

**Title:** Arctic Caribou Contaminant Monitoring Program

**Project Leader:**

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**Abstract**

This project studies contaminant levels in caribou in the Canadian Arctic to determine if these populations remain healthy (in terms of contaminant loads), whether these important resources remain safe and healthy food choices for northerners and if contaminant levels are changing over time. In 2014/15 samples were collected from 2 Porcupine and 21 Qamanirjuaq caribou. Sample analyses for these collections had not been completed at the time this report was prepared. Qamanirjuaq and Porcupine caribou samples collected in the 2013/14 year have been analyzed, and results are presented in this report. Age was positively correlated with renal cadmium and zinc in both herds and negatively correlated with mercury in the Porcupine herd. Renal lead is declining over time in the Porcupine caribou herd, perhaps due to the reduction in use of leaded gasoline in Canada over the last two decades. Renal selenium is increasing over time in the Qamanirjuaq caribou, but not to levels of toxicological concern. The proximity of open ocean to the home range of this herd may have a significant effect on the dynamics of certain elements within that ecosystem. Levels of most elements measured were not of concern toxicologically, although renal mercury and cadmium concentrations may cause some concern for human health depending on the quantity of organs consumed. Yukon Health has advised restricting intake of kidney and liver from Yukon caribou, the recommended maximum varying depending on herd (e.g. a maximum of 32 Porcupine caribou kidneys/year). The health advisory confirms that heavy metals are very low in the meat (muscle) from caribou and this remains a healthy food choice.

**Key Messages**

- Levels of most elements measured in caribou tissues are not of concern, although kidney mercury and cadmium concentrations may cause some concern for human health depending on the quantity of organs consumed. Caribou meat (muscle) does not accumulate high levels of contaminants and is a healthy food choice.
- Lead appears to be decreasing over time in the Porcupine caribou, likely due to emission controls.
- This program will continue to monitor the Porcupine and Qamanirjuaq caribou herds annually to maintain confidence in this traditional food and to better understand the dynamics of contaminants within this ecosystem (particularly mercury).

**Objectives**

To determine levels of and temporal trends in contaminants in Arctic caribou in order to:

- Provide information to Northerners regarding contaminants in these traditional foods, so that:
  - They may be better able to make informed choices about food consumption. This includes providing information for health assessments and/or advisories as required.
  - Wildlife managers can assess possible health effects of contaminants on Arctic caribou populations.
- Further understand the fate and effects of contaminant deposition and transport to the Canadian Arctic.

**Introduction**

Caribou provide an important food resource for Northerners across the Arctic, and have been designated in the NCP blueprint as key species for monitoring contaminants in the terrestrial Arctic ecosystem. Two

barren-ground caribou herds, one from the eastern (Porcupine) and one from the western (Qamanirjuaq) Arctic, have been designated for annual sampling.

### **Activities in 2014/15**

Samples were collected from two Porcupine caribou in the fall of 2014 by hunters in Old Crow. Normally, Environment Yukon staff collect samples from 20 caribou as part of a Yukon Government initiative working with hunters in Old Crow to study body condition in the Porcupine caribou herd. However, this year, the migration pattern of the herd changed and the main herd did not pass through Old Crow, so no samples were taken by this group. Twenty-one samples were collected from the Qamanirjuaq caribou herd in Arviat in the fall of 2014 in cooperation with the Arviat Hunters and Trappers Organization. This was the first year of a formal agreement with this organization and it worked very well. Kidneys, liver, muscle and teeth were collected as usual. In addition, bone marrow and brains were collected from 10 caribou in response to a request from local hunters to know what contaminants were in these commonly consumed tissues.

Current-year samples are currently being analyzed for a suite of 34 elements using ICP-MS by NLET, Environment Canada, Burlington (Xiaowa Wang, Derek Muir). Liver and muscle samples were archived and incisors were used to analyze age of the animal using the cementum technique (Matson's Laboratory, Missoula, Montana). Porcupine and Qamanirjuaq caribou samples collected in the 2013/14 year have been analyzed, and results are presented here.

