DISTRIBUTION AND ABUNDANCE OF MUSKOXEN IN THE BEAVERHILL LAKE AREA (2000) AND THELON WILDLIFE SANCTUARY (1994), NORTHWEST TERRITORIES

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ABSTRACT

This report provides details of the two aerial surveys used to describe muskox *Ovibos moschatus* abundance and distribution in the central barrens, Northwest Territories and Nunavut. The first survey covered the Thelon Wildlife Sanctuary in July and August 1994. The 1994 survey was a stratified transect survey using a float equipped fixed-wing aircraft. After an initial reconnaissance at 13.3% coverage, 3,565 kilometers of the transect were reclassified as the low-density stratum. Three areas were classified as high-density strata and re-flown at 40% coverage. The estimated number of adult muskoxen in the Thelon Wildlife Sanctuary in 1994 was 1,095 $\pm$ 281 Standard Error (Coefficient of Variation 0.26) and an average density of 1.8 per 100km^2. This estimate was likely conservative. Based on all adults seen, including singles, the percentages of calves were 12.0% on transect and 16.4% off transect. In 2000, a fixed-wing aircraft was used to fly a transect survey with uniform coverage (about 20%) covering an area adjacent to the southwest corner of the Thelon Wildlife Sanctuary and including the southwest part of the Sanctuary. Most of the area had not been previously surveyed for muskoxen. We counted 261 adult muskoxen and estimated 1320 ± 183 Standard Error (Coefficient of Variation 0.14) with an average density of 3.19 per 100km^2. The proportion of calves on and off transect was 5.5%. The survey suggests that muskox distribution is continuous around the western, southern and eastern Thelon Sanctuary between Muskox Management Unit 02 in the NWT and Muskox Management Unit MX21 in Nunavut. The surveys and sightings suggest that muskox distribution has been

spreading southwest during the 1980s and 1990s. We recommend establishing a management unit southwest of the Thelon Wildlife Sanctuary with an annual quota of 11 muskoxen.

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INTRODUCTION

The Thelon Wildlife Sanctuary was established by the Government of Canada in 1927 partially as a means to protect Canada's muskoxen (*Ovibos moschatus*), which were endangered as a result of unregulated market hunting in the late nineteenth century (Barr, 1991). Travelers including Tyrell (1902) and Hornby (1925, 1934) reported that the Thelon River was a wildlife oasis and had recommended that the area be set aside as a wildlife sanctuary.

The 1992 Nunavut Land Claims Agreement states that a management plan must be prepared for the Thelon Wildlife Sanctuary. One component of the management plan is an understanding of how well the Sanctuary had achieved its primary goal of preserving muskoxen. The Thelon Wildlife Sanctuary had not been systematically surveyed since 1966 (Tener and Kuyt, 1966) and the trend in muskox numbers is uncertain. In this paper, we report a population estimate for muskoxen in the Thelon Wildlife Sanctuary based on an aerial survey conducted in the summer of 1994. The 1994 survey results were written up but not completed so we have included them in this report.

The second survey described in this report is part of conservation steps suggested as alternative dispute measures between Environment Canada, Government of the Northwest Territories and Saskatchewan Denesuline in lieu of court action for the illegal harvesting and transporting of muskoxen from the Northwest Territories. Five muskoxen were shot at Beaverhill Lake in August 1999.

Beaverhill Lake is on the eastern boundary of an area surveyed for muskoxen in 1998 (Bradley *et al*., 2001). Muskox numbers had doubled since 1989 and the muskox distribution had spread west and southwest (Bradley *et al*., 2001). The area south of Beaverhill Lake had not previously been surveyed for muskoxen. The area east of Beaverhill Lake was an un-surveyed 230 km gap between the 1998 survey area and the western edge of a 1999 muskoxen survey conducted by Nunavut (Campbell and Setterington, 2001). Muskox numbers have been increasing east of the Thelon Sanctuary and re-colonizing historic ranges (Graf *et al*., 1990; Campbell and Setterington, 2001) (Figure 1).

Our 2000 objectives were to document muskox numbers and distribution across a survey area centered on Beaverhill Lake and to determine whether muskoxen were re-colonizing the area south of the Thelon Wildlife Sanctuary toward the tree line. Up until the late-1800s, muskoxen occupied the area south of the Thelon River to the tree line and then by 1930, their distribution had contracted to the Thelon Wildlife Sanctuary (Anderson 1930 in Barr 1991). The 2000 survey area was chosen to include the area historically used by Dene from northern Saskatchewan. Some 100 years ago, Dene hunters would walk with pack-dogs from the Black Lake area to the Mosquito Lake area to hunt muskoxen (Joe Marten pers. comm., 2000). We extended our 2000 survey area to cover the southwest section of the Thelon Wildlife Sanctuary covered in 1994 and Bradley *et al.* (2001) in 1998 to detect changes over time (Figure 1). To describe changes in muskox distribution, we have also included in this report opportunistically collected muskox sightings and a compilation of Alex Hall's

muskox sightings during annual canoe trips along the Thelon River and its tributaries (Alex Hall pers. comm. 2000).

The August timing of the survey was similar to mainland muskox surveys in the adjacent areas (Bradley *et al*., 2001; Campbell and Setterington, 2001). The advantage of surveys in August is muskox group sizes are smaller. Smaller groups are easier to accurately count and as the muskoxen are less clumped (smaller sized groups); survey precision may also be increased in low-density areas.

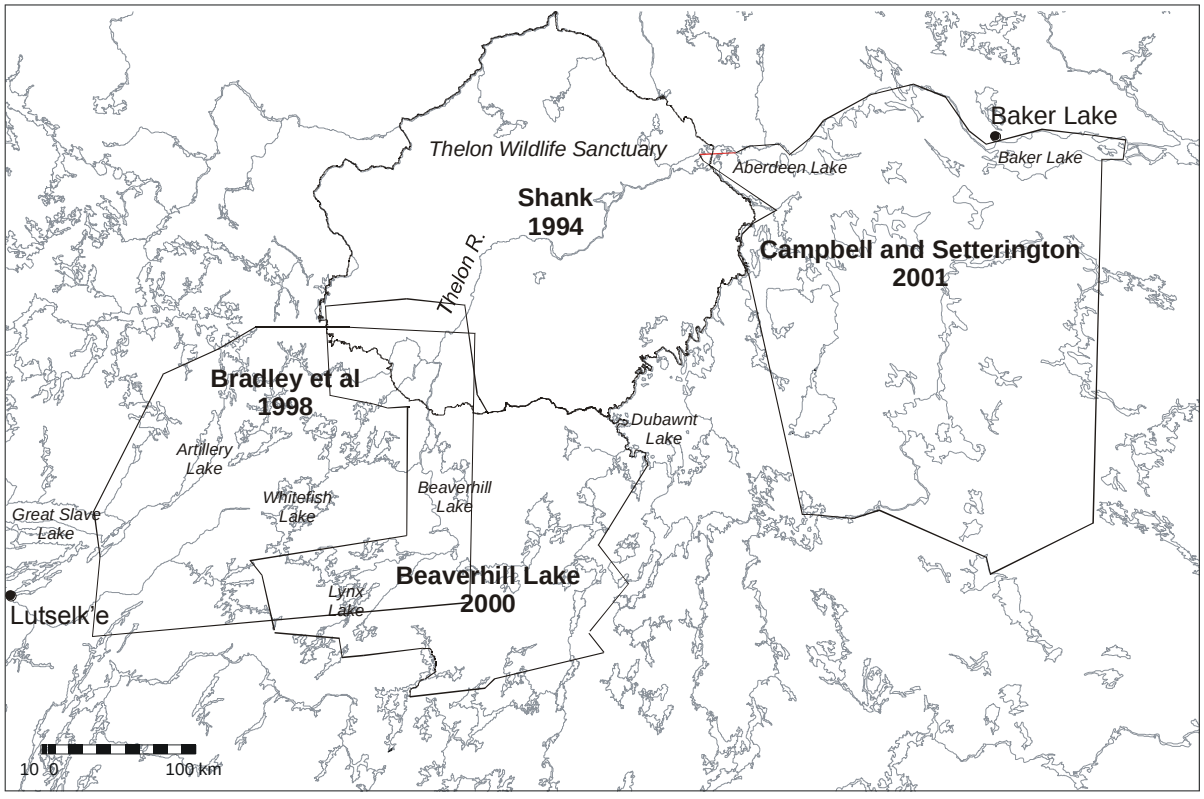

Figure 1. Beaverhill Lake area and survey boundaries for three previous surveys conducted in the 1990s.

METHODS

1994 Thelon survey

We flew a reconnaissance survey consisting of 26 transects (3,966 km) flown at 15 km internals (13.3% coverage) across the Thelon Wildlife Sanctuary. We delineated three areas as high-density strata and re-flew them with transects 5 km apart (40% coverage) (Figure 2). The reconnaissance transects were redefined to exclude the high-density zones and reassigned to a low-density stratum. Muskoxen seen during ferry flights were not included in any analyses because of the likelihood of double counting. We used Jolly 2 method to estimate population size (Norton-Griffiths, 1978).

The survey was flown at 185 m above the ground and at an airspeed of 160 km/h in a float-equipped Cessna 206. Transect strip widths were 1 km on each side of the aircraft. We verified the strip width based on a measured 1 km distance between the camp tent and a brightly coloured tarp. Calf counts are approximate because muskox groups tend to bunch up when disturbed by aircraft and the young often hide under the cows. We used photographs to confirm numbers of adults and calves in the larger groups.

We cached fuel by ski-equipped aircraft in the spring on the eastern and western borders of the Sanctuary. The fuel cache on Moraine Lake, on the eastern boundary of the Sanctuary was on a shallow, rocky, and exposed area. The fuel cache on the northeast corner of the Sanctuary was combined with fuel used in caribou *Rangifer tarandus groenlandicus* surveys and was on a large,

sand bottomed lake. The base camp was located in the middle of the Sanctuary on a small, thin, unnamed lake (Figure 2).

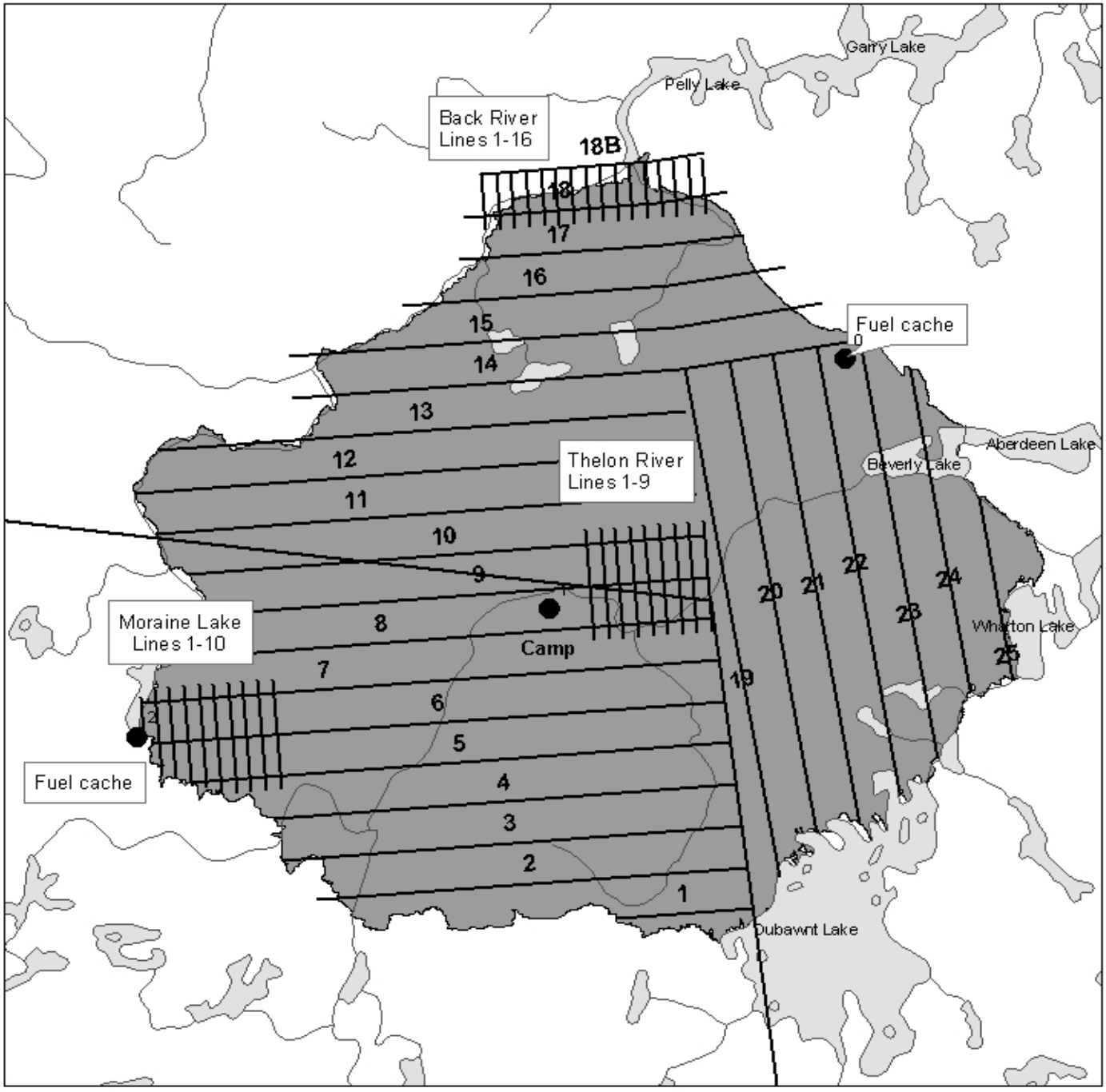

Figure 2. Reconnaissance and high-density transect lines flown during an aerial transect survey of the Thelon Wildlife Sanctuary, 25 July – 1 August 1994.

The survey aircraft was a Helio-Courier on floats. The survey crew consisted of a right and left observer, both seated in the rear, and a navigator who recorded the sightings on paper and marked them into a hand-held Global Positioning System (Garmin 48). The pilot also plotted observation numbers on 1:250,000 scale topographic maps as a back up for the GPS record. Transect strip widths were 1 km on each side of the aircraft. We calculated where to place a marker for the transect boundary on a rope stretched from an eyebolt on the fuselage of the plane to an eyebolt on each wing after Norton-Griffith (1978). The survey altitude was 185 m above ground level and the survey airspeed was about 160 km/h.

We counted muskoxen and recorded them as “on-transect” or “off-transect” but we made no effort to classify them by sex or age classes other than calves as a readily identifiable age class. We recorded grizzly bears, wolves and moose but not caribou, as they were numerous.

We used Jolly’s (1969) method #2 for unequal-sized sample units to calculate population estimates. Our estimates, and those used from the literature, include calves (unless otherwise identified). We included calves because our ability to discriminate between age classes is poor when the muskoxen group closely together.

