NCP – Synopsis Report

Title: Arctic Caribou and Moose Contaminant 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. Two barren-ground caribou herds, one from the eastern and one from the western Arctic, have been designated for annual sampling, and five additional caribou herds and two moose populations have been designated for sampling every five years. In 2008/9 tissue samples were collected from Yukon moose and the Porcupine and Qamanirjuaq caribou. Analysis of samples collected in 2005-8 showed that renal copper levels are declining in the Bluenose East caribou. This could potentially affect the health of the animals if they become severely copper deficient. Renal lead concentrations are increasing in the Bathurst caribou herd. It is unclear why this is happening, so further research is being conducted. Renal mercury concentrations are increasing in female Porcupine and Bathurst caribou and to a lesser extent in male Porcupine caribou. Female caribou are considered to be more sensitive indicators of changes in available environmental mercury. None of the elements measured were present at levels that would be expected to have toxic effects in caribou.

Key Messages

- Copper levels are declining in the Bluenose East caribou herd which could affect the health of the caribou.
- Lead levels are increasing in the Bathurst caribou although it is unclear why. Ongoing studies will try to determine why this trend is occurring.
- Mercury concentrations are changing over time in some herds, and increasing in female Porcupine and Bathurst caribou. Ongoing studies will help to determine why these trends are occurring.
- None of the elements measured were present at levels that would be expected to have toxic effects in caribou.

Objectives
To determine levels of and temporal trends in contaminants in Arctic caribou and moose 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 moose and caribou populations.
- Further understand the fate and effects of contaminant deposition and transport to the Canadian Arctic.

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. Two barren-ground caribou herds, one from the eastern Arctic and one from the western Arctic, have been designated for annual sampling, and five additional caribou herds and two moose populations have been designated for sampling every five years.

Activities in 2008-9

Tissue samples were collected from the Porcupine and Qamanirjuaq caribou herds and moose from the Yukon. Sampling information was also collected for each animal, including gender, date and location of collection.

Yukon moose and Porcupine caribou were sampled by local hunters as part of the ongoing Yukon Hunter Survey Program. Samples from the Qamanirjuaq caribou herd were taken by a local hunter under the supervision of the local regional biologist.

All samples were prepared for analysis in Whitehorse, YT by the program coordinator and analyzed at the National Laboratory for Environmental Testing (Environment Canada) using the inductively coupled plasma technique with mass spectroscopy, and for total mercury using cold vapour atomic absorption spectroscopy, under the supervision of Dr. Derek Muir. Remaining liver and muscle samples were archived at –50^{o}C at the INAC facility in Whitehorse, YT. Moose and caribou teeth were aged by the project leader and a Yukon Environment technician in Whitehorse using the tooth cementum technique.

Results and Discussion

Laboratory analyses of samples collected from 2008/9 are expected to be available by fall, 2009. Results for samples collected 2005-08 are presented here (Table 1). Although 31 elements were measured, only results for 7 elements of concern were analyzed in detail (arsenic, cadmium, copper, lead, mercury, selenium and zinc). Where possible, data collected from previous years (under this program and by GNWT) were used along with the current data to explore temporal trends. Renal cadmium, mercury, selenium and zinc increased with age in at least some caribou herds, so age was used as a covariable in analyses. Season of collection also affected some element concentrations; mercury was

