SPRING CLASSIFICATION COUNTS OF THE BLUENOSE CARIBOU HERD MARCH 1986 & 1987

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ABSTRACT

We determined spring calf:cow ratios in the Bluenose caribou herd and evaluated the accuracy and precision of those results. In 1986 we classified 2730 caribou in 29 groups where group selection was based on the location of radio collared adult females which had been collared in November 1985. We classified a further 3331 caribou in 31 groups where the groups were selected arbitrarily. In 1987, 3813 caribou in 31 collared groups and 4206 caribou in 24 arbitrary groups were classified. Caribou were classified by age (calf, yearling, subadult, or adult) and sex. Estimates of calf:cow ratios and their standard deviations were compared using cluster analysis procedures and the jackknife technique (Cochran 1977). Groups of caribou were classified during the period 7-17 March 1986 and during 3-14 March 1987. In 1986 our estimate of the calf:cow ratio in groups associated with radio-collared cows (52 ± 3.0 (SD)) was significantly lower than our estimate in groups selected arbitrarily (64 ± 4.8 (SD)). In 1987 the opposite was true (55 ± 4.8 (SD) vs 42 ± 3.1 (SD)). In 1986 we were not able to attribute the difference between estimates to observer bias, or the effects of group size, location, or the proportion of males in the group. In 1987, however, location and percentage of males in the group had a significant effect on the calf:cow ratio. We concluded that about 30 sample units, where sample units were representative groups of about 100 caribou, provided an acceptable estimate of the mean and standard deviation of the calf:cow ratio. Because the jackknife technique does not require data to be normally distributed, it is more appropriate than cluster analysis. The high calf:cow ratios estimated in both 1986 and 1987 suggest calf survivorship in excess of 65% from June until the subsequent March and that the Bluenose Herd should be growing.

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INTRODUCTION

In the Northwest Territories, estimates of caribou (Rangifer tarandus) population size are expensive and obtained only every two to three years. The calf:cow ratio in March and April is an index of recruitment that can be obtained every year to help interpret population trends. Although spring calf:cow ratios are commonly calculated for caribou, the biases and sampling errors of the field methods have not been measured.

Recruitment data are often relied on to interpret population dynamics (Bergerud 1980, Bergerud and Elliot 1986, Skogland 1985, Heard and Calef 1986), but are rarely accompanied by 1) an adequate description of sampling methods, 2) descriptive statistics or, if reporting sampling precision, an adequate description of how statistics were calculated or 3) any discussion of the accuracy and possible biases of the methods.

Funding under the Northern Oil and Gas Action Program (NOGAP) of Indian and Northern Affairs Canada (INAC) from 1985-1987 enabled us to conduct spring composition counts of the Bluenose herd, improve our sampling procedures, and test the biases and sampling errors of our data.

Spring classification counts were conducted in March 1986 and March 1987 on the Bluenose winter range predominantly below the tree line (Figure 1). Our objectives were to: (1) determine the best method for estimating the precision of calf:cow ratios, and