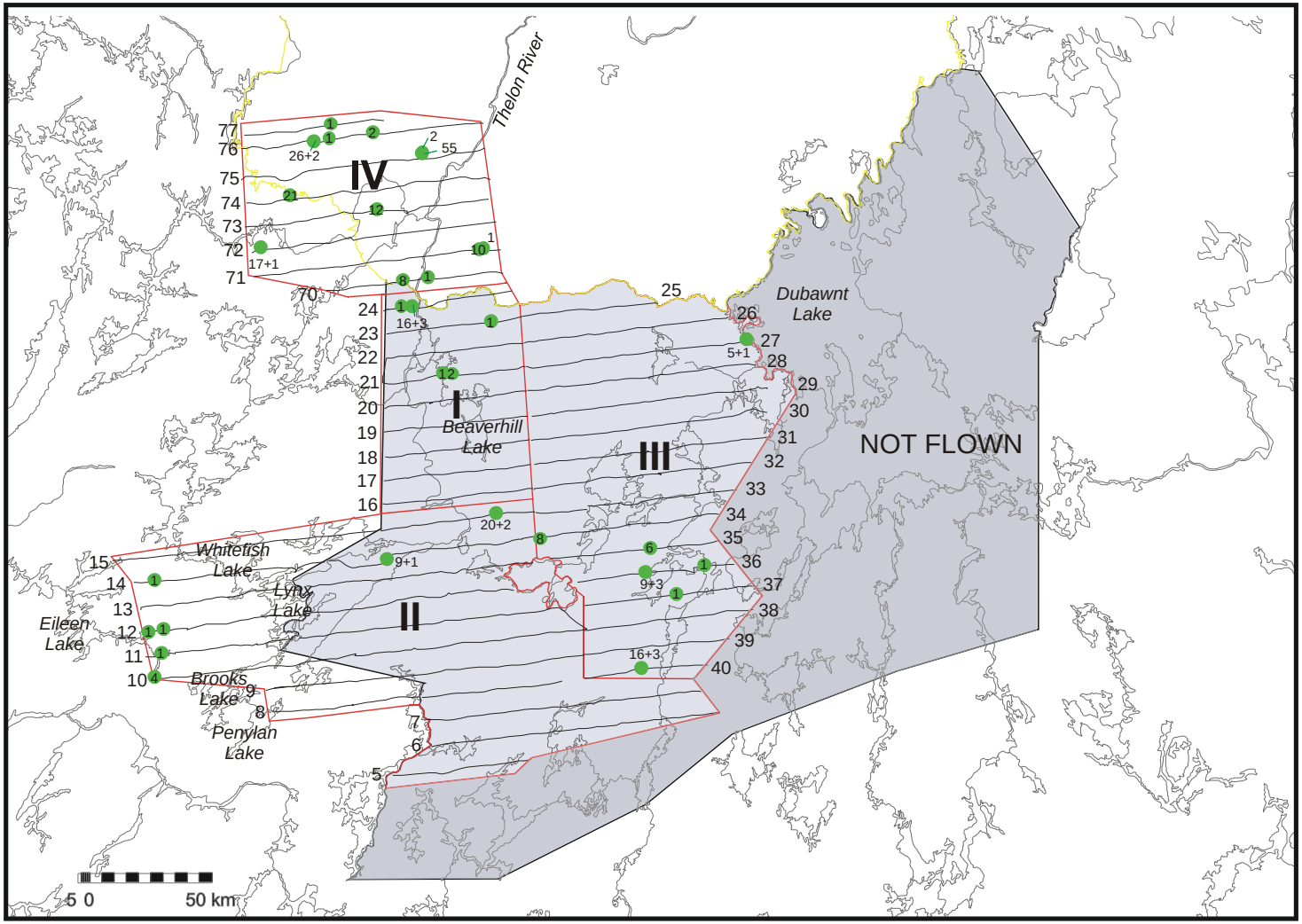

Figure 3. Beaverhill Lake study area showing proposed survey area (shaded), transect lines flown and 'on' transect observations of muskoxen (+ calves) for the 2000 muskoxen survey.

RESULTS

1994 Thelon survey

We conducted the survey between July 20 and August 7, 1994. We flew a total of 94 hours of which 36.4 hours were on transect (Appendix A). Considerable time was spent ferrying backwards and forwards between Baker Lake and Lutsel K'e to pick up and drop off the observers. Between July 21 – 29, Peter Enzo from Lutsel K'e served as an observer. Jacob Ikinilik, from Baker Lake, was an observer from July 30 – August 6. Judy Williams and Chris Shank were observers throughout the survey and the pilot was Carl Falsnes of Northern Air Link.

We counted 181 adult muskoxen and 22 calves on transect and 119 adults and 23 calves were seen off transect during the 3,966 km of reconnaissance flights (Table 1, Figure 4, Appendix B). The mean population estimate based on the reconnaissance flights is 1,358 $\pm$ 460 Standard Error adult muskoxen (Coefficient of Variation 0.34); a density of 2.3 per 100km^2.

In the Moraine Lake high-density area we counted 40 adults on transect and estimated 100 $\pm$ 29 (Coefficient of Variation 0.29); a density of 5.7 adults per 100km^2 (Table 1, Figure 5, Appendix C). We saw 70 adults in the Thelon River high-density area leading to an estimate of 175 $\pm$ 72 (Coefficient of Variation 41), a density of 9.8 adults per 100km^2 (Table 1, Figure 5, Appendix C). Ten adults were seen on transect in the Back River high-density area (Table 1, Figure 5, Appendix C) yielding an estimate of 25 $\pm$ 12 (Coefficient of Variation 0.48). The

stratified estimate is 1,095 ± 281 adult muskoxen (Coefficient of Variation 0.26); a density of 1.8 per 100km^2 (Table 1, Figure 5, Appendix C).

Calf percentages seen during reconnaissance flights in groups larger than one were 12.0% on transect and 16.4% for off transect. Single males (N=19) accounted for 10.5% of adults (N=181) and for 56% of groups (N=34) seen on transect during reconnaissance flights but only 1.7% (N=119) of adults seen off transect. The average group size of adults, excluding single males, was 10.8 (SD=6.4, N=15) on transect and 10.6 (SD=6.8, N=11) off transect (Appendix B). We saw eight moose, three grizzly bears and 12 wolves (Appendix D).

Table 1. Summary of data from an aerial transect survey used to calculate estimates of muskoxen (mean ± SE) in the Thelon River area, Northwest Territories, July-August 1994.

Variables	Reconnaissance	Low Density	High Density Strata			Total
			Moraine Lake	Back River	Thelon River	
Stratum area, km^2	59,490	53,447	1,768	1,600	1,800	58,615
Sampling area, km^2	7,932	7,130	708	640	720	9,198
No. possible transects	140	140	25	40	22	227
No. transects flown	26	24	10	16	9	59
No. muskox counted	181	106	40	10	70	226
Mean density, Muskox per 100 km^2	2.3	1.5	5.7	1.6	9.8	1.8
Population estimate	1,358	795	100	25	175	1,095
Standard error	460	270	29	12	72	281
Variance	211,880	72,899	843	143	5,245	79,130
Coefficient Variation	0.34	0.34	0.29	0.48	0.41	0.26
% of total area surveyed	13.3	13.3	40.0	40.0	40.0	15.7

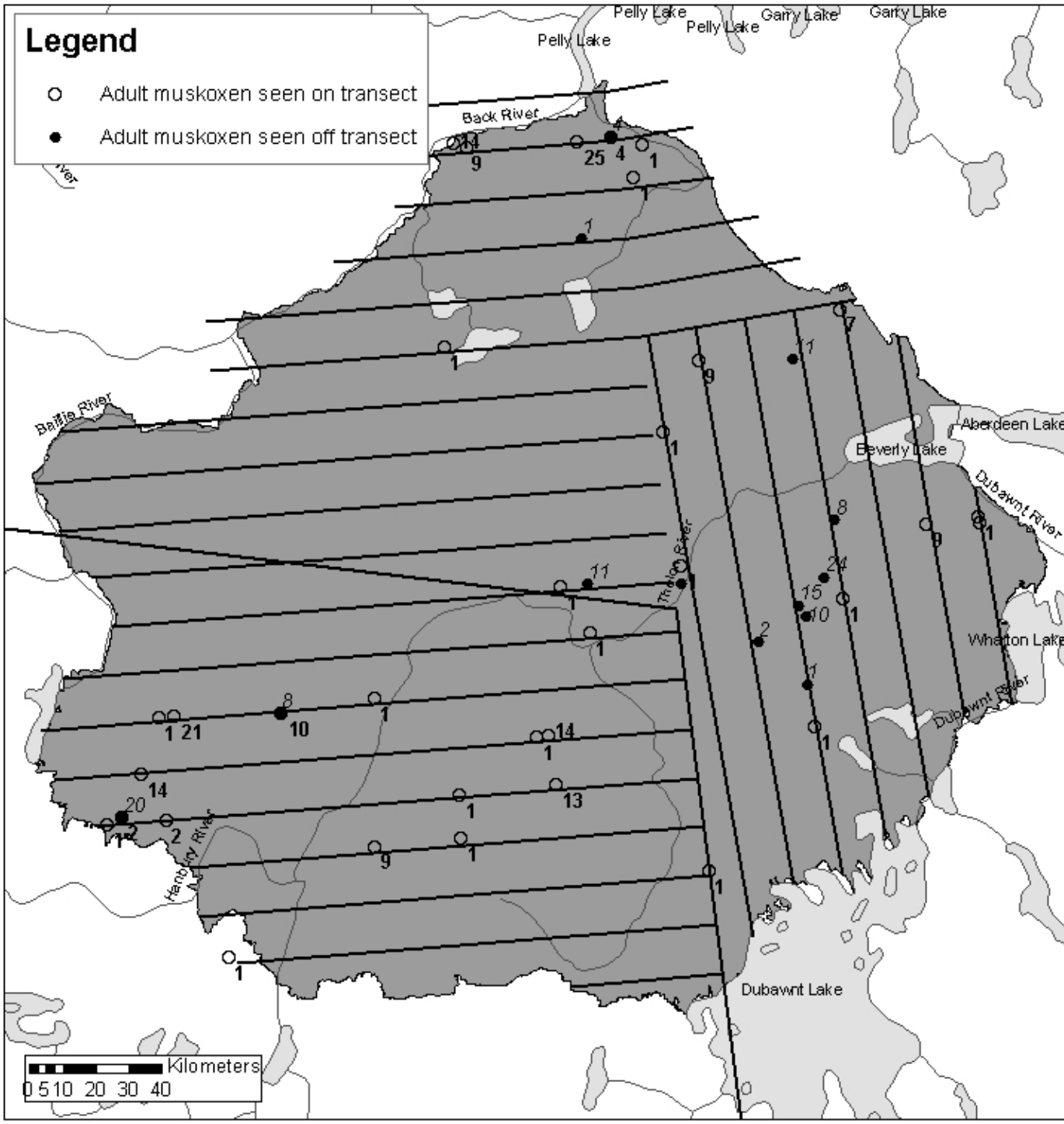

Figure 4. Number and approximate location of adult muskoxen seen on and off transect during a reconnaissance survey, Thelon Game Sanctuary, 25 July – 1 August 1994. Muskoxen seen during ferry flights are not included.

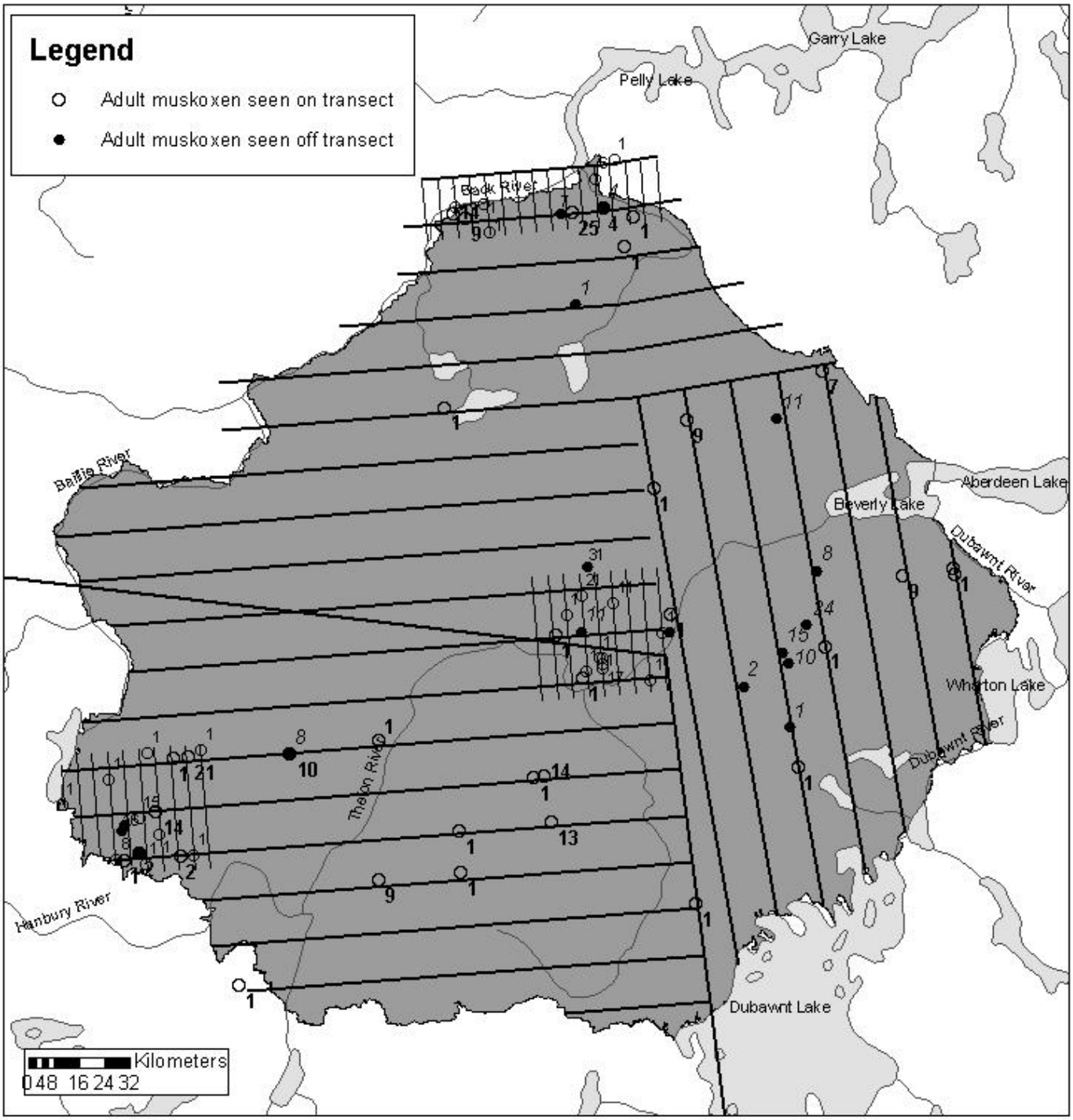

Figure 5. Number and approximate location of adult muskoxen seen on and off high-density strata and those portions of the reconnaissance transects redefined as low-density strata, Thelon Game Sanctuary, 25 July – 1 August 1994. Muskoxen seen during ferry flights are not included.

2000 Beaverhill Lake Survey

We completed the survey between August 9 – 21 2000, flying 64 hours (25.2 hours on transect) at an average aerial coverage of 19.8% (8,174 km^2) of the 41,326 km^2 survey area (Table 2, Appendix E). Survey conditions were generally favourable (Appendix F). Lines 5, 6, 7 and half of line 8 were flown at 152 m above ground level because of low ceilings. Total strip width was then reduced to 1,065 m (825 m on either side of the aircraft). We covered western strata (strata I, II, III and VI), but not strata IV and V east of Dubawnt Lake as we did not have enough flying time (Figure 3). Based on local knowledge (Joe Martin pers. comm.) we extended lines 8 to 15 further west to include areas where muskoxen had been recently reported (Figure 3).

We counted 261 muskoxen (and 16 calves) on 4,134 km of strip transects flown in strata I, II, III and VI. We estimated 1,320 $\pm$ 183 SE muskoxen within the 41,326 km^2 survey area with an overall mean density of 3.19 muskoxen per 100 km^2 (Table 2, Figure 3, Appendix E). We also counted 67 muskoxen and 3 calves either off-transect or on ferry flights. We saw a total of 26 solitary muskoxen (13 on-transect and 13 off-transect) and 26 herds (19 on-transect and 7 off-transect). Herd size ranged from 2-55 animals. Mean size of the 26 herds (including calves and excluding solitary muskoxen) was 12.3 ± 2.20 SE. The proportion of calves (on and off transect) was 5.5%. We saw three moose, six grizzly bears and 14 wolves.

Table 2. Data from an aerial transect survey used to calculate estimates of muskoxen (mean ± SE) in the Beaverhill Lake area, Northwest Territories, August 2000.

Variables	Stratum				
	I	II	III	Thelon Wildlife Sanctuary (VI)	Total
Stratum area, km^2	5,335	15,715	13,085	7,191	41,326
Sampling area, km^2	1,078	3,034	2,552	1,510	8,174
No. possible transects	45	56	81	38	220
No. transects flown	9	11	16	8	44
No. muskox counted	21	37	46	157	261
Mean density, Muskox per 100 km^2	1.95	1.22	1.80	10.40	3.19
Population estimate	104	192	236	748	1,320
Standard error	77	88	93	179	183
Variance	5,853	7,794	8,672	32,079	33,559
Coefficient Variation	0.74	0.46	0.39	0.24	0.14
% of total area surveyed	20.2	19.3	19.5	21.0	19.8

DISCUSSION

The 1994 Thelon Sanctuary estimate of muskox numbers is the first estimate for 28 years and the first one based on the NWT's standardized survey procedures (Graf and Case, 1989). However, as a starting point to measure future trends in muskox numbers, the estimate of 1,095 ± 281 (SE) is hampered by the relatively low precision. Clumped distribution contributed to the estimate's imprecision.

