BEVERLY CALVING GROUND SURVEY

JUNE 2 - 14, 1988

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ABSTRACT

In June 1988, the number of caribou on the Beverly caribou herd's calving ground was estimated using a stratified transect strip survey where caribou were counted on aerial photographs. The survey resulted in an estimate of 108,000 ± 28,100 (SE) caribou one year old and older. Based on the reproductive condition of a sample of animals classified from a helicopter, the number of parturient (pregnant and post-partum) females on the calving ground was estimated to be 82,000 ± 28,500, which extrapolates to a total population estimate of 190,000 ± 71,000. Herd size appears to have declined since 1984 but it is more likely that the population has been relatively stable since 1982 with variation in the estimates a reflection of sampling error. The herd no longer appears to be increasing as was believed in 1984.

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INTRODUCTION

Prior to the use of aerial photography, the trend in the size of the Beverly caribou herd was based on visual sample counts along strip transects on the calving ground (Heard 1985). Population estimates using aerial photography provide a more accurate indication of herd trend and the first two such estimates suggested that the herd had increased between 1982 and 1984 (Williams and Heard 1986). Weather conditions were unsuitable for aerial photography in 1987 but the estimate based on the visual counts was considerably lower than the corresponding estimate from 1984 (Heard et al. 1989). This report describes the results of the 1988 photographic census.

METHODS

Reconnaissance flights on 2 and 4 June in a Cessna 337 aircraft were made over the traditional Beverly calving ground (Fig. 1). The area covered by those flights was arbitrary but based on the location of calving caribou in previous years. On 5 and 6 June, sixteen systematically spaced transects were flown over the entire calving distribution as determined by reconnaissance. Observers counted all caribou except neonates within a 400m strip on each side of the aircraft. Transects were flown at 120m above ground level at approximately 170-180 kph. End points were determined during the flights when cow densities declined to near zero.

Caribou densities determined from the transect flying were then used to divide the calving ground into three strata, where densities within each stratum were similar. On 8, 9 and 12 June those strata were resurveyed using aerial photography. Two thousand two hundred and forty-eight photographs (black and white, 230cm x 230cm XX2405 film) were taken from 600m above ground level to provide an image scale of 1:4000. Photographs had 60% forward overlap. Caribou were counted on the photographic contact prints using a stereoscope.

Between 8 and 14 June, we recorded the age, sex and reproductive condition of all caribou observed from a Bell Jet Ranger 206B helicopter while flying along lines systematically spaced within each stratum (Fig. 2). The helicopter was flown at

Figure 1. The location of survey strata, population estimates and reconnaissance flight lines on the Beverly calving grounds in 1988

