**Title:** Arctic Caribou Contaminant Monitoring Program

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**Abstract**
The objective of this project is to determine contaminant levels in caribou in the Canadian Arctic to determine if the animal populations remain healthy (in terms of contaminant loads), whether these important resources remain safe and healthy food choices for northerners and to see if contaminant levels are changing over time. In 2011/12 samples were collected from 16 Porcupine caribou and from 20 Qamanirjuaq caribou. Neither cadmium nor mercury are increasing or decreasing significantly over time in either caribou herd. Lead concentrations in the both 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. Zinc appears to be increasing over time in the Porcupine caribou herd, but this may be part of normal annual fluctuations. These concentrations are not of concern toxicologically, but should continue to be monitored. Levels of most elements measured in both 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. 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 does undergo a cycle. More research is required to determine causes of the cycle and mercury dynamics within the caribou food chain.
- Zinc appears to be increasing in the Porcupine caribou and although not of concern toxicologically at this time, should continue to be monitored.

**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 2010-2011**

Samples were collected from 16 Porcupine caribou in the fall of 2011, 11 from a Yukon Government initiative working with hunters in Old Crow, and 5 from the Hunters and Trapper's Association in Aklavik. Unfortunately only one sample from Aklavik was suitable for analysis, so in total 12 kidneys from the Porcupine herd were analyzed. Complete samples were taken from 20 Qamanirjuaq caribou in the fall of 2011 by one hunter from Arviat, and 20 kidneys were 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).

In addition to these, four samples from 2010 and one sample from 2009 from the Porcupine caribou herd were received from communities. These samples were analyzed as described above and the results added to the database for temporal trend analysis.

Although kidneys were analyzed for 34 elements, only results for 7 elements of concern were analyzed in detail (arsenic, cadmium, copper, lead, mercury, selenium and zinc).

Temporal trends were assessed for the Porcupine and Qamanirjuaq caribou using a general linear model. In the case of the Porcupine caribou only males were considered since all samples collected in 2011 were male. In the case of the Qamanirjuaq caribou only females were considered since only 2 males were included in the 2011 collection. These two males were excluded from the statistical analyses. 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.

**Results and Discussion**

While there was a significant negative correlation between year of collection and renal arsenic in male, fall-collected Porcupine caribou, the absolute decline is small and particularly in the case of arsenic, may reflect an increased ability for the laboratory detection of smaller amounts of the element as well as an increase in precision and accuracy of measurement of this element rather than an actual decline in the caribou over time. It is notable that arsenic concentrations measured prior to 2004 were erratic and variable whereas from 2004 to the present measured renal concentrations have been uniformly low. Renal arsenic concentrations in the Qamanirjuaq caribou have only been measured since 2006 and are similarly uniformly low.

There is a statistically significant decline in renal copper concentrations in the Qamanirjuaq caribou. However, the apparent decline from 2006-2011 closely mirrors fluctuations in renal copper concentrations in the Porcupine caribou for which copper is stable over time (Figure 1). Likely this is simply an artifact of the short time span being analyzed for the Qamanirjuaq caribou.

Table 1. Element concentrations (mg·g-1 dry weight) in fall collected male Porcupine caribou and fall collected female Qamanirjuaq caribou.

Porcupine fall-collected male 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 |

Qamanirjuaq fall-collected female caribou

| Year | N | Age | Arsenic | Cadmium | Copper* | Lead | Mercury | Selenium+ | Zinc |
|---|---|---|---|---|---|---|---|---|---|
| 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 ± 30.5 | 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 ± 16.0 | 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 ± 11.3 | 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 ± 10.9 | 107.9 ± 10.9 |

* indicates a significant decrease over time

+ indicates a significant increase over time

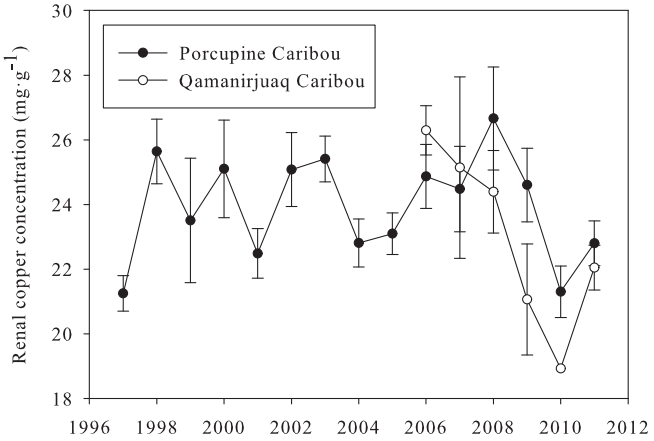


Figure 1. Renal copper concentrations (dry weight) in male Porcupine and female Qamanirjuaq caribou.

