UTILITY OF THE STRATIFIED RANDOM QUADRAT SAMPLING CENSUS TECHNIQUE FOR WOODLAND CARIBOU IN YUKON

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Abstract: Using past techniques, it has proven notoriously difficult to obtain demographic data on woodland caribou (*Rangifer tarandus caribou*) populations occupying forested environments. We report on an adaptation of a stratified random quadrat aerial census technique originally developed by Gasaway et al. (1985) to census moose (*Alces alces*) in Alaska. The adapted technique was applied to 2 caribou herds (the Wolf Lake and Finlayson Herds) in southcentral and eastcentral Yukon in winter 1986 and 1987. We compare the population size estimates derived from the stratified random technique with earlier attempts to census the herds using total count census techniques, and conclude that estimates based on the stratification technique are more reliable than those of the total census approach. In addition, we assess the sightability bias inherent in surveying caribou in forested environments and compare population estimates using a sightability correction factor with those in which the sightability correction factor is not used. We conclude that population estimates that fail to include a correction for sightability bias consistently and significantly underestimate population size. Finally, we assess the relationship between the number of quadrats sampled in the stratification technique and the associated precision estimates. We conclude that it is not always necessary for managers to survey all quadrats in the high-density stratum.

Key Words: caribou, census technique, Finlayson Herd, *Rangifer*, Wolf Lake Herd

At the 2nd North American Caribou Workshop in Montreal, October 1984, an open session was held on caribou (*Rangifer tarandus*) census techniques

(Meredith and Martell 1985). Participants identified the need for techniques to reliably estimate caribou population sizes, particularly for woodland caribou (R. t. caribou) populations occupying forested habitat. General problems associated with woodland caribou population estimates are: (1) poor sightability in forest environments; (2) the failure of observers to see all caribou; (3) caribou movements between areas sampled; (4) broad extrapolations resulting from highly variable population densities; (5) poorly based assumptions on population distribution and behavior; and (6) financial limitations.

The most common method used to census woodland caribou has been the "total count" (i.e., known minimum) during various seasons (Bergerud 1983). In summer, total counts have consisted of enumerating caribou on mountain snowfields during July (Ritcey 1976); aerial photography has been used to improve accuracy (Farnell and Russell 1984). Total counts have been used extensively to census breeding aggregations on alpine plateaus (Bergerud 1978; Edmonds and Bloomfield 1984; Hatler 1986; Farnell and McDonald 1987a,b). Both summer and fall total counts assume that the entire population is distributed in upland areas, which is rarely true (Hatler 1986). Total counts during winter (Fuller and Keith 1981) have been higher than those in fall (Edmonds and Bloomfield 1984) but remain inadequate for management or research purposes. Reliable total counts have, to our knowledge, only been obtained through intensive study of Yukon's Burwash caribou herd (Gauthier and Theberge 1985); these counts were reliable primarily because the Burwash herd ranges wholly in a tundra environment.

Population estimates derived from samples using capture-recapture methods have been satisfactory for caribou in tundra environments (Gauthier 1984), but the technique is inefficient because it requires impractically large samples. In recent years, spray paint marking has been used in British Columbia and Newfoundland to provide large samples for woodland caribou capture-recapture estimates. This technique has the potential to provide useful data in certain types of forested environments (J. Elliot pers. commun.; S. Mahoney, pers. commun.). Population estimates derived from strip-transect samples have been improved when stratified (Siniff and Skoog 1964). Quadrat sampling methods have produced higher population estimates than the strip-transect method, but neither method has proven satisfactory for purposes of woodland caribou management (Fong et al. 1985). We suggest that reliable estimates for woodland caribou populations inhabiting forested environments may best be achieved during winter with an intensive sampling method.

Radiotelemetry-assisted studies of woodland caribou in Yukon have consistently documented confined distributions of animals during late winter (Farnell and Russell 1984; Farnell and McDonald 1987a,b). These distributions are considered "traditional" and are the result of an obligatory response to increasing snow depths over winter combined with habitat preference (Farnell and Russell 1984; Farnell and McDonald 1987a). Studies have further shown that Yukon's woodland caribou populations are discrete and should be managed individually. Based on the above findings, we believe that stratified quadrat sampling of caribou on winter ranges can provide reliable estimates of the size of distinct populations.

We report on an adaptation of a stratified random quadrat sampling aerial census technique (SRQT) originally developed by Gasaway et al. (1986) to census moose (*Alces alces*) in Alaska. The adapted SRQT was applied to 2 woodland caribou populations (the Finlayson and Wolf Lake Herds) in east-central and southcentral Yukon in winters 1986 and 1987, respectively. We compare the SRQT population estimates with earlier estimates based on total count techniques. In addition, we assess caribou sightability in forested environments and compare population estimates using or lacking a sightability correction factor (SCF). Finally, we assess the relationship of the number of quadrats sampled in the SRQT to the associated precision estimates.