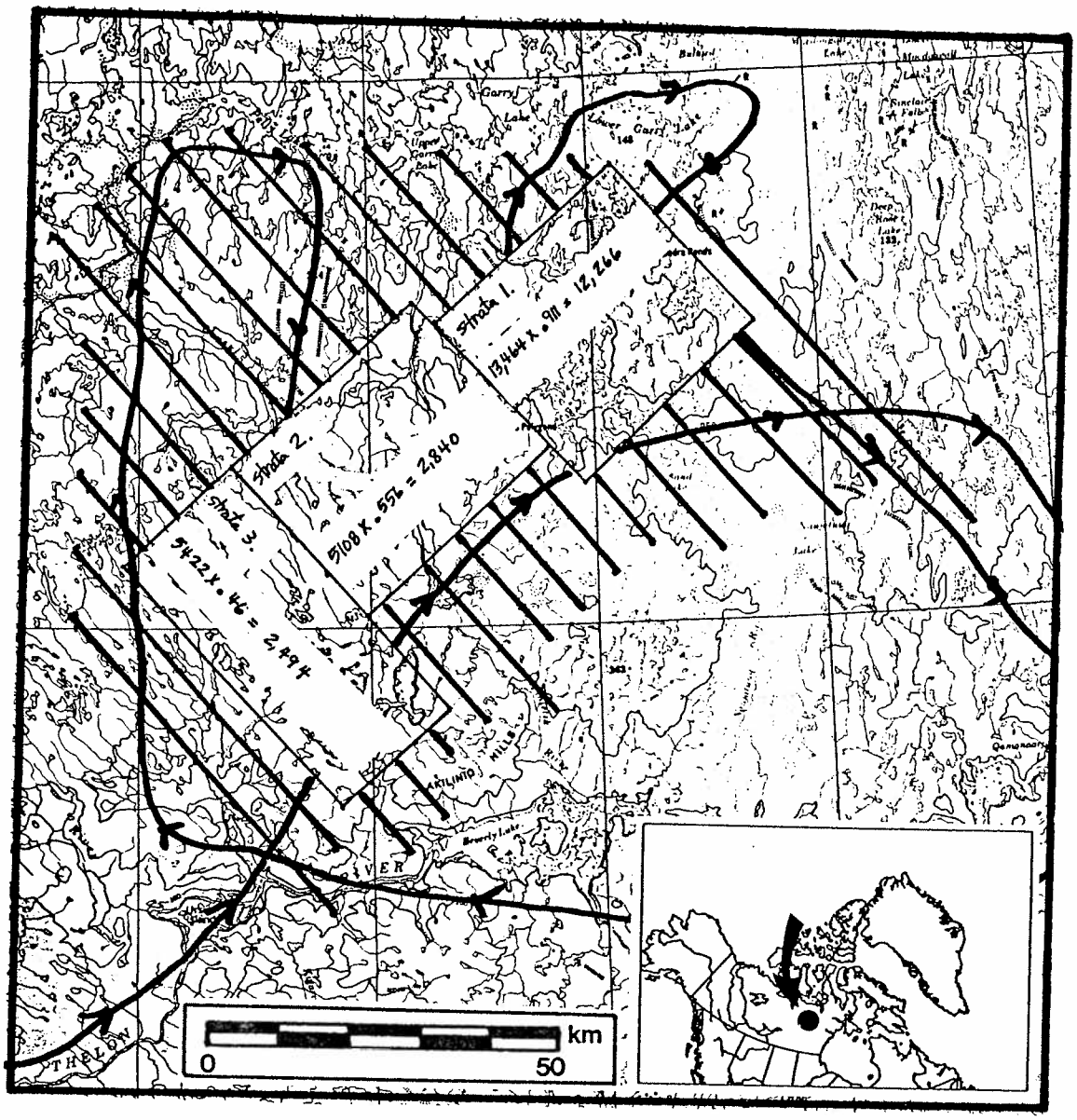
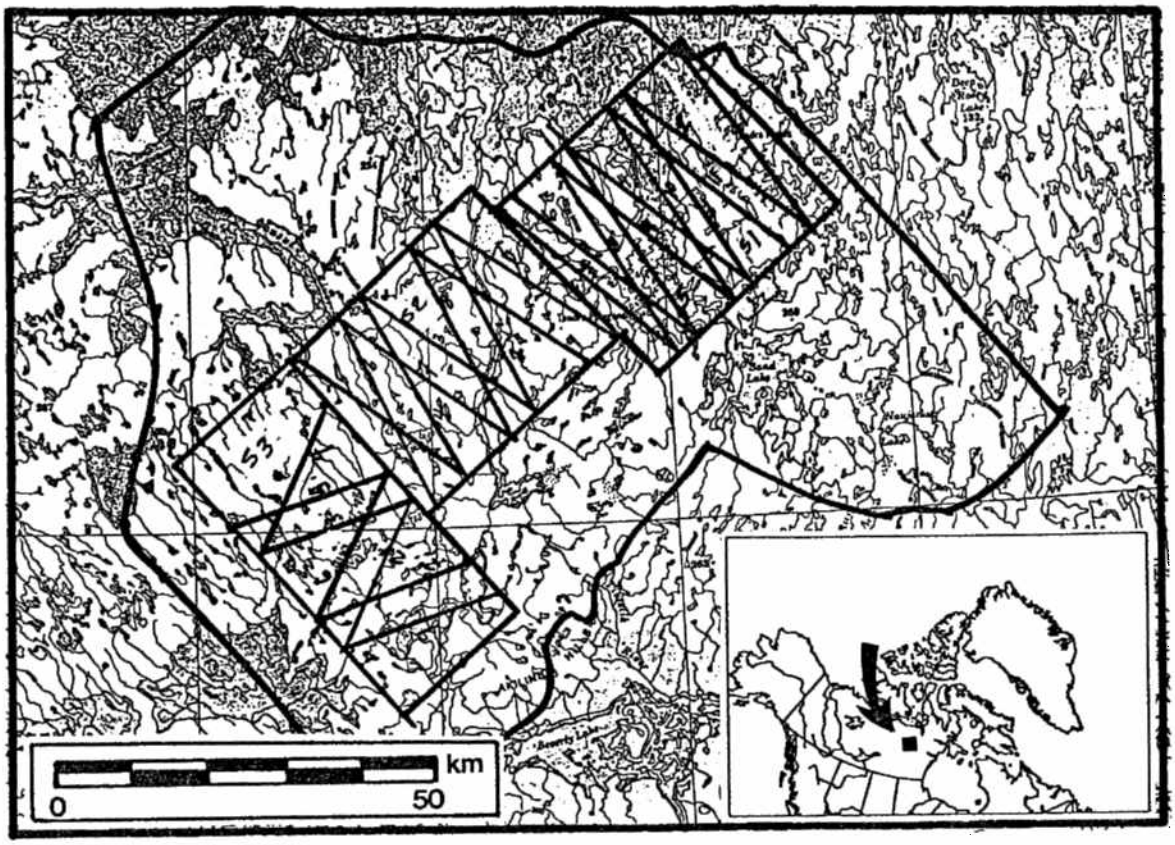


