

Title: Arctic Caribou Contaminant Monitoring Program

Project Leader:

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Project Team:

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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 2015/16 samples were collected from 18 Porcupine, 19 Qamanirjuaq, 13 Dolphin & Union and 20 Bluenose East caribou. Sample analyses for these collections had not been completed at the time this report was prepared. Qamanirjuaq and Beverly caribou samples collected in the 2014/15 year have been analyzed, and results are presented in this report. Age was positively correlated with renal cadmium and zinc in both herds. In the Beverly herd cows had higher concentrations of renal cadmium and lead than bulls, while in the Qamanirjuaq herd, concentrations of renal arsenic, cadmium and mercury were higher in cows than bulls. These 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. Temporal trends were unable to be assessed in the Beverly herd due to insufficient data from the past. Contaminant concentrations in the Qamanirjuaq caribou appear to be stable. Marrow and brain tissue sampled from the Qamanirjuaq caribou do not have elevated levels of contaminants and continue to be a healthy traditional food choice. 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.
- Contaminant levels in the Qamanirjuaq caribou appear to be stable.
- Marrow and brain tissue from the Qamanirjuaq caribou do not have elevated levels of contaminants and continue to be healthy traditional food choices.
- 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 2015/16

Samples were collected from 18 Porcupine caribou in the fall of 2015 by hunters in Old Crow with the assistance of Environment Yukon (Martin Kienzler and Mike Suitor). Samples were collected from 19 Qamanirjuaq caribou herd in Arviat in the fall of 2015 in cooperation with the Arviat Hunters and Trappers Organization. GNWT (Brett Elkin) provided 20 kidneys from the Bluenose East caribou herd, collected in the spring of 2013. This herd was sampled in the spring of 2000, 2005 and 2006. The Dolphin & Union caribou were sampled by GN (Myles Lamont and Lisa LaClerc) in Kugluktuk in the fall of 2015 in cooperation with local hunters. Only 13 samples were collected, so they will continue the sampling in the spring of 2016 to try to attain the maximum number of samples (20).

Current-year 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). 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).

In 2014/15 only two samples were collected from the Porcupine caribou. Six Porcupine caribou kidney samples from the tissue archive were analyzed to fill in data gaps from previous years. Results are presented for samples from 22 Qamanirjuaq caribou collected in the fall of 2014 and 16 Beverly caribou collected in the spring of 2013. In addition to kidneys, 10 marrow and 10 brain samples from the Qamanirjuaq herd were also analyzed in response to concerns from local hunters regarding these traditional foods.

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]). Qamanirjuaq results were compared to previous results from fall-collected animals and Beverly results were compared with previous results from spring-collected animals. Note that As and Se were not measured in the Beverly herd in 1994 or 2000 (these are not NCP data, but were kindly provided by GNWT). 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.

Capacity Building

In October, 2015, 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 is proposed to be offered again in October, 2016.

Communications

A summary of this long-term project was presented to the following: Environmental Technology Program of

Arctic College in Iqaluit (Oct 2015); Canadian Ecotoxicity Conference in Saskatoon (Oct 2015); Wood Street High School in Whitehorse (Oct 2015); Yukon Biodiversity Forum in Whitehorse (Nov 2015); NCP Results Workshop in Vancouver (Dec 2015); Dolphin and Union Caribou Management Plan Meeting in Kugluktuk (Jan 2016; via internet). A plain language summary of current results for the Qamanirjuaq caribou was sent to Nunavut stakeholders (in English and Inuktitut) in Nov 2015. This summary was included in the Winter 2016 edition of the newsletter of the Beverly Qamanirjuaq Caribou Management Board (Caribou News in Brief). Presentations of current results for the Porcupine caribou were made to Chief and Council of the Vuntut Gwitch'in First Nation, students of the Chief Zzeh Gittlit School (Old Crow) and the community of Old Crow in a public meeting in Jan 2016. Synopsis reports will be distributed to all stakeholders.

