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MUSKOX HEALTH MONITORING PROGRAM IN THE CANADIAN ARCTIC

University of Calgary members of the Kutz lab, Government of Nunavut (Lisa-Marie Leclerc, Terry Milton, Kevin Methuen & Russell Akeeagok), Government of the NWT, Kugluktuk Angoniatit Association, Olokhaktomiut Hunters and Trappers Committee, Ekaluktutiak Hunters & Trappers Organization

Community Presentation – October 10, 2023

By Juliette Di Francesco (former PhD student of the Kutz lab)

Contact information: Juliette Di Francesco – juliettedifi@gmail.com ; Susan Kutz – skutz@ucalgary.ca

What do the Sample Kits Include?

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Information form

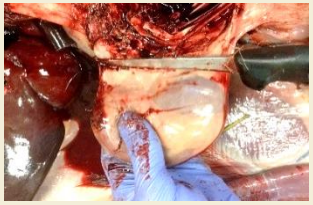
Additional information on the sampled animal and the whole herd

Spleen

For diseases, in particular viruses

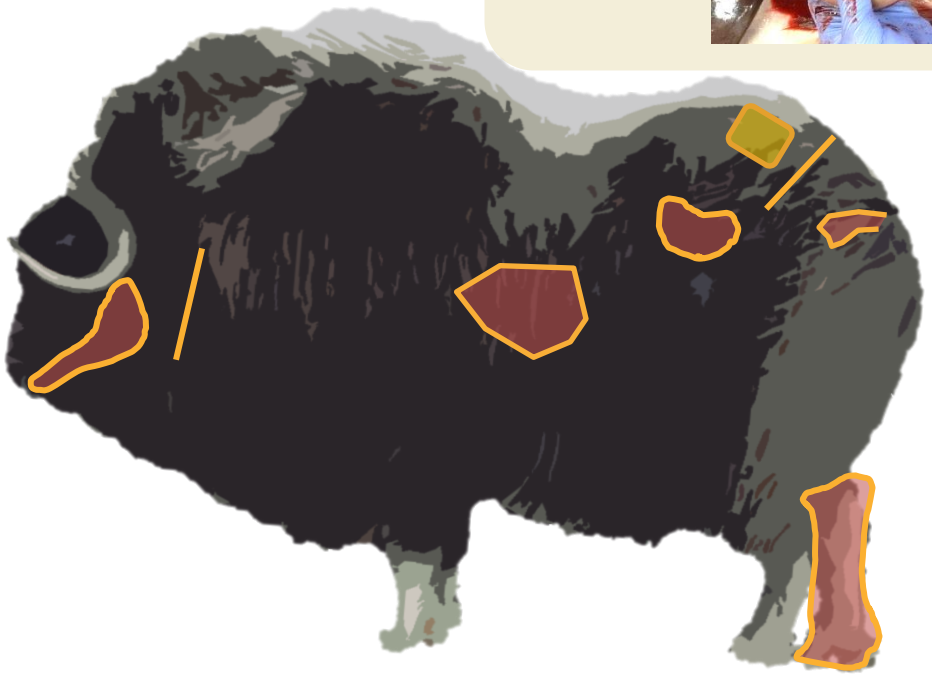
Left kidney + Fat

For fatness and contaminants



Back fat thickness

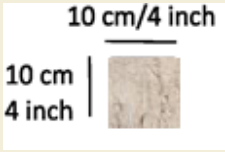
For fatness



Blood on filter paper

For diseases and pregnancy

Skin and hair

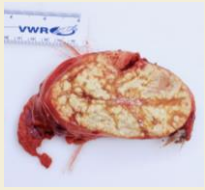


For stress levels, contaminants, and food deficiency

Lower jaw

For teeth problems and age determination

Anything abnormal



To be examined and figure out what it is

Lower left hind leg

For hoof problems, parasites, bone marrow fat, size

Feces

For parasites, stress levels, pregnancy, genetics, and contaminants

Muskox Sample Kits Collected 2014-2022

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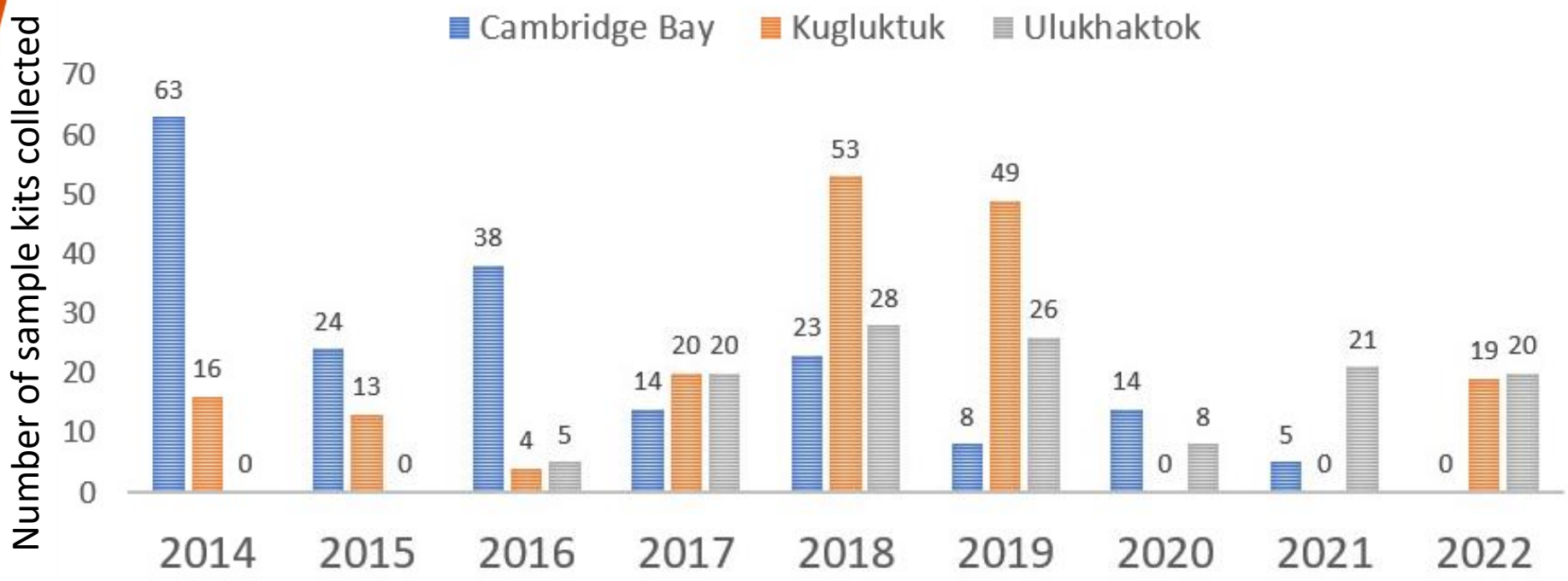

Why Study Stress in Muskoxen?

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- Muskoxen **increasingly exposed to things that may stress them** in the rapidly changing Arctic

- Increased stress over **long periods of time** may cause **negative effects**
  - Reduced health
  - Increased diseases
  - Reduced reproduction
  - Reduced survival

How Can We Measure Stress?

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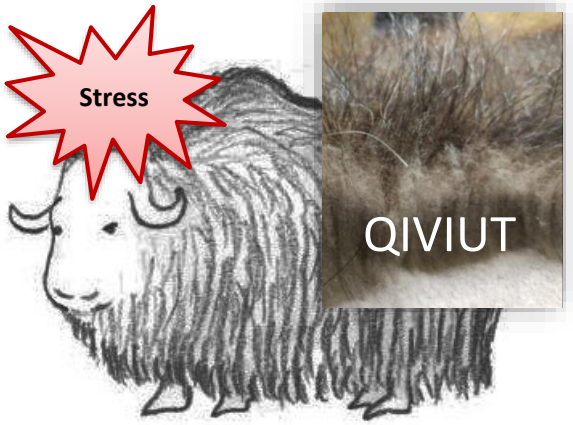
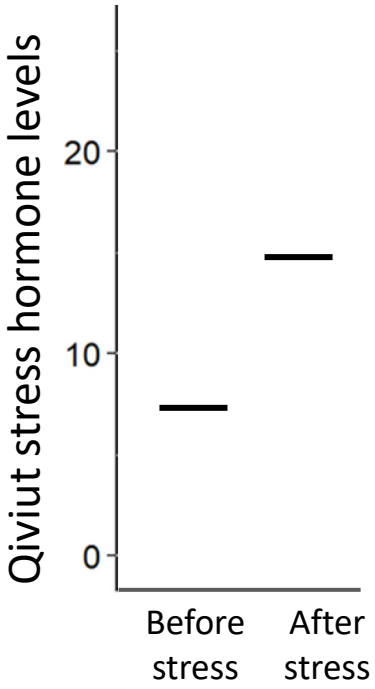
- When a muskox is stressed, it produces a hormone (cortisol) that is incorporated into hair (**qiviut** & guard hairs) during its growth



How do we know that we're **measuring stress** in qiviut?



- **Experimental study on captive muskoxen**
- Injection to ↑ stress

- Qiviut stress levels = measure of stress experienced by muskox during qiviut growth

Muskox Sampling Kits

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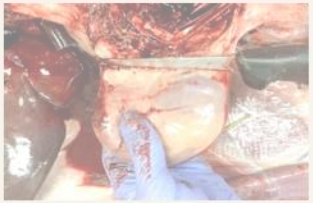

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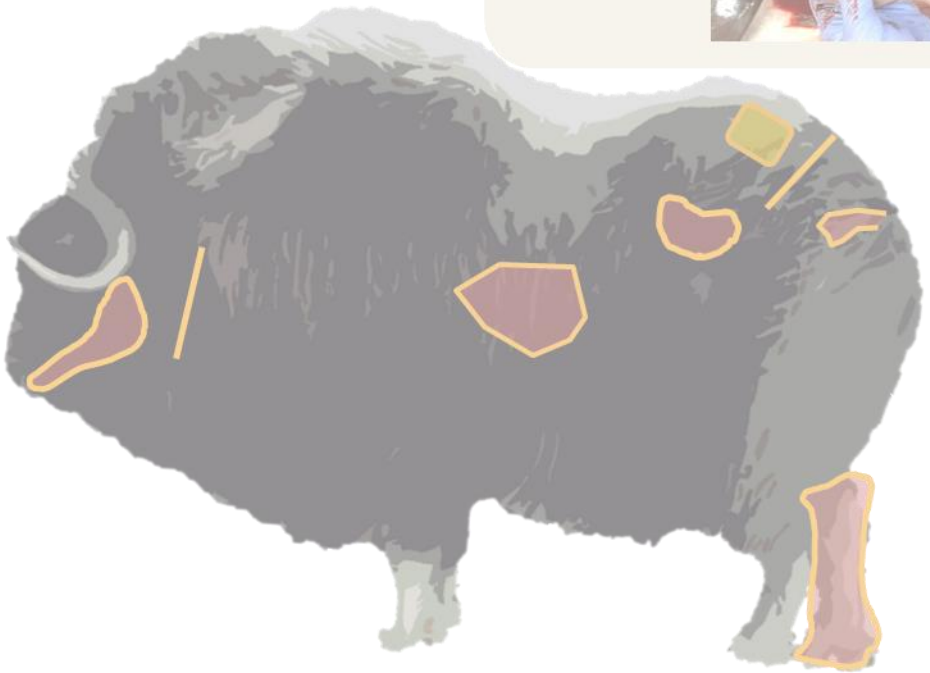

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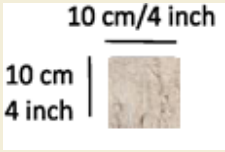

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Measurement of Stress Levels in Qiviut of Wild Muskoxen

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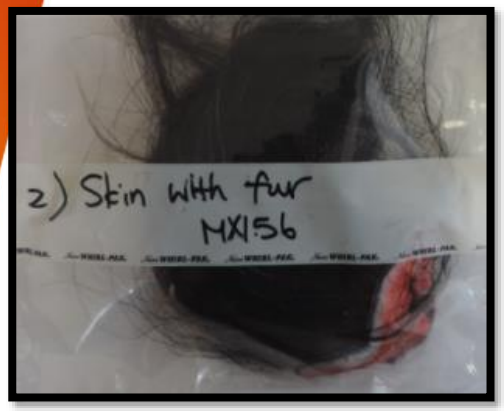
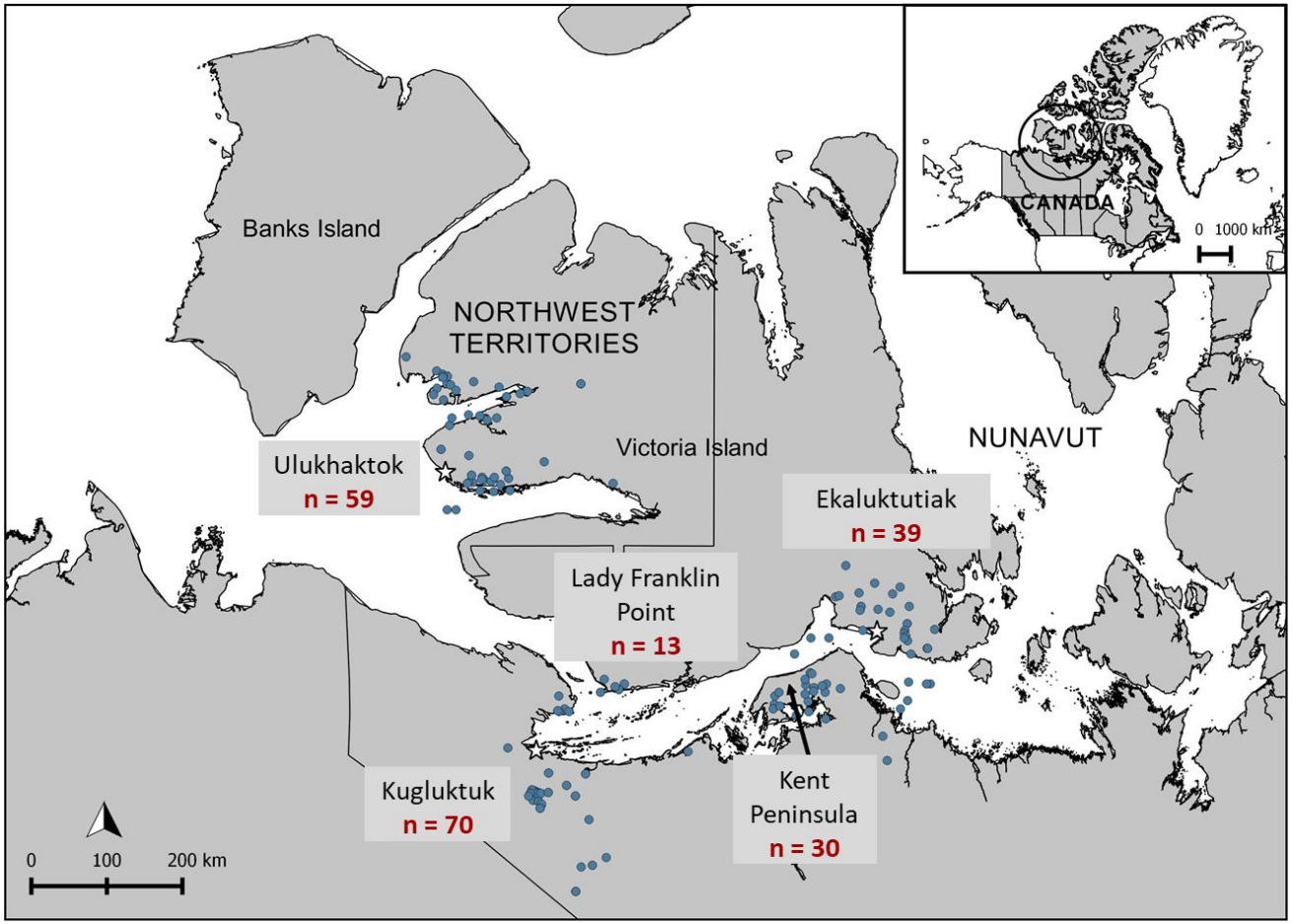
Are muskoxen in poor health or in declining populations more stressed?



- Qiviut samples collected from **211** harvested muskoxen **between 2015 and 2019**



Differences Between Sexes and Seasons

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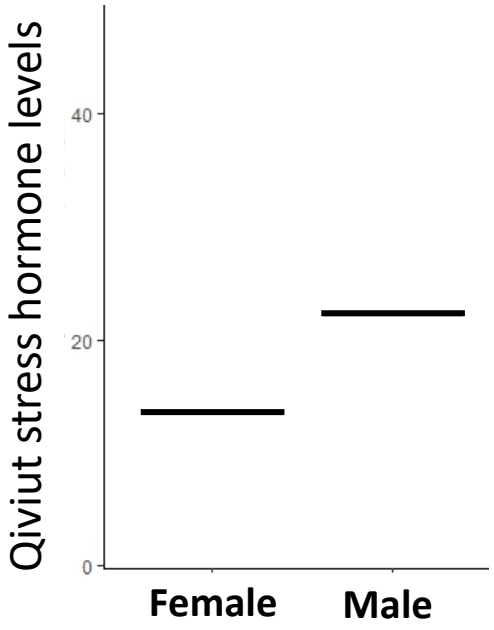
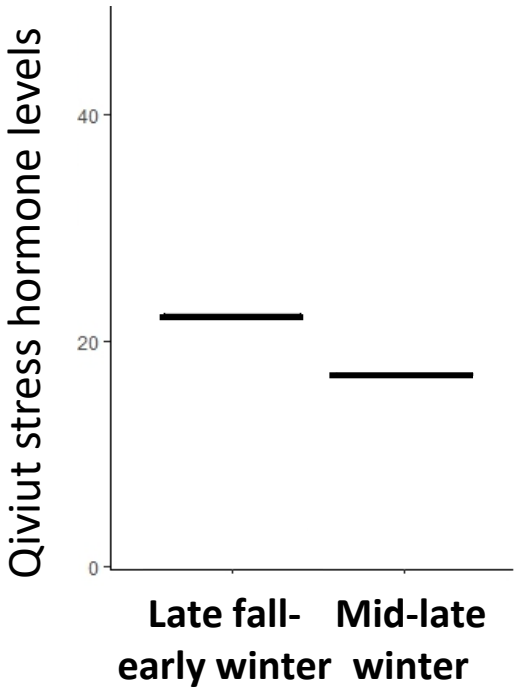
Sex Differences



Seasonal Differences – Males



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Differences Between Years

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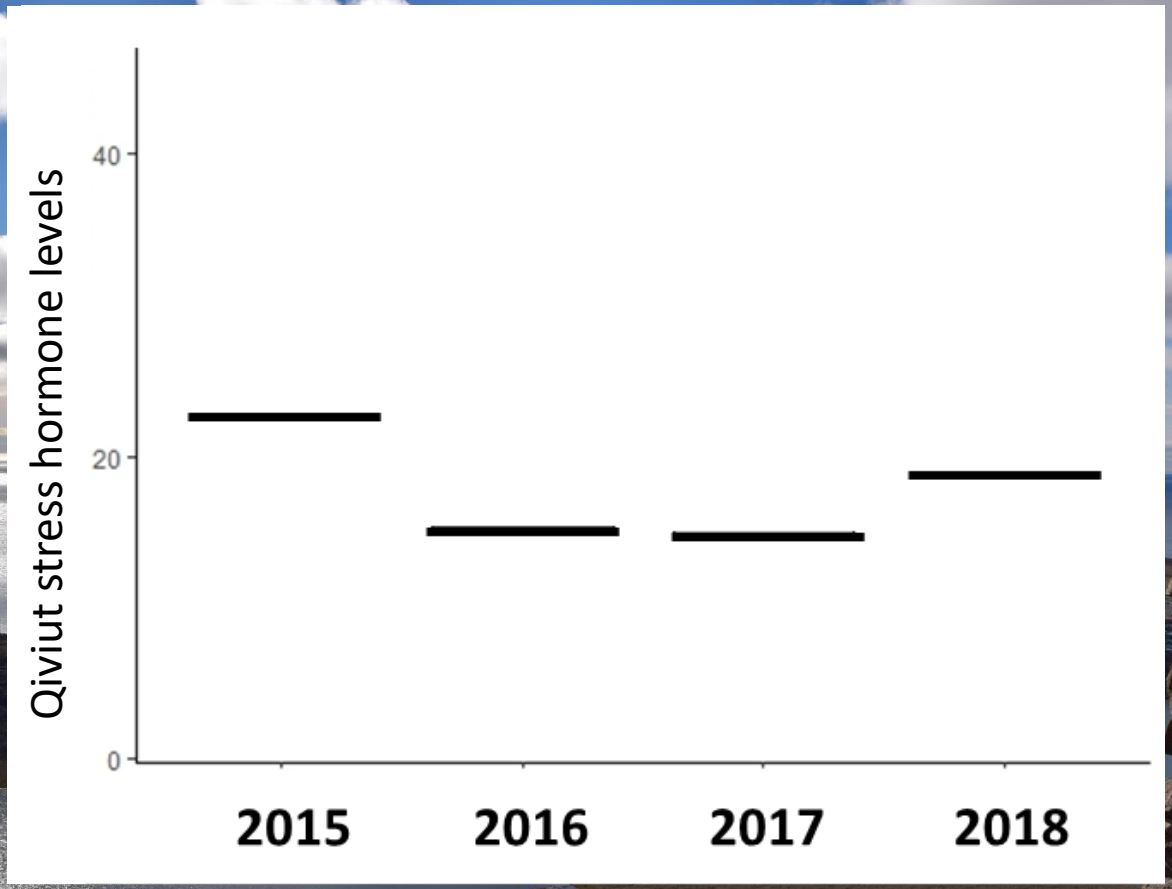

2016 & 2017 < 2018 & 2015

Differences Between Geographical Locations

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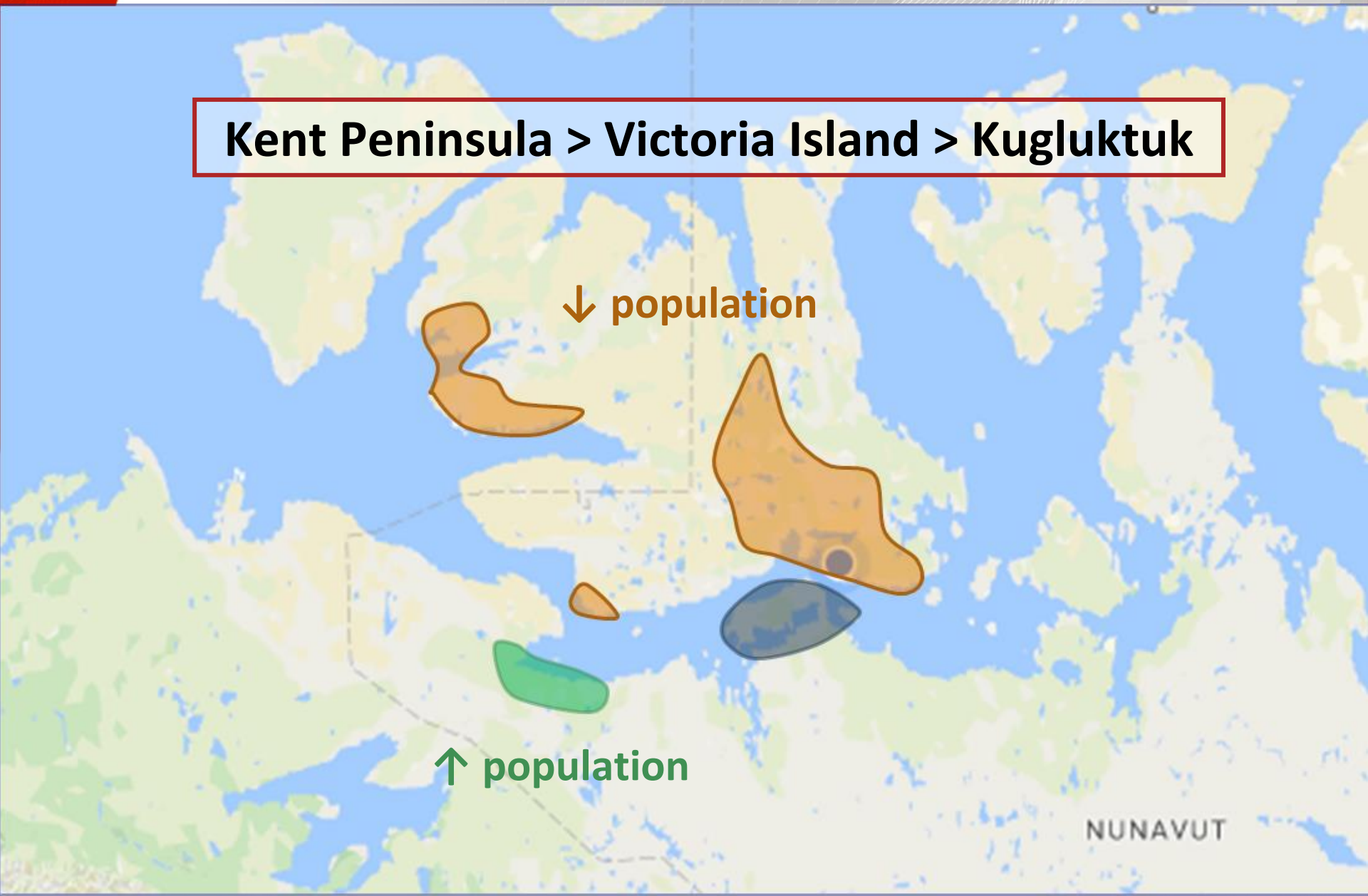
Kent Peninsula > Victoria Island > Kugluktuk



Relationship With Health Measures

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- **Fat** muskoxen **less stressed than skinny** muskoxen

- Muskoxen with **broken teeth not more stressed**

=

Are Muskoxen with Worms More Stressed?

