BEVERLY CALVING GROUND SURVEY

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ABSTRACT

The current Beverly and Qamanirjuaq Caribou Management Plan suggests that aerial photographic surveys of calving grounds be conducted at six-year intervals to monitor trends in the size of both of these herds. The last photographic survey of the number of breeding cows on the Beverly herd's calving ground was conducted in 1994. Due to concerns raised by community members from northern Saskatchewan about the status of the Beverly herd and the lack of biological information collected of the Beverly herd since 1994, we felt that a systematic reconnaissance survey of the Beverly herd's calving ground would help to determine the need for an aerial photographic survey, as well as aid in the logistical support for such a survey method. The technique outlined by Williams (1994), except for the use of aerial photography, was used to delineate and document densities on the calving ground, as well as determine peak of calving. The 2002 calving ground of the Beverly herd was located in the same general area as in 1994 and 1993, centred around an unnamed river draining into Upper Gary Lake. The 2002 calving ground covered 2,856 km^2, which is the smallest area that has been defined to date using a systematic reconnaissance approach outlined by Williams (1994). Density of caribou aged one year or older on the calving ground was estimated to be 9.06 caribou/km^2. Although it is hard to make direct comparisons to previous survey density estimates due to counting bias, the density estimate for 2002 is lower than survey previous years except for the 1987 density estimate. The systematic reconnaissance survey results do not

indicate a population decline or increase nor was the survey designed for that purpose. A photographic survey is required to determine trend in herd size.

TABLE OF CONTENTS

Introduction **1**

Objectives **3**

Methods **3**

Data Analysis **9**

Results **12**
Non-systematic Reconnaissance Survey 12
Systematic Reconnaissance Survey 13
Second Systematic Reconnaissance Survey 20
Further Calving Ground Delineation 25
Timing of Calving 26

Date **27**

Discussion **29**
Distribution 29
Size of 2002 Calving Ground 30
Density 33

Recommendations **38**
Regular Reconnaissance Surveys 38
Distribution of Caribou on the Calving Ground 39

Bibliography **41**

Appendixes **44**

Appendix A: Number of caribou (1 year or older) observed on transect segments (time at one - two minute intervals) during the systematic reconnaissance survey of the Beverly herd's calving ground, June 2002. ..... **44**

Appendix B: Number of caribou (1 year or older) on transect segments of Stratums 1 and II during the systematic visual survey of the Beverly herd's calving ground, June 2002. ..... **51**

Appendix C: Summary of the 1980–2002 systematic reconnaissance survey results (where it is available) obtained from Beverly calving ground surveys. **63**

Appendix D: Summary of the 1980–2002 systematic visual survey results (where it is available) obtained from Beverly calving ground surveys. **63**

LIST OF FIGURES

Figure 1. Non-systematic flights flown to locate the Beverly herd's calving ground, 6–8 June 2002. ..... **6**

Figure 2. Transects flown during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002. ..... **7**

Figure 3. Transects flown in stratum I and II during the second systematic reconnaissance survey of the Beverly herd's calving ground, 10–11 June 2002. ..... **10**

Figure 4. Additional non-systematic reconnaissance flights to confirm the distribution of the Beverly herd's calving ground, 9–12 June 2002. ..... **11**

Figure 5. Caribou groups observed during the non-systematic reconnaissance flights of the Beverly herd's calving ground, 6–8 June 2002. ..... **16**

Figure 6. Composition of caribou observed during the non-systematic reconnaissance survey flights of the Beverly herd's calving ground, 6–8 June 2002. ..... **17**

Figure 7. Densities of caribou (1 year or older) observed along transect segments during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002. ..... **18**

Figure 8. Strata I and II defined from caribou densities observed during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002. ..... **19**

Figure 9. Densities of caribou (1 year or older) observed along 2-km transect segments in strata I and II during the second systematic reconnaissance survey of the Beverly herd's calving ground, 10–11 June 2002. ..... **24**

Figure 10. Composition of caribou groups observed during the additional non-systematic reconnaissance flights of the historic Beverly herd's calving ground, 9–12 June 2002. ..... **28**

Figure 11. Location of the 2002 Beverly herd's calving ground in relation to past calving grounds defined in 1994, 1993, 1988, 1987, 1984, 1982, 1980, and 1979. ..... **32**

Figure 12. Locations of collared cows from the Ahiak, Bathurst, Beverly and Qamanirjuaq herds during the calving period, 1–20 June 2002. ..... **37**

LIST OF TABLES

Table 1. Densities of caribou observed on transect during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002. **...14**

Table 2. Caribou densities from the first systematic reconnaissance survey on 8–9 June 2002 contained within the two delineated strata (strata I and II). **.....15**

Table 3. Caribou densities observed within strata I and II from the second systematic reconnaissance survey on 10–11 June 2002. **.....22**

Table 4. A comparison of the density per stratum between the first systematic reconnaissance and the second systematic reconnaissance survey of the Beverly herd's calving ground, 2002. **.....23**

Table 5. Comparison of the variability in the density of caribou observed during the first and second systematic reconnaissance survey of the Beverly herd's calving ground, 2002. **.....23**

Table 6. Ratio of cows with calves to caribou aged one year or older on the calving ground from ground and aerial fixed wing observations, 9–11 June, 2002. **.....27**

Table 7. Average daily distance travelled by one satellite-collared cow during pre-calving, calving and post-calving, 15 May–30 June 2002. **.....27**

Table 8. Size of the annual calving ground (km^2) of the Beverly herd defined from the results of systematic reconnaissance surveys, 1980–2002. **.....33**

INTRODUCTION

The Beverly herd is one of the more inaccessible barren ground caribou herds. Depending on the location of their winter range, NWT hunters can have long distances to travel to hunt the caribou and consequently, little observational information is available to evaluate their local distribution and condition. The last time that we estimated the size of the herd and trend in herd size was in 1994. Williams (1995) used an aerial photographic survey to count the number of breeding females on the calving ground. At that time, the number of breeding females on the calving ground was estimated to be 120,000 ± 43,100 SE (standard error) from which the total herd size was estimated to be 276,000 ± 106,600 (Williams, 1995). Since 1994, no biological data have been collected on the Beverly herd, and thus, presently, there is no biological information to assess the status of the Beverly herd.

Heard and Williams (1990a) recommended that the optimal survey interval for mainland caribou is once in every six years to be able to detect a significant change in herd size assuming a long-term average rate of change of 10%, a precision level where the coefficient of variance equals 0.15 and a 90% probability of a Type 2 error (concluding no trend when in fact there is one). Following Heard's and Williams' (1990a) review of mainland barren ground caribou management, the Beverly and Qamanirjuaq Caribou Management Board (BQCMB) recommended in their current management plan that calving ground surveys using aerial photographic techniques be conducted at least every six

years as a means to ensure the sustainable use of Beverly and Qamanirjuaq caribou for future generations (BQCMB, 1996a; 1996b).

Over six years have elapsed since the last photographic survey of the Beverly herd's calving ground. Additionally, annual spring calf recruitment counts of the Beverly herd have not been conducted since 1993 (Williams, pers. comm.). Surveys of yearly calf survival (the proportion of calves in the herd in March and April is a measure of calf survival from birth in June to late winter or almost age of one year, when they are considered to be recruited into the population) have been used in the past as a secondary means to assess potential herd growth. Calf recruitment counts were used in the 1980s and early 1990s as an additional means to monitor population trends of the Beverly herd between calving surveys.

At the November 2001 meeting of the BQCMB, community board members from northern Saskatchewan expressed concerns about the status of the Beverly herd due to increased harvest of caribou as a result of greater accessibility to the herd by southern Saskatchewan residents. Based on community user concerns and the absence of information collected on the status of the Beverly herd since 1994, the BQCMB recommended at the same meeting that an aerial photographic survey of the Beverly calving ground be conducted in June 2002.

An aerial photographic survey of the Beverly calving ground did not take place in June 2002 because support from all stakeholders was uncertain. However, due to the eight-year period since work was last done on the Beverly

calving ground, we felt that a systematic reconnaissance survey would help determine the need for an aerial photographic survey as well as aid in the logistical preparation for such a survey method. The location of annual calving grounds of the Beverly herd between 1957 and 1994 has undergone cumulative shifts in calving distribution (Gunn and Sutherland, 1997); therefore, documenting any distributional changes since the last survey in 1994 would greatly assist in planning a photographic survey of the Beverly calving ground.

OBJECTIVES

In June 2002, a systematic reconnaissance survey of the Beverly calving ground was conducted to gain some basic information about the distribution and density of caribou aged on year or older on the calving ground. The main objectives of this survey were to:

1. Delineate the annual calving ground for 2002 based on the location of calving cows;
2. Determine the density of caribou aged one year of older on the 2002 calving ground;
3. Determine the date of peak calving; and
4. If possible, compare relative densities of caribou aged one year or older on the calving ground with previous surveys.

METHODS

The survey was based out of Baker Lake from 6–12 June 2002. Methods are similar to those outlined by Williams (1994) and those used on the 1980,

1982, 1987, 1988, 1993, and 1994 calving ground surveys (Williams, 1995; Heard and Jackson, 1990b; Heard *et al.*, 1990c; Stephenson *et al.*, 1984; Gunn and Decker, 1982), with the exclusion of the aerial photography.

Unsystematic reconnaissance flights were conducted on 6–8 June 2002 in a Cessna 185 aircraft to delineate the general area of calving cows. The ferry flight from Yellowknife to Baker Lake on 6 June 2002 was used to examine the location, direction, and density of tracks through a cross section of the migration route into the calving area (Figure 1). The remaining unsystematic reconnaissance flights were conducted over previously recorded calving grounds, as well as known migration corridors into the calving ground due to the lateness of spring (Figure 1). For the most part, these flights were conducted at approximately 160–300 metres above ground level (agl) depending on snow cover. During these flights, no fixed strip width was used and all caribou and other wildlife observed, as well as caribou tracks were recorded along with a geographic position (captured using a handheld GPS unit). When possible, caribou were classified as cow, yearling, or bull (cows were identified by either having hardened antler(s) and/or accompanied by a calf). Tracks were classified as either light, moderate, or heavy based on the number of multiple tracks seen. A classification rating of light consisted of ten or less tracks, 10–25 tracks were recorded as moderate, while numbers of tracks >25 were rated as heavy. Single tracks were also evaluated as to whether they represented use by one or a few caribou moving single file or were indicative of multiple single trail use. In

addition, the direction and age of the tracks were recorded whenever it was possible to discern this information.

Based on observations from the unsystematic reconnaissance flights, the general area of calving caribou was delineated and a systematic reconnaissance survey of the calving ground was conducted on 8–9 June 2002 to determine relative densities of caribou within the calving area. There were no set criteria to initially delineate the calving ground for the systematic reconnaissance survey. Caribou observations from the unsystematic reconnaissance flights were plotted on 1:500,000 maps while in the air and digitally with OziExplorer by downloading waypoints of observations from the GPS unit. The calving ground was drawn to include the main concentration of caribou observed using presence of yearlings and areas of low density (<0.1 km^2) to exclude areas from the systematic survey area. The delineated calving area was relatively small, therefore, the spacing of the systematic transects was reduced from 10 km to approximately 6 km in order to increase the number of transects in the sample from 7 to 13. Transects were oriented north to south, perpendicular to the long axis of the delineated calving ground area (Figure 2). The survey crew consisted of the pilot, a navigator, and two observers that counted all caribou aged one year old or older within a 400-metre strip on both sides of the aircraft (transect strip width of 0.8 km). While flying transects, the navigator called out waypoints every minute so that density could be allocated to regular intervals across the calving ground. The survey altitude was 120 m agl and survey speed ranged from 160–180 km/h.

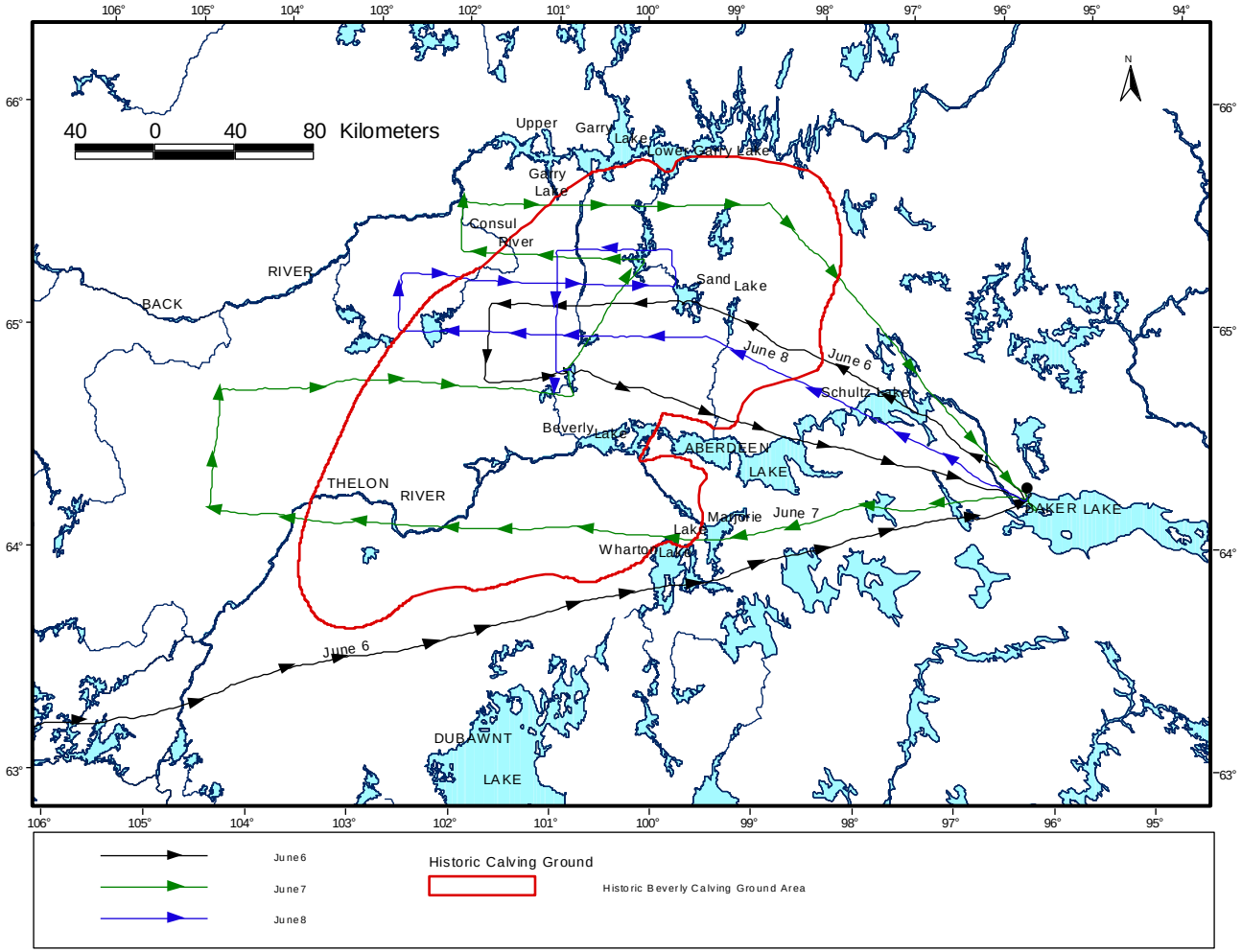

Figure 1. Non-systematic flights flown to locate the Beverly herd's calving ground, 6–8 June 2002**.**

