Monitoring Results

Boots on the Ground
Caribou Monitoring Program

Tłı̨chǫ
Traditional Knowledge
and Land Use Study

Dedats'eetsaa:
Tłı̨chǫ Research & Training Institute
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2017

Boots-on-the-Ground

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Boots-on-the-Ground Monitoring Results

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Tłı̨chǫ Yatıì

Placenames

Kokètì	Contwoyto Lake
Deèzàatì	Point Lake
Ek'atì	Lac de Gras
Ek'adìì	Island on Lac de Gras
Ewaànıt'ıtì	Courageous Lake
Nǫdìikahtì	Mackay Lake
Ets'àitì	Rawalpindi Lake
Łiwets'aɔòats'ahtì	Lac de Sauvage

Geography

Nǫɔokè	Water crossing
Tataa	Land between water bodies
Whatàa	Esker
Hozìı shìa	Low hill/ mountain on barrenland
Tì	Lake/water
Dı	Island
Tabàa	Lake shore
Tı k'abàa	Shoreline (walking by the shoreline)
Nàłeèzheà	Caribou calving grounds
Dechı̨laa	Treeline

Animals

Ekwǫ̀	Caribou
Dìga	Wolf
Sah dek'oo	Grizzly bear
Hozìı edzıe	Muskox
Didi	Ground Squirrel

1. Introduction

Boots-on-the-ground is a caribou monitoring program based on the traditional knowledge (TK) of indigenous elders and harvesters. The program is a collaboration between the Tłı̨chǫ Government, Government of Northwest Territories-Environment and Natural Resources (GNWT-ENR), the Wek'èezhìi Renewable Resource Board (WRRB) and Dominion Diamond Ekati Corporation (DDEC). Funding was provided by DDEC and the GNWT-Cumulative Impact Monitoring Program[1] (CIMP). The program's first field season commenced in the summer of 2016; additional monitoring will take place in 2017 and 2018.

This document presents the results from 2016, the pilot year of Boots-on-the-Ground. Monitoring fieldwork was conducted from July 5th to August 2nd, 2016 by two teams. The study area of the program is Kokètì (map 1), where the teams camped and travelled on foot and by boat to follow caribou and document TK and wildlife observations. The program's objectives included a) setting up a long term traditional knowledge monitoring program for the Bathurst caribou; b) monitoring the conditions of the caribou herd and its habitat, and c) attempting to understand potential effects that natural and anthropogenic factors have on caribou health, population and behavioural patterns.

This program's approach to caribou monitoring is based on the principle that local people who live on the land and rely on caribou for their daily subsistence are the people best positioned to know the current conditions of caribou and of the land. The program is, therefore, primarily based on the TK of elders and harvesters, although other interdisciplinary research techniques were applied during the development of Boots-on-the-Ground, and further technique development is expected for the following years. Information regarding the program's development, theoretical framework and techniques can be found in the document "We Watch Everything: A Methodology for Boots-on-the-Ground Caribou monitoring" (TRTI 2017).

1.1. Study Area and Timeline

Kokètì (Contwoyto Lake) is the northernmost extent of Tłı̨chǫ traditional land use. The lake has been extensively used by the Tłı̨chǫ and Inuit people for caribou hunting in summer and fall, fur trapping in winter, and as a trade route between the two cultures. Inuit and Tłı̨chǫ have a long history of meeting at historical caribou hunting locations. The Tłı̨chǫ name for Contwoyto Lake is Kokètì, which means "empty campsite lake" in reference to the many camps erected on this lake throughout history. Kokètì is the tenth largest territorial lake, with a total surface area of 957 km^2 and 982 km of shoreline.

The lake runs approximately northwest to southeast, bisecting the landscape. At its widest point, the lake is approximately 19 kilometres wide; numerous eskers, moraines, and islands form nǫʔokè (water crossings) that caribou use to cross the lake yearly. The elongated shape of the lake creates a limited number of Nǫʔokè that caribou use to cross the lake, and established Ekwǫ̀ Etǫ (caribou trails) used by caribou annually. Hunters would typically wait for caribou at these points (Section 4.1.3).

[1] This article is Project CIMP94 of the Government of the Northwest Territories Department of Environment and Natural Resources, Northwest Territories Cumulative Impact Monitoring Program.

Kokètì is southwest of the Bathurst caribou calving grounds, and the areas around the lake form part of the post-calving and summer range of the Bathurst caribou. In July, during the post-calving aggregation, the herds of cows from the calving grounds mix with the bulls to form large herds numbering thousands of animals. This area is therefore ecologically significant for caribou, during migration from their calving grounds and as the herds travel regularly between Kokètì and Ek'atì (Lac de Gras). There are several under-researched factors in this region that could affect caribou health, behavior and migration within its post calving and summer ranges. These include: insect harassment, predators, climate change, and anthropogenic factors.

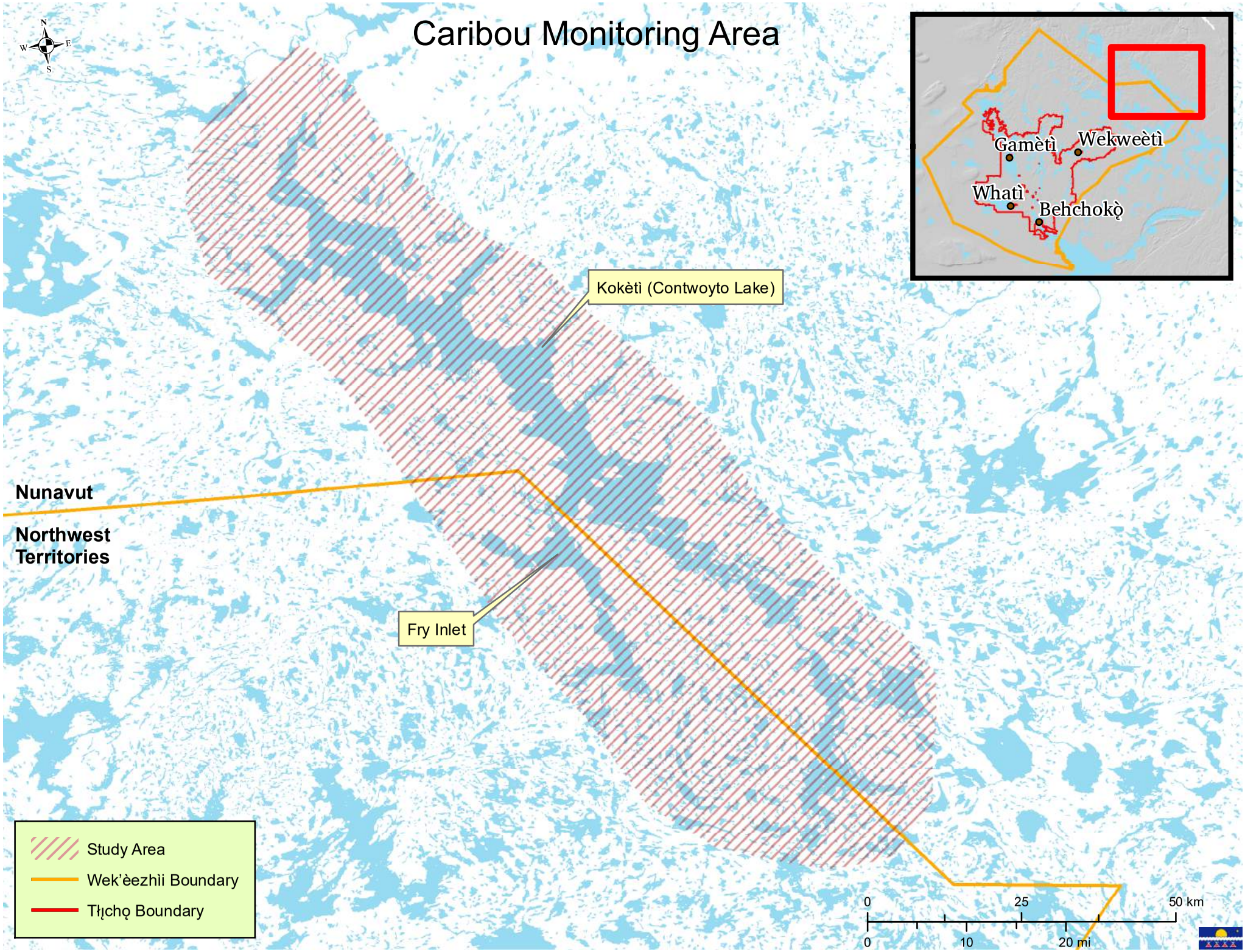
Timeline and study area were determined using the elder's TK on Kokètì, and Bathurst caribou GPS-collar data collected every four days by ENR biologists. For the pilot season, we established base camps on Kokètì and rented a boat and outboard engine from the local Inuit family who lives on Contwoyto. The first camp was established in an inlet on the northeast shore of the lake in Nunavut territory. After a week, the camp was moved near the water crossing between Kokètì and Fry Inlet, in the Northwest Territories, where it stayed for the remaining three weeks (map 2).

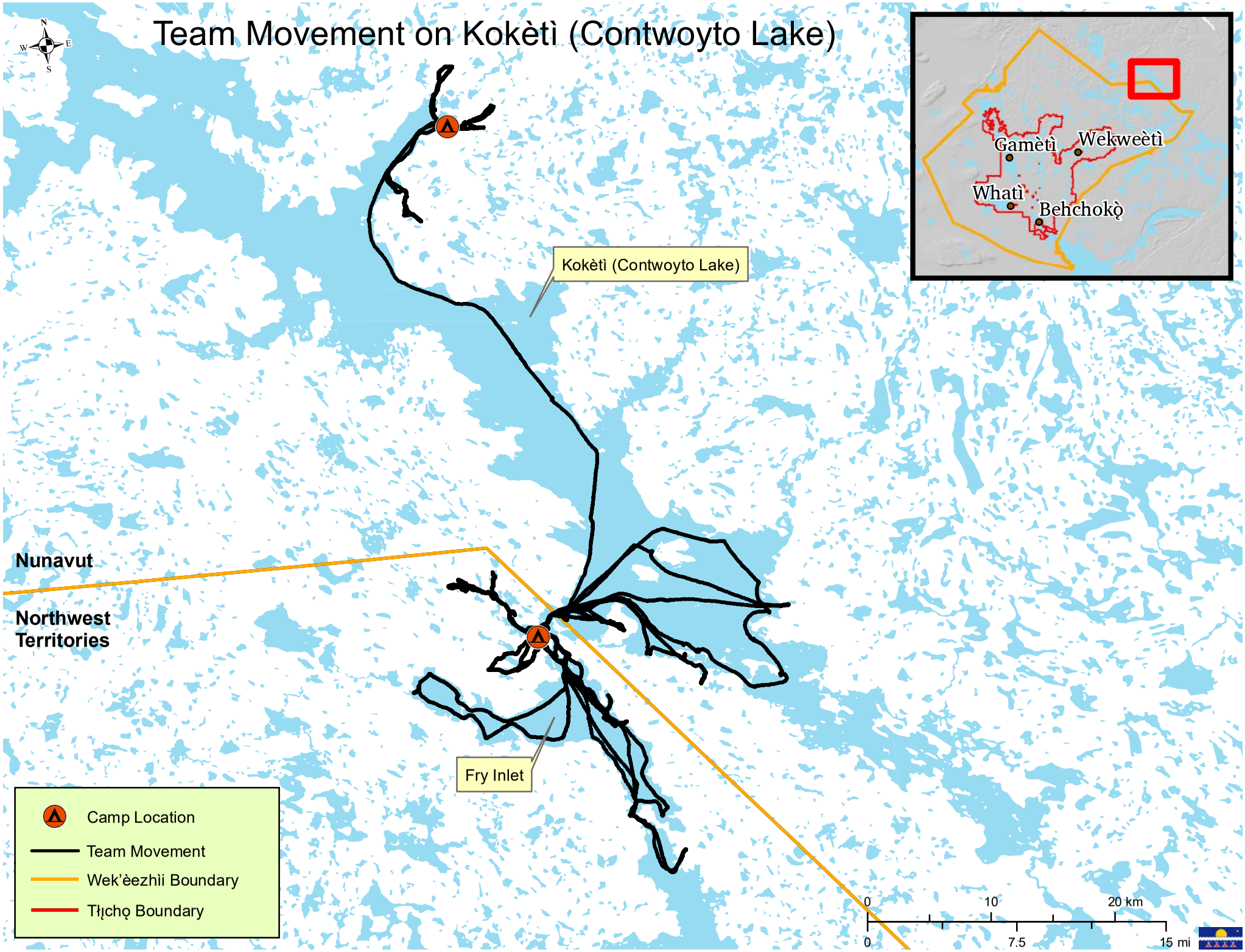
Kokètì is accessible by canoe and floatplane during the summer; and in the winter months, winter roads are built from Yellowknife to Kokètì for mining resupply. There are currently two non-active mines (Lupin and Jericho) in the monitoring area, and several active mines south of the area (Ekati, Diavik, Snap Lake), as well as numerous abandoned exploration camps scattered across the landscape.

1.2. Teams

Two teams of four spent 14 days at a camp each, following caribou movements on foot and by boat. Each team consisted of one elder, a younger hunter, a hunter/safety person, and a TK researcher. Team personnel were selected based on their knowledge of the barrenlands and caribou. This team structure provided each member with specific roles and daily responsibilities. Joergen Bolt, a member of Kugluktuk Hunter and Trapper Organization (HTO), was part of the program from 14th to 21st of July. By Tłı̨chǫ Government policy, all trips on the land are required to have a person with a Wilderness Safety Certificate, who can provide first aid and wildlife safety. The safety person was also chosen based on his/her knowledge of caribou and on-the-land skills, thus complementing the team's study objectives.