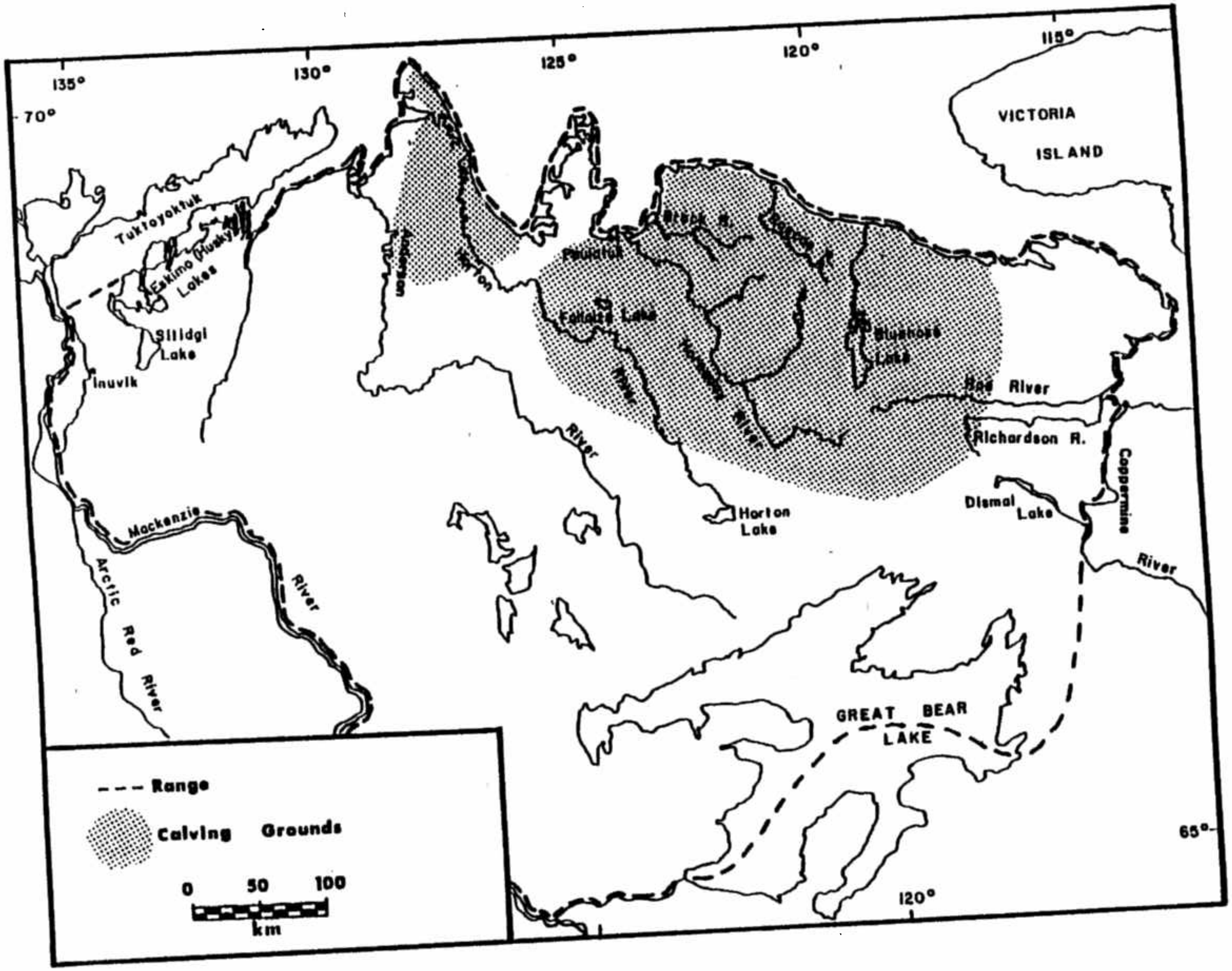

Figure 1. Range and general calving area of the Bluenose herd 1986 and 1987.

(2) test for sampling biases by comparing calf:cow ratios based on sample units located arbitrarily with sample units located near radio-collared cows.

METHODS

We determined the location of the majority of radio collared animals on 5 March 1986. Between 7 and 17 March 1986 we classified groups of caribou to obtain calf:cow ratios. Animals were located in late February in 1987 by radio-tracking and groups were classified during the period 3-14 March 1987. Initially we pinpointed the location of the collared cows and attempted to get a visual confirmation. Caribou associated with the collared animal were considered a group and were then classified. Crews were positioned near a group either by a Cessna 185 on skis or a Bell 206B helicopter. Groups were classified from the air by helicopter when landing was impossible. We attempted to classify all caribou in the immediate vicinity of the collared animal.

From the ground, caribou were observed through 20-45x spotting scopes on tripods. Caribou were classified as calves (9 month old animals), yearling males or females, adult females, young bulls or mature bulls. Sex determination was based on the presence or absence of a vulva or the presence of a penis. Calves were distinguished by their small body size and rounded skull profile. Younger bulls retained at least one hard antler, while mature bulls were large and antlerless. Observations were recorded on pocket tape recorders and later transposed into fieldbooks. "Cows" refers to adult plus yearling females and "bulls" refers to young bulls plus mature bulls.

The selection of non-radio-collared groups was arbitrarily based upon large group size, available landing sites and ease of viewing (i.e., lakes, open areas) as is normally done for spring classification counts in the NWT (Williams and Elliott 1985).

Estimates of ratios and standard error were based on cluster sampling procedures and the jackknife method (Cochran 1977). Variation in estimates due to observer bias was tested by paired t-test, or chi-square tests of independence. The effects of location, sampling date, group size, and proportion of males on the calf:cow ratio was tested by linear regression.

Calf:cow ratios obtained by the two sampling methods were compared with a t-test ; $t= (R_1-R_2)/(V_1+V_2)^{.5}$ where R_1 is the calf:cow ratio obtained from the arbitrary sample and V_1 is its variance and R_2 and V_2 are the corresponding estimates from the radio-collared sample. Calf survival was estimated by assuming an initial birth rate (Parker 1972, Heard and Calef 1979) and comparing the change in calf:cow ratios from birth until spring.

RESULTS

Distribution and Movements

The location of radio-collared caribou in January and February 1986 suggested that most of the Bluenose caribou herd wintered between Inuvik and the Anderson River, and between Eskimo Lakes south to Traivaillant Lake and Colville Lake (Figure 2). Small groups, predominantly bulls, occupied the western fringes of that range while larger groups of females and young bulls occupied the central locations. A segment of the Bluenose herd was seen near Dismal Lake in late March 1986 during the course of other work (D. Heard field notes), but we did not attempt to classify caribou there. Caribou movements became more pronounced by 12-14 March and by 16-17 March, long lines of migrating caribou eastwards were observed near the mouth of the Kugaluk River and the forks of the Anderson River.

In March 1987 large numbers of caribou were located in approximately the same area as March 1986 (Figure 3). Part of the herd had travelled west to the Mackenzie River just north of Inuvik in November 1986, before moving back to the east of Inuvik by January - February 1987. By 14 March bands of caribou were migrating to the east similar to March 1986.