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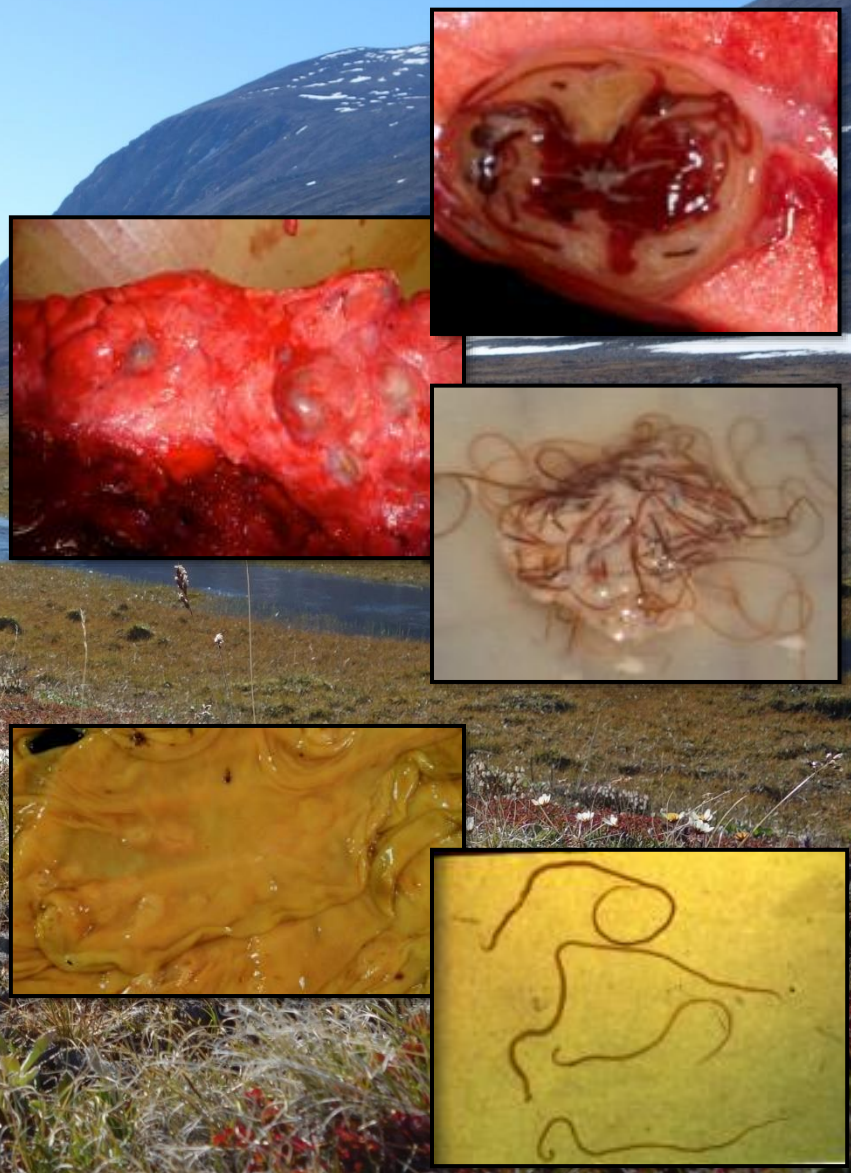
- Muskoxen with lots of **lungworms not more stressed**



- Muskoxen with lots of **worms** in **stomach** and **intestines not more stressed**

Understanding the Stressors Affecting Muskoxen

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Document **traditional Inuit knowledge** to **understand what stresses muskoxen**

- **What affects muskoxen in a positive/negative way?**
- **Discuss results from study on muskox stress** (sex, seasonal & yearly differences)

Photo credit: Andrea Hanke

- **Seven small group interviews** with muskox harvesters (2019)
- Transcription and determination of **themes**
- Clarification and confirmation of results through **validation sessions** (2020)

Photo credit: Andrea Hanke

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WHAT AFFECTS MUSKOXEN?

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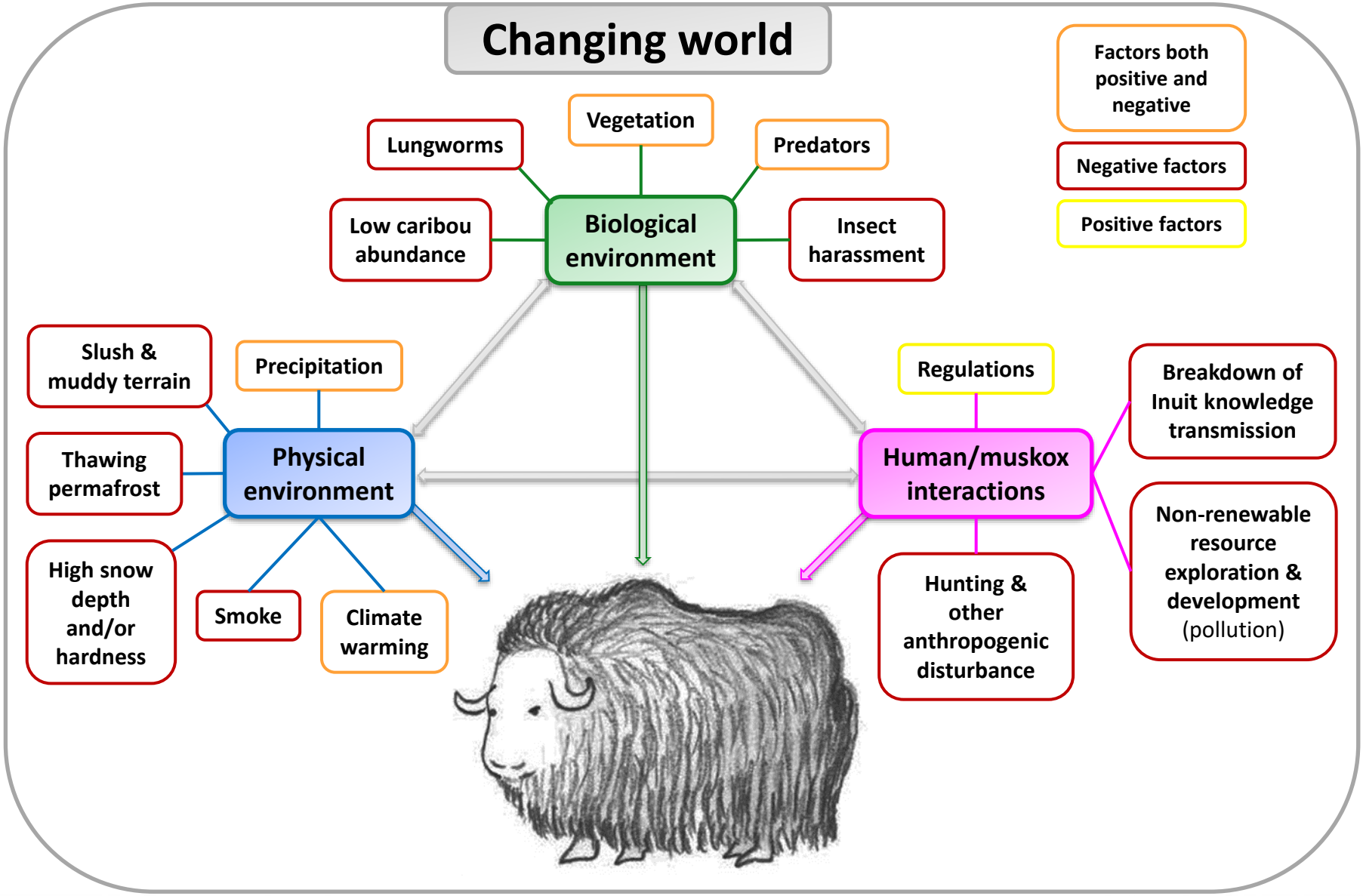

INSECTS

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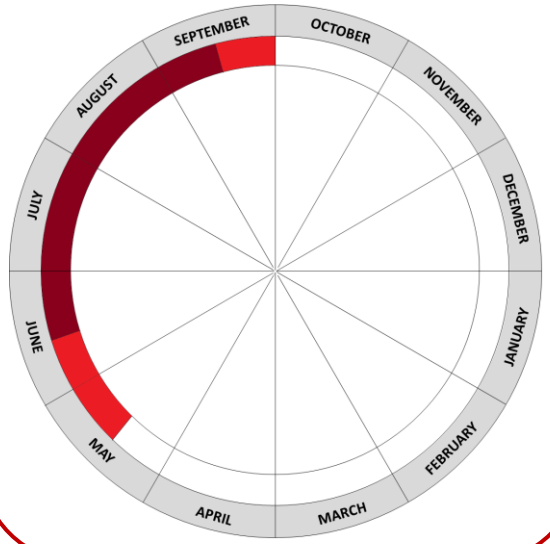
Timing of insect activity



Changes over time

- Climate warming & air/sea traffic → **increase in diversity of species** since 1980s-1990s
- **Abundance** – strong annual variations, increase?
- **Longer period of activity**

Effects on muskoxen – only one study in 1982

Negative Impact

- Thick skin & long hair → **less harassed & sensitive** than caribou
- Avoid harassment → water sources
- **Affected on legs & face** → moderate restlessness, ↑ movements, ↓ eating

→ Limited but non-negligible effect

Collaborative Interpretation of Qiviut Stress Results

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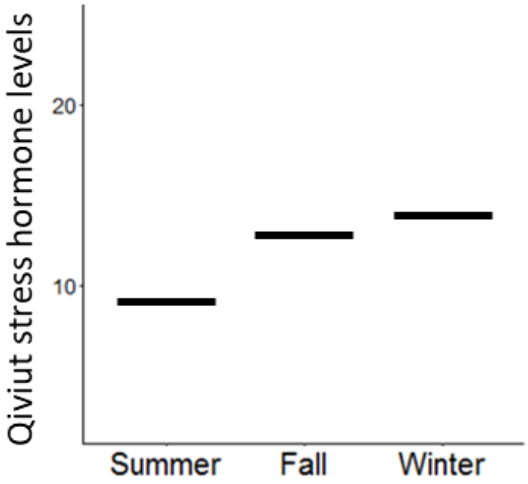
Seasonal Differences



Lower food availability, quality and accessibility

Higher pressure from predators

Insect harassment

Poor air quality

Heat stress

Fall = Winter > Summer

Reproduction (rut and mating)

Higher hunting pressure and human disturbance

Helicopter activity

Predators

Muskox Sampling Kits

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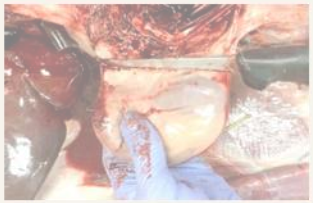

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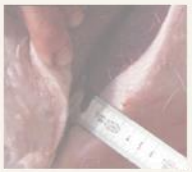
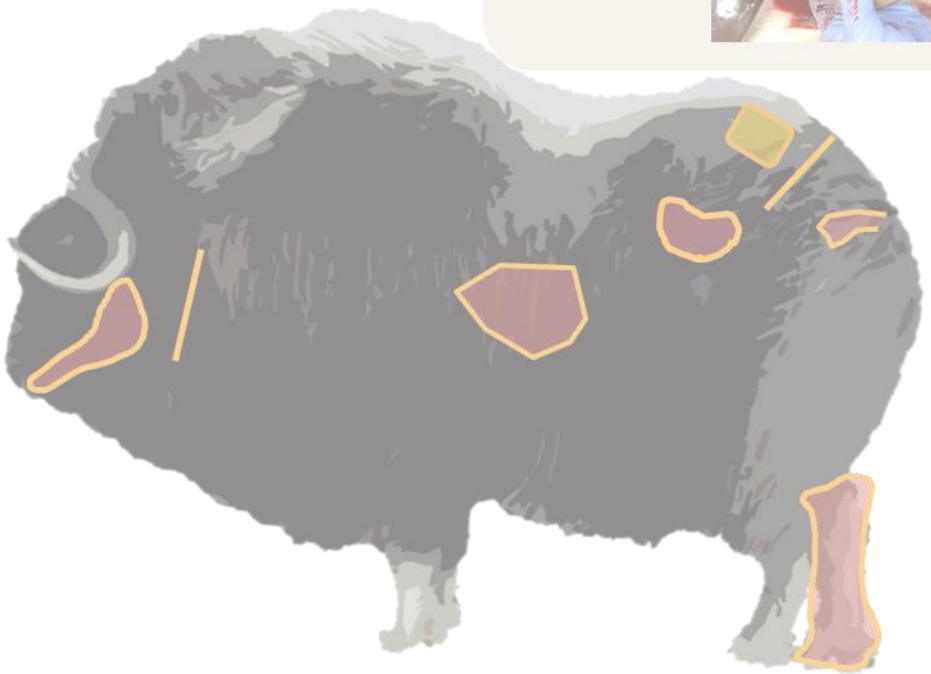


For fatness



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Teeth Abnormalities in Muskoxen

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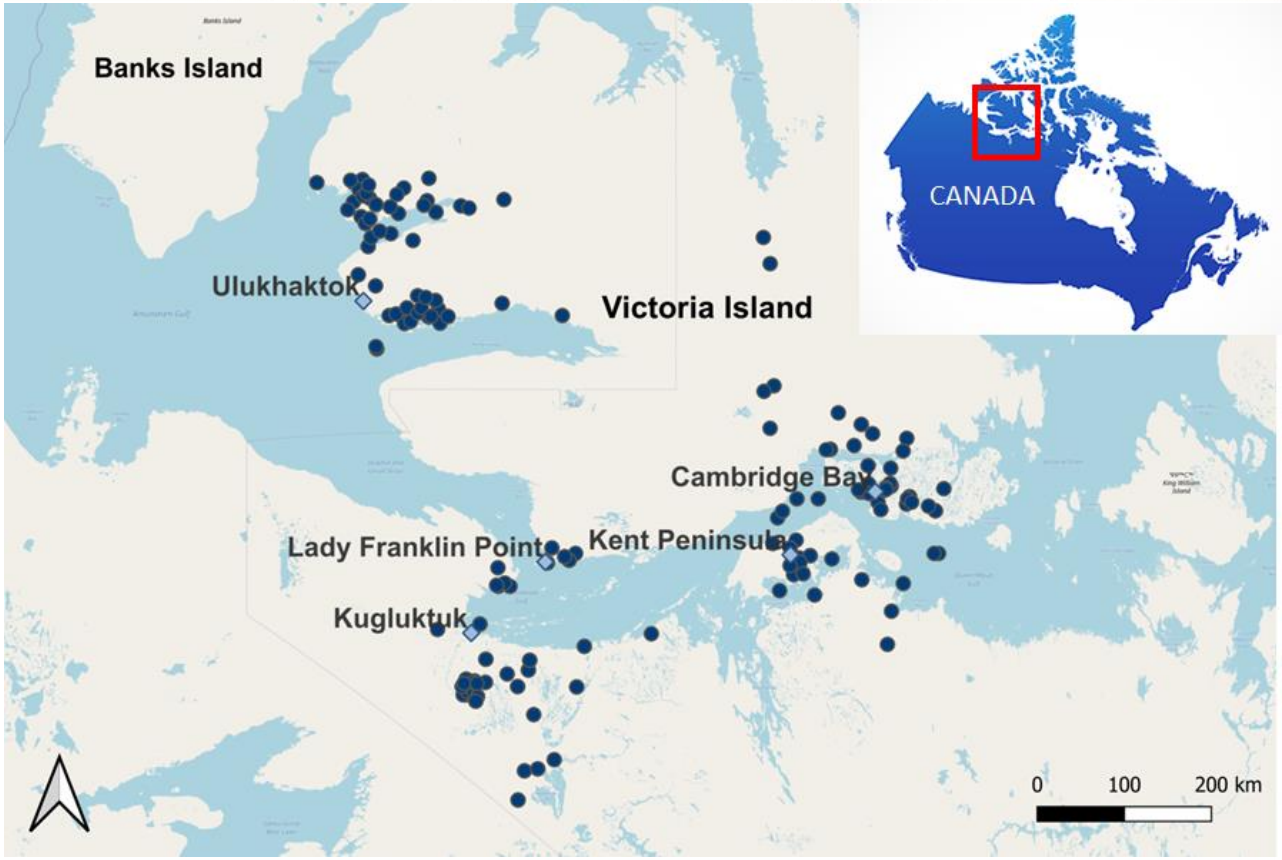
Erica Suitor
PhD Student



Age	Island	Mainland	Total
Under 4 yo	53	28	81
4 yo & older	83	98	181
Total Jaws	**136**	**126**	**262**

Teeth Abnormalities Observed

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Fractured

Cracks

Rotation and Crowding

Displacement

Anterior Wear

Asymmetry

Differences in Teeth Abnormalities Between Regions

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Broken teeth

Rotated teeth

Victoria Island

Anterior wear

Mainland

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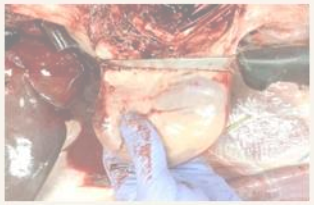

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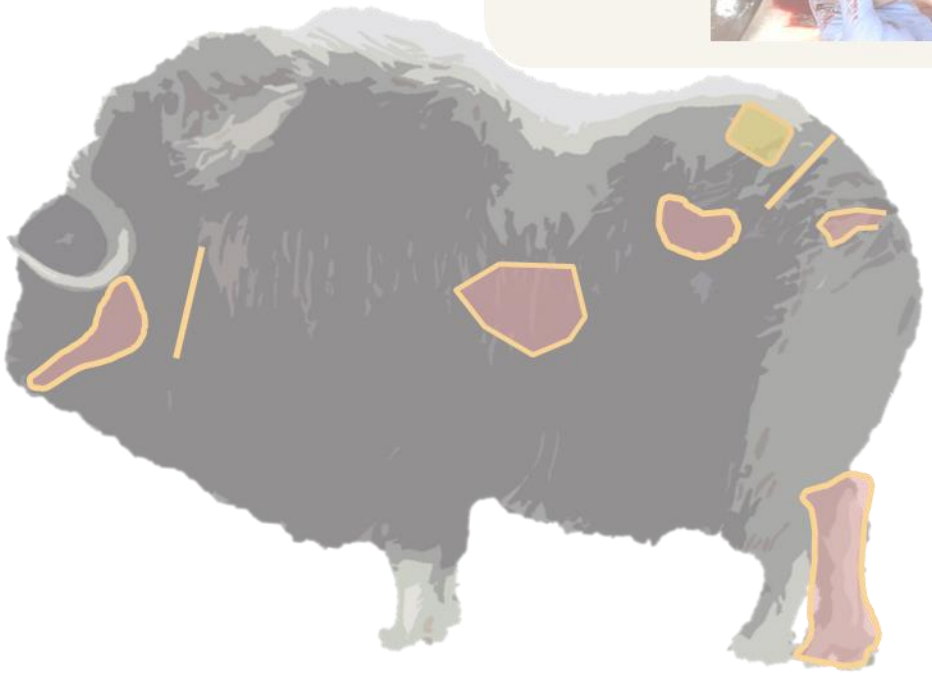

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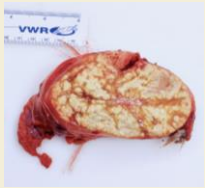

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Brucellosis in the Arctic

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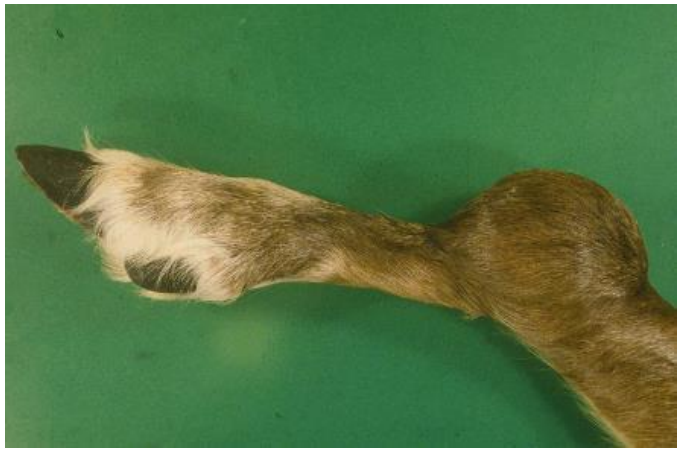
- Disease caused by bacteria from the genus *Brucella* sp.
- **In Northern Canada** – *Brucella suis* biovar 4 in caribou and muskoxen
- **Can infect people and cause disease**
- **Blood on filter paper** to **test for previous exposure** to the disease



Current Status of Brucellosis in Muskoxen

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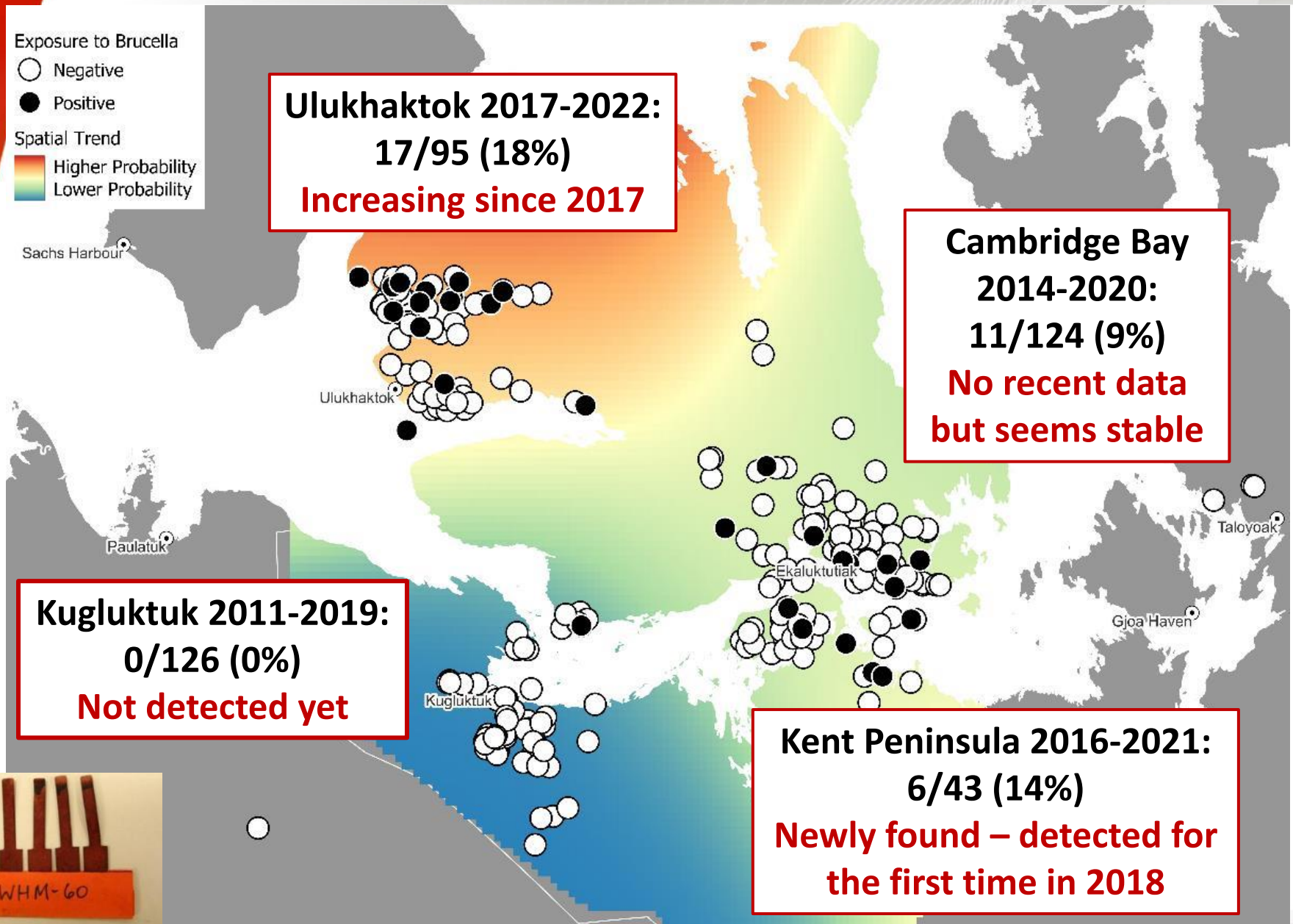

Current Status of Brucellosis in Dolphin & Union Caribou

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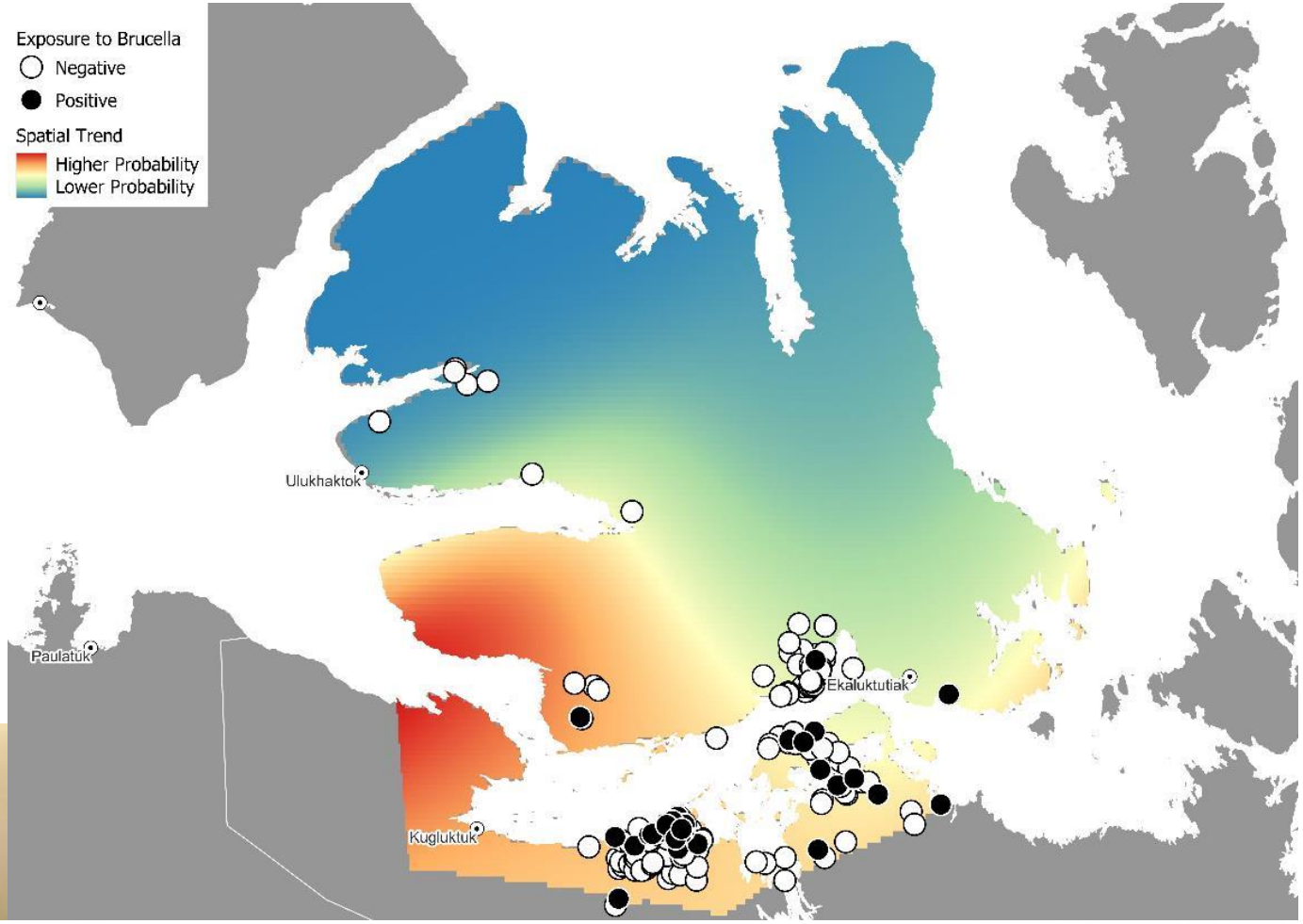
- 46/298 (**15%**) caribou tested between 2015 and 2022 positive
- **No clear trend over time**



Common Signs of Brucellosis

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- **Typical signs** of brucellosis
  - Swollen joints filled with liquid
  - Swollen testicles
  - Swollen udders

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Signs of Brucellosis Not Always Detected by Harvesters

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  - Swollen joints filled with liquid
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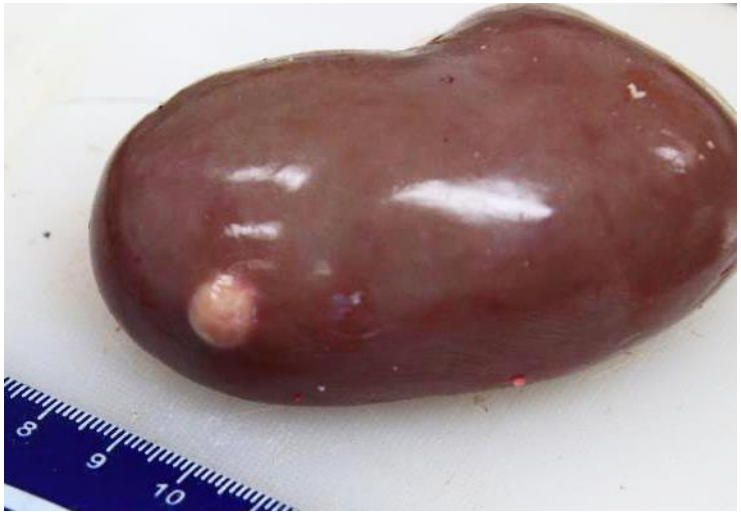

Kidney from a Bluenose East caribou harvested **near Kugluktuk**

- **Other signs** are also possible
  - **White spots filled with pus** in organs (kidney)
  - White spots filled with pus in muscle (meat) or even bones

Thanks A Lot For Your Attention!

