

**Title:** Arctic Caribou Contaminant Monitoring Program

**Project Leader:**

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**Project Team Members:**

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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 2013/14 samples were collected from 20 Porcupine and 4 Qamanirjuaq caribou. Samples analyses had not been completed at the time this report was prepared. Qamanirjuaq samples collected in the 2012/13 year have been analyzed, and results are presented in this report. Renal cadmium, mercury, selenium and zinc concentrations were positively correlated with age in the Qamanirjuaq caribou collected in 2012. No differences were seen between the sexes for any of the elements tested, contrasting with significantly higher concentrations of arsenic, cadmium and mercury in females from previous collections from this herd in the fall. This suggests transplacental transfer of at least cadmium and mercury from the pregnant female to the fetus in the spring. Temporal trend analysis using the 2012 spring data is not possible because there are only two years of spring-collected data (2010 and 2012). We can only conclude that renal lead concentrations were lower while selenium and zinc concentrations were higher in 2012. In all cases, the differences between years are small and likely not of biological significance. 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.
- There is evidence that some cadmium and mercury are transferred from the pregnant female to the fetus before birth. This results in somewhat lower concentrations in females than males in the spring.
- 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 2013/14**

Samples were collected from 20 Porcupine caribou in the fall of 2013 by Environment Yukon staff as part of a Yukon Government initiative working with hunters in Old Crow to study body condition in the Porcupine caribou herd. Only four samples were collected from the Qamanirjuaq caribou herd in Arviat in the fall of 2013 due to poor weather conditions and changes in the herd's migration close to that community. Community hunters will try to collect the remaining 16 samples in the spring of 2014.

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 (Angela Milani, Yukon Government). Qamanirjuaq samples collected in the 2012/13 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 on element concentration was tested using 2012 data (10 F: 10M) and the effect of year was tested using results from female caribou from 2010 and 2012 (the only years in which caribou were collected in spring). In all statistical analyses, age was tested as a cofactor, and where necessary data were log-transformed to achieve normality. If normality was not achieved by this transformation, non-parametric tests were used to analyze the data.

## *Capacity Building*

The collection of samples from the Porcupine caribou herd was carried out by Yukon Environment biologists in coordination with local hunters in Old Crow. As part of this project, a program has been developed with the high school class at Chief Zaeh Gittlit School in Old Crow. The students were taken out on hunting trips to participate in the harvest, and at the same time were shown how to take measurements and samples for a variety of purposes, including contaminants analyses.

In October, 2013, 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 specifically in caribou. This workshop will be offered again in October, 2014 with the opportunity for hands-on training in extracting contaminant samples from caribou.

## *Communications*

Results and conclusions from this ongoing program were presented in poster format at the NCP Results Workshop in Ottawa, YT in September, 2013, to the students of the Environmental Technology Program of Arctic College in Iqaluit in October, 2013, to the Hunters and Trappers Association in Aklavik NT in January, 2014 and to the local high school, students of the BEAHR program and the Hunters and Trappers Association in Arviat in February, 2014. Synopsis reports and plain language summaries will be shared with all stakeholders.

## *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 Hunters and Trappers Associations 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.

### Results

Results for the seven elements of interest are presented in Table 1. Renal cadmium, mercury, selenium and zinc concentrations were positively correlated with age in the Qamanirjuaq caribou collected in 2012 and no differences were seen between the sexes for any of the elements tested. Renal lead concentrations were lower in female spring-collected caribou from 2012 than in 2010 while selenium and zinc concentrations were both higher in 2012 (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.

The lack of statistically significant differences in element concentrations between the sexes in 2012 is interesting because female caribou had consistently higher concentrations of renal arsenic, cadmium and mercury concentrations in fall-collected animals from the same herd (Figure 1). In spring-collected animals, arsenic was still higher in female caribou, although the high variation made the difference statistically insignificant.

Cadmium concentrations in spring-collected caribou were very similar between the sexes whereas levels in females were higher in fall-collected caribou. Previous research on the Porcupine caribou herd has indicated that caribou get most of their cadmium from lichens which are consumed almost exclusively in the winter. This results in higher concentrations in the spring than in the fall after they have switched to eating low-cadmium grasses, sedges and flowering plants over the summer (Gamberg *et al.* 2005). The relative drop of cadmium in females in the spring suggests a sex-specific reduction in intake or method of elimination over the winter season. Previous research on the Porcupine caribou herd indicates that females tend to have higher concentrations of cadmium than males because they must eat a larger proportion of food (including lichens) relative to their body weight to support pregnancy and lactation (Gamberg 2009). This would preclude the possibility of a reduction of intake of cadmium over the winter and suggests a transplacental transfer of cadmium from the mother to the fetus. This has been documented in other species (Goyer 1995).

