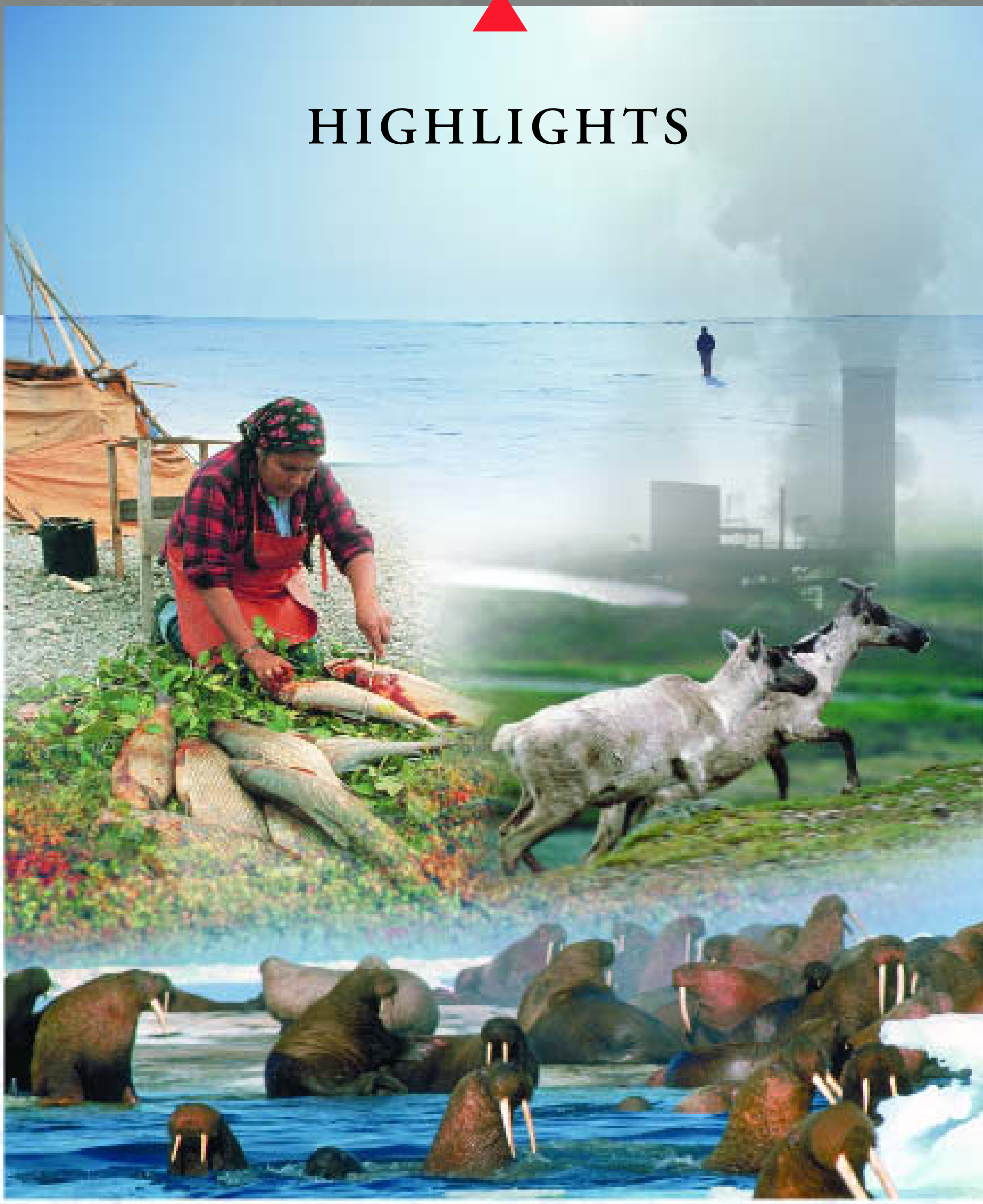
Northern Contaminants Program

Canadian Arctic Contaminants Assessment Report II



HIGHLIGHTS

Inuit Tapiriit Kanatami

CYFN

Dene Nation

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Canada


Chukchi Sea
Arctic Ocean
Beaufort Sea
Sachs Harbour (Ikaahuk)
Tuktoyaktuk
Old Crow
Aklavik (Akłarvik)
Inuvik (Inuuvik)
Fort McPherson (Teetł'it Zheh)
Tsiigehtchic (Tsıigehtshık)
Paulatuk (Paulatuuq)
Holman (Uluqsaqtuuq)
Colville Lake (K'áhbamį́túé)
Fort Good Hope (Rádeyı̨lı̨kǫ́ę́)
Dawson
Keno Hill
Beaver Creek
Mayo
Pelly Crossing
Norman Wells (Tłegóhtı̨)
Kugluktuk (Coppermine)
Iqaluktuutiaq (Cambridge Bay)
Umingmaktuuq
Faro
Ross River
Carmacks
Tulita (Tulít'a)
Déline (Délı̨ne)
Qinguaq (Bathurst Inlet)
Haines Junction
Whitehorse
Wrigley (Pedzéh Kı̨)
Rae Lakes (Gameti)
Snare Lakes (Wekweti)
Carcross
Teslin
Wha Ti (Wha Tı)
Rae-Edzo (Behchokǫ̀-Edzo)
Watson Lake
Fort Simpson (Łíídlı̨ Kų́ę́)
Jean Marie River (Tthek'éhdélı̨)
Yellowknife (Sǫ̀mbak'è)
Nahanni Butte (Tthenáágó)
Fort Liard
Fort Providence (Zhahtı Kų́ę́)
Lutselk'e (Łútsëlk'é)
Hay River (Xátł'odehchee)
Fort Resolution (Deninu Kų́ę́)
Fort Smith (Tthebacha)

Alert
Ausuittuq
(Grise Fiord)
Resolute
(Qausuittuq)
Ikpiarjuk/Tununirusiq
(Arctic Bay)
Mittimatalik
(Pond Inlet)
Kangiqtugaapik
(Clyde River)
Baffin Bay
Taloyoak
Igloolik
Sanirajak
(Hall Beach)
Qikiqtarjuaq
(Broughton Island)
Uqsuqtuuq
(Gjoa Haven)
Kugaaruk
(Pelly Bay)
Pangnirtung
Naujaat
(Repulse Bay)
Iqaluit
Kinngait
(Cape Dorset)
Qamanittuaq (Baker Lake)
Salliq
(Coral Harbour)
Kimmirut
(Lake Harbour)
Igluligaarjuk (Chesterfield Inlet)
Ivujivik
Salluit
Kangiqsujuaq
Kangiqliniq (Rankin Inlet)
Tikirarjuaq (Whale Cove)
Quaqtaq
Akulivik
Kangirsuk
Arviat
Puvirnituq
Aupaluk
Kangiqsualujjuaq
Tasiujaq
Nain
Hudson Bay
Kuujjuaq
Inukjuak
Hopedale
Makkovik
Postville
Rigolet
Umiujaq
Sanikiluaq
Happy Valley/Goose Bay
Kuujjuarapik

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“ᑖᓐᓇ ᐅᖃᓕᒫᒐᖅ ᖃᑐᐃᓐᓇᐅᕙᒃ ᐃᓄᒃᑎᑐᑦ ᑕᐃᒍᒃᑕᐅᓯᒪᓂᑦ.”

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ᑲᓇᑕᐅᑉ ᐅᑭᐅᖅᑕᖅᑐᐊᓂ ᓱᕈᖅᓯᓐᓇᖅᑐᓂ
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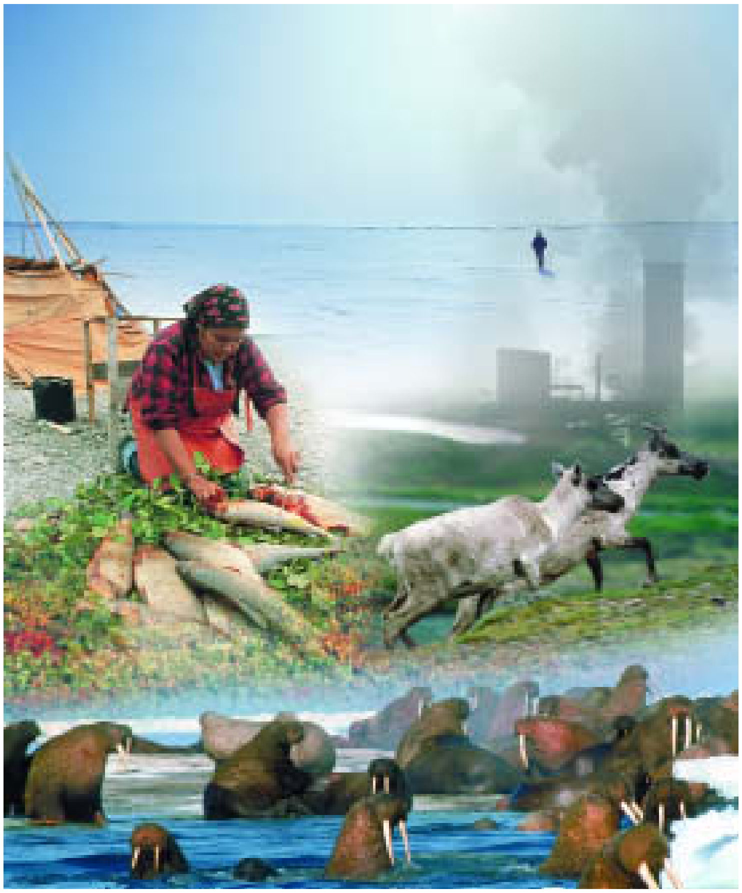
HIGHLIGHTS



A **Statement** Prepared by the Aboriginal Partners of the Northern Contaminants Program

The North is our homeland. The region that others consider remote has for millennia been central to our identity as peoples. We use huge areas for hunting, fishing, trapping and gathering, and we eat what we hunt. Our relationship with the land is deep, abiding, and central to our cultures, ways of life, and our future.

Having learned in the late 1980s of transboundary contamination in the North through what were essentially reconnaissance studies, the Council of Yukon First Nations (CYFN), the Dene Nation, the Inuit Circumpolar Conference Canada (ICC), the Inuit Tapirisat of Canada (ITC) later renamed Inuit Tapiriit Kanatami (ITK), and the Metis Nation–Northwest Territories, agreed to join federal and territorial agencies to manage the Northern Contaminants Program (NCP), established through Canada's 1991 Green Plan. We appreciated the need for a detailed and comprehensive examination of the issue, as a prelude to doing something about it, and knew we had to be fully involved.

To us, persistent organic pollutants (POPs), heavy metals and radioactivity in traditional country food is not just an environmental or public health issue but raises questions of our cultural survival. If we lose confidence in our traditional country food we will question whether to continue hunting. We have few alternatives to our highly nutritious traditional country food. Our hunting cultures teach our young valuable and important values and skills required in the modern world —patience, tenacity, courage, and judgment.

A key feature of the NCP is its commitment to carry out work in small northern communities and to help people most impacted by transboundary contaminants make appropriate food choices. The Aboriginal partners have assumed considerable responsibility to inform their constituents of the work carried out by the NCP. Communities need to know the potential risks posed by contaminants that end up in the northern environment, as well as the considerable benefits of eating traditional country food.

The research and partnerships developed through the NCP have significantly raised the profile of environmental contaminants in the North and our capacity to effectively address them. We have used experience gained through the NCP to bring the public health and environmental issues of contaminants in the North to the national, circumpolar, and international stages. We may be small in number but we have exerted significant influence in negotiation towards the 1998 POPs Protocol under the United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution, and the 2001 United Nations Environment Program global convention on POPs signed in Stockholm. Data generated through the NCP is used in the ongoing work of the Arctic Monitoring and Assessment Programme (AMAP), a constituent program of the eight-nation Arctic Council.

We continue to see contaminants as a major threat to our traditional foods. The first Canadian Arctic Contaminants Assessment Report released in 1997, and this second assessment, illustrate the need for continued vigilance and further research and education in northern communities. In particular, increased monitoring of contaminants and their impacts in the Arctic is required to enable Canada to live up to responsibilities it assumed in the Stockholm Convention. We recommend strongly that the Government of Canada renew the NCP, and continue to implement this innovative program in partnership with northern Aboriginal peoples.

Ed Schultz
Grand Chief
Council of Yukon First Nations

Bill Erasmus
National Chief
Dene Nation

Duane Smith
President
Inuit Circumpolar Conference Canada

Jose Kusugak
President
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Foreword

to the CACAR II Highlights Report

On behalf of the Government of Canada, I am pleased to present the Canadian Arctic Contaminants Assessment Report II (CACAR II).

CACAR II provides a comprehensive assessment of contaminants in Canada's Arctic. This report not only reflects the work conducted by the Northern Contaminants Program (NCP) over the last five years, but it is also a critical component of a long-term strategy to safeguard the northern environment and the general health of the North.

We have learned from other environmental issues like climate change, that the arctic is an indicator of global environmental health. Managed by the Department of Indian Affairs and Northern Development, the NCP, which was established in 1991, is a co-operative effort involving the federal departments of Health, Environment, and Fisheries and Oceans, the three territorial governments, the provinces of Québec and Newfoundland and Labrador and northern Aboriginal organizations.

The NCP co-ordinates Canada's action on the issue of northern contaminants nationally and provides the research necessary to take action internationally. The NCP addresses concerns about exposure to elevated levels of contaminants in fish and wildlife species that are important to the traditional diets of northern Aboriginal peoples.

In addition, the NCP has set new standards for Aboriginal and northern communities' participation in scientific and government programs. The traditional knowledge of our northern Aboriginal partners is key in understanding how chemicals and pollutants, many of which had no Arctic or Canadian source, affect the lives of northerners.

The Government of Canada recognizes the enormous potential of the North as well as its fragility. Through CACAR II, we are providing information to governments and northerners to enable them to make informed decisions about their health and their environment.

I would like to take this opportunity to thank all those who contributed to this report.

Robert D. Nault
Minister of Indian Affairs and Northern Development

Acknowledgements

This report highlights the main results of work carried out for the Northern Contaminants Program since 1997, and is based on the technical reports that are part of the Canadian Arctic Contaminants Assessment Report — Phase II series. This is the plain language report of the Aboriginal Partners:

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Dene Nation (contact: Chris Paci)

Inuit Circumpolar Conference (contact: Stephanie Meakin)

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The preparation of the Highlights Report took many months. We would like to offer special thanks to Jill Watkins of Enviroscope, who prepared this report, and to Stephanie Meakin of Meakin Consultants, who was central in the early stages of development. Many individuals took time to review various drafts and provide comments and suggestions. We sincerely thank the following people for their contributions:

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Executive Summary and Recommendations

The Highlights of the Canadian Arctic Contaminants Assessment Report (CACAR) — Phase II report is part of a series of reports that summarize the work carried out since 1997 during Phase II of the Northern Contaminants Program (NCP). This report conveys in plain language the main results of the technical reports, keeping a readership of northerners specifically in mind.

The aim of the NCP is to work towards reducing and, where possible, eliminating contaminants in traditional/country foods, while providing information that assists individuals and communities in making informed decisions about their food use. During Phase II, emphasis was placed on continuing research on the health benefits and risks of consuming traditional/country foods; developing effective community communication; and continuing work on international agreements to control contaminants. The traditional knowledge of the northern Aboriginal peoples also became increasingly important during Phase II.

Contaminants and the Physical Environment

The three main categories of contaminants studied through the NCP are heavy metals, persistent organic pollutants (POPs) and radionuclides. Most of these contaminants arrive in the North on air and ocean currents from southern agricultural and industrial sources. Contaminants are found in northern waters, soils, sediments, snow, rain, ice and in the air. The main reason for studying contaminants in the physical environment is to determine their sources, main transport mechanisms and pathways into the biological environment. Levels are quite low, but these contaminants can bioaccumulate and biomagnify in the food web, eventually to reach levels of concern in people. Research into contaminants in the physical environment, in particular sources of contaminants, is also useful for work to restrict their use through international agreements. Follow-up research can tell us whether these agreements are proving effective at reducing contaminant levels in the North.

Contaminants in the northern atmosphere

In general, the Canadian northern atmosphere contains lower levels of POPs and heavy metals than those found over most other circumpolar countries. Levels of most contaminants are declining slowly right across the circumpolar Arctic. However, it is still too early to tell whether mercury levels are increasing or decreasing. The main sources of heavy metals in the air over northern Canada are thought to vary seasonally with these sources being: the Canadian Arctic islands and western Greenland (fall); western and northwest Europe (late fall and winter); and Asia and Russia (late spring and summer).

Levels of mercury in the northern Canadian atmosphere suddenly drop in the spring when the sun reappears after the long polar night. This phenomenon is also now being observed at other locations in the circumpolar Arctic. Mercury is deposited from the atmosphere onto the snow surface during what is called a mercury depletion event (MDE) and may be an important route for mercury to enter the food web.

Most POPs are declining in the Canadian northern atmosphere, with the exception of dieldrin and endosulfan. Decreases in the hexachlorocyclohexanes (HCHs) and toxaphene are undoubtedly a result of international controls on their use. Lindane is expected to continue to be transported northward for some years from residues in Canada, France and China. Some pesticides are thought to be carried to western North America, including Yukon, from Asia during the winter.

Several new contaminants not previously studied under the NCP are now being found in the Canadian northern atmosphere but it is still too early to tell whether levels are increasing. These include the brominated flame retardants, chlorinated paraffins and chlorinated phenols. The flame retardants are widely used and may be of concern in the future as they easily enter the food web. More research is required in this area.

Contaminants in lake sediments

Mercury levels appear to be increasing in lake sediments in Nunavut south of 80° N and possibly in other areas as well. These increases may be because more mercury is being transported from the south, or possibly because of climate change as mercury is released into the environment from melting permafrost and along with organic matter entering lakes and rivers. At virtually all Yukon sites (with the exception of Hanson Lake), levels of most POPs have been declining over the past 20 years.

Contaminants in the marine environment

In marine waters, HCHs are the most common contaminants, followed by PCBs. HCH levels are higher in the Canadian Arctic islands compared to other parts of the Arctic Ocean and most alpha-HCH is now arriving through the Bering Strait in seawater instead of through the atmosphere as in the past. Beta-HCH, which may be more toxic for animals and humans, travels to the Arctic primarily in ocean currents and levels are highest in the Bering-Chukchi region. Lindane and endosulfan are the only modern pesticides found in the Arctic Ocean.

Low levels of the new POPs such as the brominated flame retardants and chlorinated paraffins are now being detected in marine sediments.

Very few radionuclides being released from European nuclear plants are reaching the Canadian Arctic Ocean.

Climate change and contaminants

Climate change is now modifying atmospheric and ocean currents and more contaminants may reach the Canadian North than before. Levels of mercury and other heavy metals are expected to increase in the Canadian Arctic Ocean. The strength and location of the mercury depletion events may change. Levels of some POPs may also increase. More radionuclides may also reach the Canadian North in ocean currents. Contaminants will likely bioaccumulate and biomagnify in ways not yet understood. This may have implications in the future for the health of animals, and for the levels of contaminants in traditional/country foods.

Contaminants in Fish and Wildlife

Ringed seals

There is no evidence as yet of a general increase in mercury or other heavy metal levels in fish and wildlife. However, increases in mercury and cadmium are being observed in some marine mammal populations, generally near the mouths of large rivers, and in some seabirds.

Mercury levels are staying about the same in the livers and kidneys of most ringed seal populations, but are rising in others for reasons that are not yet clear. Similar patterns are found for cadmium levels. Though there are no consumption guidelines for seal meat, many of the mercury levels in ringed seal kidneys and livers are higher than the guidelines set for fish consumption.

In contrast to mercury, levels of POPs in the blubber of ringed seals are similar across the Canadian North, though they are declining in some locations. PCB levels have dropped up to 60% from 1975 levels and DDT levels have also dropped. Computer models predict that levels of both PCBs and DDT will drop even further by 2010. However, alpha-HCH levels have increased. Blubber from Canadian ringed seals contains more POPs than seals from Alaska; however, seals from Europe and northeast Greenland have even higher levels.

Beluga whales

It has been known since the 1980s that mercury levels in beluga organs may be cause for concern, both for the whales and to consumers. However, much of the mercury is converted to a less toxic form in the organs. Over the last 15–20 years, mercury levels have increased four times in the livers of belugas from the Beaufort coast and 10 times or more in belugas from western Hudson Bay.

The levels of some POPs in beluga whales are decreasing (e.g., PCBs, dieldrin), while levels of others are staying the same (e.g., DDT, toxaphene), or increasing (e.g., chlordane, endosulfan).

New POPs are being detected and are rising in ringed seal, beluga and narwhal blubber. For example, levels of the fire retardant polybrominated diphenyl ethers (PBDEs), while not currently of concern, are now nine times higher in seal blubber from Holman (Uluqsaqtuuq) than they were in 1981. These contaminants should be monitored, as they may become of concern in the future.

Walrus

Levels of mercury and other heavy metals are staying about the same in walrus but PCB and DDT levels may be decreasing. Animals from east Hudson Bay and the Foxe Basin contain similar levels of POPs. Canadian walrus generally have similar levels of POPs to those found in walrus in other countries.

Polar bears

Scientists are more concerned about the effects of POPs on polar bears than any other wildlife species. Polar bears are particularly vulnerable to bioaccumulating POPs from eating seal blubber, and they can also biotransform many POPs into more toxic forms. For example, PCBs are known to cause problems with both vitamin A levels and the thyroid hormone in polar bears. This concern remains even though levels of HCHs, DDT and PCBs are decreasing in the fat of polar bears from Hudson Bay. Levels of other POPs appear to be staying at about the same levels.

Arctic foxes

Arctic foxes feed at various levels in the food web but this does not appear to affect their levels of POPs. Most levels are quite low and, overall, Canadian foxes contain lower levels of POPs than Arctic foxes from Svalbard, the Norwegian mainland or Iceland.

Invertebrates and marine fish

Invertebrates such as clams and mussels contain variable but low levels of heavy metals. Levels of POPs are also very low.

Marine Arctic char contain only very low levels of mercury, and virtually undetectable levels of cadmium and lead. POPs levels are also very low. Arctic cod contain levels of mercury and POPs similar to Arctic char. In contrast, Greenland sharks are thought to bioaccumulate and biomagnify contaminants much more than other marine fish. Levels of mercury are more than 10 times the levels found in other fish, though they are still much lower than those found in marine mammal livers. The levels of some POPs are similar to those found in polar bears and other predators at the top of the food web. DDT levels are the highest found in any northern Canadian animal.

Seabirds

Mercury levels have been increasing in Arctic seabirds, but they transform much of this mercury into non-toxic forms. Mercury levels have almost doubled in the eggs of thick-billed murres since 1975, and have increased in northern fulmars by 50%. The higher levels are found in predatory birds such as glaucous gulls, while lower levels are found in non-predatory species such as dovekies. Mercury levels in long-tailed ducks vary greatly from place to place.

In contrast to mercury, the levels of most POPs, especially PCBs and DDT, are decreasing in the eggs of seabirds. However, HCHs are increasing in many birds, possibly because more HCHs are now reaching the Arctic through the Bering Strait rather than through the atmosphere. Birds that migrate south, such as the black-legged kittiwake, have higher levels of selenium which is picked up from southern regions. Non-migrating birds such as black guillemots tend to pick up more mercury, which is then passed on to their eggs. Black guillemots in some locations, however, are exposed to high levels of PCBs which may be affecting their health.

Many of the new POPs are also being detected at low levels in seabirds. These levels, however, are increasing.

Land mammals

Two large monitoring programs during Phase II of the NCP measured heavy metals and POPs in land mammals, including 15 caribou herds, moose, bison and mule deer across the Northwest Territories and Yukon. Wolves, wolverines, beaver and muskrat were also studied. Levels of various POPs, heavy metals and radionuclides are quite low in land mammals. The only potential concern is the fairly high levels of cadmium found in the kidneys and livers of Yukon caribou. These cadmium levels, however, are not thought to have changed over thousands of years, and come mostly from natural sources.

Freshwater fish

In contrast to land mammals, levels of mercury are increasing in the organs of some freshwater fish in certain lakes, but there is much variation from lake to lake.

Mercury levels have increased in the livers of loche (burbot) from the Mackenzie River (Dehcho), in some locations by more than 35% since 1985. In some cases mercury levels are above the subsistence consumption level, but all are below the guideline for commercial sale. In other locations, mercury levels are rising and, while not of concern for consumption, should continue to be monitored.

Loche (burbot) from Yukon lakes do not contain high levels of POPs with the exception of Lake Laberge, where toxaphene levels in livers continue to be high. As with other animals in the North, the new brominated flame retardants are being found in loche (burbot). Levels are very low but are increasing with time and should continue to be monitored.

Land-locked Arctic char from Nunavik and Labrador generally contain only low levels of mercury and POPs. In contrast, some land-locked Arctic char from Resolute Lake on Cornwallis Island contain mercury levels above the guideline for subsistence consumption, though below the commercial guideline. These higher levels may have resulted from some Arctic char becoming predatory. Levels of POPs are low and not considered to be of concern for human health.

In the Mackenzie River (Dehcho) Basin and in Nunavut, predatory fish such as lake trout, jackfish (northern pike) and pickerel (walleye) generally contain levels of mercury above both the subsistence and commercial guidelines. In contrast, non-predatory fish such as whitefish generally contain much lower levels. Freshwater fish from Great Slave Lake (Tucho) and Great Bear Lake (Sahtú) contain some of the lowest levels of mercury found in the Canadian North. Levels of POPs are low in all these fish, even in predatory fish, and are not of concern.

Waterfowl and game birds

High levels of cadmium and mercury are being found in the livers and kidneys of eider ducks. Cadmium levels in the kidneys of king eider ducks from the East Bay Migratory Bird Sanctuary on Southampton Island were some of the highest ever measured in eiders and more than four times the levels measured in European eiders. Common eiders have much lower levels of cadmium, but age may be a factor as the common eider samples may have come from younger birds. The cadmium in Canadian eiders is thought to come from local underlying rocks.

Similar to the patterns of cadmium, common eiders contain lower levels of mercury compared to king eiders. This is thought to be caused by differences in diet. Common and king eiders both eat mussels, but king eiders also consume bottom-dwelling invertebrates which may contain higher levels of contaminants.

Plants

Plants in northern Canada contain only low levels of POPs and heavy metals. However, some plants near local contaminant sources (e.g., gold mines) may contain higher levels of certain contaminants such as arsenic. This has led to advisories being issued on the consumption of berries in these areas.

Contaminants and Human Health

During Phase II, NCP research relating to contaminants and human health has resulted in the message to northerners that the known nutritional, economic, social and cultural benefits of consuming traditional/country foods are believed to outweigh the currently known risks. Further studies are being undertaken to develop a better understanding and clarification of these risks.

Dietary patterns

A major dietary survey carried out during Phase II looked at how much traditional/country food (and market food) people consume, and the nutritional value of these foods. On the days when people eat traditional/country food, the diet generally contains less sugar, more of the healthy types of fat, more vitamin E, more iron and more zinc. Overall, a traditional/country food diet is healthier than a typical northern market food diet. More traditional/country food is eaten in remote communities than in urban areas. People over 40 years old tend to eat more traditional/country foods than younger people, and men consume more than women. Moose, caribou and whitefish are eaten most often among Yukon First Nations, Dene and Métis; caribou and Arctic char most frequently among Inuit in Inuvialuit, Kitikmeot and Kivalliq; caribou, Arctic char and ringed seal most often among Inuit in Baffin; and caribou and trout most often among Inuit in Labrador.

