

A photograph of a caribou with large, dark antlers standing in a snowy, mountainous landscape. The caribou is facing right, and the background shows rolling snow-covered hills under a clear blue sky. The overall scene is serene and captures the natural habitat of the caribou.

UNDERSTANDING CARIBOU TOGETHER:

A MULTIREGIONAL
WORKSHOP TO DESIGN
CARIBOU CO-MONITORING
FOR THE FUTURE

Photo: X.F. Aguilar

November 1-2, 2023, Yellowknife, Northwest Territories



Hosts, Sponsors: University of Calgary, Tłıchq Government, Government of Northwest Territories
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Locations: Wed Nov 1: Commissioner’s Room, Nova Inn Yellowknife, 4401 Franklin
Avenue, Yellowknife NT X1A 2N2
Thu Nov 2: North Slave Wildlife Lab and Conference Room, 3803 Bretzlaff
Drive, Yellowknife NT X1A 1Z4

Contact: Pat Curry, DVM, PhD - Kutz Research Group p.curry@ucalgary.ca | 250-921-4340

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UNDERSTANDING CARIBOU TOGETHER: A MULTIREGIONAL WORKSHOP TO DESIGN CARIBOU CO-MONITORING FOR THE FUTURE

Background

In November 2023, a diverse group gathered in Yellowknife, Northwest Territories for a 2-day caribou health and sampling workshop. The roughly 30 participants (see Appendix I) included **residents of Kugluktuk, NU, Deline NT, and multiple Tłıchǫ First Nation communities in NT**, as well as **researchers** conducting scientific studies, and **regional and federal scientists**. The community attendees were a mix of **Elders and youth**, and represented experienced caribou hunters, younger harvesters and others tasked with winter road monitoring for the Tłıchǫ Government, and participants in the **Ekwõ̀ Nàxoèhdee K'è** (“Boots on the Ground”) caribou monitoring program. All the northern communities involved currently observe and harvest from the Bluenose East caribou herd as well as other herds that transit their land. The Bluenose East herd is of particular concern because the population was estimated to be approximately 104,000 individuals in 2000 but it has since gone through a major decline, with herd size now hovering around 20,000.

Workshop Goals

The broader calling of the workshop was to exchange Indigenous Knowledge and scientific knowledge, and to collaboratively discuss the monitoring of caribou in northern Canada. Specific goals were to facilitate in-depth discussions and learning about caribou health, disease, and the Community-based Wildlife Health Surveillance program that involves hunter sample kits and Indigenous Knowledge. Putting hunter-based sampling into action has proven to be effective for monitoring various wildlife species, including caribou in the Canadian North. This approach depends on collaboration, which is essential to design a system for collecting, organizing, and storing samples that aligns with the unique needs of local communities. This workshop aimed to share practical insights into caribou health, pinpoint vital indicators, and customize sampling kits in ways that work with community harvesting practices.

This new program will bring Indigenous Knowledge and scientific knowledge together to better understand caribou health. The documented Indigenous Knowledge on the Bluenose East herd will be summarized and gaps in documented knowledge will be addressed through new interviews. Indicators of health identified by communities will be incorporated into the community-based wildlife health surveillance program. Ultimately the goal is to establish proactive indicators of caribou health and population trajectory that can then be used to guide management decisions. Collected samples will be shared with Frank van der Meer and his team, who will investigate virus diversity and diagnostic test development. Samples will also be shared with Mary Gamberg and her team, who will do contaminants and epigenetics studies.

Research Projects

- **Proactive Indicators of Caribou Conservation Status to Guide Management and Policy**
Funder: Environment and Climate Change Canada | Principal Investigator: S Kutz
- **Community-defined and Monitored Indicators of Recovery in Barren-ground Caribou**
Funder: NWT Cumulative Impact Management Program
Co-principal Investigators: F van der Meer, S Kutz
- **Contaminants, Caribou Epigenetics and Genomic Health**
Funders: NWT Cumulative Impact Management Program, Northern Contaminants Program
Co-principal Investigators: M Gamberg, R Barrett
- **Ekwo Nàxoèhdee K'è: Boots on the Ground**
Tłıchq Government

Brief Summary

“Avalitumik havakgaunapta ayokhaktok kihimi,
katmaugugupta hivounighaptivun ayokhaniaatok.”

[When we work alone we can have a hard time,
but when we get together, moving forward is easier
and we can find solutions.]

- Allen Niptanatiak, Kugluktuk

The workshop days were full and active (see the agenda in Appendix II). The first morning was an opportunity for the researchers to share their work, their history collaborating on community-based caribou health monitoring, and their perspectives on each project's relevance. In the afternoon, the tables were turned as community members took the floor to talk about their concerns regarding caribou and what is happening on the land. The observations and perspectives from the three different arctic regions (representatives from Kugluktuk, Deline, and Tłıchq communities) was of interest to everyone, and session leaders facilitated discussion on how we can all work together for a better future for caribou. These conversations helped create a dynamic knowledge exchange that led to various new ideas for future projects and scopes of collaboration.

On the second day of the workshop, participants gathered at the Government of Northwest Territories Wildlife Laboratory. After a video presentation from the Kutz Laboratory on hunter-based

sampling in northern Canada, the hands-on program got underway. Part of the day was spent gaining first-hand understanding of how hunter kit specimens are collected from a harvested animal, with participants doing necropsies to locate different organs. Groups also visited workstations for up-close demonstrations of how different samples are analyzed in the lab. Attendees were enthusiastic about the activities and learning. The information shared clearly piqued people's interest and hopefully built more motivation and trust regarding sampling methods and what happens to samples that hunters collect.



A large amount of ground was covered during the two days. There were opportunities for people to connect and for community members from different regions to talk and share their knowledge and experiences related to wildlife health. As the workshop ended, it was evident that the interactions between community members, government representatives, and researchers had laid the groundwork for working collaboratively on caribou sampling. The shared experiences, from learning about community concerns and research projects to hands-on demonstrations of sampling and analyses, solidified a sense of unity in our efforts to understand caribou. Moving forward, these connections will be crucial for collaborative projects on caribou health.

WORKSHOP DAY 1 - November 1, 2023

The goal of Day 1 was to introduce the research projects, foster discussions regarding caribou health and diseases, address community concerns, and explore how we can better understand Indigenous Knowledge (IK) along with Western science to monitor caribou health. Morning presentations covered research related to caribou health monitoring, contaminants in our ecosystems, the importance of IK, and viruses that may affect caribou. The afternoon featured interactive discussions aimed at identifying concerns about the health and disease of the Bluenose East caribou herd, as well as community-based monitoring efforts. Below is a summary of the first day's activities.

DAY 1 – MORNING

❖ OVERVIEW OF THE RESEARCH PROJECTS

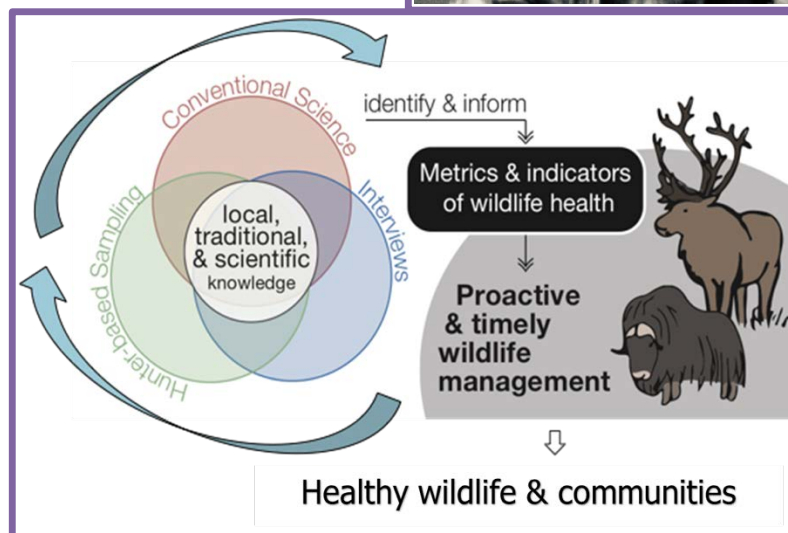
PROJECT 1: Proactive Indicators of Caribou Conservation Status to Guide Management and Policy

PROJECT 2: Community-defined and Monitored Indicators of Recovery in Barren-ground Caribou

Presenter: Susan Kutz

Dr. Kutz began by explaining the overarching objectives of these two projects:

- Operationalize community-based monitoring and Indigenous Knowledge in caribou stewardship
- Address important knowledge gaps about the types and impacts of viruses in caribou.