The muskoxen were not evenly distributed throughout the Sanctuary, but there were pockets of higher density including the center of the Sanctuary (9.8 adults per 100 km^2 between the Finnie River downstream to Ursus Island). Two other areas of higher muskox densities were in the northern Sanctuary along the Back River and on the west side of the Sanctuary (Hanbury River and Moraine Lake). Although stratifying the survey efforts relative to muskox density estimate increased the precision of the estimate (Coefficient of Variation increased to 26% from 34%), the stratification likely contributed to a lower estimate. With hindsight, we suggest that the mean estimate of 1,100 to be conservative.

Lack of fuel prevented us from including one area of higher density recorded during the reconnaissance survey as fourth high-density strata. Four herds (51 muskoxen) were seen off-transect in an area to the southwest of Ursus Island, where four single bulls and one herd of 9 muskoxen were counted on transect (Figure 2).

The Back River High Density Stratum may have been too small to accommodate possible muskox movements. This is suggested, as we did not

find as many animals in the High Density Stratum as during the reconnaissance survey. The High Density Stratum estimate of 25 was lower then the 53 (transect 18: 52 muskoxen in 4 herds; 18B: one muskox) muskoxen actually counted on transect during the reconnaissance despite less then a third of the coverage. One likely explanation of this discrepancy is that the four herds were on one transect, which was only a few kilometers inside the High Density stratum. Muskoxen would have had to only move a few kilometers to be out of the high-density area in the three days between the reconnaissance and high-density surveys.

In terms of bias (accuracy), we likely missed muskoxen. Many early travelers in the Thelon noted that most muskoxen are not seen because of their propensity to feed in tall willows (Appendix G). Most willows in the Thelon are fairly low to the ground, but some riparian willows are quite large and an unknown proportion of muskoxen may not have been visible.

Comparisons with previous surveys to determine past trends of muskoxen in the Sanctuary are hampered as approaches and techniques have varied in previous attempts to describe muskox numbers in the Sanctuary (Appendix G)**.** Most of the ground-based sightings are along the Thelon River and estimates before 1956 refer to the older boundaries of the Sanctuary (see MacKinnon 1983). Hoare (1930) based his estimate of 250 muskoxen in the Sanctuary on seeing muskoxen while traveling by dog team, foot and canoe. He counted 126 muskoxen along the Thelon and Hanbury rivers (1928-29), which included 93

muskoxen (4 herds) in one day near the confluence of the Thelon and Hanbury rivers.

Kelsall (1951) estimated 1,085 based on counting 334 muskoxen during a canoe trip along the Thelon River (confluence with Hanbury River to Baker Lake) in 1951. Tener (1956) counted 192 muskoxen during an aerial survey of about half the Sanctuary in late March 1956. Then, Tener and Kuyt (1966) in March 1966 attempted a complete count by flying at 300 to 400 m above the ground and using binoculars to search for muskoxen. The complete count was an attempt to deal with the problem of individuals clumped into widely dispersed herds over a large area. The count was 568 muskoxen over an estimated 75% of the Sanctuary and they concluded that at least 600 muskoxen were in the Sanctuary. Decker (1979) flew the area extensively, but unsystematically during the Arctic Land Use Research Program. His flights covered different parts of the Sanctuary between 1978 and 1980, and he concluded that the Thelon muskox population did not exceed the 600 noted by Tener and Kuyt and “may even be less”.

The sporadic survey frequency and differences in survey methods prevent us from estimating trends in muskox abundance for the Thelon Game Sanctuary. We also can say relatively little about distribution based on the 1994 survey compared to previous surveys. We have been unable to locate the maps for the March 1956 and 1966 surveys, but the reports suggested that 84% of the muskoxen were north of the Thelon River in 1966 (Tener and Kuyt, 1966). During

the 1994 reconnaissance survey, we recorded 55% of the muskoxen were north of the Thelon River.

Although we cannot determine a trend in muskox abundance within the Sanctuary from the aerial surveys, we have included in this report muskox sightings during canoe trips. These canoe trip sighting have been included as they cover several decades and the sighting effort (number of days) was recorded (Appendix H and I). The annual sightings along the rivers are from June into August during two or three separate trips. This would likely average out any effects of annual differences in plant phenology and muskox foraging along the river banks, which could contribute to local scale movements. The canoeists are also motivated to see and record muskoxen as part of their canoeing experience.

The trend in muskox sightings per day within the Thelon Sanctuary between 1971 and 2004 was not statistically significant (linear regression $r = 0.256$, $P = 0.172$) (Figure 6). The trend suggests that muskox numbers along the major rivers within the Sanctuary increased during the late 1980s and decreased in the mid-1990s. However, extrapolating the trend of sightings along the Thelon, Clarke and Hanbury rivers within the Thelon Game Sanctuary to the trend in muskox numbers across the Sanctuary would be risky.

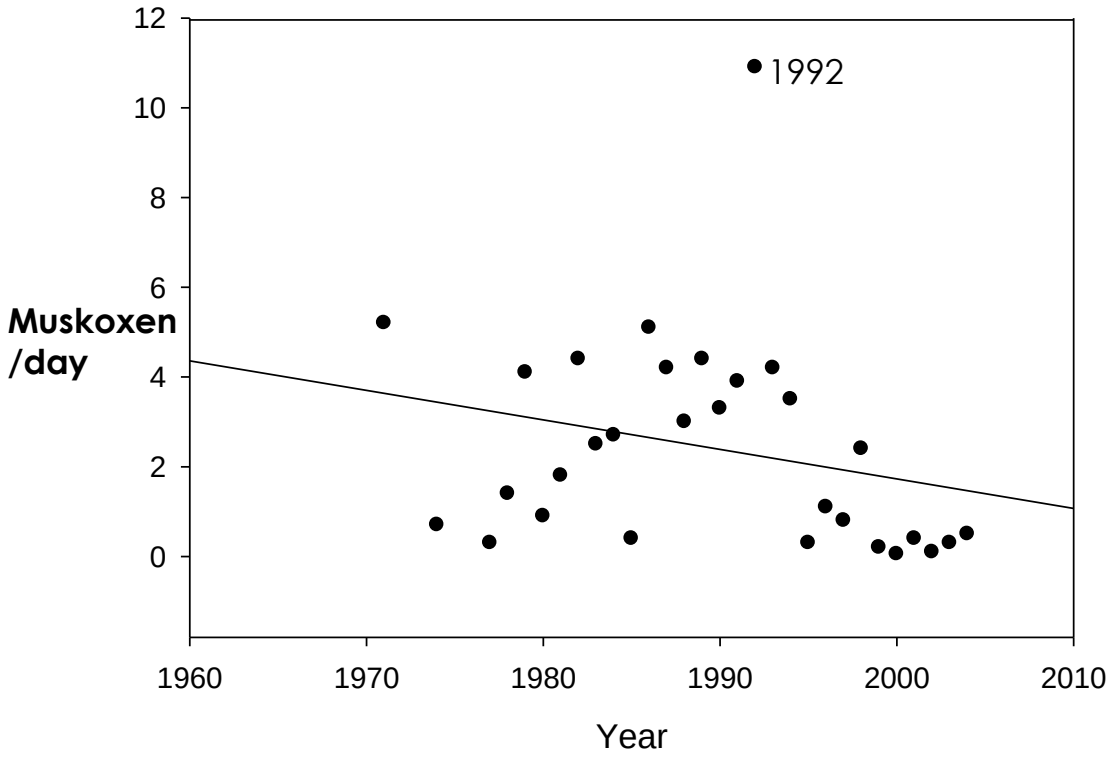

Figure 6. Alex Hall's muskox sightings during guided canoe trips along the Thelon, Clark and Hanbury Rivers within the Thelon Game Sanctuary, 1971-2004 (circles are muskox numbers/day as listed in Appendix H and I and the line is a linear trend).

No trend was detectable in the percentage of calves recorded during the canoe trips within the Sanctuary (Appendix H and I). Between 1971 and 2004, the percent calves of total muskoxen seen were 4.5 ± 0.71 (SE) (Appendix J). In 1994, when 12% calves were recorded on transect during the aerial survey across the Sanctuary, only 83% were seen during the canoe trips. However, in 2000, the percent calves recorded during the canoe trips (5.3%) and the aerial survey (5.5%) were similar.

Our aerial survey in 2000 further supports information suggesting that outside the Sanctuary, muskox abundance to the west, east and south has

increased since the 1980s. West of the Sanctuary, the Hanbury River in the vicinity of the western Sanctuary boundary is the only area that has been covered by aerial surveys using similar techniques, and the trend in muskox abundance is a relatively slight increase although the surveyed strata varied in size and location (Table 3).

Table 3. Comparison of muskox densities in the Hanbury River-Moraine Lake area, NWT, 1989, 1994, 1998 and 2000.

Survey Date	Hanbury River and Moraine Lake Area			
	March 1998	July 1994	July 1998	August 2000
	Hanbury River Strata	Moraine Lake Strata	Hanbury Strata	Thelon Strata
Mean density (adults per 100km^2)	3.4	5.7	6.0	10.4

Muskoxen have re-colonized the area south and southwest of the Thelon Wildlife Sanctuary during the last two to three decades. Our basis for identifying the current muskox distribution as a re-colonization is that the area south of the Thelon Wildlife Sanctuary, between Dubawnt Lake to the east and Lynx-Whitefish Lake to the west, was included within the historic range (Anderson 1930 in Barr 1991). The disappearance of muskoxen from the area southwest of the Sanctuary is summarized in Barr (1991) and attributed to commercial hunting for hides which were traded at Fort Resolution.

The return of the muskoxen to the area southwest of the Sanctuary is based on muskox sightings during canoe trips on the Thelon 1986-2004 and supplemented by sightings during unsystematic aerial wildlife surveys from 1978-1987 (Appendix K and L). Those sightings are sporadic in time and space, but

examination of flight lines (Decker, no date; Thomas *et al.,* 1998) add credence that the lack of sightings was in areas covered by surveys.

The area was covered during unsystematic aerial surveys for wildlife between 1978 and 1980 (Decker, no date) and then extensive winter surveys for caribou from 1982-1983 to 1986-1987, supplemented by less extensive surveys between 1979 and 1982 (Thomas *et al.,* 1998). Decker (no date) recorded few muskox herds between 1978 and 1980: three small herds at the north-end Eyeberry Lake, one herd at Mary Frances Lake and two herds on the east side of Artillery Lake. Thomas' *et al.* (1998) surveys covered mostly forested areas but some flights did cross our 2000 survey area (Appendices 12-14, 16, 18 and 19 in Thomas *et al.* 1998). The pattern of sightings was similar to that recorded by Decker (no date) with Artillery Lake being the extent of southwest sightings. That is until in November 1983 when a herd of seven muskoxen was seen on the Thelon River (Jim Lake 62^{o}25'N) some 40 km south of Beaverhill Lake (Figure 7).

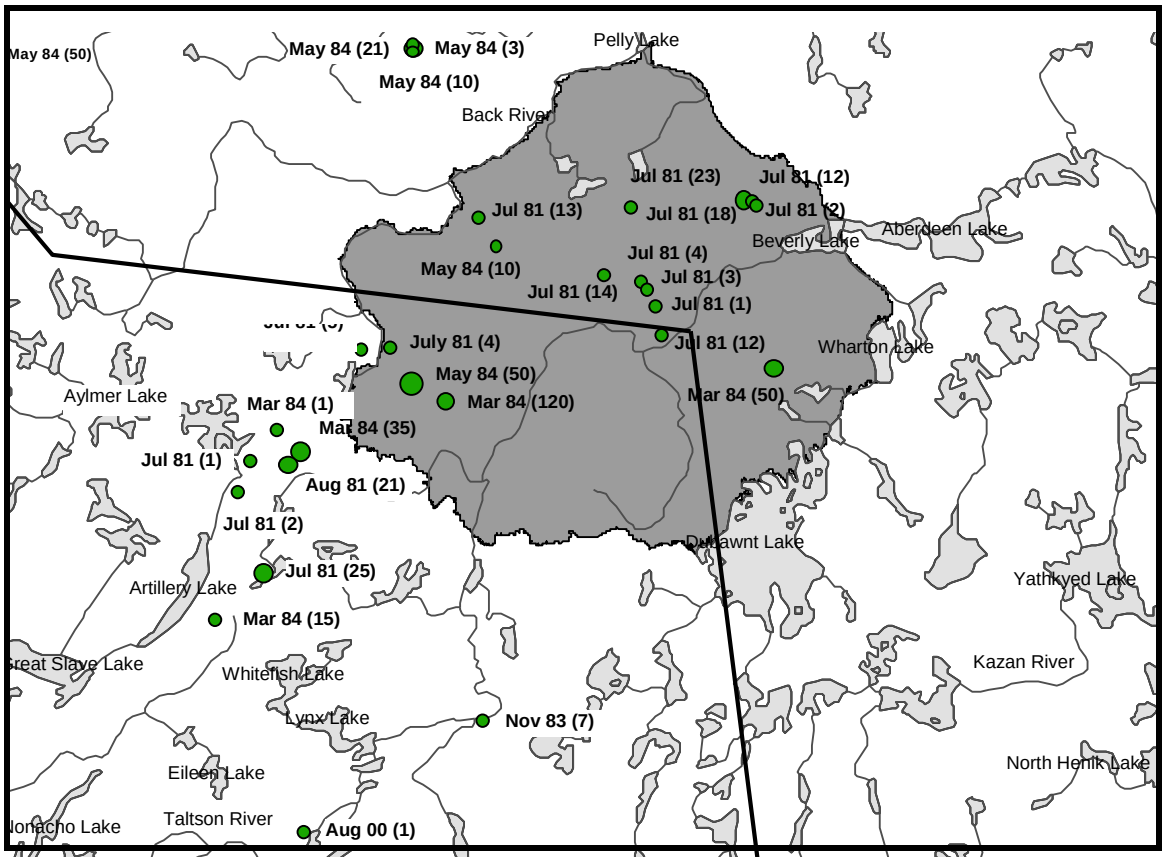

Figure 7. Muskox sightings (date and numbers) recorded during reconnaissance surveys to map barren-ground caribou distribution, 1981-2000 (Don Thomas pers. comm.).

Further evidence for the muskox distribution expanding south of the Thelon Wildlife Sanctuary is from Hall's sightings along the Thelon River (Appendix M in this report and Hall 2003) and ferry flights between Fort Smith and south of Mary Frances Lake (Figure 8). During annual canoe trips since 1971, Hall did not see muskoxen along the Thelon River outside the Thelon Game Sanctuary until 1986. Since the 1980s, the higher number of concentrated sightings has shifted from the center of the Sanctuary to Eyebury Lake. By 1995, Hall was recording single bulls and pairs of bulls at Eileen Lake and then a herd of 15 muskoxen south of Eileen Lake in 1996. In 2000, we saw 4 single bulls and

a herd of four muskoxen in the vicinity of Eileen Lake, which was the western extent of our survey lines. Eileen Lake was the southern edge of a band of muskox sightings that, in 1998, curved northwest toward the neck of land between Great Slave Lake and Artillery Lake (Bradley *et al.,* 2001). By 2004, muskoxen were seen on the shore of Great Slave Lake at the mouth of the Lockhart River (A. Enzoe pers. comm.).