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STUDY AREAS

The Wolf Lake and Finlayson Caribou Herds occupy areas of similar physiography and climate. The Wolf Lake Caribou Herd ranges in the southcentral Yukon and is bounded by the Nisutlin River to the west, the upper Liard River to the north, the eastern flank of the Cassiar Mountains to the east, and the Alaska Highway to the south (Fig. 1). The survey area selected for censusing the Wolf Lake Herd corresponds to the herd's winter distribution in 1987, and occurred wholly within the Wolf Lake lowlands. This area is dissected by plateaus and rolling hills ranging from 600 to 1,500 m in elevation; treeline is at 1,200 to 1,350 m. The area is extensively forested. Vegetation was described by Oswald and Senyk (1977).

The Finlayson Caribou Herd ranges in the eastcentral Yukon and is bordered by the Ross River drainage to the west, the Logan Range of the Selwyn Mountains to the north and east, and the St. Cyr Range of the Pelly Mountains to the southern boundary (Fig. 1). The winter distribution and subsequent survey area selected for the Finlayson Herd in 1986 occurred in the Ross River-Pelly River lowlands. Terrain in this area consists of deeply cut broad valleys, with occasional rolling hills and plateaus. Elevations are above 1,000 m, except for the 2 major river valleys which lie below 600 m. The Finlayson study area is also extensively forest-covered and described by Oswald and Senyk (1977).

METHODS

The SRQT first requires delineating a survey area, which in our case was the winter distribution of the study populations. The survey area is then divided into quadrats using, to the extent possible, natural features to define boundaries. Quadrats may vary in size but should be large enough such that movement of animals among quadrats over a 24-hour period is unlikely. Once quadrats have been defined, a low-level survey of the survey area is flown by fixed-wing aircraft to stratify the entire area based on the relative density of the caribou present. The strata categories are ranked in gross classifications, such as high, medium,