Figure 2. Composition sampling transects on the Beverly calving grounds in 1988



about 50m and 100 kph although speed and height were variable. Caribou were classed as neonates, yearlings, two year old and older males, and two year old and older cows. Parturient females, pregnant and post-partum cows, were identified by the presence of an udder. The proportion of parturient females on the calving ground and its variance were determined by the Jackknife method. The finite population correction factor used in that procedure was equal to the number of caribou classified divided by the stratum population estimate.

The proportion of parturient females was multiplied by the population estimate to obtain an estimate of the number of parturient females in each stratum. Total herd size was calculated by dividing the estimate of the number of parturient females by the sex ratio of the population and by the proportion of females in a caribou herd that are usually pregnant (Heard, Williams and Poole unpublished manuscript).

RESULTS

The Beverly herd's calving ground was located in the same area as past years. Reconnaissance data adequately defined the calving ground boundaries except in the west and northwest where the transect data were required (Fig. 1).

Number of caribou estimated from the transect densities was 27,800 ± 4,350 (SE) of which 24,000 ± 3,900 were within the three strata designated for aerial photography (Table 1). Most of the 3,800 caribou estimated outside of the three designated strata were probably yearlings. The estimate of parturient females based on the transect data was 17,600 ± 4,900 (Appendix 5). The standard error of the parturient female estimate was probably underestimated because it was based on post-census stratification.

The number of caribou estimated from the aerial photographs was 108,000 ± 28,100 of which 82,000 ± 28,500 were parturient females (Table 2, 4). The total herd size was estimated to be 190,000 ± 71,000 (Appendix 4).

The proportion of parturient females ranged from 91% in stratum 1 to 46% in stratum 3 (Table 3). Cumulative estimates of the proportion of parturient females in strata 1 and 3 were relatively unaffected by sample size, whereas the estimate in stratum 2 declined as sample size increased (Fig. 3). The coefficient of variation (CV) appeared to asymptote in stratum 1 but did not do so in strata 2 and 3. All CV's were higher than

Table 1. The estimated number of caribou on the Beverly herd's calving ground in June 1988 based on the visual transect strip survey.

Stratum	Estimate	Density (caribou/km^2)	Variance	SE	CV
1	13,464	5.74	13426585		.2721
2	5,108	2.44	955382		.1913
3	5,422	2.65	951048		.1798
Totals	23,994		15333015	3916	.1632

Table 2. The estimated number of caribou on the Beverly herd's calving ground in June 1988 based on an aerial photography transect strip survey.

Stratum	Estimate	Density (caribou/km^2)	Variance	SE	CV
1	65,214	29.27	553921658	23536	.3609
2	32,295	16.11	225056430	15002	.4645
3	10,761	5.06	7884828	2808	.2609
Totals	108,270		786855464	28051	.2591

Table 3. Composition of one year and older caribou classified on the Beverly herd's calving ground in June 1988

Classification	Number of caribou			Total
	Stratum 1	Stratum 2	Stratum 3	No.
Parturient cows	1538	584	147	2269
-calf and 2 antlers	1131	380	105	1616
-calf and 1 antler	124	72	7	203
-calf and 0 antlers	283	132	35	450
Parturient cows	601	365	82	1048
-udder and 2 antlers	408	225	30	663
-udder and 1 antler	66	65	7	138
-udder and 0 antlers	127	75	45	247
Barren cows	56	283	11	350
-no udder and 2 antlers	28	119	11	158
-no udder and 1 antler	0	0	0	0
-no udder and 0 antlers	28	164	0	192
Yearlings	134	463	247	844
Bulls	7	5	10	22
Total	2336	1700	497	4533
Proportion of parturient cows*	.9110	.5556	.4597	
SE	.2513	.1114	.1184	
CV	.2758	.2005	.2576	