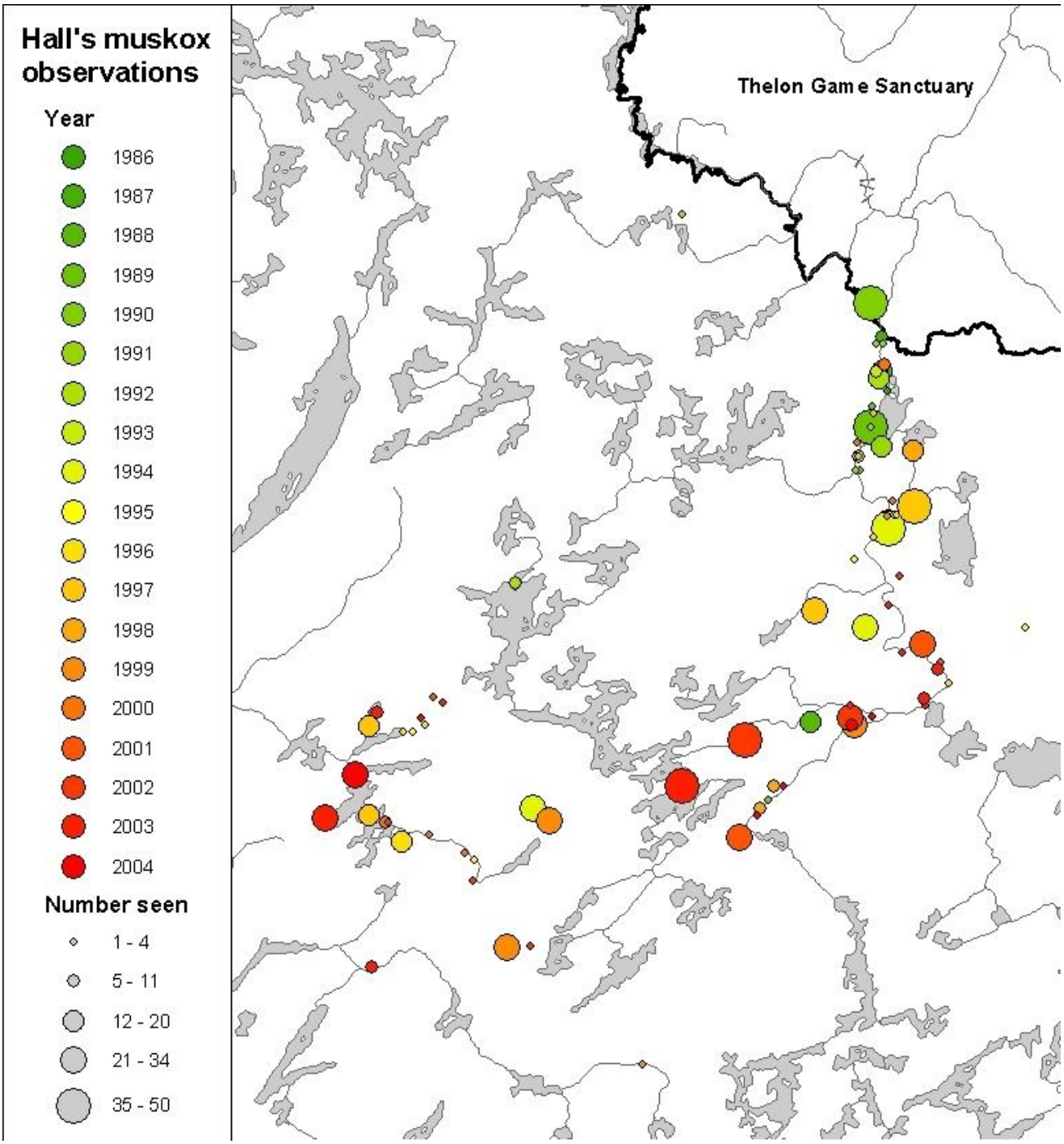

Figure 8. Location, size class and year of muskox herds seen during canoe trips and flights 1986-2004 (compiled from Alex Hall's sightings listed in Appendix L).

There is a tendency for the initial colonizers to be single bulls, as muskox colonization or re-colonization is frequently preceded by sightings of solitary bulls in an area before mixed sex and age herds are seen (Gunn and Case, 1984; Smith, 1989). Range expansion is a form of environmental dispersal as it occurs in pulses following periods of increasing densities, which have been most documented in northeastern Alaska (Reynolds, 1998). We plotted Hall's muskox sightings by distance from the Thelon Game Sanctuary by year (figure 9), and although the relationship was insignificant, there is a suggestion that the smaller groups and single bulls occur more frequently earlier at greater distances from the Sanctuary.

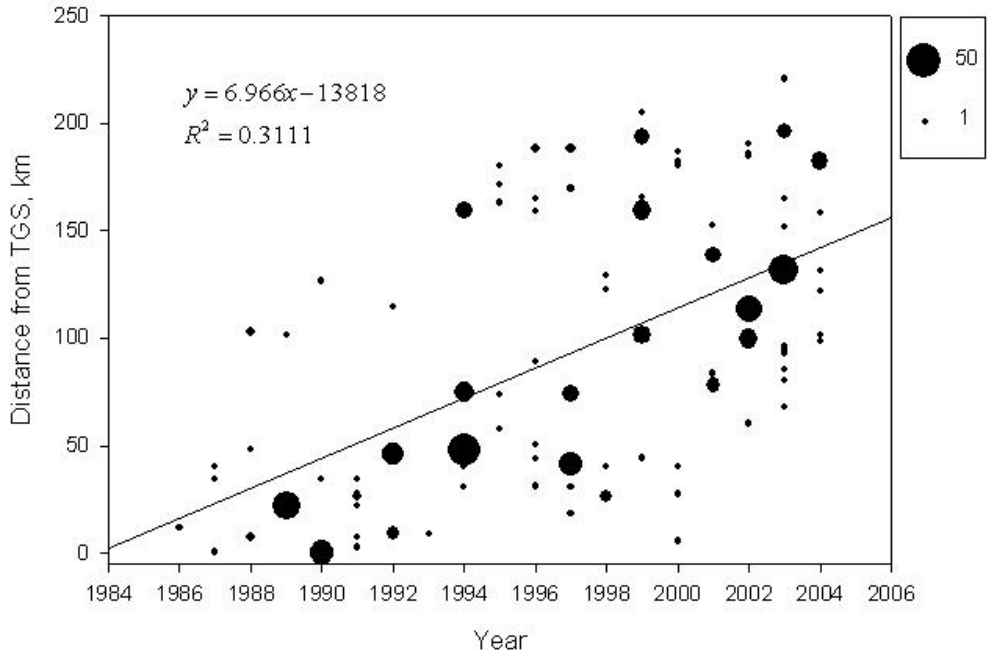

Figure 9. Muskox sightings by distance from the Thelon Game Sanctuary and herd size graphed against time, 1984-2004, NWT (A. Hall unpublished data).

Sightings since 1998 suggest that muskoxen are spreading further southwest. However, we agree with Bradley *et al.*'s (2001) comment that it is difficult to precisely define muskox distribution boundaries in areas of low density. We did not see muskoxen on the southernmost lines that we flew in August 2000, although we had extended the survey lines southwest toward Penylon Lake on the basis of a muskox sighting in winter 1999-2000 (Joe Marten pers. comm.) In August 2000, a bull was seen at Brooks Lake about 10 km north of Penylon Lake and in 2002, a herd of about 30 muskoxen was seen eight km north of McArthur Lake (which is about 20 km south of Penylon Lake) (B. Croft pers. comm.). The most recent sightings in 2003 and 2004 reveal a large extension of the muskox range to the southwest and well within the boreal forest. About 150 km further west of Penylon Lake was a herd of seven muskoxen near Nonacho Lake in August 2003 (Merlyn Carter to Al Helmer, pers. comm.). Tom Lockhart (pers. comm.) reported a muskox 32 km southwest of Lutsel K'e (62^{o} 07'N 110^{o}59'W), which is 226 km west of Penylon Lake. The sightings suggest a rate of southwest movement at roughly 17 km/year. Muskoxen spread east on Canada's mainland at 13 km/year (Gunn and Case, 1984) during the 1970s and 1980s.

We counted 104 muskoxen on our survey lines south of the Thelon Wildlife Sanctuary (Strata I, II and III) in August 2000 and we estimate that there are between 274 and 790 muskoxen in the area southwest of the Sanctuary. The average density is low (1.7 muskoxen per 100km^2) and similar to 1994 average density for the Thelon Wildlife Sanctuary (2.3 muskoxen per 100km^2) and the

average density for the area west toward Great Slave Lake (2.0 muskoxen per 100km^2), excluding the Hanbury and Thelon river valleys (Bradley *et al.,* 2001). Although our 2000 survey suggests a re-colonization of the area south of the Sanctuary, along the Thelon River south of the Sanctuary, we recorded a lower density of muskoxen (Strata I: 1.95 muskoxen per 100km^2) than in 1998 (6.3 muskoxen per 100km^2).

North and southeast of the Sanctuary, muskox abundance and distribution has increased during the 1980s and 1990s (Graf *et al*., 1990; Mulders and Bradley, In prep; Campbell and Setterington, 2001). Originally, when we planned the 2000 survey, we intended to cover the area between Dubawnt Lake and the western boundary of the most recent aerial survey in 1999 (Campbell and Setterington, 2001). This would have determined if muskox distribution was continuous across the south Thelon Sanctuary. Lack of time prevented us flying the area in 2000. We suspect that the distribution is continuous around the western, southern and eastern Thelon Sanctuary as we saw a small muskox group on the west side of Dubawnt Lake. Decker (no date) mapped two herds on the northeast shores of Dubawnt Lake in 1978-1980, and Campbell and Setterington (2001) recorded a muskoxen on their western transects of Muskox Management Unit MX21 which reached the northeast corner of Dubawnt Lake.

In 2000, we recorded a relatively low proportion of calves. Including both on and off-transect muskoxen, calves were 5.5% (19/347) which is less than the 13.0% (45/345) recorded in 1994 (Bradley *et al.,* 2001 did not classify calves).

The 2000 calf percentage is low compared to those recorded during other surveys of muskoxen (Table 4).

Table 4. Percentage muskox calves recorded during aerial surveys and (helicopter supported ground sex and age surveys).

Date	Trend	% Calves	Reference
Central Keewatin			
1999	Increase	15.4	Campbell and Setterington 2001
1991	Increase	16.4	Mulders and Bradley In prep.
1986	Increase	11.5	Graf et al. 1990
Queen Maud Gulf			
1996	Decline	14.9	Nishi and Gunn In prep.
1989		(14.7)	Gunn and Sutherland 1997
1988	Stable	8.9 (10.3)	Nishi and Gunn In prep.
1982	Increase	13.5	Gunn and Case 1984
Rae River area			
1991	Decline?	(15.2)	Gunn and Fournier 2000
1990	Decline?	(12.7)	Gunn and Fournier 2000
1989	Decline?	(20.8)	Gunn and Fournier 2000
1987	Stable	11.1	Gunn 1995

In August 2000, we estimated between 274 and 790 muskoxen in the area southwest of the Sanctuary. The low average density (1.7 muskoxen per 100km^2) is similar to the average density (2.4 muskoxen per 100km^2) for the area west toward Great Slave Lake (Bradley *et al.,* 2001). The conventional rule of thumb for muskox management has been to recommend quotas based on 3-5% of the most recent estimate. We suggest the lower value of 3% and applied to the lower end of the 95% confidence limits for the estimate. We recommend the lower end rather than the mean because our estimate was relatively precise (Coefficient of Variation 14%), but is greater then the recommended level for management decisions (Graf and Case, 1989). We

also suggest that caution is needed in setting a quota as we recorded a low percentage of calves. It is our experience elsewhere on the mainland that muskox populations do not maintain the phase of increase for many years before a decline starts. For example, on the mainland in four areas where muskox abundance increased in the 1980s, declines followed in the 1990s. In Queen Maud Gulf (N/MX/16) area, muskox numbers declined to 4,260 ± 680 (SE) between 1988 and 1996 (Nishi and Gunn, unpubl. data). West of Kugluktuk, muskox numbers declined in the early 1990s (J. Nishi unpublished data in Fournier and Gunn 1998) and further west, J. Nagy (pers. comm.) reports a decline in muskoxen west of Paulatuk.

Although the pattern of re-colonization and increased abundance followed by a decline is the classic portrayal of an erupting herbivore (Caughley, 1970), we lack the diagnostic evidence for confirmation. If the decline was forage-related, then increased harvesting would be a rational strategy. If, however, the decline was related to predation, then intensified harvesting would be inappropriate. During the time when the muskoxen have been increasing, caribou numbers have increased which would support higher numbers of predators, especially wolves and barren-ground grizzly bears. Both grizzly bears and wolves are effective predators of muskoxen, especially muskox calves (references in Gunn and Adamczewski, 2003). However, Kuyt (1969) reported that wolves did not heavily prey on muskoxen, which was based on finding muskox remains in only 19 of 595 wolf scats examined in the Thelon Game Sanctuary. Two scats were with a dead muskox bull killed in

willow thickets and we also suspect that adult muskoxen foraging in riparian willows may be also vulnerable to grizzly bear predation (Gunn and Miller 1982, Hall in Appendix H). The numbers of grizzly bears has increased in the Sanctuary during the 1980s and 1990s (A. Hall pers. comm.). Although the percent calves seen within the Sanctuary and southwest of the Sanctuary are similar (Appendix H), over-winter calf survival may be less within the Sanctuary as few yearlings and 2-year-old muskoxen are seen (A. Hall pers. comm.) compared to outside the Sanctuary. Until we have the information to determine if forage-related factors or predation are driving changes in abundance, we are cautious in recommending quotas and we recommend that population trend be tracked through aerial surveys at the very most with 10 year intervals.

Future aerial surveys should follow Graf and Case's (1989) recommendations with the additional suggestion that a few but larger strata are more likely to increase the precision of the estimate. Standardization of survey methods and timing increase the comparability of estimates, as the biases should be similar between surveys. Thus we would recommend surveys in July-August flown at 185 m above ground level with 1 km strip width on either side of the aircraft. However, those methods while suitable for the barrens are less suitable for muskoxen within treed areas. If the survey objectives are to measure population trend, then the same methods as in 1994 and 2000 are appropriate for similar survey areas. If the objective is, however, to determine muskox distribution within treed areas, we would recommend a late winter survey even though muskoxen will be in larger herds. Larger herds can

contribute to reduced precision in the estimate (clumping of individuals) and inaccuracy (difficulty of counting all individuals). However, against a snow background, muskoxen and their tracks and craters will be more detectable especially as the muskoxen feed on more open areas where there are grasses and sedges in the winter.

We recommend an annual quota of 11 muskoxen and the quota to be applied to our 2000 survey area. Beaverhill Lake is close to but outside the original 1927 Thelon Wildlife Sanctuary boundary and even further south after the 1956 boundary change. However, Beaverhill Lake would fall within the proposed extension to the Sanctuary to protect the Thelon's headwaters (Horizon Group, 1997).

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APPENDIX A.

Time spent on each transect and weather encountered during the muskox survey, Thelon Wildlife Sanctuary, August 1994.

Transect	Date	Time on transect	Hours	Weather conditions encountered
1	94.07.25	1557-1619	0.40	High, dense overcast, flat light, some smoke, good conditions
2	94.07.25	1458-1546	0.80	Strong SW wind, high overcast, some smoke
3	94.07.25	1636-1746	1.16	High, dense overcast, flat light, some smoke, good conditions
4	94.07.25	1752-2014	1.37	High, dense overcast, flat light, some smoke, good conditions
5	94.07.25	1157-1342	1.75	NW winds, no smoke, overcast
6	94.07.29	0926-1059	1.55	Moderate N wind, 90% low cloud cover, good visibility, 8^{o}C
7	94.07.27	1440-1552	1.20	50% high clouds, strong W winds, good visibility
8	94.07.25	1107-1221	1.23	Brisk E wind, some smoke, high overcast
9	94.07.27	1041-1210	1.48	Strong W wind, cool, some high clouds
10	94.07.29	1832-1945	1.22	Cool, high overcast, light winds
11	94.07.26	2031-2148	1.28	Low sun at our backs, clear, sunny, some wind
12	94.07.26	1807-1835 1922-2025	1.52	(Stopped for break). Sunny, some wind, cool.
13	94.07.26	1639-1800	1.35	Overcast turning to sunny, moderate winds, good visibility
14	94.07.28	1033-1205	1.53	Strong W wind, high overcast turning sunny, 15^{o}C
15	94.07.28	1211-1231 1416-1500	1.33	Sunny, strong W wind
16	94.07.31	1656-1764	0.97	Sunny, not much wind
17	94.07.31	1552-1646	0.90	Sunny, not much wind
18	94.07.31	1238-1320 1524-1536	0.90	Sunny, not much wind
18B	94.07.31	1159-1231	0.53	Sunny, not much wind
19	94.07.31	1159-1231	0.47	Windy, cold ominous clouds, rain occasionally
20	94.08.02	1217-1245	0.60	Windy, cold ominous clouds, rain occasionally
21	94.08.02	1133-1209	1.23	Windy, cold ominous clouds, rain occasionally
22	94.09.01	1012-1126	1.27	Smoke, rain started at 1730
23	94.08.01	1706-1822	0.58	Warm, some smoke
24	94.08.01	1346-1521	0.93	Warm some smoke
25	94.08.01	0954-1132	1.63	Warm, some smoke
B1	94.08.03	1201-1209	0.13	Cold, clear, windy

APPENDIX A. Continued.

