

Kitikmeot Traditional Knowledge Studies on Dolphin and Union Caribou, 2003 and 2018-2020

(*Rangifer tarandus groenlandicus* x *pearyi*, island tuktu)

Research update



Report prepared by Andrea Hanke (andrea.hanke1@ucalgary.ca) and Susan Kutz (skutz@ucalgary.ca), Department of Ecosystem and Public Health, Faculty of Veterinary Medicine, University of Calgary

In collaboration with Kugluktuk Angoniatit Association, Ekaluktutiak Hunter's and Trappers' Organization, Government of Nunavut, Department of Environment

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Roles of Researchers and Other Contributors:

2003 Ekaluktutiakmiut and Kugluktukmiut Traditional Knowledge Study on Dolphin and Union Caribou

Kugluktuk Angoniatit Association: Amanda Dumond and the board of directors reviewed project deliverables. Results were presented at the Kugluktuk Angoniatit Association's annual general meeting in January 2019.

Ekaluktutiak Hunters' and Trappers' Organization: Beverly Maksagak and the board of directors reviewed project deliverables. Results were presented at the Ekaluktutiak Hunters' and Trappers' Organization annual general meeting in January 2019.

Government of Nunavut: Monica Angohiatok was lead interviewer and project designer in 2003. Ida Kapakatoak was the interview assistant, translator, and transcriptionist in 2003. Lisa-Marie Leclerc and Ashley Newman supported the digitization of the participatory maps in 2018. Kate England, and Lisa-Marie Leclerc, and Caryn Smith reviewed project deliverables.

University of Calgary: Andrea Hanke led the interview analysis and reporting with input from all partners, including co-supervisors Susan Kutz and Cindy Adams, in 2018-2020.

2018-2020 Kugluktukmiut Traditional Knowledge Study on Dolphin and Union Caribou

Kugluktukmiut Knowledge Keepers: Individual interview contributors: Anonymous, Anonymous, Anonymous, Anonymous, Larry Adjun, Bobby Anavilok, Gerry Atatahak, Stanley Carpenter, Joe Allen Evyagotailak, Randy Hinanik, Eric Hitkolok, Roger Hitkolok, John Kapakatoak, Kevin Klengenberg, and Sheldon Klengenberg. Focus group contributors: Anonymous, Anonymous, Anonymous, Larry Adjun, Bobby Anavilok, OJ Bernhardt, Charlie Bolt, Stanley Carpenter, Joe Allen Evyagotailak, Eric Hitkolok, Roger Hitkolok, John Kapakatoak, Kevin Klengenberg, Sheldon Klengenberg, Wendy Klengenberg, and Tommy Noberg. Feedback session contributors: Anonymous, Anonymous, Anonymous, Bobby Anavilok, Gerry Atatahak, Ida Ayalik McWilliam, OJ Bernhardt, Charlie Bolt, Stanley Carpenter, Joe Allen Evyagotailak, Mike Hala, George Haniliak, Roger Hitkolok, Randy Hinanik, Dettrick Hokanak, Ida Kapakatoak, John Kapakatoak, Kevin Klengenberg, Perry Klengenberg, Sheldon Klengenberg, Wendy Klengenberg, Allen Kudlak, Billy McWilliam, Tommy Noberg, Agnes Panioyak.

Kugluktuk Angoniatit Association: Amanda Dumond and the board of directors co-directed the project design, identified Kugluktukmiut knowledge keepers, and took part in the interview analysis. Provided in-kind office space and technical expertise. Results were presented at the Kugluktuk Angoniatit Association's annual general meeting in January 2020. Amanda Dumond and the board of directors reviewed project deliverables.

Government of Nunavut: Lisa-Marie Leclerc provided input on the project design and took part in the interview analysis. Terry Milton contacted Kugluktukmiut knowledge keepers to schedule interviews and reviewed transcripts. Provided honoraria costs, in-kind office space, and technical expertise. Kate England, Lisa-Marie Leclerc, and Caryn Smith reviewed project deliverables.

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EXECUTIVE SUMMARY

Dolphin and Union (DU) caribou (*Rangifer tarandus groenlandicus x pearyi*, locally referred to as island tuktu) were recently assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada in 2017. The recorded DU caribou history includes a limited collection of Western knowledge and Traditional Knowledge studies. In this project, we thematically summarized Traditional knowledge on DU caribou from interviews in 2003 with Ekaluktutiakmiut (15) and Kugluktukmiut (15) and interviews in 2018-2020 with Kugluktukmiut (33). The information gained provides important insights on the history, abundance, distribution, and health of DU caribou.

Methods in brief: This report presents Kitikmeot Traditional knowledge of DU caribou documented in two separate projects. The Government of Nunavut, Department of Environment initiated the first project in 2003, and it involved structured, individual interviews and participatory mapping. The second project began in 2018 as a collaboration among the Kugluktuk Angoniatit Association, Government of Nunavut, and the University of Calgary. The 2018-2020 project involved semi-structured individual interviews, focus groups, feedback sessions, and participatory mapping, involving 56 points of contact with 33 Kugluktukmiut over 2 years. We analyzed the interview transcripts using a qualitative analytical method, thematic analysis, to find patterns within and across the interview accounts in each individual project. We digitized and analyzed the participatory maps within ArcMap (Esri) using built-in geoprocessing tools to illustrate and summarize the Traditional knowledge keepers' (TKK) mapped DU caribou ranges and hunting areas (DU caribou hunting areas in 2003; general and DU caribou hunting areas in 2018-2020). We used the term 'Kitikmeot Traditional knowledge' in accordance with the requests from Kugluktukmiut involved in the 2018-2020 study.

Context of Observations: TKKs explained that their observations of DU caribou distribution and abundance depended on their personal spatial areas of expertise and observation. A key theme from the interviews was that DU caribou and people used the land in accordance with annual and seasonal variations. They said that the lives of DU caribou are dynamic and that they are constantly adapting to the changing environment around them.

Distribution and Abundance: TKKs mapped the past and present distribution of DU caribou and their hunting ranges. Of the DU caribou range mapped in 2003, approximately 24% mapped by Kugluktukmiut fell outside of the current ECCC (2018) range map for this herd. The total hunting range area in 2003 had decreased to approximately 1/3 of the total historical hunting area for both communities. However, based on the 2018-2020 interviews, Kugluktukmiut hunting range had increased since the early 2000s.

TKKs described fluctuations in DU caribou abundance over time with very low numbers in the 1920s to 1950s. Recent declines in abundance appear to have occurred at different times in different communities. For Kugluktukmiut, the herd peaked in approximately the mid-to late 1980s and had since declined to approximately 40% of that abundance peak by 2020. The western boundary of the DU caribou distribution, historically extending far west of Kugluktuk on the mainland, progressively shifted eastward from Kugluktuk and towards Ekaluktutiak. This was coincident with an abundance decline in the west (confirmed in narratives and mapping). Today, Kugluktukmiut mapped similar total area for the herd's range per decade (1980-2010). While no new interviews were done in 2018-2020, previous participatory interviews in 2014 by Tomaselli et al. (2018) indicated that the herd peaked near Ekaluktutiak from 1990s to mid-2000s and had since declined to approximately 20% of this abundance peak by 2014.

In interviews from 2003 and 2018-20, TKKs indicated that DU caribou could be found on both the mainland and Victoria Island year-round. Further, the 2003 TKKs said that not all DU caribou would make the migration back to Victoria Island and more caribou were migrating off the island near 2003 than had previously. They said the timing and likelihood of migration was influenced by DU caribou abundance and the timing of sea-ice formation. Severely delayed sea-ice formation was observed to result in DU caribou crowding staging grounds, poorer body condition, and moving eastward while waiting for the sea-ice to form. TKKs described progressively riskier fall travel seasons for DU caribou. They described that unstable sea-ice formation resulted in more DU caribou falling through thin ice and drowning, becoming hypothermic, receiving injuries, and/or experiencing increased energy loss compared to previously.

Health and concerns: In 2003, TKKs described or named conditions consistent with brucellosis and tapeworm cysts in the muscles in DU caribou. However, Kugluktukmiut emphasized more concern about DU caribou health conditions than Ekaluktutiakmiut did in 2003. TKKs said sick DU caribou were more frequently observed during the spring when the caribou were the skinniest. Kugluktukmiut in 2018-2020 expressed concerns about the following impacts on DU caribou well-being and as possible causes of declines: poorer hunting practices of inexperienced harvesters (caribou herds and predators); increased non-renewable resource exploration and traffic; climate changes; increasingly unstable sea-ice, and increasing insect harassment (intensity and diversity). TKKs said that predator harvesting was not as common nor practiced the same today compared to the past. This has resulted in increased predator abundance. In the 2003 interviews, TKKs said the introduction of rifles in the 1920s resulted in more successful caribou hunts, but that more caribou mortalities had resulted from harmful sea-ice encounters and severe ground freezing that prevented access to vegetation.

Management Recommendations: Kugluktukmiut were asked in 2018-2020 what could be done to help protect DU caribou. They advocated for education opportunities for inexperienced harvesters as the most feasible, short-term action to mitigate pressure on the DU caribou herd for long-term outcomes. People suggested this could include pairing together inexperienced hunters who want to learn with experienced hunters who want to teach, and that this could be done through a coordinated effort between the Kugluktuk Angoniatit Association and the Government of Nunavut. TKKs did not agree whether the Kugluktuk Angoniatit Association or the Government of Nunavut should implement a restriction similar to a Total Allowable Harvest, but they emphasized that such a strategy would need to adapt alongside changes in the DU caribou abundance.

Conclusion: The Traditional knowledge interviews in 2003 and 2018-2020, together with those done by Tomaselli et al. (2018) in 2014, have provided critical insights into the abundance, distribution, and health trends of the DU caribou. TKKs' concerns for DU caribou were brought forward and they provided management recommendations. Key findings demonstrate that the cumulative historic DU caribou range is much broader than their current distribution, and that seasonal distribution and migration is perhaps more variable than previously documented. Considering the full and cumulative extent of the DU caribou range within current management plans is critical to manage landscape-use if a full recovery of the herd to historical numbers and range use is desired. The community-based knowledge on DU caribou distribution, abundance, and health was nuanced and complementary within and between Ekaluktutiakmiut and Kugluktukmiut accounts. Specifically, the different spatial and seasonal use of the land and interactions with the caribou by Ekaluktutiakmiut and Kugluktukmiut provided critical insights at different times in the life of DU caribou. This highlights the critical importance of involving multiple communities and TKKs from across the DU caribou range to understand the full life history of DU caribou, including seasonal and spatial variability, and to develop effective herd-level conservation approaches.

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OVERALL INTRODUCTION

This report presents information documented during two separate Traditional knowledge projects focused on Dolphin and Union (DU) caribou. The first project started in 2003 with Ekaluktutiakmiut and Kugluktukmiut, and the interviews were not analyzed fully until 2020. The second project was done in 2018-2020 with Kugluktukmiut. Research ethics boards at the University of Calgary (REB17-2427) and the Nunavut Research Institute (#04 003 19R-M) approved both projects in 2018. The teams involved in these projects come from diverse backgrounds, including experts in caribou health and social science methodologies and methods at the University of Calgary, Ekaluktutiak Hunters' and Trappers' Organization (EHTO), Kugluktuk Angoniatit Association (KAA), and the Government of Nunavut, Department of Environment (DOE). The results of these studies are presented below, starting with (1) the 2003 Ekaluktutiakmiut and Kugluktukmiut Traditional Knowledge Study on DU Caribou, followed by (2) the 2018-2020 Kugluktukmiut Traditional Knowledge Study on DU Caribou.

For context, the Traditional knowledge keepers (TKK) involved in these studies colloquially referred to DU caribou as island tuktu or as a crossbred caribou between Peary and barren-ground caribou. Harvesters consistently distinguished DU caribou from Peary and barren-ground caribou. In Ekaluktutiak, the accessible barren-ground caribou herds include the Bathurst and Beverly herds. In Kugluktuk, the accessible barren-ground caribou herds include the Bluenose East, Bathurst, and, some years, the Beverly herds. Although TKKs were specifically asked about DU caribou, it is possible that some TKKs' comments could, on occasion, refer to their experience with these other herds rather than DU caribou. DU caribou are traditionally harvested by Kugluktukmiut on the mainland in the fall and spring, on southwestern Victoria Island in late summer before the rut, and on the southern shoreline of Victoria Island when they start their fall migration. Ekaluktutiakmiut also harvest DU caribou on the southern shoreline of Victoria Island before they cross to the mainland and on the mainland during the spring.

2003 Ekaluktutiakmiut and Kugluktukmiut Traditional Knowledge Study on DU Caribou

BACKGROUND & METHODS

In 2003, the DOE initiated Traditional knowledge study on DU caribou because of concern about DU caribou drowning, unknown harvesting rates, and to document Traditional knowledge on DU caribou distribution and movement. The project involved structured, individual interviews with Ekaluktutiakmiut (15) and Kugluktukmiut (15). The interviews explored historical DU caribou abundance trends, spatial and temporal migration trends, and trends in body condition and abundance when the herd migrated and times when it did not migrate (see *Appendix A* for interview guide). There was an assistant present during each interview who, when needed, translated back and forth between Inuinnaqtun and English and completed the transcriptions from the audio-recordings. Each TKK created a participatory map comprising DU caribou seasonal locations (summer and winter), migration movements (spring and fall), and DU caribou hunting areas that they used in the past (before 2003, no exact years indicated) and present (2003). No monthly detail was recorded for the participatory maps. In 2017, analysis of these data started with a collaboration with the Kutz Research Group at the University of Calgary, Faculty of Veterinary Medicine, in 2017.

We base the following results on an analysis led by Andrea Hanke, PhD student, University of Calgary. We used a specific philosophical approach, an interpretivist paradigm and critical realism ontology, to help negotiate the differences between Traditional and Western knowledge (Maxwell and Mittapalli 2011). We digitized and analyzed the participatory maps using geoprocessing tools in ArcGIS (Esri software). Then, we incorporated these maps to the narrative analysis and compared the mapping summaries to the ECCC (2018) range map for DU caribou. We analyzed the interview transcripts by community (two separate analyses) using a qualitative analytical method, thematic analysis. This allowed us to use coding strategies to assign labels to the data in order to find patterns within and across the interview accounts (Braun and Clarke, 2006). We used two different coding strategies for the thematic analysis: a holistic strategy which focuses on clumping topics within the data and organizing sub-categories within those topics and an *in vivo* strategy that focuses on assigning labels to the data using the exact words of the TKKs (Saldaña, 2013). Following the coding, we used concept mapping to help visualize the interactions amongst the codes. We presented the initial results at the EHTO's and KAA's annual general meetings in January 2019 as a chance for the community to provide feedback on the analysis. After incorporating this feedback, we presented the results at the DU caribou user-to-users working group meeting in May 2019 and the EHTO's special meeting with Transport Canada that focused on ship icebreaking in October 2019. The results presented here will focus on population, health, distribution, and habitat of caribou as documented by the TKKs.

RESULTS

Thirty people, nine older than 55 and six younger than 54 from Ekaluktutiak and eight older than 55 and seven younger than 54 from Kugluktuk, were interviewed for this study. All 30 interviews were transcribed, and all 30 individual participatory maps were digitized.