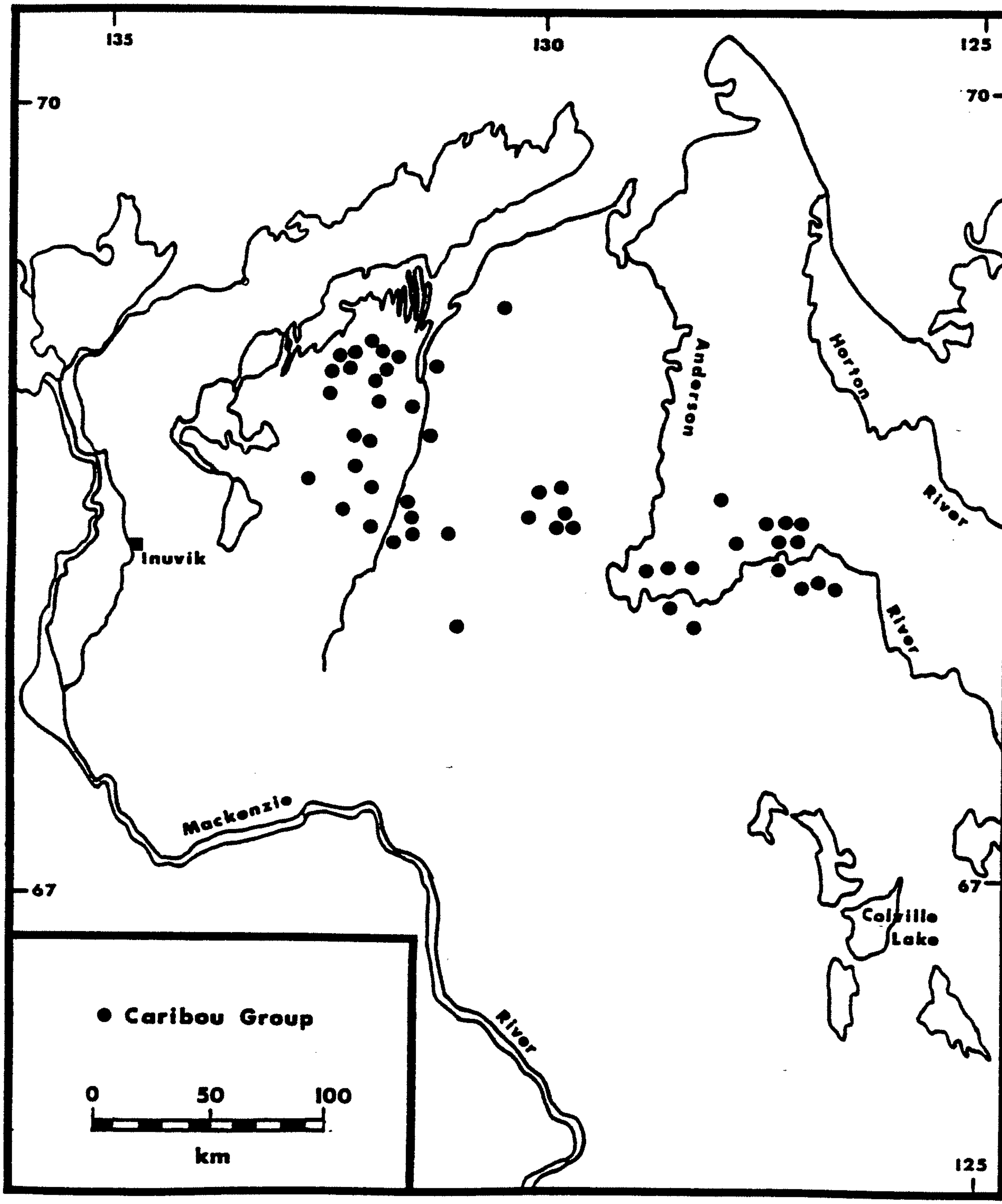

Figure 2. Locations of Bluenose caribou groups classified during the composition survey, March 1986.

