Title: Mercury in Caribou Forage

Project Leader
Mary Gamberg, Gamberg Consulting, Whitehorse, Yukon Phone 867-668-7023, Fax 867-668-7024, E-mail mary.gamberg@northwestel.net

Project Team Members:
Derek Muir, Environment Canada; Laurie Chan, UNBC; Sharon Katz, Aurora Research Institute; Yukon Contaminants Committee including Council of Yukon First Nations.

Abstract
Results from the Arctic Caribou and Moose Contaminant Monitoring Program indicate an increasing temporal trend in renal mercury in Porcupine caribou, particularly in females. In order to better understand the dynamics of mercury within these caribou populations and be better able to predict if mercury may become a toxicological issue, we have investigated the question of why mercury levels are higher in female caribou than in males. Samples of caribou forage were collected from the winter and summer range of the Porcupine caribou and analyzed for total and methyl mercury. The results were used with an energetics model developed for the Porcupine caribou herd to estimated mercury intake by cows, bulls and non-reproducing cows. Results suggest that although cows may ingest slightly more MeHg than bulls on the North Slope (summer range), the more likely reason for the higher concentrations of Hg seen in cows is due to their smaller body size and their proportionally higher intake of forage. One remaining question is how much Hg is ingested from mushrooms in the fall, and whether both cows and bulls ingest mushrooms at the same rate.

Key Message

- Female caribou have higher concentrations of renal mercury than males, most likely because they are smaller and eat proportionally more food (and therefore more mercury).

Objectives

- To determine why female Porcupine caribou have higher renal mercury concentrations than males. This will allow a better understanding of mercury dynamics within the caribou population, enabling more accurate predictions of whether mercury is likely to become a health issue for the caribou or consumers of the caribou.
- To further understand the fate and effects of mercury deposition in the Canadian Arctic.

Introduction
Caribou provide an important food resource for Northerners across the Arctic. Many Arctic caribou herds, including the Porcupine, are currently in decline and this is causing considerable concern among wildlife managers as well as those people of the north using these herds as a food source (Russell et al. 2002; Gunn et al. 2005). Results from the Arctic Caribou and Moose Contaminant Monitoring Program indicate an increasing

temporal trend in renal mercury in Porcupine caribou, particularly in females. Although mercury levels are not yet at the point where toxicological effects are thought to occur, if concentrations continue to increase, there may come a point where they will (if they have not already) begin to negatively impact the health of the caribou population, or those consuming the caribou.

In order to better understand the dynamics of mercury within these caribou populations and be better able to predict if mercury may become a toxicological issue, we have investigated the question of why mercury levels are higher in female caribou than in males.

There is potential for the mercury content of the forage consumed during the calving season to be different between the genders. In early April, female Porcupine caribou travel north to the Arctic Coast while the males remain in the more southern wintering grounds. By early June, the females reach the coast and spend about six weeks there before the males join them and they begin their journey back south (Russell et al. 1992). During the calving period, therefore, although males and females are consuming relatively similar species of forage, they are doing so in very different geographical areas. The Arctic Coast may be subject to an increased mercury load from mercury depletion events in the spring, or simply the proximity of the ocean, which acts as a sink and a transport pathway for mercury (Steffen et al. 2007). If this is the case, caribou forage in this area should have higher levels of mercury than similar species in the more southern wintering areas where the males are foraging at that time, which would explain the higher levels of mercury seen in female caribou.

In order to further explore these hypotheses, a mercury intake model was developed for the Porcupine caribou utilizing an existing forage intake model used by Environment Canada to estimate nutrient intake by the Porcupine caribou.

Activities in 2008-9

Vegetation was collected in late June, 2008 from Chapman Lake (southern Dempster Highway) by the PI, two employees of the Aurora Research Station and five volunteers from the Tr'ondek Hwech'in First Nation in Dawson. Vegetation was collected at the same time from the North Slope by Don Reid, Wildlife Conservation Society.

Vegetation samples were kept frozen until sorted (by species) and analyzed. Total and methyl mercury were analyzed by Quicksilver Labs, Colorado, using a High Pressure Liquid Chromatography Speciation System. Quality assurance from this laboratory was within acceptable parameters.

Total mercury (THg) and methyl mercury (MeHg) intakes were modeled for the Porcupine caribou herd using an energetics model (Russell et al 2004). The model tracks the intake, digestion and allocation of fat and protein for an individual caribou throughout the year. Because not all plant groups considered in the model were analyzed in this study, the following assumptions were made:

- Evergreen shrubs, forbs, *Equisetum* had THg and MeHg concentrations equivalent to willows.
- *Eriophorum* heads and standing dead had THg and MeHg concentrations equivalent to entire *Eriophorum* plants.
- Mosses and mushrooms had THg and MeHg concentrations equivalent to lichens.

