**Title: Arctic Caribou Contaminant Monitoring Program**

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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 2016/17 samples were collected from 23 Porcupine, 40 Qamanirjuaq, 23 Bluenose West and 10 Ahiak caribou. Samples were taken from an additional 20 Qamanirjuaq cows immediately post-rut to explore the possible effect of mercury on pregnancy. Sample analyses for these collections had not been completed at the time this report was prepared. Porcupine, Qamanirjuaq, Bluenose East and Dolphin & Union samples collected in the 2015/16 year have been analyzed, and results are presented in this report. Age was positively correlated with renal Cd and Zn in the Porcupine, Qamanirjuaq and Beverly caribou. Renal lead declined over time in those three herds as well. Mercury appears to be stable over the long term in the Porcupine and Qamanirjuaq herds. Toxic elements tended to be higher in cows than bulls, likely due to the relatively higher volume of food intake (and hence toxic element intake) by cows due to their smaller size and higher energetic requirements from parturition and lactation. Levels of most elements measured in caribou kidneys 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 25 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.
- Mercury concentrations in the Porcupine and Qamanirjuaq caribou appear to be stable over the long term.
- 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, and two additional herds are sampled each year on a rotating basis.

**Activities in 2016/17**

Samples were collected from 23 Porcupine caribou in the fall of 2016 by hunters in Old Crow with the assistance of Environment Yukon (Martin Kienzler and Mike Suitor). Samples were collected from 20 Qamanirjuaq caribou herd in Arviat in the fall of 2016 in cooperation with the Arviat Hunters and Trappers Organization. An additional 20 Qamanirjuaq caribou cows were sampled in the fall of 2016 immediately post-rut to explore the potential relationship between mercury and pregnancy. GNWT (Stephanie Behrens) provided 23 kidneys from the Bluenose West caribou herd, 13 collected in the spring of 2005 and 10 collected in the spring of 2014. This herd was previously sampled in the spring of 1994 and 2002. Samples were collected from 10 Ahiak caribou in cooperation with the Spence Bay Hunters and Trappers Organization in Taloyoak, NU.

Current-year kidney samples are currently being analyzed for a suite of 34 elements using ICP-MS by NLET, Environment Canada, Burlington (Xiaowa Wang, Derek Muir). Ten liver samples from the Porcupine and Qamanirjuaq herds are being analyzed for PBDEs (including deca-BDE), PFOS and PFCAs by a private laboratory (ALS Global). Twenty fecal samples from the post-rut Qamanirjuaq caribou cows were analyzed for pregnancy at the Toronto Zoo and twenty liver and kidney samples from the same animals are currently being analyzed for total mercury at NLET. Liver and muscle samples were archived at the National Wildlife Research Centre (Environment Canada). Incisors were used to analyze age of the animal using the cementum technique (Angela Milani, Government of Yukon).

*Capacity Building*

In October 2016, 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 in caribou, specifically. This workshop will be offered again in November 2017.

*Communications*

Results of this project were communicated in the following ways: ‘Contaminants in Arctic Caribou: 20 years of research from Yukon, NWT, Nunavut and Greenland’ as part of a Climate Change Lecture series offered by MacBride Museum of Yukon History and the Northern Climate Exchange, Yukon Research Centre, Yukon College, September, 2016; Presented to Environmental Technology Program of Arctic College in Iqaluit in September, 2016, as part of an NCP project: Wildlife Contaminants Workshop–linking wildlife and human health through a hands-on workshop; Presented to the Whitehorse High School Experiential class at Wood St. School, October, 2016; Presented to the Arviat HTO, Oct 2, 2016; Distributed ‘Report to Hunters of the Porcupine Caribou Herd’ widely to stakeholders, Nov, 2016; Distributed ‘Report to Hunters of the Qamanirjuaq Caribou’ (fact sheet and poster formats) widely to stakeholders (English and Inuktitut), Jan, 2017; Presented to Yukon community members at part of the Yukon Contaminants Workshop in Whitehorse, March, 2017.

Three manuscripts are currently being prepared for publication of data from this project. The first will be a comparison of contaminant profiles of various Arctic caribou herds which will incorporate mostly element data collected under NCP, but will also include data provided collaboratively by other researchers on caribou from Banks Island NWT, Greenland, Sweden, Svalbard and Russia. The second paper will be a comparison of Perfluorinated compounds in the same herds. The third paper will focus on temporal trends of contaminants in the Porcupine caribou and will attempt to interpret temporal changes with environmental drivers.