Benefits of traditional/country foods

Many traditional/country foods help people fight illness, injury and disease better than the popular market foods and provide the necessary dietary intake of most vitamins, essential elements and minerals. Harvesting traditional/country food is physically demanding and helps people stay fit. There are significant social, cultural and spiritual benefits to harvesting, preparing, sharing and consuming these foods. Individuals feel they are part of the group and have their sense of culture reinforced. Young people learn skills necessary for living off the land, and develop qualities such as responsibility, patience and respect. There are also clear economic reasons which support continued and extensive use of traditional/country foods. It is almost always cheaper than market food and is an economic necessity for many northerners. Most Inuit, Yukon First Nations, Dene and Métis state that they would not be able to feed their families relying only on market food.

Most of the market foods consumed in Aboriginal communities do not provide adequate nutrition. On the days that people do not eat traditional/country food, they consume more sugar, unhealthy fats and carbohydrates than usual. More Aboriginal northerners than before are becoming overweight and developing "western-style" problems such as diabetes and heart disease. In Baffin region, 40% of women over 40 years of age may develop health problems because they are too heavy. For women under 40, and men over 40 years of age, 20% may develop health problems.

Contaminant exposure

In most Kivalliq and Baffin communities, more than ¼ of the population is taking in levels of mercury above the level known to be safe (the tolerable daily intake or TDI level). In Kivalliq, most of the mercury comes from consuming caribou meat, beluga muktuk and lake trout muscle. In Baffin, most comes from eating ringed seal meat, narwhal muktuk and caribou meat.

The levels of mercury in mothers' blood, hair, or umbilical cord blood follow a somewhat similar pattern to intake levels. Ten percent of mothers in Baffin region and 16% of Nunavik mothers have mercury blood levels that fall within Health Canada's "increasing risk" category. Nearly 80% of Nunavik mothers and 68% of Baffin mothers have mercury blood levels that exceed a new guideline based on United States studies. Mercury levels in Yukon First Nations, Dene, Métis, and Inuit from Kivalliq and Kitikmeot regions are much lower and fall within Health Canada's "acceptable" range.

Inuit in Greenland and people from the Faroe Islands contain higher levels of mercury than Inuit in northern Canada. Inuit in Greenland eat more marine mammals compared to Inuit in Canada and this is likely the reason for the difference in levels.

Lead levels are elevated in some Dene and Métis mothers as well as in Inuit mothers. The use of lead shot for hunting is the probable reason. Cadmium levels are elevated in some Inuit, Dene and Métis mothers. Most cadmium comes from smoking cigarettes.

While intake levels of many POPs are below the TDIs, people from the Inuvialuit, Kitikmeot, Kivalliq and Baffin regions are taking in levels of chlordane and toxaphene that are on average higher than the TDIs. In some communities in the Baffin and Kivalliq regions, 25–50% of residents take in more chlordane and toxaphene than the TDIs. Intakes of PCBs are also higher than the TDI in Baffin region. The consumption of marine mammal blubber and muktuk is thought to be the reason.

Levels of chlordane, toxaphene and PCBs in the blood, hair and umbilical cord of mothers follow a similar pattern to intake levels. Levels of PCBs are elevated in the blood of mothers in Baffin, Kivalliq and Nunavik. Nearly ½ of the mothers have levels above the "level of concern". Levels of PCBs are not thought to be of concern for Dene or Métis mothers.

Mothers from Nunavik have PCB blood levels similar to levels in mothers from the Netherlands. Levels are 2–3 times higher in mothers from Greenland compared to Canadian Inuit, likely because Greenland Inuit eat more marine mammals. People from the Faroe Islands also have blood levels 2–3 times that of Canadian Inuit.

Northerners are exposed to higher levels of radionuclides compared to people who live in the south. These radionuclides occur naturally and for thousands of years have been reaching humans at approximately the same levels through the lichen→caribou→human food web. No significant health risks have been associated with radionuclides in northerners to date.

Effects of contaminants on health

There have been few studies of the effects of mercury and other contaminants on the health of Canadian northerners. A study is now being conducted in Nunavik which should soon provide useful information on effects and risks, particularly for those groups most vulnerable to contaminants: women of child-bearing age, pregnant women, the fetus and children.

International research results presented in the Arctic Assessment and Monitoring Programme's report "Arctic Pollution 2002" confirm that breastfeeding should continue and that the benefits of breastfeeding outweigh the currently known risks. There are substantial benefits to both mother and child from breastfeeding, even though breast milk can contain most of the POPs found in the Canadian North.

While research in the Faroe Islands shows that low levels of mercury may lead to slightly slower development in children, other studies elsewhere in the world do not show any health problems related to low levels of mercury. There is early evidence based on animal research that vitamin E, and a combination of vitamin E and selenium may provide some protection against mercury. Certain fatty acids and fish protein may also help reduce the effects of methylmercury.

Very little is known as yet about the effects of chlordane and toxaphene on the health of northerners but some information is available about the effects of PCBs and DDT. In Nunavik, mothers having elevated levels of PCBs in their blood gave birth to slightly smaller infants. These infants may possibly have difficulty fighting infections and disease. DDT in breast milk may also be causing more infections in infants and children. Vitamin E and omega-3 fatty acids found in many traditional/country foods may help protect people from the effects of contaminants such as PCBs.

Benefit-risk communication

The Aboriginal Partners and territorial health departments have taken the lead in providing benefit-risk information and advice to northerners. Both sides of the issue must be considered, including the type and amount of food consumed and the social, cultural, nutritional, economic and spiritual benefits of these foods. Management decisions are taken together with the communities affected. The benefits of continued consumption of traditional/country foods are currently considered to outweigh the known risks.

Education, Training, Capacity Building and Communication

The NCP recognizes that any information northerners receive about contaminants in traditional/country foods may significantly affect their diet, economy and way of life. Therefore, the program invests considerable time and resources into education, training, capacity building and communication.

Specific initiatives undertaken during Phase II of the NCP include the development of educational materials for use in school curricula, Regional Contaminants Coordinators (RCCs), frontline training courses, community tours, and Elder-scientist retreats. One-on-one communications and small groups have proven effective. The lessons learned from experience are invaluable in the ongoing delivery and exchange with northern residents on contaminant issues. However, more formal evaluation of these activities and their outcomes is needed.

Materials for school curricula

Education materials for school curricula were initially developed by the Metis Nation–NWT, together with teachers, school boards, and the Government of the Northwest Territories Department of Education. Materials were also developed in Yukon, using the Metis Nation–NWT model, but adapted to reflect the regional situation. School children were also involved.

Regional Contaminants Coordinators

With the support of the Aboriginal Partners, RCCs act as community and regional coordinators for some research activities, and as communicators and program representatives at the community level. Positions were created in regions where there are human safety concerns relating to contaminants, and as the RCCs are often local residents, they have been able to forge relationships of trust with their communities. Because the RCC positions are successful in providing experience and supporting interest in contaminant issues, many RCCs have been able to move on to positions of greater responsibility, or to higher education.

Frontline training courses

Frontline workers in northern communities, including renewable resources officers, health workers, and Elders among others, are the people most likely turned to locally for information and advice. During Phase II of the NCP, six training courses on contaminants were provided to over 100 frontline workers in Labrador, Nunavut and the Northwest Territories. Materials were developed by the Metis Nation–NWT, which also helped to run the courses. These courses have greatly increased the awareness of contaminants issues at the grassroots level.

Community tours

Community tours about contaminants were taken to nearly 50 communities in the Northwest Territories and Nunavut. A team of experts composed of an Aboriginal Partner, a health expert, a scientist, and an RCC presented information to community members. The community tours have had considerable success, with the crucial factor being the people involved.

Elder-scientist retreats

Retreats that bring Elders and scientists together were developed by the Dene Nation as a way for Elders and scientists to gain a better understanding of one another and to improve two-way communication. The retreats also provided scientists with an opportunity to learn more about traditional knowledge (TK). Four Elder-scientist retreats were carried out during Phase II of the program.

While informal experience-based evaluation has been ongoing, sometimes important points can be missed. Another area that needs to be evaluated is the effect that the information communicated has on people.

Action at the National and International Levels

The NCP has led Canada to produce world-class science on the past and current sources of metals and POPs, and in predicting their movement through the atmosphere. The results of NCP studies have provided the basis for policy decisions and action in Canada and on the international stage. Canadian northern Aboriginal organizations have played a key role over the years, especially at the international level.

Domestic action

Children are particularly vulnerable to a wide range of environmental contaminants. Results and data from NCP studies on contaminants and their effects on the developing fetus, infants and preschool children has helped set the federal agenda on children's health. The federal government now gives special attention to the ways in which northern Aboriginal children are exposed to contaminants, and to the levels and effects of these contaminants on their health. The NCP continues to provide direct input and direction to both the federal and NAFTA initiatives. NCP research played a significant role in the development of the domestic voluntary agreement to stop using lindane.

International action

International agreements to control emissions are recognized as the only long-term solution to the problem of contaminants in the Arctic. It has taken less than 15 years — light-speed for international diplomacy — to move from initial research that identified a POPs-related problem in the Canadian North to global action that addresses the issue. The NCP produced persuasive evidence that certain contaminants which originate from outside Canada are accumulating in the traditional foods and in the tissues of some northern people at levels which are of concern to health authorities. This information strongly influenced international agreements, concluded in 1998 and 2001, to significantly reduce emissions of key heavy metals and POPs to the environment.

Long-range Transboundary Atmospheric Pollution Convention Protocols

NCP research results contributed to the United Nations Economic Commission for Europe Long-range Transboundary Atmospheric Pollution (UN/ECE LRTAP) Convention Protocols which address heavy metals and 16 POPs, all of which are of concern in the Canadian North. The objective of the POPs Protocol is to control, reduce, or eliminate discharges, emissions and losses of these 16 POPs, and it makes special reference to the distinct concerns of Arctic and Indigenous peoples. The UN/ECE LRTAP Convention Protocols were signed by 36 countries in June 1998. As of October 2002, the POPs Protocol had been ratified by 13 countries, as had the Heavy Metals Protocol. Canada ratified both protocols in December 1998.

The Stockholm Convention

The NCP data also contributed significantly to the United Nations Environment Programme (UNEP) Global POPs Convention (Stockholm Convention) which aims to: eliminate or severely control the production and use of 12 POPs; ensure environmentally sound POPs waste disposal; and prevent new chemicals with POPs-like characteristics from emerging. This convention also specifically acknowledges the special situation and risks faced by the North and Aboriginal peoples. The UNEP Global POPs Convention became available for signing in May 2001 in Stockholm, Sweden. Canada was the first country to ratify the convention. As of October 2002, over 150 countries had signed the POPs Convention and 22 countries had ratified it.

Canadian Arctic Indigenous Peoples against POPs (CAIPAP)

The Canadian Arctic Indigenous Peoples against POPs (CAIPAP) group was formed in 1997 to influence Canada's position in the UN/ECE LRTAP and UNEP Global POPs negotiations. The NCP Aboriginal Partners formed the members of CAIPAP. CAIPAP participated actively and very successfully in the global POPs negotiations, due in part to the support of the NCP.

Arctic Monitoring and Assessment Programme (AMAP)

The Arctic Monitoring and Assessment Programme (AMAP) of the Arctic Council draws heavily on NCP research results. In addition, an Aboriginal Partner to the NCP, the Inuit Circumpolar Conference, together with the Gwich'in Council International and Arctic Athabaskan Council, helps develop policy recommendations for AMAP, many of which are based on NCP experience.

The NCP model is now well-known and being copied in the circumpolar Arctic. Aboriginal peoples in northern Canada also view the NCP as a model for other research and monitoring programs to address issues such as climate change and biodiversity conservation. The success of the NCP was also recognized in the 1999 Report of the Commissioner of the Environment and Sustainable Development and in an independent evaluation conducted in 2002.

Summary of Recommendations

Contaminants and the Physical Environment

- it is important to monitor the levels of the new POPs in the physical environment, e.g., brominated flame retardants, chlorinated paraffins and chlorinated phenols
- continued research on the properties of contaminants will help identify which are more likely to travel to the Canadian North from southern sources
- older POPs should continue to be monitored in the atmosphere, as there is not enough data as yet to determine long-term trends
- air monitoring and modelling need to continue to increase understanding of the sources, routes and levels of contaminants coming to the Yukon from Asia
- more work is needed on the routes taken by heavy metals (especially mercury) to the Canadian North
- continued research is required to assess the importance and nature of mercury depletion events
- studies on levels of contaminants in lake water and sediments should continue as these are very sensitive to changes in inputs from the atmosphere, runoff and rivers
- research is needed to increase understanding of the importance of microbes in removing contaminants from the physical environment
- POPs in seawater should continue to be monitored, as ocean currents are now recognized as being more important transport routes than previously thought
- the role of sea ice in moving contaminants from one part of the environment to another needs to be better understood — this is particularly important given climate change may change sea ice patterns
- research using radionuclides to “trace” ocean currents may provide information on the routes used by contaminants in seawater to reach the Arctic
- more research on the properties of contaminants will provide useful information on what is likely to happen to them once they reach the Canadian North
- although snow is known to be important for bringing contaminants to the surface, more needs to be understood about how this happens, and what happens to the contaminants once they reach the surface
- climate change is expected to have a profound effect on the Canadian North and more research is needed to increase understanding of the effects of climate change on contaminants
- studies are needed on how melting permafrost will affect the flow of contaminants
- it is important to look closely at the links between human behaviour worldwide (e.g., energy consumption, and international policies), and contaminants in northern Canada

Contaminants and Plants, Fish and Wildlife

- monitoring of contaminants now subject to international controls should continue in animals, to study the effectiveness of these controls
- the new POPs should continue to be monitored in a variety of animals including freshwater fish and marine mammals
- large variations in mercury levels in seals cannot yet be explained and should be studied further
- the potential effects of PCBs on polar bears may be serious and need to be considered further
- mercury and other metals should continue to be monitored in fish and wildlife as levels appear to be increasing in some populations and locations, but decreasing in others — these differences are not well understood
- much existing POPs data should be analyzed and interpreted to gain a better understanding of POPs and trends in freshwater fish
- research is needed to assess the levels of PCBs in black guillemots across northern Canada as even low levels are thought to cause effects

- the biological effects of contaminants on animals remain a gap in knowledge — more research is needed on what levels of contaminants (including the new POPs and toxic forms of PCBs) will cause effects for northern species

- the movement and effects of contaminants in northern ecosystems and in food webs has not been well studied — the behaviour of the new contaminants is not well understood, and the ability of contaminants to biomagnify, bioaccumulate and transform into other forms is also an area needing further research

- climate change should be a priority area for future work since climate change may result in higher levels of some contaminants in animals

- archives of samples of animals and plants are extremely valuable and should continue to be supported

- quality assurance monitoring programs should also continue for laboratories involved in analyzing samples

- greater analysis of data and publication in peer-reviewed journals is also encouraged

- the health of plants, fish and wildlife near sources of local contaminants (e.g., harbours and military sites) should be assessed, as these local sources are of considerable concern to the northern peoples

Contaminants and Human Health

- more research is needed on the health consequences of not consuming traditional/country foods

- the risks of taking in higher levels of mercury need to be studied further, especially in Baffin and Nunavik regions

- regular monitoring of contaminants in humans, especially mercury and various POPs (e.g., PCBs, chlordane and toxaphene), should continue to get a better idea of whether levels are increasing or decreasing

- it is important to continue monitoring the consumption patterns of traditional/country foods in those communities consuming the most traditional/country food containing contaminants

- levels of mercury, chlordane, toxaphene, PCBs and other POPs in northern populations should also continue to be monitored to provide a better picture of intake levels, regional variations and trends

- more human health research should focus on the toxic effects of contaminants on northern peoples, and if and how contaminants are related to health problems

- a controlled human study of the effects of various nutrients such as certain fatty acids, selenium and vitamin E on methylmercury would be useful to confirm the results of animal experiments

- NCP research relating to human health should be published in the peer-reviewed literature and evaluated to see how it affects the present provisional tolerable daily intake (TDI)

- more research is needed on how various types of toxaphene bioaccumulate and behave in animals including people, to shed light on the potential effects of toxaphene and to assess safe intake levels

- more research is needed on how the levels and effects of chlordane on animals can be related to effects in people

- new ways to predict health effects should be explored in the ongoing Nunavik study as well as in other studies elsewhere in the circumpolar Arctic

- more work is needed on the effects of mixtures of POPs on human health, especially on the fetus, infants and children

- conduct further research on the perceptions and understanding of risk among different northern groups (e.g., women of child-bearing age) to better tailor benefit-risk messages and communicate risk management options

- written benefit-risk materials should take into account different dialects

Education, Training, Capacity Building and Communication

- maintain the focus and direction of contaminants-related research and activities through the use of strategic "blueprints" that are reviewed and revised annually
- maintain the integrity of the review process for project funding so that northern research continues to meet high scientific standards as well as criteria for social and cultural considerations
- continue to address the contaminants issue through a multidisciplinary, ecosystem-based and partnership management approach
- continue to develop and strengthen partnerships with northern Aboriginal peoples at the regional, territorial and national levels to enhance the capacity development and meaningful involvement initiated by the NCP
- conduct a formal evaluation of the new NCP consultation process and adapt the process as appropriate
- continue to promote and support responsible research through the use and application of guidelines and requirements for consultation, as established under the NCP
- develop and implement a more formal process to identify and incorporate community concerns in research projects on contaminants and health
- continue to address local contaminants issues through regionally managed funds such as Local Contaminants Concerns
- develop practical guidelines on incorporating traditional knowledge in northern contaminants and health research
- evaluate current approaches used to deliver health advice and advisories regarding their impact on how individuals make decisions about their food use
- continue to support ongoing open communication with communities on contaminants and related environmental health issues using a variety of methods
- develop a dictionary or guide for translators on these issues in northern Aboriginal languages
- assess the feasibility of using new information technologies in the North and exploit them where appropriate in future activities
- revise NCP educational material to make it more compatible with existing curricula and useful for teachers and students; provide in-service training for teachers to introduce them to the material, and make it more widely available in print and digital format
- strengthen communications activities for youth about these issues as they are the decision makers of tomorrow in northern communities and regions
- evaluate the effectiveness of specific communication activities under the NCP to improve understanding about contaminants issues in northern communities, and build capacity and communication networks

Action at the National and International Levels

- ensure effective support for national and international policy and implementation activities related to contaminants of concern in Canada's North
- support the role of northern Aboriginal peoples in international negotiations and initiatives aimed at ensuring the safety of their traditional/ country foods

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CHAPTER 1

Introduction

1.1 What is the Canadian Arctic Contaminants Assessment Report — Phase II (CACAR-II)?

The Canadian Arctic Contaminants Assessment Report — Phase II (CACAR-II) provides a summary of the research and related activities carried out by the Northern Contaminants Program (NCP). The focus is on the period for Phase II (1998–2003) though earlier results are sometimes included where relevant.

There are five reports in the CACAR-II series. Three of these are technical reports that deal specifically with NCP research on:

- contaminants in fish and wildlife
- where contaminants come from and how they get to the Canadian North
- human exposure to contaminants and the effects of this on human health

The fourth technical report, called "Knowledge in Action", is concerned primarily with the difference the NCP has made at the local, regional, national and international levels. It also covers the structure and management of the program, and the initiatives taken by the program to educate and communicate contaminant issues in the North, in some detail.

The fifth in the series is the *Highlights of the Canadian Arctic Contaminants Assessment Report — Phase II.*

1.2 What is the CACAR-II Highlights Report?

The Highlights Report is the part of CACAR-II that conveys in plain language the main results or "highlights" of the four reports, keeping a readership of northerners specifically in mind. Therefore, as far as possible, the research results are presented in ways that are meaningful to those who live and work in the Canadian North. One question that most northerners have concerning the NCP and the meaning of the research results is "Is my food safe to eat?" The Highlights Report keeps this question in mind throughout.

There are likely to be additional readers of this document, e.g., Canadian policy makers and scientists, decision-makers at the international level, as well as the media. While these other groups are important, it is difficult to structure a single document in a way that suits each perspective. Because of this difficulty, the Highlights Report addresses the perspective of northerners above all others.

1.3 How is this different from the first CACAR Highlights Report?

In 1997, the first CACAR was published. It too contained highly technical reports (published together as the single volume *Canadian Arctic Contaminants Assessment Report*) as well as the *Highlights of the Canadian Arctic Contaminants Assessment Report — a community reference manual*. This original Highlights Report was written first and foremost for front-line community people working on contaminants issues. It was also for those interested in knowing more about contaminants in the North and who wanted a general overview of information that came to light through the NCP during 1991–1997.

The first Highlights Report also was designed to help people provide answers to questions raised by others. Because of the first Highlights Report, people were able to know where to find more information to help them make informed decisions about food use. They also had access to a plain language description of a complex environmental health issue.

The CACAR-II Highlights Report is somewhat different from the one produced for the first CACAR. While still oriented to northern readers, community professionals already have a manual to understand and work with the NCP and its results. The first CACAR Highlights Report still fills that need. What is needed now is a plain-language report that summarizes the new NCP research results in ways relevant to northerners' perspectives, questions and concerns.

1.4 Structure of this report

This report continues with a brief summary of the Canadian North and its unique situation with respect to the rest of Canada and the world. A description of the NCP follows, as it is this program that has enabled researchers to carry out their work, and which is responsible for the results presented in the remaining chapters of this report.

The main scientific research result highlights are presented in Chapters 2, 3 and 4, with a focus on the results since 1997 (since the first CACAR). Each chapter illustrates how northerners have participated and contributed to the research and related activities. Traditional knowledge (TK) has also played an important role in many research projects. Each chapter concludes with a short summary of the main points, and possible future work that should be done.

Chapter 2 describes the progress made in understanding contaminants, where they are coming from, how they travel to the North and what happens once they arrive. Several new contaminants have been found in the North since the first CACAR, and some remarkable new discoveries have been made about mercury as well.

Chapter 3, one of the central chapters of the Highlights Report, covers what has been learned about the levels, trends and possible effects of contaminants in northern fish and wildlife. This chapter is arranged species by species to make it easy for the reader to locate information about a particular species of interest. A wide range of species have been studied under the NCP from large mammals such as moose, caribou, and beluga; to many species of fish; to birds; plants; and finally to smaller organisms such as clams and invertebrates. Where appropriate, the information on key fish and wildlife species is linked to human health considerations.

Chapter 4 focusses more extensively on the levels of contaminants that people are exposed to, along with the possible effects of contaminants on human health and the benefits and risks of consuming traditional/country foods that contain contaminants. In most cases, it is far healthier to harvest and eat traditional/country food than to avoid it because it may contain contaminants. Some new and important studies have been carried out since 1997.

Following the three central chapters, the Highlights Report deals with how the results and knowledge gained from Phase II of the NCP have been used locally, nationally and internationally. Some of the important questions that are addressed include: How has this research made a difference to northerners? Is the research information being communicated to northerners in useful ways? Are northerners becoming better equipped to deal with contaminants? What changes are being made in Canada and elsewhere in the world because of this research? Are some contaminants now being banned? Are contaminants now being handled in a way that is safer for people and the environment? These are important questions since most contaminants found in the North come from further south, and from other parts of the world.

The final part of this Highlights Report takes the results of the research on contaminants and draws out some important observations, conclusions and recommendations. For example, are there contaminants or effects (on the environment, in wildlife, or in people) that we should know more about? What about the new contaminants which have only recently been discovered in the North? How is the changing climate (warmer temperatures, changes in rainfall and snow) going to affect contaminants? Are there gaps in the health studies? The answers to many of these questions will help guide future work.

1.5 The Canadian North

There are many definitions of the Canadian North. In this and the other CACAR reports, the Canadian North is composed of the three territories of Yukon, Northwest Territories and Nunavut, together with Nunavik (northern Québec) and the north coast of Labrador. Together these areas comprise approximately 60% of Canada's total land area.

1.5.1 Peoples

The peoples of northern Canada are diverse and distinct. Northerners are a varied group, composed of Aboriginal peoples such as Inuit, Dene, Métis and Yukon First Nations, and the non-Aboriginal population.

Just over one-half (56,000) of the total population of about 100,000 is Aboriginal. Yukon First Nations live in 14 First Nations throughout the Yukon. Dene live in five regions of the Northwest Territories, in an area known to them as Denendeh; Métis people also live primarily in Denendeh; and Inuit live in Nunavut, Nunavik and Labrador, and in the Inuvialuit Settlement Region in the Northwest Territories.

Yukon First Nations have legends and stories that tell about their origins, how the world started, and how everything came to be as it is. From the earliest times the people have defined themselves by the environment and the animals. This is at the very essence of all that is important to Yukon First Nations. Over thousands of years the people in the Yukon settled into traditional territories and developed distinct languages and cultures, and this is how the various groupings are defined today.

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Dene live in 29 communities in five regions in Denendeh (part of the Northwest Territories): Akaitcho (Treaty 8), Tlicho (formerly Dogrib Treaty 11), Deh Cho, Sahtú and Gwich'in. Contact between Dene and non-Aboriginal people is relatively recent, with most contact occurring after the 1850s.

The Métis in the Northwest Territories originate primarily from Métis families further south. Some moved to the Northwest Territories from Saskatchewan after the Battle of Batoche in the 1890s. Others trace their lineage to the Red River Settlement in Manitoba in the late 1700s.

Inuit have lived in the northern and eastern parts of northern Canada during the past 5,000 years. They also live in Alaska, eastern parts of Russia and in Greenland. More than 40,000 Canadian Inuit live in communities in the six Inuit regions: Inuvialuit, Kivalliq, Kitikmeot, Baffin, Nunavik, and Labrador.

Aboriginal peoples, through a close relationship with the environment and the teachings that have been handed down from previous generations, hold a vast and intricate knowledge of the lands, waters, plants and animals that have sustained them for thousands of years. Because of an acute awareness of how the environment functions and changes, they consequently are often the first to point to any change.

Many profound changes have occurred over the past six years or so in the Canadian North. The new territory of Nunavut has been created, and land claims continue to be negotiated, settled and implemented. Similarly, there have been major social changes. Young people continue to make up more of the total population, and it has become important to provide them with the basis for a good life through education, training and employment. The average age of Northern peoples, especially Inuit, is lower than the average age of other Canadians. A greater proportion of the population in northern communities is composed of young people compared to the rest of Canada.

The way of life of many northerners has changed over the past several years. There is an increase in wage labour and broader access to store-bought items and food shipped in from southern locations. Despite these changes, traditional/country food remains central to cultural identity as well as to social, economic and mental well-being.

1.5.2 Landscape and wildlife

The North is a vast area with geographic and ecological diversity. From the forests of the Yukon to the high Arctic tundra to the fjords of Labrador, there are a number of ecosystems, and fish and wildlife habitats. Parts of the Northwest Territories and all of Nunavut are located north of the treeline. The Denendeh landscape in the Northwest Territories includes mountain ranges in the west. Particularly significant features are the lakes, rivers, bogs and marshes. Nunavik and Labrador have mountainous areas, river valleys and deltas as well as tundra. Coastal, marine and terrestrial environments extend over very large areas.

Even across the same latitude, where there are similar extreme seasonal changes in the amount of daylight and darkness, the climate varies greatly from west to east. Average temperatures decrease as one travels towards the north and the east and the summer season becomes progressively briefer. As one would expect, these variations in landscape and climate mean that the wildlife found in these areas also are quite different from west to east and south to north. Whereas loche (burbot). moose and caribou and may be very important fish and wildlife (food) species in the west, seabirds, seals, whales and caribou (different herds) dominate further north and east.

The biodiversity and geographic, climatic and cultural variations make it challenging to design and run a program such as the NCP. The people and the species they consume may be completely different depending on their location. The types and amounts of contaminants taken in by fish and wildlife from the physical environment require a flexible program across the North that can be adapted to local and regional requirements.

Biodiversity and geographic, climatic and cultural diversity make it challenging to design and run a program such as the NCP.

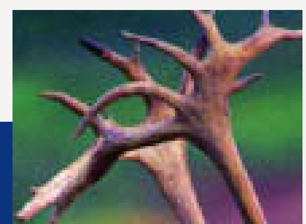
1.6 The value and benefits of traditional/country food

Traditional/country foods have nutritional, cultural and other health benefits not found in alternative foods in the Canadian North. These benefits are identified through traditional knowledge and western science. Aboriginal peoples and scientists believe that the benefits and value of harvesting and eating traditional/country foods exceed the currently known risks posed by contaminants.