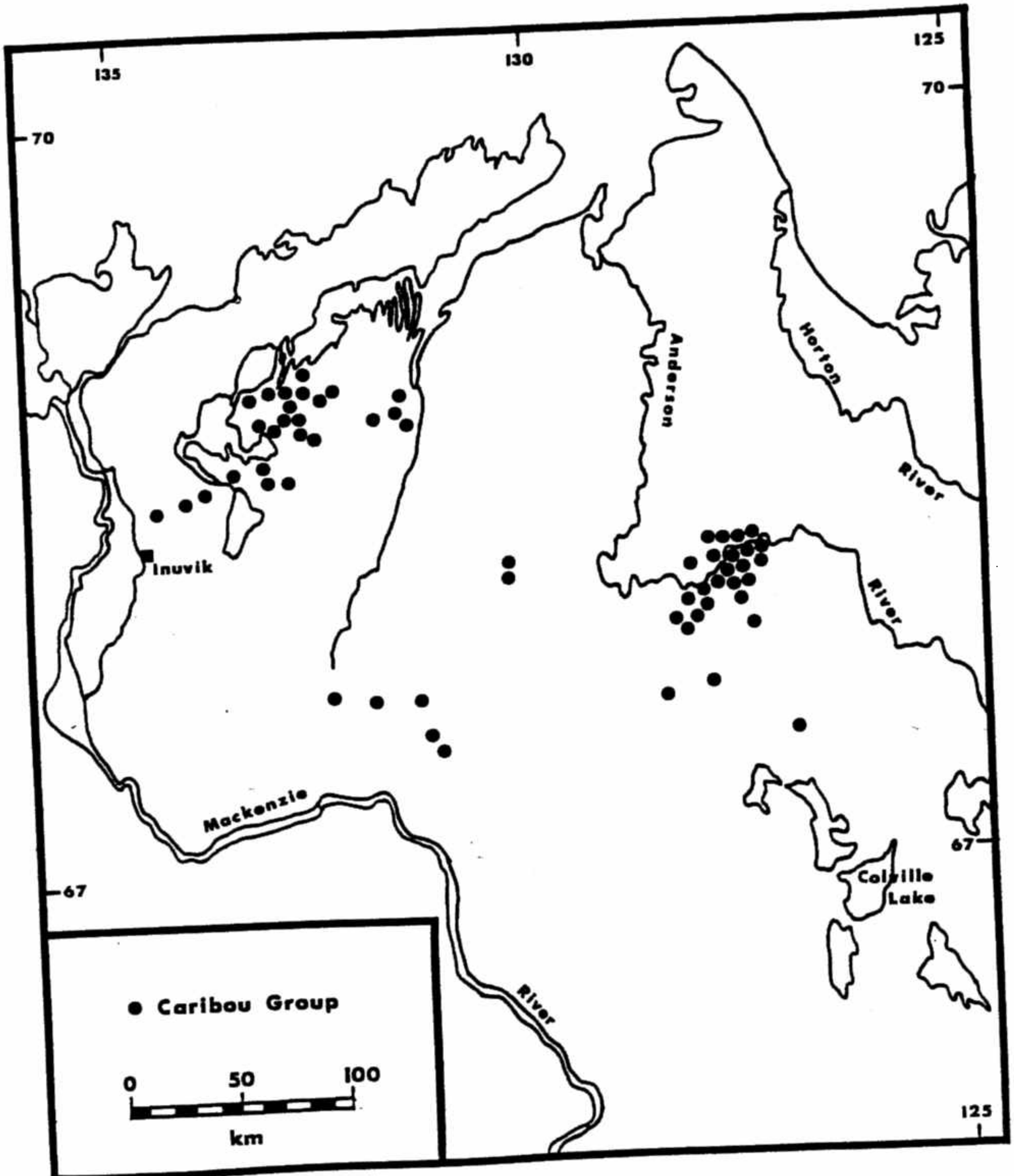

Figure 3. Location of Bluenose caribou groups classified during the composition survey, March 1987.

Composition Analysis

A total of 2730 caribou were classified in 29 groups in 1986 where group selection was based on the location of radio collared cows (Table 1). We classified a further 3331 caribou in 31 groups in 1986 where the groups were selected arbitrarily (Table 2). In 1987, 3813 caribou in 31 collared groups (Table 3) and 4206 caribou in 24 arbitrary groups were classified (Table 4).

We compared estimates of sampling variation of calf:cow ratios based on cluster sampling to the variation estimated from the jackknife method.

Our estimate, using the jackknife method, of 52 $\pm$ 3.0 (SD) calves:100 cows in groups associated with radio-collared caribou was significantly lower than our estimate of 64 $\pm$ 4.9 (SD) calves: 100 cows in groups selected arbitrarily (Table 5, $t=2.15$, $df=56$, $p<0.05$) in 1986.

In 1987 the opposite relationship occurred. Our estimate of 55 $\pm$ 4.8 (SD) calves:100 cows in groups associated with radio-collared caribou was significantly higher than our estimate of 42 $\pm$ 3.1 (SD) calves:100 cows in groups selected arbitrarily (Table 5, $t=2.27$, $df=57$, $p<0.05$).

In 1986 we were not able to attribute the difference between estimates to observers bias, or to the effects of group size, location, or the proportion of males in the group. In 1987, however, location and percentage of males in the group had a significant effect on the calf:cow ratio.

Table 1. Composition of groups associated with radio-collared caribou in the Bluenose caribou herd, March 1986.

Date	Group number	Calves	Adult females	Yrlg females	Yrlg males	Young bulls	Mature bulls	Total	Observers
7/3/86	15	48	112	9	11	24	2	206	DH
7/3/86	9	16	37	3	0	10	0	66	DH
7/3/86	26	43	68	4	8	25	1	149	MW
7/3/86	27	16	32	1	1	2	1	53	MW
7/3/86	30	74	107	6	4	14	1	206	MW/LK
7/3/86	2	6	26	1	0	2	0	35	DH
9/3/86	17	25	69	10	7	7	1	119	DH
9/3/86	1	12	13	0	1	2	0	28	DH
9/3/86	11	26	54	5	1	3	0	89	DH/BM
9/3/86	21	10	27	2	0	3	0	42	DH/BM
9/3/86	24	23	30	4	0	11	3	71	MW/LK
9/3/86	6	59	103	9	14	35	2	222	MW/LK
9/3/86	28	8	16	5	1	1	0	31	MW
9/3/86	7	20	18	4	1	14	1	58	MW/LK
10/3/86	29	7	21	0	4	5	1	38	MW/LK
10/3/86	22	6	14	0	0	0	1	21	DH
10/3/86	8	13	14	0	0	2	0	29	DH
10/3/86	3	15	23	4	4	1	0	47	DH/BM
10/3/86	14	3	6	1	1	12	0	23	DH
10/3/86	20	18	42	4	3	12	0	79	DH/BM
10/3/86	25	9	13	2	1	2	0	27	MW
11/3/86	5	63	127	11	9	9	0	219	DH/BM
11/3/86	12	61	94	2	1	17	2	177	DH/BM
11/3/86	18	18	18	2	0	19	1	58	DH/BM[1]
11/3/86	13	24	48	8	0	11	1	92	DH/BM
11/3/86	10	67	86	5	1	11	1	171	DH/BM[1]
12/3/86	4	7	13	1	1	3	0	25	DH
12/3/86	19	45	76	2	2	35	0	160	DH/BM
12/3/86	23	52	109	12	7	9	0	189	DH
Totals		794	1416	117	83	301	19	2730	
Per cent		29	52	4	3	11	1	100	

51.8 ± 2.86 (SD) calves: 100 cows[2]

[1] All or part of composition determined from the air
[2] Cows = adult plus yearling females

Table 2. Composition of arbitrarily selected groups of caribou in the Bluenose caribou herd, March 1986.