Herd	Season	Sex	Year	N	Age	Arsenic			Cadmium			Copper			Lead			M
Bathurst	Fall/ Winter	F	2006	25	N/A	0.22	±	0.08	29.3	±	18.1	16.2	±	3.6	0.29	±	0.11	5.30
			2007	5	3.0	0.12	±	0.01	20.5	±	19.4	24.0	±	0.8	0.16	±	0.08	1.40
		M	2005	22	N/A	0.08	±	0.03	18.4	±	8.8	21.6	±	3.1	0.14	±	0.14	1.77
			2007	11	2.7	0.14	±	0.06	19.4	±	25.9	24.6	±	4.3	0.16	±	0.05	1.41
	Spring/ Summer	F	2008	23	N/A	0.08	±	0.04	38.1	±	17.9	21.8	±	1.7	0.26	±	0.13	4.86
		M	2008	1	N/A	0.07			20.1	±		22.1			0.33			4.53
Beverly	Spring/ Summer	F	2008	10	6.3	0.06	±	0.02	34.3	±	23.1	20.5	±	2.9	0.31	±	0.08	5.71
		M	2008	1	4.0	0.10			30.8			20.3			0.28			7.22
Bluenose East	Spring/ Summer	F	2005	5	6.8	0.03	±	0.01	46.7	±	32.5	18.0	±	1.4	0.23	±	0.06	4.49
		M	2006	15	4.6	0.04	±	0.01	22.9	±	10.7	17.4	±	2.2	0.40	±	0.78	4.67
George River	Fall/ Winter	F	2008	15	4.9	0.03	±	0.01	16.8	±	9.7	22.1	±	1.8	0.47	±	0.13	5.15
		M	2008	6	2.7	0.03	±	0.01	10.7	±	4.2	23.4	±	3.7	0.37	±	0.08	4.40
Porcupine	Fall/ Winter	F	2005	4	7.3	0.05	±	0.03	56.4	±	51.1	22.5	±	2.0	0.19	±	0.06	3.28
			2006	3	4.0	0.07	±	0.00	41.4		22.9	22.8	±	2.7	0.14	±	0.06	3.21
			2007	1	7.0	0.04			24.2			17.6			0.11			1.25
		M	2005	14	3.8	0.05	±	0.04	23.1	±	14.8	23.1	±	2.4	0.15	±	0.04	1.81
			2006	11	4.9	0.07	±	0.03	38.7	±	22.3	25.3	±	3.0	0.23	±	0.40	2.07
			2007	6	4.3	0.04	±	0.01	21.0	±	7.0	23.7	±	6.3	0.18	±	0.06	1.72
Qaminuriaq	Fall/ Winter	F	2006	7	7.3	0.03	±	0.02	18.7	±	13.9	26.3	±	2.0	0.58	±	0.81	3.37
			2007	10	5.1	0.04	±	0.01	24.0	±	15.7	25.1	±	8.9	0.44	±	0.15	5.57
		M	2006	14	5.8	0.01	±	0.01	14.0	±	8.9	25.8	±	1.8	0.34	±	0.24	2.58
			2007	8	4.0	0.03	±	0.01	11.5	±	8.2	20.8	±	2.5	0.39	±	0.21	4.23

Table 1. Renal element concentrations (µg/g dry weight) in caribou herds collected in 2005-8 (Mean ± standard

higher in spring-collected animals while copper was higher in fall-collected animals. It is important to take this into account when comparing results among herds.

Copper, selenium and zinc are required in trace amounts for the normal functioning of the animal and although selenium and zinc were found in adequate concentrations in all caribou herds measured, copper levels are considered marginal. There is no evidence that any of these elements reached toxic levels in any of the animals measured. The toxic elements (arsenic, cadmium, lead and mercury) were found in measurable amounts, but never higher than is considered 'normal to high' for domestic cattle (Puls 1994). None of these elements approached levels that would be expected to cause toxic effects in the caribou.

Renal cadmium concentrations in caribou showed a general geographical trend, increasing from east to west (Figure 1). Terrestrial lichens from the Yukon averaged 0.08 mg/g (dry weight)(unpublished data) as compared with an average of 0.171 mg/g (dry weight) in northern Quebec (Crête et al. 1992). This suggests that the long-range transport of cadmium that is then absorbed by Arctic lichens and consumed by caribou is not the cause of this trend. It likely reflects higher levels of naturally occurring cadmium in the soil in the west, which is taken up by cadmium hyperaccumulators like willows and passed on to caribou foraging on the willows.