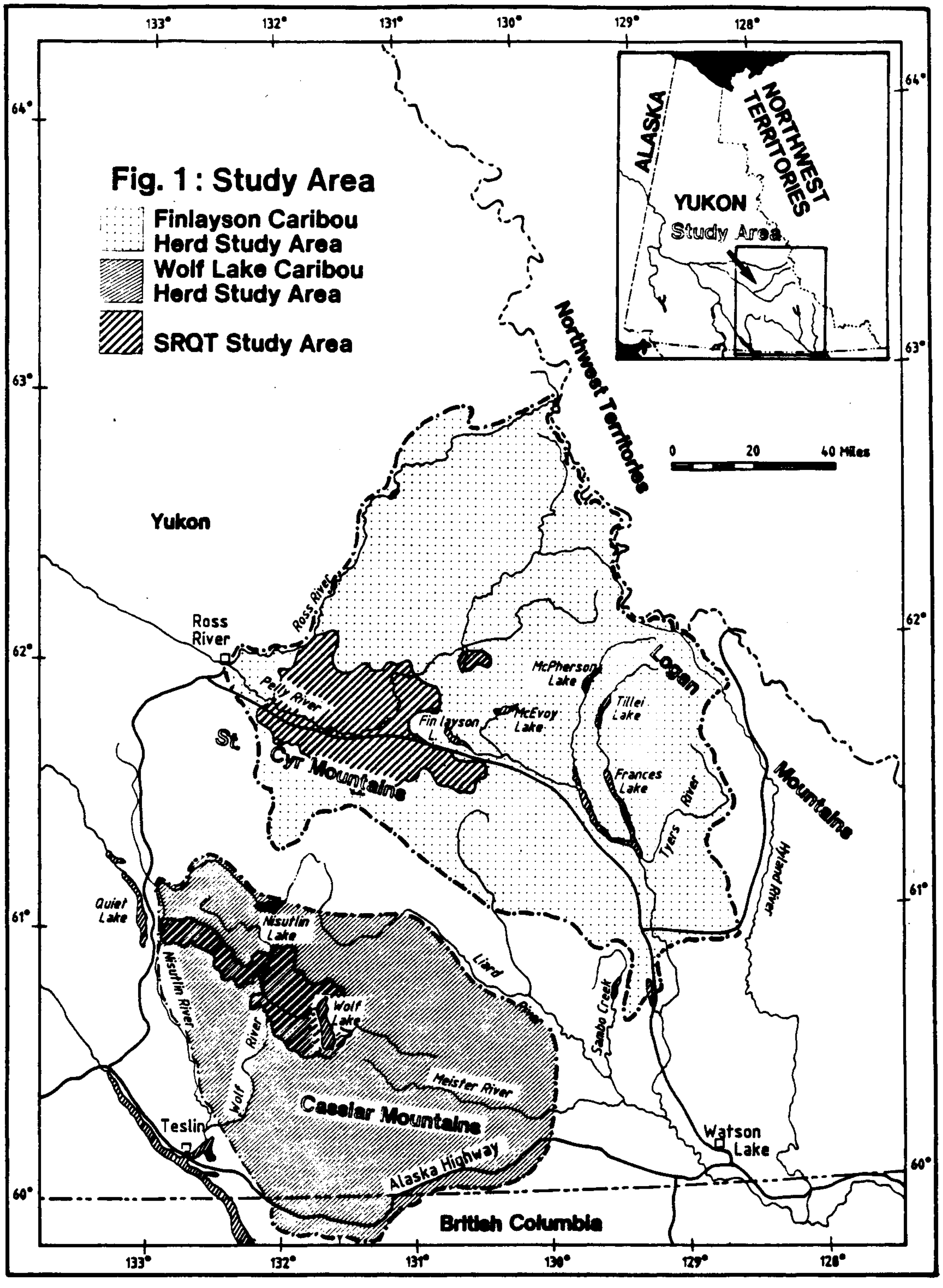


Fig. 1 : Study Area
Finlayson Caribou Herd Study Area
Wolf Lake Caribou Herd Study Area
SRQT Study Area
ALASKA
NORTHWEST TERRITORIES
YUKON
Study Area
Northwest Territories
0 20 40 Miles
Yukon
Ross River
Ross River
Pelly River
St. Cyr Mountains
Finlayson L.
McPherson Lake
McEvoy Lake
Tillei Lake
Logan
Frances Lake
Tyers River
Mountains
Hyland River
Quiet Lake
Nisutlin Lake
Nisutlin River
Liard River
Wolf Lake
Wolf River
Sambo Creek
Meister River
Cassiar Mountains
Teslin
Alaska Highway
Watson Lake
British Columbia
133° 132° 131° 130° 129° 128°
64° 63° 62° 61° 60°

4

low, or very low. Not all such categories may be present in a given survey area. The survey flight line must transect all quadrats, and each quadrat is subjectively assigned to a stratum based on number of animals and/or amount of sign seen.

A random sample of quadrats is chosen from each stratum for more intensive sampling. Of the total number of quadrats chosen, the proportion from each stratum should be proportional to the variation in the stratum.

Once quadrats have been chosen for more intensive sampling, they are searched in the order in which they were randomly drawn for each stratum. Intensive sampling should immediately follow the stratification flight to reduce the possibility of animal movement among quadrats. In Yukon, intensive surveying has been conducted by helicopter, using a search intensity of at least 4 min/mi^2. Number of animals and age and sex composition are recorded for each sighting.

To assess sightability biases, a number of quadrats are re-surveyed at a survey intensity of approximately 12 min/mi^2. These more intensive surveys are conducted to establish a sightability correction factor for population estimates (Gasaway et al. 1985).

Gasaway et al. (1986) provided a computer program for the Hewlett-Packard 41C and 41CV hand-held calculator that provides stratum and total population estimates with associated confidence limits. We have adapted that program for mainframe and micro-computers using the SAS (Statistical Analysis System) programming package (Version 5). The program is available on request from the authors.

In applying the SRQT to our study populations, we established 44 quadrats for the Wolf Lake area and 85 for the Finlayson area. Based on stratification flights, quadrats in each area were classified according to 2 density categories--high density (primary stratum) and low-to-moderate density (secondary stratum). Table 1 shows the total number of sample units within each stratum for each study area, the number selected for intensive sampling, the number used to establish a SCF for each area, and the size of each study area.

Table 1. Summary of survey data for the Wolf Lake and Finlayson Caribou Herds.

	Wolf Lake		Finlayson	
	High stratum	Low stratum	High stratum	Low stratum
Total number of quadrats	15	29	39	46
Number of quadrats in intensive survey	15	11	39	19
Number of quadrats surveyed for the sightability correction factor	8	0	8	0
Total area per stratum (sq km)	486.6	540.43	519.5	662.8

Earlier attempts to census these herds consisted of total counts during the breeding season in October. A helicopter was used to enumerate and classify caribou, both on alpine plateaus and across the herd distribution as determined by radiocollar relocations. These total counts were carried out on the Finlayson Herd in 1982, 1984, 1986, and on the Wolf Lake Herd in 1985 and 1986.