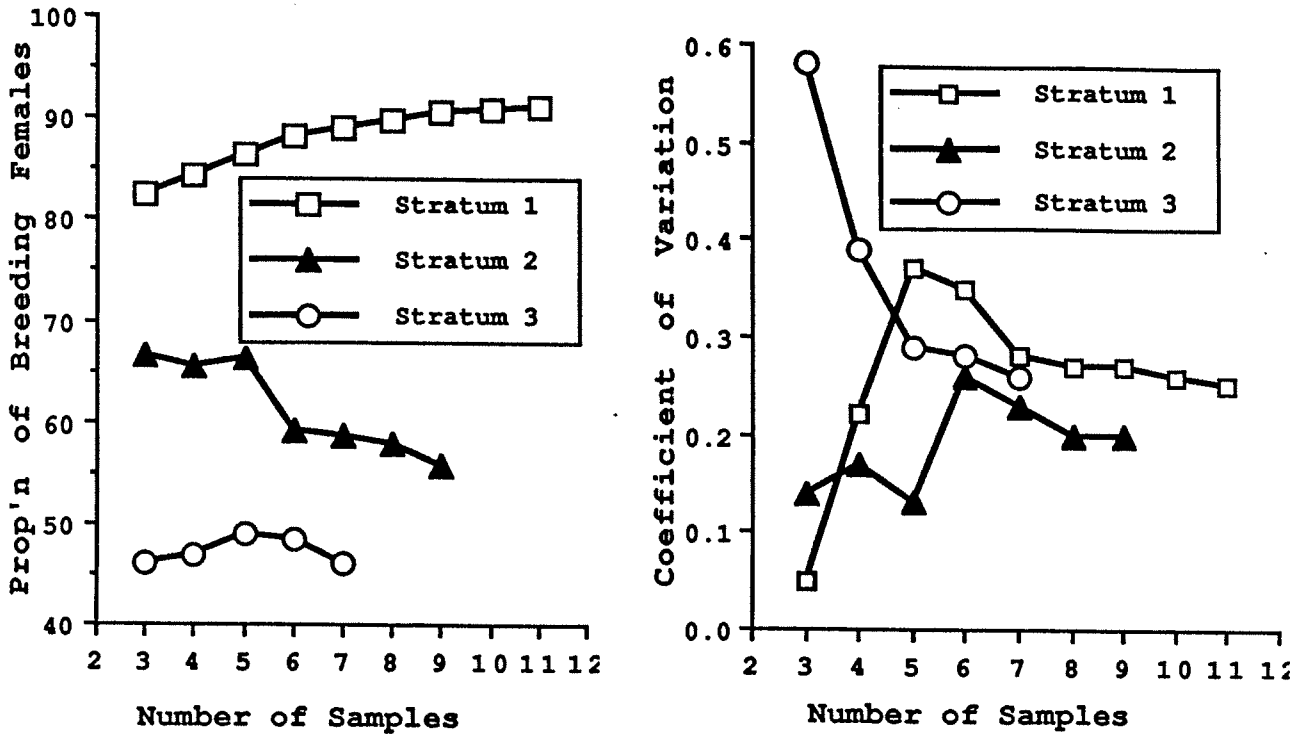
* Jackknife technique (see methods)

Table 4. The estimated number of parturient female caribou on the Beverly herd's calving ground in June 1988 based on composition counts and the photographic transect strip estimates.

Stratum	Estimate	Proportion	(CV)		Number of Parturient females	Variance*	SE
1	65,214	x 0.9110		=	59,410	728196780	
2	32,295	x 0.5556		=	17,943	82406803	
3	10,761	x 0.4597		=	4,947	3289796	
Totals					82,300	813893379	28,529

* Variance in each stratum is equal to the number of parturient females (the product) squared, times the sum of the squares, of the CV's of the estimates that were multiplied together to get that product (Heard 1987) eg., $59,410^2 \times [(.3609)^2 + (.2758)^2]$

Figure 3. The effect of sample size on the estimate of the proportion of parturient females and its coefficient of variation on the Beverly calving ground in 1988.



our objective of 0.1.

