Brief Communication

Are the Jameson Land muskoxen, Northeast Greenland, in decline?

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Abstract: The Jameson Land region contains the largest muskox population in Northeast Greenland. In the period 1980-1990, late winter population size averaged 3,645. A late winter 2000 survey estimated ca. 1,705 muskoxen. Although no further late winter surveys for muskox abundance have occurred since, there have been two summer bird surveys, which recorded incidental observations of muskoxen, i.e., 607 in 2008 and 610 in 2009. We report on muskox observations obtained in a subarea of Jameson Land during the summer 2016 ground survey for birds. Although in the 1982-2000 period this subarea averaged 1,153 ± 346 muskoxen, we observed 138 individuals and a low calf number. The few muskoxen observed and poor calf production suggest population decline. We briefly discuss possible factors that could influence muskox mortality and population abundance. Surveys specific to muskoxen are necessary to ascertain current population abundance, demographics and trend.

Key words: abundance; decline; demographics; muskox; *Ovibos*; recruitment; survey.

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Introduction

Muskoxen (*Ovibos moschatus*) are endemic to the Northwest Territories and Nunavut in Canada, and to northern and north-eastern Greenland (Gunn & Forchhammer, 2008). After extirpation from large parts of its former range during the 19th and 20th centuries, the species has spontaneously recovered part of its range in the circumpolar region (Gunn & Forchhammer, 2008). In addition, translocations or re-introductions have been successfully conducted in Alaska, West Greenland, Norway and Russia. Jameson Land, in north-eastern Greenland, is a stronghold for muskoxen (Boertmann *et al.,* 1992). In the period 1982 to 1990, in late winter, muskoxen were monitored annually in Jameson Land by unsystematic aerial counts. Numbers averaged 3,645 ± 617 muskoxen, with a maximum of 4,679 and a minimum of 2,871 (Aastrup & Mosbech, 2000). A decade later, in 2000 a further late winter aerial survey ascertained 1,705 muskoxen in Jameson Land (Ingerslev, 2000). Thereafter, no further late winter surveys occurred. However, there have been two summer bird surveys covering a large part of the Jameson Land (Figure 1). These recorded incidental observations of muskoxen, i.e., 607 in 2008 and 610 in 2009 (Glahder *et al.,* 2010; Boertmann & Nielsen, 2010). Albeit these were surveys for birds and not muskoxen, and that they were summer rather than late winter surveys, the low numbers of muskoxen observed suggests declining abundance. Nevertheless, current status of the Jameson Land muskox population is unknown.

In July 2016, we conducted a ground survey for birds in a subarea of Jameson Land known to contain a third of the total Jameson Land muskox population in the 1980-1990 period (Aastrup & Mosbech, 2000). Our observations of muskox numbers and calf production are discussed in light of the earlier suggestion of muskox population decline on Jameson Land.

Material and methods

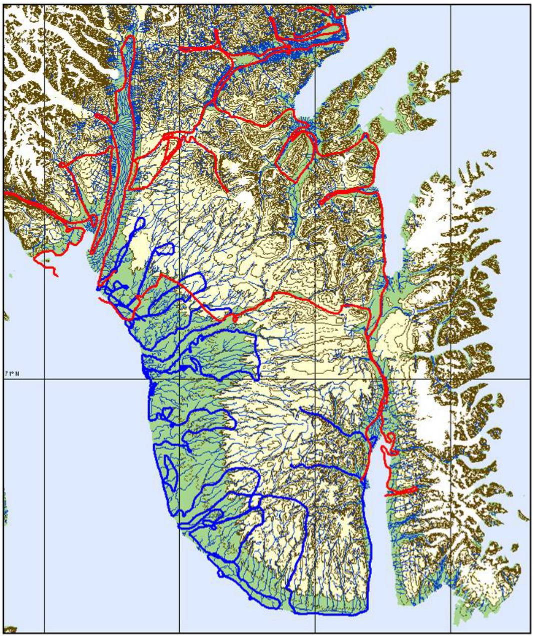
The Jameson Land is a vast peninsula of about 10,000 km², extending from 70°30'to 72°00'N (Figure 1). It lies on the junction of the low and high arctic zones (Bay, 1997). The Jameson Land has been described in detail by Aastrup & Mosbech (2000). Most of the peninsula is a relatively flat plateau with maximum elevations of 500-600 m. Yearly mean temperatures are -6°C to -10°C, with a mean annual precipitation of 400 mm/year (Aastrup & Mosbech, 2000). The vegetation is characterised by moist dwarf scrub heath, which is excellent forage for muskoxen. Most of the plateau is even or moderately sloped, though intersected by numerous rivers. Valleys are wide, relatively straight and levelled, providing an opportunity to detect large animals from a great distance.

