

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 2012/13 samples were collected from 20 Porcupine and 20 Qamanirjuaq caribou. The Qamanirjuaq samples were collected in the spring and had not been analyzed at the time this report was prepared. Arsenic and lead concentrations decreased significantly over time in Porcupine caribou kidneys, although the absolute declines were small, possibly reflecting an increased ability in laboratory detection of smaller amounts of these elements as well as an increase in precision and accuracy of measurement rather than actual declines in the caribou over time. Renal lead concentrations in these caribou may also be affected by the reduction of the use of unleaded gasoline after the prohibition of leaded gasoline in Canada in 1990. Although other elements of interest (cadmium, copper, mercury, selenium, zinc) did not show overall increasing or decreasing trends, inter-annual variation in element concentration was common and may be of particular interest in the case of mercury, where that variation may offer insight into potential drivers of these elements in caribou. The inter-annual variation seen in mercury levels in the Porcupine caribou herd seems to be at least somewhat cyclic and is likely affected by atmospheric patterns of deposition of Hg as well as local environmental conditions affecting Hg concentrations in winter forage in conjunction with forage availability and selection by the caribou. This includes timing of green-up in the spring and the subsequent switch to lower-mercury forages and could therefore potentially be impacted by a changing climate. Levels of most elements measured in Porcupine caribou 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 concentrations in the Porcupine and Qamanirjuaq herds are declining over time, likely reflecting reductions in lead in the environment due to the prohibition of the use of leaded gasoline in Canada.
- Over the long term, mercury in the Porcupine caribou is stable, but appears to undergo a cycle. More research is required to determine drivers of the cycle and mercury dynamics within the caribou food chain.

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 2012/13

Samples were collected from 20 Porcupine caribou in the fall of 2012 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 three samples were collected from the Qamanirjuaq caribou herd in Arviat in the fall of 2012 due to poor weather conditions and changes in the herd's migration close to that community. However, samples from 50 Qamanirjuaq caribou from the spring of 2012 were acquired from a GNWT project studying body condition in that herd. Twenty samples from this collection were chosen to fulfill the 2012 requirement for these caribou.

As of April 2013, only the Porcupine caribou samples have been analyzed and are presented. Samples from the Qamanirjuaq herd are in the process of being analyzed. All kidneys were 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). Incisors from the Qamanirjuaq caribou herd were aged by Matson's Laboratory (Milltown, Montana).

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). Temporal trends were assessed for the Porcupine caribou using a general linear model. Only males were considered since all samples collected in the fall of 2012 were male. 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

This year provided few opportunities for capacity building and training, since the project was limited to collections from the two caribou herds by territorial agencies in cooperation with local hunters. However, results of past years of this project were presented to several venues in Whitehorse including Yukon College and an experiential high school in which the students were very engaged.

Communications

Results and conclusions from this ongoing program were presented in poster format at the NCP Science Event in Whitehorse, YT in October, 2012 and at the Biodiversity Forum presented by Yukon College in November, 2012. A presentation was also made to an experiential science high school class (Wood St. School, Whitehorse) in October, 2012 which was very well received. This program was discussed in several radio, newspaper and television interviews in October 2012.

Results of this project are communicated to the YCC and NAC by this report and will be presented at the NCP symposium scheduled for the fall of 2013. The project coordinator is available throughout the year to answer specific questions or address relevant issues from any of the participating groups or Regional Contaminants Committees as they arise. All data will be incorporated into the existing database for Canadian Arctic moose and caribou contaminants, currently maintained by INAC, Whitehorse. Plain language summaries, brochures and/or posters focussing on individual herds/populations will be prepared and circulated to stakeholder groups in cooperation with each Regional Contaminants Committee as requested. Special presentations may be made as the results dictate, or upon request, in cooperation with the Regional Contaminants Committees. Data collected through this program were included in the most recent updates of the CACAR and AMAP reports. Results of this (and other related NCP projects) will be presented at the 2013 International Mercury Conference in Edinburgh, Scotland in July, 2013.

Although participating Government of Nunavut biologist (Mitch Campbell) has, in the past, included project results in ongoing communications with local communities and HTOs, the NAC has requested more direct contact with this program. This will be developed over the coming year and will include the production of brochures on contaminants in the Qamanirjuaq and Dolphin and Union caribou which have been in development for some time.

Although the data gathered through this program is the technical property of NCP, the data is being made available to participating researchers and communities for public information purposes. Publication of the data in scientific journals is the responsibility of the project leader. All researchers participating in this program have agreed to abide by the Northern Contaminants Program Data and Sample Accessibility Agreement.