Photo 1: Team members: Domenico Santomauro, Petter Jacobsen, Archie Black, Leon Ekendia, Sean Richardson, Roy Judas, Joergen Bolt, Moise Rabesca and Michel Louis Rabesca.


Caribou Monitoring Area
N
W
E
S
Gamètì
Wekweètì
Whatì
Behchokǫ̀
Kokètì (Contwoyto Lake)
Nunavut
Northwest Territories
Fry Inlet
Study Area
Wek'èezhìi Boundary
Tłı̨chǫ Boundary
0
25
50 km
0
10
20 mi


Team Movement on Kokètì (Contwoyto Lake)
N
W
E
S
Gamètì
Wekweètì
Whatì
Behchokǫ̀
Kokètì (Contwoyto Lake)
Nunavut
Northwest Territories
Fry Inlet
Camp Location
Team Movement
Wek'èezhìi Boundary
Tłı̨chǫ Boundary
0
10
20 km
0
7.5
15 mi

2. Methods

2.1. Overview

Monitoring indicators were assessed through daily observations by the monitoring team. Each team travelled to locations selected using the elder's knowledge of the area and caribou movement, and GPS collar data provided by GNWR-ENR. Detailed, on-the-ground observations of caribou were described in qualitative and quantitative terms using field notes, GPS, and digital photography. The recording of knowledge in the field, the terms for describing knowledge, as well as the techniques for finding caribou were implemented using a methodology we named "Do as Hunters Do." This method, amply described in the methodology paper, is a participatory action research approach fashioned after a traditional caribou hunt, in which members of the hunting party travel to specific locations on the barrenlands to find caribou together, collectively participating, experiencing, and sharing knowledge.

"Do as Hunters Do" is based on specific ways of observing caribou. These include observations at key locations traditionally used to find caribou: nǫ̀ǫ̀kè (water crossings), ekwò etǫ (caribou trails), ti k'abàa (shorelines), and daka (elevation points). The team travelled to these locations, and subsequently proceeded to observe and record TK using detailed field notes protocols and ethnographic techniques of enquiry, primarily developed by engaging with the elders as a junior hunter.

A degree of caution is required when interpreting the wildlife numbers provided in this study. Due to the difficulty in estimating animals from the ground level the caribou numbers observed are provided as estimates. It is possible that some small herds and individual animals may have been counted twice as they moved back and forth within the study area over the course of the program.

2.2. Monitoring Indicators

Monitoring is based on the periodic assessment of key indicators. Monitoring indicators for Boots-on-the-Ground have been developed using an interdisciplinary approach founded on the elders' knowledge of the Bathurst herd through *dè*, and scientific wildlife monitoring indicators. *Dè* can be translated as "land" but with a broader meaning than the connotation usually associated with this word; it refers to a whole ecosystem or environment; "however, where the word ecosystem is based on the idea that living things exist in association with non-living elements, the Dogrib term *dè* expands the meaning of "association" to encompass the knowledge that everything in the environment has life and spirit" (Legat, Zoe & Chocolate, 1995). Based on the holistic Tłı̨chǫ knowledge of *dè* and scientific indicators, we highlighted several monitoring categories: (1) habitat and environmental conditions; (2) caribou; (3) predators; and (4) industrial and human disturbance. These broad categories have been subsequently divided into individual indicators, as presented below:

Caribou Habitat and Environment

- Daily weather pattern (temperature, wind direction, humidity, barometric pressure)
    a. Caribou behaviour in response to weather

    b. Daily insect activity in response to weather
- Caribou and predator behaviour in response to weather/ insect activity
- Conditions of vegetation and caribou forage
- Effects of environmental changes on habitat and caribou

Caribou

Caribou health

- Unhealthy: skinny; bony; fatigued
- Healthy: normal conditions; no bones visible on rump and back
- Healthy: Layer of fat shows on the neck and back, and back to rump. Look at tail: if it's short, then the animal is fat and healthy

Hide color

- Unhealthy: discoloured; patchy
- Healthy: nice color; no patches. In July: white colored hide (shed winter coat in June- July); August: darker color and shorter hair (new winter coat is coming)

Walking posture

- Unhealthy: walking with lagging head
- Healthy: prancing, or normal posture: head straight or slightly down when walking

Injured animals

- Number of caribou injured in the herd
- Types of injuries
- Signs of disease

Calves

- Cow-to-calf ratio
- Number of cows without calves
    i. When no calves: sign of unhealthy herd, and cows under stress
- Number of twins: sign of a healthy herd, as the cow is healthy enough to support two calves—demonstrates cows have not been under stress, and good habitat quality

Predators

- Number and location of caribou predators
    - Signs: tracks, kill sites
- Relationship between caribou and predators

Industrial Disturbance

- Caribou behaviour and movement affected by visible presence, noise, scent from industrial infrastructure and activities

2.3. Quantitative Techniques

For the pilot year, the use of quantitative techniques was limited to recording weather observations using the weather station, the movement of animals using GPS data, and direct observations of amounts of wildlife including estimates of cow/calf ratio and predator's distribution within the landscape. The analysis of this data is correlated to the qualitative descriptions by elders.

2.4. Qualitative Techniques

Documentation of TK occurs during monitoring sessions throughout the day, including discussions in the mornings and evenings. The advantage of having a TK researcher on-site is documentation of TK through casual conversations and individual sessions with *in situ* monitors. We follow standard Tłı̨chǫ Research and Training Institute (TRTI) methodology for traditional knowledge research (Tłı̨chǫ Research and Training Institute 2012, 2013, 2015 and 2016). This documentation technique applies to both the open-ended and semi-structured methods.

2.5. Field Notes Protocols

Field notes protocols were created to provide consistency between the researcher's observations. Table 1 below provides an overview of the information collected by the researcher each day.

ITEM	**DESCRIPTION**
WEATHER (from portable weather station)	
Temperature:	Humidity:
Wind Speed:	Wind direction:
Weather Notes: *describe daily weather*	
Weather/Insect: *describe insect harassment in relation to weather and wind speed*	
Weather/wildlife: *describe wildlife activity in relation to weather*	
WILDLIFE OBSERVATION NUMBER	
Number of animals:	Species:
Description: *describe animal activity, including location, behaviour, signs, and method and location of observation*	
TK NOTES	
Title: *key word used for content analysis, i.e. caribou hunting on Kokètì*	Description: *Describe elder's knowledge*
END OF DAY SUMMARY	
Km travelled:	Total time of observation:
No. of animals: totals	Key Tłı̨chǫ words/concepts:
Highlights for the day:	

Table 1: Template for observations.

The template provides consistency to the daily observations and experience of the team. The recording is completed in a field journal, using Rite in the Rain™ waterproof paper. A designated number is assigned for each new observation. The template systemizes the recording, while the notes themselves are flexible and open-ended, to allow for different durations of each observations, and adjusting to the nature of the elders' descriptions. The note-taking is conducted throughout the day by the researcher, in accordance with explanations made by elders.

At the end of each day the totals for the day are tabulated into a master sheet saved into a shared drive. Photographs and spatial data in the form of tracks and waypoints are saved into separate folders, one for each day of fieldwork. Spatial data totals of the day are analyzed each evening by the lead researcher to identify gaps in spatial coverage of areas, update team progress, and identify new areas to present to the group for discussion. A morning meeting is held to discuss the previous day's observations and plans for the days monitoring activities and locations.

2.5.1. Observations at Nǫ̀ǫkè

Nǫ̀ǫkè are the closest points of contact between land across waterbodies, used by caribou to cross the numerous large lakes dotting the tundra. Kokètì Lake has numerous eskers used as n*ǫ̀ǫkè*. *Nǫ̀ǫkè* eskers are typically long, twisted ridges formed by the movement of ice melt and deposits of sand and gravel reaching from shore, or in between islands. As part of our methodology, waiting at *nǫ̀ǫkè* allows the researchers to "do as hunters do" and therefore:

- Observe animals in close proximity
- Observe herd dynamics
- Observe predators following or waiting for the herds and their behaviour in close vicinity
- Determine the relative importance of attributes such as the presence of sand, rocks, and orientation in regards to prevailing winds for caribou choice of crossings

2.5.2. Follow Ekwǫ̀ Etǫ (Caribou Trails)

Ekwǫ̀ etǫ trails are numerous and interspersed throughout the northern landscape. The location and significance of caribou trails is recorded to help locate animals across the land, determine animal distribution, and document caribou behaviour. Observations related to caribou trails include:

- Caribou forage and diet
- Predator behaviour
- Cow-calf relationships (calves falling behind, and cows searching)
- Estimates of the number and health of injured animals falling behind, and their interaction with predators

2.5.3. Follow Tı K'abàa (Shorelines)

The analysis of *tı k'abàa* is functional to understand both n*ǫ̀ǫkè*, constraints on movement, and presence of predators. The analysis of local shorelines enables the researchers to:

- Understand how shorelines are used in the context of n*ǫ̀ǫkè* and *tataà.*
- Observe animal signs in soft material such as sand.
- Observe predators, since they usually walk along shorelines to smell anything that comes downwind from the lake.
- Observe and record the locations of "white shores," where caribou hair dispersed by the herd during swimming accumulates on the beach, giving the impression of snow or white foam.

2.5.4. Observations from Daka (Elevation Points)

Daka (elevated points) across the landscape such as *hozìı shìa* (hills on barrenland) and *what'àa* (eskers) were extensively used by the team to choose the direction of travel, locate features such as favourable pastures rich in lichen and other forage, track the progression of predators and other species, and as points of observation with limited insect harassment. Elevation points are useful to:

- Gain an understanding of the landscape and caribou movement

- Understand insect harassment and the factors affecting its intensity such as wind speed and weather.
- Assess vegetation quality and caribou forage areas.

2.6. Researcher and Elder

Personal knowledge, including the researcher's western academic background and professional background can become a source of bias when working with indigenous peoples' knowledge of the land. It is often necessary for the researcher to undergo a process of acknowledging one's own limitations, recognize personal points of view and opinions, avoid judgmental approaches and appreciate the differences. We define this process as maintaining naiveté, described as the skill of the researcher to be a novice, someone who genuinely wants to learn a new culture (Russel 2006). In this program, the relationship between the elder and the researcher is akin to that of an elder and a junior hunter, and can be summarized into the role of teacher and participant-observer. From the researcher perspective, participant-observers are insiders who participate, observe and record aspects of the life around them, in this case the TK of elders and harvesters.

Techniques for eliciting and documenting information are often based on the personal characteristics of each elder. Each elder had different knowledge and different ways of expressing himself. Some elders elaborated more than others and chose to communicate in long monologues. During such conversations, it is better to adapt to the characteristics of the elder and sit and listen without interrupting, rather than interrupt with a series of questions (Jacobsen 2011).

This method follows the cultural characteristics of learning among the Dene and Tłįchǫ cultures, in which knowledge is transferred mainly by personal observation, experience and storytelling, rather than solely by direct question-and-answer (Legat 2012; Goulet 1998). The Tłįchǫ and other Dene peoples share similar cultural attributes related to learning that are different from those of Euro-Canadian societies. The elder wants the researcher to learn in the same ways that they learn, preferably through personal experience and observation (Legat 2012, Goulet 1998, Guedon 1988, Ridington 1988). The use of direct questions often yields useful information and descriptive stories of the land, but open-ended conversations in which the elders take the role of teachers and explain the areas they feel important from their own experiences on the land are usually the most successful and insightful. This method of research is more in-tune with Tłįchǫ traditional forms of teaching and, thus, enhances the research process.

2.7. Data Analysis Method

The complex methodology of the TK program—combining ecological observations with cultural knowledge about landscapes—requires a multidisciplinary data analysis approach. Information collected in field journals during the pilot season of the program was collected using Participatory Action Research (PAR) and ethnographic documentation, and analyzed using content analysis, a technique that systematically categorizes and describes written, spoken, or visual forms of communication. This method was chosen as the primary technique of data analysis because it allows for qualitative text interpretation, while providing a framework of data analysis that can be employed for the duration of the multi-year program.

The field journals captured specific field observations of wildlife and statements made by elders and monitors during daily observations and team meetings. Content analysis of the recorded field data was completed by TK researchers using standard TRTI research analysis methodology (Tłı̨chǫ Research and Training Institute 2012, 2013, 2015, 2016). Content analysis consisted of developing categories and identifying sub-themes and codes within each category. The categories parallel the monitoring focus of (1) caribou; (2) habitat and environment, (3) predators and (4) industrial disturbance, while the emerging sub-themes and codes often cross between the categories. We approach content analysis using both quantitative techniques, for specific observations, and qualitative techniques for recorded TK statements.

The monitoring indicators were delineated prior to and during the field season. Next, we identified main categories from the statements collected in the journals. The statements were divided into categories (i.e. caribou). Categories were coded using keywords selected from the elders' statements; this way, each category was imbued with meaning and personal stories from the elders' lived experiences on the land. These were subsequently divided into sub-categories as required to provide the necessary definition to each topic (i.e. caribou health). The result of content analysis are tables of statements, from which inferences about trends, patterns, and correlations can be made.

Additional statements collected by the researchers relate to team experiences, often of multi-day events, as well as experiences of weather systems or recurring animal observations. By using the ethnographic and PAR format of data gathering, the researchers were able to observe and live each phenomenon from the point of view of the subject of the study, and document traditional knowledge. In TK research, it is often challenging to include knowledge that is shared privately between elder and researcher, as some types of knowledge are only shared in certain situations and to certain people. For example, knowledge of grizzly bears will not be discussed openly among team members in the field. Or, knowledge of spiritual aspects of caribou migration can only be shared to certain people. This form of knowledge often escapes the boundaries of theoretical classifications and categories. Therefore, in employing content analysis as sole analytical technique, the researcher risks losing the depth and intensity of the lived experience as part of the "hunting team." As an attempt to avoid this, we combined content analysis with qualitative descriptions of the lived experiences. More insights on this topic are provided in the Discussion section of this document.

