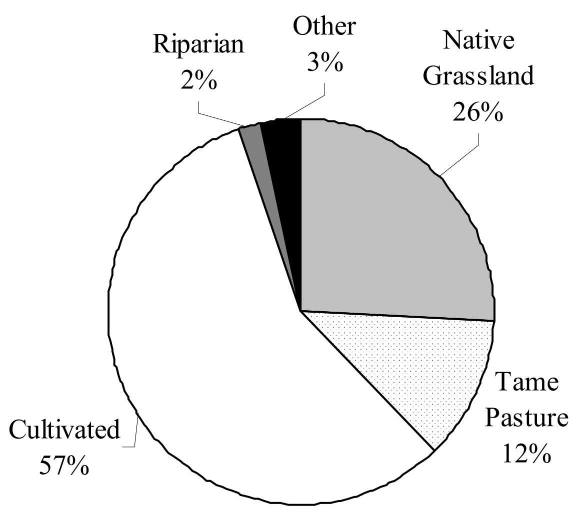
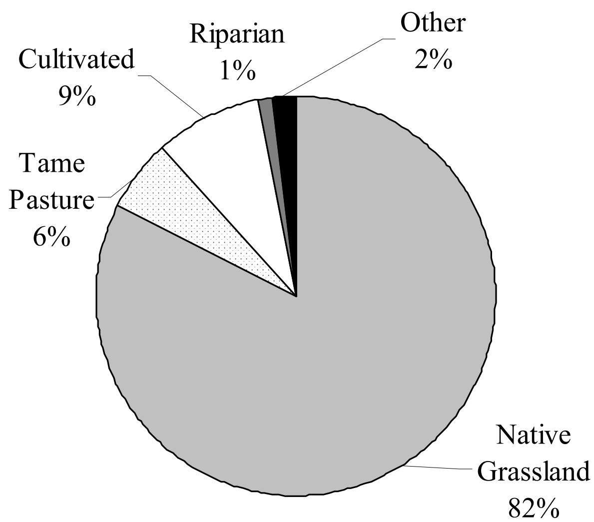
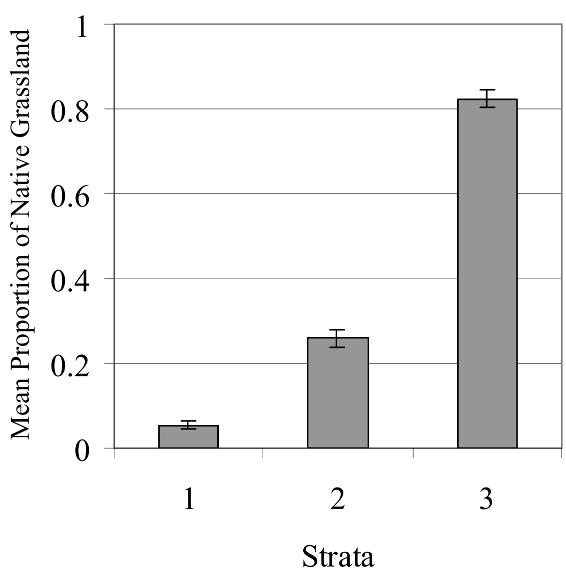


Figure 6: Average proportion of each broad habitat type for Stratum 3 (based on habitat data collected along 36 sample units).



To confirm that there were significant differences in the amount of native grassland between strata, the mean proportion of native grassland for each stratum was examined. The proportion of native grassland was found to vary significantly with strata ($F_{2,107} = 313.21$, $P < 0.0001$, Figure 7).

Figure 7: Mean proportion of native grassland by strata.



Overall, the average amount of native grassland in the sample units reflected the broad strata that were originally defined (5% in stratum 1, 26% in stratum 2 and 82% in stratum 3). However, it is somewhat surprising that the average amount of prairie along sample units in stratum 1 was as high as 5%. It is possible that the survey sample units traversed areas where

there was more native grassland than the average for the township, although this seems unlikely as one would expect native areas to be further from roads. It is also possible that some tame pasture was mistaken for native grassland by field observers or that the native prairie inventory was underestimating the amount of native grassland in some intensively cultivated areas. The higher than expected average of native grassland in stratum 1 can largely be explained by three sample units that had considerably more than 5% native grassland (sample unit 107 with 27.4% native grassland, sample unit 110 with 16.7% native grassland and sample unit 122 with 25.0% native grassland). All three of these sample units lie in the Strathmore area. The habitat data were collected by three different observers, suggesting that these anomalies were probably not due to observer error. As strata 1 and 2 were combined in order to calculate the population estimate, these anomalies did not present a problem in the data analyses.

4.4 Relationships between Habitat and Curlews

4.4.1 Results at the Strata Level

From the earlier literature review and examination of BSOD data (Saunders 2001), a close relationship between long-billed curlews and native grasslands was apparent. It was anticipated that few curlews would be found in stratum 1 (0-5% native grassland). However, the inventory revealed that long-billed curlews are present and apparently breeding in areas where there is little or no native grassland. The data show that curlews were just as common in the 0-5% native prairie stratum (2.55 ± 0.51 curlews per sample unit) as in the 6 –50% native prairie stratum (2.21 ± 0.44 curlews per sample unit, Figure 2). In the 51-100% native prairie stratum, curlews were twice as abundant (4.63 ± 0.68 curlews per sample unit).

4.4.2 Results at the Sample Unit Level

The results of the correlations between habitat proportions in each sample unit and curlew numbers are shown in Table 2. In addition to the original broad habitat types, total irrigated habitat was also examined.

Table 2: Correlation coefficients of habitat proportions (per sample unit) and number of curlews (values are Kendall's Tau)

* P < 0.1; ** P< 0.05; *** P < 0.01

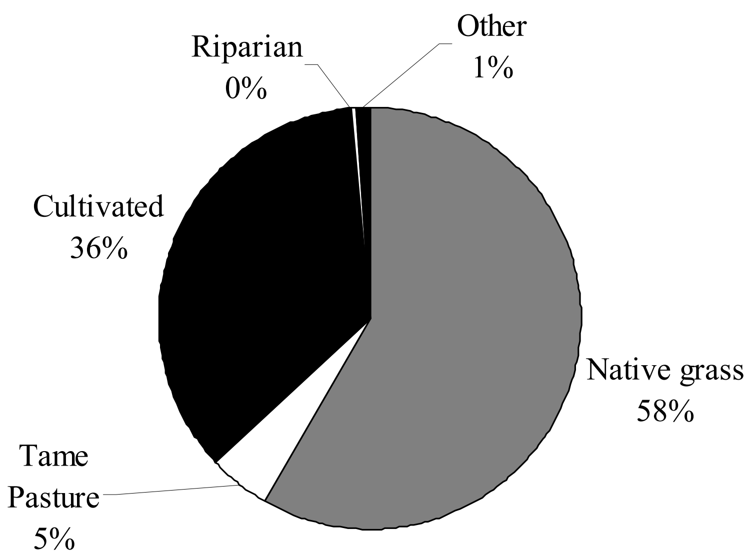
Habitat	Correlation Coefficient Kendall's Tau
Native Grassland	**+0.144****
Tame Pasture	+0.056
Cultivated	**-0.137****
Riparian	**-0.166****
Other	-0.018
Irrigated Land	-0.021

The strongest predictor of curlew numbers was the percentage of native grassland in the sample unit. Conversely, there was a negative relationship between the number of curlews and the amount of cultivated land. Curlews were negatively correlated with riparian areas.

4.4.3 Curlews by Individual Observation

Curlews were observed most often in native grassland (58%, Figure 8). In 36% of the observations, curlews were in cultivated areas. There were few observations in tame pasture (5%), but tame pasture made up only 8.8 % of the sample units. No curlews were observed directly in riparian areas. The "other" observations included curlews seen flying over roads, over an irrigation canal and bordering on more than one habitat type.

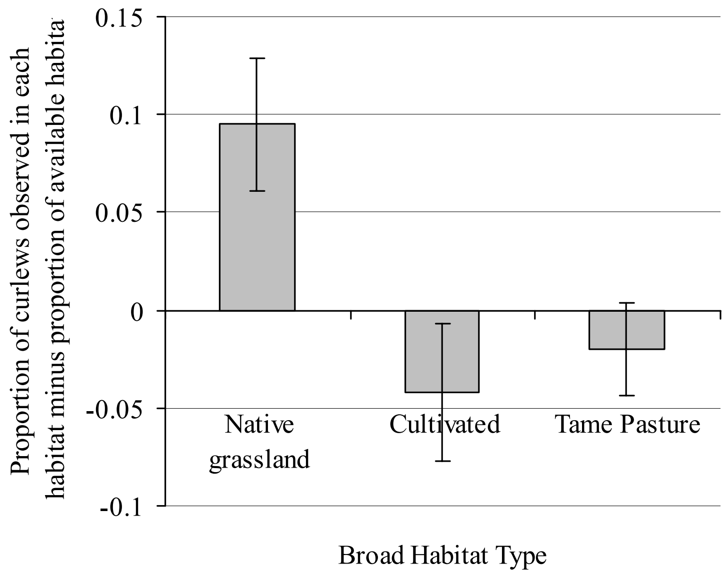
Figure 8: Broad habitat types in which curlews were observed.