Date	Group number	Calves	Adult females	Yrlg females	Yrlg males	Young bulls	Mature bulls	Total	Observers
10/3/86	R1	17	30	2	0	8	3	60	DH
12/3/86	R2	8	15	0	0	5	0	28	DH
12/3/86	R3	84	57	9	16	137	2	305	DH/BM
12/3/86	R4	47	78	8	2	14	0	149	DH
12/3/86	R5	30	53	1	5	4	0	93	DH
12/3/86	R6	14	27	1	1	2	0	45	DH
12/3/86	BM1	87	77	1	12	37	3	217	BM/LK
12/3/86	R7	0	0	0	0	5	1	6	DH
13/3/86	R8	0	1	0	0	4	5	10	DH
14/3/86	R9	1	2	0	2	21	1	27	DH
14/3/86	R10	145	199	10	14	49	2	419	DH/LK
14/3/86	R11	76	108	8	6	14	0	212	DH/LK
14/3/86	R12	39	68	8	1	2	0	118	DH/LK
14/3/86	R13	7	15	2	1	2	0	27	DH
14/3/86	R14	4	7	0	0	6	0	17	DH
14/3/86	R15	0	0	0	1	12	11	24	DH
14/3/86	R16	15	17	0	4	30	5	71	DH
14/3/86	BM2	16	21	1	1	7	0	46	BM[1]
14/3/86	BM3	10	16	1	0	10	1	38	BM
14/3/86	BM4	13	39	3	2	4	1	62	BM[1]
14/3/86	BM5	25	45	3	1	5	0	79	BM
14/3/86	BM6	39	92	4	1	0	0	136	BM[1]
14/3/86	BM7	8	21	3	0	0	0	32	BM[1]
14/3/86	BM8	11	10	1	0	5	0	27	BM
14/3/86	BM9	15	19	1	0	1	0	36	BM[1]
14/3/86	BM10	40	24	0	5	9	0	78	BM[1]
16/3/86	BM11	36	105	10	4	3	0	158	BM
16/3/86	BM12	40	72	2	1	7	0	122	BM
16/3/86	BM13	23	15	3	1	6	0	48	BM
16/3/86	BM14	117	172	10	4	20	1	324	BM
16/3/86	BM15	109	172	5	1	27	3	317	BM
Total		1076	1577	97	86	456	39	3331	
Per cent		32	47	3	3	14	1	100	

64 ± 4.8 (SD) calves: 100 cows[2]

[1] All or part of composition determined from the air

[2] Cow = adult plus yearling females

Table 3. Composition of groups associated with radio-collared caribou in the Bluenose caribou herd, March 1987.

DATE	COLLARS	CALVES	ADULT FEMALES	YRLG FEMALES	YRLG MALES	YOUNG BULLS	MATURE BULLS	TOT.	OBSR.
3/3/87	25,54	57	69	9	4	44	1	184	DH
5/3/87	25,54, 43,46	111	143	11	5	48	6	324	BM/LK
5/3/87	4B	47	65	3	4	22	7	148	BM/LK
5/3/87	33	1	1			6	24	32	BM
5/3/87	5	20	35			1		56	BM
5/3/87	35	66	171	8	6	27	5	283	BM
5/3/87	45,39,40, 55,24,3	100	125	14	14	98	11	362	DH
5/3/87	47	10	23		3	14	1	51	BM
6/3/87	44	78	99	15		61	5	258	DH
6/3/87	26,30	22	56	2	1	11	3	95	BM
6/3/87	10	10	15	1	1	6		33	BM
6/3/87	49	1				20	49	70	BM
6/3/87	29	68	82	7	7	33	5	202	BM/LK
7/3/87	2	22	35		1	4		62	BM
7/3/87	20	30	58	3		4	2	97	BM
7/3/87	14,41	19	33	1	2	3		58	BM
7/3/87	19	18	32			6		56	BM
7/3/87	17	19	71	1	1	8		100	BM
7/3/87	13	12	12	1	2	13	4	44	BM
8/3/87	18	11	8	3	2	9	15	48	DH
8/3/87	15	10	18		5	11		44	DH
8/3/87	1	44	32	9	12	81	9	187	DH
8/3/87	9	25	25	5	6	38	2	101	DH
8/3/87	12	39	94	5	1	4		143	DH
8/3/87	22	24	56	5	3	11		99	DH
8/3/87	6	12	45	3				60	DH
8/3/87	11	23	83	5	1	4		116	DH
8/3/87	37	16	76	7				99	DH
8/3/87	38	29	48		4	2		83	DH
8/3/87	8	32	34	2	3	13		84	DH
9/3/87	53	11	9	3	4	34	13	74	DH
9/3/87	52	2	2		1	8	39	52	DH
9/3/87	50					3	19	22	DH
9/3/87	51				1	4	25	30	DH
9/3/87	31					2	26	28	DH
TOTALS		989	1655	123	94	653	271	3785	
Percent		26.1	43.7	3.2	2.5	17.2	7.2		

55 ± 4.8 (SD) calves:100 cows

Table 4. Composition of arbitrarily selected groups of caribou in the Bluenose caribou herd, March 1987.

