Yukon North Slope
Wildlife Conservation and Management Plan
2021

Companion Report 3: Contaminants / Halumailiȓuq

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Companion Report to the Yukon North Slope Wildlife Conservation and Management Plan Number 3: Contaminants / Halumailir̂uq

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About the Companion Report

This report is a companion document to the *Yukon North Slope Wildlife Conservation and Management Plan* (WMAC (NS), 2022). The *Yukon North Slope Wildlife Conservation and Management Plan* (the Plan) is grounded in traditional knowledge and Western science. It addresses traditional use and wildlife conservation and management issues affecting the Yukon North Slope. Strategies in the Plan align with actions underway or planned by a range of agencies and organizations with jurisdiction on the Yukon North Slope.

This companion report summarizes the information that was used to support the objectives and strategies in the Plan, and provides references for the studies used in its development. The companion report draws from authoritative works, reports that synthesize knowledge and issues, and presentations of recent research findings. Sources include traditional knowledge and traditional use, scientific reports and journal articles, and management and conservation reports.

There are fourteen companion reports, addressing four selected topics of key interest as well as ten wildlife species featured in the Plan.

Companion Report Table of Contents

Selected Topics	Featured Species and Species Groups	
1. Traditional Use	5. Caribou	10. Broad Whitefish
2. Climate Change Effects	6. Moose	11. Geese
3. Contaminants	7. Grizzly Bear	12. Furbearers
4. Aullaviat/Aunguniarvik	8. Polar Bear	13. Dall's Sheep
	9. Dolly Varden	14. Muskox

Each chapter is available for download at https://wmacns.ca/what-we-do/conservation-plan/companion

This companion report summarizes the information that guides the objectives, strategies and conservation requirements in the *Yukon North Slope Wildlife Conservation and Management Plan*.

Companion Report: Contaminants / Halumailiȓuq

This companion report is one of four reports on selected topics that cut across species divisions for the Plan. The phrase Halumailiȓuq is from the Inuvialuktun Uummarmiutun dialect, and can be translated as 'it is not clean anymore / get dirty' (IRC, 2020). Contaminant-related objectives and actions in Yukon North Slope plans and programs are listed, and strength and gaps in knowledge about contaminants related to wildlife on the Yukon North Slope are summarized.

This report draws on Northern Contaminants Program research and monitoring since the early 1990s, including studies on the Yukon North Slope, in the Mackenzie River and Delta, and in other parts of the Canadian Arctic. Additional information sources relevant to the Yukon North Slope are included, such as circumpolar contaminants studies and research undertaken to address specific contaminants issues, including how climate change affects contaminant levels in wildlife.

Introduction to Contaminants

Contaminants can be released through industrial or agricultural activities, and from products in common use, such as chemicals used in electrical equipment or in flame retardants.

Many contaminants in the environment are human-made chemicals known as persistent organic pollutants (POPs). These include many pesticides and PCBs[1]. “Legacy” POPs are those that were used historically but are now banned or restricted.

Another category of contaminants is heavy metals, including mercury and cadmium. These toxic metals occur naturally in rocks and soils, and are widespread at low levels. However, they can become contaminants of concern when they are processed or released to the environment as part of human activities, or as a result of climate change effects, including permafrost thaw and slumping.

Radioactivity is also considered a contaminant. Some radioactive substances are from natural sources. Sources of human-caused radioactivity include nuclear weapons, such as those tested during the 1950s and 1960s, or from accidents at nuclear power generating plants.

Almost all contaminants that are detected in the Yukon North Slope were transported by air or ocean currents from the more populated, agricultural, and industrial regions of the world. The exception is historical localized contamination from the former Distant Early Warning (DEW) line sites (such as Komakuk Beach). Clean-up at these sites was completed in 2014.