4.4.4 Habitat Preference

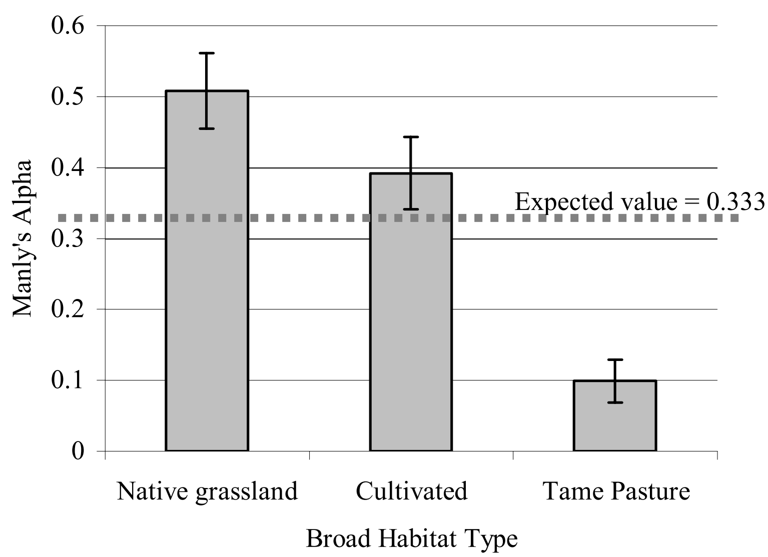
For each of the sample units in which curlews were recorded, the mean proportion of curlews seen in a habitat minus the mean proportional representation of that habitat on that sample unit was calculated. The significant positive value for native grassland suggests that curlews preferentially selected native grassland more than it was represented in the environment (Wilcoxon signed-rank test, $W = 365$, $P = 0.021$; Figure 9). Although there is a negative value for cultivated land, this result was not statistically significant ($W = 88$, $P = 0.569$, Figure 9). Curlews appeared to use tame pasture considerably less than its abundance in the environment ($W = 762$, $P < 0.001$; Figure 9).

Figure 9: Proportional use index for broad habitat types.
Note: Expected value is "0"; meaning habitats are used in proportion to their availability.



Measures of preference with Manly's alpha produced the same results. Curlews preferred native grassland (W = 598, P = 0.001; Figure 10), were unselective for cultivated land (W = 185, P = 0.316; Figure 10), and tended to avoid tame pasture (W = 1009, P < 0.001; Figure 10).

Figure 10: Manly's alpha (an index of habitat preference).
Note: Expected value is 0.333, meaning that there is no preference.



4.5 Curlew Activities and Behaviour

For each individual curlew observed, the activity the bird was engaged in when it was first observed was recorded (using BSOD activity codes). Additional behavioural notes were made under "comments".

4.5.1 Curlew Activities Recorded

The majority of curlews observed during the surveys were performing territorial or seasonal vocalizations (38%, Table 3). Other frequently observed activities were foraging (18%), flight (11%) and courtship behaviour (9%). There is some overlap between activity categories. For example "observed in flight" and "courtship behaviour" overlap, because although the bird was first observed flying, it was then sometimes noted under general comments that the bird was performing the SKK display, a courtship behaviour.

Table 3: Activities of observed curlews.
Note: all activity types are BSOD categories

Activity	Number	Percent
Recently fledged young observed	1	0%
Adult seen attending nest or incubating	1	0%
Courtship behavior	49	9%
Counter-singing	5	1%
Pair observed in suitable habitat	20	4%
Territorial nesting behavior	6	1%
Visting probable nest site	27	5%
Aggressive behaviour/display	10	2%
Alarm calls	13	2%
Territorial or seasonal vocalization	205	38%
Resting individual	6	1%
Observed foraging	99	18%
Observed in flight	61	11%
Unspecified activity	2	0%
Not recorded*	38	7%

*observer did not record the BSOD activity code on data sheet

4.5.2 Behavioural Observations

Observers were encouraged to record details of any behavioural observations in the "comments" section of the data form. Below is a summary of these comments:

Reaction to vehicle and observers

Curlews rarely reacted to the presence of the vehicle or observer, except in a few cases where the bird was originally very close to the place where the vehicle stopped. In such cases, the bird flushed, usually flying 25m – 100m. Birds appeared to remain on their nesting territory versus following the vehicle to the next stop. On many occasions birds could still be seen/heard from the next stop, remaining in the vicinity of where they were first observed on the previous stop. The few instances of birds following observer's vehicles occurred at the very end of the survey

period, after June 6th. This behavioural change is likely explained by the presence of recently hatched young.

Courtship and territorial displays
The often described "soft kerr-kerr" (SKK) flight was recorded a total of 18 times during the surveys. In this display the male ascends vertically and then glides slowly down towards the ground with its wings curved downward. As he does this, he gives a series of soft "kerr kerr" notes. According to Allen (1980) this display is observed for up to three days and takes place almost exclusively on the first day a male pairs up with a female. However, in this study, this display was observed through the entire survey period and until as late as June 6th. "Curlee curlee" calls and whistling were the most common vocalizations. On numerous occasions, birds from neighbouring territories were heard whistling back and forth to each other.

Interspecific interactions
Curlews displayed aggressively towards willets and godwits on several occasions. However they were also observed foraging with the latter species on four occasions. Curlews were also observed acting aggressively towards merlins, Swainson's hawks, northern harriers and pigeons.

Timing of curlew activities
In 2001 curlews were first observed in southern Alberta on April 15th. A pair of copulating curlews was observed on May 11th. One nest was observed during the course of the survey – the female was seen incubating on May 15th. The first hatched young were observed on May 31st. With an incubation period of 28 days, this pair would have begun incubating on May 3rd.

Other observations
Although most often observed on the ground, there was one observation of a curlew perched on a fencepost and one perched on top of a power pole. On May 9th, four curlews (two males and two females) were observed under an active irrigation pivot. The males were interacting in a territorial fashion, while the females foraged.

5.0 DISCUSSION

5.1 Evaluation of Methods

The methods used were selected after an extensive review of survey methods, curlew biology and curlew survey data from other studies (Saunders 2001). However, a pilot project was not conducted, so it was not possible to test the proposed methods in advance of the full inventory. This section evaluates the methods used and the reliability of the resulting population estimate.

5.1.1 Discussion of Assumptions

The curlew population estimate is based on the following assumptions:

1. All curlews and/or curlew males within the sample unit were detected.
2. No curlews were counted more than once.
3. Curlews were recorded in the correct distance band
4. Curlew densities do not change with distance from roads.
5. The curlew population has an even sex ratio.

Below is a discussion of each of these assumptions and how the population estimate would be influenced if the assumptions were violated.

All curlews and/or curlew males within the sample unit were detected.

Several factors likely influenced the detection and identification of curlews during the surveys:

Although curlews are generally easy to identify, an unexpectedly high number of marbled godwits were present on the sample units. Observers had to be especially careful that they did not confuse the two species. It was particularly problematic when a bird was stationary, in the distance and not vocalizing. Spotting scopes helped observers to distinguish godwits from curlews in the field. Observers were alerted to this identification concern after the first few surveys were conducted. It should be noted that misidentification did not likely occur within the 400m distance band, but rather at farther distances. Only curlews observed within the 400m distance band were used to calculate the population estimate.

As curlews are quite vocal during the courtship and incubation stages, the majority of the curlews were first detected aurally. Some sample units were subject to anthropogenic noise that may have affected the observer’s ability to hear curlew vocalizations. Particularly bothersome were irrigation pumps and pivots, vehicle traffic and industrial activity such as compressor stations and wells. The majority of these types of disturbances occurred in stratum 1, although industrial activity was common in stratum 3. Wind was the primary weather influence. As wind speed increased, it became more difficult to hear distant birds. On calm days it was possible to hear curlews from the previous two to three stops.

Topography was the primary factor affecting the visual detection of curlews. This varied greatly throughout the study area. However, curlews could generally be heard from some distance away, even in rolling topography. Lack of visibility in rolling terrain likely resulted in some curlews being missed, particularly those that were not vocalizing during the five-minute count period. Where there was tall or shrubby vegetation, visibility was also obscured. This

was particularly the case in the northern part of the study area. Heat hazes also may have influenced visual detection of birds. By the second half of the survey period, heat hazes were common after about 8:30 am.

Given the above discussion, it is likely that some curlews were missed due to detection problems (i.e. curlews did not vocalize during the survey period and were hidden out of sight by terrain and/or vegetation). This would mean that the population was under-estimated.

Curlews/curlew males were not counted more than once.

One of the main reasons for conducting the survey before the young hatched was to avoid the problem of repeat-counting birds that can occur as a result of curlew mobbing behaviour. Once their young have hatched, adult birds react more strongly to human intruders and will fly considerable distances to join other curlews in mobbing activities, resulting in an over-estimation of curlew numbers (Redmond et al. 1981).

Because the surveys were conducted during the incubation period, most of the birds were not observed to respond or react to the observers. On a few occasions where curlews were originally very close to the road, they reacted by flushing a short distance away from the vehicle and observer and landing 25 to 100m away. Curlews were observed reacting in an aggressive manner to raptors, but these instances involved single curlews or pairs, rather than groups. June 1^{st} was the first day that a curlew was observed following an observer's truck from one stop to the next. On June 7^{th}, there were several observations of curlews acting aggressively towards the observer's vehicles. Presumably this change in behaviour related to the hatching of broods.

In general, over-counting was not considered to be a problem. There were only 28 stops where more than one curlew pair was observed in the 400m distance band and there were no situations where more than two pairs were recorded in the 400m band at one stop.

Curlews were recorded in the correct distance band.

Although the field observers underwent training in distance estimation, ability to estimate distance varies with observer, topography and atmospheric conditions. Errors in estimating distance tend to get larger as the distances increase. In this case, the most important distance estimate was to determine whether the curlew was first observed in or outside of 400 meters, as only those birds observed within 400m were used in the population estimate. There were several visual clues that helped field observers estimate this. Firstly, the stops were placed 800m apart. Therefore the observer usually had a reference point by looking back to the last stop, 800m away. In addition to this, on much of the prairie landscape, fencelines are 800m (half a mile) apart. Therefore there was often a fenceline running parallel to the road, 800m away. Where this existed, it was a useful reference to aid in distance estimation. Overall it is much easier for observers to determine whether a bird is outside or inside of a certain distance band than it is to estimate an absolute distance from them to the bird. As there is a tendency for observers to want to record all birds seen, even if they are outside of the sample unit (i.e. observers tend to err towards including rather than not including a bird), observers were also instructed to record curlews in more distant bands (400-800m and over 800m). Although these birds were not included in the population estimate, by having observers record them it may have reduced the amount of birds erroneously included in the 400m band. Thus, it is possible that a

few curlews may have been included in the 400m band when they were actually more distant, and some may have not been included when in fact they were within 400m. The former is likely the more common error. Inclusion of more distant birds in the 400m band would result in an over-estimate of the population.

