NCP – Synopsis Report

Title: Porcupine Caribou Monitoring Program

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Abstract
Moose and 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. Samples from 19 Porcupine caribou, submitted by Yukon hunters as part of the ongoing Yukon Hunter Survey Program, were analyzed for a suite of 31 elements.

Levels of renal and hepatic arsenic, cadmium, copper, lead, mercury, selenium and zinc found in Porcupine caribou from this study should all be considered normal background levels that should not pose a toxicological concern for the animals. Cadmium in caribou livers and kidneys could pose a risk to people consuming them (if enough were consumed), and Yukon Health has issued a health advisory recommending limiting consumption of these organs, based on previously collected data. It should be noted that no health advisory has been issued on any wild meat from the Yukon. Copper concentrations measured in the Porcupine caribou are low and may suggest the potential for copper deficiency in some individuals.

Concentrations of renal cadmium, lead, mercury and zinc were significantly higher in spring than in fall, while arsenic and copper concentrations were lower and selenium levels were unaffected by season. This may be related to differential uptake of some elements by lichens and other caribou forage during the summer months, and/or seasonal differences in kidney weights. Concentrations of arsenic, cadmium, copper, lead and mercury were significantly higher in female caribou than in males, while renal concentrations of selenium and zinc were unaffected by gender. This may be related to the higher energy demands of females, and the resulting higher requirement for food relative to body weight. Age was positively correlated with renal cadmium, selenium and zinc concentrations. Renal arsenic showed a significant decline over time while renal mercury showed a significant increase in female caribou, but not in males. Concentrations of both elements may be varying over time in a cyclic rather than a linear fashion. Continuing to monitor these caribou on an annual basis should help to clarify these apparent trends.

Key Messages

- Porcupine caribou continue to be a healthy traditional food choice.
- Most elements measured do not seem to be changing over time; continuing monitoring will clarify the situation with those that do seem to be changing (mercury and arsenic).

Objectives

- To investigate the fate and effects of contaminant deposition and transport to the Yukon, allowing Northerners to better manage the issue of contaminants.
- To determine levels of contaminants in traditional foods for use in long term trend monitoring.
- To provide additional information for use in updating health advisories.

Introduction

Moose and 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. An effective annual hunter collection program of caribou and moose tissues has been carried out in the Yukon since 1993 through the Yukon Contaminants Committee (YCC) Hunter Survey Program. Health advisories have been issued in response to high levels of cadmium in livers and kidneys of moose and caribou, and mercury in caribou kidneys. Ongoing communication from this long-term project maintains dietary confidence in traditional foods for aboriginal and non-aboriginal hunters. The program has also produced a valuable temporal database that allows a more in-depth understanding of annual variation of contaminant levels in the terrestrial environment and an archival tissue sample set that will enable us to generate trends for any relevant "emerging" contaminants as they are identified. The Porcupine caribou are an integral part of this program, and are the focus of the project for 2005/6.

Activities in 2005/6

Kidney, liver, muscle and tooth samples from 32 Porcupine caribou were submitted by Yukon hunters as part of the ongoing Yukon Hunter Survey Program, but not all sample sets were complete. Each hunter submitting samples was sent a letter with the background and results of the program, and the age of their animal. As an incentive, all hunters submitting samples had their name put in a draw to win a charter flight with a local airline.

Incisors were aged using the tooth cementum technique, and liver and muscle samples were archived at $-40^{o}C$ for possible future analysis. Nineteen kidneys and five liver samples were individually homogenized and analyzed for a suite of 31 elements using the inductively coupled plasma technique with mass spectroscopy, and for total mercury using cold vapour atomic absorption spectroscopy. All analyses were conducted at the National Laboratory for Environmental Testing (Environment Canada) under the supervision of Dr. Derek Muir.

