MUSKOX MORTALITY SURVEY, BANKS ISLAND

AUGUST, 1996

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INUVIK, N.W.T.

1999

Manuscript Report No. 117

ABSTRACT

During July and August 1996, a minimum of 66 and a maximum of 86 muskoxen carcasses were located on aerial and ground surveys conducted in areas where fresh muskox carcasses had been reported. Although carcasses were found in localized areas, they were distributed widely across the 70,000 km^2 island and were not all located in areas of high muskox density. Dead animals: 1) showed no evidence of starvation as all had large supplies of mesenteric fat lining the stomach, 2) generally had thrashed with either the legs or head prior to succumbing, 3) generally had bleeding from the nose and blood tinged abdominal fluid, 4) were rarely located >200m from a water course, and 5) covered a range of sex and age classes. We collected small intestine samples from 12 carcasses from across the island between 1 and 25 August, 1996. All tissue samples were necropsied and cultured for the presence of bacteria. Gross necropsies in the field and of tissue samples in the lab pointed to Yersiniosis as the likely cause of death, however no *Yersinia* species were isolated in any of the cultured tissue samples. Little is known about the transmission and the cause of outbreaks of yersiniosis in muskoxen. *Yersinia pseudotuberculosis* was reported in muskoxen for the first time in 1986 on Banks Island.

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INTRODUCTION

Between 20 and 23 July, 1996 a minimum of 30 and a maximum of 50 muskox carcasses were spotted along the Kange River drainage, NE Banks Island (Figures 1 and 2), by a mineral survey crew working for Canagrad Surveys. The survey crew advised the Sachs Harbour Hunters' and Trappers' Committee, who requested that the Department of Resources, Wildlife & Economic Development conduct an aerial survey in the area to determine the number of dead muskoxen, the extent of the problem, and to collect biological samples to determine the cause(s) of death. This report describes the findings of this survey and the subsequent analyses of biological samples.

METHODS

On 1 August, 1996, we conducted a low level (≤100 m above ground level) aerial survey, using a Bell 206L helicopter, of the Thomsen, Dissection, and Parker River drainages (Figure 2). We surveyed only 8 km of the eastern part of the Kange River drainage because fog, sleet and wind conditions in the valley made helicopter travel impossible. All muskox carcasses were counted and their locations determined by an onboard Trimble global positioning system (GPS). On our return leg from the confluence of the Parker and Kange Rivers we stopped at 3 locations to collect biological samples from 8 carcasses (Figure 2). We collected samples from 2 carcasses at the first location (labelled 1 and 2 on Figure 2), from 2 carcasses at the second location (labelled 3 and 4 on Figure 2) and from 4 carcasses at the third location (labelled 5, 6, 7, and 8 on Figure 2). We also collected a 1 l water sample from a creek entering the Parker River at the third location. This small area had the highest density of carcasses observed; 6 within approximately 2 ha.

At each carcass we determined the sex and age class of the muskox, following Olesen and Thing (1989). We were unable to determine the sex of one yearling because of scavenging. We photographed each carcass, noted its proximity to a water course, and noted whether there was evidence of thrashing and/or bleeding from the nose. We cut into the abdominal cavity, noting relative amounts of mesenteric fat, the color of abdominal fluid, and removed two samples (≤100 g) of small intestine and its contents. The samples were tied off at each end to secure the contents. One sample/animal was placed in a ziplock bag and kept chilled in a snow-filled cooler. The other sample was placed in a 50 ml centrifuge tube and fixed in 10% buffered formalin. The chilled samples were returned to the laboratory in Inuvik and frozen within 22 h of being collected.

Additional biological samples and data were collected from 4 more carcasses. One was spotted on the return to our field camp, approximately 250 km SW of the Parker River carcasses (labelled 9 on Figure 3). Similar samples were collected from this carcass on 2 August. The other 3 carcasses were sampled on 25 August in the Deep Creek area (labelled 10, 11, and 12 on Figure 3). Six carcasses had been located by a local hunter and reported to us. We travelled to the area by 4x4 ATV's and collected the data described previously from 3 different carcasses. Because no formalin was available for this trip we collected only one small intestine sample/carcass. These samples were chilled, and frozen within 8 h of collection.

All biological samples were forwarded to the Western College of Veterinary Medicine (WCVM), University of Saskatchewan, Saskatoon for pathological analyses.

During November we retrieved an intact frozen femur from animal #9, located in the vicinity of our field camp. A sample of the marrow from this bone was extracted at the WCVM and analyzed in the same fashion as the previously forwarded tissue samples.