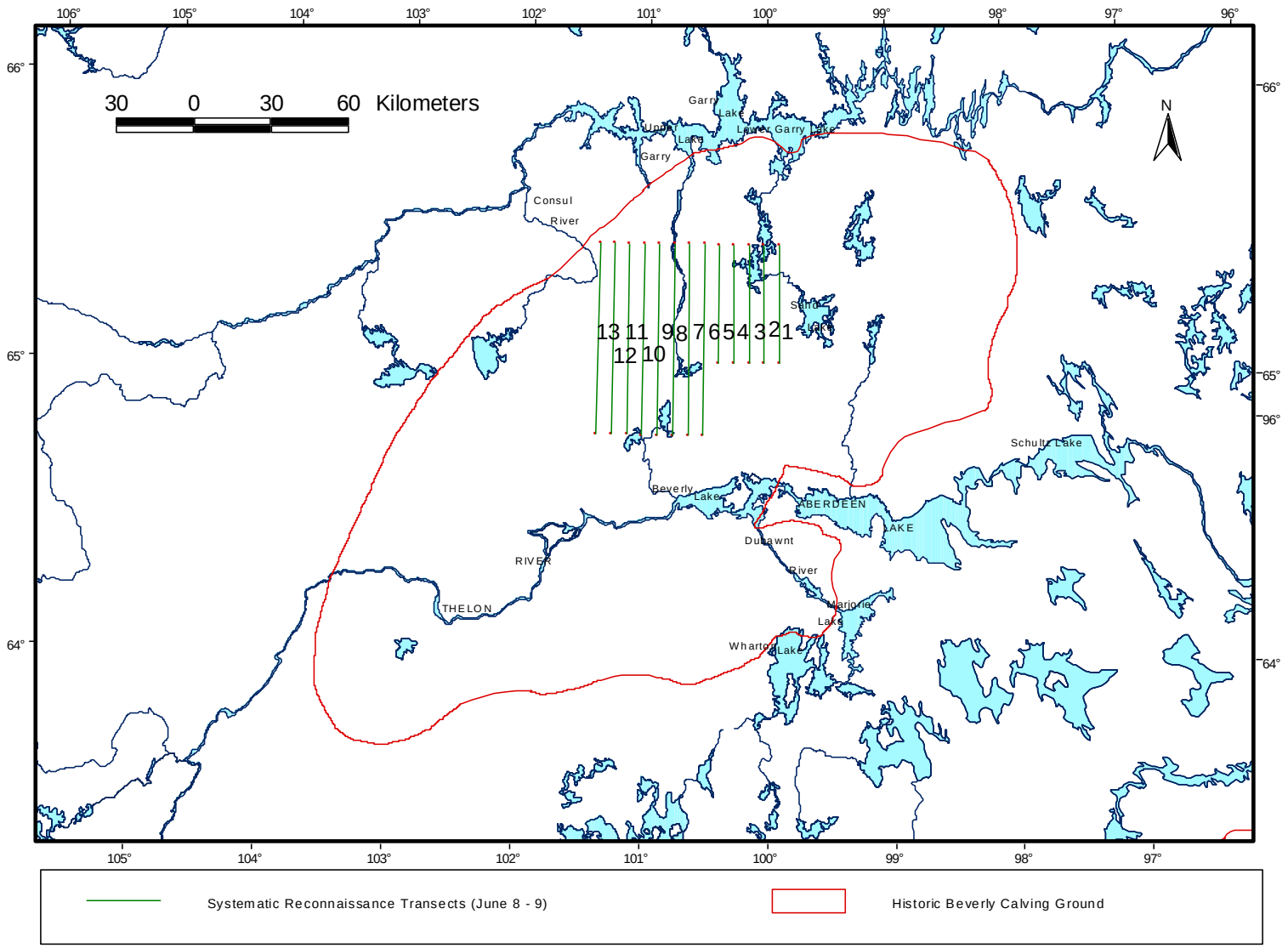

Figure 2. Transects flown during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002.

Due to low densities of caribou (aged one year and older) observed on the calving ground, a second systematic reconnaissance survey was subsequently conducted 10–11 June 2002. The results from the systematic reconnaissance survey were used to divide the calving ground into three strata of differing caribou densities. The proportion of animals in each stratum and the number of aircraft hours available was used to determine the survey effort allocated to each stratum. The high density stratum I had 21 transects spaced at 2.03 km for 42% coverage and the medium density stratum II had 14 transects at a spacing of 3.45 km for 25% coverage (Figure 3).

On 9–11 June 2002 while the systematic reconnaissance survey and the systematic visual survey were being conducted, flights to and from the survey area were planned to cover as much of the historic calving ground documented by Gunn and Sutherland (1997) to ensure that no major congregation of calving caribou was missed (Figure 4). Due to the lateness of spring, there was concern that there may have been a tail of calving cows southwest of the calving ground as was witnessed in 1979 (Gunn and Sutherland, 1997). The ferry flight back to Yellowknife from Baker Lake of 12 June 2002 was also used to cover the southern extent of the calving ground (Figure 4). During these flights, all caribou observed were recorded (no fixed strip width used) as well as the density, freshness, and direction of tracks. Where possible, caribou were classified as cows (presence of hardened antler(s) or calf), yearlings, and bulls; however, fuel and air charter hour limitations prevented the categorization of all groups seen.

An attempt was made to estimate the peak of calving on the delineated calving area. The delineated calving ground was traversed by air on 9 and 11 June 2002 and the number of calves and caribou aged one year and older were counted. In addition, caribou and calves were counted on 9 June 2002 from the ground.

Daily flight paths and observations were recorded using a handheld GPS unit (Garmin II+) and these recorded data were downloaded daily into OziExplorer.

DATA ANALYSIS

The Jolly 1 Method for equal sample units and the Jolly 2 Method for unequal sample units were used to calculate the density and variance estimates for the first and second systematic reconnaissance surveys, respectively (Norton-Griffiths, 1978). Gasaway *et al.*'s (1986) formulae were used to compare the density estimates from the first and second systematic reconnaissance surveys.

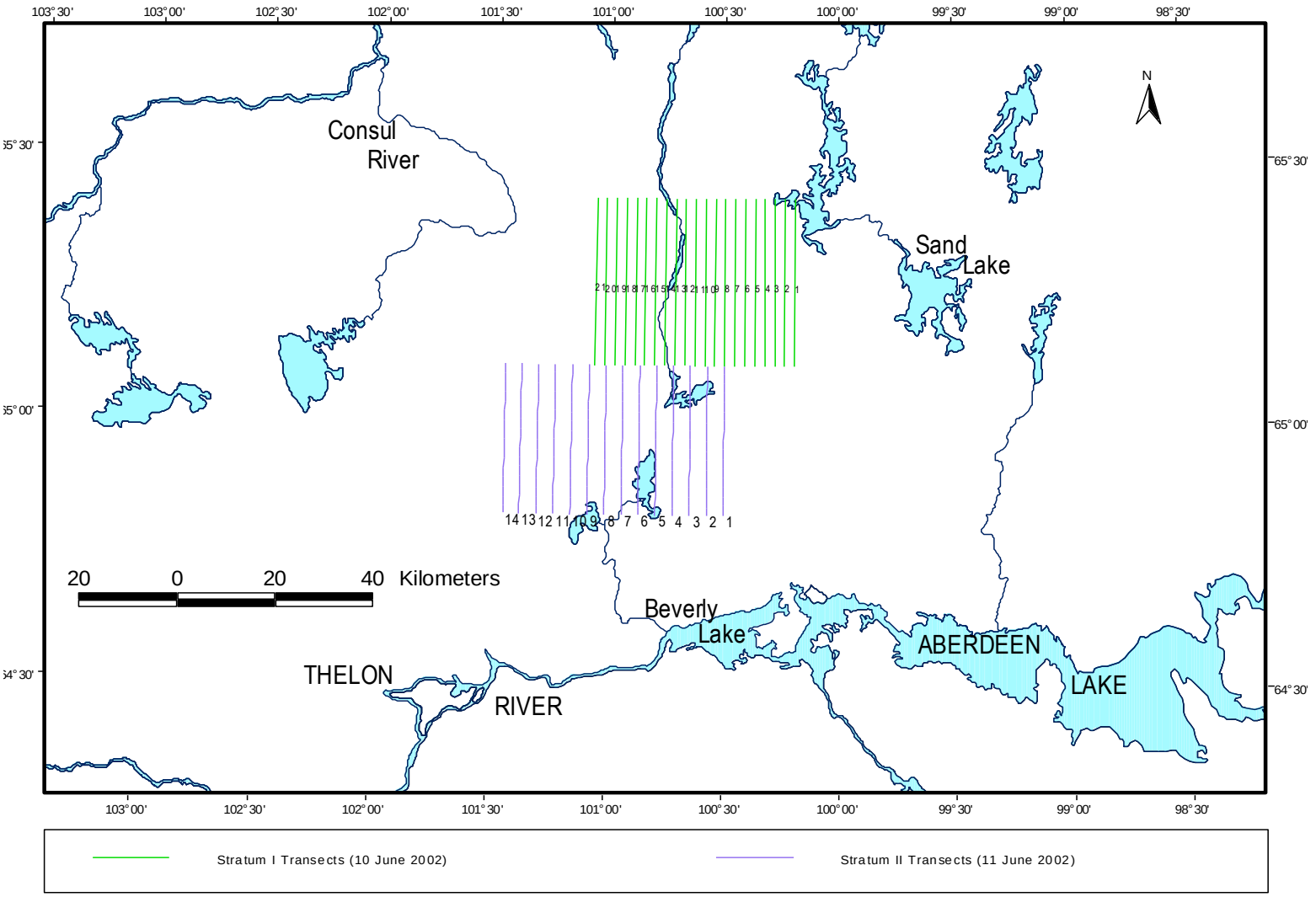

Figure 3. Transects flown in stratum I and II during the second systematic reconnaissance survey of the Beverly herd's calving ground, 10–11 June 2002.

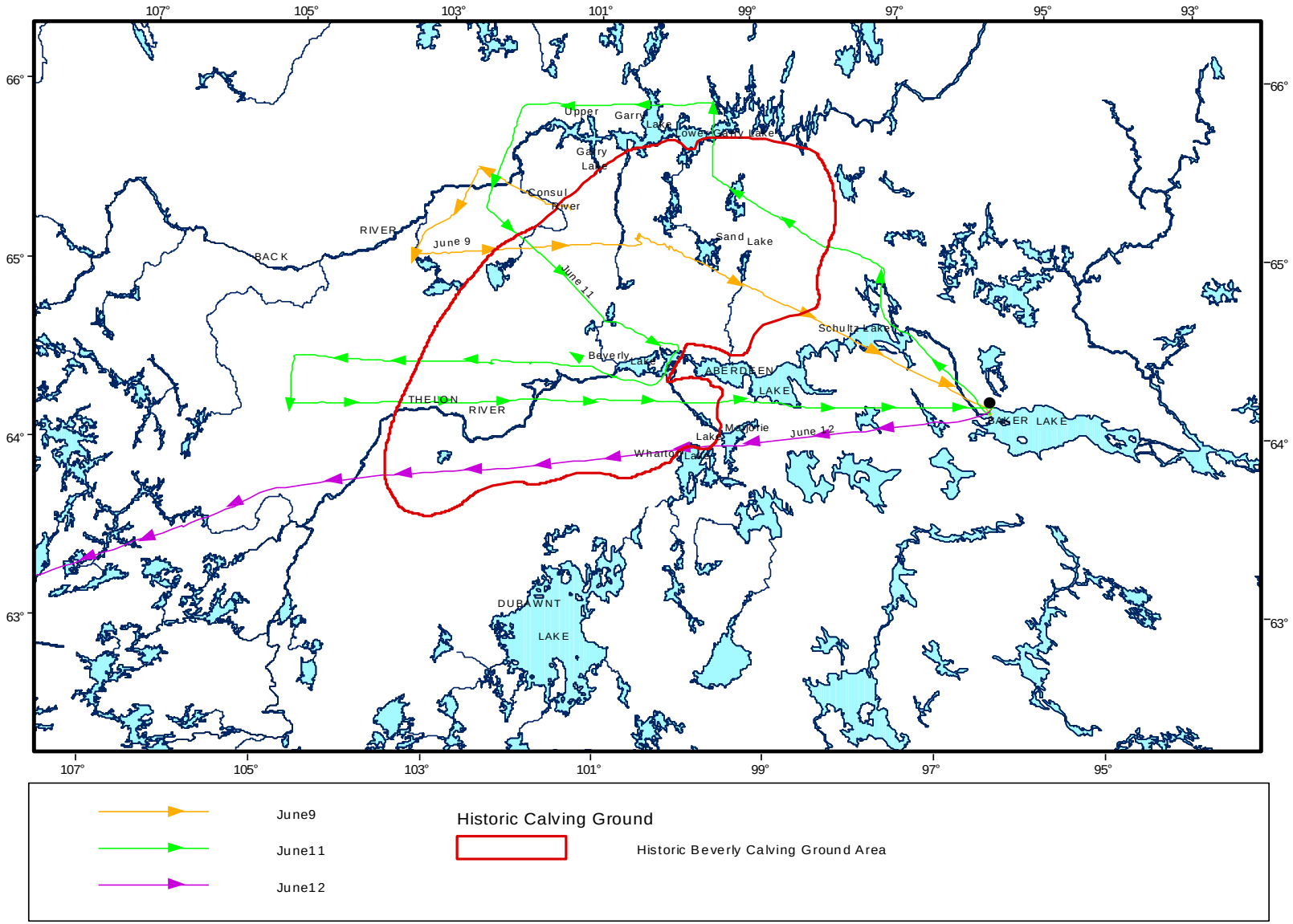

Figure 4. Additional non-systematic reconnaissance flights to confirm the distribution of the Beverly herd's calving ground, 9–12 June 2002.

RESULTS

Non-systematic Reconnaissance Survey

Spaghetti reconnaissance flights were flown on 6–8 June 2002. The area (Figure 1) covered included the migration corridor south of the calving ground; the southern portion of the historic calving area west from Baker Lake through Marjorie and Wharton Lakes, and across the Thelon River to 104°30′ W; north to just below Pelly Lake and the Garry Lakes complex; and east to Deep Rose Lake. Most of the caribou seen were concentrated around an unnamed river draining north into Upper Garry Lakes (Figure 5); caribou on the fringes consisted primarily of yearlings (Figure 6). Although only groups close to the aircraft were classified, no bulls were seen on these non-systematic reconnaissance flights.

Although it is hard to quantify caribou tracks, the main migration into the calving area likely was to the southwest through Lookout Point on the Thelon River. Movement on the calving area was also documented from the west through Consul Lake and from the north and east. These tracks most probably represent north/south and west/east movement of caribou onto the calving ground or indicate low density of caribou peripheral to the core calving area in 2002; however, sparse tracks seen within the historic calving ground outside of the core calving area may also be representative of resident tundra caribou that inhabit the area year round.

Systematic Reconnaissance Survey

The area for the systematic reconnaissance was delineated east of Sand Lake to approximately 30 kilometres east of Consul Lake and at an approximate latitude of 65°30′ N. The southern and northern boundaries of the area were less well defined from the non-systematic reconnaissance flights and transect lengths during the systematic reconnaissance survey were lengthened to accommodate caribou groups seen near transect ends. Transects 6–13 were extended further south to include groups of cows seen beyond their original extent. Transects were stopped when groups of cows were no longer seen or when groups consisted primarily of yearlings. Thirteen transects covered an area of 4,412 km^2; 830 km of transects corresponded to an area of 662 km^2 flown or 15% coverage (Appendix A). Densities of caribou on transects (Table 1) ranged from 0.11 to 1.21 caribou per km^2 on the three outer western and eastern lines, and from 2.50–22.61 on the remaining middle transects (transects 4–10).

Densities of caribou observed during the systematic reconnaissance survey were calculated for segments equal to one-minute intervals flown along each transect (Figure 7). Greatest concentrations of caribou were observed just east of the river draining into Upper Gary Lake; caribou were also congregated to the west and south of this drainage. The observed densities were used to delimit high and medium strata, I and II respectively (Figure 8). Stratum I (high) had an average density of 10.08 caribou per km^2, while stratum II (medium) had a mean of 1.82 caribou per km^2. Although calving cows were observed on the outer transects (transects 1–3 and 11–13), either the whole transect or portions were

not included in the calving area, as densities were less than 1 caribou per km^2. In addition, the northern portions of transects 1–13 were not included, as they primarily represented yearling groups. The area of the calving ground delineated by strata I and II (2,856 km^2) corresponded to approximately 65% of the systematic reconnaissance survey area and contained the majority of caribou observed on the traditional calving ground from 6–8 June 2002. The reconnaissance data were analysed by stratum; the density of caribou counted on portions of transects located in each stratum are shown in Table 2. Strata I and II contained 81% and 14% of the total caribou counted during the systematic reconnaissance survey, respectively. A density of 10 caribou per km^2 observed in stratum I was almost ten times higher than that in stratum II (1.8 caribou per km^2).