Although kidneys were analyzed for 34 elements, only results for 7 elements of concern were statistically analyzed in detail (arsenic, cadmium, copper, lead, mercury, selenium and zinc). The effect of gender was unable to be tested since all Porcupine caribou collected were male and all Qamanirjuaq caribou were female. The effect of year and age on element concentration was tested comparing 2013 to previous years for the same gender for each herd. In all statistical analyses, data were log-transformed, where necessary to achieve normality. If normality was not achieved by this transformation, non-parametric tests were used to analyze the data.

### *Capacity Building*

In October, 2014, the PI participated in a wildlife contaminants workshop presented to the students of the Environmental Technology Program of Arctic College in Iqaluit, providing information on contaminants in the general environment as well as in caribou, specifically. The workshop provided the opportunity for students to dissect two caribou as part of the 'hands-on training' portion of the workshop. The students also learned how to age caribou teeth using the cementum technique. This workshop will be offered again in October, 2015.

### *Communications*

Interviews about this project were done with CBC radio and television in Inuvik (Sept 2014) and CBC radio in Iqaluit (Oct 2014). A summary of the project was provided to the Inuit Tapiriit Kanatmi for their contaminants website, and the project was featured by SAON Canada (Sustaining Arctic Observing Networks Canada) in their bulletin (<http://arcticobservingcanada.ca/SAON-Results-Bulletin-v1-2%20Dec-5.pdf>). Plain language summaries were created for the Porcupine and Qamanirjuaq caribou herds separately and distributed to stakeholder groups. The Qamanirjuaq summary was also supplied in Inuktitut. Synopsis reports will be distributed to all stakeholders. Results and conclusions from this ongoing program were presented to the following groups in person:

- Beverly Qamanirjuaq Caribou Management Board, Regina. May, 2014
- North American Caribou Conference, Whitehorse. May 2014
- Inuvik High School, Sept 2014 (Grade 11 and Experiential Science classes)
- Nihtat Gwich'in Renewable Resource Council, Inuvik, Sept 2014
- Environmental Technology Program students at Arctic College, Iqaluit, NT, Sept 2014

- Issatik HTO, Whale Cove, NT, Oct 2014
- Aqigiq HTO, Chesterfield Inlet, NT, Oct 2014
- Baker Lake HTO, Baker Lake, NT, Oct 2014

Presentations were made at public meetings in the following communities:

- Fort MacPherson, NT, Sept 2014 (organized in collaboration with the Tetlit Gwich'in Renewable Resource Council; included a talk on the local radio station)
- Inuvik, NT, Sept 2014 (organized in collaboration with Aurora Research Institute)
- Tsiigehtchic, NT, Sept 2014 (organized in collaboration with the Gwichya Gwich'in Renewable Resource Council)
- Iqaluit, NT, Oct 2014 (organized in collaboration with Nunavut Research Institute)

#### *Traditional Knowledge Integration*

This program relies on the traditional knowledge of both Aboriginal and non-Aboriginal people when collecting samples from caribou for analysis. In all cases local hunters use traditional knowledge when hunting caribou and ultimately submitting samples as well as providing food for their families. Meetings between the PI and local HTOs provide an opportunity for the exchange of traditional and western scientific information that will enhance understanding of contaminants in caribou and facilitate the implementation of this project. In the fall of 2014, meetings with HTOs in the small communities in the Hudson Bay region, yielded the traditional Inuit knowledge that caribou commonly consume seaweed, which could be a significant source of mercury for Qamanirjuaq caribou. This information has been incorporated into the workplan for this project for the coming year.

#### **Results**

Results for the seven elements of interest are presented in Table 1. Age was positively correlated with renal cadmium and zinc in both herds and negatively correlated with mercury in the Porcupine herd.

Year was not correlated with any of the elements measured in male, fall-collected Porcupine caribou, with the exception of As and Pb. In the case of As, this is likely due to more erratic older measurements. If data collected prior to 2004 is omitted from the analysis, the relationship of As to year disappears. The same is not true of Pb, which does seem to be declining over time in this herd (Fig 1). Renal Se was positively correlated with year in the Qamanirjuaq herd (Fig 1). Renal Hg was not correlated with year in either herd (Fig 1).

#### **Discussion and Conclusions**

Correlations between some elements and age are common in ungulates and need to be considered when comparing element concentrations within and among caribou herds (Gamberg et al. 2005).