Participatory Maps (*Fig. 1&2a,b&c*)

The participatory maps depicted DU caribou seasonal ranges, DU caribou migration routes, and TKK's DU caribou hunting ranges (*Fig. 1&2a,b&c*). Four hundred and eight polygons denoted summer (64) and winter (67) caribou ranges, past (pre-2003) (146) and "current" (2003) (131) DU caribou hunting ranges, and 524 polylines denoted fall (265) and spring (259) migration routes. The DU caribou range mapped by the TKKs represented approximately 52% of the total ECCC (2018). DU caribou range. Divided by community, Ekaluktutiakmiut covered approximately 37% and Kugluktukmiut covered approximately 32% of the total ECCC (2018) DU caribou range. In total, the mapped DU caribou ranges were approximately 81% inside and 19% outside of the ECCC (2018) DU caribou range (*Table 1*). Of their total DU caribou range mapped in 2003, approximately 4% mapped by Ekaluktutiakmiut and 24% mapped by Kugluktukmiut fell outside of the current ECCC (2018) range map for this herd.

Table 1. Comparison between TKKs' DU caribou range maps and ECCC (2018) management plan range.

DU Caribou Range by TKKs	Inside ECCC (2018) Range	Outside ECCC (2018) Range
Both Communities	81%	19%
Ekaluktutiakmiut (total)	96%	4%
Summer	95%	5%
Winter	100%	0%
Kugluktukmiut (total)	76%	24%
Summer	93%	7%
Winter	71%	29%

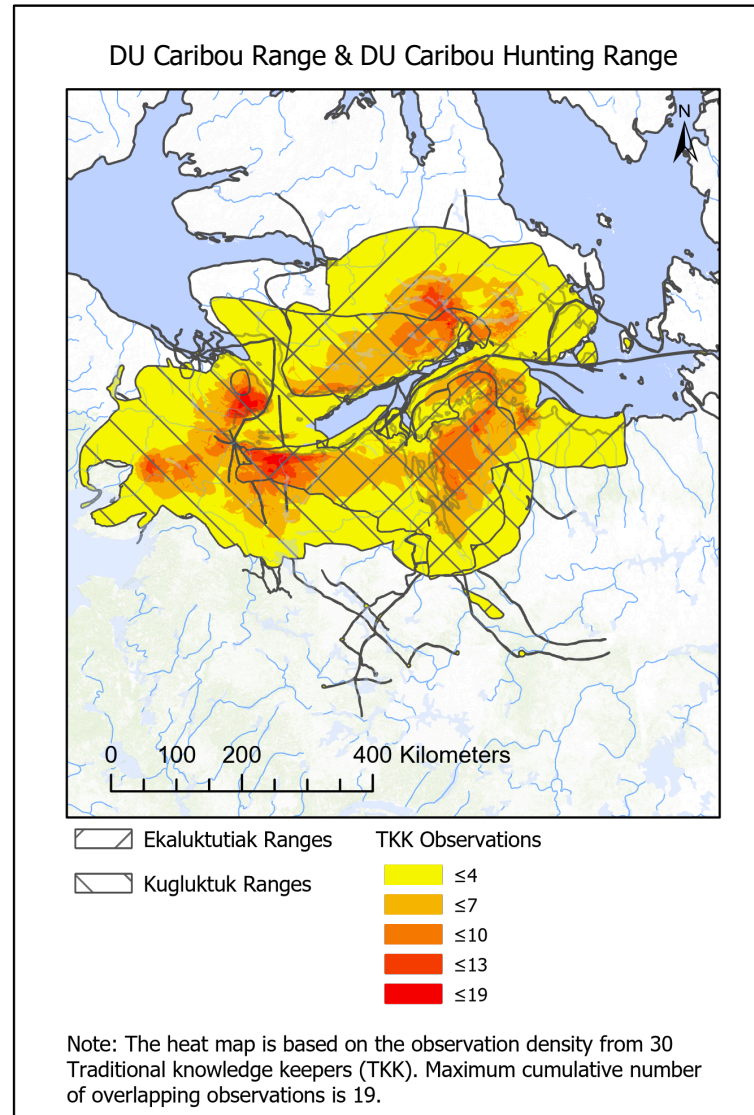
Changes in hunting areas

Kugluktukmiut mapped ranges extended further west and south than those delineated by Ekaluktutiakmiut. Ekaluktutiakmiut mapped ranges extended further east and north than those delineated by Kugluktukmiut (*Fig. 1*). For both communities, the area (km²) covered by "current" (2003) DU caribou hunting ranges declined to approximately 1/3 the area of those used in the past (pre-2003) (*Table 2; Fig. 3a&b*). There was no explanation why these changes occurred nor a defined a time period for the past hunting (pre-2003).

Table 2. DU caribou range and DU caribou hunting range summarized, as mapped by TKKs in 2003. The only values that consider overlapping areas is the community overlap column.

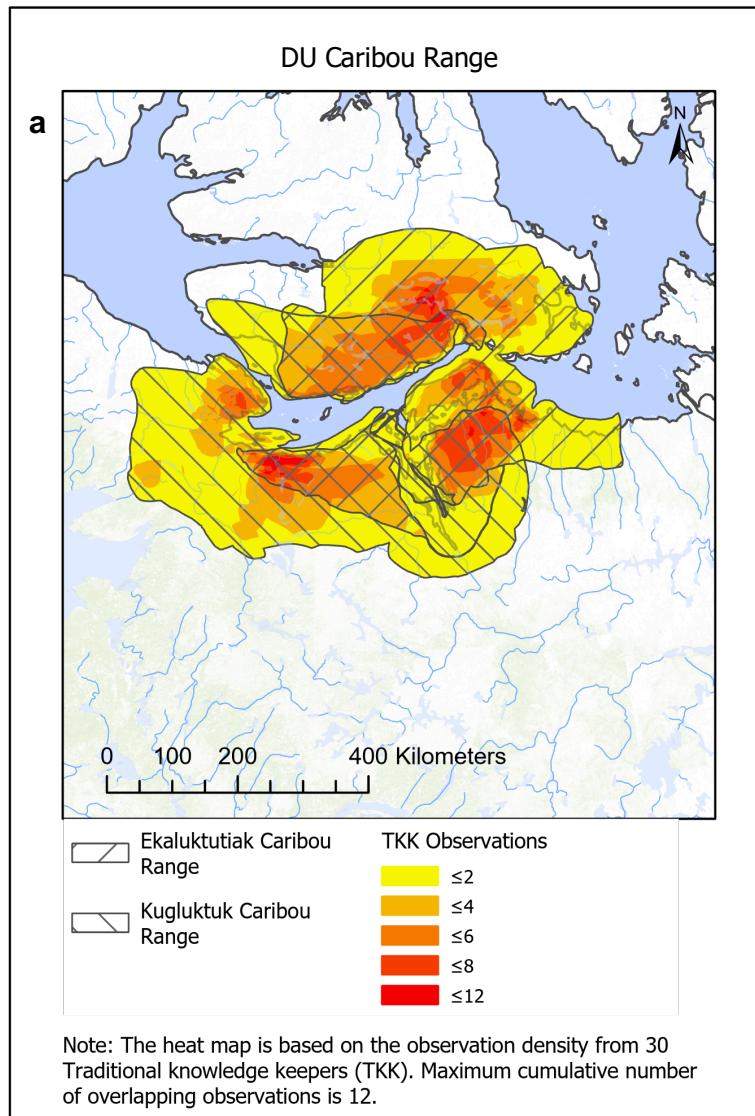
Range Type	Total Area	Ekaluktutiakmiut Area	Kugluktukmiut Area	Community Overlap
All Mapping	277 100 km ²	173 700 km ²	193 100 km ²	89 700 km ²
DU Caribou	248 200 km ²	149 100 km ²	164 200 km ²	65 000 km ²
(% of all mapping)	(90%)	(86%)	(85%)	(72%)
Summer	170 800 km ²	121 100 km ²	78 300 km ²	28 600 km ²
(% of total DU caribou)	(69%)	(81%)	(48%)	(44%)
Winter	189 900 km ²	98 600 km ²	138 900 km ²	47 700 km ²
(% of total DU caribou)	(76%)	(66%)	(85%)	(73%)
DU Caribou Hunting	165 300 km ²	80 200 km ²	107 100 km ²	22 000 km ²
(% of all mapping)	(60%)	(46%)	(55%)	(25%)
Past (pre-2003)	150 300 km ²	67 200 km ²	104 200 km ²	21 100 km ²
(% of total DU caribou hunting)	(91%)	(84%)	(97%)	(96%)
"Current" (2003)	58 100 km ²	26 200 km ²	32 400 km ²	400 km ²
(% of total DU caribou hunting)	(35%)	(33%)	(30%)	(2%)

Figure 1. Combined DU caribou range and DU caribou hunting range as reported by Ekaluktutiakmiut and Kugluktukmiut in 2003. Colour gradient is based on the density of observations.

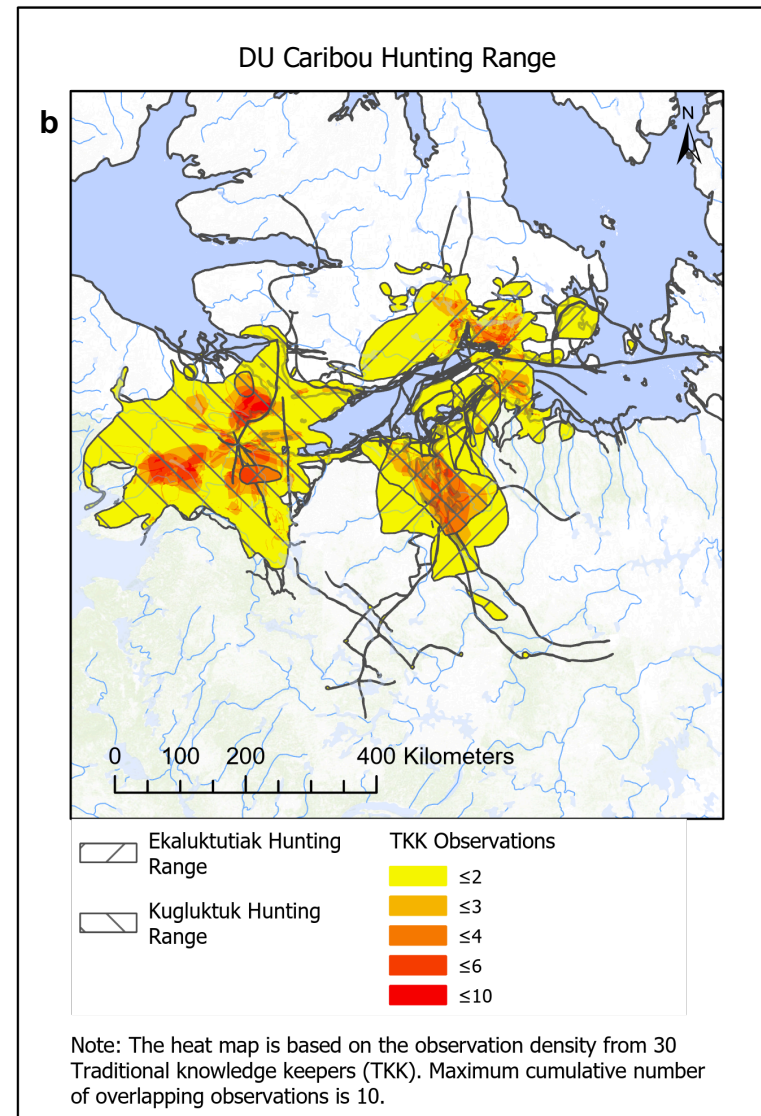


Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator

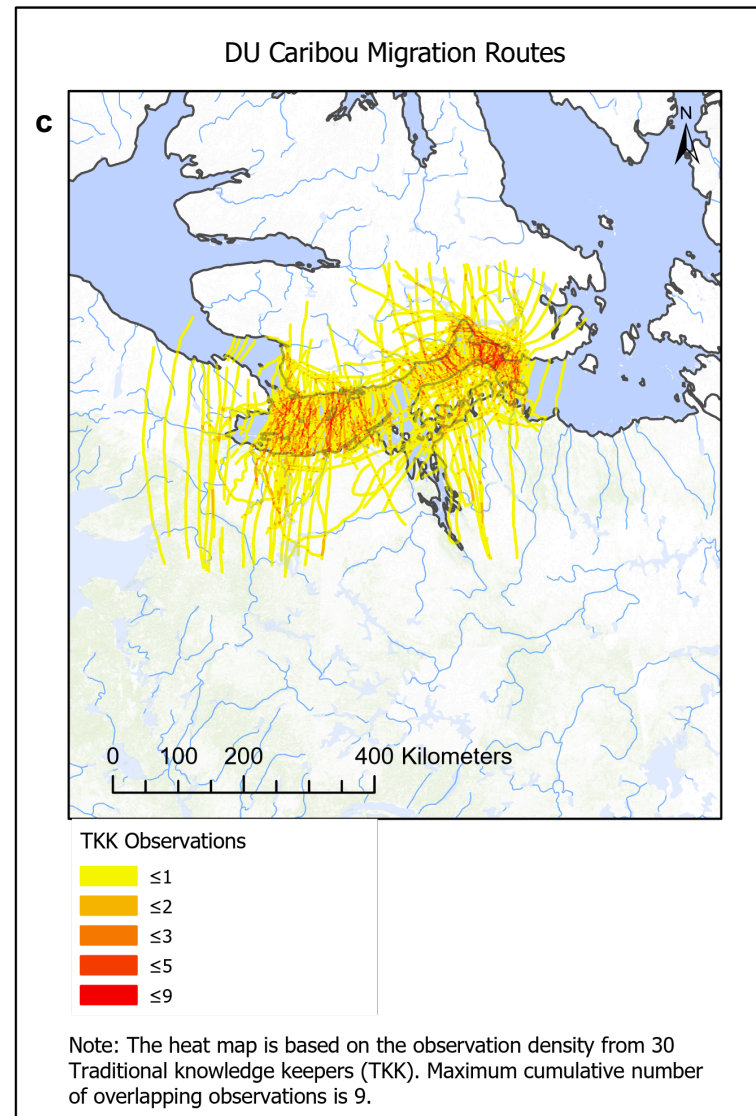
Figure 2. Summaries of DU caribou range (a), DU caribou hunting range (b), and DU caribou migration routes (c) as reported by Ekaluktutiakmiut and Kugluktukmiut in 2003. Colour gradient is based on the density of observations.



Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
 Coordinate System: NAD 1983 UTM Zone 12N
 Projection: Transverse Mercator

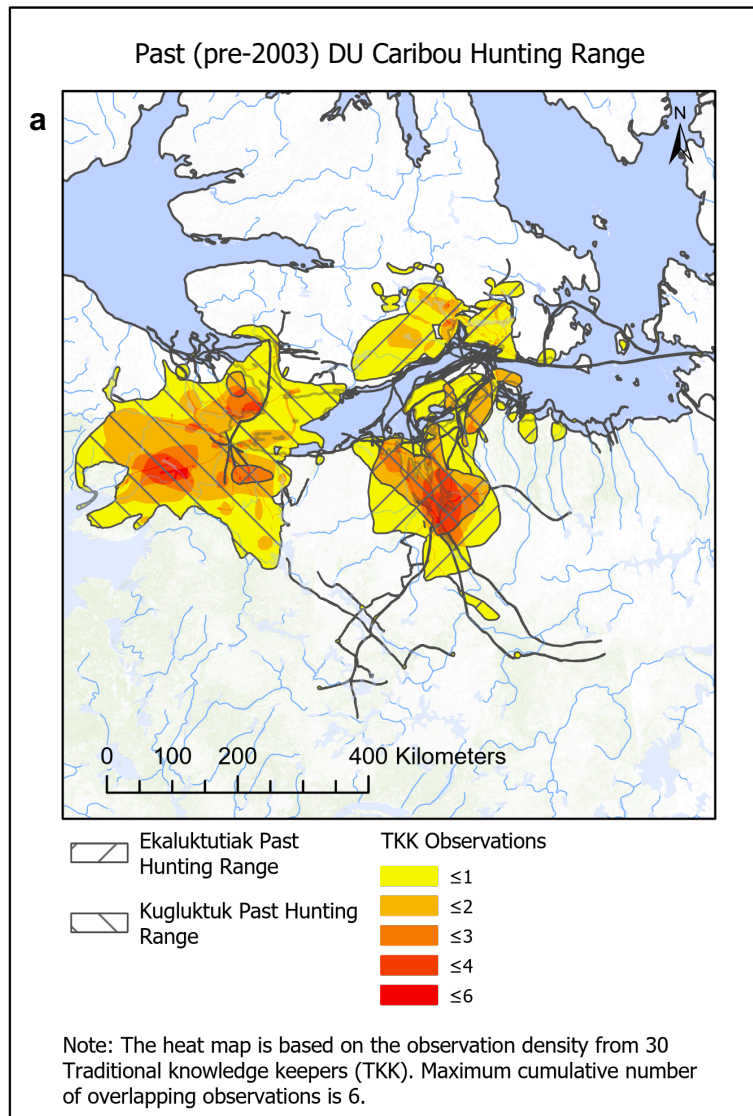


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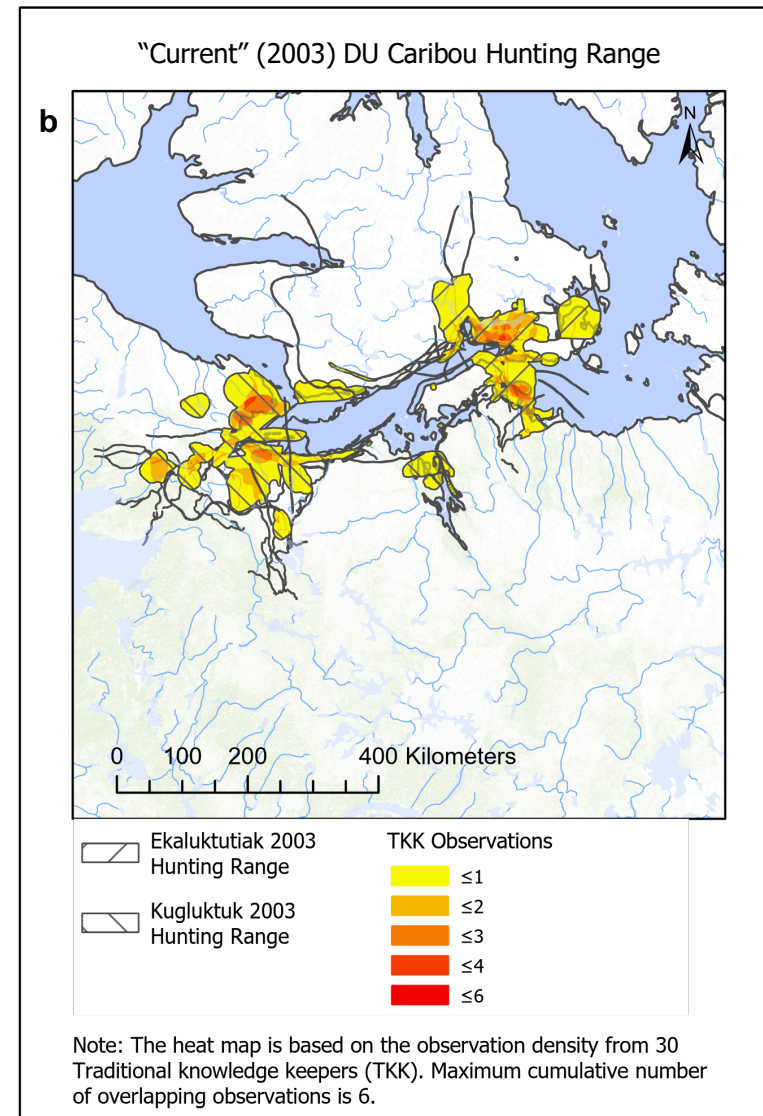


Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator

Figure 3. DU caribou hunting range in past (pre-2003) (a) and “current” (2003) (b) as reported by Ekaluktutiakmiut and Kugluktukmiut in 2003. Colour gradient is based on the density of observations.



Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
 Coordinate System: NAD 1983 UTM Zone 12N
 Projection: Transverse Mercator



Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
 Coordinate System: NAD 1983 UTM Zone 12N
 Projection: Transverse Mercator

DU Caribou Behaviour

Related to abundance (Fig. 4a,b)

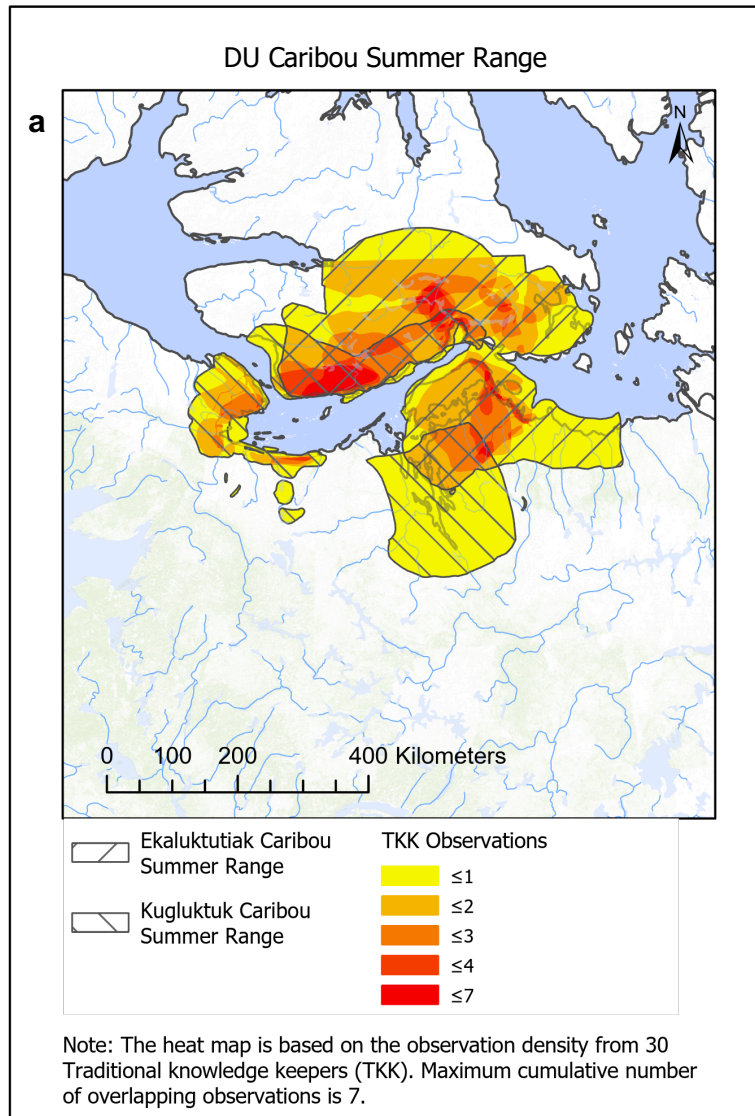
TKKs described variations in DU caribou behaviour that were expected and related to abundance. They said that when the number of caribou fell below the ‘migration threshold’, DU caribou did not migrate and remained on Victoria Island for the winter: “the herd never used to migrate to [the mainland] long ago. Long ago in Victoria Island there were hardly any caribou.” (Kugluktuk TTK 3). TKKs found that when the DU caribou abundance was increasing but not yet migrating, there were many DU caribou gathering on the southern shore of Victoria Island: “more than 20 years ago, there were many [non-migrating] caribou on the south side of Victoria Island” (Kugluktuk TTK 10). They said when the DU caribou abundance exceeds the ‘migration threshold’, the caribou migrated to the mainland for the winter. TKKs agreed that there normally would be some DU caribou that stay on Victoria Island throughout the winter regardless of abundance. They did not indicate the proportion of the herd that would remain on Victoria Island. This appeared to have recently changed near the time of the 2003 interviews, as TKKs described an abnormal change in migrating behaviour where DU caribou “seemed to migrate right onto the mainland, right off [Victoria] Island” (Kugluktuk TTK 6) and further south than observed previously. Further, some TKKs said that not all DU caribou return to Victoria Island; some speculated that DU caribou are migrating too far south to make the migration back across the sea-ice. TKKs said the DU caribou abundance also influences the duration of the migration. When there are fewer migrating caribou, the migration is completed quicker and vice versa.

Related to sea-ice conditions

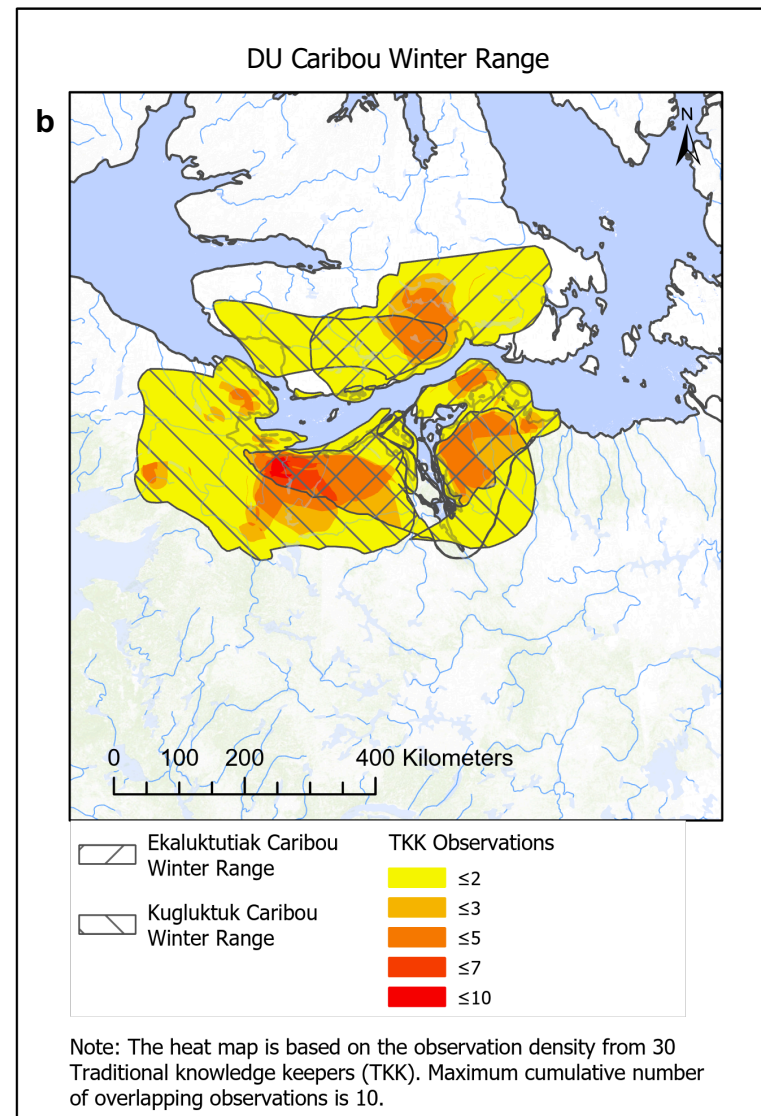
TKKs described changes in climate and weather that influenced the timing of seasonal changes and the presence of wind, snow, and sea-ice. They said that wind was more problematic, snow quantity was reduced, and sea-ice formation was later in 2003 than in the past. The accounts linked temperature and wind observations with sea-ice formation, such that hotter and windier conditions limited sea-ice formation by delaying appropriate freezing temperatures and breaking-up any pack sea-ice that had formed. TKKs reported snowmobile trails that had disappeared “in a couple of days from the wind. No more ice; the ice we just travelled on is all open water from the wind” (Ekaluktutiak TTK 3).

TKKs explained that these changes in climate and weather had delayed freeze-up of sea-ice and impacted DU caribou during migration by increasing the risk of mortality events. Some DU caribou would fall through the sea-ice; some of these caribou could get out of the water, but this caused “a lot of the energy loss from the body, [leaving] hardly any fur on them; the front legs totally no hair on them. Patches of ice on their back, all matted on backs, chunks of ice hanging. I’ve seen them die of hypothermia” (Kugluktuk TTK 6). DU caribou also drowned after falling through the sea-ice. TKKs said that delays in sea-ice formation also caused changes in DU caribou staging and migrating behaviour (*Fig. 5a&b*). They explained that when the sea-ice formed later in the year, the lack of sea-ice acted as a barrier to migration and this resulted in DU caribou crowding their southern Victoria Island staging range and moving further east in search of suitable ice to initiate migration. More so, TKKs said the longer DU caribou waited for the sea-ice to form, the more “the animals seemed to get leaner” (Kugluktuk TTK 6). As the delays continued, TKKs reported some DU caribou would abandon migrating behaviour: “some of the caribou didn’t migrate because they were looking for a place to cross. The ones that didn’t cross they just turned around and went back inland, stayed on the island” (Ekaluktutiak TTK 2).

Figure 4. DU caribou range in the summer (a) and winter (b) as reported by Ekaluktutiakmiut and Kugluktukmiut in 2003. Colour gradient is based on the density of observations.