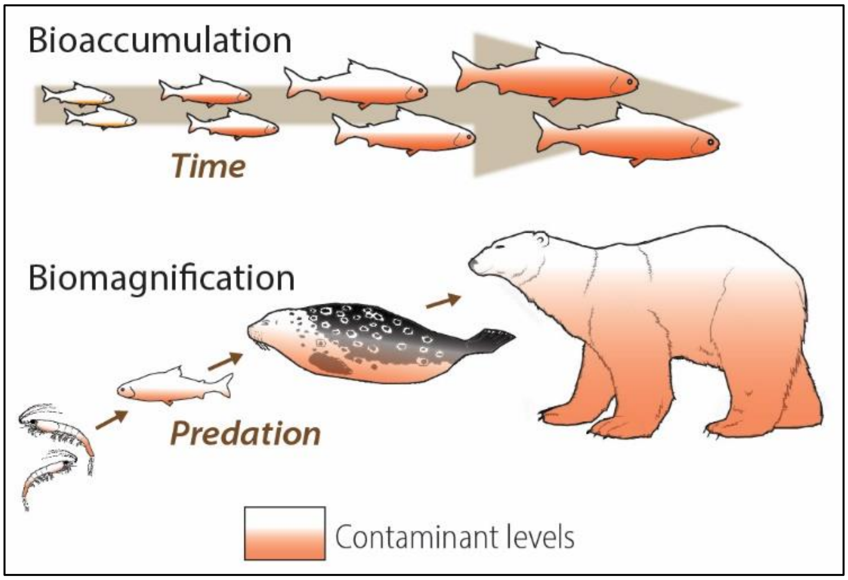
Another potential route for contaminants to enter the Yukon North Slope is via rivers. Pollutants discharged to the Mackenzie River have the potential to reach Yukon North Slope marine waters, though greatly diluted along the river’s pathway.

As contaminants arrive in the Yukon North Slope, they may be taken up by algae and plants and enter the food chain. Many of the POPs are stored in fats and build up in fatty tissues like blubber or fish livers. Plants, land animals, and many fish usually have only low levels of contaminants, while some predatory fish may have higher levels. Marine mammals generally

[1] Polychlorinated biphenyls, chemical compounds with chlorine once widely used, for example as a coolant in electrical equipment.

have the highest contaminant levels, because they are long-lived top predators. Figure 3– 1 shows how these contaminants build up in wildlife.

Figure 3– 1. How contaminants build up in wildlife



The longer an animal lives the more contaminants build up in its body. This is called bioaccumulation. For some contaminants, biomagnification also occurs. This is when contaminant levels rise through the food chain when one animal eats another animal that has accumulated contaminants.
Source: adapted from www.blue-growth.org

Because the presence of contaminants in the environment is a global problem, it can only be fixed with global solutions. Results of studies in northern Canada have been important in making the case for global regulation of many contaminants (Government of Canada, 2018). International agreements include the 2004 Stockholm Convention on POPs, which was expanded to regulate additional contaminants in 2017 (United Nations, 2018), and the 2017 Minamata Convention on mercury (United Nations, 2019).

Selected Studies and Research Results Relevant to the Yukon North Slope

Persistent Organic Pollutants

These agricultural and industrial chemicals are widespread in the Arctic environment and can accumulate to high levels in marine predators, especially in some marine mammals and birds. POPs are either not detectable or at very low levels in terrestrial wildlife but sometimes build up to high levels in fatty tissues of freshwater predator fish, such as in the livers of loche (burbot, *Lota lota*).

- **Review of trends in POPs in the circumpolar Arctic (Rigét et al., 2019)**
  Levels of legacy POPs have declined in most Arctic animals, with some exceptions, including beluga whales. Chemicals that were used more recently or are still in use, such as brominated flame retardants[1] and perfluorinated compounds[2], show a mixed pattern of trends.