DATE	GROUP #	CALVES	ADULT FEMALES	YRGL FEMALES	YRGL MALES	YOUNG BULLS	MATURE BULLS	TOTAL	OBSRS.
3/3/87	R-1	30	65	5	3	16	7	126	DH
3/3/87	R-2	41	112	8	5	23		189	DH/LK
3/3/87	R-3	25	50	4	2	21	1	103	DH
3/3/87	R-4	43	55	5	4	11		118	DH
3/3/87	R-5a					18	24	42	DH
3/3/87	R-5	28	37	10	16	118	42	251	DH
3/3/87	R-6	3	2			19	42	66	DH
3/3/87	R-7	3	2	1	3	34	45	88	DH
3/3/87	R-8	69	176	15	4	23	1	288	BM
4/3/87	R-9	72	128	12	7	19	14	252	DH/BM
4/3/87	R-10	42	73	5	4	11	2	137	DH/BM
4/3/87	R-11	90	197	15	10	86	10	408	DH/LK
4/3/87	R-12	61	13	6	4	13	5	102	DH
4/3/87	R-13	4	1		1	18	111	135	DH
4/3/87	R-14a					4	48	52	DH
7/3/87	R-14	52	189	10	5	13	1	270	DH/BM
7/3/87	R-15	40	121	2	3	12		178	LK
8/3/87	R-16	41	161	9	4	15	1	231	BM/DH
8/3/87	R-17	38	35	9	6	26	8	122	DH
8/3/87	R-18	20	47	5	3	9	1	85	DH
8/3/87	R-19	10	26	7	2	3		49	DH
8/3/87	R-20	16	23	3		4		46	DH
8/3/87	R-21	36	34	5	11	20	1	107	DH
8/3/87	R-22	8	22	2	2	6		40	LK
14/3/87	R-23	64	173	15	14	79	2	347	BM
14/3/87	R-24	64	156	11	10	27		268	BM
TOTALS		901	1898	164	123	648	366	4100	
Percent		22.0	46.3	4.0	3.0	15.8	8.9		

64 ± 4.9 (SD) calves: 100 cows

Table 5. Number of calves/100 cows, Bluenose herd, 1986 and 1987.

Year	Collared groups		Arbitrary groups		Analysis
	Mean	SD	Mean	SD	
1986	52	2.9	64	4.8	Cluster
	52	3.0	64	4.9	Jackknife
1987	55	4.7	42	3.0	Cluster
	55	4.8	42	3.1	Jackknife

DISCUSSION

The calculated calf:cow ratios were quite high in both years, using either method of data collection. This suggests good calf overwinter survival. An average of only 50% of calves in many herds live to 12 months of age (Bergerud 1978). In the Delta caribou herd in Alaska, a herd thought to be stable, the calf:cow ratio was 29/100 cows in April 1987 (Davis et al. 1988).

We were unable to explain fully the significant differences between the ratios from the two methods of group selection. The radio-collars led us to locations that would not have been sampled by arbitrary group selection. Our data suggests that groups sampled farther from their winter range and groups with fewer bulls had lower calf:cow ratios, probably because some calves stayed behind with the bulls when their mothers began migrating to the calving ground. Because most calves remain with their mothers throughout the winter and age segregation is essentially complete by the time the cows reach the calving ground in June, the breakdown of most cow-calf bonds must occur just before or during spring migration. Radio-collaring a sample of calf-cow pairs and monitoring them from June until the next June would document the breakdown of this bond. Presumably segregation occurs because pregnant cows move too quickly for the less motivated calves to keep up. Although some segregation of cows and calves had already occurred during our study, as was demonstrated by group R_3 in 1986 which had more calves than cows, none of our indices of segregation indicated that differential segregation led to the difference in calf:cow ratios between the two sampling methods in 1986.

Group size often increases as migration progresses but there was no relationship between calf ratios and group size. Although traditionally we often select for large groups to classify, our arbitrary groups in this study were only marginally larger than radio-collared groups that we considered representative. We speculated that the rate of movement might accentuate age segregation but neither group location nor date was related to calf:cow ratios in 1986. If the departure of cows resulted in their calves being left behind with the remainder of the winter group then the calf:cow ratio should increase with the proportion of bulls in the group but the regression was not significant ($P>0.05$).

Differences in calf:cow ratios could not be explained on the basis of observer bias, sampling date, location, group size, or the percentage of males in the group in 1986. We felt that there was little difference in the types of groups selected by either sampling method although a few of the radio-collared cows were in small dispersed groups among the trees and it is unlikely that such groups would have been detected when selecting groups arbitrarily.

Selecting groups based on the presence of radio-collared cows may have been biased against calf groups, therefore underestimating the true calf:cow ratio. Although the groups we located by radio-telemetry should be representative of cow groups in the herd (Valkenburg et al. 1983), some segregation of cows and calves had already occurred by the time we carried out this work (in both years). The severity of the underestimation depends on the amount of segregation between cows and calves. In the extreme case of complete cow-calf segregation, there would be no calves in any of the radio-collared groups indicating 0 calves:100 cows regardless of the true ratio. This bias could explain the difference we found in calf:cow ratios between our sampling methods. The accuracy of spring composition counts may be increased if sample units were selected using radio-collared calves as well as collared cows or if sampling occurred before the breakdown of cow-calf bonds.

Our arbitrary group selection criteria differed from most previous spring composition counts that have been conducted in the NWT because our use of a helicopter allowed us to classify groups that would not have been accessible when using fixed wing aircraft. The effect of habitat and, therefore, landing conditions on the accuracy of composition counts was not addressed in the study but would be worthwhile testing.

Increased precision (smaller variance) of the ratio estimate may be achieved by increasing the number of groups classified but because both coefficients of variation were below 0.10, the recommended level for wildlife studies (Heard 1985), we felt that increased sampling effort would not be justified.

The estimates of calf ratios both years indicate high calf survival and potential recruitment (Table 6). This data would suggest that the Bluenose herd is growing. Photo census of the herd in 1986 and 1987 estimated that the herd had increased to 115,000

Table 6. Calf/cow ratios, yearling/cow ratios, and overwinter calf survival, Bluenose herd, 1981 - 1987.