Table 1. Densities of caribou observed on transect during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002.

Transect			Caribou Counted			Density
No.	**Length (km)**	**Area (km^2)**	**Left**	**Right**	**Total**	**Caribou/km^2**
1	46.5	37.2	25	15	40	1.08
2	46.5	37.2	4	0	4	0.11
3	46.5	37.2	25	19	44	1.21
4	46.5	37.2	69	24	93	2.50
5	46.5	37.2	388	455	843	22.66
6	74.4	59.52	397	139	536	9.01
7	74.4	59.52	107	98	205	3.44
8	74.4	59.52	168	58	226	3.80
9	74.4	59.52	77	116	193	3.24
10	74.4	59.52	180	104	284	4.77
11	74.4	59.52	55	9	64	1.04
12	74.4	59.52	45	17	62	1.04
13	74.4	59.52	22	14	36	0.60
Totals	**827.7**	**662.16**	**1,560**	**1,069**	**2,629**	**3.97**

Table 2. Caribou densities from the first systematic reconnaissance survey on 8–9 June 2002 contained within the two delineated strata (strata I and II).

Transect			Caribou Counted			Density
No.	**Length (km)**	**Area (km^2)**	**Left**	**Right**	**Total**	**Caribou/km^2**
Stratum I (1,436 km^2)						
3	35.3	14.12[a]	25	0	25	1.77
4	35.3	28.24	55	24	79	2.80
5	35.3	28.24	382	455	837	29.64
6	35.3	28.24	365	124	489	17.32
7	35.3	28.24	97	86	183	6.48
8	35.3	28.24	149	44	193	6.83
9	35.3	28.24	58	110	168	5.95
10	35.3	28.24	94	67	161	5.70
Total	**282.4**	**211.8**	**1,225**	**910**	**2135**	**10.08**
Stratum II (1,420 km^2)						
6	31.6	25.28	24	7	31	1.23
7	31.6	25.28	9	12	21	0.83
8	31.6	25.28	19	14	33	1.31
9	31.6	25.28	13	6	19	0.75
10	31.6	25.28	86	37	123	4.87
11	31.6	25.28	50	8	58	2.29
12	31.6	25.28	34	15	49	1.94
13	31.6	25.28	21	14	35	1.38
Total	**252.8**	**202.24**	**256**	**113**	**369**	**1.82**

[a] Only one half of transect three was included in stratum I.

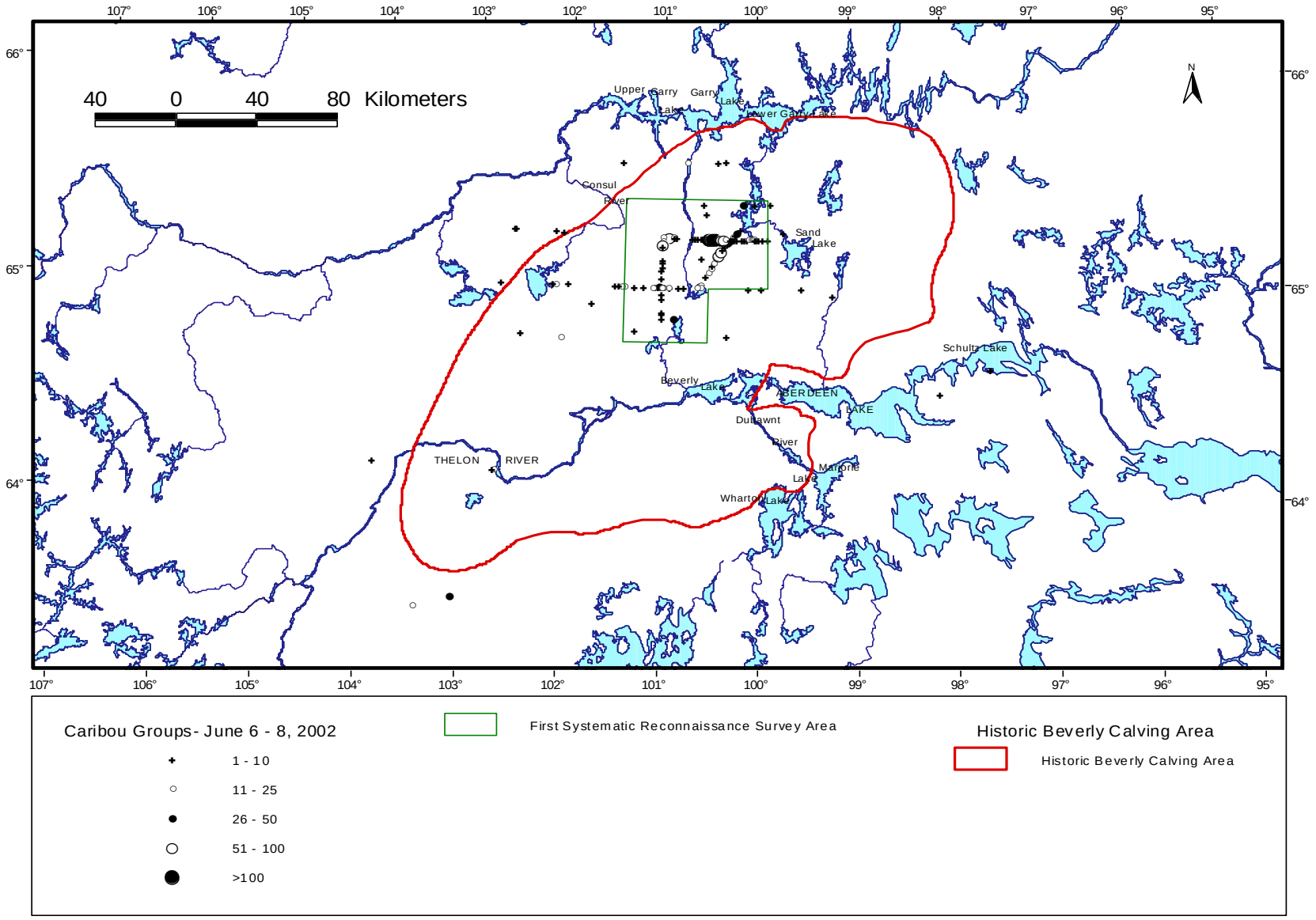

Figure 5. Caribou groups observed during the non-systematic reconnaissance flights of the Beverly herd's calving ground, 6–8 June 2002.

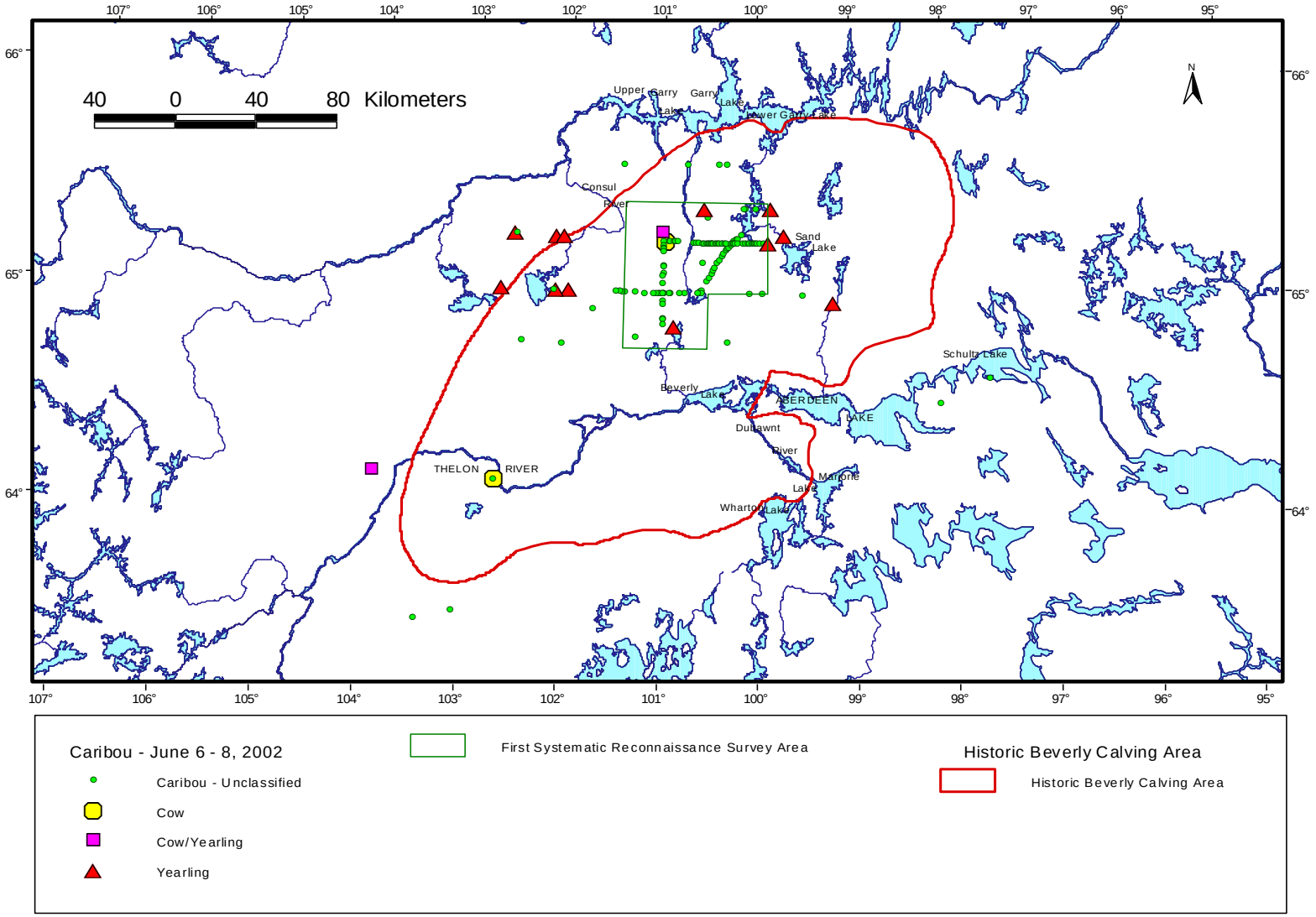

Figure 6. Composition of caribou observed during the non-systematic reconnaissance survey flights of the Beverly herd's calving ground, 6–8 June 2002.

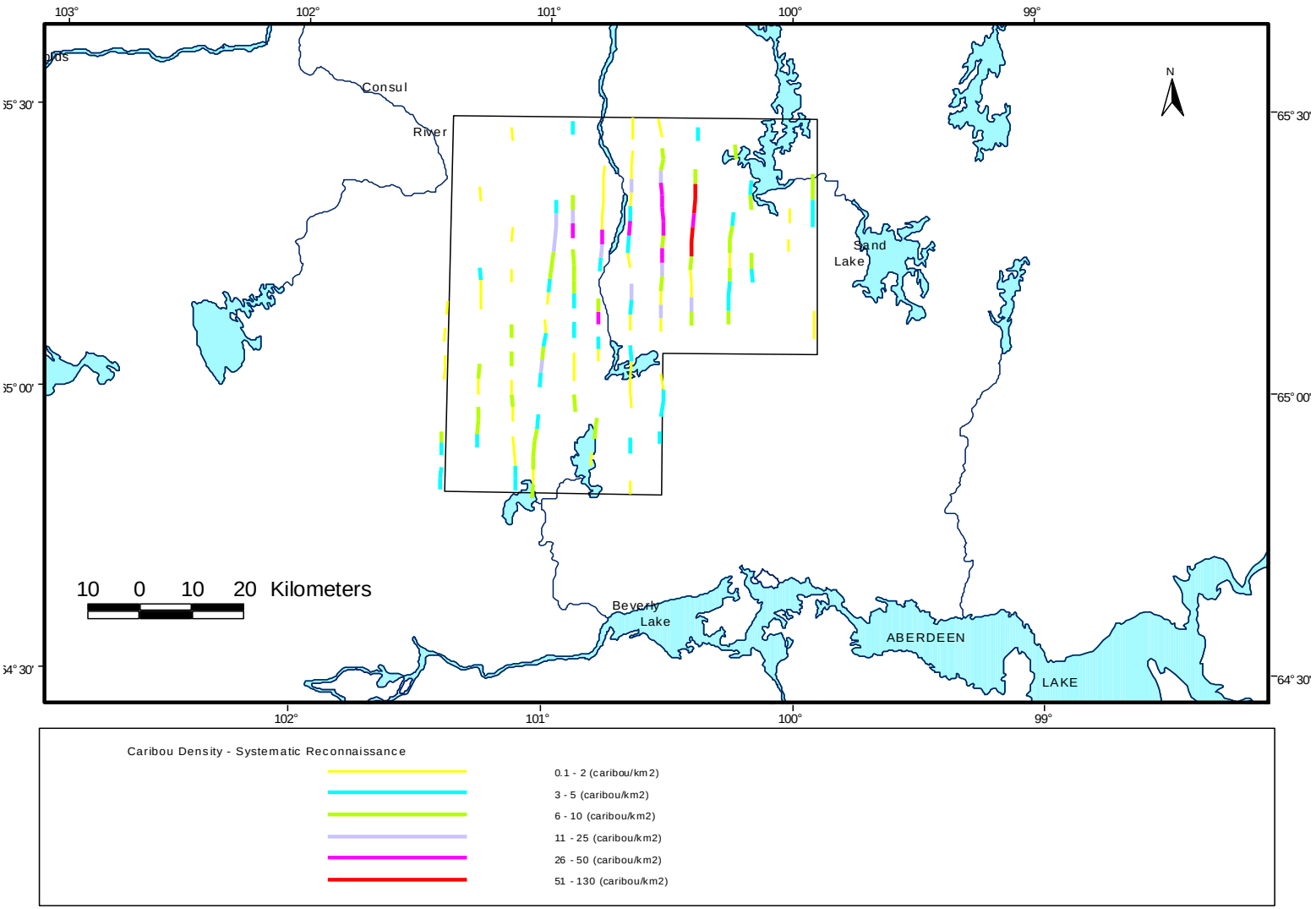

Figure 7. Densities of caribou (1 year or older) observed along transect segments during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002.

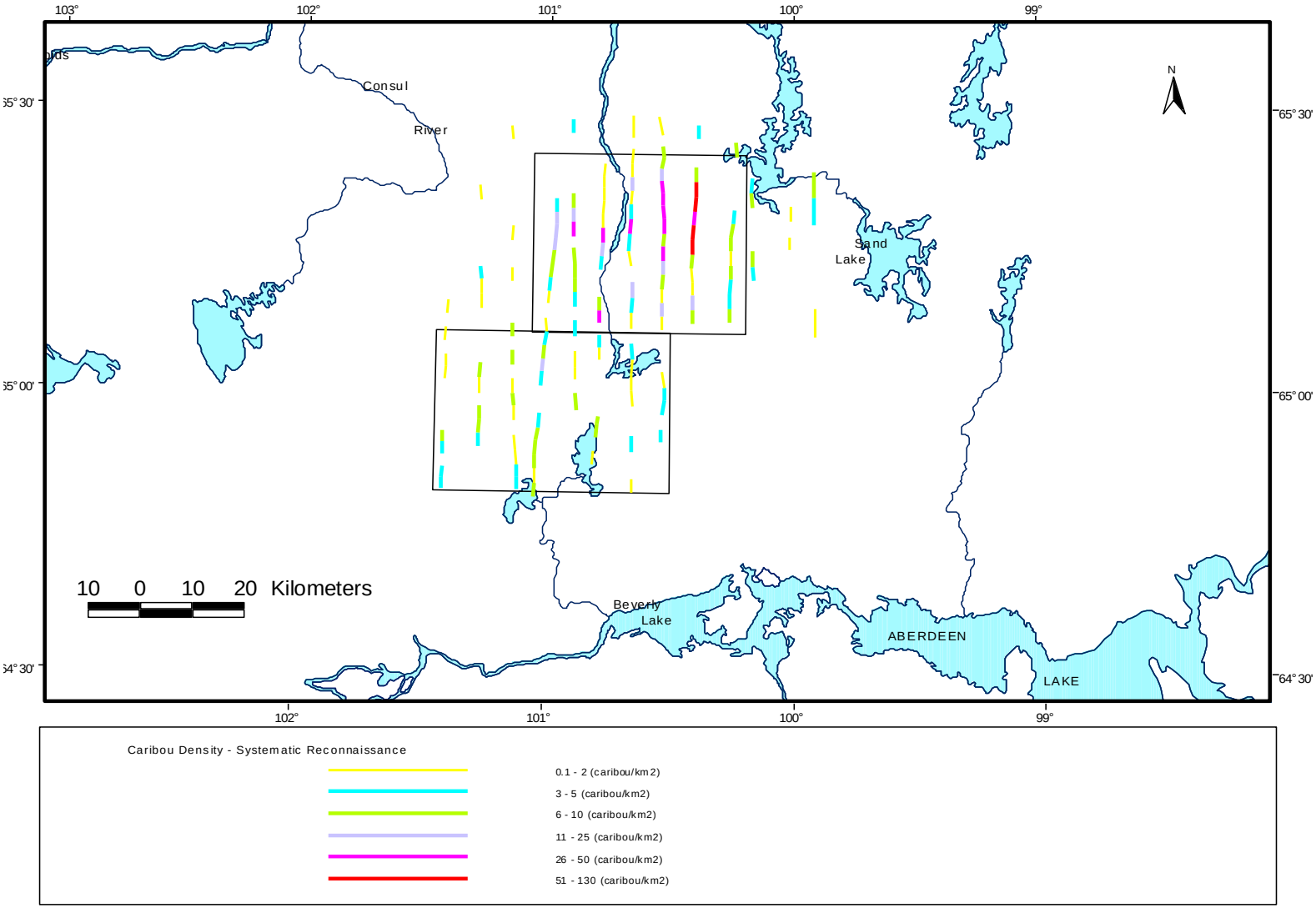

Figure 8. Strata I and II defined from caribou densities observed during the first systematic reconnaissance survey of the Beverly herd's calving ground, 8–9 June 2002.