Aboriginal peoples consider certain foods to have special properties that others do not. At Sanikilluaq (Sanikiluaq), for example, people find that certain foods such as seals generate body warmth and strength in a way not possible with imported foods. Traditional/country foods also form an essential basis for personal and community well-being.

"Inuit foods give us health, well-being, and identity. Inuit foods are our way of life ... Total health includes spiritual well-being. For us to be fully healthy, we must have our foods, recognizing the benefits they bring. Contaminants do not affect our souls. Avoiding our food from fear does."

(Egede, I. 1995. *Inuit food and Inuit health: Contaminants in perspective*. Speech made to Inuit Circumpolar Conference, 7th General Assembly, July 1995. Nome, Alaska.)



"When I eat traditional food I know who I am."

(translation — you are what you eat)

Among the Aboriginal peoples of the Canadian North, the integration of the body and soul is accomplished through capturing, sharing and consuming traditional/country food. The cultural aspects of harvesting such as sharing and communal preparation of food are important to individual and community health.

The social and cultural aspects of harvesting such as sharing and communal preparation of food are important to individual and community health.

There are also economic realities which influence how much Aboriginal people rely on traditional/country food. This food is an economic necessity for many Aboriginal northerners. Employment and incomes are often low, and the cost of nutritional imported food is very high in many northern communities. Relying on nutritious store-bought food to feed a family of four for one year would cost approximately $12,000.

The benefits of consuming traditional/country food along with the risks posed by contaminants in this food are looked at throughout this Highlights Report. This is to ensure that a balanced picture is provided to those making decisions on whether to harvest and eat traditional/country food. More information on the nutritional and other benefits and risks of traditional/country food is provided in Chapter 4. Overall, traditional/country food provides valuable and unique nutritional, cultural, spiritual, economic and social benefits, most of which are irreplaceable.

Aboriginal peoples and scientists believe that the benefits and value of harvesting and eating traditional/country foods exceed the currently known risks posed by contaminants.

GNWT/NWT Archives/B. Harnum

1.7 The Northern Contaminants Program (NCP)

The Northern Contaminants Program (NCP) was established in 1991 in response to studies in the mid-1980s that showed the presence of contaminants in northern ecosystems. These contaminants are released into the environment from industrial activities and agricultural practices, which are occurring primarily outside the North. The three main contaminant groups of concern are persistent organic pollutants (POPs), heavy metals and radionuclides.

The NCP is managed by the Indian and Northern Affairs Canada in partnership with other federal departments (Health, Environment, and Fisheries and Oceans), the Yukon, Northwest Territories and Nunavut governments, and four northern Aboriginal organizations — Council of Yukon First Nations, Dene Nation, Inuit Tapiriit Kanatami, and Inuit Circumpolar Conference. The Metis Nation–NWT was also a partner from 1997–2000. Much of the strength of the NCP is derived from this partnership approach. Bringing a grassroots perspective into the NCP has been a learning process for the program overall and has resulted in what the NCP is today.

Elements that have been essential to the success of the NCP include: adaptability and flexibility; a non-hierarchical structure; decentralized and shared decision making; a partnership approach; participation of local peoples within the NCP structure; sound, credible and leading science; innovative, ongoing and two-way communication; and capacity building.

The aim of the NCP is to work towards reducing and, where possible, eliminating contaminants in traditionally harvested country food, while providing information that assists individuals and communities in making informed decisions about food use.

The first phase of the NCP ran from 1991–1997 and focussed on locating the various sources of contaminants, how these get to the North (transport pathways), and what happens to them when they arrive. This phase of the program also looked at the levels of contaminants found in northern ecosystems and humans, and how these levels changed with time and from place to place. Education and communication of contaminants information with northerners was heavily emphasized, and led by the Aboriginal organizations. The results from the first phase were used in international negotiations to restrict contaminants. The first CACAR summarizes the results from the first phase.

GNWT/RWED/Brett Elkin

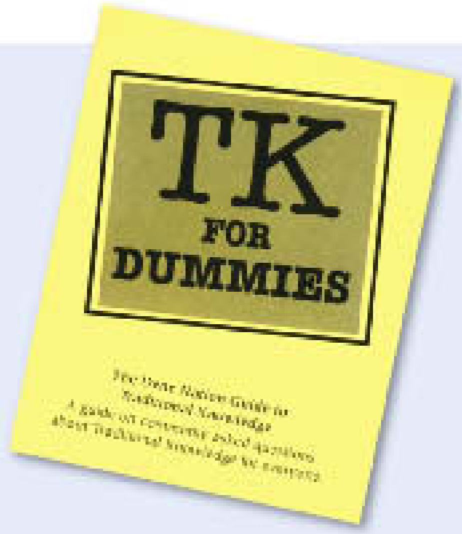
The aim of the NCP is to work towards reducing and, where possible, eliminating contaminants in traditionally harvested country food, while providing information that assists individuals and communities in making informed decisions about food use.

The emphasis of Phase II is to continue research on the health benefits and risks of consuming traditional/country foods; to develop effective community communication; and to continue work on international agreements to restrict contaminants.

Phase II of the NCP started in 1998 and will run until 2003. It has been funding research on northern contaminants issues at approximately $5.4 million per year. In addition, the NCP supports the participation of Aboriginal organizations in the NCP. The emphasis of Phase II is on expanding research on the implications (benefits and risks) of consuming traditional/country foods for human health; developing effective community communication; and continuing work on international agreements to restrict contaminants.

The long-term strategic direction and priorities of the NCP are laid out in a series of "blueprint" documents. They outline the objectives, goals and priorities for research and activities supporting the overall aim of the NCP, and serve as a guide for annual funding decisions. The NCP research project proposal review process ensures that the work carried out under the program is scientifically defensible, consistent with the vision and priorities set out in the blueprints, and socially and culturally responsible in a northern context.

The current design of the NCP is strategic in that it provides (or supports) infrastructure, people and plans to gather important data related to contaminants, communicates the results to northern communities in a sensitive manner, and makes use of the results to bring about change through international negotiations.



Addressing the issue of contaminants is not only a matter of finding the answers to scientific questions such as: What contaminants are there and at what levels? Where in the ecosystem are they found? Where do they come from? How did they reach the Canadian North? What do we do about them? There is also the very immediate concern about the consequences of these findings for the health of northern people, particularly Aboriginal people. Harvesting and consuming traditional/country food is as integral to the social fabric and cultural identity as it is to good nutrition and overall health and economic well-being.

The traditional knowledge (TK) of the northern Aboriginal peoples, together with western science, have made valuable and complementary contributions to defining the problem of contaminants in northern Canada and setting priorities under the NCP. TK is unique to each Aboriginal culture, community and individual. The NCP describes TK as an "existing Aboriginal knowledge system of lands, water, climates, seasons, and related animal behaviours in an Aboriginal territory, based on ancestral experiences, oral history, and subsistence harvesting and traditional use of plants and animals, as well as the use of historical waterways, trails, and other nomadic travel paths".

Northern Aboriginal peoples recognize the ways in which western science can help with concerns about contaminants. Conversely, research scientists recognize the value of the knowledge of local people, which gives them a perspective on wildlife and environmental systems that can assist in scientific research.

The traditional knowledge (TK) of the northern Aboriginal peoples, together with western science, have made valuable and complementary contributions to defining the problem of contaminants in northern Canada and setting priorities under the NCP. In Phase II, TK has become increasingly important.

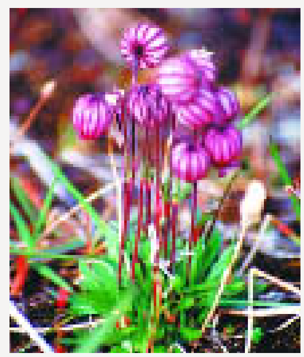
In Phase II of the NCP, TK has become increasingly important. One of the Aboriginal Partners, the Council of Yukon First Nations, produced the document *Traditional Knowledge Research Guidelines*, and the Dene Nation produced *TK for Dummies: The Dene Nation Guide to Traditional Knowledge*. The latter publication was produced as a result of discussions among Elders, scientists and youth at the Dene Elders/Scientists Retreat, which was sponsored by the NCP.

The interests and concerns of individuals and communities in the North about contaminants, food sources, and health and environment in general have played a key role in setting the NCP agenda. This grassroots perspective has been brought into the NCP process by connecting with people in communities, meeting concerns, and conducting research that will provide answers about the traditional/country foods that are so important.

The NCP is now concluding Phase II. The results are being analyzed and will be used to help determine what work needs to be done in the future.

"Without TK and the ability to observe changes from historical patterns, it is likely that some very good research projects might have been delayed or reduced in scope."

(T.K. Gussman Associates Inc. 2002. *Evaluation of the Northern Contaminants Program Phase II Final Report*. April 2002.)



ITK/Scot Nickels

ITK/Eric Loring


ITK/Eric Loring

CHAPTER 2

Contaminants — **Sources, Transport Routes,** and **Levels** in the **North**

2.1 Contaminants and their sources

The three main categories of contaminants studied through the NCP are heavy metals, persistent organic pollutants (POPs) and radionuclides.

2.1.1 Are contaminants natural or made by humans?

Some contaminants have natural and human-made sources. However, human activities are responsible for most of the contaminants in northern Canada. The POPs studied under the NCP are almost entirely human-made. Heavy metals and radionuclides have both natural sources within the North and human-made sources around the world. Most radionuclides (except for cesium) come from natural sources, and the heavy metals including mercury are also found in the natural environment.

Most human-made contaminants arrive in the North on air currents from sources outside of the Canadian North.

2.1.2 Most contaminants come from outside the North

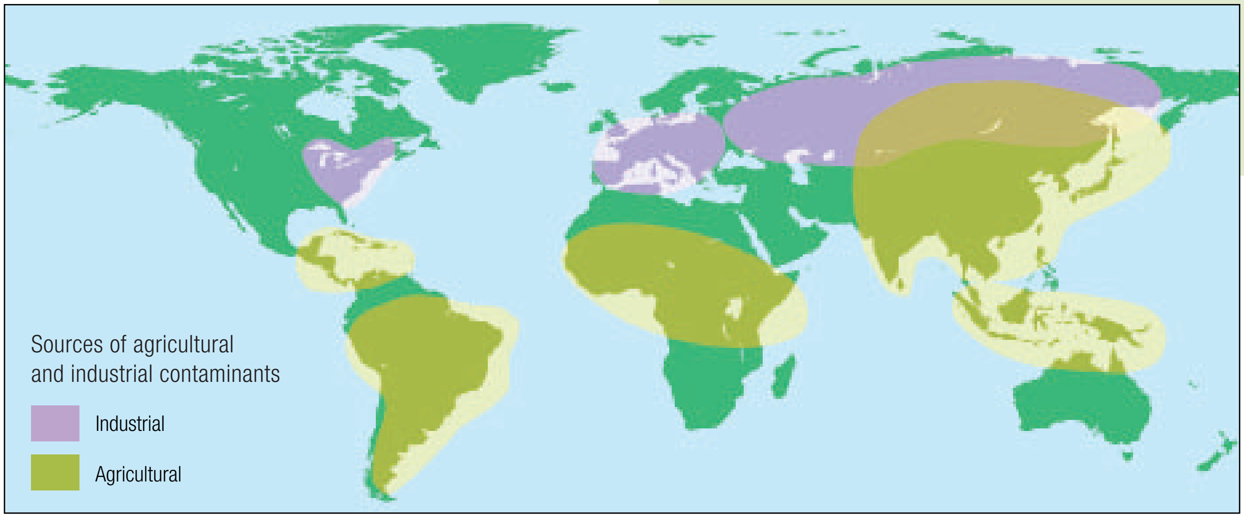
Most human-made contaminants in the North come from sources outside of the Canadian North. Most arrive directly from other countries through the atmosphere. Some may also arrive by a mechanism known as the "grasshopper effect". Oceans also transport contaminants but it can take years for contaminants to reach the North by these routes compared to just days in the air. Once contaminants have arrived in the North, sea ice is important for moving them in the marine environment. Rivers (particularly those in Russia) are also thought to transport contaminants from land into the northern marine environment.

Computer models are being used to predict how contaminants move through the atmosphere from their source regions to the North. These models are also being used to estimate the levels of contaminants actually reaching the North compared to the levels that fall into the oceans or onto land further south. The models also predict how quickly the contaminants will disappear.

Examples of contaminants studied in the NCP, their uses and sources

Contaminant	Why does it exist? What is it used for?	Where does it come from?
Persistent organic pollutants (POPs)		
• polychlorinated biphenyls (PCBs)	• used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment • found in old electrical transformers	• mostly locally contaminated soils/plants, landfill sites, and also can be created when burning
• dichlorodiphenyltrichloroethane (DDT) • toxaphene • endosulfan • chlordane • hexachlorocyclohexanes (HCHs) including lindane	• pesticides used mainly in agriculture to kill pests (e.g., unwanted animals such as insects) or to prevent human diseases	• northern hemisphere, particularly mid-latitudes, including North America, Asia, Europe
• chlorinated paraffins (PCAs)	• used in making plastics and in materials to reduce the risk of fire	• mostly industrial sources in the northern hemisphere
• polychlorinated naphthalenes (PCNs)	• used in electrical insulation fluids and as wood preservatives • also come from burning metal waste and garbage	• mostly industrial sources in the northern hemisphere
• polycyclic aromatic hydrocarbons (PAHs)	• produced whenever something is burned, from meat to vehicle exhaust to industrial sources	• mostly industrial sources in the northern hemisphere
• brominated fire retardants (e.g., polybrominated diphenyl ethers – PBDEs)	• used in materials to reduce the risk of fire	• mostly industrial sources in the northern hemisphere
• butyltins	• used in e.g., special paint to prevent unwanted growth of plants or animals on ship hulls	• from passing ships
Heavy metals		
• mercury and methylmercury • cadmium • lead	• are all naturally occurring elements in rocks and soils • released to the environment from mining and smelting (processing) metals • lead is released from coal-burning power stations, incinerators and from burning leaded gasoline • mercury can also be released from flooded lands when reservoirs are created	• mostly Europe, Asia and North America
Radionuclides		
• cesium • polonium • uranium	• except for cesium, are naturally occurring radioactive elements in rocks and soils • can be released to the environment from atmospheric testing of nuclear weapons, dumping of nuclear waste, and nuclear accidents	• mostly natural sources in the Canadian North • some very limited transport from northern Europe and Russia

The three main categories of contaminants studied through the NCP are heavy metals, persistent organic pollutants (POPs) and radionuclides.

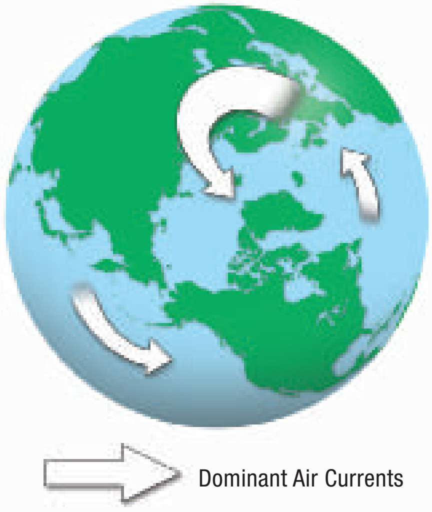


For example, hexachlorocyclohexanes (HCHs) are transported to the North in both the atmosphere and the oceans. In contrast, only a small proportion of polychlorinated biphenyls (PCBs) released to the atmosphere reach the North. Most PCBs are now found in the soil in areas near where they were used.

2.1.3 Local sources of contaminants

It is important to remember that there may be local sources of some contaminants (e.g., from harbours and military sites) which pose a real concern at a local level. Local sources are not the reason for the widespread presence of contaminants in the Canadian North, but they may dominate in certain locations. The NCP deals with local sources of contaminants or their levels in the environment through the Local Contaminants Concerns projects. While most research undertaken through the NCP deals with contaminants that have been transported long distances from southern sources, many community concerns are local and site-specific. Local contamination may be found at some 2000 military sites, abandoned mines and exploration sites, former construction sites and small industrial sites.

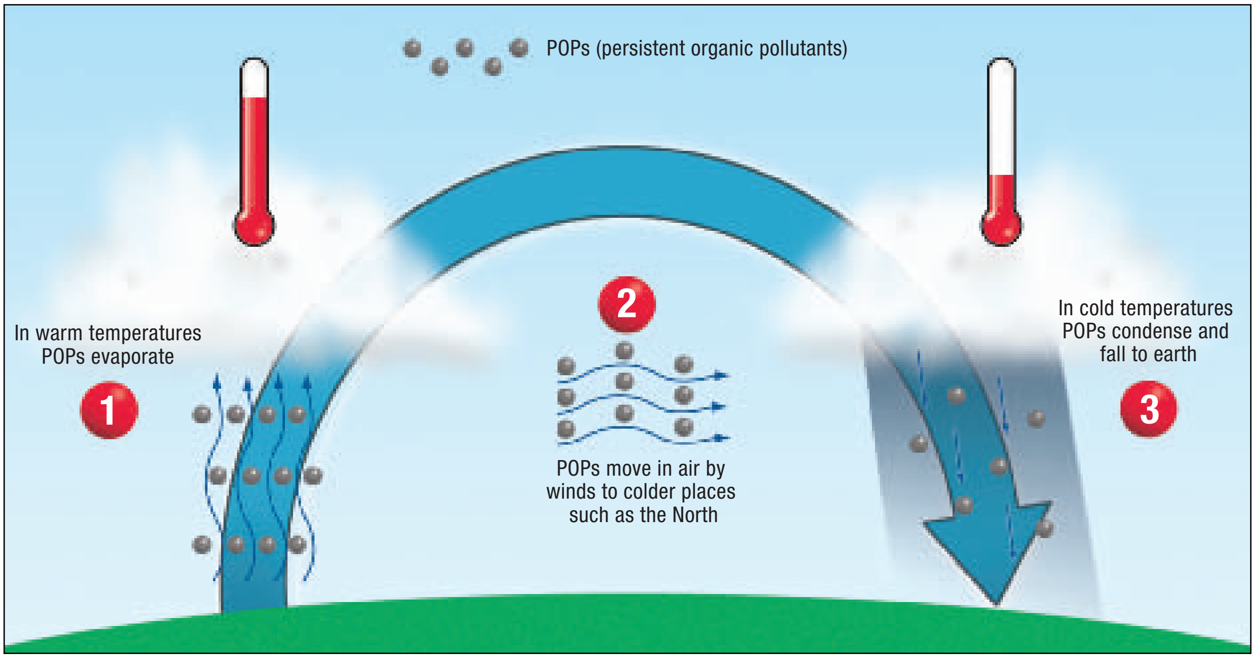
Certain sites have been identified as a high priority for cleanup. PCBs, mercury, arsenic and radio-nuclides are the main contaminants of concern.



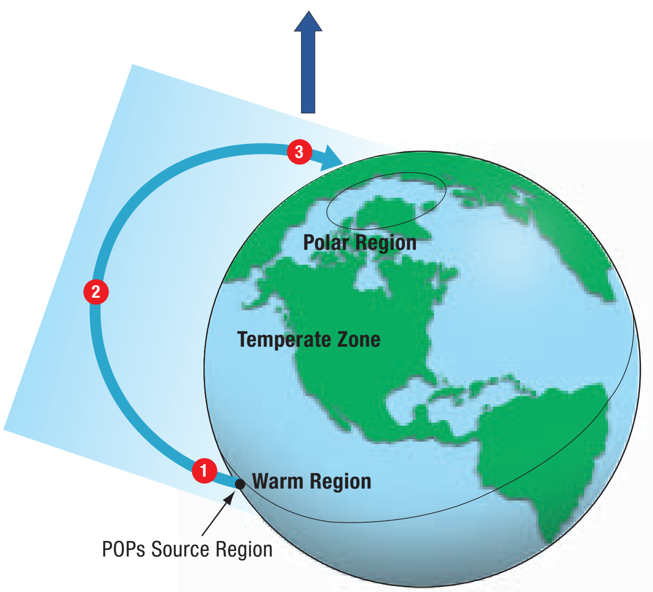
Transport of Contaminants by Winter Air Currents
Contaminants are a global problem. Winter winds carry contaminants from major industrial areas in Asia, Europe, and the eastern United States to the circumpolar Arctic.

> ***Local sources are not the reason for the widespread presence of contaminants in the Canadian North, but they may dominate in certain locations.***

Examples of sites with local contaminants concerns (not funded by NCP)				
	Contaminant	**Concern**	**Levels**	**Conclusion**
Resolution Island, Nunavut (radar base)	PCBs	leakage of PCBs into the marine environment	PCBs not considered a risk to humans or fish and wildlife	to meet legal requirements, soils containing PCBs should be removed
Saglek, Newfoundland and Labrador (DND site)	PCBs	possible high levels of PCBs in soils, plants and sediments in the area	most PCBs found within 3 km of the site; some PCBs found up to 30 km away; mice right at the site found to have very high levels of PCBs; caribou at the site have somewhat elevated levels in muscle; marine sediments within 1 km of the site have elevated PCB levels; ringed seals have slightly elevated levels of PCBs, but Arctic char do not; black guillemot muscle and eggs have PCB levels about 4-5 times higher than levels found in birds well away from Saglek; the levels found in the black guillemots may be high enough to cause health effects in the birds	most PCBs are now contained; decisions needed on what to do with marine sediments containing PCBs
Giant Gold Mine, Northwest Territories	arsenic	arsenic levels in the soils and water of the area	lake sediments near to the mine have high levels of arsenic that exceed the interim freshwater sediment quality guideline; effects of the arsenic are likely on the animals and plants but these have not been studied; arsenic levels in the soils within Yellowknife (Sǫ̀mbak'è) are elevated but levels in berries not considered of concern for health; vegetables grown in city gardens have levels of arsenic about ten times that of store-bought vegetables; there is no indication of a health risk from eating home-grown vegetables; Giant Mine is downstream of the intake for the city's drinking water and therefore has no impact — tests show the water to be safe with respect to arsenic; some subsurface water contains elevated levels of arsenic from the Giant Mine	need to address the long-term management of arsenic at Giant Mine (currently being studied by Indian and Northern Affairs Canada); releases of arsenic to Back and Yellowknife Bays need to be reduced to under 2,000 kg/year to ensure there is no risk to fish, wildlife or human health
Port Radium Mine, Northwest Territories	radionuclides	levels of exposure to radionuclides	in the past, mine waste deposited in Great Bear Lake (Sahtú) and elsewhere nearby; highest levels of radionuclides are found at certain locations at the mine site; most waste is well-contained	some cleanup needed for an area 2-3 hectares in size (Indian and Northern Affairs Canada has been working to clean up the site over the years)
Railway Tie Plant, Carcross, Yukon	dioxins and furans (from chemicals used to preserve railway ties)	leaks of dioxins and furans into the soils and water nearby	high levels of dioxins and furans found at some locations at the plant; at locations upstream and downstream from the site, sediments show elevated levels but all levels are lower than the guidelines; fish also show slightly elevated levels but these are not thought to be of concern since they are still very low	the source of contamination has been contained and is being cleaned up; monitor levels in the future to track changes



The Grasshopper Effect
POPs can be transported by one or more "hops" consisting of 1) evaporation, 2) travel in the atmosphere and 3) condensation in colder regions. Once POPs reach the North, because of the colder temperatures, they may accumulate rather than evaporate again and be transported away.



Most research undertaken under the NCP deals with contaminants that have been transported long distances from southern sources.

The potential consequences of contaminants for residents in northern Canada can be of greater concern than they are for other Canadians.

2.1.4 Contaminants travel long distances and are found everywhere around the world

Contaminants do not affect only the Canadian North. Air and ocean currents transport contaminants to many other parts of the world where levels of contaminants are often much higher than those found in the North. An exception is HCHs in seawater. Levels of these pesticides are higher in northern waters than elsewhere because of their long persistence.

The presence of contaminants in the North is, however, of special significance. Northern people, in particular Aboriginal northerners, depend much more on traditional/country food, and have fewer acceptable alternatives, than most other Canadians. A few of these traditional/country foods may contain levels of contaminants that may be of concern to health. Chapters 3 and 4 discuss this in more detail.

ITK/Eric Loring

In contrast, Canadians in southern regions generally have access to fresh, healthy and affordable store-bought food, and for the most part do not have a culture closely linked to harvesting and eating traditional/country food. The Canadian Food Inspection Agency monitors contaminants in store-bought food but not in traditional/country foods.

In the North, traditional/country food is an integral and important part of the way of life, and store-bought food is often poor in quality with prices beyond the reach of most residents. Even where store-bought food of good quality is available, it cannot replace the cultural and nutritional benefits of harvesting, sharing and eating traditional/country food. Therefore, the potential consequences of contaminants for residents in northern Canada can be of greater concern than they are for other Canadians.

Pesticide residues can take a long time to disappear. These will continue to evaporate and be transported to northern Canada for many years.

As long as contaminants are still being produced and used in other parts of the world, they will continue to be released to the atmosphere and oceans and transported to the Canadian North.

2.1.5 Can we expect contaminant levels in the Canadian North to decrease or increase in the future?

In some cases contaminants come from countries that are still actively producing and using them (e.g., DDT, endosulfan and dieldrin). As long as these contaminants are still being produced and used in other parts of the world, they will continue to be released to the atmosphere and oceans and transported around the world, including to the Canadian North.

Some contaminants are no longer being produced or used in the world, or they are being used much less than before, and are subject to international restrictions. These include many POPs such as some of the HCHs, PCBs, chlordane and toxaphene. It is expected that levels of these contaminants in the Canadian North will continue to decrease with time.

Some pesticides, however, can still be found on agricultural land even years after they were last used. These pesticide residues can take a long time to disappear. Lindane (a type of HCH) and toxaphene are examples of pesticides that now primarily exist as residues on agricultural lands in southern regions. Computer models are making it easier to predict how quickly these residues evaporate into the atmosphere. This information can indicate how many more years these pesticides will be transported to northern Canada.

Some "new" human-made contaminants have been found (usually at very low levels) in the North. These new contaminants are being produced and used in many parts of the world. If these continue to be used they can be expected to continue to show up in the Canadian North, possibly at higher levels.

2.2 Why look at contaminants in the physical environment?

This chapter of the Highlights Report focusses on the latest results from the NCP research concerning sources and transport of contaminants in the Canadian North, and what happens to contaminants once they arrive. For a more general discussion of contaminants and their transport to the North, and to learn about the results from the first phase of the NCP, please refer to the first CACAR.

The North is particularly vulnerable to certain contaminants. Because of the cold climate, POPs disappear more slowly and persist longer than they do in southern regions. Many contaminants travel to the North on air currents from sources outside the North which are beyond the direct control of northerners. Once they arrive in the North, they usually remain as there is nowhere else for them to go.

Contaminants are found in northern waters, soils, sediments, snow, rain, ice, and in the air (i.e., in all of the northern physical environment). The levels of these contaminants are very, very low and in some cases undetectable. Contaminants measured in the physical environment are at such low levels that they pose no risk to human health.

However, contaminants can get into the food web where they can become a cause for concern. Because animals can store contaminants for a long time in different parts of their bodies (through bioaccumulation and biomagnification), their contaminant levels may become higher than the levels found in the surrounding physical environment. Sometimes levels in wildlife can become so high that there is a risk they could cause health problems in both wildlife and the people who consume them. Because a significant proportion of northerners eat traditional/country food, compared to southerners they are exposed to a greater degree to contaminants in their diet. Information about contaminants is very important for the people who need to make decisions about harvesting and eating traditional/country food.

Measuring the levels of contaminants in the physical environment gives us the first part of the whole picture. If contaminants are found in the air, on the land (in the soil or on snow), in lakes or rivers, and in the marine environment, then there is a chance that they will be accumulated by plants and animals and enter the food web.