Date	Calves: 100(1yr+) cows ± SD	Yearlings: 100 (2yr+) cows ± SD	Overwinter calf survival (%)[d]	Source
02/81	/(18[ab])	-	-	Carruthers & Jakimchuk 1981
02/83	/(15[a])	-	-	Carruthers et al. 1983
03/83	44 ±2.5/(24[a])	18 ±0.6/(8.0[c])	59	Williams & Elliott 1985
03/86	55 ±2.5/(26[a])	13 ±1.2/(5.0[c])	73	This study.
03/87	49 ± /(24[a])	14 ± /(6.0[c])	65	This study.

a) Percentage calves of total classified.
b) Aerial classification by fixed-wing aircraft.
c) Percentage yearlings of total classified.
d) Assuming 69 calves born per 100 cows in June (Parker 1972) and females survivorship from June to March of 93% (Heard and Calef 1979).

non-calf caribou in July 1987. Other caribou herds in the NWT also had high calf:cow ratios in 1986 (Kaminuriak 48-56 calves:100 cows, Bathurst 48-61 calves:100 cows, unpubl. Dept. Ren. Res. files).

The sex ratio in our samples (26-35 bulls:100 cows) in 1986 was lower than the estimate of 73 bulls:100 cows found by Brackett et al. (1982) in the fall of 1982. Spring composition counts consistently underrepresent the male component of the herd because of differential use of the winter range and segregation of males and females. The mature bulls usually winter in separate groups farther west and south of the cow groups (Carruthers and Jakimchuk 1981). Bergerud (1980) considered 60 bulls:100 cows to be representative of caribou herds subject to wolf predation and relatively unselective hunting. We estimated the percentage of calves in the herd by assuming the Bluenose herd had a sex ratio of 60 bulls:100 cows and correcting for the unrepresented male component of the herd. Our estimates of 27% calves in 1986 suggests that the Bluenose herd size is increasing and that overwinter calf survival from July 1985 to March 1986 was approximately 70% (Appendix A.)

The relatively low proportion of yearlings in our samples is probably a reflection of the classification bias of classifying yearlings as adults. We do not feel that we were misclassifying yearlings as calves. It is unlikely that mortality from 9 months to 21 months of age is significantly different from adult mortality rates. The best method to determine mortality rates accurately would be a program in which calves were collared and monitored until at least two years of age. This has been done in Alaska on the Delta caribou herd where mortality rates were variable in general but differed little from 5 to 24 months as compared with animals older than 24 months (Davis et al. 1988). This data is important in interpretation of the calf/cow ratios to true recruitment, namely how many animals reached breeding age. It has been suggested that caribou herds do not seem to increase with calf percentages in March of less than 10 percent (Bergerud 1978). Data is not available on the natural mortality rates of Bluenose caribou, but hunter kill information should be available soon as harvest studies are underway or planned in the principal communities which hunt the herd.

ACKNOWLEDGEMENTS

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Appendix A. Calculations for March 1986 and March 1987 composition surveys.

1986

1. Sex ratio of animals over one year old

Collared groups (n=29)

Total bulls = 403

Total cows = 1533

Therefore, there were 21% bulls in the sample (403/[403+1533]) or 26 ± 3.4 (SD) bulls:100 cows (100x403/1533).

Random groups (n = 31)

Total bulls = 581

Total cows = 1533

Therefore, there were 26% bulls in the sample (581/[581+1674]) or 35 ± 9.9 (SD) bulls:100 cows (100x581/1674).

All groups (n = 60)

Total bulls = 984

Total cows = 3207

Therefore, there were 23% bulls in the combined sample (984/[984+3207]).

2. Calf:cow ratios and the percent calves in the samples and in the herd.

Collared groups (n=29)

Total calves = 794

Total cows = 1533

Total animals classified = 2730

Therefore, there were 29% calves in the sample (794/2730) or 52 calves: 100 cows (100x794/1533).

Random groups (n=31)

Total calves = 1076

Total cows = 1416

Total animals classified = 3331

Therefore, there were 32% calves in the sample (1076/3331) or 64 calves:100 cows (100x1076/3331)

3. Percent yearlings in the samples and the ratio of yearlings to adult females.

Collared groups (n = 29)

Total yearlings = 200

Total adult females = 1416

Total classified = 2730

Therefore, there were 7.3% yearlings in the sample (200/2730) or 14 ± 1.5 (SD) yearlings :100 adult females (100x200/1416)

Random groups (n = 31)

Total yearlings = 183

Total adult females = 1577

Total classified = 3331

Therefore, there were 5.4% yearlings in the sample (183/3331) or 12 ± 1.7 (SD) yearlings:100 adult females (100x183/1577).

All groups (n = 60)

Total yearlings = 383

Total adult females = 2993

Total classified = 6061

Therefore, there were 6.3% yearlings in the combined sample (383/6061).

4. Survival of calves from birth through March.

If we assume 1) an initial calf production of 72 calves:100 cows (Parker 1972, Dauphine 1976); and 2) female survival from June 1985 to March 1986 of 93 % (Heard and Calef 1986) then there were 108 cows in June 1985 for every 100 cows still alive in March 1986 (100/.93). Those 108 cows produced 75 calves (108 x 0.69) of which 55 calves (both samples combined) or 73 % were still alive in March 1986 (100 x 55/75). Thus calf survival was estimated at 71 % from June 1985 to March 1986.

1987

1. Sex ratio of animals over one year old

Collared groups (n=35)

Total bulls = 1018

Total cows = 1778

Therefore, there were 36% bulls in the sample (1018/[1018+1778]) or 57 bulls:100 cows (100x1018/1778).