Second Systematic Reconnaissance Survey

The density of caribou observed in each stratum during the second systematic survey from 10 and 11 June 2002 are presented in Table 3 (see Appendix B for a more detailed account of numbers). The objective was to fly stratum I at 42% coverage; however, due to overlapping flight lines, four transects from the stratum had to be eliminated to prevent double counting of animals. As a result, survey coverage in stratum I was reduced from 42.0% to 33.5% (21 lines decreased to 17 lines). Densities of caribou observed in strata I and II were greater from the second systematic reconnaissance survey than the first (Table 4). Figure 9 illustrates densities of caribou along 2-km segments for each transect and highlights areas of concentrated caribou on the calving ground. As seen for the first systematic reconnaissance survey, the major concentration of cows was located east of the river draining into Upper Garry Lake, with smaller congregations to the west and south of this same drainage. It appears that there was northeast movement into and within the calving ground during the time period between the two systematic reconnaissance surveys. Densities from the second systematic visual survey were higher both numerically and spatially within the calving ground (wider radii of high density areas) and there was an increased density along the southwest portion of stratum II, which may represent movement into the calving ground from the southwest. The average density on stratum I was 14.70 caribou/km^2; however, densities over the 2-km transect segments ranged from 0 to 300 caribou/km^2, which demonstrates the variability of clumping on the calving ground. Clumping is most likely in

response to the variability of habitats along the transects as well as the aggregation of cows and calves into large groups. For stratum II, densities over the 2-km transect segments ranged from 0 to 35.6 caribou/km^2, while the average density was 3.36 caribou/km^2. Caribou were more evenly distributed over stratum II than stratum I; however, clumping of animals was still evident on stratum II.

Stratifying the calving ground and increasing survey coverage during the second systematic reconnaissance survey increased the precision of density estimates for strata I and II compared to the density estimate for the first systematic reconnaissance survey. There was a gain in precision from a coefficient of variance of 0.31 from the first to a coefficient of variation of 0.07 from the second systematic reconnaissance survey (Table 5). Stratifying the calving ground increased the precision of the density estimate; however, using Gasaway *et al.*'s (1986) formulae, there was no statistical difference between the density estimates derived from the first or second systematic reconnaissance survey (t_2=1.44, 16 df, p>0.90).

Table 3. Caribou densities observed within strata I and II from the second systematic reconnaissance survey on 10–11 June 2002.

STRATUM I						
	Transect		**Caribou counted**			**Density**
No.	**Length (km)**	**Area (km^2)**	**Left**	**Right**	**Total**	**Caribou/km^2**
1	35.3	28.3	43	24	67	2.37
2	35.3	28.3	110	59	169	5.98
4	35.3	28.3	280	158	438	15.50
5	35.3	28.3	570	575	1145	40.51
6	35.3	28.3	1006	569	1575	55.72
7	35.3	28.3	453	535	988	34.96
8	35.3	28.3	485	268	753	26.64
9	35.3	28.3	176	277	453	16.03
10	35.3	28.3	160	128	288	10.19
12	35.3	28.3	94	33	127	4.49
13	35.3	28.3	32	25	57	2.02
14	35.3	28.3	13	47	60	2.12
16	35.3	28.3	140	204	344	12.17
17	35.3	28.3	79	160	239	8.46
18	35.3	28.3	70	76	146	5.17
19	35.3	28.3	76	121	197	6.97
20	35.3	28.3	7	8	15	0.53
Totals	**600.6**	**480.5**	**3794**	**3267**	**7061**	**14.70**
STRATUM II						
	Transect		**Caribou counted**			**Density**
No.	**Length (km)**	**Area (km^2)**	**Left**	**Right**	**Total**	**Caribou/km^2**
14	31.6	25.3	104	59	163	6.44
13	31.6	25.3	51	57	108	4.27
12	31.6	25.3	32	82	114	4.51
11	31.6	25.3	117	100	217	8.58
10	31.6	25.3	69	44	113	4.47
9	31.6	25.3	57	38	95	3.76
8	31.6	25.3	52	29	81	3.20
7	31.6	25.3	9	12	21	0.83
6	31.6	25.3	22	18	40	1.58
5	31.6	25.3	8	43	51	2.02
4	31.6	25.3	28	2	30	1.19
3	31.6	25.3	21	65	86	3.40
2	31.6	25.3	38	8	46	1.82
1	31.6	25.3	4	21	25	0.99
Totals	**442.7**	**354.1**	**612**	**578**	**1190**	**3.36**

Table 4. A comparison of the density per stratum between the first systematic reconnaissance and the second systematic reconnaissance survey of the Beverly herd's calving ground, 2002.

Stratum	Caribou Density (caribou/km^2) 1st Systematic Reconnaissance Survey (Non-Stratified)	2nd Systematic Reconnaissance Survey (Stratified)
I	10.08	14.70
II	1.82	3.36

Table 5. Comparison of the variability in the density of caribou observed during the first and second systematic reconnaissance survey of the Beverly herd's calving ground, 2002.

Survey	Density (# of caribou/km^2)	Variance	Standard Error	Coefficient of Variation
1st Systematic Reconnaissance	3.97 (n=13)	29 900 170	5 468	0.31
2nd Systematic Reconnaissance				
Stratum I	14.70 (n=17)	3 372 192	1 836	0.087
Stratum II	3.36 (n=14)	44 371	210	0.044
Total	9.06 (n=31)	3 416 563	1 848	0.071

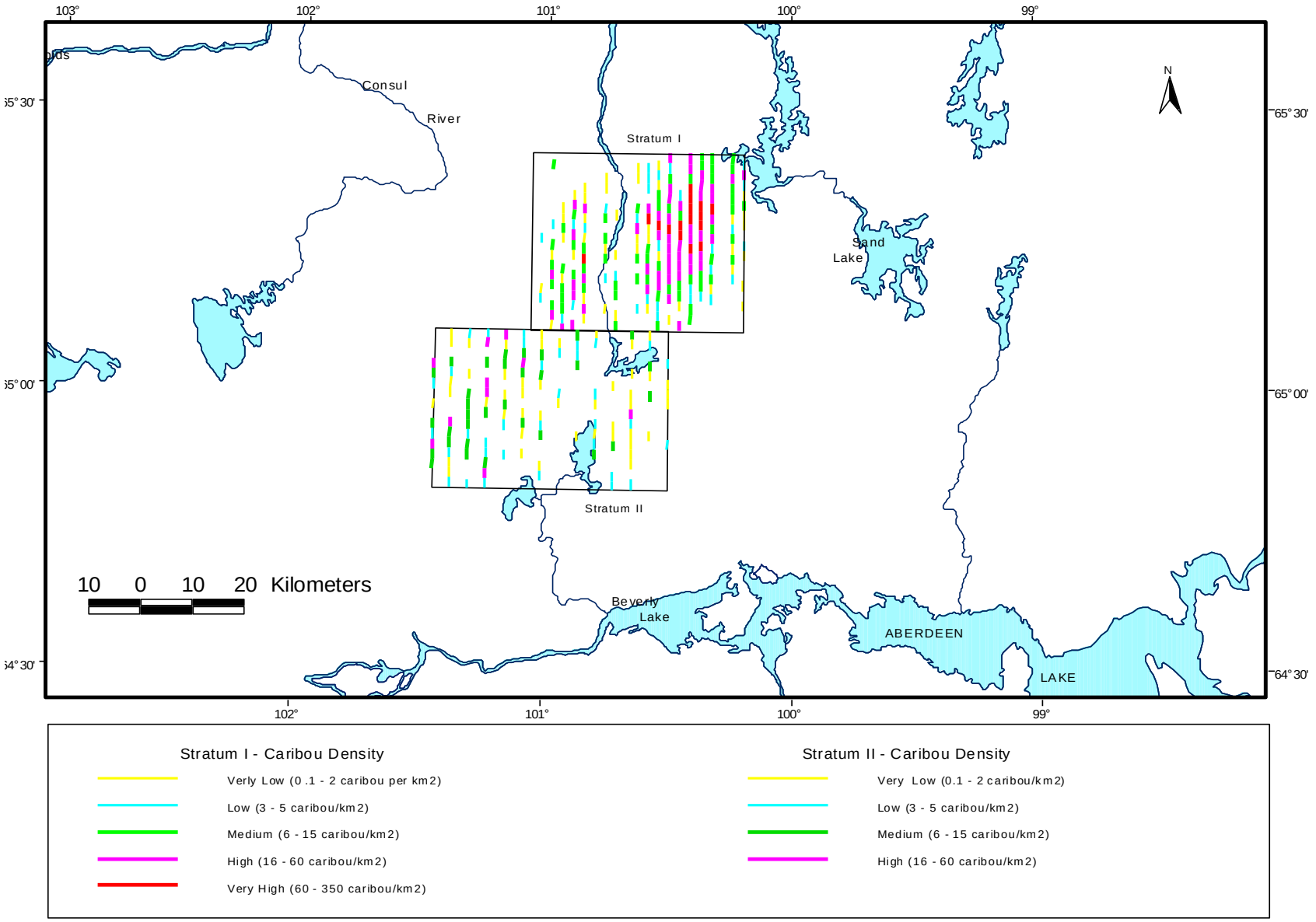

Figure 9. Densities of caribou (1 year or older) observed along 2-km transect segments in strata I and II during the second systematic reconnaissance survey of the Beverly herd's calving ground, 10–11 June 2002.

Further Calving Ground Delineation

Additional flights were conducted on 9, 10, 11 and 12 June 2002 to ensure that no major groups of calving caribou were missed. These flights covered the traditional calving ground compiled by Gunn and Sutherland (1997) and included east of Deep Rose Lake, north of the Garry Lakes complex, west of the Consul River and south through the migration corridor to the calving ground (Figure 4). Few caribou were observed to the east, north and west of the calving ground, but increased to the southwest of the calving area (Figure 10). During flights south of the calving ground, the 0.8-km strip width was not used to quantify the number of caribou observed; all groups that were visible, within a 2- to 3-km distance swath, were recorded. Although there are no substantiating criteria to distinguish differences between migratory and resident caribou groups that use the northeast mainland, it is proposed that small groups of caribou outside of the historic calving ground to the east and north represent resident caribou. Cows and a few cow/calf pairs seen south of the calving area are assumed to belong to the Beverly herd; however, it is difficult to estimate their relative proportion, as most groups were not classified due to fuel limitations and time constraints on the air charter. Out of 1,115 caribou observed, 54% were yearlings, 38% were not classified, 7% were a mixture of cows and yearlings, 1% were cows and less than 1% were calves. No bulls were classified during these flights; their absence may corroborate the late spring theory or may be attributed to incorrectly classifying bulls as cows. The density of caribou southwest of the calving ground was approximately 0.3 caribou/km^2. Most cow/calf pairs were located within the

historic calving area; however, one cow/calf pair was observed as far west and south as 106°00″W on the Hanbury River (Figure 10).

Timing of Calving

Calves were evident on 7 June 2002 when the major concentration of caribou was traversed during a non-systematic reconnaissance survey flight. As the survey did not begin until 6 June 2002, the start of calving was not documented. Furthermore, the first flight to quantify timing of peak calving was not conducted until 8 June 2002 and the classification of caribou to calves was only conducted in stratum I. The emphasis of counting caribou one year or older on transect and the difficulty of seeing bedded calves precluded using caribou/ calf ratios observed during the systematic reconnaissance surveys to discern peak of calving. From the classification counts, it appears that peak of calving in stratum I occurred prior to 9 June 2002. Ground and aerial fixed wing observations of the number of cows with calves to the number of caribou (one year or older) in stratum I are presented in Table 6. Calf/cow ratio in the core of stratum I was 59/100 on 9 June 2002, while calf/caribou ratio on the periphery of stratum I was 47/100 on the same day. Combined counts of the periphery and core of stratum I on 10 and 11 June 2002 resulted in calf/caribou ratios of 53/100 and 75/100, respectively. Although not representative of the Beverly herd, the movement of one collared Beverly cow decreased considerably in average daily distance moved after 10 June 2002 (Table 7).

Table 6. Ratio of cows with calves to caribou aged one year or older on the calving ground from ground and aerial fixed wing observations, 9–11 June, 2002.

Date (2002)	Method	Cows with calves	Cows without calves			Caribou without calves	Yearlings	Ratio cows with calves
			1 Antler	2 Antlers	No Antlers			
June 9	Ground[C]	44	1	30	5		8	58.7
June 9	Aerial[P]	62				88	35	41.3
June 9	Above combined	106	1	30	5	88	43	47.1
June 10	Aerial[CP]	79				69	3	53.4
June 11	Aerial[CP]	240				78	10	75.5

C - Core area of Stratum I
P - Periphery of Stratum I
CP - Traverse from Periphery to Core of Stratum I

Table 7. Average daily distance travelled by one satellite-collared cow during pre-calving, calving and post-calving, 15 May–30 June 2002.