Mercury concentrations in males actually exceed those in females in spring-collected caribou from the Qamanirjuaq herd (Fig. 1). The same rationale used to explain cadmium dynamics can be used to explain this difference, with the aspect of transplacental transfer of mercury likely playing a larger role in providing a route of elimination for pregnant females. This has been well-documented for mercury (World Health Organization 2008).

Temporal trend analysis using the 2012 spring data is not possible because there are only two years of spring-collected data (2010 and 2012). We can only conclude that renal lead concentrations were lower while selenium and zinc concentrations were higher in 2012. In all cases, the differences between years are small and likely not of biological significance.

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.

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

Year	N	Age	Arsenic		Cadmium		Copper		Lead		Mercury		Selenium		Zinc		
Porcupine fall-collected male caribou																	
1997	14	4.1	0.42	± 0.32	23.2	± 12.1	21.2	± 2.1	0.17	± 0.11	1.47	± 0.32	3.8	± 0.6	93.4	± 11.8	
1998	14	4.7	0.19	± 0.05	26.9	± 21.0	25.6	± 3.7	0.25	± 0.28	1.76	± 0.72	5.2	± 1.2	108.4	± 16.6	
1999	11	4.7	0.08	± 0.04	36.0	± 25.9	23.5	± 6.4	0.18	± 0.09	1.23	± 0.63	4.6	± 0.8	113.5	± 16.3	
2000	8	4.8	0.30	± 0.11	37.4	± 17.6	25.1	± 4.3	0.25	± 0.39	1.23	± 0.18	4.9	± 1.0	121.6	± 21.5	
2001	12	5.1	0.36	± 0.12	29.8	± 11.9	22.5	± 2.6	0.17	± 0.15	1.74	± 0.78	4.4	± 1.1	115.8	± 27.2	
2002	9	5.6	0.18	± 0.04	26.8	± 8.4	25.1	± 3.4	0.13	± 0.05	1.39	± 0.27	5.4	± 0.6	123.3	± 14.1	
2003	23	5.8	0.25	± 0.06	37.5	± 18.1	25.4	± 3.4	0.16	± 0.18	1.19	± 0.25	6.1	± 0.7	121.6	± 15.4	
2004	16	4.9	0.05	± 0.01	24.2	± 13.8	22.8	± 3.0	0.14	± 0.04	1.62	± 0.59	4.2	± 0.6	121.0	± 15.9	
2005	14	3.5	0.05	± 0.04	23.1	± 14.8	23.1	± 2.4	0.15	± 0.04	1.81	± 0.33	4.5	± 0.6	121.9	± 18.0	
2006	9	5.1	0.07	± 0.02	41.6	± 23.7	24.9	± 3.0	0.10	± 0.02	2.18	± 0.51	5.1	± 0.6	130.6	± 14.5	
2007	12	4.7	0.04	± 0.01	28.3	± 12.2	24.5	± 4.6	0.12	± 0.08	1.58	± 0.45	4.4	± 0.7	120.0	± 27.5	
2008	20	6.1	0.03	± 0.02	27.3	± 16.8	26.7	± 7.1	0.18	± 0.38	1.34	± 0.60	4.3	± 0.5	138.4	± 33.7	
2009	21	6.3	0.05	± 0.04	38.1	± 16.6	24.6	± 5.2	0.10	± 0.06	0.98	± 0.43	4.6	± 0.7	139.5	± 39.5	
2010	4	6.8	0.07	± 0.01	26.6	± 9.9	21.3	± 1.6	0.11	± 0.03	1.53	± 0.51	5.3	± 0.8	130.1	± 17.8	
2011	11	4.9	0.05	± 0.04	23.0	± 12.7	22.8	± 2.3	0.07	± 0.03	1.42	± 0.45	4.5	± 0.6	107.8	± 8.0	
2012	20	6.2	0.11	± 0.11	34.7	± 21.9	22.8	± 2.1	0.09	± 0.03	1.84	± 0.70	4.8	± 0.5	107.8	± 9.3	
Qamanirjuaq fall-collected female caribou																	
2006	7	7.3	0.03	± 0.02	18.7	± 13.9	26.3	± 2.0	0.58	± 0.81	3.37	± 0.96	3.6	± 8.5	104.1	± 8.5	
2007	10	5.1	0.04	± 0.01	24.0	± 15.7	25.1	± 8.9	0.44	± 0.15	5.57	± 2.33	4.1	± ###	110.1	± 30.5	
2008	10	8.1	0.04	± 0.02	29.7	± 11.8	24.4	± 4.0	0.36	± 0.08	4.99	± 1.57	4.0	± ###	105.7	± 16.0	
2009	4	0.5	0.04	± 0.02	19.8	± 14.7	21.1	± 3.4	0.25	± 0.06	5.32	± 2.16	3.5	± ###	94.7	± 11.3	
2010	1		0.05		21.5		18.9		0.49		6.69		3.8		96.5		
2011	17	6.0	0.04	± 0.02	21.0	± 24.6	22.0	± 2.8	0.30	± 0.13	5.04	± 1.90	4.2	± ###	107.9	± 10.9	
Qamanirjuaq spring-collected caribou																	
2008 Female	1		0.04		16.2		20.9		0.51		###		4.4		94.0		
2010 Female	8	7.0	0.07	± 0.01	40.1	± 15.7	19.1	± 8.9	0.45	± 0.15	7.12	± 2.33	4.0	± 0.4	99.3	± 9.2	
2012 Female	10	7.3	0.07	± 0.02	33.3	± 24.6	19.0	± 2.8	0.37	± 0.13	5.89	± 1.90	4.7	± 0.8	113.8	± 14.2	
2012 Male	10	6.8	0.05	± 0.04	32.7	± 12.1	21.0	± 2.1	0.44	± 0.11	7.29	± 2.45	5.3	± 0.6	115.3	± 9.7	