Results

Renal and hepatic concentrations of elements of concern are presented in Table 1. A more complete summary of measured elements is presented in the full technical report on this project (Gamberg, 2006). Levels of arsenic, cadmium, copper, lead, mercury, selenium and zinc found in Porcupine caribou from this study should all be considered normal background levels that should not pose a toxicological concern for the animals. Cadmium in caribou livers and kidneys could pose a risk to people consuming them (if enough were consumed), and Health Canada has issued a health advisory recommending limiting consumption of these organs, based on previously collected data. Copper concentrations measured in the Porcupine caribou are low and may suggest the potential for copper deficiency in some individuals.

Discussion and Conclusions

Barren-ground caribou feed mainly on lichen, which absorb contaminants along with necessary nutrients from the air. Having no root system, lichens do not absorb anything from the soil on which they grow. Arctic lichens are blanketed with low concentrations of cadmium brought to the north by long-range transport via large air masses. In the absence of local point sources of airborne cadmium, this is virtually the only route of cadmium contamination for barren-ground caribou, and it tends to be fairly consistent across the arctic. The barren-ground caribou in this study (Porcupine herd) had concentrations of renal cadmium similar to those found in five barren-ground herds studied in the Northwest Territories (Elkin and Bethke 1995), as would be expected. None of the caribou sampled this year had cadmium levels that approached the threshold range of 400-800 $\mu g \cdot g^{-1}$ (dry weight) at which renal tubule dysfunction has been shown to occur (Kjellstrom, 1986), or exceeded the level at which sublethal effects would be expected (150 $\mu g \cdot g^{-1}$ dry weight; Outridge et al., 1994). Because cadmium is a potential health concern for people, Yukon Health has recommended limiting consumption of Porcupine caribou kidneys and livers based on previously collected data.

Renal mercury concentrations found in caribou from this study were low relative to those found in NWT caribou (2.76-14.14 $\mu g \cdot g^{-1}$ dry weight; Elkin and Bethke 1995). Even the highest mercury level measured in this study, (4.9 $\mu g \cdot g^{-1}$ dry weight or 0.99 $\mu g \cdot g^{-1}$ wet weight) is far below the threshold level of 30 $\mu g \cdot g^{-1}$ wet weight cited by Scheuhammer (1991) at which neurological effects might be expected to occur. Braune et al. (1991) suggested that high mercury levels in the Canadian arctic reflect naturally occurring geological sources rather than industrial pollution.

Concentrations of renal cadmium, lead, mercury and zinc were significantly higher in spring-collected female caribou than in fall-collected females, while arsenic and copper concentrations were lower. Renal selenium levels were unaffected by season of collection. This may be related to differential uptake of some elements by lichens and other caribou forage during the summer months. Some of the higher concentrations in spring-collected animals may be attributable to the differences in kidney weight between those two seasons (spring-collected kidneys weighing less than fall-collected kidneys (Crete et al., 1989). If the same absolute amount of an element were present in the kidney

in both seasons, the concentration would be higher when the kidney weighs less (ie. in the spring).

Concentrations of arsenic, cadmium, copper, lead and mercury were significantly higher in female fall-collected caribou than in male fall-collected caribou, while renal concentrations of selenium and zinc were unaffected by gender of the animal. This may be related to the higher energy demands of females (due to reproduction), and the resulting higher requirement for food relative to body weight. It is of note that the elements that were not higher in females, selenium and zinc, are both essential elements that are naturally homeostatically controlled within the body. Copper also falls within that category, but may also be deficient in the caribou diet, so the higher levels in females may reflect more 'adequate' concentrations of copper. The other elements higher in females are toxic, non-essential, and excreted and/or sequestered rather than homeostatically controlled within the body.

Age was positively correlated with renal cadmium, selenium and zinc concentrations. The increase in cadmium concentrations with age has been well documented (Gamberg and Scheuhammer, 1994; Glooschenko et al., 1994) and should be taken into account when assessing data or comparing herds or species. Interestingly, both male and female caribou have similar cadmium concentrations when they are young, but females accumulate cadmium at a greater rate (Fig. 1), likely related to their higher requirement for food relative to body weight (due to reproduction).