Plans for the upcoming year (2013/14) were discussed with the Yukon Contaminants Committee, the NAC, First Nation traditional users of the caribou and related Resource Councils and Management agencies.

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.

Results

Results for the seven elements of interest are presented in Table 1. Renal mercury concentrations were negatively correlated with age while cadmium, selenium and zinc concentrations were positively correlated with age in male Porcupine caribou (Figure 1). Arsenic and lead concentrations decreased significantly over time (Figure 2), while none of the other elements studied (cadmium, copper, mercury, selenium, zinc) showed an overall trend over time in Porcupine caribou kidneys.

Discussion and Conclusions

As in previous years, year of collection was negatively correlated with renal arsenic and lead in male, fall-collected Porcupine caribou (Figure 2). However, the absolute declines are small and may reflect an increased ability for the laboratory detection of smaller amounts of these elements as well as an increase in precision and accuracy of measurement rather than actual declines in the caribou over time. It is notable that both arsenic and lead concentrations measured prior to 2004 were more erratic and variable whereas from 2004 to the present measured renal concentrations have been more consistent and relatively low. Renal lead concentrations in these caribou may also be affected by the reduction of the use of unleaded gasoline after the prohibition of leaded gasoline in Canada in 1990.

Table 1. Element concentrations ($\mu\text{g g}^{-1}$ dry weight) in kidneys from male fall-collected Porcupine caribou.

Year	N	Age	Arsenic*		Cadmium		Copper		Lead*		Mercury		Selenium		Zinc	
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

*statistically significant decline over time ($p < 0.05$)

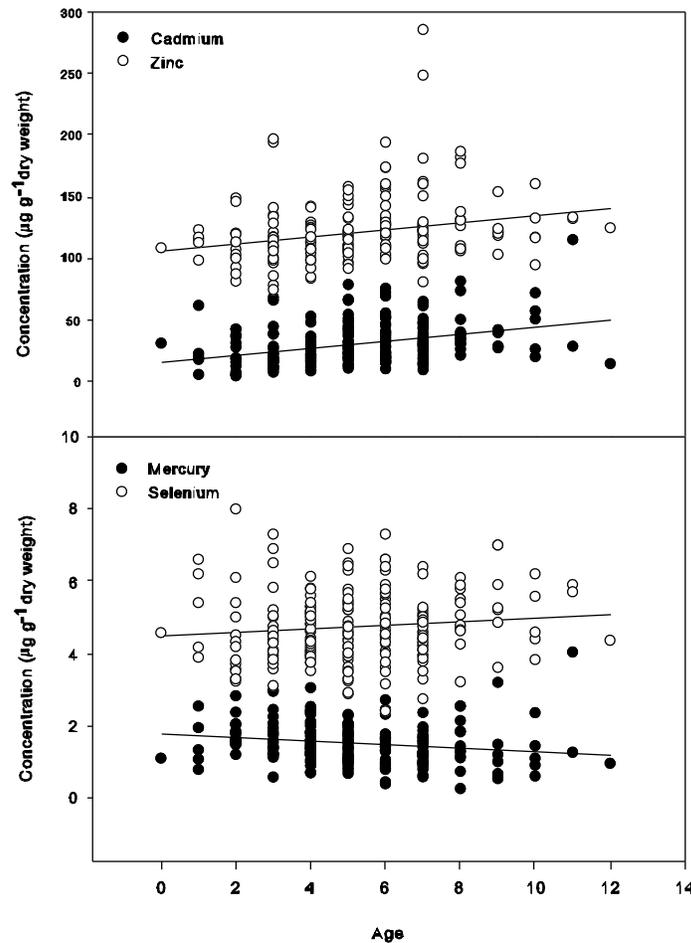


Figure 1. Renal element concentrations in male Porcupine caribou, collected fall, 1993-2012. Cadmium, zinc and selenium were positively correlated with age while mercury was negatively correlated with age ($p < 0.05$).

Renal cadmium, copper, mercury, selenium and zinc neither increased nor decreased significantly over time in the Porcupine caribou herd. However, inter-annual variation in element concentration was common and may be of particular interest in the case of mercury (Figure 3), where that variation may offer insight into potential drivers of this element in caribou. The inter-annual variation seen in mercury levels in the Porcupine caribou herd seems to be at least somewhat cyclic and is likely affected by atmospheric patterns of deposition of Hg as well as local environmental conditions affecting Hg concentrations in winter forage in conjunction with forage availability and selection by the caribou. This includes timing of green-up in the spring and the subsequent switch to lower-mercury forages and could therefore potentially be impacted by a changing climate.