RESULTS

A minimum of 66 and a maximum of 86 carcasses were observed in the Thomsen, Dissection, Kange, Parker, Sungukpagaluk Rivers, and Deep Creek areas that were surveyed either as part of the Canagrad flights or our aerial and ground survey. A minimum of 30 and a maximum of 50 animals were observed in the western part of Kange River drainage by Canagrad personnel (Figure 2). Other animals were located during our aerial and ground surveys in the Thomsen River drainage (2), in the Parker and extreme eastern part of the Kange River drainages (21), in the Dissection River drainage (3) (Figure 2), in the Coyote River drainage (1), in the Deep Creek drainage (6), in the Sachs River drainage (1), and 2 animals were observed along nameless drainages between Sungukpagaluk River and Deep Creek during the ground survey, one being the examined carcass #9 (Figure 3).

All 36 carcasses observed by Department personnel and by local hunter John Lucas Sr. were located within 200 m of a watercourse. Ten of the 12 carcasses sampled were located within 30 m of a watercourse. The carcasses we sampled were from a range of different sex and age classes with adult males predominating (Table 1). All carcasses had large supplies of mesenteric fat and had blood tinged liquid in the abdominal cavity (Table 1). The majority of animals showed evidence of either leg or head thrashing and bleeding from the nose prior to succumbing (Table 1).

The presence of blood tinged liquid in the abdominal cavity, and a distinctive odor of the carcasses we examined, are consistent with those found in muskox that died of Yersiniosis on northern Banks Island in 1986 (A. Gunn, pers. comm.). The lesions and the fluid found in the majority of the small intestine samples necropsied are also consistent with symptoms associated with

Yersiniosis (H. Philibert, pers. comm.). No *Yersinia* spp. were isolated in any of the cultures from the tissue samples or the bone marrow sample we submitted to WCVM. Therefore, although the most likely cause of death was Yersiniosis, we cannot state that Yersiniosis was the absolute cause of death.

No bacteria were found in the water sample.

DISCUSSION

Yersinia pseudotuberculosis was reported in muskoxen for the first time in 1986 on Banks Island when 20 necropsied muskoxen were determined to have died from acute yersiniosis (Blake *et al.*, 1991). All 20 animals were in excellent body condition with abundant fat stores and covered a wide range of different sex and age classes. Findings similar to that from the 12 animals examined in this survey. The majority of the dead muskoxen located in 1986 were located in the Thomsen River area, a few were located in the Parker River area.

Little is known about the transmission of yersiniosis in muskoxen and why the results of the infection are not always fatal. Muskoxen on Banks Island have been exposed to yersiniosis and survived. Based upon liver lesions, approximately 20% of the muskox sampled during the 1997 commercial muskox harvest on Banks Island had been previously exposed to yersiniosis, but had survived the infection (Nagy and Branigan, unpubl. data). Stressors such as sudden climatic changes, poor nutrition and overcrowding are implicated in the pathogenesis of the disease, with hot weather during the arctic summer and wild rodents and birds as disease carriers other possible factors (Obwolo, 1976; Stovell, 1980). After the deadly outbreak in 1986 there was increased speculation that the disease was endemic to Banks Island, unique to the Thomsen River area, and that the high density of muskoxen in the area (1.5 muskox/km^2), not nutritional stress, was a major contributing factor to the outbreak (Blake *et al.*, 1991).

If we accept that the 1996 mortalities were caused by yersiniosis then we would concur with Blake *et al.* (1991) that the disease may be endemic to Banks Island, and that nutritional stress was not a major contributing factor, because all animals we examined had abundances of fat. However, the disease is not unique to the Thomsen area and it is unlikely that it is directly related to animal density.

Island-wide population surveys were conducted in summers 1989, 1991, 1992, 1994, and 1998. The population density of muskoxen on Banks Island increased from 1986 to 1994, and in some areas had reached almost 3.0 muskox/km^2 (Nagy *et al.*, 1996; Larter and Nagy, unpubl. data). Between 1994 and 1998 the muskox population decreased (Nagy and Branigan, unpubl. data). There has not been another documented deadly yersiniosis outbreak from 1986 until 1996, and no large numbers of muskox carcasses were observed during island-wide population surveys or summer research field trips. The carcasses we found were from areas with a wide range of densities; 0.5-2.7 muskox/km^2 based upon 1994 estimates and 0.4-1.4 muskox/km^2 based upon 1998 estimates. Therefore, it does not appear that high animal density was a major contributing factor to this deadly outbreak. Even with the recent decline in muskox numbers on Banks Island, deadly outbreaks of yersiniosis certainly have not been the major mortality factor affecting the muskox population since 1986 as implied by Blake *et al.* (1991).