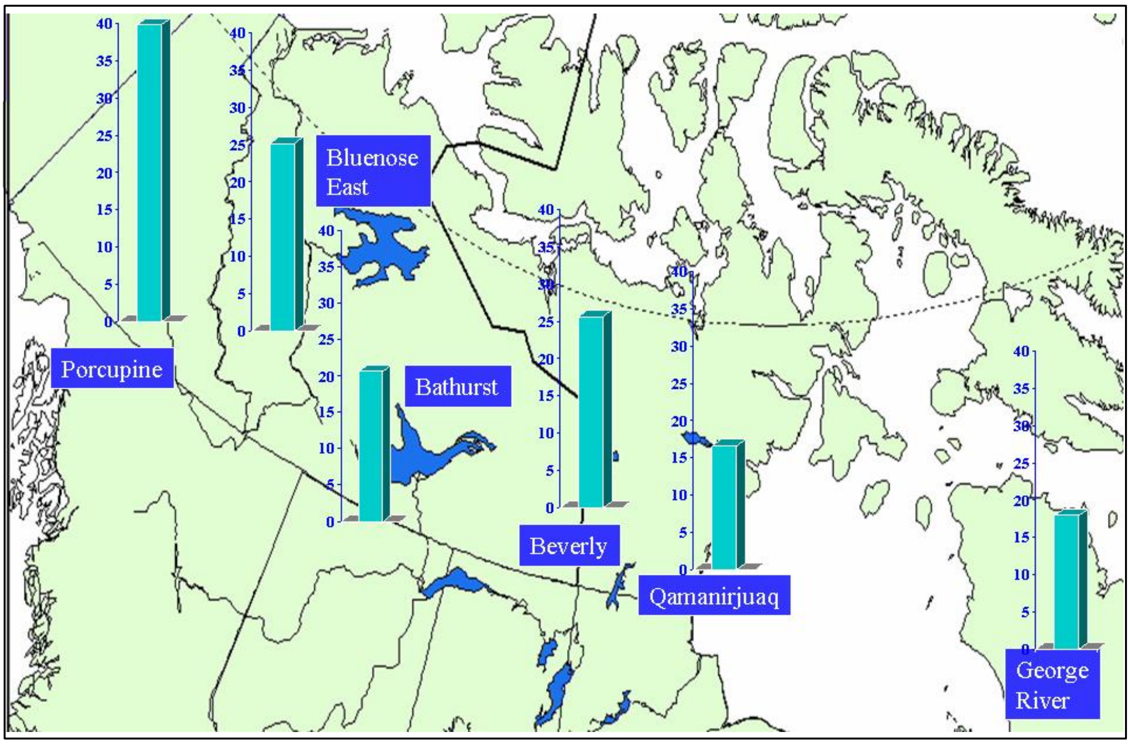

Figure 1. Average renal cadmium concentrations (µg/g dry weight) in 4-6 year old caribou.

Although most caribou herds measured had low levels of copper when compared with the level of 10-25 ppm (wet weight) that was considered 'marginal' for moose (Flynn and Franzman 1987), the combination of low and declining copper concentrations in the Bluenose East herd (Figure 2) may be a particular concern for the health of the animals in this herd. The average concentration of copper in the Bluenose East herd (4.4 ppm wet weight) is only slightly higher than the 3.72 ppm (wet weight) thought indicative of copper deficiency causing death in moose from Alaska (O'Hara et al. 2001). Copper deficiency can cause reduced fertility and low conception and ovulation rates in cattle (Puls 1994), so even if concentrations are not low enough to cause mortality, they may be low enough to be having an effect on reproduction and therefore population growth/decline. Further monitoring of this herd is recommended.

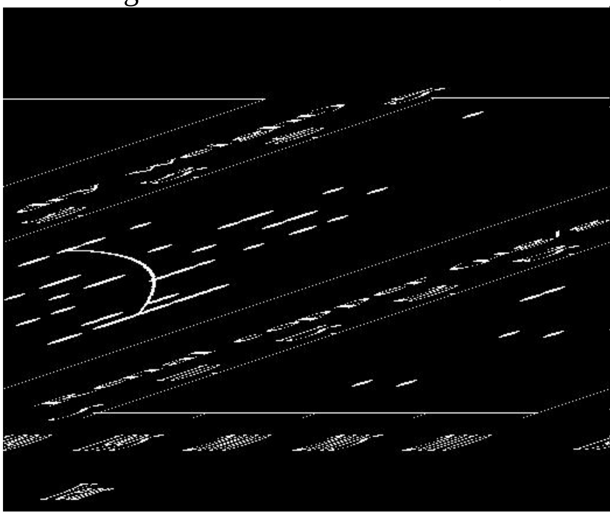

Figure 2. Renal copper concentrations in the Bluenose East caribou herd.

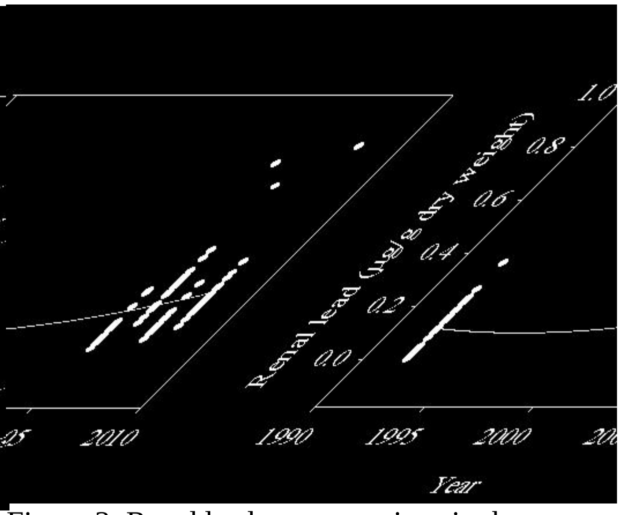

Figure 3. Renal lead concentrations in the Bathurst caribou herd.

Renal lead concentrations were generally low, but are increasing over time in the Bathurst herd (Figure 3). It is not clear why this increase is occurring, particularly since it is unique to this herd. Caribou forage samples from the Bathurst range will be collected in the summer of 2009 and analyzed for lead to try to determine the origin of this contaminant.