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Environment and Climate Change Canada
Environnement et Changement climatique Canada

Natural Sciences and Engineering Research Council of Canada
Conseil de recherches en sciences naturelles et en génie du Canada
Canada

ArcticNet

Crown-Indigenous Relations and Northern Affairs Canada
Relations Couronne-Autochtones et Affaires du Nord Canada

Polar Knowledge Canada
Savoir polaire Canada

Government of Northwest Territories

Current Status of Brucellosis in Muskoxen and Caribou

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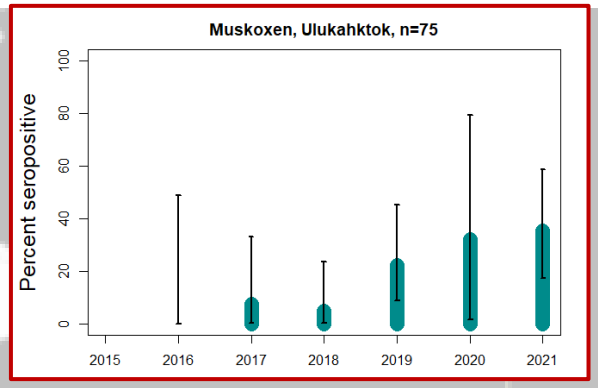
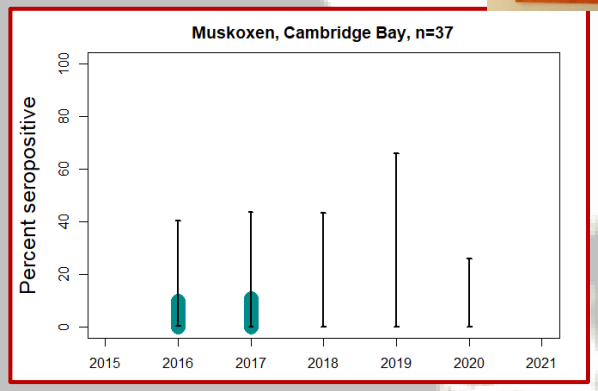
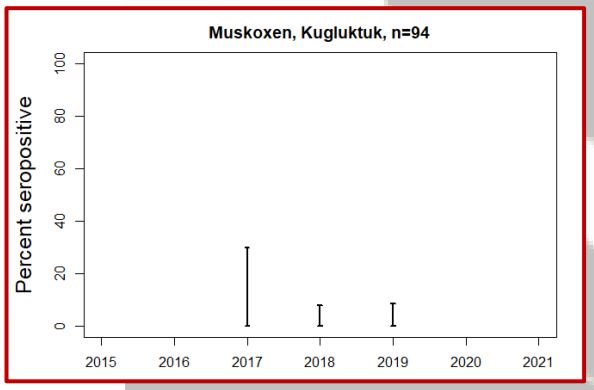
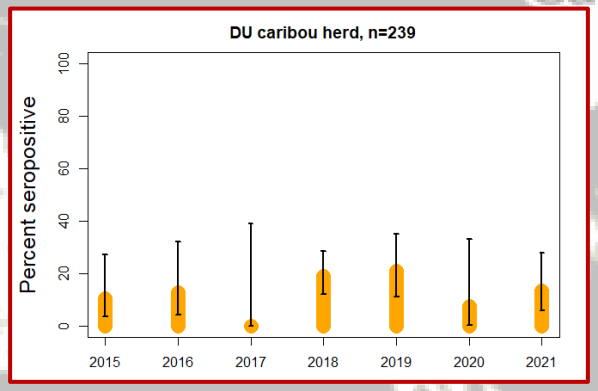
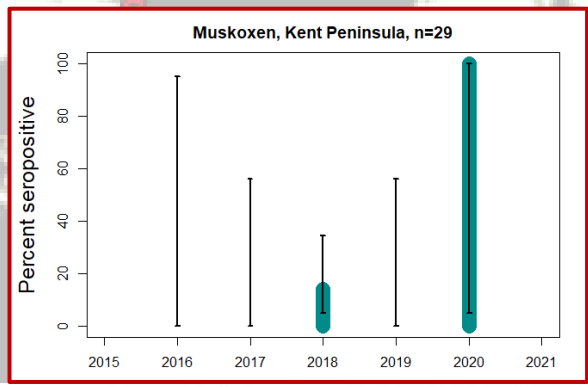
- **Muskox**: Increasing on NW Victoria Island; Expanding on Kent Peninsula; Not yet detected around Kugluktuk
- **DU caribou**: Constantly in around **10-20%** of tested animals











Causes and Consequences of Incisor Abnormalities

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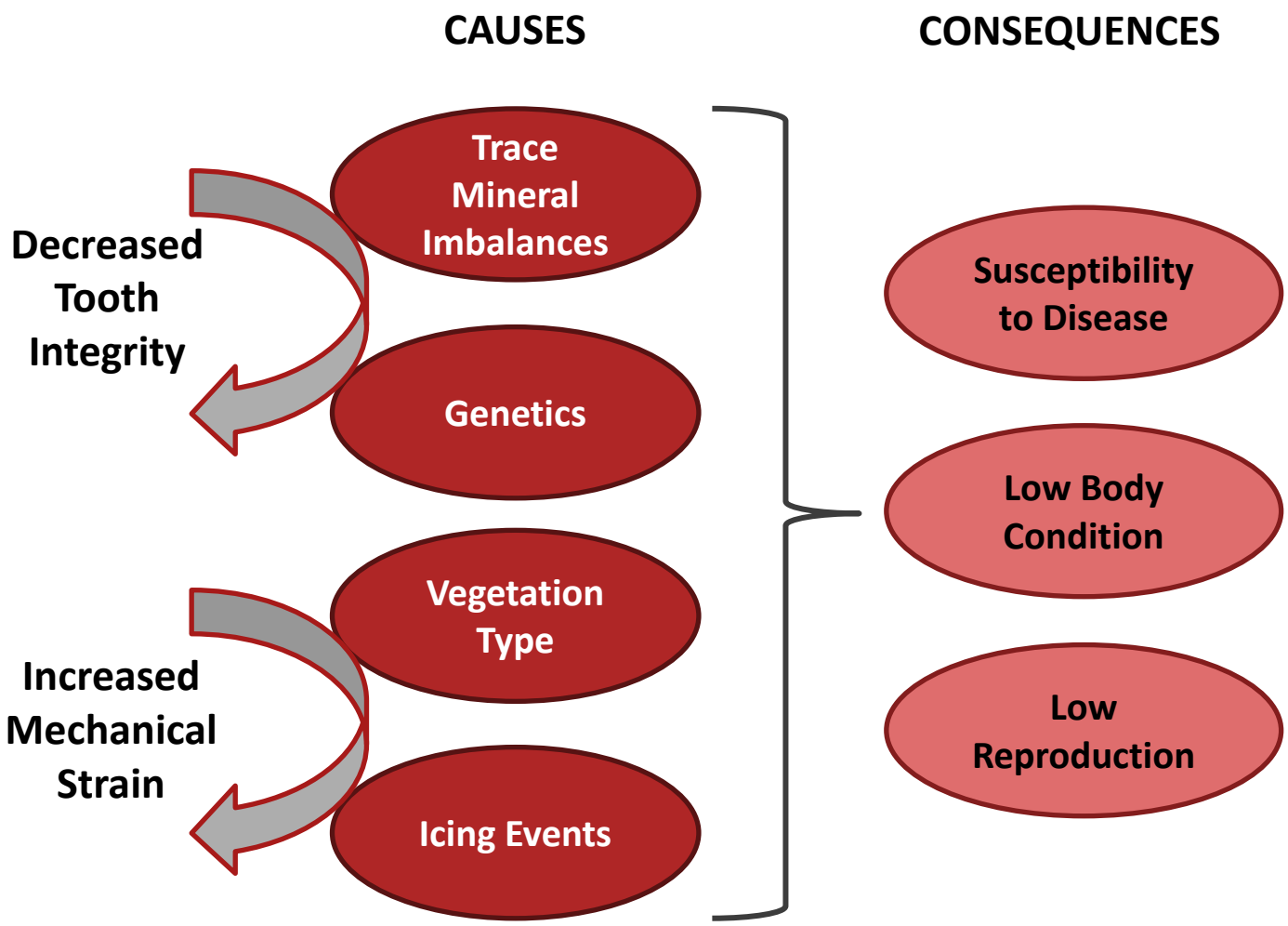

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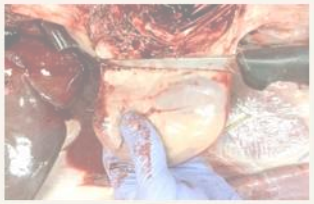

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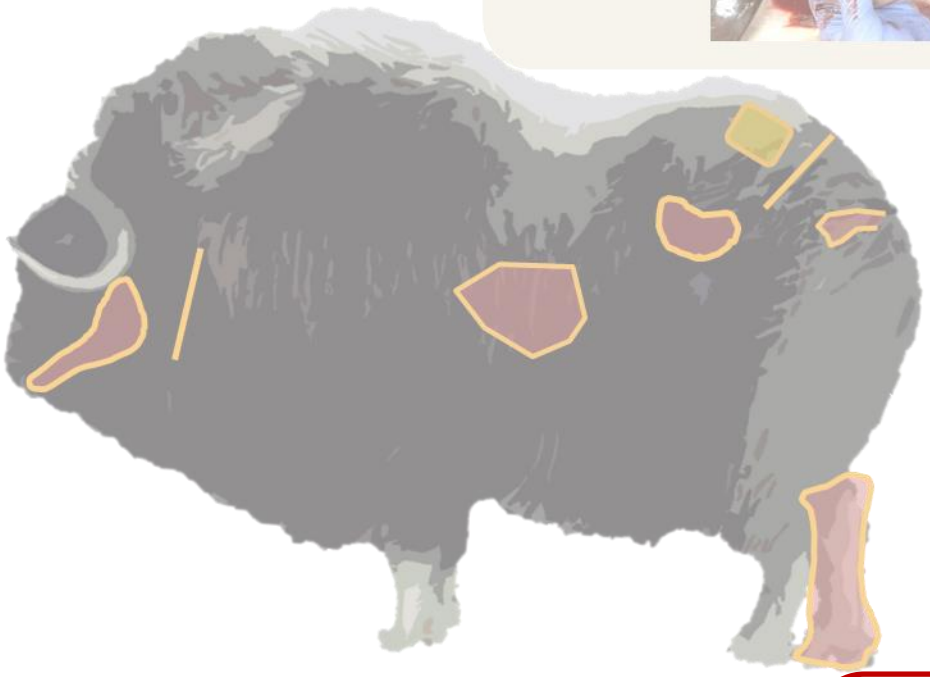

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Exploring Methods for Pregnancy Diagnosis

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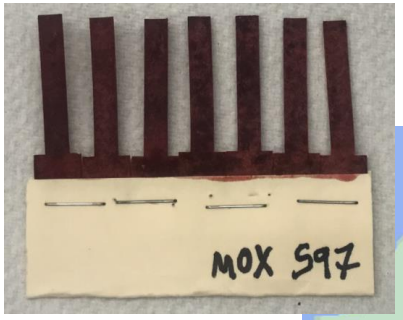
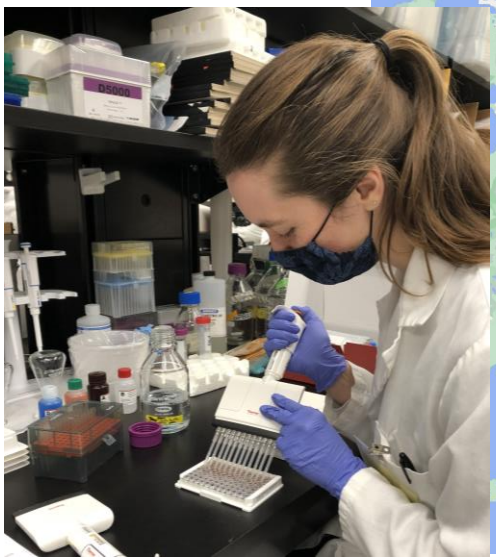
- Use of **fecal samples** – measurement of a hormone that ↑ during pregnancy → **works well in late pregnancy**, but **not in early months**

- **Objective**: Develop a test for **filter paper blood** to **improve pregnancy testing** in muskoxen

- **Method**: Use of captive muskoxen with known pregnancy status to compare blood and fecal tests





Olivia Hee
Master Student

WHAT DID WE FIND OUT?

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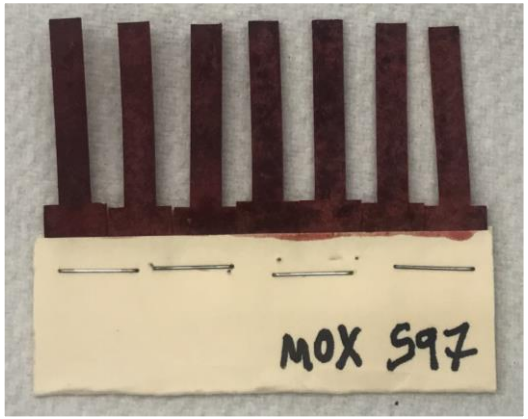
FILTER PAPER BLOOD



- Worked well for diagnosing pregnancy **throughout the gestation**
- **More accurate**

FECES

- **Less accurate**
- Works well for samples collected in **winter**

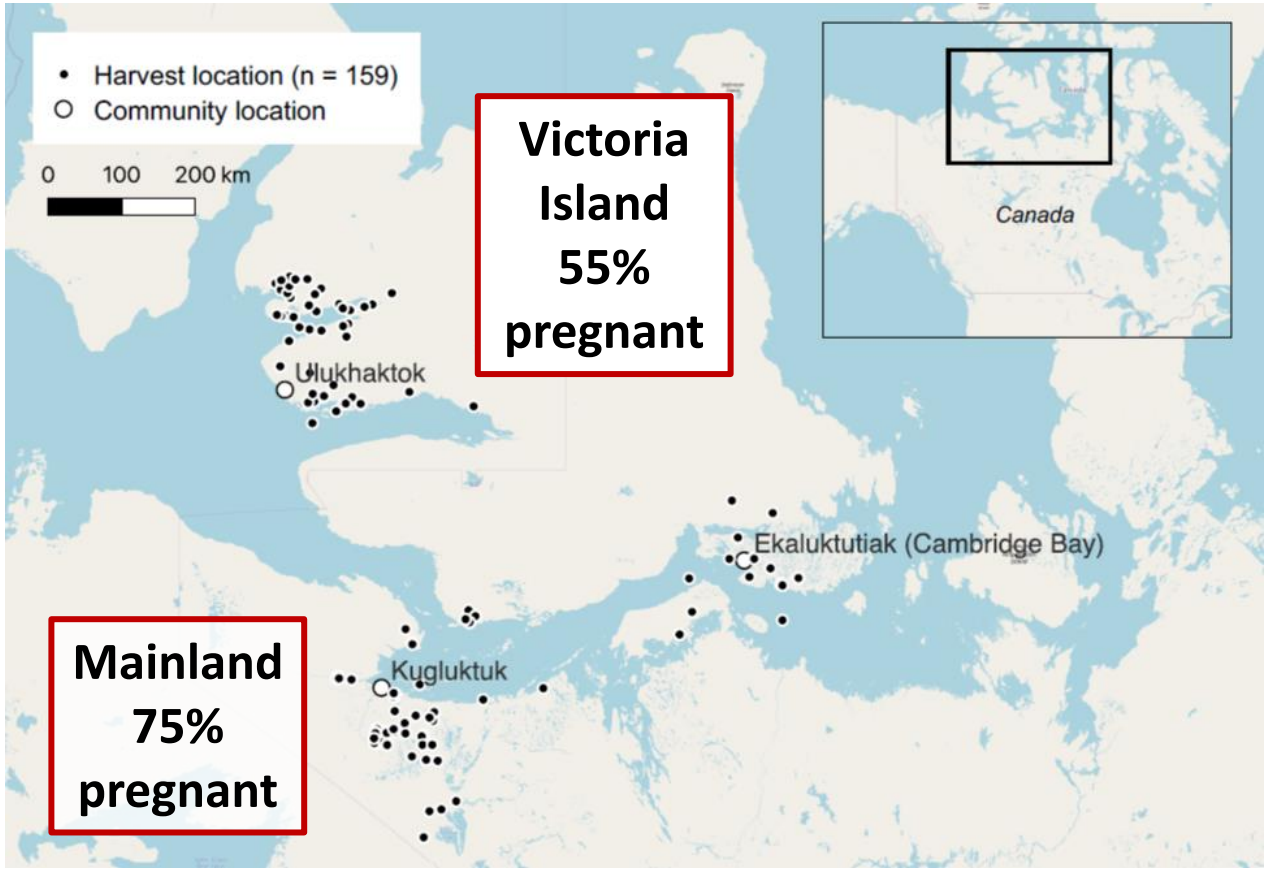
→ Application to filter paper samples collected through the community-based monitoring program

Application to Samples from Harvested Muskoxen

Kutz Research

- Analysis of **159** filter paper blood samples from **female muskoxen aged 2 years or older**, collected from **2014 to 2022** between **November and April**

Percentage of pregnant muskoxen **higher on Victoria Island** than on Mainland



- Improved pregnancy diagnosis will allow **investigation of factors that may be affecting pregnancy**

Dolphin and Union Caribou

Trends in abundance and distribution

Andrea Hanke and Susan Kutz

University of Calgary, Faculty of Veterinary Medicine

Kugluktuk Community Meeting – Kugluktuk Nunavut

October 2023

Kutz Research

UNIVERSITY OF CALGARY

Kutz Research Group: Working together to understand caribou + muskoxen

Kugluktuk Angoniatit Association

Ekaluktutiak Hunters and Trappers Organization

Olokhaktomiut Hunters and Trappers Committee

Government of Northwest Territories / Gouvernement des Territoires du Nord-Ouest

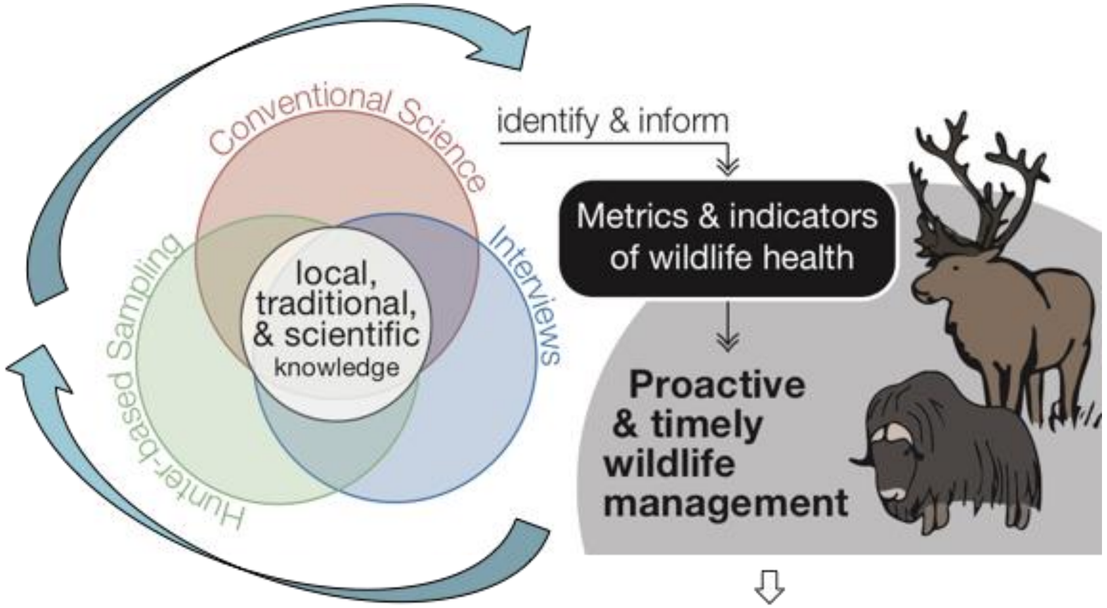
Government of Canada / Gouvernement du Canada

Kutz Research Group

Wildlife Management Advisory Council (NWT)

Government of Nunavut

Research approach



Healthy wildlife & communities

Traditional knowledge research on Dolphin and Union caribou

- Started as a Masters student in 2017
- Changed to a PhD student in 2019
- Wrapping the projects up by Apr 2024
- Interviewed with 43 people, youth to Elders
- Shared your TK at 12 co-management, 5 community, and 13 academic meetings

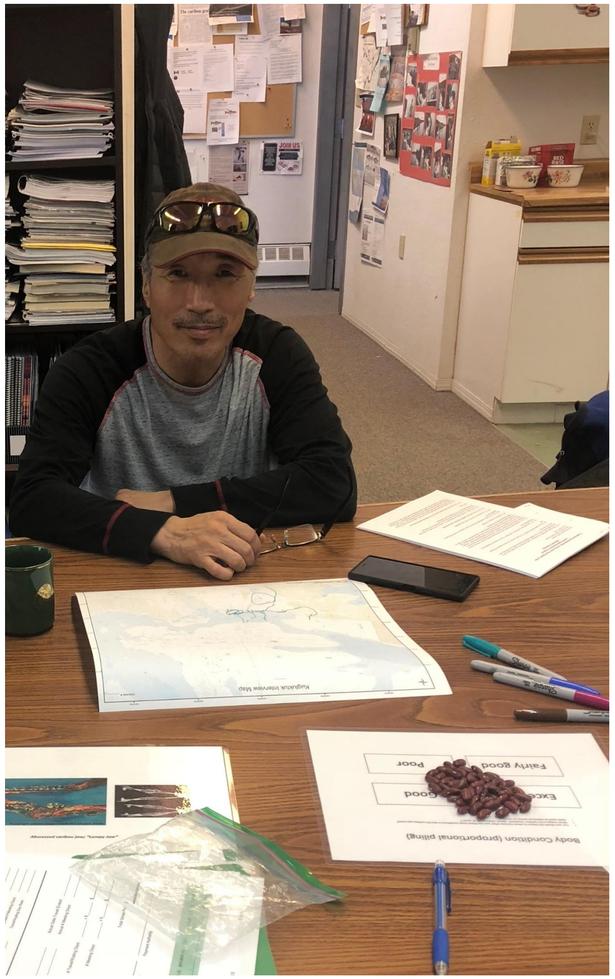
Research phases

1. Complete analysis and reporting for unfinished studies
    a. GN study from 2003 in Kugluktuk and Cambridge Bay
    b. GNWT (now WMAC) study from 2011-2014 in Ulukhaktok

2. Document, analyze, and report new data
    a. Interviews from 2018-2020 in Kugluktuk
    b. Elder interviews from 2021-2023 in Ulukhaktok, Kugluktuk, and Cambridge Bay