Renal arsenic showed a significant decline over time for both male and female caribou, although the decline was more rapid in females (Fig. 2), while renal mercury showed a significant increase in female caribou, but not in males (Fig. 3). For both elements, the data suggest that females are more sensitive to potential environmental drivers of element availability, possibly due to their higher food requirements relative to body weight. The data for both elements also suggest that rather than a linear trend, concentrations may be varying over time in a cyclic fashion. The mercury data, in particular (Fig. 3) seem to suggest a cycle, perhaps reflecting a cyclic environmental driver of mercury availability to the caribou. Continuing to monitor these caribou on an annual basis should help to clarify these apparent trends.

Project Completion Date: Project was completed March 31, 2006

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Table 1. Element concentrations (μg·g-^{1} dry weight) in kidneys and liver (averages and standard deviations) from Porcupine caribou collected in 2005.

	Kidney (N=19)		**Liver (N=5)**	
	Average	**StDev**	**Average**	**StDev**
Age	4.4	1.9	3.2	0.8
Moisture (%)	79.9	1.9	68.4	2.6
Arsenic	0.059	0.050	0.018	0.010
Cadmium	30.38	28.03	2.78	0.73
Copper	23.08	2.29	33.01	8.30
Lead	0.16	0.04	0.18	0.03
Mercury	2.09	0.85	0.31	0.06
Selenium	4.56	0.61	0.90	0.07
Zinc	124.2	18.9	92.5	15.2

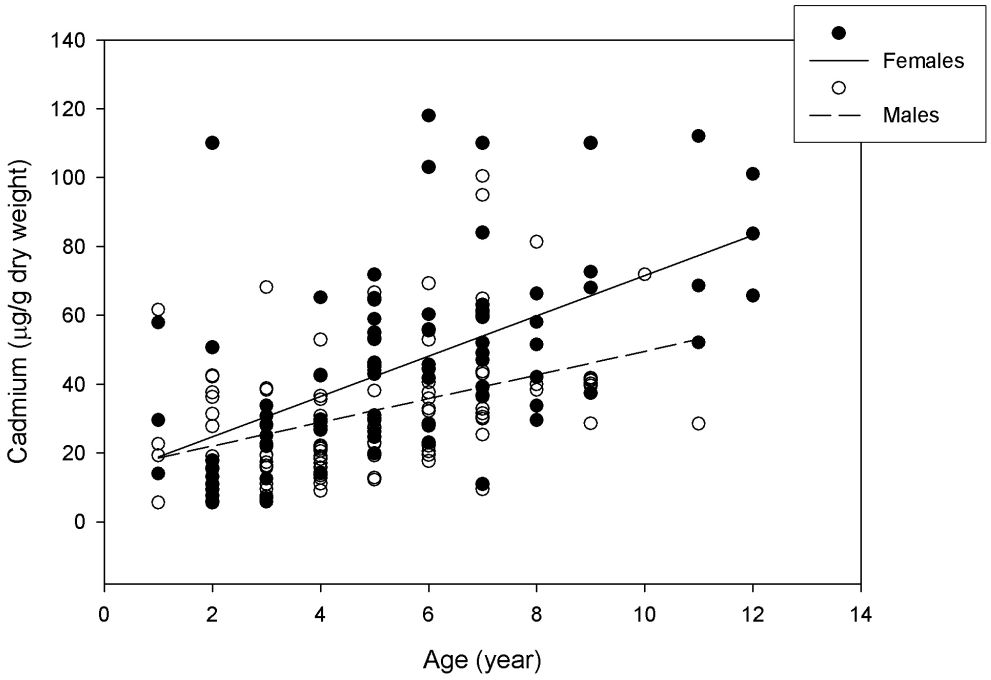

Figure 1. Renal cadmium concentrations in fall-collected Porcupine caribou.