We conducted a ground survey to investigate bird flu among geese in the period 21 July to 4 August 2016. We walked through the following subareas of Jameson Land (Figure 1): Gurreholm plain, lower Schuchert Dal valley, Ranunkel Dal valley, Colorado Dal valley, and the upper Ørsted Dal valley (Gaidet *et al.,*2018). We walked approximately 230 km. From vantage points of higher elevation (hilltops or hillsides), we observed muskoxen by using binoculars (10x) and telescopes (20-60x). We also observed muskox carcasses, i.e., those with flesh and hair, and described their state of decomposition. During the entire survey period, dry weather prevailed and created optimal conditions for detecting wildlife. GPS tracking recorded our daily routes and animal locations, which we plotted on a map (1:100,000). We present our results in comparison to Aastrup & Mosbech (2000).

Sources of error

Since our ground survey took two weeks at walking speed, we recognize that there was the possibility of double counting muskoxen, which would overestimate the number of muskoxen observed. Underestimating muskox number could have occurred for two reasons. First, we were unable to differentiate one group from another and group size was uniform and small. Since we repeated walking routes, if new groups appeared in a similar location to a group of the same size from a previous day, we could not recognize them as a new group. Secondly, although the terrain was primarily open, terrain features could hide muskoxen from view.

Thanks to David Boertmann (Arctic Research Centre, Aarhus University, Denmark) we had access to all incidental muskox observations obtained during the 2008 and 2009 unsystematic aerial bird surveys of the Jameson Land region. We present these muskox locations and group sizes beside our 2016 results in figure 1 and use both for discussions in relation to the 1982-1990 muskox surveys by Aastrup & Mosbech (2000).



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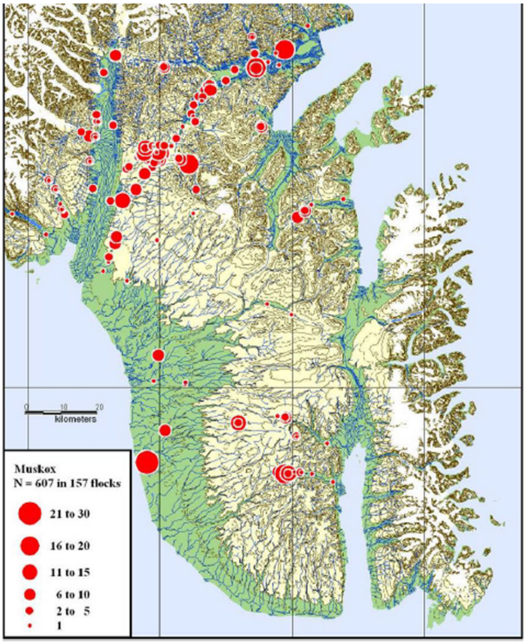

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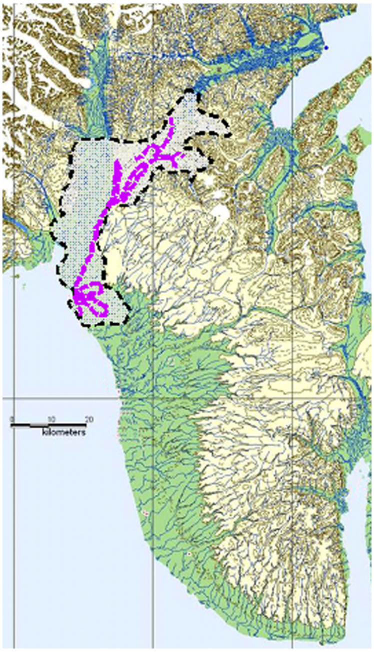

