Combining local, indigenous and scientific knowledge to enhance wildlife health surveillance

WOAH's Training Workshop

National Focal Points for Wildlife, European Region

June 27th, 2023

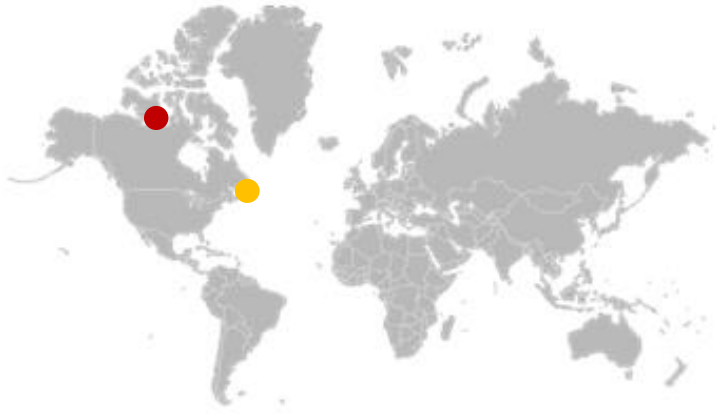
Matilde Tomaselli – Research Scientist, POLAR

POLAR POLAIRE

Polar Knowledge Canada | Savoir polaire Canada





Canada

Polar Knowledge Canada | Savoir polaire Canada

Matilde Tomaselli, DVM PhD

Research Scientist and Wildlife Health Specialist

Canadian High Arctic Research Station

Polar Knowledge Canada

CHARS

EDUCATION:

UNIVERSITÀ DEGLI STUDI DI MILANO

Dr. Lanfranchi
Dr. Ferrari

UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA
Facultad de Veterinaria

Faculty of Veterinary Medicine

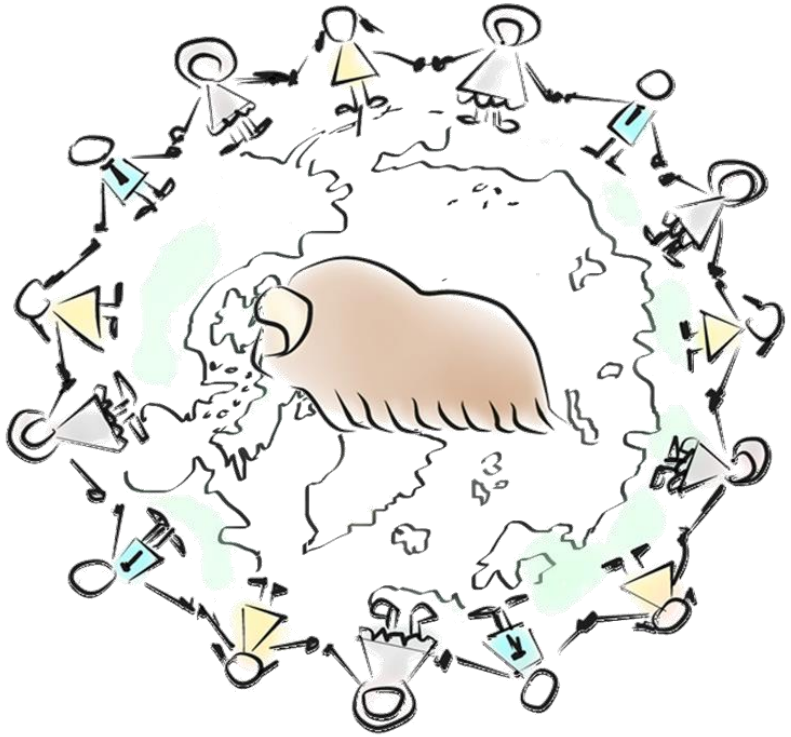
UNIVERSITY OF CALGARY

Faculty of Veterinary Medicine
Department of Ecosystem and Public Health

Dr. Checkley
Dr. Kutz

PhD thesis: "Improved Wildlife Health and Disease Surveillance through the combined use of Local Knowledge and Scientific Knowledge

MUSKOX HEALTH PROJECT



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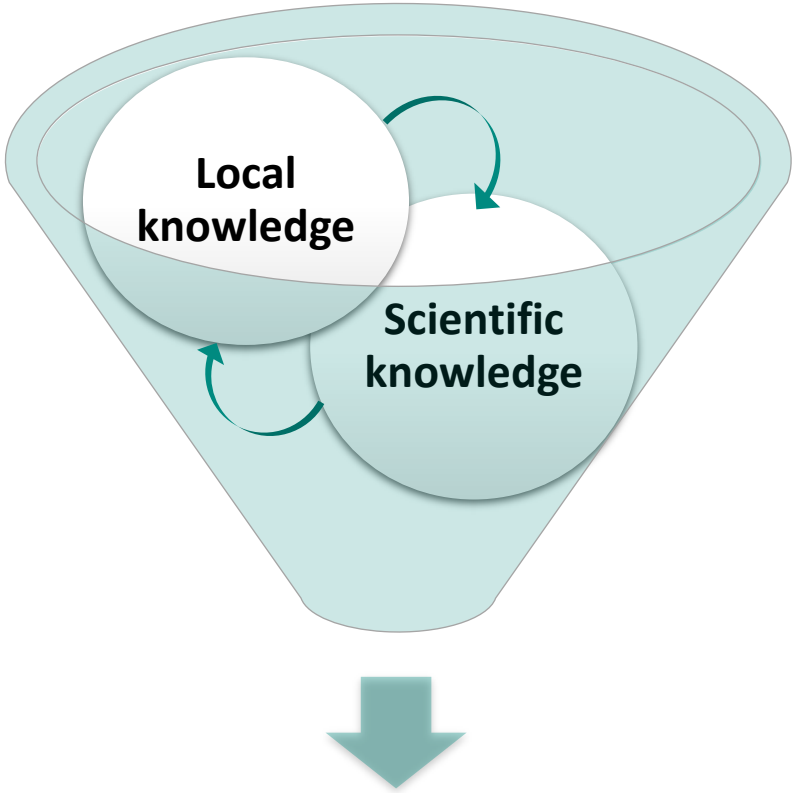
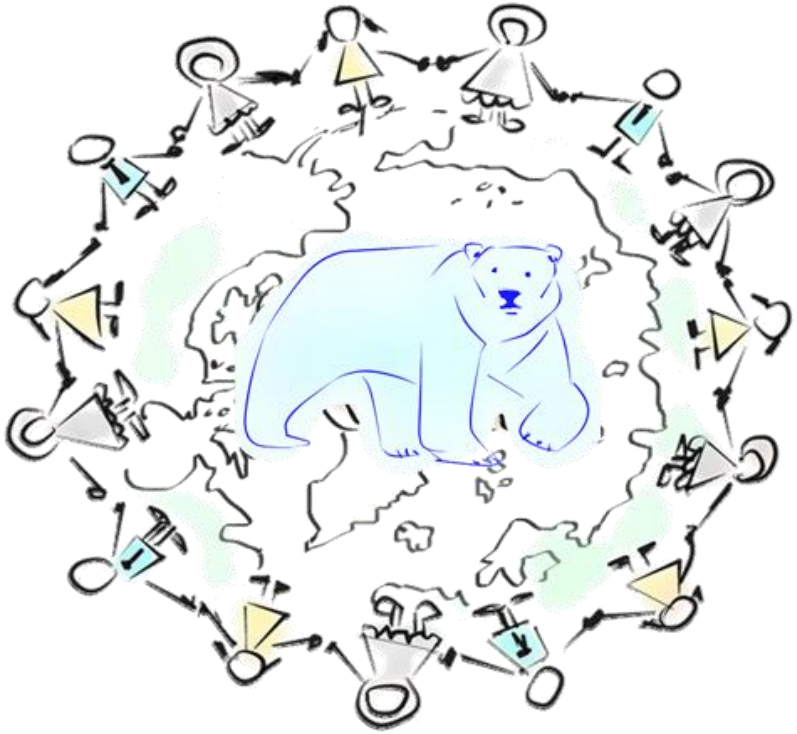


Participatory Wildlife Health Surveillance

POLAR BEAR HEALTH PROJECT



Access here

INTRODUCTION

Importance of and challenges for wildlife health surveillance

Traditions referenced for combined approach: LK and Science

The working context: The Canadian Arctic

PS FOR WILDLIFE HEALTH IN ACTION

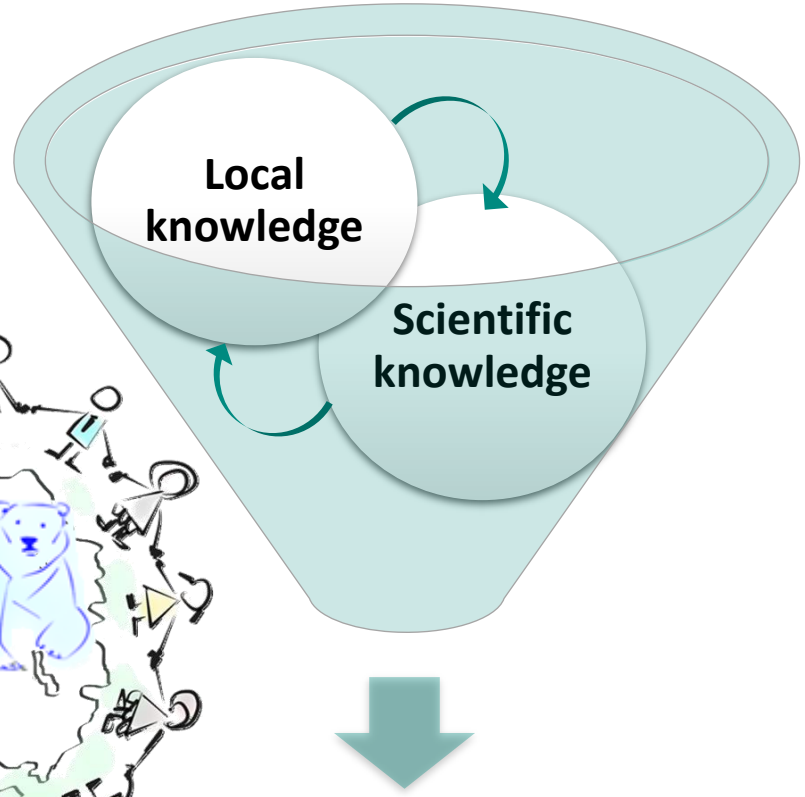
The Participatory Muskox Health Surveillance Project

Participatory epidemiology on polar bear health

CONCLUSION

Lessons learned: broader application and added values

Strengths and challenges



Participatory Wildlife Health Surveillance

Acknowledgements : supporters, funders and partners

Polar Knowledge Canada

Environment and Climate Change Canada

Nunavut

Nunavummi Qaujisaqtulirijikkut · Nunavut Research Institute

University of Calgary

University of Saskatchewan

ITraP

Pangnirtung Hunters & Trappers Organization

Nunavut General Monitoring Plan
Nunavunmi Tamainni Takuurivangnikkut Parnaiyautaanni
Plan de surveillance générale du Nunavut

Nunavut Wildlife Management Board

Kitikmeot Inuit Association

Mayukalik H.T.A. Kimmirut

NSERC
CRSNG

Canadian Wildlife Health Cooperative

Since 1981
Canada North Outfitting

Kitikmeot Foods
Cambridge Bay

Land of the Midnight Sun
High Arctic Lodge

Acknowledgements: knowledge holders

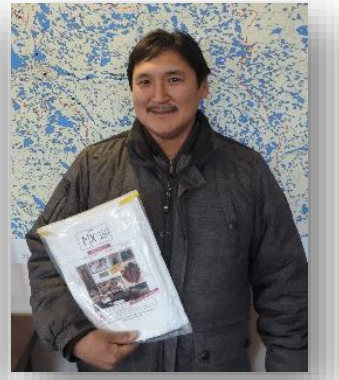





This work was made possible by

collaboration with residents of northern communities

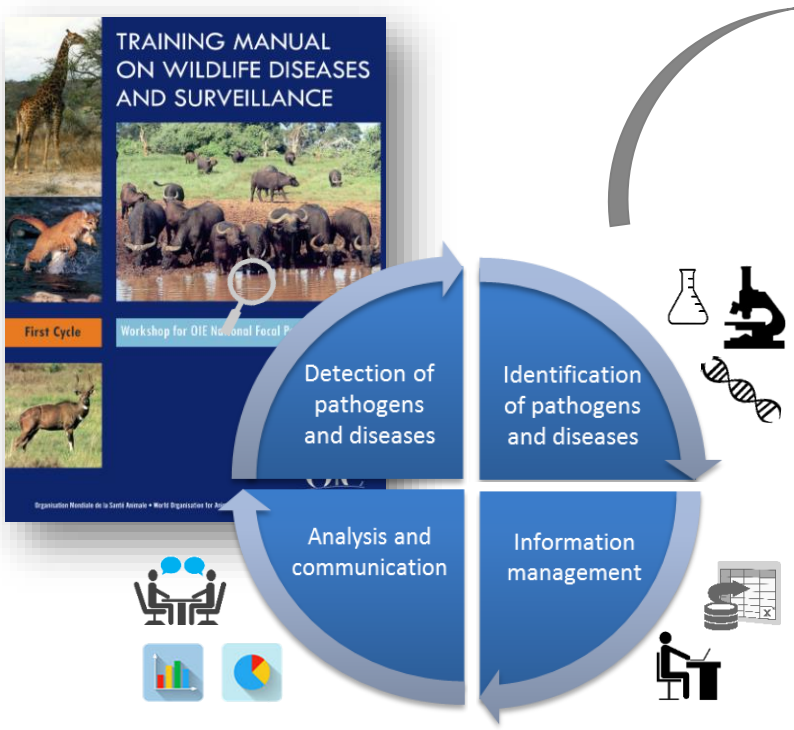
and their generous intellectual contributions


Veterinary Surveillance

"is the ongoing collection, collation, analysis of information related to animal health, and the timely dissemination of this information so that action can be taken"

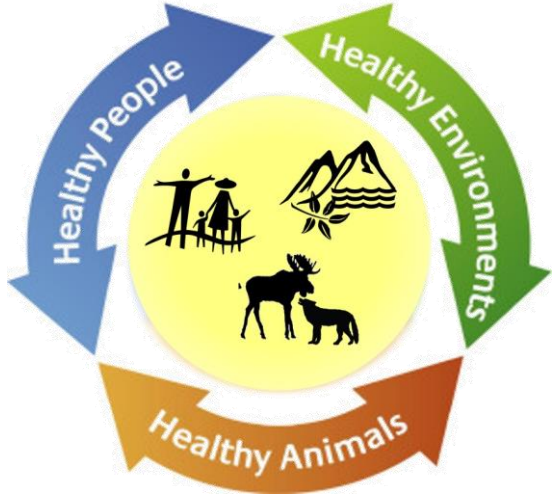
OIE Terrestrial Animal Health Code, 2017



Adapted from OIE, 2010

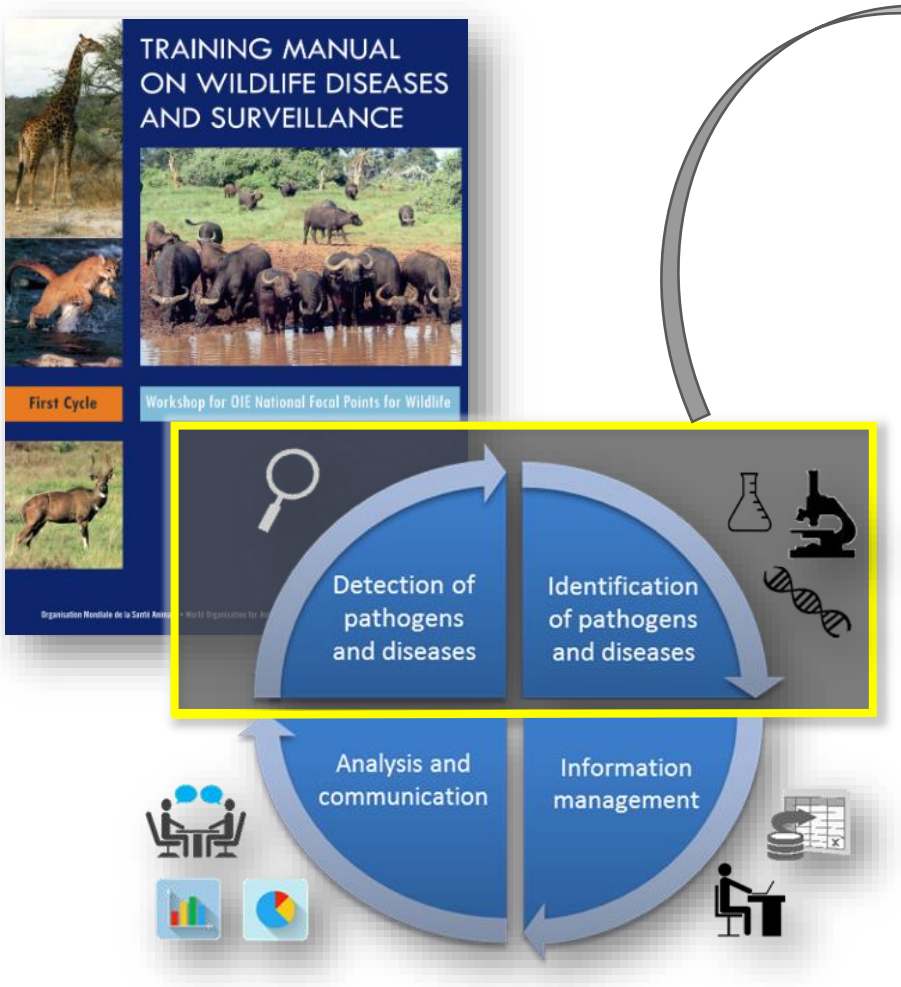
Interventions
Wildlife management (animals, habitat)
Wildlife and biodiversity conservation
Safeguard human and animal health

Peterson and Ferro 2007; Artois et al. 2009; OIE 2010



Picture credit University of Alaska

Challenges to wildlife health surveillance

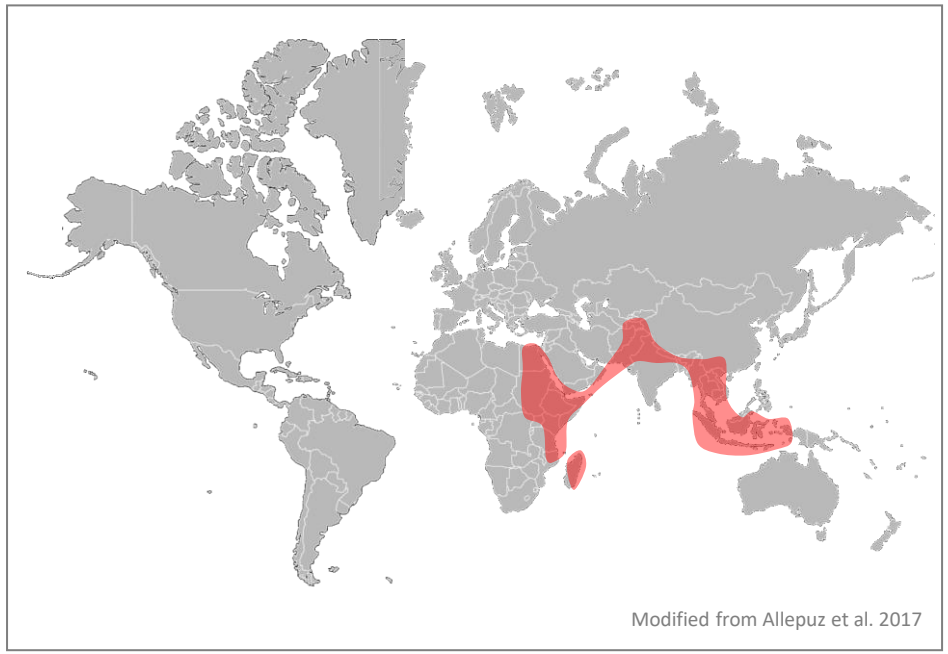


Adapted from OIE, 2010

Challenges from initial data aquisition and field data interpretation
Difficulties accessing the animals / finding cases
Lack of demographics for the target population
Lack of validated tests
Selection and measurment bias
Lack of representativeness
Logistical and financial restrictions