Photo 2: Michel Louis Rabesca, Leon Ekendia, John Koadlak and Joergen Bolt observing herd. July 12th 2016. Photo: Petter Jacobsen

3. Results

The two teams camped in the study area for a total of 27 days, divided in two shifts of 14 days each. Table 2, provided below, summarizes the total study time and distances travelled on foot and by boat.

Table 2: Total study time and spatial movement of teams.

Total On-Ground Time and Movement	
Field days	27
Hours travel by boat and foot	59.65
Hours observation	92.15
Total hours moving & observing	140.3
Kilometres travelled by boat and foot	481.4

During the time spent in the study area, the team observed indicators of caribou habitat, caribou health, predators and other wildlife observations. The timeline for the study was selected to overlap with the caribou migration through Kokètì. Over the course of 27 days, the two teams observed 10,258 *ekwǫ̀* (caribou*/Rangifer tarandus groenlandicus*), of which the majority were observed between 12th and 24th of July. The teams also recorded other wildlife, including six *sah dek'oo* (grizzly bears*/Ursus arctos*), one *dìga* (wolf*/Canis lupus*), 50 *hozìı edzıe* (muskox*/Ovibos moschatus*), numerous *didi* (arctic ground squirrel*/Spermophilus parryii*) and numerous avian species. These include the short-eared owl (*Asio flammeus*), northern pintail (*Anas acuta),* common eider (*Somateria mollissima*) as well as numerous species of migratory birds and waterfowl typical of the region. Table 3, provided below, summarizes the number of large mammals observed during the study.

Table 3: Observations of large mammals

Total Mammals Observed	
Caribou	10,258
Grizzly bears	6
Wolves	1
Muskox	50

A note should be made on our description of animals in this report. As outlined in "We Watch Everything: A Methodology for Boots-on-the-Ground Caribou Monitoring", the program "recognize[s] animals as sentient beings with personal autonomy and the ability to communicate, hold memory, and accrue knowledge" (TRTI 2017:9). In this view—and implicit to the descriptions in this report—a sentient animal *choses* specific strategies, and an animal *knows*; for example, caribou *know* weather will change. Furthermore, the report follows the Tłı̨chǫ tradition of addressing animals in a similar manner to people. For example, a bear is described as *him*, or a caribou leader as *she*. Or, a caribou cow with calf is addressed as a *mother,* or a yearling as *sister*, depending the relational context.

3.1. Caribou Habitat

3.1.1. Climate Change

Combining traditional knowledge and our team's observations, we studied the overall conditions of the summer range habitat, with a particular view towards on-the-ground effects of climate change and the overall conditions of the summer range. By analyzing these factors, we discuss the impacts that its change has on caribou. We identified earlier spring melt and the disappearance of snow patches during summer (appendix 1) as a key habitat change affecting caribou within our study area.

3.1.2. Early Spring Melt

The first camp was located at the end of a long inlet on northeast shore of Kokètì (map 2). At the time of arrival—July 6th—there were no sheets of ice or ice slush floating on the lakes. The Inuit who live by the lake said the timing of spring melt was approximately two weeks earlier than usual. In earlier years, ice cover remains on the northern part of the large lake until mid-July. This year, the entire lake and its numerous inlets were ice-free by late June. These observations are consistent with a host of scientific literature detailing the accelerated effects of climate change on arctic and subarctic regions (IPCC, 2014).

3.1.3. Melted Snow Patches

The higher temperatures, experienced earlier in spring, had melted the snow cover on land around Kokètì by late June. Usually numerous snow patches covering crevasses or sun-shaded slopes can be observed in mid-July. This year, the remaining snow patches melted in late June and there were no snow patches left in early July. As a result of the early melt, the vegetation was more desiccated than usual for this time of year. Usually the snow patches remain into July and meltwater from the snow patches continuously runs down hills and slopes, and soaks the ground in low-lying areas.

3.2. Caribou Observations

We observed approximately 10,258 caribou (appendix 2). Herds and individual animals may be counted twice as it is possible we observed the same animals on multiple occasions. The majority of the animals were observed between July 12th and 24th. Numerous herds, each numbering hundreds of animals, followed the same migration route from the peninsula between Kokètì and Fry Inlet toward to the higher hills northwest of Fry Inlet. The other caribou observations were of individual or smaller herds.

July 8th

One cow yearling observed on the peninsula across the bay from camp 1. Front left leg was injured. Caribou was positioned upwind from us, and did not smell us. She saw us and stared right in our direction, but did not run. After five minutes, she bedded down and continued to watch in our direction. She was alone on the peninsula. No other caribou observed in the area. Due to her injury, she was most likely not able to follow the fast pace of the migrating herds when the larger herds moved through this area.

July 12th

Large caribou herd of approximately 1,000 animals on the peninsula between Kokètì and Fry Inlet. Herd was first observed when skylining the hills further inland on the peninsula at four p.m. Herd moved in northeast direction from the higher rolling hills down the sloping hills toward the lakeshore. The herd

moved in a constant zigzagging motion into the slightly shifting northeast breeze. Insect harassment was high. Herd moved in one tight unit.

July 13th

A large herd of 1,000+ caribou. Large herd was gathered along the shoreline drinking water on the west side of the peninsula between Kokètì and Fry Inlet, approximately eight kilometres south of *nǫɔokè*. Probably not same herd as on July 12th: more bulls were observed in this herd. Herd started a fast pace in a northern direction on the peninsula towards the *nǫɔokè* at the same time as tall cumulus thunderclouds with rain and wind came in from the north (photo 3). Three cows ran back for their lost calves once the herd left the watering place. One calf was disoriented and ran south in opposite direction of the herd. A cow mother and a yearling (sister) ran two kilometres back for the disoriented calf. The cow, yearling and calf returned in the path of the herd 15 minutes later. Several injured animals lagging behind the herd.

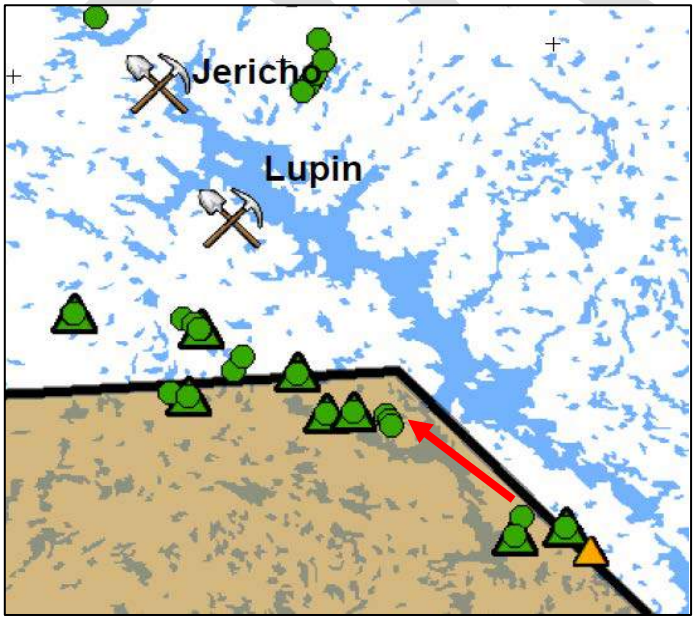
July 13th

7-10 000 caribou swam across the *nǫɔokè* between Kokètì and Fry Inlet (Map 5). The herds followed the migration route from the peninsula between Kokètì and Fry Inlet to the land northwest of Fry Inlet (map 3). Numerous herds of hundreds of animals, each with their own cow leader, crossed after each other following the same scent trail. The mass migration, from our first observation, lasted three hours. The herd moved approximately eight kilometres, from first observation (by shoreline) to the *nǫɔokè*, in about 20 minutes. Approximately 90% of last part of herd had leg injuries.

July 14th

One yearling bedded down in the grass two kilometres west of esker/ camp 2. Probably injured and left behind during the mass migration on July 13th. Too far away to observe sex. The yearling was bedding down in wet grass/muskeg, probably to cool down injured area.

Large herd of 1,000+ animals observed on hills southwest of Fry inlet (map 3). The herd is either same herd we saw during migration yesterday or a different herd that moved in from south of Fry Inlet. The herd was skylining the hills. We watched them with binoculars from the esker west of camp 2.



Map 3: Bathurst caribou collars on July 14th, 2016. Green triangle: Bathurst male caribou; green circle: Bathurst female caribou. Inserted red arrow indicate direction of movement Source: GNWT-ENR.

July 15th
One cow with injured back left leg. She was walking among tall willow bushes by a stream to a small lake, two kilometres west of camp 2.

One calf running around close to the injured cow. The calf was looking for its mother. The calf ran right up to us looking for its mother. The injured cow ran into bushes when we approached. After we left, the calf ran through bushes looking for the cow, but cow walked away, and distanced herself from the lost calf. The cow was not its mother and will not adopt the calf.

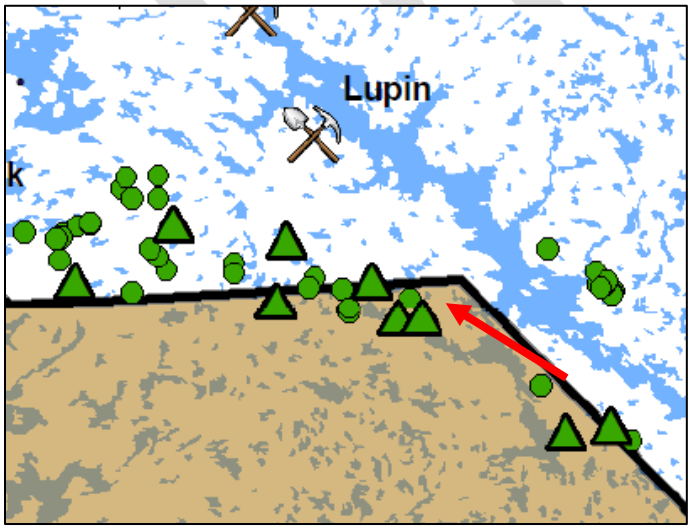
July 16th
One cow: injured back left leg, and one calf: running around, looking for its mother (same as July 15th).

July 17th
One cow caribou. We came across her in the water, swimming across the *nǫɔkè* by herself. She was following the same trail as the herd we saw on July 13th. She was possibly blind. Possibly looking for her calf. The cow was sniffing the ground for scent.

July 21st
Several herds, numbering 100-200 animals each, for a total of 600+ animals. The herds swam across the *nǫɔkè* between Kokètì and Fry Inlet. The herds were running west, following the same scent trail as the herds sighted on July 13th, towards the area northwest of Fry Inlet. Several slower and injured animals were lagging behind at the end of the herd. The herds were following the wind-exposed ridges as they moved west.

July 22nd
Herd of nine caribou observed. The caribou were following the same scent trail, from the peninsula between Kokètì and Fry Inlet, across the *nǫɔkè* and towards the hills northwest of Fry Inlet, as the other herds had in previous days (map 4). The herds were not bothered by insects and remained stationary, grazing.

A herd of 13 animals were observed on the peninsula between Kokètì and Fry Inlet. The herds were stationary and grazing.



Map 4: Bathurst caribou collars on July 22nd, 2016. Green triangle: Bathurst male caribou; green circle: Bathurst female caribou. Inserted red arrow indicate direction of movement. Source: GNWT-ENR.

July 23rd
Herd of 70-80 animals, following the same scent trail as previous herds, travelled from the *nǫ̀ɔ̀kè* in a westerly direction.

All the animals appear peaceful and are not bothered by insects. One herd moved west along the same trail, while 19 animals moved north, along an old trail.

July 24th
Three caribou observed on an esker on the east side of the peninsula between Kokètì and Fry Inlet. The insect harassment was increasing but the animals were not too bothered. They grazed and, when the wind decreased, ran into the wind to a different spot that provided relief from insects.

July 28th
One caribou cow observed on east shore of Kokètì. The cow appeared healthy. Running and twitching due to high insect harassment.

One yearling observed west of camp 2. One grizzly bear walked close to the caribou, but made no attempt to approach or attack it.

Photo 3: Caribou herd moving past team on peninsula between Kokètì and Fry Inlet. July 13th, 2016. Photo: Petter Jacobsen.

3.2.1. Injured Animals

Many injured animals were observed in the larger herds (appendix 5). The injured animals were identified as walking at a slower pace in the back end of the herd. On July 13th, we observed large herds crossing the *nǫ̀ɔ̀kè*. Moving in a slow pace behind the main pack, followed a trail of numerous animals with various injuries limiting their mobility. Injured animals were also observed travelling alone. The single animals were not able to maintain the fast pace of the migrating herds and were left behind when the larger herd moved through. These injured animals were mostly bedding down to rest. The following are the amount and type of injures observed:

July 8th
One yearling with an injured front left leg (photo 9). Possibly left behind when larger herd moved through. Yearling was alone on the peninsula. No other caribou observed nearby.

July 12th
Four injured caribou observed in a large caribou herd of 1,000+ animals: 1 bull; 1 cow; 1 calf; 1 yearling. The large herd was on the peninsula between Kokètì and Fry Inlet. All injured animals had leg injuries. Too far away to observe injuries in more detail. All of the animals were walking at a slower pace in the back of herd.

July 13th
Two injured animals in a large herd of 1,000+ caribou: 1 calf; 1 bull. They walked at a slower pace behind the herd. The large herd gathered along the shoreline to drink water on the west side of the peninsula between Kokètì and Fry Inlet.

