# Monitoring as a Means to Focus Research and Conservation - The Grassland Bird Monitoring Example[1]

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## Abstract

One recommendation of the Canadian Landbird Monitoring Strategy of Partners in Flight-Canada is to improve monitoring capability for rapidly declining grassland birds. In Canada, we lack statistical power for many grassland species because they are detected in small numbers, on a low number of routes, or show high year-to-year variability. In developing a Grassland Bird Monitoring program we focused our efforts on improving coverage of "at risk" and endemic grassland species by intensifying coverage of Breeding Bird Survey type routes within degree blocks where grassland is still relatively common. To evaluate the Grassland Bird Monitoring data, collected from 1996 through 2000, we compared values to those collected by the Breeding Bird Survey during the same time period. Adding random routes inside the core of grassland bird distribution had a number of positive results. New routes averaged 48 percent grassland coverage and 36 percent crop coverage while Breeding Bird Survey routes averaged 70 percent cropland. The number of routes available for analysis increased by more than 25 percent for eight of ten primary and two of ten secondary target grassland birds. The number of birds per route was higher for eight of ten primary species. We collected simple habitat information and determined that, for many of the species, only a small proportion of available grassland was used (Baird's Sparrow [*Ammodramus bairdii*], 36 percent; McCown's Longspur [*Calcarius mccownii*], 8.5 percent). A substantial proportion of detections for some bird species were in crop where successful reproduction is unlikely. For McCown's Longspur the proportion varied from 19.4 to 41.8 percent during the five-year study. Trends from Grassland Bird Monitoring routes were more positive than Breeding Bird Survey trends for the same time period for 12 of 18 species. For four of ten primary target species (Sprague's Pipit [*Anthus spragueii*], Baird's Sparrow, Lark Bunting [*Calamospiza melanocorys*], and McCown's Longspur) declines on Grassland Bird Monitoring routes were more dramatic than those from Breeding Bird Survey. This may indicate that habitat quality, as well as quantity, is an issue or that additional productivity or wintering ground issues are affecting populations of these species. The Grassland Bird Monitoring pilot study demonstrates the program's present and future utility for improving monitoring power while focusing conservation and research.

*Key words:* Baird's Sparrow, Breeding Bird Survey, conservation, grassland, grassland birds, McCown's Longspur, monitoring, Sprague's Pipit, trends.

## Introduction

Effective conservation requires surveys able to identify declines and track recovery; carefully directed research; and conservation efforts that focus on prevention or reversal of conditions associated with declines. A well constructed monitoring program may be able to contribute to all three of these elements.

Begun as an internal plan to guide the Canadian Wildlife Service's (CWS) efforts to support worthwhile volunteer monitoring, the Canadian Landbird Monitoring Strategy (CLMS) was revised and adopted by Partners in Flight—Canada as its monitoring strategy (Downes 1994, Downes et al. 2000). Its goals are ambitious:

- Monitor the status of all Canadian landbirds;

- Make the information available, and encourage its use for research and conservation.

The basis for the CLMS is the "Integrated Monitoring" concept of the British Trust for Ornithology (Baillie 1990). A variety of monitoring activities are coordinated, and the results integrated (i.e. looked at together bearing in mind the ecology and life history of the species) to try and understand what element(s) of population dynamics are associated with population change. Research efforts are directed to precisely determine the cause of the decline and the means to reverse it. In some cases, integrated monitoring may even be

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able to suggest initial means of conservation without further research. To be effective, an integrated monitoring system needs to collect information on distribution, relative abundance and trend, habitat association, and trends in habitat, productivity, and survival.

The CLMS first identified volunteer monitoring programs that had the potential to deliver one or more of the five components (distribution, trends, survival, productivity, and habitat) at a regional or national scale, and focused efforts on supporting and improving them. Another early step was to identify gaps and weaknesses. The CLMS identified grassland birds as a group that required improved monitoring coverage (Downes 1994). As of 1991 approximately 75 percent of grassland in prairie Canada had been converted to crop land (Statistics Canada 1992). Habitat loss continues with 570,000 ha (approximately 6 percent of what remained in 1991) lost in prairie Canada between 1991 and 1996 (Statistics Canada 1997). Grazing intensity on the remaining grassland often varies with market prices rather than the amount of forage available (Gayton 1991). Birds using this declining, and intensively used habitat, were a logical priority for improved monitoring efforts.

The primary North American landbird monitoring tool is the volunteer-based Breeding Bird Survey (BBS) which was established in 1966 and is managed by the U.S. Geological Survey (USGS) in the United States and by the CWS in Canada. It is a roadside survey with routes chosen using a stratified random design. The BBS shows that grassland birds are declining more rapidly than any other group of birds in North America (Sauer et al. 2000). However, BBS trends for individual grassland bird species, particularly "at risk" (listed by the Committee on Endangered Wildlife in Canada) or endemic (restricted to) species (*table 1*), are not always statistically significant ($P < 0.05$) even when the magnitude of the trend is substantial. Many grassland bird species occur on few BBS routes, occur in low numbers per route or show high year-to-year fluctuations in numbers. Any or all of these conditions can result in a low statistical power to detect a trend.