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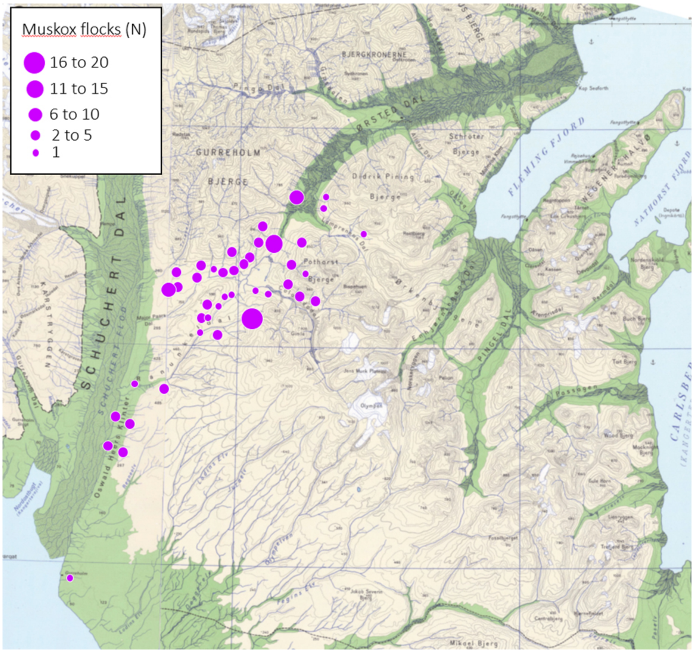

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Figure 1. Jameson Land region, illustrating routes flown (a) and observed muskox locations and group sizes (b) recorded during unsystematic aerial bird survey, July 2008 (from Glahder *et al.,* 2010). July 2016 walking routes and censused area (c) and observed muskox locations and group sizes (d).

Results

In July 2016, we recorded a total of 138 individuals, including eight calves. Hence, calves represented 5.8% of the total number of individuals recorded. Our detection range varied from less than 100m to ca. 3km. We observed 80 muskoxen in the Colorado Dal valley, 17 in lower Schuchert Dal valley, 16 in upper Schuchert Dal valley, 12 in Ranunkel Dal valley and 12 in upper Orsted Dal valley (Figure 1). We sighted one individual only in the Gurreholm area; however, there were tracks, wool and old skulls.

Most individuals were observed in small groups, with more than 70% of the sightings consisting of 1 to 3 individuals (Figure 2). Calves were sighted in only 4 groups. The median group size was 2 individuals.

We also observed 12 muskox carcasses: 3 in the lower Schuchert Dal valley, 8 in Colorado Dal valley, and 1 in upper Orsted Dal valley. All were adults. In contrast to live animals, we could detect carcasses at distances of only 100-200m from our path. All were isolated occurrences and evidenced scavenging (Figure 3). We did not observe wolves (*Canis lupus*) or wolf tracks, but we found scats that appeared wolf-like at two separate sites.

Discussion

Historically, Jameson Land contained the majority of muskoxen in northeastern Greenland (Boertmann *et al.,* 1992; Boertmann & Nielsen, 2010). Available data suggest that the Jameson Land population fluctuated within rather stable limits through the last century. Although 'guesstimates', the population may have been 3,000 animals in the early 1930s, 4,500 (including some adjacent areas) in 1945, and 5,000 in 1969-1970 (Aastrup & Mosbech, 2000). Meanwhile, for the period 1982-1990, late winter aerial surveys for muskox abun-