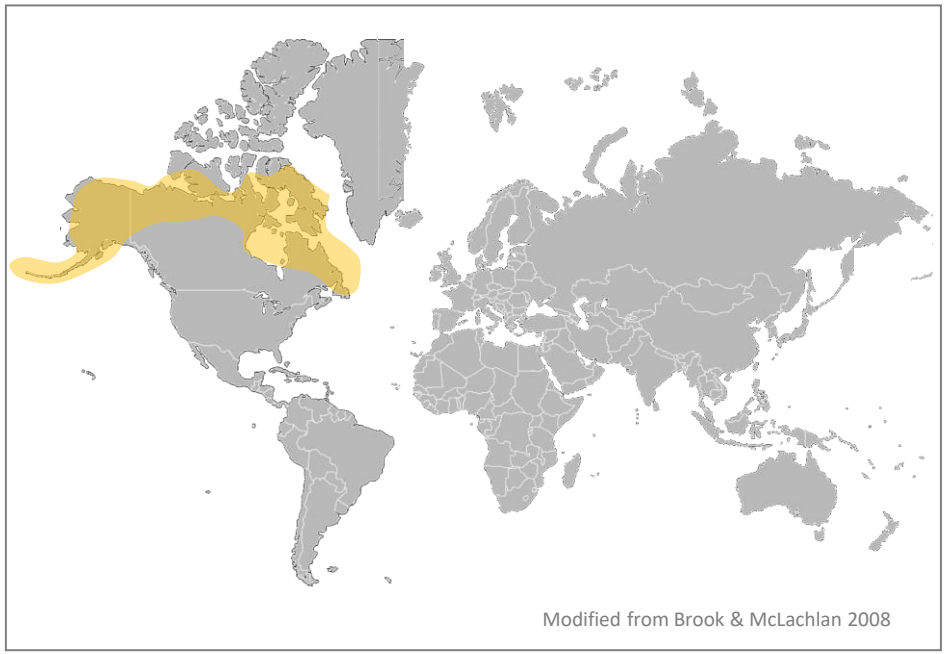
Stallknecht 2007; Wobeser 2007; OIE 2010; Ryser-Degiorgis 2012

Participatory surveillance for livestock diseases



Ethnoveterinary knowledge

Adaptive management of natural resource



Ecological knowledge

Tomaselli M (2018, 2022)

Learning lessons from other field of study

Participatory surveillance (PS) for livestock diseases

Ethnoveterinary knowledge

↓

Participatory epidemiology (PE) on livestock diseases

Sensitive and timely tool to identify cases of disease

+ conventional veterinary diagnostics

Used to confirm 'cases',
increasing the specificity of the surveillance

Participatory appraisal techniques

e.g., semi-structured interviews, graphic and scoring exercise

e.g., Mariner & Paskin 2000; Jost et al. 2007; Catly et al. 2012

Learning lessons from other field of study

Participatory surveillance (PS) for livestock diseases

Ethnoveterinary knowledge

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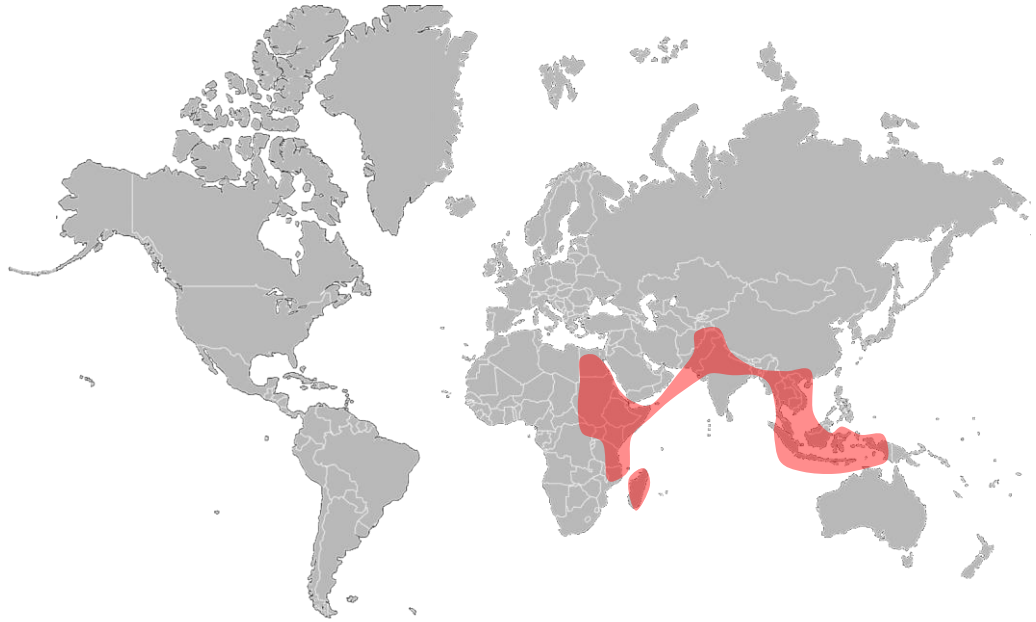


Modified from Allepuz et al. 2017

Participatory appraisal techniques

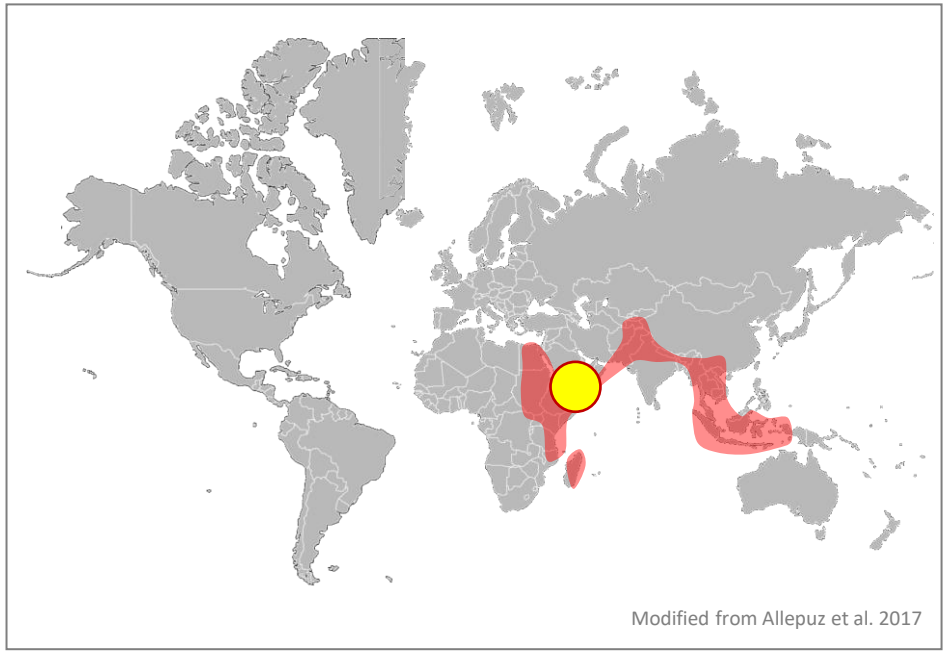
e.g., semi-structured interviews, graphic and scoring exercise

e.g., Mariner & Paskin 2000; Jost et al. 2007; Catly et al. 2012

Learning lessons from other field of study

Participatory surveillance for livestock diseases

2011 – Global eradication of rinderpest
'Cattle plague'



Modified from Allepuz et al. 2017

Rinderpest Eradication: Appropriate Technology and Social Innovations
Jeffrey C. Mariner *et al.*
Science **337**, 1309 (2012);
DOI: 10.1126/science.1223805

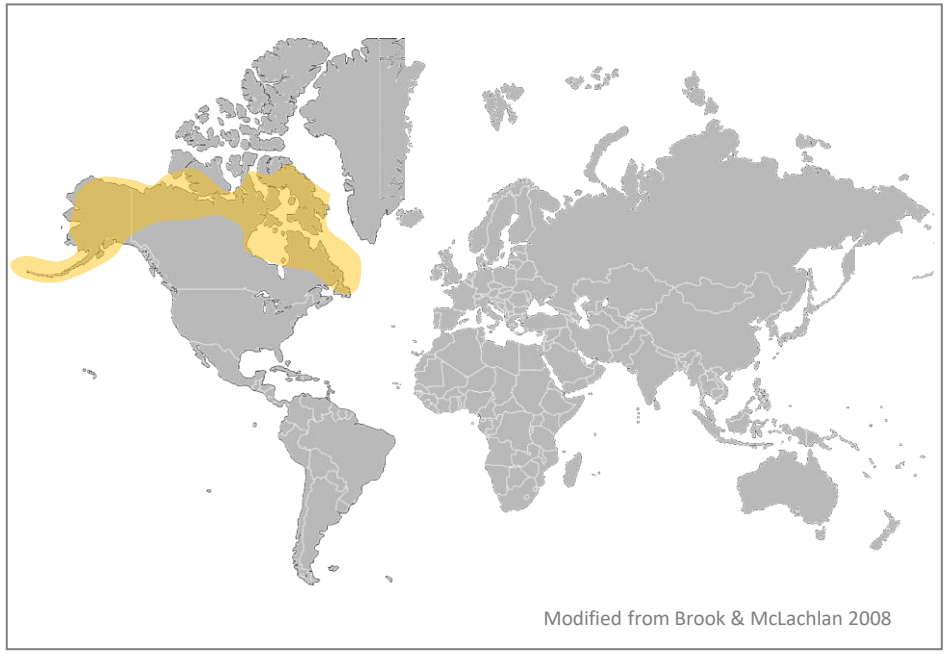
Learning lessons from other field of study

Adaptive management of natural resource

Ecological knowledge

↓

Wildlife co-management systems



Modified from Brook & McLachlan 2008

Used to complement scientific information on

Wildlife distribution, abundance and trends

Wildlife behavior and body condition

Interspecific interactions

Ecosystem and habitat changes

e.g., Berkes et al. 2000; Huntington 2000; Davis & Wagner 2003; Huntington et al. 2004

Qualitative methods

e.g., interviews, workshops,
collaborative fieldwork, questionnaires

Dismissed as anecdotal knowledge
Validation with Western Science

The approach: learning lessons from other field of study

Participatory surveillance for livestock diseases

Ethnoveterinary knowledge

Adaptive management of natural resource

Ecological knowledge

Robust qualitative research design

Novel application of traditional and local knowledge for wildlife health surveillance

Tomaselli M (2018, 2022)

"Two-eyed seeing" for wildlife health, *Science*

Inuit harvester Julia Ogina, of the Kitikmeot Inuit Association (left), shares her knowledge on muskox health with wildlife veterinarian Matilde Tomaselli (right), in Cambridge Bay, Nunavut, Canada.

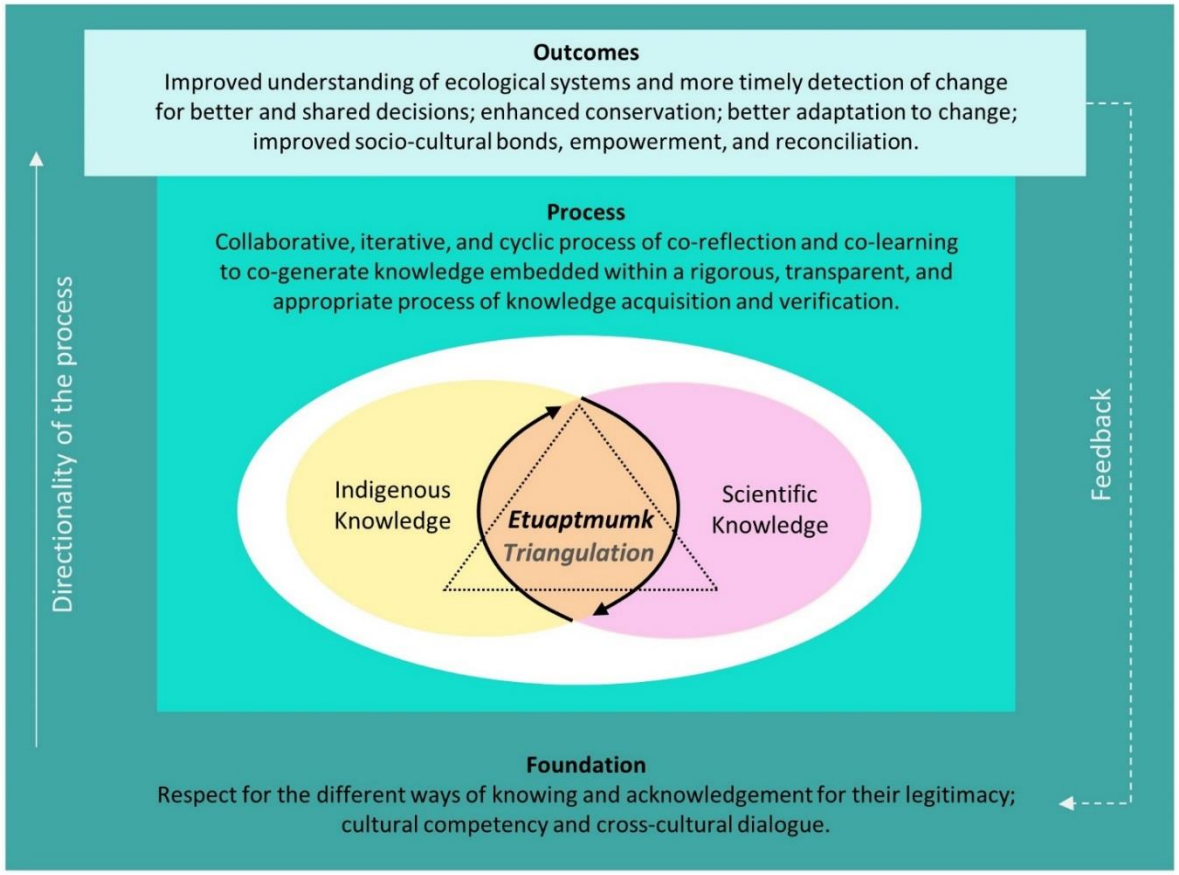
BRIDGE: INDIGENOUS AND SCIENTIFIC KNOWLEDGE

"Two-eyed seeing" supports wildlife health

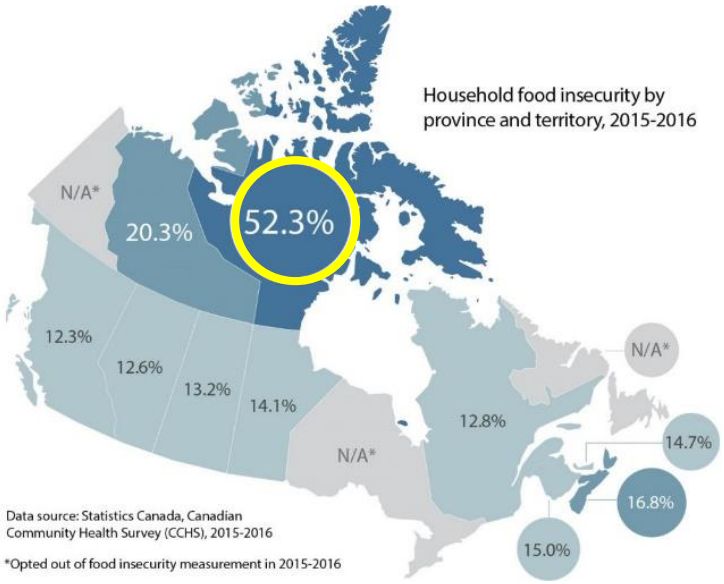
Bridging Indigenous and scientific knowledge improves wildlife surveillance and fosters reconciliation

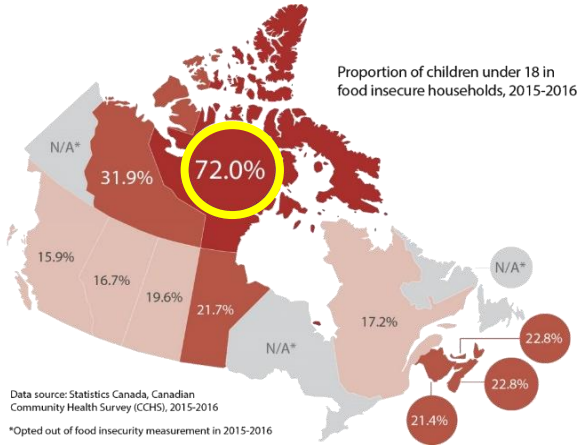
Kutz S and Tomaselli M. *Science*, 2019.

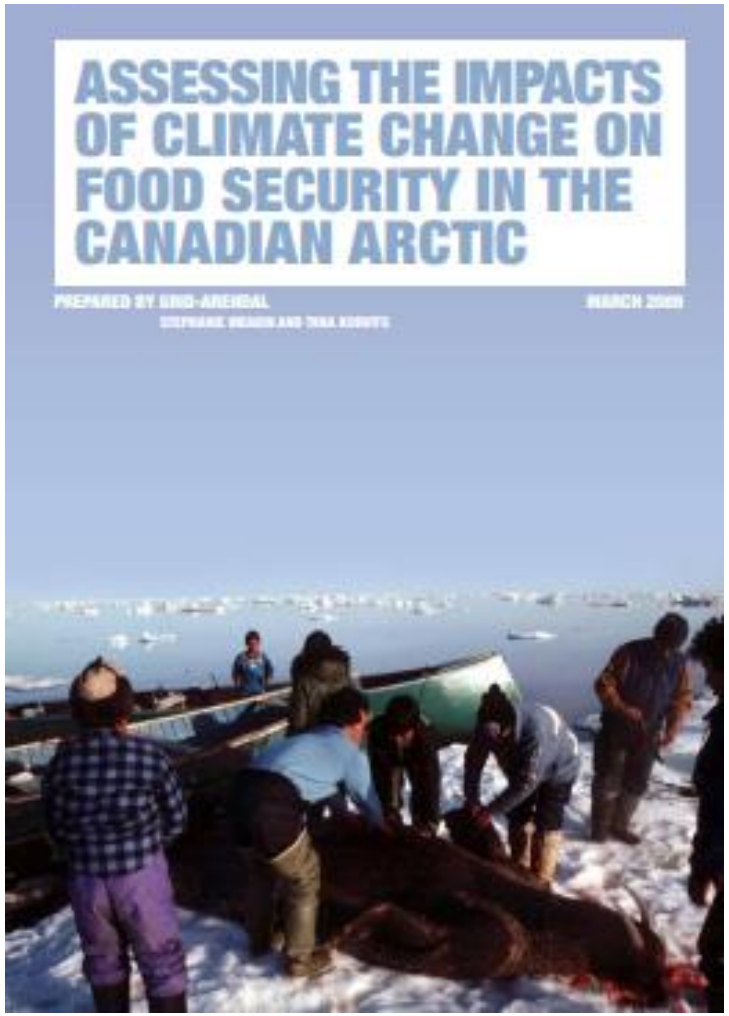
Pathway to enable cogeneration of knowledge



Canadian Arctic: the working context







Indigenous peoples of the North – Inuit

Library of Congress Archives

Iqaluktutiak Heritage Societey

Iqaluktutiak Heritage Societey

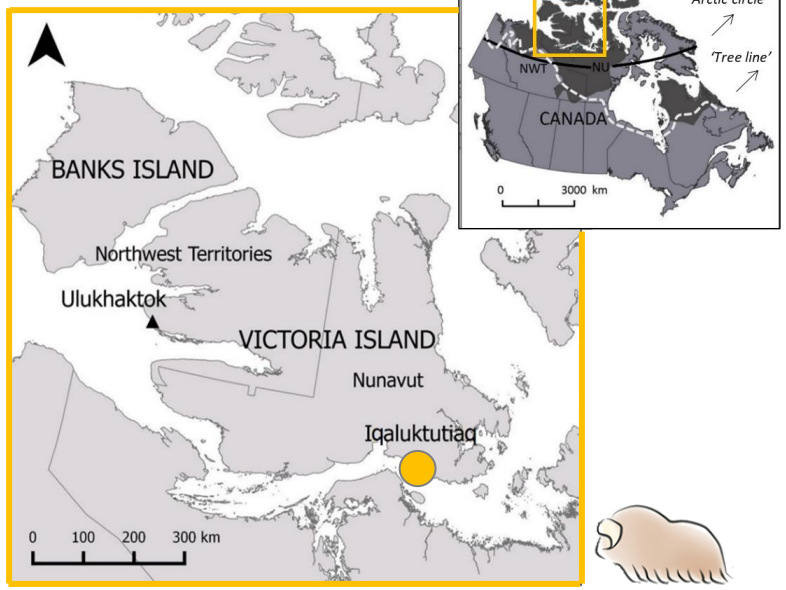
Victoria Island

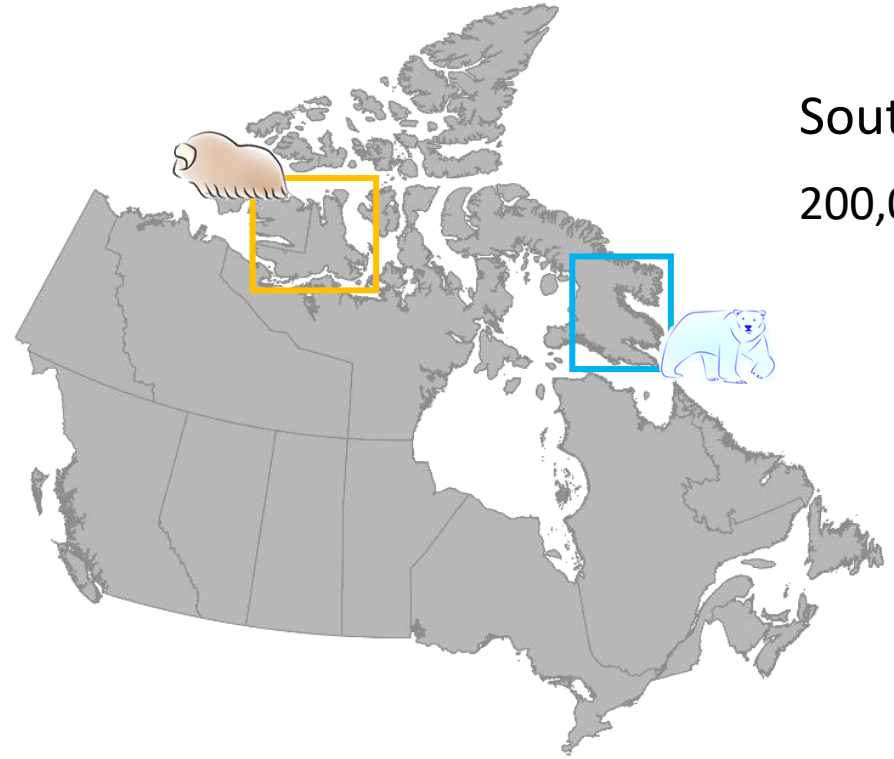
217,291 km²

1 community:

Cambridge Bay (Iqualuktutiaq)

2,000 people





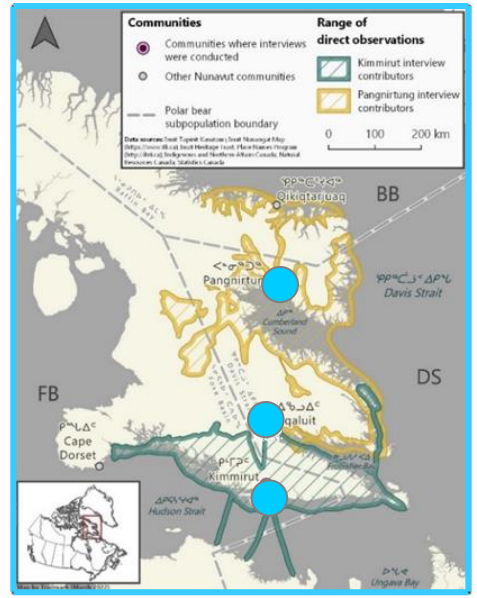
South Baffin Island

200,000 km²

3 communities:

Kimmirut, Pangnirtung and Iqaluit

From 400 to 5,000 people



The study area and objective

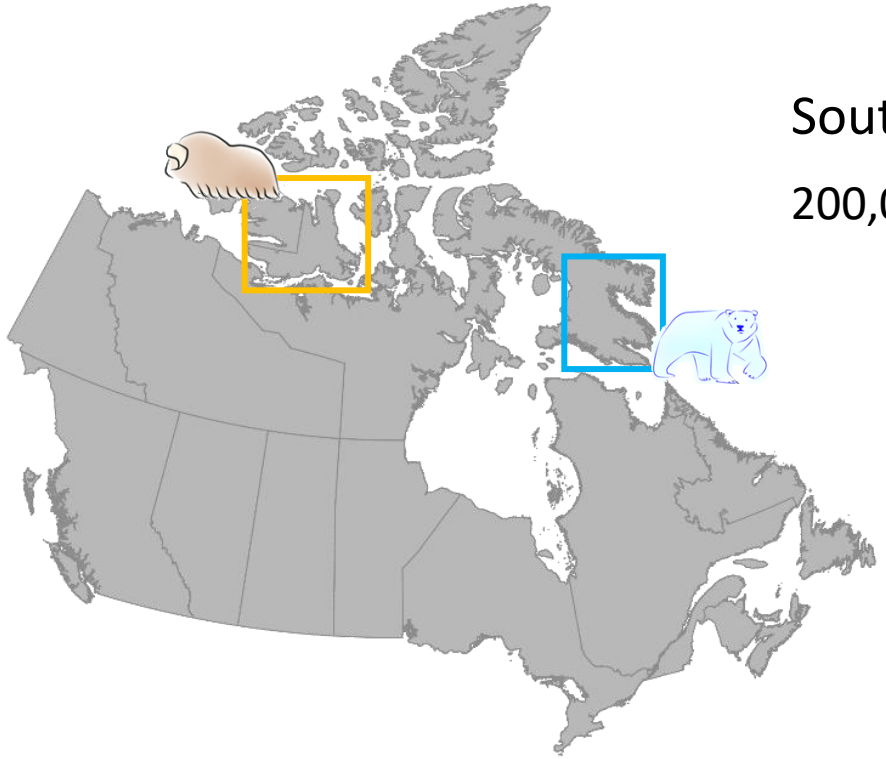
Victoria Island

217,291 km²

1 community:

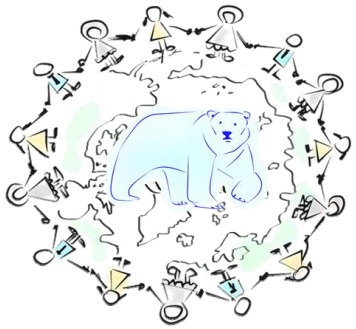
Cambridge Bay (Iqualuktutiaq)

2,000 people



South Baffin Island

200,000 km²

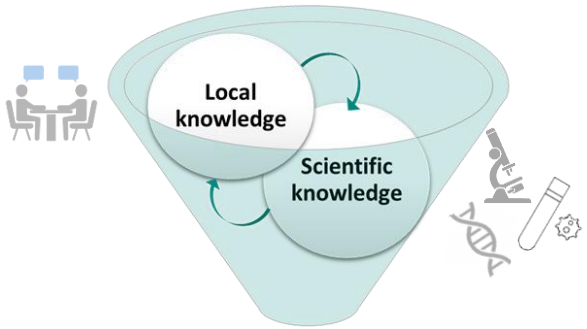


3 communities:

Kimmirut, Pangnirtung and Iqaluit

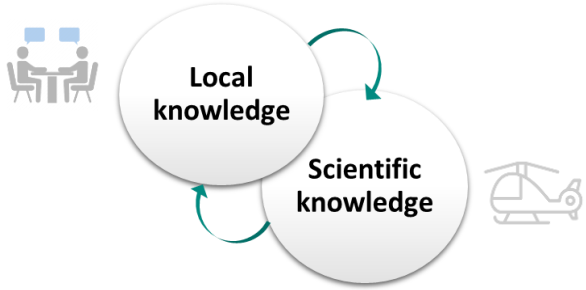
From 400 to 5,000 people

What happened to muskoxen?



PVS for wildlife health

Inuit knowledge on polar bear health



PE on polar bear health

The study area – need to understand muskox health

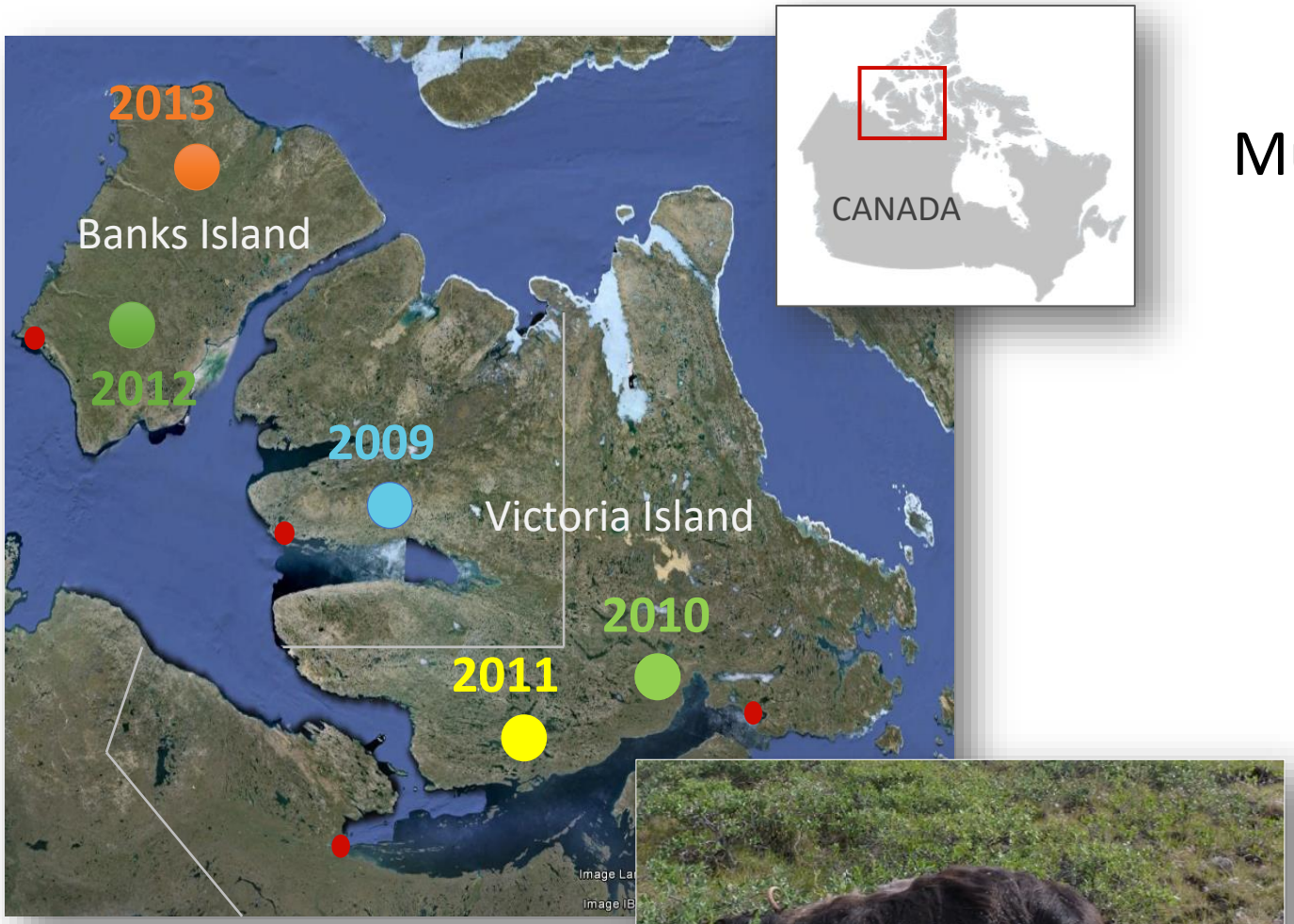


Photo credit S. Kutz

Muskox – *Ovibos moschatus* [1,2]

- Cold-adapted ungulate
- Early 1900s almost extinct
- 1917 active management
- Recolonization of range

Recent concerns

- Lungworm emergence and expansion [3]
- Die-off events

  Erysipelorthrix rhusiopathiae [4]
- Halt to commercial harvest

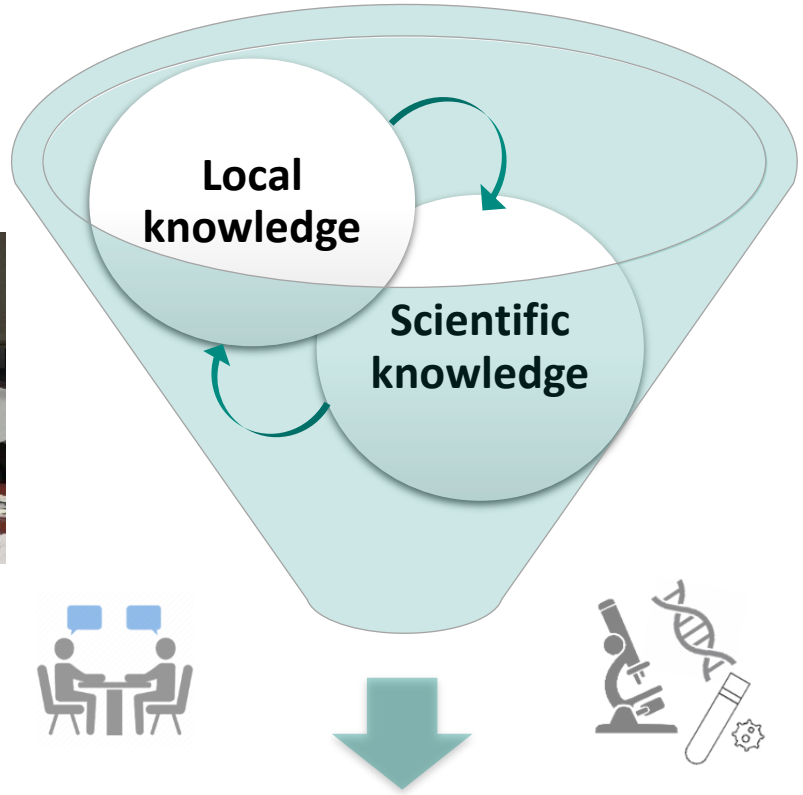
1 Tener 1958; 2 Lent 1999; 3 Kutz et al. 2013; 4 Kutz et al. 2015

The Participatory Muskox Health Surveillance

INTERVIEWS with key informants

Individual interviews
Group interviews
Participatory activities

Feedback sessions



Participatory Muskox Health Surveillance

HUNTER-BASED SAMPLING

FIELD DISEASE INVESTIGATIONS

TARGETED SCIENTIFIC STUDIES

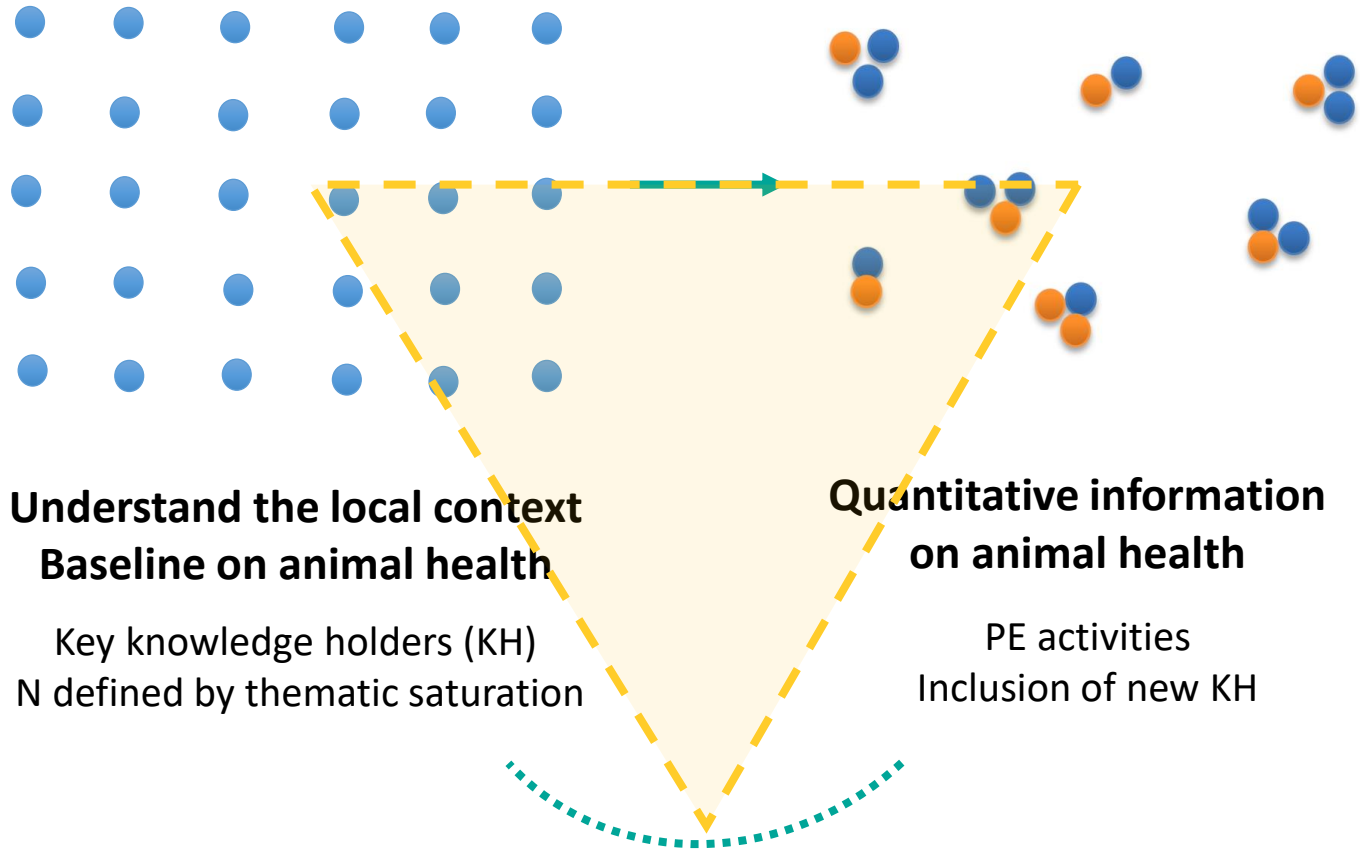
Tomaselli M (2018, 2022)

INTERVIEWS with key informants

Robust qualitative research design

1. Individual interviews

2. Small group interviews



Understand the local context
Baseline on animal health

Key knowledge holders (KH)
N defined by thematic saturation

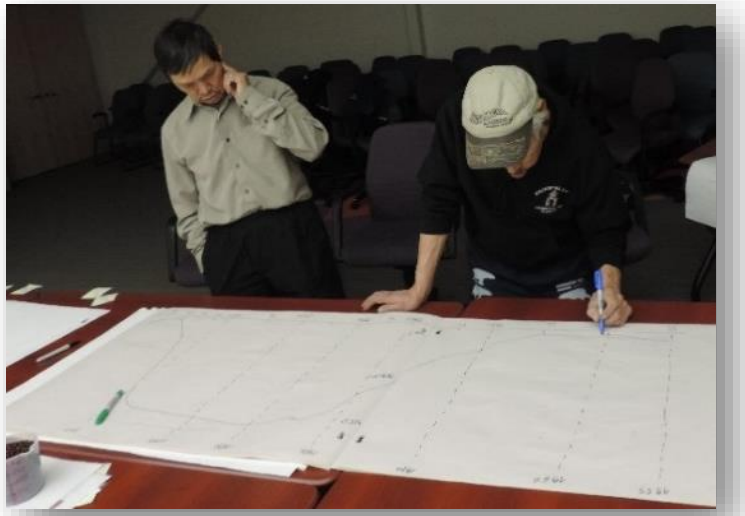
Quantitative information on animal health

PE activities
Inclusion of new KH

3. Feedback of analyzed/summarized information

Tomaselli et al. *Biol Cons* (2018)

Participatory appraisal techniques



Participatory mapping

Participatory drawing

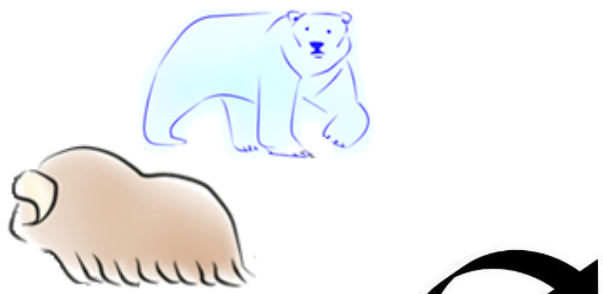
Timeline of events

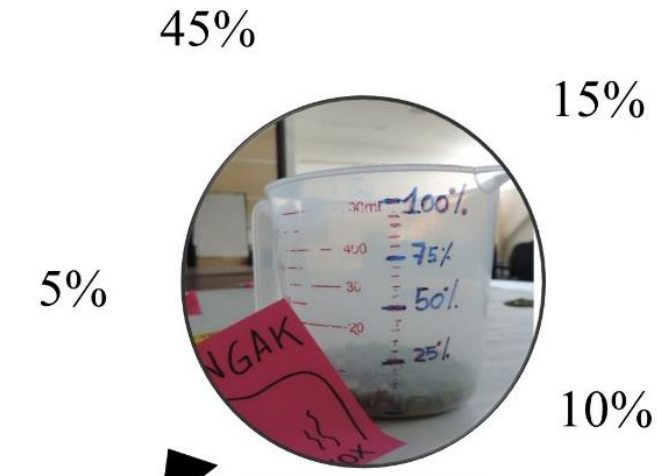
Seasonal calendars

Proportional piling

Tomaselli et al. *Arctic & Biol Cons* (2018)