When the BBS was initiated two BBS routes were selected per degree block within the three prairie provinces. Remaining areas of extensive grassland in Canada are concentrated in a relatively small area and contain a minority of existing BBS routes in the prairies. Sparse survey coverage in the areas of highest grassland bird density means we have little information about species within the core of their population distribution.

In our Grassland Bird Monitoring (GBM) pilot study we tested means to make volunteer monitoring coverage in Canadian prairie grassland more effective for detecting trends and directing conservation of target grassland birds (*table 1*) by:

- Increasing monitoring coverage within that portion of the prairie provinces where remaining grassland habitat and grassland birds are concentrated;

- Collecting habitat information;

- Comparing bird occurrence and trend data from GBM to BBS data collected during the same period.

**Table 1**—*Target species of grassland bird monitoring.*

| Primary[1] | Secondary[2] |
|---|---|
| Ferruginous Hawk (*Buteo regalis*) | Swainson's Hawk (*Buteo swainsoni*) |
| Long-billed Curlew (*Numenius americanus*) | Sharp-tailed Grouse (*Tympanuchus phasianellus*) |
| Marbled Godwit (*Limosa fedoa*) | Upland Sandpiper (*Bartramia longicauda*) |
| Burrowing Owl (*Speotyto cunicularia*) | Horned Lark (*Eremophila alpestris*) |
| Loggerhead Shrike(*Lanius ludovicianus*) | Clay-colored Sparrow (*Spizella pallida*) |
| Sprague's Pipit | Brewer's Sparrow (*Spizella breweri*) |
| Lark Bunting | Vesper Sparrow (*Pooecetes gramineus*) |
| Baird's Sparrow | Savannah Sparrow (*Passerculus sandwichensis*) |
| McCown's Longspur | Grasshopper Sparrow (*Ammodramus savannarum*) |
| Chestnut-collared Longspur (*Calcarius ornatus*) | Western Meadowlark (*Sturnella neglecta*) |

[1]Primary species are either considered "at risk" grassland species by the Committee on the Status of Endangered Wildlife in Canada or primary grassland endemics (restricted to Great Plains [Mengel 1970]).
[2]Secondary species are all secondary endemics (grassland birds that also occur outside the Great Plains [Mengel 1970]).

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# Methods

Rather than develop a new survey method, we chose to simply intensify use of existing BBS methodology. BBS is a well designed survey using a stratified random design for routes and a standardized protocol that controls for many of the factors (observer, weather, time of day and year) that influence detectability of birds. The BBS recently underwent peer review that confirmed its scientific strength (O'Connor et al. 2000). We collected data for multiple seasons to allow the calculation of trends and a more thorough assessment of the GBM's usefulness.

## *Study Area*

The pilot study took place in 19 degree blocks in southeast Alberta and southwest Saskatchewan where grassland is still reasonably common (*fig. 1*).
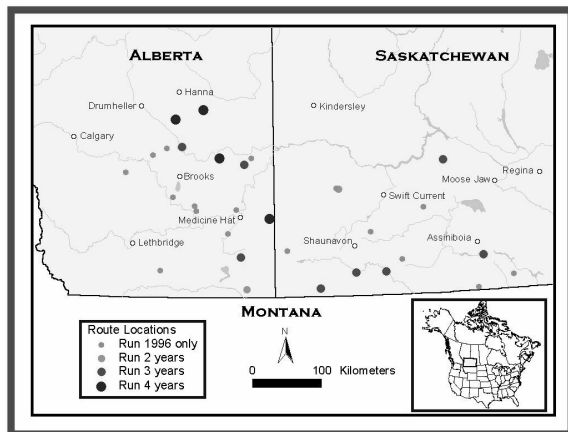


**Figure 1—**Locations of Grassland Bird Monitoring routes in southern Alberta and Saskatchewan.

## *Routes*

In 1996 we followed BBS guidelines and randomly chose 35 GBM routes in southeast Alberta and southwest Saskatchewan. We modified the BBS route selection protocol slightly and accepted the nearest passable road, rather than the nearest secondary (or better) road. Routes were checked in the field before surveying and, if access was a problem, then routes were adjusted to the next nearest usable segment of road in keeping with BBS route selection procedures. Some individual stop locations were shifted by 0.1 km, in accordance with BBS guidelines, when noise levels from gas line compressor stations were deemed unacceptably high. In the initial year (1996) we attempted to collect data on all 35 routes but were unable to do so. In subsequent years we only surveyed routes which had been attempted in 1996. Thirty-one routes were surveyed in 1996, and 7-13 routes were completed in each of the other years. Seventeen routes were visited only once.

Fourteen routes were surveyed two or more times (four surveyed 4 times, eight 3 times, and two 2 times - *fig. 1*).