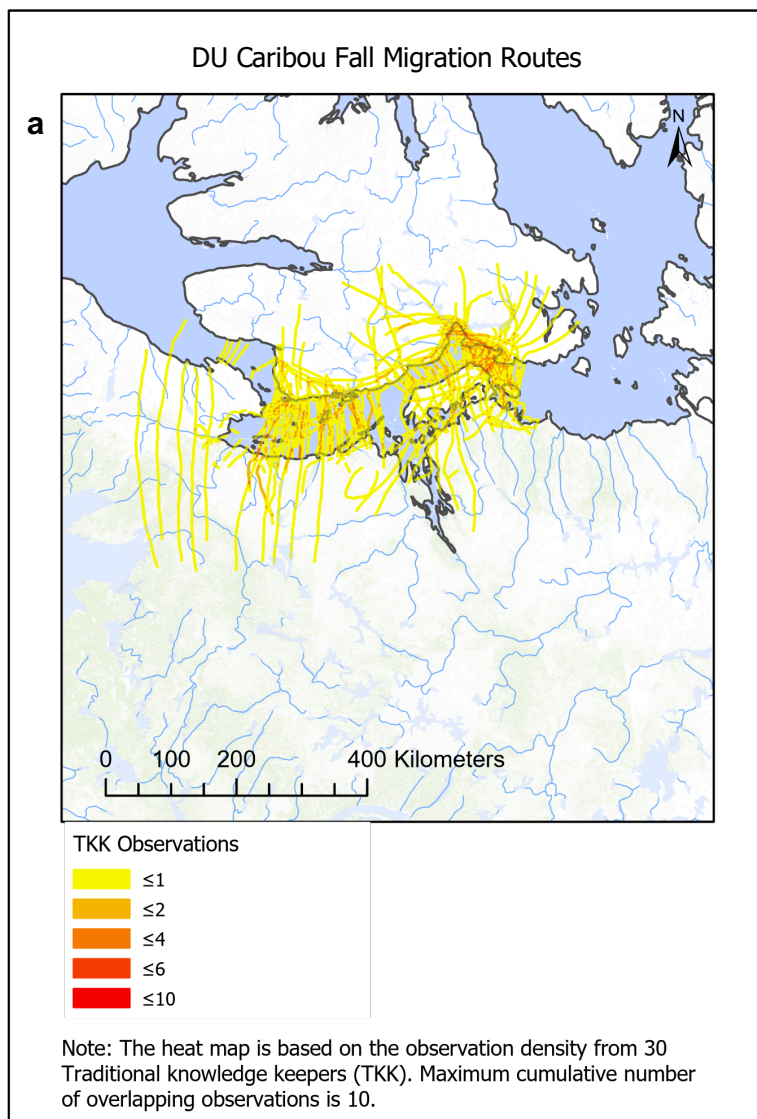


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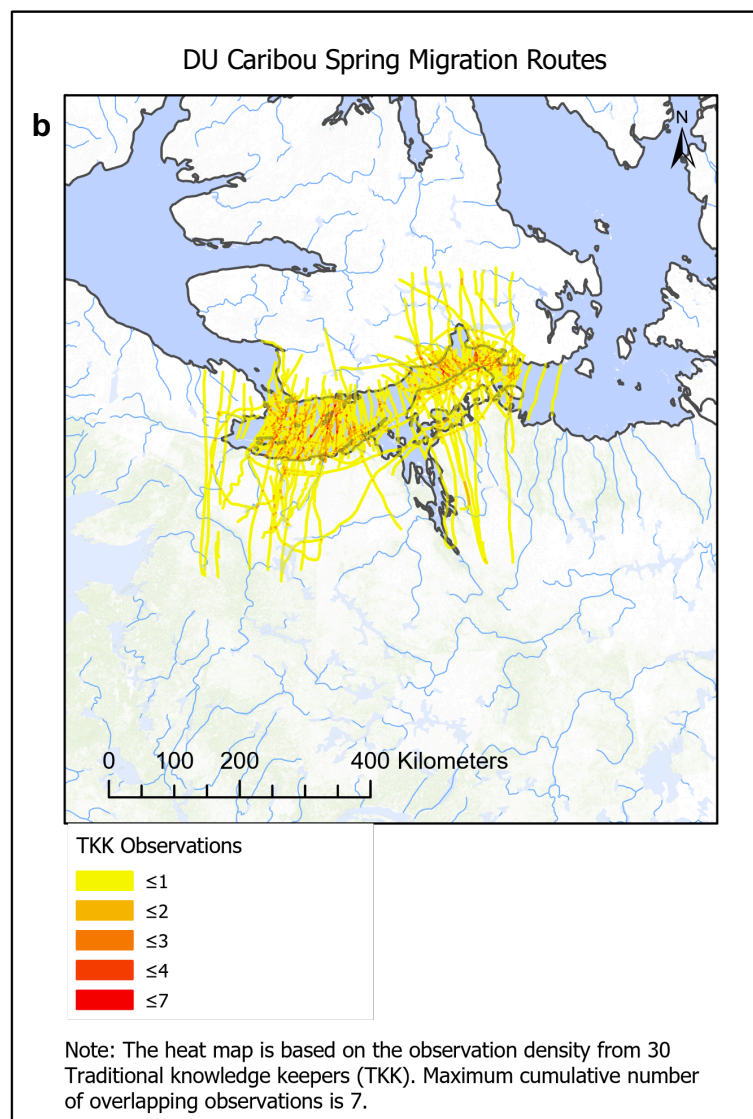


Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
 Coordinate System: NAD 1983 UTM Zone 12N
 Projection: Transverse Mercator

Figure 5. Migration routes for DU caribou in the fall (a) and spring (b) as reported by Ekaluktutiakmiut and Kugluktukmiut in 2003. Colour gradient is based on the density of observations.



Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
 Coordinate System: NAD 1983 UTM Zone 12N
 Projection: Transverse Mercator



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DU Caribou Health

Disease syndromes

TKKs described or named conditions consistent with brucellosis, such as “watery joints”, “joints really three times the leg size”, “swollen joints” and tapeworm cysts (likely caused by *Taenia* spp.), such as “small white round cysts”, “right in the meat, little cysts, look like pearls” (Kugluktuk TKK 6). They said that while some caribou were very healthy, these disease syndromes were more frequently observed during the spring when the caribou were the skinniest.

In addition, Kugluktukmiut described rashes and hairless legs, green meat, broken jaws, “funny bones”, lungs stuck to the chest cavity, “spleen and stomach stuck together”, and enlarged spleens. Ekaluktutiakmiut described “a few [sick caribou] over the years” (Ekaluktutiak TKK 1) with big stomachs, green meat/puss, irritated spleens, hoof problems, antlers stuck together, and sick caribou when calving. When contrasting Ekaluktutiakmiut and Kugluktukmiut observations, Kugluktukmiut emphasized more concern about DU caribou health conditions than Ekaluktutiakmiut.

Body condition

TKKs indicated that DU caribou body condition changed according to the seasons. They said caribou were “really fat” (Ekaluktutiak TKK 9) during the summer and fall, not bad during the winter, and skinny during the spring. The accounts associated migration and rut with having the greatest influence on body condition, with Ekaluktutiakmiut primarily reporting on the influence of rut and Kugluktukmiut primarily reporting on the influence of migration. During the summer and fall, TKKs said DU caribou recovered the accumulated nutritional debt incurred from these energetically costly life stages of the previous year.

TKKs explained that extreme temperatures (hot and cold), rough snow conditions, and rain during snow seasons could further reduce body condition. They said extreme heat during the summer resulted in skinny caribou, but they did not indicate the mechanisms that caused this to happen. TKKs also said hard winters, which could include extreme cold, deep and/or hard snow, and/or rain during snow seasons, resulted in skinny caribou. One TKK explained that “when the snow is [very] hard” (Ekaluktutiak TKK 10) it is difficult for caribou to access the vegetation during the winter. Similarly, they reported that rain during snow seasons created a layer of ice over the vegetation that blocked access to food. TKKs associated rain during snow seasons with massive declines in caribou, where “all the caribou died off from thick rain” (Kugluktuk TKK 15). People said that extreme rain-on-snow events starved caribou to death in the 1920s because they could not break through the ice to access the vegetation.

DU Caribou Abundance Trends

TKKs described a general abundance cycle for DU caribou, where there were times that they would “go for days and days and never see a single live animal” (Ekaluktutiak TKK 1) to times when there were so many they were “lining up outside the houses” (Kugluktuk TKK 7). From both communities, TKKs described a decline in caribou numbers from 1920 until the 1950s, after which the DU caribou became more abundant. Kugluktukmiut described many DU caribou

through 1970s and 1980s, where “there were lots of caribou right in town, migrating through” (Kugluktuk TKK 7). This trend shifted and by 2003 people noted that DU caribou were no longer found around the airport: “the caribou used to come behind the airport, now there is hardly any caribou” (Kugluktuk TKK 14). Conversely, Ekaluktutiakmiut described many DU caribou from the 1980s to 2003, “back to the way it used to be long ago today” (Ekaluktutiak TKK 10) and that “every year now, caribous come [...] right to town” (Ekaluktutiak TKK 3). *Figure 6* illustrates the details of the DU caribou abundance cycle.

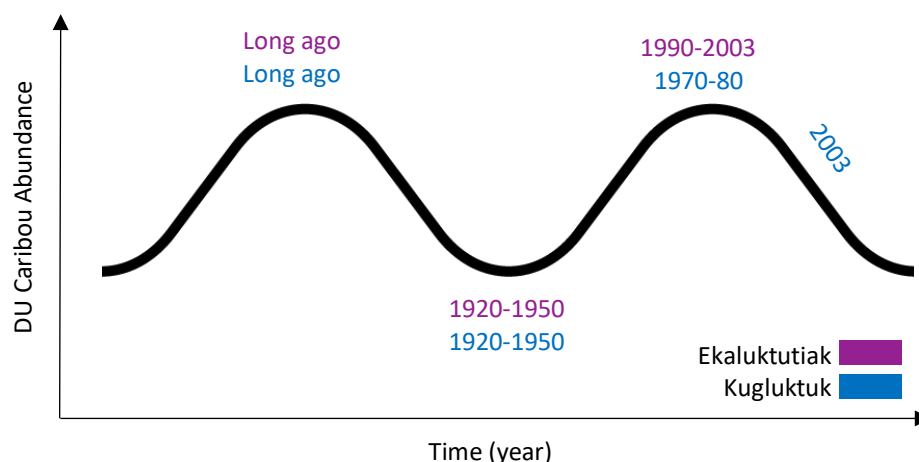


Figure 6. Trends in abundance of DU caribou as described in interviews from 2003. The purple (top) time-intervals represent observations from Ekaluktutiakmiut, and the blue (bottom time-intervals represent observations from Kugluktukmiut.

SUMMARY

The 2003 interviews with Ekaluktutiakmiut and Kugluktukmiut contained important similarities and differences within the Traditional knowledge. For both communities, the “current” (2003) hunting range area used by TKKs’ in 2003 had decreased when compared to the past (pre-2003) hunting ranges, yet no reason was given for this change. There are various reasons that could be implicated in the hunting range change, from changes in the range of the DU caribou herd to changes within the communities; drawing causality is beyond the scope of this research. However, the mapped DU caribou ranges and the narratives around DU caribou location and abundance suggest that the western boundary of the DU caribou distribution moved eastward approximately between 1980 to 2003. The hunting ranges would logically follow this range shift. TKKs from both communities also linked DU caribou range and migration, with migration happening only once an abundance threshold was reached. Both communities explained that even when migration occurred, some DU caribou were present on both Victoria Island and the mainland in all seasons. DU caribou were also reported on the mainland during the summer in Tomaselli et al. (2018).

In addition to distribution, differences in community observations are important to acknowledge for herd status. Ekaluktutiakmiut, described a stable abundance with healthy DU caribou close to the community in 2003 and emphasized rut when discussing body condition. Kugluktukmiut accounts described a declining abundance with sick DU caribou far from the community in 2003 and emphasized migration when discussing body condition. These observations in body condition by each community are consistent with the seasons the communities interact with DU caribou, and the further descriptions of

seasonal body condition are consistent with expected results from Western knowledge (Åhman and White, 2018) and other documented Traditional knowledge (Parlee et al., 2013). Altogether, these differing observations on the same herd that were documented in the same year highlight how Traditional knowledge is embedded in place. This is particularly critical to consider in a species like caribou that are migratory across a vast geographic range. It is important to consider Traditional knowledge from multiple communities throughout the range to develop a spatial and temporal herd-level understanding of DU caribou.

This analysis was based on archived Traditional knowledge: interviews from 2003. These historical data have provided important insights into DU caribou ecology, health, and variability over space and time. The Traditional knowledge accounts described changes in DU caribou health, abundance and annual and seasonal distribution. Considering the full seasonal and historical extent of the DU caribou range as described through these accounts is critical for managing landscape use that accommodates full recovery of the herd to historical numbers and range use.

2018-2020 Kugluktukmiut Traditional Knowledge Study on Dolphin and Union Caribou

BACKGROUND

We started this project in response to community concerns about the status of the DU caribou herd and the desire to increase Traditional knowledge representation and guidance in co-management discussions. The research built on an existing partnership among the KAA, DOE, and the University of Calgary. These partnerships were for hunter-based sampling and monitoring for muskoxen and DU caribou and a previous Traditional knowledge study in Ekaluktutiak that included documenting Traditional knowledge on the health, demographics, and trends of DU caribou (Tomaselli et al., 2018).

METHODS

We used three sets of interviews with Kugluktukmiut to understand the health and population status of the DU caribou. These included individual interviews, focus groups, and formally held and drop-in feedback sessions (Finlay and Ballinger, 2014; Tomaselli, 2018). Each part followed a semi-structured interview guide, was audio-recorded (excluding the drop-in feedback sessions) and was held at the KAA office (see *Appendix B* for interview guides). To ensure the involvement of DU caribou experts, we invited people to take part in the research based on recommendations by the KAA (purposive sampling) and recommendations given by the TKKs during the interviews (snowball sampling) (Finlay and Ballinger, 2014; Tomaselli, 2018). As each interview set evolved, new TKKs were added to the groups. After the formal feedback sessions, we presented the results at the KAA's annual general meeting in February 2020 as a chance for the community to provide feedback on the results and interpretation.

The individual interviews explored the meaning of DU caribou to TKKs, contemporary health and population status, spatial distribution, and concerns about the status of DU caribou and potential ways to address these concerns. We designed the focus groups to generate semi-quantitative data using participatory epidemiology activities such as proportional piling and mapping (Tomaselli et al., 2018). These activities generated data on population abundance, population demography, distribution, and occurrence of disease syndromes. We brought the analyses from the individual interviews and focus groups back to TKKs during the feedback sessions as a chance for everyone to ensure that interpretation of the interviews was accurate, clear up confusion, and add in missing details.

For the participatory mapping activities, we used paper maps that we generated in ArcGIS with guidance from the KAA. We photographed or scanned (depending on resources available), geo-referenced, and digitized the participatory data on the paper maps after the interviews. The individual interviews and focus groups both used a single map and colour codes to differentiate attributes (type of observation, year, season). Each feedback session used 11 different maps to document further spatial and temporal details: one for 'What parts of the land do you know really well?', and two sets of five for 'Where do people see DU caribou?', and 'Where do people hunt DU caribou?' that covered time-intervals from 1980 to 1989, 1990 to 1999, 2000 to 2009, 2010 to 2017, and 2018 to 2020 (i.e. 'today').

We completed proportional piling exercises for population trends as described in the following steps. First, the interview facilitator asked TKKs what year they saw the most DU caribou; this became the 100% mark and was represented by a two-cup pile of beans. Second, the interview facilitator asked TKKs to use the beans to represent proportionately how many DU caribou they saw in 2019 compared to the peak time (100%). Then, the interview facilitator measured that amount of beans with a two-cup liquid

measuring cup to create a percent ratio from peak caribou (100%) to the amount of caribou in 2019 (XX%). If the TKKs had information prior to the time of peak population (100%), it was added using the same steps. The interview facilitator and TKKs then drew a line that connected the data points on a paper chart. Once drawn, the interview facilitator measured, verified, and adjusted the percentage every five years according to the guidance of the TKKs. During the feedback sessions, the TKKs had the chance to amend or re-pile the abundance data.