Only one dead caribou was seen during the survey. A wolverine was near the carcass. There were no wolf sightings.

DISCUSSION

The Beverly caribou herd no longer appears to be increasing as believed in 1984 (Williams and Heard 1986). The number of parturient females appears to have declined since 1984 but the population may have been relatively stable since 1982 with variation in the estimates a reflection of sampling error (Fig. 4,5). It is unlikely that there has been any substantial decline in herd size since 1984 because recruitment has been high each year (between 17 and 24%), pregnancy rates, body condition and prevalence of disease were within the expected range (Thomas pers comm) and the kill by hunters did not appear to have been exceptionally high.

Population estimates based on visual counting procedures suggest a long term decline dating back to 1971 (Fig. 5) but visual counts are less reliable than photographic counts. The estimate based on aerial photography was 4.5 times higher than the estimate based on visual counts of the same area. The area covered by photography did not cover the entire distribution of calving animals as determined from transect observations. Even if cows in the excluded area had moved into the area covered six days later by photography then the difference between the photographic estimates would still have been much (3.9 times) higher than the visual. We have no explanation of why sightability bias should have been so much higher than during previous surveys where photographic counts ranged between 1.6 and

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Figure 4. The trend in total population size of the Beverly caribou herd between 1982 and 1988. Band width represents the estimate based on aerial photographic counts plus and minus one standard error

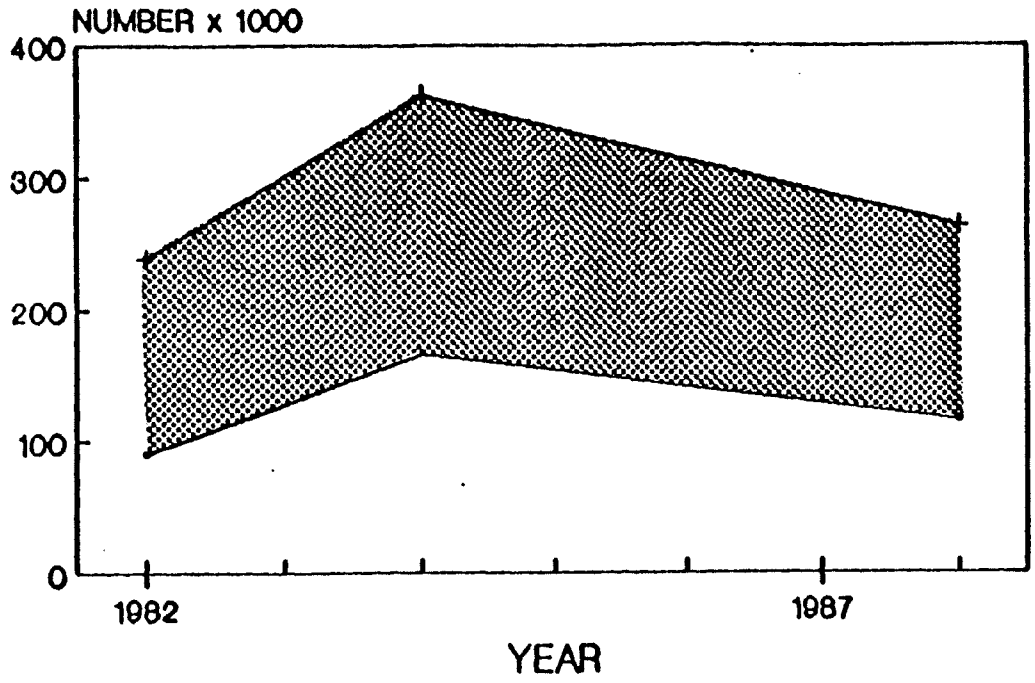
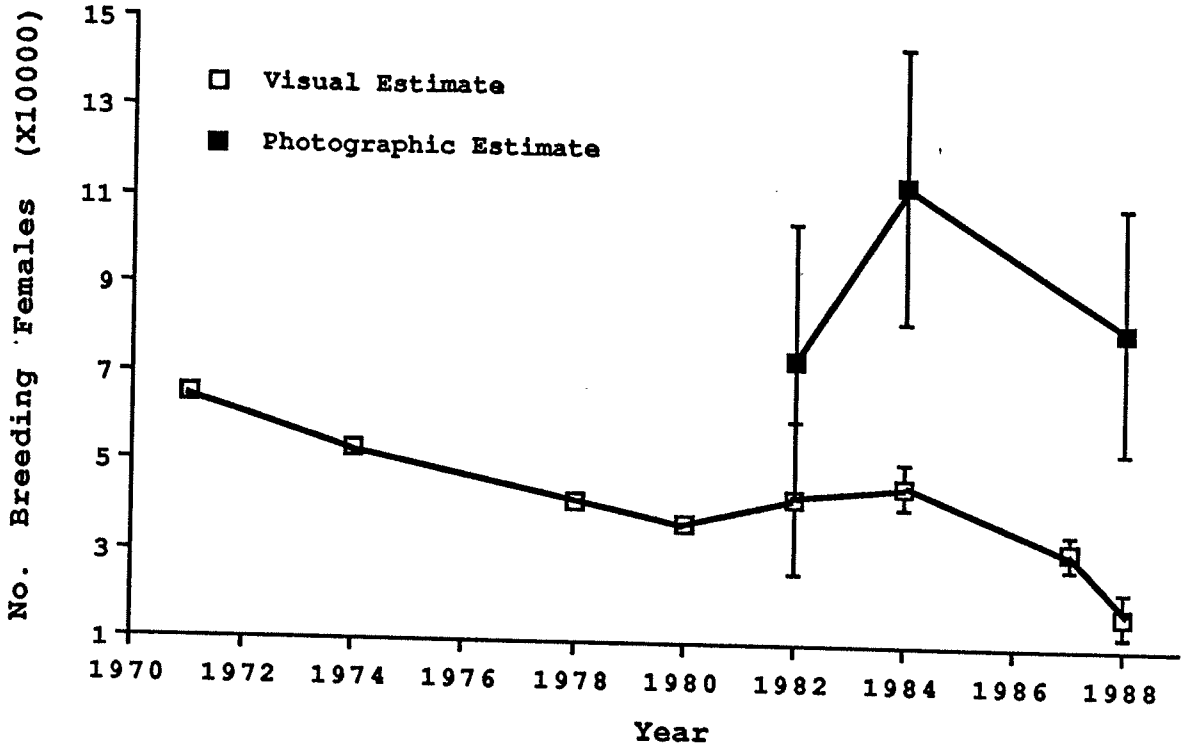