Date (2002)	Average daily distance travelled (km)*
May 15 -20	14.8
May 20 - 25	19.6
May 25 - 30	21.4
May 30 - June5	28
June 5 -10	28.8
June 10 - 15	4.8
June 15 - 20	2
June 20 - 25	0.8
June 25 - 30	1.1

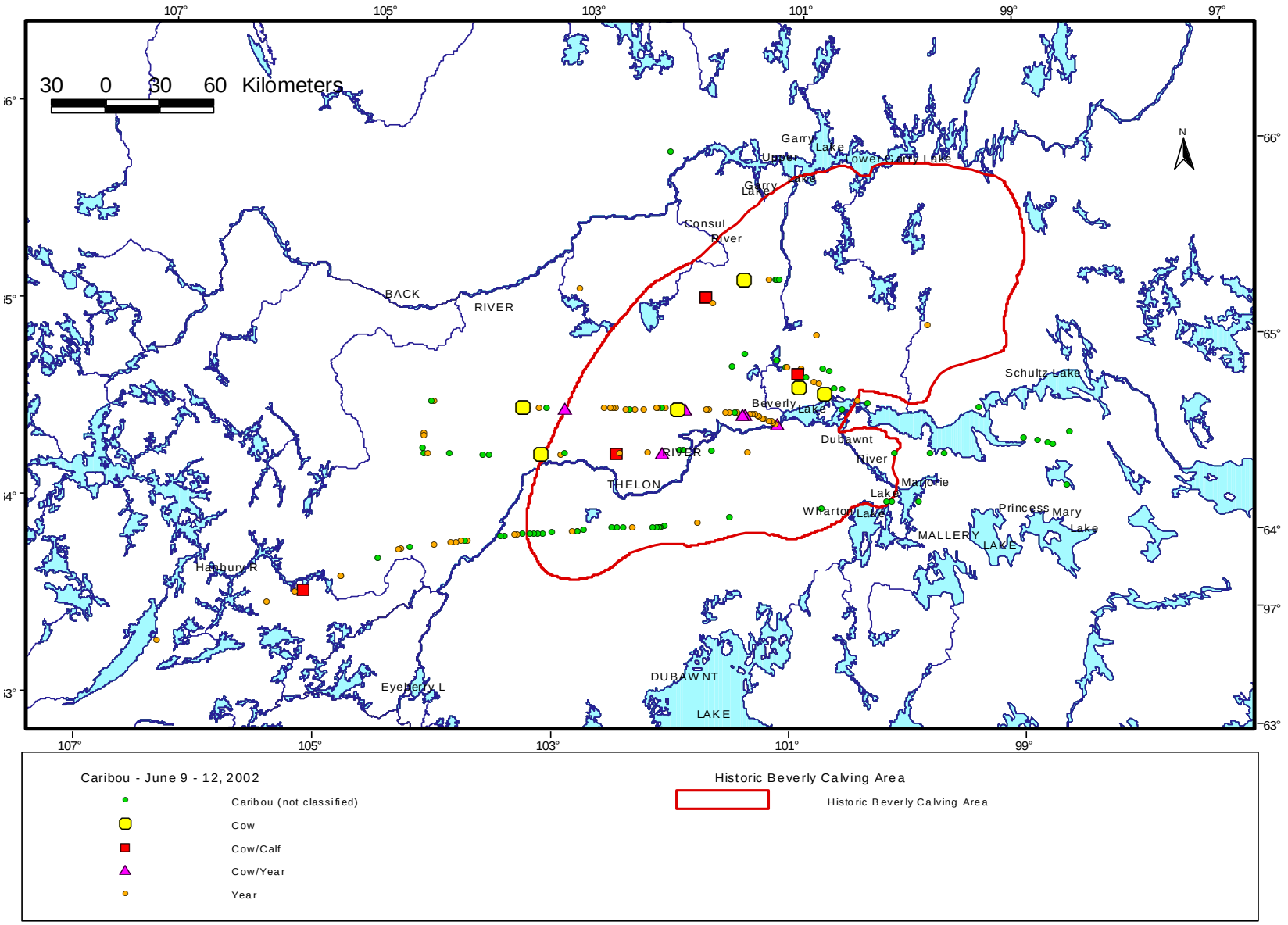

Figure 10. Composition of caribou groups observed during the additional non-systematic reconnaissance flights of the historic Beverly herd's calving ground, 9–12 June 2002.

DISCUSSION

Distribution

The calving ground delineated for 2002 fell within the historic calving area that has been documented for the Beverly herd from 1957 to 1994 (Gunn and Sutherland, 1997). The area covered in 2002 was most similar to the calving grounds defined in 1993 and 1994, with previous survey years (1988, 1987, 1984, and 1982) occupying comparable areas to the west, but extending further east and north to Deep Rose Lake and Garry Lake, respectively (Figure 11). Although it has been documented that there is long-term fidelity for specific calving areas, there are locational changes between annual calving grounds as exhibited on the Beverly calving area. However, as Gunn and Miller (1986) suggest, these differences may be more a function of different criteria used over the years to delineate calving ground, as well as variation in the timing of surveys. A standardised approach to defining calving grounds would allow comparison of spatial shifts.

The 2002 survey of the Beverly herd's calving ground identified the major congregation of calving caribou within the historic calving area. There was no evidence to suggest other areas that had high densities of calving cows (>10 caribou/km^2) within the historic calving area. However, delineation flights done later during the survey on 10 and 11 June 2002 revealed calving cows to the south and west of the calving area. These animals may represent late movement of cows onto the calving ground or indicate that the calving area extended further southwest, but at a much lower density than exhibited on stratum I or II, as

observed in 1979. The 1979 calving ground (Darby, 1980), delineated as part of the Caribou Protection Measures program, was characterized by high density (32 caribou/km^2) of calving caribou around Sand Lake, medium density (4 caribou/km^2) around Consul Lake, and a large area of low density (<1 caribou/km^2) cows that extended west from Sand Lake to south of Lookout Point on the Thelon River. This distribution was attributed to a combination of a late spring on the late winter and spring range, which limited movement onto the calving area, and an early spring east of the calving area, which resulted in cows travelling further east once they reached the calving area.

Size of 2002 Calving Ground

The size of the calving ground of the Beverly herd has shown considerable variability between years (Gunn and Sutherland, 1997). Table 8 illustrates the variation in the size of the calving ground from 1979 to present; sizes, with the exception of 1979, are only presented for years in which a systematic survey was conducted in order to standardize how the boundary was defined. Further variation exhibited in the size of the calving ground may reflect survey timing, but is also attributed to ecological and environmental factors. The area defined in 1979 is much larger than current years; however, Darby (1980) delineated a large area of calving cows at low density (approximately 0.7 caribou/km^2). Surveys conducted since 1980 have not included areas with such low density when defining the boundaries of the calving ground. Failure to include large areas with low densities of caribou may explain low estimates that

have been recorded for some years, especially when the calving ground defined is relatively small and densities are moderate.

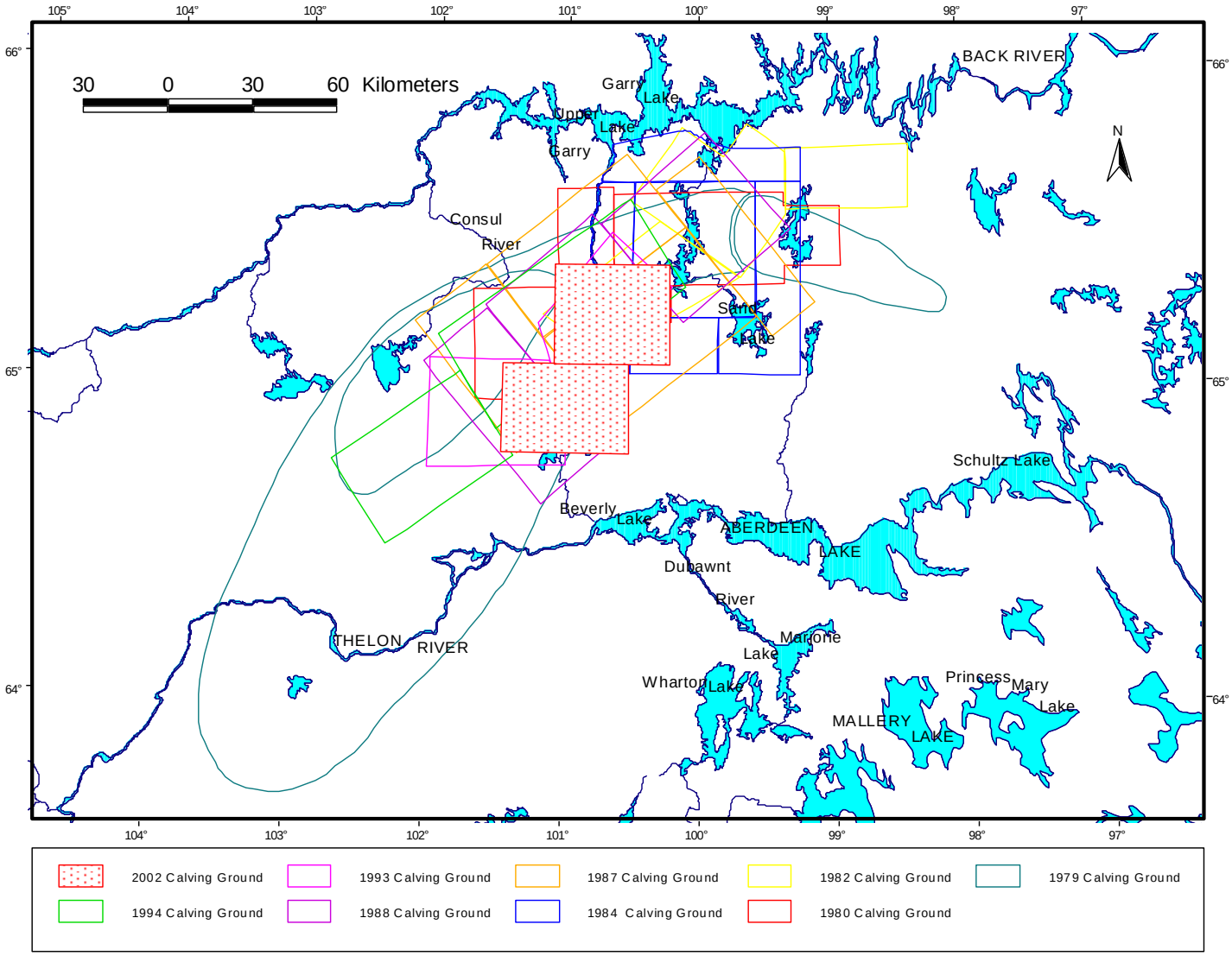

Figure 11. Location of the 2002 Beverly herd's calving ground in relation to past calving grounds defined in 1994, 1993, 1988, 1987, 1984, 1982, 1980, and 1979.

Excluding 1979, the size of the calving ground has ranged from 2,856 to 7,828 km^2, with 2002 being the smallest. It is postulated that environmental conditions in 2002 are similar to those in 1979. Unfavourable spring weather conditions delayed spring migration, and consequently, not all calving cows reached the calving ground. However, in 1979, the resultant spread of calving cows was incorporated into the delineation of the calving ground, but was not in 2002. The range in calving grounds observed also demonstrates that population size does not correlate to the area of the calving ground. The small size defined in 2002 in no way infers a declining population, but rather reflects criteria used to define the boundaries, as well as environmental influences.

Table 8. Size of the annual calving ground (km^2) of the Beverly herd defined from the results of systematic reconnaissance surveys, 1980–2002.

Year	Area (km^2)	Survey Method used to Delineate Calving Grounds	Source
1979	16,000	Unsystematic reconnaissance	Darby, 1980
1980	5,288	Systematic reconnaissance	Gunn and Decker, 1982
1982	4,219	Systematic reconnaissance	Stephenson *et al.*, 1984
1984	5,889	Systematic reconnaissance	Gates, 1984
1987	7,828	Systematic reconnaissance	Heard *et al.*, 1990
1988	6,183	Systematic reconnaissance	Heard and Jackson, 1990
1993	3,200	Systematic reconnaissance	Willliams, 1995
1994	3,300	Systematic reconnaissance	Williams, 1995
2002	2,856	Systematic reconnaissance	This report

Density

The survey provided an estimate of the density of caribou one year or older on the calving ground. Tight sequencing of timing between the non-systematic reconnaissance, systematic reconnaissance, and the systematic

visual survey resulted in less time for movements to affect densities observed on the calving area. In addition, survey timing was conducted during peak of calving when there is reduced tendency for caribou to move during this period. Increased densities observed from the first and second systematic reconnaissance survey may be attributed to movement onto the calving ground but is most likely a result of increased sampling precision, as there was no statistical difference between the two density estimates.

Densities observed on the calving ground for 2002 were lower than those reported for most years. However, it is hard to make direct comparisons to previous survey results due to counting bias. For example, during 1982, 1984, and 1988 calving ground surveys where both systematic visual and photographic techniques were used, the differences between the visual and photographic estimates varied by a factor of 1.68 to 4.5. Comparison of the first systematic reconnaissance survey (no stratification) results for 2002 with 1993, 1994, 1988, 1987, 1982, and 1980 indicate that the calving area for 2002 was smaller than average and had a low density, but was comparable to densities observed in 1987 and 1988 (Appendix C). For 1980, 1982, and 1987 where the results from the systematic visual surveys are available, the density from the second systematic reconnaissance survey (stratification) in 2002 was lower than previous years except for 1987 (Appendix D). As stated above, however, it has been demonstrated that visual counts are inaccurate and highly variable; therefore, low densities observed on the 2002 calving ground may be a result of counting bias.

Lower densities observed on the calving ground for 2002 may be explained by the formation of a new calving ground(s) outside of the documented historic calving area. However, it seems that this scenario is unlikely, as the literature to date does not support the idea of population level changes in calving areas (Heard, 1990; Gunn and Miller, 1986; Valkenburg and Davis, 1986).

Although there is no empirical information on weather and snow conditions on the migration routes into the calving area, the late spring conditions to the west and east of the calving area may explain the distribution and density of calving caribou seen in 2002. The tail of calving cows observed southwest of the calving ground and the lack of males seen around the periphery of the calving ground may indicate that there was a significant portion of calving cows that did not congregate onto the calving ground, but were dispersed to the southwest at low densities. Although not representative of the herd, movements of one collared Beverly cow (cow #80) corresponded to movements documented in 1979 (Darby, 1980). Cow #80 did not leave the tree line until 15 May 2002, reached Eyeberry Lake on 31 March 2002 and reached the southwest corner of the calving ground by 10 June 2002. Migration by cow #80 was late when compared to movements documented by Caribou Protections Measures Program; on average, most cows were observed within the traditional calving area by mid-May (Gauthier and Mulders, 1990; Chalmers, 1989; Olgilvie, 1987 and 1989; Liepins, 1986; Duquette, 1985; Bradley, 1985; Clement, 1982 and 1983, Gray, 1981; Darby, 1980). Locations of satellite-radio collared cows for 2002 from the Bathurst, Ahiak and Qamanirjuaq herds indicate that with the

exception of 2 cows from the Qamanirjuaq herd, all of the collared cows reached their respective historic calving areas by 10 June 2002 for each respective herd (Figure 12).

The relative densities observed from the 2002 survey do not indicate a population decline or increase and nor was the survey designed for that. The results indicate that the size of and density on the calving ground was low compared to previous years. However, the low density observed on the calving ground may be explained by a combination of dispersed distribution of calving cows and counting error. In hindsight, more effort should have been allocated to determining the southern extent of calving cows and their relative density. Although concerns about decreasing population numbers were not alleviated, there is no conclusive evidence that suggests a population decline. The survey results, however, highlight how distribution of calving cows can greatly influence densities seen of the calving ground (surveys do not reflect the full population of breeding female caribou). A photographic survey of the Beverly herd is needed to determine trend in herd size; however, before conducting such a survey, management strategies need to be implemented to determine whether the full population of breeding female caribou reach the calving ground.