*Traditional Knowledge Integration*

This program relies on the traditional knowledge of both Aboriginal and non-Aboriginal people when collecting samples from caribou for analysis. 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 HTOs provide an opportunity for the exchange of traditional and western scientific information that enhance understanding of contaminants in caribou and facilitate the implementation of this project. In the fall of 2014, meetings with HTOs in the small communities in the Hudson Bay region, yielded the traditional Inuit knowledge that caribou commonly consume seaweed, which could be a significant source of mercury for Qamanirjuaq caribou. This information has been incorporated into a companion project exploring mercury in seaweed, lichens and mushrooms in the Kivalliq region.

**Results and Discussion**

Results are presented for samples collected in 2015 in the spring (Bluenose East herd) and fall (Porcupine, Qamanirjuaq and Dolphin & Union herds). Although kidneys were analyzed for 34 elements, only results for 7 elements of concern were statistically analyzed in detail (arsenic [As], cadmium [Cd], copper [Cu], lead [Pb], mercury [Hg], selenium [Se] and zinc [Zn]). Porcupine, Qamanirjuaq and Dolphin & Union results were compared to previous results from fall-collected animals and Bluenose East results were compared with previous results from spring-collected animals. In all statistical analyses, data were log-transformed, where necessary to achieve normality. If normality was not achieved by this transformation, non-parametric tests were used to analyze the data.

Results for the seven elements of interest are presented in Table 1. Age was positively correlated with renal Cd and Zn in the Porcupine, Qamanirjuaq and Beverly caribou. These correlations were not apparent in the Dolphin & Union caribou, likely because of lower sample numbers. Correlations between some elements and age are common in ungulates and need to be considered when comparing element concentrations within and among caribou herds (Gamberg et al. 2005).

Levels of most elements measured in these caribou herds were not of concern toxicologically, although renal Hg and Cd 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 25 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.

***Porcupine Caribou***

Only two cows were sampled in 2015, so differences in element concentrations between genders were unable to be tested.

Renal As and Pb have declined significantly over time in fall-collected bulls from the Porcupine caribou herd, while none of the other elements studied changed significantly (Figure 1). These declines may reflect reductions in emissions since the shift to unleaded gasoline and away from arsenical pesticides, or they may reflect increased precision and accuracy in laboratory analyses. Renal Hg continues to be stable over the long term in this herd, while undergoing cyclic fluctuations (Figure 2). These fluctuations are likely affected by atmospheric patterns of deposition of Hg as well as local environmental conditions affecting Hg concentrations

Table 1. Renal element concentrations (X ± SD; µg·g$^{-1}$ dry weight).

