

Influence of Survey Length and Radius Size on Grassland Bird Surveys by Point Counts at Williams Lake, British Columbia¹

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Abstract: We examine the effect of survey length and radius on the results of point count surveys for grassland birds at Williams Lake, British Columbia. Four- and 8-minute counts detected on average 68 percent and 85 percent of the number of birds detected during 12-minute counts. The most efficient sampling duration was 4 minutes, as long as travel time between points was under 15 minutes. Density estimates derived from 4-minute counts were significantly lower than 12-minute counts for most radius sizes. A larger radius yielded a larger number of detections but not always proportionally with the increase in area. This resulted in lower estimated density with an increase in radius size, especially when using maximum values at a given point. However for the Horned Lark (*Emeophila alpestris*), the most abundant species, estimates of densities derived from individual counts did not differ significantly with radius size. A 100-m radius yielded nearly as many detections as an unlimited radius for most species, suggesting that it may be the most efficient radius to use in open habitats.

The estimation of bird abundance in a given area still presents a challenge for researchers. Three main techniques are currently used: spot mapping, point counts, and transects (Ralph and Scott 1981, Verner 1985). Each technique has its strengths and weaknesses; however, in recent years point counts have been widely used.

In a pilot year of a study of grassland birds in Williams Lake, British Columbia, we examined the efficiency of the point count technique in estimating the relative abundance of birds in a grassland setting. In this paper, we compare the number of bird detections obtained with various survey lengths and survey radii and attempt to identify the most efficient survey length in terms of the number of detections per hour.

Methods

Our study area centered around Williams Lake, British Columbia. The grasslands sampled were located within the Fraser River Basin in the Interior Douglas-fir and Bunchgrass biogeoclimatic zone (Krajina 1969, British Columbia Ministry of Forests 1988).

Throughout 12 different grassland areas, 48 points were established. Point counts had a radius of 100 m and were placed at least 300 m apart. Counts were made for three consecutive 4-minute periods at each point (12 minutes total per point), and the distance of all bird detections from the center of the point was recorded. In each 4-minute period, we started the count over and recorded all detections during that 4 minutes.

We also noted, however, whether the individual detected in the second or third period had been detected in the first or second period. Thus, we could determine the number of detections in a 4-, 8-, and 12-minute count as well as divide the 12 minutes into three 4-minute segments.

To compare the relative efficiency of point counts of different lengths, we used the total number of birds detected per hour of survey time and compared this value for different travel time between points. Nonparametric tests (Kruskal-Wallis and Mann-Whitney) were used in statistical analysis. We calculated, for each of the four surveys, the average number of birds detected per point ($n = 48$) during 4-, 8-, and 12-minute counts. We multiplied this value by the number of points that could be surveyed in 1 hour, given various travel times. The sample size for each comparison is thus four.

Points were located away from fencelines, crop fields, woodlands, forests, dense shrubbery, and wetlands to avoid edge effects. Each point was surveyed on four different mornings between 0530 and 1000 from May 8 to June 17. Analyses were done using the number of bird detections at a given point without using correcting factors.

When more than one survey is carried out at a given point, all surveys are often combined for a given point using either the mean, the median, or the maximum. Use of the mean considers all counts as comparable estimates, the median considers only the middle value(s) excluding high and low counts, and the maximum takes the highest value. Here, we used either single counts as replicates or the maximum as the best estimate of the abundance of a species at a given point. As our surveys were conducted well after migration had finished, maximum values may represent a realistic approximation.

Results

Relative Abundance of Birds

Fourteen bird species were recorded in the point count surveys (table 1). Horned Larks were dominant in terms of total numbers recorded and in frequency of observations. Vesper Sparrows (*Pooecetes gramineus*) were second in abundance, followed by Long-billed Curlews (*Numenius americanus*) and Savannah Sparrows (*Passerculus sandwichensis*). All other species occurred in low numbers at fewer than 5 of the 48 point locations. Mountain Bluebirds (*Siala currucoides*) and Western Meadowlarks (*Sturnella neglecta*) occurred mostly along grassland edges. Because these edges were not sampled, relative abundance of these species was probably underestimated.

Effects of Point Count Duration on Individual Count Results

Four- and 8-minute counts averaged 68 ± 3 percent and 90 ± 1 percent of the 12-minute counts for the total number of

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Table 1--Numbers and species of birds recorded by the point count method. The number of points at which species was recorded (*n*) = 48.

