



number are being discussed. Participants can be sent to breakout rooms, and perhaps the largest benefit, is that participants are able to see one another face to face during these heady interactions. We suggest that this format is preferable to a strictly telephone based meeting structure, and does not detract from the current plan, only augments it with an additional and slightly more appropriate level of engagement.

2. The NIRB's August 25, 2020 correspondence indicates that "simultaneous English and Inuktitut interpretation will be provided to the extent practicable", however we advise that English and Inuktitut interpretation are a requirement for our participation.
3. Given the highly technical nature of the discussions, we request that the NIRB consider extending the agenda and lessening the number of hours in session each day. This will give opportunity for parties to make connections after the formal meeting closes each day to caucus on items of interest, and return the following day having had time and space for these important discussions to take place. We suggest a 3/4 day format - beginning at 8:00 MT as planned, and ending at 2:00 MT, also keeping the NIRB's proposed 15 minute health and 1 hour lunch breaks. This would mean extending the Technical Meeting agenda to include 2-4 additional days over the following week.

With regard to comment on the **Draft Technical Meeting Agenda** provided August 25, 2020, we provide the following comments:

1. We have concerns with the amount of time allotted to Baffinland - the entire first day is dedicated to its update presentations, and the agenda provides for it to make presentations at the start of each topic and sub-topic. We have had experiences where Baffinland extends its presentation window to the point where the time available for questions and comments from parties is significantly limited. We request that NIRB provide clear guidance to Baffinland in terms of its presentations, that these focus on issues presented by intervenors, commitments made to address outstanding issues, resolution status, and any next steps. We also ask that during the meeting, the NIRB be conscientious of this issue, and ensure the presentations are kept within the designated time windows.
2. The recent Marine Workshop held in Pond Inlet extended past the meeting time, leaving some intervenors without an opportunity to present questions and concerns for the benefit of members of the public in attendance. The NIRB has suggested it would allow time at the Technical Meeting for those agencies to make presentations.

We are concerned that the Technical Meeting agenda is already full, and suggest that additional time be built in to a 5th day to provide an opportunity for those agencies not having had a chance to present their questions and comments to the NIRB and Baffinland, to do so.

The Marine Workshop was recommended by the Responsible Ministers to promote discussion of current operations and concerns with monitoring, whereas the Technical Meeting is a venue for consideration of impacts and assessment of proposed Phase 2 activities - these are distinctly different, and we suggest it best to maintain the necessary separation between them. We note the Agenda for Day 2, item 2 (b) (i) provides for a Marine Workshop update - it is not clear whether this is the opportunity provided for parties to raise questions and concerns from the workshop or whether there was another session that would take place. Again, we suggest this be separated out from the Technical Meeting.



We are concerned that members of the public will not be present to hear these questions and comments, and will not have an avenue to raise questions for the Board's consideration. The Ministers' recommendation for the NIRB to host annual marine workshops in Pond Inlet indicated that doing so "would allow for direct involvement of the community in the review of project monitoring data, including but not limited to information collected under community based monitoring programs."<sup>1</sup> As mentioned by our technical advisor on the teleconference, James Simonee and Vincent L'Herault had requested the details to call in and participate, but had not received the coordinates and were unable to do so. Mr. Simonee and Dr. L'Herault have been collaborating on marine and freshwater community based monitoring projects for the past number of years, and had been hoping to raise topics for consideration during the Marine Workshop. This would have provided an excellent opportunity for the community of Pond Inlet to hear important information around community based monitoring of char, narwhal, and seals relevant to the Mary River project, and would have been equally informative for intervenors and Baffinland to consider. We have included in Appendix B, summary information from the community based monitoring work conducted by James Simonee over the past number of years. We anticipate these items to be raised by James and/or Vincent during the upcoming Technical Meeting at the relevant topical sessions, but also suggest that the Marine Workshop would provide a more meaningful opportunity to share this information with members of the community.

To address the need for the public to have access to this important information and questions/comments from intervenors, we further suggest that however the NIRB decides to proceed with Marine Workshop discussions, that it consider coordinating with the local radio station in Pond Inlet, specifically providing the English and Inuktitut recordings of the additional discussion related to the Marine Workshop, including comments and concerns raised by other intervenors, and that it look to host a radio show where these recordings are aired, and which provides the community an opportunity to phone in (to the NIRB staff) with their questions and concerns.

3. The North Baffin Communities have recently tabled important information regarding Baffinland's intention to ultimately ship 18 MT of ore per year via Milne Port. This significantly affects our understanding of the project, and the matter should be given space as a solitary agenda item to engage discussion among parties, including Baffinland.
4. The current agenda provides review of the Commitment List only during the last day of the Meeting. We request the NIRB give consideration to circulating a draft list at the end of each day (or as close to as possible), so that agencies might review and confirm the following day if any changes are required. We suggest that waiting to review the entire list at the close of the meeting may be onerous and delay its ultimate acceptance and finalization.

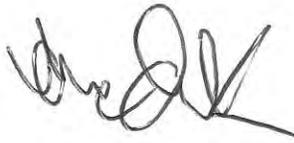
We thank the NIRB for considering our comments and suggestions, and look forward to attending and participating in productive and informative Technical Meetings later this month. Please direct any questions to Molleen Anaviapik, MHTO Manager, at [pond@baffinhto.ca](mailto:pond@baffinhto.ca).

Sincerely,

---

<sup>1</sup> Ministers Leblanc and Bennett Letter to NIRB Chairperson Re Approval Production Increase, Sept 30, 2018.

Eric Ootoovak  
Chairperson  
Mittimatalik HTO



cc: Joshua Arreak, Mayor of Pond Inlet

Encl: Appendix A: List of Participants for NIRB Technical Meeting  
Appendix B: Summary Documents of James Simonee Community Based Monitoring



## **Appendix A: List of Participants for NIRB Technical Meeting**

### **Eric Ootoovak, Chairperson, Mittimatalik HTO**

Qualifications and areas of expertise: Marine and terrestrial subsistence harvester, IQ and community knowledge holder

### **Enookie Inuarak, Vice-Chairperson, Mittimatalik HTO**

Qualifications and areas of expertise: Marine and terrestrial subsistence harvester, IQ and community knowledge holder, licensed guide and outfitter, Diploma - Environmental Technology Program (NAC)

### **Caleb Sangoya, Secretary/Treasurer, Mittimatalik HTO**

Qualifications and areas of expertise: Marine and terrestrial subsistence harvester, IQ and community knowledge holder, Elder

### **Amanda Hanson Main, Technical Advisor**

Qualifications and areas of expertise: MSc. Environmental Practice, BSc. Conservation Science, 15 years expertise in environmental assessment, community engagement, project monitoring, Nunavut's environmental assessment and regulatory regime

### **James Simonee, Arctic Connexion, Community Based Researcher**

Qualifications and areas of expertise: Community Wildlife Officer, hunter, and traditional knowledge holder. Community-based researcher with 5 years experience in the monitoring of Marine country food in the Eclipse Sound and Milne Inlet.

### **Vincent L'Herault, Arctic Connexion**

Qualifications and areas of expertise: Director, ArctiConnexion. PhD Biologist with 6 years of experience with community-based monitoring in Mittimatalik, including marine country food and freshwater systems.