It is not clear why Pb appears to be declining in the Porcupine herd, but not the Qamanirjuaq, and why Se appears to be increasing in the Qamanirjuaq herd, but not the Porcupine. Since the primary source of Pb for caribou is from atmospheric Pb absorbed by lichens consumed by the caribou, the reduction of the use of unleaded gasoline after the prohibition of leaded gasoline in Canada in 1990 may be affecting concentrations in some Arctic caribou and causing a decline in the Porcupine caribou. The proximity of the Qamanirjuaq caribou home range to the ocean may affect element concentrations in those caribou as will be discussed further with reference to Hg.

Table 1. Renal element concentrations ( $X \pm SD$ ;  $\mu\text{g}\cdot\text{g}^{-1}$  dry weight).

Year	N	Age	Arsenic		Cadmium		Copper		Lead		Mercury		Selenium		Zinc	
Porcupine fall-collected male caribou																
1997	14	4.1	0.42	$\pm$ 0.32	23.2	$\pm$ 12.1	21.2	$\pm$ 2.1	0.17	$\pm$ 0.11	1.47	$\pm$ 0.32	3.8	$\pm$ 0.6	93.4	$\pm$ 11.8
1998	14	4.7	0.19	$\pm$ 0.05	26.9	$\pm$ 21.0	25.6	$\pm$ 3.7	0.25	$\pm$ 0.28	1.76	$\pm$ 0.72	5.2	$\pm$ 1.2	108.4	$\pm$ 16.6
1999	11	4.7	0.08	$\pm$ 0.04	36.0	$\pm$ 25.9	23.5	$\pm$ 6.4	0.18	$\pm$ 0.09	1.23	$\pm$ 0.63	4.6	$\pm$ 0.8	113.5	$\pm$ 16.3
2000	8	4.8	0.30	$\pm$ 0.11	37.4	$\pm$ 17.6	25.1	$\pm$ 4.3	0.25	$\pm$ 0.39	1.23	$\pm$ 0.18	4.9	$\pm$ 1.0	121.6	$\pm$ 21.5
2001	12	5.1	0.36	$\pm$ 0.12	29.8	$\pm$ 11.9	22.5	$\pm$ 2.6	0.17	$\pm$ 0.15	1.74	$\pm$ 0.78	4.4	$\pm$ 1.1	115.8	$\pm$ 27.2
2002	9	5.6	0.18	$\pm$ 0.04	26.8	$\pm$ 8.4	25.1	$\pm$ 3.4	0.13	$\pm$ 0.05	1.39	$\pm$ 0.27	5.4	$\pm$ 0.6	123.3	$\pm$ 14.1
2003	23	5.8	0.25	$\pm$ 0.06	37.5	$\pm$ 18.1	25.4	$\pm$ 3.4	0.16	$\pm$ 0.18	1.19	$\pm$ 0.25	6.1	$\pm$ 0.7	121.6	$\pm$ 15.4
2004	16	4.9	0.05	$\pm$ 0.01	24.2	$\pm$ 13.8	22.8	$\pm$ 3.0	0.14	$\pm$ 0.04	1.62	$\pm$ 0.59	4.2	$\pm$ 0.6	121.0	$\pm$ 15.9