Species	Number recorded	Frequency observation	Number per point
Horned Lark	210	47	4.38
Vesper Sparrow	49	26	1.02
Long-billed Curlew	24	16	0.50
Savannah Sparrow	11	8	0.23
Common Raven	11	3	0.23
European Starling	8	4	0.17
Mountain Bluebird	4	3	0.08
Western Meadowlark	4	4	0.08
Brewer's Blackbird	4	1	0.08
American Crow	1	1	0.02
American Robin	1	1	0.02
Brewer's Sparrow	1	1	0.02
Killdeer	1	1	0.02
Northern Harrier	1	1	0.02
Total	330		

birds, and 87 ± 5 percent and 91 ± 3 percent for the number of species (table 2). Generally, 4-minute counts were nearly twice as variable: (based on coefficients of variations) as 8-minute counts (table 2). The use of the maximum number of birds seen at a given point doubled the overall number of detections, and 4- and 8-minute counts recorded 75 percent and 89 percent of the birds seen in a 12-minute count.

Four- and 8-minute counts recorded an average of 68 ± 4 percent and 84 ± 3 percent of the total number of Horned

Larks, and 73 ± 6 percent and 87 ± 4 percent of the Vesper Sparrows recorded during 12-minute counts (table 2). Patterns for less numerous species like Savannah Sparrows and Western Meadowlarks were inconsistent between counts, probably because of small sample sizes.

For travel times under 8 minutes, 4-minute counts yielded significantly more detections per hour than 12-minute counts (Mann Whitney, $P < 0.05$, fig. 1). For travel times under 2 minutes, all count lengths differed in their yield of detections per hour with the smaller length yielding significantly more detections ($P < 0.05$). No significant differences were found in the number of bird detections per hour between 8- and 12-minute counts or between 4- and 8-minute counts for travel times between 4 and 32 minutes. For travel times over 20 minutes, however, 4-minute counts yielded significantly fewer detections than 12-minute counts ($P < 0.1$ for 22, 24 minutes and $P < 0.05$ for 26 to 32 minutes). Our ability to establish the presence or absence of Horned Lark and Vesper Sparrow at a given point did not improve greatly with count length (table 2).

Effect of Point Count Radius on Count Results

Detections of total numbers of birds and numbers of species increased as point count radius increased (fig. 2). There was an obvious disturbance created by the observer's presence though, as no birds were detected within 10 m of the observer (fig. 2). For three of the four most common species-Horned Lark, Savannah Sparrow, and Vesper Sparrow-a radius of 100 m provided almost as many detections as an unlimited radius (fig. 3). However, more than three times the numbers of Long-billed Curlews were recorded with an unlimited radius as with a 100-m radius. Patterns

Table 2--Influence of count duration on the number of detections.

Survey	Total number of birds			Total number of species			Horned Lark			Vesper Sparrow			Long-billed Curlew		
	Percent of <i>n</i> ^b			Percent of <i>n</i>			Percent of <i>n</i>			Percent of <i>n</i>			Percent of <i>n</i>		
	<i>n</i> ^a	4 min	8 min	<i>n</i>	4 min	8 min	<i>n</i>	4 min	8 min	<i>n</i>	4 min	8 min	<i>n</i>	4 min	8 min
1	168	65	81	7	86	86	124	60	78	18	67	78	13	85	100
2	145	72	83	8	75	88	96	74	84	34	74	88	7	71	100
3	180	73	91	8	75	88	142	75	90	21	90	95	5	20	100
4	173	63	86	8	100	100	125	62	84	21	62	86	11	55	100
x		68.3	85.3		84.0	90.5		67.8	84.0		73.3	86.8		57.8	100
Standard Error		2.5	2.2		5.9	3.2		3.9	2.5		6.1	3.5		14.0	-
Maximum ^c	330	75	89	14	86	93	210	77	90	49	78	90	24	67	92
Frequency ^d							47	100	100	26	96	96	16	81	94
Coefficient of Variation		7	5		14	7		12	6		17	8		48	-

^a *n* = total of 48 points for a 12-minute count at each point.

^b 4- and 8-minute counts as a percent of the 12-minute count.

^c We used the higher of the four counts at a given point and then summed it up for the 48 points.

^d The number of points at which the species was recorded; *n* = number for a 12-minute count with percent seen in 4- and 8-minute counts.