Curlew densities do not change with distance from roads.
The population estimate assumes that curlew densities are the same alongside a road as they are away from a road. An effort was made to use only minor roads, in order to keep the influence of roads at a minimum. A test of this assumption was planned once the surveys were complete (Saunders 2001), but as the surveys were conducted right up until when the birds started to hatch, the test was not possible. If this assumption is incorrect, it would be expected thatthe trend would be that fewer curlews nest along roads (i.e. densities would likely be higher further from the disturbance of roads). If this assumption is incorrect, this may result in an under-estimate of the population. Unfortunately there is limited information about curlew densities and roads. Although one might expect that densities would be lower near roadsides, it is also possible that curlews may be attracted to roadsides and ditches because of different foraging opportunities. Cochrane and Oakleaf (1982) found that more curlews were observed in the first 60m of the road in their Wyoming study. They speculate that this may be due to errors in distance estimates, declining detectability with distance or possibly a roadside attraction for curlews. Considering that several studies have found that curlews prefer a low vertical vegetation profile (McCallum et al. 1977, Bicak et al. 1982, Pampush and Anthony 1993), it seems unlikely that curlews would be attracted to the longer vegetation of roadside ditches, except perhaps during the brood rearing phase, where the longer vegetation may provide increased protection from heat stress and predators. Further investigation in this area would be useful.

The curlew population has an equal sex ratio.
There is no reason to assume that there is an unequal sex ratio in the overall curlew population. However, there is some evidence from other regions that there may be more males than females present on the breeding grounds. Juvenile long-billed curlews appear to remain on their wintering grounds until they reach breeding age. It has been speculated that males may return to the breeding ground at an earlier age than females, leading some males to be present as non-breeders for a year or two (Redmond et al. 1981). In a two year study, Allen (1980) found that in one year all the males in her study area acquired a mate, but in the second year there was a shortage of females, leaving "almost half of the males unpaired". Her study in Washington may not be directly comparable to the situation in Alberta, for several reasons: Allen observed what she speculates were one-year old birds in small flocks around her study area. This has not been observed in Alberta. She also found that males arrived first and the females arrived about a week later. This is different than the situation in Alberta, where the curlews appear to arrive paired (pers. obs.). Arrival in pairs has also been observed in Colorado (Wolf 1931), in Montana (Silloway 1900) and northern Utah (Forsythe 1970). Redmond et al. (1981) were unable to quantify a non-breeding component to their study population, but did confirm that some males were unsuccessful at attracting a mate. If in Alberta there were unpaired males included in the survey, this would mean that the estimate of curlew males cannot be doubled to accurately estimate the number of individual curlews in the province. However, as was pointed

out in the results section, even if the young females are not present in Alberta, they still exist as part of the curlew population.

5.1.2 Method Refinements

Although the inventory was successful and the objectives were achieved, there are some suggestions for improving the survey if it were to be conducted again or in a different geographical region:

1. Provide more rigid instructions to observers regarding what to do during the five-minute count period in order to standardize procedures. Although this was standardized to some extent through discussions with the field crew, it could have been formalized more thoroughly. For example, observers could be instructed to listen for curlews in the first minute and then scan the terrain with binoculars for birds while continuing to listen and watch for flying birds during the remaining four minutes.

2. Observers should record the number of minutes into the count period that birds are first observed and record whether the observation is aural, visual or both. Although the observers generally felt that most birds were first observed or heard during the first few minutes and that most birds were first detected aurally, it would have been useful to have had quantitative data on this.

3. Develop more rigid instructions for data reporting, particularly for the activity codes. BSOD activity codes were used to describe the activity of the birds. This was done in part so that observations from the survey could easily be entered into BSOD. However it would have been useful to have more rigid codes that applied specifically to curlews as this would have provided more useful information on curlew behaviour and activity changes during the breeding season. In a few instances, different observers interpreted the BSOD codes differently. For example, on occasion observers used “OH – observed in flight” and then wrote under comments that the bird was performing the SKK flight, a male display used to attract a mate. This would have been more appropriately recorded as “C – courtship behaviour”. More rigorous training in the use of the codes could have reduced these problems. Fortunately observers made good use of the “comments” column to help with interpretation of activities.

4. A measure of topography (or the degree of flatness/hilliness) should be included in the habitat data collection. As it would appear that good visibility is an important factor in curlew habitat selection (Pampush and Anthony 1993), it would be useful to be able to examine correlations between topography and curlew numbers.

5. As marbled godwits were often seen on the surveys, in hindsight it might have been valuable to include them in the survey as there is little existing quantitative data on this species.

5.2 Comparison With Other Studies

As there have been no other published regional scientific population estimates for long-billed curlews, it is difficult to make comparisons. In the national status report, DeSmet (1992) reported a population estimate of 4,600 to 7,300 curlews for the entire Canadian prairies based on unpublished data from a survey in southwestern Saskatchewan. This estimate was arrived at based on an extrapolation of the Saskatchewan results and the amount of habitat available in Alberta (A. Smith, pers. comm.). The Saskatchewan study estimated at least 2,000 curlews in that province (A. Smith pers. comm.). The status report estimates an additional 300 to 500 curlews in British Columbia.

The Alberta population estimate for the Grassland Natural Region presented here (between 9,560 and 14,323 curlew males or assuming an even sex ratio, 19,122 to 28,646 curlews) is considerably higher than the estimates that were based on the Saskatchewan study. It should also be remembered that, based on the discussion in section 5.1.1, this is likely a conservative estimate. One of the reasons why the results of this inventory are higher than earlier estimates may be that previous estimates did not take into account the curlew population present in areas with little or no native grassland. Although curlews are half as numerous in areas of intensive cultivation, this still represents a significant part of the Alberta curlew population. In fact, 54% of the Alberta population was found to be in the stratum with 0-50% native grassland.

Table 4 compares the mean number of curlews per km^2 found in the current study with density estimates from other studies.

Table 4: Density estimates from other curlew studies.

Region	Habitat Comments	Pairs per km^2	Study
Washington (SE)	In favourable habitat	1.5	Fitzner 1978
Idaho	In grazed habitats	Mean = 4.5	Medin and Clary 1990
Idaho		2.5	Jenni et al. 1982, in DeSmet 1992
Washington		5.0 – 16.0 (extrapolated from reported territory sizes of 6 – 20 ha)	Allen 1980
Idaho (W)		5.0 – 7.0	Redmond and Jenni 1986
Oregon	Cheatgrass habitat	Mean = 9.0 (range 5.0 – 22.5)	Pampush and Anthony. 1993.
Oregon	Bitterbrush habitat	Mean = 1.25 (range 0 – 5.0)	Pampush and Anthony. 1993.
British Columbia		4.2	Ohanjanian 1985, in DeSmet 1992
Saskatchewan		0.14 - 0.16 (estimate of approx. one pair per 6-7 km^2)	Sadler and Maher 1976
Alberta	Native prairie	1.6 – 2.7 (from birds detected per 15ha site)	Prescott and Bilyk 1996, Prescott 1997a
Alberta	Agricultural land	0.4 – 0.9 (from birds detected per 15ha site)	Prescott and Bilyk 1996, Prescott 1997a
Alberta	Native prairie (natural wetland basins)	0 – 0.3	Gratto-Trevor 2001
Alberta	**Stratum 1 (0-5% native grassland)**	**Mean = 0.1 (range 0 - 0.35)**	**Current Study***
Alberta	**Stratum 2 (6 – 50% native grassland)**	**Mean = 0.09 (range 0 – 0.47)**	**Current Study***
Alberta	**Stratum 3 (51 – 100% native grassland)**	**Mean = 0.18 (range 0 - 0.47)**	**Current Study***

* mean density based on number of pairs per 25.6km^2 sample unit

Directly comparing the results of the studies given in Table 4 is questionable because they were all conducted in differing manners. For example, Allen (1980) selected an area of relatively dense curlew population for her study and the density estimate is based on her calculations of territory size ranging from 6 – 20 ha. In the current study "density" represents a mean value across all sample units for each stratum. If we look at specific sample units where relatively large numbers of curlews were observed, "density" values are higher. For example, in the first 10 stops of sample unit 328, there were five pairs recorded, giving a density of 0.78 pairs per km^2.

Overall, the mean densities calculated from the Alberta inventory are considerably lower than those reported for Washington, Nevada, Idaho, Oregon and British Columbia. The densities reported by Prescott and Bilyk (1996) and Prescott (1997a) are also higher than those found in the current study (from 9 to 15 times higher). The Saskatchewan estimate from Sadler and Maher (1976) of one pair per 6-7 ha is much closer to the values found in the current study. Unfortunately they do not explain how this estimate was derived. The densities found in the

Brooks area study (Gratto-Trevor 2001) are comparable to those found in the current study in areas of native grassland.

As in this study, others have found curlew abundance to be higher in native grassland than cultivated areas. Owens and Myers (1973) found curlew abundance to be 4.5 times greater in native grassland than cultivated land in the Hand Hills of Alberta. Also in Alberta, Prescott (1997a) found curlew numbers 2.8 times higher in native mixed grasslands than in planted cropland and 6.5 times higher than in hayfields. In the current study, curlew numbers were found to be twice as high in the stratum containing 51 to 100% native grassland as in the stratum containing 0 – 50% native prairie.

5.3 Alberta Population Estimate

The results of the 2001 inventory suggest that there is a relatively healthy long-billed curlew population in Alberta that is larger than has been estimated in the past. However it must be recognized that the 2001 inventory is simply a snapshot of the current curlew population and gives no indications of trends. Grassland birds are notorious for experiencing large fluctuations in population in relation to weather conditions and the resulting habitat changes across their range (Cody 1985). It is unknown how variable curlew populations are from year to year. The longest term study on curlews, conducted in western Idaho by Redmond and Jenni (1986) was performed over the course of seven years, from 1977 to 1983. They found no significant differences among annual density estimates of territorial male curlews, although they report a gradual decline in males attempting to breed between 1978 and 1981. A range fire in 1981 resulted in a 30% increase in breeding densities the following year, suggesting that curlew populations can respond rapidly to vegetative changes in their breeding areas. Fluctuations in population may possibly be greater at the outer edges of their range, such as in Alberta.