Two observers conducted surveys in each year 1996-1998; no surveys were done in 1999 and only a single observer was available in 2000. Each observer was assigned routes from both Alberta and Saskatchewan. The observer changed for several routes between 1996 and 1997.

## *Data Collection*

Bird data were collected in the identical manner as for the BBS, using a single observer, 3-minute point counts, and 400-m radius circles. We adhered to the weather standards and recorded weather parameters using the BBS system and codes. Start times were those applicable for BBS in the degree block in which the GBM route occurred.

We used a global positioning system (GPS) to record the exact location of each stop. We visually estimated the proportion of a number of crude habitat classes present within 400 m radius at each stop along the route in 1996 or 2000. Habitat classes included: Native Grass, Non-native Grass, Hay, Unclassified Grass (grass that could not be clearly assigned to one of the first three categories), Crop (includes both growing and fallow fields), Water, Settlement (farm yards, towns), Industry, and Other (trees, cliffs, badlands, and other rare habitats).

## *Trend Calculations*

Fitted trends for the period 1996-2000 were calculated using an estimating equations approach (Link and Sauer 1994, Collins 2000) for GBM alone, BBS alone, and GBM and BBS combined.

### GBM alone

Data for all 14 GBM routes surveyed at least twice between 1996 and 2000 were used. Any incomplete route (<50 stops) was reduced, in all years, to the number and identity of stops completed in the shortest incomplete survey.

### BBS alone

Data from 91 BBS routes from the Canadian portion of Bird Conservation Region 11 for 1996-2000 were used. This included BBS routes from the same degree blocks as GBM routes. The weighting factors normally used to balance for inequality in sampling effort among degree blocks were not employed. To increase sample size, the selection and matching criteria used for the standard BBS analysis were ignored. Routes were included no matter what wind conditions they were run under. The

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criterion that routes are run by the same observer each year was suspended. A route was included in the trend analysis for a species if it had at least two non-zero counts for that species.

## Data Comparisons

The number of BBS and GBM routes in the above-mentioned data sets on which each species occurred at least twice was calculated. The percent increase in coverage (number of routes useable in trend analysis) brought about by GBM in the period 1996 to 2000 was calculated for each target grassland bird species.

The fourteen GBM routes surveyed at least twice between 1996 and 2000 were compared with 91 BBS routes from the same period in BCR 11 for three parameters:

1. The proportion of routes which were useful for trend analyses (i.e. at least two non-zero counts) of target species were compared using a two-sided Fisher's Exact Test;

2. The average count of individual species per survey stop (on routes where the species was encountered) was compared using a randomization test (Sokal and Rohlf 1981). Because several GBM routes were incomplete in some years we used average count per stop rather than birds / route in order to increase comparability;

3. The fitted trends were compared using a randomization test (Sokal and Rohlf 1981).

## Habitat Calculations

All habitat variables were summarized for each route attempted at least once, and across all routes. Minimum, maximum, and mean coverage per route and standard error for each variable were calculated.

A simple frequency of occurrence was calculated for each species out of a maximum possible number of stop-visits for three habitat types. All routes (including incomplete and those attempted once), and all years of data were pooled, so stops surveyed in multiple years were included more than once in this summary. From this data pool we considered only stops with 100 percent Native Grass or 100 percent Total Grass, or 100 percent Crop. Stops with 95 percent Crop and 5 percent Settlement were treated as 100 percent Crop. Only species presence or absence was considered.

We calculated the proportion of birds occurring in two major habitat types (crop and grassland) for two bird species known to make use of crops. All detections for each of Baird's Sparrow and McCown's Longspur were extracted from the pool of complete and incomplete routes. Each individual detected was assigned to either grass or crop habitats according to the habitat data collected in 1996 or 2000. Birds detected at stops with a mix of grass and other habitats were assigned to grass unless notes on the data sheet indicated otherwise (one observer - BCD - consistently noted which habitat was used in mixed habitat situations). For each species, the proportion of birds in grass and crop habitat was totaled for each year and proportions were compared across the four years of data collection using Chi-square tests. The analysis was run twice: once including all routes surveyed and again excluding those routes which were only surveyed once.

The size of native grass habitat blocks on GBM routes was estimated based on the number of consecutive stops with 100 percent native grass. We then calculated frequency of occurrence of block sizes.

# Results

## Comparison to BBS

GBM increased the number of routes available for analysis over BBS for most target species (*table 2*). Burrowing Owl and Sharp-tailed Grouse (not shown in tables) were detected on several GBM routes but never on the same route twice. Not all target species were recorded in two or more years on every route but the increase in number of routes was still considerable.

The proportion of routes available for trend analysis was significantly larger for GBM routes than for BBS routes for 11 out of 18 species (*table 3*), including seven of nine tested primary grassland species. One additional primary species (Loggerhead Shrike) approached significance.