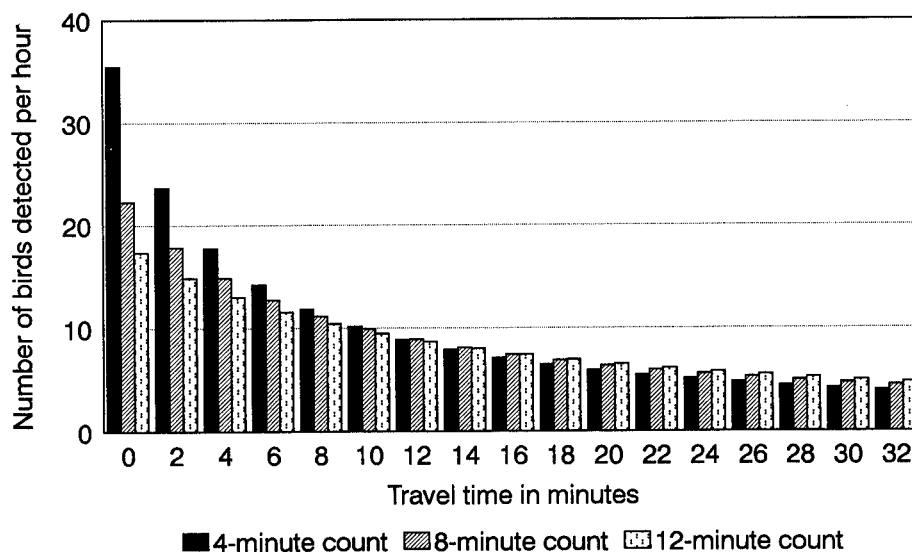


Figure 1—Comparison of efficiency in terms of the number of birds detected per unit of time of point counts of various duration.

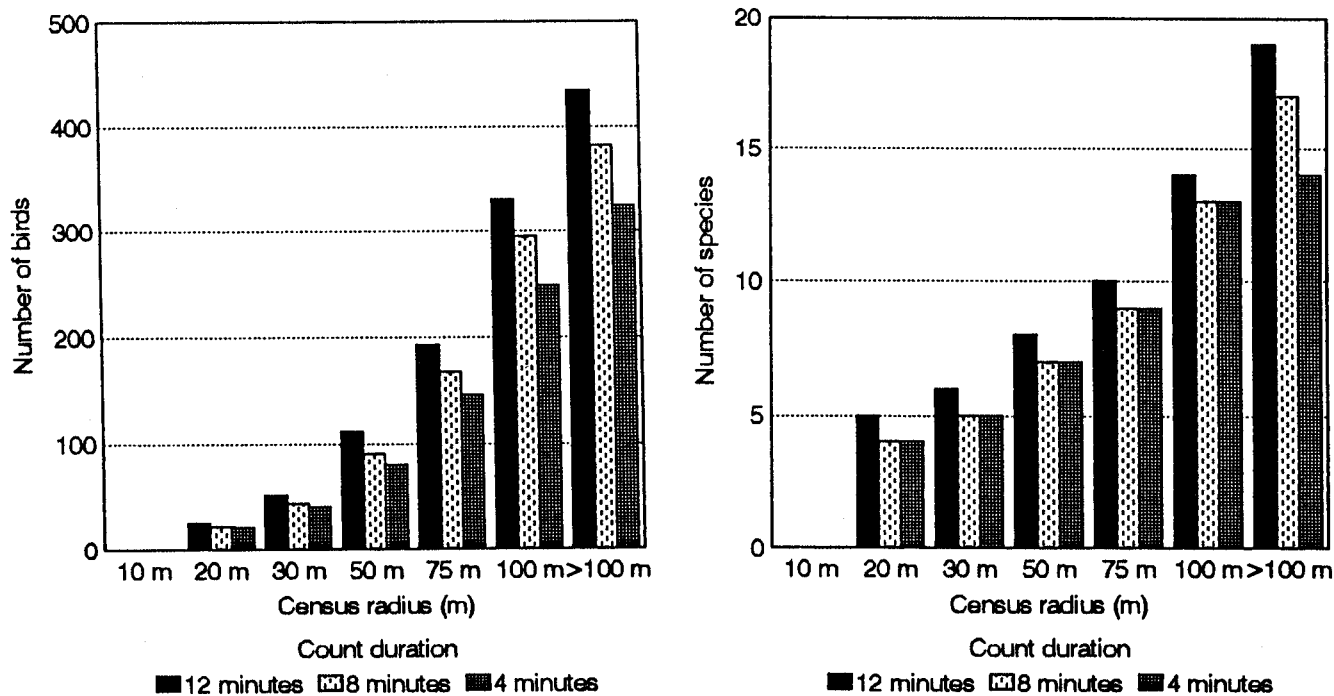


Figure 2—The total number of birds and number of bird species detected by variable point count radii during 48 point counts (using maximum values).

were similar for all three survey durations for any one species. Detections for most species increased more with radius size than with count length (*fig. 3*).