It should be noted that both 2000 and 2001 were considered drought years in southern Alberta. The effect of drought conditions on Alberta's curlew population is unknown. As curlews establish nesting territories early in the spring, it is expected that the weather conditions, and resulting vegetation growth, of the previous year would exert more influence on curlew habitat than the current year.

There are some speculations regarding drought in DeSmet (1992): Wayne Harris (pers. comm., in DeSmet 1992) felt that there was a slight increase in curlew numbers in southwestern Saskatchewan during the 1990s due to a lessening of drought conditions. Cleve Wershler (pers. comm. in DeSmet 1992) suggests that nesting populations near Lost River have declined considerably, possibly due to recent drought. Allen (1980) speculates that drought conditions may reduce curlew breeding success by reducing areas of dense vegetation required for brood-rearing.

Conversely, drought conditions decrease vegetation cover, perhaps creating more favourable conditions for curlews during the courtship and incubation phases (Bicak et al. 1982). Various studies have shown that curlews prefer lower vegetation (Bicak et al. 1982, Redmond 1986, Pampush and Anthony 1993). Bicak et al. (1982) speculate that short vegetation facilitates predator detection, improves foraging and locomotion and increases the efficiency of intraspecific interactions within the curlew population.

There is simply not enough information available to speculate whether the past two years of drought (2000 and 2001) in southern Alberta would result in higher or lower curlew numbers in the 2001 inventory.

5.4 Curlew Population Trends

The only source of information regarding long-billed curlew population trends is the North American Breeding Bird Survey (BBS). In the period 1966 to 2000, the survey wide trend for long-billed curlew shows a decline of 1.2 % per year (Sauer et al. 2001), This North American trend was not quite statistically significant (p=0.11, N=227). Regional trends during this time period vary across the species' range from strong declines (e.g. Kansas –10.3%/yr, Oklahoma –14.4%/yr) to large increases (e.g. Oregon +6.0%/yr, Wyoming 18.1%/yr). However, it should be noted that because of the low numbers of curlews detected on BBS routes, there are very few statistically significant trends. The trends for Canada, along with the statistical significance, number of routes and confidence intervals, are given in Tables 5 to 7.

Table 5: 1966-2000 Trends in long-billed curlew numbers from the North American Breeding Bird Survey (from Sauer et al. 2001).

Region	Credibility Measure*	Trend	p	N**	95% confidence interval	
Alberta	Moderate precision and abundance	-0.7	0.71	24	-4.4	3.0
British Columbia	Important Data Deficiency	2.7	0.61	9	-7.2	12.5
Saskatchewan	Data Deficiency	-10.7	0.03	7	-17.5	-3.1
Canada Overall	Moderate precision and abundance	-0.6	0.73	40	-3.9	2.8

*BBS results are categorized in three credibility categories; Important Data Deficiency (regional abundance is lower than 0.1 birds/route, sample is less than 5 routes, a 5% per year change would not be detected), Data Deficiency (regional abundance is less than 1.0 birds/route, sample is less than 14 routes, a 3% per year change would not be detected) and Moderate Precision and Abundance (reflects data with at least 14 samples in the long term, of moderate precision and moderate abundance on routes).
**N = number of survey routes

Table 6: 1966-1979 Trends in long-billed curlew numbers from the North American Breeding Bird Survey (from Sauer et al. 2001).

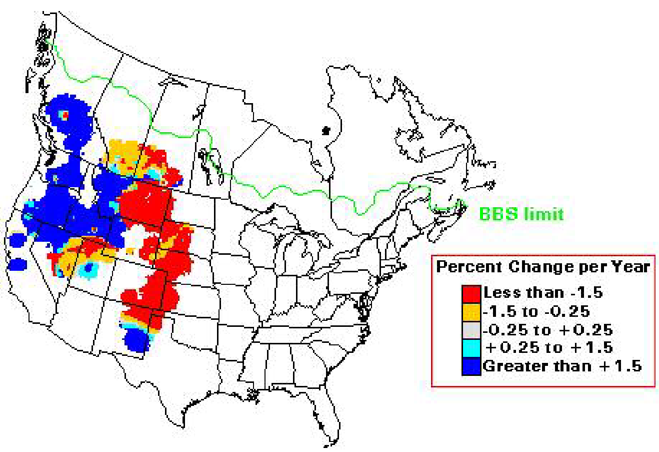
Region	Credibility Measure	Trend	p	N
Alberta	Moderate precision and abundance	-4.1	0.56	8
British Columbia	Important Data Deficiency	-42.4	0.26	2
Saskatchewan	Data Deficiency	-10.7	0.03	7
Canada Overall	Moderate precision and abundance	-0.6	0.73	40

Table 7: 1980-2000 Trends in long-billed curlew numbers from the North American Breeding Bird Survey (from Sauer et al. 2001).

Region	Credibility Measure	Trend	p	N
Alberta	Moderate precision and abundance	-2.0	0.32	22
British Columbia	Important Data Deficiency	2.9	0.62	9
Saskatchewan	Data Deficiency	-7.5	0.11	6
Canada Overall	Moderate precision and abundance	-1.5	0.42	37

Because of low numbers of curlews on BBS routes, the relatively few routes on which curlews are observed and the resulting lack of statistical significance, it is difficult to draw many conclusions from these data. In general the data indicate that over the last 20 years, curlew numbers have been declining quite rapidly in Saskatchewan, are possibly increasing in British Columbia and are possibly declining moderately in Alberta. Figure 11 shows the BBS trend map for 1966 – 1996.

Figure 11: BBS Trend map for 1966-1996 for the long-billed curlew (from Sauer et al. 2001).



The trend map suggests that curlews are declining most rapidly in the eastern parts of their range, including Saskatchewan. Moderate declines are occurring in the northern and south-central parts of their range, including most of southern Alberta. In the central and western parts of their range, there is an increasing trend, possibly encompassing the extreme southern parts of Alberta. Again, it should be noted that these trends are based on relatively limited data.

In the future, the Canadian Wildlife Service's Grassland Bird Monitoring Program (GBMP) should be able to provide useful trend information for long-billed curlews in Alberta (Dale 1999). This program is based on the Breeding Bird Survey methods, but employs additional routes in areas of native grassland in order to better determine long-term trends in grassland bird populations. Although conducted in June, the survey is measuring trends and not actual numbers, therefore it will still yield useful trend information for curlews. As the GBMP is being conducted in areas of native grassland, the information can only be interpreted to relate to

the curlew population in the Grassland Natural Region that inhabit areas of native grassland, versus the part of the population in intensively cultivated areas.

5.5 Repeating the Inventory

It is extremely challenging to measure and detect changes in animal populations over time (Bibby et al. 1992, Thompson et al. 1998). Given the large variance in the current sample, an inordinately large and unrealistic number of samples would be required in order to detect changes in the population size. To illustrate this, estimates were made of the sample sizes required to detect population changes of 20%, 25% and 30% in stratum 3 at statistical powers of 95%, 90% and 80%. The number of sample units required was calculated using the following from Krebs (1989):

$$n = \frac{2(z_\alpha + z_\beta)^2 s^2}{d^2}$$

where;

n	=	required sample size (number of samples required each year to detect a change)
z_α	=	standard normal deviate for α level of probability (in this case $z_{.05} = 1.96$ was used)
z_β	=	standard normal deviate for the probability of a type II error (the power of the test; values are taken from tables of the standard normal deviate, z)
s^2	=	variance of the sample (in this case, the variance in number of curlews per route for stratum 3)
d	=	smallest difference that is required to be detected (e.g. a 20% change in the curlew population = 0.2 x mean of 4.63 = 0.9 birds per route)

The results are given in Table 8.

Table 8: Sample sizes required to detect population changes in stratum 3.

	95% power	90% power	80% power
Number of sample units required to detect a **20%** population change	508	412	307
Number of sample units required to detect a **25%** population change	325	263	197
Number of sample units required to detect a **30%** population change	226	183	137

One potential solution to this problem is to sample a proportion of the same sample units again in another year. Because the same routes are being used, paired t-tests can be used to compare the results from year to year. Paired t-tests are much more powerful than standard t-tests as they compare only the results within each individual sample unit (from year to year) versus between sample units, thus the large variance from sample unit to sample unit is not a concern. To do this, it would be preferable to have at least ten sample routes in each of the two strata. Sample units should be selected in an unbiased fashion from those routes that had at least one curlew in 2001 (i.e. it would not be possible to detect a decrease on a route that had zero curlews in 2001). Re-sampling of routes should be conducted within ± five days of last year's sample in order to

avoid sampling routes during different parts of the curlew breeding cycle. Although this would not give a population trend that could be applied across the Grassland Natural Region, it would be possible to state that "across X% of re-sampled routes, there was a significant decrease/increase/no change in curlew numbers".

Such a sub-sampling of the original sample units could be conducted next year, in two years or at any time interval. An advantage to conducting a sub-sample next year would be that the results should give an indication of year to year variability in curlew populations as it would be unlikely that there would be a major change in the curlew population in one year as a result of external factors (based on findings of other studies, such as Redmond and Jenni 1986). A sub-sample should include modifications to the survey as recommended in section 5.1.2.

A complete repetition of the inventory as it was carried out in 2001 would only be necessary if the results of sub-samples (such as those suggested above) or other monitoring programs (the BBS or GBMP) indicated a dramatic change in the long-billed curlew population.

5.6 Habitat Relationships

As the analyses show, the amount of native grassland is a strong predictor of curlew numbers during the courtship and incubation stages. However, there were many apparent anomalies in the data. For example, out of the nine sample units in stratum 1 containing no native grassland, five of these recorded no curlews, one sample unit had one pair, one sample unit had two pairs, one had five pairs and one had seven pairs. So although curlews show a preference for native grassland, where it exists, they are also using and breeding in areas with little or no native grassland. Conversely, there were sample units in stratum 3 (51-100% native grassland) in which no curlew pairs were found. Overall, 22% of the stratum 3 sample units did not contain curlews. The stratum 3 sample units with no curlews ranged from 65% native grassland to 100% native grassland. One data set that exemplifies this are the results from the sample units surveyed on Suffield Military Base. The sample units on the base were covered all on the same morning by a team of six observers. Weather conditions were favourable and were the same across all sample units. All six sample units contained between 96% and 100% native grassland. Three of the sample units recorded one curlew pair each, one of the sample units recorded six curlew pairs, one sample unit recorded eight pairs and one recorded twelve pairs. This likely reflects the long-billed curlews' tendency to nest in loose social aggregates. Allen (1980) speculates that the presence of curlews in an area attracts conspecifics to the area and increases the probability of obtaining a mate. Group nesting may also reduce predation as a result of increased detection by neighbouring birds. Allen (1980) found a tendency for curlews to nest within sight of one another in favourable habitat.

