Preliminary Study:
Investigating Lead Exposure in Northern Canada and the Sahtú region, NWT

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Project Rationale

1. From the Mackenzie Valley Human Biomonitoring Project[1] (PI: Laird), lead levels in blood and urine were elevated in the Sahtú region relative to levels observed in the Dehcho region and from the Canadian Health Measures Survey (Table 1).

Table 1. Levels of lead in the Sahtú region, NWT and Canadian population (ug/L)

LEAD	Detection (%)	Sahtú Samples		Canadian population[a]	
		GM	P95	GM	P95
Blood (n=140)	100	23	82	13	27[b]
Urine (n=113)	98	0.67	4.6	0.52	1.9

[a] From the Canadian Health Measure Survey cycle 2, for 6-79 y.o.
[b] From the Canadian Health Measure Survey cycle 4, for 3-79 y.o.

2. Researchers and community partners in the Sahtú wanted to know why the lead levels were higher.

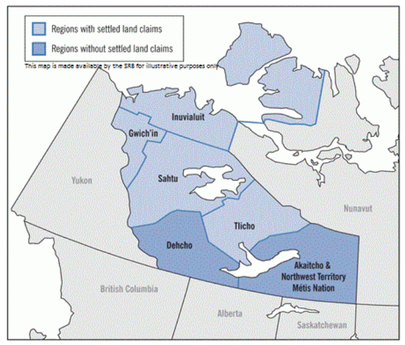


Figure 1: Map of Sahtú and Dehcho regions, NWT[2]

4 Project Objectives

1. Produce a **literature review/ knowledge synthesis** of levels of lead and sources of exposure for northern Canadians;
2. Investigate **lead levels in water samples** (surface water and municipal supplies) and fish samples around Fort Good Hope;
3. Investigate **lead levels in hunter-shot birds** from Fort Good Hope; and
4. Work with Sahtú community members to **develop a survey** that identifies risk factors for exposure to lead.

1 Literature Synthesis

- A search strategy was developed with a university librarian, and comprehensive search of all relevant published literature in academic databases (Scopus®, PubMed®, and Google Scholar) and unpublished grey literature (Google, manual searches) was completed using established systematic review methods.[3]
  - The search included the lead levels in northern populations with a focus on Canadian groups, identification and assessment of lead sources (e.g., country food - especially birds, water, paint), and assessment strategies of lead exposure determinants and sources (e.g., surveys, monitoring, isotopic ratios).
- After screening and data extraction using inclusion/exclusion criteria, 229 references remained.

Inclusion Criteria

- The study was published during or after January 2000.
- The study was in English.
- The study site was located in the Canadian territories, the Inuit Nunangat, the northern parts of the Canadian provinces, or in countries that are a part of the circumpolar north in general UNLESS the study focused on a migratory bird.
  - If the bird study was not located in the north, the birds needed to be measured in a way that it was plausible that they could transport lead to a different ecosystem.
- The study measured lead levels in some way that could affect humans or birds (in the water, air, dust, soil, plants, animals/traditional food, inside homes, in humans).

Results

- Majority of the literature was located in Canada (54%).
- Canadian Indigenous people in Arctic and subarctic communities have higher levels of lead than the rest of Canada. Lead levels can be influenced by a number of factors including using lead ammunition to harvest traditional food and living in close proximity to mines.
  - Based on other studies in the North, the **consumption of wild game harvested with lead-based ammunition might be a main route of exposure of lead intake** for Indigenous and northern groups.
  - Literature also point out the possibility of long range transport through migratory birds.
  - Lead levels in water, soil, and sediment are generally low, except those near mining operations, shooting ranges, or sewage and waste disposal areas.
  - Lead in Arctic atmosphere is low, but levels are higher than background levels due to industrial emissions from southern locations.
  - Household lead sources can include lead-based paint, dust, or municipal water.