# Appendix B: Summary Documents of James Simonee Community Based Monitoring

# Developing local research capacity for the monitoring of marine resources near Pond Inlet, Nunavut

James Simonee (1,2), Andrew Jaworenko (2), Ivan Koonoo (2), Elijah Panipakochoo (2), Heidi Swanson (3), Pierre-Yves Daoust (4), Derek Muir (5), Xiaowa Wang (5), Chris Furgal (6), and Vincent L'Hérault (1)

1 ARCTICconnexion, Québec, QC; 2 Community of Pond Inlet, NU; 3 Department of Biology, University of Waterloo, Waterloo, ON; 4 Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, PEI; 5 Environment Canada, Burlington, ON; 6 Indigenous Studies, Trent University, Peterborough, ON



## INTRODUCTION

As a resident of Mittimatalik (Pond Inlet) all my life, I have been noticing changes in weather, sea ice, marine mammals, land wildlife, and fish. My experience at Nunavut Arctic College's Environmental Technology Program (2012) made me question what I see out there (my observations) and it made me realize that there is some changes that we cannot tell just by our "naked" eye and that we, as Inuit, need to seek more to find out the unnoticeable things impacting our environment. As Inuit, country food is our main resource all year round and we especially need to know if the animals that we hunt or fish are being affected. There is a need for more Inuit to do the testing of our food in the North, the scientific way, in order to find out.

I wanted to start my own research project on arctic char and seals, to find out if they are being affected not only by "climate change" but also by human activities. There is especially more and more ships passing through in front of our community and going to the Iron ore mine port in Milne Inlet which, on its own, is likely already affecting marine mammals and arctic char. Through the oceans, the Arctic is also connected to all other regions of the world and can carry and bank contaminants that can be absorbed by wildlife and Inuit.

## METHODS

Back in 2015/2016, I started, with the help of ARCTICconnexion and other partners for mentorship, a project on arctic char looking at body condition and mercury levels during winter when we do a lot of fishing in lakes. In 2016, me and my team went fishing to two different lakes, one of them, Qurluqtu, is close to the Milne Inlet port where they load ships of raw iron ore. The other lake is called Tugaat and is also not far from the port. I also bought chars from local fishermen from two other lakes, Kangiluaqjuuk and Inalugaarjuuk, which are far from the port. I compared mercury concentration in fish meat among these four lakes. The samples that I collected were sent down to University of Waterloo to measure mercury levels in fish and for aging them with based on otolith's ring count.

Linear regressions were performed on the fish data to test the effect of age, gender, and harvest locations on mercury concentrations.



In the spring of 2016, and in spring and fall of 2017, I started a similar project on ringed seals looking at mercury concentration and trace metals in meat and liver. Persistent Organic Pollutants in blubber, body condition, and infectious disease with the help of a veterinarian from University of Prince Edward Island. Lab analysis is ongoing and so I only present highlights of my sampling.

## RESULTS

We harvested 93 char in total: 32 from Tugaat, 21 from Qurluqtu, 20 from Inalugaarjuuk and 20 from Kangiluaarjuuk. We harvested 30 seals in total: 15 in the spring and 15 in the fall.



Figure 1 - Map of the study area where we harvested chars and seals near Pond Inlet, Nunavut.

The char from Qurluqtu had the highest mercury concentration and the oldest fish were found there. Kangiluaarjuuk had the lowest concentration of mercury level and the youngest fish. Although Inalugaarjuuk was the furthest from the mine port it had the second highest concentration of mercury.

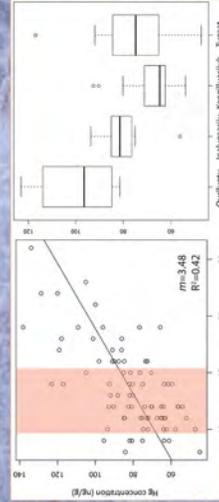


Figure 2 - Mercury (µg/g) concentration as function of age (left panel) and harvest location (right panel). In the left panel, the line illustrates the average obtained in their region. The orange rectangle indicate a subset set that correspond to char of fish between 10 and 15 years old that were selected for the among location comparison (right panel). This is because youngest locations were unequal in age composition only. Qurluqtu and Inalugaarjuuk had char > 15. The 10-15 age class maximized the sample size for each location. In the right panel, box plots provide the average (black line), the 50% Confidence Interval, and the 95% Confidence Interval.

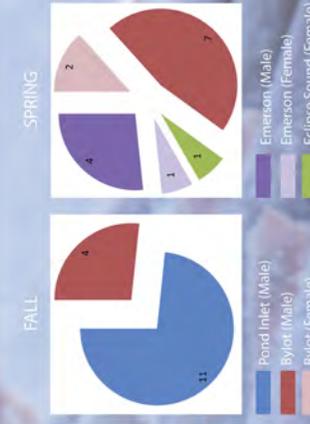


Figure 3 - These indicate when and where we harvest the seals and indicate the gender.

## DISCUSSION

According to us Inuit, the fish that we get from different lakes around Pond Inlet are safe to eat. Our results allowed us to confirm that the mercury concentrations in fish are about three times lower than the Health Canada Guidelines (0.5 µg/g).

Nevertheless, according to our research, Qurluqtu is still a concern for us because it had the highest concentration of mercury. Because of its proximity to the port, it raises additional questions about the potential effects of dust and fossil fuels release to the environment and water from industrial activities including terrestrial and marine ore transport. In addition, the fish harvested in Qurluqtu were older than the fish harvested in any other lake despite that we used the same mesh size for nets. Should we assumed that the young fish eat the same food as the older ones? Or is Qurluqtu simply a better habitat for fish and can sustain older ones? In any case, there is a need for more research in this lake among seasons and including the ore shipping season (in summer) and at different sampling sites.

As for the seals, our lab analyses will soon reveal the mercury and other trace metals level which can be reported in meat and liver as reported in other regions of the Arctic.

## ACKNOWLEDGEMENTS

We thank the Mittimatalik Hunters and Trappers Organization, the fishermen in Pond Inlet, and Sarah Arnold and the NCAAP for support and training. We thank our funders the Government of Nunavut fisheries and sealing division, the Northern Contaminants Program, and the Nunavut Research Institute and Irving shipping inc.



## Northern Contaminants Program 2018-2019 Synopsis of Research Report

Contaminants concentrations in traditional country food from the Eclipse Sound and dietary exposure in Pond Inlet, Nunavut: Science and local knowledge assessing a local baseline of the risks to human health



**James Simonee**, Community-based researcher in Pond Inlet  
PO Box 23  
Pond Inlet, NU X0A 0S0  
Ph: 867-899-6060 /Cell: 867-222-3335  
Email: [james@arcticconnexion.ca](mailto:james@arcticconnexion.ca)



## Project Team

**Vincent L'Hérault**, ARCTICconnexion- Quebec City, and University of Winnipeg  
**Derek Muir**, Environment Canada, Water Science and Technology Directorate- Burlington  
**Xiaowa Wang**, Environment Canada, Water Science and Technology Directorate- Burlington  
**Chris Furgal**, Indigenous Environmental Studies Program, Trent University, Peterborough  
**Heidi Swanson**, Department of Biology, University of Waterloo, Waterloo  
**Pierre-Yves Daoust**, Atlantic Veterinarian College, University of Prince Edward Island, Charlottetown.

## Abstract

Traditional country food is vital to Inuit culture and it has provided high-quality diet for millennia. With the event of industrial development, natural contaminants concentration (*e.g.* mercury) has constantly increased in the Atmosphere and Oceans and have accumulated in ecosystems and living organisms to reach the most remote Arctic regions, and many adverse effects of contaminants on animal and human health have been identified. Balancing the benefits that country food brings to Arctic residents (body health, mental health, and culture) with the risks associated with the utilization of country food that contains contaminants is not an easy task.