A negative correlation was found between curlews and riparian areas. This result supports the findings from an Alberta study in the Brooks area, where curlews were least common in areas with substantial amounts of water (Gratto-Trevor 1999). In the Brooks study, all curlew nests found were more than 1km from any permanent water, including dugouts (Gratto-Trevor 2001). Contrary to this, in Colorado, McCallum et al. (1977) reported that 41% of curlews were within 100m of water and 68% of observations were within 400m of water. Studies in Utah, Colorado and Texas report that proximity to water may be of some importance to curlews (Cochrane and Anderson 1987, Dechant et al. 2001).

Perhaps one of the most unexpected results of this current study is the relatively large number of curlews that occurred in some areas of intense cultivation in southern Alberta. Some areas, such as the area between Stavely, Vauxhaul, Fort Macleod and Lethbridge appear to support concentrations of curlews despite the lack of native grasslands. There are scant references in the literature to curlews in cultivated areas. Shackford (1994), in Oklahoma, found 33 curlew territories (based on nests, chicks or agitated adults) in 28 locations. Of these locations, 14 were in cultivated fields (fallow and plowed or planted to wheat), 13 were in native shortgrass prairie and one in tame pasture. Because his definition of "curlew territory" was based largely on the sightings of chicks and agitated adults, he recognizes that it is debatable how many of these broods actually originated in cultivated fields. However, he did find two nests in cultivated fields and reports that "this was the first confirmed nesting of curlews in a cultivated field in Oklahoma and to the best of our knowledge, no other exists elsewhere" (Shackford 1994). Both nests failed; one was run over by a vehicle and one was plowed under. He suggests that part of the curlew's recent increased nesting success in Oklahoma might be related to increased productivity due to curlews nesting in wheat fields.

Renaud (1980) reports curlews in fallow and stubble fields and in forage crops or grain crops in the nesting season in Saskatchewan, but notes that these observations are usually where cultivated areas abut prairies or shrublands. In an observation reported from White Bear, Saskatchewan by S. Jordhelm (in Renaud 1980): "the curlew tends to nest on cultivated ground…the young are usually wandering in the fields at spraying time". Renaud then speculates that observations of curlews in cultivated areas likely represent adults tending broods that were hatched in grasslands and which then wander into croplands. He cites one exception to this; "the long-billed curlew is rare or absent as a breeder in large areas under complete cultivation, except that Belcher has a possible breeding record, based on the behaviour of two adults on 12 June 1959, in a stubble field on the well cultivated Regina Plains".

A study in Wyoming reports that during the peak breeding season, 44% of observations (n=25) were in irrigated hay compared with 16% in grasslands (Cochrane and Oakleaf 1982). In Oregon, Pampush and Anthony (1993) found that adults with broods used alfalfa fields for foraging until the plants grew to 30cm, then they ceased to use the alfalfa fields until the next swathing.

The Canadian Wildlife Service's Grassland Bird Monitoring Program, reports that over four years, an average of approximately 7% of curlew observations were made in cropland (B. Dale pers. comm.). It should be noted that all of the GBMP monitoring sample units are in areas where there are significant amounts of grassland. This supports the results of this study, which found that where there are areas of significant amounts of native grassland present, curlews preferentially selected to use the native grassland over cultivated areas and tame pasture.

In a British Columbia curlew count, 33% of curlew observations in 2000 were in agricultural land (conducted on May 6th). In 2001, 15% of curlew observations were made in agricultural land (conducted on April 28th and 29th; E. Palmer pers. comm.).

The current study did not find direct evidence of curlews actually nesting in intensively cultivated areas. However, it seems likely that they are, based on the presence of pairs and courtship activity through the courtship and incubation periods. It would be useful to compare reproductive success between curlews nesting in cultivated areas and those nesting in native prairie. Presumably there are more anthropogenic hazards associated with cultivated areas (e.g. haying, plowing, pesticides, cropping and vehicular traffic). Conversely, cultivated areas may offer more cover for broods to forage in, reduced heat stress and possibly decreased natural predation. Redmond and Jenni (1986) found badgers to be one of the main predators on curlew eggs. They report that in one year badgers were particularly destructive of curlew eggs in an area of high Townsend ground squirrel density (67% of curlew nests were destroyed by badgers). It is likely that ground squirrel and badger numbers would be lower in cultivated areas.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The 2001 long-billed curlew inventory represents one of very few regional-scale efforts to obtain a scientific population estimate of a prairie wildlife species. In prairie Alberta scientific population estimates based on a random sample have been made for loggerhead shrikes in a part of their breeding range (Bjorge and Prescott 1996) and for ferruginous hawks across most of their breeding range (Schmutz 1993, Stepnisky 2001). In addition to providing a population estimate, the inventory results also provide some further insights into curlew habitat associations. The conclusions from this study are summarized below, including recommendations resulting from these findings.

1. The 2001 inventory estimates the long-billed curlew population in the Grassland Natural Region of Alberta at 11,942 ± 2,381 curlew males or, assuming an equal sex ratio, 23,884 ± 4,762 individual curlews. As a few curlews have been reported nesting in the Parkland Natural Region, the total Alberta population would be slightly larger than this estimate. This is a higher number than was previously estimated for Alberta, but should be considered a relatively conservative estimate because it is likely that curlews were missed rather than double-counted, surveys were conducted from roads and individual curlews seen close together were assumed to be part of a pair (versus two males).

2. It should be remembered that this population estimate represents a snapshot in time and cannot give an indication of trends. Breeding Bird Survey data suggests that curlew populations in Alberta may be gradually declining, although this trend is not statistically significant because of the few curlews observed on routes in the province. Although 23,884 ± 4,762 curlews may seem like a healthy population, their close association with native grassland, plus the dramatic declines in their population in adjacent Saskatchewan suggests that it is a species that should be monitored carefully in the future. One way to monitor trends in the population will be through the Grassland Bird Monitoring Program, although this program only covers the part of the curlew population present in areas of extensive native grassland. It is recommended that a proportion of the sample units be sampled again in 2002 (e.g. at least 10 routes in each of the two strata) to gain a better understanding of year-to-year variability within the long-billed curlew population in Alberta. This sub-sampling should then be continued at regular intervals in order to monitor trends in the population across the curlew's entire range in Alberta.

3. There is a positive relationship between long-billed curlews and native grassland. Where native grassland is abundant, curlews preferentially select to use the native grassland over cultivated fields and tame pasture. Curlews are not present in all areas of apparently suitable native grassland habitat. Curlews also inhabit and appear to breed in areas with little or no native prairie. According to most of the literature, curlews do not use intensively cultivated landscapes (Hill 1998). However, the current study suggests that they are present in cultivated areas during the breeding season, and in some places they are present in quite high numbers. It would be valuable to investigate curlew use of intensively cultivated areas. As curlews using cultivated landscapes represent a significant portion of the population (54% of the population is in the 0-50% native

grassland strata), it would be useful to know if these curlews are breeding successfully and whether they are being impacted by agricultural practices.

4. Considering the historical declines in the population of this species and the species' relatively high observability, there has been very little research conducted on this species, especially in prairie Canada. Many aspects of curlew ecology remain unknown. A long-term banding study would be highly useful as so little is understood about the population biology of curlews. Such a study may ultimately provide information on territory and mate fidelity, sex ratios, dispersal of juveniles and population structure. Without knowledge of age classes and sex ratios, it is difficult to interpret population data or to make predictions for the future of the curlew population in Alberta.

7.0 OTHER SPECIES

7.1 Incidental Priority Species

Observations of six other prairie bird species were collected in conjunction with the curlew surveys: ferruginous hawk, short-eared owl, burrowing owl, upland sandpiper, loggerhead shrike and Sprague's pipit. These species were observed and recorded in the same manner as long-billed curlews. Table 9 gives the numbers of these six species seen on surveys, recorded by strata.

Table 9: Numbers of individuals of priority incidental species observed during surveys.

Stratum	Ferruginous Hawk	Short-eared Owl	Burrowing Owl	Upland Sandpiper	Loggerhead Shrike	Sprague's Pipit
1	4	6	0	3	1	2
2	7	1	0	56	11	87
3	26	0	3	48	13	231
Total	37	7	3	107	25	320

7.2 Population Estimates for Incidental Species

The inventory method was primarily designed to gain a relatively precise estimate of the population of long-billed curlews in Alberta. However, it is possible to derive less precise population estimates for some of the priority incidental species based on the data collected during the curlew surveys. Out of the six species, it is possible to derive population estimates only for those species that were recorded relatively frequently and even for those, the population estimates have low levels of precision (Table 10). It should be noted that for upland sandpipers and Sprague's pipit, only the males performing territorial displays were used in the population estimate. The estimates for loggerhead shrike and ferruginous hawk were based on pairs (single birds were considered to be one half of a pair, two birds seen nearby at the same stop were considered to be a pair).

Table 10: Population estimates (number of pairs) for priority incidental species in the Grassland Natural Region.

	Upland Sandpiper* (territorial males)	Sprague's Pipit (singing males)	Loggerhead Shrike (pairs)	Ferruginous Hawk (pairs)
N (within 400m distance band)	78	306	20	24
Population Estimate	1,194	11,428	818	852
Min.	739	6,745	394	391
Max	1,649	16,112	1,242	1,313
Precision	38%	41%	52%	54%

* For upland sandpiper, strata 2 and 3 were combined as there was no significant difference in the mean number of birds per route between these two strata.

Although the precision of these population estimates is low, they are of some value, particularly for the upland sandpiper and Sprague's pipit. There are currently no population estimates for

these two species in Alberta and these results provide a crude estimate of their populations in the Grassland Natural Region.