Schematic of proportional piling





Fixed volume of counters
(0.5 kg beans)
used as unit of measure

→

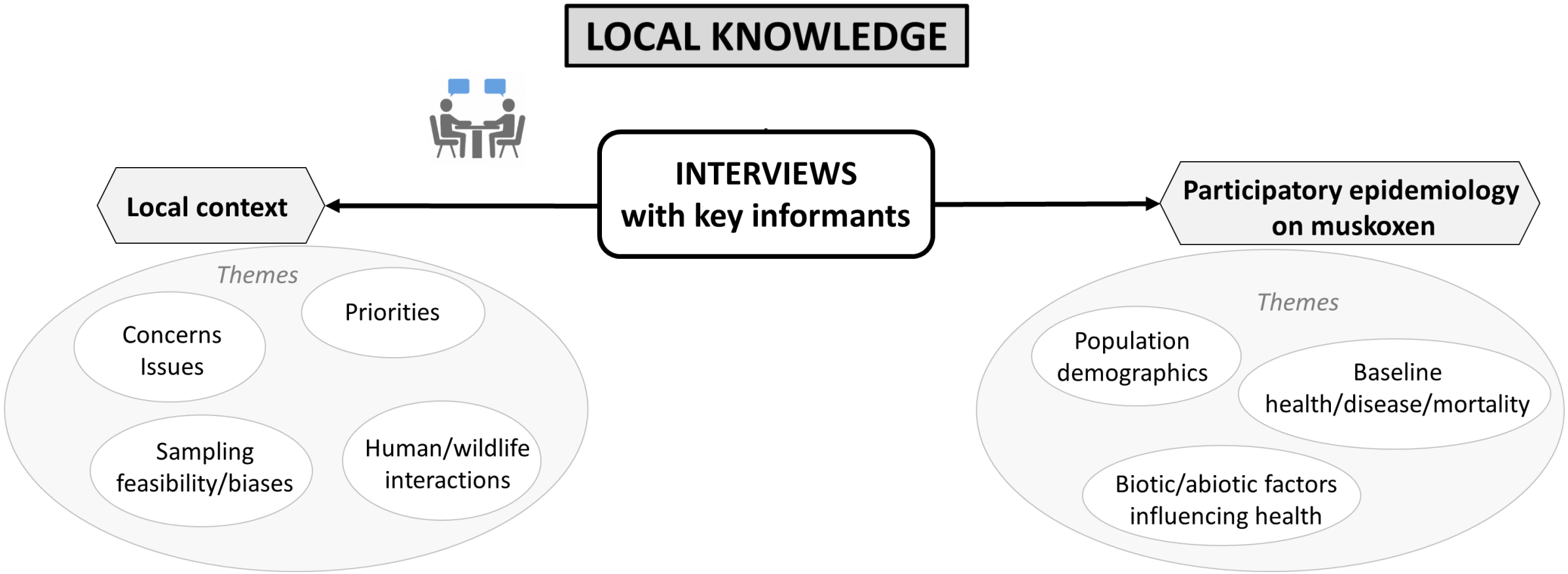
Collaborative work
to separate counters
proportionally

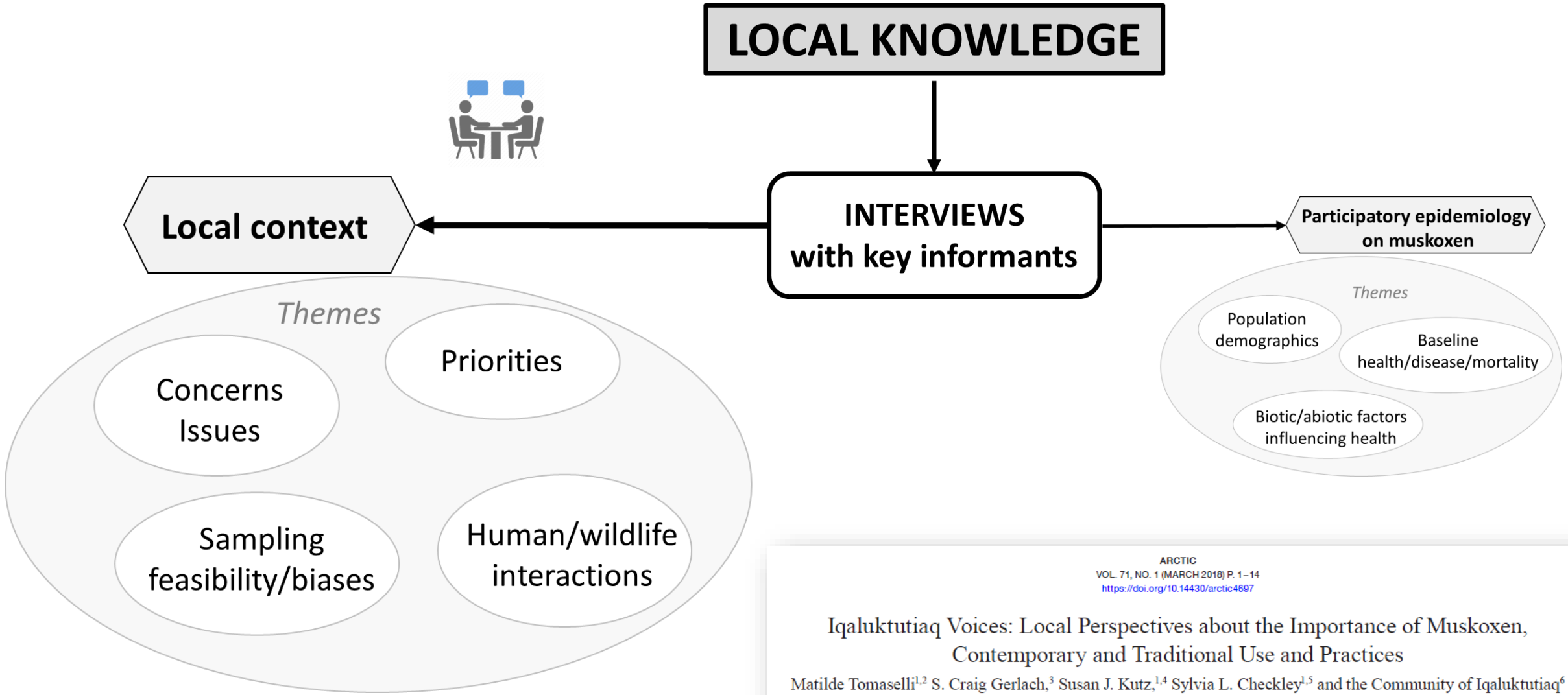
→

Measuring counters
to generate proportions

Tomaselli et al. *Biol Cons* (2018)

Surveillance activities implemented

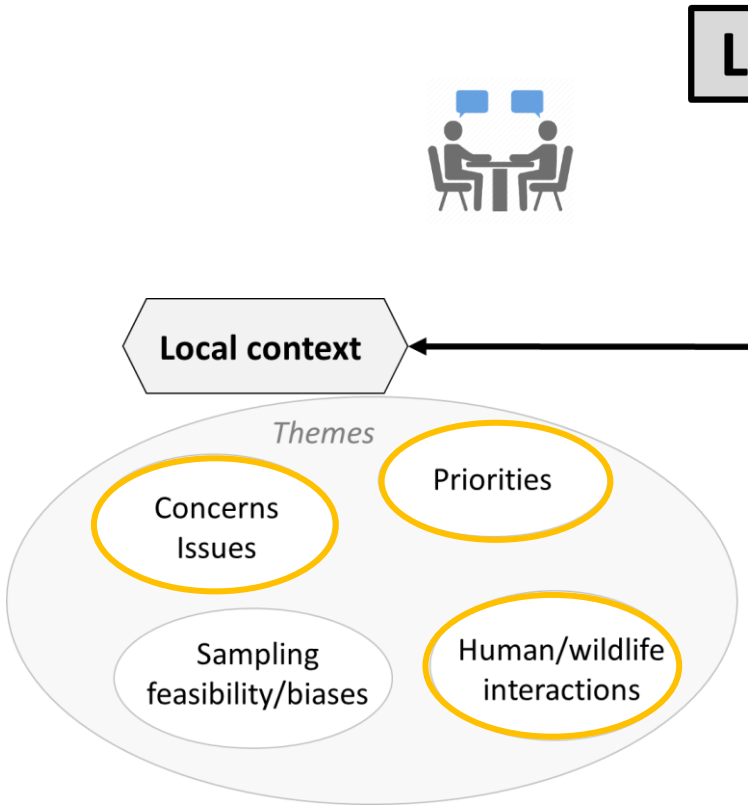




ARCTIC
VOL. 71, NO. 1 (MARCH 2018) P. 1–14
https://doi.org/10.14430/arctic4697

Iqaluktutiaq Voices: Local Perspectives about the Importance of Muskoxen, Contemporary and Traditional Use and Practices

Matilde Tomaselli[1,2] S. Craig Gerlach,[3] Susan J. Kutz,[1,4] Sylvia L. Checkley[1,5] and the Community of Iqaluktutiaq[6]



Platform for identification of problems and solutions

Local decline of caribou of Dolphin and Union herd

Loss of traditional harvesting/management practices

Interpretation of data on muskox health

Description of the different types of muskox harvests

Butchering methods, parts consumed, and cultural taboos

Public health risk mitigation

Interactions that can potentially increase pathogen transmission

Tomaselli et al. *Arctic* (2018)

Interviews to co-design the hunter-based sampling

LOCAL KNOWLEDGE

INTERVIEWS with key informants

Local context

Themes

- Priorities
- Concerns Issues
- Sampling feasibility/biases
- Human/wildlife interactions

co-design

HUNTER-BASED SAMPLING

SCIENTIFIC KNOWLEDGE

The hunter-based sampling has been implemented since 2014 and is still ongoing

Tomaselli M (2018, 2022)

LOCAL KNOWLEDGE

INTERVIEWS with key informants

Local context

Themes

- Concerns Issues
- Priorities
- Sampling feasibility/biases
- Human/wildlife interactions

Participatory epidemiology on muskoxen

Themes

- Population demographics
- Baseline health/disease/mortality
- Biotic/abiotic factors influencing health

Biological Conservation 217 (2018) 337–348

Contents lists available at ScienceDirect

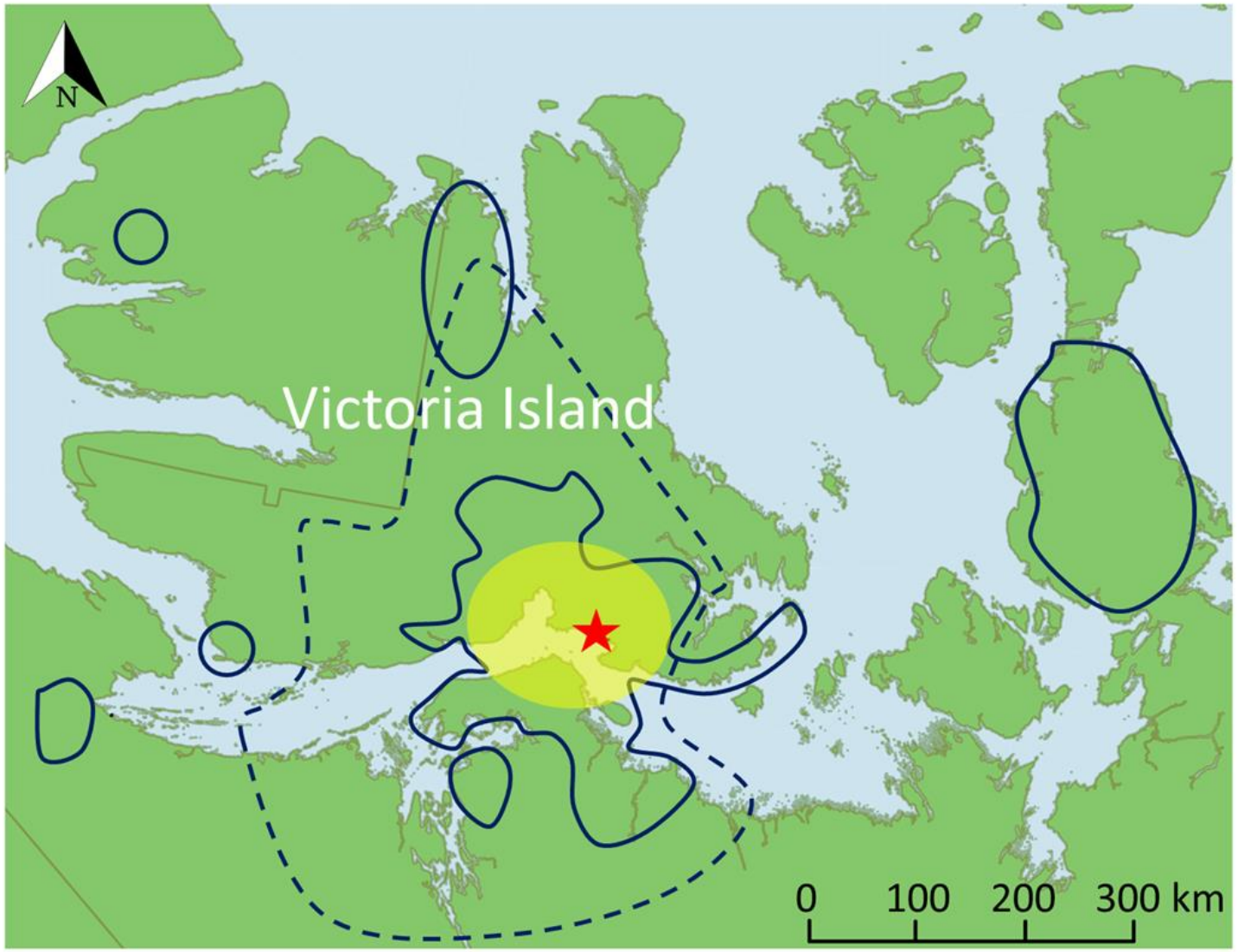
Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Local knowledge to enhance wildlife population health surveillance: Conserving muskoxen and caribou in the Canadian Arctic

Matilde Tomaselli[a,*], Susan Kutz[a,b], Craig Gerlach[c], Sylvia Checkley[a,d]

The spatial context



★ Cambridge Bay - Iqaluktutiaq

↑ data accuracy

Boundaries of the area observed

- - - - - from air (n=2)

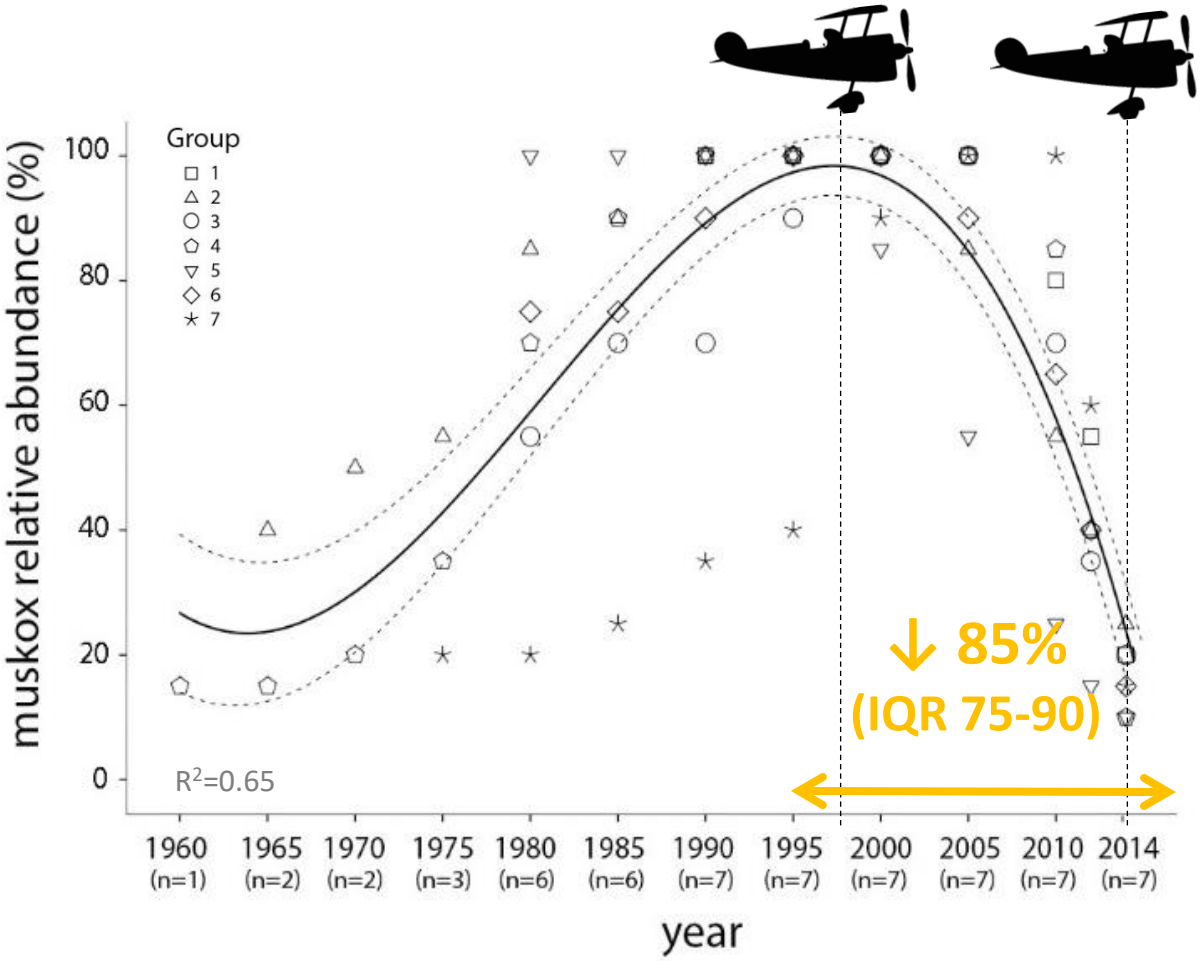
——— from land (n=22)

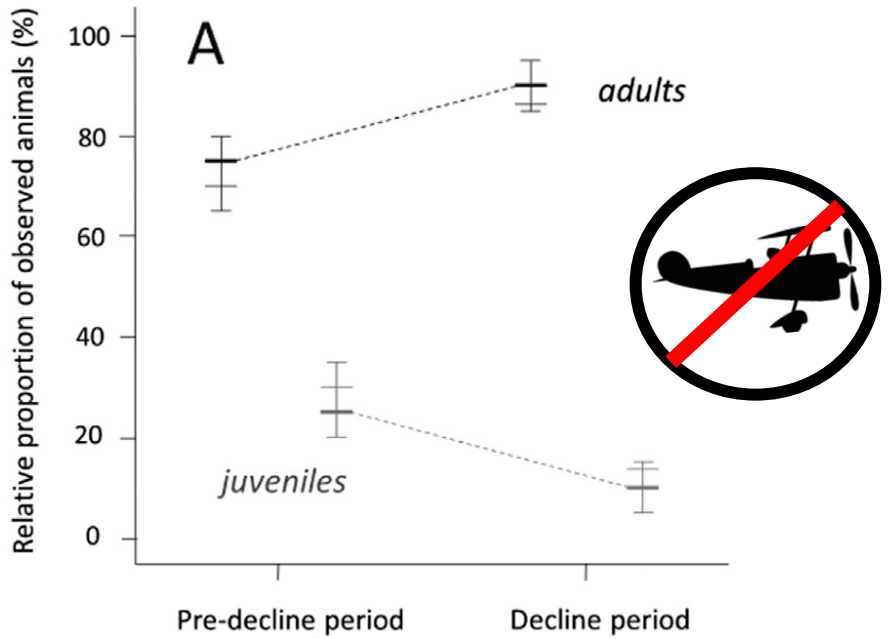
Tomaselli et al. *Biol Cons* (2018)

INTERVIEWS with key informants

Missing population trends

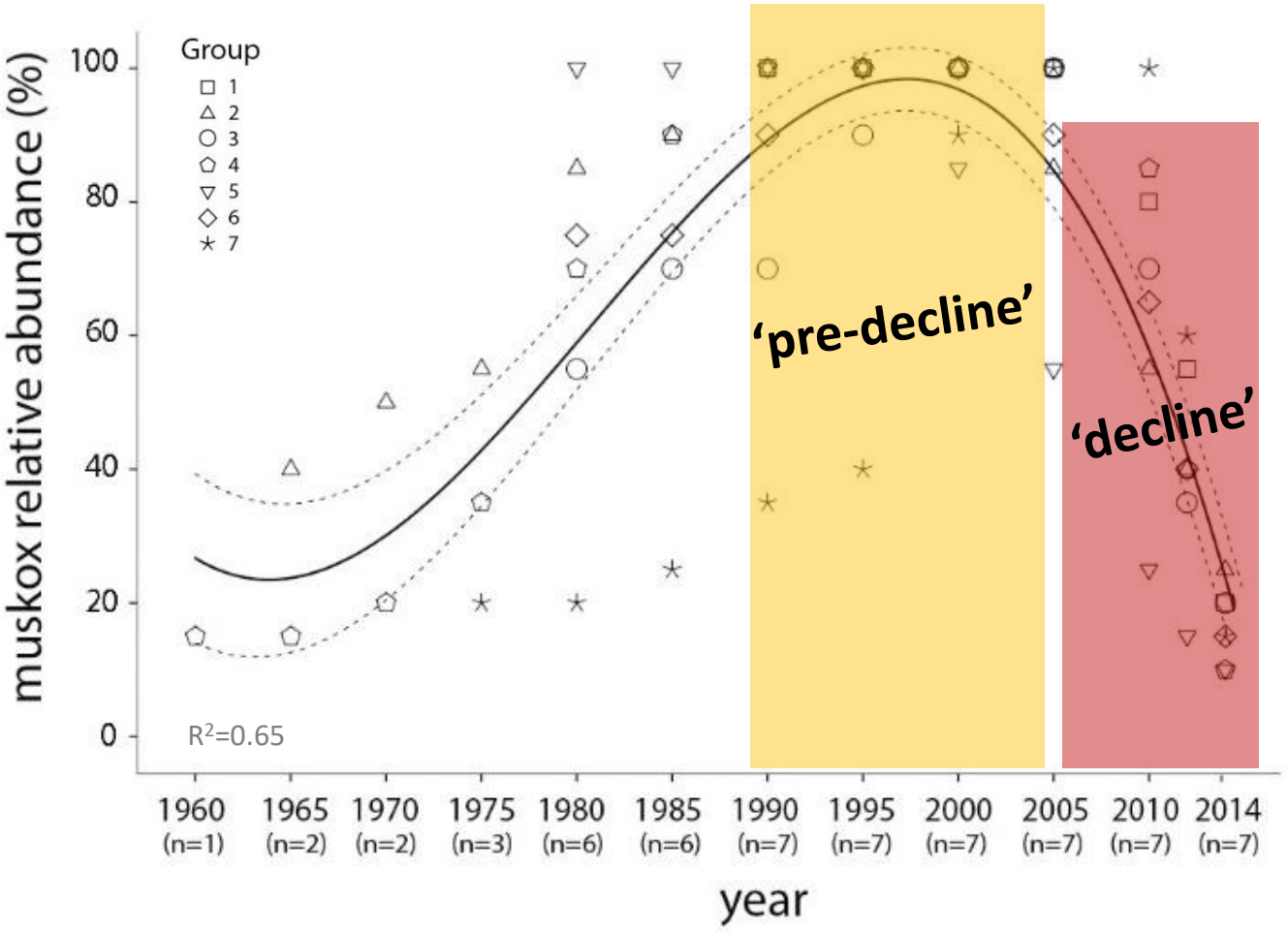
Participatory epidemiology techniques





Tomaselli et al. *Biol Cons* (2018)