Strategy to identify health metrics and indicators for wildlife.

The main emphasis of Susan’s presentation was how we can work together to better monitor caribou health and mobilize IK into conservation frameworks. She described previous work by the Kutz lab team and collaborators to use multiple approaches (conventional science, hunter-based sampling, and IK) in understanding the population dynamics and health of the Dolphin and Union caribou herd. Susan stressed the importance of finding effective means to look at science-based health indicators and IK alongside one another systematically, as this is a more powerful way to identify which indicators most accurately reflect the status of different caribou herds. The goal is to identify these most-telling key health indicators, establish a benchmark (i.e., a standard level or value we can compare against) for each, and then be able to use these benchmarks to clarify whether a caribou population is declining, stable, or recovering. The image above illustrates these concepts visually.

PROJECT 3: Contaminants, Caribou Epigenetics, and Genomic Health

Presenter: Mary Gamberg

Research Scientist Mary Gamberg's presentation explored the relationships between contaminants in caribou and the sublethal effects that can affect caribou survival, reproduction, and recruitment. The safety and long-term health of crucial country foods such as caribou meat are continuing concerns for communities and Indigenous groups across northern Canada. The health of caribou remains a central concern given the declining numbers in many herds. Mary's project serves as a companion project to the *Contaminants in Arctic Caribou Program* under the Northern Contaminants Program.

The project has several objectives:

- **collect samples** from the Bluenose East and Beverly herds;
- **analyze tissues for contaminants** (e.g., liver for trace elements);
- analyze liver for **genomics and epigenetics**; and
- travel to communities to hold **workshops** and continue important **knowledge-sharing** and discussions.



Mary Gamberg describing contaminants that affect caribou, and their possible effects on caribou epigenetics.

Epigenetics: Mary also explained the part of her study involving caribou “epigenetics.” All animals have a unique genetic or hereditary code, known as DNA. Sections of this code are called genes, and these define particular features, such as an animal’s hair colour. Certain genes have functions in reproduction, growth, and immune responses to diseases. “Gene expression” basically refers to how

gene effects get turned up and down. **Epigenetics is the study of how external factors (for example, contaminants and disease) can cause chemical changes that affect gene expression.**

Recent studies have shown that contaminants can affect the expression (i.e., the “turning up” or “turning down”) of certain genes. While we know that contaminants can affect gene expression, the immune system, reproductive health (e.g., a female may not conceive), and growth rate, these effects have not been measured in wild caribou. **By learning more about the sub-lethal effects of contaminants, we hope to identify how contaminants may affect the overall health of caribou herds.**

These kinds of effects can mean that a caribou might be less able to survive an infection, less likely to breed and become pregnant, or possibly grow slowly and end up being smaller and weaker as an adult. Such impacts might affect survival and reproduction for individual caribou, and thereby alter “demographic trajectories” (i.e., the life courses that different caribou subgroups take [e.g., different age groups, or females vs males]) at the herd level.



❖ MORE PROJECT INFO

● **Caribou Health Monitoring:
Examples and Developing Community-defined Proactive Indicators of Change**

Presenters: Fabien Mavrot, Amish Dua

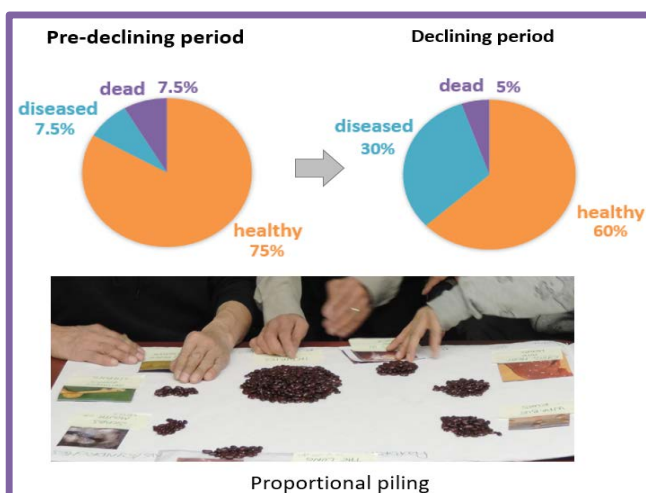
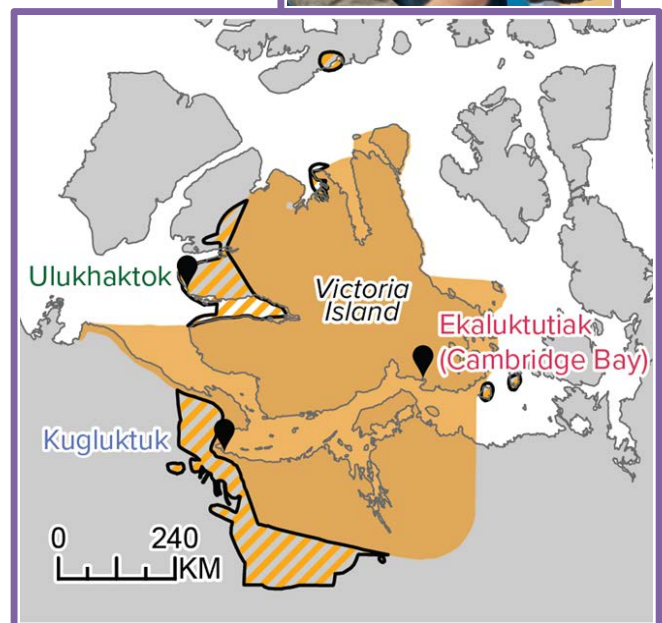
Together, communities, governments, and the University of Calgary's Kutz Research Group have been successfully monitoring caribou health from several arctic locations (Ekaluktutiak, Kugluktuk, and Ulukhaktok) using hunter-based sample kit collection. **Dr. Fabien Mavrot** described what has and is being done in this Community-based Wildlife Health Surveillance (CBWHS) program.



The program has three components:

1. **hunter-based sample collection;**
2. **passive health surveillance** (e.g., recording things noticed while hunting); and
3. **Indigenous Knowledge mobilization.**

Fabien explained each of these, emphasizing the importance of IK mobilization. He described previous research by Matilda Tomaselli, Andrea Hanke, and Xavier Fernandez to demonstrate how IK can improve our understanding of the bigger picture of wildlife health and can shed light on long-term trends specific to different health indicators of caribou. The examples demonstrated the bridging of knowledge of northern Indigenous peoples, acquired through oral tradition and practice over generations, with Western scientific knowledge to gain better insights about caribou ecology.



Indigenous Knowledge research by Kutz Lab's Andrea Hanke and Matilda Tomaselli used participatory mapping (see map above) and participatory epidemiology methods like "proportional piling" of beans to represent caribou numbers (left).

University of Calgary PhD student Amish Dua also presented, as he will be leading the knowledge mobilization aspect of the project *Community-defined and Monitored Indicators of Recovery in Barren-ground Caribou*. Amish talked about the **global perspectives of bridging IK and scientific knowledge**. He emphasized the usefulness of techniques like **participatory mapping** and **participatory epidemiology**, which are ways of applying IK to wildlife health (see photo above). He noted that such methods extend beyond the Arctic and caribou health, and that projects like this one can be a template and proof of concept that we *can* bridge IK and Western science. Amish pointed out that our collaborative project has the scope to inspire and encourage similar initiatives globally, which could foster a more holistic and inclusive approach to wildlife health management and conservation around the world.