- **Legacy POPs in Beaufort Sea beluga (Noël et al., 2018)**
  Beluga and other marine top predators are particularly vulnerable to contaminant-associated health risks because they have long lives, limited ability to excrete contaminants, and low reproductive rates. Samples of beluga blubber obtained from Inuvialuit harvesters in the Mackenzie estuary area from 1989 to 2015 were analyzed for legacy contaminants. In beluga, most POPs showed no change or little change over the period, despite declines in other Arctic wildlife. Although the release of POPs has declined greatly due to regulation, climate change and melting sea ice are affecting how the chemicals move through the Arctic marine environment. The authors conclude that continued monitoring is needed to understand these mechanisms and to be informed about current levels of contaminants in beluga.

- **Contaminants of emerging concern in Beaufort Sea beluga (Smythe et al., 2018)**
  Samples of beluga blubber were obtained from harvesters in the Inuvialuit Settlement Region and the eastern Arctic over the period 1982 to 2013. The samples were analyzed for contaminants of emerging concern. The Beaufort Sea samples showed the strongest trends: increases in two types of chemicals used as flame retardants[3] and decreases in another group of chemicals used in manufacturing.[4] The authors concluded that it is important to continue monitoring for contaminants of emerging concern, especially as it is not always known if these contaminants will build up in food chains and whether they affect the health of animals or are a danger to people eating harvested foods. The authors also concluded that further monitoring is needed because the effects of climate-change-driven processes on contaminants in the environment are not well understood.

Mercury

Mercury is found naturally in rocks and it is released to the air by volcanoes. Human-caused sources of mercury are outcomes of industrial processes and the burning of fossil fuels.

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[1] A group of chemicals used to reduce flammability of materials, especially plastics and textiles.

[2] A group of chemicals used in making stick- or stain-resistant products.

[3] Polybrominated diphenyl ether (PBDEs) and hexabromocyclododecane (HBCDs). These compounds have been phased out of use but are still present in the environment

[4] Perfluoroalkylcarboxylic acids

- Review of mercury in the Canadian Arctic marine environment (Braune et al., 2015)
  Recent past: Over the past several decades mercury levels have increased in some marine animals and remained unchanged in others. Ringed seals, beluga and polar bears from the Beaufort Sea region have higher concentrations of mercury than those in other parts of the Canadian Arctic.

  Long-term trends: Teeth from marine mammals can be analyzed to look at long-term trends of mercury. Teeth from Beaufort Sea beluga have more mercury in recent decades than before the rise of industry in the late 19^{th} century. The biggest increase in mercury was in the mid-20^{th} century. The recent trend in mercury in Beaufort Sea beluga is a decline since the 1990s. Mercury in Beaufort Sea ringed seals has remained about the same since the 1990s.

- Review of mercury in the Canadian Arctic terrestrial environment (Gamberg et al., 2015)
  Arctic terrestrial mammals and birds typically have low levels of mercury, though caribou can have higher levels because they eat lichen. Lichens have more mercury than other types of vegetation because they have no roots and absorb mercury and other contaminants directly from the air.

- Porcupine caribou
  Porcupine caribou samples have been analyzed for mercury most years since 1999. A report to the Porcupine Caribou Management Board in 2017 advised that caribou are largely free from contamination and healthy to eat (Gamberg Consulting, 2017). Some Porcupine caribou, however, can accumulate relatively high levels of cadmium and mercury in their organs (mainly in their kidneys and liver), partly from natural sources and partly from industry in other parts of the world. Mercury levels measured in Porcupine caribou vary with the seasons but have not increased or decreased over the past 20 years (Gamberg et al., 2015).

- Dolly Varden
  Sea-run (anadromous) Dolly Varden are very low in mercury, based on a review of mercury levels in Arctic char from the Canadian central and eastern Arctic, Dolly Varden from the Rat and Vittrekwa rivers (Evans et al., 2015), and Babbage River Dolly Varden (Tran et al., 2016). Summer ranges of Rat River and Vittrekwa River sea-run Dolly Varden extend along the Yukon North Slope coast (DFO et al., 2019). In contrast to land-locked Arctic char in high Arctic lakes, which accumulate high levels of mercury (AMAP, 2018a), the freshwater Dolly Varden in the Babbage River had lower mercury levels on average than the sea-run char from the same river. These differences in mercury levels were attributed to differences in growth patterns (Tran et al., 2016).