The average count per stop on GBM routes was non-significantly higher than BBS for six species and significantly larger for seven species, including four of nine tested primary target species (*table 4*). BBS had significantly higher counts for two species and was non-significantly higher for three other species.

Trends calculated from the BBS and GBM data sets yield different results (*table 5*). The trend was more positive (showed a larger positive trend or a smaller negative trend) for GBM than for BBS for 11 species but most trend differences were not significant. The GBM trend was significantly more positive for Long-billed Curlew ($P = 0.030$) and the BBS trend was significantly more positive for Savannah Sparrow ($P = 0.028$) and Lark Bunting ($P = 0.018$).

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**Table 2—** *Number of Grassland Bird Monitoring and Breeding Bird Survey routes on which target grassland species were observed on two or more years.*

| Species | GBM (N = 14) | BBS (N = 91) | Percent increase in coverage |
|---|---|---|---|
| Swainson's Hawk | 14 | 59 | 23.7 |
| **Ferruginous Hawk** | **4** | **11** | **36.4** |
| Upland Sandpiper | 7 | 34 | 20.6 |
| **Long-billed Curlew** | **8** | **17** | **47.1** |
| **Marbled Godwit** | **13** | **58** | **22.4** |
| **Loggerhead Shrike** | **7** | **25** | **28.0** |
| Horned Lark | 14 | 69 | 20.3 |
| **Sprague's Pipit** | **14** | **31** | **45.2** |
| Clay-colored Sparrow | 13 | 91 | 14.3 |
| Brewer's Sparrow | 8 | 2 | 400.0 |
| Vesper Sparrow | 14 | 86 | 16.3 |
| **Lark Bunting** | **6** | **10** | **60.0** |
| Savannah Sparrow | 14 | 90 | 15.6 |
| Grasshopper Sparrow | 7 | 9 | 77.8 |
| **Baird's Sparrow** | **13** | **28** | **46.4** |
| **McCown's Longspur** | **6** | **9** | **66.7** |
| **Chestnut-collared Longspur** | **12** | **20** | **60.0** |
| Western Meadowlark | 14 | 81 | 17.3 |

Notes: Primary target species appear in bold.

**Table 3—** *Proportion of Grassland Bird Monitoring and Breeding Bird Survey routes on which target species were observed in two or more years.*

| Species | GBM (N = 14) | BBS (N = 91) | P value |
|---|---|---|---|
| Swainson's Hawk | 100 | 65 | 0.009 |
| **Ferruginous Hawk** | **29** | **12** | **> 0.200** |
| Upland Sandpiper | 50 | 37 | > 0.200 |
| **Long-billed Curlew** | **57** | **19** | **0.004** |
| **Marbled Godwit** | **93** | **64** | **0.033** |
| **Loggerhead Shrike** | **50** | **27** | **0.119** |
| Horned Lark | 100 | 76 | 0.001 |
| **Sprague's Pipit** | **100** | **34** | **< 0.001** |
| Clay-colored Sparrow | 93 | 100 | > 0.200 |
| Brewer's Sparrow | 57 | 02 | < 0.001 |
| Vesper Sparrow | 100 | 95 | > 0.200 |
| **Lark Bunting** | **43** | **11** | **0.007** |
| Savannah Sparrow | 100 | 99 | > 0.200 |
| Grasshopper Sparrow | 50 | 10 | < 0.001 |
| **Baird's Sparrow** | **93** | **31** | **< 0.001** |
| **McCown's Longspur** | **43** | **10** | **= 0.005** |
| **Chestnut-collared Longspur** | **86** | **22** | **< 0.001** |
| Western Meadowlark | 100 | 89 | > 0.200 |

Notes: Primary target species appear in bold.

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**Table 4**—*Number of target species counted per stop for Grassland Bird Monitoring and Breeding Bird Survey routes.*

| Species | No. / GBM stop | No. / BBS stop | P value |
|---|---|---|---|
| Swainson's Hawk | 0.051 | 0.053 | > 0.200 |
| **Ferruginous Hawk** | **0.019** | **0.040** | **> 0.200** |
| Upland Sandpiper | 0.050 | 0.072 | > 0.200 |
| **Long-billed Curlew** | **0.191** | **0.173** | **> 0.200** |
| **Marbled Godwit** | **0.175** | **0.125** | **> 0.200** |
| **Loggerhead Shrike** | **0.055** | **0.037** | **> 0.200** |
| Horned Lark | 1.446 | 0.750 | 0.011 |
| **Sprague's Pipit** | **0.613** | **0.165** | **< 0.001** |
| Clay-colored Sparrow | 0.373 | 0.656 | 0.011 |
| Brewer's Sparrow | 0.116 | 0.045 | > 0.200 |
| Vesper Sparrow | 0.861 | 0.516 | 0.001 |
| **Lark Bunting** | **0.372** | **0.183** | **0.048** |
| Savannah Sparrow | 0.546 | 0.865 | 0.031 |
| Grasshopper Sparrow | 0.103 | 0.063 | > 0.200 |
| **Baird's Sparrow** | **0.365** | **0.105** | **< 0.001** |
| **McCown's Longspur** | **0.281** | **0.105** | **0.022** |
| **Chestnut-collared Longspur** | **0.732** | **0.523** | **> 0.200** |
| Western Meadowlark | 1.799 | 0.904 | 0.003 |

Notes: Primary target species appear in bold. Only routes where target species were recorded are included.