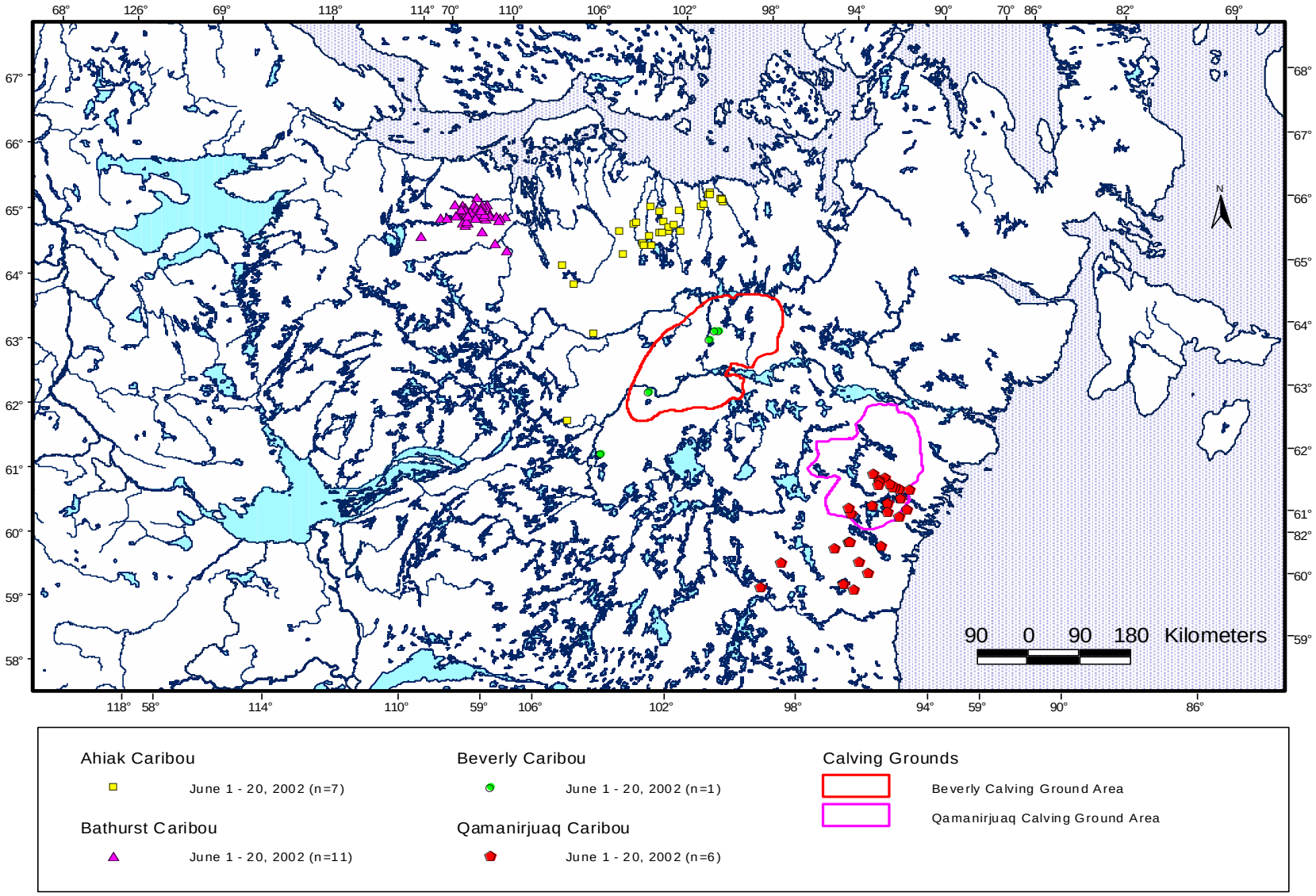

Figure 12. Locations of collared cows from the Ahiak, Bathurst, Beverly and Qamanirjuaq herds during the calving period, 1–20 June 2002.

RECOMMENDATIONS

Regular Reconnaissance Surveys

As reconnaissance surveys are relatively inexpensive, there are two advantages to obtaining distribution and density of cows on the calving ground. Although variation in counting error, differing criteria used to define calving grounds and timing of surveys, influence conclusions regarding herd trends based on reconnaissance surveys, reconnaissance surveys firstly contribute to information on distribution needed to protect caribou calving grounds. Secondly, they provide insight into annual variation in density of calving cows on the calving ground. It is important to document annual distribution and density on the calving ground, as it determines variation in conditions that may be encountered on the calving ground, especially with respect to conducting photographic surveys. For example, low density on the core calving areas was documented in 1993 with a subsequent increase the following year. Being able to detect this pattern and identify associated causes will help improve the timing of future photographic surveys.

As the success of photographic surveys is dependent upon properly defining the calving ground and stratifying densities of calving cows, recurrent reconnaissance surveys would provide a means to define a standardised method to delineate calving grounds and develop criteria to determine when and when not to conduct photographic surveys. For example, regular surveys may determine what level of coverage(s) during the reconnaissance survey is

required to allow optimal allocation of strata under various distributions of cows (Mowat and Boulanger, 2001). It would also provide a chance to test various methods to digitally display data in the field to help delineate stratum when time is a constraint. More importantly, regular surveys provide staff with valuable experience and knowledge of the calving ground required to successfully conduct the more labour intensive and expensive photographic survey procedure.

Distribution of Caribou on the Calving Ground

There have been two documented cases in 1979 and 1993 were the number of cows on the core calving ground was low. The most likely explanation is that due to environmental conditions (e.g. freezing temperatures and snow conditions), movement onto the core calving area is reduced and cows are dispersed at relatively low densities along the migration corridor and north into the calving area. This lag of cows may represent a significant portion of the cow population. To test this hypothesis, it is recommended that a combination of satellite-radio and radio collars be deployed on cows to examine the annual distribution and density of cows on the calving area. Collars would help determine when photographic surveys may not be feasible due to dispersed low densities of cows or the exclusion of cows from the calving ground. Consequently, it is suggested that a photographic survey of the Beverly herd's calving ground not be conducted until collars have been deployed to assist with the survey procedure. Furthermore, once collars are deployed, it is recommended that a reconnaissance survey precede a photographic survey to

ensure that methods to locate collared cows, and delineate and stratify the calving grounds have been tested concurrently.

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APPENDIXES

Appendix A: Number of caribou (1 year or older) observed on transect segments (time at one - two minute intervals) during the systematic reconnaissance survey of the Beverly herd's calving ground, June 2002.

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
1	1_1	0	0	0	2	1.6	0
	1_2	0	0	0	3.1	2.48	0
	1_3	1	1	2	5	4	0.5
	1_4	0	0	0	5.1	4.08	0
	1_5	0	0	0	4.9	3.92	0
	1_6	0	0	0	4.9	3.92	0
	1_7	2	12	14	4.8	3.84	3.6458333
	1_8	22	3	25	4.7	3.76	6.6489362
	1_9	0	0	0	5	4	0
	1_10	0	0	0	5.3	4.24	0
2	2_1	0	0	0	2.5	2	0
	2_2	0	0	0	2.6	2.08	0
	2_3	0	0	0	2.5	2	0
	2_4	0	0	0	2.6	2.08	0
	2_5	0	0	0	2.7	2.16	0
	2_6	0	0	0	2.6	2.08	0
	2_7	3	0	3	2.6	2.08	1.4423077
	2_8	0	0	0	2.9	2.32	0
	2_9	1	0	1	2.4	1.92	0.5208333
	2_10	0	0	0	2.3	1.84	0
	2_11	0	0	0	2.4	1.92	0
	2_12	0	0	0	2.5	2	0
	2_13	0	0	0	2.3	1.84	0
	2_14	0	0	0	2.3	1.84	0
	2_15	0	0	0	2.2	1.76	0
	2_16	0	0	0	2.4	1.92	0
	2_17	0	0	0	2.2	1.76	0
	2_18	0	0	0	2.3	1.84	0
	2_19	0	0	0	2.4	1.92	0
3	3_1	0	0	0	2.4	1.92	0
	3_2	0	1	1	2.7	2.16	0.462963
	3_3	0	0	0	2.6	2.08	0
	3_4	0	0	0	2.7	2.16	0
	3_5	0	0	0	2.6	2.08	0
	3_6	0	0	0	2.6	2.08	0
	3_7	0	0	0	2.7	2.16	0
	3_8	0	0	0	2.3	1.84	0
	3_9	10	0	10	2.5	2	5
	3_10	11	4	15	2.8	2.24	6.6964286

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	3_11	0	0	0	2.5	2	0
	3_12	0	0	0	2.6	2.08	0
	3_13	0	0	0	2.6	2.08	0
	3_14	4	9	13	2.6	2.08	6.25
	3_15	0	6	6	2.6	2.08	2.8846154
	3_16	0	0	0	5.3	4.24	0
	3_17	0	0	0	2.7	2.16	0
	3_18	0	0	0	2.7	2.16	0
4	4_1	0	0	0	2.3	1.84	0
	4_2	0	0	0	2.5	2	0
	4_3	14	0	14	2.6	2.08	6.7307692
	4_4	0	0	0	2.5	2	0
	4_5	0	0	0	2.2	1.76	0
	4_6	0	0	0	2.6	2.08	0
	4_7	0	0	0	2.3	1.84	0
	4_8	7	0	7	2.5	2	3.5
	4_9	13	3	16	2.5	2	8
	4_10	5	7	12	2.4	1.92	6.25
	4_11	1	0	1	2.6	2.08	0.4807692
	4_12	12	0	12	2.5	2	6
	4_13	8	0	8	2.6	2.08	3.8461538
	4_14	5	2	7	2.6	2.08	3.3653846
	4_15	4	12	16	2.5	2	8
	4_16	0	0	0	2.5	2	0
	4_17	0	0	0	2.5	2	0
	4_18	0	0	0	2.5	2	0
	4_19	0	0	0	2.6	2.08	0
5	5_1	0	0	0	2.6	2.08	0
	5_2	0	0	0	2.7	2.16	0
	5_3	0	0	0	2.7	2.16	0
	5_4	0	0	0	2.6	2.08	0
	5_5	0	0	0	2.6	2.08	0
	5_6	1	19	20	2.6	2.08	9.6153846
	5_7	17	4	21	2.5	2	10.5
	5_8	0	3	3	2.5	2	1.5
	5_9	0	2	2	2.4	1.92	1.0416667
	5_10	2	15	17	2.4	1.92	8.8541667
	5_11	61	65	126	2.7	2.16	58.333333
	5_12	111	140	251	2.5	2	125.5
	5_13	40	17	57	2.6	2.08	27.403846
	5_14	107	87	194	2.7	2.16	89.814815
	5_15	36	96	132	2.6	2.08	63.461538
	5_16	7	7	14	2.6	2.08	6.7307692
	5_17	0	0	0	5.1	4.08	0
	5_18	6	0	6	2.3	1.84	3.2608696
6	6_1	3	0	3	3.5	2.8	1.0714286
	6_2	0	0	0	2	1.6	0

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	6_3	5	8	13	2	1.6	8.125
	6_4	14	0	14	2	1.6	8.75
	6_5	17	1	18	2.2	1.76	10.227273
	6_6	60	15	75	2.3	1.84	40.76087
	6_7	47	19	66	2.3	1.84	35.869565
	6_8	57	1	58	2.4	1.92	30.208333
	6_9	43	28	71	2.5	2	35.5
	6_10	11	2	13	2.3	1.84	7.0652174
	6_11	64	33	97	2.6	2.08	46.634615
	6_12	24	12	36	2.4	1.92	18.75
	6_13	5	11	16	2.6	2.08	7.6923077
	6_14	0	2	2	2.3	1.84	1.0869565
	6_15	22	0	22	2.4	1.92	11.458333
	6_16	1	0	1	2.5	2	0.5
	6_17	0	0	0	2.5	2	0
	6_18	0	0	0	2.7	2.16	0
	6_19	0	0	0	2.4	1.92	0
	6_20	4	0	4	2.8	2.24	1.7857143
	6_21	2	6	8	2.2	1.76	4.5454545
	6_22	10	1	11	2.8	2.24	4.9107143
	6_23	0	0	0	2.7	2.16	0
	6_24	8	0	8	2.2	1.76	4.5454545
	6_25	0	0	0	2.4	1.92	0
	6_26	0	0	0	2.4	1.92	0
	6_27	0	0	0	3.5	2.8	0
7	7_1	3	0	3	2.3	1.84	1.6304348
	7_2	0	0	0	2.3	1.84	0
	7_3	0	0	0	2.5	2	0
	7_4	0	6	6	2.9	2.32	2.5862069
	7_5	0	0	0	2.5	2	0
	7_6	0	0	0	2.6	2.08	0
	7_7	0	1	1	2.8	2.24	0.4464286
	7_8	0	2	2	2.9	2.32	0.862069
	7_9	0	3	3	2.7	2.16	1.3888889
	7_10	6	0	6	2.8	2.24	2.6785714
	7_11	0	0	0	2.7	2.16	0
	7_12	3	0	3	2.8	2.24	1.3392857
	7_13	6	1	7	2.8	2.24	3.125
	7_14	38	12	50	2.7	2.16	23.148148
	7_15	0	0	0	2.8	2.24	0
	7_16	1	1	2	2.9	2.32	0.862069
	7_17	5	7	12	3.1	2.48	4.8387097
	7_18	6	50	56	2.6	2.08	26.923077
	7_19	0	8	8	2.7	2.16	3.7037037
	7_20	2	0	2	2.4	1.92	1.0416667
	7_21	33	6	39	2.4	1.92	20.3125
	7_22	0	1	1	2.4	1.92	0.5208333

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	7_23	3	0	3	2.7	2.16	1.3888889
	7_24	0	0	0	2.5	2	0
	7_25	1	0	1	3.9	3.12	0.3205128
8	8_1	0	0	0	2.4	1.92	0
	8_2	0	0	0	1.8	1.44	0
	8_3	0	0	0	2.1	1.68	0
	8_4	0	0	0	2.3	1.84	0
	8_5	0	3	3	2.2	1.76	1.7045455
	8_6	1	0	1	2	1.6	0.625
	8_7	2	0	2	2.3	1.84	1.0869565
	8_8	3	0	3	2.4	1.92	1.5625
	8_9	1	0	1	2.6	2.08	0.4807692
	8_10	37	30	67	2.6	2.08	32.211538
	8_11	39	0	39	2.4	1.92	20.3125
	8_12	4	0	4	2.4	1.92	2.0833333
	8_13	0	0	0	2.4	1.92	0
	8_14	0	0	0	2.4	1.92	0
	8_15	12	1	13	2.4	1.92	6.7708333
	8_16	50	10	60	2.3	1.84	32.608696
	8_17	0	0	0	2.1	1.68	0
	8_18	0	5	5	2.1	1.68	2.9761905
	8_19	3	0	3	2.2	1.76	1.7045455
	8_20	0	0	0	2.4	1.92	0
	8_21	0	0	0	2.1	1.68	0
	8_22	0	0	0	2.3	1.84	0
	8_23/4	0	0	0	3.3	2.64	0
	8_25	0	9	9	1.3	1.04	8.6538462
	8_26	13	0	13	2.5	2	6.5
	8_27	0	0	0	2.7	2.16	0
	8_28	3	0	3	2.5	2	1.5
9	9_1	0	0	0	2.9	2.32	0
	9_2	0	0	0	2.9	2.32	0
	9_3	13	0	13	2.9	2.32	5.6034483
	9_4	0	0	0	2.5	2	0
	9_5	0	3	3	2.1	1.68	1.7857143
	9_6	0	3	3	2.8	2.24	1.3392857
	9_7	0	0	0	2.7	2.16	0
	9_8	2	7	9	2.7	2.16	4.1666667
	9_9	0	0	0	2.5	2	0
	9_10	0	9	9	2.6	2.08	4.3269231
	9_11	0	14	14	2.6	2.08	6.7307692
	9_12	1	10	11	2.6	2.08	5.2884615
	9_13	17	0	17	2.7	2.16	7.8703704
	9_14	0	0	0	2.1	1.68	0
	9_15	23	50	73	2.5	2	36.5
	9_16	3	20	23	2.4	1.92	11.979167
	9_17	12	0	12	2.6	2.08	5.7692308

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	9_18	0	0	0	2.7	2.16	0
	9_19	0	0	0	2.6	2.08	0
	9_20	0	0	0	2.9	2.32	0
	9_21	0	0	0	2.6	2.08	0
	9_22	6	0	6	2.4	1.92	3.125
10	10_2	0	0	0	2.1	1.68	0
	10_3	0	0	0	2.4	1.92	0
	10_4	0	0	0	2.4	1.92	0
	10_5	0	0	0	2.5	2	0
	10_6	0	0	0	2.5	2	0
	10_7	0	0	0	2.3	1.84	0
	10_8	0	5	5	2.6	2.08	2.4038462
	10_9	18	16	34	2.1	1.68	20.238095
	10_10	23	14	37	2.4	1.92	19.270833
	10_11	14	19	33	2.3	1.84	17.934783
	10_12	25	11	36	4.9	3.92	9.1836735
	10_13	10	0	10	2.6	2.08	4.8076923
	10_14	0	2	2	2.4	1.92	1.0416667
	10_15	0	0	0	2.5	2	0
	10_16	4	0	4	2.5	2	2
	10_17	5	2	7	2.5	2	3.5
	10_18	17	3	20	2.5	2	10
	10_19	25	2	27	2.3	1.84	14.673913
	10_20	6	3	9	2.5	2	4.5
	10_21	0	0	0	2.5	2	0
	10_22	0	0	0	2.4	1.92	0
	10_23	6	0	6	2.7	2.16	2.7777778
	10_24	8	5	13	2.4	1.92	6.7708333
	10_25	0	11	11	2.6	2.08	5.2884615
	10_26	6	11	17	2.5	2	8.5
	10_27	3	0	3	5.1	4.08	0.7352941
	10_28	10	0	10	2.3	1.84	5.4347826
11	11_1	4	0	4	2.3	1.84	2.173913
	11_2	4	0	4	2.2	1.76	2.2727273
	11_3	2	0	2	2.6	2.08	0.9615385
	11_4	0	1	1	2.6	2.08	0.4807692
	11_5	0	0	0	2.6	2.08	0
	11_6	2	0	2	2.7	2.16	0.9259259
	11_7	17	0	17	2.3	1.84	9.2391304
	11_8	0	1	1	2.5	2	0.5
	11_9	0	0	0	2.5	2	0
	11_10	7	6	13	2.6	2.08	6.25
	11_11	0	0	0	2.3	1.84	0
	11_12	14	0	14	2.6	2.08	6.7307692
	11_13	0	0	0	2.4	1.92	0
	11_14	0	0	0	2.5	2	0
	11_15	0	0	0	2.4	1.92	0