ITK/Eric Loring

Exactly where contaminants are found, e.g., close to the sea surface, or deeper in the water; in lake sediments or in free-flowing water provides clues as to which animals and plants are more likely to accumulate contaminants. For example, land animals such as caribou are more likely to accumulate contaminants that are on or in vegetation than contaminants found in the air or water. Most animals accumulate contaminants from their food.

Some northern locations contain more contaminants than others. This information can be valuable, for example, if someone wants to know whether contaminants may be causing a problem in a particular area, or how one area compares to other areas in the Canadian North or circumpolar Arctic.

Some contaminants transform into different forms which may be more or less toxic than the original contaminants. For example, mercury can transform into an organic form called methylmercury. Methylmercury is more toxic than the original form of mercury (elemental mercury). The physical environment contains elemental mercury, but once this mercury reaches fish and wildlife, it is often transformed into the more toxic methylmercury. Some contaminants, particularly POPs, also disappear, but at different speeds, so some of these contaminants may be present much longer than others. Heavy metals do not disappear.

The North is particularly vulnerable to contaminants. POPs disappear more slowly and persist longer than they do in southern regions.

Pat Roach

"Temporal trend" studies provide evidence as to whether or not the national and international restrictions placed on a number of contaminants are working.

Research on contaminants in the physical environment is useful because it sheds light on factors such as levels, occurrence and toxicity. Another reason to measure contaminants in the northern physical environment is to find out whether levels are changing over time (i.e., whether levels are increasing, decreasing, or staying the same). These are called "temporal trends" and they can show whether wildlife (and humans) are being exposed to increasing (or decreasing) amounts of contaminants.

"Temporal trend" studies also provide evidence as to whether or not the national and international restrictions placed on the production and use of a number of contaminants are working. Are we seeing lower levels of contaminants that are now banned or severely restricted in their use? It is hoped that such restrictions will lead to fewer and lower levels of contaminants reaching the Canadian North and elsewhere in the world.

For those contaminants that are not yet restricted or banned, measuring levels in the physical environment and understanding how they get to the North is essential when deciding whether to establish new restrictions.

Contaminants measured in the physical environment are at such low levels that they pose no risk to human health. However, once they get into the food web, contaminants can become a cause for concern.

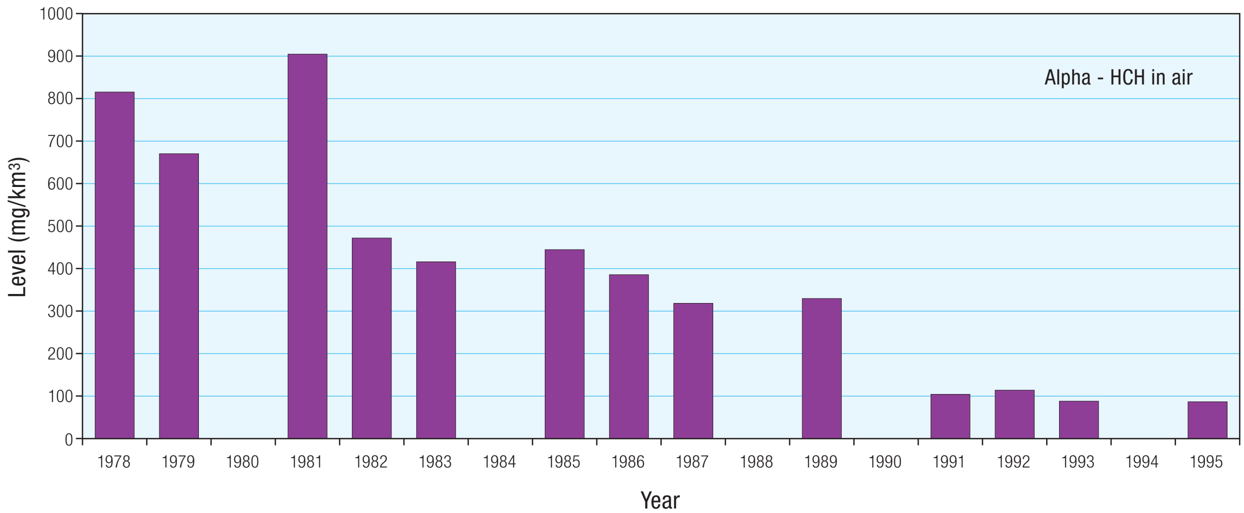
2.3 Contaminants in the northern physical environment — the air, lakes and rivers, soil, snow, sediments and marine waters

In the first phase of the NCP, the focus was on identifying the sources and levels of various contaminants finding their way to the Canadian North. Under Phase II, more emphasis has been placed on monitoring the transport and levels of contaminants in the atmosphere. A major objective is to develop a sound scientific basis for international action to reduce the input of contaminants into the circumpolar Arctic from distant sources. Particular priorities for Phase II are:

- to monitor the trends over time of contaminants in the atmosphere, to assess whether levels are increasing or decreasing in response to national and international controls
- to research which atmospheric transport routes bring contaminants to the North, and the levels of contaminants carried on each route
- to look at mechanisms that affect how contaminants are made available to plants and animals (especially marine fish and wildlife)
- to research the transfer of mercury between the atmosphere and the ocean, and determine what happens to mercury
- to identify whether there are other contaminants of concern in the North

2.3.1 Contaminants in the atmosphere

The Canadian northern atmosphere generally contains lower levels of POPs and heavy metals than found over most other countries in the circumpolar Arctic. Both measurements and computer models (computer programs which are used to imitate the real atmosphere) show that the levels of most POPs and heavy metals in the air are declining slowly right across the Arctic, including over northern Canada. As most of the contaminants reaching the North arrive on air currents, this is very positive news.



Levels of alpha-HCH in circumpolar air
Alpha-HCH levels are decreasing over time, following a similar decrease in emissions of alpha-HCH around the world. By the late 1990s alpha-HCH levels in circumpolar air were only about one-ninth of 1980s levels. This means that much less alpha-HCH in air is now available than before to plants and animals.

Under Phase II, more emphasis has been placed on monitoring the transport and levels of contaminants in the atmosphere. A major objective is to develop a sound scientific basis for international action to reduce the input of contaminants into the circumpolar Arctic from distant sources.

2.3.1.1 Mercury and other heavy metals

Mercury (and other heavy metals) in the air at Alert, Nunavut is being measured but more data are needed to indicate if levels are increasing, decreasing or staying the same. Mercury levels in fish and wildlife are generally not changing except in a few locations where levels are increasing (see Chapter 4 for more information). Scientists are continuing research to understand what is happening.

Changes in the air currents over the North mean that the levels of various heavy metals measured at Alert fluctuate from season to season.

Why do we measure contaminants in the air at remote locations?

Contaminants are measured at a number of meteorological (weather) and atmospheric (air) monitoring stations around the circumpolar Arctic including stations in northern Canada.

Most of these stations have been operating for many years and are located in areas useful for atmospheric research in the northern atmosphere. They are usually not located near northern communities in order to minimize effects such as local air pollution. Although these stations may be distant to areas of direct interest to northern people, data from these stations is quite valuable for understanding how contaminants reach the Canadian North.

The data from monitoring stations, computer models and satellites show air currents, which can be several thousands of kilometres long. Air currents from Europe, Russia and North America tend to dominate over the central and eastern parts of the Canadian North, while currents from Asia influence the western part of North America to a greater extent.

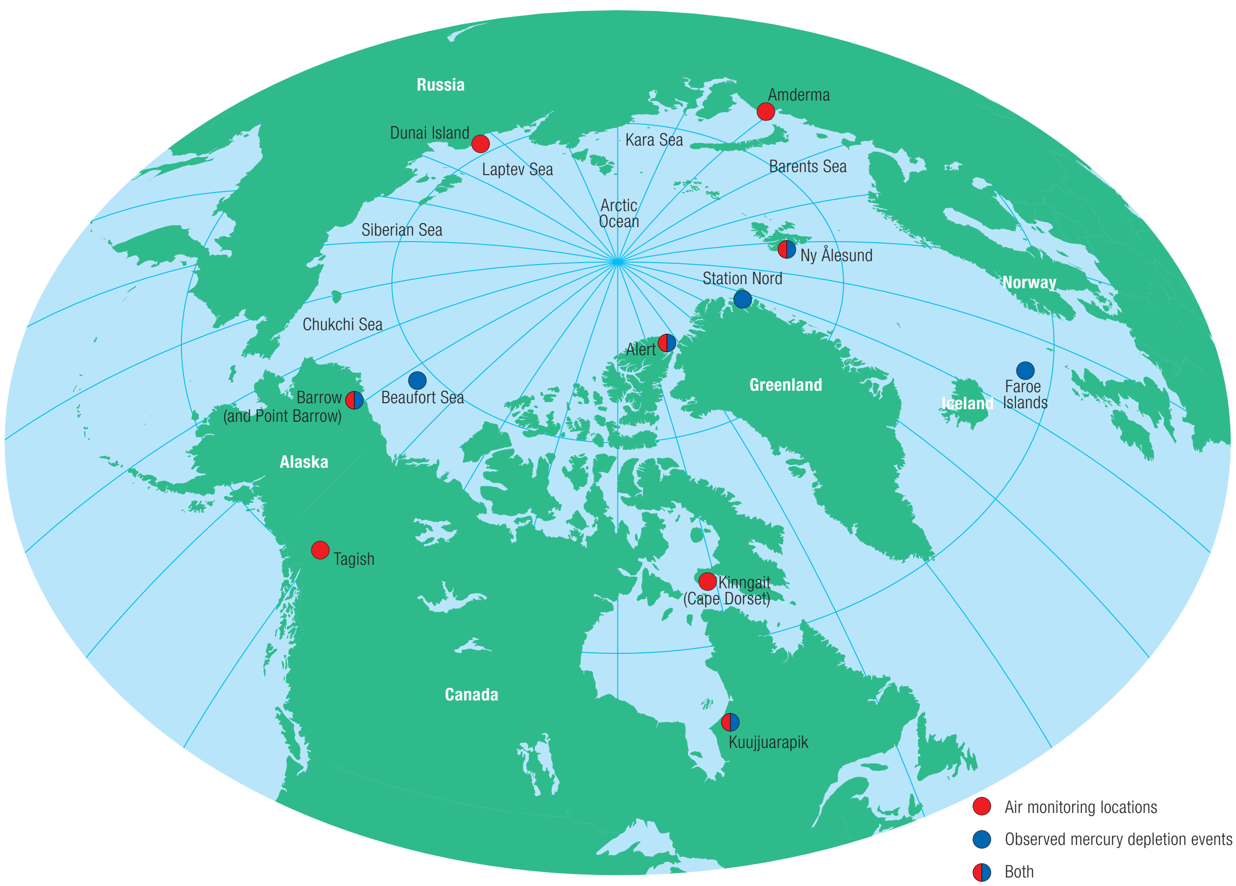
ITK/Eric Loring

The Canadian northern atmosphere generally contains lower levels of POPs and heavy metals than are found over most other countries in the circumpolar Arctic.

The levels of most POPs and heavy metals are declining slowly right across the northern atmosphere.

In September, heavy metals likely come from natural sources in the Canadian Arctic islands and western Greenland; from western and northwest Europe in late fall and winter (mainly from human-made sources); and from Asia and Russia in late spring and summer (again from human-made sources). The Russian northern atmosphere contains a number of metals including calcium, aluminium, manganese, copper, zinc and lead at 3-4 times the levels measured at Alert or at Barrow, Alaska. (Mercury was not included in the comparison.)

Mercury levels in the air are fairly stable during September-March, but during the spring the levels drop. Recent research has shown that a special mechanism is at work at this time of year — the polar sunrise phenomenon.



Locations of air monitoring data used in NCP research, and locations of observed mercury depletion events
Mercury depletion events have also been observed in Russia and Antarctica. Such events may be important for bringing mercury to the Earth's surface, thus making it more available to plants and animals.

Each year, just after the sun reappears after the long polar night, atmospheric mercury is transformed and deposited onto the snow surface where it becomes available to plants and animals.

Polar sunrise and mercury

Canadian scientists have recently made significant advances in the knowledge of atmospheric mercury in the Arctic. The discovery of a northern springtime drop in the levels of atmospheric mercury has led to subsequent discoveries of how mercury is transformed and deposited in the Arctic.

Each year, just after the sun reappears after the long polar night (polar sunrise), mercury is converted to a different form. This new form of mercury is much more easily deposited onto the surface (usually snow or ice at this time of year) than the original form of mercury. The transformation and removal of this new form of mercury from the atmosphere onto the surface is called a mercury depletion event (MDE). Measurements show that more mercury is found in the snow after a MDE, though some may be released back into the air from the surface.

Some of the new form of mercury in the surface snow dissolves in water, and may be converted into methylmercury — the most toxic form of mercury for wildlife and humans. This happens at the time of year when plants and animals are starting to prepare for peak summertime activity and when they are more vulnerable to picking up the toxic form of mercury.

Although first discovered in Canada, the same phenomenon has been seen at other northern locations (e.g., Ny Ålesund on Svalbard, northern Norway; Barrow, Alaska; and Amderma, Russia). It has even been found to occur in Antarctica.

More research is needed to provide a better understanding of what is happening, and to determine the overall significance of this event for fish and wildlife in the northern environment.

ITK/Eric Loring

Scientists cannot yet say whether levels of mercury are increasing or decreasing in the air over northern Canada.

2.3.1.2 Persistent organic pollutants

Most POPs are declining in the atmosphere over northern Canada. The main exceptions are the insecticides dieldrin and endosulfan (which is still being used in parts of the world) which are still increasing. From time to time some pesticides increase briefly in the atmosphere over the Yukon, especially during the winter months. It is believed that these pesticides come from Asia and are carried to the western part of North America on strong air currents during the winter.

Decreases in the HCH pesticides in the atmosphere across the Canadian North are undoubtedly a result of restrictions on their use. One of these HCH pesticides (lindane) is still used for agricultural purposes by China and the United States. Canada used to be one of the biggest users, applying lindane mostly to agriculture land in the prairies, southern Ontario and south of the St. Lawrence River in Québec. A voluntary agreement, however, was reached to restrict the use of lindane in Canada starting with the 2002 growing season.

It is likely that the lindane residues in Canada are finding their way to the Canadian North. Residues from other countries, especially France (which no longer uses lindane) and China, may also be finding their way to northern Canada.

Dieldrin and endosulfan levels are still increasing in the northern atmosphere.

Alert, Nunavut. *Defence R&D Canada/Janice Lang*

Some pesticides are carried to the western part of North America from Asia on strong air currents during the winter.

Toxaphene, another banned or highly restricted pesticide, has also been declining in the atmosphere over northern Canada and Russia. Most of the toxaphene still reaching the Canadian North is likely to be coming from the soil residues of toxaphene used in the United States before the ban came into effect.

Decreases in the HCH pesticides in the atmosphere across the Canadian North are undoubtedly a result of international and national restrictions on their use.

2.3.1.3 New persistent organic pollutants

Several contaminants not previously studied under the NCP have now been found in the atmosphere over the Canadian North, though only at very low levels. Data have been collected only recently, and it is too early to tell if levels are going up or down. More monitoring is needed to tell whether there are any long-term trends.

The new POPs include (brominated) flame retardants (which are added to materials to reduce the chance of fire), chlorinated paraffins (PCAs) and chlorinated phenols. The flame retardants are widely used and may be of concern because they can easily enter the food web.

One of the flame retardants, polybrominated diphenyl ethers (PBDEs), is now found across the Arctic at extremely low levels. The air over Tagish (Yukon) and Alert (Nunavut) have higher levels than those found in the air over Dunai Island (Russia). Interestingly, all these levels are considerably higher than those found over Chicago (USA) or the Great Lakes.

Local burning of garbage in the Tagish area (i.e., a local source of PBDEs) may have resulted in higher levels there, but scientists cannot yet explain why levels at Alert are higher than those in the heavily populated areas of North America.

Other POPs now being detected in the North include polychlorinated naphthalenes (PCNs), which are used for purposes similar to PCBs; different types of PCBs known as coplanar PCBs; and octachlorostyrene (OCS) (which is a by-product of manufacturing processes that use magnesium and chlorine). All the levels are very low. PCNs are widely found in the atmosphere in northern regions as well as further south. Levels of PCNs appear to be associated mostly with haze in the winter and early spring. Scientists are still trying to find out if sunlight breaks down PCNs in the atmosphere during the summer months.

Several of the other contaminants (e.g., OCS and chlorinated phenols) have been detected in the atmosphere but scientists are not clear on where they come from, or why they are found at higher levels in some locations and not others. Overall levels are very low.

2.3.2 Contaminants in lake sediments

Sediments can be difficult to analyze for contaminants, particularly if the sediment layers have been disturbed. What is undisputed, however, is that a wide variety of contaminants have found their way into northern Canada.

Lake sediment cores suggest that, at least in some parts of the Canadian North, more mercury has been deposited during the past 100 years compared to previous centuries. In Nunavut south of 80° N, mercury levels appear to have doubled in lake sediments. These increases may be caused by increasing mercury emissions into the atmosphere from industrial sources in the south. Global climate change may also be a cause, with more mercury being released into the environment as the permafrost melts, and more organic matter (which encourages the transformation of mercury to the more toxic methylmercury) being washed into lakes and rivers.

Some "new" human-made contaminants such as the brominated flame retardants, chlorinated paraffins and chlorinated phenols are now showing up in the Canadian North.

Various different types of POPs have been found in the sediments from several Yukon lakes (Watson Lake, Hanson Lake, Fox Lake, Lake Laberge, Little Atlin Lake, Kusawa Lake, Lindeman Lake and Coal Lake), in Lake DV09 in northern Devon Island, Nunavut, and in Great Slave Lake (Tucho), Northwest Territories. Some high Arctic lakes have also been studied. None of these levels are of direct concern to fish, wildlife or human health.

Often the maximum levels of the pesticides found in sediments can be linked to when they were used extensively in North America and other parts of the world such as southeast Asia. In other cases, local use of pesticides such as toxaphene, PCBs and DDT are likely responsible. Levels of POPs, however, have in general been declining over the past 20 years or so at virtually all of the sites.

ITK/Eric Loring

Maximum levels of pesticides in northern sediments can often be linked to when they were used extensively in North America and elsewhere in the world. At virtually all the sites, POPs levels have been declining over the past 20 years or so.

At one time toxaphene was used in both Canada and the United States to eliminate fish from lakes. At least one lake in the Yukon (Hanson Lake) was treated in this way. Toxaphene is extremely persistent, and despite a ban in the 1960s, the lake continued to be toxic for fish for many years. Hanson Lake sediments continue to show toxaphene levels that are more than 100 times higher than levels found in the sediments of other Yukon lakes.

In Great Slave Lake (Tucho), POPs are usually found more in the sediments at the mouth of the Slave River (Desnedé) in the West Basin than elsewhere in the lake. All levels are quite low, and fish are not thought to pick up POPs easily from sediments.

ITK/Eric Loring

2.3.3 Contaminants in marine waters and sediments

Under Phase II of the NCP, research focussed on POPs and, to a lesser extent, on radionuclides in the Arctic Ocean. Very little research was funded for heavy metals in seawater under Phase II of the program; therefore no results for mercury or other heavy metals in seawater are presented.

2.3.3.1 Persistent organic pollutants in marine waters and sediments

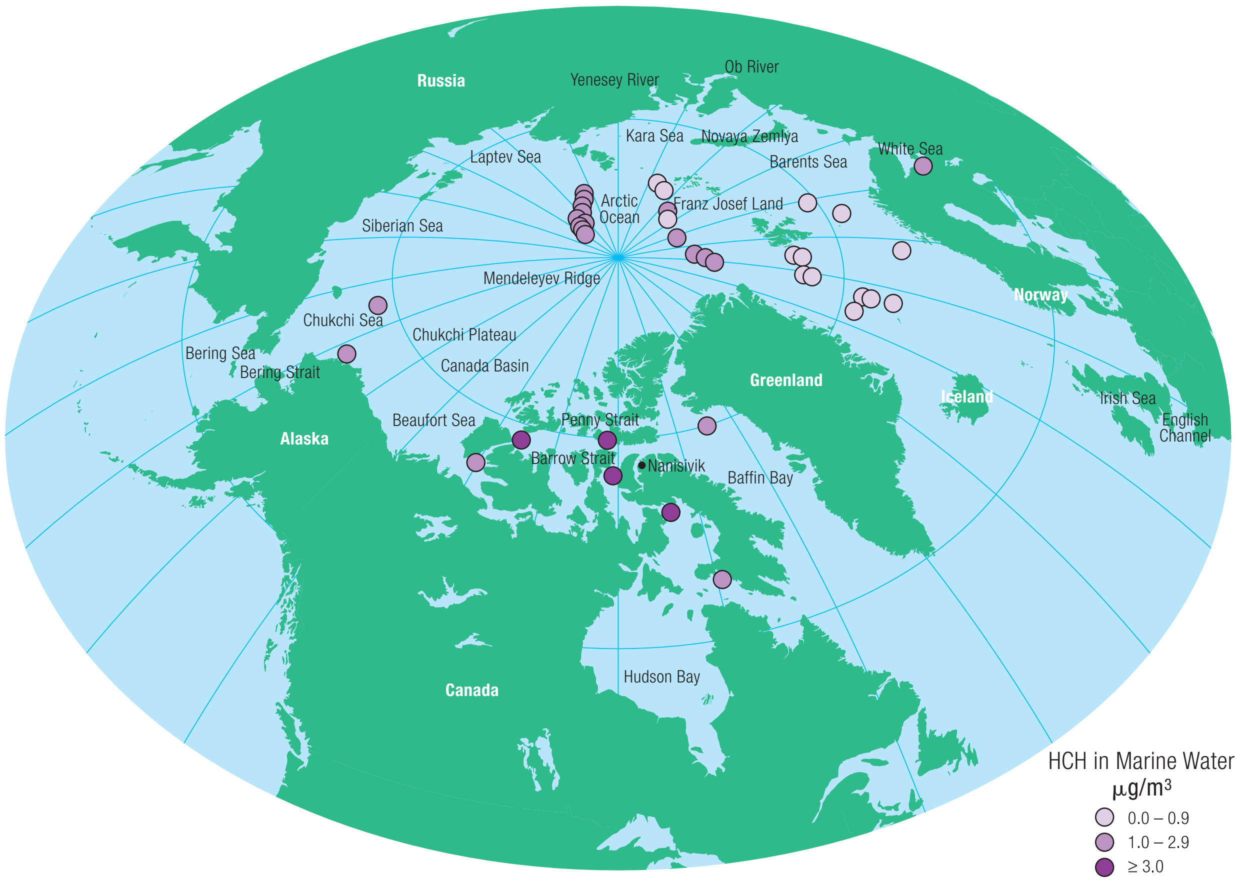
HCHs are the most common contaminants found in the Arctic Ocean. Levels are highest in the Canadian Arctic islands, somewhat lower in the Beaufort and Chukchi Seas and at the North Pole, and are much lower in the Greenland Sea and northern Barents Sea. HCHs leave the Arctic Ocean by travelling through the Canadian archipelago and down the east Greenland current. Some also disappear through the action of microbes.

One HCH pesticide (known as alpha-HCH) used to be transported mostly on air currents, but is now arriving in the Canadian North more in ocean currents flowing through the Bering Strait. In spite of the ban on this pesticide some years ago, it can take many years for pesticides in water to reach the Arctic, and so we may be seeing the effects of this delay.

Another HCH pesticide (known as beta-HCH) has a strong tendency to bioaccumulate and is therefore more likely than alpha-HCH to be a problem for fish, wildlife and human health. In contrast to most other pesticides, beta-HCH is deposited quickly into the ocean from the atmosphere and transported north by ocean currents. The highest levels are found in the water of the Bering-Chukchi region.

PCBs are the second most common contaminant found in Arctic seawater. However, they have not been measured to the same degree as the HCHs. In the central Arctic Ocean, most of the PCBs are carried there on air currents, though some PCBs arrive in the Arctic via the Bering Sea.

Endosulfan is more easily deposited from the atmosphere into water than onto ice. Climate change may affect how much endosulfan and other POPs are transferred to the northern marine environment, as the amount and patterns of ice cover change.



Levels of HCHs in marine water
The highest levels in the circumpolar Arctic are found in the Canadian Arctic islands. though these levels are still very low overall. HCHs and other contaminants in marine waters are available to marine plants and animals, and levels often increase up the food web.

There are quite strong variations in the levels of PCBs and other POPs in marine sediments throughout the Canadian Arctic islands, northern Baffin Bay and in Hudson Bay. All levels are very low and are not a direct concern.

Toxaphene levels in seawater also vary from place to place, and the highest levels in Canada are found in northern Baffin Bay. The lowest levels are found in the White Sea and northern Chukchi Sea, while levels in the southern Beaufort Sea lie somewhere in between.

Generally, the Canadian Arctic islands and the Beaufort Sea (near the shore) have higher levels of DDT than the Chukchi Sea or the central Arctic Ocean.

> ***HCHs are the most common contaminants found in the Arctic Ocean.***

Unlike some of the other contaminants, the highest levels of DDT are not always found at the ocean surface. In July, levels are actually much lower at the surface, and more DDT is found at a depth of about 200–250 m. This may be a result from DDT being carried by organic matter from the surface to deeper water in the spring.

Of the modern agricultural chemicals, only endosulfan and lindane have been found in the Arctic Ocean. Most of the lindane found in the Arctic Ocean is likely to have been there for some time, having come from Europe and Asia before many countries stopped using it. Until recently, Canada was also using lindane.

Endosulfan is widespread in the eastern Arctic islands and off Holman (Uluqsaqtuuq). Levels of endosulfan are much lower than lindane but rise slightly during periods of open water in the Canadian Arctic islands.

It is easier for this contaminant to be deposited from the atmosphere into water than onto ice. For this reason, climate change (which is expected to result in more open water) may affect how much endosulfan (and other POPs) is transferred to the marine environment in northern Canada and elsewhere in circumpolar region.

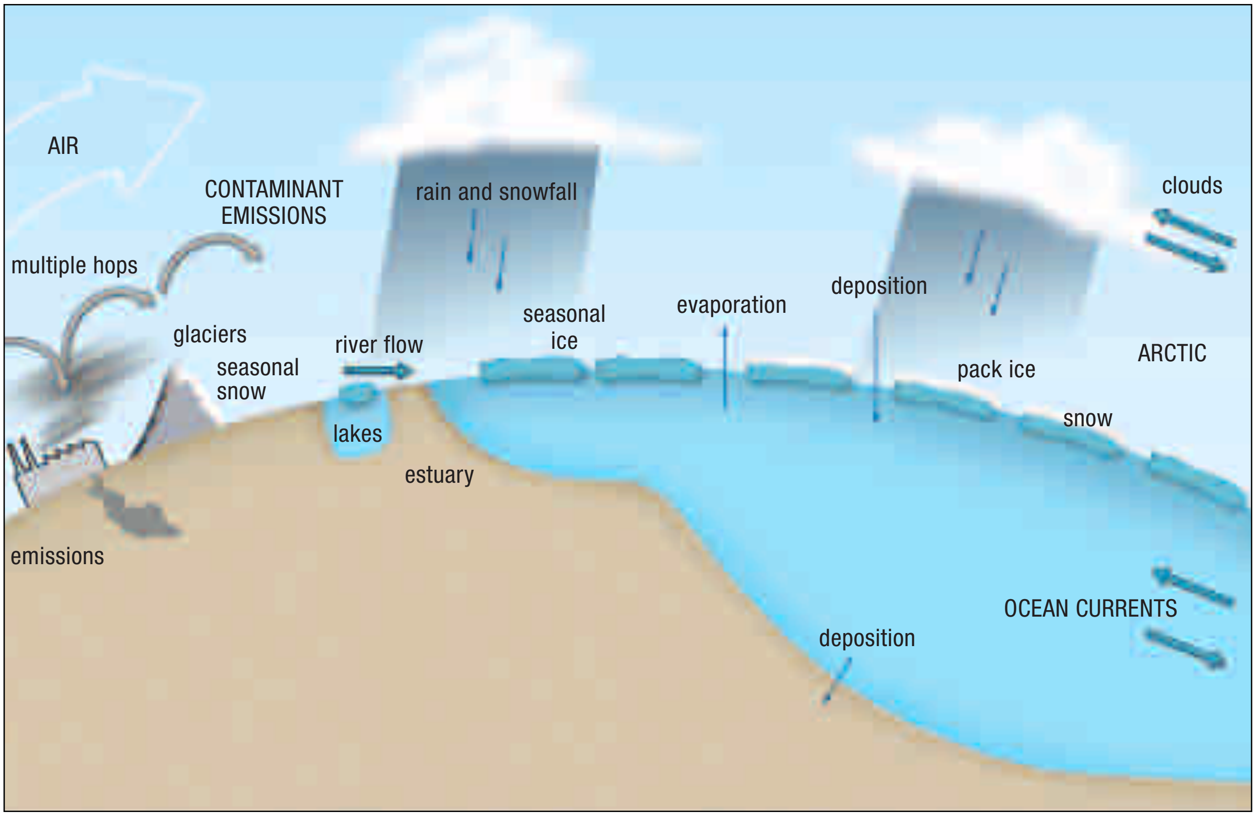
The levels of PCAs in marine sediments correspond to times when PCAs were being used extensively in the south. Typically, it takes about 10 years for PCAs used in the south to end up in northern marine sediments. We may now start to see levels of PCAs decrease in northern sediments.