Levels of most elements measured in the Porcupine caribou herd 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.

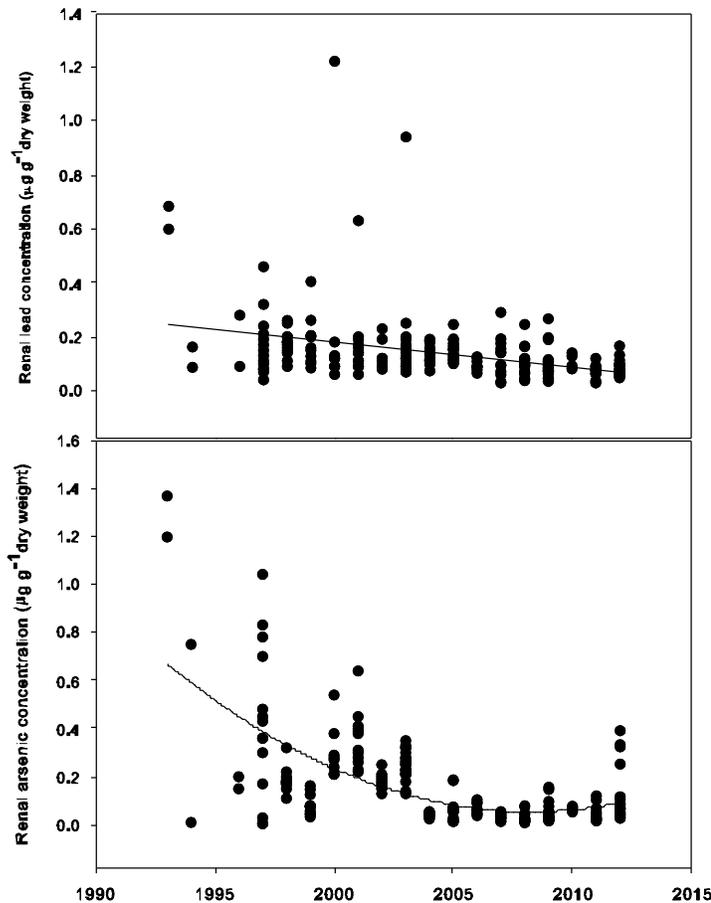


Figure 2. Renal lead (top panel) and arsenic (bottom panel) concentrations in male Porcupine caribou, collected fall, 1993-2012. Both lead and arsenic significantly declined over time ($p < 0.05$).

Data collected from this program continues to provide baseline data for contaminants in the Porcupine caribou as well as a valuable tissue archive for legacy and emerging contaminants. This tissue archive has recently been accessed to assess whether these 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). 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.

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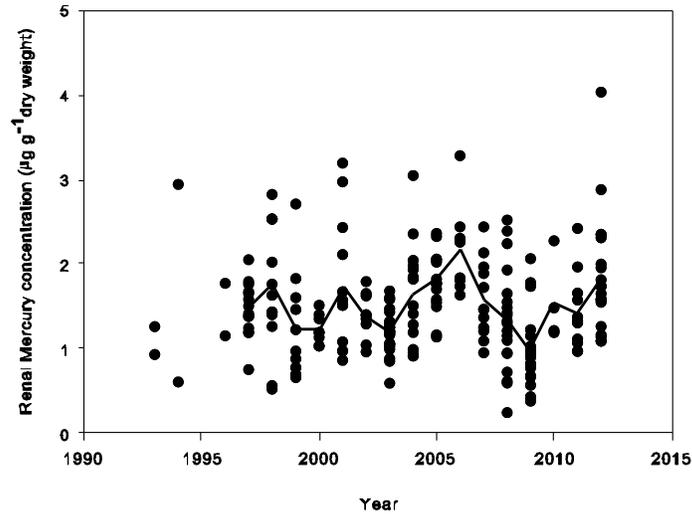


Figure 3. Renal mercury concentrations in male Porcupine caribou, collected fall, 1993-2012. Line indicates running average concentration.

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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	10/24	Whitehorse	20	'Contaminants' presentation to experiential science high school class
	Consultations	11/01 to 01/15	YK NWT NU	16 4 2	Project proposal consultation
	Part of your project team	09/20 to 09/23	Old Crow, YT	11	Collecting caribou samples
		04/04 to 04/16	Selwyn Lake, NT	4	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	11/17 10/18	Whitehorse Whitehorse	1 1	Biodiversity Forum NCP Science Event
	Other	10/17 to 10/18	Whitehorse	1	Radio interview

Expected Project Completion Date: This program is ongoing.

Acknowledgements

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