Comparison between periods



From the 'pre-decline' to the 'decline' period

↓ proportion of young

↑ proportion of muskoxen in poor body condition

↓ size of herds and ↑ distance between herds

↑ observation of mortalities, including cases consistent with disease outbreaks

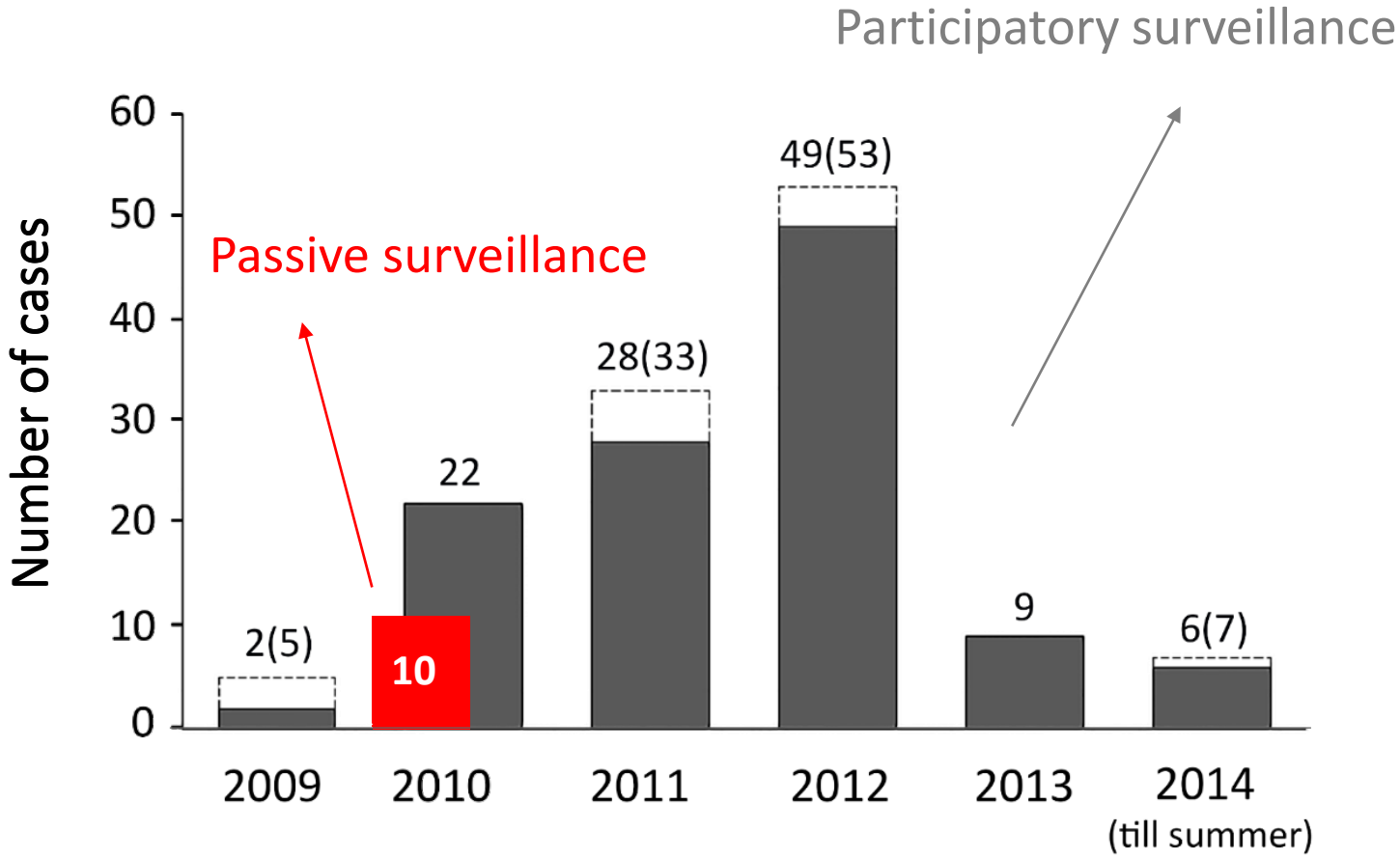
↑ trends of morbidity, including newly observed abnormalities

Tomaselli et al. *Biol Cons* (2018)

Mortalities consistent with disease outbreak

Photo credit S. Kutz

△ Cambridge Bay ● 2010



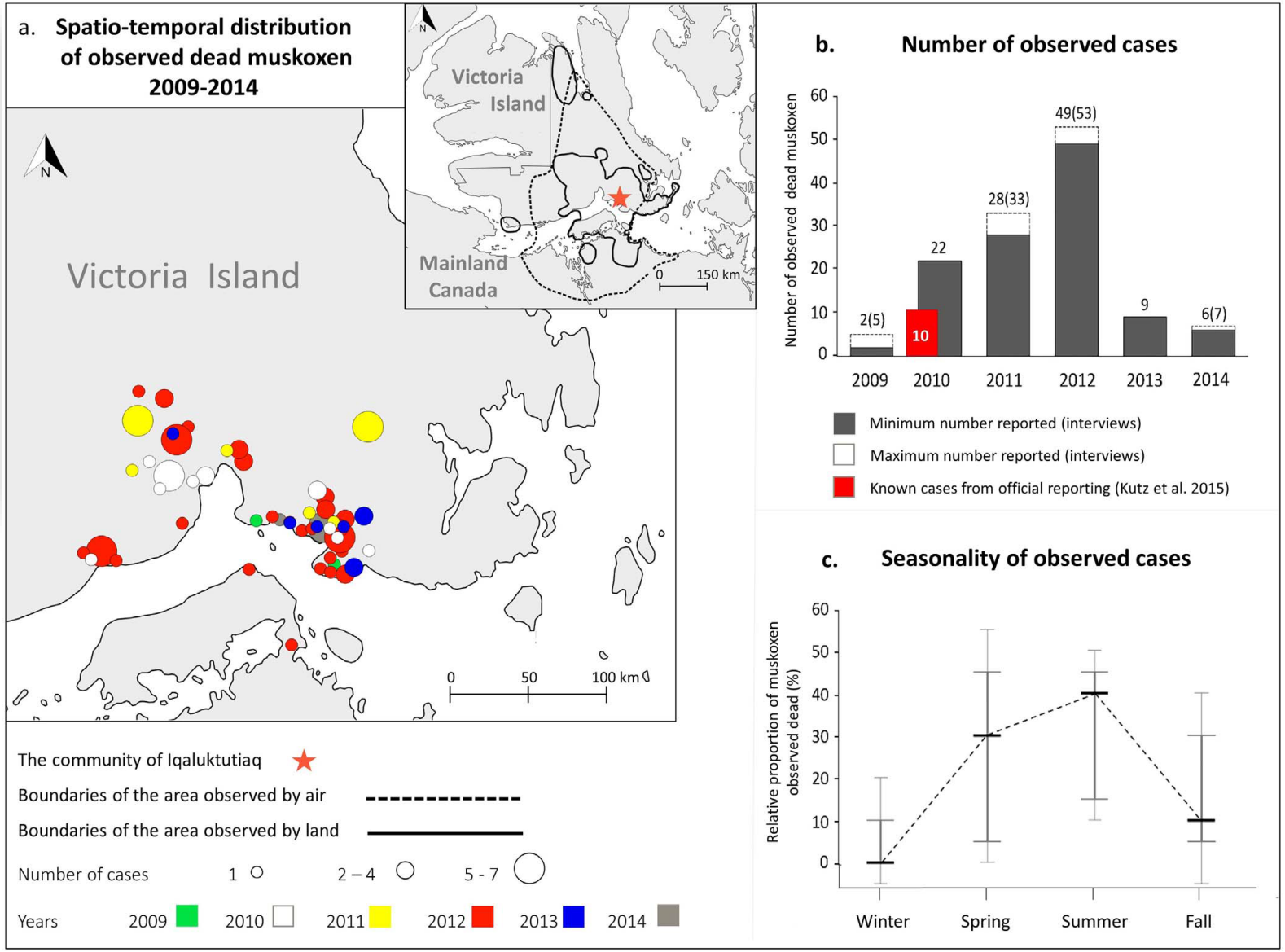
Tomaselli et al. *Biol Cons* (2018)

Mortalities consistent with disease outbreak

Participatory mapping

Timeline of events

Proportional piling



Tomaselli et al. *Biol Cons* (2018)

Baseline of morbidity

ALREADY NOTICED PRIOR THE DECLINE

Abscesses and traumas

White cysts in meat/heart

Swollen joints, limping animals

Sand paper disease

Warble larvae

→ Increasingly observed since mid-2000s

Liver cysts

Lung cysts (liquid and solid)

Hoof overgrown/infections

NEWLY OBSERVED SINCE THE DECLINE

Scabby lesions (nose and mouth)

White eyes – corneal opacity

Yellow color of subcutaneous tissue

Relative proportion
First observation
Trend

Tomaselli et al. *Biol Cons* (2018)

SCIENTIFIC KNOWLEDGE

HUNTER-BASED SAMPLING

FIELD DISEASE INVESTIGATIONS

TARGETED SCIENTIFIC STUDIES

Conventional surveillance activities

In this program these activities were informed by local knowledge e.g., logistics, targeting priorities, and data interpretation

Tomaselli M (2018, 2022)

Summer 2014

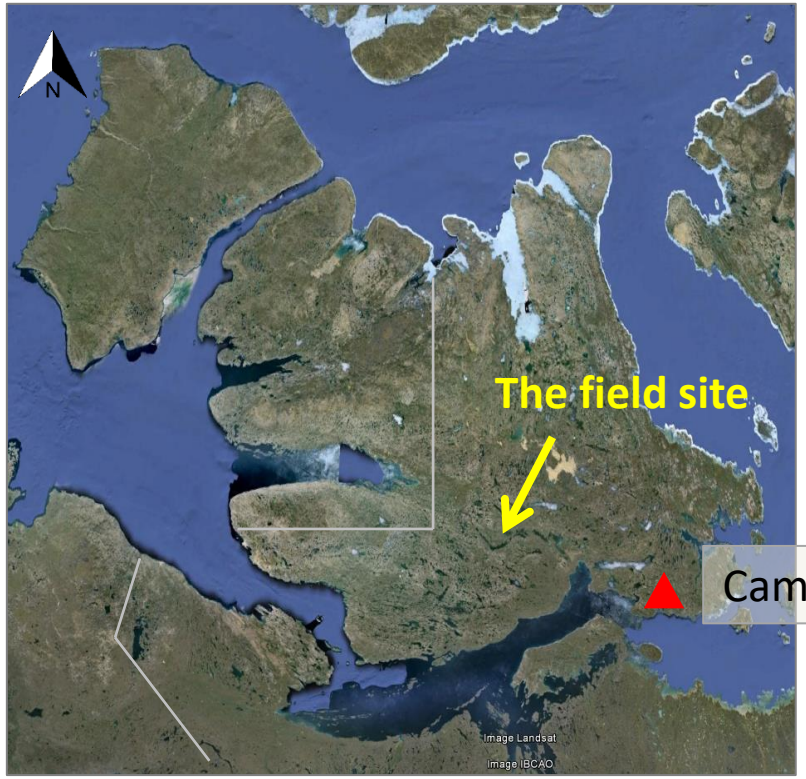
Photo credit G. Shuttleworth

Orf-like lesion observed
in one outfitted-hunted muskox

Tomaselli et al. *JWD* (2016)

Summer 2014

FIELD DISEASE INVESTIGATIONS



Tomaselli et al. *JWD* (2016)

Zoonoses

First time detection

2014

Contagious ecthyma

Orf virus

Rangiferine brucellosis

***Brucella suis* biovar 4**

Tomaselli et al. *JWD* (2016)

Orf-like lesions

Observed in 2004, 2008 in bulls

and in 2012 in a dead calf

Brucella-like syndromes

Noticed since the 1980s

↑ trend since mid-2000s

Tomaselli et al. *Biol Cons* (2018)

Interconnection between surveillance activities

INTERVIEWS with key informants

PE data on muskox health

↓ number of muskoxen since mid-2000s
↓ proportion of young
↑ *Brucella*-like syndromes since mid-2000s

FIELD DISEASE INVESTIGATIONS

Sport-hunted muskox - Summer 2014

Euthanized cow - Spring 2015

Isolation of *Brucella suis* biovar 4

HUNTER-BASED SAMPLING

+ Existing samples archives

TARGETED SCIENTIFIC STUDIES

Study to assess
Brucella exposure and infection in muskoxen

Tomaselli M (2018, 2022)

TARGETED SCIENTIFIC STUDIES

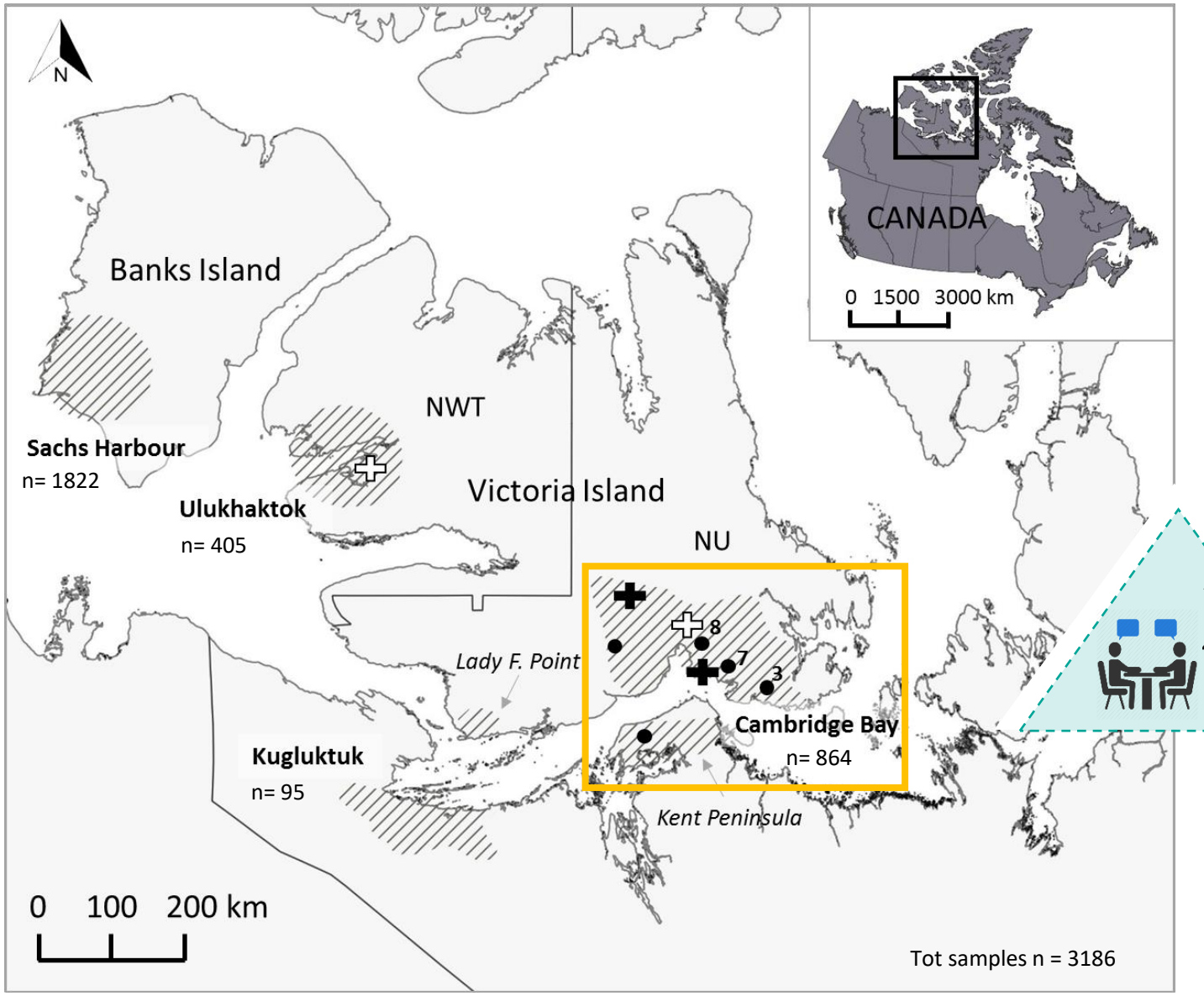
A Transdisciplinary Approach to *Brucella* in Muskoxen of the Western Canadian Arctic 1989-2016

Matilde Tomaselli,[1,2] Brett Elkin,[1,3] Susan Kutz,[1,4] N. Jane Harms,[5] H. Ingebjørg Nymo,[6] Tracy Davison,[3] Lisa-Marie Leclerc,[7] Marsha Branigan,[3] Mathieu Dumond,[7] Morten Tryland,[8] and Sylvia Checkley[1,9]

EcoHealth

\+ Samples archives

Assessing *Brucella* exposure and infection in muskoxen 1989-2016



Legend

- Sampled area
- Serology positive sample (*Brucella spp.*)
- Serology positive(*Brucella spp.*) and microbiology positive (*Brucella suis* biovar 4) sample
- Microbiology positive (*Brucella suis* biovar 4) sample

Cambridge Bay area

Multiple knowledge sources, including PE

↑ confidence in the results obtained

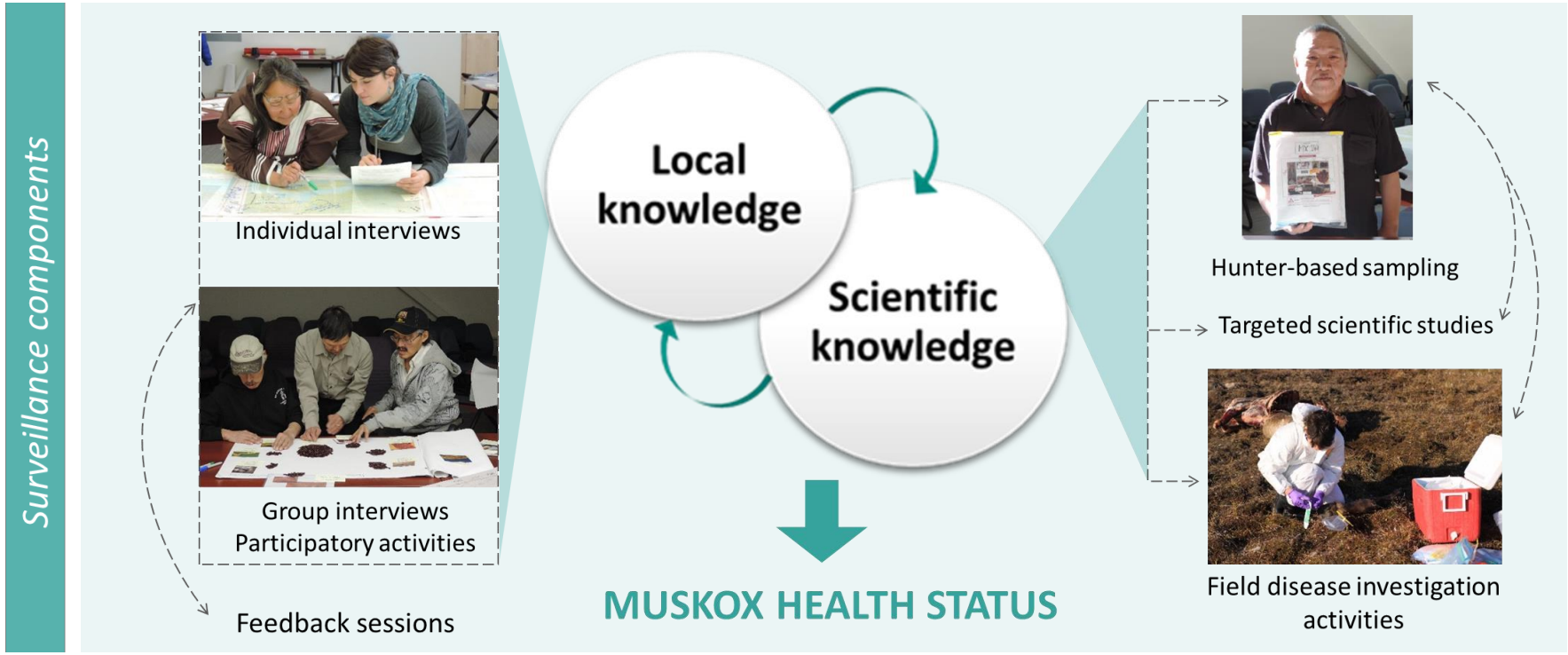
Cambridge Bay – serology data

↑ trend of *Brucella* exposure since the population peak of the late 1990s

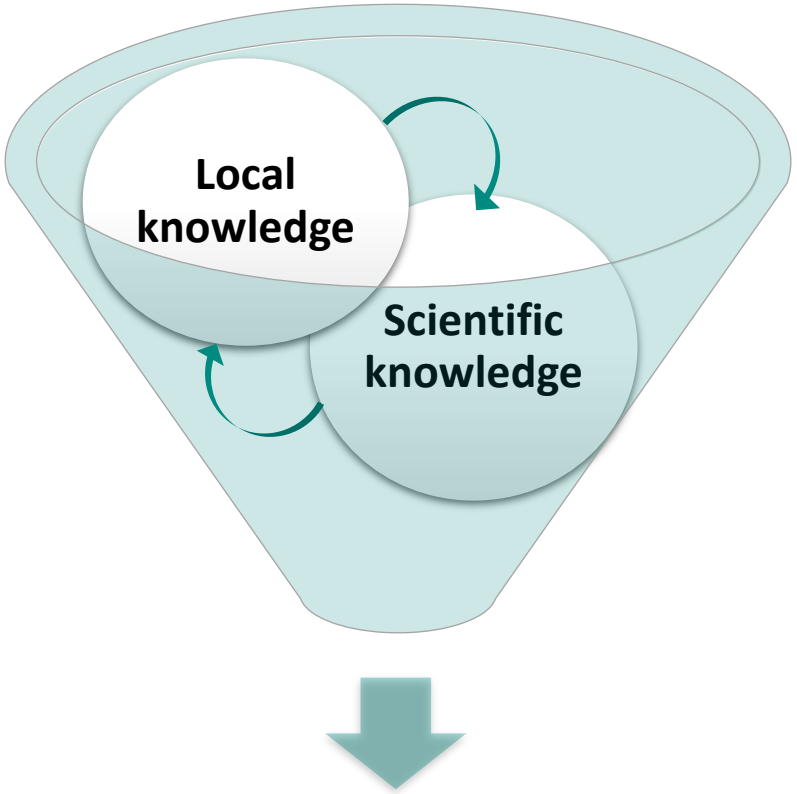
[from 0.9% (pre-decline) to 5.6% (decline)]