Transect	Date	Time on transect	Hours	Weather conditions encountered
B2	94.08.03	1212-1219	0.12	Cold, clear, windy
B3	94.08.03	1221-1229	0.13	Cold, clear, windy
B4	94.08.03	1231-1238	0.12	Cold, clear, windy
B5	94.08.03	1244-1243	0.13	Cold, clear, windy
B6	94.08.03	1256-1303	0.12	Cold, clear, windy
B7	94.08.03	1305-1312	0.12	Cold, clear, windy
B8	94.08.03	1322-1330	0.13	Cold, clear, windy
B9	94.08.03	1436-1444	0.12	Cold, clear, windy
B10	94.08.03	1447-1454	0.12	Cold, clear, windy
B11	94.08.03	1501-1509	0.13	Cold, clear, windy
B12	94.08.03	1512-1525	0.22	Cold, clear, windy
B13	94.08.03	1528-1536	0.13	Cold, clear, windy
B14	94.08.03	1538-1545	0.12	Cold, clear, windy
B15	94.08.03	1248-1557	0.15	Cold, clear, windy
B16	94.08.03	1559-1606	0.12	Cold, clear, windy
M1	Not flown.			
M2	94.08.04	1444-1459	0.25	Smokey, warm windy
M3	94.08.04	1428-1441	0.22	Smokey, warm windy
M4	94.08.04	1408-1425	0.28	Smokey, warm windy
M5	94.08.04	1343-1405	0.28	Smokey, warm windy
M6	94.08.04	1317-1339	0.37	Smokey, warm windy
M7	94.08.04	1257-1313	0.27	Smokey, warm windy
M8	94.08.04	1238-1253	0.25	Smokey, warm windy
M9	94.08.04	1219-1236	0.28	Smokey, warm windy
M10	94.08.04	1202-1217	0.25	Smokey, warm windy
T1	94.08.06	1655-1714	0.32	Weak sun, moderate wind, scattered cloud
T2	94.08.06	1718-1732	0.23	Weak sun, moderate wind, scattered cloud
T3	94.08.06	1734-1755	0.35	Weak sun, moderate wind, scattered cloud
T4	94.08.06	1758-1814	0.27	Weak sun, moderate wind, scattered cloud
T5	94.08.06	1817-1843	0.43	Weak sun, moderate wind, scattered cloud
T6	94.08.06	1850-1913	0.38	Weak sun, moderate wind, scattered cloud
T7	94.08.06	1916-1933	0.28	Weak sun, moderate wind, scattered cloud
T8	94.08.06	1936-1950	0.23	Weak sun, moderate wind, scattered cloud
T9	94.08.06	1954-2011	0.28	Weak sun, moderate wind, scattered cloud

APPENDIX B.

Transects, muskox adults and calves on and off transect, reconnaissance survey, Thelon Wildlife Sanctuary, 25 July- 1 August 1994. Muskoxen seen during ferry flights are not included.

Transect Number	Adults on transect	Calves on transect	Adults off transect	Calves off transect	Latitude		Longitude	
2	1				63	25	104	58
3	1				63	31	102	00
4	9				63	41	104	01
4	1				63	41	103	29
5	13	4			63	48	102	52
5	1				63	48	103	28
5	2				63	48	105	17
5	2				63	49	105	33
5	1				63	48	105	39
5			20	3	63	49	105	33
6	14				63	56	102	53
6	1				63	56	102	57
6	14				63	56	105	25
7	1				64	05	105	17
7	21	4			64	05	105	11
7	10				64	04	104	31
7	1				64	05	103	56
7			8		64	04	104	31
8	1				64	12	102	33
9			11	4	64	20	102	32
9	1				64	20	102	42
14	1				65	01	103	16
16	1				65	25	101	55
16			1		65	16	102	18
18	14	2			65	34	103	04
18	9	4			65	33	102	59
18	25	5			65	32	102	15
18	4				65	32	102	02
18			4	2	65	32	102	02
18B	1				65	30	101	50
19	1				64	21	100	02
19	1				64	22	100	02
20	9	2			64	22	100	22
21	7	1			64	59	100	42
22	1				64	12	100	59
22			11	2	64	52	101	03
22			24	5	64	16	101	03
22			8		64	25	100	56
23	1				63	52	101	14
23			1		63	59	101	15
23			10	3	64	10	101	12

APPENDIX B. Continued.

Transect Number	Adults on transect	Calves on transect	Adults off transect	Calves off transect	Latitude		Longitude	
23			15	2	64	12	101	14
24	9				64	54	101	39
24			2		64	07	101	31
25	1				64	21	101	56
25	1				64	43	101	56
25			4	2	64	18	101	57
Total	181	22	119	23				

APPENDIX C.

Transects, muskox adults and calves on and off transect, high density strata survey, Thelon Wildlife Sanctuary, 3 - 6 August 1994. Muskoxen seen during ferry flights are not included.

Transect Number	Adults on transect	Calves on transect	Adults off transect	Calves off transect	Latitude		Longitude	
B3	1				65	35	103	03
B5	1				65	30	102	50
B5	1				65	35	102	51
B10			7	3	65	32	102	20
B12	6	1	7		65	37	102	04
B13	1				65	40	101	55
M1	1				63	58	106	02
M4	8	2	10		63	48	105	42
M4	1				64	02	105	43
M5			17	1	63	54	105	38
M5			16	2	63	53	105	39
M5	10	2	12		3	50	105	37
M6	1				63	47	105	31
M6	15	3	18		63	55	105	32
M7	1				64	06	105	27
M7	1				63	52	105	25
M9	1				63	48	105	12
M10	1				64	06	105	06
T1	1				64	18	102	00
T2	1				64	10	102	07
T4	11	1	12		64	24	102	18
T5	17	7	24		64	13	102	25
T5	1				64	14	102	25
T5	1				64	15	102	26
T5	15		15		64	15	102	25
T5			31	4	64	31	102	26
T6	21	1	22		64	26	102	30
T6	1				64	13	102	32
T7	1				64	23	102	37
Total	120	17	191	10				

APPENDIX D.

Sightings of bears, wolves, and moose during the muskox survey, Thelon Wildlife Sanctuary, August 1994. Buildings, significant occurrences of garbage, and good landing lakes are noted.

Date	Description	Latitude		Longitude		Comments
		BEARS				
94.07.25	Young male	63	15	102	29	
94.07.28	Single bear	64	36	102	15	
94.08.02	One 3 year old (?)	64	02	102	03	
		WOLVES				
94.07.25	One white	64	12	105	25	On transect
94.07.26	One while, one grey	64	45	105	35	On transect
94.07.26	One white	64	41	105	59	On transect
94.07.27	One white	64	21	103	43	On transect
94.07.28	One	65	00	101	35	On transect
94.07.29	One	64	05	105	57	On ferry flight
94.07.29	One	63	56	102	51	On transect
94.08.01	One white, one dark	64	25	101	53	On ferry flight
94.08.02	One white	63	49	101	34	On transect
94.08.04	One	64	01	105	27	On transect
		MOOSE				
94.07.25	One bull	64	11	102	42	On transect
94.07.27	Two	64	17	102	41	On ferry flight
94.08.01	Two bulls + others (?)	64	27	101	36	On transect
94.08.05	One cow	64	13	102	42	On ferry flight
94.08.05	One	64	12	102	24	On transect
94.08.05	One	64	09	102	31	On transect
		BUILDINGS				
94.07.25	Water gauging station	63	35.46	105	09.08	
94.07.26	Water gauging station	65	00.50	104	29.54	
94.04.28	Two red buildings	66	06.13	102	24.59	
94.08.01	Fishing camp (?)	63	26.06	101	25.44	Photos taken and submitted to KIA

APPENDIX D. Continued.

GARBAGE						
Date	**Description**	**Latitude**		**Longitude**		**Comments**
94.07.27	About 20 drums, plywood	64	03.42	102	57.31	Reported to KIA
94.08.01	Orange Tri-engine plane	63	48.28	101	37.01	Reported to KIA
94.08.02	One drum on shore	64	35.13	100	40.19	Reported to KIA
94.08.02	Six drums	64	09.43	100	02.11	Reported to KIA
RECOMMENDED LANDING LAKES						
		64	04.59	105	04.59	
		63	54.09	101	57.30	
		65	00.00	101	45.54	
		64	06.21	105	04.10	
		64	07.40	104	51.50	
		64	05.20	104	46.36	
		64	05.24	105	05.02	

APPENDIX E.

Transects and observations during an aerial survey of muskoxen in the Beaverhill Lake area, 9 – 21 August 2000.

Strata	Transect	Length (km)	Area (km2)	Muskoxen on transect	Muskoxen off transect	Date flown
II	5	57.865	95.5	0	0	15-Aug-00
II	6	119.549	197.3	0	0	15-Aug-00
II	7	114.833	189.5	0	0	15-Aug-00
II	8	116.150	212.0	0	0	15 & 17
II	9	132.634	265.3	0	1	14 & 17
II	10	182.685	393.3	4	0	14 & 17
II	11	172.242	344.5	1	0	14 & 17
II	12	157.909	315.8	1,1	11	14 & 17
II	13	162.991	326.0	0	15+2	11 & 17
II	14	171.433	342.9	9+1,1	8+1, 1	11-Aug-00
II	15	176.162	352.3	20+2	0	11-Aug-00
I	16	62.397	124.8	0	0	11-Aug-00
I	17	60.844	121.7	0	0	11-Aug-00
I	18	60.330	120.7	0	0	11-Aug-00
I	19	59.827	119.7	0	0	11-Aug-00
I	20	61.734	123.5	0	0	11-Aug-00
I	21	69.704	139.4	1,2	0	11-Aug-00
I	22	56.943	113.9	0	0	11-Aug-00
I	23	56.215	112.4	1	0	13-Aug-00
I	24	50.940	101.9	1,16+3	8,1,1,1	18-Aug-00
III	25	56.327	112.7	0	0	13-Aug-00
III	26	85.250	170.5	0	1	13-Aug-00
III	27	94.105	188.2	5+1	0	13-Aug-00
III	28	95.125	190.3	0	0	13-Aug-00
III	29	98.517	197.0	0	0	13-Aug-00
III	30	98.600	197.2	0	0	13-Aug-00
III	31	99.496	199.0	0	0	13-Aug-00
III	32	94.129	188.3	0	0	13-Aug-00
III	33	83.596	167.2	0	0	13 & 14 Aug -00
III	34	76.686	153.4	8	0	14-Aug-00
III	35	72.439	144.9	6	0	14-Aug-00
III	36	67.622	135.2	1,9+3	0	14-Aug-00
III	37	70.729	141.5	1	0	14-Aug-00
III	38	70.327	140.7	0	0	14-Aug-00
III	39	60.449	120.9	0	0	14-Aug-00
III	40	52.486	105.0	16+3	1	14-Aug-00
VI	70	74.602	149.2	1,8	0	18-Aug-00
VI	71	105.599	211.2	1,10	1	18-Aug-00
VI	72	102.393	204.8	17+1	1,2,1	18-Aug-00
VI	73	102.829	205.7	12	0	18-Aug-00
VI	74	104.738	209.5	21,2	1	18-Aug-00

APPENDIX E. Continued.

Strata	Transect	Length (km)	Area (km2)	Muskoxen on transect	Muskoxen off transect	Date flown
VI	75	103.063	206.1	55	0	18-Aug-00
VI	76	103.661	207.3	2,1,26+2	7,3	18-Aug-00
VI	77	58.082	116.2	1	1,1	18-Aug-00
				261+16	**67+3**	

APPENDIX F.

Weather and light conditions during an aerial muskoxen survey in the Beaverhill Lake area, 9 – 21 August 2000.

Date	Transects flown (Stratum)	Light and weather conditions
9 – 10 August	Ceilings too low to fly, rain and dull light	
11 August	13 – 21	Clouds obscured to broken, 1000+ foot ceilings. Visibility good to dull. Occasional showers.
12 August	Ceilings too low to fly, rain and dull light	
13 August	23 – 32 33 (eastern portion)	Clouds broken with occasional showers. Temp 10-15 ^{o}C. Winds strong in am (15 kt NW to NE) but lighter in pm. Visibility good.
14 August	33 (western portion) 34 – 40 9 - 12	Clouds broken to overcast. Temp 10-15 ^{o}C. Winds variable 5 – 15 kts. Visibility good, fair during showers.
15 August	5 – 8 9 extended to west (Lines flown at 500 agl as light very dull)	Clouds overcast 2000-5000' down to 1800'. Winds from south at 15+ kts. Visibility poor as light very dull.
16 August	Ceilings too low to fly, rain and dull light	
17 August	8 – 15 extended to west Extended lines of 8 and 9 reflown	Clouds Broken at 5000'. Temp 12-15 ^{o}C. Winds from south at 5-15 kt. Visibility good.
18 August	24 (reflown) 70 – 77	Clouds broken to overcast. Occasional showers. Temp 10-15 ^{o}C. Winds from south at 10-15 kts. Visibility mostly good, duller in pm.

APPENDIX G.

Summary of published data on muskox counts in the Thelon Wildlife Sanctuary and general area.

Author (Publishing year)	Year of travel	Number of muskoxen seen	Means of travel
J.W. Tyrell (1902)	1900	"About 20" muskoxen seen on Hanbury. Numerous muskoxen seen along the Thelon, all but one on north shore.	Canoe from Artillery L. to Hudson's Bay.
E.A. Pelletier in Barr (1991)	1908	3 solitary animals seen but also tracks. "…at certain times of the year large herds must frequent the shores of this river".	Police patrol by canoe down Hanbury and Thelon Rivers.
F.H. French in Barr (1991)	1917	Shot 20 muskoxen on the Thelon R. west of Beverly Lake.	Police dogteam from Baker L. to Bathurst Inlet.
J.C. Critchell-Bullock (1930)	1925	At least 44 muskoxen mostly around Grassy I. falls on Hanbury. Noted that the willows along the river hid them. Suggested that muskoxen were plentiful.	Cane from Artillery L. to coast with Hornby.
J. Hornby (1925, 1934)	1925	51 muskoxen in with signs of more.	Canoe (with Critchell-Bullock).
Christian (1937) in Clarke (1940)	1926-27	None seen	Over wintered and starved.
W.H.B. Hoare (1930)	1928-29	126 muskoxen from April to late July. 93 at one time. Estimated number in Sanctuary at 250.	Built cabin at Warden's Grove. Traveled by canoe and dogteam between Artillery L. and Baker L.
G.C. Goodwin (1936) in Clarke (1940)	1935	Col. T.C. Steele sighted 171 muskoxen from the air.	Four days by aircraft in early August.
C.H.D. Clark (1940)	1936/37	174 muskoxen from the air and 65 from the ground. Estimated 300 animals, 200 of them along the Hanbury. Commented on difficulty in censuring because of the willows.	Aerial survey in 1936 followed by canoe trip in 1937.
R.W. Thompson (1939) in Barr (1991)	1939	No muskoxen from Ft. Reliance to Baker Lake but 12 near Finnie River on return.	RCMP flight in mid-July.
H.A. McBeth (1940) in Barr (1991)	1940	Five seen but thought to be common.	RCMP canoe patrol.

APPENDIX G. Continued.