July 13th
Numerous herds observed at the *nǫɔkè* between Kokètì and Fry Inlet. 7-10,000 swam across the *nǫɔkè* and ran along the migration trail west of Fry Inlet.

1 cow (with radio collar), injured.
Approximately 90% of last section of herd were injured.

All visible injured animals had leg injuries. Due to the fast pace and large number of animals crossing at once, it was difficult to record exact numbers and details of injuries.

July 14th
One lone yearling, two kilometres west of the *nǫɔkè*. The yearling was bedding down in wet grass/muskeg, possibly to cool down injured—and perhaps infected—leg. Probably left behind by its herd during mass migration on July 13th.

July 15th
One cow, injured back left leg. She was walking among the tall bushes by a stream towards a small lake, two kilometres west of camp 2. A calf was following her. The cow did not adopt the calf.

July 16th
One cow, injured back left leg (same as July 15th). The same calf was following the cow.

July 21st
Five injured animals at the last part of herd.

3.2.2. Calf Health

All calves, except the one observed on July 15th and 16th, belonged to larger herds. Calf observations were made between July 12th and 23rd, as part of the larger herds following the migration route between the peninsula between Kokètì and Fry Inlet and the hills northwest of Fry Inlet (map 4)**.** The following observations were made of calves (appendix 6):

Herd of 500+ caribou observed July 12th
In a herd of 500 animals: approximately 1/3 calves and 50 % cows. The elders stated the ratio of calves to cows was normal for a herd that size. All calves showed signs of normal health conditions: healthy hide color, strong body posture and running at a fast pace. One calf injured.

Herd of 1,000+ caribou observed July 13th
Approximately 40% of the herd was comprised of calves and yearlings. All calves show signs of normal health.

One calf became disoriented as the large herd moved north from the shoreline towards the *nǫɔokè*. The calf ran south, opposite to the direction of the herd. A couple of minutes later, the calf's mother ran back approximately two kilometres to find the calf. The calf's sister (a yearling) followed the mother, trying to find the calf as well. The mother, yearling and calf were reunited. Mother and calf ran back to main herd, while the yearling lingered in back for a while. Strong north winds and a rain storm descended as the family was reunited.

Herd of 7,000+ caribou observed July 13th
All cows were with calf. All calves showed signs of normal health: healthy hides and running fast. One calf injured.

One calf observed July 15th
Calf was by itself and searching for its mother (photo 10). An injured cow was close by, but it was not its mother and will not adopt or recognize the calf. The calf was left alone.
Calf appeared healthy. The hide looked normal and the animal was running around the area. When we approached, the calf ran right up to us.

One calf observed July 16th
Same calf as observed on July 15th. It was still close by the injured cow.

Herd of 50+ caribou observed July 23rd
Five bulls, 10 females, and four calves (10:4 ratio).
All calves show signs of normal health.

3.3. Predator Observations

Our observation technique was designed to detect predators in the vicinity of the herds. We specifically waited until after the herds had moved on to observe potential predators following further behind the herd or the wounded animals lagging behind the main herd. As we watched the herds, we also scanned the surrounding hills to spot any potential predators following the herds at a distance.

3.3.1. Grizzly Bear Observations

Six observations were made of male grizzly bears (appendix 7). We possibly observed the same bear on multiple occasions, as all observations were of males and in the same approximate area within a radius of 10 kilometres. The first grizzly bear observations were made five days after the mass caribou migration over the *nǫɔokè* between Kokètì and Fry Inlet. The observations were made between July 18th to 28th, while smaller herds of caribou were passing through the area. All observations were made in proximity to the *nǫɔokè*, either on the peninsula between Kokètì and Fry Inlet, or along the esker system north of the *nǫɔokè*. One old abandoned bear den was located on the northeast side of the esker north of the *nǫɔokè*

and close to camp 2. No recent dens were observed. No observations were made from camp 1. The following observations were made:

July 18th
Fresh male grizzly bear tracks were observed in the gravel on top of the esker one kilometre west of camp. The bear walked along the esker during the night and observed our camp. The tracks followed north along the esker.

At five p.m., we observed a male grizzly three kilometres southeast of camp on the opposite, east side of Fry Inlet. A young male, with light brown-coloured fur on his back and black fur underneath. He was walking with his nose close to ground to better smell, along the trail caribou used two days before. Possibly the same bear as the one who left his tracks behind last night.

From the boat, the team approached him slowly. The bear walked directly towards us and stopped only 30 meters away by the shoreline. One of the team members stood up and spoke firmly to him: "*we were not here to harm you and as we mind our own business, you should do the same and stay away from us.*" Following the speech, the bear started to run away from us, stopped once, turned around to look at us, then proceeded inland and beyond our sight.

July 22nd
One male grizzly bear observed by the *nǫɔkè* south of camp. Large male with an estimated 1.5-metre back height. He seemed to be missing his left ear. He was sniffing around the ground along the esker and was hunting for ground squirrel. The bear started running towards us, and came approximately 100 metres from us. We fired off several bear bangers, and he turned around and ran several kilometres, until he was out of our sight.

July 23rd
One grizzly bear observed on the eastern shore of the Fry Inlet. The bear was approximately five kilometres from caribou. His behaviour searching around the rock outcrop indicated that the bear was searching for ground squirrels.

July 25th
One grizzly bear observed at a distance.
July 28th
One grizzly bear observed south of an esker, one kilometre from camp. The bear moved close to a caribou but did not attack, or even make an attempt at hunting it down. The caribou was a yearling, and the bear possibly knew it would take too much effort to hunt down a fast yearling. The bear was moving in the direction of camp, and we scared him off with bangers and rifle shots.

3.3.2. Wolf Observations

One wolf was observed and one track was documented (appendix 7). The observations were made on July 13th and 15th. Both observations were made in proximity to the *nǫɔkè* between Kokètì and Fry Inlet, during the two days following the mass migration across the *nǫɔkè*. No observations of wolves were made while teams were at camp 1. Den sites were not observed, neither recent or old dens. No fresh or old kill sites made by wolves were observed. The following observations were made:

July 13th

One wolf was spotted in camp 2, at three a.m. The wolf circled around the campsite to see and smell who was there, during the first night at the new camp location. Once it circled the camp, the wolf ran away. We never saw the wolf again.

July 15th
One wolf track observed four kilometres west of the *nǫɔokè*. The footprint was from the prior night, and printed in mud. The track ran opposite to the western movement of the caribou herd two days prior. The wolf was possibly running northeast to look for injured animals.

3.4. Other Wildlife Observations

The monitoring area is home to numerous other animal species. Outside of our monitoring focus, muskox was the other large mammal observed. The muskox observations were all northwest of Fry Inlet, approximately between one and five kilometres from camp 2. No muskox were observed near camp 1. The observations were made from the tall esker directly west of camp 2, between July 15th and 28th (appendix 8).

July 15th
One lone muskox—an old bull—observed on south side of a sloping hill, approximately four kilometres northwest of the esker.

July 16th
One male muskox. Same as observed on July 15th.

July 20th
Three muskox observed on a windswept slope. They did not appear to be bothered by insects. However, it was noted that they grazed on a windswept slope, likely trying to avoid areas with little wind.

July 22th
Three muskox, approximately 3.5 kilometres from camp 2. Two muskox bedding down.

A group of 21 muskox grazing northwest of camp 2, approximately 3.7 kilometres away. The group was likely part of the same group. They appeared unhurried and not bothered by insects, which is not an issue today.

July 23rd
Observed a group of approximately 20 muskoxen. The herd was probably same group as observed on July 22nd. They are grazing. Located approximately two kilometres from camp 2.

July 28th
One muskox observed near camp 2.

Other wildlife observed were: arctic ground squirrel (*Spermophilus parryii*); numerous avian species, including the short-eared owl (*Asio flammeus*); northern pintail (*Anas acuta*); common eider (*Somateria mollissima*) and numerous species of migratory birds and waterfowl typical of the region.

4. Discussion

4.1. Caribou Habitat and Climate Change

The climate of Kokètì is subarctic and characterized by long, very cold winters and short, cool-to-mild summers, with moderate amounts of precipitation. Water levels and fresh water in this region are regulated by the movement of arctic air masses, the thawing of snow in the summer season, and continuous and discontinuous permafrost. Changing climatic patterns significantly impact the study area, and consequently the Bathurst caribou. Temperatures, snowfall abundance, precipitation and permafrost affect caribou forage, energy expenditure, insect harassment, and the availability of refuge habitats (Brotton and Wall, 1997; Witter et al.; 2012).

"Do as Hunters Do" provided us with the opportunity to personally experience and observe the direct effects of climate change on caribou habitat. We observed a strong correlation between climate change and the conditions of caribou habitat. These include events such as the early approach of spring: earlier melt of lakes and rivers; warmer and drier weather at earlier dates and the disappearance of snow patches and overland inundations usually visible in mid-July (appendix 1).

The herd's seasonal movement through the area correlates with the timing of freeze-up and spring thaw. According to the knowledge collected, spring melt has been occurring approximately two weeks earlier than in "normal [previous] years." On their migration routes, the herds cross numerous waterbodies and rivers. These are described as opening progressively earlier in spring. The herds follow the same migration routes and use same crossings, but as timing of the melt is changing, the ice and snow conditions at the crossings are unpredictable compared to earlier years' observations. Consequently, crossing these waterbodies has become more dangerous. John Koadlak stated, "the sun moves in a higher position in the sky; as the sun is higher earlier in the spring season, the melt will occur earlier and faster**."** According to the elders, warmer climates are changing the quality of the environment for caribou.

Vegetation

From July 5th to 13th we experienced high temperatures, no significant precipitation, and none of the snow patches described by the elders as crucial in keeping the vegetation "moist." During long, dry periods, the ground vegetation becomes dry, and the lichen and mosses become "crusty," especially on sun-exposed hillsides. The elder Michel Louis Rabesca describes how it becomes hard for caribou to continuously walk on crusty vegetation: "In middle of hoof is a soft spot that can become sore from walking on the dry and hard vegetation. At times with prolonged drought and crusted vegetation, caribou hooves get hurt."

Continuous permafrost helps maintain surface water levels and groundwater in the arctic near or around the surface, affecting the type and quality of vegetation. Warmer temperatures result in the loss or disruption of continuous permafrost, and therefore changes in soil fertility and plant species. Scientific research has determined that deciduous shrub growth has increased across the arctic simultaneously with recent warming trends (Michael M Loranty and Scott J Goetz (2012). The reduction of albedo occurring

with the greening of the tundra as well as the shrinking of permafrost have the potential to impact the quality of caribou habitat in several ways. As large areas of land lose continuous permafrost and spring-thaw moisture earlier in the season, drying of surface vegetation as well as the availability of lichens has the potential to negatively affect caribou. We intend to investigate the relationship between permafrost, higher temperatures and vegetation in more detail using the "Do as Hunters Do" methodology, as well as exploring other research we might pursue in the next years of the program.

Snow Patches

Caribou look for residual snowy patches to decrease their body temperature on warm summer days, as well as to find relief from insects, and to use for bedding areas. Snow patches around Kokètì are the result of wind accumulation from windswept slopes, and overflows of rivers and streams onto vast swath of low-lying areas. In late winter, the overflow areas will build up thick layers of snow and ice. These overflow areas usually remain on the land until mid-July. As described by Rouse *et al*. (1997), the spring flooding of ice-jammed north-flowing rivers is a major event, which renews the water supply of lakes in delta regions and which determines the availability of habitat for aquatic organisms (Rouse et al., 1997).

Elders have noted how, in recent years, the water levels in lakes and rivers has decreased. Subsequently, the intensity of overland flooding in the spring and the availability of snow patches for caribou in the summer is reduced. According to elders, the disappearance of snow patches forces caribou to continuously walk and run into the wind as a relief from insects, and thus spend less time resting. The presence or absence of snow patches also has cultural significance: "As hunters travel the land in late winter, they observe and remember the locations with overflow. On hot summer days, they know where likely to find caribou to hunt."

4.1.1. Analysis of Nǫɔkè on Fry Inlet

When the herds travel over the vast land they need to walk around Kokètì and other waterbodies on their migration routes. At times, caribou prefer to swim across water bodies rather than walk the long way around. In those circumstances, they often choose to swim, entering the water at the point of shortest distance to the other side. *Nǫɔkè* is a Tłı̨chǫ term for water crossings; it literally means "swim across." It refers to the interface between water, land, and caribou movement; *nǫɔkè* are crucial to understanding the patterns of summer and fall caribou migrations.

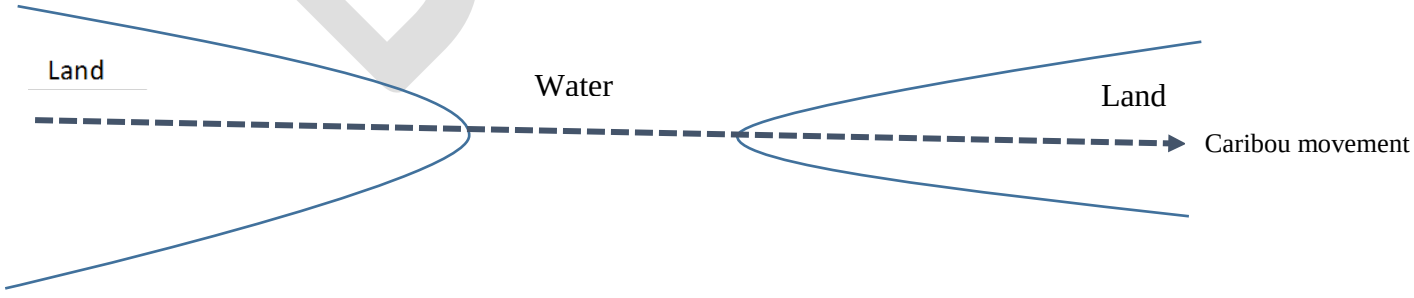


Figure 4: Outlines of a *nǫɔkè* (water crossing)

Crossing the lake can be dangerous—and possibly fatal. The leaders of each herd, typically a female with a calf, appear to use a risk-based selection process of water crossings. The surface conditions along the shoreline are studied to determine the places where the herd chooses to cross. Decisive factors, according to elders, include the presence of large erratic boulders, a rocky undersurface, strong currents, or other perceived physical hazards such as the scent of potential predators.