In the model, the caribou are 'presented' with a changing complex of plant communities throughout their annual cycle. In late winter, cows begin to move north from the taiga to their tundra calving grounds. During this period the bulls and non-pregnant cows stay back on the winter range and follow up to 3 weeks later. During spring green-up, coincident with the calving periods cows remain primarily on the coastal plain while bulls are much more mobile and are able to better track newly emerging plant communities. We modeled the intake for bulls, cows and the hypothetical situation where cows remained with the bulls using mercury measured in vegetation from the winter range (Chapman Lake) and the summer range (North Slope). Note that a different activity budget was not used for bulls during the rut. We know that bulls drastically reduce feeding for a 3 week period in October during the rut although separate activity budgets have not been collected. We can assume that this period, coincident with some of the highest intake of Hg for cows, would be a period of low intake of Hg in bulls.

Results and Discussion

Statistical comparisons of vegetation mercury concentrations between locations on a species basis were difficult because only two species were able to be collected from both locations (Table 1). As a result, the species were grouped according to plant type (Figure 1). Although the average concentration of MeHg is higher in all plant groups from the North Slope than from Chapman Lake, the only statistical difference is for willows ($p = 0.027$ using a Kruskal-Wallace one-way ANOVA). THg was not significantly different between locations in any of the plant groups (Figure 1), but the proportion of THg found as MeHg was significantly higher in vegetation from the North Slope for all plant groups except sedges where it approached significance ($p=0.053$)(Figure 2).

Average THg and MeHg intakes by Porcupine caribou over the course of a calendar year are shown in Figure 3. In the winter both genders are eating mainly lichen which have relatively high concentrations of Hg. In March there is an increase in Hg intake as the snow melts and the quantity of lichens consumed increases (as the caribou have to spend less time cratering through snow for the lichens and can spend more time eating). In April/May the caribou start eating newly emerging vegetation (deciduous shrubs and forbs) which are lower in mercury than lichens, so mercury intake declines rapidly. During June and July THg remains low while MeHg fluctuates, likely due to consumption of willows which, on the North Slope, contain a higher proportion of MeHg. As the summer wanes the diet shifts back to lichens and the mercury intake increases accordingly. The peak in mercury intake seen in mid-September is due to a brief period of mushroom intake. In this model we have assumed that mushrooms are equivalent to

Table 1. Total (THg) and Methyl (MeHg) Mercury in vegetation collected from Chapman Lake and the North Slope of the Yukon in June, 2008.

	Chapman Lake			North Slope		
Species	N	THg (ng/g dry wt)	MeHg (ng/g dry wt)	N	THg (ng/g dry wt)	MeHg (ng/g dry wt)
Carex aquatilis	5	5.62 ± 2.33	0.25 ± 0.10	3	5.36 ± 1.33	0.60 ± 0.51
Cladina mitis	5	107.33 ± 123.41	2.07 ± 2.63			
Eriophorum angustifolium				4	5.27 ± 1.34	0.30 ± 0.14
Eriophorum vaginatum	5	11.15 ± 10.87	0.20 ± 0.21	4	10.97 ± 3.81	0.31 ± 0.17
Flavocetraria cucullata	5	71.77 ± 86.29	1.79 ± 1.96			
Flavocetraria nivalis				1	48.86 ± 4.65	2.53 ± 0.02
Salix glauca				4	5.24 ± 1.57	1.10 ± 0.54
Salix pulchra	5	5.55 ± 1.40	0.31 ± 0.25			