In this 2018-19 NCP project, we:

- 1) monitored contaminants (mercury and trace metals) and stable isotopes in different tissues collected on ringed seals in the spring (n=14) and fall (n=13) of 2018;
- 2) ran statistical analyses on the 2017-2018 contaminants data (mercury and trace metals) collected on ringed seals;
- 3) determined the nutritional content of ringed seals based from the 2017-18 data.

Results for trace metals and stable isotopes on the 2018-19 data are not yet available and pending at the laboratory. Arctic char could not be sampled this year. POPs analysis will be performed on the last year of the project (2020-21).

In addition to the NCP objectives, in partnership with Dr. Pierre-Yves Daoust from UPEI, we determined the occurrence of infectious pathogens in ringed seals from the 2017-2018 data (see Appendix).

2018-19 was the conclusion of our ringed seal monitoring. Based on the success of this baseline study and local capacity developed, we intend to pursue this project in 2019-20 for the monitoring of narwhals. Consequently, we request for the unspent funds from 2018-19 to be carried over to 2019-20.

This community-based project was led by James Simonee, with the support from ARCTICconnexion, the Mittimatalik HTO, and team members. Synopsis report was prepared by ARCTICconnexion, with the contribution of James Simonee.

## Table of Content

Project Team	2
Abstract	2
Objectives	4
Introduction	4
Activities conducted in 2018-2019	5
Obj. 1 and 2 ( <i>Mercury and trace metals concentrations, and POPs</i> )	5
<i>Seal</i>	5
<i>Arctic char</i>	6
Community Engagement	6
Capacity Building and Training	6
Communications and Outreach	6
<i>Local</i>	6
<i>National</i>	7
Indigenous Knowledge	7
Results and Outputs/Deliverables	7
2018	7
2017	8
2017- <i>Among-tissue comparison</i>	9
2017- <i>Among-season</i>	9
2017- <i>Contaminants vs Age</i>	10
2017- <i>Methyl mercury</i>	11
2017- <i>Nutritional fact of liver</i>	11
2017- <i>Stable isotopes</i>	12
Discussion and Conclusions	14
Expected Project Completion Date	14
Project website	15
Acknowledgments	15
References	15
Project Metrics and Information April 1, 2018 – March 31, 2019	17
Annual review of Revenue and Expenditures 2018-2019	20
APPENDIX – Seal results Pamphlet	21

## Key messages

- 1) The advancement of a community-based project on ringed seals led by local researchers and supported by mentors and NCP researchers;
- 2) Higher Hg concentration in liver than muscle;
- 3) Liver concentrations above recommended threshold for Hg, Ar, and Cd. Positive correlation between Hg concentration and age in liver. Higher Hg concentration in the spring than fall;
- 4) Concentration of methyl mercury (toxic) averaged 35% of Total mercury concentration;
- 5) Temporal and spatial variation in food use.

## Objectives

- 1) Portray seasonal/spatial variation in mercury and trace metals concentration in ringed seal and Arctic char of the Eclipse Sound;
- 2) Establish a baseline on POPs (legacy and newer concern POPs) for ringed seals;

## Introduction

In the early 2000s, mercury concentrations in ringed seal liver and kidney were well above Health Canada guidelines (0.5 mg/kg weight tissue) in Pond Inlet (Mittimatalik) as determined by other NCP scientists (Braune *et al.* 2015). Some POPs (e.g. bromure derives utilized as flame retardants) concentrations have recently increased in marine mammals tissues in other Arctic regions as well as in human biomarkers (Rotander *et al.* 2012, Hoguet *et al.* 2013), yet no data is available in Pond Inlet.

In 2017-18, our NCP project was the first to contribute to contaminants knowledge since the 2000s, and the first to integrate local observations and knowledge to contaminant science in the region. However, results from contaminants analyses were not yet available and hence not included in our previous Synopsis Report.

In this 2018-19 NCP project, we harvested additional ringed seals to increase or sample size which will allow us to identify the factors that influence the concentration of mercury and trace metals in ringed seals. We also ran statistical analyses based on the 2017-18 results which provide us with a good starting point.

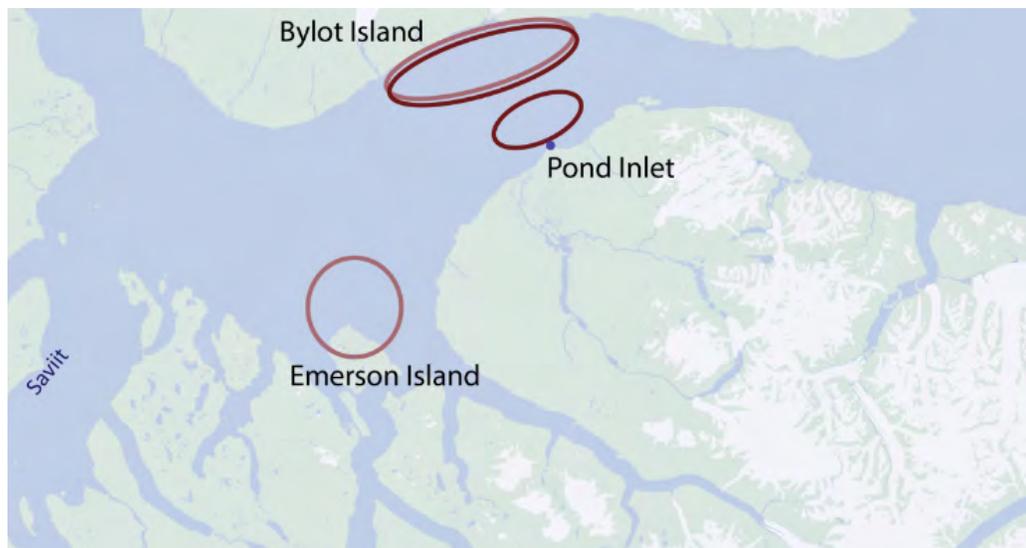
Local research capacity in the field of contaminants science is still very limited in Arctic communities and our project has shown in the past that local support and promotion of contaminant research can lead to very interesting community-based initiatives. In 2018-19, James Simonee still played an active role and showed leadership in all aspects of the research. Because of his involvement, the project objectives, progress, and results are continually shared and promoted in the community, which enables a more actual and adapted outreach. Again this year, we involved a team of mentors to support James, including high-profile NCP researchers.

## Activities conducted in 2018-2019

### Obj. 1 and 2 (*Mercury and trace metals concentrations, and POPs*)

#### *Seal*

In order to determine seasonal variation in the concentration levels of ringed seals, we harvested seals in the spring (ice season) and fall (ice-free season) of 2018. Most of the seals were sampled from the Emerson Island area in the spring (**Fig. 1**), and from across Pond Inlet up to Bylot Island in the fall. However, we were not able to harvest seals in the Milne Inlet area as planned due to early ice forming in the fall.



**Figure 1-** Regional map of the study area. Pale and dark brown ellipses represent ringed seal harvest areas in spring and fall of 2018, respectively.

On-site, we recorded body measurements and collected and stored specific animal tissue (meat, liver, blubber, fur, blood) utilized for contaminants analysis, isotope analysis, and serology for infectious pathogens analysis. Samples were shipped to Environment Canada's Burlington lab, U of New Brunswick's Sinlab, and U of Prince Edward Island for processing. Blubber and liver samples were stored for future analysis of POPs levels.