We followed the same interview analysis employed in the 2003 project (described on pg. 3) to analyze the interview narratives on abundance trends, spatial trends, and TKKs' concerns for DU caribou. As such, we followed an interpretivist paradigm, critical realism ontology, and thematic analysis framework with holistic and in vivo coding to find patterns and themes in the interviews (Braun and Clarke, 2006; Maxwell and Mittapalli 2011; Saldaña, 2013). Although, in the 2018-2020 study, we did not compare between communities because this study was only done in Kugluktuk. In addition, we completed this analytical process after each interview set and then returned the preliminary results in the subsequent interview set. The analysis of DU caribou health and demography and still in progress. The results presented here will focus on DU caribou distribution, abundance, and TKKs' concerns and their solutions.

RESULTS

We interviewed nine Elders and six adults in September and October 2018, facilitated seven focus groups that engaged nine Elders and seven adults in January 2019, and held four formal feedback sessions with 11 Elders and seven adults along with a few rolling drop-in sessions to allow people with scheduling conflicts to participate in February 2020 (five Elders and two adults). Elder designation was based on self-identification by the TKK (as an Elder or adult) and confirmed by the KAA. In total, we had 56 points of contact over two years with 33 TKKs.

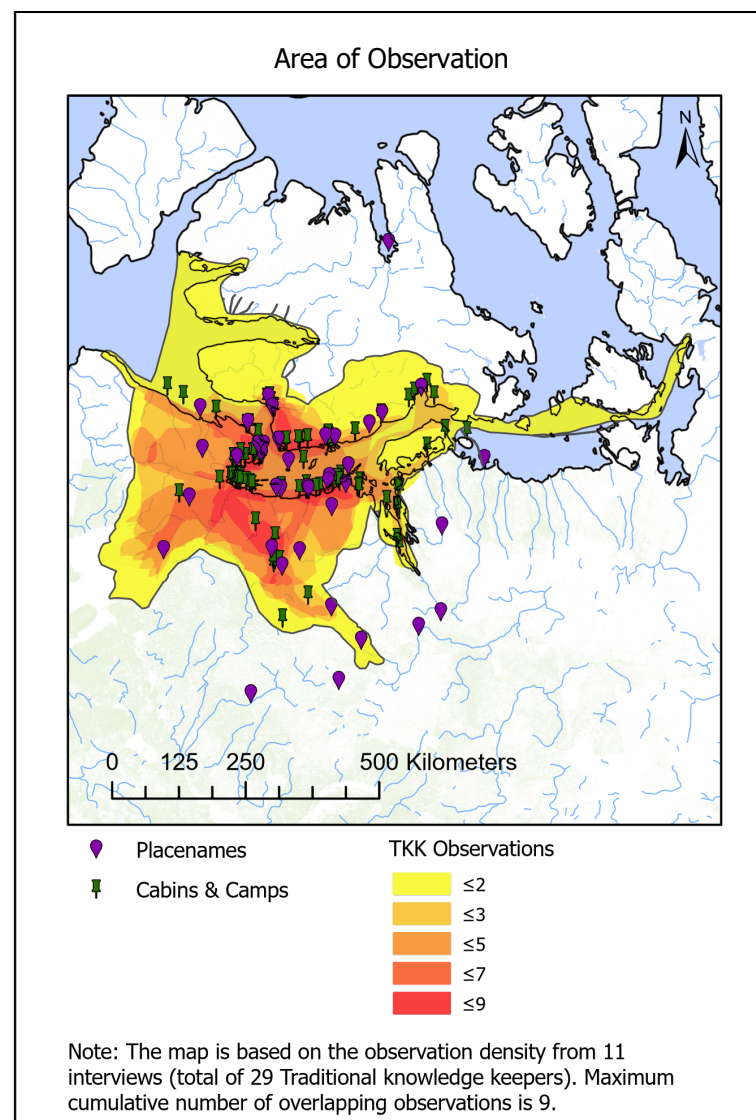
Variations in Experience

TKKs emphasized that how people and DU caribou experience the land is expected to vary by season and year. Harvesters travel on the land differently depending on the season (ATV, snowmobile, boat) and the year (weather conditions, etc.), and DU caribou also change depending on the season and the year. TKKs said they never expect to see DU caribou in the same locations every year. They said interpretation of DU caribou changes requires consideration of expected seasonal and annual variations.

Participatory Maps

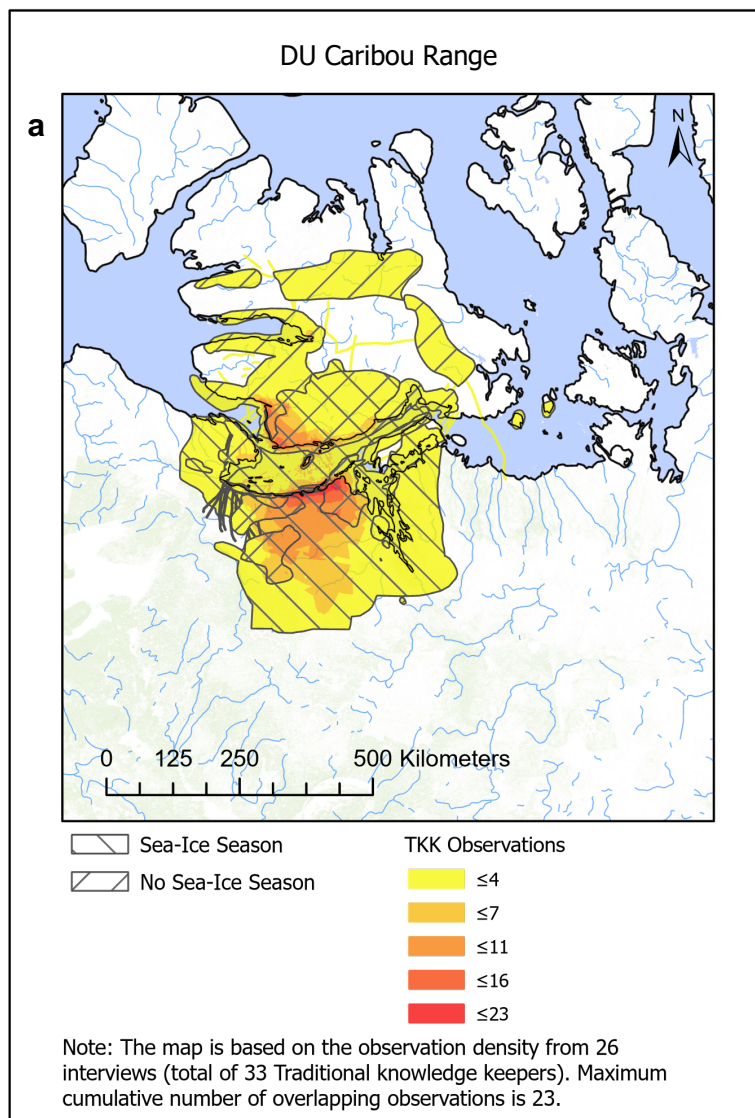
Altogether, the TKK's participatory maps covered 286 200 km² of land that they considered knowing well. This comprised of travel and general hunting areas (*Fig. 7*). They also mapped 240 400 km² as DU caribou range (*Fig. 8a*), 33% of which laid outside the land considered known well. TKKs mapped 138 700 km² of land they used to hunt DU caribou (*Fig. 8b*), 8% which lie outside the land considered known well. The summarized participatory mapping data suggest an increasing trend in DU caribou hunting range area since the early 2000s (*Table 3*). TKKs described a gradual change in DU caribou locations, where harvesters had to travel further east on the mainland and further inland (northeast) on Victoria Island to see and hunt DU caribou over the years. These changes are detailed through maps and interview narratives.

Figure 7. Area of observation as reported by Kugluktukmiut in 2018-2020. Includes Kugluktukmiut travel and general hunting ranges, camps/cabins, and placenames used throughout the interviews. Colour gradient is based on the density of observations.

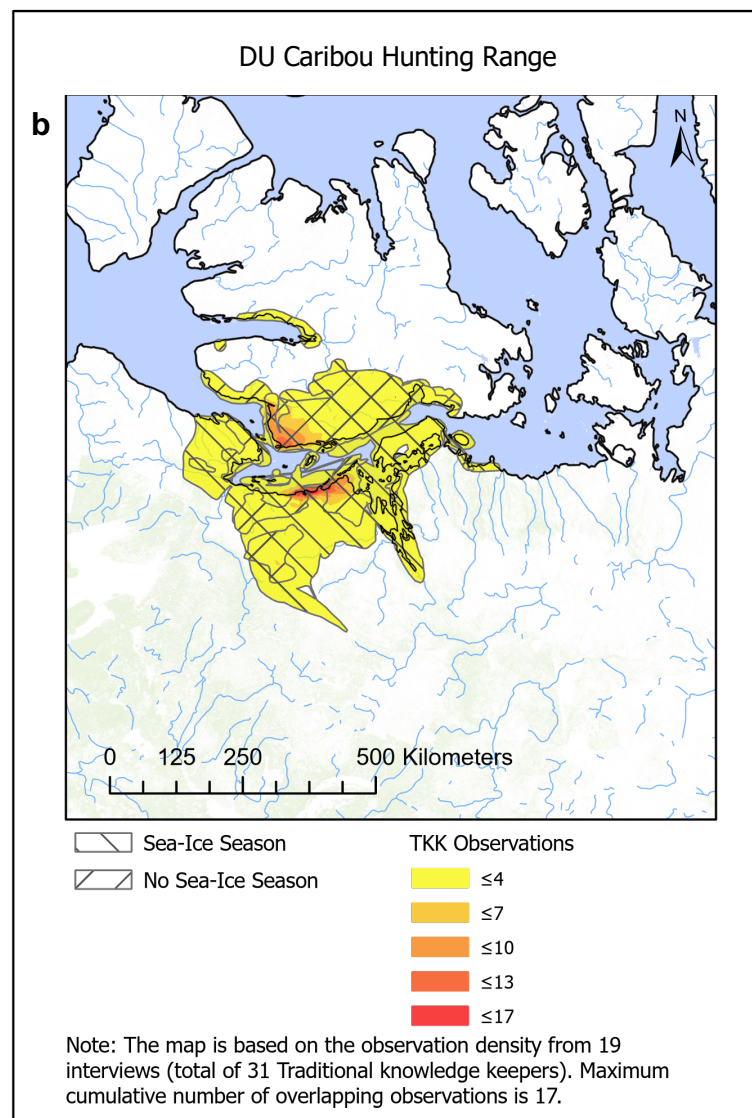


Base Maps Source: Esri Canada, Canadian Community Maps contributors; NRCAN Hydro, Land
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Projection: Transverse Mercator

Figure 8. DU caribou range (a) and DU caribou hunting range (b) as reported by Kugluktukmiut in 2018-2020. Colour gradient is based on the density of observations.



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Table 3. DU caribou range and DU caribou hunting range summarized by decade from 1980-2020, as mapped by TKKs in 2018-2020. The values reflect absolute areas and do not consider overlapping areas. % of Total indicates the percent of the related 1980-2020 interval range (maximum) represented in the specific year interval. % Change indicates the percent change in area from the previous decade.

Range Type	Year Interval	Total Area	% of Total	% Change
DU Caribou Range and DU Caribou Hunting Range	1980-2020	247 200 km ²	100%	n/a
DU Caribou	1980-2020	240 400 km ²	100%	n/a
	1980-1989	122 800 km ²	51%	n/a
	1990-1999	158 300 km ²	66%	29%
	2000-2009	133 300 km ²	55%	-16%
	2010-2020	156 200 km ²	65%	17%
DU Caribou Hunting	1980-2020	138 700 km ²	100%	n/a
	1980-1989	66 400 km ²	48%	n/a
	1990-1999	64 500 km ²	47%	-3%
	2000-2009	77 600 km ²	56%	20%
	2010-2020	93 700 km ²	68%	21%

1980s (Fig. 9a) & early 1990s (Fig. 9b)

TKKs said DU caribou were abundant in the 1980s and 1990s near Kugluktuk and were found both east and west of the community during the winter and summer. They said people would see DU caribou on the small islands between the mainland and Victoria Island during the summer. TKKs describe the most recent abundance peak in the 1980s and early 1990s and when people did not have to travel far to find and hunt DU caribou.

Late 1990s & early 2000s (Fig. 9c)

TKKs described the late 1990s and early 2000s as a time of change for DU caribou. They said DU caribou were not as abundant on the mainland west of Kugluktuk, and there were fewer reports of DU caribou crossing the Dolphin and Union Strait. Instead, they saw DU caribou more frequently on the mainland east of Kugluktuk, moving towards Tree River. TKKs familiar with the PIN3/Rymer Point/Read Island area on Victoria Island said that there were fewer DU caribou seen in this area during the summer/fall hunt, but still enough for hunting purposes.

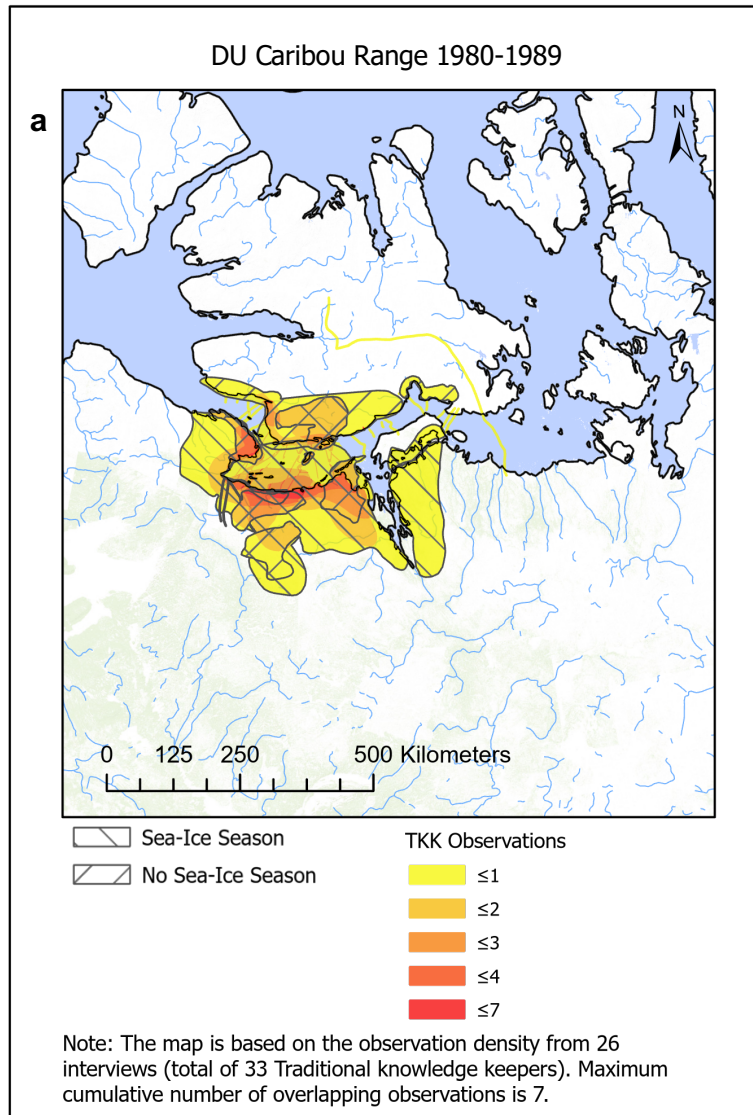
Late 2000s & early 2010s (Fig. 9d)

TKKs said people continued travelling further east on the mainland to find DU caribou, now mostly between Tree River and Grays Bay. Those familiar with the PIN3/Rymer Point/Read Island area on Victoria Island said this time period was when they started travelling further inland to find DU caribou and needed to plan their hunting trips later in the season to match the DU caribou movements.