Two 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 data collected under NCP, but will also include data provided collaboratively by other researchers on caribou from Banks Island NWT, Greenland, Sweden and Svalbard. The second 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. In all cases 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 will 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 the workplan for this project for the coming year.

Results and Discussion

Results for the seven elements of interest are presented in Table 1. Age was positively correlated with renal Cd and Zn in both the Qamanirjuaq and Beverly caribou. Correlations between certain 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).

In the Beverly herd cows had higher concentrations of renal Cd and Pb than bulls, while in the Qamanirjuaq herd, concentrations of renal As, Cd and Hg were higher in cows than bulls. It is interesting that toxic elements (As, Cd, Pb, Hg) 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 (Gamberg 2008). Other non-toxic elements are more likely to be homeostatically controlled and so we do not see a difference between the genders.

In the Beverly caribou herd, renal As was lower and renal Se was higher in 2013 than in 2008, but with only two years of data, trends cannot be inferred (neither As nor Se was measured in the 1994 and 2000 collections). Although renal Cu and Hg declined over time, both trends were driven by 1994 data. Levels of both elements have not changed since the year 2000. Although a statistical increase in renal Pb was seen in bulls, the 1994 data were all below the detection limit, and there was only one data point from 2008. The remaining data is insufficient to infer a true trend. Similarly, a statistical increase was seen in renal Cd in bulls over time as well as with age. However, with so few data (technically data from 3 years, but only one data point from 2008) it is difficult to infer a true trend. Zn did not change over time. Unfortunately, it is difficult to ascertain any true temporal trends from these data.

Table 1. Renal element concentrations ($X \pm SE$; $\text{mg}\cdot\text{g}^{-1}$ dry weight).