  Another study compared mercury in Dolly Varden that were collected from the Rat River and Firth River in the 1980s with Dolly Varden that were collected from the same rivers in the 2010s. This comparison concluded that mercury levels have increased slightly in Rat River Dolly Varden, but not in Firth River Dolly Varden (Tran et al., 2019). The study also found that there are local variations in how mercury is accumulated by Dolly Varden and concluded that it is important to continue to monitor mercury levels and to gain a better understanding of mercury uptake.

Radioactivity

The largest human-activity-related source of radioactivity in Arctic environments has been radiocesium[1] in fallout from nuclear weapons testing, starting in the 1950s. After the Nuclear Test Ban Treaty was signed in 1963, there were few atmospheric nuclear explosions, and levels of radiocesium in the Arctic declined. The greatest risk now is from accidents at nuclear power plants (Strand et al., 2002). Radioactivity has largely been a concern for consumers of caribou and reindeer because lichens take up radioactive fallout from the air.

- Caribou (Macdonald et al., 2007)
  Radioactivity has been monitored in caribou, including Porcupine caribou, since the 1960s. Human-caused radioactivity from weapons testing in the 1950s and 1960s was found in caribou but it has declined over the decades. Radioactivity is lower in Porcupine caribou than in caribou herds in eastern Canada. While the Chernobyl nuclear reactor accident in 1986 caused large increases in radioactivity in reindeer in Europe, the effect was small for the Porcupine herd. An increase in radioactivity of less than 10% in Porcupine caribou was measured in the late 1980s.

- Fukushima nuclear accident (Stocki et al., 2016)
  This study addressed concerns from northern communities about whether radioactivity from Japan's Fukushima Daiichi nuclear accident in 2011 was contaminating harvested animals. The study looked at radiocesium in Porcupine caribou and Beaufort Sea beluga whales as well as radiocesium in the food sources of these two species. This included lichens and mushrooms from the Old Crow area and fish caught at Shingle Point. Samples from before the accident and from after the accident showed that there was no increase in radioactivity in either caribou or beluga or in any of their food sources.

Risk to Wildlife

Research in recent years has applied information about toxicity of contaminants and assessed their effects on Arctic wildlife. Researchers have identified the effects of mixtures of contaminants (Villa et al., 2017; Desforges et al., 2017) and looked at effects that may be hard to detect in individuals, but show up at the population level. For example, studies show that there

[1] Radiocesium, also called caesium-137, is a common product of nuclear fission in nuclear reactors and nuclear weapons. Because it forms compounds that dissolve in water, it spreads through the environment.

is a link between elevated contaminant levels and changes in polar bear endocrine, immune, and reproductive systems (Joint Secretariat, 2017).

The Arctic Monitoring and Assessment Programme periodically reviews knowledge on biological effects of contaminants on Arctic fish and wildlife, including Canadian research and monitoring results (Fisk et al., 2005; Letcher et al., 2010; AMAP, 2018a; Dietz et al., 2019). The most recent review (AMAP, 2018b) found that:

- Legacy chemicals and mercury continue to pose a significant concern for Arctic biota.
- The suite of environmental contaminants found in many Arctic top predators is expanding and may require new investigation of potential biological effects.
- The mixtures of chemicals Arctic wildlife are exposed to needs to be taken into account to improve risk prediction.

The impact of contaminants on wildlife needs to be considered in combination with other threats to wildlife.

Risk to Human Health

Indigenous people in northern Canada have experienced higher levels of exposure to contaminants because of the high proportion of harvested food in their diets. The people most at risk from contaminants are Inuit of the eastern Arctic who harvest a lot of marine mammals. Because Inuvialuit diets are more varied, the risk of exposure to contaminants is lower.