| Year | N | Age | Arsenic | Cadmium | Copper | Lead | Mercury | Selenium | Zinc |
|---|---|---|---|---|---|---|---|---|---|
| **Porcupine herd; Fall-collected Males** | | | | | | | | | |
| 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 | 112.8 ± 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 |
| 2013 | 22 | 5.3 | 0.04 ± 0.02 | 21.2 ± 9.2 | 24.3 ± 2.6 | 0.07 ± 0.02 | 1.79 ± 0.50 | 4.3 ± 0.5 | 109.4 ± 6.5 |
| 2015 | 15 | 5.2 | 0.04 ± 0.04 | 23.0 ± 10.6 | 24.6 ± 2.9 | 0.08 ± 0.03 | 1.37 ± 0.40 | 4.3 ± 0.4 | 116.2 ± 10.1 |
| **Qamanirjuaq caribou; Fall-collected** | | | | | | | | | |
| **Females** | | | | | | | | | |
| 2006 | 7 | 7.3 | 0.03 ± 0.007 | 18.7 ± 5.3 | 26.3 ± 0.8 | 0.58 ± 0.31 | 3.37 ± 0.36 | 3.6 ± 0.2 | 104.1 ± 3.2 |
| 2007 | 10 | 5.1 | 0.04 ± 0.003 | 24 ± 5.0 | 25.1 ± 2.8 | 0.44 ± 0.05 | 5.57 ± 0.74 | 4.1 ± 0.4 | 110.1 ± 9.6 |
| 2008 | 10 | 8.1 | 0.04 ± 0.005 | 29.7 ± 3.7 | 24.4 ± 1.3 | 0.36 ± 0.02 | 4.99 ± 0.50 | 4.0 ± 0.2 | 105.7 ± 5.1 |
| 2009 | 4 | 0.5 | 0.04 ± 0.009 | 19.8 ± 7.4 | 21.1 ± 1.7 | 0.25 ± 0.03 | 5.32 ± 1.08 | 3.5 ± 0.1 | 94.7 ± 5.6 |
| 2010 | 1 | | 0.05 | 21.5 | 18.9 | 0.49 | 6.69 | 3.8 | 96.5 |
| 2011 | 17 | 6.0 | 0.04 ± 0.005 | 21 ± 6.0 | 22.0 ± 0.7 | 0.30 ± 0.03 | 5.04 ± 0.46 | 4.2 ± 0.1 | 107.9 ± 2.6 |
| 2013 | 4 | 5.5 | 0.03 ± 0.004 | 31.1 ± 17.6 | 27.2 ± 0.9 | 0.26 ± 0.05 | 3.96 ± 0.36 | 4.4 ± 0.1 | 120.5 ± 7.9 |
| 2014 | 10 | 10.0 | 0.04 ± 0.004 | 28.6 ± 4.4 | 19.9 ± 2.1 | 0.27 ± 0.07 | 5.45 ± 0.55 | 3.5 ± 0.3 | 98.2 ± 11.0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2015 | 9 | 7.1 | 0.03 ± 0.011 | 26.2 ± 9.8 | 25.8 ± 2.5 | 0.16 ± 0.03 | 5.22 ± 1.39 | 4.5 ± 0.4 | 117.7 ± 4.4 |

Table 1 (continued). Renal element concentrations (X ± SD; $\mu g \cdot g^{-1}$ dry weight).

| Year | N | Age | Arsenic | Cadmium | Copper | Lead | Mercury | Selenium | Zinc |
|---|---|---|---|---|---|---|---|---|---|