Understanding the contributions of Indigenous Knowledge can have global impacts beyond caribou and Canada. Leaving this puzzle piece out is a gap that has consequences for wildlife health management.



● **Ekwò Nàxoèhdee K'è: Boots on the Ground**



Members of the Ekwò Nàxoèhdee K'è team.

Fabien and Amish also highlighted the Tłı̨chų Government's successful Ekwò Nàxoèhdee K'è (ENK) monitoring program and its potential contributions for developing caribou health indicators. The ENK was discussed multiple times during the workshop by program leaders Petter Jacobsen and Roy Judas, and by Wildlife/Fisheries Biologist Stephanie Behrens and others. This research, formerly known as "Boots on the Ground," started caribou monitoring on the traditional Tłı̨chų hunting

grounds in 2016 when **the Tłı̨chǫ people wanted to independently verify reports being published by the Government of NWT**. Specifically, the Tłı̨chǫ chiefs saw a need to confirm the status of caribou in the region after hunting restrictions were implemented in 2009 and 2015. Focusing mainly on the kokèti ekwō (Bathurst herd caribou), ENK conducts annual monitoring at Kokèti Lake (Contwoyto Lake) and Deèzàati Lake (Point Lake) on the herd's summering grounds and fall migration route. Bluenose East caribou are now also passing through the ENK monitoring areas.

- **Northern Contaminants and Caribou**

Presenter: Mary Gamberg

In this session, Mary gave more detail about which contaminants affect caribou, and how. She explained that **contaminants from distant industrial sites can reach wildlife in the Arctic through air currents**. Cold temperatures trap these contaminants in the North, where **they settle on land and water**. Caribou consume them through vegetation, especially lichens. This accumulation can lead to sub-lethal effects, for example reduced pregnancy rates and mercury-induced neurotoxicity in caribou fetuses, as well as cancer and liver disease from various chemicals, including per- and polyfluoroalkyl substances known as "PFAS." These risks are heightened when animals face multiple contaminants or other environmental stressors, such as food scarcity. Recognizing these effects can drive global efforts to limit contaminant use, which would lower concentrations in caribou and help safeguard them as a vital food source.

PFAS in Arctic Caribou

- PFAS are man-made chemicals used in water repellents, stain guards, fire-fighting foams.
- Accumulate in caribou liver
- Levels are low in most Arctic caribou
- Some groups of PFAS are declining over time in the Porcupine caribou, likely due to new legislation

Dominating air currents

Central industrial areas

Mercury (Hg)

Man-made Sources

- Coal-fired power plants
- Industrial processes (chlorine, steel phosphate and gold production; metal smelting; electronics; incineration of municipal wastes)
- Small scale artisanal mining

Cadmium (Cd)

- Nickel-cadmium batteries; pigments and plastics, electroplating
- Mining and smelting
- Smoking cigarettes
- Natural sources (geological)
- Chronic – Kidney damage; cancer
- Bioaccumulates

Information about contaminants (including per- and polyfluoroalkyl substances [PFAS]) that Mary Gamberg's project will focus on, and how these chemicals can travel the globe.

Mary emphasized the importance of this research, talked about impacts of different levels of contaminants in individual caribou, and provided insights into how the chemicals might affect caribou gene expression at the herd scale. She explained that this information will be used to explore patterns of genomic health over time within herds and among herds of different population status (i.e., stable or declining). It has long been known that contaminants can have negative effects on caribou and potentially on people who harvest and eat them. **These new tools will allow us to understand much more clearly how contaminants affect caribou, how they affect gene expression, and what these effects mean at a herd level.**

- **Virus Research: Impacts of Viral Infections on Barren-ground Caribou Health**

Presenters: Frank van der Meer, Jessie Olson

Dr. Frank van der Meer first explained what viruses are, how they are transmitted, and their impact on populations of various species worldwide, including humans. This provided understanding of why the research team is studying viruses in caribou.



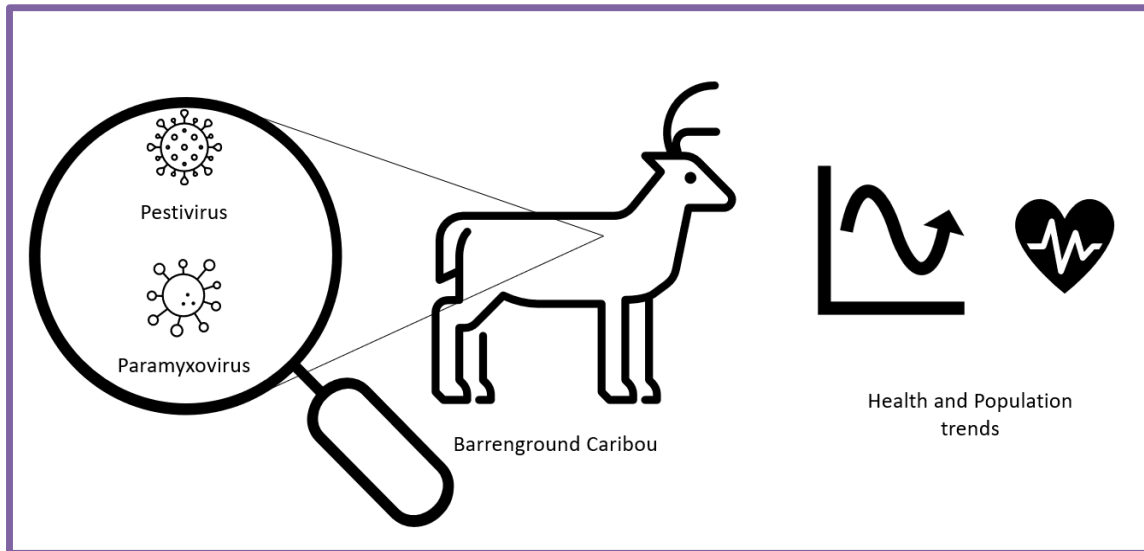
What are viruses made of?

- The genome
- Proteins
- Sugars
- Lipids
- All cell derived material

There are many different types of viruses, but their structure and components are similar.

Until now, there has been limited research on viruses affecting caribou, and existing studies have mainly focused on *exposure* to viruses without providing information on the *specific identity* of the virus/es or their *impacts* on a population. There is a need to identify viruses as potential contributors to caribou population decline and barriers to recovery. Frank explained that the main aim of this project is to **address knowledge gaps regarding the diversity and impacts of viruses in caribou populations.**

This research project will improve our understanding of viruses that affect barren-ground caribou, their interactions with hosts, and their influences on survival and reproduction. Collaboration with local experts, including knowledge holders, harvesters, biologists, veterinarians, and monitors, will be crucial to increasing ongoing sampling efforts and health surveillance of northern wildlife.



The van der Meer lab will investigate the presence, identity, and health impacts of viruses in barren-ground caribou.

University of Calgary Master's student Jessie Olson will be working on this project with Frank. Some “serological” studies (i.e., studies that detect *antibodies* [signalling exposure] to disease agents) have provided evidence that **certain families of viruses are more likely than others to be present in arctic caribou herds**. Based on these findings, Jessie’s research project will investigate caribou spleens and lymph nodes to test whether viruses belonging to the **pestivirus and paramyxovirus families** are circulating in barren-ground caribou, and how these viruses are affecting the animals. Antibodies to both these virus families have been observed in caribou herds with significant population declines, and they are known to have detrimental health effects in other species.



Key points about the importance of researching paramyxoviruses and pestiviruses in caribou.

DAY 1 – AFTERNOON



INTERACTIVE DISCUSSIONS:

led by Naima Jutha, Mary Gamberg, Fabien Mavrot, Stephanie Behrens

Identifying concerns about Bluenose East caribou health and disease

Addressing concerns using community-based caribou monitoring

In the afternoon, we switched gears and had open discussions among the entire group of participants in hopes of getting insights into current concerns of caribou harvesters and communities in the different regions, particularly regarding the Bluenose East herd. We also wanted to hear people's ideas regarding sampling kits for caribou monitoring that are based on hunter and community input, and to find the most effective ways that IK and Western science can both be put forward and complement each other for the future benefit of caribou.