2 Lead Levels in Water and Fish Samples

- Water monitoring conducted with Fort Good Hope and collected and tested water samples from various waterbodies and the treated tap water system (Table 2).
  - Local knowledge guided the selection of water sampling locations
  - Collected by trained local coordinators
- 10 fish samples provided (Table 3)
  - Generally liver samples > lead level than muscle
- Overall, lead levels low in water and fish

Table 3. Concentration of lead in muscle and liver of burbots (n=10)[a,b]

ID sample	Muscle Pb (mg/kg)[c]	Liver Pb (mg/kg)
BRBT 20	< RL	0.016
BRBT 11	< RL	0.002
BRBT 17	< RL	0.003
BRBT 15	< RL	0.004
BRBT 16	< RL	< RL
BRBT 13	< RL	0.008
BRBT 5	< RL	0.002
BRBT 9	< RL	0.002
BRBT 19	0.003	< RL
BRBT 3	< RL	0.002

[a]Fish collected from Mackenzie River in December 2019
[b]Samples provided by Dr. Gary Stern, University of Manitoba
[c]The reporting limit (RL) is 0.002 mg/kg

Table 2. Concentration of lead in water samples collected around Fort Good Hope in 2019-2020

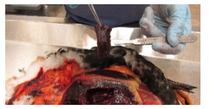
No	Type of water	ID Site	Pb (ug/l)	Date of Sample
1	Tap water	Tap water in private house	0.051	2020
2	Tap water	Tap water in private house	0.081	2020
3	Source Water	Mackenzie river at pumping site	1.143	2020
4	Alternate source	Jackfish creek	0.013	2020
5	Reservoir	Reservoir at water station	0.005	2020
6	Treated water	Treated water at water station	0.019	2020
7	Treated water	Public tap	0.026	2020
8	Treated water	Water delivery truck	0.101	2020
9	River	Rabbitskin	0.077	2020
10	River	Rabbitskin	0.057	2020
11	River	river under the bridge in FGH	0.068	2020
12	River	RAMPART RIVER	0.235	2020
13	River	RAMPART RIVER	0.274	2020
14	Water	Tap water in private house	0.147	June 2019
15	Water	Reservoir at water station	0.189	June 2019
16	Water	Mackenzie river at pumping site	0.138	June 2019
17	Wetland water	WF04	0.080	June 2019
18	Wetland water	WF02	0.038	June 2019
19	Wetland water	WF01	0.094	June 2019
20	Wetland water	E05-02	0.170	June 2019
21	Wetland water	E05-03	0.151	June 2019
22	Wetland water	E05-06	0.150	June 2019
23	Wetland water	P13-01	0.101	June 2019
24	Wetland water	P13-03	0.170	June 2019
25	Wetland water	P13-04	0.582	June 2019
26	Treated Water	Treated water at water station	0.009	May 2019
27	Treated Water	Truck tank for delivering water	0.009	May 2019
28	Source water	Mackenzie river at pumping site	0.038	May 2019
29	Tap Water	Tap water in private house	0.015	May 2019
30	Reservoir	Reservoir at water station	0.005	May 2019

3 Lead Levels in Hunter-Shot Birds

- Worked with Fort Good Hope Renewable Resources Council to hire two local project coordinators.

John Tobac: Guardian and Harvester from Fort Good Hope

- Coordinators facilitated collection of 20 harvested birds (May 2021) - mostly geese and other waterfowl.
- Coordinators also collected key information from harvesters, including details on ammunition used.[4]
- **Next Steps**: Bird tissue samples will be analyzed for lead in Fall 2021.



4 Survey Development
Sources of Exposure to Lead

- Developed from various sources:
  - prior surveys implemented by the human biomonitoring project[1],
  - reports from various government organizations (including Health Canada, Centers for Disease Control),
  - expertise from researchers specific to wild bird harvesting.
- 62 questions in four sections:
  a) socio-demographic
  b) harvesting practices and food preparation
  c) other lead exposure determinants (e.g., work, hobbies, household, etc.)
  d) symptoms of lead poisoning
- **Next Steps**: Feedback currently being gathered from Sahtú community members and harvesters to refine and incorporate into the survey.

References

1. Ratelle M, Skinner K, Brandow D, Packull-McCormick S, Laird B. Contaminant Biomonitoring in the Northwest Territories Mackenzie Valley: Investigating the Links Between Contaminant Exposure, Nutritional Status, and Country Food Use. Waterloo, ON: University of Waterloo; 2019.
2. NWT Surface Rights Board Map: https://nwtsrb.ca/about-us
3. Godin K, Stapleton J, Kirkpatrick SI, Hanning RM, Leatherdale ST (2015). Applying systematic review search methods to the grey literature: a case study examining guidelines for school-based breakfast programs in Canada. Systematic Reviews, 4, 138.
4. Tisdale CA, Martin JA, Beasley JC. (2021). Lead Contamination Differences in the Muscle of Wild Turkeys Harvested with Lead and Copper-Plated Lead Shot. *Journal of Fish and Wildlife Management, 12*(1), 250–256.

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