Tomaselli et al. *EcoHealth* (2019)

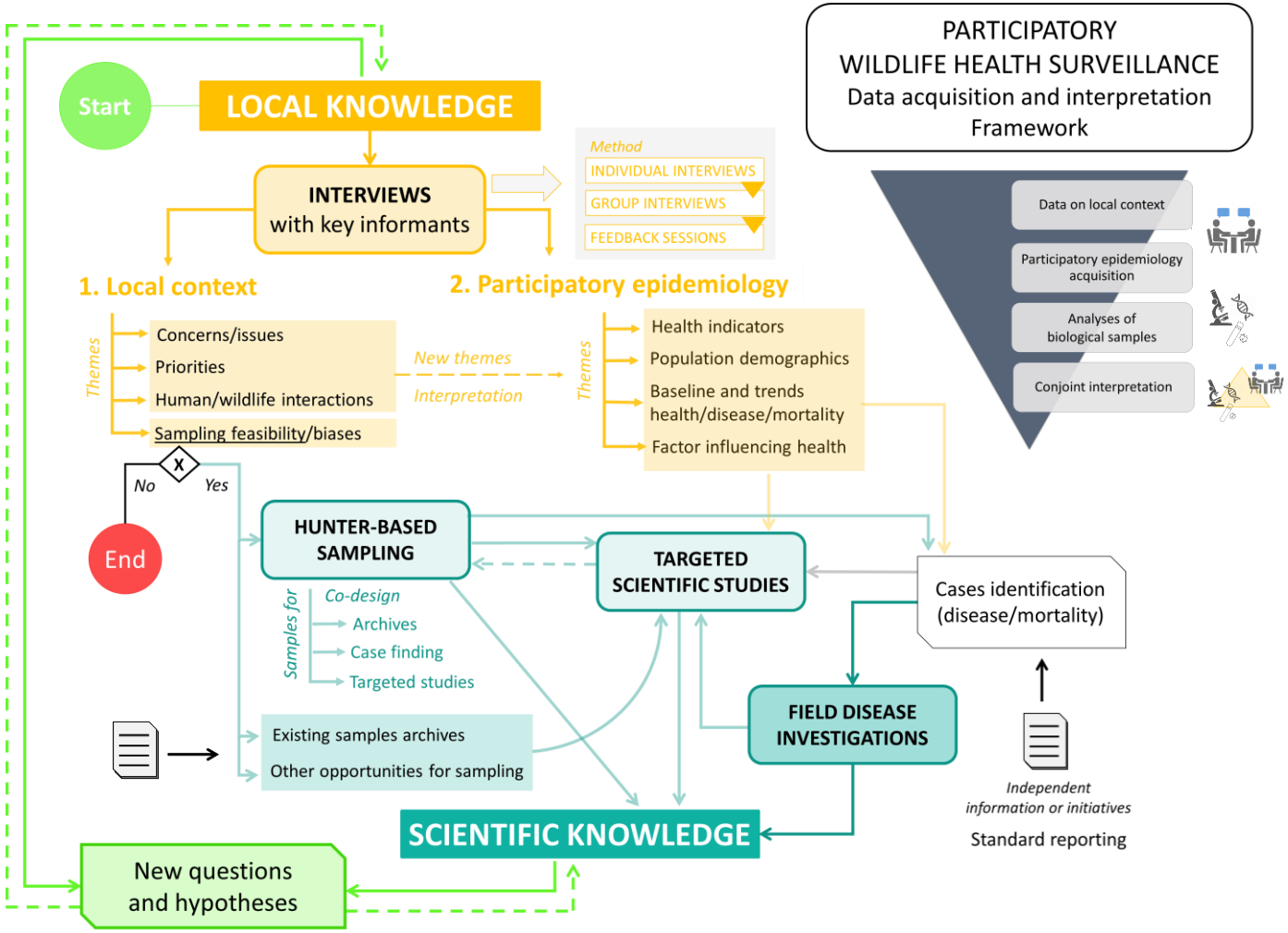
The participatory muskox health surveillance program



Adapted from Tomaselli M (2022) - Chapter 5, In: 'Wildlife Population Health'



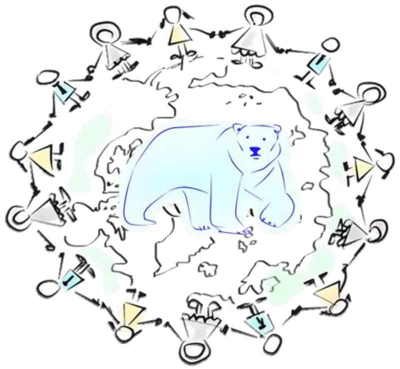
Participatory Wildlife Health Surveillance



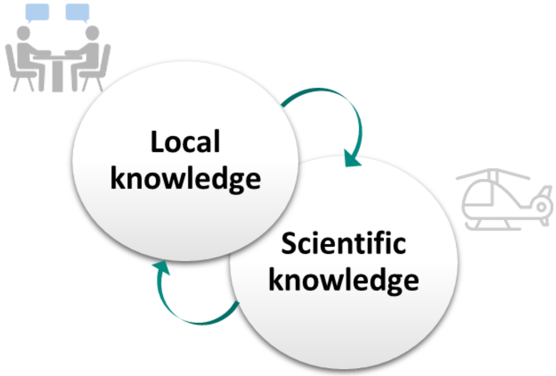
Assessment continuously made relevant to the local reality

Fig. from Tomaselli M (2022) Chapter 5, In: 'Wildlife Population Health'

Project team



Inuit knowledge on polar bear health



PE on polar bear health

Markus Dyck
ᒫᑲᔅ ᑎᒃ

Government of Nunavut
ᓄᓇᕗᒻᒥ ᒐᕙᒪᒃᑯᑦ

Matilde Tomaselli
ᒪᑎᐅᕐᑎ ᑐᒪᓯᐊᓕ

Polar Knowledge Canada
ᑲᓇᑕᒥᑦ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ
ᖃᐅᔨᒪᓂᖅᑲᖅᑐᓕᕆᔨᒃᑯᑦ

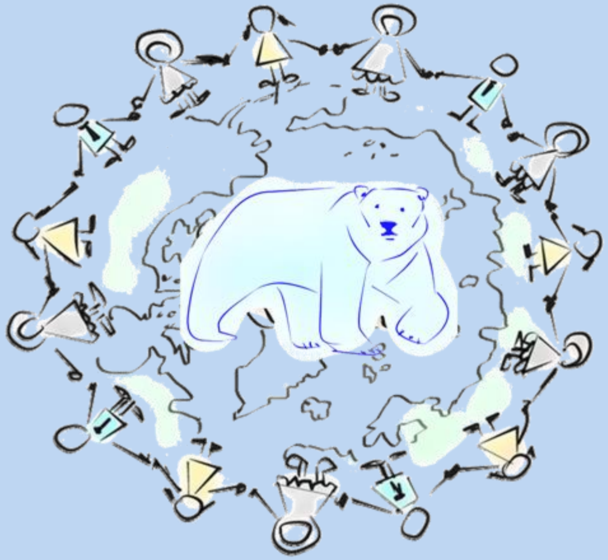
Dominique Henri
ᑖᒥᓂᒃ ᕼᐊᓄᕆ

Environment and Climate Change Canada
ᑲᓇᑕᒥᑦ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ
ᐊᒻᒪᓗ ᓯᓚᐅᑉ ᓯᔾᔨᖅᐸ

Evan Richardson
ᐃᕙᓐ ᕈᐃᑦᓱᑦᓴᓐ

Environment and Climate Change Canada
ᑲᓇᑕᒥᑦ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ
ᐊᒻᒪᓗ ᓯᓚᐅᑉ ᓯᔾᔨᖅᐸ

Hunters and Trappers Organizations



Naomi Akavak
ᓇᐃᐅᒥ ᐋᑲᕙᒃ

Kimmirut
ᑭᒻᒥᕈᑦ

Doreen Kanayuk
ᑑᕇᓐ ᑲᓇᔪᖅ

Pangnirtung
ᐸᓐᓂᖅᑑᖅ

Rosemary Kanayuk
ᕉᔅᒥᐅᕆ ᑲᓇᔪᖅ

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Pamela Wong
Trailmarks Systems
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Jasmine Ware
Government of Nunavut
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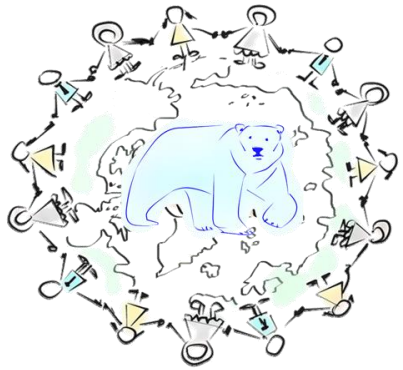
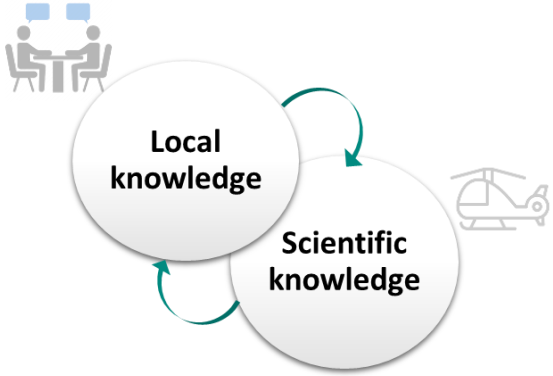
Pudloo Pisiulak
ᐸᑦᓗ ᐱᑦᓯᐅᓛᖅ

Kimmirut
ᑭᒻᒥᕈᑦ

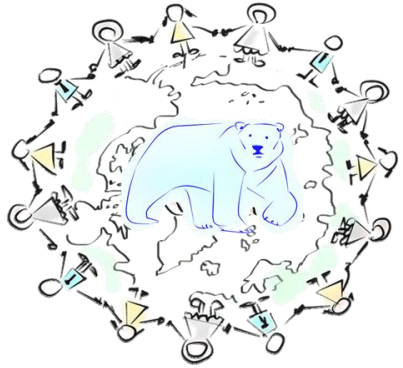


Inuit knowledge on polar bear health

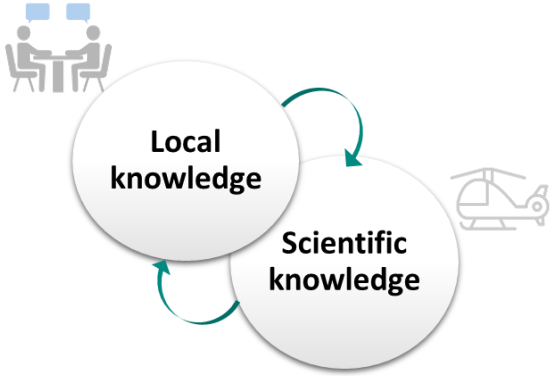


PE on polar bear health

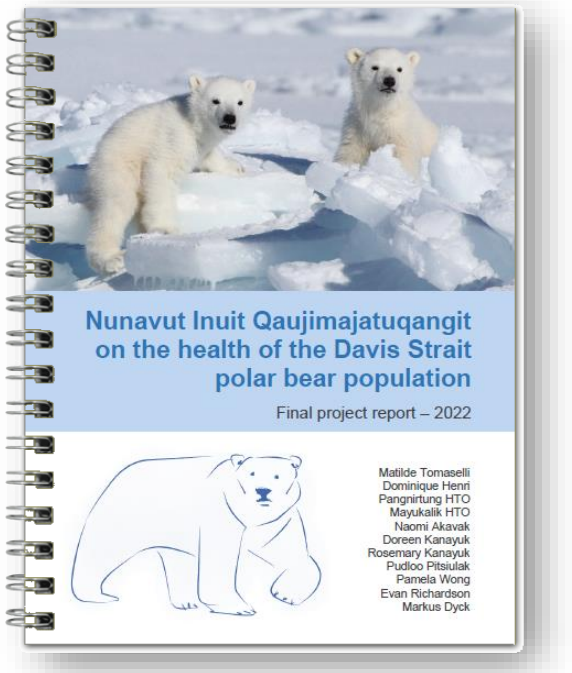
Jawlie Akavak – Sandy Akavak – Rosemary Allen – Joe Arlooktoo – Joannie Ikkidluak – Akulujuk Judea – Akeego Killiktee – Mikidjuk Kolola – Pitsiula Michael – Saimata Onalik – Eliyah Padluq – Ejetsiak Padluq – Jeannie Padluq – Kooyoo Padluq – Davidee Temela – Isaac Temela – Itee Temela – Leopa Akpalialuk – Meeka Alivaktuk Leesee-Mary Kakee – Peter Kanayuk Abraham Keenainak – Simeonee Keenainak – Michael Kisa – David Kooneeliusie – Lazarusie Ishulutaq – Johnny Mike Geetee Maniapik – Matiusie Maniapik – Davidee Nowyuk – Five anonymous contributors

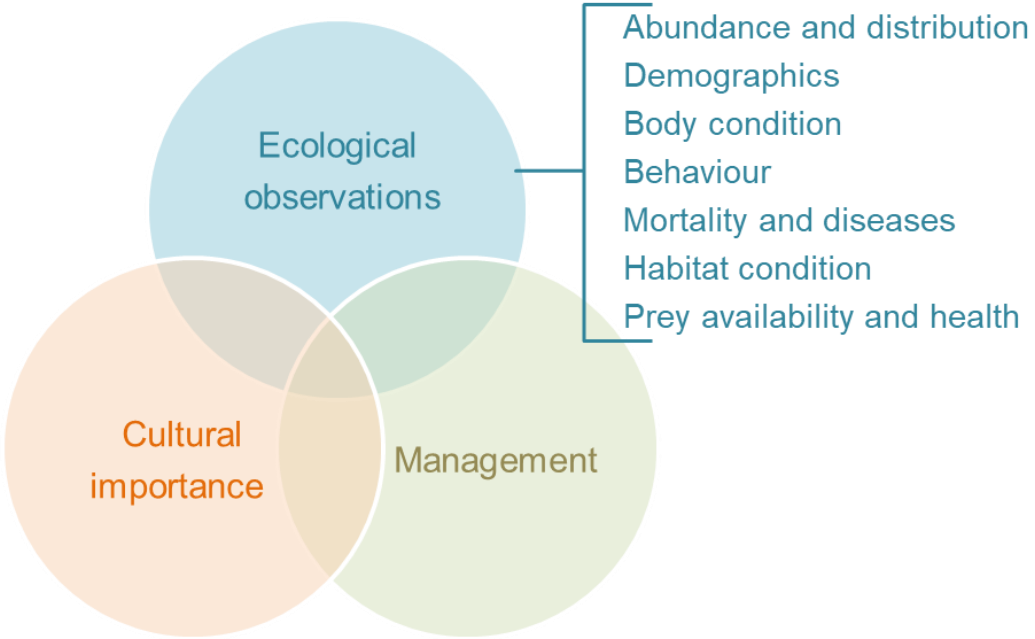


Inuit knowledge on polar bear health

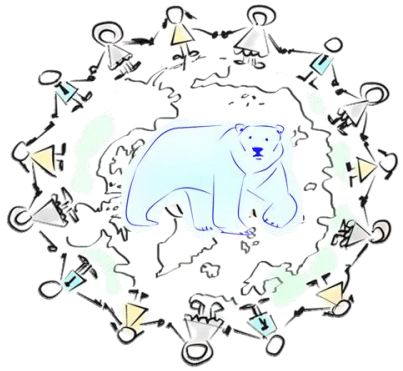


PE on polar bear health





Tomaselli et al. (2022)



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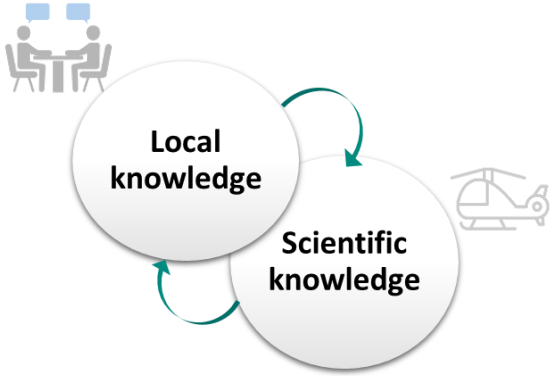
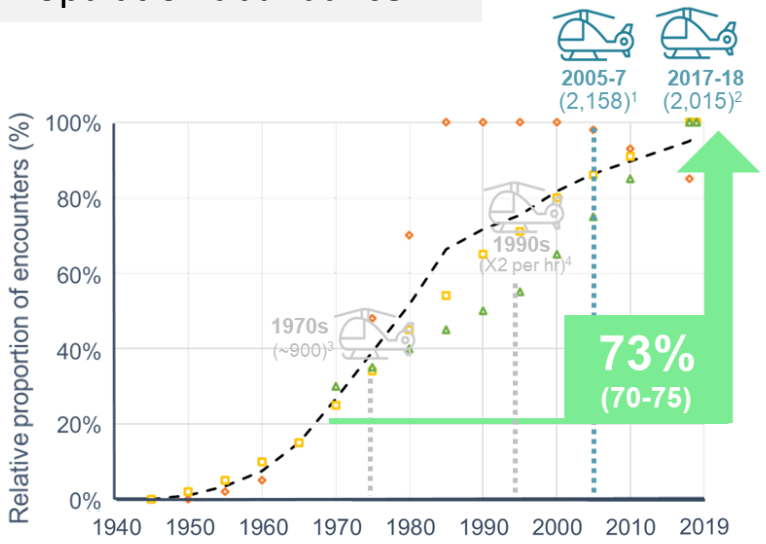
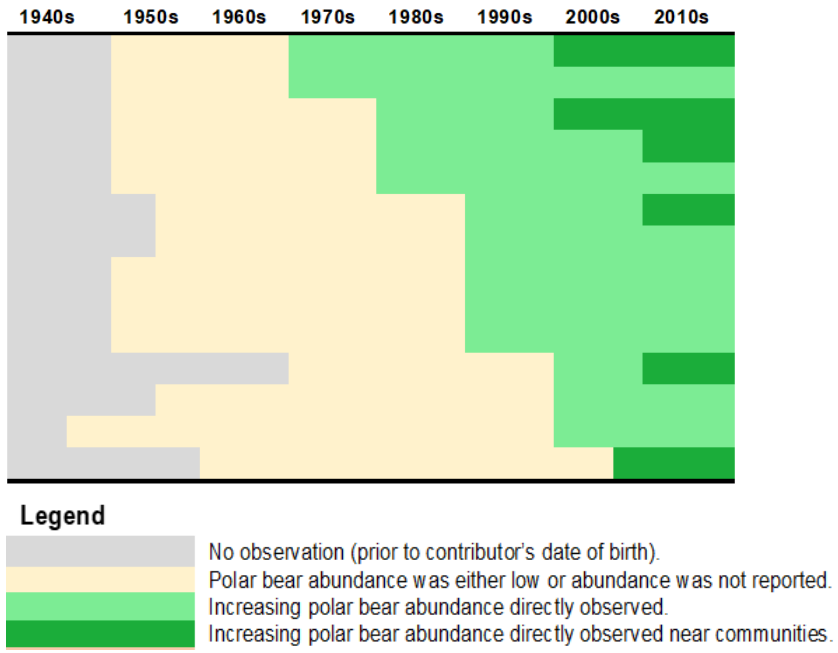