Several recurring themes emerged during the discussions, including considerations about the environment, predators, and opportunities for learning and education. One important question put to community members was how they envision that progress can be made towards including both IK and scientific knowledge in policy making. The following sections summarize concerns, opinions, and ideas that were put forward during the interactive discussions.

- **Indigenous Knowledge and Policy**

“Traditional Knowledge is something that we are born with and grow up with, but the policy is something that is enforced upon us.” - Myles Pedersen, Kugluktuk

“Indigenous worldviews are very different from how scientists see the world; our elders and grandfathers saw the world very differently.” - Walter Bezha, Deline

Myles' statement reflects the complex relationship between IK and policy, and emphasizes the need for a more inclusive, culturally sensitive approach to policy development. Walter highlighted how we should not look at IK as a branch of science that we can “integrate” into our frameworks; he believes in the independence of IK as a different worldview with its own value and essential beauty.

- **Caribou and our Relationship with the Land**

An important discussion that emerged multiple times over the day focused on humans' connection to the land. It was stated that we are an integral part of the land and, therefore, we must view the ecosystem holistically rather than in fragments. This means considering all elements (e.g., mice, plants, lichen, all species) and their interrelationships. By examining numerous environmental indicators beyond caribou health and disease, we can develop a more comprehensive understanding of the overall well-being of the ecosystem.

"I learned from my professors, who were my grandparents, is that 'Watch everything!' starts with watching the mice. We depend on our environment." - Allen Niptanatiuk, Kugluktuk

We must always ask "What would the caribou want?" and we need to check in with ourselves and others and ask, "What is our relationship to the land?"

When examining this dynamic ecosystem it is crucial to consider predators. Participants noted an increase in bear numbers on the land, with grizzlies now often being seen with three cubs, particularly within the calving grounds of the Bluenose East caribou. In the past, these predators were hunted for sustenance and clothing, but such hunting is now prohibited; consequently, their populations have grown, putting additional pressure on both the caribou and the landscape. Some participants also expressed interest in researching stable isotopes of a predator diet to try to determine predators' impact on caribou.

*"This was severe burns. The fire was so strong that it burnt areas that burnt previously; this has not happened before."
- Walter Bezha, Deline*

Wildfires were also an important point of discussion; in the summer of 2023, 4.2 million hectares were burnt in the NWT. Many wildfire-related questions were raised:

- ***"How long will it take for vegetation to come back after the fire? Will it be a good habitat for the future?"***
- ***"How does a wildfire affect caribou?" (removes food sources, changes migration patterns)***
- ***"Should we be worried about fire retardants in our ecosystems?"***

Despite a day of talking about the negative impacts of various factors on caribou, themes of resilience developed out of these conversations, highlighting that things are changing and there is still hope for a brighter future for caribou.

"Our land is unhealthy; the caribou are not eating healthy, but the plants are coming back. Something happened that killed all of the plants before that." - Allen Niptanatiuk, Kugluktuk

Allen's statement captures a complex interplay between environmental challenges, the well-being of caribou, and ecosystem resilience. The observation of vegetation regrowth introduces a positive story, emphasizing the potential for recovery and a more optimistic future for caribou and their habitat.

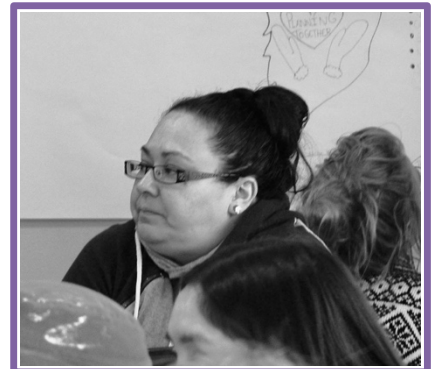
Petter Jacobsen, lead for the Tl̓icho Government's Ekwoḷ Nàxoèdee K'e program, offered some



valuable on-the-land observations regarding the Bathurst caribou herd that were part of ENK field observations. He mentioned that the last 3 to 4 years have been really good food for Bathurst caribou they have seen; the land is moist and wet, and the caribou are healthy and fat, especially the bulls. The caribou are less stressed due to lower numbers of wolves, reduced mosquitos, and no hunters, but despite all these positive impacts, Petter emphasized that they are still not seeing enough calves in the Bathurst herd. Discussions revolved around possible reasons and a question *"Is there something that we cannot see?"*

"I don't understand what stops Bluenose East caribou from coming to Bear Lake. Elders blame different people, but I don't agree with that, we need cooperation, we need to work together." - Walter Bezha, Deline

Stephanie Behrens, Wildlife/Fisheries Biologist for the Tl̓icho Government, reported abundant Bluenose East caribou calves alongside cows at Point Lake. While larger herds were relatively small (20-30), bull numbers were limited. The noteworthy increase in Bluenose East calf numbers, including



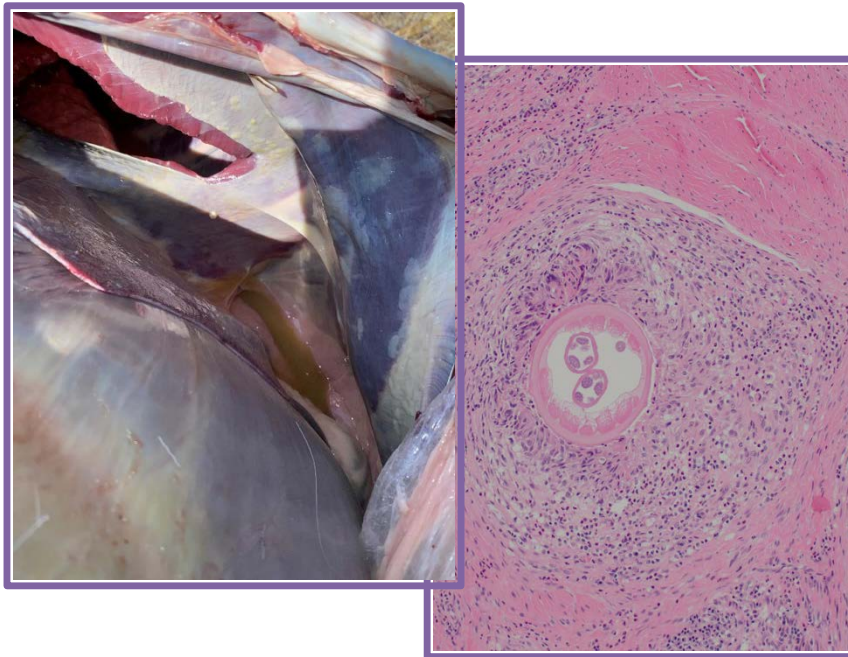
observations of twins, was considered a positive signal of a recovering population. However, concerns were noted regarding the Bathurst herd, where calf numbers have declined. Complicating matters is the absence of hunting in the range of the Bathurst herd, which leads to questions about how to sample and assess the population effectively. Addressing this challenge is crucial for informed conservation efforts and understanding factors that are affecting Bathurst caribou.

- **Caribou Health and Disease**

The workshop really highlighted that we are a team with diverse backgrounds, skills, and knowledge, and that every one of us plays a crucial role in the monitoring of caribou health and disease. Our responsibilities span from harvesting to assessing caribou pathogens and contaminants in the laboratory, to monitoring caribou stress levels, populations, pregnancy rates, calves, and body

condition on the land. Our discussions touched on key factors that participants considered signals of the overall health of caribou, including behavioural changes, weight fluctuations, coat condition, meat quality, and even tail position (*up* indicating healthy, *down* indicating unhealthy).