| **Qamanirjuaq caribou; Fall-collected** | | | | | | | | | |
| **Males** | | | | | | | | | |
| 2006 | 14 | 5.8 | 0.01 ± 0.003 | 14 ± 2.4 | 25.8 ± 0.5 | 0.34 ± 0.07 | 2.58 ± 0.23 | 3.6 ± 0.1 | 112.3 ± 3.7 |
| 2007 | 8 | 4.0 | 0.03 ± 0.004 | 11.5 ± 2.9 | 20.8 ± 0.9 | 0.39 ± 0.08 | 4.23 ± 0.57 | 3.6 ± 0.2 | 94.2 ± 3.6 |
| 2008 | 11 | 5.0 | 0.03 ± 0.003 | 16.8 ± 2.8 | 24.4 ± 1.3 | 0.27 ± 0.03 | 3.10 ± 0.47 | 4.1 ± 0.1 | 105.8 ± 2.6 |
| 2009 | 1 | | 0.04 | 3.84 | 22.4 | 0.36 | 4.72 | 3.6 | 90.0 |
| 2011 | 2 | 5.5 | 0.03 ± 0.014 | 15.3 ± 2.9 | 22.9 ± 1.3 | 0.25 ± 0.09 | 4.77 ± 1.94 | 4.7 ± 0.5 | 110.5 ± 2.6 |
| 2014 | 10 | 6.9 | 0.04 ± 0.004 | 19.2 ± 3.9 | 23.0 ± 3.1 | 0.18 ± 0.02 | 5.42 ± 0.68 | 4.1 ± 0.3 | 99.9 ± 3.5 |
| 2015 | 9 | 6.8 | 0.03 ± 0.011 | 17.1 7.0 | 23.9 ± 2.5 | 0.15 ± 0.07 | 3.55 ± 1.18 | 4.3 ± 0.3 | 114.4 ± 6.2 |
| **Dolphin & Union herd; Fall-collected Males** | | | | | | | | | |
| 1993 | 9 | 5.7 | | 4.3 ± 6.5 | 23.0 ± 6.4 | 0.16 ± 0.14 | 1.62 ± 1.79 | | 98.5 ± 22.2 |
| 2006 | 3 | 3.7 | 0.05 ± 0.018 | 5.3 ± 4.1 | 22.5 ± 2.2 | 0.13 ± 0.06 | 2.73 ± 0.19 | 3.4 ± 0.5 | 104.4 ± 16.7 |
| 2015 | 14 | 4.1 | 0.02 ± 0.005 | 12.2 ± 4.2 | 19.1 ± 3.5 | 0.07 ± 0.07 | 1.40 ± 0.79 | 3.4 ± 0.4 | 108.0 ± 17.7 |
| **Bluenose East herd; Spring-collected** | | | | | | | | | |
| **Females** | | | | | | | | | |
| 1998 | 10 | | | 18.9 ± 14.6 | 23.4 ± 7.6 | 0.28 ± 0.13 | 2.19 ± 1.14 | | 108.7 ± 27.4 |
| 2005 | 5 | 6.8 | 0.03 ± 0.011 | 46.7 ± 32.5 | 18.0 ± 1.4 | 0.23 ± 0.06 | 4.49 ± 2.02 | 3.5 ± 0.4 | 97.5 ± 8.0 |
| 2013 | 13 | 6.4 | 0.10 ± 0.035 | 62.9 ± 19.2 | 22.1 ± 1.1 | 0.19 ± 0.06 | 4.60 ± 1.35 | 4.5 ± 0.4 | 120.7 ± 8.6 |
| **Males** | | | | | | | | | |
| 2006 | 15 | 4.6 | 0.04 ± 0.013 | 22.9 ± 10.7 | 17.4 ± 2.2 | 0.4 ± 0.78 | 4.67 ± 0.97 | 4.1 ± 1.0 | 101.5 ± 24.2 |
| 2013 | 7 | 3.1 | 0.10 ± 0.04 | 30.4 ± 15.1 | 21.4 ± 2.5 | 0.15 ± 0.04 | 3.53 ± 0.80 | 4.1 ± 0.5 | 112.1 ± 10.8 |