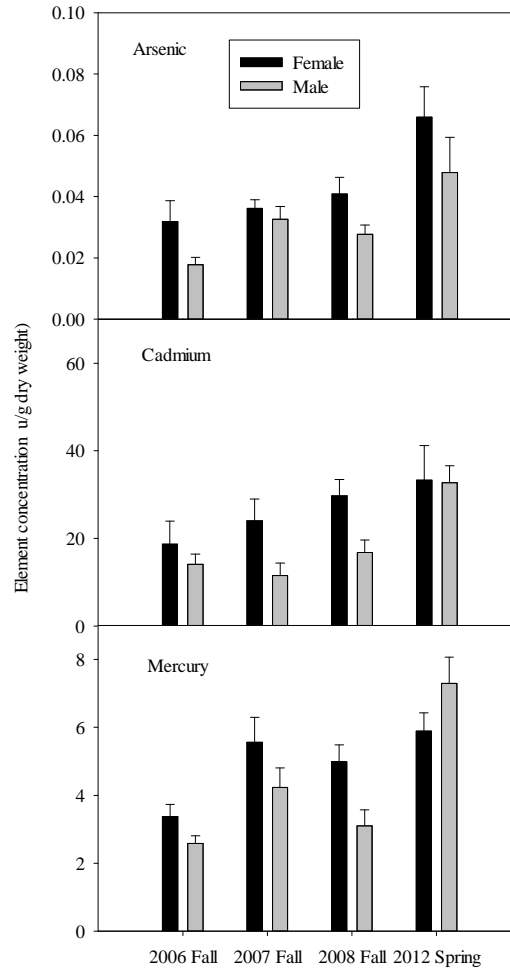


Figure 1. Renal arsenic, cadmium and mercury concentrations in Qamanirjuaq caribou.

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. This tissue archive has recently been accessed to assess whether Porcupine caribou were affected by fallout from the recent nuclear accident in Fukushima, Japan (NCP project: Monitoring of Radioactivity in Caribou and Beluga in response to the Fukushima accident) and to provide samples for a caribou genetics study at the University of Saskatchewan. 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) in the coming fiscal year.

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

### Acknowledgements

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Performance Indicators April 1, 2012 – March 31, 2013						
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	School visits	10/27 to 10/29	Iqaluit, NU	20	Lecture to Arctic College	
		2/27	Arviat, NU	40	Lecture to High School	
		2/27	Arviat, NU	12	Lecture to Arctic College (BEAHR program)	
	Meetings	01/14	Aklavik, NT	20	Hunters and Trappers Assn	
		2/27	Arviat, NU	11	Hunters and Trappers Assn	
	Consultations	11/01 to 01/15	YT NT NU	18 13 7	Project proposal consultation	
	Part of your project team	09/25 to 09/30	Old Crow, YT	12	Collecting caribou samples	
		09/10 to 10/15	Arviat, NU	1	Collecting caribou samples	
		02/04 to 02/18	Whitehorse, YT	1	Aging caribou teeth	
		04/01 to 31/03	Whitehorse, YT	1	Program management	
Recipients of project materials	Posters	09/24	Ottawa	1	NCP Results Workshop	
	Reports	05/04	YT NT NU	18 13 7	NCP Synopsis Report	
Publication & Data Indicators	Description	Date	Name Journal, Conference, Database	Number Volume Page, Data Record #	Details Links to material	
Number of citable	Journals					

publications	Conference presentations				
	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 ; Yukon State of the Environment Report		
Access to Data	Meta Data In Polar Data Catalogue			PDC Record #	19115:2003

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