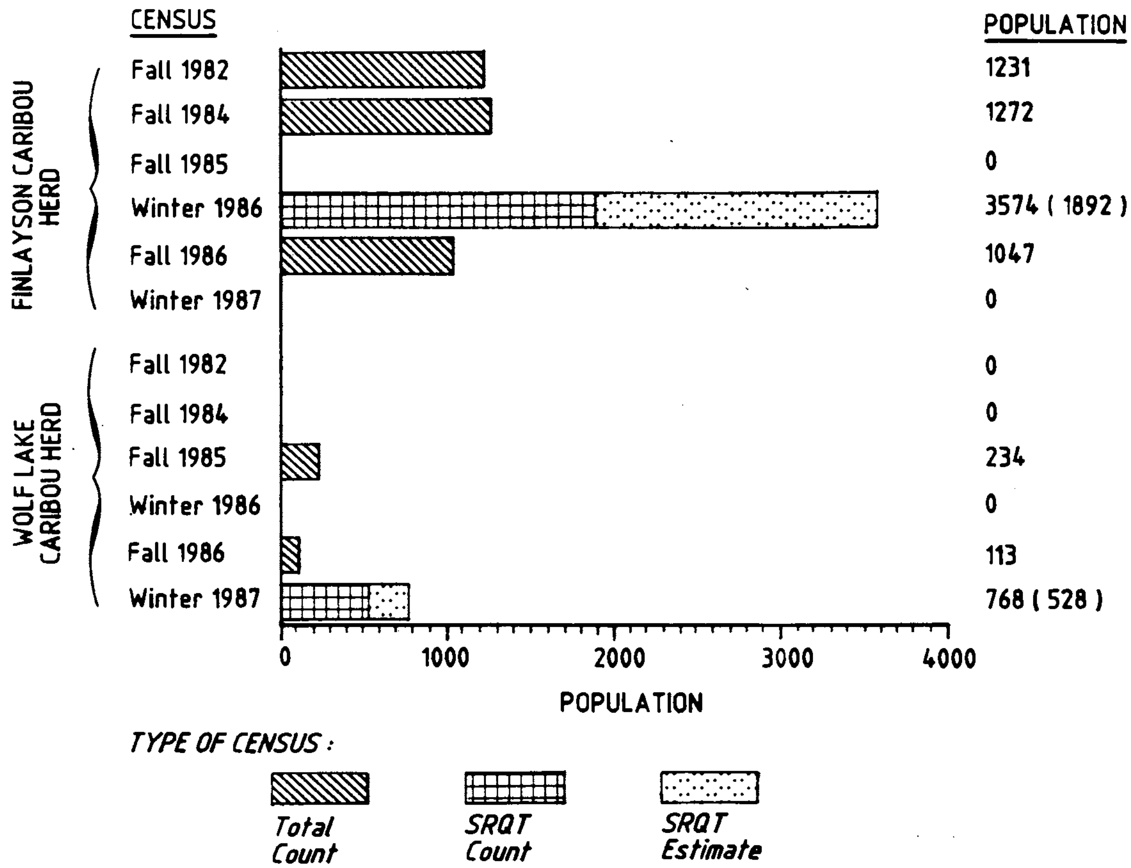
In addition to deriving population estimates for management purposes, objectives of this project were to: (1) compare the SRQT with the earlier total count technique; (2) assess the need for sightability correction factors; and (3) determine if acceptable estimates could be achieved by sampling less than the full number of quadrats within the primary stratum. To address the second objective, population estimates were calculated using the SCF and compared with estimates derived without using the SCF. The third objective was addressed by calculating a population estimate and confidence limits based on all quadrats that were sampled, and then recalculating population estimates by progressively removing information for additional quadrats from the calculations. For example, 15 quadrats were sampled in the primary stratum of the Wolf Lake Herd and 8 of those were resampled at a higher intensity to derive a SCF. We first calculated a population estimate based on all 15 quadrats, and then removed the information for the last quadrat that was randomly selected and recalculated the population estimate based on 14 quadrats. We repeated this procedure for the Wolf Lake Herd until information for only 3 quadrats in the primary stratum remained. At that point, only 2 of the original 8 sets of intensive search data were left to establish the SCF. As population estimates based on the SCF cannot be calculated with information on less than 2 quadrats, the iterative procedure stopped at that point. Therefore, there were 13 population estimates for the Wolf Lake Herd based on information from 15 through 3 primary stratum quadrats. For the Finlayson Herd, 23 population estimates were calculated based on information from 39 through 17 primary stratum quadrats; data on <17 quadrats yielded confidence limits on the population estimates that were too wide to provide usable information.