Figure 5. The trend in the number of parturient females on the Beverly caribou herd's calving ground. Vertical bars represent one standard error of the mean.



2.5 times higher than visual counts (Heard 1985). This result further emphasizes the potential variability in caribou sightability on calving grounds. Evidence for a decline in the Beverly herd is not strong enough to warrant another census before the one scheduled in 1991. Recounting some of the 1988 photographs would be one way to evaluate how much confidence should be placed in our conclusion regarding herd trend.

ACKNOWLEDGEMENTS

Bruce McLean assisted with the field work, Mark Williams assisted with the analysis, Geographic Air Survey Ltd. took the photographs and Paul Roy counted the caribou on the photographs. Polar Continental Shelf Project provided helicopter support.

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Appendix 1. Personnel and itinerary

Personnel
Bruce McLean and Francis Jackson

Itinerary
June 2
Total flying hours: 5.5 (1 Hour for survey)
Bruce and I departed YK 1000 hrs with Landa Aviation Cessna 337, our pilot was Chris Stokland. Weather was scattered overcast with drizzling rain, along the way to Baker we looked for muskox and caribou sightings. As we approached last years calving area we flew at a lower altitude looking for signs of cows and calves to help determine their movement to a possible calving area. As we flew over last years calving area the visibility was poor so we decided to head for Baker making a pass between Garry and Aberdeen Lakes, we found no signs due to the poor visibility.

June 3
Total flying hours: 0
Weather day, rain and low cloud. Bruce worked on reports while I read past calving reports and prepared the 1:250,000 maps for the stratified survey.

June 4
Total flying hours: 6.0 (Surveying)
After the ground fog cleared up in the afternoon we departed Baker at 1350 to begin the Spaghetti Recon. The highest concentration of cows and calves was located NW of Sand Lake. The general movement of the caribou seemed to be in a SW to NE direction with most of the yearlings in the SW area, just north of Ursus Islands and mostly cows and calves NW of Sand Lake. The Spaghetti Recon. flight lines allow us to determine the boundaries for the systematic recon., air photo plane and composition work.