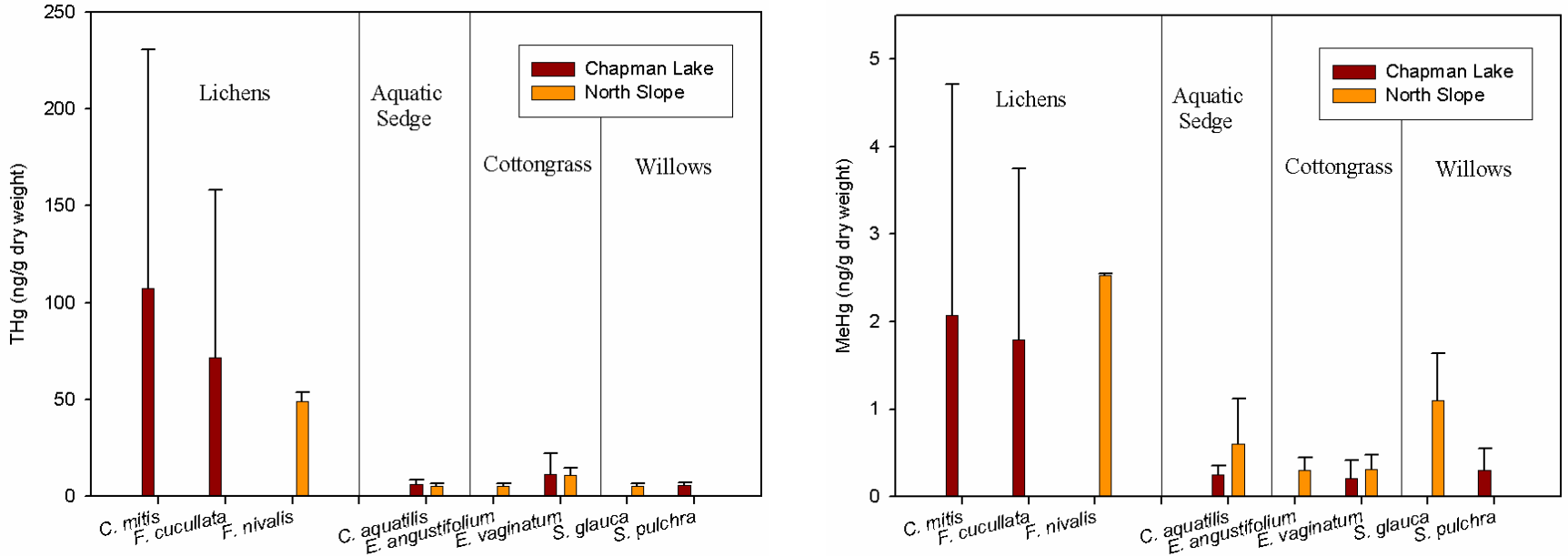

Figure 1. Total and Methyl mercury in vegetation collected from Chapman Lake and the North Slope of the Yukon in June, 2008.

lichens in terms of mercury content, but in fact they may actually be higher. Kalač et al (2004) report THg in mushrooms from unpolluted areas ranging from 1-20 mg/kg (or 20,000 ng/g) which is considerably higher than lichens measured in this study.

The model used to calculate mercury intake used vegetation data from the appropriate location (ie. North Slope or Chapman Lake), depending where the caribou were on that Julian day (on average). Cows with bulls were assumed to be in the same locations and eating the same diet as bulls. Therefore, any difference in Hg intake between cows with bulls and cows would be due to location. Figures 3 and 4 shows very little difference among the three groups for total intake of Hg over the year, although there is a slight increase in MeHg in cows in mid-June, likely due to consumption of willows on the North Slope. However, if the Hg intake is expressed as a proportion of body weight, bulls clearly ingest less Hg (proportionally).

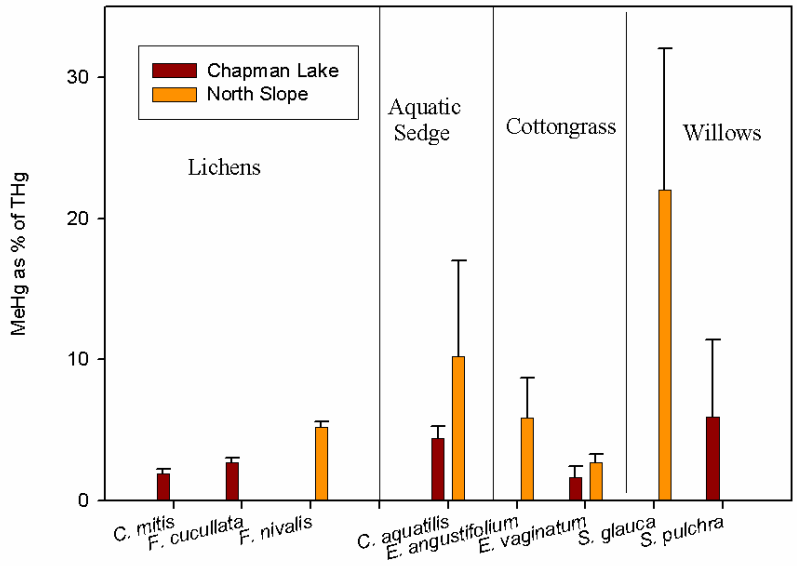

Figure 2. The proportion of THg found as MeHg in vegetation collected from Chapman Lake and the North Slope of the Yukon in June, 2008.