**Table 5**—*Trends for target species in the period 1996-2000 for GBM alone, BBS alone, and the two surveys combined.*

| Species | GBM trends (95% confidence) | BBS trends (95% confidence) | Combined trends (95% confidence) |
|---|---|---|---|
| Swainson's Hawk | 0.5 (-14.0, 17.4) | -6.9** (-13.0, -0.3) | -6.4** (-12.1, -0.2) |
| **Ferruginous Hawk** | **11.0 (-39.4, 103.3)** | **4.8 (-21.0, 39.1)** | **6.9 (-14.2, 33.0)** |
| Upland Sandpiper | -1.5 (-20.3, 21.6) | 3.8 (-7.1, 15.9) | 2.5 (-7.5, 13.6) |
| **Long-billed Curlew** | **22.3 (-1.6, 51.9)** | **-0.1 (-16.9, 20.2)** | **7.3 (-5.8, 22.3)** |
| **Marbled Godwit** | **5.1 (-14.8, 29.6)** | **-8.0* (-16.3, 1.1)** | **-3.7 (-11.9, 5.1)** |
| **Loggerhead Shrike** | **1.1 (-21.4, 30.2)** | **-2.9 (-21.1, 19.5)** | **-1.5 (-14.6, 13.7)** |
| Horned Lark | -5.5* (-11.3, 0.7) | -12.3** (-15.7, -8.8) | -11.0** (-13.9, -7.9) |
| **Sprague's Pipit** | **-6.6 (-19.0, -7.6)** | **5.3 (-6.1, 18.1)** | **-0.7 (-10.5, 10.2)** |
| Clay-colored Sparrow | 0.9 (-5.3, 7.5) | -0.5 (-3.2, 2.2) | -0.4 (-2.8, 2.2) |
| Brewer's Sparrow | -3.7 (-48.2, 79) | -28.1 (-42.7, -9.7) | -3.4 (-43.9, 66.4) |
| Vesper Sparrow | 0.4 (-5.1, 6.1) | 1.1 (-2.2, 4.5) | 0.8 (-1.7, 3.4) |
| **Lark Bunting** | **5.2 (-43.2, 94.9)** | **90.5** (51.3, 139.8)** | **40.5** (2.4, 92.8)** |
| Savannah Sparrow | -6.1 (-13.2, 1.7) | -0.1 (-2.5, 2.5) | -0.4 (-2.6, 1.9) |
| Grasshopper Sparrow | -11.2 (-34.4, 20.4) | -16.4 (-59.8, 73.7) | -12.2 (-36.6, 21.7) |
| **Baird's Sparrow** | **-23.8** (-31.5, -15.2)** | **-9.8 (-23.1, 5.8)** | **-19.3** (-26.9, 11.1)** |
| **McCown's Longspur** | **-23.4 (-62.5, 56.4)** | **-17.6 (-35.7, 5.6)** | **-20.2 (-39.9, 5.8)** |
| **Chestnut-collared Longspur** | **-10.0* (-18.8, -0.2)** | **-19.0** (-31.9, -3.5)** | **-17.2** (-26.8, -6.3)** |
| Western Meadowlark | 4.0 (-0.5, 8.6) | 3.1* (-0.4, 6.8) | 3.3** (0.4, 6.3) |

Notes: Trends represent change/yr
    Sample sizes for each species, by survey, are in *table 2*.
    Primary target species are shown in bold.
* 0.05 < P < 0.20
** P < 0.05

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**Table 6—** *Summary of percent habitat coverage on 31 GBM routes.*

| Habitat | Minimum cover | Maximum cover | Mean | SE |
|---|---|---|---|---|
| Native Grass | 12.4 | 93.51 | 48.00 | 4.67 |
| Non-native Grass | 0 | 21.60 | 4.51 | 0.96 |
| Hay | 0 | 37.80 | 6.62 | 1.52 |
| Unclassified Grass | 0 | 17.49 | 2.66 | 0.89 |
| Total Grass | 22.90 | 100.00 | 61.79 | 4.74 |
| Crop | 0 | 77.10 | 35.56 | 4.80 |
| All Other | 0 | 13.40 | 2.65 | 0.53 |