2005	14	3.5	0.05	$\pm$ 0.04	23.1	$\pm$ 14.8	23.1	$\pm$ 2.4	0.15	$\pm$ 0.04	1.81	$\pm$ 0.33	4.5	$\pm$ 0.6	121.9	$\pm$ 18.0
2006	9	5.1	0.07	$\pm$ 0.02	41.6	$\pm$ 23.7	24.9	$\pm$ 3.0	0.10	$\pm$ 0.02	2.18	$\pm$ 0.51	5.1	$\pm$ 0.6	130.6	$\pm$ 14.5
2007	12	4.7	0.04	$\pm$ 0.01	28.3	$\pm$ 12.2	24.5	$\pm$ 4.6	0.12	$\pm$ 0.08	1.58	$\pm$ 0.45	4.4	$\pm$ 0.7	120.0	$\pm$ 27.5
2008	20	6.1	0.03	$\pm$ 0.02	27.3	$\pm$ 16.8	26.7	$\pm$ 7.1	0.18	$\pm$ 0.38	1.34	$\pm$ 0.60	4.3	$\pm$ 0.5	138.4	$\pm$ 33.7
2009	21	6.3	0.05	$\pm$ 0.04	38.1	$\pm$ 16.6	24.6	$\pm$ 5.2	0.10	$\pm$ 0.06	0.98	$\pm$ 0.43	4.6	$\pm$ 0.7	139.5	$\pm$ 39.5
2010	4	6.8	0.07	$\pm$ 0.01	26.6	$\pm$ 9.9	21.3	$\pm$ 1.6	0.11	$\pm$ 0.03	1.53	$\pm$ 0.51	5.3	$\pm$ 0.8	130.1	$\pm$ 17.8
2011	11	4.9	0.05	$\pm$ 0.04	23.0	$\pm$ 12.7	22.8	$\pm$ 2.3	0.07	$\pm$ 0.03	1.42	$\pm$ 0.45	4.5	$\pm$ 0.6	107.8	$\pm$ 8.0
2012	20	6.2	0.11	$\pm$ 0.11	34.7	$\pm$ 21.9	22.8	$\pm$ 2.1	0.09	$\pm$ 0.03	1.84	$\pm$ 0.70	4.8	$\pm$ 0.5	107.8	$\pm$ 9.3
2013	22	5.3	0.04	$\pm$ 0.02	21.2	$\pm$ 9.2	24.3	$\pm$ 2.6	0.07	$\pm$ 0.02	1.79	$\pm$ 0.50	4.3	$\pm$ 0.5	109.4	$\pm$ 6.5
Qamanirjuaq fall-collected female caribou																
2006	7	7.3	0.03	$\pm$ 0.02	18.7	$\pm$ 13.9	26.3	$\pm$ 2.0	0.58	$\pm$ 0.81	3.37	$\pm$ 0.96	3.6	$\pm$ 8.5	104.1	$\pm$ 8.5
2007	10	5.1	0.04	$\pm$ 0.01	24.0	$\pm$ 15.7	25.1	$\pm$ 8.9	0.44	$\pm$ 0.15	5.57	$\pm$ 2.33	4.1	$\pm$ 30.5	110.1	$\pm$ 30.5
2008	10	8.1	0.04	$\pm$ 0.02	29.7	$\pm$ 11.8	24.4	$\pm$ 4.0	0.36	$\pm$ 0.08	4.99	$\pm$ 1.57	4.0	$\pm$ 16.0	105.7	$\pm$ 16.0
2009	4	0.5	0.04	$\pm$ 0.02	19.8	$\pm$ 14.7	21.1	$\pm$ 3.4	0.25	$\pm$ 0.06	5.32	$\pm$ 2.16	3.5	$\pm$ 11.3	94.7	$\pm$ 11.3
2010	1		0.05		21.5		18.9		0.49		6.69		3.8		96.5	
2011	17	6.0	0.04	$\pm$ 0.02	21.0	$\pm$ 24.6	22.0	$\pm$ 2.8	0.30	$\pm$ 0.13	5.04	$\pm$ 1.90	4.2	$\pm$ 10.9	107.9	$\pm$ 10.9
2013	4		0.03	$\pm$ 0.01	31.1	$\pm$ 35.1	27.2	$\pm$ 1.8	0.26	$\pm$ 0.10	3.96	$\pm$ 0.72	4.4	$\pm$ 0.3	120.5	$\pm$ 15.8