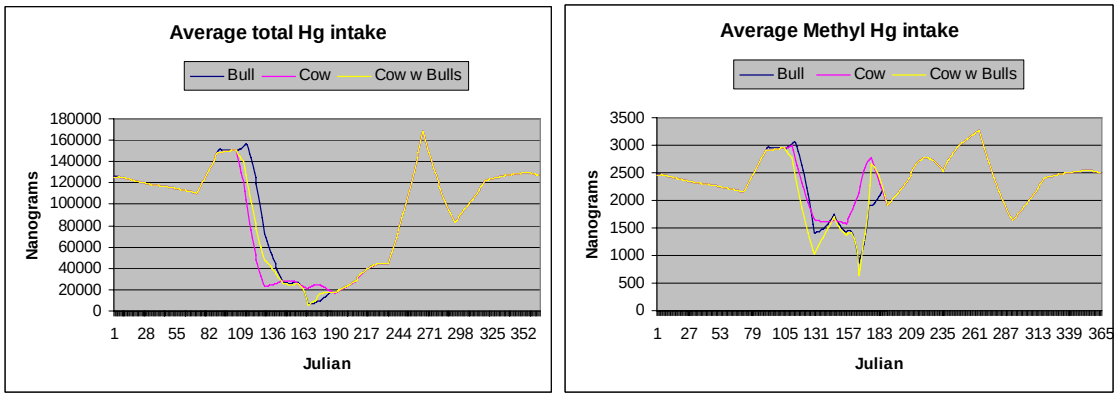

Figure 3. Average THg and MeHg intake by Porcupine caribou over one calendar year.

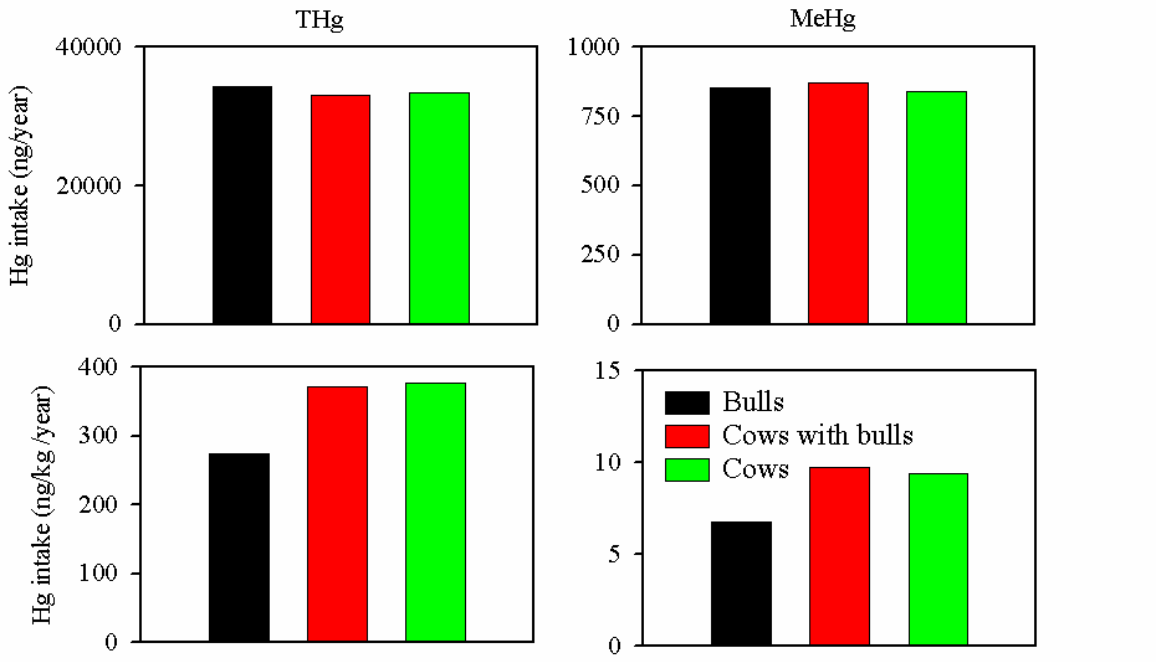

Figure 4. Hg intake by Porcupine caribou over a calendar year, and Hg intake over a calendar year as a proportion of body weight.

Using the vegetation data from this study in the energetics model for the Porcupine caribou suggests that although cows may ingest slightly more MeHg than bulls on the North Slope, the more likely reason for the higher concentrations of Hg seen in cows is due to their smaller body size and their proportionally higher intake of forage. One remaining question is how much Hg is ingested from mushrooms in the fall, and whether both cows and bulls ingest mushrooms at the same rate.

Project Completion Date: This project has been completed.

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