3. Bring together information to support co-management

Photos



Photos

Photos

Photos

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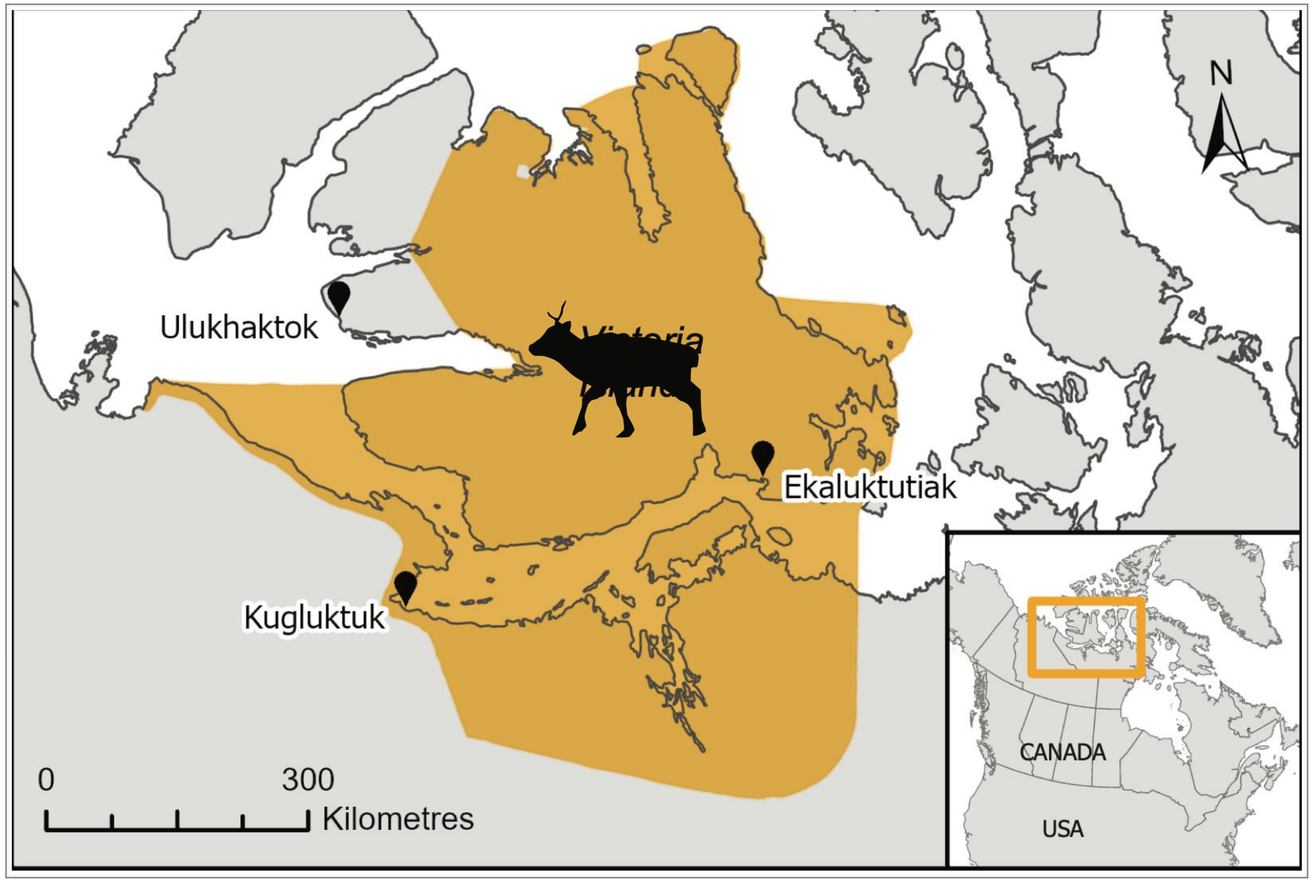
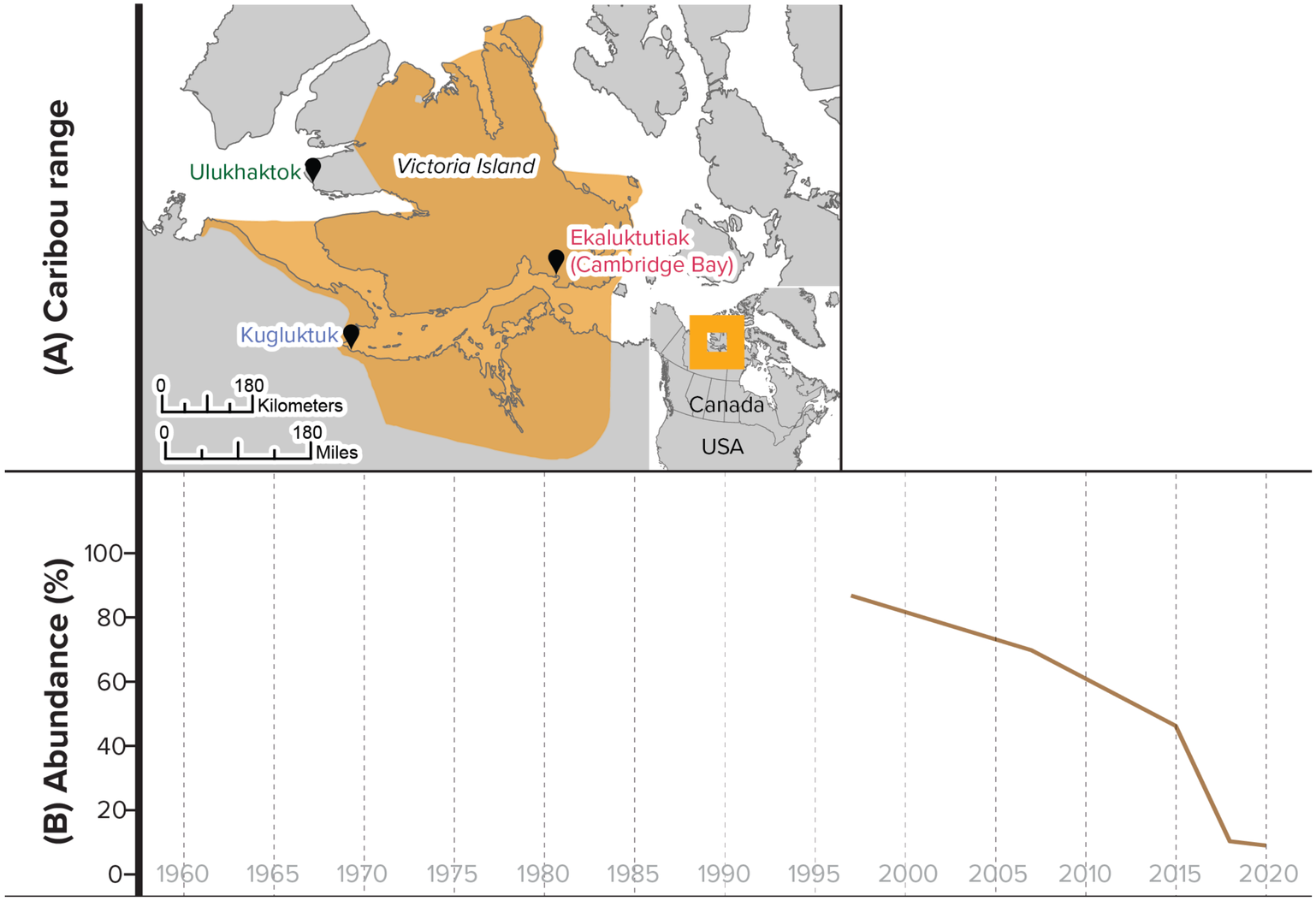
3. **Bring together information to support co-management**

‘Dolphin and Union’ caribou



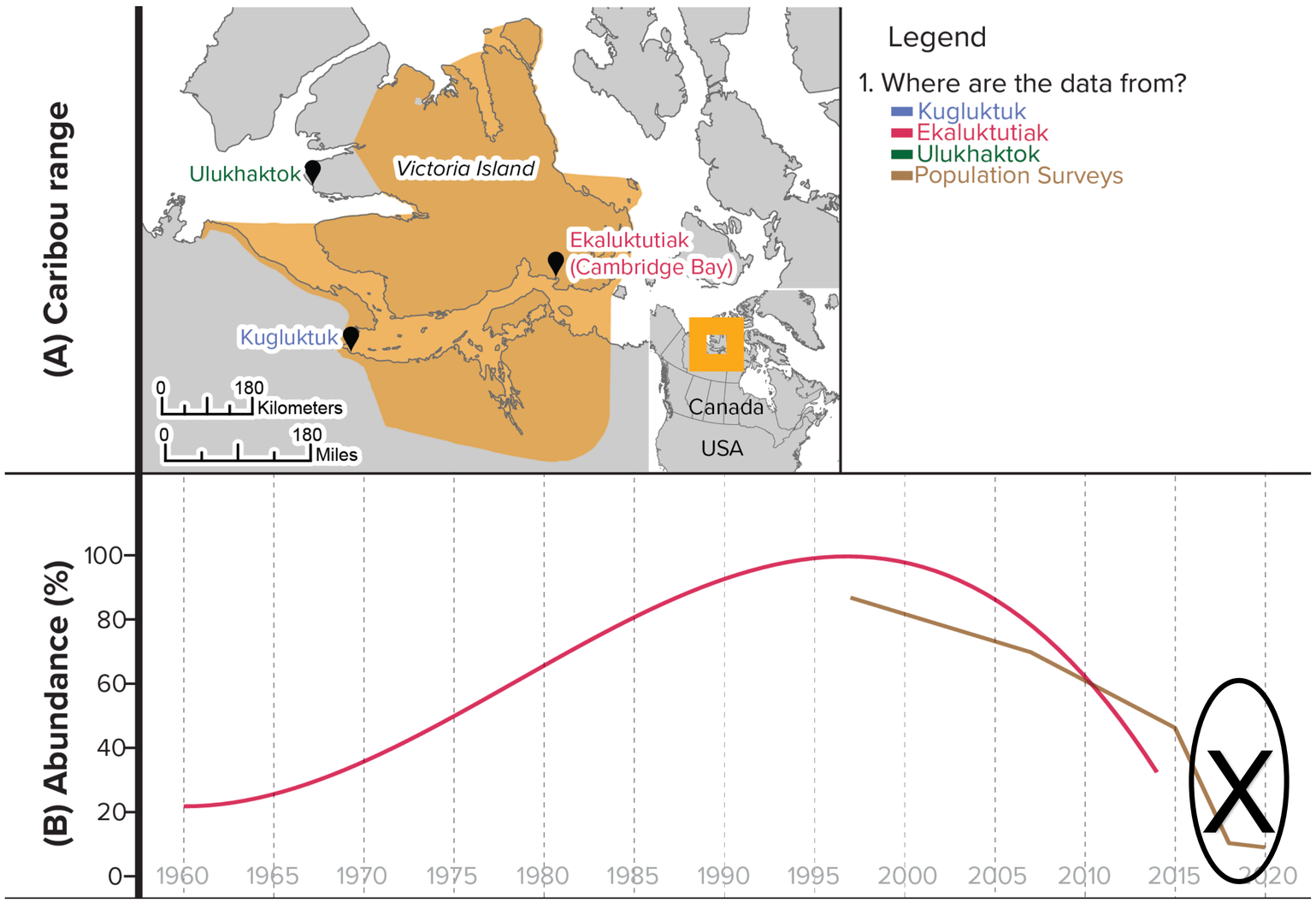
Dolphin and Union caribou management plan (2018)

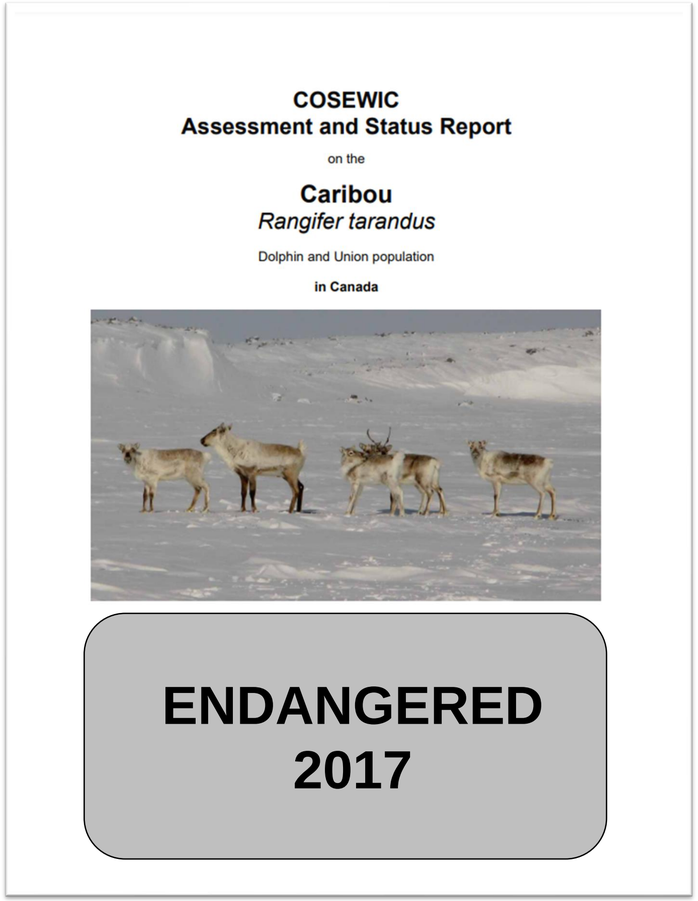
Caribou range + surveys



Nishi et al. 2003; Dumond et al. 2013; Leclerc et al. 2018; Leclerc et al. 2020; Campbell et al. 2021

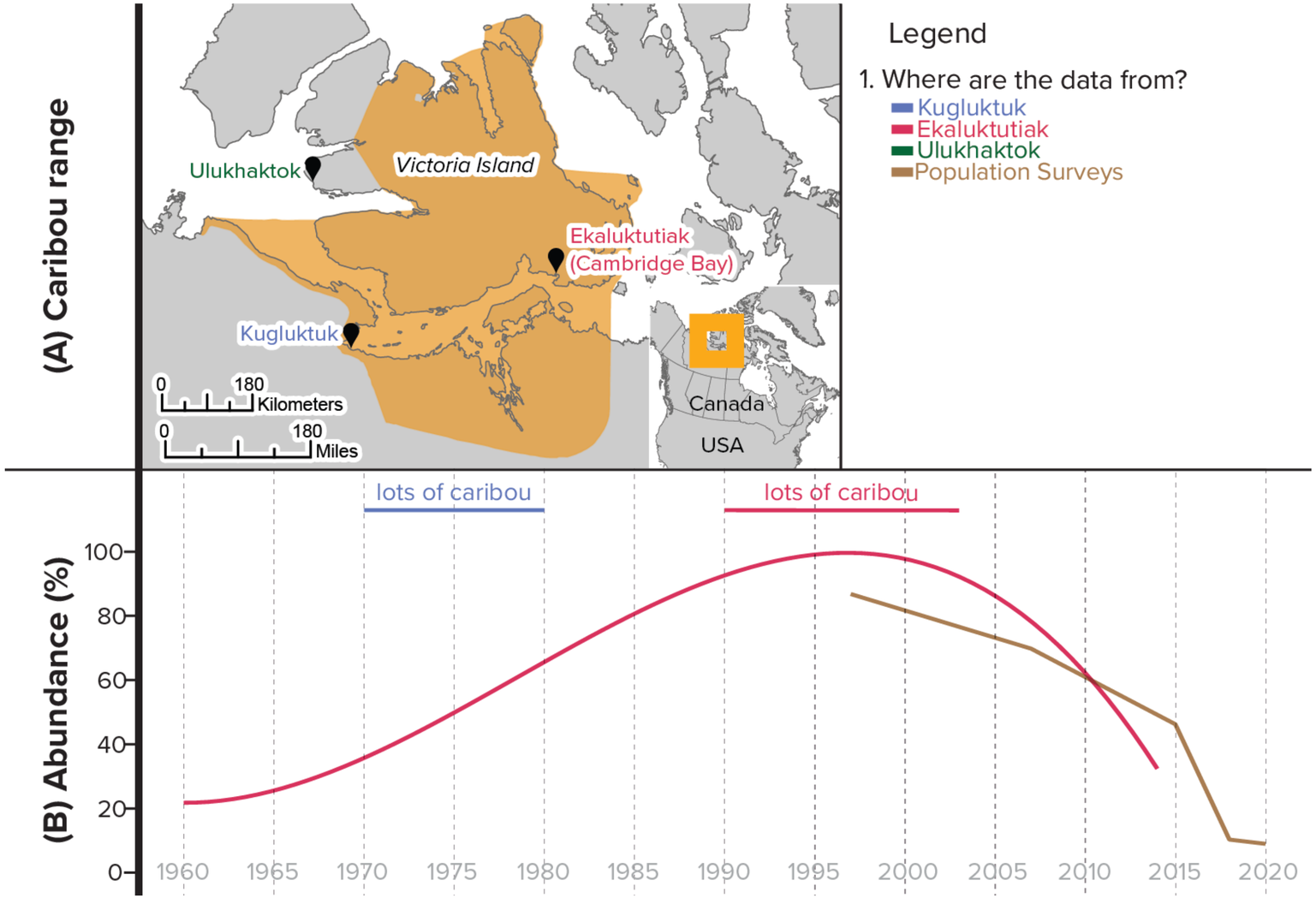
Caribou range + surveys + TK from 2014





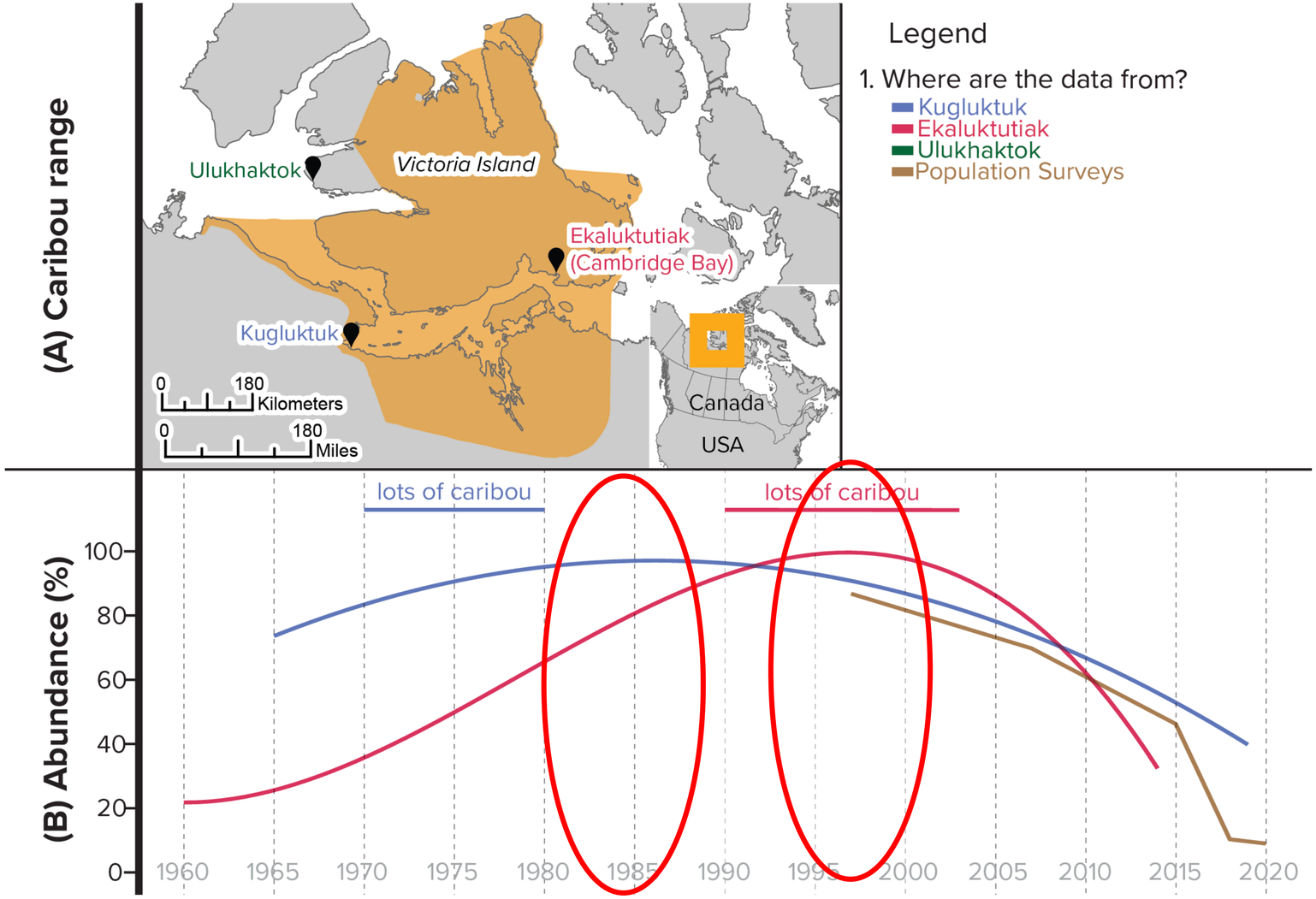
Nishi et al. 2003; Dumond et al. 2013; Leclerc et al. 2018; Tomaselli et al. 2018; Leclerc et al. 2020; Campbell et al. 2021

Caribou range + surveys + TK from 2003 + 2014



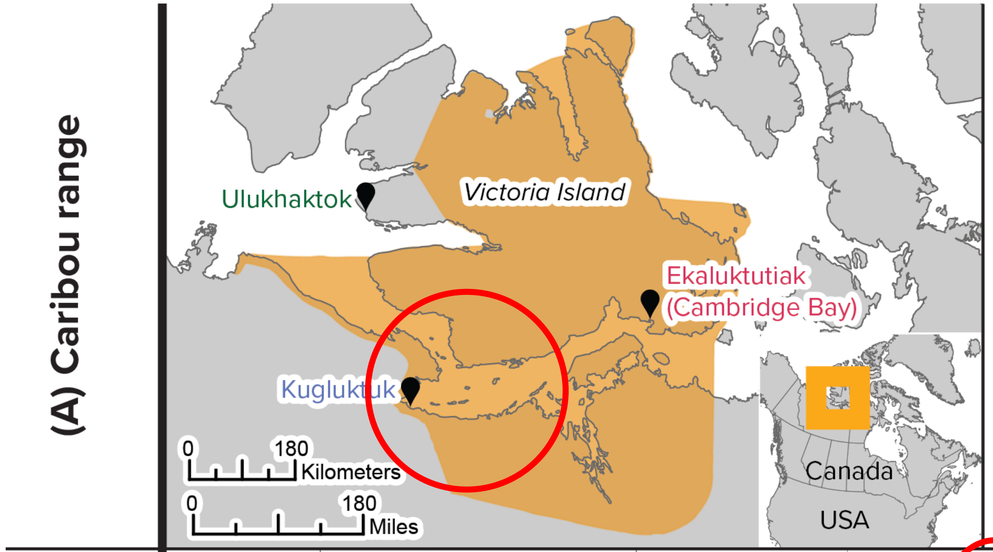
Nishi et al. 2003; Dumond et al. 2013; Leclerc et al. 2018; Tomaselli et al. 2018; Leclerc et al. 2020; Campbell et al. 2021; Hanke et al. 2021, Hanke et al. In prep

Caribou range + surveys + TK from 2003 + 2014 + 2018



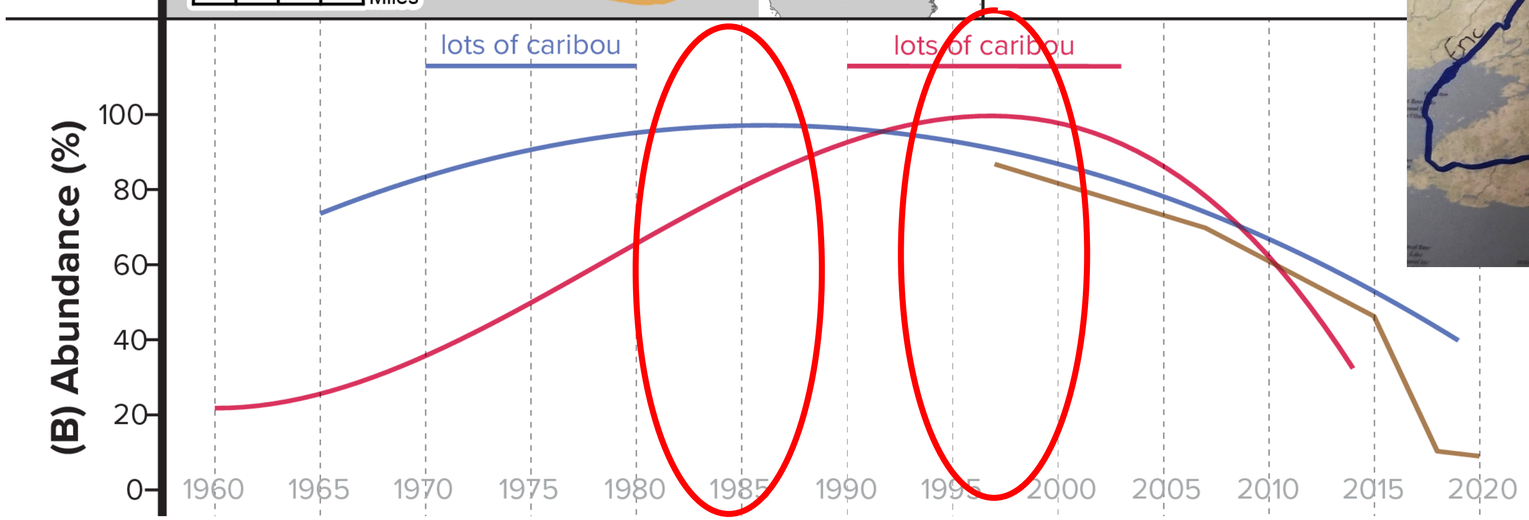
Nishi et al. 2003; Dumond et al. 2013; Leclerc et al. 2018; Tomaselli et al. 2018; Leclerc et al. 2020; Campbell et al. 2021; Hanke et al. 2021, Hanke et al. In prep