Low levels of PBDEs show up in sediments from the Barrow Strait, medium levels in Penny Strait sediments and higher levels in sediments at Nanisivik.

Overall levels of PBDEs are very low and are not currently of concern to wildlife or human health.

2.3.3.2 Radionuclides in marine waters and sediments

Measurements of radionuclides are useful for monitoring ocean currents. In the Arctic Ocean, iodine measurements clearly show that Atlantic Ocean water meets Pacific Ocean water near the Mendeleyev Ridge. Measurements in the interior of the Canada Basin show that some water has come from shelf north of the Chukchi Plateau. Very few of the radionuclides being released from European nuclear plants are reaching the Canada Basin, though they are significant locally. The studies did not look at the potential effects of these radionuclides on fish or wildlife.



Pathways for contaminants in the northern physical environment
Contaminants are emitted from agricultural and industrial sources in other parts of the world, and are carried to the North primarily on air and water currents. They may fall to the surface directly, or in rain or snow, and end up in lakes, rivers, the ocean, surface snow and ice. These contaminants may then make their way into plants and animals and increase up the food web.

These local European sources of radionuclides include iodine and cesium, both of which are released into the English Channel and Irish Sea. The radionuclides are then carried into the Arctic Ocean. Background levels of iodine in the Barents Sea have increased at least 500% since 1992. European nuclear facilities at Sellafield (United Kingdom) and La Hague (France) are the main sources.

Other human-made sources are found in the Kara Sea and the Ob and Yenesey Rivers in Russia, and at Amchitka in Alaska. Some of the highest plutonium levels measured in the marine environment are found in sediments near a nuclear weapons testing site on Novaya Zemlya. Plutonium has found its way into the eastern Barents Sea sediments, and is accumulating in invertebrates and algae in this region.

Very few of the radionuclides being released from European nuclear plants are reaching the Canada Basin, though they are significant locally.

2.4 How do contaminants end up on the land, and in the lakes and rivers? Do they ever disappear?

Some contaminants have a strong tendency to stay in one part of the physical environment rather than another. Once in the North, some contaminants stay in the atmosphere while others fall easily to the surface and stay in the snow, ice, soil, or on vegetation. Some contaminants that arrive in ocean currents tend to stay in the water while others fall to the bottom sediments.

What happens to contaminants in lakes? The case study of Amituk Lake, Cornwallis Island

At Amituk Lake on Cornwallis Island, most mercury and POPs reach the lake from the surrounding land (watershed) during snowmelt.

Almost 30% of the mercury washes into the lake from natural, local sources (local rocks). These natural levels have remained steady for several decades, while mercury levels from human-made sources have gradually been increasing. Climate change has been suggested as a reason why more mercury is now entering the lake than before (see Section 2.5).

Approximately 25% of the mercury which reaches the lake falls to the lake bottom sediments and nearly 60% flows out of the lake. The implications for fish are not clear as mercury levels in lake sediments do not seem to be related to mercury levels in fish.

In contrast to mercury, a high proportion of the POPs entering the lake flows out again, eventually to reach the Arctic Ocean. Less than 4% of the POPs fall to the bottom. Several POPs also disappear while in the water. For example, half of the HCHs in the water disappear within a year. For endosulfan, over 90% disappears within a year. Microbes are an important reason why some POPs disappear from lakes, wetlands and the marine environment.

The rates at which the POPs disappear are important for fish and wildlife. The less persistent POPs disappear quickly and have less time to enter the food web. As most POPs flow out of the lake, little remains behind to affect the lake ecosystem and food web.

Microbes are an important reason why some POPs disappear from lakes, wetlands and the marine environment.

These "preferences" can be important for fish and wildlife and for the food web. If a contaminant falls out of the atmosphere and is deposited onto the surface then plants and animals are more exposed to that contaminant. If a contaminant stays in the atmosphere and is not deposited onto the surface, then it is much less likely to be accumulated by animals and plants. It may be easier for fish to accumulate contaminants from the water than from the bottom sediments.

Pat Roach

Location of Amituk Lake on Cornwallis Island, Nunavut

Some contaminants are easily carried on snow from the atmosphere to the surface. When the snow melts, these contaminants flow into the soil, rivers, lakes, seawater and onto vegetation.

Temperature can also make a difference. Contaminants are more likely to be accumulated by fish and wildlife when the temperature is higher, as their metabolism increases.

Snow and ice appear to play particularly important roles in moving contaminants from one part of the environment to another. Some contaminants are easily attached to falling snow, and are carried on snow from the atmosphere onto the surface. There are usually higher levels of POPs on the surface when there is more snowfall. When the snow melts, these contaminants flow into the soil, rivers, lakes and coastal seawater, and onto vegetation, where they may be eaten by animals.

2.5 Climate change may affect contaminants in northern Canada

Most contaminants travel to northern Canada from the south and the rest of the circumpolar Arctic on air and ocean currents. Climate change is modifying these currents and as a result scientists expect to see higher levels of some contaminants in the Canadian North.

Climate change is modifying air and ocean currents and as a result scientists expect to see higher levels of some contaminants in the Canadian North.

Pat Roach

As species and patterns of plants and animals react to climate change, food webs are expected to become longer. Contaminants will likely bioaccumulate and biomagnify in ways not yet understood.

Climate change will also affect the amount, character and location of snow and rain in the North. These are important for carrying contaminants from the air to the surface. The extent and location of sea ice is also expected to continue to change. For example, sea ice prevents mercury from moving from the water to the atmosphere. The amount of sea ice will affect the amounts of mercury available to animals and plants.

Climate change may affect the organisms that live in the North. Different species of plants and animals may show up in unexpected places, while others may disappear. Shifts in permafrost and patterns of ice cover are expected to change with climate change. Animals dependent on permafrost and sea ice (e.g., seals and polar bears) are already being found in different areas.

With climate change, contaminants from Russian rivers are expected to flow more into the Canadian Arctic Ocean than before.

As species and patterns of plants and animals react to climate change in the North, food webs are expected to become longer. Contaminants will likely bioaccumulate and biomagnify in ways not yet understood. Animals at the top of the food web will accumulate higher levels of contaminants. This could affect the health of the animal as well as the levels of contaminants found in some traditional/country foods.

2.5.1 The Arctic Oscillation and climate change

Climate change is closely linked to a phenomenon in the atmosphere and oceans known as the Arctic Oscillation. During an Arctic Oscillation, which normally occurs every 5–7 years, the usually stable and predictable air and ocean currents in the North change direction. As a result, contaminants in the ocean water are also carried further into the Canada Basin and less into the East Siberian Sea.

Because of climate change, rivers leaving the Russian coast are expected to flow more towards the East Siberian Sea and the Canada Basin instead of leaving the Arctic quickly as would normally be expected. The contaminants in these rivers are also expected to arrive in the Canada Basin, carried along with the new flow pattern.

The polar ice cap is shrinking and getting thinner because of climate change, and may disappear entirely within the next 100 years. Climate change is also changing the habitat of wildlife species such as polar bears by changing the sea ice. Such changes already appear to be negatively affecting polar bears in Hudson Bay as the ice is important for them to find and catch their main prey, seals. *ITK/Eric Loring*

With climate change, the Arctic Oscillation is expected to be stronger and occur more frequently. These changes may affect contaminants across the North. Overall, levels of mercury and possibly other heavy metals are expected to increase in the Arctic Ocean. The levels of some POPs are also expected to increase. Others may actually decrease, however, because they are no longer being used in most of the world, and much lower levels are now being transported to the Arctic than before.

2.5.2 Mercury and other heavy metals

With climate change and a stronger Arctic Oscillation, scientists expect there to be less sea ice in the Arctic Ocean. Sea ice normally prevents mercury from leaving the ocean and entering the atmosphere. Because of climate change, more mercury may therefore move into the atmosphere from the ocean. The strength and location of the polar sunrise phenomenon (when mercury moves from the air to the snow surface) may also change.

As permafrost melts and temperatures rise, lakes and rivers will contain more organic matter and, therefore, more mercury. (Mercury levels are generally higher where there is more organic matter.) The mercury will be carried in rivers to lakes and coastal areas where it is more available to freshwater and marine animals. Once mercury enters the food web, top predators are likely to accumulate more mercury.

Lead enters the Arctic Ocean primarily from the Atlantic Ocean or the Laptev Sea and current levels of lead are highest in Eurasian Basin sediments. However, with climate change, ocean currents are expected to transport lead into the Canada Basin, especially from sources in Eastern Europe and Russia.

Cadmium in the Arctic Ocean comes primarily from natural sources. With climate change, less water is expected to flow from the North Pacific Ocean through the Bering Strait into the Arctic Ocean. The Bering Strait is particularly rich in cadmium and thus less of this heavy metal is expected to end up in the Arctic Ocean. Cadmium is also found in ocean upwellings (places where water moves from the deeper ocean to the surface). The location and strength of upwellings along the edges of the ocean shelves and among the Canadian Arctic islands is expected to change as a result of climate change. Cadmium levels in these locations are also expected to change.

2.5.3 Persistent organic pollutants

Climate change is expected to divert the flow of Russian rivers into the Canada Basin. This water will also stay longer in the Arctic Ocean than it does today. The actual levels of certain POPs in the Canada Basin may decrease, however, despite these changes in flows, as some pesticides (e.g., DDT and HCHs) are no longer being used in most countries.

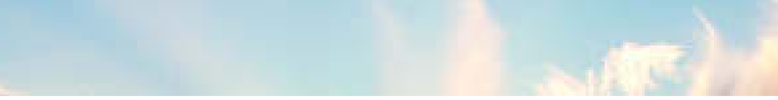
As the ocean becomes warmer, some POPs (e.g., HCHs) will likely evaporate from the water into the atmosphere while PCBs and endosulfan will tend to be deposited more onto the water. As a result, both PCBs and endosulfan are expected to become more available to plants and animals in the marine food web.

2.5.4 Radionuclides

Some human-made radionuclides are currently carried by Russian rivers to the Laptev Sea and Kara Sea. Changes in ocean currents and ice flows may direct radionuclides into the Canadian North and the Canadian Arctic islands more than before as a result of climate change.

As the permafrost thaws, uranium may naturally decay at a faster rate, and uranium radionuclide levels in the northern environment may increase as a result.

As permafrost melts and temperatures rise, lakes and rivers will contain more organic matter. Mercury levels are expected to rise and become more available to plants and animals in the food web.



2.6 Knowledge gaps and future work

The basic building blocks of contaminants research focus on contaminants in the physical environment. It is from this part of the environment that plants and animals are first exposed to contaminants. These then move up the food web to biomagnify in the top predators, including humans. Research on contaminants in the physical environment is used to support the development of national and international controls on contaminants coming into northern Canada from other parts of the world.

The research carried out under Phase II of the NCP has clarified many of the outstanding questions from the first phase of the program. These include studies on whether levels of contaminants are increasing or decreasing in response to national and international controls; the transport of contaminants and what happens to them once they reach northern Canada; and if there are other (new) contaminants of concern. Phase II has provided much new information about these topics; however, new questions have arisen. It is important that these questions be answered, especially in response to the appearance of new contaminants in the northern environment and in an era of climate change.

ITK/Eric Loring

As many of the older POPs are phased out around the globe, new ones are being developed and put into use for various purposes. Some of these new POPs are now being detected in the northern environment at very low levels. It is important to monitor the levels of these "new" POPs (e.g., PBDEs, PFAs, chlorinated phenols, OCS) to see if levels are increasing in the North. Some of these POPs may become toxic if levels increase.

Sometimes it is difficult to predict which new POPs may show up in the Canadian North. Research on the properties (e.g., the ability of these contaminants to move to the North; their persistence) of a whole series of contaminants may reveal some clues about which ones to look for next.

The older POPs should also continue to be monitored in air, as there is not yet enough information to state whether levels are increasing or decreasing over time. This monitoring is also essential to determine whether national and international controls on a number of POPs are working.

Eastern Asia appears to be a significant source of new and older POPs reaching Yukon and the Northwest Territories. Air monitoring and modelling need to continue to get a better idea of the sources and amounts of contaminants coming from Asia, and what routes they take to reach northern Canada.

Additional work is needed on the routes taken by various heavy metals reaching the North from other regions. For example, scientists are not yet sure where the increasing levels of mercury are coming from.

The remarkable polar sunrise phenomenon, in which mercury is deposited onto the surface once the sun reappears on the horizon after the long polar night, has only recently been discovered. This is a potentially very important mechanism for making mercury available to plants, fish and wildlife. Continued research is needed to assess how important the polar sunrise phenomenon really is; what happens to the mercury deposited on the snow; whether this phenomenon occurs away from marine locations; and whether human actions leading to climate change and industrial activities are somehow responsible.

The levels of contaminants in lakes are known to respond quickly to changes in levels falling from the atmosphere or coming in from rivers and runoff. Levels in lakes (water and sediments) should continue to be monitored as these are important for freshwater fish. Research on how quickly contaminants disappear altogether from lakes should also continue.

Microbes are now known to be important for making HCHs disappear from oceans and lakes. Research is needed to understand whether microbes are also important for making other POPs disappear as well.

Levels of POPs should continue to be measured in seawater in the North, since seawater may be a more important transport route than originally thought. Levels of POPs in seals and seabirds also increase and decrease with levels in seawater. Like air monitoring, long-term monitoring of POPs in seawater will show how levels are changing overall, and if international and national controls are being effective.

Sea ice is also now known to be important for controlling the movement of contaminants between e.g., water and air. Contaminants in the water are more available to fish and wildlife than contaminants in the air. More research is needed to provide a better understanding of the role of sea ice, particularly as the amount and character of sea ice is changing because of climate change.

Monitoring and using computer models of radionuclides in sea ice and in the ocean is an excellent way to improve knowledge about the routes taken by ice and ocean currents. As contaminants are carried along with ice and in ocean currents, using radionuclides as these "tracers" may provide us with valuable information on the routes followed by other contaminants as well.

The physical and chemical properties of contaminants will affect what happens to them once they have reached the North. Standardized studies of contaminants such as PCBs and mercury will enable scientists to understand their fate (e.g., whether they stay in the air or water, or move on to ice and snow). Research on the behaviour of contaminants at different temperatures is expected to help scientists understand how these contaminants will react to climate change.

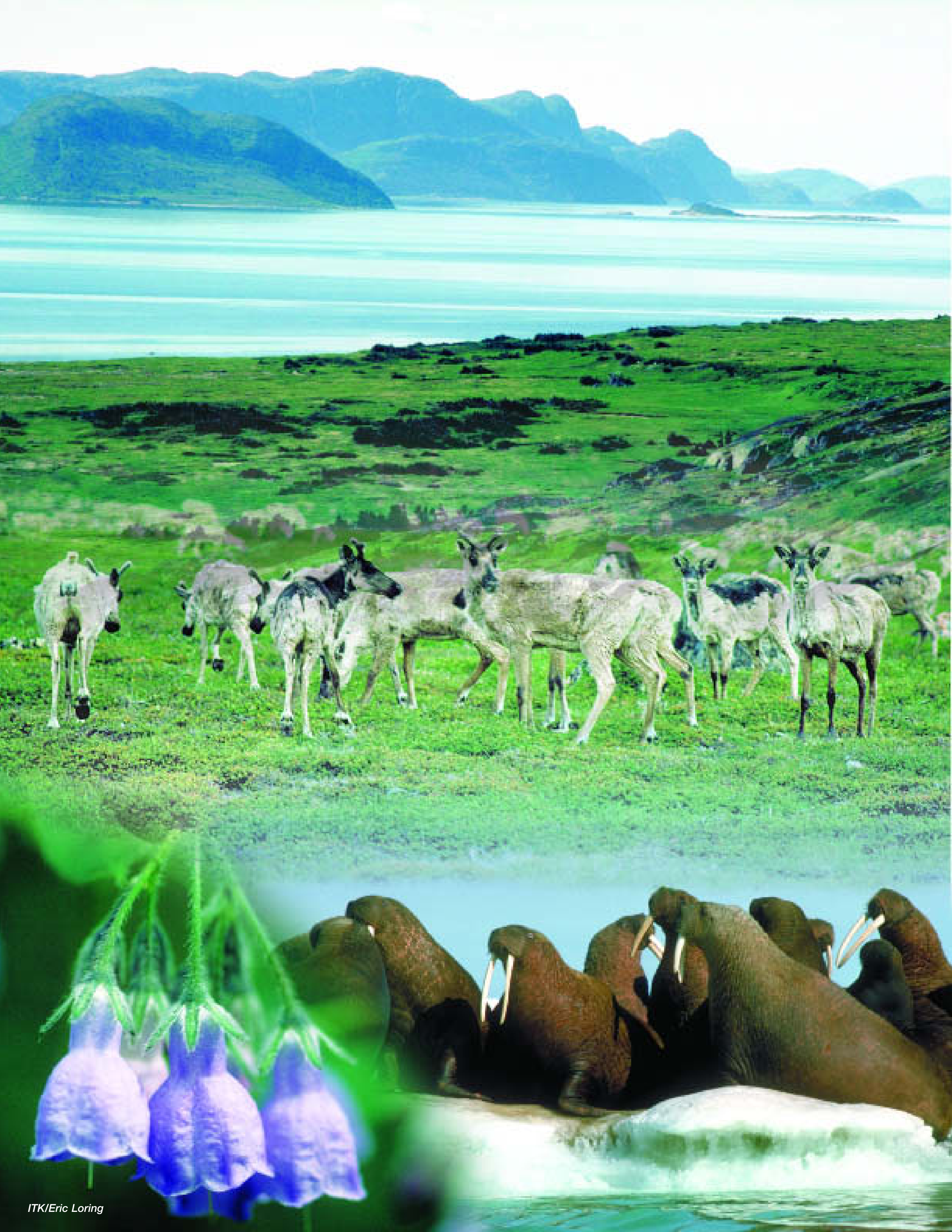
ITK/Scot Nickels

Snow is known to be a very important route for bringing contaminants to the surface. However, scientists do not really understand how this happens, or what happens to the contaminants once they are on the surface. Do they stay there? Are they washed into lakes and rivers? Do they evaporate back into the air? More research will help explain what happens to contaminants brought to the surface in snow.

Climate change is expected to have a profound effect on the North, and changes are already being seen. Parts of the northern marine environment, especially Hudson Bay, in the Arctic Islands and the Beaufort Sea, are particularly sensitive to climate change and have experienced many changes already over the past 20 years. More research is needed to provide a better understanding of these changes, especially as climate change in these regions will affect wildlife and humans.

Studies are needed to discover how melting permafrost will affect the flow of contaminants. Organic matter is released when permafrost melts, and mercury is often found with organic matter.

Finally, changes in human behaviour on a global scale will affect the patterns of contaminants and their effect on northern Canada. Global energy consumption, and international policies such as the Kyoto Protocol, are expected to influence patterns of contaminants, e.g., PAHs, dioxins and furans in the North. It is important to look closely at these links, not only to help predict levels of contaminants in the North, but also to provide information in support of future national and international controls.

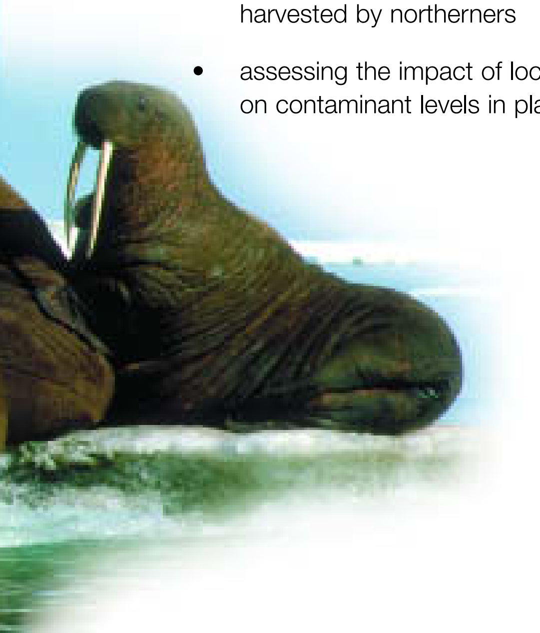

ITK/Eric Loring

How Do Contaminants Get into Fish and Wildlife? What Happens to Wildlife that Contain Contaminants?

3.1 Introduction

During Phase II of the NCP, a large amount of data was produced on contaminants and fish and wildlife in the Canadian North. The main focus has been on measuring and monitoring a number of POPs, as well as the heavy metals mercury and cadmium. Research focussed on the high priority areas identified at the end of the first phase of the NCP:

- temporal trends of most contaminants in fish and wildlife
- levels of certain contaminants in fish and wildlife (e.g., dioxins, furans, toxaphene, some types of PCBs, chlorinated naphthalenes, chlorinated and brominated diphenyl ethers, and pesticides that are still in use)
- better geographical coverage of contaminants in freshwater fish, including fish in the Northwest Territories, and fish other than Arctic char in Nunavut and Nunavik
- better geographical coverage of contaminant levels in marine fish and invertebrates (e.g., mussels) which are important links in marine food webs and because some animals are harvested by northerners
- assessing the impact of local pollution sources on contaminant levels in plants, fish and wildlife
- better integration of contaminant measurements with computer models of the fate of contaminants, especially their bioaccumulation in the food web
- biological effects, especially the effects of contaminants on an animal's ability (in particular polar bears and beluga whales) to fight disease and infection; and the effects of mercury and cadmium on seabirds, marine mammals and caribou

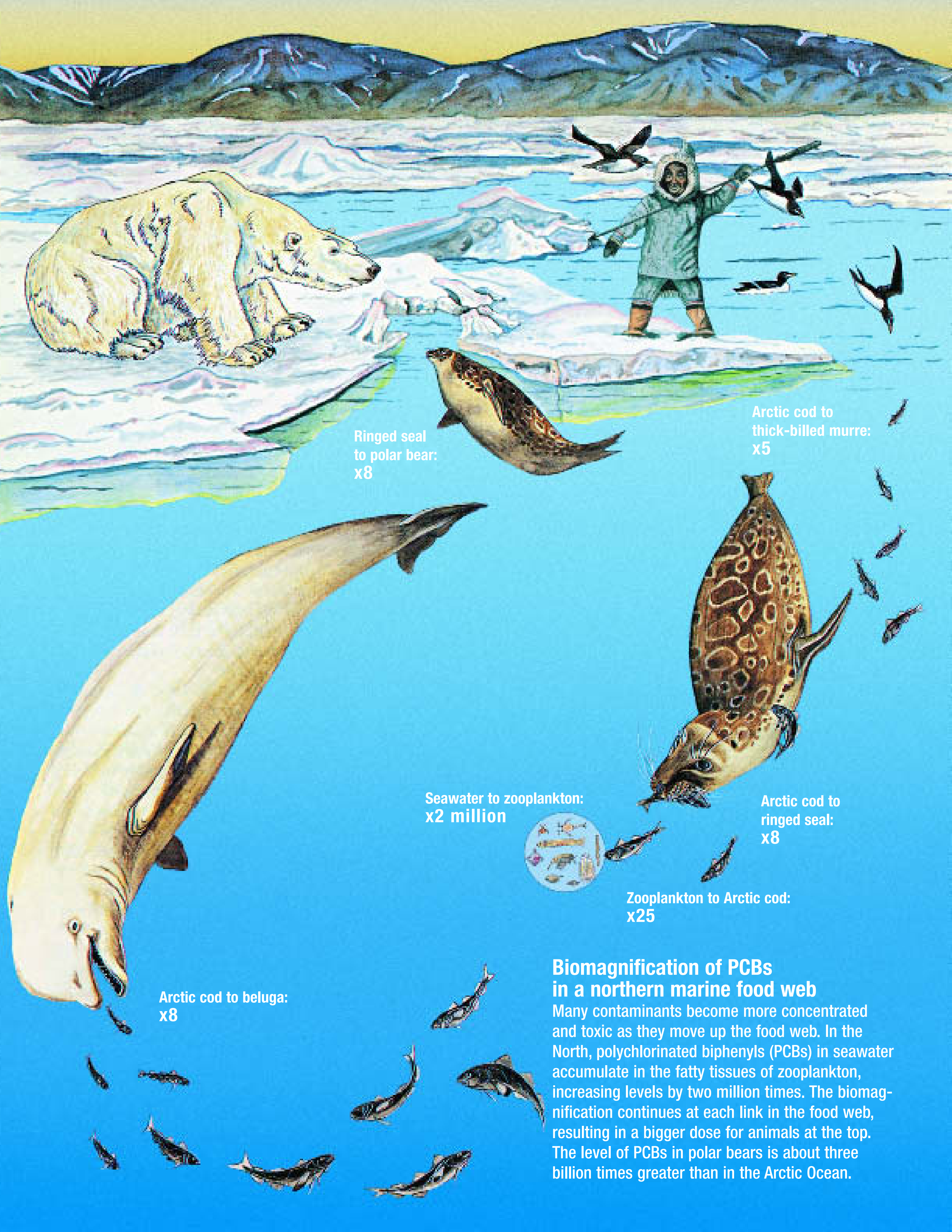


Many local harvesters have gained experience with scientific sampling of wildlife and are highly skilled in maintaining scientific standards and procedures.

NCP Guidelines for Responsible Research

The NCP has established methods to ensure that its research is carried out responsibly. Responsible research involves elements such as consultation, community participation, partnerships, communications, and data reports. An important part of the process is building relationships based on trust and cooperation, building capacity, and making appropriate use of traditional knowledge.

The NCP Aboriginal Partners led the development of the Guidelines for Responsible Research and related consultation requirements. These are used to involve northern communities as partners in research activities. Partnership occurs from the beginning with project design and ensures there is good communication during all stages of the research.



Biomagnification of PCBs in a northern marine food web

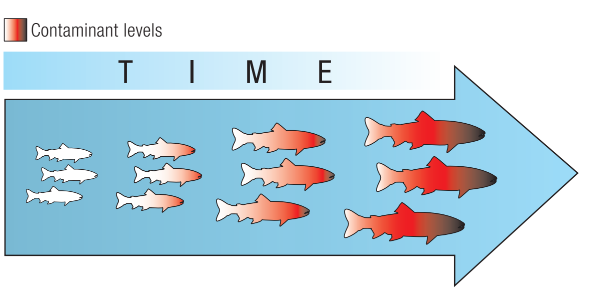
Many contaminants become more concentrated and toxic as they move up the food web. In the North, polychlorinated biphenyls (PCBs) in seawater accumulate in the fatty tissues of zooplankton, increasing levels by two million times. The biomagnification continues at each link in the food web, resulting in a bigger dose for animals at the top. The level of PCBs in polar bears is about three billion times greater than in the Arctic Ocean.