On Kokètì there are several *nǫɔokè* that caribou use, some of which are formed by eskers and island chains. According to elders, caribou preference to travel across islands is strategic, as islands provide temporary relief from predators and insects. At other times, caribou use islands as "stepping stones" to reach the opposite shore. During the transition from post-calving movements in July, when the herds congregate, to fall, when the herds scatter, caribou may use islands to find quality forage and cool humid conditions. This seems to be corroborated by our observations. On occasion, caribou were observed on isolated islands at least a kilometer away from the Fry Inlet peninsula or the lake shores.

During our fieldwork, the researchers strived to locate all potential *nǫɔokè*, based on the knowledge of our experienced guides, who knew exactly where caribou would cross. Numerous locations, considered "good crossings," were visited by boat to determine what made a *nǫɔokè* suitable for caribou. In almost all occasions, caribou were deterred from using the crossing by the presence of erratic boulders and rocky surfaces. Smooth, sandy crossings with few rocks and pebbles were almost always favoured. This hypothesis was further tested in the southern portion of Fry Inlet, where a long peninsula stretches almost entirely across the lake and the lake shores are only about a hundred meters apart, with shallow water in the channel between the peninsula and the western shoreline. According to our maps and our human understanding of what constitutes an ideal crossing, this location would be chosen due to the short distance, lack of currents, and relatively flat ground on both sides. However, rough subsurface conditions and the presence of large boulders deterred caribou from using these areas entirely. No fresh or old caribou trails were found on either shore, despite their relative vicinity to each other. Caribou crossings at Fry Inlet (map 5) seem to be localized instead at a *nǫɔokè* between Kokètì and Fry Inlet (photo 4), approximately 20 kilometres further north. Here, the ground is sandy and pebbly (photo 5), with only a few interspersed large rocks that can be avoided by using the northern sandy shoreline of the point. The smooth substrate minimizes the risk of leg injuries and allows for a safer crossing. Also, the terrain approaching the crossing from either side is flat and open, which allows for an increased visual assurance that no predators are in the vicinity.

The team member from Kugluktuk, Joergen Bolt, explained "*nǫɔokè needs to be good. You can't have too many rocks or the caribou won't cross*" (July 22th, 2016). The cow leader (see section 4.2.3) decides where the herd will cross, and at the same time she teaches her calf the migration routes to the crossings she prefers to use. These are the places that are safe for them to wade into the water with minimum chance for injuries and where they cannot easily be ambushed

Photo 4: Nǫʔokè between Kokètì and Fry Inlet. The north (left) side is the preferred due to sand while right side with rocks is often avoided. Photo: Petter Jacobsen.

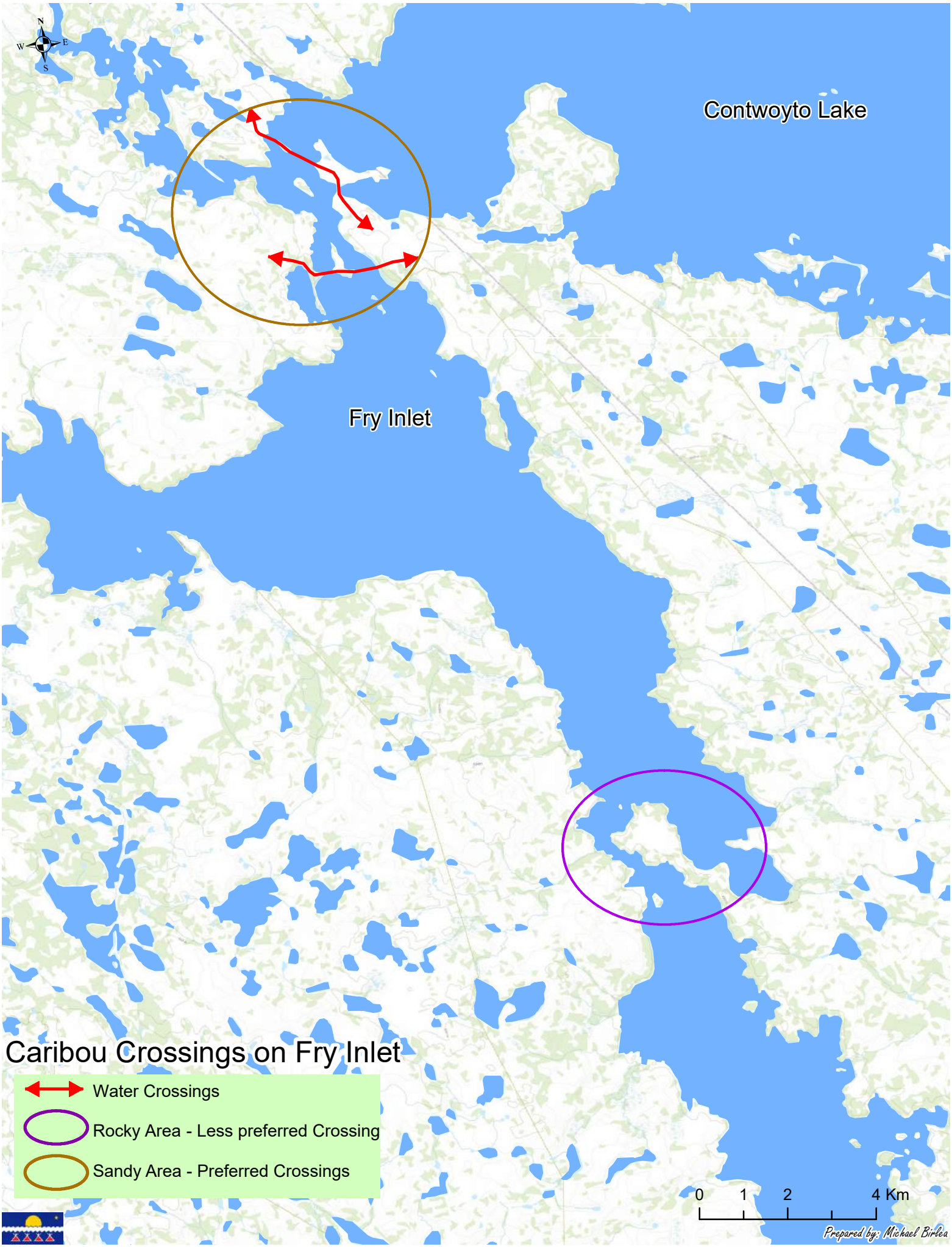
Photo 5: Tracks after mass migration in sand on north side of nǫʔokè between Kokètì and Fry Inlet. Photo: Petter Jacobsen.

4.1.2. Industrial Development and Nǫʔokè

The elders explained the importance of the *nǫʔokè*, and the caribou trails leading to the *nǫʔokè*. They also emphasized the potential dangers of disturbing the crossing and the trails leading to them. *Nǫʔokè* have been established over the course of centuries of caribou migration, and if they are blocked or disturbed, caribou may avoid an entire area, or be forced to select more dangerous migrating patterns, thereby increasing the risk of injuries. An ample body of literature describes the effects that anthropogenic disturbance has on caribou route selection and habitat use. Boulanger *et al.* (2012) suggest that Bathurst caribou select habitats at further distance from Ekati and Diavik. Influence of mine sites have been documented to alter caribou migration routes by as much as 50 to 65 kilometres. The elders noted that mining infrastructure established on or in the vicinity of the *nǫʔokè* at Ek'adiì, the island on which Diavik mine is located, and at the narrows between Ek'atì and Łiwets'aʔòats'ahtì (Lac de Sauvage), in close proximity to the Misery open pit mine, has blocked these important crossings. The caribou once used these trails and crossings during their fall migration. Now, herds must travel on different migration routes and use other *nǫʔokè*, normally not preferred (TRTI 2016). Consequently, the herds need to use less favorable *nǫʔokè* and trails which are not as safe.

4.1.3. Caribou hunting at Nǫʔokè

Certain *nǫʔokè* have been known by local hunters for countless generations. The presence of current and historical camps, and the numerous stories demonstrate that such places were most often a secure place to successfully hunt caribou, as "it is easier to spear animals, in the big herds, at the water crossings." The


Contwoyto Lake
Fry Inlet
Caribou Crossings on Fry Inlet
Water Crossings
Rocky Area - Less preferred Crossing
Sandy Area - Preferred Crossings
0 1 2 4 Km
Prepared by: Michael Birlea

nǫɔokè between Kokètì and Fry Inlet is one such place, and is part of the collective memory of the Tłı̨chǫ caribou hunting culture on the barrenlands (appendix 9).

Elder Michel Louis Rabesca remembers the stories his grandmother used to tell of this important *nǫɔokè*. Families used to paddle all the way from Behchokǫ to Kokètì entirely because of the significant *nǫɔokè* there: "Further south the lakes do not have such big crossings. Here, this *nǫɔokè* on Kokètì, is the main big crossing. People paddled to the barrenlands in July and August only for the type of hide one could get at that time of the year, and to make dry meat to bring back to the communities. People paddled along the shoreline, while the dogs walked alongside on the shore. Often the dogs' paws got sore from continuous running on rocks and dry vegetation. They would hope for rain, as the moist and wet vegetation is easier on the paws and they don't get sore from running."

Once the hunting parties reached this *nǫɔokè* they would sit close by and wait for the herds to come. "As soon as the cow leader goes in the water the herd won't turn back and will all follow her. Hunters wait for the leader to pass first, then hunter used canoe to spear the following animals in the water. The hunters wait on the side where the herd come from. Usually the family wait in the *kwea* - dwarf birches for the hunters".

Elder Michel Louis Rabesca paddled the canoe route three times from Behchokǫ to hunt caribou at Ets'àitì (Rawalpindi lake) and Deèzàatì (Point Lake) when he was young. The hunters would seek out the young animals, calves and yearlings, which were desired for their soft, warm hides. When preparing moccasins and pants, women used this type of hide for linings. Michel was about nine years old on his first trip to the barrenlands by boat. The area is often cold and rainy in fall. During the night, they slept only in the canvas they carried, and when it became cold, Michel's uncle would often say, "when we get to the barrenlands, you will sleep well." At the time, Michel did not know what he meant. But when got to the barrenlands, and shot caribou, Michel recounted how he slept well in all the warm hides.

The stories surrounding the *nǫɔokè* between Kokètì and Fry Inlet exemplify the need to understand the relationship between caribou and landscapes at a finer scale and from the ground level. In the extremely practical traditional knowledge of Inuit and Dene hunters, the knowledge of this *nǫɔokè*, of the procedures to observe when reaching the *nǫɔokè* and while hunting caribou, and the respect for the animals they hunted there, ranked as high as the knowledge of caribou on the larger scale. Knowledge, respect and cultural practices ensured that animals returned to this location every year: "It is known that as long as you respect the animal, they will show themselves to the hunter. The animals know they will be taken care of, so the caribou can 'give' themselves to the person who respects them."

4.2. Caribou Behaviour

4.2.1. Weather, Insect Harassment and Caribou Activity

The key driver to caribou activity levels and movements across the landscape was the correlation between shifting weather patterns and the level of parasitic insect (mosquitoes, black flies, oestrid flies) activity (table 10). Insect harassment can severely affect caribou, resulting in a less healthy body condition, energy deficit, and the selection of habitats providing relief from insects (Witter et al., 2012). Of all species of insects, the elders reported that blackflies cause the highest amount of harassment and stress, as they tend to lodge themselves into the eyes and ears of the caribou. "Sandflies" tend to be large and "go to

the soft spot on the skin, to the ears, eyes, and nose." In comparison to these insects, mosquitoes are deemed to be less harassing to caribou (appendix 4).

On July 12th and 13th, we experienced high temperatures and relatively light winds. Significant changes in the weather system occurred between July 13th to 15th. During the day on July 13th, two large weather systems appeared on the northern horizon. John Koadlak noticed the systems and told the team that in two days we would experience cloud cover and rain. That evening, a large rain storm passed over us. During the night and the following day, July 14th, the wind direction shifted from predominantly southeast to northeast, and later northwest. On July 14th, the wind speed increased to an average of 30 kilometres per hour. The barometric pressure dropped during the day, and cloud cover lowered. As John predicted, two days later we had full cloud cover and rain. On July 15th, the barometric pressure was at its lowest, at 954 [units], and winds strongest at 30 to 40 kilometres per hour. Rain showers lasted all day. On July 16th, the temperatures dropped to high of 14 degrees Celsius, with a low of nine degrees Celsius. The cold temperatures and strong winds continued until July 27th.

The colder temperature and strong north wind, following the weather shift starting on July 14th, significantly reduced the level of overall insect activity. In all wind-exposed areas, insect harassment was nearly non-existent. Mosquitoes were only present in wind-sheltered areas such as shrubs and leeward slopes; overall, wind and rain were the predominant factors reducing insect activity level.