Random groups (n = 24)

Total bulls = 1137

Total cows = 2062

Therefore, there were 36% bulls in the sample (1137/[1137+2062]) or 55 bulls:100 cows (100x1137/2062).

All groups (n = 55)

Total bulls = 2155

Total cows = 3840

Therefore, there were 36% bulls in the combined sample (2155/[2155+3840]).

2. Calf:cow ratios and the percent calves in the samples and in the herd.

Collared groups (n=35)

Total calves = 989

Total cows = 1773

Total animals classified = 3813

Therefore, there were 26% calves in the sample (989/3813) or 56 calves: 100 cows (100x989/1773).

Random groups (n=26)

Total calves = 901

Total cows = 2062

Total animals classified = 4206

Therefore, there were 21% calves in the sample (901/2062) or 44 calves:100 cows (100x901/2062)

All groups (n=59)

Total calves = 1890

Total cows = 3840

Total animals classified = 8019

Therefore, there were 24% calves in the sample or 49 calves /100 cows.

3. Percent yearlings in the samples and the ratio of yearlings to adult females.

Collared groups (n = 35)

Total yearlings = 217

Total adult females = 1655

Total classified = 3813

Therefore, there were 6.0% yearlings in the sample (217/3813) or 13 yearlings :100 adult females (100x217/1655)

Random groups (n = 24)

Total yearlings = 287

Total adult females = 1898

Total classified = 4206

Therefore, there were 7 % yearlings in the sample (287/4206) or 15 yearlings:100 adult females (100x287/1898).

All groups (n = 59)

Total yearlings = 504

Total adult females = 3553

Total classified = 8019

Therefore, there were 6 % yearlings in the combined sample (504/8019).

4. Survival of calves from birth (June 1986 through March 1987).

If we assume 1) an initial calf production of 72 calves:100 cows (Parker 1972, Dauphine 1976); and 2) female survival from June 1986 to March 1987 of 93 % (Heard and Calef in press) then there were 108 cows in June 1986 for every 100 cows still alive in March 1987 (100/.93). Those 108 cows produced 75 calves (108 x 0.69) of which 49 calves (both samples combined) or 65 % were still alive in March 1987 (100 x 49/75). Thus calf survival was estimated at 65 % from June 1986 to March 1987.

Appendix B. Spring composition as an index of recruitment in barren-ground caribou; abstract of poster presentation, 3rd N. American Caribou Workshop.

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Abstract: In the Northwest Territories, estimates of caribou (*Rangifer tarandus*) population size are expensive and obtained only every 2-3 years. The calf:cow ratios in March and April are an index of recruitment that can be obtained every year to help interpret population trends. Although spring calf:cow ratios are commonly calculated for caribou, the biases and sampling errors of the field methods have not been measured.

Our objectives were to: (1) determine the best way to define a sample unit and the best method for estimating the precision of calf:cow ratios, and (2) test for sampling biases by comparing calf:cow ratios based on sample units located arbitrarily with sample units located near radio-collared cows. Calf:cow ratios were calculated based on field classifications of caribou in the Bluenose Herd during March 1986 and 1987. About 30 sample units (n = 29, 1986; n = 31, 1987), which were groups of caribou, were chosen by their association with a radio-collared individual (mostly cows) or were chose arbitrarily, as is normally done for spring classification counts. Classification was done either from the ground where landing by fixed-wing or helicopter was possible, or directly from the helicopter. Caribou were classified as calves (9 months old), male or female yearlings, adult females, young bulls, or mature bulls. Estimates of calf:cow ratios and their standard deviations were compared using cluster analysis procedures and the jackknife technique (Cochran 1977).

Groups of caribou were classified during the period 7-17 March 1987. In 1986 our estimate of the calf:cow ratio in groups associated with radio-collared cows was significantly lower than our estimate in groups selected arbitrarily (Table 1). In 1987 the opposite was true.

Table 1. Number of calves/100 cows, Bluenose Herd, 1986 and 1987.

Year	Collared groups Mean	SD	Arbitrary groups Mean	SD	Analysis
1986	52	2.9	64	4.8	Cluster
	52	3.0	64	4.9	Jackknife
1987	55	4.7	42	3.0	Cluster
	55	4.8	42	3.1	Jackknife

In 1986 we were not able to attribute the difference between estimates to observers bias, or the effects of group size, location, or the proportion of males in the group. In 1987, however, location and percentage of males in the group had a significant effect on the calf:cow ratio.

We concluded that about 30 sample units, where sample units were representative groups of about 100 caribou, provided an acceptable estimate of the mean and standard deviation of the calf:cow ratio. Because the jackknife technique does not require data to be normally distributed, it is more appropriate than cluster analysis. We were unable to fully explain the significant differences between the ratios from the 2 methods of group selection. The radio collars led us to locations that would not have been sampled by arbitrary group selection. Our data suggest that groups sampled farther from their winter range and groups with fewer bulls had lower calf:cow ratios, probably because some calves stayed behind with the bulls when their mothers began migrating to the calving ground. We recommend, therefore, that spring composition counts be conducted before spring migration begins.

Further data on the timing of the breakdown of the cow-calf bond and the subsequent segregation of calves from cows (particularly male calves), as well as the calf mortality rate through winter, would assist in interpretation of the calf:cow ratios as indices of recruitment. Data collected from the Bluenose Herd in 1986 and 1987 suggest good calf survival and potential growth for the Bluenose Herd.

Key Words: caribou, *Rangifer tarandus*, recruitment, sex and age composition

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