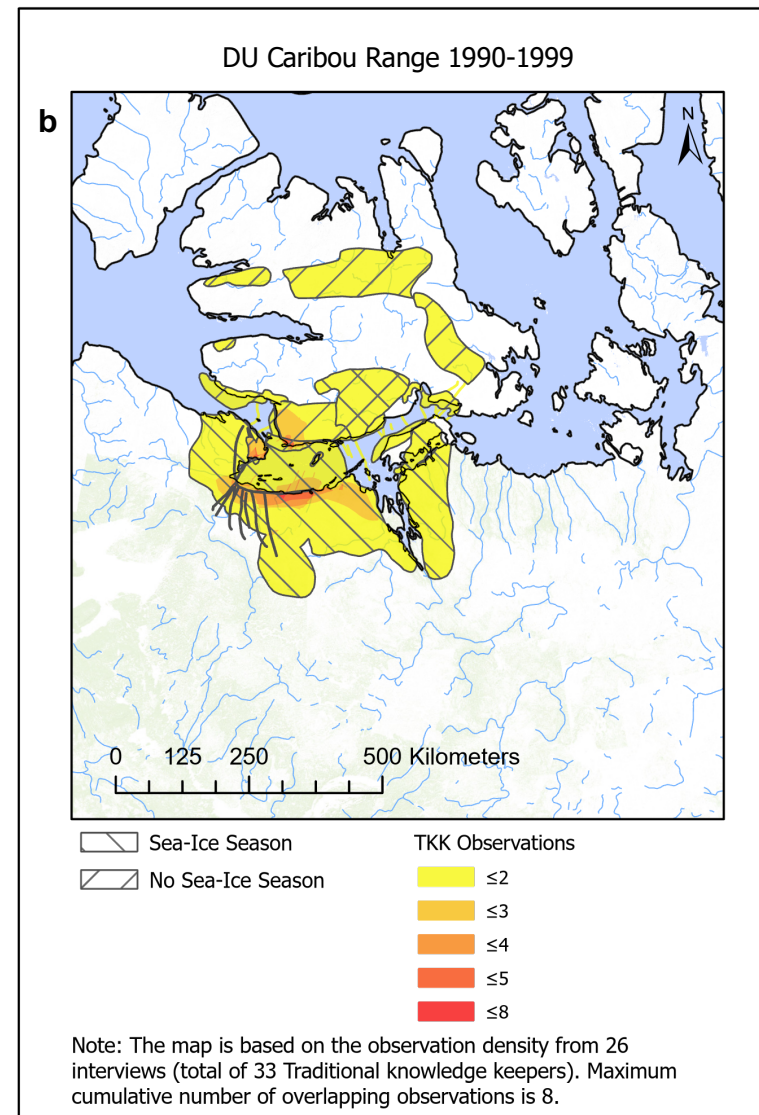
Late 2010s & today

TKKs said people continued travelling further east on the mainland to find DU caribou, now mostly travelling to Grays Bay, Wenzel River, and beyond into Bathurst Inlet. Those familiar with the PIN3/Rymer Point/Read Island area on Victoria Island said that during this time period, even though they are travelling further inland to find DU caribou, they find fewer DU caribou than the late 2000s and early 2010s.

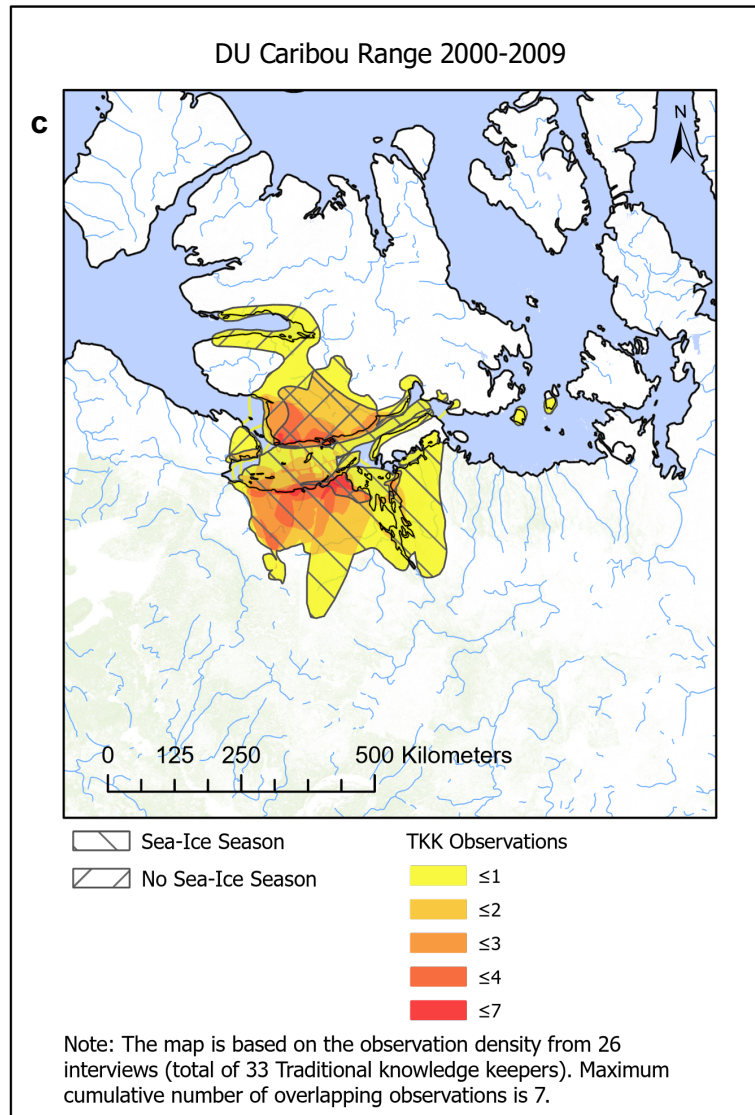
Figure 9. DU caribou range per decade as reported by Kugluktukmiut in 2018-2020, including 1980-1989 (a), 1990-1999 (b), 2000-2009 (c), and 2010-2020 (d). Colour gradient is based on the density of observations.



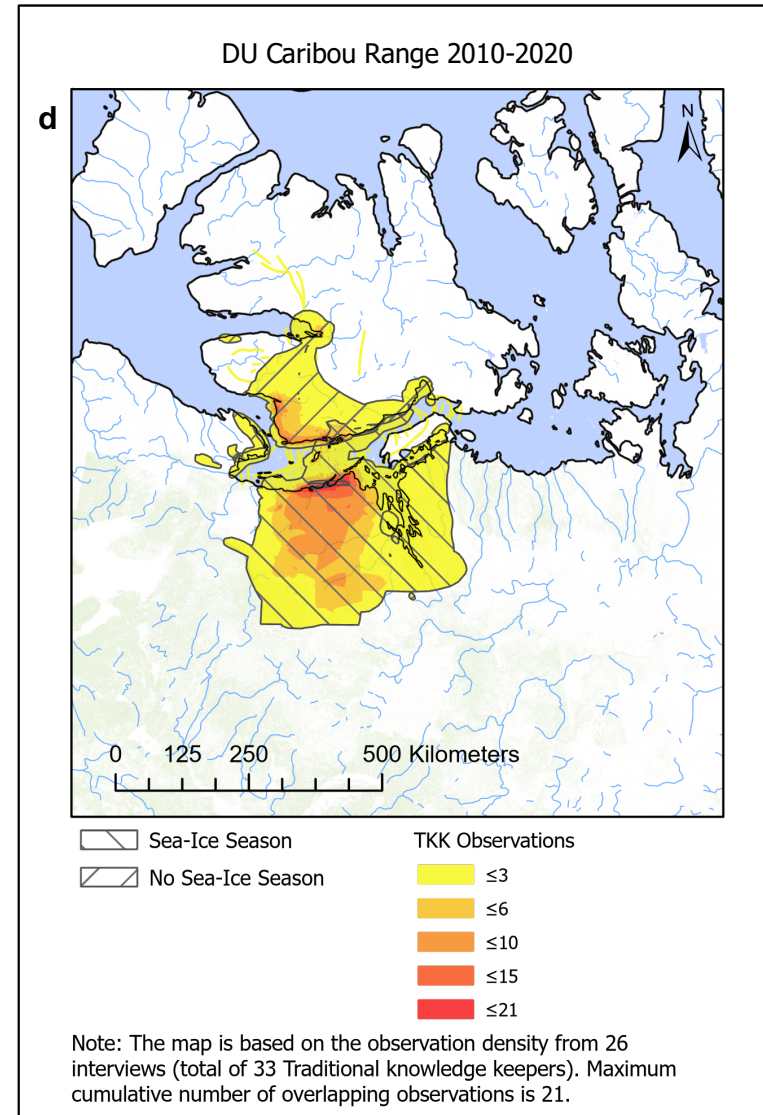
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Abundance Trends

The proportional piling activities were done in 2019 with seven focus groups (two to three people per group; *Fig. 10a&b*). Focus group five elected to skip the activity, leaving data from six focus groups. One group had observations beginning in 1965, one beginning in 1970, and the rest beginning between 1980-1990. The group from 1965 described peak abundance then with a decline observed starting in 2005, whereas the 1970 group described an increase in abundance from 1970-1985 and a decline observed by 1995. The remainder of the groups described peak abundance at the beginning of their observation period, and the decline noticed between 1990-2005. All groups agreed that the herd's abundance had declined substantially by the time of the interviews. Each focus group either described or drew annual variation in the abundance curves, explaining that the caribou abundance does not smoothly change but increases then decreases (or vice versa) in a jagged line with a general increasing or decreasing trend.

For the feedback sessions, we used a smoothed quadratic linear model to illustrate the collective trends in the proportional piling data for abundance (Tomaselli et al., 2018). The model, supported by the narratives, indicated that the DU caribou abundance peaked in 1986 and the lowest abundance percentage occurred in 2019 at 40%. *Figure 11* was presented back to the TKKs during the feedback sessions. All TKKs during the feedback sessions agreed with the trends of increase and decrease with no amendments, but some TKKs who were not originally involved in the focus groups did not want to comment on the percentages associated with the trends. TKKs explained that the abundance percentages were associated with distribution of the animals and location of the TKKs. For example, people who were more familiar with the eastern range saw changes in DU caribou abundance during different years than the people who were more familiar with the western range. This accounts for some variability within the dataset.

Concerns for DU Caribou Status and Suggested Management Actions

TKKs identified concern about five main issues that potentially impact the status of DU caribou (*Fig. 12*).

Hunting practices

TKKs expressed concerns around hunting practices, including DU caribou subsistence and sport hunting, and predator harvesting (hunting and trapping). Changes in DU caribou subsistence hunting practices included poor meat management (ex. spoiling meat, feeding meat to dogs, not knowing what meat is safe to eat or not), lack of proper sharing practices, and inadequate hunting practices of inexperienced hunters (ex. harvesting the wrong type of animal for the season, approaching the animals directly rather than on an angle). TKKs related these changes to education barriers between youth and Elders. They also related the changes to insufficient knowledge transfer about these topics with the public, including youth and adults. As a potential solution to this, TKKs indicated a desire for more educational opportunities for inexperienced hunters who want to learn about DU caribou hunting. This would include, but would not be limited, to selecting appropriate animals in regard to the season and population status, safe butchering and handling of the harvested animal, how to recognize what is safe to eat, etiquette around meat sharing, quantity of harvest, as well as general camping skills, such as collecting safe drinking water and safe land and water travelling. TKKs said these programs should include support and/or coordination by/between the DOE and KAA. Further, they said it is important to include hands-on learning, such as through on-the-land camp programs that connects those who want to learn with those who want to teach.



Figure 10a. Proportional piling activity with an Elder focus group in January 2019. Photograph includes Roger Hitkolok, Andrea Hanke, Juliette Di Francesco, John Kapakatoak, and Larry Adjun (left to right).

Figure 10b. Image shows an example of bean piling, where all the beans together represented 100%, and the smaller pile of beans on the right represented the number of caribou seen in 2019.

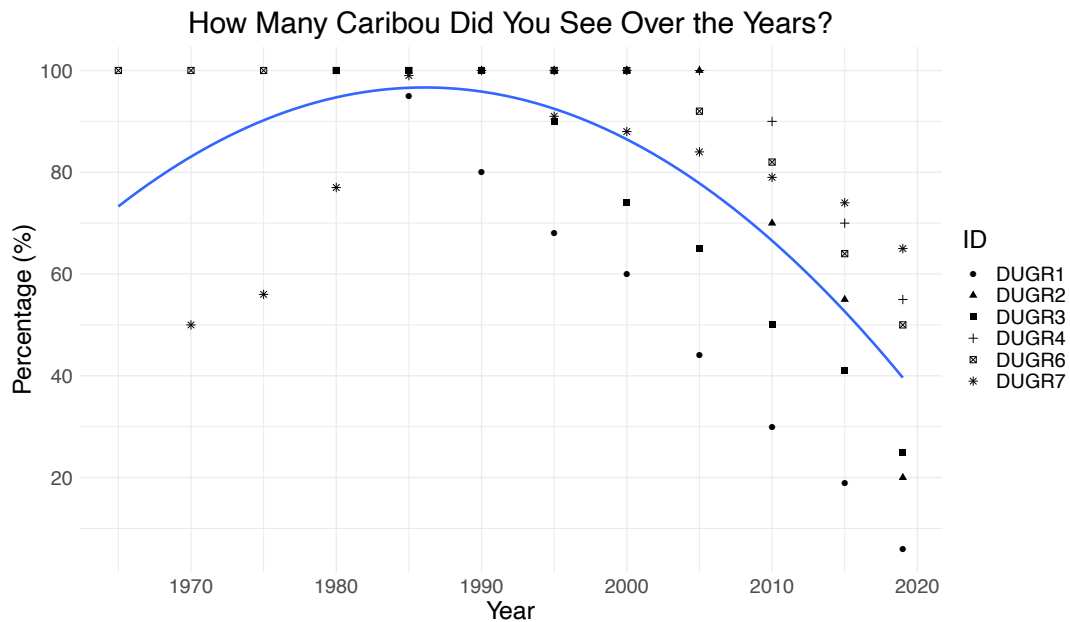


Figure 11. Collective DU caribou abundance trend created during proportional piling activities and based on Kugluktukmiut knowledge. ID represents each focus group that participated in the piling exercises (note: group 5 elected to not complete the activity). The blue line represents a smoothed quadratic linear model and was reviewed and accepted during feedback sessions in 2020 with Kugluktukmiut as the DU caribou abundance trend from Kugluktukmiut perspective.