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	11_16	0	1	1	2.4	1.92	0.5208333
	11_17	0	0	0	2.5	2	0
	11_18	0	0	0	2.4	1.92	0
	11_19	3	0	3	2.6	2.08	1.4423077
	11_20	0	0	0	2.6	2.08	0
	11_21	0	0	0	2.7	2.16	0
	11_22	0	0	0	2.4	1.92	0
	11_23	0	0	0	2.9	2.32	0
	11_24	0	0	0	2.3	1.84	0
	11_25	0	0	0	2.4	1.92	0
	11_26	2	0	2	2.4	1.92	1.0416667
12	12_1	0	0	0	2.5	2	0
	12_2	0	0	0	3	2.4	0
	12_3	0	0	0	2.1	1.68	0
	12_4	0	0	0	2.5	2	0
	12_5	0	0	0	2.5	2	0
	12_6	2	0	2	2.6	2.08	0.9615385
	12_7	0	0	0	2.3	1.84	0
	12_8	0	0	0	2.4	1.92	0
	12_9	0	0	0	2.3	1.84	0
	12_10	0	0	0	2.3	1.84	0
	12_11	0	0	0	2.4	1.92	0
	12_12	7	0	7	2.3	1.84	3.8043478
	12_13	2	0	2	2.5	2	1
	12_14	0	2	2	2.6	2.08	0.9615385
	12_15	0	0	0	2.6	2.08	0
	12_16	0	0	0	2.4	1.92	0
	12_17	0	0	0	2.3	1.84	0
	12_18	0	0	0	2.3	1.84	0
	12_19	12	0	12	2.6	2.08	5.7692308
	12_20	4	0	4	2.8	2.24	1.7857143
	12_21	0	0	0	2.3	1.84	0
	12_22	0	15	15	2.5	2	7.5
	12_23	14	0	14	2.4	1.92	7.2916667
	12_24	4	0	4	2.4	1.92	2.0833333
	12_25	0	0	0	4.8	3.84	0
13	13_1	0	6	6	2.1	1.68	3.5714286
	13_2	4	0	4	1.9	1.52	2.6315789
	13_3	0	0	0	2.1	1.68	0
	13_4	6	1	7	2.2	1.76	3.9772727
	13_5	7	6	13	2.1	1.68	7.7380952
	13_6	0	0	0	2.4	1.92	0
	13_7	0	0	0	2.2	1.76	0
	13_8	0	0	0	2.3	1.84	0
	13_9	0	0	0	2.2	1.76	0
	13_10	0	1	1	2.4	1.92	0.5208333
	13_11	1	0	1	2.1	1.68	0.5952381

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	13_12	0	0	0	2.5	2	0
	13_13	3	0	3	2.4	1.92	1.5625
	13_14	0	0	0	2.4	1.92	0
	13_15	1	0	1	2.5	2	0.5
	13_16	0	0	0	2.6	2.08	0
	13_17	0	0	0	2.6	2.08	0
	13_18	0	0	0	2.6	2.08	0
	13_19	0	0	0	2.4	1.92	0
	13_20	0	0	0	2.6	2.08	0
	13_21	0	0	0	2.6	2.08	0
	13_22	0	0	0	2.6	2.08	0
	13_23	0	0	0	2.7	2.16	0
	13_24	0	0	0	2.3	1.84	0
	13_25	0	0	0	2.5	2	0
	13_26	0	0	0	2.6	2.08	0
	13_27	0	0	0	2.7	2.16	0
Total		**1562**	**1070**	**2632**	**755.2**	**604.16**	**4.3564619**

Appendix B: Number of caribou (1 year or older) on transect segments of Stratums 1 and II during the systematic visual survey of the Beverly herd's calving ground, June 2002.

STRATUM I

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
1	1_1	0	0	0	2	1.6	0
	1_2	0	0	0	2	1.6	0
	1_3	0	3	3	2	1.6	1.875
	1_4	0	0	0	2	1.6	0
	1_5	0	1	1	2	1.6	0.625
	1_6	0	0	0	2	1.6	0
	1_7	0	0	0	2	1.6	0
	1_8	0	3	3	2	1.6	1.875
	1_9	2	4	6	2	1.6	3.75
	1_10	0	0	0	2	1.6	0
	1_11	0	1	1	2	1.6	0.625
	1_12	0	1	1	2	1.6	0.625
	1_13	11	0	11	2	1.6	6.875
	1_14	0	1	1	2	1.6	0.625
	1_15	5	0	5	2	1.6	3.125
	1_16	19	8	27	2	1.6	16.875
	1_17	6	2	8	2	1.6	5
	1_18	0	0	0	1.2	0.96	0
2	2_1	6	13	19	2	1.6	11.875
	2_2	19	2	21	2	1.6	13.125
	2_3	21	14	35	2	1.6	21.875
	2_4	5	17	22	2	1.6	13.75
	2_5	11	0	11	2	1.6	6.875
	2_6	12	0	12	2	1.6	7.5
	2_7	1	0	1	2	1.6	0.625
	2_8	1	5	6	2	1.6	3.75
	2_9	21	0	21	2	1.6	13.125
	2_10	2	1	3	2	1.6	1.875
	2_11	10	1	11	2	1.6	6.875
	2_12	1	0	1	2	1.6	0.625
	2_13	0	6	6	2	1.6	3.75
	2_14	0	0	0	2	1.6	0
	2_15	0	0	0	2	1.6	0
	2_16	0	0	0	2	1.6	0
	2_17	0	0	0	2	1.6	0
	2_18	0	0	0	1.2	0.96	0
4	4_1	9	0	9	2	1.6	5.625
	4_2	15	0	15	2	1.6	9.375
	4_3	16	0	16	2	1.6	10
	4_4	23	10	33	2	1.6	20.625
	4_5	26	42	68	2	1.6	42.5
	4_6	76	46	122	2	1.6	76.25

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	4_7	43	16	59	2	1.6	36.875
	4_8	11	6	17	2	1.6	10.625
	4_9	37	7	44	2	1.6	27.5
	4_10	8	0	8	2	1.6	5
	4_11	10	5	15	2	1.6	9.375
	4_12	1	7	8	2	1.6	5
	4_13	3	14	17	2	1.6	10.625
	4_14	1	0	1	2	1.6	0.625
	4_15	1	5	6	2	1.6	3.75
	4_16	0	0	0	2	1.6	0
	4_17	0	0	0	2	1.6	0
	4_18	0	0	0	1.2	0.96	0
5	5_1	0	0	0	2	1.6	0
	5_2	0	0	0	2	1.6	0
	5_3	0	0	0	2	1.6	0
	5_4	5	2	7	2	1.6	4.375
	5_5	9	1	10	2	1.6	6.25
	5_6	8	12	20	2	1.6	12.5
	5_7	5	26	31	2	1.6	19.375
	5_8	24	66	90	2	1.6	56.25
	5_9	91	89	180	2	1.6	112.5
	5_10	0	30	30	2	1.6	50
	5_11	95	39	134	2	1.6	83.75
	5_12	115	99	214	2	1.6	133.75
	5_13	111	90	201	2	1.6	125.625
	5_14	43	24	67	2	1.6	41.875
	5_15	41	27	68	2	1.6	42.5
	5_16	16	41	57	2	1.6	35.625
	5_17	4	18	22	2	1.6	13.75
	5_18	3	11	14	1.2	0.96	14.583333
6	6_1	14	27	41	2	1.6	25.625
	6_2	38	0	38	2	1.6	23.75
	6_3	22	0	22	2	1.6	13.75
	6_4	128	2	130	2	1.6	81.25
	6_5	61	70	131	2	1.6	81.875
	6_6	212	99	311	2	1.6	194.375
	6_7	349	131	480	2	1.6	300
	6_8	28	61	89	2	1.6	55.625
	6_9	45	26	71	2	1.6	44.375
	6_10	34	76	110	2	1.6	68.75
	6_11	7	29	36	2	1.6	22.5
	6_12	23	32	55	2	1.6	34.375
	6_13	13	1	14	2	1.6	8.75
	6_14	5	3	8	2	1.6	5
	6_15	7	0	7	2	1.6	4.375
	6_16	9	12	21	2	1.6	13.125
	6_17	11	0	11	2	1.6	6.875
	6_18	0	0	0	1.2	0.96	0
7	7_1	7	29	36	2	1.6	22.5

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	7_2	0	0	0	2	1.6	0
	7_3	0	2	2	2	1.6	1.25
	7_4	10	0	10	2	1.6	6.25
	7_5	9	4	13	2	1.6	8.125
	7_6	33	13	46	2	1.6	28.75
	7_7	18	40	58	2	1.6	36.25
	7_8	43	15	58	2	1.6	36.25
	7_9	29	51	80	2	1.6	50
	7_10	105	158	263	2	1.6	164.375
	7_11	170	146	316	2	1.6	197.5
	7_12	2	16	18	2	1.6	11.25
	7_13	27	55	82	2	1.6	51.25
	7_14	0	6	6	2	1.6	3.75
	7_15	0	0	0	2	1.6	0
	7_16	0	0	0	2	1.6	0
	7_17	0	0	0	2	1.6	0
	7_18	0	0	0	1.2	0.96	0
8	8_1	7	20	27	2	1.6	16.875
	8_2	8	0	8	2	1.6	5
	8_3	0	10	10	2	1.6	6.25
	8_4	51	10	61	2	1.6	38.125
	8_5	48	15	63	2	1.6	39.375
	8_6	7	17	24	2	1.6	15
	8_7	16	26	42	2	1.6	26.25
	8_8	142	34	176	2	1.6	110
	8_9	0	43	43	2	1.6	26.875
	8_10	61	20	81	2	1.6	50.625
	8_11	56	37	93	2	1.6	58.125
	8_12	43	1	44	2	1.6	27.5
	8_13	28	5	33	2	1.6	20.625
	8_14	16	0	16	2	1.6	10
	8_15	2	29	31	2	1.6	18.125
	8_16	0	0	0	2	1.6	0
	8_17	0	1	1	2	1.6	0.625
	8_18	0	0	0	1.2	0.96	0
9	9_1	0	9	9	2	1.6	5.625
	9_2	0	5	5	2	1.6	3.125
	9_3	2	3	5	2	1.6	3.125
	9_4	8	14	22	2	1.6	13.75
	9_5	26	43	69	2	1.6	43.125
	9_6	17	25	42	2	1.6	26.25
	9_7	1	10	11	2	1.6	6.875
	9_8	0	4	4	2	1.6	2.5
	9_9	0	7	7	2	1.6	4.375
	9_10	10	66	76	2	1.6	47.5
	9_11	52	75	127	2	1.6	79.375
	9_12	26	0	26	2	1.6	16.25
	9_13	10	10	20	2	1.6	12.5
	9_14	17	2	19	2	1.6	11.875

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	9_15	2	0	2	2	1.6	1.25
	9_16	4	4	8	2	1.6	5
	9_17	1	0	1	2	1.6	0.625
	9_18	0	0	0	1.2	0.96	0
10	10_1	0	0	0	2	1.6	0
	10_2	5	2	7	2	1.6	4.375
	10_3	0	5	5	2	1.6	3.125
	10_4	7	0	7	2	1.6	4.375
	10_5	0	0	0	2	1.6	0
	10_6	23	2	25	2	1.6	15.625
	10_7	65	57	122	2	1.6	76.25
	10_8	3	0	3	2	1.6	1.875
	10_9	2	0	2	2	1.6	1.25
	10_10	10	11	21	2	1.6	13.125
	10_11	0	17	17	2	1.6	10.625
	10_12	10	16	26	2	1.6	16.25
	10_13	7	4	11	2	1.6	6.875
	10_14	22	10	32	2	1.6	20
	10_15	5	2	7	2	1.6	4.375
	10_16	1	2	3	2	1.6	1.25
	10_17	0	0	0	2	1.6	0
	10_18	0	0	0	1.2	0.96	0
12	12_1	0	0	0	2	1.6	0
	12_2	0	3	3	2	1.6	1.875
	12_3	0	1	1	2	1.6	0.625
	12_4	0	0	0	2	1.6	0
	12_5	0	0	0	2	1.6	0
	12_6	14	0	14	2	1.6	8.75
	12_7	0	5	5	2	1.6	3.125
	12_8	53	3	56	2	1.6	35
	12_9	0	4	4	2	1.6	2.5
	12_10	0	3	3	2	1.6	1.875
	12_11	10	3	13	2	1.6	8.125
	12_12	0	0	0	2	1.6	0
	12_13	9	10	19	2	1.6	11.875
	12_14	0	0	0	2	1.6	0
	12_15	0	0	0	2	1.6	0
	12_16	4	1	5	2	1.6	3.125
	12_17	0	0	0	2	1.6	0
	12_18	4	0	4	1.2	0.96	0
13	13_1	11	0	11	2	1.6	6.875
	13_2	1	1	2	2	1.6	1.25
	13_3	0	0	0	2	1.6	0
	13_4	7	6	13	2	1.6	8.125
	13_5	6	13	19	2	1.6	11.875
	13_6	5	2	7	2	1.6	4.375
	13_7	0	0	0	2	1.6	0
	13_8	0	3	3	2	1.6	1.875
	13_9	0	0	0	2	1.6	0

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	13_10	0	0	0	2	1.6	0
	13_11	0	0	0	2	1.6	0
	13_12	2	0	2	2	1.6	1.25
	13_13	0	0	0	2	1.6	0
	13_14	0	0	0	2	1.6	0
	13_15	0	0	0	2	1.6	0
	13_16	0	0	0	2	1.6	0
	13_17	0	0	0	2	1.6	0
	13_18	0	0	0	1.2	0.96	0
14	14_1	0	0	0	2	1.6	0
	14_2	0	0	0	2	1.6	0
	14_3	0	2	2	2	1.6	1.25
	14_4	1	0	1	2	1.6	0.625
	14_5	0	0	0	2	1.6	0
	14_6	0	8	8	2	1.6	5
	14_7	5	7	12	2	1.6	7.5
	14_8	0	0	0	2	1.6	0
	14_9	0	14	14	2	1.6	8.75
	14_10	0	1	1	2	1.6	0.625
	14_11	1	15	16	2	1.6	10
	14_12	0	0	0	2	1.6	0
	14_13	5	0	5	2	1.6	3.125
	14_14	0	0	0	2	1.6	0
	14_15	0	0	0	2	1.6	0
	14_16	1	0	1	2	1.6	0.625
	14_17	0	0	0	2	1.6	0
	14_18	0	0	0	1.2	0.96	0
16	16_1	0	0	0	2	1.6	0
	16_2	0	0	0	2	1.6	0
	16_3	0	0	0	2	1.6	0
	16_4	2	0	2	2	1.6	1.25
	16_5	2	0	2	2	1.6	1.25
	16_6	3	33	36	2	1.6	22.5
	16_7	0	3	3	2	1.6	1.875
	16_8	2	3	5	2	1.6	3.125
	16_9	4	0	4	2	1.6	2.5
	16_10	11	0	11	2	1.6	6.875
	16_11	43	56	99	2	1.6	61.875
	16_12	16	7	23	2	1.6	14.375
	16_13	17	67	84	2	1.6	52.5
	16_14	0	15	15	2	1.6	9.375
	16_15	3	0	3	2	1.6	1.875
	16_16	36	18	54	2	1.6	33.75
	16_17	1	2	3	2	1.6	1.875
	16_18	0	0	0	1.2	0.96	0
17	17_1	6	33	39	2	1.6	24.375
	17_2	0	0	0	2	1.6	0
	17_3	8	0	8	2	1.6	5
	17_4	3	27	30	2	1.6	18.75