The movement of caribou herds appeared to correspond to the shifting weather systems. Before the weather shift on July 14th, we observed herds moving constantly into the lightly-shifting southeast wind, seeking relief from insects in high ridges and by rapidly moving across the landscape. During the evening of July 13th, when the weather shifted with large cumulus clouds, strong northwest winds and rain, an estimated 7-10,000 animals moved from the peninsula between Kokètì, across the *nǫɔokè,* and continued toward the hills northwest of Fry Inlet. At the start of the weather change from a high to low pressure system, we observed all the herds convene on the peninsula and move quickly, and with determination, into the evening's rain storm. The rain lasted for approximately two hours, during which numerous smaller herds of hundreds of caribou emerged from further south on the peninsula and followed each other along the same scent trail. By the team's estimate the herds migrated approximately 40 to 50 kilometres to reach this location and the refuge from insects afforded by wind and rain. From our first observation of the herd drinking by the lakeshore, we watched them move almost eight kilometres to the *nǫɔokè* in approximately 20 minutes.

The elders emphasized that the caribou were moving with purpose, and they only see such fast-paced mass migration when the cow leader wants to move to a certain place for a certain reason. The leading cows appeared to feel that a low-pressure system was approaching, bringing wind and cold, and decided to move into windward areas where they could bed down, cool body temperatures from the previous nine warm days, and rest away from insects.

During post-calving aggregation and in the summer, caribou find rest and refuge from insect harassment during periods of rain, high winds, and cooling temperatures. On such days, calves and energy-deficient animals recover after the long migration, by resting and grazing. Spread across the landscape on windward slopes, hundreds of animals were seen bedding down or standing still, facing into the elements. Furthermore, caribou know the weather system will change again in the coming days—temperatures will increase, winds will decrease, and consequently, insect harassment will increase as well. Again, the

caribou will need to constantly move. Thus, they know the importance of resting and foraging during these cold, windy days. If caribou move on these days, they often prefer to travel during evening or night, when the wind calms down and insect activity increases. Having personally experienced the effects that insect harassment had on our teams, we could not help but feel relief for the caribou, and gratitude for the cold rain and the wind soaking the landscape. As poor weather and high winds persisted in the following days, the caribou could be seen moving again. However, as one team member put it they appeared "more peaceful."

Time	Weather	Insect Activity	Caribou Activity
July 12th	High temp, low southeast wind	High	High: constant movement into wind
July 13th	High temp (20+ Celsius), low southeast wind (8km/h)	High	Herds move constantly: fast pace over long distance
July 14th	High temperature (20°C), strong northwest wind (30km/h)	Low	Low: grazing, stationary
July 15th	High temperature (19°C), strong northwest wind (30km/h)	Little/none	Low: grazing, stationary
July 21st	cold temp (6°C), strong north wind (30km/h)	Little/none	High: Moving, peacefully, due to low insect harassment
July 22nd	cold temp (9°C), strong north wind (30-40km/h)	None	Low: grazing, stationary due to low insect harassment.
July 23rd	cold temp (5°C), strong north wind (40-50km/h)	None	High: Moving, but "peacefully"
July 24th	Mid temp (12°C), low wind (8-18km/h)	Medium	Low: grazing, stationary. Running, when wind drops
July 25th	Med temp (15°C), medium wind (6-14km/h)	High	High: constant movement into wind

Table 5: Weather, insect activity and caribou activity level on days with observations of herd activity

4.2.2. Insect Harassment and Dust

For three hours during the afternoon on July 12th, we observed a large caribou herd of 500+ animals, as it moved northeast over the peninsula between Fry Inlet and Kokètì. The herd moved down the sloping hills towards the lake at a steady pace into the light wind. The caribou stayed close together, travelling as one tight unit, and zig-zagged across the sloping terrain. This behaviour rose a considerable amount of dust. Elders explained that caribou may move in a such a fashion to create dust and repel insects. In some occasions, large caribou herds have been observed moving rapidly in tight circles. The dust cloud created engulfs all the animals in the herd, and works as insect repellent. Hunters have reported seeing these large dust clouds up to 30-40 kilometres away. Once the herd moves on, some caribou and, at times, small mammals, are found dead on the ground as they have been trampled or suffocated in the centre of the circle.

4.2.3. Cow Leaders

"Cow leaders" is a term we use here to describe the female caribou leading the separate groups that form the entire herd. In the elder's knowledge, an older cow of each herd is the leader due to her experience on the land (appendix 3). Each year of her life, the cow leader travels from the northern calving grounds in the barrenlands to the southern forest for winter; she has knowledge of their whole range. Each cow leader has her own set of trails or routes that she follows, while other cow leaders have other set of trails/routes that they follow. At times, they overlap and the herds move in same direction, and other times the leader follows her own trails. The mass migration observed on July 13th was comprised of numerous smaller herds that had joined to form a larger herd. Each of these herds had a cow leader, who always went first. Calves could be seen at the front or near the cow leader. This behaviour has been explained as the passing of knowledge the younger generation of caribou. When the cow leader has a calf, it is important that she passes on her knowledge of the land. She teaches her calf the location and direction of migratory trails, the timing of herd movement, and the dangers to avoid. Once a leader becomes old or injured, the calf will use the knowledge her mother taught her, as she takes over as leader.

The elders describe how scent is important to distinguish the leader. All the individuals in the herd smell her (the caribou leader), and then all the animals in the herd follow her movement. Her sense of direction, and the ability to recognize dangers ahead, from predators to unsafe crossing conditions at *nǫɔokè*, is a key characteristic of a leading cow: "the cow leader will always walk with her nose close to the ground to pick up the scent of any predators or other animals that have crossed the trail." Scent is central for knowing and predicting dangers ahead. The cow leader knows predators at one point follow in front of the herds, or after the herds ahead of her. If wolves follow the herd in front of her, she can detect the smell and choose to go a different and safer route.

At crossings, the cow leader is the first caribou to enter the water. She will stop for a few moments at the start of the crossing to smell and watch ahead to the other side. The herd will mingle there until she chooses the direction and makes a decision on what to do. As soon as the leader goes into the water, the rest of herd will not turn back. The lead cow with her calf can be seen first, followed by other cows and their calves (photo 6). Bulls, however, would typically follow the cows and calves. Some bulls chose to stay on the barrenlands all winter, while most of the herds migrate south to enter the cover of the southern forest. When the herds travel north again in April or May, the cow leaders will "pick them up" on their way back to the calving grounds.

Photo 6: Cow leader ahead of herd at nǫɔokè between Kokètì and Fry Inlet. July 13th, 2016. Photo: Petter Jacobsen.

4.2.4. Food for migration

During the biannual migration between the northern calving grounds and the southern boreal forest, caribou run for thousands of kilometres. Caribou employ different strategies to maintain hydrated and replenished while running. For instance, caribou will look for a particular type of mushroom (photos 7 and 8), which they pick up and keep in their mouths. While running, they chew and roll the mushroom around in their mouth. By doing this, the mushroom gives off moisture, which will help the animal stay hydrated. Caribou have also been observed to break off and pick up a small piece of antler in their mouth. They nibble on antlers to replenish calcium, phosphorous, and other minerals.

Photo 7: Mushroom that caribou chew during migration. Photo: Domenico Santomauro.

Photo 8: Joergen Bolt holds the type of mushroom caribou chew during migration. Photo: Petter Jacobsen.

4.3. Caribou Health

4.3.1. Predicted Caribou Health in July and August

We estimated caribou health by considering: (1) body fat and overall body condition; (2) hide conditions and (3) walking posture. Prior to observations in the field, the team set up descriptions of anticipated caribou health conditions for July and August (appendix 5). Variations exist in relation to the exact timing of post-calving and summer movements, and the statements provided below were used as guiding principles of expected conditions based on the elders' knowledge.

- In July, the animals do not have excessive body fat. During the post-calving movements, caribou congregate in large herds, travelling extensively in relatively high temperatures and spurred on by parasite insect harassment. The herds spend much time walking and running and less time for forage and rest. The herds are mostly grouped together as tight units as they move over the land.

- In August, the large aggregations of caribou split into smaller herds. As temperatures and insect harassment start to decrease, caribou run less, and tend to settle down in areas to properly

forage. This is the time when caribou start to accumulate fat. Bulls will start to get fat "after their bone marrow becomes good." Large fat reserves start to become visible on their back, from the rump to the neck. In general, when the animal has a short tail, it is an indication that the animal is fat and has larger fat reserves on upper part of its hind legs and rump. These large fat reserves often become heavy for the animals.

- At the end of August and into September the pace and progress of the migration is influenced by the weather. Caribou know that winter is soon approaching and are actively feeding all day before the coming of the first signs of winter and prior to the rut.

4.3.2. Overall Herd Health Observations

We observed the conditions of migrating caribou in relation to the indicators described above. Based on our observations, the herds showed signs of strong health in July, with increasing signs of fat reserves towards the end of the monitoring period in August.

Fat

- The animals showed few signs of being skinny: only one injured yearling appeared skinny.
- The animals were not excessively fat, which is normal for summer health condition.
- No visible signs of bones on the rump.

Hide color

- The conditions of the hides were, although ragged, considered normal and of regular colour and consistency for this time of the year.
- In July, the animals are shedding their winter fur, and it is normal for many to have ragged coats.

Walking posture

- The herds were mainly running or walking fast, due to the necessity of running into the wind to avoid insects.
- Injuries were the only health issues observed.
- All injuries were leg or ankle wounds.

Injuries were the main health issue observed in animals (Appendix 5). Several of the injured animals we observed chose specific strategies to stay safe. On July 14th, an injured cow was observed bedding down in a wetland. The elders explained this behaviour as a means to cool down and relieve the pain of an injured and possibly infected leg. Being an easy target for predators and for insects, injured animals sought islands or peninsulas. If chased by a predator, caribou will run into the water where they can outswim wolves and bears. Furthermore, the islands or peninsulas are also more wind-exposed, so they provide relief for the caribou, who have no other means of avoiding the masses of insects.

4.3.3. Calves

Calves appeared to be in normal health, indicated by the white colour and visible consistency of the hides, and by their walking posture *(i.e.* constantly running and jumping around) (appendix 6). Several of the calves observed were separated from their mothers. In some cases, the mother sought to find her calf, and the reunion was successful. In other instances, as observed on July 15th, the calf was seen without her

mother (photo 10). A cow in the calf's vicinity was not its mother and did not make contact with the calf. This is typical, as cows without calves will not adopt a calf who is lost from its original mother.

During the post-calving aggregation in early July, cow and calf stay together within the herd. This has been explained as the time for the mothers to teach the calves how to walk, follow the trail and how to travel long distances over the land. Stressful circumstances experienced by the cows will result in their milk being less nutritious. Consequently, calves will not be as strong and will struggle to follow the fast pace of the herd. In late July and August, calves are over a month old and usually become sufficiently strong to follow the pace of the herd on the long migrations independently. In August and September, when calves are stronger and faster, the herds spread out over the land in smaller groups.

Photo 9: Caribou yearling with injured front left leg close to camp 1, July 8th, 2016. Photo: Petter Jacobsen

Photo 10: Lone calf. Ran up to team looking for its mother, July 15th, 2016. Photo: Petter Jacobsen

4.4. Predators

The location of camp 2 was two kilometres north of a key *nǫ̀ɔ̀kè* on the caribou's summer range. During the monitoring period, up to 10,000 caribou moved over the crossing and followed the migration routes west. We observed one wolf, one wolf track and closely encountered six grizzly bears (appendix 7). No observations were made of wolverines.

During daily excursions, we scanned the surrounding area for indications of kill sites, such as scattered fur or bones, or circling ravens and other bird activity indicating a kill at a distance, but none were observed. No attacks or attempted attacks were made by predators on the numerous wounded animals walking slowly after the larger herds. No attempt of attacks on the single calves were observed.

4.4.1. Wolves

Contrary to their southerly counterparts, tundra wolves do not have set home ranges but tend to follow migrating caribou. The central tundra region is dominated by the Precambrian shield and bedrock. The elders stated that wolves dig their dens in esker complexes, in the proximity of known caribou migration routes on the summer range, and away from water and low-lying ground prone to flooding with the snowmelt. Scientific literature (Klaczek *et al.* 2015) also suggests that wolves choose den sites based on those criteria. From late April to August, according to traditional knowledge and scientific literature

(Klaczek *et al.* 2015), wolves are mainly confined to the den, which they rarely abandon but for short hunting trips. In mid- to late-August, once the pups grow and are able to follow the adults, the pack will leave the den.

We anticipated observing some level of wolf activity along the caribou trails, thinking wolves might attack injured animals as they walked slowly behind the larger herds, or calves disoriented from the larger herd and walking by themselves. No such observations were made during the program. One wolf track was noted on July 15th; it was located approximately one kilometre north of the migration routes caribou used on the previous day. The direction of the track was opposite to the direction of caribou movement. The track was near a location where we observed an injured animal and a lone calf on both July 15th and 16th. No nearby sightings of the wolf or evidence of predation were noted.

Despite the presence of suitable habitats for denning (esker complexes), the areas covered by the monitoring teams around Kokètì and Fry Inlet did not seem to have wolf dens or signs of past denning activity. In Cluff *et al.* (2002), a study of movements and habitat use of wolves denning in the central Arctic, Northwest Territories and Nunavut, the majority of historical wolf dens appeared to concentrate southwest of Kokètì, in the Northwest Territories. The 90% reduction of available Bathurst caribou as prey may have also influenced tundra wolf behaviour and the selection of yearly denning sites (Klaczeck et al., 2015). However, the local Inuit guide stated that a wolf den was located further north along the long esker complex between Fry Inlet and the Lupin mine site. Further research into locations of wolf dens and behaviour of wolves on the summer range is planned for the upcoming field season.

Being able to observe wolf movement on the tundra without snow is another influencing factor of our observations. Once the wolf pack has left the den and the first snowfalls occur, wolves are constantly moving over the landscape, and it is easier to observe them and their interaction with caribou. The elders said this might be the reason for the few observations of wolves on the land or in vicinity of the caribou. In September and later in fall, wolves are more active on the land and it is easier to observe the movement of wolves on the land.