RESULTS AND DISCUSSION

Figure 2 compares earlier total counts of the 2 study herds with estimates derived from the SRQT. The number of caribou estimated and observed during SRQT surveys greatly exceeded the number observed during total counts. For the Finlayson Herd, 49% more caribou (*n* = 1,892) were observed on the SRQT survey (March 1986) than determined from the previous highest total count of animals in October 1984 (*n* = 1,272). Similarly, a total count of caribou (October 1986) after the SRQT survey was 45% lower (*n* = 1,047). The estimated population size (3,574) derived by SRQT was 181% higher than the highest total count (1,272).

For the Wolf Lake Herd, 126% more caribou (*n* = 528) were observed on the SRQT survey than on the previous highest total count (*n* = 234) in October 1985. The estimated population size (768) derived by SRQT was 228% higher than the highest total count (234).

Fig. 2 : Total census counts and expanded population estimates (SRQT method) for the Wolf Lake and Finlayson caribou herds.



In both cases the disparity between the total counts and SRQT results are likely due to greater accuracy in the SRQT method rather than population flux. The problems with total counts during fall seem to be: (1) the inaccurate assumption that all animals are distributed entirely in open habitats; (2) no correction for animals not observed; and (3) no estimate of precision.

Our population estimates for the 2 study herds derived from the SRQT, including the SCF (the expanded total) and excluding it (the observed total), are shown in Table 2. Confidence limits are given for the estimates derived using the SCF. The observed population estimate for the Wolf Lake Herd falls within the 95% confidence interval of the expanded population estimate, but the same is not true for the Finlayson Herd. The SCF was 1.3 for the Wolf Lake Herd vs. 1.7 for the Finlayson Herd, and the 95% confidence interval was ±28.0% of the mean for the Wolf Lake Herd vs. ±17.6% for the Finlayson Herd (Appendix A). These results suggest that incorporating a SCF is a significant improvement in census techniques. Applying a SCF accounts for much of the increase in the population estimates for the 2 study herds when comparing results from the SRQT and the total count censuses.

Table 2. Observed and expanded population estimates with 90% and 95% confidence intervals for the Wolf Lake and Finlayson Caribou Herds.

	Wolf Lake Herd	Finlayson Herd
Observed[a] population estimate	578	2,052
Expanded[b] population estimate	768	3,574
90% confidence interval	569-940	3,071-4,077
95% confidence interval	553-992	2,947-4,202

[a] Estimate without a SCF.
[b] Estimate with a SCF.

Figure 3 shows population estimates for the Wolf Lake and Finlayson Herds that incorporate the SCF (expanded totals), with their associated 90% and 95% confidence limits, and population estimates that do not incorporate a SCF (observed totals). Appendix A provides a detailed summary of all calculated values. Figure 3a indicates that the precision estimate for the Wolf Lake Herd widens above ±30% of the mean at the 90% confidence level; attaining 90% precision required sampling 11 of 15 quadrats (73% sampling effort) in the high-density stratum (assumes 11 quadrats were sampled in the low-density stratum) (Appendix A). With sampling effort >73% in the primary stratum, precision estimates fall between ±22 and ±29%.

For this analysis, we have arbitrarily decided that population estimates with >±30% precision at the 90% confidence level are of limited utility, and that estimates with >±40% precision are of little practical value. At the 95% confidence level, surveying all 15 quadrats in the Wolf Lake Herd was required to obtain a precision <±30% (Fig. 3c). In contrast, Figure 3b shows that, for the Finlayson Herd, the precision estimate at the 90% confidence level exceeds ±30% when only 23 of the 39 quadrats (59% sampling effort) in the high-density stratum are sampled (assumes 11 sample units surveyed in the low-density stratum) (Appendix A). Above this 59% sampling effort, precision estimates fall between ±14 and ±26%. Acceptable precision at the 95% confidence level for the Finlayson Herd (Fig. 3d) required that 27 (69%) of the 39 quadrats be sampled. These results suggest that calculations of variance, and not rules of thumb, should guide managers in deciding the number of quadrats to be sampled within high-density strata. In Yukon, managers have learned through experience that most or all quadrats within the high-density stratum, and ≥40% of the quadrats within the medium stratum, need to be sampled. Less emphasis is placed on sampling within the low or very low strata because of the reduced probability of encountering substantial numbers of animals there.

In conclusion, the unrealistically low population estimates derived from total count censuses of the 2 study herds contributed to the concern of those responsible for managing them. In addition, the unknown accuracy

Fig. 3 : Observed and expanded population estimates with 90% and 95% confidence intervals for the Wolf Lake and Finlayson Caribou herds according to the number of plots sampled.