Caribou range + surveys + TK from 2003 + 2014 + 2018 + spatial data



Legend

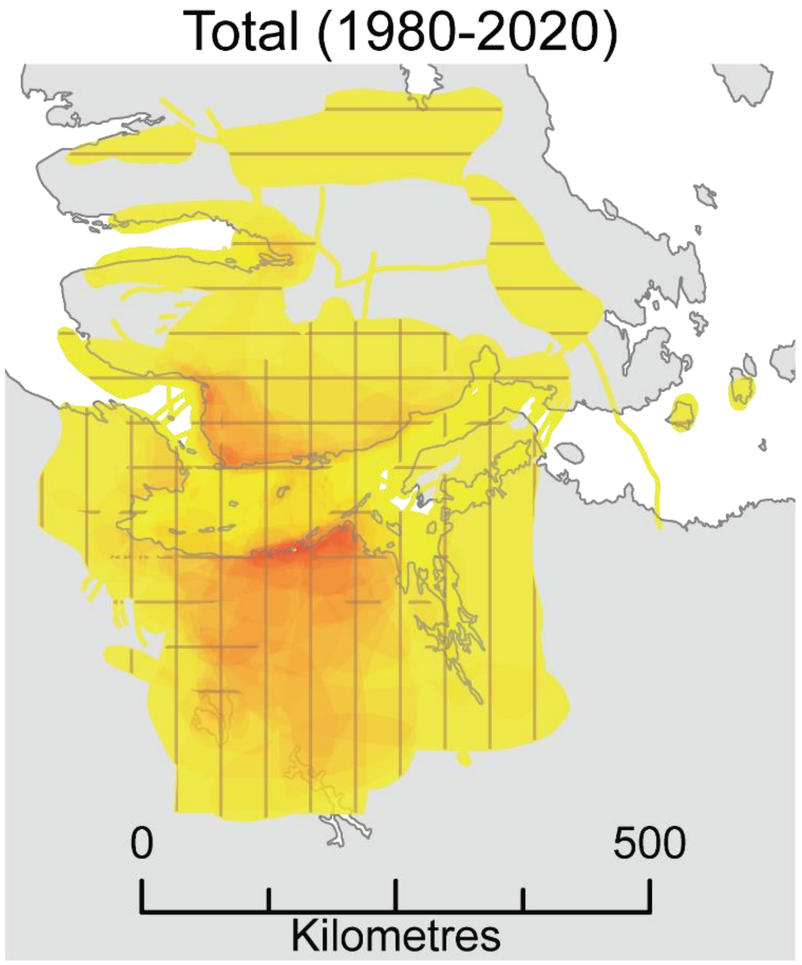
1. Where are the data from?
   - Kugluktuk
   - Ekaluktutiak
   - Ulukhaktok
   - Population Surveys



Nishi et al. 2003; Dumond et al. 2013; Leclerc et al. 2018; Tomaselli et al. 2018; Leclerc et al. 2020; Campbell et al. 2021; Hanke et al. 2021, Hanke et al. In prep

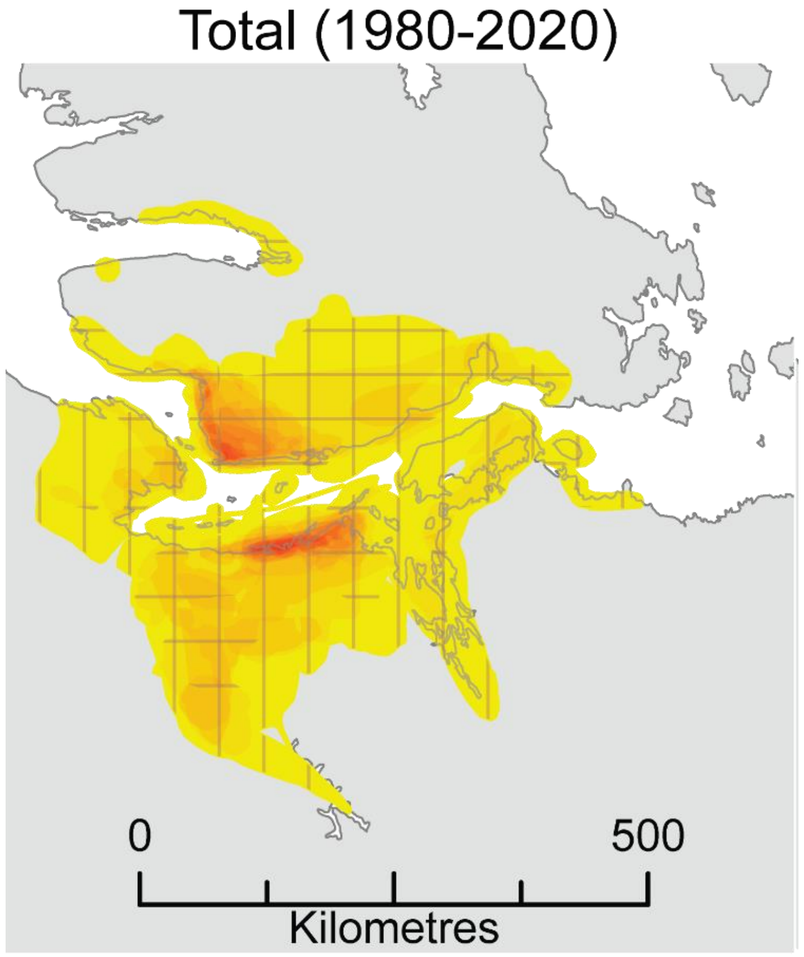
Kugluktuk interview map summaries

DU Range



Maximum overlapping maps were 22/24

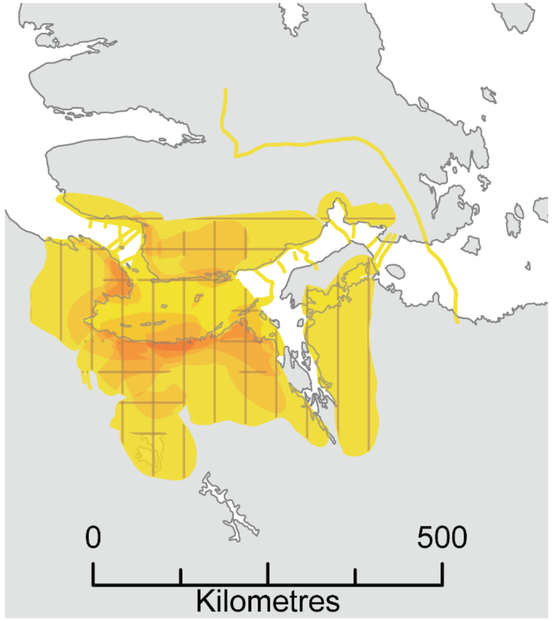
Harvesting



Maximum overlapping maps were 17/18

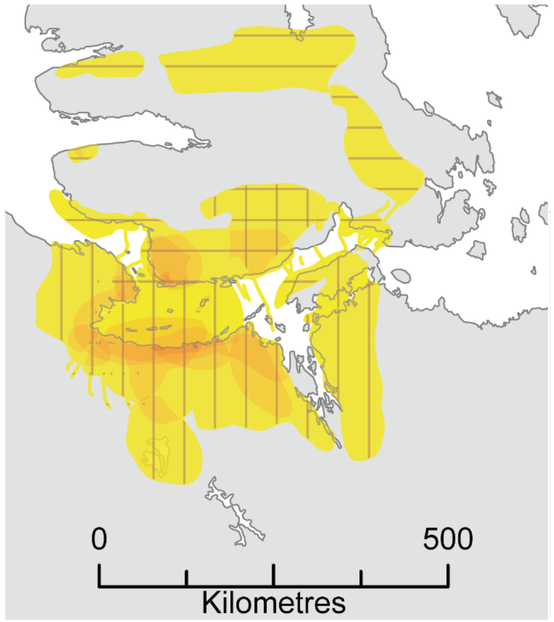
DU Range

1980-1989



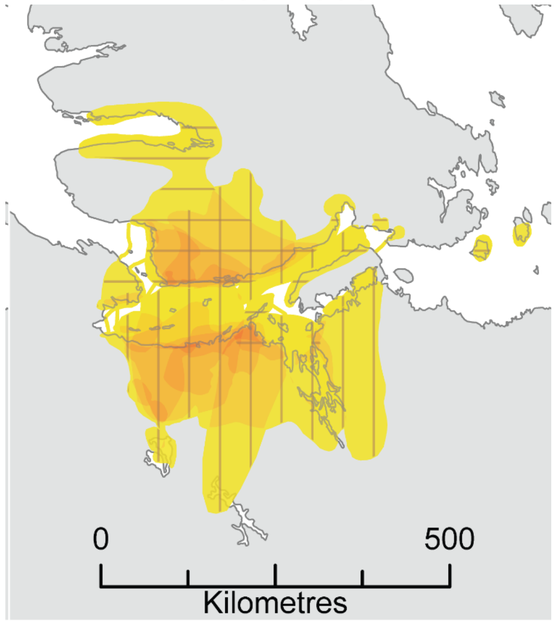
Maximum overlapping maps were 7/9

1990-1999



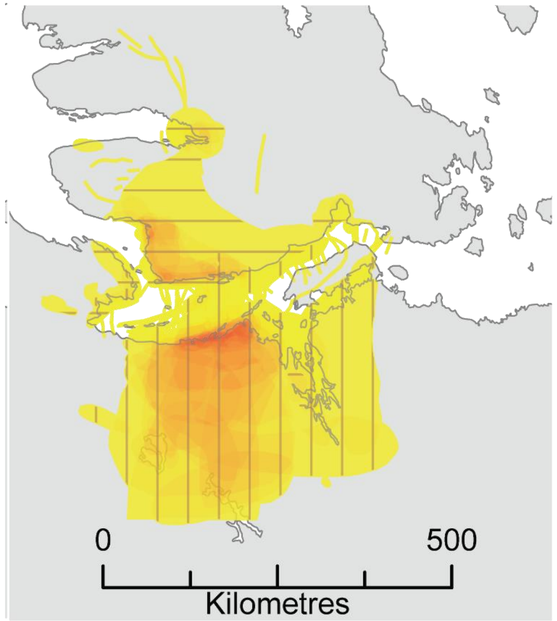
Maximum overlapping maps were 8/12

2000-2009



Maximum overlapping maps were 7/11

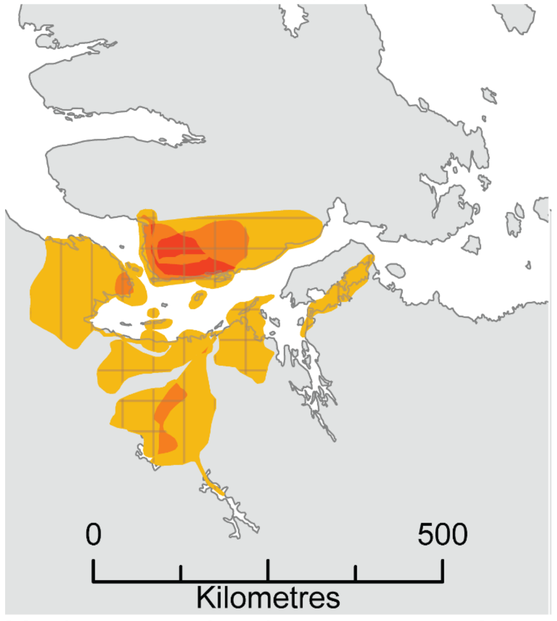
2010-2020



Maximum overlapping maps were 21/24

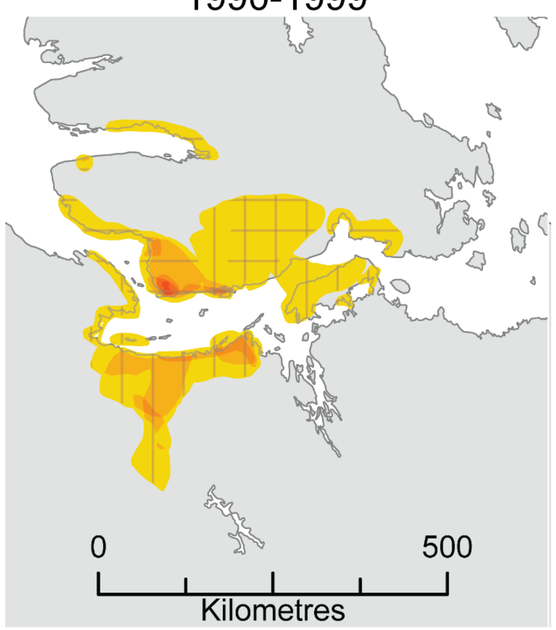
Harvesting

1980-1989



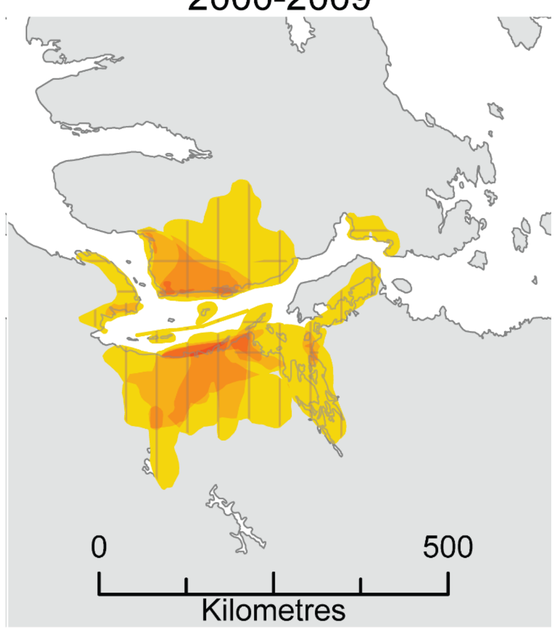
Maximum overlapping maps were 3/4

1990-1999



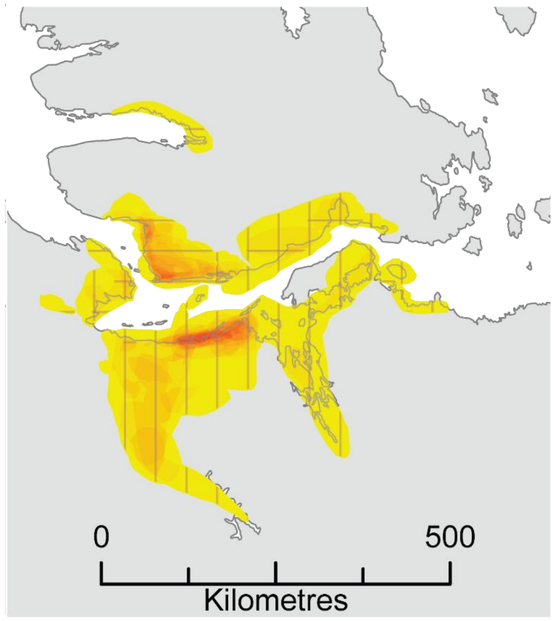
Maximum overlapping maps were 5/7

2000-2009



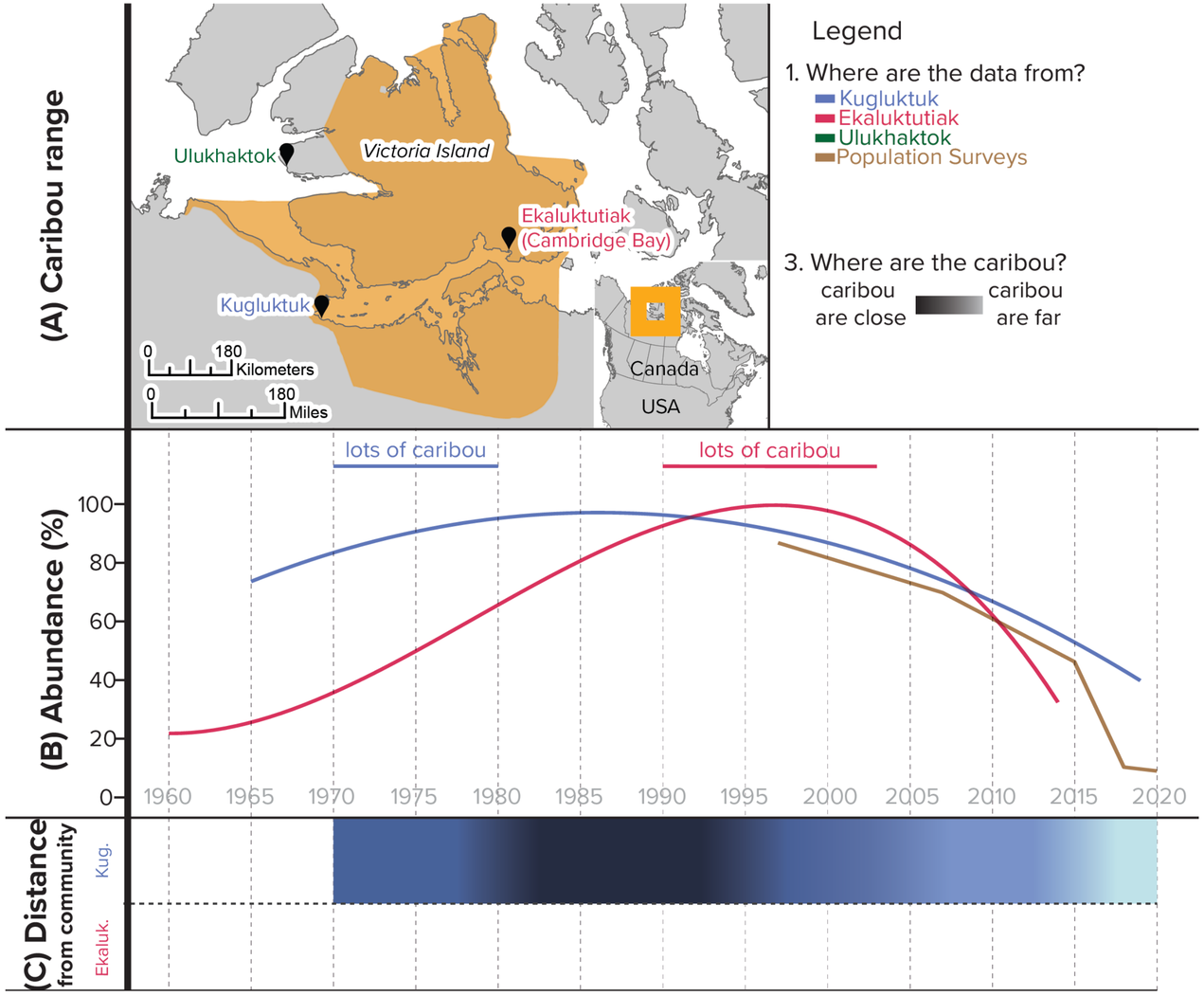
Maximum overlapping maps were 5/7

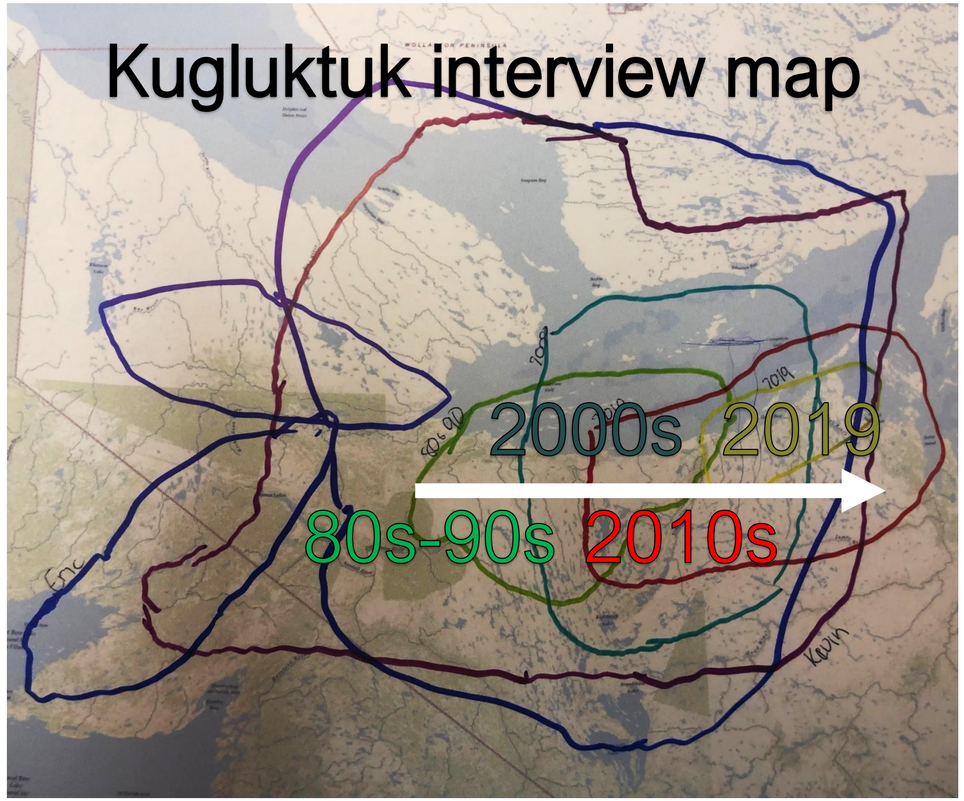
2010-2020



Maximum overlapping maps were 17/18

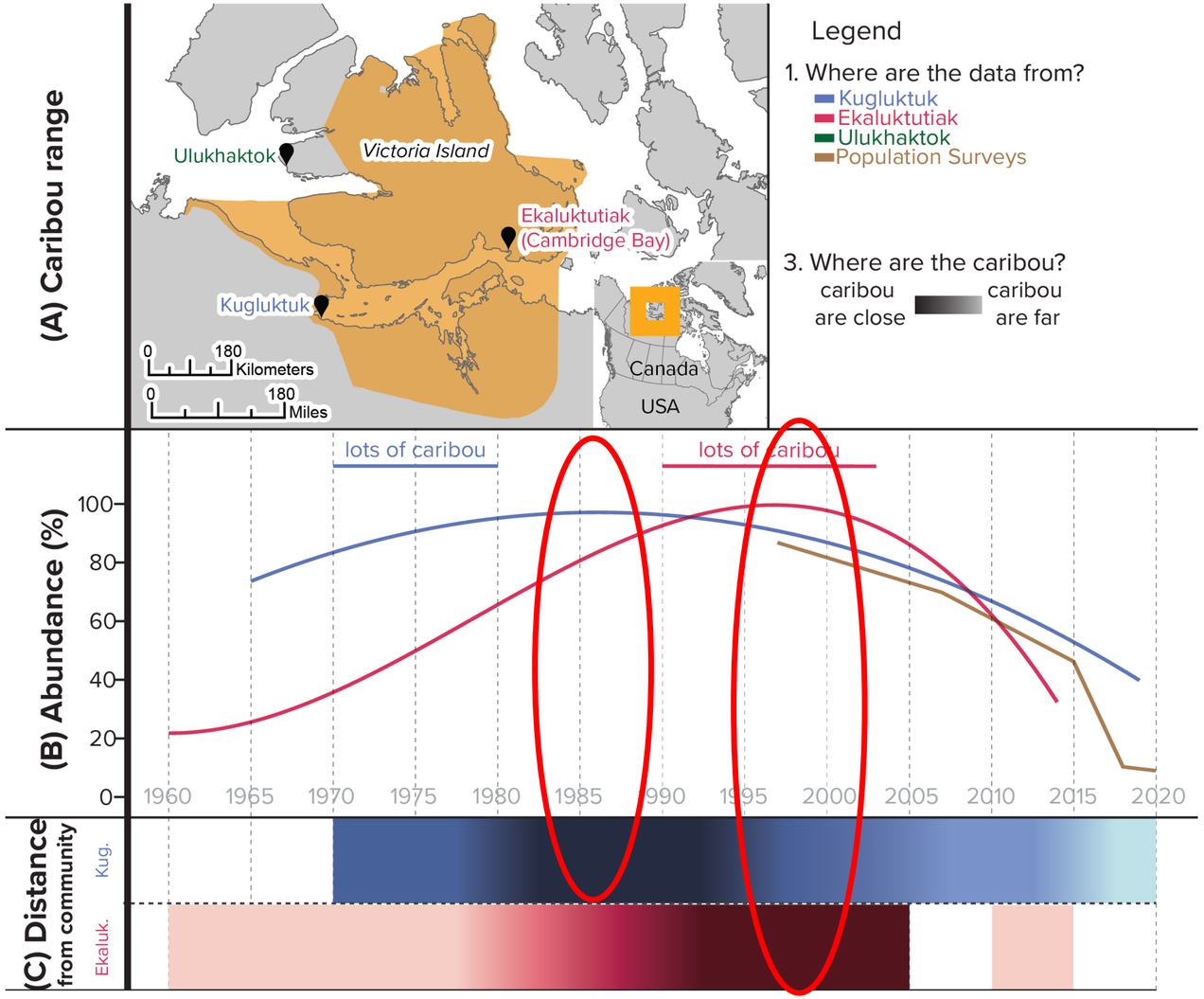
Caribou range + surveys + TK from 2003 + 2014 + 2018 + spatial data

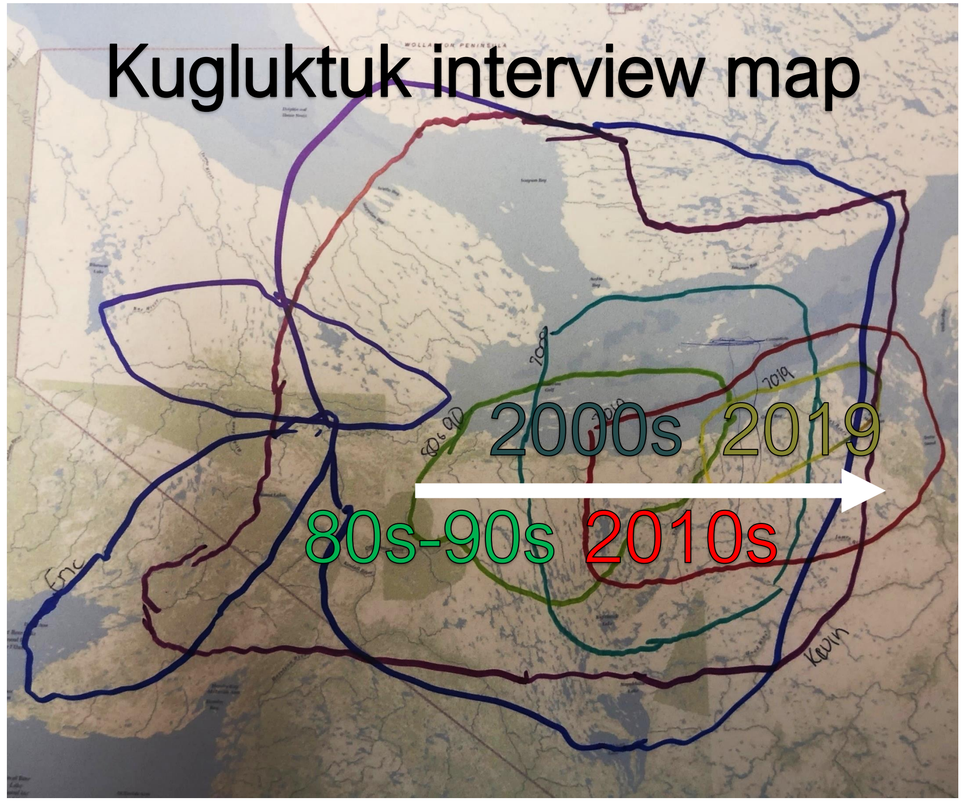




Nishi et al. 2003; Dumond et al. 2013; Leclerc et al. 2018; Tomaselli et al. 2018; Leclerc et al. 2020; Campbell et al. 2021; Hanke et al. 2021, Hanke et al. In prep

Caribou range + surveys + TK from 2003 + 2014 + 2018 + spatial data





Nishi et al. 2003; Dumond et al. 2013; Leclerc et al. 2018; Tomaselli et al. 2018; Leclerc et al. 2020; Campbell et al. 2021; Hanke et al. 2021, Hanke et al. In prep

Outcomes

1. Communities and researchers interact with caribou at different times of the year in different parts of their range

→ Can result in apparently contrasting information

→Must interpret information within community context and study design

→Detailed contribution sections can help with this

2. Synthesized abundance data suggested the general DU caribou abundance increased since ~1990s and decreased after ~2000s alongside a range contraction

→Learning about the population status requires info from across the range

→Can put this info into the management plan

Lesson learned: Need detailed contributor sections

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

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

Research update

Report prepared by Andrea Hanke (andrea.hanke1(
(skutz@ucalgary.ca), Department of Ecosystem and Public H
University of Calgary

In collaboration with Kugluktuk Angoniatit Association, I
Organization, Government of Nunavut, Depar

Submitted to Kugluktuk Angoniatit Association, Ekaluktutiak
Olokhaktomiut Hunters' and Trappers' Committee, Kitikme
Management Advisory Council (NWT), Government of Nu
Government of Northwest Territories, Environment and Natu
Environment and Climate Change Canada, Nunav

September 2020

UNIVERSITY OF CALGARY

Roles of Researchers and Other Contributors:

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

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

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

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

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

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

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

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

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

University of Calgary: Andrea Hanke led the project design, implementation, interview analysis, and reporting with input from all partners, including co-supervisors Susan Kutz and Cindy Adams, in 2018-2020. Juliette Di Francesco assisted during the focus groups and feedback sessions.