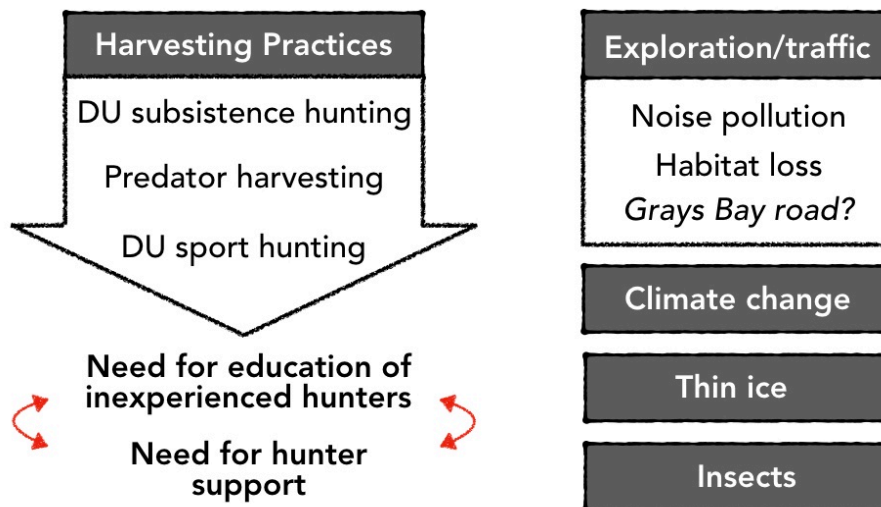


Figure 12. Five main issues that TKKs identified might impact DU caribou status. They identified hunting practices as the most important for immediate action, through increasing opportunities for educating inexperienced hunters and providing support (financial, resources, education, etc.) for hunters to maintain presence on the land and pressure on predators. Other concerns included rate of exploration and traffic, climate change, presence of thin ice, and increased burden from insects.

TKKs also explained that Total Allowable Harvest (TAH) restrictions for Bluenose East and Bathurst caribou herds had created unbalanced harvesting pressure on DU caribou, since this herd has no TAH restrictions. Some TKKs suggested that it could be useful to have DU caribou on a similar system until they recover. There was disagreement amongst people about whether the KAA or DOE should implement a restriction similar to the TAH. TKKs emphasized that if it was implemented, such a strategy would need to adapt alongside changes in the DU caribou abundance. Some TKKs said people would not follow the restrictions, and others further clarified that it would make food security too difficult to achieve. Some TKKs said that emphasizing education on proper hunting practices would be more beneficial than TAH restrictions for long-term change. However, they also indicated that an annual or seasonal restriction, like a TAH, may be needed for short-term change.

TKKs considered predator harvesting pressure as one of their top concerns for DU caribou. They explained that predator harvesting requires extensive time, resources (gas, food, equipment, repairs), and expert knowledge (safety, technical). They also said predator harvesting had an insufficient return reward that did not act as an incentive to engage in the process. Further, TKKs said that predator harvesting was not as common nor practiced the same today compared to the past. As a result, they said there are more predators today than in the past. TKKs indicated a desire to have more support for people to take part in these activities so they could maintain presence on the land and pressure on the predators. This could be in the form of resources and financial support, and/or with educational opportunities. For example, the educational opportunities could cover what incentive and educational resources already exist and additional programming that reviews requisite expertise and safety knowledge specific to predators.

TKKs also expressed concern about DU caribou sport hunting and its undue pressures on the most important breeding caribou. Some TKKs were conflicted about this concern because they understood the sport hunts as good employment opportunities. Other TKKs were conflicted as they did not know how much impact the limited sport hunts could have at a herd-level. The TKKs' suggested solution was to pause DU caribou sport hunts until the herd recovers.

Exploration/traffic

TKKs described an increase in noise pollution over time, with more helicopters, planes, and snowmobiles around today than in the past. Some TKKs expressed concern about potential mining, roads, and port developments as they would take up important caribou habitat. Also, some TKKs indicated concern about municipality contributions to pollution in the area, for example dump smoke during routine burning. There was a lot of discussion and conflicting views about the potential Grays Bay road and port project, and this was not covered in depth nor was there agreement among the TKKs. One suggested solution was to have stricter, or more enforced, regulations or restrictions around aircraft, developments, and/or municipalities to limit their potential impact on DU caribou. TKKs also suggested that more public education regarding those regulations would be useful so people understand what is being done and the reasons behind those actions.

Climate changes

TKKs described many changes in climate, including rain, wind, temperature, moisture, vegetation, sun, and timing of season changes. Linked to these climatic changes were rain-on-snow events that formed layers of ice over the vegetation, making it more difficult for DU caribou to access their food. TKKs also linked climatic changes with changes in sea-ice formation. There were no specific weather events mentioned that were directly connected to the recent abundance decline.

Sea-ice

TKKs explained that the sea-ice formed earlier in the eastern portion than the western portion of the DU caribou range. They explained that this has contributed to the changing DU caribou distribution. Also, TKKs frequently discussed thin ice and said that DU caribou often fall through near islands or fast currents. When the caribou fall through the sea-ice, they said DU caribou either drown, freeze on land, or have balls of ice attached to them (for example, on the legs or back). They said that the sea-ice is thawing before all DU caribou migrate north to Victoria Island in the spring, leaving some portion of the DU caribou on the mainland for the summer. Some TKKs said that this happened once in a while in the past, and others said that this is happening more now because the caribou are migrating further south than before and are taking longer to return to the mainland shoreline.

Insects

TKKs also mentioned changes in insect intensity and diversity, and that they are worse with hot and wet summers. They said this impacted caribou by preventing rest and eating. TKKs also mentioned insects in relation to climate change, but they talked extensively about insects and this warranted it as a stand-alone concern.

SUMMARY

The 2018-2020 Kugluktukmiut interviews documented an eastern shift in the western range boundary and a decline in abundance for the DU caribou herd from 1980 to 2020. TKKs explained and illustrated that they had to travel progressively further east on the mainland and further inland on Victoria Island to find DU caribou over the years. The participatory mapping and interviews narratives demonstrated that the DU caribou distribution is different today (2010 to 2020) compared to the 1980 to 1989. TKKs also said that there are fewer caribou today (2018 to 2020) compared to 2010, even when they travel further east and inland. Through the participatory proportional piling exercises and within the Kugluktukmiut spatial areas of observation, the DU caribou population in 2019 was estimated at approximately 40% of what it was in the 1980s. This collective Kugluktukmiut perspective is an important

account to consider, along with accounts from other communities within the DU caribou range, for future herd management.

In addition to herd status, TKKs identified concern about potential threats to DU caribou and suggested management actions. The concerns included harvesting practices (DU caribou subsistence hunting, predator hunting, predator trapping, and DU caribou sport hunting), exploration/traffic, climate change, thin ice, and insects. TKKs generated a list of suggested solutions to help mitigate these threats, and most of the suggestions addressed a need for hands-on education of inexperienced harvesters. TKKs advocated for the prioritization of inexperienced harvester education, covering topics from proper harvesting techniques, etiquette around meat sharing, and specialized predator knowledge. While TKKs indicated that there is increased importance on DU caribou harvesting since the harvesting restrictions on the neighbouring caribou herds, some TKKs emphasized that overall harvest of DU caribou has not increased as a result. Not all TKKs agreed about implementing a TAH for the DU caribou herd, but they agreed that if one were implemented, the harvest restrictions would need to adapt alongside changes in the DU caribou. The TKKs identified concerns for DU caribou were identified in the ECCC (2018) management plan and warrant due consideration in management discussions.

OVERALL DISCUSSION

Abundance

The 2003 and 2018-2020 Traditional knowledge studies on DU caribou provided critical information about this herd's population trend. The 2018-2020 study used individual interviews, focus groups, and feedback sessions to document Kugluktukmiut Traditional knowledge around DU caribou. Results from this study demonstrate an eastward shift in the western boundary of DU caribou distribution and an increase in DU caribou hunting ranges since 2000s, coincident with a substantial abundance decline to 40% of the prior mid-1980s peak. The range shifts and abundance decline are consistent with those identified in the 2003 interviews with Ekaluktutiakmiut and Kugluktukmiut. This suggests that the decline recognized by Kugluktukmiut in 2003 was real and had continued until present day, with the abundance peak occurring around the mid-to late 1980s. These results are congruent with observations by Ekaluktutiakmiut and local knowledge keepers in 2014 (Tomaselli et al., 2018). There, Ekaluktutiakmiut and local knowledge keepers reported that the DU caribou population had declined to 20% of its prior 1990s to mid-2000s peak. They associated the decline with smaller group sizes, smaller proportions of juveniles, poorer body condition, and a larger proportion of sick animals (Tomaselli et al., 2018). The population survey conducted in 2018 reported a 38% annual decline since 2015 (4 105 animals), along with fewer groups, smaller group size, lower stratum density, and low survival rates (0.62) (Leclerc and Boulanger, 2020). The 2018 survey result represents 12% of the 1997 survey result (34 558 animals) (Leclerc and Boulanger, 2020). A remaining DU caribou population of 12% since 1997 could be consistent with the Traditional knowledge near Ekaluktutiak in 2003 and by Tomaselli et al. (2018). However, it is a greater decline than that derived from the Kugluktukmiut accounts.

Leclerc and Boulanger (2020) reported a recent western range shift for DU caribou based on collar locations and in correspondence with an Ekaluktutiakmiut decrease and Ulukhaktokmiut increase in recently observed DU caribou. Meanwhile, the Kugluktukmiut perspective suggests an eastward shift in the western boundary of DU caribou distribution in both the 2003 and 2018-20 studies. The variability in the abundance and distribution accounts may be influenced by three points of interpretation. (1) The Kugluktukmiut knowledge refers to the 1980s and the survey baselines refer back to 1997. This may create a temporal scale issue that could be influencing the results, as has been reported in other studies (Neis et al., 1999; Armitage et al., 2011). (2) Seasonal harvesting locations and access to the land have been shown to change the reported relative abundance by the communities (see Ferguson et al., 1998, Neis et al., 1999, Kendrick and Manseau, 2008). Unpacking spatial scales among Traditional knowledge studies and population surveys may help facilitate understanding across the research. (3) The Traditional knowledge from 2003 and 2018-20 indicated that DU caribou behaviour changes in response to abundance and sea-ice. An Ulukhaktok community member reported freezing rain in Prince Albert Sound area in fall/winter of 2018 and that DU caribou might have turned back from their fall migration (F. Mavrot, pers comm). This weather event that may have influenced a change in behaviour could have impacted the number of DU caribou congregating along the southern shore of Victoria Island during the survey period (for similar accounts, see Parlee et al., 2013, Gurarie et al., 2019). These three points require further investigation in order to best understand the different information sources.

Distribution

Caribou abundance is known to fluctuate through time (Ferguson et al., 1998; Bergerud 2008). Population decreases are often accompanied by range contractions while population increases are often accompanied by range expansions (Ferguson et al., 1998; Bergerud 2008). Since TTK accounts are

specific to their land-based knowledge, a reported decrease in caribou sightings is locally based and needs to be interpreted in relation to, and combination with, observations from other areas. As such, a locally observed abundance decrease in one location does not necessarily mean a population decrease (Ferguson et al., 1998). Drawing on our results and previously published peer-reviewed and grey literature, we get a fairly detailed account of the DU caribou dynamics and range over time. Thorpe et al. (2001) describe a *Kiillinik* caribou herd in the Bathurst Inlet region as a herd of small, white caribou that come from Victoria Island to spend the winter. Elders explained that the *Kiillinik* caribou (DU caribou) started to come further south in the 1970s and mixed with the *Ahiarmiut* caribou (barren-ground caribou) (Thorpe et al., 2001). From this account, it seems the southern boundary of the DU caribou distribution shifted southward to include the Umingmaktok and Bathurst Inlet regions in the 1970s. This corresponds with the time Kugluktukmiut from the 2003 study said DU caribou peaked by their community (further refined to the 1980s in the 2018-2020 study). Ulukhaktokmiut reported a decline DU caribou abundance in 1990s (Ulukhaktok TK interviews 2011-2013, as cited in ECCC, 2018). Thorpe et al. (2001) reports that DU caribou became progressively more abundant near Ekaluktutiak from the 1980s to 2000s, Bates (2006) reports regular hunting of DU caribou twice a year by Ekaluktutiakmiut in 2000, and Tomaselli et al. (2018) recorded the peak for DU caribou from 1990s to mid-2000s by Ekaluktutiak. This is consistent with the Kugluktukmiut observed eastward change in the DU caribou distribution starting in the late 1990s and early 2000s. These data suggest that the boundaries of the DU caribou distribution fluctuate alongside population abundance. The Traditional knowledge alongside the most recent population survey (Leclerc and Boulanger 2020) further suggest that DU caribou have contracted its western and eastern boundaries to create a narrower distribution.

Hunting Range

The extent of DU caribou hunting ranges appeared to contract when DU caribou were abundant near the community and expand when DU caribou were far from the community. The 2003 study showed an approximate 65% decrease in DU caribou hunting range from the past (pre-2003) to 2003, transitioning from a period of very few DU caribou in 1920-50s to many DU caribou in 1970-2003. The 2018-20 study showed a 45% increase in hunting range area from 1990-1999, including 21% increase since 2000-2009, to 2010-2020. This period is transitioning from many caribou in the 1980s to early-1990s to a period of fewer DU caribou in 2020. Increases in hunting ranges have been reported during other wildlife declines, linked to increases in search intensity and further travel distances (Neis et al., 1999, Kendrick and Manseau, 2008). The overall area accounted in the participatory mapping was greater in the 2018-20 study than the 2003 study.

Concerns & Management Suggestions

The identified Kugluktukmiut concerns for the DU caribou herd are similar to concerns previously voiced by Indigenous communities about this caribou and other caribou herds (Dumond, 2007; Sangris, 2010; Padilla & Kofinas, 2014; Tomaselli et al., 2018). Foremost, they advocated for education for inexperienced harvesters with a strong hands-on learning component. Future development of this type of education initiative could draw from the Aqqiumavvik Society, such as their young hunters, mentoring young men, and culture of cooking programming (Aqqiumavvik Society, n.d.). Kugluktukmiut in the 2018-20 study and in Dumond (2007), indicated concern over the decrease in predator harvesting today compared to the past and the recent increase in predator numbers. The DOE Wolf Sample Program has been supporting Kitikmeot wolf harvesters since November 2018 (Legislative Assembly of Nunavut, 2019), and the Government of Northwest-Territories recently expanded their North Slave Wolf Harvest

Incentive Program to include Nunavut harvesters in 2019 (ENR, n.d.). In addition to the wolf initiatives, the DOE is currently analyzing data on wolverines and is planning a grizzly bear study (Government of Nunavut, 2020). The KAA is also planning a Traditional knowledge study on grizzly bears (A. Dumond, pers comms).

OVERALL CONCLUSION

Together, the 2003 and 2018-20 studies detail the history, distribution, abundance trends, and concerns for DU caribou. The discussion of these results together with other studies like Tomaselli et al. (2018) and Leclerc and Boulanger (2020) have highlighted the importance of having information from multiple sources and times in order to weave together the complex ecology, distribution, and population trends of DU caribou. Further, the diversity of available information can allow for better consideration of the different data limitations (Bates, 2007). The expressed concerns for DU caribou declines and the suggested management actions can help guide future decisions for this herd. Considering the full and cumulative extent of the DU caribou range within current management plans is critical to manage landscape-use if a full recovery of the herd to historical numbers and range use is desired. The community-based knowledge on DU caribou distribution, abundance, and health was nuanced and complementary within and between Ekaluktutiakmiut and Kugluktukmiut accounts. This reflects the TKKs' varied spatial and seasonal use of the land and interactions with the caribou. These studies have highlighted the critical importance of involving multiple communities and TKKs from across the DU caribou range to understand the full life history of DU caribou, including seasonal and spatial variability, and to develop effective herd-level conservation approaches.