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-Hg forages and could therefore potentially be impacted by a changing climate.

***Qamanirjuaq Caribou***

Renal As, Cd and Hg were higher in fall-collected cows than bulls from the Qamanirjuaq herd. This likely reflects the proportionally greater intake of food (and hence contaminants) by the smaller cows that have higher energetic requirements due to parturition and lactation. Homeostatically controlled essential elements did not generally follow this trend. It is notable that although lead did not follow the trend for toxic elements (being higher in cows), the three bulls that had higher Pb concentrations had smaller kidneys, likely indicative of a smaller body size, making them more similar to cows. Renal Pb decreased over time in the Qamanirjuaq caribou as it did in the Porcupine and Bluenose East herds (Figure 1). Renal Se increased over time in both genders and renal Zn increased over time in just cows. In both cases the changes were small and likely of little biological significance. Renal Cd did not change over time. Although it appears that renal As and Hg increased over time in bulls, this is likely an artifact of the minimal number of bulls sampled since 2008. In fact, both elements in bulls closely follow those in cows which are not changing over time (Figure 2).

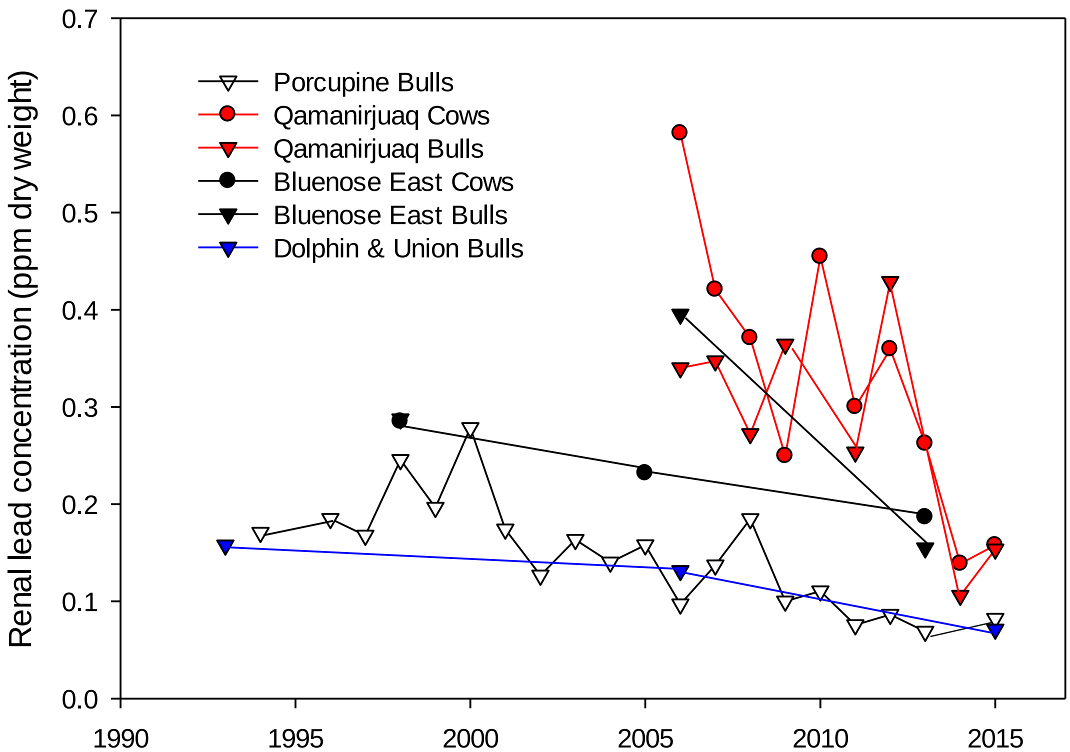


Figure 1. Average renal lead concentrations in four Arctic caribou herds.

***Bluenose East Caribou***

Results from Bluenose East caribou collected in the spring of 2013 were compared to those from four other spring collections (1998, 2002, 2005 and 2006). Renal Cd was higher in cows than bulls, as was seen in the Porcupine and Qamanirjuaq caribou. The lack of differences between genders for other elements demonstrates a difference from the other herds, possibly reflecting the sporadic nature of the sampling for the Bluenose East herd, as compared with the more frequent annual sampling of the Porcupine and Qamanirjuaq herds. Renal Pb has declined over time in the Bluenose East caribou, as in the Porcupine and Qamanirjuaq herds (Figure 1), and likely for the same reason. Renal As, Cd, Hg, Se and Zn demonstrated significant increases over time in the Bluenose herd, although with large gaps among sampling years, it is difficult to say whether these are true increases or simply parts of cycles that are not evident due to the paucity of data (Figure 2).

***Dolphin & Union Caribou***

Results from Dolphin & Union caribou collected in the fall of 2015 were compared to bulls collected from the fall of 1993 and 2006. Renal Cu, Pb, Hg, Se and Zn showed no differences among years while As showed a decreasing trend and Cd showed an increasing trend. As with the Bluenose East caribou, it is difficult to say whether these are true increases or an artifact of large gaps among sampling years.