It should be noted that the range of the Sprague's pipit in Alberta extends beyond the boundaries of the Grassland Natural Region. Prescott (1997b) states that "although the population of Sprague's pipits in Alberta likely numbers in the tens or hundreds of thousands, the species is declining rapidly in this province". He comments that there is some evidence that Sprague's pipits avoid areas adjacent to roads (Prescott 1997b), therefore the curlew survey methods may have underestimated pipit numbers.

The upland sandpiper's range in Alberta also extends beyond the Grassland Natural Region, although 70% of breeding records submitted from bird atlas surveys were from the Grassland Natural Region (Semenchuk 1992). The population estimate for the upland sandpiper (1194 ± 455 pairs) is relatively low, however it is thought that upland sandpipers have never been overly common in Alberta (Salt and Salt 1976). Considering the relatively low population estimate and that the majority of upland sandpipers in Alberta inhabit the Grassland Natural Region, it may be useful to further review the status of this species (currently listed as "Sensitive" in Alberta).

Although the sampling time frame was suitable for upland sandpiper and Sprague's pipit (i.e. the birds were present on the breeding ground and acting in a territorial manner), it may have been rather early for sampling loggerhead shrikes. The loggerhead shrike population survey from central Alberta by Bjorge and Prescott (1996) was conducted between June 15th and July 7th, well after the curlew survey period. It is also known that roadside surveys are not the most appropriate method for sampling loggerhead shrikes and that they tend to underestimate population size (Bjorge and Prescott 1996). The estimate found here for shrikes (818 ± 424) is similar to that estimated in a roadside survey in Alberta by Telfer et al. (1989). Their survey suggested that there were fewer than 1000 pairs in Alberta. Bjorge and Prescott (1996) conducted complete counts in randomly selected survey blocks in a 23,600 km^2 area in central Alberta. They estimated the population in this area to be 2477 ± 889 pairs and felt that the provincial population may be close to 5000 pairs.

The population estimate for ferruginous hawks (852 ± 461 pairs) is remarkably close to a recent estimate of 731 ± 366 (Stepnisky et al. 2001). The latter estimate was based on a survey conducted in 2000 involving surveys of 85 randomly selected survey plots. It is possible that the curlew inventory methods may have underestimated ferruginous hawk numbers. This is because the survey was conducted from roadsides, and ferruginous hawks are known to avoid human activity (Schmutz 1999). Therefore one would expect that ferruginous hawk densities may be lower within 400m of roads.

The extremely low number of short-eared owls observed is somewhat surprising. The Alberta Bird Atlas lists the short-eared owl as "fairly common in the grassland and parkland regions" (Semenchuk 1992). However it was one of the rarest birds recorded during the curlew surveys (only seven were observed). Short-eared owl numbers fluctuate depending on the availability of their food supply, primarily voles. Breeding Bird Survey trends show a rather alarming statistically significant 14.7% per year decrease in Canada between 1966 and 2000 (Sauer et al. 2001).

7.3 Habitat Relationships for Priority Incidental Species

Table 11 shows the relationships between habitat variables and numbers of the incidental species.

Table 11: Correlation coefficients of habitat proportions (per sample unit) and number of individuals (values are Kendall's Tau).
*P < 0.1; ** P< 0.05; *** P < 0.01

Habitat	Ferruginous Hawk	Short-eared Owl	Upland Sandpiper	Loggerhead Shrike	Sprague's Pipit
Native Grassland	**+0.264*** **	**-0.191** **	**+0.229*** **	+0.048	**+0.432*** **
Tame Pasture	-0.063	+0.004	+0.068	+0.023	-0.103
Cultivated	**-0.240*** **	**+0.202** **	-0.218	-0.012	**-0.382*** **
Riparian	-0.030	-0.087	+0.110	-0.053	**-0.135***
Other	**-0.209*** **	**-0.118**	-0.045	-0.022	**-0.210*** **
Irrigated Land	**-0.181** **	+0.123	**-0.202** **	+0.016	**-0.347*** **

Not surprisingly, ferruginous hawk, upland sandpiper and Sprague's pipit were positively correlated with native grassland. Ferruginous hawk and Sprague's pipit were negatively correlated with cultivated land. Short-eared owl was positively correlated with cultivated land, although this was based on only seven observations. There were no statistically significant relationships between loggerhead shrikes and habitat types. This supports the results of Prescott and Bjorge (1996) who found that loggerhead shrikes preferred a mosaic of habitat types.

Table 12 gives a summary of the habitat that each individual bird was observed in.

Table 12: Habitat types in which priority incidental species were observed.

	Ferruginous Hawk (n=37)	Short-eared Owl (n=7)	Burrowing Owl (n=3)	Upland Sandpiper (n=107)	Loggerhead Shrike (n=25)	Sprague's Pipit (n=320)
Habitat	**Percentage of Observations**					
Native Grassland	84	14	100	76	48	97
Tame Pasture	3	0	0	11	24	2
Cultivated	14	86	0	11	24	1
Riparian	0	0	0	0	4	0
Other	0	0	0	2	0	0

7.4 Activity Observations

Table 13 gives the activities of the priority incidental species when observed during the surveys.

Table 13: Activities of priority incidental species.

	Ferruginous Hawk (n=37)	Short-eared Owl (n=7)	Burrowing Owl (n=3)	Upland Sandpiper (n=107)	Loggerhead Shrike (n=25)	Sprague's Pipit (n=320)
Activity	**Percentage of Observations**					
Recently fledged young observed	0	0	0	0	0	0
Nest building	3	0	0	0	0	0
Adult seen attending nest or incubating	38	0	0	0	0	0
Courtship behavior	5	0	0	0	0	0
Counter-singing	0	0	0	0	0	0
Pair observed in suitable habitat	5	0	67	6	0	0
Territorial nesting behavior	3	0	0	0	0	0
Visiting probable nest site	5	86	0	1	16	0
Aggressive behaviour/display	8	0	0	1	0	0
Alarm calls	0	0	0	1	0	0
Territorial or seasonal vocalization	0	0	0	75	12	100
Resting individual	14	0	0	2	20	0
Observed foraging	5	0	0	7	28	0
Observed in flight	14	14	0	1	24	0
Unspecified Activity	0	0	0	2	0	0
Not Recorded	0	0	33	5	0	0

7.5 Other Incidental Species

Observers were encouraged to record observations of other prairie wildlife species, particularly species at risk and species for which little information exists. A list of the species that observers were asked to record is given in Appendix E. A total of 107 observations of 16 additional species were made and entered into BSOD. Data entered for each observation includes geographical position, date, activity and notes. Table 14 gives a summary of the species recorded.

Table 14: Other incidental species recorded and reported to BSOD during the duration of the curlew inventory.

Species	Number of individuals observed
American Badger	8
Baird's Sparrow	17
Burrowing Owl*	3
Ferruginous Hawk*	25
Golden Eagle	9
Long-billed Curlew*	6
Loggerhead Shrike*	5
Peregrine Falcon	1
Piping Plover	3
Prairie Falcon	4
Prairie Rattlesnake	1
Short-eared Owl*	2
Sharp-tailed Grouse	16
Swift Fox	2
Thirteen-lined Ground Squirrel	1
Upland Sandpiper*	4

* Note: this only includes observations of curlews and priority incidental species made outside of formal curlew surveys

7.6 Conclusions and Recommendations Regarding Incidental Species

The information collected on six additional prairie bird species during the curlew surveys provides limited, but potentially useful information on population densities of these species in Alberta and their habitat preferences. In summary, the following conclusions were reached:

1. The data collected on the six incidental species provide some weak population estimates in the Grassland Natural Region for four of the species. This is potentially useful information, especially for upland sandpipers (1194 ± 455 pairs) and Sprague's pipit (11,428 ± 4683 pairs), where there is no existing information regarding population size. The population estimate for ferruginous hawks (852 ± 461 pairs) was close to an estimate made based on data collected in 2000 (Stepnisky et al. 2001).

2. Considering the relatively low population estimate for upland sandpipers, it is recommended that a review of their status in Alberta be undertaken.

3. Similar to findings elsewhere, Sprague's pipit, ferruginous hawk and upland sandpiper were positively correlated with native grassland. Short-eared owls were seen only in cultivated areas.

4. It would be wise to further investigate the status of the short-eared owl in Alberta. Only seven were observed during the course of the curlew inventory and BBS data shows a statistically significant 14.7% per year decrease in Canada between 1966 and 2000 (Sauer et al. 2001). There is no obvious reason why observers would not have detected short-eared owls during the course of the curlew survey, had they been present.

5. 107 observations of 16 additional species, considered sensitive or at risk or lacking in information, were added to Alberta's Biodiversity Species Observation Database.

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9.0 PERSONAL COMMUNICATIONS

Brenda Dale – Wildlife Biologist, Canadian Wildlife Service, Edmonton, Alberta

Janna Foster – M.Sc. student, University of Regina, Saskatchewan

Erin Palmer – Project Biologist, British Columbia Conservation Foundation, Kamloops, British Columbia

Shawn Pinder – GIS Technician, Alberta Fish and Wildlife Division, Lethbridge, Alberta

Dave Prescott - Regional Endangered Species Biologist, Parkland Region, Alberta Fish and Wildlife Division, Department of Sustainable Resource Development, Red Deer, Alberta

Richard Quinlan – Regional Endangered Species Biologist, Prairie Region, Alberta Fish and Wildlife Division, Department of Sustainable Resource Development, Lethbridge, Alberta

Al Smith – Wildlife Biologist, Canadian Wildlife Service, Saskatoon, Saskatchewan

10.0 APPENDICES

Appendix A – List of Sample Units

Note: Maps and route descriptions for all sample units are stored at the Lethbridge office of Alberta Fish and Wildlife Division.