**Table 7—** *Mean proportion of stops covered entirely by native grass, all grass, and crop where target species occurred.*

| Species | Native grass | All grass | Crop |
|---|---|---|---|
| Swainson's Hawk | 4.62 | 4.51 | 3.29 |
| **Ferruginous Hawk** | **0.77** | **0.71** | **0.00** |
| Upland Sandpiper | 3.08 | 3.72 | 0.33 |
| **Long-billed Curlew** | **16.05** | **15.49** | **4.61** |
| **Marbled Godwit** | **20.41** | **19.56** | **6.91** |
| **Loggerhead Shrike** | **0.64** | **1.15** | **0.33** |
| Horned Lark | 59.82 | 59.91 | 93.42 |
| **Sprague's Pipit** | **67.91** | **62.92** | **2.63** |
| Clay-colored Sparrow | 25.42 | 27.79 | 15.46 |
| Brewer's Sparrow | 7.96 | 7.43 | 0.99 |
| Vesper Sparrow | 58.54 | 60.62 | 53.62 |
| **Lark Bunting** | **5.39** | **7.08** | **14.47** |
| Savannah Sparrow | 46.34 | 46.64 | 54.93 |
| Grasshopper Sparrow | 6.68 | 9.29 | 0.33 |
| **Baird's Sparrow** | **36.59** | **34.87** | **18.42** |
| **McCown's Longspur** | **8.47** | **7.26** | **24.34** |
| **Ch.-collared Longspur** | **45.44** | **43.36** | **9.54** |
| Western Meadowlark | 92.04 | 93.36 | 63.16 |

Notes: Primary target species appear in bold

**Table 8—** *Proportion of observations of Baird's Sparrow and McCown's Longspur in grass and crop, by year.*

| | Baird's Sparrow | | McCown's Longspur | |
|---|---|---|---|---|
| Year | Grass | Crop | Grass | Crop |
| 1996 | 90.4 | 9.6 | 58.2 | 41.8 |
| 1997 | 95.2 | 4.8 | 75.4 | 24.6 |
| 1998 | 92.0 | 8.0 | 80.6 | 19.4 |
| 2000 | 100.0 | 0.0 | 75.8 | 24.2 |

## Habitat

Most of the 31 GBM routes, surveyed at least once, were dominated by grassland (*table 6*). Native grass made up almost half the coverage and varied from as little as 12 percent on some routes to almost 94 percent on others. Crop averaged less than 36 percent of cover. Only Horned Lark, Lark Bunting, Savannah Sparrow, and McCown's Longspur were seen more often at crop sites than grassland sites (*table 7*). Western Meadowlark commonly used crop as well as a high proportion of grassland sites. The proportion of available grassland utilized by other target species varied from less than 1 percent (Ferruginous Hawk) to almost 68 percent (Sprague's Pipit).

Up to about 10 percent of Baird's Sparrow and nearly 42 percent of McCown's Longspurs were found in crop

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habitats (*table 8*). The first year of the study had the highest proportion of these two species seen in crop. The proportion of birds seen in crop on all routes varied significantly among years ($\chi^2$ test, P = 0.0056 for Baird's Sparrow and P = 0.0007 for McCown's Longspur). The pattern was the same when we made similar calculations using only those routes sampled in two or more years.

The distribution of 100 percent native grass block sizes along GBM routes was extremely skewed (*fig. 2*) with many blocks representing a quarter-section of land (one stop) and only a few very large blocks. The largest blocks were of 25 consecutive stops; these blocks would represent areas of native grass of a minimum of 6.25 sections of land. Although the number of large blocks is low, more than half the survey stops were in blocks larger than two legal sections in extent.
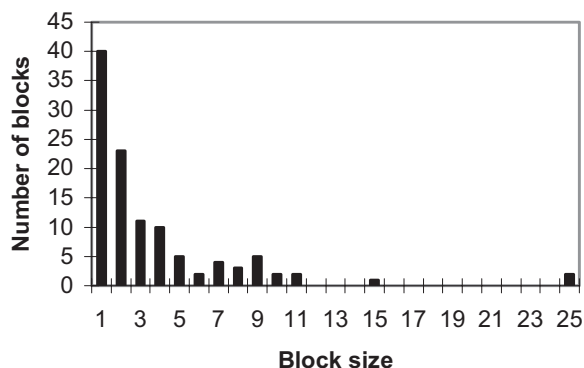


**Figure 2—** Frequency distribution of native grass block sizes represented on GBM routes. Block size is expressed as the number of consecutive survey stops located in 100 percent native grass habitats (one stop surveys an area roughly equivalent to one quarter section of land).

# Discussion

## Sources of Bias

We removed the route selection criteria for secondary roads but do not feel this is a source of bias. The original intent of BBS methodology in requiring secondary roads was to ensure roads would be passable in bad weather. In the prairies almost any road is passable in dry weather and even secondary roads may be impassable following rain. BBS exclusion of tertiary roads may have under-sampled remaining large blocks, which have fewer secondary roads (Droege 1990).