Mid-May through June 1996 had higher temperatures than average in Sachs Harbour and at a weather station near Sungukpagaluk River. This is consistent with the hypothesis that hot summer weather is a factor implicated in deadly outbreaks of yersiniosis. Contrastingly, during the same period in 1986, temperatures were lower than average in Sachs Harbour. During summer 1996 lemming numbers were high on Banks Island (Larter, 1998) which is consistent with the hypothesis that wild rodents are potential disease carriers associated with deadly outbreaks. However, lemming numbers were low in 1986 and were much higher in summer 1993 than summer 1996 (Larter, 1998); there was no recorded yersiniosis outbreak in 1993. Birds, especially jaegars and raptors, were much more numerous in summers when lemming numbers were high. Therefore, high summer temperatures, high lemming numbers and high bird numbers may be factors that are involved in a deadly yersiniosis outbreak.

The apparent rapid mortality experienced during a deadly outbreak precludes long distance transmission of the disease by muskox and would tend to limit it to pockets where entire groups succumb. This is consistent with our findings. Dead animals were from a wide range in sex and age classes. Where only one animal was found in a drainage it was generally a lone adult male.

The lack of bacteria in the water sample is not surprising because the water was not stagnant; it was freely flowing. The fact that all carcasses were found in the vicinity of the water courses may indicate that deadly yersiniosis outbreaks have water borne transmission or that the infection is readily transmissible between animals as they congregate to drink.

Deadly outbreaks of yersiniosis appear to act in a density independent fashion. All animals that happen to be in the wrong place when a certain set of conditions to unleash a deadly yersiniosis infection occur, are likely to perish. Currently we can only speculate on what those conditions might be. Yersiniosis was likely responsible for some mortality between 1994 and 1998 when the population decreased, but from 1985 to 1994 the muskox population increased at *ca.* 10% per year. The "large" outbreak documented by Blake *et al.* (1991) represented <1% mortality in the Thomsen area and the outbreak in 1996 represented <0.01% mortality islandwide. Deadly yersiniosis outbreaks do not appear to have had a major effect on the population dynamics of Banks Island muskox. What effects the exposure to non-lethal infections of yersiniosis has on the muskox population is unknown.

RECOMMENDATIONS

1) Actively investigate alternate methods for diagnosing or determining the presence of *Yersinia* spp. in biological samples because of the difficulty of culturing *Yersinia* spp., even from tissue samples from known infected animals.

2) Continue to determine the levels of exposure to non-lethal infections of yersiniosis in Banks Island muskox by collecting samples from animals of different sex and age classes at commercial muskox harvests.

3) Continue to monitor for muskox carcasses during aerial population surveys of Banks Island and any aerial reconnaissance associated with field research on Banks Island.

4) Continue to encourage other government and private agencies to report any occurrence of muskox carcasses they find during the course of their operations on Banks Island.

5) Continue to investigate and collect biological samples whenever group mortalities are reported.

ACKNOWLEDGEMENTS

Funding for this work was provided by the Inuvialuit Final Agreement. We thank Brad Wood and John Lucas Sr. for alerting us to the muskox mortalities in the Kange River and Deep Creek areas, respectively. Dwayne Semple and Miles Dillon are thanked for their assistance in collecting biological samples. Parks Canada loaned fuel to complete the aerial survey as expediently as possible due to rapidly deteriorating weather conditions. Brett Elkin made comments on earlier drafts of this manuscript. N. Mair of the Remote Sensing Centre is thanked for assistance with the figures.

PERSONAL COMMUNICATIONS

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Table 1. Summary of the 12 muskox carcasses sampled, and their locations. Sex and age class, evidence of thrashing (head and/or legs), presence of mesenteric fat supplies, presence of blood tinged abdominal fluid, and evidence of bleeding from their nose.

	Parker River								Camp 1	Deep Cr/Ski Lake		
	1	2	3	4	5	6	7	8	9	10	11	12
Sex (M/F)	M	M	F	M	n/a	F	M	F	M	M	F	F
Age (Years)	≥ 4	≥ 5	2	3	1	2	≥ 5	2	≥ 5	≥ 5	2	2
Thrashing (Y/N)	Y	Y	N	Y	N	Y	Y	Y	N	Y	N	N
Mesenteric Fat (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bloody Abdom. Fluid (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nasal Bleeding (Y/N)	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	N