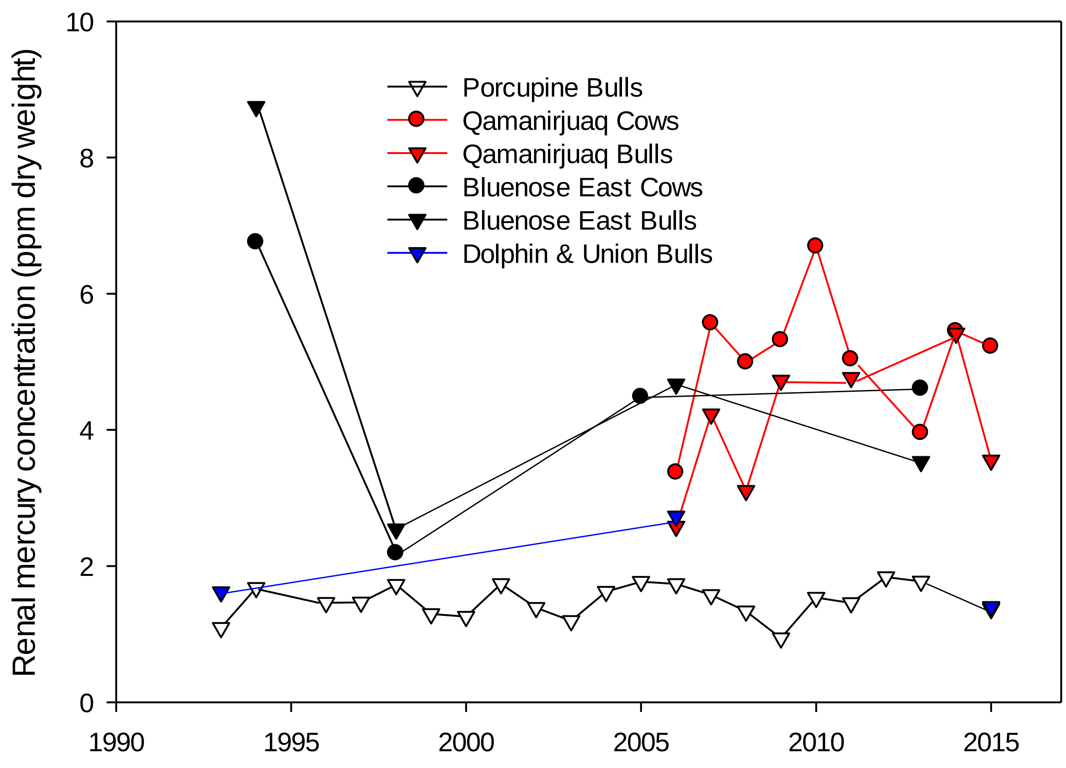


Figure 2. Average renal mercury concentrations in four Arctic caribou herds.

***Comparisons among herds***

Data were compared among fall-collected bulls from the Porcupine, Qamanirjuaq and Dolphin & Union caribou. As, Cd, Se and Zn were higher in the Porcupine caribou than the other two herds while Se was also higher in the Qamanirjuaq than the Dolphin & Union herd. It is not clear why these elements are higher in the Porcupine herd, but it is common, both biologically and geologically to find an association between Cd and Zn. Pb and Hg were higher in the Qamanirjuaq caribou than the other two herds. This has been seen in the past and is currently being investigated under the NCP project 'Mercury in Seaweed and Lichens from the Home Range of the Qamanirjuaq Caribou.' Cu was lower in the Dolphin & Union caribou than the other two herds. This is consistent with the findings of the NCP project 'Muskox Health program: Contaminants in Country Foods in Kitikmeot, NU' which found that 76% of the muskox from the Cambridge Bay are of Victoria Island are likely to be copper deficient and 33% of the muskox from the Kugluktuk region of the mainland are likely to be so. The Dolphin & Union caribou range from Cambridge Bay to the mainland and, although they have lower renal copper levels than the other two herds, they have almost double the concentration found in muskox from the area (10.3 ppm dry weight). It should be noted that although hepatic levels of Cu are a much better indicator of body status than renal levels, we could not make that comparison because we have not analyzed caribou liver for Cu.

***Perfluorinated chemicals in caribou liver***

Results for PFASs in caribou liver from the Porcupine, Bluenose, Dolphin & Union and Qamanirjuaq herds are shown in Figure 3. Major PFASs are the long chain perfluorocarboxylates (PFCAs) with 9, 10 and 11-carbon chains (PFNA, PFDA and PFUnA) as well as perfluorooctane sulfonate (PFOS). However, short chain PFCAs with 4 and 5 carbon chains (PFBA, PFPeA) were also detectable especially in the Porcupine, Bluenose, Dolphin & Union. PFBA and PFPeA are degradation products of the replacements for PFOS which was phased out in Canada and the USA in the early 2000s. PFBA is also a degradation product of HCFCs used in automobile air conditioners. Concentrations of total PFCAs (with 9 to 12 carbon chains) and PFOS in the Porcupine and Qamanirjuaq herds appear to have declined by about 50% compared to previous liver sample analyses (2007-2008) (Müller et al 2011). However, trends for PFBA and several other PFASs such as PFECHS (perfluoroethylcyclohexane sulfonate) are unknown because they were not measured in earlier samples.

Data collected from this program continue to provide baseline data for contaminants in Arctic caribou as well as a valuable tissue archive for legacy and emerging contaminants. 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 contaminants of concern (eg. Hg) within the terrestrial ecosystem. This program will continue to collect and analyze samples from the Porcupine and Qamanirjuaq caribou herds (20 animals from each) as well as two additional herds in the coming fiscal year.