In fall of 2023, hunters in Kugluktuk reported multiple observations of abnormal caribou meat, specifically describing “runny” muscle tissue around joints, and bubbly tissues and pus in the abdomen and thorax. The harvesters at the workshop mentioned that the Kugluktuk summer had been hot and dry, and the same conditions had occurred in Rankin Inlet and Coral Harbour. We discussed how this situation demonstrates the crucial role that hunter-based sampling and opportunistic samples (i.e., unplanned collections when something looks strange) from communities play in understanding caribou health. Despite the benefits of knowledge gained from obtaining abnormal tissues for analysis, it was also stressed that if diseased meat is found, it is important for hunters to take precautions when sampling. Further, if a harvester does not feel comfortable sampling such an animal, then taking photographs is also a very valuable method of recording the problem.



Harvesters reported sticky green-yellow stuff on organs and extra yellow brown fluid in the abdomen (left). Adult worms were seen in muscle sections under the skin (microscope view on right) and parasite DNA was found from tissues in the abdomen and under the skin.

Some excellent questions were raised regarding **meat safety and communication**. For communities new to hunter-based sampling, we discussed the importance of educating and communicating that collecting samples does not signal that the animal is unhealthy and does not affect the meat harvested for food. Participants also discussed how, in practice, it is difficult to use the same knife that is used for butchering food to take samples of abnormal tissue. This led to various suggestions, including the possibility of including a dedicated knife for “strange stuff” in the sample kit.

- **How Can We Monitor Effectively?**

The workshop provided a good opportunity for Northerners from multiple regions/communities to interact and share their experiences with hunter-based sampling. The participants from Kugluktuk, who have been involved in hunter-based sampling for many years (focused on the Dolphin and Union caribou herd), shared valuable observations and insights on how best to carry out this type of program.

“We watch everything; monitoring change, caribou is a way of life. We want this to improve.”

- Stephanie Behrens, Tłı̨chǫ Government

A key question:

- ***“Finding monitors that stay for long periods of time is difficult; how should each community collect and organize samples?”***

The Kugluktuk attendees emphasized how their Hunters and Trappers Organization leaves the decisions to harvesters on how they want to manage their kits. Submitting a basic kit garners a baseline payment, and samples added afterwards (e.g., jaw, spleen, or leg) brings additional payment. The winter road monitors who were present (and who would be new to hunter-based sampling) questioned whether they should send out a call to hunters and request to collect, or would it make more sense to hire a dedicated monitor who goes out on community hunts to help collect and organize samples? Would sending a member of the research team on community hunts be a preferred solution for collecting and organizing samples? There were no direct answers to these questions at the workshop, but these will be important to consider as the research progresses.

Other participants also talked about their roles related to the collected caribou samples. Bridget Enright, Specimen Bank Biologist with the National Wildlife Research Center, indicated that portions of wildlife samples are shipped to her lab in Ottawa. The center collects wildlife tissues from all over Canada and archives them, making it possible to assess health changes in species and populations over time. Bridget mentioned that being a part of this workshop had given her valuable history and context regarding the samples she might receive from this collaborative research, knowledge that she can pass on to her coworkers to impress on them the importance of handling caribou samples with the care and respect they deserve.

- **Steps Forward in Caribou Monitoring**

People’s presence and engagement made it clear that everyone shared a deep concern for the well-being and future of caribou. The pressing question before us was how to chart a path forward.

Sampling kits and willingness to collect:

Participants emphasized that workshops like these provide valuable information to attendees about the purpose of sampling and the subsequent use of hunter sample kits. The presentations also made it clear that being able to investigate contaminants and viruses is important for understanding caribou health. Hunters catch caribou for food, and some harvesters may initially be hesitant to part with kidneys and livers, which are not always large in caribou and may be considered valued food sources. Receiving education on how all the samples in a hunter kit are used can increase a person's willingness to collect them for these projects. By explaining to community harvesters the research objectives and the extensive knowledge that can be gained from the samples, we are hopeful that hunters will be willing to take kits out with them and collect.

Importance of workshops, public education, reporting back:

Participants also noted how valuable the knowledge provided by these workshops is, and that dedicated public education efforts will be needed in all the involved communities before harvest season. Public education initiatives could involve more workshops, community meetings, informative materials suitable for all age groups, and ensuring that the findings from these studies are reported back to the communities for discussion. A specific concern was raised regarding how study results are communicated to communities: Once results arrive at the Hunters and Trappers Organization, who will then disseminate the information? How can we support these organizations to ensure results are effectively delivered to the communities after they are received?

Need for effective planning:

Walter Bezha from Deline noted that this initiative will require planning with the right people in each community and extensive community engagement. He pointed out that there are already many projects ongoing in Deline, and this research could be incorporated into or align with those. He urged the importance of involving community leadership, potentially starting a discussion with management of the Sahtu Renewable Resources Board. Stephanie Behrens also reiterated that she would work to reach out to all members of the Tłı̨chǫ Government and to communities to bring awareness. It was also stated that an important piece of this project is helping people understand their own history, potentially starting with proper translation and attention paid to traditional language learning, as this is foundational in moving forward. It is key that people affected by the projects can understand and listen well.

Interviews regarding Local and Indigenous Knowledge:

Regarding listening, there were questions surrounding what interviews should look like for the duration of this project. Should they be short form? One suggestion was that we should identify questions that would be asked every year, such as numbers of twins observed, numbers of caribou seen, numbers of groups seen. It was noted that the interviews should be conducted in the appropriate season/s (e.g. when hunters are not out on the land), and that the right person is needed to deliver the messages. We heard that hunters in wildlife monitoring programs have found questionnaires hard to answer, so efforts are needed to hone questions and improve.

Women and caribou:

Walter Bezha from Deline stressed that women possess valuable insights about the land and animals, and he emphasized the importance of learning from their wisdom. There was also mention of some cultural beliefs regarding negativity around women’s involvement with butchering caribou. The significance of actively listening to women and recognizing their extensive knowledge about caribou and the environment was a recurring theme throughout several discussions.

“We can get younger people more involved. It is nice to see young people, see them skin the caribou. Seeing young women also cut caribou [out on the land] would be great. It is important to change things and we need to take some steps. Women sampling needs to be thought through; women need to know how to harvest caribou [samples] because not all the men [who hunt] are doing it.” - Walter Bezha, Deline

WORKSHOP DAY 2 - November 2, 2023

Day 2 was mainly dedicated to hands-on training and learning at the GNWT North Slave Wildlife Laboratory in Yellowknife. The goals were to teach sampling procedures and explain what tests are done and the knowledge we can gain from the caribou blood, organs, tissues and other sample requested in the hunter kits. Answering the “why” can naturally increase our interest in doing a task and doing it as well as possible. By informing hunters and winter road monitors about what happens to the samples they collect, the hope was to clarify the important roles they play in the work, erase the “black box” view of scientific sample analysis, and foster interest and investment in our collaborative teamwork for the planned program.

❖ **ACTIVITY 1 – Cadaver Demonstration of Sample Collection**

GNWT Wildlife Veterinarian Naima Jutha arranged for the workshop to use the GNWT Wildlife Laboratory and led the hands-on cadaver work with Frank. Since a caribou carcass was not available, fetal calves (cattle are ruminants like caribou) were used to demonstrate sampling techniques for the different tissues included in the hunter kit. This also served as a good test run for the sample kits, as the participating hunters were able to provide direct feedback about whether the materials and requirements are intuitive and user-friendly for harvesters in the field.



❖ ACTIVITY 2 – Workstation Demos of Tests, Analyses

● **Fecal Floats and Baermann Method**

Fecal flotation is a technique used to concentrate and collect parasite eggs and oocysts from fecal samples. It operates on the principle that the **eggs and oocysts** (another parasite life cycle stage in feces) are less dense (lighter weight) than the sugar-based solution we mix the fecal specimen into. When the specimen breaks up in this solution, the eggs and oocysts are released and rise to the top surface. There they can be collected on a small square glass “coverslip” and examined under a microscope. In this workshop, caribou fecal pellets were used to search for parasite eggs and participants tried their hand at the fecal flotation process and microscope exam.

The **Baermann technique** is used to concentrate and collect **larval stages** of parasites from fecal samples. Fecal pellets are suspended in a porous (i.e. leaky) funnel that is immersed in water for 24 hours, preferably under light because this attracts the larvae. During this time, the live larvae move out of the feces, through the holes of the funnel, and out into the water. They then sink to the bottom and can be collected and examined under the microscope. In this workshop, muskox feces were used to search for parasite larvae, and participants were able to view moving worm larvae when they looked through the microscope.