We dropped the requirement that the observer remain the same, and the restriction on wind conditions when accepting routes for analysis. Wind conditions were unacceptable, according to BBS standards, on only two GBM route/yr combinations but excluding those combinations would have reduced our already small sample

size. Using counts from different observers and less than ideal conditions does increase between year variance and thus confidence intervals but should not bias population trends unless the occurrence of bad weather conditions was systematic, which it was not.

Comparisons here do not take into account degree block weighting factors which are used in standard analysis of BBS in Canada, but this should not bias the results because the number of GBM routes was evenly distributed across the sampled degree blocks. Dropping the weighting made our analysis more similar to that employed by the USGS, which does not normally weight routes to equalize the contribution of blocks to the trend.

## Comparison to BBS

The pilot phase of GBM has shown the following improvements over BBS alone for target grassland species: an increase in the number of routes on which a species is detected, an increase in the proportion of routes suitable for use in trend calculation, and an increase in the number of individual birds per species detected.

The improvement in number of routes exceeds 25 percent for two secondary (Brewer's and Grasshopper Sparrows) and all but one (Marbled Godwit) primary target species; the increase was less for some of the more widespread secondary target species (*table 2*). These are conservative estimates of potential increase in survey coverage through GBM, since only 14 routes were run two or more times in the pilot phase. Some may argue that simply adding more BBS routes throughout BCR 11 would similarly increase power. An earlier phase of the GBM pilot study ran a series of "empty" (created but unassigned BCR 11 BBS routes) and gained very few additional records of target species.[1] The increase in routes useable for analysis is largely a result of adding additional random routes in degree blocks in the core of grassland and grassland bird distribution.

The higher proportion of GBM routes with target species (*table 3*) confirms that in areas with a higher percentage of grassland habitats there is a greater probability of detecting target species with each additional route surveyed. Proportion of routes, a second component of the statistical power of trend analyses, can thus be improved for most target species through implementation of GBM.

A third element of statistical power for trend detection (higher counts per stop) can be delivered by GBM

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[1] unpublished data, B. Dale, Canadian Wildlife Service, Edmonton, Alberta.

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(*table 4*). The higher number of individuals of target species also suggests that GBM may be providing coverage of the higher density portion of these species' distributions.

We emphasize that the trends themselves (*table 5*) are of less importance than the fact that the trends from the two surveys differ. The trends should be interpreted with caution. Trends for a short period from any survey may reflect short-term fluctuation rather than long-term trend. This is particularly true for many grassland species that respond to temporary weather related habitat conditions and other stochastic events.

The GBM trend was more negative than the BBS trend for five species including three species - Sprague's Pipit, Baird's Sparrow and Lark Bunting - whose populations tend to fluctuate greatly depending on precipitation levels. Precipitation levels declined during our pilot study period. Should a pattern of population decline, even where habitat is common, continue over a longer term then we must consider the possibility that the decline is being driven by productivity issues or problems during migration or winter.

It is not surprising that grassland species might be either increasing, or declining less steeply, in that portion of the landscape where grass is still relatively common, and which was the focus of the GBM pilot project. The BBS and GBM surveys may be tracking different portions of populations, or trends may differ between habitats, or some species may be undergoing range contractions. The difference in trends suggests that a standard analysis of BBS data *alone* may not provide sufficient information to determine grassland species trends. BBS appears to be sampling habitats in proportion to their occurrence in the landscape but the current number of active BBS routes is low in the small, less modified portion of the prairies with higher grassland bird abundance. GBM provides greater detail in this important portion of the range of many grassland bird species. Thus, the combined trend (*table 5*) may better describe what is happening to the entire population during this five year period.

The GBM pilot study resulted in significant improvement in the three elements (number of routes, proportion of routes, and birds/route) necessary to improve statistical power for monitoring eight of nine primary grassland species and seven of nine secondary species. Data for one primary and one secondary species (Burrowing Owl and Sharp-tailed Grouse) were insufficient to be tested. Our findings are consistent with those of Cochrane and Oakleaf (1982), who determined that BBS methodology was suitable to detect Long-billed Curlews but would require a great increase in the number of random routes to adequately monitor curlew population trends.

The different size of trends on GBM compared to BBS seems to indicate that trends in core areas (GBM) may differ from those calculated from the landscape as a whole (BBS). Separate and combined trends will add to our understanding of bird populations and their dynamics. It may allow us to target research and conservation more effectively. Certainly GBM route data should remain separate from the BBS data as a whole until this relationship is better understood.

### Habitat

The frequency of grass and crop habitats on GBM (*table 6*) is very different from BBS routes. A recent study based on interpreted satellite imagery found about 70 percent of coverage on Canadian prairie BBS routes was cropland.[2] Because we have geo-referenced location, habitat, and bird information for each stop along the GBM routes the potential exists to calculate population trends by habitat type as determined by either ground or satellite surveys.