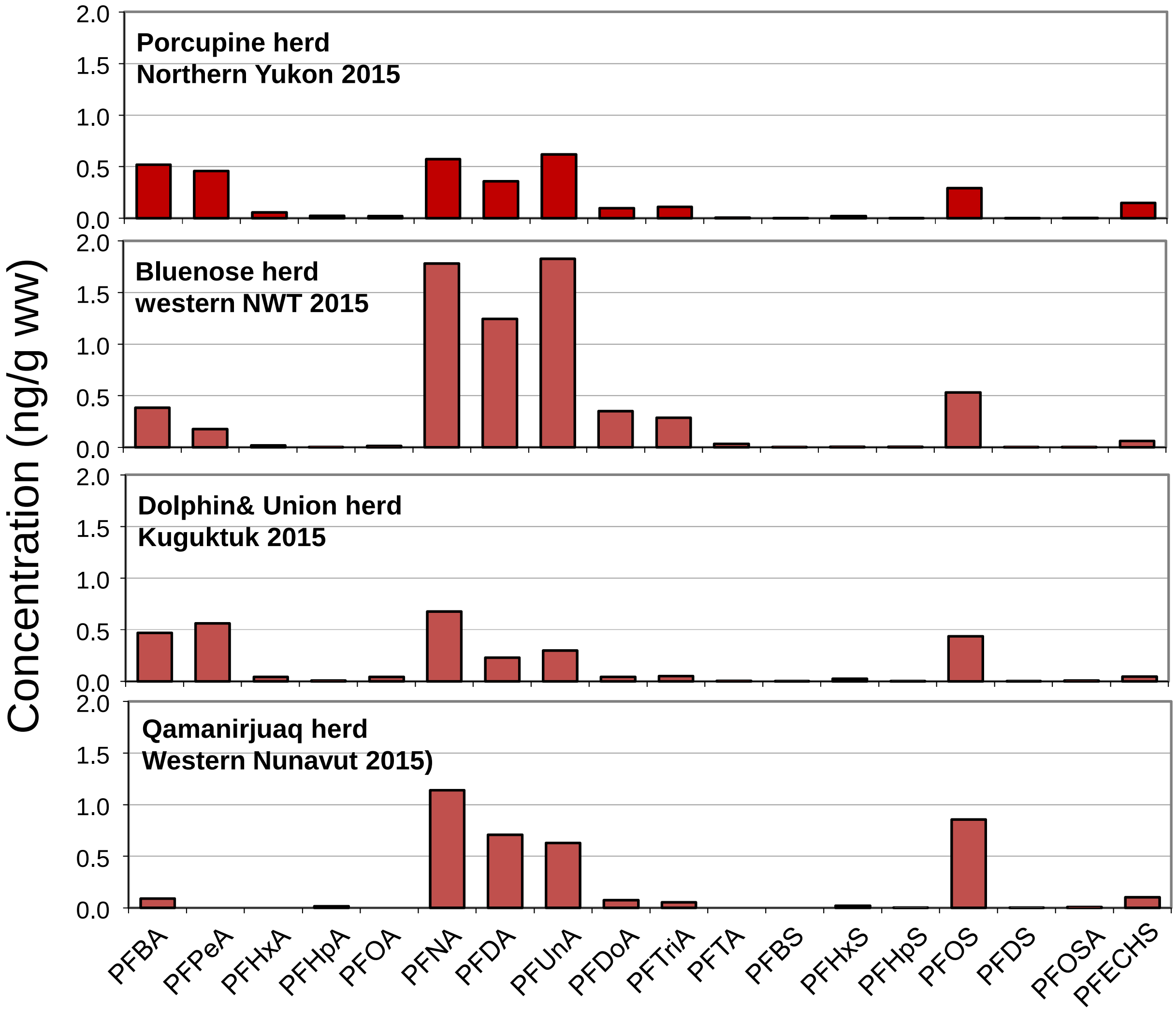


Figure 3. Average concentrations of 18 perfluorinated alkyl substances in caribou liver. Each bar represents the mean of 10 samples from each herd.