In the fall of 2018, contaminants and stable isotopes results from 2017 were obtained and analyzed. We ran statistics models (linear regressions and ANOVAs) to determine seasonal and spatial variation in the contaminant levels found in ringed seals. We also addressed the contribution of other factors such as the age of the seal and tissue type to contaminant levels. We ran similar analyses on the stable isotopes data to address variation in diet use. Results from 2018 are pending.

In the winter of 2019, we compiled contaminants and infectious pathogens results into an easy-to-read pamphlet designed for community members and local organizations (see Appendix). A

copy of the pamphlet content was shared with Nunavut Dep. of Health, and comments were accounted, for prior to release.

### *Arctic char*

No anadromous Arctic char were sampled in 2018 as planned. Project leader James Simonee reevaluated the Arctic char objective along with the Mittimatalik HTO and, since Arctic char were already monitored in 2015-2016, priorities were reframed and put on the incoming narwhal monitoring. HTO still has interest to deepen the research on Arctic char in the Qurluktuk lake area nearby the Mine port, and this component will be re-evaluated in the future.

## Community Engagement

- Project leader James Simonee is based in Pond Inlet and benefits from daily and continuous support from community members, hunters fellow, family, and local HTO. For example, during the fall sampling, James requested the help of local hunters for the harvesting of ringed seals and the hunter's community answered immediately, allowing the project to fulfill its objectives;
- 3 assistants (Andrew Jaworenko, Jassie Simonee, and Ivan Koonoo) participated to the project. They provided help during hunting trips and the sampling ringed seals;
- Local elders and hunters provided help and guidance along the project.

## Capacity Building and Training

- Veterinarian from UPEI, Pierre-Yves Daoust, travelled to Pond Inlet at spring to provide field work training to James Simonee and assistants for serology sampling;
- Research mentor Vincent L'Hérault travelled to Pond Inlet at fall to provide support and training during the field work;
- James Simonee could not travel to Ottawa for presentation at the Arctic Net conference due to work duty;
- James Simonee travelled to Québec City in February 2019 for a one-week data analysis and report writing training at ARCTICConnexion, along with mentor Pierre-Yves Daoust;
- James Simonee could not travel to the Water Science and Technology Directorate lab in Burlington, Ontario, in March 2019 for a training of lab analysis, due to work duty. This activity is postponed to 2019-20.

## Communications and Outreach

### *Local*

- Project progresses were shared along the way with community members and the

- Mittimatalik Hunters & Trappers Organization (HTO); especially during field works period;
- A pamphlet showing results highlights (see Appendix) was released in March 2019.
  - James Simonee presented an update of the project and the pamphlet to the HTO in March 2019.

### *National*

- General project progresses were discussed with funders and partners at the 2018 ArcticNet conference held in Ottawa. Oral and poster presentation could not be presented;
- Communications with a large public, academics and media were ensured through the ARCTICConnexion's Web Site ([www.arcticconnexion.ca](http://www.arcticconnexion.ca)) and Facebook page ([www.facebook.com/ArctiConnexion](https://www.facebook.com/ArctiConnexion));
- Metadata records were submitted to the Polar Data Catalogue in March 2019 <https://www.polardata.ca/pdcinput/metadata/display?ccinRefNumber=13059>

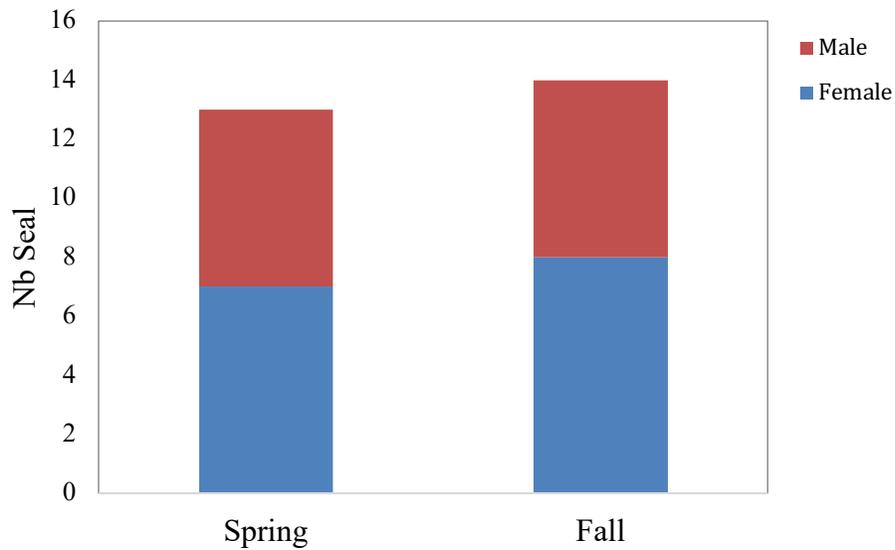
### Indigenous Knowledge

- Indigenous knowledge was embedded in all aspects of this research project because it was led by a local hunter and supported by the hunters' community;
- The scientific design of the project (sampling areas/sites and seasons) was inspired by the knowledge of James Simonee and other hunters.

## Results and Outputs/Deliverables

### *2018*

We harvested a total of 27 ringed seals in 2018, for a total of 57 seals in this project. We harvested 13 and 14 ringed seals in the spring and in the fall, respectively. **Figure 2** shows the sex ratio for each season. At the moment of this reporting, lab analysis of mercury and trace metals, stable isotopes, and aging are on the way.



**Figure 2-** Summary of the 2018 ringed seal harvest by season and gender.

*2017*

To address the potential impact of metal concentration on human health, we compared our results to the thresholds determined by different international organizations (**Table 1**). In Canada, tolerable upper intake levels have been established for mercury but not for arsenic, lead and cadmium (Health Canada, 2009).

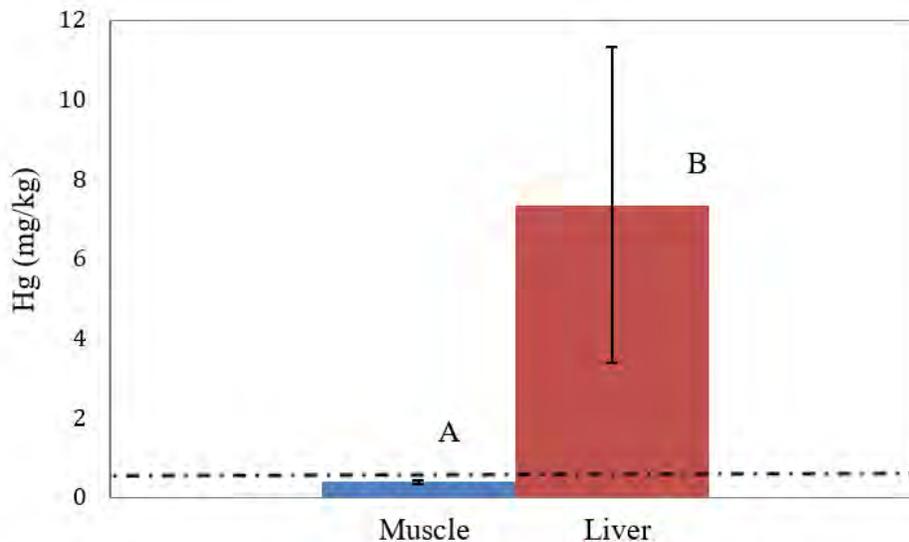
**Table 1.** Tolerable metal concentration thresholds recommended for consumption determined by different organizations

Contaminant	Threshold	Source
Arsenic	0.2 mg/kg	European Commission, 2016
Cadmium	0.025 (Provisional Tolerable Weekly Intake)	World Health Organization, 2017
Lead	Not available	-
Mercury	0.5 mg/kg	Health Canada, 2009

\*All thresholds are for adults.