Analyzing temporal trends using the current data is difficult for many of the caribou herds because annual sampling has not often been conducted. The Porcupine caribou herd has been sampled annually since 1994, making it the ideal candidate for temporal trend analysis. Renal mercury concentrations are increasing significantly over time in female Porcupine (both spring and fall-collected) and although concentrations in male Porcupine caribou are also increasing over time (Figure 4), the relationship is not quite significant ($p=0.055$). A recent NCP study on mercury in caribou forage concluded that female Porcupine caribou consume proportionally more mercury than males simply because they consume proportionally more forage. This makes them more sensitive environmental indicators of changes in available environmental mercury than male caribou.

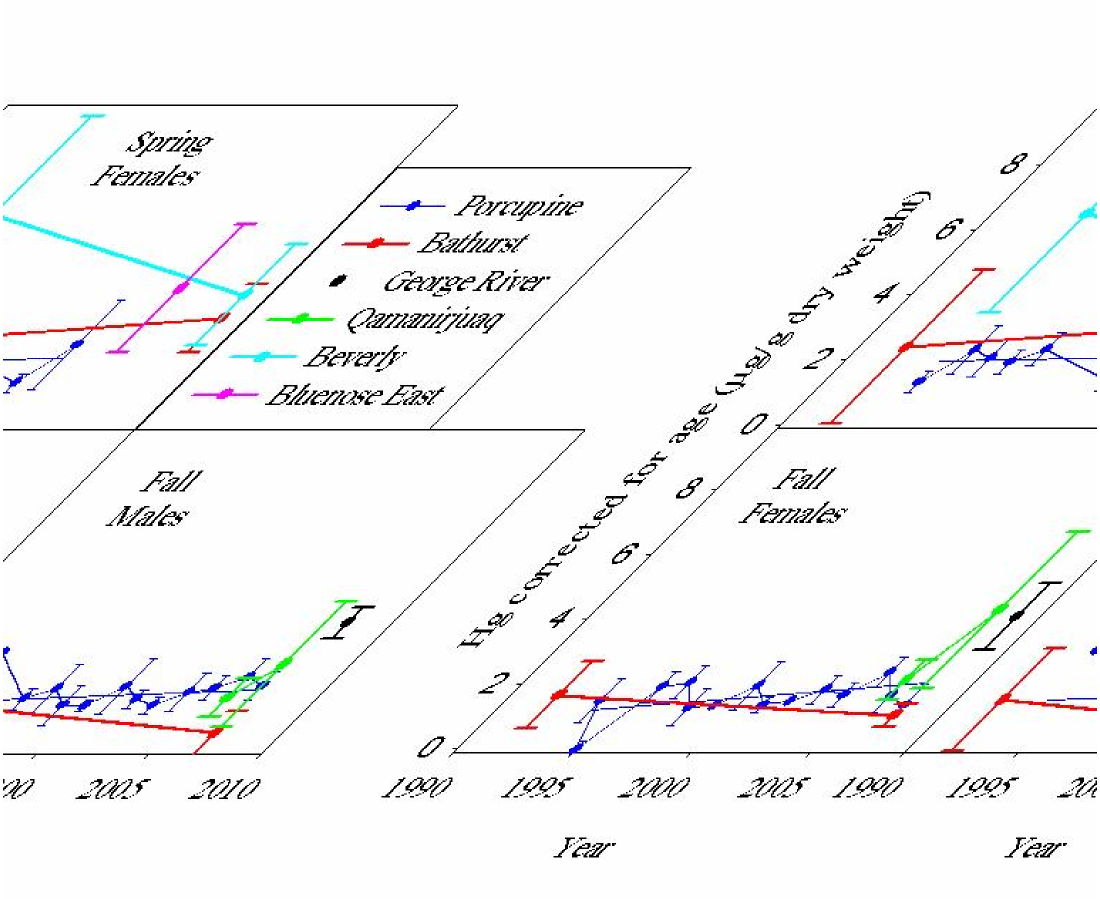

Figure 4. Temporal trend of age-corrected renal Hg in fall-collected Porcupine caribou.

Renal mercury concentrations in spring-collected female Bathurst caribou are also increasing over time, but are decreasing in fall-collected males and females, and in all animals in the Beverly herd. Although these are statistically significant relationships ($p<0.05$), they are driven largely by relatively old data (>15 years) with low sample numbers and the comparisons may be confounded by differences in tissue preparation or analysis. Continuing monitoring of these herds using standardized techniques should give a more reliable picture of temporal trends. The Qamanirjuaq caribou herd also shows an increase in renal mercury for males and females (Figure 4) but it is over only two years. Again, continuing to monitor this herd on an annual basis will indicate whether this is a true temporal increase or simply annual variation. Although average renal mercury was slightly lower in George River caribou collected in 2007 than those collected in 1994-96 (0.56 ppm wet weight; [Robillard et al. 2002] as compared with 0.49 ppm wet weight from this study), since age corrections were unable to be applied to the earlier data, a valid comparison is not possible.

Project Completion Date: This project is ongoing.

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