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

**Acknowledgements**

Many thanks to Yukon Environment staff: Martin Keinzler and Mike Suitor for providing samples from the Porcupine caribou herd, Mary Vanderkop and Meghan Larivee for laboratory support, and Angela Milani for aging caribou teeth. I would also like to acknowledge the efforts of all hunters who have submitted samples to this program over the years – without them, this work would not be possible. A particular thank you goes to the Arviat Hunters and Trappers Association who organize collections of the Qamanirjuaq caribou and to Lisa Leclerc for organizing collections of the Dolphin & Union caribou. Thanks also to Brett Elkin, GNWT for providing samples from the Bluenose East caribou herd. This project was funded by the Northern Contaminants Program, Aboriginal Affairs and Northern Development Canada.

| **Project Statistics and Information: April 1, 2015 – March 31, 2016** | | | | | |
|---|---|---|---|---|---|
| **Engagement & Communication Indicators** | **Description** | **Date** | **Location** | **Number** of people of materials | **Details** How were they involved? |
| Northerners engaged in your project | Workshops | Sept 2016<br><br>March 2017 | Iqaluit, NU<br><br>Whitehorse, YT | 29<br><br>50 | Nunavut Arctic College: Presentation and Discussion<br><br>Yukon Contaminants Workshop: Presentation and Discussion |
| | School visits | Oct 2016 | Whitehorse, YT | 30 | Wood St. School: Presentation and Discussion |
| | Meetings | Oct 2016<br><br>Oct 2016<br><br>Jan 2016 | Iqaluit, NU<br><br>Arviat, NU<br><br>Whitehorse, YT | 7<br><br>8 | Nunavut Contaminants Committee<br><br>Arviat Hunters and Trappers Organization<br><br>Yukon Contaminants Committee |
| | Consultations | Nov, Dec 16 and Jan 17 | Old Crow, Dawson, Mayo, Whitehorse YT; Inuvik, Fort Macpherson, Aklavik, Tsiighetchic, Yellowknife NT; Arviat, Whale Cove, Chesterfield Inlet, Rankin Inlet, Baker Lake Iqaluit NU | 105 | Consultation with local HTOs, Renewable Resource Councils and Boards, First Nations, Regional contaminant committees, local and federal government agencies and Wildlife Management |
| | Part of your project team | ongoing | YT, NU<br><br>YT, NU<br><br>YT, NU | 4<br><br>4<br><br>12 | Biologists assisting with sampling<br><br>Renewable Resource Board and HTO coordinators<br><br>Hunters |
| | Hired | | | | |
| | Other | | | | |
| Students involved in your NCP project | Northern | | | | |
| | Southern | | | | |
| Distribution of project materials/ information and | Reports to Hunters | Jan 2017 | YT, NT, NU | 100 | Distributed widely to stakeholder groups |
| | Newsletters | | | | |

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|---|---|---|---|---|---|
| results | Posters | Jan 2017 | NU, MN | 20 | Posters to Arviat HTO and Beverly Qamanirjuaq Caribou Management Board |
| | Other | Sept 2016 | Whitehorse, YT | 30 | Climate Change Lecture Series |
| **Publication & Data Indicators** | | **Details**<br>Including references and links | | | |
| Citable publications | Journal articles | | | | |
| | Conference presentations | | | | |
| | Other | | | | |
| Media articles (print/ online) related to your project | | | | | |
| **Knowledge Integration Indicators** | | **Details** | | | |
| How are your project results, data, and information used, and by whom? (i.e., names/types of assessments, initiatives, *etc*, that will use your project results) | Local | | | | |
| | Regional/ National | CACAR Hg Assessment; Canadian Hg Science Assessment | | | |
| | International | AMAP Hg Assessment; | | | |
| Access to Data | Meta Data In Polar Data Catalogue | PDC Record # 12007 | | | |

## References

Gamberg M, Braune B, Davey E, Elkin B, Hoekstra PF, Kennedy D, Macdonald C, Muir D, Nirwal A, Wayland M, Zeeb B. 2005. Spatial and temporal trends of contaminants in terrestrial biota from the Canadian Arctic. Sci Total Environ 351/352 :148–164.

Müller CE, De Silva AO, Small J, Williamson M, Wang X, Morris A, Katz S, Gamberg M, Muir DCG. 2011. Biomagnification of Perfluorinated Compounds in a Remote Terrestrial Food Chain: Lichen-Caribou-Wolf. Environ Sci Technol 45 (20), pp 8665–8673.