### 2017- Among-tissue comparison

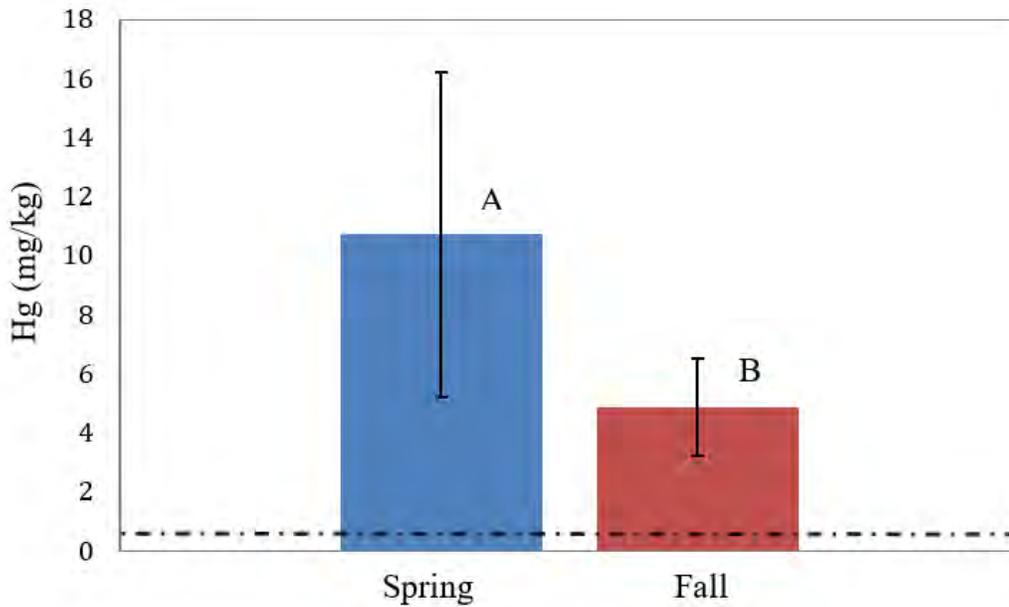
Muscle of ringed seal contained  $\bar{x} = 0.38 \pm 0.06$  mg/kg (n=26; **Fig. 2**), which is below the acceptable level for consumption (**Table 1**). The liver of ringed seals contained  $\bar{x} = 7.34 \pm 3.97$  mg/kg (n = 26; **Fig. 2**) which was significantly higher than the muscle ( $F_{1,24}=7.09, p=0.001, n=26$ ), and well above the recommended threshold for consumption (**Table 1**).



**Figure 2-** Among-tissue comparison of mercury concentration in ringed seals. Averages and standard deviations (bars) are shown. Letters over the bars indicate statistical difference. Dashed line indicates the acceptable level for consumption.

### 2017- Among-season

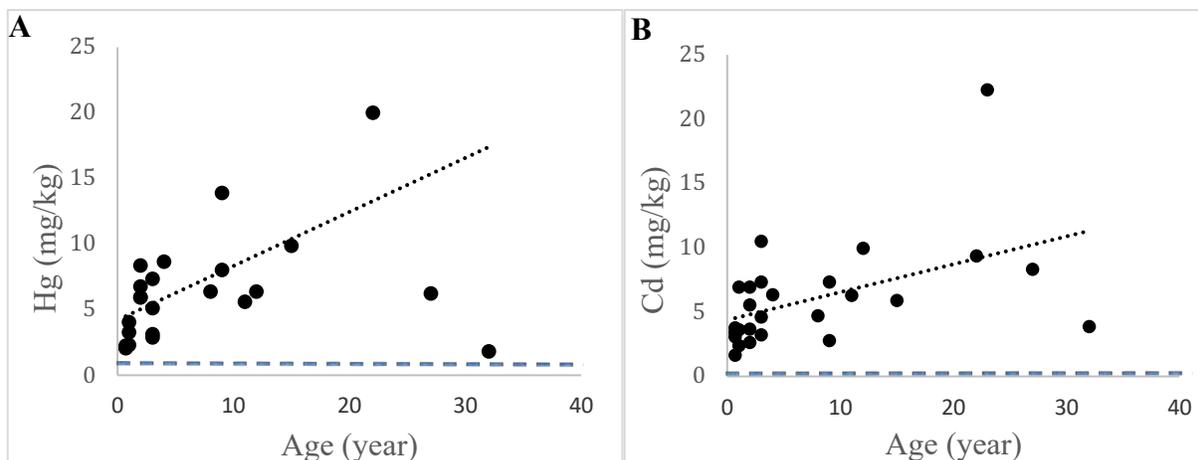
Mercury levels were significantly higher in the spring ( $\bar{x} = 10.71 \pm 5.50$  mg/kg, n=10) than in the fall ( $\bar{x} = 4.87 \pm 1.64$  mg/kg, n=14) ( $F_{1,24}=7.32, p=0.01$ ; **Fig. 3**). However, spring and fall samples were not sampled at the same location, which implies that some of the among season variation observed in mercury levels could be attributed, at least partly, to spatial variation. All other trace metals were not different among season.



**Figure 3-** Among-season comparison of mercury concentration in the liver of ringed seals. Average and standard deviation (bars) are shown. Letters over the bars indicate statistical difference. Dashed line indicates the acceptable level for consumption.

*2017- Contaminants vs Age*

Mercury and cadmium concentration in liver were positively correlated to the age of the seal ( $p=0.04$ ,  $R^2=0.16$ ; **Fig. 4.A**, and  $p=0.002$ ,  $R^2=0.33$ ; **Fig. 4.B**, respectively). Liver of ringed seal contained other contaminants such as arsenic ( $\bar{x} = 1.04 \pm 0.15$  mg/kg,  $n=26$ ) and lead ( $\bar{x} = 0.007 \pm 0.003$  mg/kg,  $n=26$ ), which were not correlated to age. All liver samples were above the recommended threshold for mercury, cadmium and arsenic (**Table 1**).



**Fig. 4-** Linear regression (black dashed line) of the mercury (A) and cadmium (B) concentration in liver as a function of the age of the ringed seal. Dashed blue line indicates the acceptable level for consumption.

### 2017- Methyl mercury

The mercury concentrations measured in ringed seal livers correspond to Total mercury, which contains both nontoxic inorganic Hg selenides, and toxic methyl mercury (MeHg) compounds (Wagemann et al. 2000). To quantify the proportion of toxic mercury in the liver and how it relates to total mercury, we ran MeHg analysis on 10 ringed seal livers (samples balanced between season, age, and sex). MeHg concentration averaged  $2.57 \pm 0.40$  mg/kg, which corresponds to ~35% of the Total mercury average. We ran a linear regression of MeHg as a function of Total Hg in order to develop algorithms to predict MeHg concentration in future work. The regression was not significant, possibly due to our small sample size. In future work, it will be important to run MeHg/ THg regression for different seasons and age class.

### 2017- Nutritional fact of liver

Despite its load of mercury and other metals, our results show that liver still remains a valuable source of essential elements for human diet, such as iron (**Table 2**).