Density estimates based on different radius sizes and count duration were analyzed for the Horned Lark and Vesper Sparrow using maximum values (*table 3*). Density estimates of Horned Larks decreased with increasing radius size, especially between 50 m and 75 m. Radii of 20

m and 30 m provided the highest and somewhat similar estimates. Density estimates of Vesper Sparrows were highest at 30 m, then decreased with increasing radius size. The lower density with 20-m radius may reflect observer avoidance by the species. Shorter counts yielded lower densities than longer counts.

We recalculated Horned Lark densities using individual counts. Density estimates were nearly one-half those based on

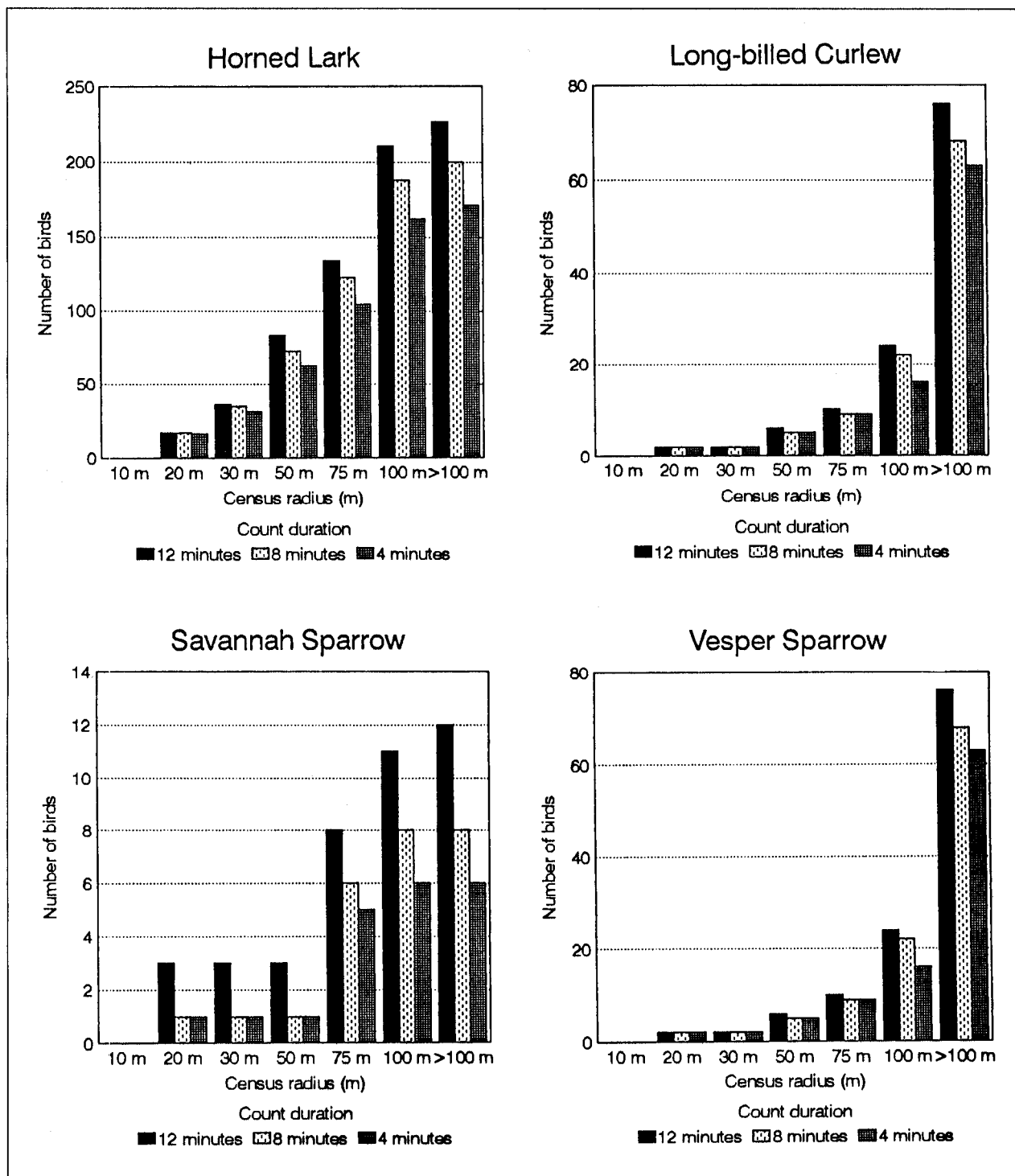


Figure 3—The number of Horned Larks, Long-billed Curlews, Savannah Sparrows, and Vesper Sparrows detected by variable point count radii during 48 point counts (using maximum values).