June 5
Total flying hours: 7.0 (Systematic Reconnaissance)
After calculating the proper distance on the ground for the appropriate strip widths the wooden dowels were attached to the wing struts on the 337 cessna, enabling us to start our stratified sampling on the designated calving area found the day before. We started the stratified surveying finishing only one third, should be able to complete the rest tomorrow.

June 6
Total flying hours: 6.5 (Systematic Reconnaissance)
Called for the air photo plane but they were experiencing bad weather and were not sure when they would arrive, possibly by tomorrow. Finished off the rest of the stratified sampling allowing us to draw the strip widths of each stratum to determine

the densities and enabling us to allocate our efforts for the air photo crew.

June 7
Total flying hours: 4.0 (For Kaminuriak crew)
Larry Gray, Robert Mulders and Cam Elliott arrived and used the 337 Cessna to start their spaghetti reconnaissance. Bruce and I prepared the strata and allocated the effort for the air photo crew. The air photo plane arrived at 1900 hrs and will start tomorrow. Kaminuriak crew will work out of Baker starting tomorrow, they will return to Eskimo Point tonight. Bruce called Doug for the helicopter, should be finished with it by tomorrow and will arrive in the afternoon.

June 8
Total flying hours: 5.5 (Composition)
During the morning Bruce and I went over the area to be photographed with Peter and Marvin (Geographical Air Survey). They prepared their maps and departed for their first run on the designated high density area. By 1330 Associateds' helicopter arrived, the pilot was Vick Cobb. Bruce and I departed Baker at 1500 to do some composition work, found two dead calves on transect, post-mortem indicated that one died of a crushed skull and the other was unknown (no visible markings). The photo plane managed to complete the high density area and 1/3 of the medium density. We finished off 1/3 of the composition in the high density area.

June 9
Total flying hours: 4.4 (Composition)
The weather during the morning was too bad for composition work, it eventually cleared and we departed Baker at 1330, the air photo plane managed to get 4 more lines done today before weather turned bad and we managed to get half the high density area done. On the last transect of the day we came upon an area approx. 100m x 100m where 10 calve carcasses was being fed upon by a grizzly it looked as though the bear came across an area where a group of cows had bedded down and started calving, most of the calves heads and abdomens had been eaten, another observation noted was that most of the calve carcasses still had prominent foot tabs.

June 10
Total flying hours: 0
Weather day: overcast, raining, snowing and fog. Bruce and I worked on composition and recorded muskox locations obtained from the beginning of the survey. To this day the number of line miles yet to be flown for composition work is approx. 600 miles.

June 11
Total flying hours: 9.2 (Composition)
The weather was good for composition work today but the ceiling was too low for the air photo crew, we were unable to complete

the composition work and since the air photo crew were unable to fly today a recon flight must be made tomorrow over the area yet to be photographed to check if any animals had moved out of the area.

June 12
Total flying hours: 3.0 (Reconnaissance flight in 337)
Composition work was not completed today due to mechanical problems (boost pump). Instead we made a recon flight on the medium and low density area to check for any southward movement of the parturient cows. Bruce and I departed at 1050 and found there was no movement, which meant we did not have to re-draw any strip lines for the air photo crew. We called in the air photo crew and they finished their work today.

June 13
Total flying hours: 0
Helicopter still down, waiting for the part to arrive, as soon as it gets here we will be on our way to complete the composition work. The part arrived late in the evening and the engine will be fixed by morning.

June 14
Total flying hours: 9.1 (Composition)
Helicopter repaired and we departed Baker at 0810 to complete the low density area (53) composition, finished the work at 19:15 and decided to head back to Yellowknife that same night. We departed Baker at 2110 and arrived in Yellowknife and 0100.

Total Survey Hours Flown by Cessna 337
- 24.5 hours (includes spaghetti and systematic reconnaissance)

Total Survey Hours Flown by 206B Jet Ranger
- 28.1 hours (composition)

Appendix 2. Caribou counted on each photographic transect of the Beverly herd's calving ground June 1988

Transect No.	Area	Caribou Counted
Stratum 1		
1	41.4	10
2	41.4	96
3	41.4	446
4	41.4	321
5	41.4	235
6	41.4	3745
7	41.4	1277
8	41.4	1399
9	41.4	3437
Totals	372.6	10,966
Stratum 2		
1	37.3	1754
2	37.3	353
3	37.3	333
4	37.3	414
5	37.3	150
Totals	186.5	3004
Stratum 3		
1	27.6	21
2	27.6	153
3	27.6	276
4	27.6	112
5	25.3	125
Totals	135.7	687