The food web, bioaccumulation and biomagnification

Plants and animals are linked together in feeding relationships called food webs. Green plants and plankton that convert sunlight into food energy are at the bottom of food webs. An animal that eats the plants is then eaten by another animal, and so on up a food chain. In nature, food chains overlap to form food webs. The number of animals involved can vary. For example, in the North, the lichen→caribou→human food chain has fewer feeding links, and is much shorter than the algae (a small plant that lives in water but needs sunlight)→fish→seal→polar bear→human food chain.

Contaminant levels in an animal can slowly build up over time, as the animal eats foods containing contaminants. This is called bioaccumulation. Younger animals usually have lower levels of contaminants than older animals because they have been taking in and storing contaminants for less time.

When an animal eats a plant or another animal, it consumes all the contaminants stored in that food. Animals that eat other animals can build up higher levels of contaminants than those that eat only plants. Higher up the food web, contaminant levels increase because the contaminants are passed up each level in the food web from prey to predator. This is called biomagnification.



Bioaccumulation

ITK/Eric Loring

Many NCP projects rely to some extent on community involvement to collect fish and wildlife samples. Many local harvesters have gained experience in scientific sampling of wildlife and are highly skilled in maintaining scientific standards and procedures. In some cases, a scientist may be present to ensure that the correct techniques are used for sampling and storing wildlife samples.

Often local Hunters and Trappers Organizations and Committees (HTOs and HTCs) liaise between scientists and local harvesters for projects that require samples of wildlife. Some researchers have employed local liaison people to conduct and record interviews.

3.2 Marine animals

Under Phase II of the NCP, contaminants were studied in a number of marine mammals known to be important to the diet and/or economy of northerners, and in particular to northern Aboriginal peoples. Section 4.3 provides information on the value and importance of different species in the diets of Yukon First Nations, Dene, Métis and Inuit.

Not all species of dietary importance were studied under the NCP. For example, while there was considerable research done on ringed seals, no research was carried out during Phase II on bearded seals or harp seals.

3.2.1 Marine mammals

Marine mammals are very important to the Inuit diet and culture. Seals and whales are among the most frequently consumed traditional/country foods, especially in communities in the Baffin and Kivalliq regions. It is very important, therefore, to monitor the levels of contaminants in these animals, and to convey the results in a useful way.

Less research has been carried out on heavy metals in marine mammals than on POPs. Generally, there is no evidence that levels of mercury or other heavy metals are increasing in fish and wildlife across the Canadian North. However, both mercury and cadmium may be of concern in a few instances. Both metals have been found at higher levels in some animals at specific locations. This is particularly true for seabirds, and for marine mammals found near the mouths of large rivers.

There has been more research on POPs in marine mammals in the North than on other northern fish and wildlife species. This is because marine mammals and other animals in the northern marine environment often contain higher levels of POPs than those found in animals living on land. POPs tend to move from the land into water and become more accessible to marine organisms. Plankton easily accumulate POPs from the water. Marine mammals, which are near the top of a long marine food web, accumulate higher levels of contaminants compared to land-based animals.

Mercury and other heavy metals do not appear to be increasing in fish and wildlife in the Canadian North. However, both mercury and cadmium may be increasing in some animals at specific locations.

High levels of POPs are often found in the blubber of marine mammals, and therefore humans and polar bears that eat blubber are also exposed to these high levels. Metals tend to accumulate in the organs of marine mammals, e.g., the liver and kidneys.

3.2.1.1 Ringed seals

Ringed seals are the most common and widely found marine mammal living in the North. They are eaten extensively by Inuit and play an important cultural role.

Contaminants have been found in the livers and kidneys of ringed seals from Labrador, Nunavik, Nunavut and northern Baffin Bay. Ringed seals from the NWT were not studied during Phase II of the NCP. Levels of heavy metals are much higher in seal organs than in the muscle of the seals. For example, mercury concentrations are about 20 times higher in the seal livers than in the muscle.

Marine food webs

Food webs play a very important role in the movement and biomagnification of contaminants. Contaminants will move and may change form when one animal is consumed by another. The levels of contaminants found in each species depend on where the species is in the food web, and on the properties of the contaminants.

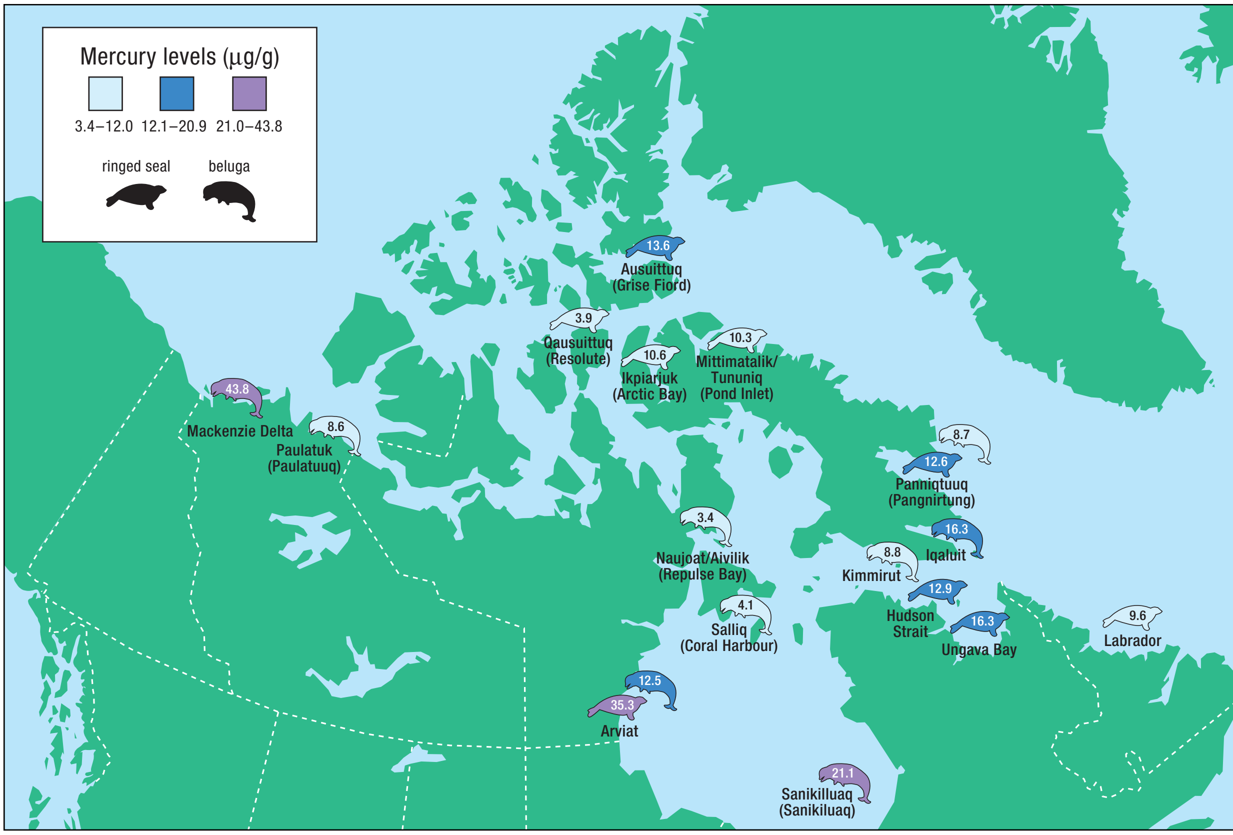
Studies in Lancaster Sound and in the Northwater Polyna north of Baffin Island have focussed specifically on how food webs influence contaminant levels in various animals. Levels of mercury and POPs are higher in animals higher up the food web than in those that are further down. In marine food webs most mercury is biomagnified as methylmercury, the most toxic form of mercury.

In contrast to mercury, levels of arsenic, cadmium, lead and selenium actually decrease up the food web. The higher levels are found in animals low in the food web such as zooplankton.

Like mercury, POPs also biomagnify up the food web. But how quickly the POPs biomagnify depends on the animals involved. For example, species that eat marine mammals (e.g., polar bears and humans) will generally biomagnify POPs more than species which do not prey on marine mammals. This is because the marine mammals themselves contain higher levels of POPs which are then passed on to those species that eat them.

Warm-blooded animals such as seabirds and mammals also biomagnify POPs more rapidly than cold-blooded animals such as fish. This is because warm-blooded animals must eat more food to maintain body temperature. The ability of an animal to change contaminants into other forms may also be important since these new forms may be more (or less) toxic than the original contaminant.

Marine mammals are very important to the Inuit diet and culture. It is important to monitor the levels of contaminants in these animals, and to convey the results in a useful way.



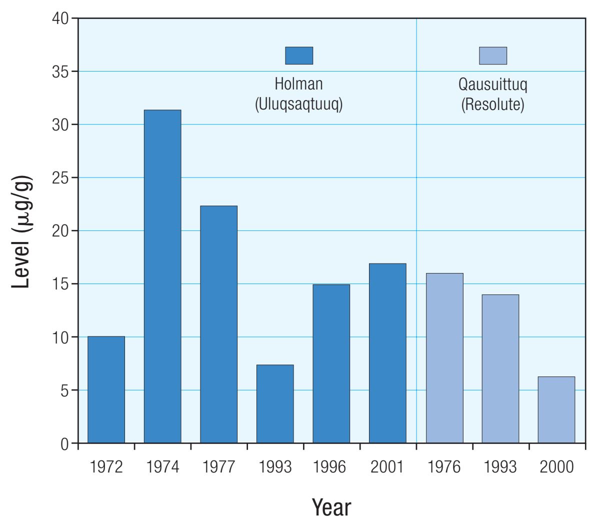
Levels of mercury in the livers of ringed seals and belugas across the Canadian North
Mercury levels are generally higher in the organs of marine mammals, e.g. the liver and kidney than in other parts of the animal. While there are no consumption guidelines for mercury in marine mammals, the guideline for subsistence consumption in fish is 0.2 µg/g, and for commercial sale is 0.5 µg/g.

POPs generally accumulate in the blubber of marine mammals, while metals tend to accumulate in the organs such as liver and kidney.

Levels of some of these contaminants (especially mercury and new POPs) are increasing in some seal populations while levels of the older POPs are becoming much lower.

Mercury levels vary from seal to seal and it is difficult to predict whether a particular seal will have high or low levels of mercury.

Compared to land animals, northern marine animals often contain higher levels of POPs because of the long marine food web.



Changes in mercury levels in ringed seal liver over time at Holman (Uluqsaqtuuq) and Qausuittuq (Resolute)
The levels vary a lot and show no definite trend up or down at either location. Even the highest levels are much lower than the levels known to cause liver damage in the seal.

Cadmium levels in the livers of ringed seals
Levels are lower in marine mammal liver than in caribou kidney, and are thought to come primarily from local, natural sources of cadmium.

Regardless, it appears that levels of mercury, particularly in the liver and kidneys, are getting higher in ringed seals in some regions. Levels have increased over the past 25 years in the livers of ringed seals from Mittimatalik (Pond Inlet), Ungava Bay, Sachs Harbour (Ikaahuk) and Paulatuk (Paulatuuq). Levels have remained about the same over the past 30 years in seal livers and kidneys from Holman (Uluqsaqtuuq). Mercury levels have tripled in the livers of seals from Mittimatalik (Pond Inlet) during the 1970s, but the data need further analysis to confirm this trend. The highest levels are found in seal livers from Qausuittuq (Resolute) (30 micrograms of mercury per gram of seal liver; 30 µg/g) but these are still much lower than the levels known to cause liver damage in the seal. A microgram (µg) is one-millionth of a gram.

Mercury levels are staying about the same in the livers and kidneys of most ringed seal populations, but are rising in others (e.g., at Mittimatalik/Pond Inlet).

Though there are no guidelines or standards for human intake of contaminants in seals or other marine mammals, the consumption guidelines developed for fish may be useful. For subsistence consumption, the standard is 0.2 µg/g, while for commercial sale, the guideline is 0.5 µg/g. The levels of mercury found in the livers and kidneys of some ringed seals are considerably higher than these guidelines.

Cadmium levels appear to be remaining the same over time in ringed seals. Like mercury, cadmium levels in the organs of ringed seals also vary a great deal from seal to seal. Scientists do not believe that these variations can be explained by the age of the seal. Cadmium levels tend to be higher in seals from Baffin Island, e.g., at Mittimatalik (Pond Inlet) and

Cadmium levels appear to be remaining the same over time in the organs of ringed seals. Lead and arsenic levels are not of concern.

Panniqtuuq (Pangnirtung), compared to Labrador seals. Cadmium levels are not considered of concern for human health. Northerners who smoke get most cadmium from cigarettes.

Arsenic, while not of concern, is higher in the organs of ringed seals from the high Arctic sites — Ausuittuq (Grise Fiord), Mittimatalik (Pond Inlet), Panniqtuuq (Pangnirtung) and Qausuittuq (Resolute), compared to seals in Ungava Bay, Labrador and Arviat. Lead levels are very low overall and are also not of concern.

While metals tend to concentrate most in the kidneys and livers of marine (and other) mammals, most POPs combine well with fat and are therefore found more in the blubber of ringed seals than in other parts of their bodies.

Levels of POPs in the blubber of seals tend to be quite similar across the Canadian North. The lowest levels are found in the Northwest Territories, except for the HCH pesticides which are higher. These HCHs are still being carried to Canada from Asia.

The levels of some POPs in blubber are clearly going down in ringed seals from Ikpiarjuk and Ausuittuq (Grise Fiord) in Nunavut and from Holman (Uluqsaqtuuq) in the Northwest Territories. Levels of some PCBs are now up to 60% lower than those found in 1975, and are well below the levels thought to cause a vitamin A deficiency in seals. Levels of DDT have also decreased, with current levels in ringed seal blubber at about ⅓ of the levels found in 1975. DDT is not thought to be causing any health problems for seals as their diets contain only low levels of this pesticide. However, alpha-HCH is now being found at higher levels than before in ringed seal blubber.

Levels of POPs tend to be quite similar in the blubber of seals across the Canadian North.

GNWT/NWT Archives/George Calef

Computer models have been able to accurately predict the levels of POPs found in seals from Holman (Uluqsaqtuuq) for 1972–1991. Using these models, scientists now predict that between 2000 and 2010, levels of DDT and PCBs in ringed seal blubber will decrease by another 40%. Changes in climate and weather patterns may also influence these levels in the future (see Section 2.5).

The levels of some POPs are clearly decreasing in the blubber of some ringed seal populations. Levels of some PCBs are now as low as 40% that of 1975 levels, and DDT levels have dropped to about one-third.

Contaminant levels in ringed seals: scientists and communities working together

A study of changes in the levels of metals and POPs in ringed seals provides a good illustration of how well scientists and community members can work together under the NCP.

During an NCP Contaminants Tour, scientists presented data on contaminants in ringed seals from Holman (Uluqsaqtuuq) to northern residents in Ausuittuq (Grise Fiord) and in Qausuittuq (Resolute). People were very interested in the data and wanted to learn if contaminant levels were increasing or decreasing in the local seals. A study of contaminant levels in the local seal population would also address a known gap in the NCP on temporal trends, and so a project was started.

Community people, in particular the local hunters and trappers committees (HTCs), were involved from the beginning and helped to design the project. The communities of Qausuittuq (Resolute), Ikpiarjuk (Arctic Bay), Panniqtuuq (Pangnirtung), Mittimatalik/Tununiq (Pond Inlet), Sachs Harbour (Ikaahuk), Holman (Uluqsaqtuuq), Paulatuk (Paulatuuq), Tuktoyaktuk, Kangiqsujuaq (Wakeham), Kangiqsualujjuaq (George River), Quaqtaq and Inukjuaq were central to the work. They were consulted and consented to the work, as per the NCP guidelines for responsible research.

During the project itself, the HTCs liaised between scientists and community residents. Hunters were given a kit and video providing instructions for sampling, prepared by the Nunavik Research Centre (NvRC) in both English and Inuktitut. During the regular spring/summer hunt, hunters collected samples of blubber, liver, muscle, kidney and tooth/lower jaw from about 25 seals. Key seal measurements were also taken (e.g., length, girth, blubber thickness, and gender).

Monthly contact was maintained between the scientists and hunters during the hunting season. Regular communications took place in both English and Inuktitut, sometimes using Inuktitut speakers at the NvRC. The Inuit Tapiriit Kanatami helped to identify and contact the appropriate people at the local level.

After six months, preliminary results were provided to the communities, as well as to the Northwest Territories and Nunavut Environmental Contaminants Committees, and the Nunavik Nutrition and Health Committee. Reports were tailored to the needs of each community, and discussions often followed.

The project continues to be successful, from both a scientific and community perspective. Local hunters willingly participated, and traditional knowledge was invaluable for obtaining the seal samples and measurements. Trust continues to be built between the scientists and the community members. The unique NCP cooperative model was seen as extremely valuable — it created a win-win situation for both scientists and community members and none would hesitate to work together again.

Ringed seals in the Canadian North generally have higher levels of POPs than those found in ringed seals in Alaska but are lower than those for seals in the European north and northeastern Greenland. Levels in seals from northern Baffin Bay are similar to those from western Greenland.

What may be of greater concern, at least for the future, are the rapid increases in the levels of some new contaminants in ringed seal blubber.

While still very low, levels of brominated flame retardants, in particular polybrominated diphenyl ethers (PBDEs), are now nine times higher than they were in 1981 in seal blubber from Holman (Uluqsaqtuuq). Perfluorooctane sulfonate (PFOS) (used in fire-fighting foams and in carpets to protect them from staining) are now starting to be found in ringed seal blood. Polychlorinated naphthalenes (PCNs) and other new contaminants are being found at very low levels in some seal blubber.

These very low levels of the new contaminants are not believed to be of concern for either the ringed seals or human health. However, more research and monitoring are needed to see if the levels of these contaminants continue to increase, and to find out if they may one day affect the health of the seals or humans.

> ***Rapid increases in the levels of some new contaminants are being seen in ringed seal blubber. Polybrominated diphenyl ethers (PBDEs), are now nine times higher than they were in 1981 in seal blubber from Holman (Uluqsaqtuuq). More research is needed to find out whether these new contaminants may one day affect the health of seals and humans.***

Contaminant levels may change with the age of a seal

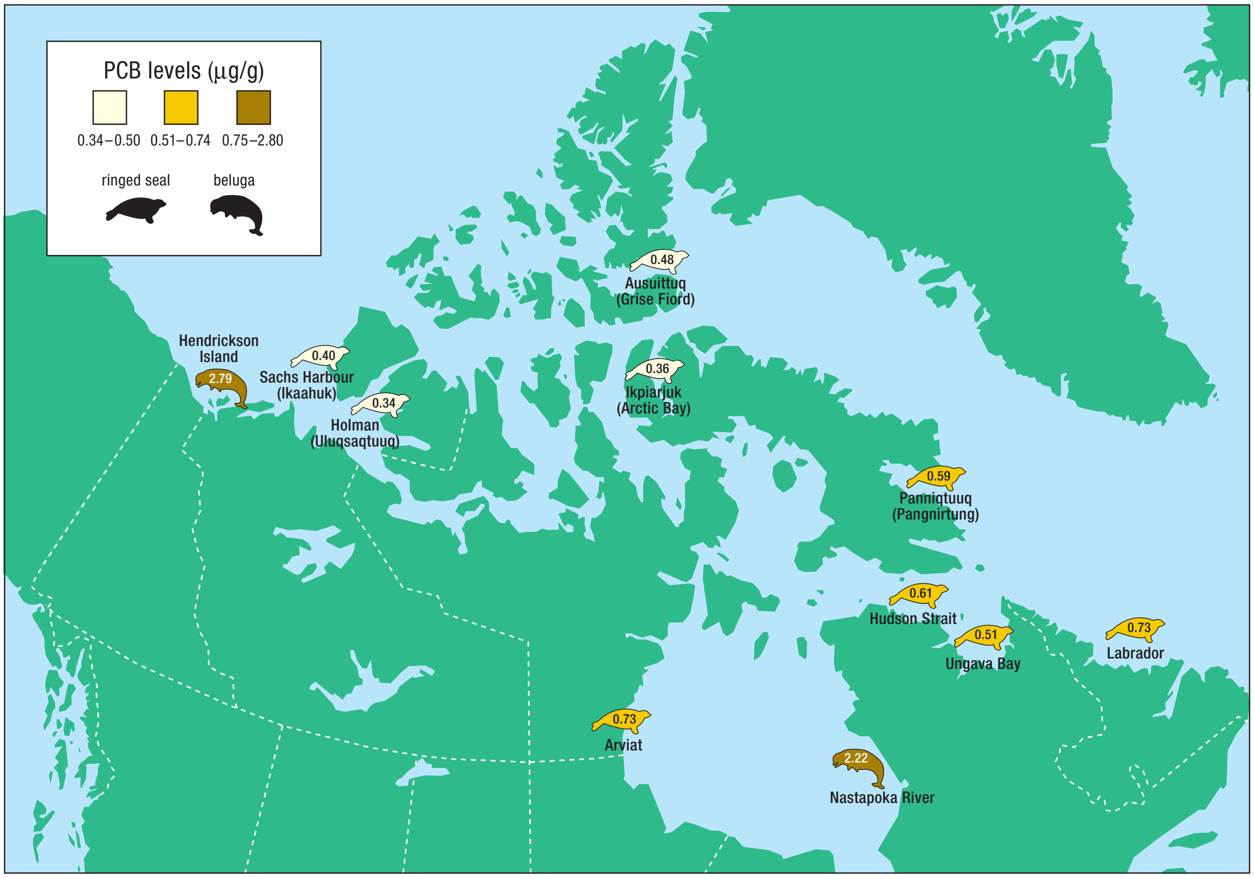
Older seals tend to have higher levels of mercury in their kidneys and livers, and higher levels of POPs such as PCBs and DDT in their blubber than younger seals. This is because the seals bioaccumulate mercury and POPs over time. Males often have higher levels of POPs (but not mercury) than females. This is because females pass POPs on to their offspring during pregnancy and in their milk, which reduces their own POPs levels.

Do contaminants pose a health hazard to ringed seals?

There is no evidence that current levels of contaminants are a health hazard to ringed seals in the Canadian North.

Scientists find that marine mammals are generally not affected by mercury if levels in their livers are below 60 µg/g. At higher levels, the animals may suffer liver damage. The mercury levels found in the organs of seals in the Canadian North are below this level, and range from less than 1 µg/g to 30 µg/g. Mercury is therefore not believed to be of concern for the health of marine mammals.

PCBs can cause a reduction in vitamin A in ringed seals once the levels in seal blubber rise above 11 µg/g. The seals studied under the NCP contain about 1⁄10 of this level. If seals eat aquatic organisms containing less than 7.6 nanograms per gram (ng/g) (0.0076 µg/g) of PCBs, then PCBs are unlikely to cause them health problems. Most seals eat zooplankton, bottom-dwelling invertebrates and small fish, all of which contain PCBs well below the 7.6 ng/g guideline. It is often difficult to determine the effects of a particular contaminant in wildlife but PCBs are currently not thought to be of concern for the health of seals.



PCB levels in the blubber and fat of female ringed seals and beluga whales
Generally speaking, PCB levels are higher in marine mammals than in land animals. PCBs and other POPs are generally found at higher levels in the fatty tissues (e.g. blubber) than in the organs.

3.2.1.2 Beluga whales

Like ringed seals, beluga whales are very important to Inuit, from both nutritional and cultural viewpoints. Belugas are near the top of the food web and feed on a variety of fish as well as invertebrates and shrimp. They are found throughout the North and migrate seasonally.

It has been known since the 1980s that the levels of mercury found in some beluga organs (liver and kidney) are high enough to cause some concern, both to the whales themselves, and to people who eat these organs. It is thus particularly important to monitor the levels and changes over time of contaminants in these marine mammals.

Much of the mercury found in the blood of the whales is methylmercury, the most toxic form of mercury. Remarkably, the whales appear to convert this to less harmful forms which are then stored in

Beluga whales appear to convert methylmercury to less harmful forms which are then stored in the organs. Consumption of beluga may be less of concern than originally thought since these organs are not heavily consumed.

the liver, kidney, brain, and spinal cord. Thus, the whales are able to survive despite the high total levels of mercury found in the animal. Consumption of beluga may be less of concern than originally thought since mercury is concentrated in organs that are not heavily consumed.

In the last 15–20 years, mercury levels in the livers of some beluga whale populations have been increasing. Levels have gone up four times in the livers of belugas from the Beaufort coast during the 1990s.

Beluga teeth tell a useful story

Beluga teeth can be very useful for measuring mercury levels. Teeth can give us an idea of what the mercury levels used to be centuries ago, since many teeth have been preserved from that time. Levels in the teeth are also used by scientists to calculate the levels in both beluga muscle and in blubber.

In the last 15–20 years, mercury levels in the livers of some beluga whale populations have been increasing. Levels have gone up four times in the livers of belugas from the Beaufort coast during the 1990s, and 10 times or more in belugas from western Hudson Bay.

Based on analyses of beluga teeth, mercury levels have increased over the past 500 years or so in the livers of beluga whales from Mackenzie Bay and Arviat in western Hudson Bay. These increases range from 10–17 times with the older whales having the higher levels. A remarkable pattern has been found for these mercury increases. The largest increases in mercury levels are being found in those beluga near the mouths of large rivers — Mackenzie River (Dehogá), Nelson River, and rivers leading to James Bay. These freshwater flows may somehow be influencing the mercury levels more than mercury being deposited directly from the atmosphere.

The levels of some POPs in beluga whales are decreasing (e.g., PCBs, dieldrin), while others are staying the same (e.g., DDT, toxaphene), or even increasing (e.g., chlordane, endosulfan).

The story for POPs is more complicated than for mercury. The levels of some POPs in beluga whales are decreasing (e.g., PCBs, dieldrin), while others are staying the same (e.g., DDT, toxaphene), or even increasing (e.g., chlordane, endosulfan).

Tributyltins (used among other things to prevent unwanted growth on the hulls of ships) are found in St. Lawrence River belugas to the south, but so far they are not found in the livers of belugas in the Hudson Strait. The volume of shipping through the Hudson Strait is not high enough to make tributyltins a contaminant problem, like they are in other parts of Canada.