Stratum 1 Sample Units

Sample Unit	Randomly selected township		Map Sheet	UTM Coordinates of Start Point		Settlement
	Range	Township		Easting	Northing	
101	28	16	82I	313573	5582852	Nanton
102	19	9	82H	391237	5515908	Tempest/Coaldale
103	26	25	82P	324393	5681183	Keoma/Calgary
104	26	11	82H	320185	5530826	Granum
105	28	25	82P	298991	5654735	Calgary
106	26	19	82I	333589	5608149	High River
107	24	26	82P	336722	5660064	Strathmore
108	23	16	82I	365122	5581305	Vulcan
109	21	5	82H	375291	5470839	Welling
110	26	28	82P	332838	5698839	Beiseker
111	24	14	82I	341662	5543114	Carmangay/Vulcan
112	13	8	72E	459289	5489196	Foremost
113	15	4	72E	428954	5460178	Warner
114	20	8	82H	377867	5493946	Coaldale
115	26	16	82I	336362	5580481	Vulcan
116	23	10	82H	364259	5539176	Nobleford
117	22	13	82I/82H	362955	5552176	Barons
118	20	7	82H	403871	5494637	Stirling
119	11	10	72E	456311	5521464	Bow Island
120	27	20	82I	299680	5619036	Aldersyde
121	28	22	82I	298903	5641735	Calgary
122	25	24	82P	322054	5660333	Strathmore
123	20	24	82P/82I	380733	5660276	Hussar
124	28	24	82P	302253	5654582	Calgary
125	27	14	82I	324085	5550149	Claresholm
126	17	9	82H/72E	396010	5509444	Taber
127	26	12	82H	310486	5534395	Woodhouse
128	21	12	82H	368892	5527837	Picture Butte
129	12	10	72E	456294	5518223	Burdett
130	14	4	72E	428966	5463419	Warner
131	19	14	82I	387248	5545963	Travers
132	24	18	82I	353013	5601066	Ensign
133	10	8	72E	482207	5495463	Maleb

Stratum 2 Sample Units

Sample Unit	Randomly selected township		Map Sheet	UTM Coordinates of Start Point		Settlement
	Range	Township		Easting	Northing	
201	3	28	72M	543206	5684964	Oyen
202	14	39	73D	433861	5806482	Castor
203	3	29	72M	538247	5693032	Oyen
204	10	32	72M	476356	5712485	Scotfield
205	1	33	72M	562096	5745093	Compeer
206	8	32	72M	493690	5734946	Hemaruka
207	2	24	72M	567713	5654465	Acadia Valley
208	22	19	82I	359850	5612227	Vulcan/Queenstown
209	15	35	83A	422856	5762194	Sullivan Lake
210	13	20	72L	460792	5615638	Patricia
211	2	21	72L	552283	5623554	Bindloss
212	9	7	72E	492153	5485653	Etzikom
213	2	34	72M	566681	5761193	Altario
214	6	38	73D	514266	5793156	Czar/Consort
215	13	7	72E/82H	440493	5482700	Skiff/Wrentham
216	19	21	82I	394904	5629193	Bassano
217	6	29	72M	517010	5705837	Cereal
218	27	3	82H	320753	5457589	Hillspring/Twinbutte
219	5	13	72L	527247	5551327	Medicine Hat
220	17	35	83A	408152	5763246	Leo/Halkirk
221	20	15	82I	383094	5567929	Travers/Lomond
222	13	34	72M	448987	5760994	Hanna/Garden Plain
223	21	21	82I	368513	5630519	Cluny/Majorville
224	5	24	72M	527380	5652484	Cappon/Oyen
225	1	27	72M	566421	5660943	Acadia Valley
226	1	9	72E	568500	5505667	Walsh
227	27	30	82P	296150	5719604	Stirlingville/Acme
228	29	5	82H	290425	5465424	Twin Butte
229	20	30	82P	374318	5721926	Drumheller/Munson
230	14	34	82P	422850	5761343	Endiang/Watts
231	18	35	82P	395035	5761849	Stonelaw/Morin
232	18	29	82P	398217	5706825	Drumheller
233	2	17	72L	567283	5596193	Hilda
234	14	10	72E	435231	5523317	Purple Springs
235	14	2	72E	432734	5431463	Coutts/WOSPP
236	6	7	72E	518071	5492183	Orion/Manyberries
237	1	26	72M	563046	5670591	Oyen
238	7	9	72E	511532	5508385	Medicine Hat
239	24	4	82H	311683	5461387	Hillspring/Glenwood
240	14	15	82I	399810	5585391	Enchant
241	28	14	82H	303533	5576326	Stavely/Pine Coulee

Stratum 3 Sample Units

Sample Unit	Randomly selected township		Map Sheet	UTM Coordinates of Start Point		Settlement
	Range	Township		Easting	Northing	
301	10	14	72L	483365	5560207	Alderson/Suffield
302	4	19	72L	048731	5602243	Suffield Military Base
303	12	14	72L/72E	452500	5557111	Rolling Hills
304	22	3	82H	362404	5457558	MacIntyre Ranch
305	8	8	72E	495248	5505132	Maleb
307	14	24	72M	442646	5660820	Bullpound/Pollockville
309	9	24	72M	486611	5654053	Cabin Lake
310	28	8	82H	313397	5518030	Head Smashed In
311	7	14	72L	502879	5562641	Bowell/Suffield
312	13	30	72M	453657	5717351	Hanna/Taplow
313	1	5	72E	572453	5450748	Cressday
314	12	26	72M	476908	5673512	Cessford/Sunnynook
315	10	16	72L	474605	5574863	Alderson
317	18	3	82H	402696	5457339	Milk River Ridge
318	21	18	82I	367103	5603250	Milo
319	5	15	72L	530480	5570187	Medicine Hat/Schuler
320	10	13	72L	481711	5550482	Suffield
321	7	17	72L	488166	5576052	Suffield Military Base
322	29	14	82I	297797	5555079	Stavely
323	14	22	72L/82I/82P	436003	5639096	Duchess/Finnegan
324	8	16	72L	520373	5563756	Suffield Military Base
325	19	1	82H	387673	5435214	Del Bonita
326	6	23	72L	511984	5640086	Buffalo/Majestic
327	4	2	72E	540788	5437647	Onefour
328	8	17	72L	522584	5579623	Suffield Military Base
329	10	2	72E	484765	5430613	Aden
330	10	27	72M	481133	5686421	Bigstone
331	12	23	72L	443014	5642738	Wardlow
332	7	18	72L	488230	5592529	Suffield Military Base
334	1	3	72E	572474	5449421	Onefour
335	2	5	72E	558643	5472045	Cressday/Manyberries
336	6	14	72L	508607	5556907	Medicine Hat
337	5	7	72E	540721	5494873	Eagle Butte
338	11	18	72L	462664	5604001	Tilly/Princess
339	3	21	72L	540994	5627491	Cavendish
340	11	33	72M	457909	5744830	Spondin
342	6	19	72L	493743	5616243	Suffield Military Base

Appendix B – Data Collection Forms

Long-billed Curlew Inventory

Route Description Form

Sample Route Number: ________ Start UTM: E N

Date Reconnaissance Completed on:___________by:_______________

DESCRIPTIONS (You do not have to describe every stop, just where there is potential for confusion when you do the curlew survey OR if someone else were to repeat the survey). Please indicate where turns occur and in which direction as well as the LAST STOP (some routes are less than 40km)

1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9
10		10
11		11
12		12
13		13
14		14
15		15
16		16
17		17
18		18
19		19
20		20
21		21
22		22
23		23
24		24
25		25
26		26
27		27
28		28
29		29
30		30
31		31
32		32
33		33
34		34
35		35
36		36
37		37
38		38
39		39
40		40

Long-billed Curlew Inventory

Habitat Field Form

Data Entered on: ________________
By: ____________________________
Spreadsheet Name ________________

Sample Route Number: ________
Date Completed:_______________ Completed by:_______________

Enter "100" in one box or "50" in two boxes (where habitat differs on either side of the transect). On some occasions you may have to enter smaller percentages in several boxes.

Additional habitat notes can be recorded on the back

Start Point Waypoint: _____ End Point Waypoint: ____

Stop	Native Grassland		Tame Pasture		Cultivated		Riparian		Other	GPS Info		Way point #	
	Ungrazed	Grazed	Irrigated	Dryland	Irrigated	Dryland	Lentic	Lotic	Please describe:	Easting	Northing		
1													1
2													2
3													3
4													4
5													5
6													6
7													7
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40													40

Long-billed Curlew Inventory

Curlew Field Form

Survey Route Number: ___________
Observer: ______________________
Date: __________________________
Start Time: ________End Time: ________

Weather Information:

START	**END**
Calm Light breeze Mod. breeze Windy	Calm Light breeze Mod. breeze Windy
Sunny Partially overcast Overcast	Sunny Partially overcast Overcast
Temperature ____C	Temperature ____C
Light Rain Light Snow	Light Rain Light Snow
Other: ________________________	Other: ________________________

Odometer Reading at Start: Number of Stops:

Data entered on:__________________
Data entered by:__________________
Excel Filename: __________________

Fill in **one line for every curlew and priority incidental species** observed.
Activity recorded should be the activity of the bird when it was **FIRST** observed.