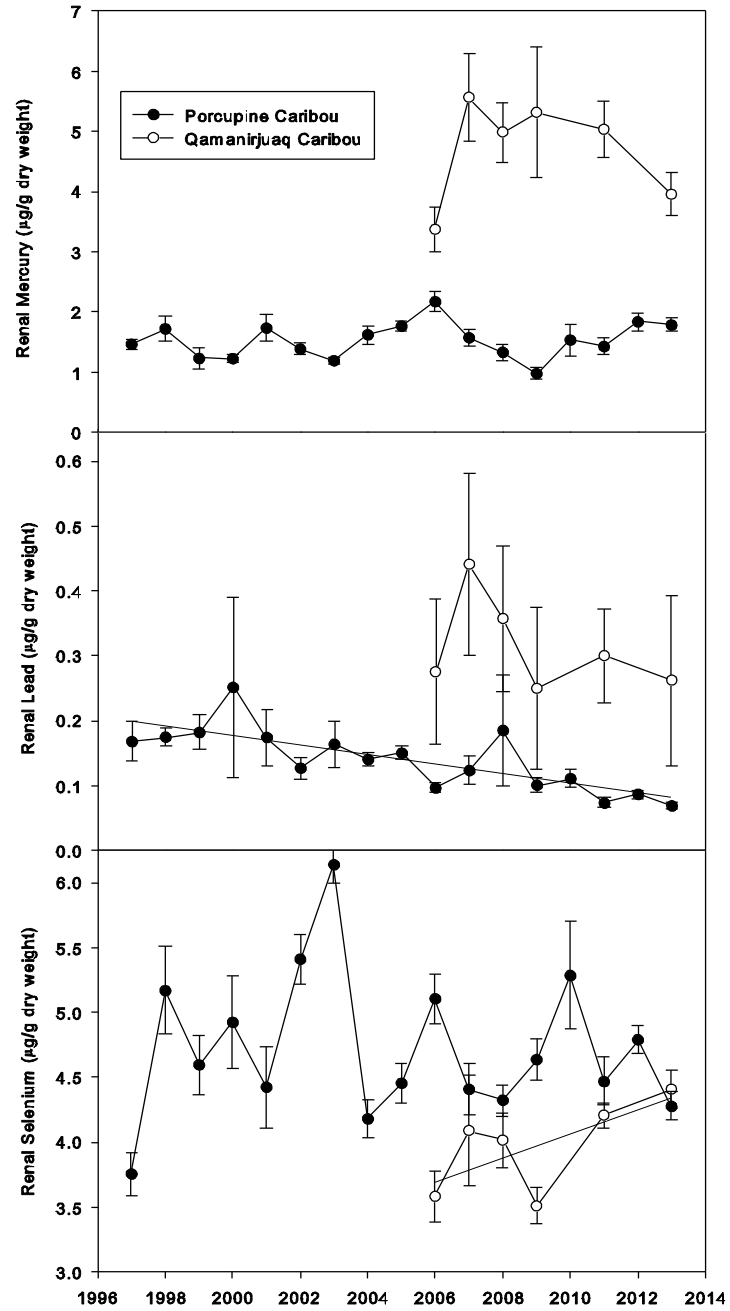


Figure 1. Renal mercury, lead and selenium concentrations in fall-collected male Porcupine and female Qamanirjuaq caribou. Regression lines were added for statistically significant relationships ( $p < 0.05$ ) only.

Although there are no long term trends up or down in renal Hg in either herd, the data for the Porcupine herd clearly indicate some sort of cycle. These data will be more thoroughly analyzed in the coming year and an attempt made to identify major drivers of that cycle. A publication on this topic is anticipated by September, 2016. The higher Hg concentrations found in the Qamanirjuaq caribou (as compared to the Porcupine) may be due, at least in part, to their proximity to the ocean. A recent study in the Canadian High Arctic found that lichens closer to the coast where there was open water had higher levels of total Hg and methylmercury, than those collected inland as well as those collected on the coast where the water was frozen all year (St. Pierre et al. 2015). The Qamanirjuaq caribou have also been noted to consume seaweed, which can contain appreciable levels of Hg (van Netten et al. 2000). A community-based monitoring project to measure Hg concentrations in lichens and seaweed in the Qamanirjuaq caribou home range will be developed over the coming year.

Levels of most elements measured in the Porcupine and Qamanirjuaq caribou herds were not of concern toxicologically, although renal mercury and cadmium concentrations may cause some concern for human health depending on the quantity of organs consumed. Yukon Health has advised restricting intake of kidney and liver from Yukon caribou, the recommended maximum varying depending on herd (e.g. a maximum of 32 Porcupine caribou kidneys/year). The health advisory confirms that heavy metals are very low in the meat (muscle) from caribou and this remains a healthy food choice.