A Three-Staged Caribou Conser

Ulukhaktokmiut accounts of 'Dolph
Union' and Peary caribou in 2011-2
suggested conservation efforts in 2

Final report on the 2011-2014 Traditional Know
on Caribou in Ulukhaktok

Report prepared by Andrea Hanke for the Wildli
Management Advisory Council (NWT)

April 2023

Report Contributors

Ulukhaktok knowledge holders in 2011-2012: John Alikamik, Pat Ekpakohak, Jean Kagyut, Elsie Klengenberg, Joseph Haluksit, Allen Joss, David Kuptana, Louis Nigiyok, Morris Nigiyok, Rene Oliktoak, and Allen Pogotak.

Ulukhaktok knowledge holders in 2022: John Alikamik, Jean Ekpakohak, Pat Ekpakohak, Sandra Goose, Janine Harvey, Annie Inuktalik, Kate Inuktalik, Allen Joss, Lillian Kanagok, Ross Klengenberg, Gibson Kudlak, Mary Kudlak, Chad Memogana, Louise Nigiyok, Mary Okheena, and Joshua Oliktoak

Government of Northwest Territories, Environment and Natural Resources: Tracy Davison was the original study lead. Tracy facilitated the interviews and first verification workshop and completed the original interview analysis and interim summary slides.

Olokhaktomiut Hunters and Trappers Committee: They selected the knowledge holders and facilitated the transcript review with the knowledge holders. The OHTC helped with all stages of coordinating the project, from the original interviews to the verification workshops.

Thorpe Consulting Services: Natasha Thorpe (PI) contributed and supervised the PhD student for the 2019 report titled: "Review of the Peary and Dolphin and Union Caribou Traditional Knowledge Project from 2011-2013".

The University of Calgary, Veterinary Medicine: Susan Kutz (professor) provided feedback on the 2019 report and the final report. Andrea Hanke (PhD candidate) was the student supervised by Thorpe Consulting Services and contributed to the 2019 report.

Joint Secretariat: Cassandra Elliott (Traditional and local knowledge coordinator) completed the recoding and prepared a draft report.

Wildlife Management Advisory Council (NWT): The WMAC (NWT) coordinated the advancement of the study and provided feedback on the reports. Andrea Hanke (contractor) completed the analysis, writing, and facilitated the final verification workshop. Karan Su (sub-contractor, GIS student) assisted with cleaning the spatial data. Susie Memogana (contractor) organized the final verification workshop logistics and assisted the facilitation.

Report designed by Roxann Corpuz

This project was undertaken with the financial support of:
Ce projet a été réalisé avec l'appui financier de:
Environment and Climate Change Canada / Environnement et Changement climatique Canada

Outcomes

1. Communities and researchers interact with caribou at different times of the year in different parts of their range

→ Can result in apparently contrasting information

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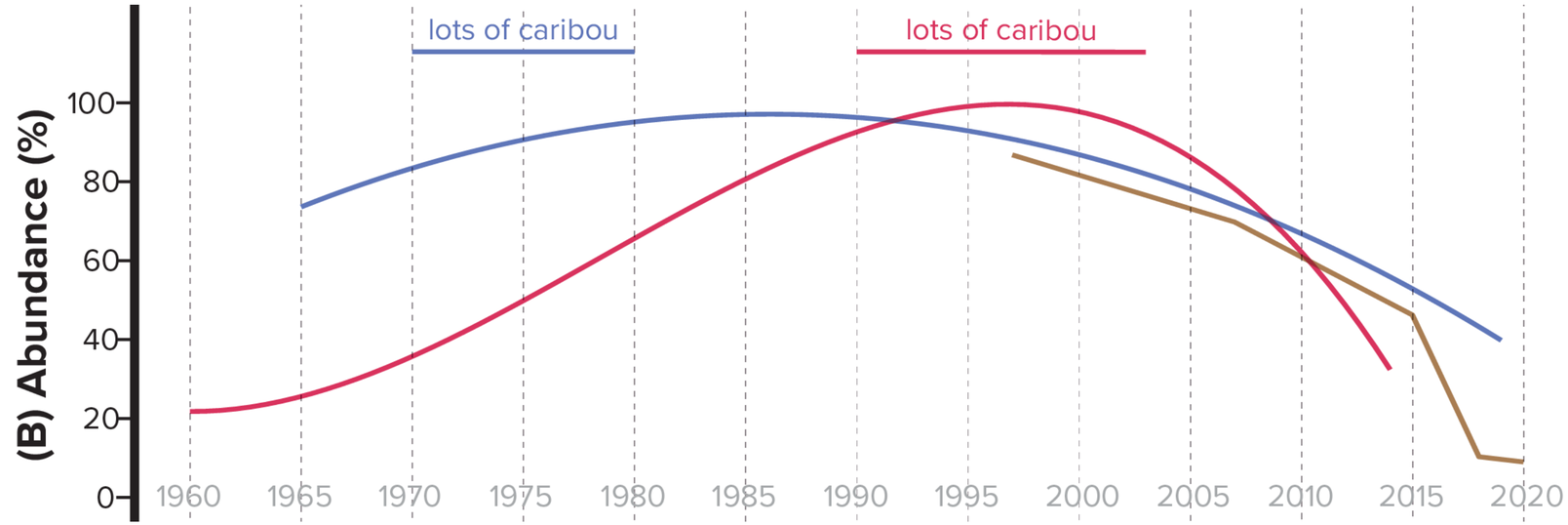
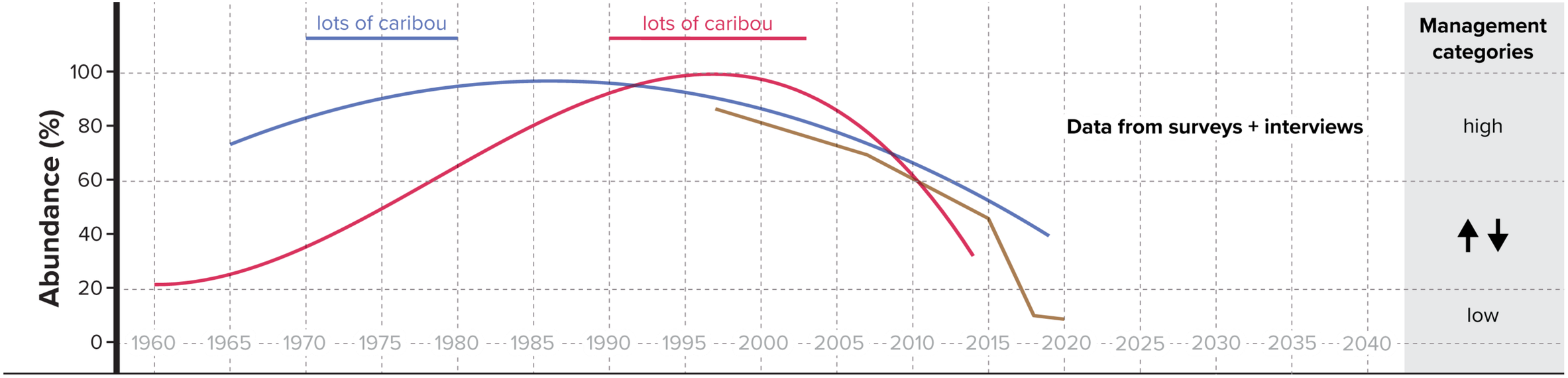
→Learning about the population status requires info from across the range

→Can put this info into the management plan

Section 6.6. Managing Based on Population Level

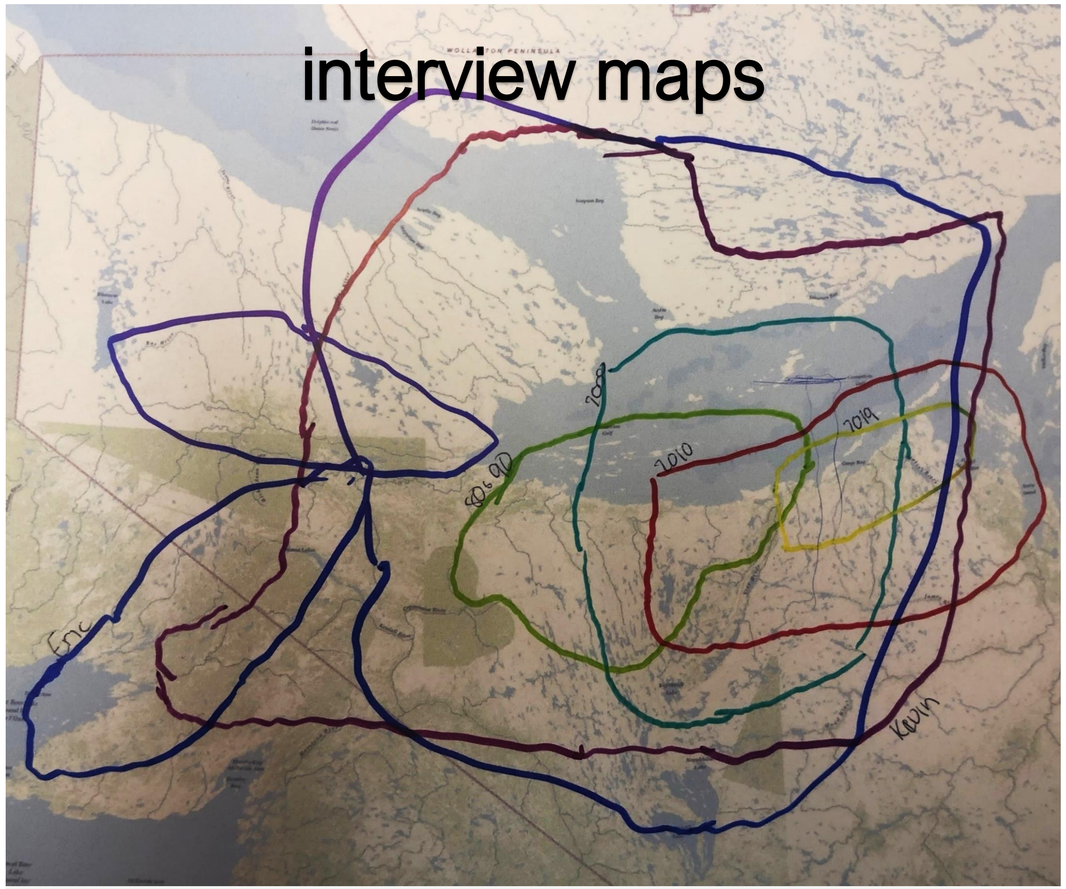


Section 6.6. Managing Based on Population Level

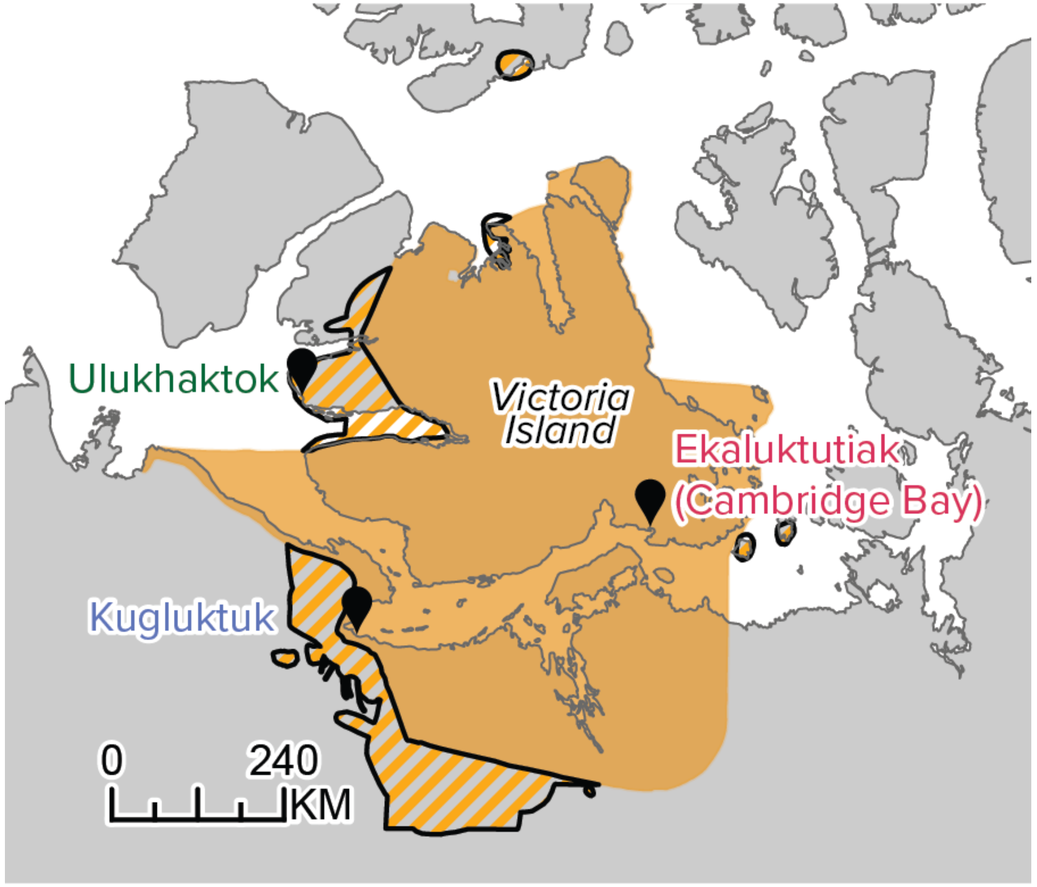


Using data to support appropriate management strategies

Update caribou range



e.g. support habitat protection



Dolphin and Union caribou management plan (2018); *Hanke et al. 2021, Hanke and WMAC 2023; Hanke et al. In prep*

What’s next?

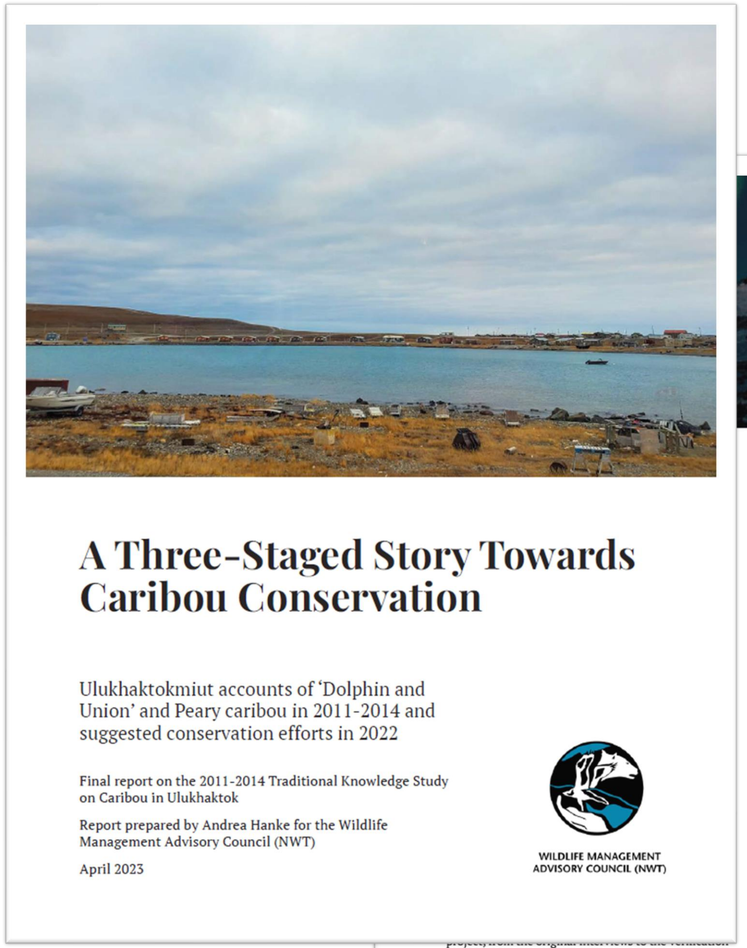
Research phases

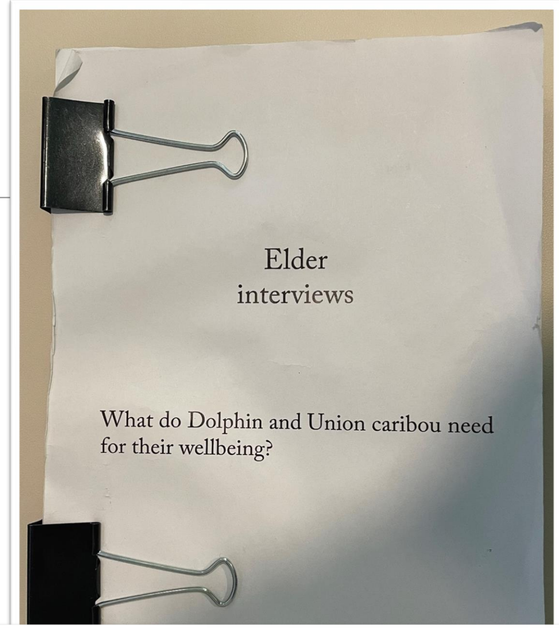
1. Complete analysis and reporting for unfinished studies
    a. Government of Nunavut study from 2003 in Kugluktuk and Cambridge Bay
    b. GNWT study from 2011-2014 in Ulukhaktok

2. Document, analyze, and report new data
    a. Interviews from 2018-2020 in Kugluktuk
    b. Elder interviews from 2021-2023 in Ulukhaktok, Kugluktuk, and Cambridge Bay

3. Bring together information to support co-management

What's next?





Elder interview book

Koana. Thank you.

Andrea Hanke andrea.hanke1@ucalgary.ca

Susan Kutz skutz@ucalgary.ca

UNIVERSITY OF CALGARY

Kutz Research

Social Sciences and Humanities Research Council of Canada | Conseil de recherches en sciences humaines du Canada

Polar Knowledge Canada | Savoir polaire Canada

Environment and Climate Change Canada | Environnement et Changement climatique Canada

Natural Sciences and Engineering Research Council of Canada | Conseil de recherches en sciences naturelles et en génie du Canada

Nunavut

Mitacs Accelerate

CANADA NORTH OUTFITTING

Alberta

Beverly and Qamanirjuaq Caribou Management Board

Safeguarding Caribou Since 1982

NSERC CRSNG PromoScience

EGALUKTUK ANGONIATIT ASSOCIATION HUNTERS' AND TRAPPERS' ORGANIZATION

WILDLIFE MANAGEMENT ADVISORY COUNCIL (NWT)

IRVING

Irving Shipbuilding, Inc.

NSTP PFSN

Northern Scientific Training Program | Programme de formation scientifique dans le Nord

Association of Canadian Universities for Northern Studies

Arctic Emerging Infectious Diseases

Canada-Inuit Nunangat-United Kingdom (CINUK) Arctic Research Programme

Arctic Emerging Infectious Diseases

Canada-Inuit Nunangat-United Kingdom (CINUK) Arctic Research Programme

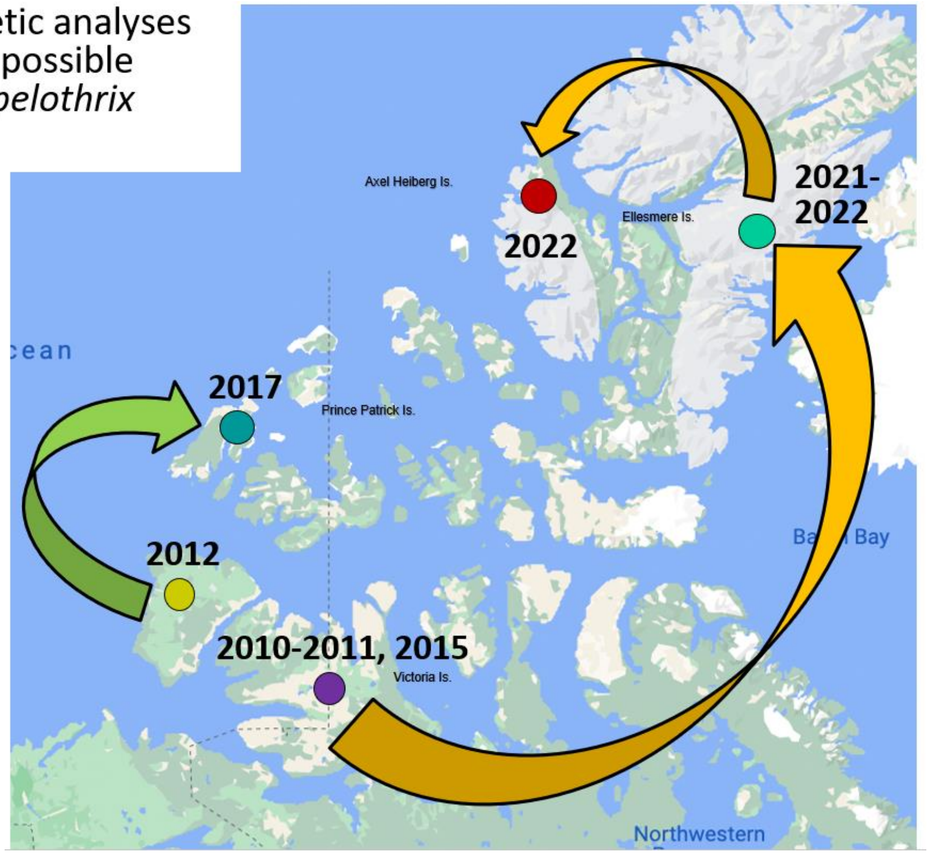
Use TK and Western knowledge to understand **brucellosis** and **erysipelas**:

- Effects on caribou
- Effects on muskoxen
- Effects on harvesters and food safety

What's done:

- Sampling for both diseases with all 3 communities
- Investigating a new disease outbreak of *Erysipelothrix* on Ellesmere Island
- Survey of researcher observations of unusual wildlife events on the land
- Pocket guides for safe butchering and consumption
- Genetic studies to understand *Erysipelothrix* spread
- Animation video about *Brucella*, *Erysipelothrix*, and the ArcticEID project
- Community workshops and wildlife sampling

Fine scale genetic analyses give insight on possible routes of *Erysipelothrix* movement



What’s next?

- Document TK on butchering and safe meat handling
- Survey of community observations of unusual wildlife events on the land
- Testing samples from community sample kits and other suspect species, and Ellesmere outbreaks

Acknowledgements

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CINUK
CANADA – INUIT NUNANGAT – UNITED KINGDOM ARCTIC RESEARCH PROGRAMME

One Health Research into Bacterial Infectious Diseases

Kutz Research

Van Sloun Foundation

CANADA
POLAR CONTINENTAL SHELF PROJECT
ÉTUDE DU PLATEAU CONTINENTAL POLAIRE

APEX GEOSCIENCE

WEBERARCTIC.

CANADA NORTH OUTFITTING

Nunavut

Government of Northwest Territories

ASTON BAY

The Arthur French Family Foundation

Natural Sciences and Engineering Research Council of Canada

UNIVERSITY OF CALGARY

University of Glasgow

QUEEN'S UNIVERSITY BELFAST

Updates on

1. Stress in Bluenose East and Dolphin Union caribou
2. New project for caribou health monitoring!
3. Observations on Sick Caribou

Misbah

PhD student, University of Calgary.