The fecal exam workstation.

● **Hair Processing for Stress and Minerals Testing**

We request that hair samples be collected with the skin intact, as this is the only way that individual fully intact hair follicles (each with a “hair bulb”; see diagram below) can be removed in the laboratory and tested. Hair studies are a **non-invasive way to monitor stress and potentially measure trace minerals** in wildlife. Hormones called “glucocorticoids” are released from the adrenal glands when a caribou is stressed, and these can accumulate in the animal’s hair. However, the hair

bulb contains a concentrated amount of stress hormone and this may not accurately reflect the long-term stress experienced by the animal. This bulb must, therefore, be removed and the **hormone level** in the rest of the hair is measured. Trace minerals, which are vital to healthy body system processes and immunity, also accumulate in hair.

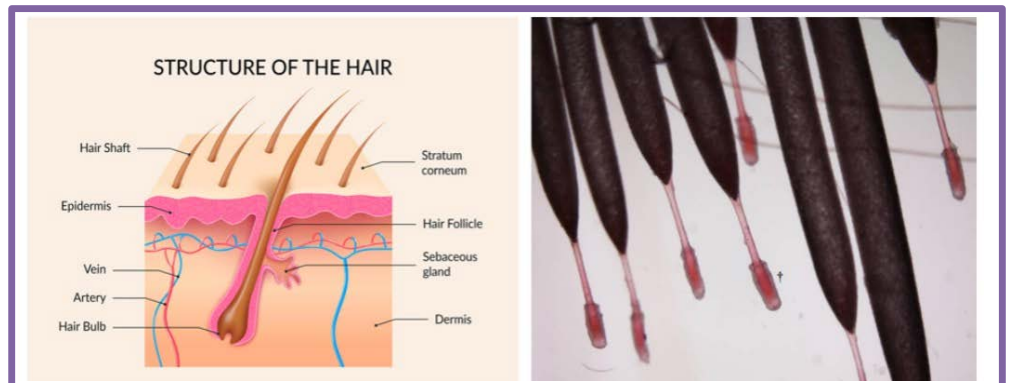
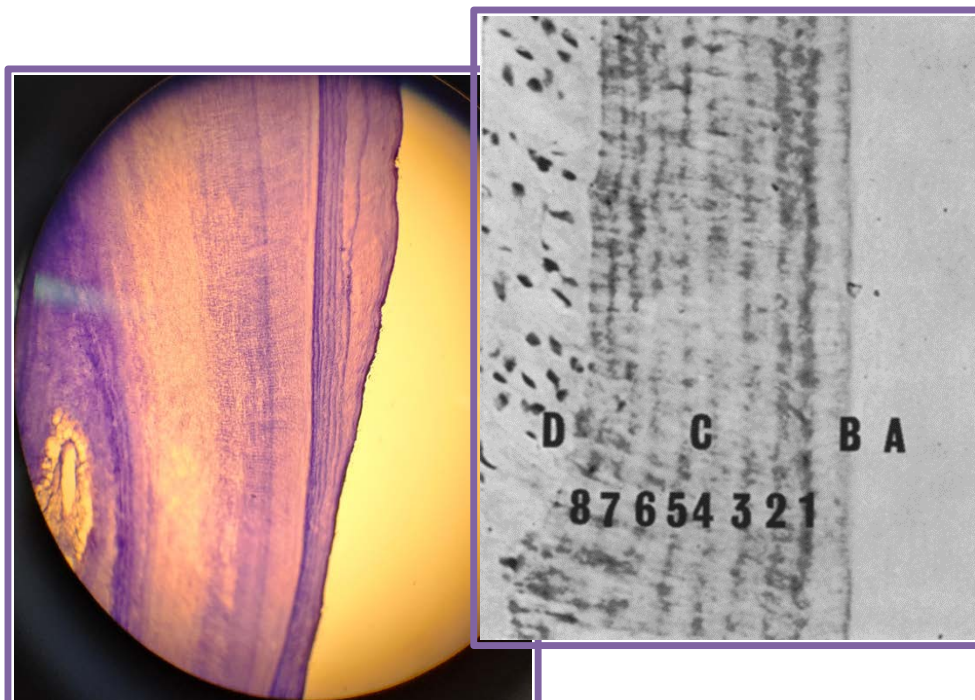


Diagram and magnified photo showing the hair bulb that is removed during hair processing.

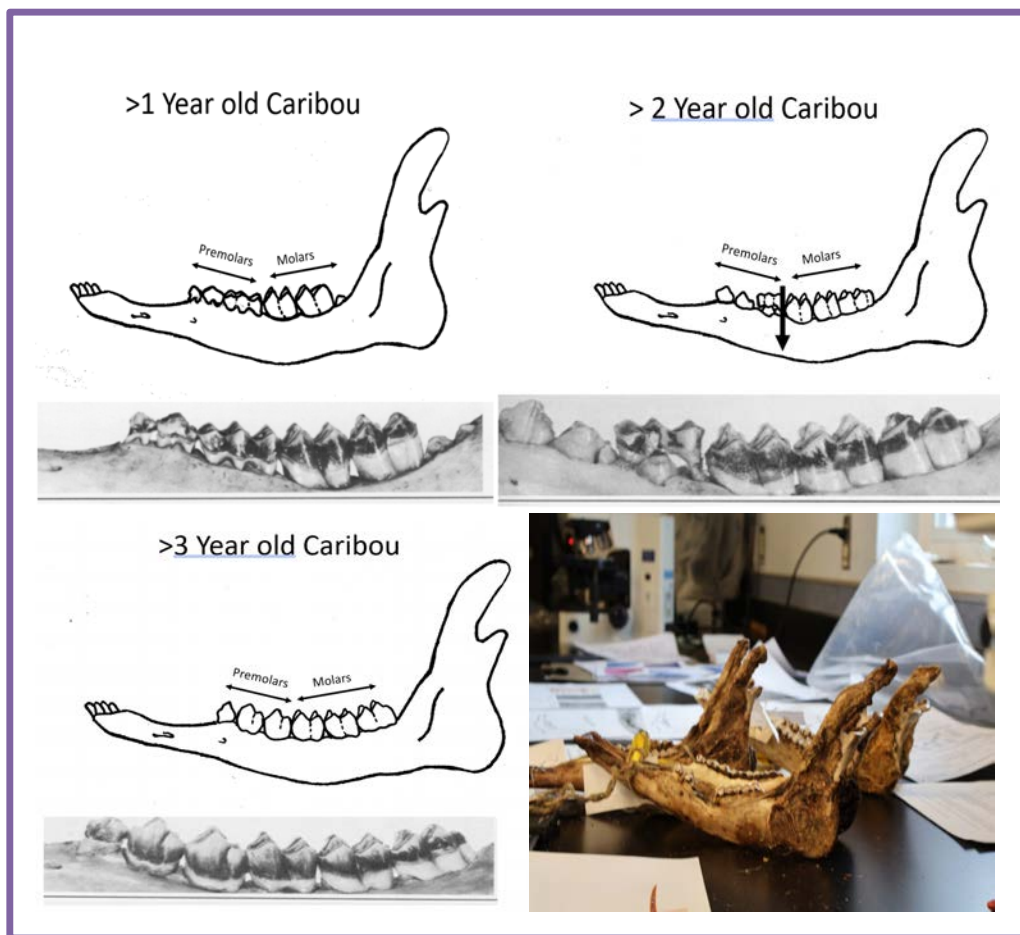
- **Jaw and Tooth Analysis**

Cementum is a hard covering that enables each tooth to be anchored in position. **Cementum analysis** is usually done on the incisor (front) teeth and provides valuable information to estimate an individual's age because cementum layers accumulate over time. Cementum lines, or "**annuli**," are similar to lines in a tree trunk. They form due to seasonal variations in the growth of the cementum. Although it is not always possible to see and count all these layers in every specimen, the number of lines in the cementum layer indicate the individual's age.