**Table 2.** Nutritional facts for 100 g of ringed seal liver, based on Health Canada dietary recommendations (Health Canada, 2019). % were calculated using the average value (n=26 ringed seals)

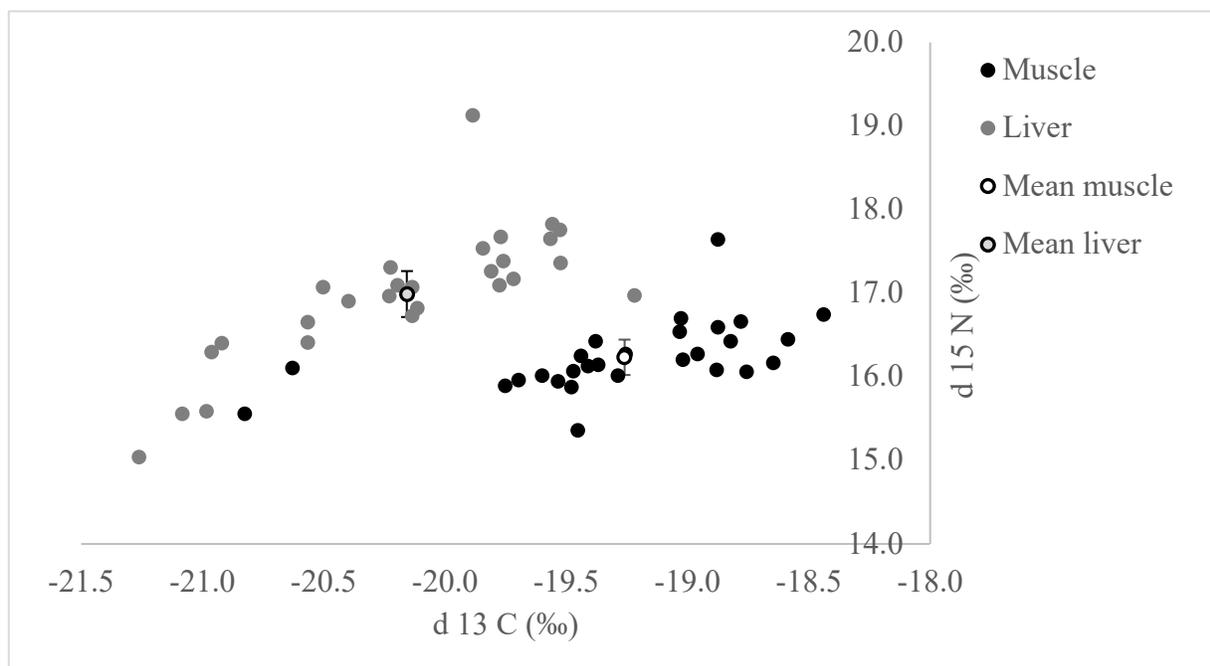
Elements	% of the Recommended Dietary Daily Allowance*	% of the Tolerable Upper Intake Level (UL)**
Calcium	0.5	0.2
Chromium	52	-
Iron	677	120
Magnesium	5	-
Manganese	16	3
Phosphorus	42	7.3
Potassium	6	-
Selenium	1.0	0.1
Zinc	44	12

\* % are for male between 19-30 years old.

\*\*The tolerable upper intake level (UL) is the maximum usual daily intake level at which no risk of adverse health effects is expected for most of the individuals. The risk of adverse effects increases as intake exceeds the UL (Health Canada, 2017)

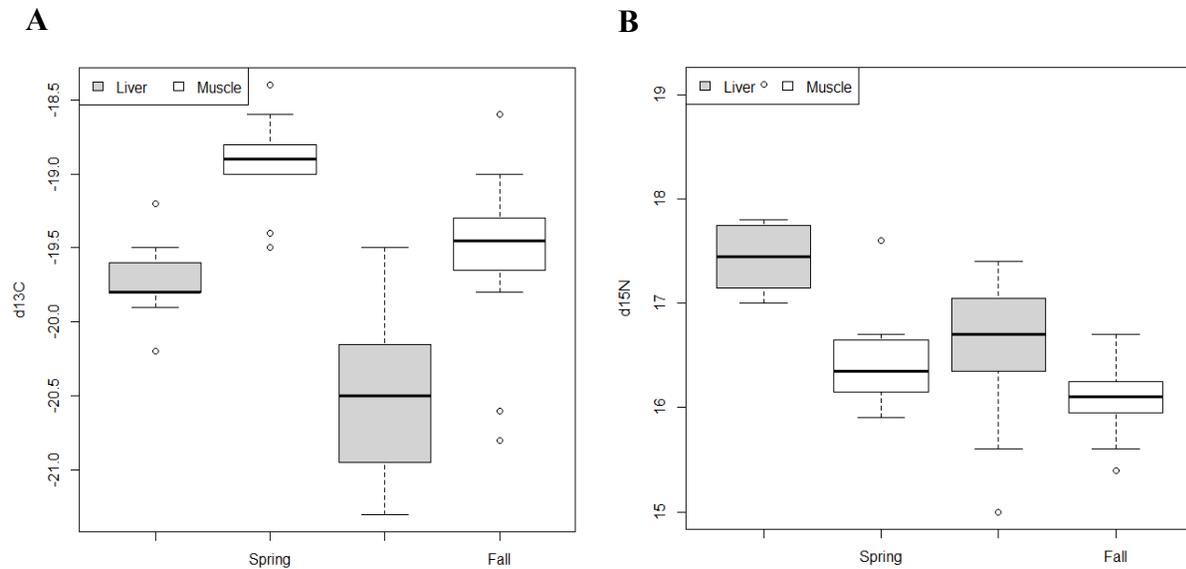
## 2017- Stable isotopes

We detected among-tissue variation in the isotopic ratios of ringed seals. Muscle ratios ranged from -20.8 to -18.4 ‰ in carbon ( $\delta^{13}\text{C}$ ) ( $\bar{x} = -19.3 \pm 0.3$  ‰), and from 15.4 to 17.6‰ in nitrogen ( $\delta^{15}\text{N}$ ) ( $\bar{x} = 16.2 \pm 0.2$  ‰) (Fig. 5). Liver ranged from -21.1 to -19.2 ‰ for  $\delta^{13}\text{C}$  ( $\bar{x} = -20.6 \pm 0.3$  ‰) and from 15.0 to 19.1‰ for  $\delta^{15}\text{N}$  ( $\bar{x} = 17.0 \pm 0.4$  ‰; Fig. 5). The relatively high variability in both  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  ratios suggest variability in food use. The elevated  $\delta^{15}\text{N}$  ratios in ringed seal is typical of animals with high trophic level (top predators).



**Figure 5-** Variation in the isotopic ratios of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) of ringed seals (n=26). Mean value  $\pm$  standard deviation is provided for muscle and liver

$\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  varied significantly among tissue ( $F_{1,54}=59.49, p < 0.0001, F_{1,54} = 29.96, p < 0.0001, n=26$ , respectively) and season ( $F_{1,54}=35.17, p < 0.0001, F_{1,54} = 22.71, p < 0.0001, n=26$ , respectively) (**Fig. 6 A, B**). The interaction between tissue and season was also tested, and was not significant for  $\delta^{13}\text{C}$ , but was significant for  $\delta^{15}\text{N}$  ( $F_{1,54} = 29.96, p < 0.0001, n=26$ ). This result suggests that the liver and muscle samples were significantly different from each other during a particular season.