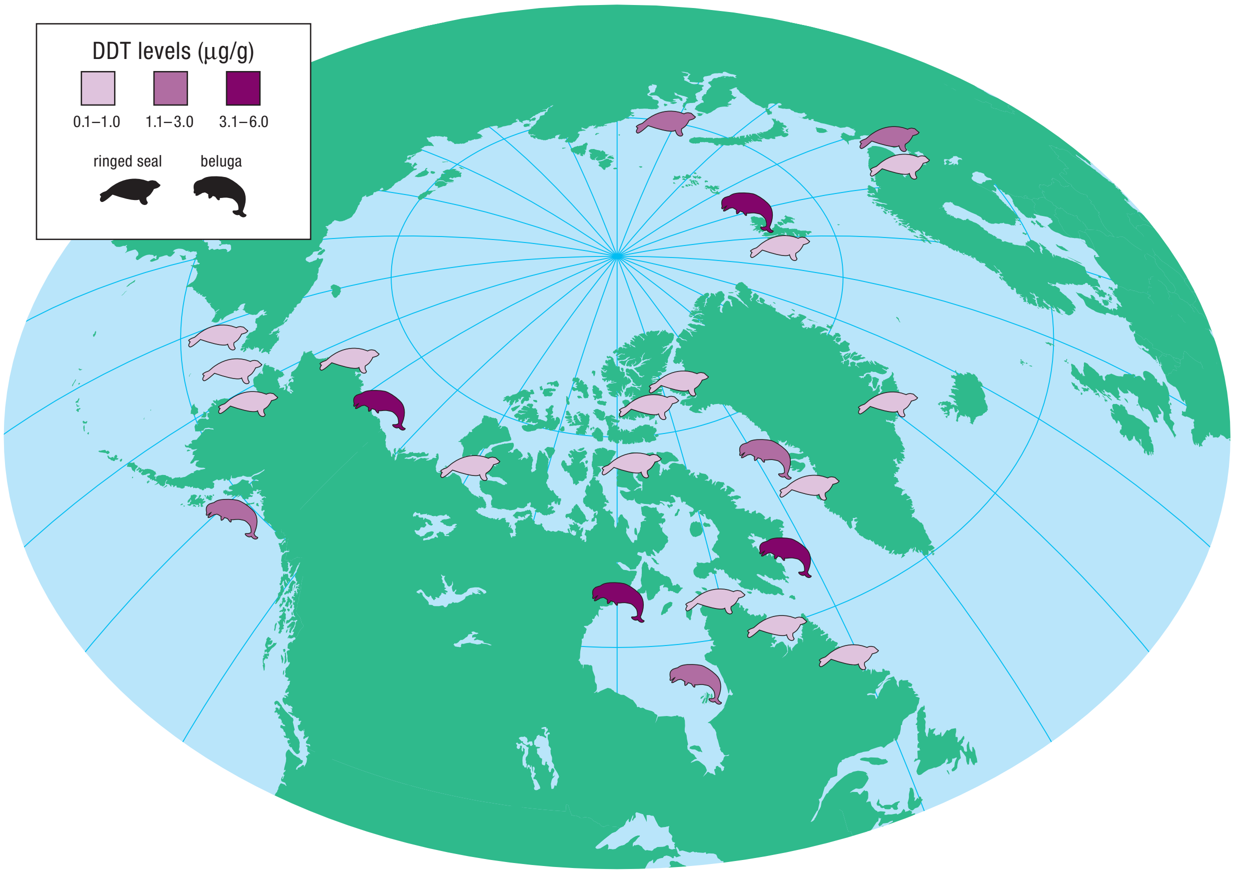
Of the new POPs, brominated fire retardants (especially PBDEs), PCNs and others are now being found in beluga in the North. Levels of PBDEs are also increasing over time. As with ringed seals, current levels are not of concern, with the possible exception of PCNs. While the actual levels are very low, PCNs are quite toxic and small amounts may be a threat to the health of the animal. Scientists need to do more work to find out whether the levels of these contaminants will continue to increase over time and whether we should be concerned about them.

3.2.1.3 Narwhal

Like beluga, narwhal are important to Inuit, from both dietary and cultural viewpoints. However, these marine mammals have not been studied to the same degree as beluga and ringed seals, though some information is available.

Mercury levels in the livers of narwhal from Mittimatalik (Pond Inlet) are increasing, following the same trend as beluga and ringed seals.

The levels of POPs in narwhal blubber have not changed very much (similar to beluga from south-eastern Baffin Island). The main difference between the two whales is that while HCH is decreasing in belugas, no decreases are being seen in narwhal. Scientists are still doing research to understand why.



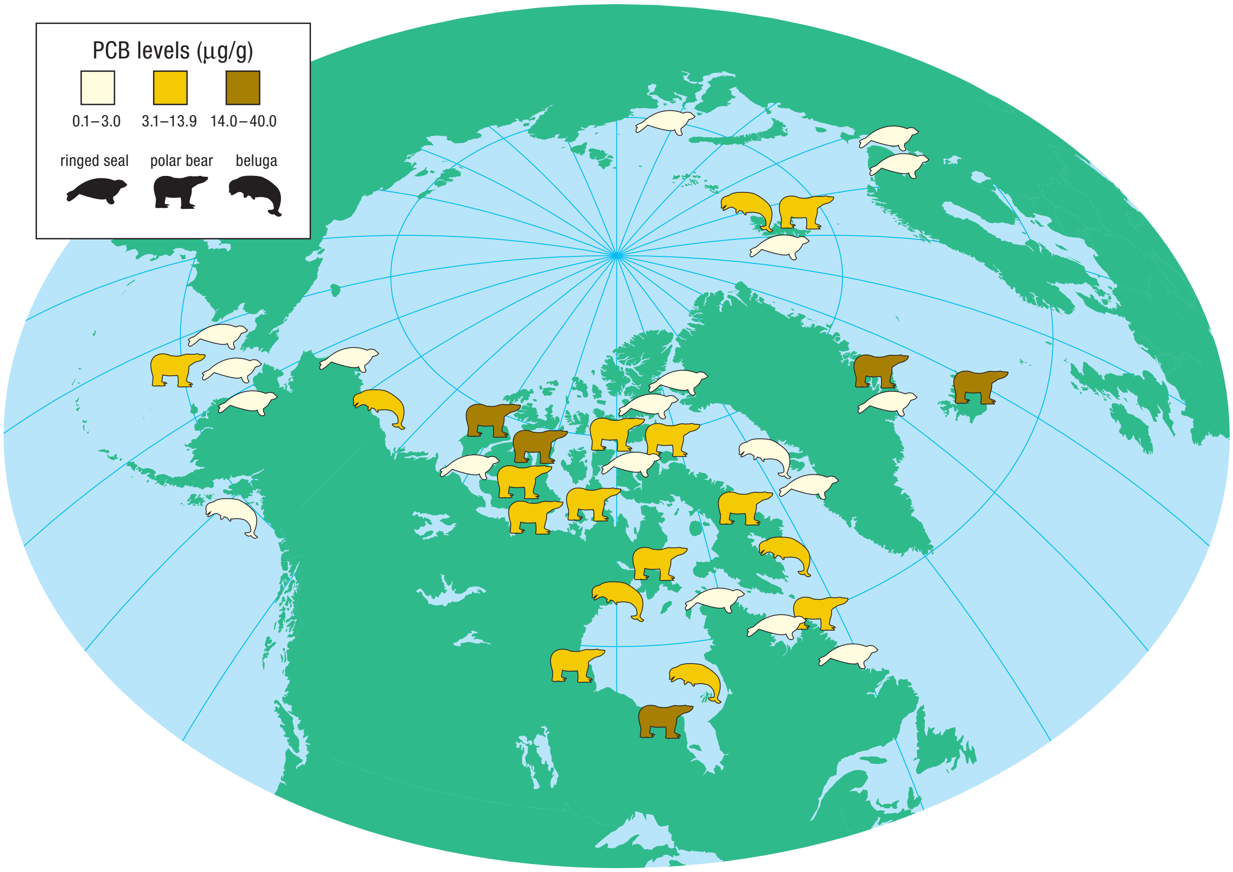
Levels of DDT in the fat of marine mammals across the circumpolar Arctic
Like PCBs, DDT levels are lower in ringed seal blubber than in beluga blubber. In general, levels of DDT are higher in the blubber of ringed seals from Greenland, northern Europe and Russia than in seals from northern Canada. Alaskan ringed seal blubber contains even lower levels.

Compared to other areas of the North, levels of PCBs and DDT in narwhal blubber are similar to those found in the whales from western Greenland, but much less than (about half) the levels found in whales from Svalbard, Norway.

3.2.1.4 Walrus

Walrus is another important species for Inuit, but like narwhal, only limited research has been done to date. Some walrus feed on animals that are high in the food web (including ringed seals), while others feed on animals at lower levels in the food web. The walrus that eat animals higher up in the food web also tend to have higher levels of contaminants.

Mercury levels in the muscle of walrus from Inukjuak in eastern Hudson Bay are generally much lower than levels in either the kidneys or livers. However, the mercury found in the muscle is methylmercury



Levels of PCBs in the fat of marine mammals across the circumpolar Arctic
Levels are generally lower in ringed seal blubber than in beluga blubber. Polar bear fat contains the highest levels, reflecting the position of the polar bear at the top of the food web. Ringed seals from Greenland, northern Europe and Russia generally contain higher levels of PCBs in their blubber than seals from northern Canada. Alaskan ringed seal blubber contains even lower levels.

which is much more toxic than the mercury found in the organs. Selenium levels are also high in muscle, kidney and liver and scientists believe that this selenium may be helping to protect walrus (and other marine mammals) from the effects of mercury.

Cadmium is high only in the livers and kidneys of walrus. The mercury and cadmium levels are similar to those found in the walrus a few years previously. In contrast to beluga, levels of mercury, cadmium and lead in walrus may not be changing very much over the centuries.

Walrus from east Hudson Bay and the Foxe Basin have similar levels of POPs. Levels of POPs such as PCBs and DDT are generally much lower now in walrus than they were in earlier years. However, we cannot be sure that these POPs are really decreasing. The walrus studied earlier likely lived in deep water and consumed seals. These walrus would logically have higher levels of contaminants as they are higher up the food web. The more recent studies were on walruses that live in shallower water, do not eat seals, and are lower on the food web, feeding mostly on clams.

Compared to elsewhere in the circumpolar Arctic, Canadian walrus generally have similar levels of POPs to those found in walrus in other countries.

Scientists believe that selenium may be helping to protect marine mammals from the effects of mercury.

ITK/Eric Loring

3.2.1.5 Polar bears

Polar bears are found throughout the North. At the top of the food web, they range over large areas looking for food, following the seasonal movements of ice with their main prey, ringed and bearded seals. Although some polar bears are eaten by the Inuit, the polar bear makes up only a small percentage of their diet.

Polar bears will often eat only the blubber from a seal and are therefore vulnerable to accumulating the high levels of POPs known to be found in seal blubber. The bears are also able to biotransform many POPs into other potentially more toxic forms. For these reasons, scientists are more concerned about the effects of POPs on polar bears than any other wildlife species.

Since the first CACAR, research on polar bears has focussed on the levels of POPs on polar bears from Cape Churchill in western Hudson Bay. Very little research was done on the levels of mercury or other heavy metals in polar bears during Phase II of the NCP.

Over the years, the levels of many POPs in the fat of polar bears from the Hudson Bay region are remaining the same. There are a few exceptions, however, where levels are decreasing, i.e., HCHs, DDT and PCBs. The decrease in DDT is especially strong. In the past, DDT was sprayed over communities (including at Churchill, which is near a major location for polar bears) and military sites around Hudson Bay to control insects. Gradually the residue levels from spraying are dropping and this is reflected in lower DDT levels in the bears.

Polar bears are at the top of the food web, and are able to biotransform many POPs into other potentially more toxic forms. Scientists are more concerned about the effects of POPs on polar bears than any other wildlife species.

Male and female polar bears deal with POPs in different ways

Polar bears get rid of the POPs in their bodies in different ways. Polar bears, more than most other animals, biotransform (process) many POPs into other forms. Many of these other forms may be more toxic, though some are less of concern than the original contaminant. Some POPs are more difficult to biotransform than others and the only way polar bears are able to get rid of these is in their feces.

As for other mammals (land and marine), whether a bear is male or female is quite important. Female bears transfer POPs to their cubs while they are nursing, and high levels of POPs have been found in some mothers' milk.

Male bears (unable to pass on POPs to their cubs) tend to accumulate higher levels of PCBs as they get older. While male bears biotransform chlordane quite well, female bears tend to accumulate this contaminant.

The levels of POPs in polar bears from the Hudson Bay region are remaining the same though HCHs, DDT, and PCBs have all been decreasing. PCBs are known to cause problems with both vitamin A and the thyroid hormone in polar bears.

PCBs are known to cause problems with both vitamin A and the thyroid hormone in polar bears. Both are important for the bears' growth and development. However, it is difficult to draw conclusions about the effects of PCBs without carrying out more research.

Dioxins and furans, while found in the polar bears, are at such low levels that they are not thought to be of concern.

During the period when the Hudson Bay polar bears fast, the levels of some POPs increase in their fat. These increases are almost entirely because as the bears draw on their fat reserves, the POPs are concentrated in the fat that remains.

ITK/Eric Loring

ITK/Eric Loring

3.2.1.6 Arctic foxes

Arctic foxes are not a traditional/country food for northerners. However, their fur is important to the traditional northern economy, providing income for hunters and trappers.

Arctic foxes wander and feed in both the marine and land ecosystems. On land they eat lemmings, birds, eggs, and caribou remains. On the coast, they eat marine invertebrates, fish, seal pups, and the remains of seals killed by polar bears. Their foods therefore come from a variety of levels in the food web.

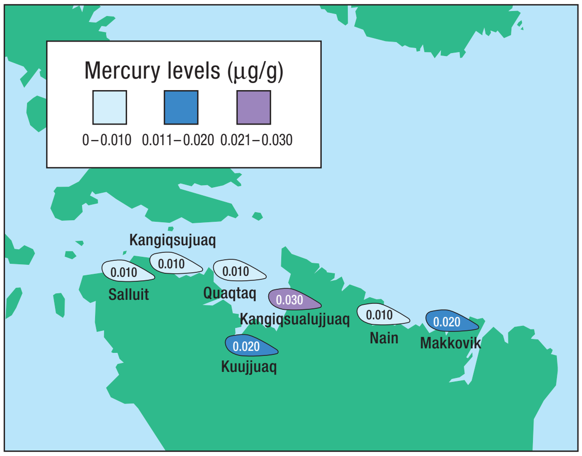
Like polar bears, Arctic foxes biotransform POPs into other forms which may cause health problems for the fox. Unlike many other animals, however, the position of the Arctic fox in the food web (higher or lower) does not seem to affect the levels of POPs in the fox.

Most levels of POPs are quite low in the livers and muscle of Arctic foxes (less than 250 ng/g) though a few individuals contain levels which could cause them health problems. Canadian Arctic foxes have lower levels of POPs than those found in foxes from Svalbard, the Norwegian mainland or Iceland. This fits well with the pattern of PCBs in ringed seals.

Unlike many other animals, the position of the Arctic fox in the food web does not seem to affect the levels of POPs in their bodies.

3.2.2 Invertebrates and marine fish

Marine invertebrates (such as clams and mussels) play an important role in the marine food web. They are also eaten by Inuit in some regions. Invertebrates are near the bottom of the food web, feed on very small animals such as plankton and are themselves eaten by fish and seabirds. Heavy metals and POPs in invertebrates are therefore passed on to their predators.



Levels of mercury in blue mussels
Mussels and other invertebrates are near the bottom of the food web and contain much lower levels of contaminants than marine mammals or birds. Mercury and other contaminants may, however, be passed on to predators which bioaccumulate and biomagnify these contaminants.

Marine fish are important to Aboriginal people both culturally and as a traditional/country food. The main marine fish studied under Phase II of the NCP are Arctic cod, migrating Arctic char, and the Greenland shark. Unlike invertebrates, fish are found at different levels in the food web, depending on the species. As a result, they bioaccumulate and pass on different levels of contaminants to predators. Arctic cod play a very important role in bioaccumulating contaminants from invertebrates (their prey). These contaminants are in turn passed onto marine mammals such as ringed seals and beluga whales which prey on Arctic cod.

3.2.2.1 Invertebrates

The levels of several heavy metals, including mercury, lead, and cadmium, as well as arsenic were measured in blue mussels and scallops at a number of locations across the Canadian North. There is a lot of variation in the levels from location to location, but levels are generally very low.

POPs such as PCBs, HCHs and DDT have also been measured in blue mussels and other invertebrates such as animal plankton. All levels are very low.

Marine Arctic char from Labrador and Nunavik contain only very low levels of mercury, and virtually undetectable levels of cadmium and lead. Levels of POPs are also low.

3.2.2.2 Marine fish

Unlike land-locked Arctic char (see Section 3.3.2.2), marine Arctic char spend part of their life in the marine environment. The muscles of marine Arctic char from Labrador and Nunavik (the areas where marine Arctic char were studied) contain very low levels of mercury, and virtually undetectable levels of cadmium and lead. Mercury levels are about 1⁄10 the guideline for subsistence consumption and are not of concern. Land-locked Arctic char sometimes contain higher levels.

Low levels of POPs have also been found in the muscle of marine Arctic char from Labrador and Nunavik. Like the heavy metals, the levels of POPs are not of concern for the fish or for human consumption. Arctic cod appear to contain levels of mercury and some POPs that are similar to those in marine Arctic char. These levels are also not of concern.

ITK/Eric Loring

Scientists do not yet know much about Greenland sharks but believe that they are long-lived and feed on other species at various levels in the food web. Greenland sharks may therefore bioaccumulate and biomagnify contaminants more than many other fish species.

Arsenic, cadmium, selenium, mercury and lead are found in sharks from Cumberland Sound. Mercury levels are high compared to levels found in other marine fish (more than 10 times higher) but are much lower than the levels found in marine mammal livers. Greenland shark livers have levels of mercury that are higher than the guideline for subsistence consumption. These levels are virtually the same as the guideline for commercial sale.

Some POPs are found in Greenland sharks at levels similar to those found in polar bears and other predators at the top of the food web. Levels are up to 100 times higher than levels found in turbot/ Greenland halibut, and up to 10 times higher than levels found in ringed seals. Levels of DDT in particular are the highest found in any northern Canadian animal. This may be because Greenland sharks can live a very long time and are only able to get rid of POPs very slowly.

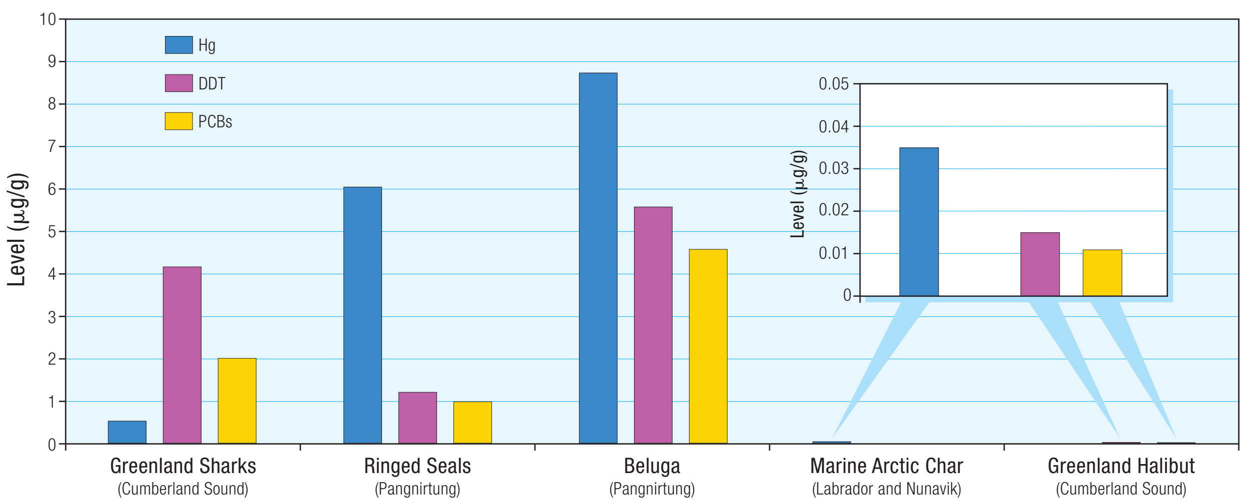
Scientists do not yet know much about Greenland sharks. Levels of mercury and POPs in this species are much higher than in other marine fish.

More research is needed on Greenland sharks as they appear to run the risk of having high levels of contaminants.

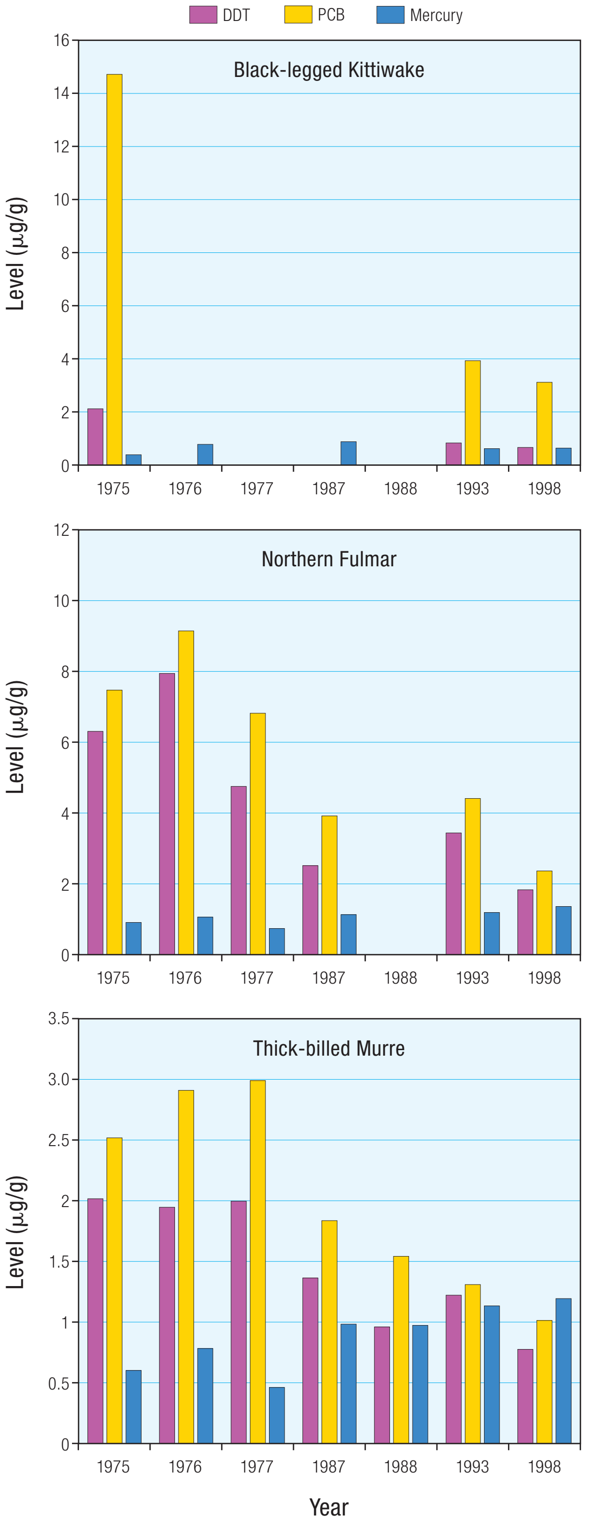
3.2.3 Seabirds

Levels of mercury have been increasing in Arctic birds. Seabirds often have higher levels of mercury compared to land-based birds because their prey contains higher levels of mercury than those found in the prey of land-based birds. In spite of the increasing levels, mercury is not of concern for the birds' health. As seabirds are able to transform methylmercury into a non-toxic form, they can tolerate higher overall levels of mercury than we would normally expect.

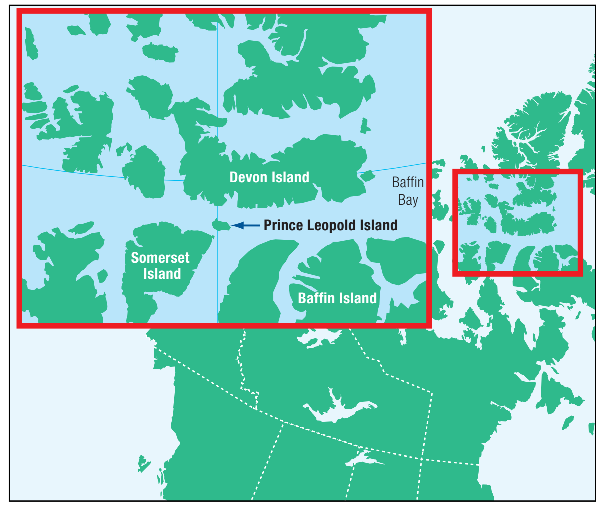
Mercury has been measured in the livers and eggs from seabirds on Prince Leopold Island. Levels have almost doubled in the eggs of thick-billed murres since 1975, and have gone up by 50% in northern fulmars.



Contaminant levels in the livers of Greenland sharks compared to other marine species
Marine fish normally have much lower levels of contaminants than marine mammals and other species high in the food web. Greenland sharks, however, have levels of DDT and PCBs similar to those in beluga and ringed seals. Mercury levels are much less than those in marine mammal organs, but are still higher than typical levels in other marine fish. Levels in Greenland shark livers are near the guideline for commercial sale (0.5 µg/g).



Changes over time in the levels of mercury, PCBs and DDT in the eggs of black-legged kittiwakes, northern fulmars and thick-billed murres on Prince Leopold Island, Nunavut
Levels of both PCBs and DDT have decreased significantly over time in the eggs of all three species. Mercury, on the other hand, has increased in the eggs of northern fulmars and thick-billed murres, as it also has in some marine mammals at certain locations.



Location of Prince Leopold Island, Nunavut

Following the trend of many northern animals in Canada, levels of most POPs, especially PCBs and DDT, are decreasing in seabird eggs. The levels of PCBs (75 ng/g, or 0.075 µg/g) found in black guillemots from Saglek (an area suffering from local PCB contamination) may cause liver damage in the birds. Levels of HCHs are an exception to the general downward trend in POPs levels. Levels of these pesticides are increasing in many birds. Scientists believe this is happening because a greater percentage of some HCH pesticides is entering the northern marine environment through the Bering Strait.

Dioxins and furans have decreased from 1975 to 1993 in the livers of most northern fulmars. Although levels are sometimes higher than levels found in marine mammals they are still too low to be of concern for the health of the birds. Some of the new contaminants such as PBDEs are also being found at low levels in seabird livers. Levels increased from 1975 to 1993 and need to be monitored further.

Since 1975, mercury levels have almost doubled in the eggs of thick-billed murres and have gone up by 50% in northern fulmars on Prince Leopold Island.

Levels of most POPs, especially PCBs and DDT, are decreasing in seabird eggs, but HCHs are increasing.

The numbers of long-tailed ducks are declining. Scientists believe this may be partly because lead shot is poisoning them and affecting their ability to reproduce. Higher levels of cadmium may also be a factor. Cadmium is accumulated from the ducks' prey (mostly bottom-feeding animals). While long-tailed ducks are harvested by northerners, these harvests are not thought to be responsible for the drop in numbers.

Heavy metals are found in the livers, kidneys and bones of long-tailed ducks across the Canadian North. The levels of mercury in the livers of long-tailed ducks vary a great deal from location to location. The levels of mercury are generally much higher than the guideline levels for fish consumption and thus may be of concern to human health.

Metals in seabirds are affected by age, migration pattern and position in the food web

Age, migration patterns, and position in the food web all affect the levels of metals found in seabirds. Like other animals, older birds have higher levels of metals.

Birds that feed higher on the food web contain higher levels of contaminants because of biomagnification. The highest levels of methylmercury are found in glaucous gulls (which are known to eat other birds) but are much lower in dovekies, which are lower on the food web.

Birds that migrate south such as the black-legged kittiwake have higher levels of selenium which is widespread in the south. Birds such as black guillemots, however, that stay in the North year-round, have higher levels of mercury in their eggs.