Caribou tooth cementum used to determine caribou age. Both images show a tooth sliced vertically, and each line is counted as representing 1 year of the animal's life.

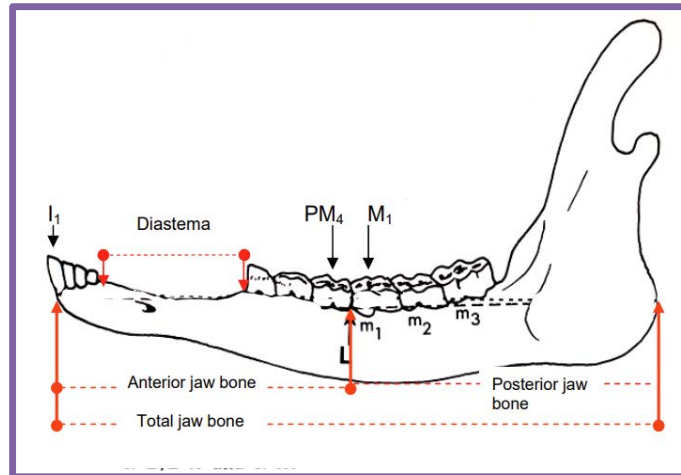
Tooth eruption patterns (the way the teeth grow and emerge from the gumline of the lower jaw) were also discussed with participants. These patterns also serve as a reliable method for estimating caribou age, as one can see distinct markers in the teeth. By examining these patterns, it is possible to reasonably estimate a caribou's age up to 3 years. During caribou jaw development, the first and second molars emerge within the first year of life. After this, the third molar begins to erupt, and by the second year the deciduous pre-molars (milk teeth) start to be replaced by permanent pre-molars. Finally, by the third year, the caribou has a fully developed jaw.



Tooth eruption patterns are also used to determine caribou age.

The techniques and use of “**jaw morphometry**” (i.e., measurements; see drawing below) were also explained. Long-term measurements of specific landmarks in a caribou’s jaw are crucial, as these give information about the animal's growth, health, and environmental conditions.

Comparing these measurements over time allows us to **track changes in health, nutrition, and environmental stressors**, and this, in turn, can shed light on population dynamics, habitat quality, and potential impacts of environmental changes on caribou populations.



Jaw morphometry: The red dashed lines show the measurements that are made between landmarks in the jawbone (each indicated by a solid red line/arrow). These are analyzed separately and together to give information about the caribou’s health, nutrition and stress.

- **Liver and Kidney Sampling**

As Mary explained in her presentation, the liver's role in the body is to **remove toxins from the blood**. Contaminants from the environment may accumulate in the liver, and this is why it is an excellent organ for measuring accumulated contaminants. Similarly, the kidneys play a crucial role in filtering and removing substances from blood. Kidneys accumulate and concentrate various contaminants, and they can provide a snapshot of an individual's exposure to environmental pollutants. During her demonstration, Mary also explained why she **requires a large piece of liver**, normally the size of a pound of butter, for her analysis. During the demonstration, she showed how the outer layers of the liver need to be discarded because they can be contaminated when the hunter butchers the caribou.



Participants learning how livers and kidneys are sampled for contaminants testing.

- **Bone Marrow**

Bone marrow from a long bone is used to **estimate the amount of fat** an animal has, and to **assess for disease**. The bone is cracked in half and the marrow is scooped out for further processing in the lab. To weigh the fat, a scoop of fresh ('wet') bone marrow is placed in a container, weighed, allowed to dry completely, and then weighed again. The difference between the wet and dry weights represents the fat content.



Fabien shows participants how to crack open a long bone (left) and sample and process the bone marrow (right).

- **Blood on Filter Paper**

Collecting blood on filter paper strips is a convenient and practical way to sample blood in the Arctic, as conventional glass blood tubes can break in the cold. These samples are easy to collect and enable us to **test for various pathogens (e.g., bacteria, viruses), immune status, and pregnancy** status in caribou. Participants were shown how to collect sets of filter paper strips correctly (i.e. **always dip the full length** of the filter paper in blood) and some processing steps to be able to test the blood in various ways.



Learning how filter-paper blood samples are collected in the field and processed in the lab.

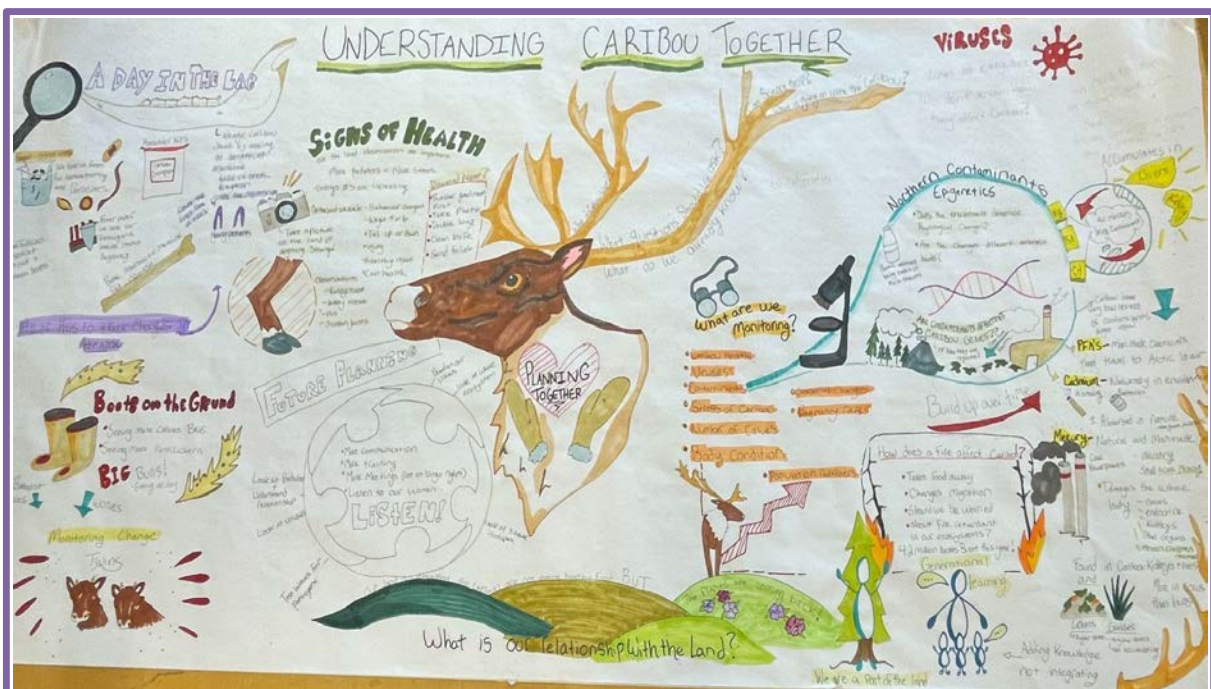


Graphic Recording of the Workshop – Jessie Olson, Artist

In addition to telling us about her virus research project, Jessie Olson volunteered to use a creative method called graphic recording to visually capture the main themes and comments as they emerged during the workshop. The simple, intriguing pictures and phrases of Jessie’s evolving mural made the workshop even more engaging as the days passed, and at the end all participants came together to view, discuss, and enjoy it. Jessie’s drawings were a beautiful and interesting way for everyone to understand and remember all the key points. The imagery and words helped us all share and remember elements of what was discussed. Her work created a lasting and accessible record of the workshop's important information for everyone, and it will be a holder of all the different viewpoints for our future use and collaboration.