**Figure 6-** Variation of  $\delta^{13}\text{C}$  (**A**) and  $\delta^{15}\text{N}$  (**B**) in ringed seals as a function of tissue and season. Dark line represents the median, box and arrow represent the 50% and 95% confidence interval, respectively.

Yet preliminary, our results reveal that ringed seals are not homogenous but quite variable in their isotopic ratios, which reflects variation in food use. Our results suggest that food use is influenced by season, and can also vary at finer time scale as revealed by the among tissue differences in isotopic ratios. The different turnover rate of the liver and muscle determined the rate at which the carbon and nitrogen are being assimilated. Here, the liver tissue provided an indication of the diet assimilated by the animal during the past week, and the muscle provided the diet assimilated during the past month (Hobson *et al.* 1996; Sinisalo *et al.* 2008). Importantly, spring and fall samples were collected at different locations (**Fig.1**), which implies that isotopic variation (and variability in food use) could be attributed, at least partly, to spatial differences in prey sources.

In the context of this report, it is important to note that these results are preliminary and were conducted on raw isotopic values. Corrections for isotopic discrimination and lipid contents are typically applied to raw isotopic value, which were not performed here. In addition, further analyses involving the isotopic ratios of prey species are required to further our understanding of food use in ringed seal.

## Discussion and Conclusions

During the second year (2018-19) of our seal monitoring project, our team was able to complete the collection of ringed seal samples in the Eclipse sound. Although the samples are currently being processed in the lab, we were able to conduct data analyses on the 2017 data, and provide preliminary results that are very informative:

- 1) The muscle samples of ringed seals were relatively low in mercury levels and below the recommended threshold provided by Health Canada, and poses no apparent risk for consumption;
- 2) The liver samples of ringed seals were above the recommended threshold for mercury, arsenic, and cadmium, and increased with age for mercury and cadmium. Methyl mercury concentration corresponded to ~35% of the Total mercury concentration. Consumption of livers may pose a risk to human health;
- 3) The liver of ringed seal is a valuable source of essential nutrients, but its iron level was 20 % over the recommended Tolerable Upper Intake Level (UL), which may increase health risk. However, iron absorption depends on multiple factors (*e.g.* vitamin intake and interaction with food type) that need to be accounted for in further studies.
- 4) Ringed seal can use a variety of food sources in time (and space) as revealed by preliminary results stable isotopes analyses. Variation in food sources can lead to differences in contaminant levels.

Despite the preliminary nature of our results, our study revealed important trends than can be used for prevention. As confirmed by the isotopic results, the ringed seal is a top predator with a greater ability to bioaccumulate contaminants, particularly in liver. To mitigate the risks associated with the consumption of liver, **we recommend to preferably use young ringed seals and during the fall season**. The consumption of **ringed seal meat** is also recommended. However, these recommendations need to be taken with caution, as we still require to run more analyses in the future, including Methyl mercury and POPs concentration.

### *Future work*

- 1) Run mercury, methyl mercury, trace metals, POPs, and stable isotope analyses on the 2018 samples;
- 2) Combine 2017-2018 in statistical analyses;
- 3) Run stable isotopes mixed model accounting for prey signatures, test for sex (reproduction status), age, and location;
- 4) Bridge scientific results with local knowledge documented earlier in this project

## Expected Project Completion Date

The ringed seal sub-project will be completed by winter 2020.

## Project website

Facebook pages:

[www.facebook.com/Contaminants-monitoring-in-marine-country-food-in-Pond-Inlet](http://www.facebook.com/Contaminants-monitoring-in-marine-country-food-in-Pond-Inlet)

[www.facebook.com/ArctiConnexion](http://www.facebook.com/ArctiConnexion)

Website:

[www.arcticonnexion.ca](http://www.arcticonnexion.ca)

## Acknowledgments

Board members of the Mittimatalik Hunters and Trappers Organization, Jamal Shirley at the Nunavut Research Institute, research assistants Andrew Jaworenko, Jassie Simonee and Ivan Koonoo. Hunters and Elders: Jaykolassie Kiliktee, Sam Oomik, Abraham Kunuk, Moses Konark, Joanassie Mucpa, Qamaniq Sangoya, Rodha Koonoo, Regellie Ootook, Rodha Arnakalak.

## References

Braune, B., Chetelat, J., Amyot, M., Brown, T., Clayden, M., Evans, M. et al. 2015. Mercury in the marine environment of the Canadian Arctic: review of recent findings. *Science of the Total Environment*, 509-510: 67–90.

European Commission. 2016. Arsenic in food. European Food Safety Authority, European Union. Consulted Online 2019-06-02: [https://ec.europa.eu/food/safety/chemical\\_safety/contaminants/catalogue/arsenic\\_en](https://ec.europa.eu/food/safety/chemical_safety/contaminants/catalogue/arsenic_en)

Health Canada. 2017. Fourth Report on Human Biomonitoring of Environmental Chemicals in Canada. Minister of Health, Ottawa, ON. Consulted online 2019-05-30: <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/environmental-contaminants/fourth-report-human-biomonitoring-environmental-chemicals-canada.html>.

Health Canada. 2009. Dietary Reference Intakes. Minister of Health, Ottawa, ON. Consulted online 2019-05-30: <https://www.canada.ca/en/health-canada/services/food-nutrition/healthy-eating/dietary-reference-intakes/tables/reference-values-elements-dietary-reference-intakes-tables-2005.html>

Hobson, K.A., Schell, D.M., Renouf, D., and Noseworthy, E. 1996. Stable carbon and nitrogen

- isotopic fractionation between diet and tissues of captive seals: implications for dietary reconstructions involving marine mammals, *Canadian Journal of Fisheries and Aquatic Science*, 53: 528–533.
- Hoguét, J., Keller, J.M., Reiner, J.L., Kucklick, J.R., Bryan, C.E., Moors, A.J., Pugh, R.S. and Becker, R.S. 2013. Spatial and temporal trends of persistent organic pollutants and mercury in beluga whales (*Delphinapterus leucas*) from Alaska, *Science of The Total Environment*, 449: 285–294.
- Rotander A., Bavel, B.V., Polder, A., Rigét, F., Auðunsson, G.A., Gabrielsen, G.W., Víkingsson, G., Bloch, D. and Dam, M. 2012. Polybrominated diphenyl ethers (PBDEs) in marine mammals from Arctic and North Atlantic regions, 1986–2009. *Environment International*, 40: 102-109.
- Sinisalo, T., Jones, R.I., Helle, E. and Valtonen, E.T. 2008. Changes in diets of individual Baltic ringed seals (*Phoca hispida botnica*) during their breeding season inferred from stable isotope analysis of multiple tissues, *Marine Mammal Science*, 24 (1): 159-170
- Wagemann R, Trebacz E, Boila G, Lockhart WL, 2000. Mercury species in the liver of ringed seals. *Sci Total Environ*;261:21–32.
- World Health Organisation. 2017. Evaluations of the Joint FAO/WHO Expert Committee on Food Additives (JECFA), Consulted Online 2019-06-02: <https://apps.who.int/food-additives-contaminants-jecfa-database/search.aspx?fcc=2>