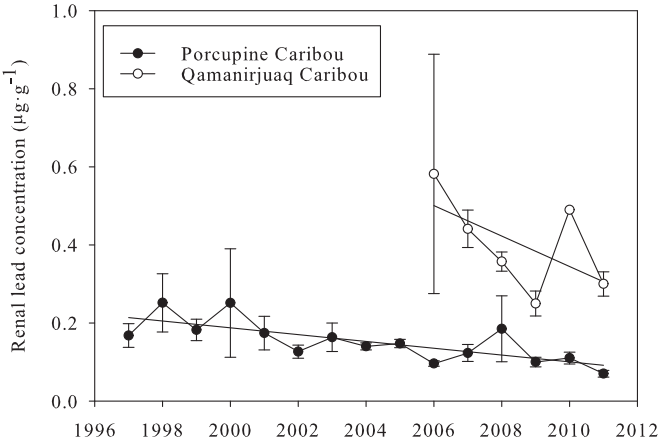


Figure 2. Renal lead concentrations (dry weight) in male Porcupine and female Qamanirjuaq caribou.

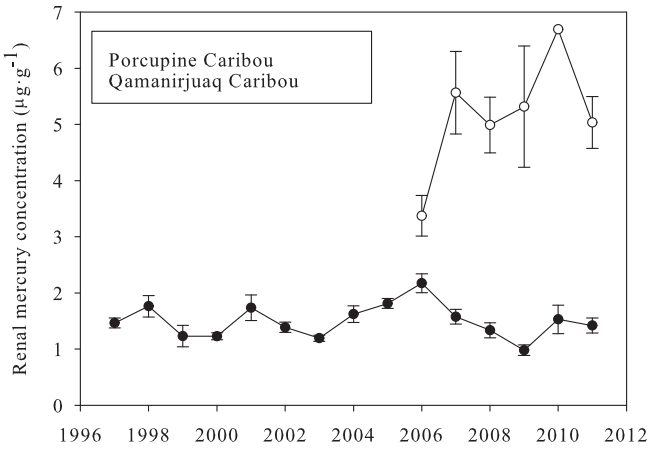


Figure 3. Renal total mercury concentrations (dry weight) in male Porcupine and female Qamanirjuaq caribou.

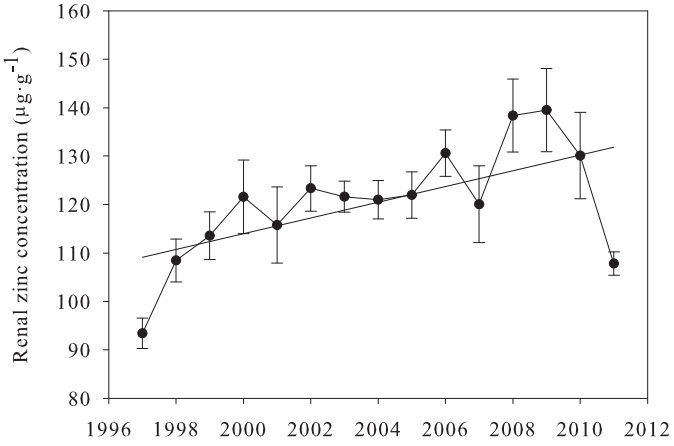


Figure 4. Renal zinc concentrations (dry weight) in male Porcupine caribou.

Renal lead concentrations have declined in both the Porcupine and Qamanirjuaq caribou herds over time (Figure 2), although only the decline in the Porcupine herd is statistically significant (note that there is a much smaller data set for the Qamanirjuaq herd). This decline may reflect the reduction of the use of unleaded gasoline followed by the prohibition of leaded gasoline in Canada in 1990.

Neither cadmium nor mercury are increasing or decreasing significantly over time in either caribou herd. Mercury concentrations in the Qamanirjuaq caribou herd are significantly higher than in the Porcupine herd, likely reflecting environmentally available mercury (Figure 3). Associated research continues to try to

explain annual fluctuations/cycles in mercury, particularly in the Porcupine caribou which has the longest-term data set. Future research will attempt to determine the source of the higher mercury concentrations in the Qamanirjuaq herd.

Renal selenium concentrations appear to be increasing in female fall-collected Qamanirjuaq caribou. However, the time span analyzed is short and the variability among years quite small, so whether this is an actual temporal increase remains to be seen. Selenium concentrations in these caribou do not approach concentrations thought to be toxic for domestic cattle (Puls 1994) and should not be a toxicological concern.

Zinc appears to be increasing over time in kidneys from male, fall-collected caribou, but not in the Qamanirjuaq herd. It is not clear why this increase is occurring, but Figure 4 shows that concentrations were low from 2002-06, then increasing until a drop in 2010 and 2011. These fluctuations may be part of a natural cycle for zinc in these caribou. Zinc is an essential and homeostatically controlled element and is unlikely to occur at toxic levels in a natural environment. Even the highest levels seen in these caribou do not approach levels that are thought to be toxic for domestic cattle (Puls 1994). Nevertheless, continuing to monitor zinc in this herd would be prudent.

Contaminants of concern in the Porcupine and Qamanirjuaq caribou are generally stable over time, although the increase in renal zinc in the Porcupine herd should continue to be monitored. Renal lead levels in both herds are declining and likely reflect reductions in levels of lead in the environment. Levels of most elements measured in both 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.

**NCP Performance Indicators**
Number of northerners engaged in this project: 15
Number of meetings/workshops held in the north: 1
Number of students involved in this project: 0
Number of citable publications: 1 anticipated (in addition to NCP synopsis report)

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

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**References**
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