4.4.2. Grizzly bears

Grizzly bears are known by the Tłı̨chǫ as powerful animals to be avoided at all cost. Bears have strong supernatural powers and know of the movement and behaviour of all other animals, including people. Due to its strong powers, the elders avoid using the name grizzly bear while in or around the barrenlands. Instead, one should address the bear by other names such as “big guy” or other fitting names to deter their attention; as the bear is powerful, the custom of not addressing the bear by its name is a tactic to avoid the bear hearing its name called out. Once someone mentions his name, he can hear it and come towards the person’s camp.

During field work, the elders emphasized the need to circumvent bear tracks, or to avoid bear kill sites. As elder Moise Rabesca explained, “you wouldn’t step over someone’s table while they were eating, so why would you step over the food to the big guy.” The same approach should be taken to the bear’s scat. One should not step over or touch it, instead walking around and avoid touching any of his remnants. As the bear is powerful, it will know and one could possibly upset the bear, which should always be avoided.

Bears are known in the cosmology of Dene and Inuit hunters as powerful and can communicate with people by entering one’s dreams. One team member experienced dreams of the “big guy” one night

before a male grizzly bear first appeared close to camp. This form of communication is a way to signal to the dreamer that the bear is in the area and caution should be taken to avoid confrontation.

Traditional knowledge of grizzly bears was not discussed in detail during the fieldwork, and is generally lacking in documented form, due to the cultural protocol of not talking directly about bears. Further research into the traditional knowledge and cultural protocols of grizzly bears and their predation on Bathurst caribou will be attempted during the next phases of this study.

5. Summary

This study was based on the traditional knowledge of Dene and Inuit hunters, collected over the course of four weeks on the summer range of the Bathurst caribou herd. This study is based on participatory action research, using a methodology we named "Do as Hunters Do," as well as a combination of ethnographic and quantitative methods such as content analysis. Its core principle is that local people who live on the land and rely on caribou for their daily subsistence are the people best positioned to know the current conditions of caribou and of the land. The program's intent was to delve into the relations between caribou, the land, and humans using an approach that employed time and traditional indigenous hunting practices as its main framework of research.

By watching caribou closely, and living and walking over the same landscape, the teams can experience the landscapes as caribou do; this monitoring approach can reach an intimate understanding of the ecological relationships of the arctic tundra. Each year, the "caribou leaders" lead the herds through the tundra, traversing Kokètì on their westward and southward migrations. During the course of this journey, the newly-born calves will learn the routes of their ancestors, strategies to avoid predators and insects, and the location of optimal forage. The choices of terrain, crossings, and refuges from predators form a continuous body of "caribou knowledge" that is shared by indigenous elders and harvesters. The study area around Kokètì was chosen due its unique position and unknown variables. Located south of Bathurst Inlet between Nunavut and the Northwest territories, the 113-kilometre-long lake creates a formidable barrier to caribou movements through the open tundra. The Kokètì shore is one location which caribou traverse regularly every year; the presence of important *nǫɔkè* (water crossings) on the lake is well known to indigenous hunters and is a significant part of both Tłı̨chǫ and Inuit traditional land use.

Our findings centered on in-depth, descriptive observations of the dynamics surrounding the migration of over 10,000 caribou through the *nǫɔkè* of Fry Inlet, and surrounding areas. The strong undercurrent of our research was the sense of change affecting the Bathurst caribou and the arctic in general. Changing weather patterns, warmer temperatures, industrial development and a 90% population decline of Bathurst caribou have profoundly altered the dynamics of people, animals and landscapes. When living in caribou habitat, climatic changes become personal and pressing. The disappearance of snow patches in early and mid-summer affected caribou and the teams alike. For caribou, there was fewer relief from parasitic insects and areas where they could cool down; for indigenous hunters, snow patches were often used as markers to find caribou across the endless landscape. Their disappearance highlights how the decline of one phenomenon affects others species, humans included. We hope to document these changes and open new venues of research in the upcoming years. The results from the pilot year revealed numerous questions to further investigate in the upcoming field seasons. Our monitoring efforts will focus on:

- The effects of climate change, and in particular the timing of spring melt and its effects on vegetation, the significance of snow patches for caribou forage and caribou behaviour, and the melting permafrost and its significance for changing water table and caribou forage.
- The correlation between weather systems and caribou behaviour, combined with observations of climatic changes.
- Caribou behaviour and migratory patterns at the fine scale by studying the ground conditions of key caribou habitat and use of specific geographical features, such as *nǫ̀ǫ̀kè* and *tataa*.
- Health of caribou populations in each season, including cow-calf ratio, and noticeable injuries.
- The locations of wolf dens in the monitoring area, and wolf–caribou seasonal dynamics.

Our monitoring indicators—caribou habitat and environmental changes, individual caribou health and behaviour, predators, and industrial disturbance—demonstrate the complexities in the elders' knowledge. This approach shows the necessity for a holistic and interdisciplinary approach to research. In the upcoming years of the program, the team will focus on integrating what is known about the Bathurst caribou by the traditional knowledge of Inuit and Tłı̨chǫ elders and scientists. Our on-the-ground approach had the potential to assess, verify and discover new elements of caribou behaviour at the fine scale, and contribute to scientific studies that use aerial surveys, remote sensing, and modern technology as their source(s) of raw data. In the upcoming field seasons, the program will grow in complexity and experiences, and further methods and results will be presented. As knowledge is documented, we discover deeper connections between the monitoring indicators, demonstrating the ancestral connection between the cultural and biological diversity on the barrenlands.

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Appendix 1: Caribou Habitat

Caribou habitat	Vegetation	Dry vegetation	Vegetation is dry for this time of the year, first week of July. The snow should have just melted and thus vegetation should hold more water.
		Dry vegetation and sore hoofs	During warm days, the vegetation becomes dry and crunchy. It is hard for caribou to walk on the dry hard vegetation. In middle of hoof, there is a soft spot, that get sore from walking on dry hard vegetation and rocks. At times they get hurt this way. When vegetation is moist, its better for their hoofs.
	Environmental Change	Snowpatches	Should be snow patches around in early July. When we arrived July 6th, its all melted and already dry conditions.
			Caribou stay on snow patches during summer to stay cool.
		Snowpatches/ Overflow	In the areas with overflow in winter, the snow/ice will be thicker and thus stay there longer in the summer. Caribou go to these areas during hot days.
			People/hunters keep the overflow areas observed during winter in mind, because then they know where to find caribou on hot summer days.
			Water level is lower – which makes rivers not as strong - and produces less overflow. With absence of overflow areas, there is a decreased period with snow on ground during late spring and summer. Consequently, less areas and time for caribou to cool down on snowpatches.
			Snow cover melts earlier during late spring now. There is no snow left for caribou to cool off on during summer.
		caribou movement	Herds follow the same migration routes, but as waterbodies and rivers opens earlier in spring, the crossings are more dangerous, as the timing for melting is changing.
		Berries	Cranberries ripe second week of July: usually mid-august.
		Sun	Sun is higher in sky: make earlier thaw and later freeze-up.
	No'oke	Mines on Nooke	Herds need to walk different and longer ways, then their natural migration route: the additional movement in new areas causes stress for herds. As they need to walk different route, they need to swim/walk across water crossings that they normally wouldn't use. The herds need to cross new na'oke with rocky dangerous ground, compared to their natural choses ones most often with sand.
		Surface conditions	"no'oke needs to be good. You can't have too many rocks or the caribou won't cross"
			We proceeded from the camp by boat to a peninsula in Fry Inlet approx. 13 km away at 65.17.350' W110.26.521' where the shores are really close. However, no traces of crossing was found. As explained by Jorgen and Moisie, caribou would not cross there instead preferring to travel for miles to find a suitable location with sandy bottoms.
		Nadloks	Nadloks is the traditional Inuit word for caribou crossings. The cow teaches the young the migration routes from the calving grounds to the crossings. Places that are safe for them to wade, without injuries. Places that have no rocks, a sandy bottom, and are not places where they can be ambushed easily. An injury to a caribou is death.

Appendix 2: Caribou Observations

Caribou Observations	08-Jul	1 one-year old female caribou
		Upwind from us, can't smell us. She is alone, no other animals around. Bedding down, standing up, resting. Not going anywhere. She seems to notice us, but stand there quietly for long time. Her front left leg is injured. Possibly left behind when larger herd moved through. No predators around the animal. No signs of predators.
	12-Jul	Large caribou herd: 1,000+ animals. Observed from camp 2, skylining hills further inland on peninsula.
		Herd moving in northeast direction on the peninsula between Contwoyto lake and Fry Inlet. The herd was walking in one tight unit, and moving in a constant zigzagging motion into the slightly shifting northeast breeze
		Herd is healthy: ratio 1/3 bulls, 50% cows
		1/3 calves: normal amount of calves in herd.
		We observed the herd on eastern shore of the peninsula moving into wind toward the lakeshore from the high hills further inland. During the warm hours, midday, they stayed in the wind-exposed hills (we saw them skylining the hills from camp) and move down towards lakeshore in evening as wind calmed down.
		The large herd moved in a tight group as a defense mechanism for insect harassment, and by creating dust clouds when moving to limited mosquitos from harassing them.
		No predators were observed in vicinity of the herds, or following the trail of the herd after they had passed.
	13-Jul	A large herd of 1,000+ caribou gathered along the shoreline, drinking water
		As we beached the boat a half-kilometre north of the herd and crawled up from the shore, the herd started to move north right in our direction. The insect harassment was high, but animals were not overly bothered. The herd moved in a tight unit.
		High insect activity. Yesterday was worse. Caribou do not seem overly bothered. Some twitch, but keep eating and walking. Do not appear to be bothered.
		All animals appear healthy/normal conditions.
		High number of bulls, more than yesterday's herd. 40% calves and yearlings.

		At the same time, tall cumulus thunderclouds came in from the north with rain showers and strong north wind. As the north wind picked up and rain came down, the herds picked up their speed in a northern direction, along the shoreline pass us, and directly into the rainclouds.
		Several injured animals lagging behind the main herd.
		Three cows running back for their lost calves. One cow mother and her yearling ran two kilometres back for the disoriented calf, who was running the opposite direction of the herd. The cow, yearling and calf returned in the path of the herd, 15 minutes later.
		No wolves or eagles, or other predators, were observed around the lost calves or single cows running back.
	13-Jul	7-10,000 caribou swam across the *nǫʔokè*. Numerous herds of hundreds of animals, each with their own cow leader, crossed after each other following the same scent trail.
		No predators observed around the migrating herds, or in vicinity of the nǫʔokè .
		The mass migration, from our first observation, lasted three hours. The herd moved approximately eight kilometres, from our first observation until they swam across the *nǫʔokè*, in approximately 20 minutes
		Six caribou with collars crossed the *nǫʔokè*.
		Approximately 90% of last part of herd had injured legs.
	14-Jul	One yearling bedded down in grass two kilometres west of esker.
		Probably injured and left behind by herd yesterday.
		Bedding down in wet grass/muskeg to cool down injured area.
		Large herd 1,000+ animals on hills southwest of west shore of Fry inlet. The herd is either same herd we saw yesterday or different herd moved in from south of Fry Inlet.
	15-Jul	One cow: injured back left leg. Walking among tall bushes by small stream to small lake.
		One calf: running around, looking for its mother.
		The calf ran up to us, stop watch, ran closer to us, looking for its mother.
		The injured cow ran into bushes when we approached. After we left, calf ran through bushes looking for the cow, but cow walked away, and removed herself from lost calf.
	16-Jul	One cow: injured back left leg (same as yesterday)

		One calf (same as yesterday) No signs of predators around injured animal or calf.
	17-Jul	One cow caribou. Swimming over *nǫʔokè* by itself, possibly looking for her calf
		Possibly blind.
		Ragged fur, hide. She is smelling the ground, head almost down. Came up from water crossing, smelled the old tracks, ate grass, then trotted away in the same scent tracks as the herd four days ago.
		She has possibly lost her calf, and possibly went back to look for it. She was smelling around for scent from possibly her calf, and from herd.
		Running back/forth on hill by lake. She is smelling the ground, head almost down. - No predators around, possibly blind, single cow. - No predators around, possibly blind, single cow.
	21-Jul	We observed several herds numbering 100-200 animals, of a total of approximately 600 animals
		Observation at the *nǫʔokè* between Contwoyto lake and Fry Inlet. The herds were running west, following the same scent trail as the previous herds, from peninsula between Contwoyto lake and Fry Inlet across the same nǫʔokè and towards the area northwest of Fry Inlet
		Several slower and injured animals were lagging behind at the end of the herd. The herds were following the wind exposed ridges as they moved west. No predators were observed around the herd or around injured animals
	22-Jul	Small herd of 9 caribou observed along the same scent trail. The herds were not bothered by insects and remained stationary and grazing.
		A second herd of 13 animals were observed on the peninsula between Contwoyto lake and Fry Inlet. The herds were stationary and grazing
		the cold temperature and strong wind had quietened the insect activity. Consequently, the herds were not bothered and took the time to graze and rest. No predators were observed around the herds
	23-Jul	More caribou—70-80 animals—follow the same scent trail as previous herds
		All the animals appear peaceful and are not bothered by insects. The herd moved west in the same trail, while 19 animals moved north, along an old trail. No insects observed.