	N	Age	Arsenic		Cadmium		Copper		Lead		Mercury		Selenium		Zinc	
Qamanirjuaq caribou herd; Fall-collected																
Females																
2006	7	7.3	0.03	\pm 0.007	18.7	\pm 5.27	26.3	\pm 0.8	0.58	\pm 0.31	3.37	\pm 0.4	3.6	\pm 0.2	104	\pm 3.21
2007	10	5.1	0.04	\pm 0.003	24	\pm 4.96	25.1	\pm 2.8	0.44	\pm 0.05	5.57	\pm 0.7	4.1	\pm 0.43	110	\pm 9.65
2008	10	8.1	0.04	\pm 0.005	29.7	\pm 3.72	24.4	\pm 1.3	0.36	\pm 0.02	4.99	\pm 0.5	4	\pm 0.21	106	\pm 5.056
2009	4	0.5	0.04	\pm 0.009	19.8	\pm 7.37	21.1	\pm 1.7	0.25	\pm 0.03	5.32	\pm 1.1	3.5	\pm 0.14	95	\pm 5.64
2010	1		0.05		21.5		18.9		0.49		6.69		3.8		96	
2011	17	6.0	0.04	\pm 0.005	21	\pm 5.96	22	\pm 0.7	0.3	\pm 0.03	5.04	\pm 0.5	4.2	\pm 0.09	108	\pm 2.634
2013	4	5.5	0.03	\pm 0.004	31.1	\pm 17.6	27.2	\pm 0.9	0.26	\pm 0.05	3.96	\pm 0.4	4.4	\pm 0.14	120	\pm 7.916
2014	10	10.0	0.04	\pm 0.004	28.6	\pm 4.39	19.9	\pm 2.1	0.27	\pm 0.07	5.45	\pm 0.5	3.5	\pm 0.32	98	\pm 11.02
Males																
2006	14	5.8	0.01	\pm 0.003	14	\pm 2.37	25.8	\pm 0.5	0.34	\pm 0.07	2.58	\pm 0.2	3.6	\pm 0.12	112	\pm 3.734
2007	8	4.0	0.03	\pm 0.004	11.5	\pm 2.9	20.8	\pm 0.9	0.39	\pm 0.08	4.23	\pm 0.6	3.6	\pm 0.21	94	\pm 3.649
2008	11	5.0	0.03	\pm 0.003	16.8	\pm 2.8	24.4	\pm 1.3	0.27	\pm 0.03	3.10	\pm 0.5	4.1	\pm 0.11	106	\pm 2.603
2009	1		0.04		3.84		22.4		0.36		4.72		3.6		90	
2011	2	5.5	0.03	\pm 0.014	15.3	\pm 2.89	22.9	\pm 1.3	0.25	\pm 0.09	4.77	\pm 1.9	4.7	\pm 0.47	110	\pm 2.63
2014	10	6.9	0.04	\pm 0.004	19.2	\pm 3.85	23	\pm 3.1	0.18	\pm 0.02	5.42	\pm 0.7	4.1	\pm 0.28	100	\pm 3.484
Beverly caribou herd; Spring-collected																
Females																
1994	5	6.2			32.9	\pm 7.15	23.9	\pm 0.5	0.18	\pm 0.07	8.16	\pm 1.3			116	\pm 7.77
2000	20				55.2	\pm 9.47	22.8	\pm 1.7	0.63	\pm 0.09	6.41	\pm 0.5			126	\pm 9.276
2008	10	6.3	0.06	\pm 0.006	34.3	\pm 7.3	20.5	\pm 0.9	0.31	\pm 0.03	5.71	\pm 0.5	4.3	\pm 0.16	105	\pm 2.782
2013	6	7.83	0.04	\pm 0.002	47.6	\pm 7.66	21.3	\pm 0.9	0.21	\pm 0.02	5.71	\pm 1	5.2	\pm 0.22	123	\pm 3.907
Males																
1994	5	7.2			29	\pm 5.24	25.1	\pm 1.2	0.1	\pm 0.00	12.36	\pm 0.5	5		119	\pm 1.37
2008	1	4	0.1		30.8		20.3		0.28		7.22		4.5		105	
2013	10	3.6	0.05	\pm 0.004	28.2	\pm 2.65	20.2	\pm 0.5	0.21	\pm 0.02	5.55	\pm 0.4	4.9	\pm 0.13	116	\pm 2.786

In the Qamanirjuaq caribou, As and Hg increased over time in bulls but there were no changes in cows. This seems to be an artifact of the data set, as there were no males collected in 2013, 2012 or 2010 and only 2 in 2011 and 1 in 2009. In fact As in bulls closely follows that in cows, which is not changing over time (Fig 1). Cd, Hg and Zn did not change over time in this herd while Se increased and Cu and Pb decreased slightly. These changes were slight and likely not of biological significance (Figure 1).