Appendix 3. Composition of one year old and older caribou by transect on the Beverly herd's calving ground in June 1988

	Transect no.	Number of parturient cows	Number of other caribou
Stratum 1	1	20	8
	2	274	58
	3	124	24
	4	195	18
	5	227	10
	6	310	20
	7	252	23
	8	270	15
	9	203	6
	10	140	8
	11	124	7
Total		2139	197
Stratum 2	1	318	139
	2	146	88
	3	62	50
	4	17	30
	5	101	33
	6	121	175
	7	63	62
	8	96	92
	9	25	86
Total		949	755
Stratum 3	1	11	41
	2	21	42
	3	72	34
	4	39	42
	5	52	44
	6	9	13
	7	25	51
Total		229	267

Appendix 4. The extrapolation of the 1982 - 1988 calving round survey data to total population size. Calculations based on visual estimates have been presented to allow comparisons with past reports but in the future only photographic data will be used

Survey data	Estimate	SE	CV
1982 visual survey			
Number of caribou on the calving ground	55,663	5,808	.1043
Number of parturient females on the calving ground	43,166	17,038	.3947
Sightability correction factor	1.25[a]		.1[a]
Proportion of females in the entire herd	.622		.1[a]
Proportion of 1.5 year old and older females pregnant	.720		.1[a]
Total population[b]	120,484	51,932	.4310
1982 photographic survey			
Number of caribou on the calving ground	93,539	18,220	.1948
Number of parturient females on the calving ground	73,597	30,672	.4168
Proportion of females in the entire herd	.622		.1[a]
Proportion of 1.5 year old and older females pregnant	.720		.1[a]
Total population[b]	164,338	72,332	.4401

1984 visual survey			
Number of caribou on the calving ground	57,552	4,682	.0814
Number of parturient females on the calving ground	45,786	5,249	.1146
Sightability correction factor	1.25[a]		.1[a]
Proportion of females in the entire herd	.603		.1[a]
Proportion of 1.5 year old females pregnant	.720		.1[a]
Total population[b]	131,823	27,378	.2077
1984 photographic survey			
Number of caribou on the calving ground	139,786	35,675	.2552
Number of parturient females on the calving ground	114,484	31,047	.2712
Proportion of females in the entire herd	.603		.1[a]
proportion of 1.5 year old and older females pregnant	.720		.1[a]
Total population[b]	263,691	80,652	.3059

1987 visual survey			
Number of caribou on the calving ground	49,109	2,814	.0573
Number of parturient females on the calving ground	32,491	3,719	.1145
Sightability correction factor	1.25[a]		.1[a]
Proportion of females in the total population	.603		.1[a]
Proportion of females pregnant	.720		.1[a]
Total population[b]	93,546	19,423	.2076
1988 visual survey			
Number of caribou on the calving ground (Table 1)	23,994	3,916	.1632
Number of parturient females on the calving ground (Appendix 5)	17,600	4,916	.1[a]
Sightability correction factor	1.25[a]		.2793
Proportion of females in the entire herd	.603		.1[a]
proportion of 1.5 year old and older females pregnant	.720		.1[a]
Total population[b]	50,673	16,653	.3287

1988 photo survey			
Number of caribou on the calving ground (Table 2)	108,270	28,051	.2591
Number of parturient females on the calving ground (Table 4)	82,300	28,529	.3466
Proportion of females in the entire herd	.603		.1[a]
Proportion of 1.5 year old and older females pregnant	.720		.1[a]
Total population[b]	189,561	70,961	.3743

[a] no data; value only a guess

[b] - total population = number of parturient females / proportion of females in the population / proportion of females pregnant x (for visual surveys only) a sightability correction factor of 1.25 eg., 43,166 x 1.25 / .622 / .720 = 120,484
- for SE calculations see Table 4 and (Heard 1987)
- CV = SE / total population eg., 51,965 / 120,484 = .4310

Appendix 5. The estimated number of parturient female caribou on the Beverly herd's calving ground in June 1988 based on composition counts and visual transect strip estimates

Stratum	Estimate	Proportion(CV)	Number of Parturient females	Variance	SE
1	13,464	x .911 (.28) =	12,266	22926898	
2	5,108	x .556 (.20) =	2,840	616865	
3	5,422	x .460 (.26) =	2,494	622004	
Totals	23,994		17,600	24165767	4916