Author (Publishing year)	Year of travel	Number of muskoxen seen	Means of travel
Kelsall (1951) in Barr 1991	1951	331 most near Grassy I. Estimated 1085.	Canoe from Hanbury Junction to Baker L.
Tener (1952) in Barr (1991)	1952	169 muskoxen mostly near Finnie River.	Canoe from Hanbury Junction to Baker Lake
Topographical Survey of Canada (Tener 1958)	1954	170 muskoxen.	Canoe.
Geographic Survey of Canada (Tener 1956)	1954, 1955	Combined total of 189 over two years.	Helicopter
J.S. Tener (1955) in Barr 1991	1955	81 muskoxen.	Canoe.
J.S. Tener (1956)	1956	192 muskoxen from the air in three days.	Systematic aerial survey over half the Sanctuary in late March followed by ground surveys by dogteam.
J.S. Tener (1965)		400 muskoxen	
J.S. Tener and E. Kuyt (1966)	1966	568 seen with estimate of 600.	Six days of unsystematic aerial survey in late March. Attempt at a total count.
This study	1994	Estimated at least 1100.	Systematic aerial survey

APPENDIX H.

Alex Hall's unpublished journal muskox sightings 1971-2004. Summary of muskox sightings within Thelon Wildlife Sanctuary on Thelon River and tributaries (Hanbury and Clarke Rivers) 1971-2004. (See Figure 6 for display of these data).

Year	No. of muskox seen	No. of calves seen	Total muskox	Percent calves	No. of days in sanctuary	No. of muskoxen seen / day
1971	109	11	120	9.2	21	5.2
1974	15	0	15	0.0	21	0.7
1977	3	0	3	0.0	12	0.3
1978	48	0	48	0.0	35	1.4
1979	70	7	77	9.1	17	4.1
1980	15	0	15	0.0	17	0.9
1981	44	3	47	6.4	24	1.8
1982	79	9	88	10.2	18	4.4
1983	63	4	67	6.0	25	2.5
1984	69	5	74	6.8	26	2.7
1985	7	0	7	0.0	19	0.4
1986	173	13	186	7.0	34	5.1
1987	114	6	120	5.0	27	4.2
1988	98	0	98	0.0	33	3
1989	151	4	155	2.6	34	4.4
1990	46	3	49	6.1	14	3.3
1991	117	2	119	1.7	30	3.9
1992	164	9	173	5.2	15	10.9
1993	142	14	156	9.0	34	4.2
1994	99	9	108	8.3	28	3.5
1995	2	0	2	0.0	8	0.3
1996	31	2	33	6.1	27	1.1
1997	22	0	22	0.0	29	0.8
1998	71	7	78	9.0	29	2.4
1999	6	0	6	0.0	28	0.2
2000	1	0	1	0.0	19	0.05
2001	8	0	8	0.0	22	0.4
2002	3	0	3	0.0	22	0.1
2003	7	0	7	0.0	22	0.3
2004	10	1	11	9.1	22	0.5
TOTALS	1,787	109				

APPENDIX I.

Alex Hall's unpublished journal muskox sightings 1971-2004. Summary of muskox sightings within Thelon Wildlife Sanctuary along Baille and Back Rivers (See Figure 6 for display of these data).

Year	No. of muskox seen	No. of calves seen	Percent calves	No of days in sanctuary	No of muskoxen seen/day
1971	109	11	10.1	21	5.2
1974	15	0	0	21	0.7
1977	3	0	0	12	0.3
1978	48	0	0	35	1.4
1979	70	7	10.0	17	4.1
1980*	15	0	0	25	0.6
1981	44	3	7.00	24	1.8
1982	79	9	11.4	18	4.4
1983	63	4	6.3	25	2.5
1984	69	5	7.2	26	2.7
1985*	119	15	12.6	33	3.6
1986	173	13	7.5	34	5.1
1987	114	6	5.3	27	4.2
1988	98	0	0	33	3.0
1989	151	4	2.6	34	4.4
1990	46	3	6.5	14	3.3
1991	117	2	1.7	30	3.9
1992*	442	17	3.8	34	13.0
1993	142	14	9.9	34	4.2
1994	99	9	9.1	28	3.5
1995*	81	2	2.5	27	3.0
1996	31	2	6.5	27	1.1
1997	22	0	0	29	0.8
1998	71	7	9.9	29	2.4
1999	6	0	0	28	0.2
2000*	72	4	5.6	38	1.9
2001*	72	0	0	33	2.2
2002	3	0	0	22	0.1
2003	7	0	0	22	0.3
2004	10	1	10	22	0.5
TOTALS	2,391	138	-		

* Includes sightings along Baille and Back Rivers.

APPENDIX J.

Alex Hall's unpublished journal muskox sightings 1971-2004. Comparison of percent calves in muskox herds between Thelon Wildlife Sanctuary and area south of sanctuary (where total numbers of muskoxen and calves in herds were known).

Area	No. of herds	No. of muskoxen in herds	No. of calves in herds	Percent calves
*Thelon Wildlife Sanctuary 1971-2004	71	1,285	132	10.3
South of Sanctuary 1987-2004	24	399	46	11.5

* Includes Baillie and Back River herds in sanctuary Average herd size in sanctuary was 18.0 and average herd size south of sanctuary was 16.6)

APPENDIX K.

Alex Hall's unpublished journal muskox sightings. Landmark muskox sightings south of Thelon Wildlife Sanctuary in the documentation of southward spread of muskoxen from sanctuary to boreal forest, 1986 to 2003.

Date	Muskoxen observations
86.07.24	First muskox seen south of sanctuary next day 55 muskoxen seen 1 mile north of southern boundary of sanctuary (colonizing front).
86.07.25	First herd seen south of boundary of sanctuary (just barely south of boundary)
88.08.25	First herd seen on Upper Thelon River (not far downriver from Lynx Lake)
89.08.15	First sign of muskoxen seen on Elk River
90.08.13	First muskox (bull) seen on Elk River
94.08.04	Two herds seen just north of Sled Lake (sought of Lynx Lake)
95.08.22	First muskox (bull) seen at treeline (Sled Creek near Sled Lake)
96.08.25	First herd seen at treeline (sought of Eileen Lake (Big Stone Bay))
98.08.11	First herd seen on Elk River
99.06.15	First muskox seen on Taltson River (treeline)
99.08.04	First muskoxen (herd of 25) seen in boreal forest (near Taltson River) (south of treeline)
99.09.01	Herd of muskox seen just north west of Damant Lake (a headwork lake of Elk River)
03.08.05	Herd of muskoxen seen on Taltson River (first herd on Taltson seen) well south of treeline.
03.09.04	2 herds of muskoxen seen just west of Eileen Lake in forest.

APPENDIX L.

Alex Hall's unpublished journal muskox sightings 1986-2004. Muskox sightings south of Thelon Wildlife Sanctuary.

Date	Location	Lat.	Long.	No. of muskox seen	No. of calves	Comments
86.07.24*	Thelon River at Eyeberry Lake	63 12	104 42	1 bull		First muskox I have seen south of sanctuary
87.07.22	Thelon River south of Mary Frances River	62 56	104 43	2 bulls		
87.07.24	Thelon River (Mary Frances River)	63 01	104 53			Saw muskox tracks in sand
87.07.25*	Sanctuary Boundary	63 20	104 42	11	2	Herd was on very boundary of Sanctuary (southern border) on Thelon River 4 yearlings in this herd of 11 – only 2 cows and 1 bull
88.07.19	Thelon River	62 52	104 47	1 bull		
88.07.21	Thelon River – Eyeberry Lake	63 15	104 43	13	1	2 yearlings
88.08.25*	Upper Thelon River	62 25	105 15	13	?	Below Lynx Lake seen from air in 1988, not 1989
89.07.18	Thelon River at south end of Eyeberry Lake	63 07	104 48	43+	10+	Many at least 10 calves – possibly more calves but no count – heavy willow
89.07.18	Thelon River – Eyeberry Lake	63 10	104 47	1 bull		
89.08.15*	Elk River	62 24	105 02	1 bull (track)		Track of bull muskox seen
90.07.19	Thelon River	63 01	104 53	1 bull	0	
90.07.14	Thelon River near Grangle Falls	63 25	104 45	37	?	Canoeists we met said there was lots of calves in herd. Report from other canoeists I did not see these muskox
90.08.13*	Elk River	62 14	105 30	1 bull		First muskox seen on Elk River
91.07.15	Thelon River at Mary Francis River	63 01	104 54	2 bulls		
91.07.15	Thelon at Eyeberry Lake	63 07	104 48	1 bull		
91.07.16	Thelon below Eyeberry	63 19	104 44	1 bull		
91.07.29	Thelon near Mary Frances	63 05	104 53	2 bulls		
91.07.30	Thelon, Eyeberry Lake	63 04	104 45	13	1	(some yearlings)
91.07.30	Thelon, Eyeberry Lake	63 15	104 43	7	0	1 yearling

APPENDIX L. Continued.

Date	Location	Lat.	Long.	No. of muskox seen	No. of calves	Comments
91.07.30	Thelon south of sanctuary border	63 19	104 42	3	1	2 cows and 1 calf only, no bull)
92.06.28	Whitefish Lake	62 48	106 47	5 bulls		On island on Whitefish Lake (seen from air, whitefish Lake 99+% ice covered.
92.06.29	Hanbury River	63 40	105 45	60	1	3 herds seen from air wet of sanctuary total of about 60 animals only 1 calf
92.07.19	Thelon River	62 53	104 45	34	5	
92.07.20	Thelon River above Eyeberry			9	3	(2 yearling) no bull
92.07.21	Thelon River	63 14	104 44	20	2+	At least 2 calves, possibly more.
93.07.20	Thelon River near Eyeberry	63 15	104 45	6	0	
93.07.20	Thelon River near Eyeberry	63 15	104 45	6 bulls		(4 in one bunch)
94.07.10	Thelon near Mary Francis River	62 56	104 43	2 bulls		
94.07.11	Thelon near Eyeberry	63 03	104 53	5 bulls		
94.07.24	Thelon	62 52	104 45	50	?	Seen from airplane
94.07.24	Thelon	62 54	104 43	1 bull		
94.08.04	Thelon River	62 38	104 55	30	?	Seen from air – approx. 30
94.08.04*	North of Sled Lake	62 15	106 45	25 (2 herd)	?	Seen from air north of Sled Lake
95.08.14	Thelon River	62 36	104 04	1 bull		
95.08.16	Thelon River	62 48	104 57	1 bull		
95.08.22*	Sled Creek	62 08	107 04	1 bull		Virtually on treeline (first in Sled Cr.)
95.08.27	Near Eileen Lake	62 27	107 22	1 bull		
95.08.31	Near Eileen Lake	62 27	107 37	2 bulls		Near treeline east of Tent Lake
96.07.07	Thelon River	63 03	104 54	1 bull		
96.07.21	Thelon River	62 54	104 42	2 bulls		
96.08.12	Thelon	62 29	104 30	1 bull		
96.08.13	Thelon	62 51	104 50	1 bull		
96.08.25	South of Eileen Lake	62 11	107 27	15	3	First herd at Eileen Lake (3 yearlings) treeline
96.08.27	Near Eileen Lake	62 27	107 25	1 bull		
96.09.01	Near Eileen Lake	62 28	107 18	1 bull		

APPENDIX L. Continued.

Date	Location	Lat.	Long.	No. of muskox seen	No. of calves	Comments
Early 97.07	Hanbury River	Sifton Lake		10	?	Seen at Sifton Lake – told to me by another canoeist
97.07.23	Near Thelon River	62 55	104 36	35	?	Seen from air plane (Beaverhill L. River)
97.07.23	Near Thelon River	62 41	105 11	26	?	Seen from air plane
97.07.28	Near Eyeberry Lake	63 03	104 53	1 bull		
97.07.29	Eyeberry Lake	63 09	104 47	1 bull		
97.08.31	Eileen Lake	62 15	107 37	15	2	1 yearling present
97.09.03	Northeast of Eileen Lake	62 28	107 36	12	0	2 yearlings present
98.07.28	East of Eyeberry Lake	63 03	104 35	15-20	?	Seen from air plane
98.07.26	Thelon	62 56	104 43	1 bull		
98.08.11*	Elk River	62 13	105 33	8	1	2 yearlings present. First herd of muskox seen on Elk River and I canoe this river every year.
98.08.11*	Elk River	62 16	105 28	5	1	
99.06.15*	Taltson River	61 37	106 15	1 bull		First muskox seen on Taltson River (at treeline)
99.07.25	North of Sled Lake	62 13	106 40	30	?	Seen from air plane
99.07.25	Thelon River	62 54	104 45	2 bulls		
99.08.04*	Taltson River	61 55	106 55	25	?	First muskoxen seen in forest seen from air plane
99.08.12	Elk River	62 24	105 01	27	?	# of calves not recorded in diary
99.09.02	Near Eileen Lake	62 30	107 35	4 bulls		Together
99.09*	Near Damant Lake	61 55	105 20	Herd	?	Herd of muskoxen seen by one of our pilots northwest of Damant Lake
00.07.23	Thelon River	62 56	104 43	1 bull		
00.07.24	Thelon River	63 05	014 53	1 bull		Sought of Eyeberry Lake
00.07.25	Thelon River	63 16	104 42	9	0	North of Eyeberry Lake (8 cows)
00.08.14	Elk-Thelon River			11	?	Seen in distance (miles away)
00.08.23	Sled Creek near Eileen Lake	62 09	107 07	1 bull		
00.08.24	Sled Creek near Eileen Lake	62 12	107 18	1 bull		
00.08.25	Eileen Lake	62 14	107 32	9	0	2 yearlings present
01.08.04	Elk River	62 09	105 40	25	?	(25 approx.) seen from air plane
01.08.12	Thelon River	62 32	104 32	2 bulls		High Island
01.08.12	Thelon River	62 35	104 37	23	0	4 yearlings and 2 two year olds

APPENDIX L. Continued.

Date	Location	Lat.	Long.	No. of muskox seen	No. of calves	Comments
01.08.31	SW of Whitefish Lake	62 32	107 15	1 bull		
02.06.14	Taltson River	61 55	106 48	2 bulls		In forest, lots of tracks in area
02.07.21	Thelon River	62 23	105 38	16	0	2 yearlings
02.07.21	Thelon River	62 23	105 36	40	4	
02.07.24	Elk River	62 25	105 02	30	?	Seen in distance (2+ bulls?)
02.07.27	Thelon River	62 45	104 43	2 bulls		
02.08.20	Sled Creek	62 05	107;05	1 bull		(treeline)
02.08.24	Eileen Lake	62 14	107 31	1 bull		
03.07.26	Lynx Lake	62 17	105 54	1 bull		
03.07.26	Lynx Lake	62 17	105 57	45	5	6 yearlings
03.07.30	Thelon River	62 27	105 02	2 bulls		
03.08.02	Thelon River	62 41	104 47	1 bull		
03.08.05*	Taltson River	61 53	107 38	10+	?	First herd on Taltson well south of treeline, seen from air plan (10+ muskox)
03.08.16	Thelon River	62 26	104 38	1 bull		
03.08.16	Thelon River	62 27	104 38	5	?	Seen from a great distance
03.08.17	Thelon River	62 31	104 33	10	2	
03.08.18	Thelon River	62 34	104 44	1 bull		
03.08.31	Near Eileen Lake	62 30	107 33	6	0	
03.09.02	Near Whitefish Lake	62 31	107 12	1 bull		
03.09.04*	West of Eileen Lake	62 15	107 51	2 herds	?	Seen from airplane in forest just west of Eileen Lake and numbers and calves not recorded. They were small herds – less than 15 animals per herd
04.08.08	Elk River	62 12	105 34	4 bulls		Together
04.08.09	Elk River	62 16	105 25	1 bull		
04.08.11	Elk River	62 24	105 02	7	?	Seen from great distance
04.08.12	Thelon River	62 25	104 55	1 bull		
04.08.27	Eileen Lake	62 21	107 41	27	3	1 yearling
04.08.30	Near Eileen Lake	62 29	107 19	1 bull		

* No muskoxen seen south of sanctuary and A. Hall travels down Upper Thelon. Prior to 1986 A. Hall into Sanctuary almost every year

APPENDIX M.

Alex Hall's unpublished journal muskox sightings, Thelon Wildlife Sanctuary 1971-2004 (Note: 'above' means up river, 'below" means down river).