	24-Jul	Three caribou observed on esker east side of peninsula between Contwoyto lake and Fry Inlet.
		The insect harassment is increasing but the animals are not too bothered. They graze and when wind decreases they run into wind to a different spot. The caribou grace in low lying areas, when wind drop below 8-10 km/h, they twitch and ran away from low lying areas and up to windswept hills and ridges. No predators were observed around the caribou.
	28-Jul	One caribou cow observed on east shore of Contwoyto lake. The cow appeared healthy. Running and twitching due to high insect harassment.
		One caribou, yearling, observed west of camp. One grizzly bear walked close to the caribou, but no attempt of approach or attach was made. Probably because the caribou was a yearling.

Appendix 3: Caribou Behaviour

Caribou Behaviour	Cow leader	The old cow is the leader because she goes all the way to the calving grounds and all the way to the southern forest in winter. That cow will teach her calf where to go. One day her calf will take over as leader after her mother. The cow leader passes on her knowledge to the young, who will learn the routes and the way.
		One older cow leader has one set of trails/routes that she follows. Other cow leaders have other set of trails/routes.
		The cow leader will always walk with her nose close to the ground/trail, to smell for predators or anything ese that has crossed the trail. Scent is central.
		Cow leader will walk with nose close to the ground all the time, then she can pick up scent of predators. She knows predators follow in front of the herds (or after the herds ahead of her). If wolves follows herd in front of her, she smells it and can go different route.
		Cow leader - when approaching a watercrossing, cow leader will stop before the crossing. Herd will mingle, until she goes - then the whole herd will follow into the water.
		Some bulls stay around on barrenlands all year. Cows "pick them up" on their way back north to the calving grounds.
	Fast paced movement	Herd move fast pace, non-stop, one herd continuing after each other. Galloping: when they want to get somewhere - to a particular area, for some reason (?)
	White beaches	In the barren lands, the beach shore is white with caribou hair.
	Mushrooms	During migration, the animals know they will run far, they will pick up mushrooms, which they will chew on/roll around in their mouth while running. The mushroom will give off moisture, when the animal run for long time
	Antler	When caribou migrate, they chew on small antler for calcium - put a small piece of antler in their mouth while walking.
	Food preference	Caribou up here feed mostly on lichens and bog birch shoots. They tend to stay away from a species of grass with corrugated edges (n.d. potentially referring to water sedge). In the winter, they eat mostly lichens.
	Eyesight	Caribou can see good because they have good eyesight, even in the dark. “Sometimes even if they can’t see you or smell you, caribou can feel you”.

Appendix 4: Caribou Behaviour, Weather and Insect

Insect	Insect Harasment	Blackflies	Come out in august - goes in eyes and ears – and causes high harassment/stress for caribou
		Mosquitos	Mosquitos: not so high harassment, as blackflies
		Sandflies	Sandflies – are worse for caribou then mosquitos, they go in the ears, eyes, nose and every hole. Go to the soft spot on the skin.
			Gohtsehag – sandflies
	Caribou	Dust clouds as insect repellent	Large herds (1000+ animals) move in circles, circling to create dust - can see dust cloud from far away. Dust works as insect repellent. Once herd moves on, hundreds of dead animals left - they get suffocated in the middle.
		Herd Movement / Dust Cloud	Herd move steady slowly into wind. Zigzag movement across terrain, down from hill towards lake. As herd move, we see dust cloud around herd. Stop shortly to eat, then continue moving into wind - away from mosquitos.
		Insect / Caribou	During high insect activity, caribou go to wind on high hills, sleep on top of hills.
			Flat land is usually good feeding, but when no wind too much mosquitos, need to run into wind, and to higher ground.
		Wind	The caribou appeared unafraid of us - both Moisie and Jorgen stayed in camp, but Archie explained that this is the way with caribou, and that it was because of insects. Indeed, I noted that when winds drop below 8 - 10 km/h insects returned in full, the caribou twitched and ran away from low lying areas where it was feeding and up to windswept ones.

Caribou Behaviour	Caribou Activity and Weather	Wind	Herd chose to stay on high hills today as its windy to avoid insects.
			Wind from northeast - 36kmh. Caribou probably rest into the wind during hot day as today. Then they will move later in the evening when the temperature is cooler.
			Flat land is usually good feeding, but when there is no wind its too much mosquitos. Caribou then need to walk/run into wind, or move to higher ground where it is windy.
		Cold temperature	On cold, windy day, as today, caribou don't move much, because they don't need to. It's the time for calves to rest and eat after long migration. Herds are bedding down on high ground/ hills, where its cold. In the wind, there are no insects, and no need to move.
	Seasonal Activity	July	In July, herds are travelling mostly in one tight unit
			In July, its mainly hot weather - not much activity during the hot days.
		August	In August start to spread out in smaller groups.
			In August, as temperatures and insect harassment start to decrease, caribou stop running around, and instead can often settle down in an area to eat properly
			In August/September, animals know that winter is coming and active all day to feed before winter.

Appendix 5: Caribou Health and Injured Caribou Observations

Injured Caribou Observations	July 8th	1 yearling. Injured front left leg.
		Possibly left behind when larger herd moved through.
	July 12th	1 bull,
		1 cow,
		1 calf,
		1 yearling
		All the injured animals had leg injuries (too far distance to observe details of injury. All the animals were observed in back of herd.
	July 13th	1 bull: walking in slower pace behind the herd
		1 calf
		1 cow (with radio collar) injured
		Approximately 90% of last part of herd had injured legs.
	July 14th	1 yearling
		Probably left behind by herd yesterday.
		Bedding down in wet grass/muskeg to cool down injured area.
	July 15th	1 cow, injured back left leg
	July 16th	1 cow, injured back left leg (same as on July 15th)
	July 21st	Numerous injured animals at the last part of herd

Injured Caribou	Strategy to stay safe	Injured caribou stay on islands or points to stay safe from predators.The islands or peninsulas are also more wind exposed and will provide a relief for the caribou, who has no other means of avoiding the masses of insect.
		When caribou are chased, they run for water. They can outswim all predators.
	Cool down injuries	injured animal bed down in wet muskeg with the injured area into the wet and cool muskeg, as a means to cool down the injured area

Caribou Health	Health characteristics per season	July: animals not fat, but healthy. Running around, not much time to eat properly.
		In June - July, the animals are shedding their winter fur,
		July - mid Aug: Bulls starting to get good bone marrow.
		August: stop running around. Settle down in an area to eat - get fat in that time.
		August: would shoot bulls for bedding.
		August: start to get fat, after bone marrow becomes good. Fat shows up to neck. Heavy for animals.
		Tail: when tail is small, the animal is fat.

Appendix 6: Calf Observations

Calf Health Observations	500+ herd observed on July 12th:	an estimate of 50 % cows and 1/3 calves: normal amount of calves in herd
		All calves show signs of normal health conditions: healthy hides and running fast
		1 calf injured.
	1000+ herd observed on July 13th	40 % calf and yearlings
		All calves show signs of normal health conditions
		1 calf disoriented from herd, ran opposite direction. Mother and sister ran back 2km to find the calf. Calf was reunited with herd.
	7000+ herd observed on July 13th	All cows with calf.
		Calves show signs of normal health conditions: healthy hides and running fast.
		1 calf injured
	1 calf observed on July 15th	Calf was by itself and searching for its mother. A cow close by, but it was not its mother and will not adopt or recognize the calf. The calf was left alone.
		Calf appeared healthy. Running around the area, and ran right up to us.
	50+ herd observed on July 23rd:	40% calves
		All calves show signs of normal health conditions
Calves	Cow-calf	Cow-calf stay close together in the big herd. When calf grow bigger the herds will spread into smaller groups. Now in July cows/mothers teaching calves how to walk and travel.
		Cows without calves will not adopt a calf who is lost or has lost its mother.
	July	In July, the calves are over a month old and should already be strong and be able to follow the pace of the herd on the large migrations.
	August	In August and September, when the calves are bigger, the herds spread out over the land in smaller groups, as the calves are starting to become more independent and do not need the protection of a large herd.
	Cows Milk	If cows are under stress their milk will not be as nutritious. Consequently, calves will not be as strong, and will have hard time following the fast pace of the herd. Calves should be strong now in July.

Appendix 7: Predator Observations

Predators	Wolves	Wolf pack	Don't kill the apha male in the wolf pack - they control the pack.
		Wolves Hunt Bulls Rather Than Yearlings	Bulls are heavier than cows (antlers are heavy, fresh velvet is heavy). Wolves know this and hunt for bulls rather then yearling- who are fast, while bulls are slower. Bulls are heavier, and thus they get easily tired. Also, during rut season bulls get tired from all the fighting. Wolves know that and chose to hunt for bulls instead of yearlings.
		Wolf Movement	Wolves hunt in evening.
			wolves are mainly stationary around the den in June, July and into August. The male or female wolf take few, short trips into surrounding land to hunt
			In July, during the day when its hot, they stay mostly around the den. the pups are too small to travel, the wolves will mainly stay close to the den in this period
			In September, when cubs are growing older, the wolves will move around more during the day to hunt.
			Mid- late august when pups are strong enough, they leave the den and move around to hunt.
	Wolf observations	July 13th	1 wolf observed at 3 pm. The wolf circled the camp to smell and see what was there.
		July 15th	1 wolf track observed. Tracks in opposite direction of herd: possibly moving northeast to look for injured animals.
	Wolverine		2-3 year old wolverine remnants found among boulder field close to no'oke: chewed bone: can tell age by assessing sinew left on bone: These bones no more sinew left on bone. Bones cracked by wolverines "bone breaker" tooth.
			Wolverine prefers rocky areas. Knows terrain surrounding the caribou trails. Old den in between two large boulders, or cracked rocks, remnants of chewed off caribou antlers.
	rizzly Bear Observation	July 18th	Tracks of male grizzly bear in the gravel on top of esker 1 km west of camp. Tracks from previous night, in north direction.
			One young male grizzly 3 km southeast of camp, on east, side of Fry Inlet. light brown colored fur on back and black color fur underneath.
		July 22nd	One male grizzly bear by no'oke south of camp. Large male with estimated 1.5 meters' back height
		July 23rd	one grizzly bear on the east shore of the Fry Inlet. Approximately 5 km from caribou
		July 25th	one grizzly bear
		July 28th	One grizzly bear south of esker, 1 km from camp. moved in close proximity to a caribou but did not attack, or even make an attempt at hunting it down

Appendix 8: Other Wildlife Observations

Other Wildlife	Muskox	Old muskox bull	Old bull by itself on top of the hill to northwest of camp. He is forced/locked out of his old herd, as younger bulls have taken his place. He is not accepted into the herd anymore. Will stay alone for rest of his life.
			When 3 muskox grow like friends together they can't be separated from each other. Hunters know that even if you shoot one the other two will keep circling around body and not leaving it alone. So, if you only need one you don't shoot them.
			Muskox can be in groups of 2-3, or up to hundreds. When they stay together they protect each other. As you move they close together and move. To hunt them you just split them if you can. If they are buddies, you will not because they will charge at you. They stay in sort of circle when wolf or predators come around.
	Muskox observations	15-Jul	1 muskox, old bull: on hill, northwest from esker.
		16-Jul	1 Muskox. On northwest high hill. Old male, same as yesterday. By himself.
		20-Jul	3 muskox observed did not appear to be bothered by insects. However, it was noted that they grazed on a windswept slope, likely trying to avoid areas with little wind and good forage.
		22-Jul	Noted 3 muskox approximately 3.5 Km away, 2 bedding down. Noted another 21-muskox grazing the northwest of carom approximately 3.7 km away, likely part of the same group. They also appear unhurried and not bothered by insects, which are not a problem today.
		23-Jul	Observed a group of muskox (approximately 20, probably same group as yesterday) grazing maybe 2 km from the camp.
		28-Jul	1 muskox right near camp
	Short Eared Owl		The short-eared owl follows the hunter but you can't see it. When the hunter goes on the land he feels followed, you think there's someone behind you but there's no one except owl, which you can't see because he flies above you.
	Raven	Good sign	2 ravens circling over us. Good sign to see raven because they often follow caribou. They will be around if there is a carcass.
	Bank Swallow	Climate change	Bank Swallow nests were noted near the beach. They are not supposed to be this far up north. I wonder if this could be evidence of global warming.

Appendix 9: Caribou Hunting

Caribou Hunting	Caribou hunting at No'oke	As soon as the cow leader goes in the water the herd wont turn back and will all follow her. Hunters wait for the leader to pass first, then hunter use canoe to spear the animals in the water. The hunters wait on the side where the herd come from. Usually the family wait in the kwea - dwarf birches for the hunters. Hunters came to Contwoyto lake because of the significant nooke / watercrossings here. Its is easier to spear animals, in the big herds, at the water crossings. Further south the lakes do not have so big crossings. Here, this na'oke on Contwoyto lake, is the main big crossings. People paddle along the shoreline, while the dogs run on the shore-paws get sore from rocks and dry vegetation-when moist/wet vegetation it is easier on the paws and they don't get sore from running.
	Hunting Yearling Caribou	Young animals, calves and yearlings, was desired for the soft, warm hide - use for linings in moccasins and pants. People paddled from Behchokǫ to barrenlands in August/September only for that type of hide and to make drymeat. Elder Michel Louis Rabesca paddled 3 times from Behchokǫ to hunt at Rawalpindi and Point Lake.
	Sleep Well on Barrenlands	When they paddle to the barrenland to hunt, his uncle would say " when we get to the barrenlands, you will sleep well". Michel didn't know what he meant. When they travelled to barrenlands, they slept cold only in the canvas. But when they shot caribou, they would sleep well in all the warm hides.
	Hills	You never take a straight path up the hill especially if wind is at your back. Especially in the barren lands, in the bush you can go straight up. This is done so you don't run into animals but also if you're hunting you want to have time to prepare and not scare wildlife off.
	Hunting & Respect	As long as you respect the animal, they will show themselves to the hunter.
		The caribou know they will be taken care off, thus they can give themselves to the person who respect them

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