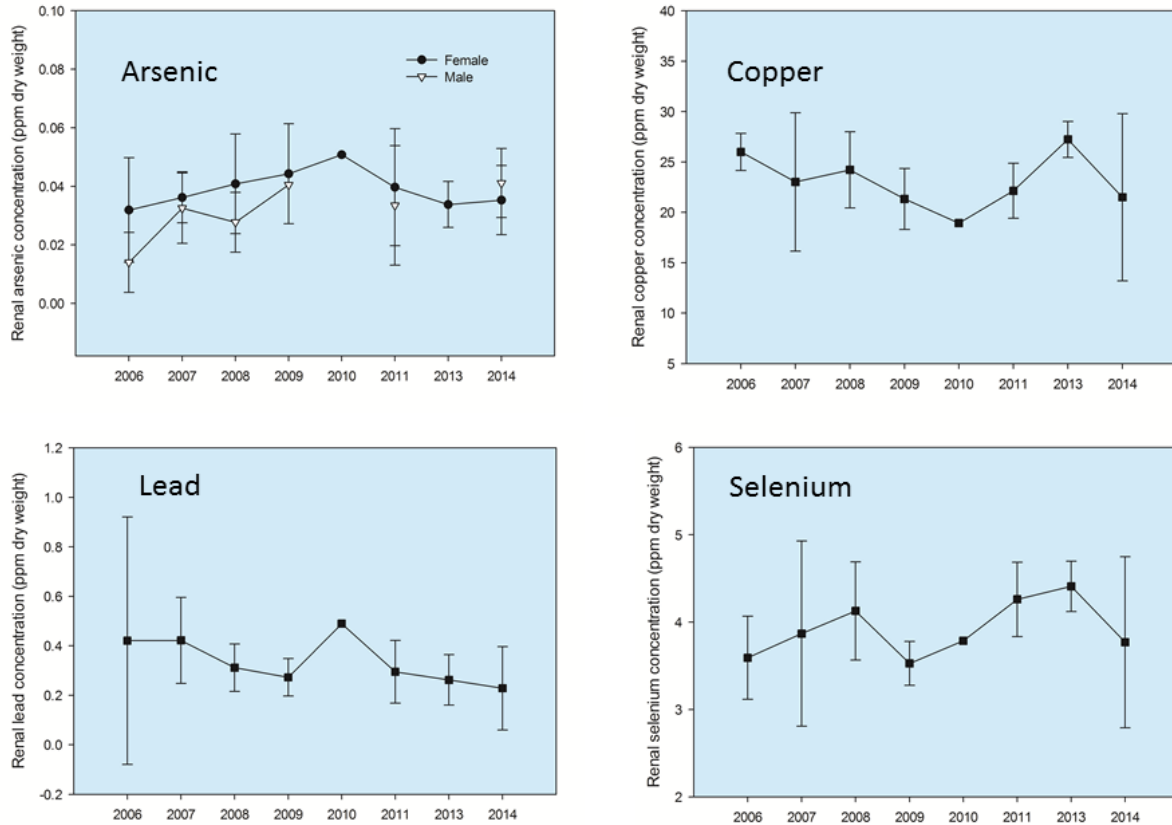


Figure 1. Temporal trends in renal elements in fall-collected Qamanirjuaq caribou. Note that data for Cu, Pb and Se are from both genders combined.

Marrow and brain had less As, Cd, Cu, Pb, Hg, Se and Zn than kidney (Fig. 2). There were no differences among the three tissues in Ca, although two individuals had very high Ca levels in marrow. Brain had similar amounts of Fe and Mg as kidney and both had more than marrow. There were no differences between the sexes in element concentrations in brain or marrow. This confirms that marrow and brain do not have elevated levels of contaminants, particularly when compared with kidneys, and that these tissues remain a healthy traditional food choice.

Levels of most elements measured in the Beverly and Qamanirjuaq 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.