A synthesis of initiatives on food security in the ISR (Kenny et al., 2018) highlights the importance of work on contaminants for ensuring food safety. Country foods are nutritious and preferred but are also the main source of exposure to persistent contaminants.

The fourth Northern Contaminants Program human health assessment (Curren, 2017) concluded that the nutritional benefits of traditional foods in general outweigh the risks from contaminants. A health survey conducted in the Inuvialuit Settlement Region (ISR) from 2007 to 2008 by the Centre for Indigenous Peoples' Nutrition and Environment contributed to the assessment (Egeland, 2010).

Contaminant levels and risks have declined since the 1990s. Many of the worst contaminants have been banned or reduced in use. This has improved the safety of harvested foods. Human blood samples in the eastern Arctic show that POPs have declined by up to 80% and mercury and lead have declined by about 60% since the early 1990s (Curren, 2017). Still, concerns remain about health effects of some contaminants, including mercury and new types of chemicals that have been found in samples of traditional foods and human blood.

Links to Plans and Programs

The following plans and programs informed the development of the *Yukon North Slope Wildlife Conservation and Management Plan* and are an integral part of its implementation.

- The Northern Contaminants Program (Government of Canada, 2018; Curren, 2017)
  The Northern Contaminants Program (NCP) is a national program that has been running since 1991. It is a partnership among governments, community organizations and researchers. Its goal is to reduce and, where possible, eliminate contaminants in harvested food in northern Canada, while providing information to help people make decisions about food use.

  The NCP funds and coordinates research and monitoring on contaminants in Arctic environments and on the human health effects of contaminants in harvested foods. NCP studies have also focused on the nutritional role and economic importance of traditional (country) foods. The program is guided by committees in the Yukon and NWT. The NCP places a strong focus on Arctic indigenous peoples' participation in research and monitoring and in communication of results.

  The NCP is Canada's partner in the Arctic Monitoring and Assessment Programme (AMAP, 2019), the Arctic-wide network that coordinates contaminants research, monitoring, and action to reduce contaminants at the international level.

- *Integrated Ocean Management Plan for the Beaufort Sea: 2009 and Beyond* (BSP, 2009)
  The plan includes objectives, strategies, and actions on providing information on contaminants in country foods to communities (objective 2.9) and on contaminants research and monitoring (objective 4.3).

- *Tarium Niryutait Marine Protected Areas Monitoring Plan* (DFO & FJMC, 2013)
  The monitoring plan supports continued monitoring of health effects of contaminants on beluga through collaborative efforts of Fisheries and Oceans Canada, the Fisheries Joint Management Committee, and the Northern Contaminants Program.

- Fish and Marine Mammal Community Monitoring Program (FJMC, 2013)
  This program was built on a beluga monitoring program that was started by Fisheries and Oceans Canada in the mid-1980s and has been administered by the Fisheries Joint Management Committee since 1987. In 2010 the program was expanded to include more species and to integrate community-based monitoring. The program includes collection of samples at Shingle Point.

- *Aklavik Inuvialuit Community Conservation Plan* (Aklavik HTC et al., 2016)
  Monitoring health and the presence of contaminants in seals was identified as a moderate research priority in the Aklavik Inuvialuit Community Conservation Plan.