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Appendix A. Interview Guide for Ekaluktutiakmiut and Kugluktukmiut Traditional Knowledge Study on DU Caribou In 2003

1. When were you born?
2. Where were you born?
3. Where do you live?
4. Where did you live when you were a kid? A young adult? Now where do you live?
5. Who are your parents? Brothers? Sisters?
6. Did you hunt caribou when you were a young adult?
7. Do you hunt caribou a lot?
8. Where did you hunt caribou long ago?
9. Where do you hunt caribou now?
10. Did you travel a lot when you were a young adult?
11. Do you travel a lot now?
12. Between the 1920's and the 1970's the Dolphin-Union herd was believed to be extinct by biologists. Do you know what happen during this period?
13. What effect did the introduction of riffles have on the herd in the 1920's into the 1970's?
14. Historical trends in the abundance of the Dolphin-Union herd? (In the past was the herd in numbers where there were many caribou or less caribou?)
 - a. When you were young/the place?
 - b. When you were a young adult/the place?
 - c. When you became an adult/the place?
15. Temporal trends in the abundance of this herd? (Any short term difference in numbers of this herd, for example in a certain year there were many caribou or less caribou)
 - a. When you were young/the place?
 - b. When you were a young adult/the place?
 - c. When you became an adult/the place?
16. Migrations, areas where the caribou traveled through. Can you mark them on the maps?
17. Have you ever seen the herd to not migrate? (What reasons do you think caused that to happen?)
 - a. What year(s)?
 - b. Weather conditions?
 - c. Amount of snow?
 - d. Were there lots of caribou?
 - e. Were the caribou in groups or spread out?
 - f. Were the caribou healthy?
 - g. Over harvest?
18. Was it because they were not coming around your camp or because there were less caribou?
19. Nowadays, the herd is migrating to the mainland in winter and comes back to the island for calving. Was it always like that?
20. Trends in abundance of caribou when the caribou migrate or did not migrate? (Were there a difference in number of caribou when the caribou migrated to mainland and when the caribou did not migrate).
21. Seasonal locations (spring, summer, fall and winter). Can you mark them on the maps?
22. Trends in body condition when the caribou migrate or did not migrate?
 - a. Body condition, when the herd did not migrate was the caribou healthy?
 - b. When the caribou migrated were the caribou healthy?

- c. Were they skinny and shown any signs of illness when they stayed on Victoria Island?
 - d. Were they skinny and shown any signs of illness when they went to the mainland?
23. What did the caribou eat? (Spring, summer, fall and winter). Did you noticed some changes along the years? Were there differences when migrating or not?
 24. What have you seen, body condition of the Dolphin-Union caribou through out the year?
 25. Do you have anything you would like to tell me in general about your knowledge or experience with the Dolphin-Union caribou herd?
 26. Do you know of any stories passed on knowledge on this caribou herd from your father/mother, grandfather/grandmother, uncle/aunt, or any elderly person in general?

Dolphin and Union Caribou Health Monitoring Program

Individual Interview Guide

Interview #: _____

Date: _____

****As with any qualitative interview guide, these questions are suggestions of what will be discussed in the interview. Prompts are included under the bolded questions to be used as needed for guiding the discussion.**

*Italicized writing indicates the use of a participatory research tool. ***

Hello! Thank you for agreeing to be interviewed. As you already know the purpose of this study is to collect traditional and local knowledge about DU caribou in order to inform a program for monitoring DU caribou health.

****Go over consent form with participant****

I have an outline of questions I would like to ask you and I will be taking some notes during our discussion. Are you okay if I audio-record the interview?

Please feel free to add any comments whenever you wish. Is there anything you would like to ask before we start?

INTERVIEW QUESTIONS:

A. General/Demography

First of all, I would like to ask you some general questions about yourself.

1. Personal information:

- a. Interviewee: Elder Hunter Outfitter Other: _____
- b. Inuit identity: Inuit non-Inuit
- c. Active Hunter: Yes No
 - a) If yes, do you hunt DU, Peary or Bluenose caribou? Muskox?
 - b) If no, were you a hunter before? Until when? For how long? _____
- d. Gender: Male
 Female

You don't have an option that applies to me. I identify as _____.
Prefer not to disclose

- e. Age _____ years
- f. Are you part of the HTO? Yes No
- g. Where were you born? _____
- h. How many years have you lived in Kugluktuk? _____ years
2. Do you hunt/handle DU caribou? Yes No
- If hunt...
- a. When did you start to hunt DU caribou? _____
- b. What kind of hunts do you participate in? Subsistence Community Sport (as a guide)
- c. About how many DU caribou do you catch/handle each year?
- | | | |
|-------------|---------|------------|
| Subsistence | # _____ | when _____ |
| Community | # _____ | when _____ |
| Sport | # _____ | when _____ |
- d. Where do you normally hunt DU caribou?
- Mapping*
- e. Where did you used to hunt DU caribou?
- Mapping*
- f. What type of animals do you hunt?
- | | | | | | |
|-------------|-------|-------------|------------|------|--------|
| Subsistence | _____ | Type: adult | young calf | male | female |
| Community | _____ | Type: adult | young calf | male | female |
| Sport | _____ | Type: adult | young calf | male | female |
- g. What do you do after you hunt a DU caribou?
- a) How do you process the carcass in the field and what do you leave out in the land?
- b) What type of hunt is it from? (subsistence/community/sport)

If handle....

- a. When did you start to handle DU caribou?
- b. Who hunts the DU caribou that you handle? From which type of hunt do these caribou come from?
- | | | |
|-------------|-----------|-------|
| Subsistence | Community | Sport |
|-------------|-----------|-------|
- c. How many caribou do you handle per year? And when?
- | | | |
|-------------|---------|------------|
| Subsistence | # _____ | when _____ |
| Community | # _____ | when _____ |
| Sport | # _____ | when _____ |
- d. What kind of caribou do you handle?
- | | | | | | |
|-------------|-------|-------------|------------|------|--------|
| Subsistence | _____ | Type: adult | young calf | male | female |
| Community | _____ | Type: adult | young calf | male | female |
| Sport | _____ | Type: adult | young calf | male | female |

B. Community Importance

Now, I would like to talk to you about **what DU caribou mean for your community**.

1. Tell me, what do DU caribou mean to you?

- a. Compared to other caribou herds? Muskox?
- b. How has this changed over time?

2. What parts of DU caribou do you eat? How?

- a) Cooked, raw, dried?
- b) How do you store DU caribou meat?
- c) Tell me about any concerns you have about butchering, handling or eating DU caribou.

D. DU Caribou Health

Now, I would like to talk to you about what you see in **DU caribou**.

1. What is a good DU caribou? What is a bad DU caribou?

2. How do you think the DU caribou herd is doing?

- a. Can you describe this further?
- b. Why do you think this is?

3. In the past, were there fewer DU caribou or more DU caribou then now?

Timeline, proportional piling

- a. When you were young/young adult/adult? Before 2003, in 2003, and now?
- b. Does the number of DU caribou change year-to-year?
- c. Descriptive probing for details
- d. If mortality events are mentioned, ask for details (season, year, location, number of animals, composition of animals)

4. Tell me about any changes you've noticed in DU caribou.

Refer to timeline, seasonal calendar

- a. Can you describe these further?
- b. When did you start to notice the changes?
- c. Why do you think this has happened?
- d. Is this related to changes in the lands or other animals?
- e. Do you think these changes are impacting how the DU caribou herd is doing? How?

5. Can you mark on the map the seasonal locations of DU caribou and the areas they travel through?

Mapping (summer and winter locations & fall and spring migration routes)

- a. Have these changed from when you were young/young adult/adult? Before 2003, in 2003, and now? *Refer to timeline*

6. Tell me about the movement of DU caribou.

- a. Today, do DU caribou move from the mainland to the island?

- a) If so,
 - Does the whole herd move or just some animals?
 - How many animals migrate together? What is their composition (calves/adults, females/males)
 - When do you see the DU caribou migrate?
 - Refer to map*
- b) If not, why do you think this has happened?
 - What year(s)?
 - Weather conditions?
 - Amount of snow?
 - Number of caribou?
 - Were caribou in groups or spread out? What size were the groups?
 - Were they good caribou? Bad caribou?
 - Did harvesting or predation have an effect?
- b. Is the movement today different from the past? *Refer to timeline*
 - a) Locations, timing, group size, group composition
 - b) When did this change? *Refer to timeline*

7. Throughout the year, when are DU caribou fat, fair, or skinny?

Seasonal calendar

- a. Why does the fatness of the animal change?
- b. Are there things that happen which make the animal become fatter or skinnier?
- c. Does the time DU caribou get fat/skinny change year-to-year?
- d. How does today's body condition compare to 2003 and before?

Refer to timeline, seasonal calendar

8. What do DU caribou eat?

- a. Spring, summer, fall and winter?
- b. Have the DU caribou changed what they eat? When you were young/young adult/adult? Before 2003, in 2003, and now? *Refer to timeline, seasonal calendar*
- c. Are there any places the DU caribou always go to eat?
 - a) Some animals risk their lives to go lick roads, mud or dirt, etc. They do this because they need the minerals, or nutrients, to be healthy. Is there anything like that for the DU caribou? *Refer to map, seasonal calendar*

E. Disease

Now, I would like to ask you some questions about diseases of DU caribou.

1. Tell me about any common diseases that you know of in DU caribou.

- a. Could you describe them further?
- b. Do these diseases go by any other names?
- c. Do you see these diseases in today's DU caribou?
- d. Have these diseases changed? *Refer to map, timeline, seasonal calendar*

2. **Have you ever seen dead DU caribou in the wild?** Yes No
- When (year and season) and where? *Refer to map, timeline, seasonal calendar*
 - Can you describe what you saw?
 - How many animals did you observe dead? _____
 - What kind of animals? adult young calf male female
3. **When you were out in the land, have you ever thought a DU caribou was sick?** Yes No
- Could you tell me more?
 - Can you indicate the location on the map and when it happened?
Refer to map, timeline, seasonal calendar
 - Can you describe what you saw?
 - How many animals did you observe?
 - What kind of animals? adult young calf male female
 - Do you have a name for this sickness?
4. **What about the animals that you hunted so far? Have you observed any strange things when you butchered them?** Yes No
- Could you tell me more?
 - Can you describe what you saw?
 - Where and when was that?
 - What kind of animals? adult young calf male female
 - Is this a common finding in the animals you hunted, so far? Yes No
 - Have you observed any changes over time in the animals?
Picture prompts, timeline, proportional piling, seasonal calendar

F. Wrapping Up

- Are there any stories you would like to share about DU caribou?**
- What things are important to monitor for the DU caribou herd?**
 - What are ways that you think we can find out how the DU caribou are doing?
 - What is important for monitoring the health of DU caribou?
- Anyone else you would recommend for this study? Someone else who is really knowledgeable about DU caribou?**
- Anything else you would like to share?**

Thank you very much for taking the time to participate in this project. If you have any concerns, please contact me (andrea.hankel@ucalgary.ca). I'll be in touch with you to go over the results from this interview and to set up the group interview.

Dolphin and Union Caribou Health Monitoring Program

Group Interview Guide

Interview #: _____

Date: _____

****As with any qualitative interview guide, these questions are suggestions of what will be discussed in the interview. Italicized writing indicates the use of a participatory research tool. ****

Hello! Thank you for agreeing to be part in this small group interview. As you already know the purpose of this study is to collect traditional and local knowledge about DU caribou in order to inform a program for monitoring DU caribou health. In this second phase, we will have a group discussion and we will do some exercises to further explore some of the findings.

We will use the map to indicate location, we will create a seasonal calendar and temporal line to create a sort of DU caribou health history and finally we use some tables to show association of factors.

During the group discussion, I will be taking some notes. Feel free to add any comments whenever you wish. Is there anything you would like to ask before we start?

First of all, I will summarize for you the findings from the analysis of the previous interviews

****Summary of the findings from INDIVIDUAL INTERVIEWS****

Do you agree with that? Would you like to add anything else?

Start the activities:

- | <u>Theme</u> | <u>Exercise</u> |
|---|------------------------|
| 1. Participants' area of observation & DU caribou range (confirmation)
Overall hunting area & confirmation of DU ranges from individual interviews | Mapping |
| 2. DU caribou demography
a. Relative abundance | Drawing exercise |

- Timeline exercise; adjust timeline span as appropriate but maintain proportionality; may develop pre/post-decline phases
- b. Relative decline *Proportional piling*
As relates to the timeline phases. Divide counters (rep. pre-decline phase) to current population size.
 - c. Group size and distribution *Categorization exercise*
Number of animals in a group and the average distance between the groups
 - d. Group sex and age structure *Proportional piling*
Divide counters: adults vs juveniles, adults into female vs males, juveniles into calves vs yearlings
3. DU caribou body condition *Proportional piling*
Divide counters into very fat, fat, not bad, and poor for observed or hunted animals
4. DU caribou morbidity and mortality
- a. Relative morbidity and mortality *Proportional piling*
Divide into healthy, diseased and dead animals
 - b. Relative prevalence of disease *Proportional piling*
Divide counters (rep. whole population) into prevalence of each disease before and after decline. Probe for intensity and presentation, season, age/sex, location
Warbles
Nose Bots
Biting flies: mosquitoes, horseflies/bulldogs, blackflies, ticks
Hair coat: Face, neck
Besnoitia
Joints: *Brucella*, keep in mind *Erysip*
Meat: *Taenia*
Lungs: Stuck, *Echinococcus*
Abdomen: Liver (*Taenia*, white spots/other), Guts stuck, any worms in abdomen? (*Setaria*)
Hooves: changes
Antlers: changes
Add new ones to the list if it's not there.
 - c. Causes of mortality *Proportional piling*
Continuing from 4a), divide the counters that represent 'dead caribou' into 'predation', 'acute deaths' and 'undetermined/other causes'. Further divide 'predation' into the predator species thought to be involved.
'Acute deaths' was defined as the presence of one or more carcasses lying on the ground within the same geographical area, with the following specific characteristics: carcass/es intact or only minimally scavenged, death/s occurred recently (within few weeks), and not attributable to predation or hunting. Further define the 'undetermined/other causes'.

Show a picture of a caribou dead from predation/hunting.

5. Patterns of DU caribou disease outbreak

a. Sex and age characteristics

Proportional piling

Refer back to 4a) 'acute morality' pile. Divide counters according to adults vs juveniles (calves plus yearlings) and then adults into females vs males.

b. Spatio-temporal distribution & Seasonality

Mapping

Map the locations of the 'acute mortalities'. Mark down number dead, age, year, and season.

Is there anything else that comes to mind that you would like to talk about?

On the behalf of my team at the University of Calgary, thank you very much for taking the time to participate in this group discussion. If you have any concerns, please contact me (andrea.hankel@ucalgary.ca).