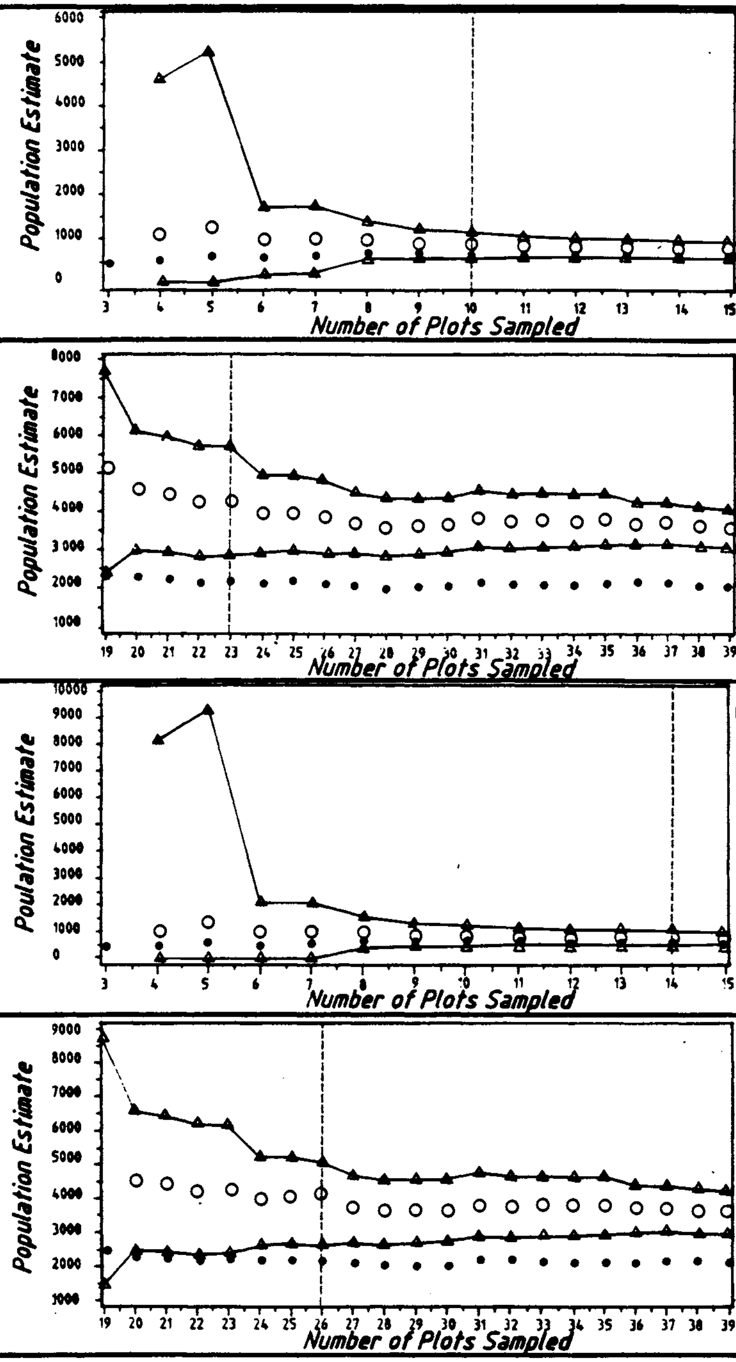


Fig. 3a : Wolf Lake Herd with 90% confidence intervals

Fig. 3b : Finlayson Herd with 90% confidence intervals

Fig. 3c : Wolf Lake Herd with 95% confidence intervals

Fig. 3d : Finlayson Herd with 95% confidence intervals

LEGEND :

○ Expanded population estimate

• Observed population estimate

△ 95% confidence intervals

Note : All estimates at and to the left of the vertical reference line have precision estimates >30%

of the total count estimates and no associated measure of precision concerned those studying the population dynamics of the herds. In particular, the low estimates for the Wolf Lake Herd elicited concern about the population's viability and suggested the need for more restrictive harvest levels. In the case of the Finlayson Herd, intensive management practices required accurate population estimates to interpret the results. The higher population estimates resulting from the SRQT method have been important in addressing many management concerns for these herds. Clearly, precise (and ideally, accurate) population estimates are essential to interpret population dynamics and for effective management of populations. We hope that the results of this paper will be of value to other woodland caribou managers.

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Appendix A. Summary of population estimation information for the Wolf Lake and Finlayson caribou herds.