Table 3--Density estimates (number of birds per ha) of Horned Lark and Vesper Sparrow derived from different point count radii and count length (mean of 48 points, using the maximum of 4 counts).

Species	Count length	Radius (m)				
		20	30	50	75	100
Horned Lark	<i>min</i>					
	4	106.1	91.4	65.8	49.0	43.0
	8	112.7	103.2	76.4	57.5	49.9
	12	112.7	106.1	88.1	63.2	55.7
Vesper Sparrow	4	13.3	14.7	8.5	9.9	10.1
	8	13.3	14.7	9.5	11.3	11.7
	12	13.3	23.6	15.9	14.6	13.0

Table 4--Density estimates of Horned Lark estimated from 4- and 12-minute counts using individual counts (Mean $\pm$ s.e., $n = 4$).

Count duration	Radius (m)			
	30	50	75	100
4-minute	29.5+6.3	23.9+2.3	21.8+1.1	21.8+2.2
12-minute	37.5+4.2	36.4+3.6	31.5+1.7	32.3+2.5
P^a	0.14	0.02	0.02	0.04

^a Mann-Whitney Test

maximum values (table 4). Density estimates based on 4-minute counts were lower than those derived from 12-minute counts for 50-m, 75-m and 100-m radii (Mann-Whitney $P < 0.05$). Estimates based on individual counts did not vary significantly with radius size either for 4-minute counts (Kruskal-Wallis $P = 0.52$) or for 12-minute counts ($P = 0.53$), although the significance level of the test is approximate due to dependence in the data.

Discussion

Results of bird counts in this study were typical for grassland habitats. In general, grasslands provide habitat for about two to six passerine species and, occasionally, as many nonpasserine species (Cody 1985).

As many curlews were detected in 8-minute counts as in 12-minute counts at a given site; but for all other species, 12-minute counts detected more individuals. As expected, 12-minute counts yielded more detections than shorter counts. This is due in part to increased detection of less conspicuous individuals, but also to movement of birds within the census area (Verner 1985). Because of the openness of the habitat and the low number of species present, count duration had less effect on the number of species detected. Most species present at a given point were detected within the first 4 minutes of the count, which is likely due to the

openness of the habitat and the low number of species. In closed habitats with more species, such as forests, this may not be the case.

By far the most efficient sampling unit in terms of number of birds detected per unit of time were 4-minute counts. Using this criterion, whenever you have to compromise between the number of points and the count duration, you should maximize the number of points. However, when habitats are restricted and travel time between points is over 15 minutes, efficiency can be increased by using longer counts. Fuller and Langslow (1984) reached similar conclusions for birds in British habitats. Also, in cases where birds' presence or relative abundance has to be related to habitat features at a given census point, longer counts may be more appropriate, especially in view of the greater variability of shorter counts.

Caution is needed when using point counts to estimate breeding density. Point count estimates vary with the radius used, the species, the area, and the actual density of the species (Bollinger and others 1988, DeSante 1986, Verner 1985, Walankiewicz 1977). DeSante (1986) found that 48-point count stations could distinguish common from rare species but that nearly three times more effort was needed to obtain reliable estimates of the relative abundance of the most common species. Our results are, therefore, not surprising given our small number of points.

Larger radius yielded a larger number of detections, but not always proportionally with the increase in area. This resulted in significant differences in calculated bird density with density decreasing with radius size, especially when using maximum values. In the case of the Horned Lark, density estimates derived from individual counts did not differ significantly with radius size. It remains to be seen, however, if this applies to other species and other habitats. The difference in density estimates for counts of different length indicates the difficulty of deriving real density estimates from point counts. When real density estimates are sought, 4-minute counts will not be appropriate. The absence of detection within the first 10 m from the observer reflects observer effect in this open habitat and cautions against the use of small radius in point counts. A 100-m radius yielded for most species nearly as many detections as an unlimited radius, suggesting that it may be the most efficient radius in this open habitat.

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