Background

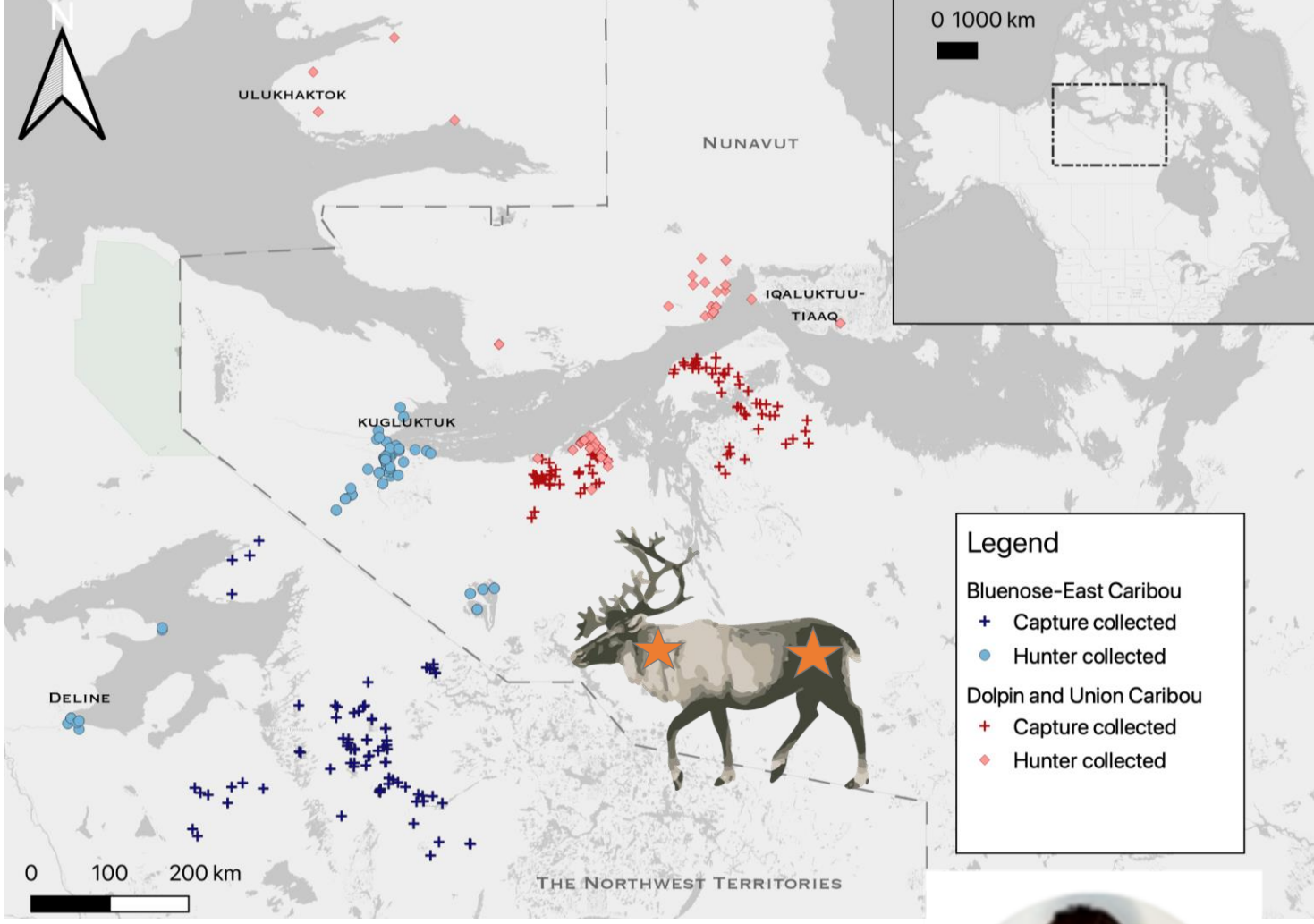
- The caribou are very important for the communities
- We want to know how stressed the caribou are
- Stress can be an indicator of how well the animals are doing
- High stress can also cause health issues
- It is possible that climate change, bugs, and other changes in the environment are making caribou stressed

Are the Caribou stressed?

Filip has worked with **hair samples** to test if the caribou are stressed

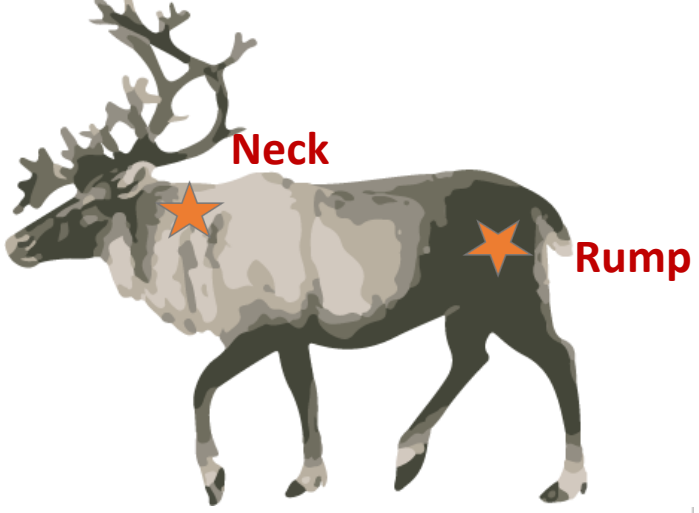
He also tested –

- Which hair samples are good (**neck/rump hair**) for testing the stress level?
- Any **season** when they are more stressed?
- How are stress conditions changing over the **years**?



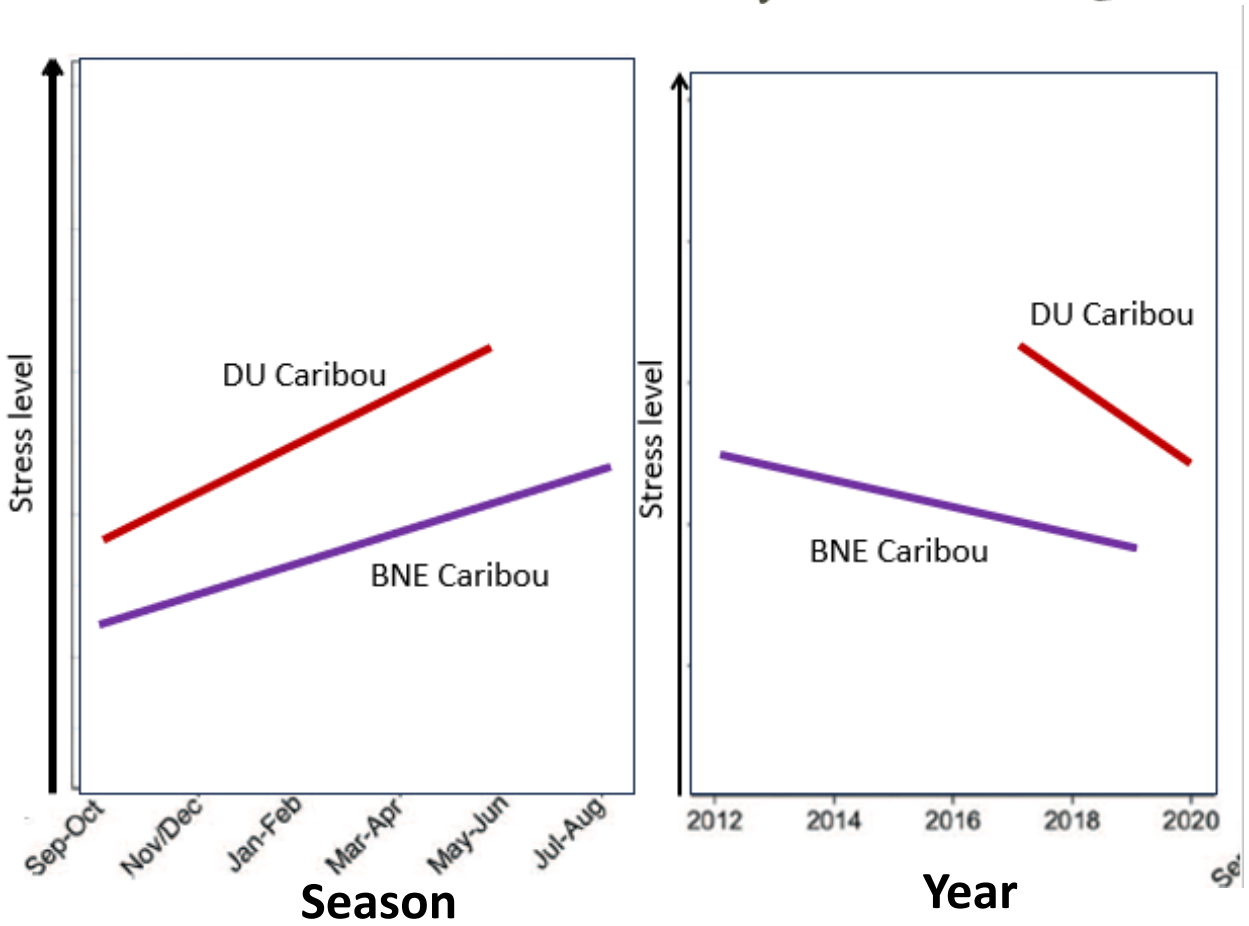
Filip Rakic, MSc student

Research findings?



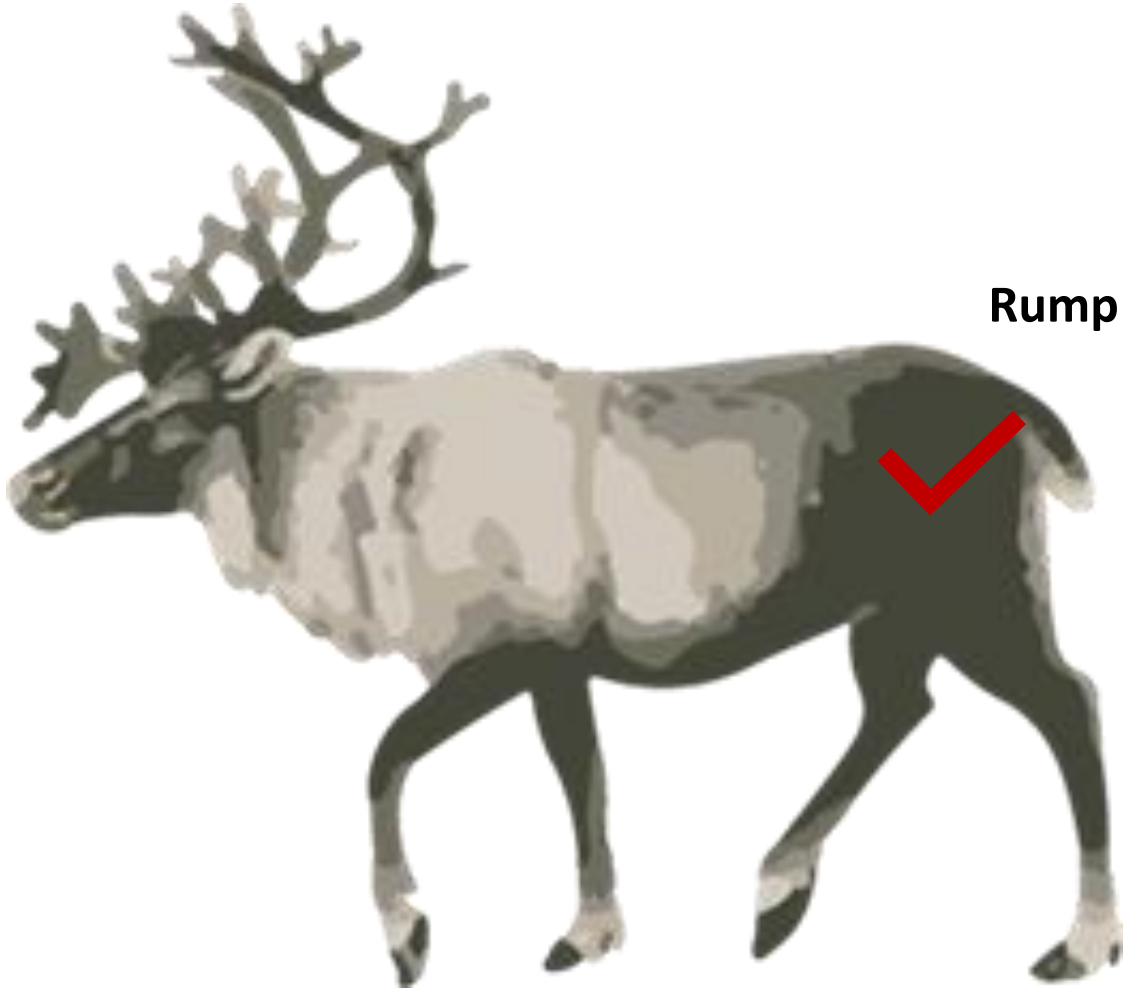
- **Rump hair is better** for identifying stress in caribou than neck hair

- Continue sampling rump hair
- **Male (higher)** **Stress** female (lower)
- More Stress in **Spring and summer** than in winter
- Stress in caribou has decreased over the years



Moving forward

- Using caribou hair is a simple way to monitor their health and stress levels
- **Long-term monitoring** tool to see how caribou are doing



New project

Community-defined and monitored indicators of recovery in Barren ground caribou.

Partners:

Nunavut

Wek'èezhìı Renewable Resources Board

CANADA NORTH OUTFITTING

Components of the new project

- Communities have identified Bluenose East caribou as important to monitor to understand -

- **how are caribou doing?** What are their **health condition**, and **how they will be doing in the future?**

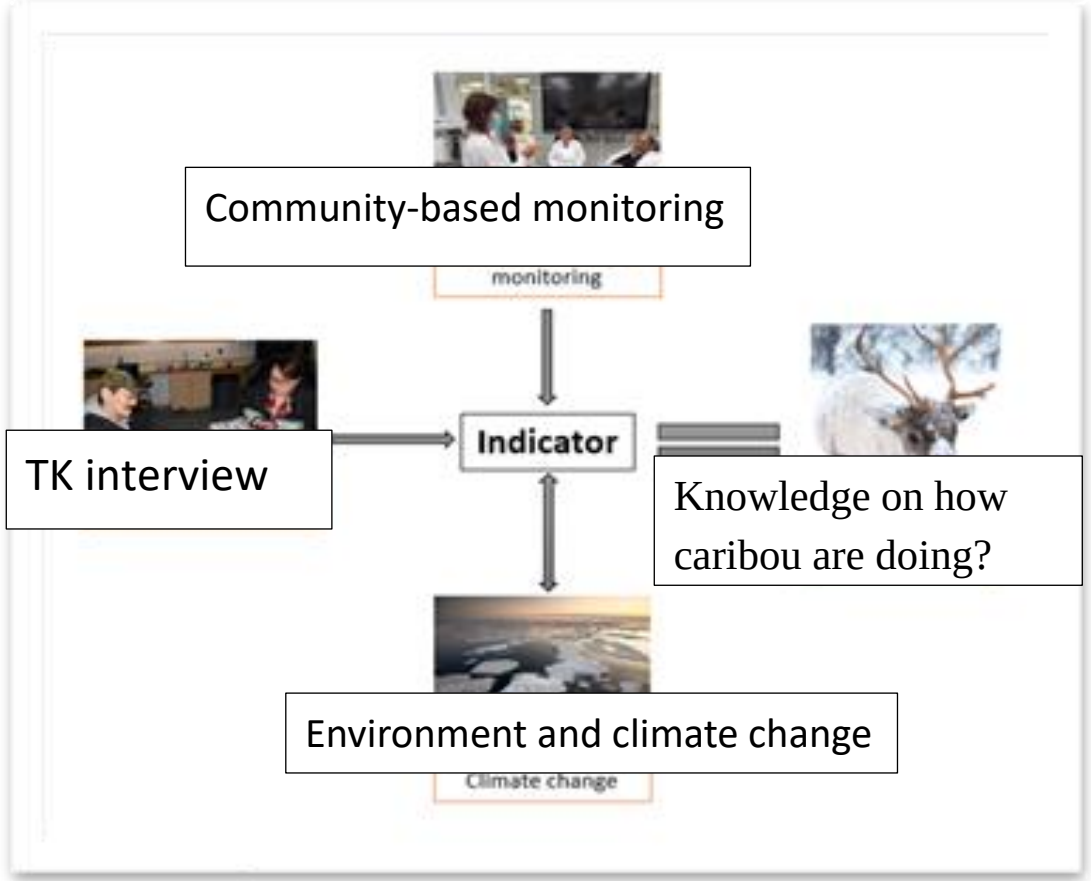
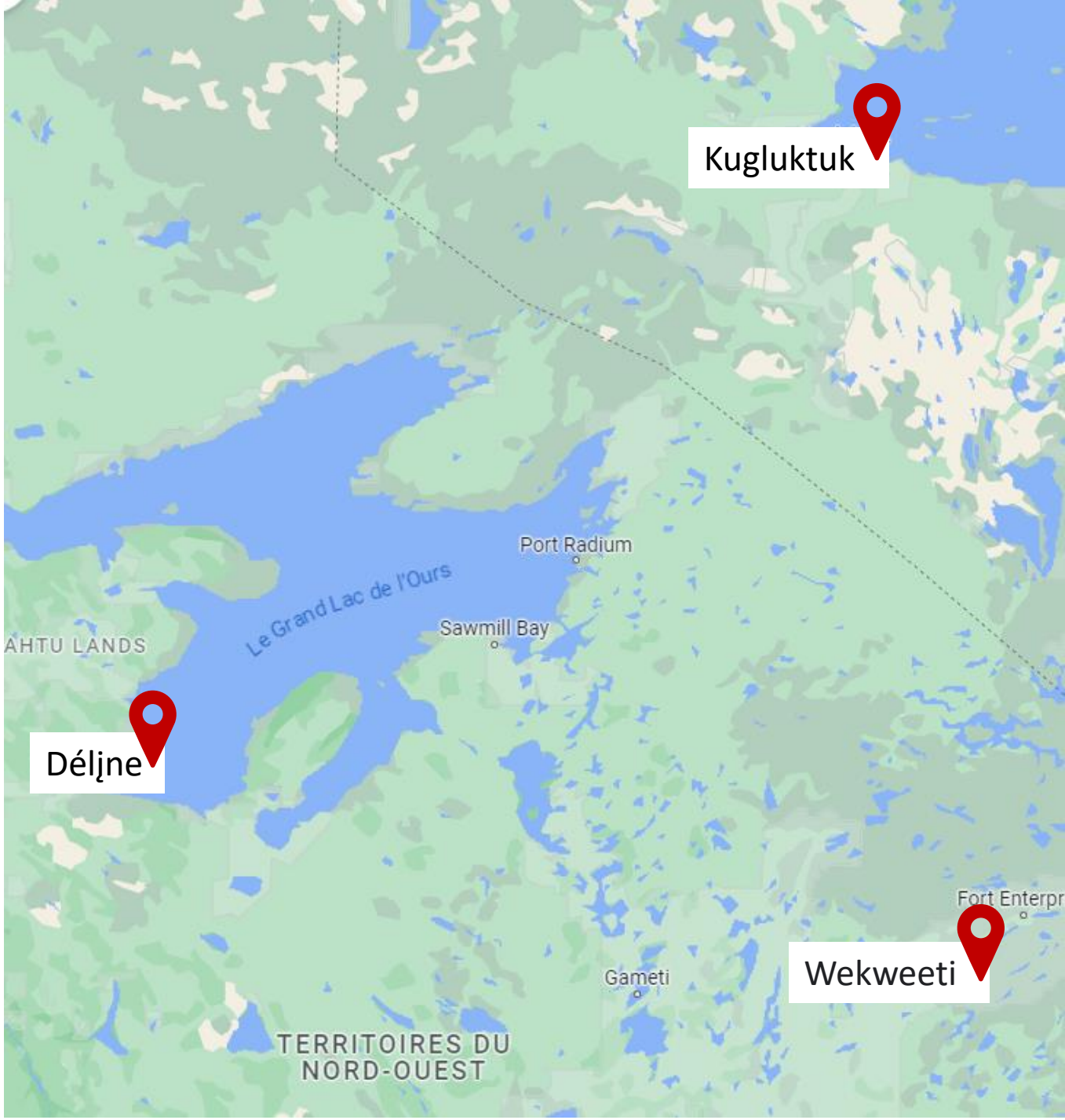


Figure: Components of the project

What is coming up?

- We will work together to monitor caribou health (both samples and traditional knowledge).
- **Workshop** - to introduce and train hunters on the redesigned kit.
- **Interviews** - about the historical trends for the Bluenose East caribou population.
- Harvester-based sampling.

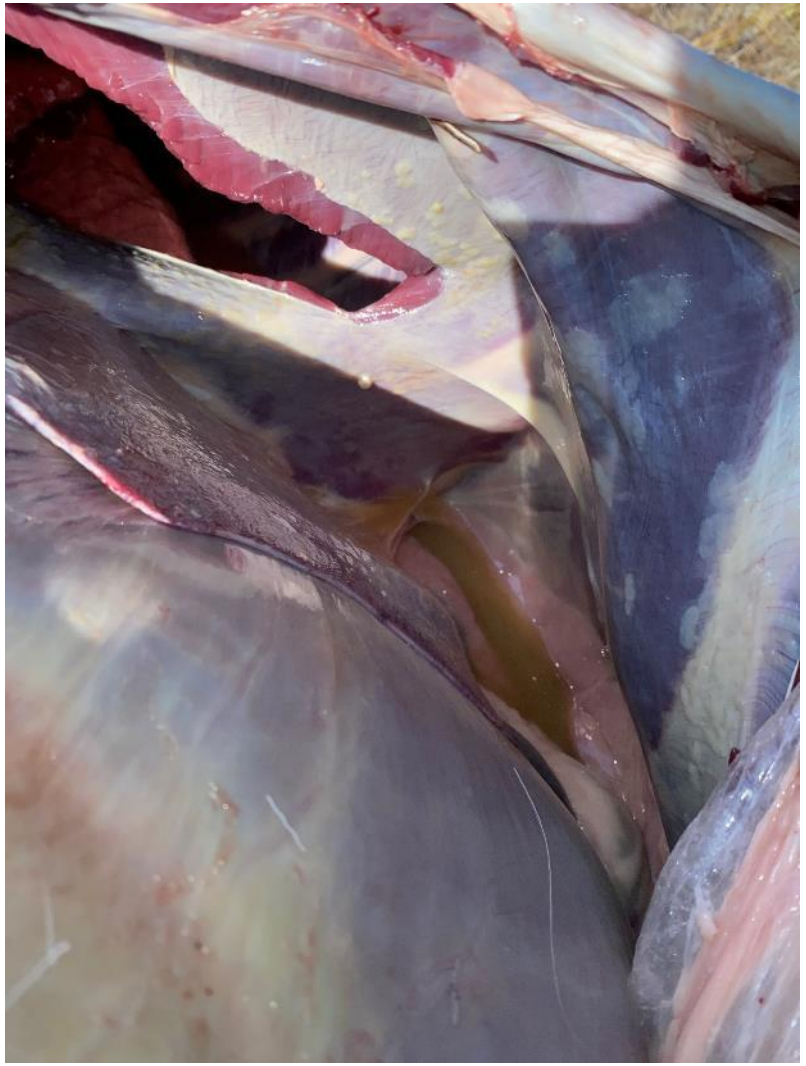


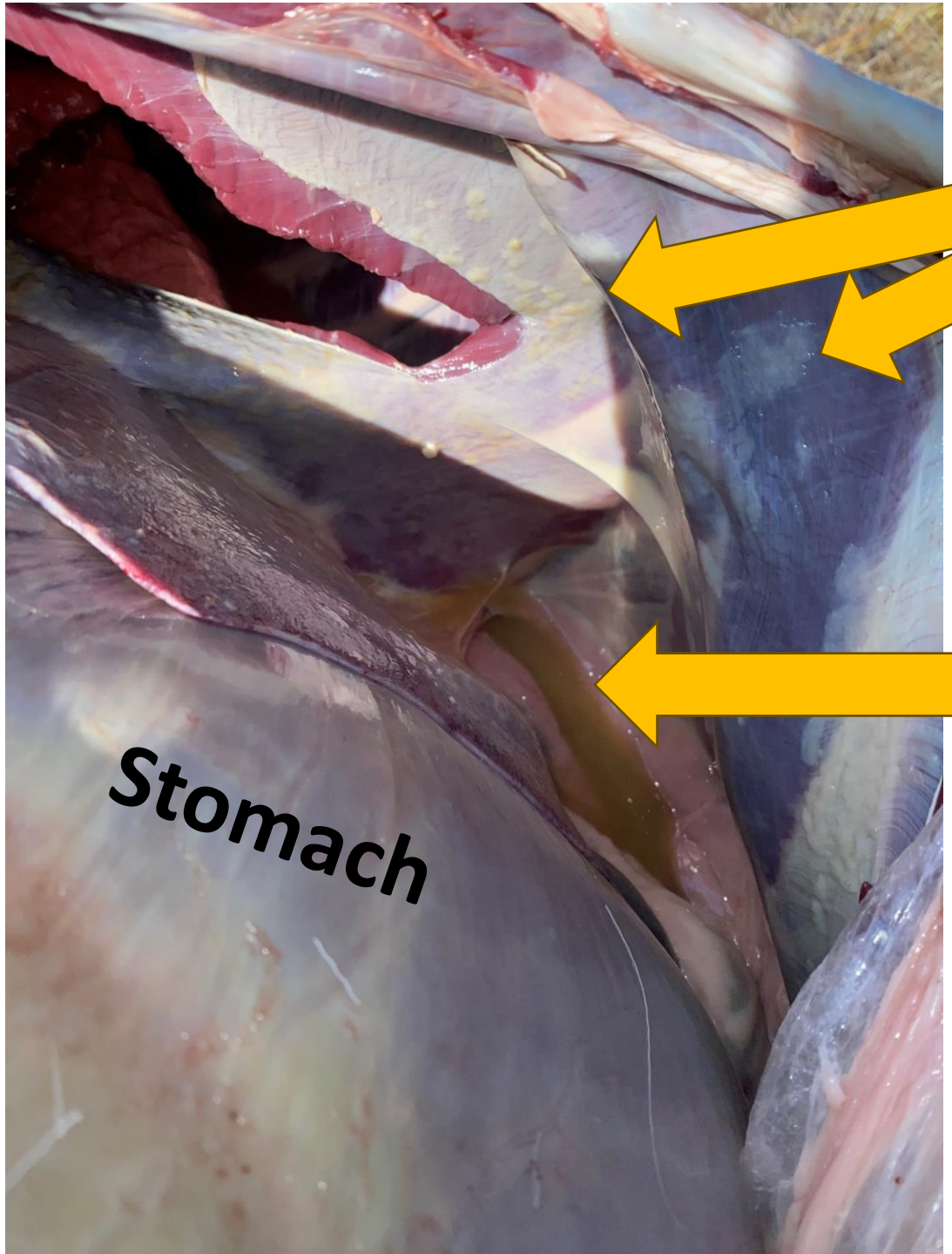
Thank you so much for your kind attention!