Date	River	No. muskox seen	No of calves	Comments
1971 muskox sightings:				
Jul 26	Hanbury River	1 bull		Near Thelon
Jul 27	Thelon River	1 bull		Near Warden's Grove
Jul 29	Thelon River	2 bulls		Between Grassy Island and Hornby Pt.
Jul 29	Thelon River near Hornby Pt.	56	8	
Jul 29	Thelon River Hornby Pt.	1 bull		
Jul 29	Thelon River Hornby Pt.	2 bulls		
Jul 30	Thelon River below Hornby Pt.	4 bulls		
Jul 31	Thelon River below Hornby Pt.	2 bulls		
Aug 2	Thelon River above Lookout Pt.	2 bulls		
Aug 2	Thelon River above Lookout Pt.	12	2	
Aug 2	Thelon River above Lookout Pt.	7	1	
Aug 2	Thelon River above Lookout Pt.	1 bull		
Aug 2	Thelon River above Lookout Pt.	3 bulls		
Aug 3	Thelon River above Lookout Pt.	1 bull		
Aug 6	Thelon River below Lockhart Pt.	1 bull		
Aug 8	Thelon River near Beverly Lake	13	?	Spotted in binoculars 2 miles away
Total for 1971: 109 muskoxen seen including 11 calves in 21 days within Sanctuary.				
1974 muskox sightings:				
Jul 13	Thelon River just above Thelon Canyon	1 bull	5	
Jul 18	Thelon River above Hornby Pt.	4 bulls		
Jul 19	Thelon below Hornby Pt.	3 bulls		
Jul 22	Thelon above Lookout Pt.	1 bull		
Jul 24	Thelon below Lookout Pt.	4 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1974 muskox sightings continued				
Jul 30	Thelon above Beverly Lake	2 bulls		
* Total for 1974 saw only 15 muskoxen passing through sanctuary along Thelon River. Total of 21 days in sanctuary (no herds seen – all bulls)				
1977 muskox sightings:				
Jul 3	Hanbury River below Hanbury Lake	1 bull		
Jul 4	Hanbury River above Hoare Lake	1 bull		
Jul 12	Thelon River below Grassy Island	1 bull		
Total of 3 muskox seen (no calves) in 12 days within the sanctuary.				
1978 muskox sightings:				
Jun 27	Hanbury River below Hoare Lake	14	0	
Jun 28	Hanbury River below Hoare Lake	14	0	
Jul 8	Thelon River above Hornby Pt.	1 bull		
Jul 9	Thelon River below Hornby Pt.	1 bull		
Jul 10	Thelon River above Lookout Pt.	5 bulls		
Jul 11	Thelon River near Lookout Pt.	3 bulls		
Jul 12	Thelon River below Lookout Pt.	2 bulls		
Jul 13	Thelon River below Lookout Pt.	5 bulls		
Jul 17	Hanbury River below Hoare Lake	1 bull		
Jul 26	Thelon River near Hornby Pt.	1 bull		
Jul 27	Thelon River below Hornby Pt.	1 bull		
Jul 31	Thelon River below Lookout Pt.	2 bulls		
Total of 48 muskox seen (no calves) in 35 days within sanctuary (2 trips down lower Hanbury and Thelon Rivers)				
1979 muskox sightings:				
Jul 3	Thelon River near Warden's Grove	1 bull		
Jul 4	Thelon River above Hornby Pt.	5	0	1 bull and 4 cows
Jul 6	Thelon River above Lookout Pt.	6	0	
Jul 8	Thelon below Lookout Pt.	9 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1979 muskox sightings continued				
Jul 9	Thelon below Ursus Is.	4 bulls		
Jul 11	Thelon close to Beverly Lake	7 bulls		
Jul 11	Thelon close to Beverly Lake	35	7	
Jul 12	Thelon close to Beverly Lake	2 bulls		
Total of 70 muskox (7 calves) seen in sanctuary in total of 17 days.				
1980 muskox sightings:				
Jun 24	Hanbury River below Howe Lake	2 bulls		
Jul 3	Thelon River below Hornby Pt.	1 bull		
Jul 4	Thelon River above Lookout Pt.	2 bulls		
Jul 5	Thelon River near Lookout Pt.	1 bull		
Jul 8	Thelon River near Ursus Is.	3 bulls		Found 3 bull muskox carcasses scattered along river in 3 days.
Jul 9	Thelon River at Thelon Bluffs	2 bulls		
Jul 10	Thelon River above Beverly Lake	4 bulls		
Jul 25- Aug 3 *				Canoed along Bank River on sanctuary border but saw no muskoxen. Saw 15 scattered bulls on Back River upriver from Thelon Sanctuary (above and below Beechey Lake).
Total of 15 muskox (all bulls) seen in 17 days inside Thelon sanctuary on Hanbury and Thelon Rivers.				
Total of 15 muskoxen seen (all bulls) in 25 days inside Thelon sanctuary on Hanbury, Thelon and Back Rivers.				
1981 muskox sightings:				
Jul 13	Thelon River below Lookout Pt.	3 bulls		Also bull carcass seen with wolf scats
Jul 14	Thelon River below Ursus Is.	4 bulls		
Jul 14	Thelon River below Ursus Is.	28	3	
Jul 15	Thelon River below Ursus Is.	2 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1981 muskox sightings continued				
Jul 16	Thelon River above Beverly Lake	7 bulls		One group of 5 bulls together
In 1981 I was in the sanctuary for a total of 24 days and saw a total of 44 muskox including 3 calves. I travelled from Hoare Lake down Hanbury River to Beverly Lake, then from Elk River, down upper Thelon into the sanctuary to end at Hornby Point. Saw no muskoxen in western part of the sanctuary at all.				
In late June I met two Swedes who had seen two herds of about 40 muskoxen near Sifton Lake on the upper Hanbury River, well west of the sanctuary. They saw them in mid June (no open water then – hauled their canoe over the ice).				
1982 muskox sightings:				
Jun 28	Hanbury River – Hoare Lake	30	6	
Jun 29	Hanbury River – Hoare Lake	17	3	
Jun 29	Hanbury River – Hoare Lake	1 bull		
Jun 29	Hanbury River – Hoare Lake	10	?	Seen from a distance
Jul 7	Thelon River, Hornby Pt.	1 bull		
Jul 9	Thelon River between Hornby Pt. and Lookout Pt.	2 bulls		
Jul 10	Thelon River below Lookout Pt.	3 bulls		
Jul 10	Thelon River below Lookout Pt.	4 bulls		
Jul 12	Thelon River below Ursus Is.	5 bulls		
Jul 13	Thelon River – Thelon Bluffs	3 bulls		
Jul 14	Thelon River above Beverly Lake	3 bulls		
Total of 79 muskox (9 calves) seen during total of 18 days in sanctuary.				
1983 muskox sightings:				
Jun 27	Hanbury River – Hoare Lake	7	?	Seen from air
Jun 27	Hanbury River – Hoare Lake	20	4	Seen from ground
Jun 28	Hanbury River – Hoare Lake	3 bulls		
Jul 6	Thelon River near Hornby Pt.	1 bull		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1983 muskox sightings continued				
Jul 7	Thelon River below Hornby Pt.	2 bulls		
Jul 8	Thelon River above Lookout Pt.	1 bull		
Jul 9	Thelon River below Lookout Pt.	4 bulls		
Jul 10	Thelon River above Ursus Is.	1 bull		
Jul 11	Thelon River below Ursus Is.	4 bulls		
Jul 12	Thelon River near Thelon Bluffs	1 bull		
Jul 13	Thelon River above Beverly Lake	5 bulls		
Jul 14	Thelon River above Beverly Lake	3 bulls		
Jul 15	Thelon River above Beverly Lake	1 bull		
Jul 29	Thelon River at southern boundary below Eyeberry Lake	1 bull		Few that south I have seen muskox – right on southern boundary of sanctuary below Eyeberry Lake
Aug 1	Thelon River below Hanbury River	1 bull		
Aug 2	Thelon River above Hornby Pt.	7 bulls		
Aug 3	Thelon River below Hornby Pt.	1 bull		
Total seen 63 muskoxen (including 4 calves) in 25 days in sanctuary in 1983.				
1984 muskox sightings:				
Jun 25	Hanbury River – Hoare Lake	2 bulls		
Jul 3	Thelon River near Grassy Is.	1 bull		
Jul 5	Thelon River near Hornby Pt.	4 bulls		
Jul 6	Thelon River below Hornby Pt.	5 bulls		
Jul 8	Thelon River below Lookout Pt.	5 bulls		
Jul 9	Thelon River below Lookout Pt.	1 bull		
Jul 10	Thelon River at Nunavut border	24	4	
Jul 10	Thelon River near Nunavut border	4 bulls		
Jul 11	Thelon River below Ursus Is.	8 bulls		
Jul 12	Thelon River above Beverly Lake	7 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1984 muskox sightings continued				
Jul 12	Thelon River above Beverly Lake	7	1	
Aug 1	Thelon River at Hornby Pt.	1 bull		
Total of 69 muskox seen (including 5 calves). Total of 26 days inside sanctuary.				
1985 muskox sightings:				
Jul 1	Baillie River upper most end	34	4	Below Moraine Lake
Jul 2	Baillie River upper most end	44	6	Below Moraine Lake
Jul 2	Baillie River upper most end	1 bull		Below Moraine Lake
Jul 3	Baillie River upper most end	6 bulls		Below Moraine Lake. Singles + 1 pair.
Jul 4	Upper Baillie River	1 calf	1	Only one calf – no other muskoxen
Jul 5	Upper Baillie River	1 bull		
Jul 6	Upper Baillie River	2 bulls		
Jul 10	Lower Baillie River	1 bull		
Jul 14	Back River near Warren River	18	4	
Jul 15	Back River above Hawk Rapids	4 bulls		
Aug 2	Thelon River below Hornby Pt.	1 bull		Half way between Hornby and Lookout
Aug 3	Thelon River above Lookout Pt.	2 bulls		
Aug 4	Thelon River near Lookout Pt.	1 bull		
Aug 5	Thelon River above Ursus Is.	3 bulls		
Total of 112 muskoxen (including 15 calves) seen along Baillie and Bark Rivers in total of 19 days.				
Total of 7 muskoxen (0 calves) seen in 19 days between Elk River and Beverly Lake along the Thelon River (all muskoxen seen on Thelon River inside sanctuary).				
Grand total for 1985 within sanctuary is 119 muskoxen (15 calves) in total of 33 days.				
1986 muskox sightings:				
Jul 9	Thelon River below Hornby Pt.	4 bulls		
Jul 11	Thelon below Lookout Pt.	2 bulls		
Jul 11	Thelon below Lookout Pt.	4 bulls		
Jul 12	Thelon above Ursus Is.	4 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1986 muskox sightings continued				
Jul 13	Thelon River below Ursus Is.	18	0	One yearling present
Jul 13	Thelon River below Ursus Is.	8 bulls		
Jul 14	Thelon River below Ursus Is.	7 bulls		
Jul 25	Thelon River just one mile north of Sadway	55	10	Numerous yearlings. Colonizing front – virtually on border of sanctuary
Aug 1	Thelon halfway between Hornby and Lookout Pts.	10 bulls		All singles
Aug 2	Thelon above Lookout Pt.	7 bulls		All singles
Aug 3	Thelon below Lookout Pt.	17	0	
Aug 3	Thelon below Lookout Pt.	2 bulls		
Aug 4	Thelon below Lookout Pt.	35	3	
Saw a total of 173 muskoxen (including 13 calves) in sanctuary during a total of 34 days.				
Note: Herd of 55 muskoxen seen on Thelon at southern boundary of sanctuary. This is the beginning of my seeing large #s of muskoxen in this area – and note large # of young present as opposed to very few young seen in the Thelon oasis herds. This is a "colonizing front" that eventually spread south to treeline and south of treeline over the next 13 and 14 years. This is the beginning of it. 1986 was also the first year I ever saw a muskox (1 bull) south of the sanctuary (at Eyeberry Lake). I didn't know it in 1986, but big changes were afoot for muskoxen.				
1987 muskox sightings:				
Jul 6	Thelon River below Hornby Pt.	2 bulls		
Jul 7	Thelon River halfway between Hornby and Lookout Pts.	2 bulls		
Jul 8	Thelon River – Lookout Pt.	2 bulls		
Jul 10	Thelon below Lookout Pt.	3 bulls		Together
Jul 11	Thelon below Lookout Pt.	3 bulls		
Jul 12	Thelon below Ursus Is.	15 bulls		
Jul 13	Thelon below Ursus Is.	3 bulls		
Jul 13	Thelon (Thelon Bluffs)	9 bulls		One group of 6 together
Jul 14	Thelon near Beverly Lake	2 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1987 muskox sightings continued				
Jul 14	Thelon near Beverly Lake	9	1	1 yearling
Jul 14	Thelon near Beverly Lake	1 bull		
Jul 29	Thelon at Wanda's Grave	1 bull		
Aug 1	Thelon at Hornby Pt.	3 bulls		
Aug 2	Thelon below Hornby Pt. and Lookout Pt.	25	2	
Aug 2	Thelon below Hornby Pt. and Lookout Pt.	11	2	
Aug 2	Thelon below Hornby Pt. and Lookout Pt.	6	1	3 yearlings
Aug 2	Thelon below Hornby Pt. and Lookout Pt.	13 bulls		
Aug 3	Thelon above Lookout Pt.	3 bulls		
Aug 5	Thelon below Lookout Pt.	1 bull		
Total of 114 muskoxen (including 6 calves) seen in a total of 27 days inside sanctuary.				
1988 muskox sightings:				
Jun 28	Clarke River upper	3 bulls		
Jul 6	Thelon River below Hornby Pt.	4 bulls		
Jul 7	Thelon between Hornby Pt. and Lookout Pt.	8 bulls		
Jul 9	Thelon below Lookout Pt.	3 bulls		
Jul 10	Thelon below Lookout Pt.	20	0	2 or 3 yearlings present and 2 two year olds.
Jul 11	Thelon below Ursus Is.	9	0	No yearlings
Jul 11	Thelon below Ursus Is.	10 bulls		
Jul 12	Thelon near Beverly Lake	12 bulls		
Jul 13	Thelon at Beverly Lake	4 bulls		
Jul 22	Thelon just north of sanctuary border	6	0	North of Eyeberry lake 1 yearling
Jul 25	Thelon near Grassy Is.	1 bull		
Jul 29	Thelon halfway between Hornby Pt. And Lookout Pt.	5 bulls		
Jul 30	Thelon above Lookout Pt.	2 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1988 muskox sightings continued				
Jul 31	Thelon below Lookout Pt.	6 bulls		
Aug 1	Thelon below Ursus Is.	3 bulls		
Aug 3	Thelon above Beverly Lake	2 bulls		
Aug 4	At Spruce Grove Lake (Kigarvi River)	80-100	?	West of Beverly Lake seen from air plane
Total # of muskox seen in sanctuary is 1988 (not counting August 4) was 98 (0 calves) in a total of 33 days in sanctuary.				
1989 muskox sightings:				
Jun 29	Clarke River 5 miles from Thelon	1 bull		
Jul 3	Thelon River at Hornby Pt.	3	0	2 bulls and 1 cow smallest herd seen to date
Jul 4	Thelon River below Hornby Pt.	3 bulls		
Jul 5	Thelon halfway between Hornby Pt.and Lookout Pt.	3 bulls		
Jul 6	Thelon above Lookout Pt.	1 bull		
Jul 7	Thelon River below Lookout Pt.	2 bulls		
Jul 8	Thelon River near Ursus Is.	26	0	
Jul 8	Thelon River near Ursus Is.	4 bulls		
Jul 9	Thelon River below Ursus Is.	4 bulls		
Jul 10	Thelon River below Ursus Is.	3 bulls		
Jul 11	Thelon above Beverly Lake	23	1	Lots of young animals
Jul 11	Thelon above Beverly Lake	9 bulls		
Jul 20	Thelon River above Thelon Canyon	13	2	Lots of young animals Several miles above (Clarke River junction)
Jul 22	Thelon River near Clarke River Junction	5	1	
Jul 23	Thelon River near Hanbury River junction	1 bull		
Jul 24	Thelon River near Grassy Island	1 bull		
Jul 26	Thelon River just above Hornby Pt.	13	0	Several yearlings present
Jul 26	Thelon River just above Hornby Pt.	3 bulls		
Jul 27	Thelon River below Hornby Pt.	6 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1989 muskox sightings continued				
Jul 28	Thelon River 20-30 miles past Hornby Pt.	10 bulls		
Jul 30	Thelon above Lookout Pt.	2 bulls		
Jul 31	Thelon above Ursus Is.	9 bulls		
Aug 1	Thelon below Ursus Is.	5 bulls		
Aug 2	Thelon above Beverly Lake	1 bull		
Total of 151 muskoxen seen (including 4 calves) inside sanctuary during a total of 34 days inside sanctuary.				
1990 muskox sightings:				
Jul 20	Thelon River on southern boundary of Sanctuary	8+	?	Stampeded thorough camp in night at least one calf
Jul 21	Thelon River just north of sanctuary boundary	2 bulls		
Jul 24	Thelon River near Grassy Is.	1 bull		
Jul 28	Thelon River halfway between Hornby Pt. and Lookout Pt.	5 bulls		
Jul 29	Thelon River well above Lookout Pt.	7 bulls		
Jul 30	Thelon River below Lookout Pt.	3 bulls		
Jul 31	Thelon River at Nunavut border	28	3	
Total of 46 muskoxen (including 3 calves) seen in sanctuary in total of 14 days.				
1991 muskox sightings:				
Jul 5	Clarke River near Thelon River	2 bulls		
Jul 9	Thelon River below Hornby Pt.	2 bulls		
Jul 10	Thelon River halfway between Hornby Pt. and Lookout Pt.	25	1	Lots of younger animals
Jul 10	Thelon River halfway between Hornby Pt. and Lookout Pt.	7 bulls		Scattered
Jul 16	Thelon River just north of sanctuary border	6	?	Seen from distance