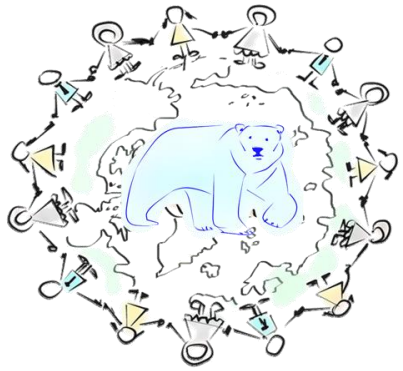
PE on polar bear health

Population abundance





Tomaselli et al. (2022)



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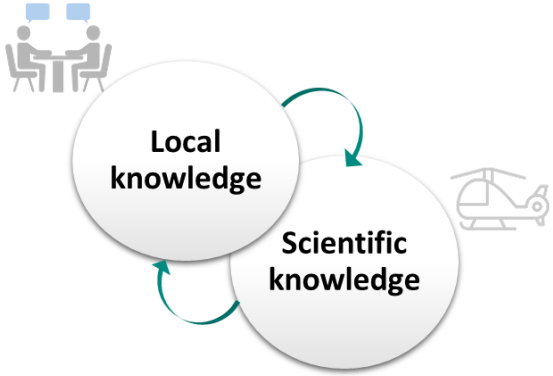

PE on polar bear health

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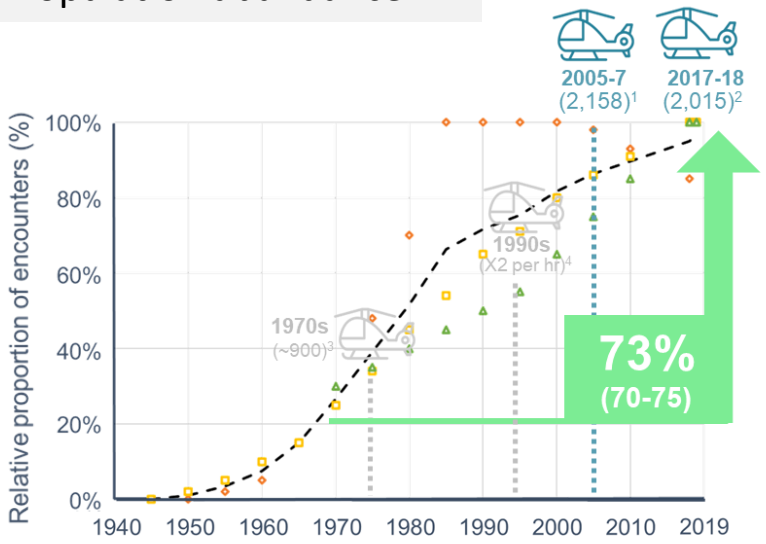
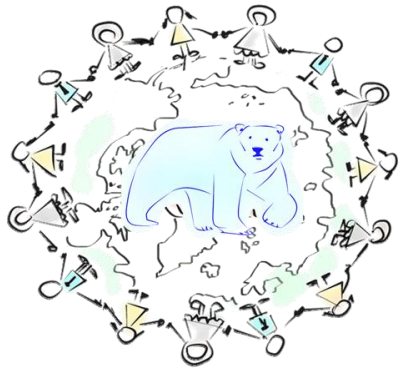
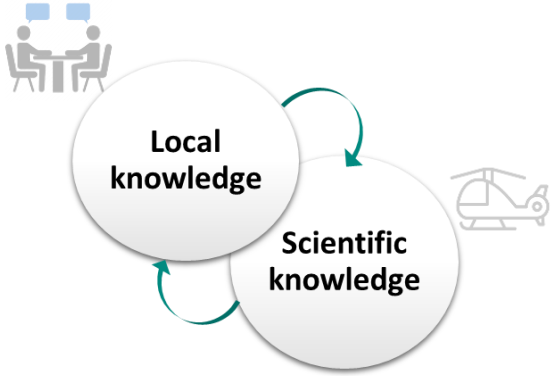


‘True’ vs. ‘Apparent’ increase ?

Tomaselli et al. (2022)



Inuit knowledge on polar bear health



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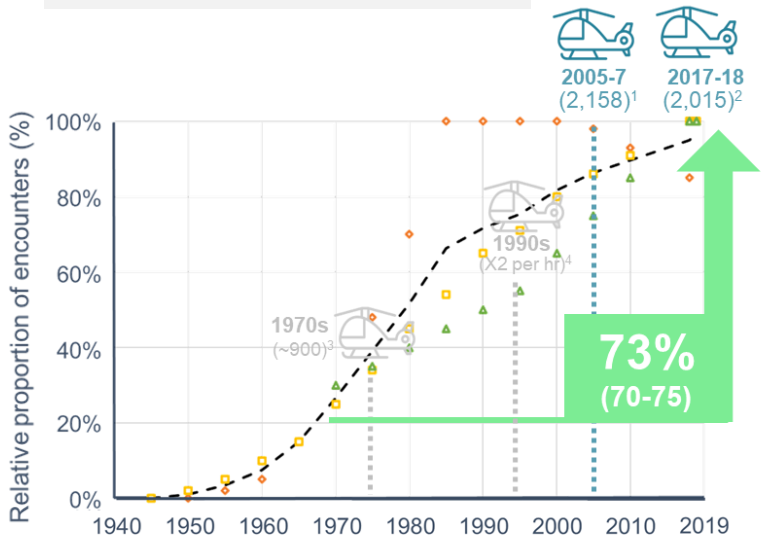
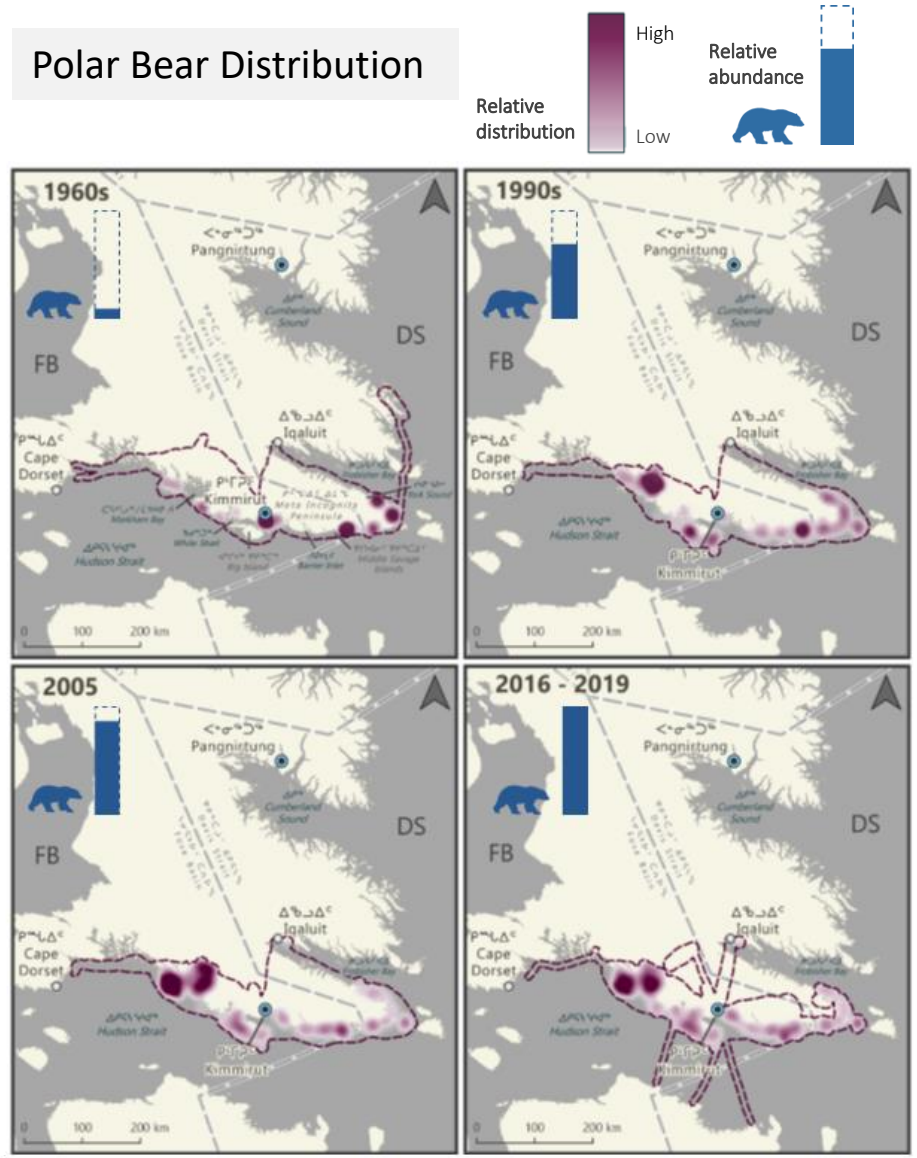
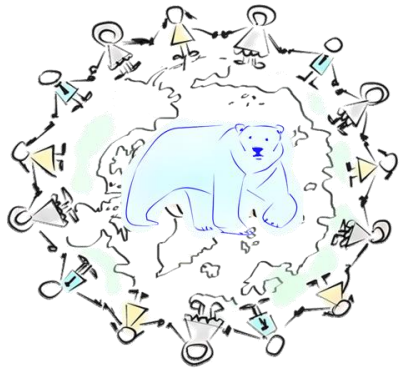


Proportional piling and mapping - timeseries

Polar Bear Distribution



Tomaselli et al. (2022)



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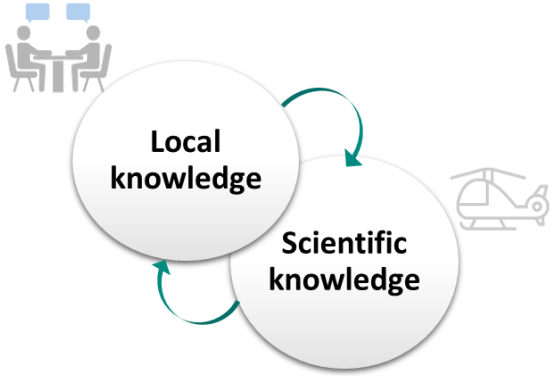

PE on polar bear health

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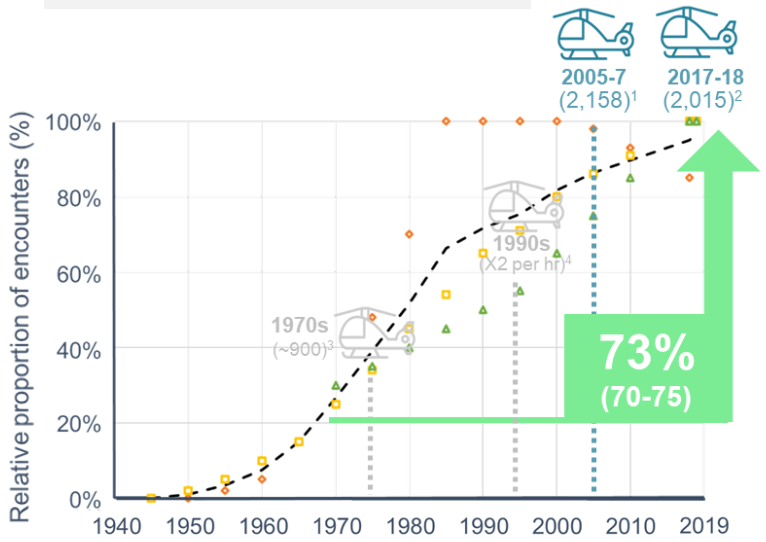
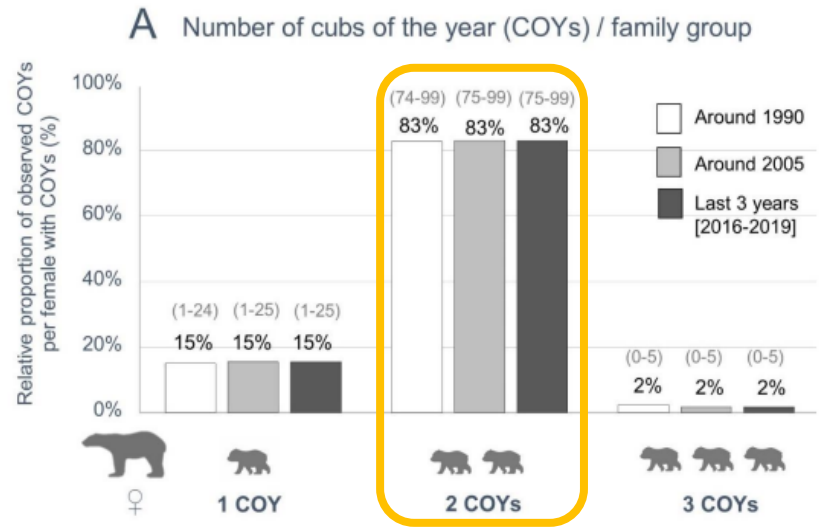
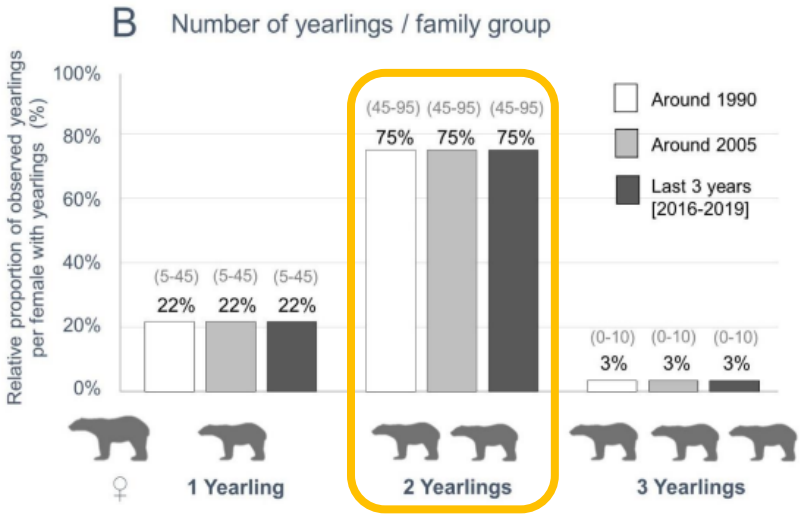


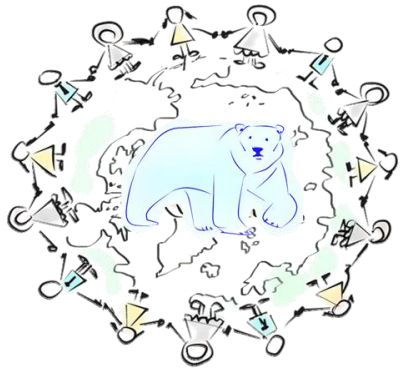
Proportional piling - timeseries

Demographics - productivity and survival

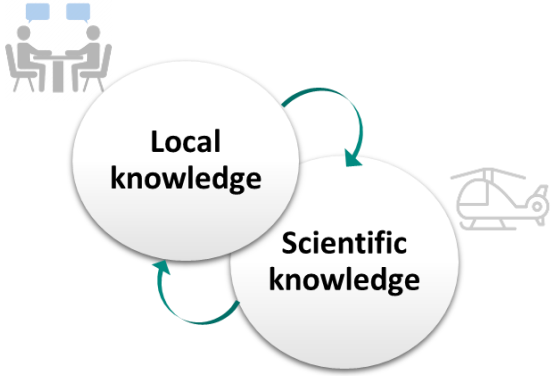




Tomaselli et al. (2022)



Inuit knowledge on polar bear health



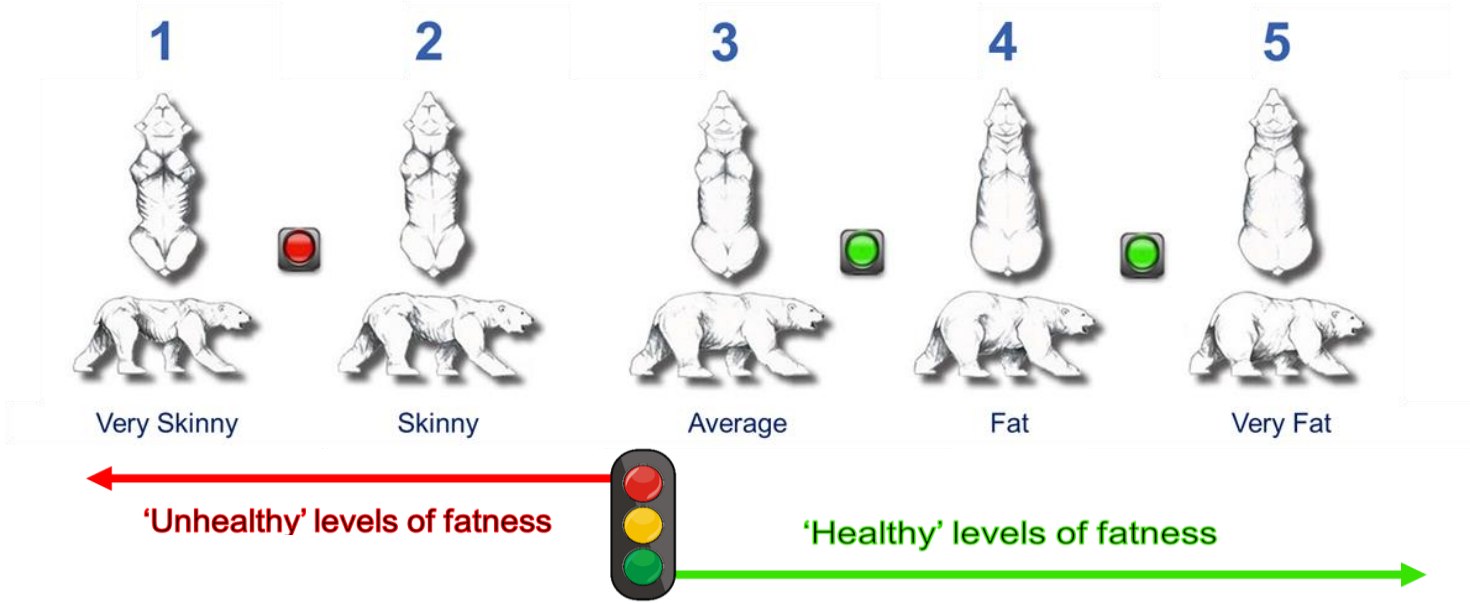
PE on polar bear health

Body condition status

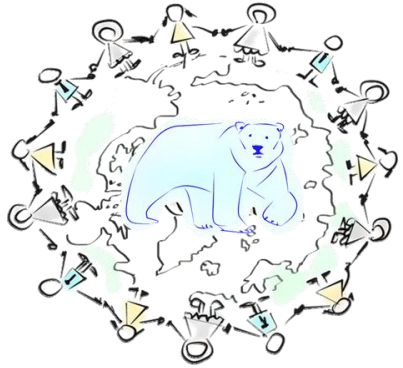
Individual interviews

≠

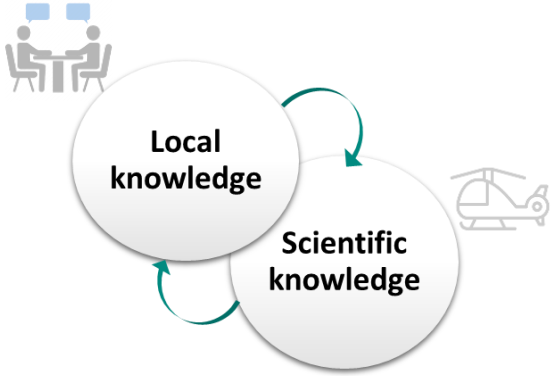
Proportional piling - timeseries



Tomaselli et al. (2022)