	Sightability correction factor	Observed population estimate (variance) High strata	Low strata	Combined strata	Expanded population estimate (variance)	90% UCL[a]	90% LCL[b]	90% C.I.[c] (± % of $\bar{x}$)	95% UCL[a]	95% LCL[b]	95% C.I.[c] (± % of $\bar{x}$)
Wolf Lake Herd											
15 S.U., high stratum 11 S.U., low stratum 8 intensive searches	1.3284	453 (0)	125 (3454.7)	578 (3454.7)	768 (8244.5)	940	596	22.4	982	553	28.0
14 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.3564	442 (258.9)	125 (3454.7)	567 (3713.6)	769 (9906.9)	963	576	25.1	1013	526	31.6
13 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.3564	458 (564.7)	125 (3454.7)	583 (4019.4)	791 (16645.4)	992	591	25.3	1044	539	31.9
12 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.3564	458 (956.8)	125 (3454.7)	583 (4411.5)	791 (11363.7)	998	584	26.2	1052	530	32.9
11 S.U., high stratum 11 S.U., low stratum 6 intensive searches	1.3855	474 (1455.4)	125 (3454.7)	599 (4910.1)	830 (14680.5)	1074	586	29.4	1142	519	37.5
10 S.U., high stratum 11 S.U., low stratum 5, intensive searches	1.4089	469 (2043.2)	125 (3454.7)	594 (5497.8)	837 (20464.3)	1142	532	36.4	1234	440	47.4
9 S.U., high stratum 11 S.U., low stratum 5 intensive searches	1.4089	496 (2730.1)	125 (3454.7)	621 (6184.8)	874 (22681.5)	1195	553	36.7	1292	456	47.8

Appendix A. Continued.

	Sightability correction factor	Observed population estimate (variance) High strata	Low strata	Combined strata	Expanded population estimate (variance)	90% UCL[a]	90% LCL[b]	90% C.I.[c] (± % of $\bar{x}$)	95% UCL[a]	95% LCL[b]	95% C.I.[c] (± % of $\bar{x}$)
8 S.U., high stratum 11 S.U., low stratum 4 intensive searches	1.4621	530 (3184.3)	125 (3454.7)	655 (6638.9)	957 (33029.9)	1385	529	44.7	1535	379	60.4
7 S.U., high stratum 11 S.U., low stratum 3 intensive searches	1.6080	469 (2492.4)	125 (3454.7)	594 (5947.1)	956 (64616.0)	1698	214	77.7	2050	0	114.4
6 S.U., high stratum 11 S.U., low stratum 3 intensive searches	1.6080	451 (4280.9)	125 (3454.7)	576 (7735.5)	926 (65872.8)	1675	176	81.0	2030	0	119.3
5 S.U., high stratum 11 S.U., low stratum 2 intensive searches	2.1302	450 (7827.2)	125 (3454.7)	575 (11281.9)	1225 (402480)	5230	0	327.1	9286	0	658.2
4 S.U., high stratum 11 S.U., low stratum 2 intensive searches	2.1302	371 (7888.6)	125 (3454.7)	496 (11343.3)	1057 (310049)	4573	0	332.5	8132	0	669.2
3 S.U., high stratum 11 S.U., low stratum 1 intensive search	cannot be calculated	291 (3361.5)	125 (3454.7)	416 (6816.2)	--	--	--	--	--	--	--

Finlayson Herd

39 S.U., high stratum 11 S.U., low stratum 8 intensive searches	1.741	1766 (0)	286 (6926.0)	2052 (6926.0)	3574 (70454.3)	4077	3071	14.1	4202	2947	17.6

Appendix A. Continued.

	Sightability correction factor	Observed population estimate (variance) High strata	Low strata	Combined strata	Expanded population estimate (variance)	90% UCL[a]	90% LCL[b]	90% C.I.[c] (± % of $\bar{x}$)	95% UCL[a]	95% LCL[b]	95% C.I.[c] (± % of $\bar{x}$)
38 S.U., high stratum 11 S.U., low stratum 8 intensive searches	1.7419	1793 (1273.8)	286 (6926.0)	2079 (8226.22)	3622 (75619.7)	4143	3100	14.4	4272	2971	18.0
37 S.U., high stratum 11 S.U., low stratum 8 intensive searches	1.7419	1833 (2629.0)	286 (6926.0)	2119 (9555.0)	3690 (81669.1)	4232	3149	14.7	4366	3014	18.3
36 S.U., high stratum 11 S.U., low stratum 8 intensive searches	1.7419	1829 (4217.7)	286 (6926.0)	2115 (11143.7)	3684 (86276.6)	4240	3127	15.1	4378	2989	18.8
35 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1820 (5868.3)	286 (6926.0)	2106 (12794.3)	3783 (121149)	4459	3106	17.9	4634	2931	22.5
34 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1802 (7621.5)	286 (6926.0)	2088 (14326.7)	3750 (125383)	4438	3062	18.3	4616	2883	23.1
33 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1812 (9514.4)	286 (6926.0)	2098 (16440.4)	3768 (132244)	4475	3062	18.8	4658	2879	23.6
32 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1792 (11433.7)	286 (6926.0)	2078 (18359.6)	3731 (136831)	4450	3012	19.3	4636	2826	24.3
31 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1842 (13229.6)	268 (6926.0)	2128 (20155.6)	3822 (146440)	4566	3078	19.4	4758	2886	24.5

Appendix A. Continued.