Question and feedback?

Currently observed in Bluenose East caribou

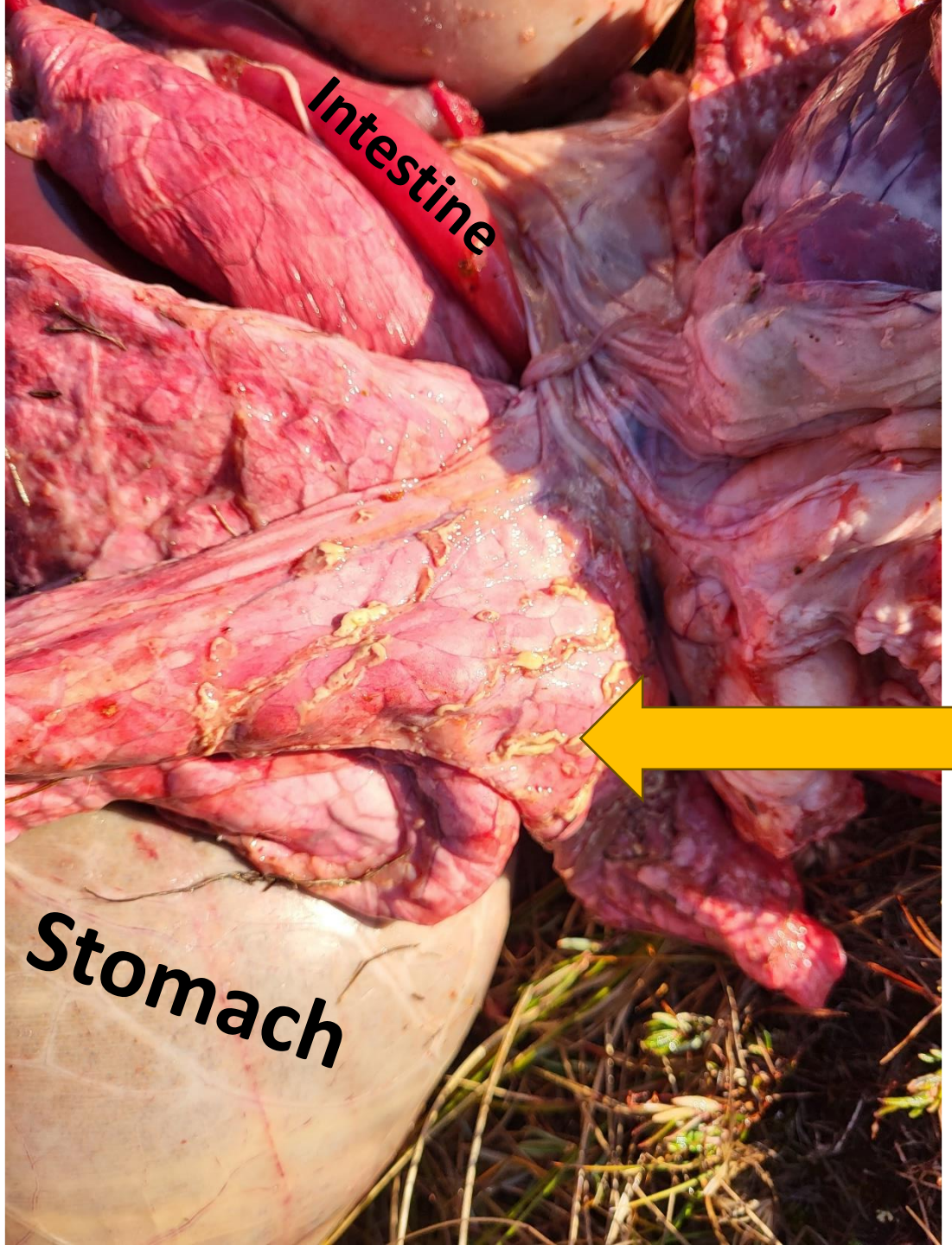
- Several harvested caribou with abnormalities
- Healthy looking animals
- White-yellowish “stuff” sticking to ribcage, intestine, rumen, spleen etc…
- Liquid in chest or belly
- Also changes in muscle (bruising, yellow-green pussy stuff)



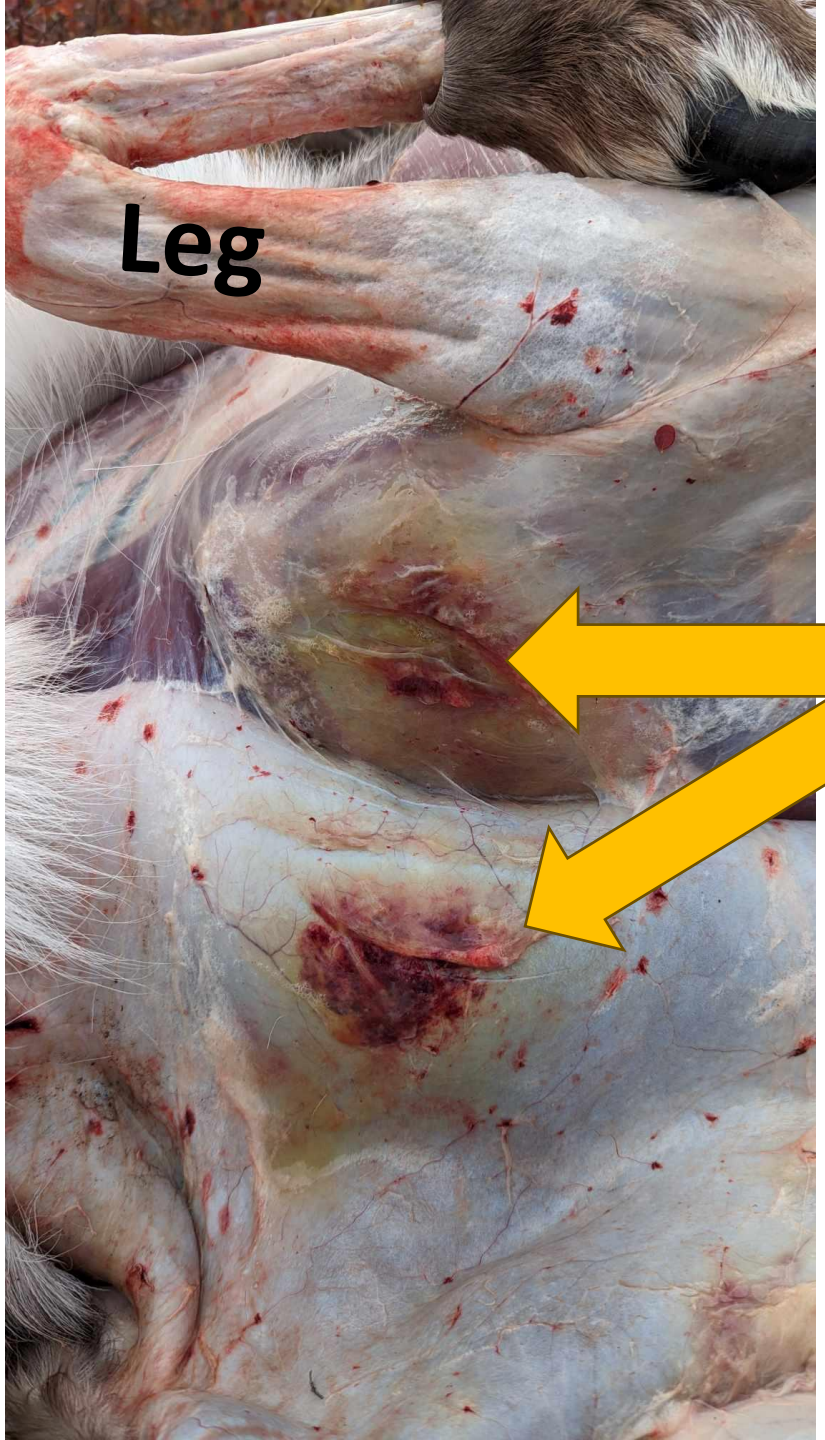


White “stuff” sticking to diaphragm and walls of the abdomen

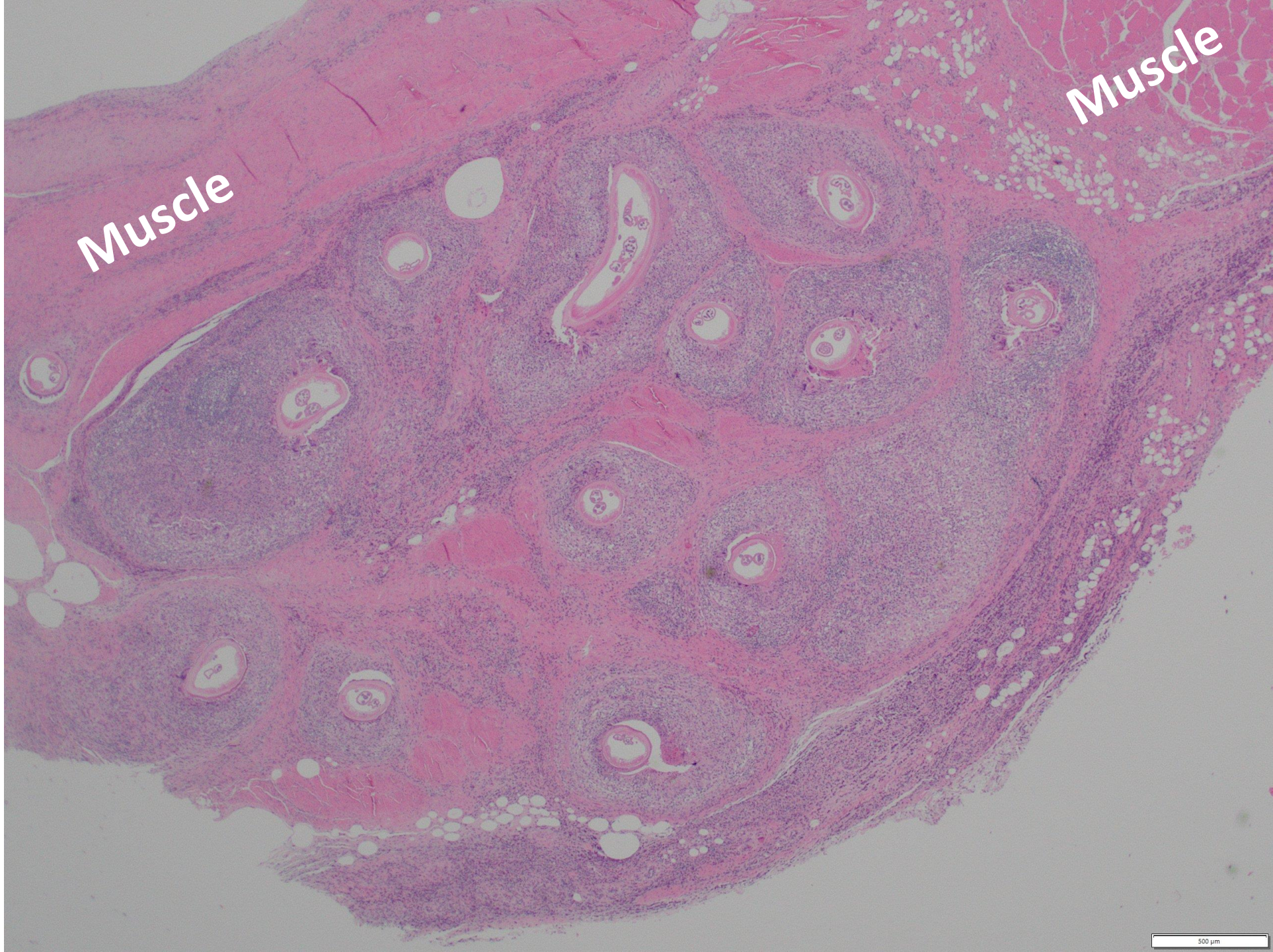
Liquid in Abdominal cavity



Yellow “stuff” sticking to the membrane holding the stomach and intestines

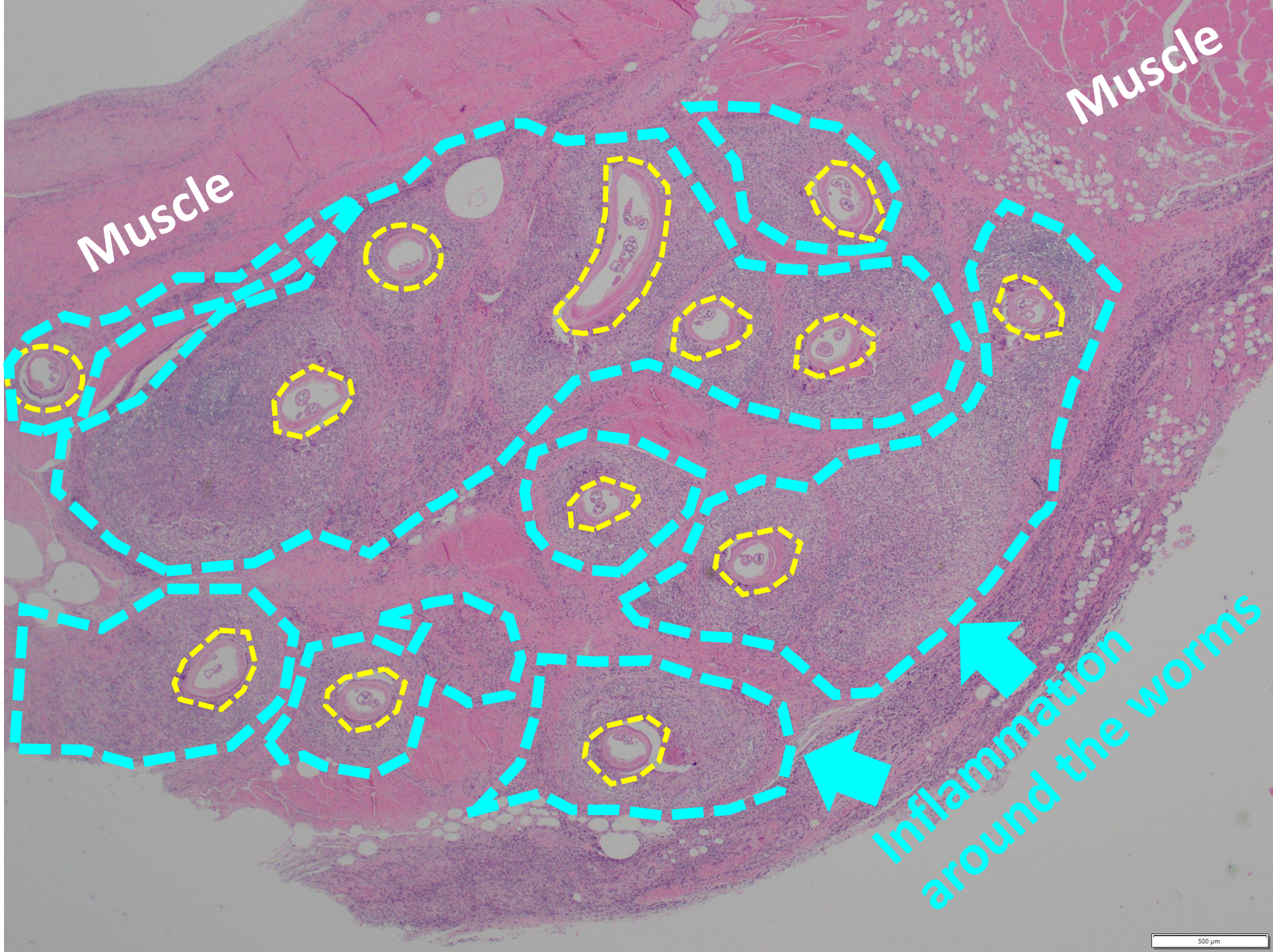

Leg
Bruising and yellowish coloration of the muscle and skin

Muscle tissue under the microscope



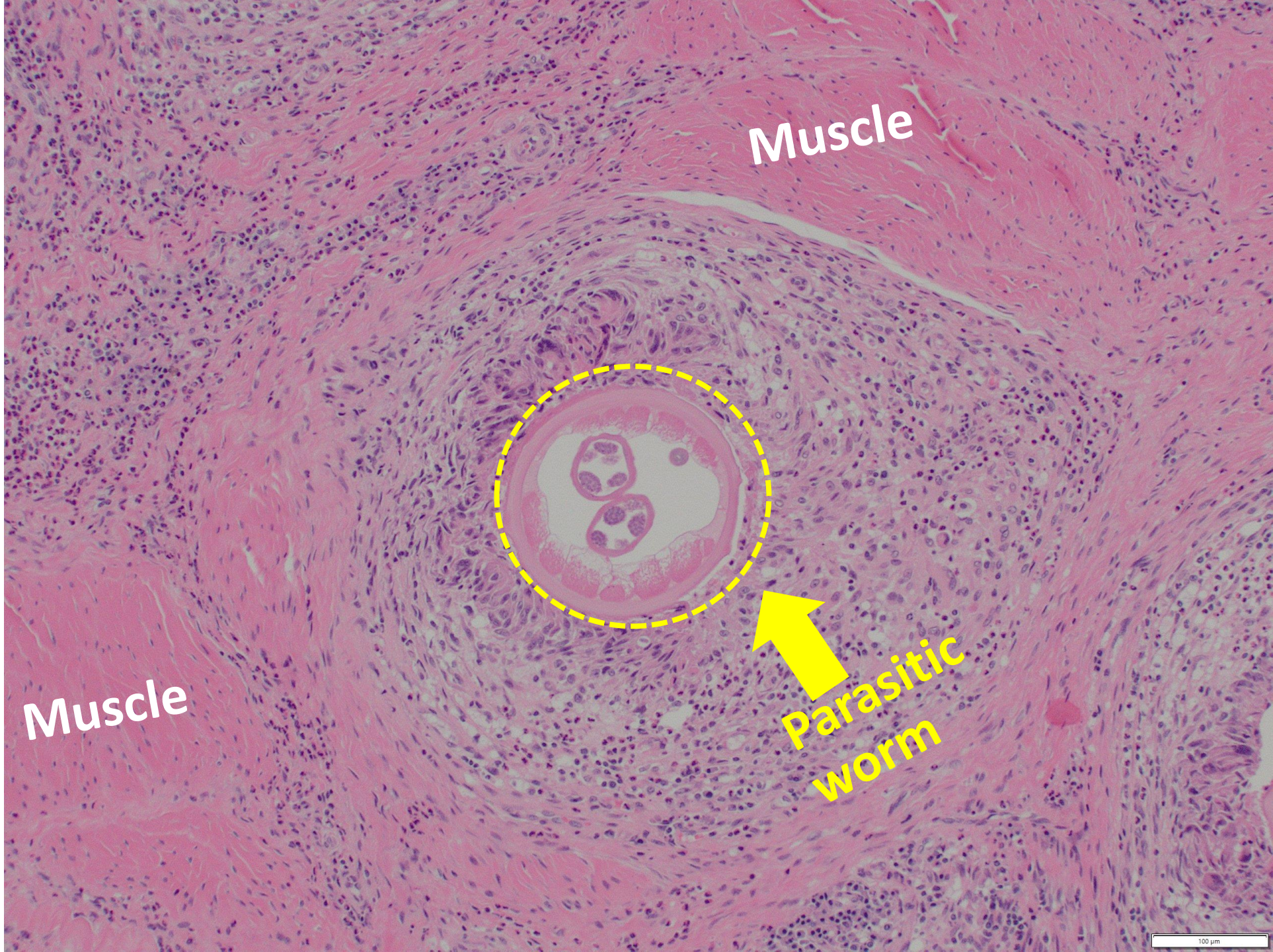
Muscle tissue under the microscope

Muscle tissue under the microscope



Muscle tissue under the microscope

Close-up of the worm



Muscle tissue under the microscope

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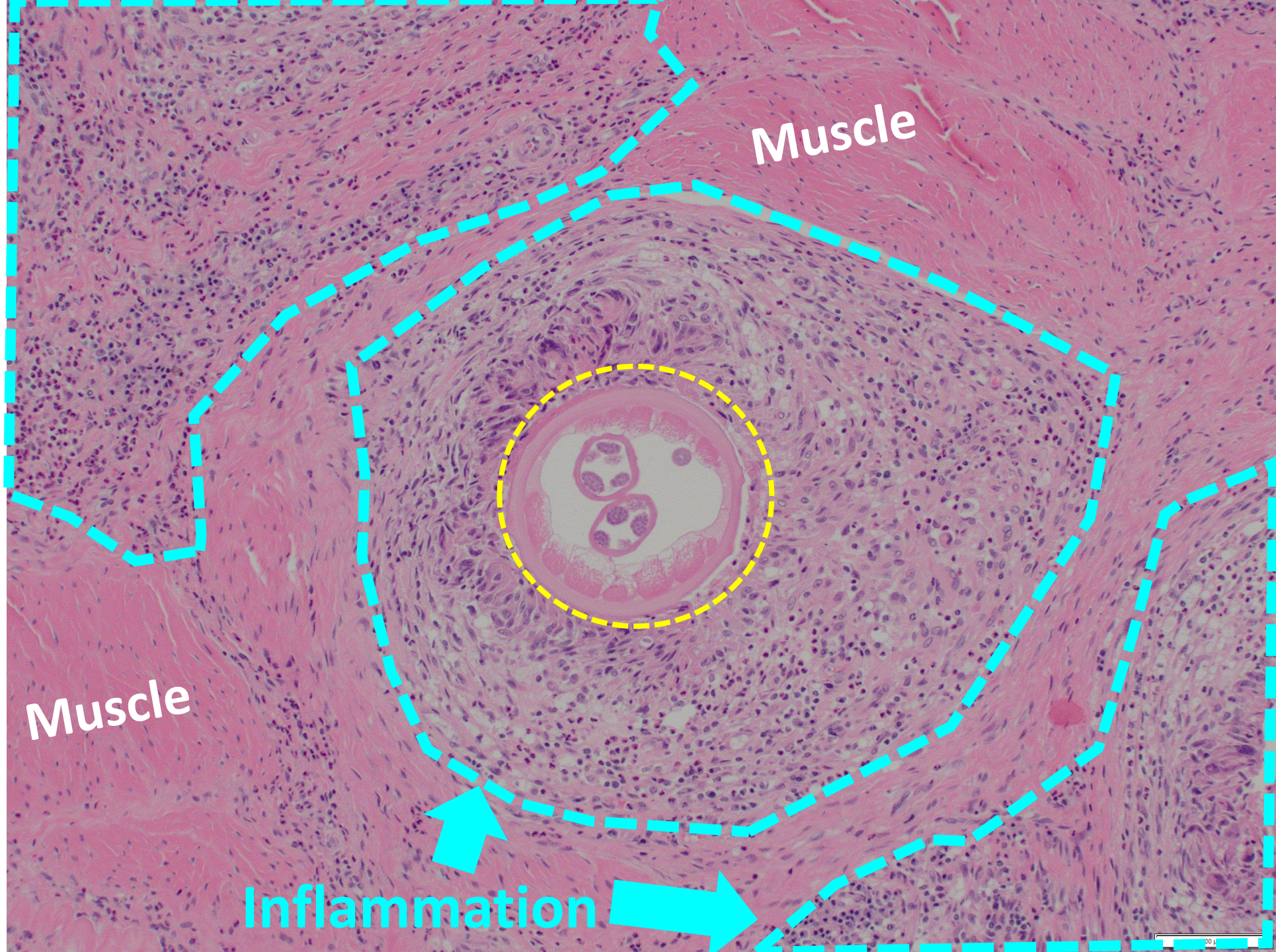

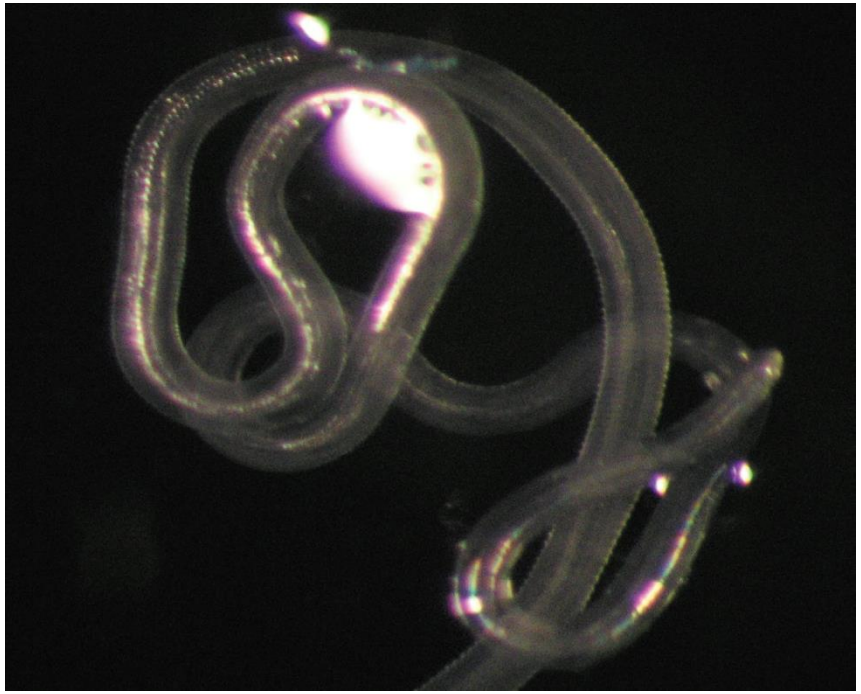

Some other Caribou cases