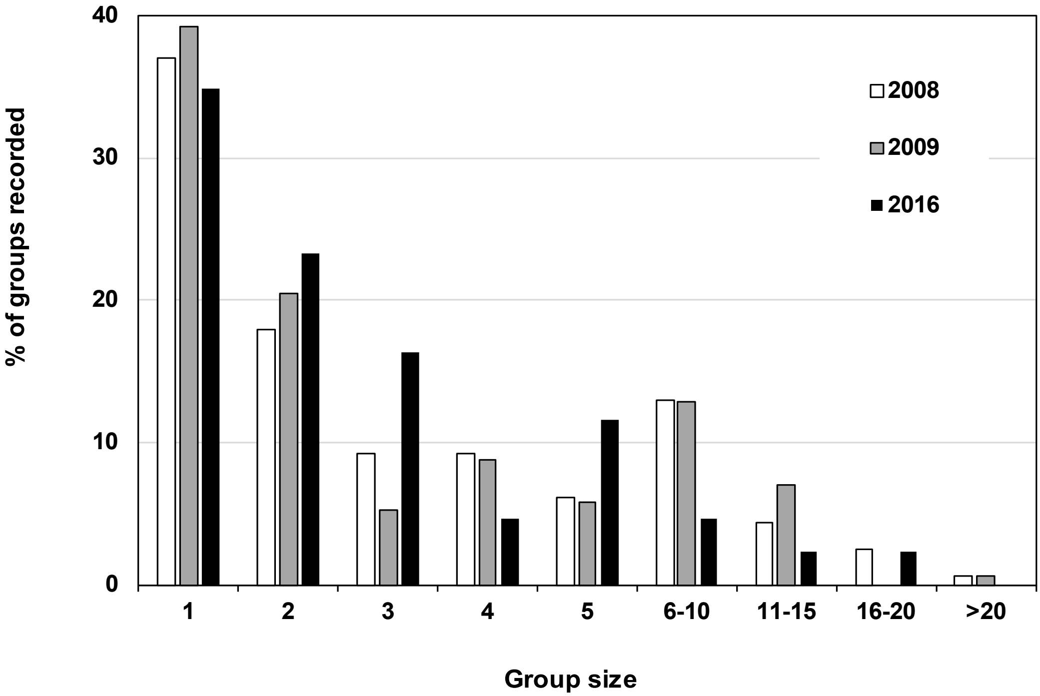

Figure 2. Summer group sizes of muskoxen in Jameson Land reported during the bird surveys of 2008 and 2009 (from Glahder *et al.,* 2010) and our ground count in 2016.

dance in Jameson Land estimated an average 3,645 (± 617 SD) muskoxen (Aastrup & Mosbech, 2000). A similar aerial survey in 2000 estimated 1,705 muskoxen (Ingerslev, 2000), which suggests decline. Alternately, it could just be the result of natural fluctuation, for which causes are typically poorly understood (Krebs, 2002). Nevertheless, summer bird surveys conducted in 2008 and 2009 observed relatively few muskoxen, albeit these surveys were unsystematic, covered only a portion of the region and were not designed to estimate muskox abundance.

Overall, the detection probability of our ground survey was high, given the configuration of the landscape (levelled and open terrain, low vegetation cover and detection distance >1km) and the regular use of vantage points. Survey procedure, however, may have introduced several biases impairing our count. First, despite high visibility we cannot exclude the possibility that terrain features may have hidden some individuals, leading to an underestimation. Second, because the duration of the survey (over two-weeks), and of the low travel speed, we cannot exclude the possibility of double counting, leading to an overestimation. Indeed, some individuals may have moved between valleys during the time of the survey, hence may have been counted twice on subsequent days. Conversely, some individuals may not have been counted because they were found in a similar location and of similar group size to a previous group at that location on a previous day, hence not recognized as a new group. Third, our survey covered only a small portion of the entire Jameson Land region. We cannot exclude the possibility that muskoxen may have shifted their range in 2016. Regardless, we observed only 138 muskoxen, which reflects few animals in the areas surveyed.

Studies since 2000 suggest a decline in the muskox population of Jameson Land during the 2000-2010 decade (Ingerslev, 2000; Glahder *et al.,* 2010; Boertmann & Nielsen, 2010). The few muskoxen and the low number of large groups (>5 individuals) recorded during our ground survey support this suggestion. Earlier studies indicated that the Colorado Dal area hosts, at least during summer, the core population of Jameson Land (Hansen et al. 2012). Further, our total of 108 individuals that we recorded in the Colorado Dal strata (wich covers the valleys Colorado Dal, Ranunkel Dal, and Upper Schuchert Dal; see Aastrup & Mosbech, 2000) is markedly lower than the 241 and 266 individuals observed in 2008 and 2009, respectively (Aastrup & Boertmann, 2009; Glahder *et al.,* 2010). Regarding group size, this is known to vary across seasons, being larger in winter and early spring (about 1.7 times larger) than in summer (Heard, 1992). This may have influenced the relatively small average group size we observed in summer 2016. Our median group of two muskoxen was similar to that reported in the 2008 and 2009 aerial counts. However, we had a lower proportion of large groups (>5 individuals, Fig. 2). Causes may include that the 2008-2009 aerial surveys' bird observers were better able to detect large groups of muskoxen as opposed to small groups.