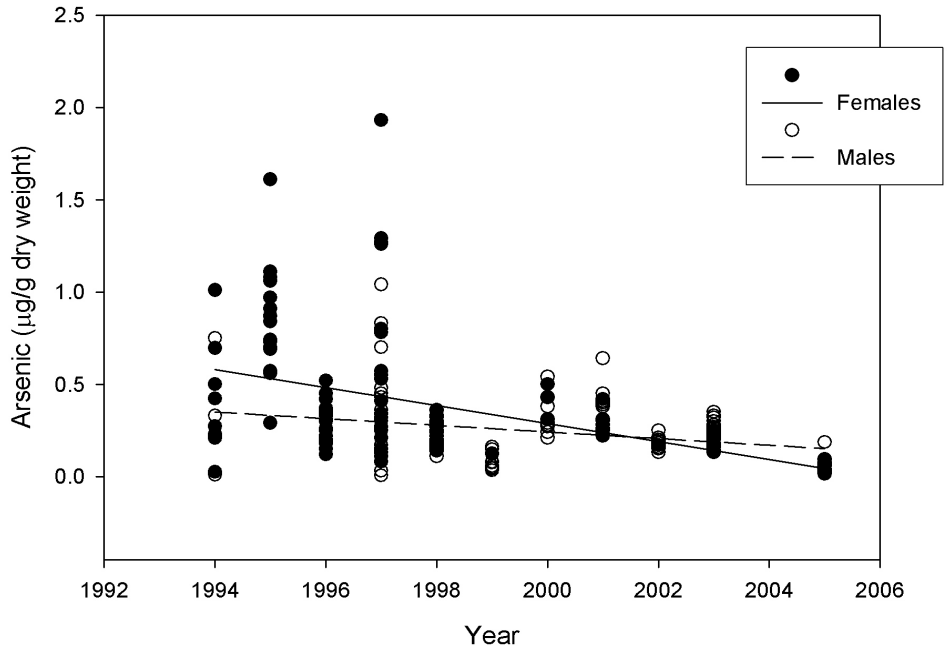

Figure 2. Renal arsenic concentrations in fall-collected Porcupine caribou.

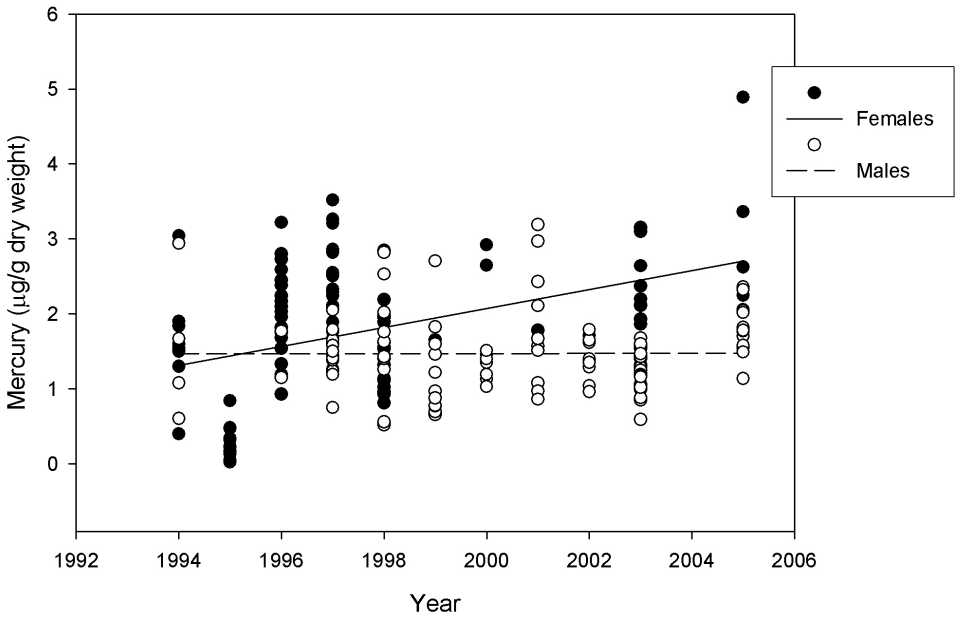

Figure 3. Renal mercury concentrations in fall-collected Porcupine caribou.