STOP #	**Species code**	**Location** 1=0-400m 2=400-800m 3=>800m **N**orth, **S**outh, **E**ast, **W**est	**Sex** **U**ndeterm. **M**ale **F**emale	**Age** **A**dult **J**uvenile	**Activity** Use BSOD Activity Code	**Habitat** **Ng**rass, **Tp**asture, **C**ult, **R**ip	**Comments**

Appendix C – Biodiversity Species Observation Database Activity Codes

Note: only those relating to birds are listed here

CF	Breeding-Confirmed-Carry food or faecal sac
DD	Breeding-Confirmed-Distraction displays
FL	Breeding-Confirmed-Recently fledged young/downy young observed
NB	Breeding-Confirmed-Nest building - carrying nest mat'l (not wrens, woodpeckers)
NE	Breeding-Confirmed-Nest with eggs observed
NY	Breeding-Confirmed-Nest with young observed
NF	Breeding-Confirmed-Nest with eggs - failed
ON	Breeding-Confirmed-Occupied nest - adult seen attending nest or incubating
PB	Breeding-Confirmed-Pair with brood observed
UN	Breeding-Confirmed-Used nest or eggshells found
C	Breeding-Probable-Courtship behavior
CS	Breeding-Probable-Counter-singing during breeding season
N	Breeding-Probable-Nest building - wrens and woodpeckers
P	Breeding-Probable-Pair observed in suitable habitat
T	Breeding-Probable-Territorial nesting behavior
V	Breeding-Probable-Visting probable nest site
AB	Breeding-Probable-Aggressive behaviour/display during breeding season
AC	Breeding-Probable-Alarm calls
BN	Breeding-Possible-Single bird observed near known nesting site
SV	Breeding-Possible-Territorial or seasonal vocalization
NA	Breeding-Possible-Non-territorial adults (>or=3) observed in suitable habitat
HN	Breeding-Historic-Old unused nest
MB	Resting-Confirmed-Non-breeding groups - all other families
RE	Resting-Confirmed-Resting individual or group - no evidence of breeding
F	Feeding-Confirmed-Observed foraging
MG	Migratory Movement-Confirmed-Non-breeding migrant observed in Alberta spring/autumn
MI	Migratory Movement-Confirmed-Observed over known migration monitoring station
MF	Migratory Movement-Probable-Flock observed on the ground during known migration season
SA	Migratory Movement-Probable-Observed at known staging area
OH	Observed-General-Observed in flight - non-migratory

For Dead Birds:
5896-01- Dead-General-Road kill
5896-02- Dead-General-Electrocuted
5896-03- Dead-General-Poisoned
5896-04- Dead-General-Unknown cause of death
5896-05- Dead-General-Killed in trap
5896-06- Dead-General-Shot
5896-07- Dead-General-Museum specimen
5896-08- Dead-General-Killed by natural predator
5896-09- Dead-General-Railway kill
5896-10- Dead-General-Natural cause of death
5899-UNS Observed-General-Unspecified Activity

Appendix D – Instructions to Observers for Conducting Curlew Surveys

DATA COLLECTION

STEP 1. Familiarization with your route and habitat data collection
Prior to conducting the actual curlew survey, drive your survey route in advance (in general you will be doing this the day before your survey). Collect habitat data for your route at this time (not during the curlew survey) using the HABITAT FIELD FORM. This data will be used to gain a better understanding of curlew habitat preferences. Information from repeat surveys will also help us to detect any changes in habitat over time.

At each stop record the GPS coordinates and the percentage of each broad habitat type AT THAT STOP (within 400m on either side of the road). In many places you will probably find that the habitat is the same on both sides of the road, in which case simply enter "100" in the appropriate box. As most of the routes are along roads, you will likely run into the situation where the habitat is different on each side of the road. Simply place "50" in the two relevant boxes. If the habitat is different from any of the options of your form (e.g. farmstead), then describe this in the "other" column.

Because these routes may be run again, and to help you when you do the actual survey, there is a ROUTE DESCRIPTION FORM that must be filled in as you do the reconnaissance run. **You do not need to describe every stop**, but please describe your start point in some detail and indicate where turns occur and where the route ends. This will be valuable information if someone else surveys the route in the future.

STEP 2. Curlew Survey

Timing
Be at the start of your route and ready to start collecting data 30 minutes before sunrise. Continue to survey the route until you have completed 40 stops.

Weather
Do not conduct the survey in high winds (>25 km/hr), moderate rainfall or snowstorm conditions! It is anticipated that wind will be our biggest enemy. If any of these conditions start during a survey, you will have to stop. You will have to use your judgment on this. If you feel that the weather conditions are hampering your ability to hear or see curlews or that curlews are "lying low" because of the weather conditions, then do not conduct the survey. If you get close to the end of your survey (e.g. past 30 stops) and the weather changes so that you are unable to complete the survey, we will still use that data. It is more sensible to do another route rather than re-do one that was almost finished.

Curlew Field Form (the 6 priority incidental species are also recorded on this form)
Before you start your survey, fill in the general information at the top of the field form. It is also essential for the data analysis that you record the number of stops (usually 40, occasionally fewer). There is a box at the top of the form for filling in once the data has been entered into a spreadsheet. It is a good idea to set your trip meter to "0" at the start of your survey so that you can use this to keep track of which stop you are at.

For **each individual bird observed**, you must complete a row on the field form. Enter the species code (will either be LBCU or one of the 6 incidental species). Record the distance band it was in **when you first observed it** and the general compass direction. Distance band codes are on the form: 1=within 400m, 2= 400-800m, 3=over 800m. For example, if you spot a curlew 300m away from on the north side of the road, you would enter "1N". Record it's gender (if in any doubt, record as undetermined – I expect many of our sightings will fall into this category). Record activity when first observed. For activity, use the appropriate BSOD code and add any more detailed behaviour and/or habitat notes in the "comments" section. Record habitat that the bird was first observed in, using the general codes on the form.

At the end of your route, please record the temperature again and the time your survey was completed by.

Recording Other Incidental Observations
The incidental species list is on the back of the Incidental Species Form. Fill in a separate line for each incidental species observation (groups of birds seen at the same time and location can be entered in the same line). This form should be used for:

1. Observations made during the curlew survey route of any of the incidental species that are NOT one of the 6 priority species (as these will be entered on your curlew field form)
2. Observations of any of the incidental species INCLUDING the 6 priority species made off of the formal surveys (e.g. while traveling to and from routes, while collecting habitat data etc.).

UTM coordinates must be given for any production sites (nests, dens, breeding ponds).
(note: NAD 83 is the standard)

DATA ENTRY

Do not discard original data sheets even after you have entered the data into spreadsheets. All original field data sheets must be kept and returned to the project coordinator.

Ideally you should enter your data as soon as possible after you have collected it.

Two workbooks are provided – one for the habitat data and one for the bird data. For the curlew and incidental species workbooks, the ID numbers are for reference purposes only – you cannot change them. This way each individual observation will have its own unique ID number (route number plus ID number e.g. 102-132). This may come in useful later – for example if the project coordinator has a question about a particular sighting.

Note that there are “comments” included wherever extra guidance may be needed (look for the red triangles in the corner of cells – put your cursor over the cell and the comment should become visible. To view all comments on a spreadsheet, select “comments” under the “View” menu.

Habitat Data Entry
You will be provided with a disk that will contain the spreadsheet “MASTER habitat workbook”. It contains a master worksheet for entering the GPS and habitat data. Liz will compile the overall data as the spreadsheets come in. Each route will be entered in a separate workbook (i.e. not on individual worksheets within the same workbook). Instructions for saving and filling in the habitat worksheet follow:

1. Open the Excel file, “MASTER habitat workbook”. Using “Save As” in the file menu, save this file as “HABITATRouteNameYourFirstName.xls” (e.g. HABITAT103Richard.xls).
2. Fill in the route details in the orange box at the top
3. Enter the GPS data on the left hand side.
4. Enter the habitat data. For quicker data entry, copy “100” and paste into cell with “Control V” rather than typing “100” each time.
5. Check your data once it is entered. The far bottom corner (yellow boxes) should read “4000” and “100%” if you have entered everything correctly. If not, check the last column on the right hand side (K) and look for rows that do not add up to 100. There lies your problem.
6. Once you have entered the data, mark the date the data was entered and who it was entered by and the file name on the field form.
7. Save, save and save again while you are entering your data!
8. Save a copy on a disk.
9. For the next route, create a new workbook from the MASTER workbook.

Curlew and Priority Incidental Species Data Entry
Use the spreadsheet “MASTER curlew and priority incidentals workbook”. It contains a master worksheet for entering the bird data collected during the surveys. Again, each route will be entered in a separate workbook (i.e. not on individual worksheets within the same workbook). Instructions for saving and filling in the habitat worksheet follow:

1. Open the Excel file, “MASTER curlew and incidental species workbook”. Using “Save As” in the file menu, save this file as “CURLEWRouteNameYourFirstName.xls” (e.g. CURLEW103Richard.xls).
2. Fill in the route details in the orange box at the top, the weather details in the blue box and the number of stops on your route (usually 40, sometimes fewer)
3. Fill in your curlew and priority incidental species observations (one observation per row). There is space for 215 observations – I can’t imagine that there will be a need for more.
4. At the bottom of the form there is a cell where you can add any overall comments about the survey (e.g. wind picked up half way through).
5. As a check, at the end of data entry for a route check that you have the same number of curlew observations on your field form as you do on your worksheet.
6. Once you have entered the data, mark the date the data was entered and who it was entered by on the field form.
7. Save, save and save again while you are entering your data!
8. Save a copy on a disk.
9. For the next route, create a new workbook from the MASTER workbook.

Other Incidental Species

These are for the following:

- Observations made during the curlew survey route of any of the incidental species that are NOT one of the 6 priority species.
- Observations of any of the incidental species INCLUDING the 6 priority species made off of the formal surveys (e.g. while traveling to and from routes, while collecting habitat data etc.).

These data will be entered directly into BSOD at the end of the field season.

Appendix E – Incidental Species

These are species that observers were asked to report if seen during curlew surveys or en route to surveys.

Mammals	**Code**
American Badger	AMBA
Swift Fox	SWFO
Thirteen-lined Ground Squirrel	THGR
Bobcat	BOCA
Herptiles	
Prairie Rattlesnake	PRRA
Hognose Snake	PHSN
Great Plains Toad	GPTO
Northern Leopard Frog	NLFR
Canadian Toad	CATO
Plains Spadefoot	PLSP
Birds	
Peregrine Falcon	PEFA
Golden Eagle	GOEA
Ferruginous Hawk**	FEHA
Burrowing Owl**	BUOW
Short-eared Owl**	SEOW
Sage Grouse	SAGR
Piping Plover	PIPL
Mountain Plover	MTPL
Upland Sandpiper**	UPSA
Loggerhead Shrike**	LOSH
Sage Thrasher	SATH
Sprague's Pipit**	SPPI
Baird's Sparrow	BDSP

** Only record observations of these species here if seen outside of surveys

List of Titles in This Series

(as of October 2001)

No. 1 Alberta species at risk program and projects 2000-2001, by Alberta Sustainable Resource Development, Fish and Wildlife Division. (2001)

No. 2 Survey of the peregrine falcon (*Falco peregrinus anatum*) in Alberta, by R. Corrigan. (2001)

No. 3 Distribution and relative abundance of the shortjaw cisco (*Coregonus zenithicus*) in Alberta, by M. Steinhilber and L. Rhude. (2001)

No. 4 Survey of the bats of central and northwestern Alberta, by M.J. Vonhof and D. Hobson. (2001)

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