- *Inuvialuit Settlement Region Polar Bear Joint Management Plan* (Joint Secretariat, 2017)
  The plan identifies contaminants as a threat to polar bears. The concern is that POPs, heavy metals and other contaminants of emerging concern may be harming the health of polar bears. The plan notes the potential for increased exposure to contaminants from an increase in shipping and from oil and gas activities. Knowledge gaps include understanding how climate change impacts might lead to changes in contaminant levels; baseline contaminant levels related to the oil and gas development; and understanding sub-lethal impacts of contaminants and pollution on individual bears and on populations. The plan lays out approaches for monitoring contaminants in polar bears and for filling the identified knowledge gaps.
- *Management Plan for the Peregrine Falcon anatum/tundrius* (Falco peregrinus anatum/tundrius) *in Canada* (ECCC, 2017)
  Contaminants are a threat to some birds of prey, as identified in this species at risk management plan. DDT (a pesticide) caused egg-shell thinning in peregrine falcons prior to the 1970s, leading to a severe population decline. Global control of DDT use in the 1970s led to population recovery, almost to historical numbers by 2017. Brominated flame retardants (PBDEs) were detected in significant quantities peregrine falcons in the 2000s and it is not yet known if regulatory measures have lowered these levels. The plan includes high priority conservation measures to ban or control contaminants and to research their effects on falcon health.

Knowledge Strengths and Gaps

Contaminants of Emerging Concern

New chemicals are still being developed and brought into use. Contaminants vary greatly in toxicity and in how fast they degrade and how much they build up in different animal tissues. Although many contaminants of emerging concern are being monitored, the effects of mixtures of low levels of many contaminants on wildlife and human consumers of country foods are not well understood. New analytical techniques mean that researchers continue to find additional chemicals in wildlife. For example, analysis of archived polar bear samples, including from Beaufort Sea bears, identified many previously unknown contaminants in polar bears (Liu et al., 2018). This may indicate that exposure and toxic risk in polar bears has been underestimated. An additional emerging issue is the spread of plastic waste, especially very small particles of plastics (microplastics) throughout the world’s oceans, including to Arctic waters.

Contaminants and Climate Change

Climate change and the related loss of sea ice are driving change in Arctic ecosystems. Changes in food webs due to climate change are linked to changes in pathways of contaminants through ecosystems and to levels of contaminants in some animals (Braune, 2011; McKinney et al., 2015). This is not an easy puzzle to solve and often the relationships between contaminants and climate change are not understood. McKinney et al. (2015) reviewed research in this field and developed recommendations for monitoring and targeted research to improve understanding of how climate change and exposure to contaminants in the Arctic interact.

Climate change, contaminants, and polar bears

Loss of sea ice can lead to long periods without food for polar bears. Prolonged fasting increases concentrations of contaminants in their tissues. This could lead to health effects, and impact reproduction and survival.

Contaminants Monitoring of Yukon North Slope Wildlife

Plans and research papers relevant to the Yukon North Slope (summarized above) recommend continued monitoring of contaminants in species with a history of high contaminant levels and/or high risks of accumulating contaminants, especially species that are regularly harvested for food or species that may be at particular risk of health effects from contaminants. Multi-year sampling records are available for several wildlife populations that frequent the Yukon North Slope are summarized in Table 3– 1:

Table 3– 1. Main multi-year sampling data sets for wildlife populations frequenting the Yukon North Slope

Wildlife population	Contaminants studied	Selected references
Dolly Varden	mercury	Babbage River (Tran et al., 2016); other stocks that frequent the Yukon North Slope coast (Evans et al., 2015)
Porcupine caribou	mercury, cadmium and radioactivity	Mercury and cadmium since late 1990s (Gamberg Consulting, 2017; Gamberg et al., 2015); radioactivity since 1960s (Macdonald et al., 2007; Stocki et al., 2016)
Ringed seals	mercury, legacy POPs, contaminants of emerging concern	Hunter samples from Sachs Harbour since late 1990s (Houde et al., 2017; Brown et al., 2016)
Beluga	mercury, legacy POPs, contaminants of emerging concern	Hunter samples from Tuktoyaktuk since the 1980s (Smythe et al., 2018; Noël et al., 2018; Stocki et al., 2016)

Polar bears	mercury, legacy POPs, contaminants of emerging concern, macro plastics in stomach contents	Southern Beaufort Sea subpopulation, various studies (e.g. Liu et al., 2018; McKinney et al., 2017), GNWT harvest sample collection

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