Inuit knowledge on polar bear health



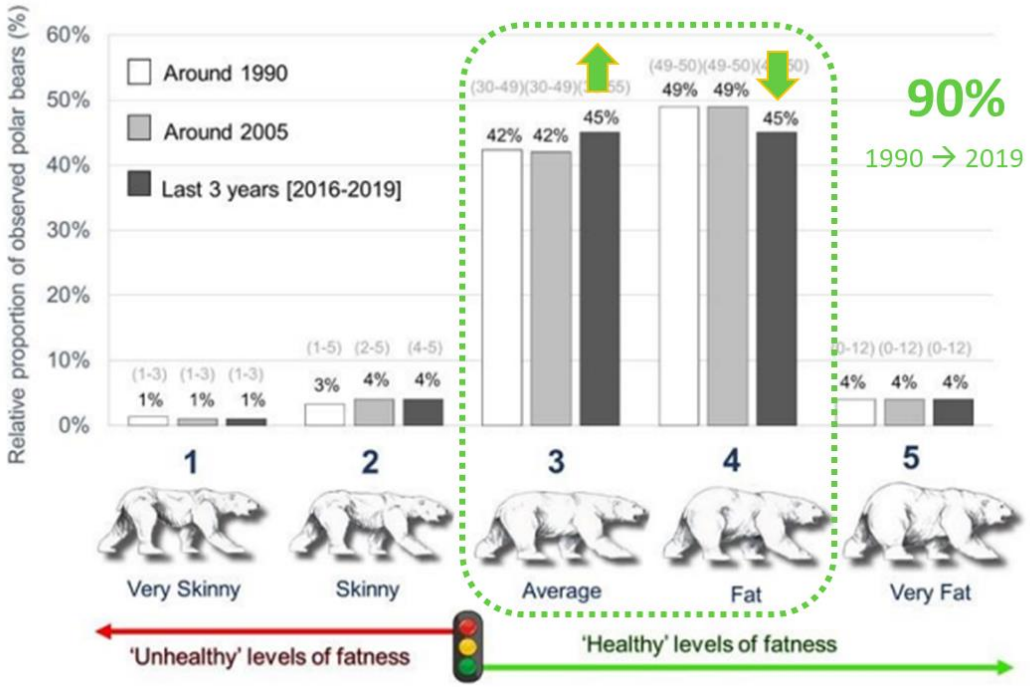
PE on polar bear health

Body condition status

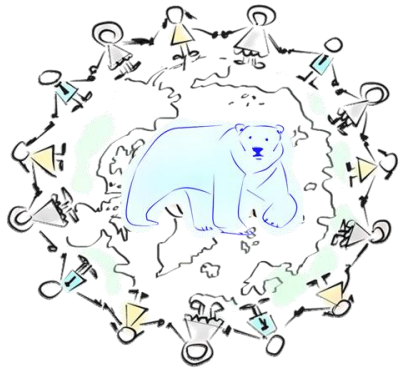
Individual interviews

≠

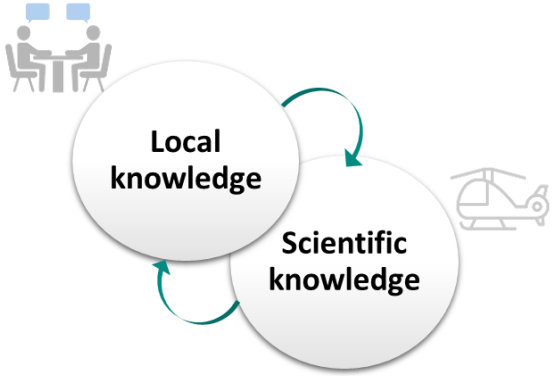
Proportional piling - timeseries



Tomaselli et al. (2022)

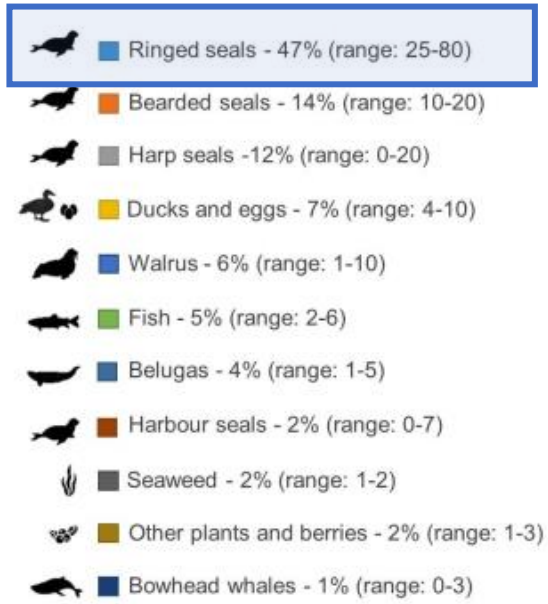


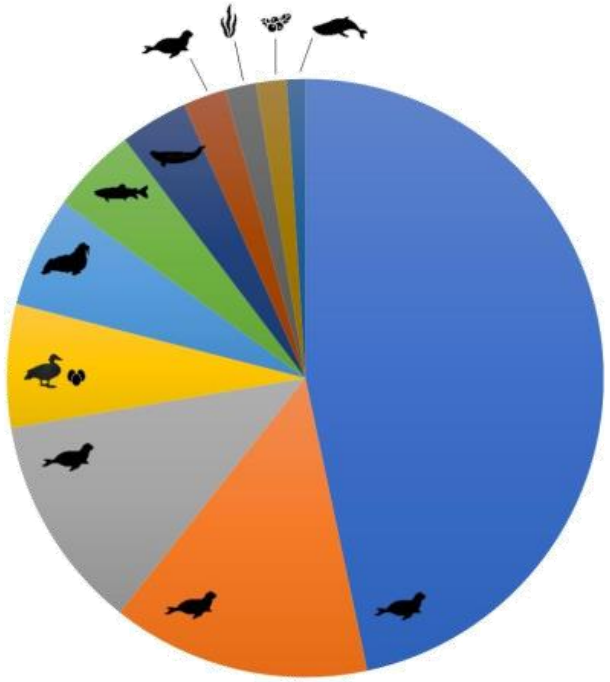
Inuit knowledge on polar bear health



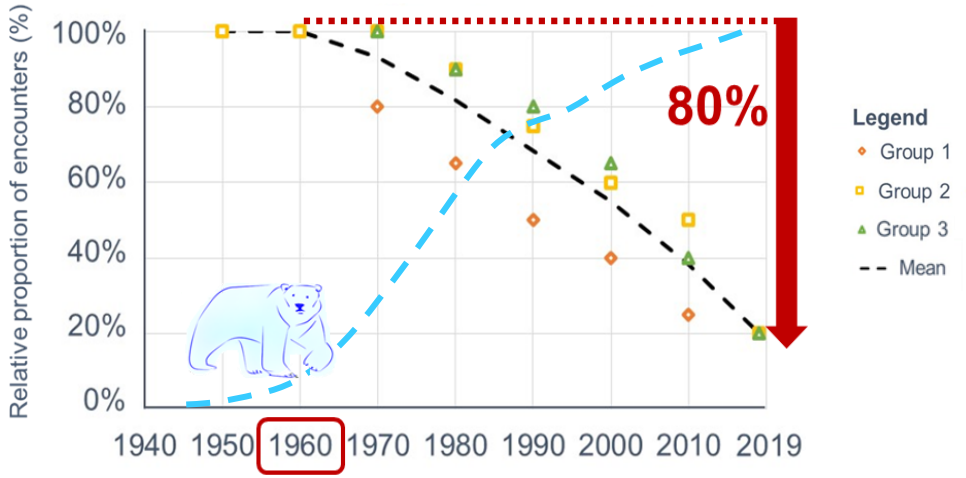
PE on polar bear health

Proportion of prey species / diet items





Availability / Abundance of main prey



Tomaselli et al. (2022)

Participatory wildlife health surveillance - added values

Trust

Identification of problems priorities and solutions

Ownership

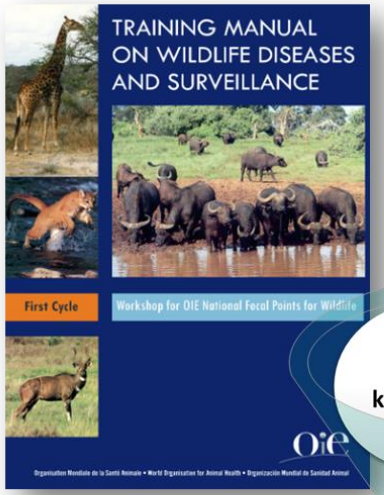
Empowerment

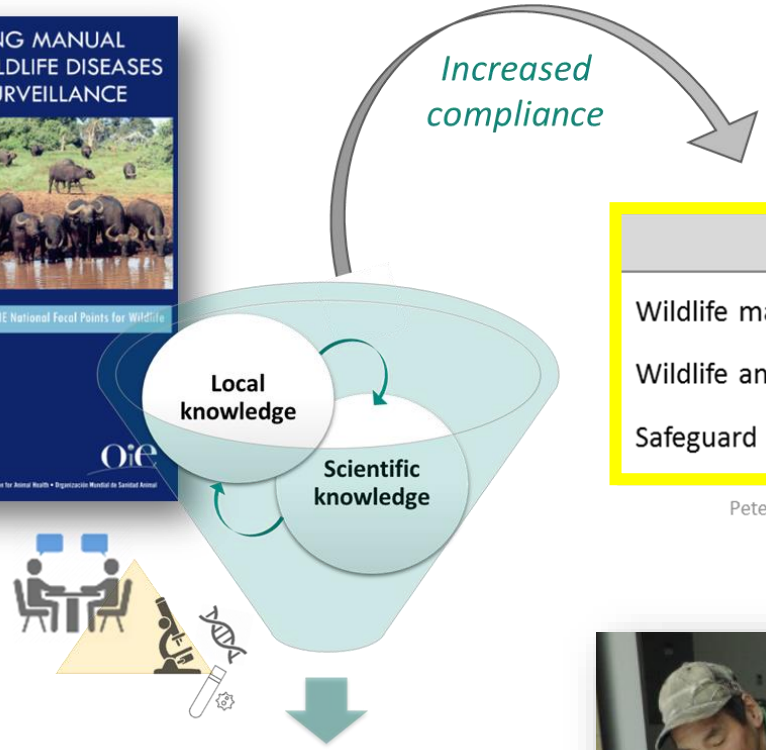
Co-management

Collaboration

James Haniliak & Eva Kakolak
Co-presenters at ArcticNet 2016

Participatory wildlife health surveillance - added values





Participatory Wildlife Health Surveillance

Interventions
Wildlife management (animals, habitat)
Wildlife and biodiversity conservation
Safeguard human and animal health

Peterson and Ferro 2007; Artois et al. 2009; OIE 2010

Trust

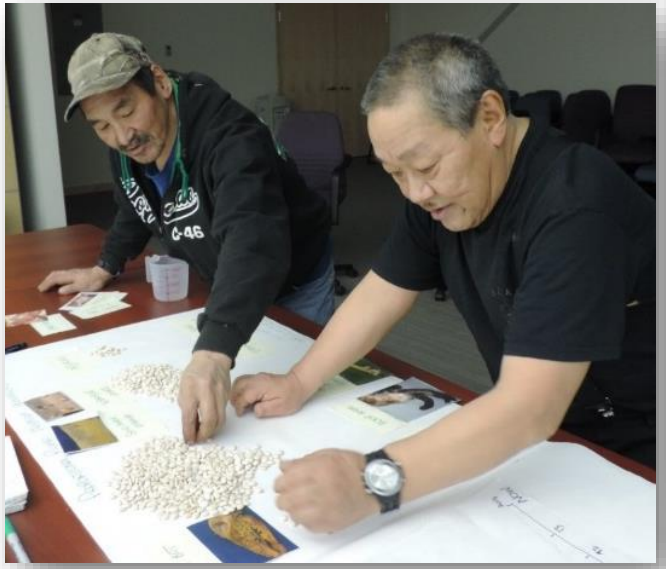
Identification of problems priorities and solutions

Empowerment

Co-management

Ownership

Collaboration



James Haniliak & Eva Kakolak
Co-presenters at ArcticNet 2016

Tomaselli M (2018, 2022)

Participatory widlife health surveillance: strengths

Participatory Wildlife Health Surveillance

Challenges from initial data aquisition and field data interpretation
Difficulties accessing the animals / finding cases
Lack of demographics for the target population
Lack of validated tests
Selection and measurment bias
Lack of representativeness
Logistical and financial restrictions

Stallknecht 2007; Wobeser 2007; OIE 2010; Ryser-Degiorgis 2012

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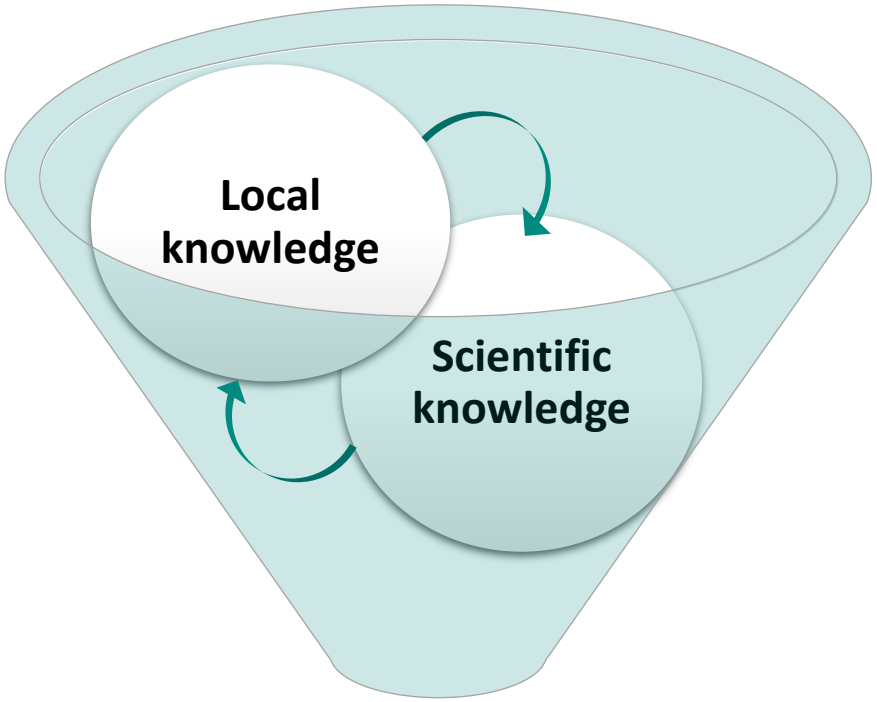


Participatory Wildlife Health Surveillance

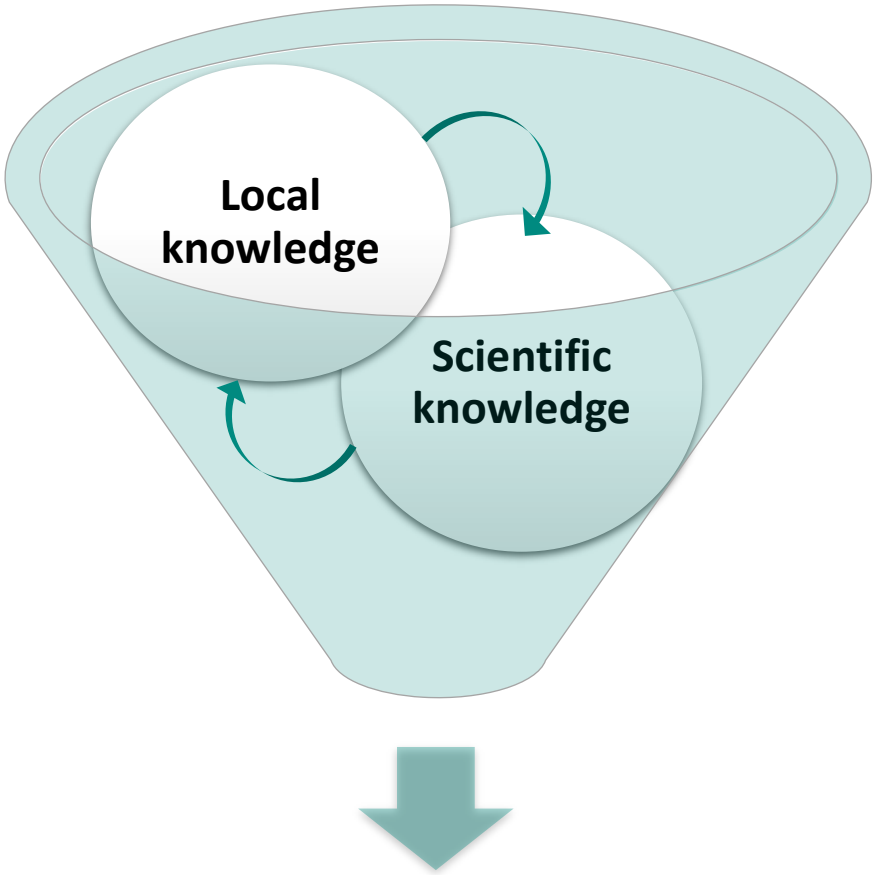
Strengths

- ✓ ↑ Reliability and accuracy of outputs
- ✓ ↑ Timeliness and sensitivity for identification of changes/issues
- ✓ Tracking health indicators real time, including demographics
- ✓ Improve design of conventional methods for assessment
- ✓ Better contextualization of scientific data (cross-sectional vs longitudinal)
- ✓ Pro-active and collaborative management rather than reactive response

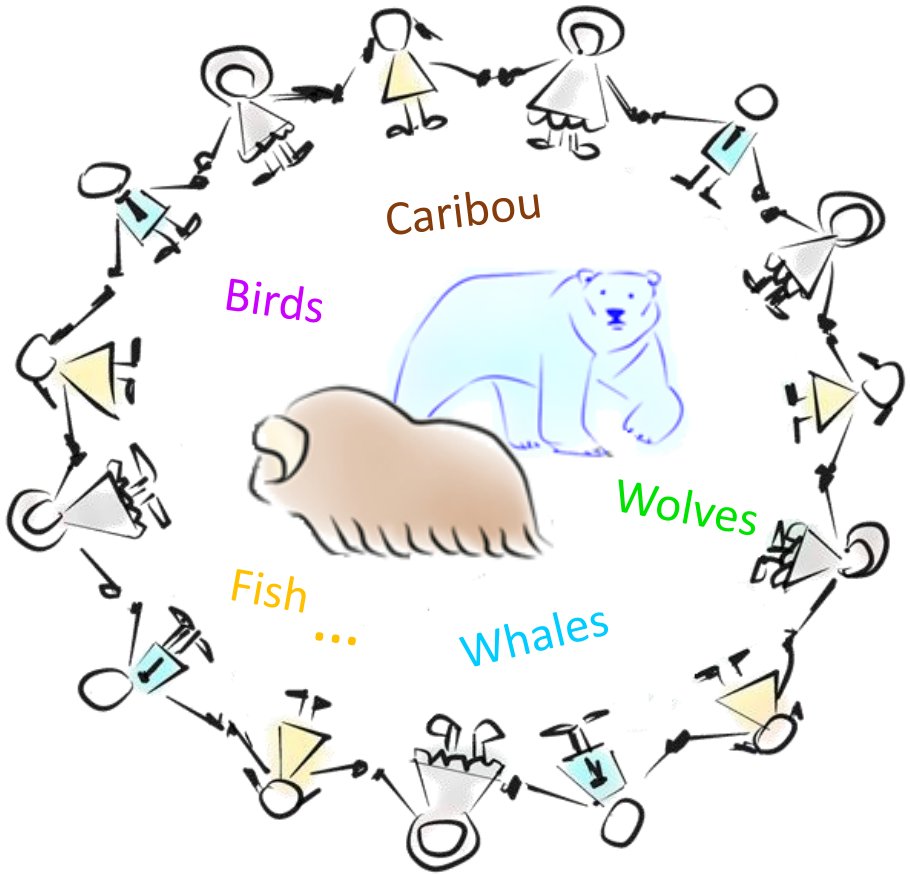
Challenges

- ✓ Considerable time commitments to build/maintain partnerships
- ✓ Willingness of local people to participate/share knowledge
- ✓ Project leader and team with transdisciplinary expertise (veterinary and social sciences)
- ✓ Cultural competence, teamwork and flexibility

Tomaselli M (2018, 2022)



Participatory Wildlife Health Surveillance



Promising approach to improve the veterinary surveillance capacity for wildlife in the Arctic and beyond

Tomaselli M (2018, 2022)

Peer-reviewed papers:

- Local knowledge to enhance wildlife population health surveillance: Conserving muskoxen and caribou in the Canadian Arctic. *Biological Conservation*, 2018
- Iqaluktutiaq voices: local perspectives about the importance of muskoxen, contemporary and traditional use and practices. *Arctic*, 2018
- "Two-eyed seeing" supports wildlife health. *Science*, 2019
- A Transdisciplinary Approach to *Brucella* in Muskoxen of the Western Canadian Arctic 1989–2016. *EcoHealth*, 2019
- Linking co-monitoring to co-management: bringing together local, traditional, and scientific knowledge in a wildlife status assessment framework. *Arctic Science*, 2020

Thesis and reports:

- Improved Wildlife Health and Disease Surveillance through the Combined Use of Local Knowledge and Scientific Knowledge. PhD thesis, 2018
- Nunavut Inuit Qaujimajatuqangit on the health of the Davis Strait polar bear population. Final project report, 2022

Book Chapters:

- Wildlife health and disease surveillance. In: Veterinary Laboratory & Field Manual, SC Cork, R Halliwell Eds., 2019
- Participatory epidemiology and surveillance for wildlife health. In: Wildlife Population Health, C. Stephen Ed., 2022
- Stakeholder Engagement for Collaborative Wildlife Health Management. In: Wildlife Population Health, 2022
- Wildlife Health Surveillance in the Arctic. In: Arctic One Health, M. Tryland Ed., 2022

THANKS FOR YOUR ATTENTION!

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