	Sightability correction factor	Observed population estimate (variance): High strata	Observed population estimate (variance): Low strata	Observed population estimate (variance): Combined strata	Expanded population estimate (variance)	90% UCL[a]	90% LCL[b]	90% C.I.[c] (± % of $\bar{x}$)	95% UCL[a]	95% LCL[b]	95% C.I.[c] (± % of $\bar{x}$)
30 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1740 (13447.8)	268 (6926.0)	2026 (20373.8)	3639 (139478)	4364	2913	19.9	4552	2725	25.1
29 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1724 (15757.7)	268 (6926.0)	2010 (22683.7)	3609 (145705)	4351	2868	20.6	4544	2675	25.9
28 S.U., high stratum 11 S.U., low stratum 8 intensive searches	1.7961	1698 (18699.3)	268 (6926.0)	1984 (25625.3)	3563 (153291)	4324	2803	21.3	4521	2605	26.9
27 S.U., high stratum 11 S.U., low stratum 7 intensive searches	1.7961	1766 (20464.8)	268 (6926.0)	2052 (27390.8)	3684 (163860)	4471	2898	21.4	4675	2694	26.9
26 S.U., high stratum 11 S.U., low stratum 6 intensive searches	1.8354	1800 (23571.8)	268 (6926.0)	2086 (30497.8)	3828 (228648)	4791	2864	25.5	5057	2598	32.1
25 S.U., high stratum 11 S.U., low stratum 6 intensive searches	1.8354	1864 (25878.6)	268 (6926.0)	2150 (32804.5)	3945 (244265)	4941	2949	25.2	5216	2674	32.2
24 S.U., high stratum 11 S.U., low stratum 6 intensive searches	1.8354	1852 (30241.9)	268 (6926.0)	2138 (37167.9)	3923 (257300)	4945	2901	26.1	5227	2618	33.2
23 S.U., high stratum 11 S.U., low stratum 5 intensive searches	1.9840	1856 (35450.4)	268 (6926.0)	2142 (42376.4)	4249 (453848)	5686	2813	33.8	6119	2379	44.0

Appendix A. Continued.

	Sightability correction factor	Observed population estimate (variance) High strata	Low strata	Combined strata	Expanded population estimate (variance)	90% UCL[a]	90% LCL[b]	90% C.I.[c] (± % of $\bar{x}$)	95% UCL[a]	95% LCL[b]	95% C.I.[c] (± % of $\bar{x}$)
22 S.U., high stratum 11 S.U., low stratum 5 intensive searches	1.9840	1854 (41205.4)	268 (6926.0)	2140 (48131.4)	4244 (475436)	5714	2774	34.6	6158	2330	45.1
21 S.U., high stratum 11 S.U., low stratum 5 intensive searches	1.9840	1941 (43696.0)	268 (6926.0)	2227 (50622)	4418 (509223)	5939	2896	34.4	6399	2437	44.8
20 S.U., high stratum 11 S.U., low stratum 5 intensive searches	1.9840	1991 (48693.4)	268 (6926.0)	2227 (55619.4)	4516 (542673)	6087	2946	34.8	6561	2471	45.3
19 S.U., high stratum 11 S.U., low stratum 4 intensive searches	2.2119	1991 (58015.5)	268 (6926.0)	2277 (64941.5)	5036 (1277354)	7696	2377	52.8	8633	1440	71.4
18 S.U., high stratum 11 S.U., low stratum 3 intensive searches	2.19736	2112.77 (49553.0)	268 (6926.0)	2398.46 (56479)	5270.27 (2232375)	9633.08	907.46	82.78	11699.4	0	121.99
17 S.U., high stratum 11 S.U., low stratum 2 intensive searches	2.81285	2109.64 (60259.7)	268 (6926.0)	2395.33 (67185.7)	6737.73 (12835143)	29358.4	0	335.73	52258.5	0	675.61

[a] UCL = upper confidence limit.
[b] LCL = lower confidence limit.
[c] C.I. = confidence interval.