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	17_5	1	26	27	2	1.6	16.875
	17_6	0	14	14	2	1.6	8.75
	17_7	0	0	0	2	1.6	0
	17_8	0	4	4	2	1.6	2.5
	17_9	18	4	22	2	1.6	13.75
	17_10	21	24	45	2	1.6	28.125
	17_11	7	0	7	2	1.6	4.375
	17_12	15	0	15	2	1.6	9.375
	17_13	0	25	25	2	1.6	15.625
	17_14	0	3	3	2	1.6	1.875
	17_15	0	0	0	2	1.6	0
	17_16	0	0	0	2	1.6	0
	17_17	0	0	0	2	1.6	0
	17_18	0	0	0	1.2	0.96	0
18	18_1	0	0	0	2	1.6	0
	18_2	0	0	0	2	1.6	0
	18_3	0	0	0	2	1.6	0
	18_4	0	0	0	2	1.6	0
	18_5	0	0	0	2	1.6	0
	18_6	2	0	2	2	1.6	1.25
	18_7	1	0	1	2	1.6	0.625
	18_8	4	11	15	2	1.6	9.375
	18_9	1	0	1	2	1.6	0.625
	18_10	0	0	0	2	1.6	0
	18_10	0	0	0	2	1.6	0
	18_12	10	0	10	2	1.6	6.25
	18_13	4	0	4	2	1.6	2.5
	18_14	9	14	23	2	1.6	14.375
	18_15	13	4	17	2	1.6	10.625
	18_16	16	5	21	2	1.6	13.125
	18_17	0	7	7	2	1.6	4.375
	18_18	10	35	45	1.2	0.96	46.875
19	19_1	0	3	3	2	1.6	1.875
	19_2	26	64	90	2	1.6	56.25
	19_3	5	7	12	2	1.6	7.5
	19_4	0	0	0	2	1.6	0
	19_5	0	20	20	2	1.6	12.5
	19_6	5	23	28	2	1.6	17.5
	19_7	9	2	11	2	1.6	6.875
	19_8	2	0	2	2	1.6	1.25
	19_9	9	1	10	2	1.6	6.25
	19_10	0	0	0	2	1.6	0
	19_11	6	1	7	2	1.6	4.375
	19_12	0	0	0	2	1.6	0
	19_13	0	0	0	2	1.6	0
	19_14	0	0	0	2	1.6	0
	19_15	0	0	0	2	1.6	0
	19_16	0	0	0	2	1.6	0
	19_17	14	0	14	2	1.6	8.75

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	19_18	0	0	0	1.2	0.96	0
20	20_1	0	0	0	2	1.6	0
	20_2	0	0	0	2	1.6	0
	20_3	0	0	0	2	1.6	0
	20_4	0	0	0	2	1.6	0
	20_5	0	0	0	2	1.6	0
	20_6	0	0	0	2	1.6	0
	20_7	0	0	0	2	1.6	0
	20_8	0	0	0	2	1.6	0
	20_9	5	0	5	2	1.6	3.125
	20_10	0	0	0	2	1.6	0
	20_11	0	0	0	2	1.6	0
	20_12	0	0	0	2	1.6	0
	20_13	2	0	2	2	1.6	0
	20-14	0	1	1	2	1.6	0.625
	20_15	0	7	7	2	1.6	4.375
	20_16	0	0	0	2	1.6	0
	20_17	0	0	0	2	1.6	0
	20_18	0	0	0	1.2	0.96	0
TOTAL		**3794**	**3267**	**7061**	**598.4**	**478.72**	**14.74**

STRATUM II

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
1	1_1	0	0	0	2	1.6	0
	1_2	0	0	0	2	1.6	0
	1_3	0	0	0	2	1.6	0
	1_4	0	0	0	2	1.6	0
	1_5	0	9	9	2	1.6	5.625
	1_6	0	0	0	2	1.6	0
	1_7	0	0	0	2	1.6	0
	1_8	0	0	0	2	1.6	0
	1_9	3	1	4	2	1.6	2.5
	1_10	1	3	4	2	1.6	2.5
	1_11	0	1	1	2	1.6	0.625
	1_12	0	0	0	2	1.6	0
	1_13	0	7	7	2	1.6	4.375
	1_14	0	0	0	2	1.6	0
	1_15	0	0	0	2	1.6	0
	1_16	0	0	0	1.5	1.2	0
2	2_1	2	0	2	2	1.6	1.25
	2_2	3	6	9	2	1.6	5.625
	2_3	0	0	0	2	1.6	0
	2_4	17	0	17	2	1.6	10.625
	2_5	0	2	2	2	1.6	1.25

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	2_6	0	0	0	2	1.6	0
	2_7	15	0	15	2	1.6	9.375
	2_8	0	0	0	2	1.6	0
	2_9	0	0	0	2	1.6	0
	2_10	0	0	0	2	1.6	0
	2_11	1	0	1	2	1.6	0.625
	2_12	0	0	0	2	1.6	0
	2_13	0	0	0	2	1.6	0
	2_14	0	0	0	2	1.6	0
	2_15	0	0	0	2	1.6	0
	2_16	0	0	0	1.5	1.2	0
3	3_1	0	5	5	2	1.6	3.125
	3_2	0	0	0	2	1.6	0
	3_3	0	1	1	2	1.6	0.625
	3_4	0	3	3	2	1.6	1.875
	3_5	0	4	4	2	1.6	2.5
	3_6	1	0	1	2	1.6	0.625
	3_7	0	9	9	2	1.6	5.625
	3_8	13	22	35	2	1.6	21.875
	3_9	2	0	2	2	1.6	1.25
	3_10	0	3	3	2	1.6	1.875
	3_11	0	0	0	2	1.6	0
	3_12	0	1	1	2	1.6	0.625
	3_13	0	0	0	2	1.6	0
	3_14	0	0	0	2	1.6	0
	3_15	0	4	4	2	1.6	2.5
	3_16	5	13	18	1.5	1.2	15
4	4_1	0	0	0	2	1.6	0
	4_2	0	0	0	2	1.6	0
	4_3	0	0	0	2	1.6	0
	4_4	0	0	0	2	1.6	0
	4_5	0	0	0	2	1.6	0
	4_6	3	0	3	2	1.6	1.875
	4_7	0	0	0	2	1.6	0
	4_8	0	0	0	2	1.6	0
	4_9	0	0	0	2	1.6	0
	4_10	2	0	2	2	1.6	1.25
	4_11	0	2	2	2	1.6	1.25
	4_12	11	0	11	2	1.6	6.875
	4_13	0	0	0	2	1.6	0
	4_14	0	0	0	2	1.6	0
	4_15	5	0	5	2	1.6	3.125
	4_16	7	0	7	1.5	1.2	5.833333

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
5	5_1	0	0	0	2	1.6	0
	5_2	0	0	0	2	1.6	0
	5_3	0	0	0	2	1.6	0
	5_4	5	8	13	2	1.6	8.125
	5_5	0	9	9	2	1.6	5.625
	5_6	0	3	3	2	1.6	1.875
	5_7	0	8	8	2	1.6	5
	5_8	0	0	0	2	1.6	0
	5_9	0	4	4	2	1.6	2.5
	5_10	0	7	7	2	1.6	4.375
	5_11	0	0	0	2	1.6	0
	5_12	0	0	0	2	1.6	0
	5_13	0	0	0	2	1.6	0
	5_14	0	0	0	2	1.6	0
	5_15	3	3	6	2	1.6	3.75
	5_16	0	1	1	1.5	1.2	0.833333
6	6_1	9	6	15	2	1.6	9.375
	6_2	5	1	6	2	1.6	3.75
	6_3	6	0	6	2	1.6	3.75
	6_4	0	10	10	2	1.6	6.25
	6_5	0	0	0	2	1.6	0
	6_6	0	0	0	2	1.6	0
	6_7	0	0	0	2	1.6	0
	6_8	0	0	0	2	1.6	0
	6_9	0	0	0	2	1.6	0
	6_10	0	0	0	2	1.6	0
	6_11	2	1	3	2	1.6	1.875
	6_12	0	0	0	2	1.6	0
	6_13	0	0	0	2	1.6	0
	6_14	0	0	0	2	1.6	0
	6_15	0	0	0	2	1.6	0
	6_16	0	0	0	1.5	1.2	0
7	7_1	0	0	0	2	1.6	0
	7_2	0	0	0	2	1.6	0
	7_3	0	0	0	2	1.6	0
	7_4	0	0	0	2	1.6	0
	7_5	0	0	0	2	1.6	0
	7_6	0	0	0	2	1.6	0
	7_7	0	0	0	2	1.6	0
	7_8	0	0	0	2	1.6	0
	7_9	0	4	4	2	1.6	2.5
	7_10	2	5	7	2	1.6	4.375
	7_11	0	0	0	2	1.6	0

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	7_12	0	0	0	2	1.6	0
	7_13	0	0	0	2	1.6	0
	7_14	6	0	6	2	1.6	3.75
	7_15	1	3	4	2	1.6	2.5
	7_16	0	0	0	1.5	1.2	0
8	8_1	3	1	4	2	1.6	2.5
	8_2	0	3	3	2	1.6	1.875
	8_3	13	0	13	2	1.6	8.125
	8_4	9	0	9	2	1.6	5.625
	8_5	4	7	11	2	1.6	6.875
	8_6	1	0	1	2	1.6	0.625
	8_7	0	0	0	2	1.6	0
	8_8	0	0	0	2	1.6	0
	8_9	4	0	4	2	1.6	2.5
	8_10	6	2	8	2	1.6	5
	8_11	0	16	16	2	1.6	10
	8_12	0	0	0	2	1.6	0
	8_13	0	0	0	2	1.6	0
	8_14	3	0	3	2	1.6	1.875
	8_15	9	0	9	2	1.6	5.625
	8_16	0	0	0	1.5	1.2	0
9	9_1	0	0	0	2	1.6	0
	9_2	0	0	0	2	1.6	0
	9_3	0	0	0	2	1.6	0
	9_4	0	4	4	2	1.6	2.5
	9_5	0	0	0	2	1.6	0
	9_6	0	3	3	2	1.6	1.875
	9_7	0	11	11	2	1.6	6.875
	9_8	2	0	2	2	1.6	1.25
	9_9	0	0	0	2	1.6	0
	9_10	2	0	2	2	1.6	1.25
	9_11	0	2	2	2	1.6	1.25
	9_12	0	11	11	2	1.6	6.875
	9_13	27	0	27	2	1.6	16.875
	9_14	21	0	21	2	1.6	13.125
	9_15	5	0	5	2	1.6	3.125
	9_16	0	7	7	1.5	1.2	5.833333
10	10_1	22	16	38	2	1.6	23.75
	10_2	1	0	1	2	1.6	0.625
	10_3	25	0	25	2	1.6	15.625
	10_4	0	20	20	2	1.6	12.5
	10_5	1	0	1	2	1.6	0.625
	10_6	0	0	0	2	1.6	0

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	10_7	2	1	3	2	1.6	1.875
	10_8	11	0	11	2	1.6	6.875
	10_9	1	0	1	2	1.6	0.625
	10_10	0	7	7	2	1.6	4.375
	10_11	0	0	0	2	1.6	0
	10_12	0	0	0	2	1.6	0
	10_13	6	0	6	2	1.6	3.75
	10_14	0	0	0	2	1.6	0
	10_15	0	0	0	2	1.6	0
	10_16	0	0	0	1.5	1.2	0
11	11_1	0	6	6	2	1.6	3.75
	11_2	0	27	27	2	1.6	16.875
	11_3	0	11	11	2	1.6	6.875
	11_4	5	0	5	2	1.6	3.125
	11_5	0	8	8	2	1.6	5
	11_6	0	0	0	2	1.6	0
	11_7	0	0	0	2	1.6	0
	11_8	10	0	10	2	1.6	6.25
	11_9	3	0	3	2	1.6	1.875
	11_10	46	0	46	2	1.6	28.75
	11_11	32	10	42	2	1.6	26.25
	11_12	0	0	0	2	1.6	0
	11_13	15	0	15	2	1.6	9.375
	11_14	0	0	0	2	1.6	0
	11_15	4	36	40	2	1.6	25
	11_16	2	2	4	1.5	1.2	3.333333
12	12_1	4	1	5	2	1.6	3.125
	12_2	2	0	2	2	1.6	1.25
	12_3	0	0	0	2	1.6	0
	12_4	0	0	0	2	1.6	0
	12_5	0	1	1	2	1.6	0.625
	12_6	0	0	0	2	1.6	0
	12_7	0	16	16	2	1.6	10
	12_8	0	23	23	2	1.6	14.375
	12_9	8	4	12	2	1.6	7.5
	12_10	0	18	18	2	1.6	11.25
	12_11	0	8	8	2	1.6	5
	12_12	2	10	12	2	1.6	7.5
	12_13	12	0	12	2	1.6	7.5
	12_14	0	0	0	2	1.6	0
	12_15	0	0	0	2	1.6	0
	12_16	4	1	5	1.5	1.2	4.166667
13	13_1	0	8	8	2	1.6	5

Transect	Transect segment	Caribou left	Caribou right	Caribou total	Transect segment length (km)	Transect segment Area (km^2)	Density (caribou/km^2)
	13_2	2	1	3	2	1.6	1.875
	13_3	0	1	1	2	1.6	0.625
	13_4	5	0	5	2	1.6	3.125
	13_5	6	14	20	2	1.6	12.5
	13_6	12	4	16	2	1.6	10
	13_7	12	18	30	2	1.6	18.75
	13_8	0	0	0	2	1.6	0
	13_9	0	0	0	2	1.6	0
	13_10	1	0	1	2	1.6	0.625
	13_11	1	0	1	2	1.6	0.625
	13_12	2	6	8	2	1.6	5
	13_13	9	2	11	2	1.6	6.875
	13_14	0	0	0	2	1.6	0
	13_15	0	2	2	2	1.6	1.25
	13_16	1	1	2	1.5	1.2	1.666667
14	14_1	0	0	0	2	1.6	0
	14_2	0	0	0	2	1.6	0
	14_3	0	0	0	2	1.6	0
	14_4	27	30	57	2	1.6	35.625
	14_5	15	0	15	2	1.6	9.375
	14_6	0	5	5	2	1.6	3.125
	14_7	0	0	0	2	1.6	0
	14_8	4	0	4	2	1.6	2.5
	14_9	0	0	0	2	1.6	0
	14_10	23	0	23	2	1.6	14.375
	14_11	0	6	6	2	1.6	3.75
	14_12	28	3	31	2	1.6	19.375
	14_13	0	12	12	2	1.6	7.5
	14_14	7	3	10	2	1.6	6.25
	14_15	0	0	0	2	1.6	0
	14_16	0	0	0	1.5	1.2	0
TOTAL		**612**	**578**	**1190**	**441**	**352.8**	**3.37**

Appendix C: Summary of the 1980–2002 systematic reconnaissance survey results (where it is available) obtained from Beverly calving ground surveys.

Survey year	Caribou counted	Transect area (km^2)	Density (caribou/km^2)
2002	2,629	662.16	3.97
1994	5,678	687	8.26
1993	2,911	421	6.91
1988			na
1987	3,104	910.2	3.41
1984			na
1982	5,357	724	7.40
1980	3,515	699.4	5.00

na – Survey data not available for display.

Appendix D: Summary of the 1980–2002 systematic visual survey results (where it is available) obtained from Beverly calving ground surveys.

Survey year	Caribou counted	Transect area (km^2)	Density (caribou/km^2)	Survey year
2002	I	7,042	480.50	14.66
	II	1,190	354.10	3.36
	Total	**8,232**	**834.60**	**9.86**
1987	I	10,508	1,134.00	9.27
	II	3,080	442.00	6.97
	III	1,098	234.00	4.69
	IV	314	215.60	1.46
	Total	**15,000**	**2,025.60**	**7.41**
1982	I	1,619	240.20	6.74
	II	15,280	826.60	18.49
	III	5,136	378.40	13.57
	Total	**22,035**	**1,445.20**	**15.25**
1980	I	15,486	957.60	16.17
	II	697	301.60	2.31
	Total	**16,183**	**1,259.20**	**12.85**