Our 2016 calf percentage (5.8%, calf age < 5-months) is a low recruitment. Freeman (1970) indicates that a percentage of 10.5% late-winter calves (i.e. age almost 1-year) is required to balance natural mortality in muskox populations. Our summer calf percentage was already below this threshold, and the calves have yet to survive to late winter. It was markedly lower than the late-winter average of 18.4% (min. 14.0%, max. 27.9%) recorded in Jameson Land during the 1982-1990 period (Aastrup & Mosbech, 2000), the 23.9% recorded in West Greenland (Olesen, 1993), the 22.3% in Labrador (Chubbs & Brazil, 2007)), and the 16%-22% in Ellesmere Island (Anderson & Kingsley, 2017). Although calf percentages for 2000-2015 period are unknown, the low 2016

Figure 3. Pictures of carcasses found in July 2016 in the lower Schuchert Dal valley (top) and the Colorado Dal valley (bottom). Photos: T. Daufresne.

calf percentage if sustained over several years would cause population decline. Further, our low calf productivity indicates possible fecundity or nutritional problems.

We recorded 12 relatively "fresh" carcasses (still covered with dry flesh and hair but no soft tissues, Figure 3) in 2016. More carcasses were likely present. Given the lower detectability of carcasses compared to live animals, combined with our inability to ascertain the year of death, a quantitative evaluation of an annual mortality rate from our carcass count is inappropriate. Nevertheless, in light of the 12 adult carcasses observed in 2016, this suggests that increased mortality may also be influencing the low calf production that year. The observed low reproductive success and possibly high mortality among adults could be the result of several adverse factors including climatic conditions restricting resource availability (Forchhammer & Boertmann, 1993; Gunn & Forchhammer, 2008), overhunting (Lent, 1999; Bennike & Andreasen, 2005), increased predation pressure (Marquard-Pedersen, 1998), infectious diseases (Blake *et al.,* 1991; Kutz *et al.,* 2004; Kutz *et al.,* 2015), and perhaps disturbance from mineral exploration activities (Aastrup & Mosbech, 2000).

In the past, winter forage availability for muskoxen in Northeast Greenland was good because ice drift off the coast prevented deep snow or ice crust formation (Forchhammer & Boertmann, 1993). Currently in Northeast Greenland, climate change will cause warmer wetter winters, i.e., increased precipitation and extreme weather events, that are expected to negatively affect muskox populations by restricting forage availability through more frequent icing and deeper snow (Gunn & Forchhammer, 2008). Understanding the role of abiotic factors on muskox populations will require further studies.

In 1958, muskox hunting in Jameson Land began with annual quotas allocated by the Government of Greenland (Sandell & Sandell, 1998; Linnell *et al.,* 2000). In the 1990s annual quotas were ca. 200 muskoxen, however, harvest reporting was absent (Boertmann *et al.,* 1992; Linnell *et al.,* 2000).

Recent quotas have been ca. 80 animals (Hansen *et al.,* 2012), which is 4.7% of the population size (1705 individuals) estimated by the aerial survey of muskoxen in 2000 (Ingerslev, 2000), but may represent a much higher percentage of the present population size. If 80 animals reflect the actual harvest, it may contribute to the population decline.

Although muskoxen dominate the diet of Arctic wolves in north and north-eastern Greenland (Marquard-Petersen, 1998), few are present in Jameson Land (Hansen *et al.,* 2012), and we found no evidence of wolf presence. If wolves are present in Jameson Land, their low numbers and infrequent visits likely do not negatively influence muskox abundance (Aastrup, 2003).

Muskoxen are susceptible to a range of infectious pathogens (Afema *et al.,* 2017) and several are implicated in muskox population change (Kutz *et al.,* 2004; Handeland *et al.,* 2014; Kutz *et al.,* 2015). We found 12 adult carcasses during our short survey. Yet, without investigation on pathology, we cannot conclude on the respective role of nutritional limitation or disease on mortality.

In conclusion, we acknowledge our summer 2016 ground count of muskoxen had limitations. However, the low number of individuals recorded, combined with the low calf percentage and number of adult carcasses, suggest that 2016 was not a good year for the Jameson Land muskox population and that the population may be declining. Ascertaining the current status for the Jameson Land muskox population requires further investigations, including assessment of abundance, health and demography, as well as collaboration with hunters in the Ittoqqortoormiit community. The latter would provide valuable local knowledge on recent trends in muskox abundance and distribution and could highlight general condition of harvested muskoxen. If assessments and local knowledge confirm a decline in the Jameson Land muskox population, this could require harvest management change and actions appropriate to facilitating long-term sustainable use of this muskox population as a secure food source for the Ittoqqortoormiit community.

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