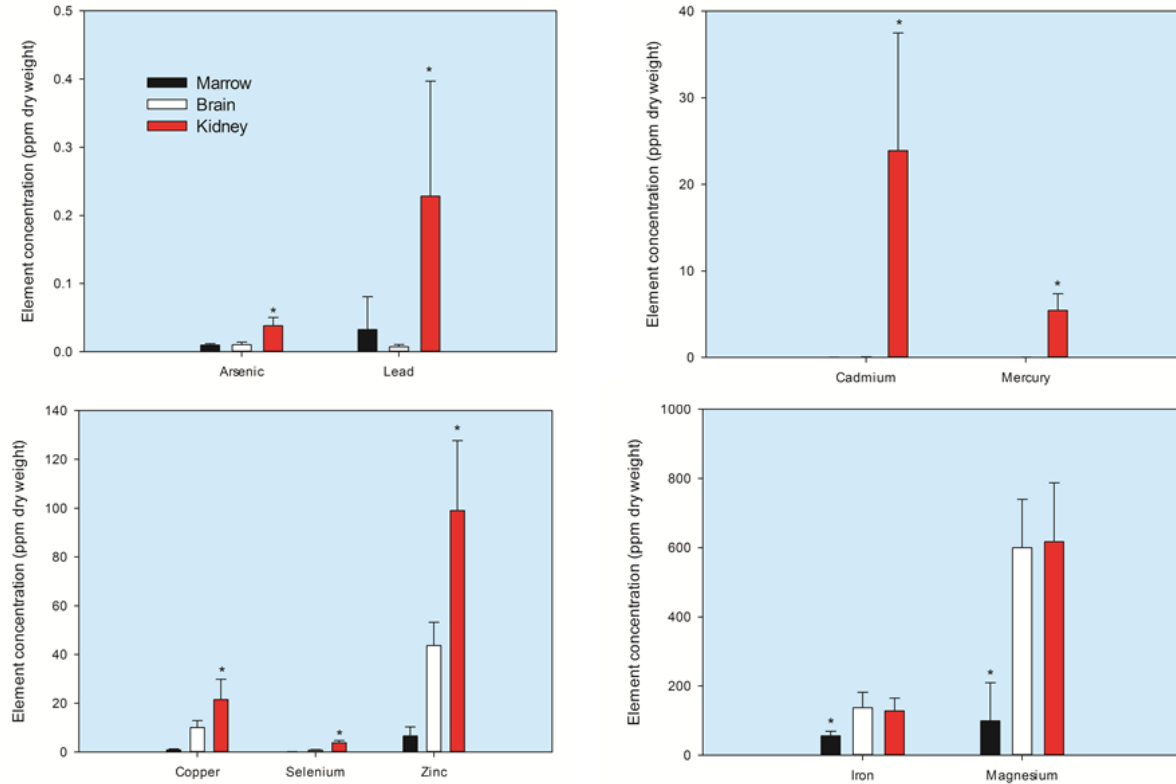


Figure 2. Element concentrations in marrow, brain and kidney from Qamanirjuaq caribou collected in the fall of 2014.

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 particular contaminants of concern (eg. mercury) within the terrestrial ecosystem. This program will continue to collect and analyze kidney samples from the Porcupine and Qamanirjuaq caribou herds (20 animals from each) as well as two additional herds in the coming fiscal year.

Expected Project Completion Date: This program is ongoing.

Acknowledgements

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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	28 Sep – 2 Oct 2015	Iqaluit, NU	30	Presentation and Discussion	
	School visits	20 Oct 15	Whitehorse, YT	28	Presentation and Discussion	
		15 Jan 16	Old Crow, YT	15		
	Meetings	12 Jan 16	Kugluktuk, NU	12	Dolphin and Union Caribou Management Plan Meeting Meeting with Chief and Council, Vuntut Gwitch'in First Nation	
		14 Jan 16	Old Crow, YT	5		
	Consultations	Nov, Dec 15 and Jan 16	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	4	Biologists assisting with sampling
				YT, NU	4	Renewable Resource Board and HTO coordinators
YT, NU				12	Hunters	
Hired						
Other						
Students involved in your NCP project	Northern					
	Southern					
Distribution of project materials/ information and results	Fact Sheets	Nov 15	NU	100	Distributed widely to stakeholder groups	
	Newsletters					
	Posters	8 Dec 15	Vancouver, BC	100	NCP Results Workshop	
	Other	7 Nov 15	Whitehorse, YT	75	Yukon Biodiversity Forum	
Old Crow, YT			25	Community Meeting		
		14 Jan				

		16		
Publication & Data Indicators		Details Including references and links		
Citable publications	Journal articles			
	Conference presentations	Canadian Ecotoxicity Conference, Saskatoon, SK Oct 5-7, 2015		
	Other			
Media articles (print/ online) related to your project		Caribou News in Brief, Winter 2016 edition (newsletter of the Beverly Qamanirjuaq Caribou Management Board)		
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

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