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1991 muskox sightings continued				
Jul 17	Thelon River above Clarke River junction	3 bulls		
Jul 19	Thelon near Hanbury River junction	1 bull		
Jul 20	Thelon near Grassy Island	1 bull		
Jul 22	Thelon near Hornby Pt.	6 bulls		Scattered
Jul 23	Thelon below Hornby Pt.	8 bulls		Scattered
Jul 24	Thelon halfway between Hornby Pt.	11 bulls		Scattered
Jul 30	Thelon just north of sanctuary border	10	?	North of Explory Lake distance from us
Jul 31	Thelon south of Clarke River junction	2 bulls		
Aug 1	Thelon above Hanbury River junction	1 bull		
Aug 3	Thelon near Grassy Is.	1 bull		
Aug 3	Thelon near Grassy Is.	2	0	1 cow and 1 bull only
Aug 5	Thelon just above Hornby Pt.	18	1	Some yearlings
Aug 6	Thelon River below Hornby Pt.	6 bulls		Scattered
Aug 7	Thelon halfway between Hornby Pt. And Lookout Pt.	3 bulls		
Total of 117 muskoxen seen (including 2 calves) in 30 days inside sanctuary in 1991.				
1992 muskox sightings:				
Jun 28	Upper Baillie River Sanctuary border	60-70 (3 herds)	?	All animals seen from air western boundary of sanctuary except 18 seen on ground
Jun 30	Upper Baillie River Sanctuary border	4 bulls		
Jun 30	Upper Baillie River Sanctuary border	2 bulls		
Jul 1	Upper Baillie River Sanctuary border	17	5	
Jul 1	Upper Baillie River Sanctuary border	7 bulls		Group of 3, group of 4
Jul 2	Upper Baillie River Sanctuary border	50	Some	Some calves but no count
Jul 2	Upper Baillie River Sanctuary border	21	0	
Jul 2	Upper Baillie River Sanctuary border	9 bulls		Scattered
Jul 3	Middle Baillie River	20	2	
Jul 3	Middle Baillie River	23 bulls		Scattered

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1992 muskox sightings continued				
Jul 4	Middle Baillie River	11	0	
Jul 4	Middle Baillie River	9	1	
Jul 4	Middle Baillie River	8 bulls		Scattered
Jul 5	Lower Baillie River	2 bulls		
Jul 7	Lower Baillie River	23	0	Some yearlings
Jul 8	Lower Baillie River	5 bulls		
Jul 9	Junction of Baillie and Back River	5 bulls		
Jul 10	Back River below Baillie River	1 bull		
Jul 14	Back River at McKinley River junction	1 bull		
Jul 22	Thelon River north of Eyeberry Lake	1 bull		
Jul 23	Thelon River north of Eyeberry Lake	1 bull		Just north of sanctuary line
Jul 24	Thelon River south of Clarke River	6	?	
Jul 24	Thelon River south of Clarke River	16	1	
Jul 24	Thelon River south of Clarke River	8	2	
Jul 27	Thelon River near Grassy Is.	1 bull		
Jul 28	Thelon River below Grassy Is.	4	0	
Jul 29	Thelon River above Hornby Pt.	4 bulls		
Jul 30	Thelon River below Hornby Pt.	4	0	2 cows, 1 yearling + 1 bull 2 years old
Jul 30	Thelon River below Hornby Pt.	5 bulls		Scattered
Jul 31	Thelon River halfway between Hornby Pt. And Lookout Pt.	7 bulls		Scattered
Aug 1	Thelon River near Lookout Pt.	5 bulls		
Aug 2	Thelon River 15 miles below Lookout Pt.	47	1	
Aug 2	Thelon River below Lookout Pt.	9 bulls		Scattered
Aug 3	Thelon River below Ursus Is.	17	2	
Aug 4	Thelon River below Ursus Is.	1 bull		
Aug 5	Thelon River above Beverly Lake	23	3	Lots of young animals

Total of 442+ muskoxen (including 17+ calves) seen in 34 days within the sanctuary. My best year (other muskoxen seen south of sanctuary on upper Thelon).

On Thelon River and tributaries inside sanctuary a total of 164 muskoxen were seen in 15 days in the sanctuary.

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1993 muskox sightings:				
Jun 27	Clarke River upper Clarke River	2 bulls		Upper Clarke on edge of sanctuary
Jul 1	Lower Clarke River near Thelon	1 bull		
Jul 3	Thelon River near Grassy Is.	23	2	
Jul 4	Thelon River above Hornby Pt.	2	0	One cow and one bull only
Jul 4	Thelon River above Hornby Pt.	3 bulls		
Jul 5	Thelon below Hornby Pt.	2 bulls		
Jul 6	Thelon halfway between Hornby Pt.	5 bulls		Scattered
Jul 7	Thelon River above Lookout Pt.	56	7	
Jul 8	Thelon River above Lookout Pt.	5 bulls		
Jul 10	Thelon River just above Ursus Is.	1 bull		
Jul 11	Thelon River below Ursus Is.	1 bull		
Jul 12	Thelon River above Beverly Lake	9 bulls		Scattered
Jul 21	Thelon River above Clarke River	1 bull		
Jul 24	Thelon River near Wanda's Grave	1 bull		
Jul 26	Thelon River above Hornby Pt.	1 bull		
Jul 27	Thelon River below Hornby Pt.	8 bulls		Scattered
Jul 28	Thelon below Hornby Pt.	2 bulls		
Jul 31	Thelon halfway between Hornby	2 bulls		
Aug 1	Thelon River above Lookout Pt.	2 bulls		
Aug 2	Thelon River below Lookout Pt.	14	5	
Aug 4	Thelon River above Beverly Lake	1 bull		
Total of 142 muskoxen (including 14 calves) seen in 34 days inside the sanctuary.				
1994 muskox sightings:				
Jun 27	Upper Clarke River	12	5	First herd seen on Clarke River travel every year since 198?
Jun 29	Middle Clarke River	1 bull		
Jul 4	Thelon River 3 miles above Hornby Pt.	2		1 bull and 1 cow only
Jul 4	Thelon River 4 miles above Hornby Pt.	3 bulls		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1994 muskox sightings continued				
Jul 5	Thelon River below Hornby Pt.	5 bulls		Scattered
Jul 6	Thelon River halfway between Hornby Pt. and Lookout Pt.	25	2	
Jul 6	Thelon River halfway between Hornby Pt. and Lookout Pt.	5 bulls		Scattered
Jul 14	Thelon River just north of sanctuary border	27	2	North of Eyeberry Lake several yearlings and some 2 year olds
Jul 19	Thelon River above Hornby Pt.	1 bull		
Jul 20	Thelon River below Hornby Pt.	2 bulls		
Jul 28	Thelon River above Clarke River junction	1 bull		
Aug 1	Thelon River above Hornby Pt.	1 bull		
Aug 2	Thelon River below Hornby Pt.	4 bulls		Scattered
Aug 3	Thelon halfway between Hornby and Lookout Pts.	2 bulls		
Total of 99 muskoxen seen (including 9 calves) in 28 days inside sanctuary.				
1995 muskox sightings:				
Jul 2	Upper Baillie River	7	?	Seen from air
Jul 3	Upper Baillie River	1 bull		
Jul 4	Upper Baillie River	1 bull		
Jul 4	Upper Baillie River	15	?	Seen in distance
Jul 5	Upper Baillie River	14	1	Judged calf no older then 2 weeks
Jul 5	Upper Baillie River	1 bull	?	
Jul 5	Upper Baillie River	7		Seen in distance
Jul 6	Upper Baillie River	8 bulls		Scattered
Jul 7	Upper Baillie River	5 bulls		Scattered
Jul 8	Upper Baillie River	1 bull		
Jul 9	Middle Baillie River	1 bull		
Jul 12	Middle Baillie River	5		Seen in distance

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1995 muskox sightings continued				
Jul 16	middle Baillie River near Hawk Rapids	1 bull		
Jul 18	Back River near McKinley River	12	1	2 yearlings included
Jul 27	Thelon River north of Eyeberry Lake	1 bull		On southern boundary of sanctuary
Jul 31	Thelon River near Grassy Is.	1 bull		
Total of 81 muskoxen seen (including 2 calves) in 27 days inside Thelon wildlife Sanctuary. However only 2 muskoxen (bulls) seen along Thelon River inside sanctuary I total of 8 days.				
1996 muskox sightings:				
Jun 27	Thelon River at Warden's Grove	1 bull		
Jun 29	Thelon River above Hornby Pt.	1 bull		
Jun 30	Thelon River 20 miles below Hornby	2 bulls		
Jul 10	Thelon River north of southern border of sanctuary	10	2	2 yearlings – no bull
Jul 10	Thelon River north of southern border of sanctuary	1 bull		
Jul 11	Thelon River above Clarke River	1 bull		
Jul 16	Thelon River at Hornby Pt.	2 bulls		
Jul 23	Thelon River at southern border of sanctuary	3 bulls		
Jul 24	Thelon River at southern border of sanctuary	1 bull		Found very old (decades old) muskox skull here
Jul 28	Thelon above Clarke River	1 bull		
Jul 29	Thelon below Hornby Pt.	7 bulls		Scattered
Jul 30	Thelon halfway between Hornby Pt. And Lookout Pt.	2 bulls		
Total of 31 muskox seen (including 2 calves) during 27 days inside Thelon Sanctuary.				

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1997 muskox sightings:				
Jul 2	Clarke River – middle Clarke	2 bulls		
Jul 7	Thelon River above Hornby Pt.	1 bull		
Jul 8	Thelon 25 miles past Hornby Pt.	7 bulls		5 bulls together
Jul 15	Thelon above Hornby Pt.	1 bull		
Jul 17	Thelon halfway between Hornby Pt. and Lookout Pt.	1 bull		
Jul 18	Thelon well above Lookout Pt.	2 bulls		
Jul 19	Thelon below Lookout Pt.	1 bull		
Jul 20	Thelon above Ursus Is.	6 bulls		
Jul 30	Thelon near southern boundary	1 bull		North of Eyeberry Lake in sanctuary boundary
Total of 22 muskoxen seen (including 0 calves) in total of 29 days inside sanctuary – all bull muskoxen. No herds seen in sanctuary in 1997.				
1998 muskox sightings:				
Jul 2	Clarke River – middle Clarke	1 bull	--	
Jul 4	Clarke River close to Thelon	1 bull	--	
Jul 5	Thelon in Grassy Is. area	4 bulls	--	
Jul 7	Thelon River just above Hornby Pt.	36	? (2)	Saw 2 calves but could have been more
Jul 7	Thelon River just above Hornby Pt.	2 bulls	--	
Jul 16	Thelon River below Hornby Pt.	2 bulls	--	
Jul 18	Thelon above Lookout Pt.	3 bulls	--	
Jul 30	Thelon north of Eyeberry Lake on sanctuary border	1 bull	--	
Aug 1	Thelon River at Hornby River junction	21	5	
Total of 71 muskoxen seen (including 7 calves) in sanctuary in a total of 29 days.				

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
1999 muskox sightings:				
Jul 2	Thelon near Hanbury River junction	3 bulls		Together
Jul 17	Thelon River below Lookout Pt.	1 bull		
Jul 30	Thelon River north of Eyeberry Lake	2 bulls		
Total of 6 muskox (all bulls) seen in total of 28 days inside sanctuary.				
2000 muskox sightings:				
Jul 3	Baillie River – upper Baillie	1 bull		
Jul 3	Upper Baillie River	14	3	
Jul 3	Upper Baillie River	1 bull		
Jul 5	Mid Baillie River	3 bulls		
Jul 6	Mid Baillie River	2 bulls		
Jul 12	Lower Baillie River	24	?	Seen in distance 2 miles
Jul 14	Mid Back River below Baillie	8	0	
Jul 16	Back River at Hawk Rapids	5	0	1 yearling present
Jul 17	Back River near McKinley River	13	1	
Jul 31	Thelon River near Grassy Is.	1 bull		
Total of 72 muskox (including 4 calves) seen in sanctuary in total of 38 days				
Note that 71 muskox (4 calves) seen along edges of sanctuary (Baillie and Back Rivers) in 19 days and that only one muskox seen in Thelon River part of sanctuary in total of 19 days (in western part of sanctuary on Thelon River).				
2001 muskox sightings:				
Jul 7	Upper Baillie River	15	?	Seen from air plane
Jul 8	Upper Baillie River	4 bulls		
Jul 9	Upper Baillie River	6	0	No yearlings
Jul 9	Upper Baillie River	12	0	No yearlings
Jul 9	Upper Baillie River	16	0	No yearlings some 2 year olds
Jul 10	Upper Baillie River	8 bulls		Scattered
Jul 15	Lower Baillie River	3 bulls		
Jul 22	Thelon River below Grassy Is.	1 bull		

APPENDIX M. Continued.

Date	River	No. muskox seen	No of calves	Comments
2001 muskox sightings continued				
Jul 23	Thelon near Hornby Pt.	1 bull		
Jul 26	Thelon below Lookout Pt.	1 bull		
Jul 27	Thelon above Ursus Is.	3 bulls		
Jul 30	Thelon above Beverly Lake	2 bulls		
Total of 72 muskoxen (no calves) seen in sanctuary over period of 33 days.				
Note 64 muskox seen on Baillie River in 11days. But only 8 muskox seen on Clarke and Thelon Rivers (passing through sanctuary) in 22 days. There are virtually no muskoxen left along the Thelon within the Thelon Oasis. Had similar results in year 2000.				
2002 muskox sightings:				
Jun 30	Thelon River 3 miles above Hornby Pt.	1 bull		
Jul 14	Thelon River at Ursus Is.	2 bulls		
Total of 3 muskox (all bulls) seen in 22 days inside sanctuary.				
2003 muskox sightings:				
Jul 1	Middle Clarke R.	1 bull		
Jul 1	Middle Clarke R.	2 bulls		
Jul 15	Thelon River above Hornby Pt.	1 bull		The ox are long gone
Jul 18	Thelon above Lookout Pt.	1 bull		
Jul 20	Thelon River below Lookout Pt.	2 bulls		
Total of 7 muskox (all bulls) seen in 22 days inside Thelon Wildlife Sanctuary.				
2004 muskox sightings:				
Jun 26	Upper most Clarke River	1 bull		
Jun 27	Upper Clarke River	1 bull		
Jun 30	Upper Clarke River	3 bulls		
Jul 11	Thelon just above Hornby Pt.	2 bulls		
Jul 19	Thelon just west of Beverly Lake	3	1	
Total of 10 muskox (including one calf) seen in 22 days within Thelon sanctuary.				