Data collected from this program continue to provide baseline data for contaminants in the Qamanirjuaq and Porcupine caribou as well as a valuable tissue archive for legacy and emerging contaminants. The ongoing nature of this program provides security and confidence for northerners using caribou as a food source and acts as an early warning system for wildlife managers. The length and consistency of this program also provides a valuable database for exploring the dynamics of particular contaminants of concern (eg. mercury) within the terrestrial ecosystem. This program will continue to collect and analyze kidney samples from the Porcupine and Qamanirjuaq caribou herds (20 animals from each) as well as two additional herds in the coming fiscal year.

**Expected Project Completion Date:** This program is ongoing.

### **Acknowledgements**

Many thanks to Yukon Environment staff: Martin Keinzler, Mike Suitor and Jane Harms for providing samples from the Porcupine caribou herd, Mary Vanderkop and Meghan Larivee for laboratory support. I would also like to acknowledge the efforts of all hunters who have submitted samples to this program over the years – without them, this work would not be possible. A particular thank you goes to the Arviat Hunters and Trappers Association who assisted with organizing collections this year. This project was funded by the Northern Contaminants Program, Aboriginal Affairs and Northern Development and administered by the Yukon Conservation Society.

### **References**

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Performance Indicators April 1, 2014 – March 31, 2015					
Engagement & Communication Indicators	Description	Date mm/dd to mm/dd	Location Town, Territory, Province	Number of people of materials	Details What was highlighted? How were they involved?
Northerners engaged in your project	Workshops	09/29 to 10/06	Iqaluit, NU	30	Students involved in collection contaminant samples from caribou and aging caribou teeth
	School visits	09/03 to 09/04	Inuvik NT	28	Presentation and Discussion (2 classes)
	Meetings	05/06 to 05/08	Regina SK	16	Beverly Qamanirjuaq Caribou Management Board Meeting
		09/02	Fort MacPherson NT	8	Public meeting and radio talk
		09/04	Tsiigehtchic, NT	10	Public meeting
	Consultations	09/03	Inuvik, NT	8	Nihtat Gwich'in Renewable Resource Council meeting
		10/07	Whale Cove, NU	10	Issatik HTO meeting
		10/08	Chesterfield Inlet, NU	7	Aqigiq HTO meeting
		10/09	Baker Lake, NU	10	Baker Lake HTO meeting
	Part of your project team	ongoing	YT, NU	4	Biologists assisting with sampling
Hired					
Other					
Students involved in your NCP work	Northern	09/29 to 10/06	Iqaluit, NU	30	Arctic College Workshop – hands on dissection of caribou and aging caribou teeth
	Southern				
Distribution of project materials/ information and results	Fact Sheets	09 and 10	YT, NT and NU	100	Distributed widely to stakeholder groups and at public meetings and lectures
	Newsletters				
	Posters				
	Other, e.g., conferences, community	06/01 09/03	web Inuvik, NT	45	Inuit Tapiriit Kanatmi Public Lecture at Aurora

	meetings	09/04	Inuvik, NT		Research Institute
		10/02	Iqaluit, NU	17	CBC radio and TV interviews
		10/02	Iqaluit, NU		Public Lecture at Nunavut Research Institute
		12/01	web		CBC radio interview
					SAON Canada <a href="http://arcticobservingcanada.ca/SAON-Results-Bulletin-v1-2%20Dec-5.pdf">http://arcticobservingcanada.ca/SAON-Results-Bulletin-v1-2%20Dec-5.pdf</a>
<b>Publication &amp; Data Indicators</b>	<b>Description</b>	<b>Date</b>	<b>Name</b> Journal, Conference, Database	<b>Number</b> Volume Page, Data Record #	<b>Details</b> Links to material
Number of citable publications	Journals				
	Conference presentations	05/13 to 05/15	Whitehorse, YT		North American Caribou Conference
	Book chapters				
	Other				
Are you aware of how your project results will be used (e.g., local/ national/ international assessments and initiatives)? If so, please describe.	Names of Assessments and Initiatives that will use your project results.		AMAP Hg Assessment; CACAR Hg Assessment; Canadian Hg Science Assessment		
Access to Data	Meta Data In Polar Data Catalogue			PDC Record #	12007