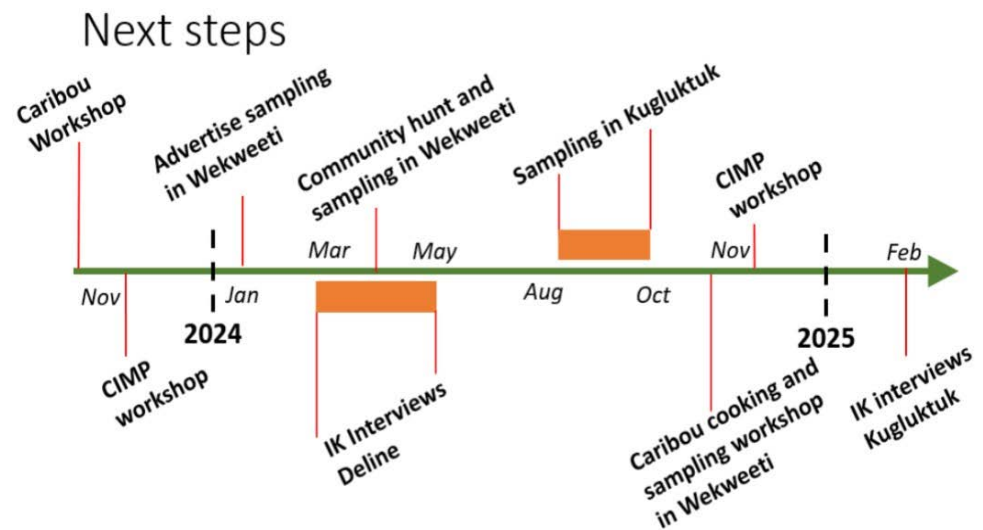
Jessie worked away adding images and phrases, and at the end we all gathered to admire what she captured and to discuss final touches.



What's Next? Future Planning and Timeline

Before going our separate ways, everyone sat down to discuss the path forward for this program over the next 3 years. The discussion was very productive and we were able to roughly sketch out sample collection times, timing for IK interviews, and community workshop dates on a timeline (see below).

The workshop brainstorming timeline shows a rough plan for sample collections, community workshops, and Indigenous Knowledge interviews over the next 3 years.



Final Thoughts ...

This workshop provided valuable insights into current concerns of caribou harvesters from multiple northern communities, and into factors that impact the health of barren-ground caribou. Our interactive discussions, our many different hopes, our diverse experience and skill sets all emphasized the importance of leveraging our varied backgrounds and knowledge to collaboratively chart a course to help conserve caribou for future generations.

Over the 2 days of discussions and knowledge sharing, several novel ideas were put forward to help optimize the planned collaborations. As well, several other lines of research were suggested that could address potential knowledge gaps related to the health of barren-ground caribou. All these (noted briefly below) are food for thought.

Potential new projects that emerged from discussions:

- Investigate stable isotopes in predator diet.
- Investigate interactions and dynamics of the calving grounds in Kugluktuk; this is a no-hunting zone but perhaps we can find a non-invasive way to collect data.

- Do winter road sampling: Can we begin sampling opportunistically from gut piles and tissues left over after hunters butcher a carcass? (e.g., study body condition, fetuses, stomach/abdomen contents, and any other wildlife observations)
- Do opportunistic fecal collections: Is there interest and is this feasible?(Stephanie Behrens has seen success with \$25 per bag.)
- Provide a field book for each winter road monitor.
- Consider including a dedicated sampling knife in each hunter kit so harvesters can avoid sampling diseased tissue with their primary clean meat-cutting knife.

To be able to truly collaborate, we all need to be on the same page; we all need to trust, we all need to be invested together and go forward with this work a good way. It is fitting to end this report with some foundational discussion points:

- The ways we speak about and use Indigenous Knowledge are important, as we have listened and we agree that IK is not to be “integrated” or “incorporated” into anything ever. This is an independent knowledge system that contributes to the world uniquely, and scientific knowledge also contributes to the world. These forms of knowledge can complement each other to be powerful.
- Generational learning is integral to understanding ecosystems; our ancestors lived in a different world and saw changes in the health of the land and caribou that must be considered when discussing future planning.
- As individuals, we can never know everything; we have to share knowledge and keep learning with each other.

APPENDIX I: Participants List

Attendee	Organization
Allen Niptanatiak	Kugluktuk Angoniatit Association
Ashton Nivingalok	Kugluktuk Angoniatit Association
Myles Pedersen	Kugluktuk Angoniatit Association
Walter Bezha	Former Deline Gotine Government Elders Advisor to the Deline Elders Council
David Taneton	Vice President, Deline Renewable Resources Council
Stephanie Behrens	Tłıchǫ Government
Roy Judas	Tłıchǫ Government
Joseph Moosenose	Tłıchǫ Government
JJ Simpson	Tłıchǫ Government
Lloyd Rabesca	Tłıchǫ Government
Jarvis Lamouelle	Tłıchǫ Government
Brendan Camsell	Tłıchǫ Government
Leegah Lafferty	Tłıchǫ Government
Ete Zoe	Tłıchǫ Government
Dillon Smith	Tłıchǫ Government
Andrew Laing	Tłıchǫ Government
Darren Rabesca	Tłıchǫ Government
Naima Jutha	GNWT Wildlife Management Division
Stefan Goodman	GNWT North Slave Wildlife Technician
Petter Jacobsen	Ekwò Nàxoèhdee K'è, Tłıchǫ Government
Mary Gamberg	Gamberg Consulting
Susan Kutz	Kutz Research Group, U of Calgary
Fabien Mavrot	Kutz Research Group, U of Calgary
Amish Dua	Kutz Research Group, U of Calgary
Pat Curry	Kutz Research Group, U of Calgary
Frank van der Meer	van der Meer Research Group, U of Calgary
Jessie Olson	van der Meer Research Group, U of Calgary
Bridget Enright	National Wildlife Research Center, Ottawa
Aimee Guile	Wekeezhii Renewable Resources Board

APPENDIX II: Agenda

Day 1

Time	Activity	Details
8:30 am	Gather	Commissioner's Room, Nova Inn Yellowknife, Breakfast
9:15 am	Welcome	Opening Prayer - Joseph Moosenose Introductions, learning goals
9:45 am	Overview of Projects	<ol style="list-style-type: none"> 1. Proactive Indicators of Caribou Conservation Status to Guide Management and Policy - Susan Kutz 2. Community-defined and Monitored Indicators of Recovery in Barren-ground Caribou - Susan Kutz 3. Contaminants, Caribou Epigenetics, and Genomic Health - Mary Gamberg
10:15 - 10:30 am	Break	
10:30 - 11:00 am	Session	Caribou Health Monitoring - Examples and Developing Community-defined Proactive Indicators of Change - Fabien Mavrot, Amish Dua
11:00 - 11:30 am	Session	Impacts of Viral Infections on Caribou Health - Frank van der Meer, Jessie Olson
11:30 - 12:00 pm	Session	Contaminants and Caribou - Mary Gamberg
12:00 - 1:00 pm	Lunch	
1:00 - 2:30 pm	Interactive Discussions	Identifying Concerns about Bluenose East Caribou Health and Disease - led by Mary Gamberg, Naima Jutha
2:30 - 3:00 pm	Break	
3:00 - 4:15 pm	Interactive Discussions	Addressing Concerns using Community-based Caribou Monitoring - led by Fabien Mavrot, Stephanie Behrens
4:15 pm	Closing Remarks	Once around the table: What will we each take away from Day 1? Closing Comments and Thanks

Day 2

Time	Activity	Details
08:30 am	Gather	North Slave Wildlife Lab & Classroom
9:15 am	Video	Bluenose West caribou sampling
9:25 am	Session	What's in a Sample Kit? – F Mavrot, M Gamberg, F van der Meer
10:15 - 10:30 am	Break	
10:30 - 12:30 am	Group Activities	Group 1 – Sampling with cadaver - N Jutha, F van der Meer Group 2 – Demos of tests and analyses - F Mavrot, M Gamberg, A Dua, J Olson, P Curry
12:30 - 1:00 pm	Lunch	
1:00 - 3:00 pm	Group Activities	Group 2 – Sampling with cadaver Group 1 – Tests and analyses demos
3:00 - 3:30 pm	Break	
3:30 - 4:30 pm	Summary Session	Graphic artist summary, presenters, participants
4:30 pm	Concluding Discussion	What's next?