## Project Metrics and Information April 1, 2018 – March 31, 2019

Northern Engagement Indicators	Type of Engagement	Date	Location	Number of Northerners engaged	Details How were they involved?
<b>Northerners engaged</b> in your project	Workshops	Juin 2018	Pond Inlet	3	Necropsy and sampling work training
	Workshops	October 2018	Pond Inlet	3	Necropsy and sampling work training
	Workshops	February 2019	Québec	1	Communication (Pamphlet), Data analysis with PY Daoust
	School visits	To come	Pond Inlet	~40	Once results known
	Meetings	--			
	Consultations	--			
	Part of your project team	June and August 2018	Pond Inlet	4	Project leader and research assistants
	Hired	June and August 2018	Pond Inlet	3	Project leaders and research assistants
	Other	--			
<b>Students</b> actively involved in your NCP project	Northern	--			
	Southern	--			

<b>Communication and Outreach Indicators</b>	<b>Description</b>	<b>Date</b>	<b>Location</b>	<b>Number of Materials distributed</b>	<b>Details</b> What materials were distributed? To whom were they delivered/presented?  <b>Include links to the materials if available.</b>
Distribution of project materials/ information and results to the <b>general public and Northerners</b>	Fact Sheets	February 2019	Pamphlet on research results	> 100	Community members and organizations, HTO
	Newsletters	--			
	Posters	--			
	Presentations	Mars 2019	Pond Inlet	1	Pond Inlet HTO
	Online (websites, videos)	May and July 2018	Online	3	Web Site Arcticonnexion.ca – Update of the project and pictures Facebook posts- ARCTIConnexion page
	Other	May 30 <sup>th</sup> 2019	Iqaluit	2	CBC North radio- interview with James Simonee
<b>Publications Indicators</b>	<b>Description</b>	<b>Details Including references and links</b>			
Citable publications	Journal articles	--			
	Conference presentations	--			
	Other	--			
Media articles related to your project	Print / Online	CBC Online: Baffinland must clarify effects on narwhal before expansion of Nunavut iron ore mine <a href="https://www.cbc.ca/news/canada/north/second-technical-meeting-for-baffinland-1.5111345">https://www.cbc.ca/news/canada/north/second-technical-meeting-for-baffinland-1.5111345</a>			

Data Management Indicators	Description	Details	
Data Management Plan	Plan completed	Provided to NCP Secretariat: May 2017	
Discoverable Data	Metadata In Polar Data Catalogue	PDC Record # 13059- Mercury and trace metals concentrations in Arctic char and Ringed seal from the Eclipse Sound near Pond Inlet, Nunavut (2016-2019)	
Preservation and Access to Data	Data Repository	ARCTICConnexion- private access, to be uploaded at Library of Pond Inlet Archives and Hunters and Trappers Organization	
Knowledge Integration Indicators	Description	Details	Details
How are/will your project results, data, and information used, and by whom? (i.e., names/types of assessments, initiatives, <i>etc.</i> , that will use your project results.)	Local	Hunters and Trappers Organization	Local use, planning and management, local hearings with industry and negotiations
	Regional/ National	-Government of Nunavut Health Department -Polar Data Catalogue, academic partners and NCP researchers	-Update of public messaging with regards to country food and contaminants. -Publication partnership with NCP scientists
	International	--	-Publication partnership with NCP scientists

Annual review of Revenue and Expenditures 2018-2019

Eligible Activities/ Expenditures	Maximum Funding	Spent	Difference
<b>Fiscal Year</b>	<b>2018-19</b>		
	67833	53512	14321
Eligible Expenditures			
Professional Fees and Services	41985	29138	12847
Equipment and Facilities	5000	2838	2162
Travel	12000	12688	-688
Administration Fee (15%)	8848	8848	0
<b>Maximum Funding for Fiscal Year 2018-19</b>	<b>67833</b>	<b>53512</b>	<b>14321</b>

An amount of 14 321\$ is left from the 2018-2019 budget. We request that this amount be transferred to the 2019-2020 budget according to the NCP flexible agreement.

# APPENDIX – Seal results Pamphlet

The pamphlet is divided into three vertical columns. The left column features three sections: 'Environment' with a photo of a frozen sea, 'Food' with a photo of seal blubber, and 'People' with a photo of a smiling child. The middle column contains contact information for James Simonee, Vincent L'Hérault, and Pierre-Yves Daoust, along with the website www.arcticonnexion.ca and a Facebook link. The right column has a title 'Seal Health Community Monitoring in Mittimatalik' and logos for Mittimatalik, University of Prince Edward Island, and Arcticonnexion. A photo of a person in winter gear is at the bottom right.

**Environment**

**Food**

**People**

**Any Question?**  
**Please Contact us:**

James Simonee  
867-899-6060  
[james@arcticonnexion.ca](mailto:james@arcticonnexion.ca)

Vincent L'Hérault  
581-246-2846  
[vincent@arcticonnexion.ca](mailto:vincent@arcticonnexion.ca)

Pierre-Yves Daoust  
Atlantic Veterinary College- UPEI  
902-566-0667  
[daoust@upe.ca](mailto:daoust@upe.ca)

**For more info visit us:**  
[www.arcticonnexion.ca](http://www.arcticonnexion.ca)

Contaminants monitoring in marine country food

**Seal Health Community Monitoring in Mittimatalik**

MITTIMATALIK UNIVERSITY of Prince Edward ISLAND AC

25th Anniversary of the Nunavut Government  
Nunavut Environment Canada

## SEAL RESEARCH?

The Arctic environment has changed under Climate Change and industrial development. All living things, humans and animals, can be affected by changes.



Seals have always been and still are very important to Inuit. As conditions of the marine environment change, new germs (surungnaqtut) and contaminants (qanimangnaqtut) can spread to seals and affect their health.

Monitoring (keeping track of) seal health is very important because:

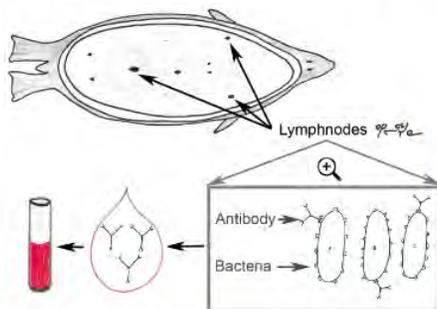
- 1) it can affect people's health;
- 2) it can affect seal numbers available to hunters now and for future generations;
- 3) it helps the community to gain skills.

This research looked at what germs and contaminants exist in seals and how to prevent the spread and transmission to humans...

## WHAT WE DID

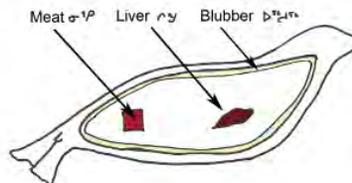
### GERMS IN SEAL

We sampled more than 50 seals harvested by local hunters in Mittimatalik. We collected meat, feces and blood for germs testing:



### CONTAMINANTS ANALYSIS

We sampled meat and liver for the testing of Mercury and trace metals levels. We also sampled blubber for future tests

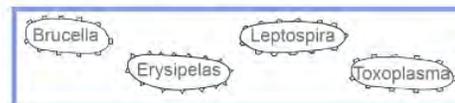


## WHAT WE FOUND

\* All SEAL LOOKED HEALTHY. Our research identified some germs that at one time infected the seals but there was no evidence that the seals were still sick from them: PEOPLE EATING SEAL ARE NOT AT RISK

\* No Trichinella was found in any of the meat samples

\* 10 to 35% of the seals had been in contact with but recovered from the following germs:



\* 25 to 40% of pup seals had potent salmonella and E.coli germs in their poop

### MERCURY LEVELS IN SEAL