Knowledge about which habitats are used on a broad scale (*table 7*) supplements species or site-specific studies and provides information about habitat preferences which may assist us to understand bird population trends. Habitat specialists like Brewer's Sparrow, which need sage or other brush as well as grassland, used only 8 percent of available native grass sites. McCown's Longspur, which needs the shortest cover in the grassland habitat spectrum, used a very small proportion of available grassland and a higher proportion of crop sites than any natural habitat. This type of information contributes to our understanding of limiting factors and threats.

Habitat use information is valuable for understanding the reasons behind trends. Species like Horned Lark, Savannah Sparrow and Western Meadowlark use crop as well as much of the available grassland, have wider distributions, and show less year to year variability. Much of the remaining grassland and even much of the modified landscape is used by them. Their long term trends show less severe declines and have narrower confidence intervals than habitat specialists like Sprague's Pipit (Sauer et al. 2000), which must have native grassland of moderate height and thickness (Robbins and Dale 1999).

Knowledge of what proportion of the population is using crop habitat, and how this varies geographically and temporally may be able to help us understand reasons for decline and target our research more effectively. Species that will set up territories in crop or in

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hay, where reproductive success may be less than in natural habitats, may suffer worse declines than those restricted to grassland alone. Hay covered a very small proportion (6.6 percent) of the cover at sites sampled by GBM and we did not attempt analyses related to that habitat. Crop was more common and we examined the proportion of all birds detected in each of grass and crop habitats for two species showing a high frequency of occurrence in crop: Baird's Sparrow and McCown's Longspur (*table 8*). The strong year effect may be related to moisture conditions, with higher usage of crop occurring in dry years with poor grass condition. A limited number of studies have explored productivity of birds in crops but the few that have been done consistently show low productivity values in agricultural habitats (Martin 1997). The reasons vary from outright destruction of nests (Cowan 1982) to a lack of pairing success in crop for Baird's Sparrow (Martin 1997). The high proportion of populations of these species using crop habitat is cause for concern.

The block size values (*fig. 2*) have several potential uses. For example, the number of individuals per stop by species in various block sizes could be compared to see if some species occur in greater numbers in larger blocks. There is reason to think large blocks are likely to support higher densities. Large holdings tended to be in better "range condition" (a measure of grassland community health) than small blocks of land (Smoliak et al. 1985). The state of grassland health is important to grassland birds. Sprague's Pipit, Vesper Sparrow, Baird's Sparrow, and Chestnut-collared Longspur are known to respond positively to range condition in North Dakota and Saskatchewan (George et al. 1992, Anstey et al. 1995).

Over a longer period, there is also the potential to calculate trends for small and large block sizes to determine if population dynamics in small blocks differ from those in large blocks. The GPS data for each stop will allow us to use satellite data to calculate a more accurate estimate of block size than that generated in this study. The GBM pilot study shows that collection of basic habitat information (on the ground and satellite data from geo referenced stops) may provide us with other insights helpful in understanding population dynamics of the target species. Examples explored here were proportion of population in particular habitats, proportion of habitat used, and comparison of trends in core and peripheral areas. Much more can still be learned from this data set: trends by density; trends by habitat; and, the influence of habitat type, block size, soil type, precipitation, and land use on both occupancy and trend. Increased understanding of population dynamics may allow us to more effectively target research and conservation efforts.

## Next Steps for GBM

Our study confirms that intensified BBS (GBM) has the potential to improve our ability to monitor and understand population changes for many grassland species. The information generated may contribute to planning efforts of Partners in Flight, Prairie Canada Shorebird Conservation Plan, and the North American Bird Conservation Initiative and implementation of "all bird" conservation by the Prairie Habitat Joint Venture among others. To help realize the program's potential we suggest:

1. Upgrade the Grassland Bird Monitoring Program from pilot to operational status. Complete the random selection of two to four routes / degree block throughout those portions of the three prairie provinces with more than 20 percent remaining grassland cover in a degree block. We suggest the CWS act as the lead organization for this program in Canada and that data be stored in the BBS data base in a manner that random GBM routes are distinguishable from BBS so that both separate and combined analyses may continue to be generated. Avian trends for GBM alone and GBM and BBS combined should be calculated every 3-5 years.

2. Recruit additional agency and volunteer observers to run routes. This will make the monitoring program more robust to variation in availability of observers, as well as reduce the burden on any single agency of providing observers. Targeting agency personnel may reduce competition with BBS for volunteer observers.

3. Global positioning system data and habitat data should be collected, following a standard protocol, at each stop of all GBM and BBS routes. The habitat information would include estimates of cover by each of several major habitat classes, and road and ditch width information. Habitat data should be checked and updated every five years. Estimates of cover and landscape characteristics such as block sizes from should be generated from remote sensing coverage.

4. Using data collected in this pilot project, investigate the effect of habitat type, soil type, precipitation, and block size on occurrence and trend.

5. Integrate various kinds of information collected to produce status reports that identify potential causes of trends and suggest relevant research and conservation action.

6. Encourage the USGS to adopt a similar program so that the entire range of primary grassland bird species can receive intensive coverage.

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# Acknowledgments

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