GNWT/RWED/Brett Elkin

Location of some caribou herds in Yukon, Northwest Territories and Nunavut

3.3 Land animals and plants

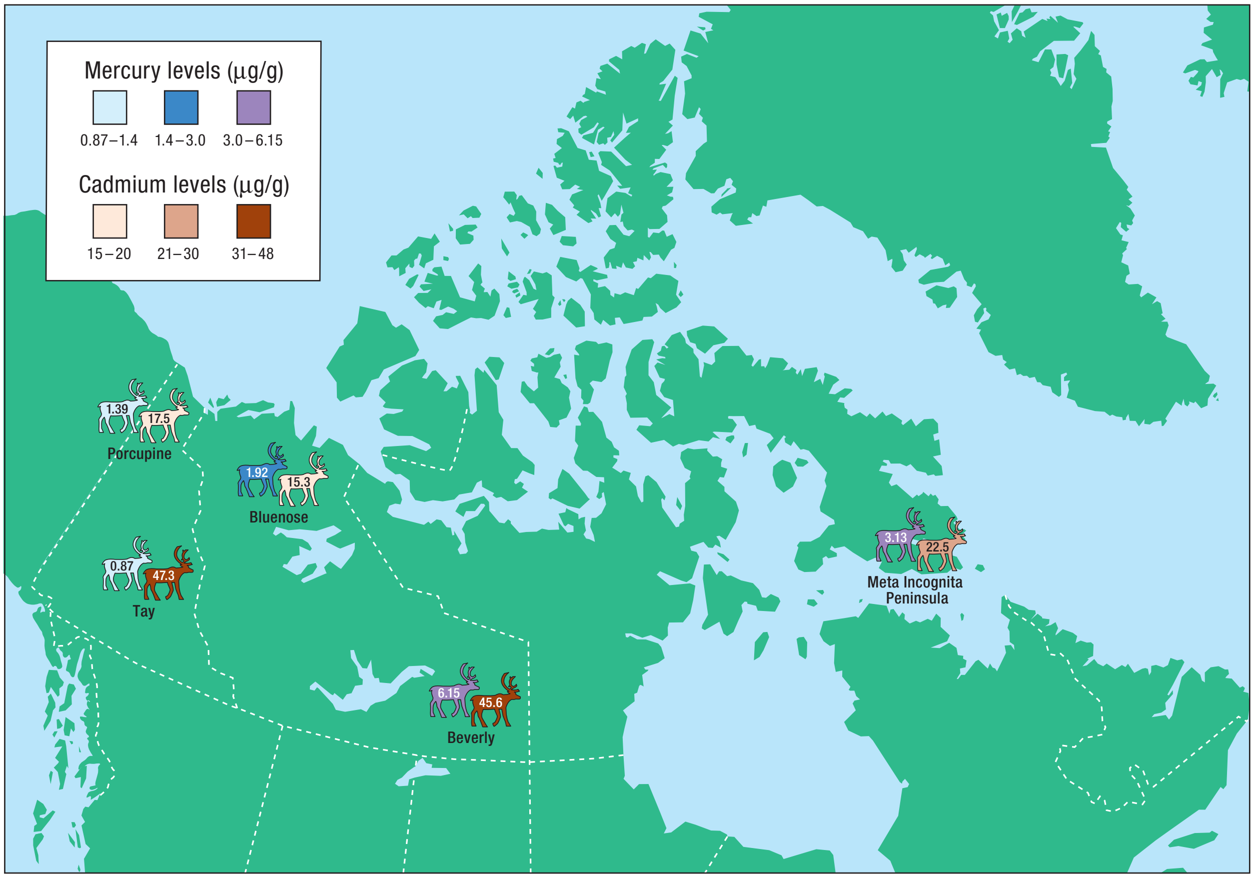
Land animals such as caribou, moose, beaver and muskrat are very important to northern peoples. Caribou is the most frequently eaten traditional/country food by the Dene and Métis in the Gwich'in, Sahtú and Dogrib regions, and in every Inuit region. Moose is eaten most by Yukon First Nations, and by Deh Cho and South Slave Dene and Métis (see Section 4.3).

Freshwater fish and waterfowl are also important to the diet and culture of Aboriginal people and other northerners.

3.3.1 Land mammals

The first CACAR covers the levels of various POPs, heavy metals and radionuclides in land mammals quite well. Levels of all these contaminants are quite low. No consumption advisories have been issued regarding caribou in the Northwest Territories or Nunavut.

The only potential concern is the fairly high level of cadmium found in the kidneys and livers of Yukon caribou and moose. This cadmium is believed to come mostly from natural sources in the underlying rocks and has found its way into large land mammals for thousands of years. The cadmium levels found in Yukon caribou, moose and other large land animals are not considered of concern for human health. Far more cadmium is obtained from smoking than from eating these animals.



Cadmium and mercury levels in caribou kidneys across the Canadian North
These average levels are lower than the levels known to cause health problems for caribou. The cadmium levels are typical for large mammals in the North, and are believed to come from local, natural sources. Some of the mercury may have come from human-made sources.

3.3.1.1 Caribou

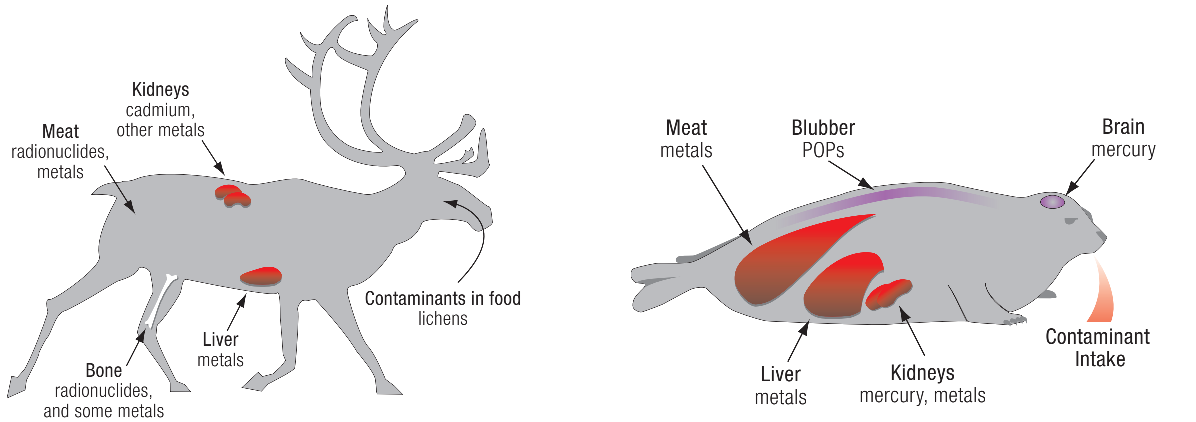
Caribou are very important in the social and cultural life of many northerners, particularly Aboriginal people. Caribou are hunted and eaten extensively in many regions and provide a large part of dietary nutrition.

Some 15 different caribou herds across Nunavut, the Northwest Territories, and the Yukon were monitored during the 1990s through two large monitoring programs. POPs such as DDT, PCBs, dioxins and furans are found at only very low levels in caribou (often too low to be detected at all) and are not of concern to either caribou or human health.

Some of the heavy metals, however, are found at elevated levels in caribou, though not to the same extent as found in some marine mammals. There are wide variations in the levels of metals from herd to herd, probably due to the variation of levels in the underlying geology.

Cadmium in the kidneys and livers of Yukon caribou and moose is believed to come from natural sources in the underlying rocks.

GNWT/NWT Archives/George Calef



How do contaminants get into land and marine mammals?
Contaminants find their way into animals such as caribou and seals through their food. Once eaten, metals such as mercury and cadmium will tend to move to the organs (e.g., liver and kidney). POPs on the other hand will tend to move to the fatty tissues such as blubber and muktuk (in whales).

Cadmium levels are higher in the kidneys and livers of Tay caribou in the Yukon, as well as Beverly caribou in the Northwest Territories and Nunavut, compared to the levels in other herds. Natural sources of cadmium in the underlying rocks in the area are likely responsible. This cadmium accumulates in lichen which is then eaten by the caribou.

Mercury levels show the opposite geographical pattern, with the highest levels found in the Beverly herd and in Meta Incognita Peninsula caribou (which are part of the South Baffin population). In the central and northeastern parts of northern Canada, levels of mercury in caribou follow the same geographic pattern as levels found in sediments. Scientists believe that this mercury has been transported from human-made sources in other parts of the world. An exception is mercury in caribou from the Yukon, where local sources may be more important.

3.3.1.2 Moose

Many of the patterns and reasons for levels of metals and POPs found in caribou also apply to moose. While levels of POPs are too low to be of concern, cadmium levels are higher in Yukon moose than in other large land mammals found elsewhere in the Canadian North.

As for caribou, scientists believe that the cadmium found in moose comes from local, natural sources, and that these sources have been present for thousands of years. The natural cadmium accumulates in vegetation which is then eaten by the moose.

3.3.1.3 Other large land mammals

Other animals in the Yukon, such as bison and mule deer also contain some heavy metals. Together with moose and caribou, the kidneys of these animals contain higher levels of cadmium than in the kidneys of animals elsewhere across northern Canada. Again, this cadmium is thought to come from natural sources.

Community-based Monitoring of Abnormalities in Wildlife

In 1997, a multi-year project was initiated by the Government of the Northwest Territories to collect and organize information from harvesters and Elders on unusual changes observed in land animal populations. The project, entitled Community-based Monitoring of Abnormalities in Wildlife, includes a community-based system to collect and investigate hunter observations. Sometimes samples of deformed or diseased wildlife are collected and analyzed by veterinarians and scientists. Surveys are also conducted in the communities to obtain information on disease and abnormalities in wildlife based on traditional knowledge.

This project relies heavily on community involvement and science to assess changing conditions and the reasons behind observed changes. Community members view the project as a valuable means to address their concerns and provide a link with scientists who can diagnose observed abnormalities.

Only low levels of metals and POPs are found in beaver and muskrat.

3.3.1.4 Wolves and wolverines

Wolves and wolverines are, like other fish and wildlife species, important to the northern Aboriginal peoples. These animals are especially important in the culture and economy of Aboriginal peoples, but neither species is consumed for food.

Levels of POPs are not of concern to the health of wolves and only a few contaminants are found at all. Levels are much lower than those found in marine mammals. Wolves do, however, tend to have higher levels than those found in other large land mammals such as caribou. This is because wolves are higher up the food web. Levels of PCBs also rise as the wolves age.

Like wolves, POPs are not of concern for wolverines from Kugluktuk (Coppermine), Nunavut (the study area). The PCB levels in wolverines are very low and similar to the levels found in Yukon wolves.

Studies were not carried out during Phase II of the NCP on metals in wolves or wolverines.

3.3.1.5 Beaver and muskrat

Beaver and muskrat meat are an important part of the traditional diet and economy of Dene and Métis in the Northwest Territories and there has been some concern about contaminants levels in these important traditional/country foods. To address these concerns, POPs and heavy metals were measured in the muscle and liver of beavers and muskrats from the Slave River (Desnedé) delta and in beaver and muskrat livers and kidneys from the Mackenzie River (Dehogá) delta. These animals were collected by local trappers.

Levels of metals in beaver and muskrat muscle are very low or at the expected level for land mammals.

Overall, PCBs, DDT and chlordane levels are very low, and other POPs are not detectable in either beaver and muskrat muscle from the Slave River (Desnedé) delta, or in liver from beavers and muskrats at both locations. All levels are below consumption guidelines.

ITK/Eric Loring

Except for a few locations, levels of POPs in freshwater fish are low and fall below consumption guidelines.

3.3.2 Freshwater fish

Freshwater fish are an important part of the diet and culture of many people in communities across the Canadian North. Yukon First Nations, Dene, Métis and Inuit all harvest and eat freshwater fish, though the species vary from west to east. Loche (burbot), whitefish and lake trout are popular with Yukon First Nations, Dene and Métis, while (land-locked) Arctic char are more commonly eaten by Inuit. In some locations, freshwater fish are also harvested and sold commercially. Freshwater fish contain many healthy nutrients.

Across the Canadian North, some fish contain high levels of mercury but much lower levels of other contaminants such as POPs. The higher levels of mercury are generally found in fish that eat other fish (i.e., predatory fish), while non-predatory fish generally have lower levels of mercury. Most of the mercury is in the organic form (methylmercury), which can be toxic. Levels of mercury are increasing in some fish in certain lakes and are sometimes higher than the guideline levels for subsistence consumption or commercial sale. More detail follows on levels found in each fish species.

In contrast, levels of POPs in freshwater fish are generally very low and fall below Health Canada consumption guidelines. The exceptions are toxaphene in loche (burbot) liver and PCBs in lake trout from Lake Laberge and Kusawa Lake. These levels may cause some health problems for the fish. Atlin Lake fish have somewhat elevated levels of the HCH pesticides but it is not known whether these levels may affect fish health.

Levels of many POPs which have been restricted at the international level are declining in freshwater fish across northern Canada. Decreases in levels are also happening elsewhere in the circumpolar Arctic (e.g., Sweden) and in Canadian northern marine fish and wildlife. New POPs, such as the fire retardant polybrominated diphenyl ethers (PBDEs), while not of concern now, should continue to be monitored as levels are increasing in freshwater fish.

GNWT/NWT Archives/Fran Hurcomb

3.3.2.1 Loche (burbot)

Loche (burbot) are a popular dietary item for Yukon First Nations, Dene and Métis. The fish are known to contain many dietary nutrients including zinc, calcium, vitamin A and fatty acids believed to be important for reducing the negative effects of methylmercury. However, loche (burbot) are predatory fish and, compared to non-predatory fish such as whitefish, are more likely to accumulate higher levels of contaminants such as mercury. Levels tend to be slightly higher in the muscle of loche (burbot) than in the liver.

Levels of mercury are increasing in some fish in certain lakes. These levels are sometimes higher than the guideline levels for subsistence consumption or commercial sale.

Why do some fish contain more heavy metals and POPs than others?

Fish accumulate contaminants mainly by eating food which contains contaminants, and to a lesser extent by passing contaminated water through their gills. Fish have a lot of difficulty removing contaminants from their bodies, though they can eliminate some contaminants through their gills.

Different parts of the fish contain different levels of contaminants. This is important since if unsafe levels of contaminants are found in just one part of the fish, the rest of the fish may still be quite safe to eat.

Health Canada has drawn up guidelines for the maximum levels of mercury in fish that are considered safe to eat:

- *for a commercial fishery, the guideline is 0.5 µg per gram of fish weight (often written as 0.5 µg/g)*
- *for subsistence consumption, the guideline is 0.2 µg/g*

The subsistence consumption guideline is lower than the commercial guideline since subsistence consumers generally eat more fish.

Level in the food web

Fish that are higher up the food web generally contain higher levels of contaminants than fish at lower levels in the food web. This is because fish biomagnify contaminants that they absorb from their food. Fish that feed on other fish (predatory fish) usually have higher levels of contaminants such as mercury.

Age and size

The age and size of the fish also influence contaminant levels. As fish age, contaminants build up (bioaccumulate) in their bodies. Size is often related to age with bigger fish containing higher levels of contaminants. However, since fish generally grow slowly in the (relatively) cold northern environment, sometimes smaller fish are found to contain higher levels of contaminants. Scientists have found that the levels of contaminants become higher than the Health Canada commercial guidelines when the fish are about 10–12 years old.

Water Temperature

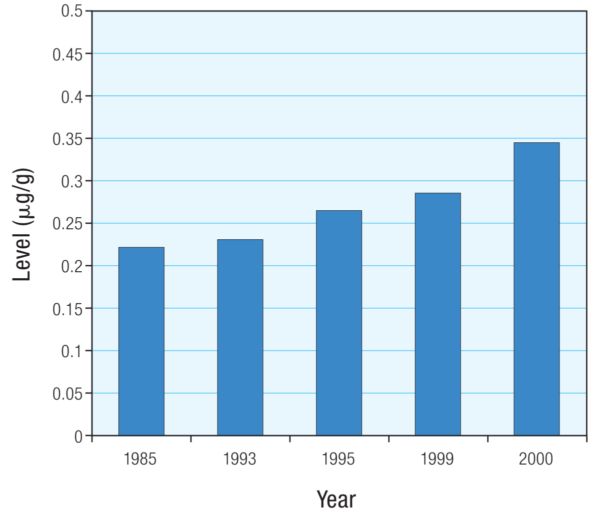
As the water temperature rises, fish become more active and more water (and contaminants) passes through their gills. For example, Arctic char in Resolute Lake on Cornwallis Island were found to gradually accumulate more cadmium over the summer as water temperatures rose. Climate change (and warmer water) may therefore lead to higher levels of contaminants in fish. If the temperature rises too high, the fish may become stressed and more prone to disease.

Geography

Changes in the size of wetlands, e.g., because of flooding or damming, appear to influence mercury levels in fish, as does the amount of organic matter in the water. However, the levels of mercury found in sediments do not appear to influence the levels found in fish.

Levels of many POPs restricted at the international level are declining in freshwater fish across northern Canada. However, levels of some new contaminants are increasing and should continue to be monitored.

Mercury levels are increasing in the livers of loche (burbot) from the Mackenzie River (Dehogá). Levels in loche (burbot) livers from Fort Good Hope (Rádeyı̨lı̨kǫ́é) have increased by more than 35% from 1985–2000, but are still lower than mercury levels in other fish. In Peel River (Teetl'it Gwinjik), loche (burbot) contain levels of mercury similar to those found in other fish. Mercury levels in the livers are below the Health Canada guideline for commercial sale but in some cases are higher than the guideline for subsistence consumption. This could be of concern since Yukon First Nations, Dene and Métis consume loche (burbot) livers.



Mercury levels are increasing in the livers of loche (burbot) from Fort Good Hope (Rádeyı̨lı̨kǫ́é). There are wide variations, however, in mercury trends between different lakes and rivers. In some areas, mercury levels in freshwater fish livers are staying about the same, while in others, levels are decreasing. At Fort Good Hope (Rádeyı̨lı̨kǫ́é), the average levels are above the guideline for subsistence consumption (0.2 µg/g) but below the guideline for commercial sale (0.5 µg/g).

Levels of contaminants in freshwater fish

Mercury levels		
loche (burbot) livers	Mackenzie River (Dehogá)	can be above subsistence guidelines
	Lake Laberge	levels safe but rising
	Fort Good Hope (Rádeyı̨lı̨kǫ́é)	levels safe but rising
lake trout muscle	Mackenzie River (Dehogá)	can be above commercial and subsistence guidelines
	Lake Laberge	can be above commercial and subsistence guidelines
	Quiet Lake	can be above commercial and subsistence guidelines
	Rae Lakes (Gahmı̨tì)	can be above subsistence guidelines
	Nunavut lakes	can be above commercial and subsistence guidelines
inconnu	Peel River (Teetl'it Gwinjik)	can be above subsistence guidelines
Arctic char muscle	Resolute Lake	can be above subsistence guidelines
Levels of other contaminants		
loche (burbot) liver	Lake Laberge	toxaphene still well above consumption guidelines
	Fort Good Hope (Rádeyı̨lı̨kǫ́é)	PBDEs found at very low levels but rising
lake trout muscle	Lake Laberge	toxaphene may have dropped to ¼ 1993 levels but this needs to be confirmed

The subsistence consumption guideline for mercury in fish is 0.2 µg/g, and the guideline for commercial use is 0.5 µg/g.

In other locations, mercury levels in loche (burbot) are not currently of concern, but they are rising in many lakes and rivers and should continue to be monitored. Exceptions are levels in loche (burbot) livers from Lake Laberge (and Quiet Lake) which have remained about the same. Levels in loche (burbot) from Resolution Bay in Great Slave Lake (Tucho) have lower levels of mercury compared to other fish in the lake.

Little information exists on the levels of selenium and arsenic in loche (burbot), and more research is needed. Levels are generally decreasing over time and are not considered of concern for human consumption.

Loche (burbot) in Yukon lakes do not contain high levels of POPs, with the exception of Lake Laberge, where toxaphene levels in the liver continue to be very high. In 1991 the fishery was closed because of high levels of toxaphene, and levels have not yet dropped in loche (burbot) muscle. In contrast, levels may have dropped substantially in lake trout through the 1990s though more research is needed to confirm this.

Levels of POPs are generally low and not of concern for loche (burbot) in other lakes including Fox Lake, Klukshu Lake, Kusawa Lake, Quiet Lake, at Fort Good Hope (Rádeyı̨lı̨kǫ́é) and in Great Slave Lake (Tucho).

One of the new brominated flame retardants (PBDEs) has been found in loche (burbot) near Fort Good Hope (Rádeyı̨lı̨kǫ́é). Levels are very low and not currently of concern, but are increasing over time and should continue to be monitored.

3.3.2.2 Land-locked Arctic char

Arctic char is frequently consumed by Inuit in all regions (see Section 4.3) and it is important to monitor levels of contaminants in the organs and flesh of this fish.

Mercury levels in land-locked Arctic char in Nunavik and Labrador are well below subsistence consumption guidelines. The land-locked Arctic char in Resolute Lake close to Qausuittuq (Resolute) on Cornwallis Island, however, sometimes contain

Pat Roach

levels that are above the guideline for subsistence consumption (though all levels are below the commercial guideline). Scientists believe that the higher levels of mercury may be due to some Arctic char becoming predatory. Levels have not changed significantly since the early 1990s. Of the POPs found in the Resolute Lake Arctic char, PCBs dominate. Levels are gradually decreasing over time and are not of concern for human consumption.

3.3.2.3 Lake trout, pickerel (walleye), inconnu, whitefish, cisco and jackfish (northern pike)

Of other freshwater fish studied during Phase II of the NCP, whitefish is generally consumed more than pickerel (walleye), lake trout, inconnu, cisco or jackfish (northern pike). This is particularly true for Yukon First Nations, Dene and Métis. In Labrador, Kivalliq and Kitikmeot, lake trout is frequently eaten (in addition to land-locked Arctic char).

Mercury levels in fish vary a lot from lake to lake and scientists continue to study why there are higher levels in some places and not in others. For example, for several lakes in the Northwest Territories, the levels of mercury rise above the Health Canada guidelines in predatory fish such as lake trout, jackfish (northern pike) and pickerel (walleye). In the Dogrib region around Rae Lakes (Gahmı̨̀tì), lake trout contain higher levels of mercury while whitefish

ITK/Eric Loring

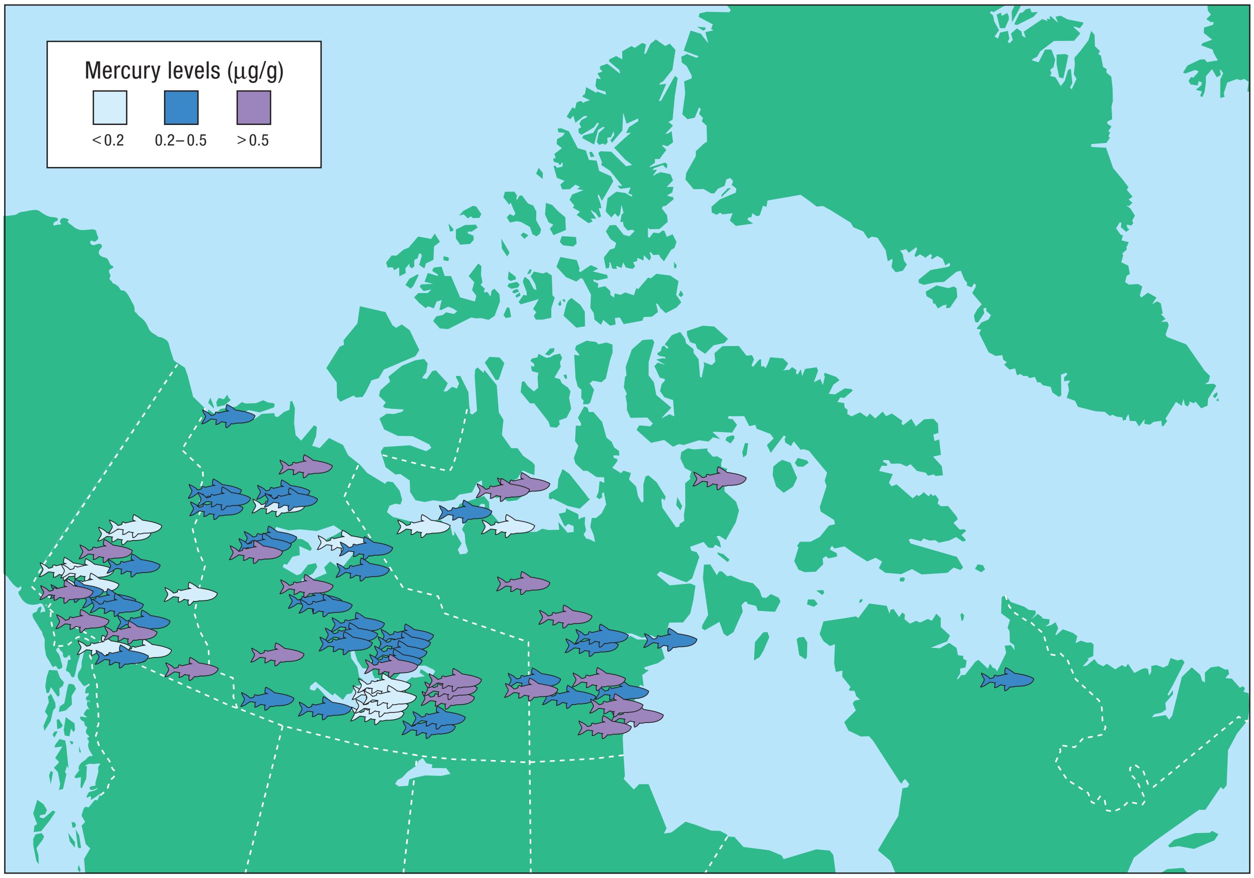
Contaminants in fish in Great Slave Lake (Tucho)

Great Slave Lake (Tucho) is an important centre in the Northwest Territories and is located in the area known as Denendeh. Several large Dene and Métis communities and one city, Yellowknife (Sǫ̀mbak'è), are located along the shores of the lake. There is a commercial port at Hay River (Xátł'odehchee) and several mines (gold and diamonds) operate in the region. A commercial fishery has operated since the 1950s, and has played a significant role in the development and continued prosperity of the communities.

Because of the ecological and economic significance of the lake, fish are being monitored for contaminants. Levels of mercury, other metals and POPs are not of concern for human consumption. Freshwater fish from Great Slave Lake (Tucho) and Great Bear Lake (Sahtú) have some of the lowest levels of mercury found in the Canadian North.

Levels of POPs are not of concern even in predatory fish. Those fish caught in the East Arm have slightly higher levels than those caught in the West Basin near the mouth of the Slave River (Desnedé). Though most sediments are deposited in the West Basin, scientists believe that fish do not easily accumulate POPs from sediments.

Some POPs (chlordane, DDT and toxaphene) appear to be decreasing slowly in both loche (burbot) and lake trout over time, but more work is needed to confirm this.



Levels of mercury in lake trout muscle across the Canadian North
The light blue shading indicates mercury levels that are below the guideline for subsistence consumption (0.2 µg/g), while the pink shading indicates levels above the guideline for commercial sale (0.5 µg/g). The dark blue shading indicates levels in between the two guidelines. Lake trout are predatory fish and generally contain higher levels of contaminants, including mercury, than non-predatory fish such as whitefish. There is a lot of variation between lakes and rivers and no clear geographic pattern can be seen.

(which are non-predatory) have lower levels which are not of concern for human consumption. In the Resolution Bay area of Great Slave Lake, mercury levels are below the subsistence guideline for jackfish (northern pike), pickerel (walleye) and inconnu. The same is true for cisco from the East Arm of Great Slave Lake (Tucho).

In contrast, in the Mackenzie River (Dehogá) Basin and in Nunavut, predatory freshwater fish generally contain levels of mercury that are above both the commercial fishery and subsistence guidelines. Levels also exceed the guidelines for lake trout muscle in Lake Laberge and Quiet Lake. Almost all these fish have levels of mercury above the subsistence consumption guideline. Most fish longer than 500 mm contain higher levels of mercury than the guidelines for commercial sale and subsistence consumption.

Like mercury, the levels of POPs in fish also vary from lake to lake. The differences may be because the contaminants come from different sources (local, from the air, or from glaciers). Levels of POPs in lake trout (especially in the muscle) are not of concern for human consumption.

The previously high levels of POPs in lake trout from Lake Laberge may have dropped to one-quarter of what they were in the mid-1990s, and to levels that are typical of fish in other Yukon lakes. However, more analysis is required to confirm this.

Mercury and POPs levels in fish vary a lot from lake to lake and scientists continue to study why there are higher levels in some places and not in others.

Though the rapid decline of eider ducks is thought to be caused primarily by parasites, contaminants, especially some of the heavy metals, may also be partly responsible.

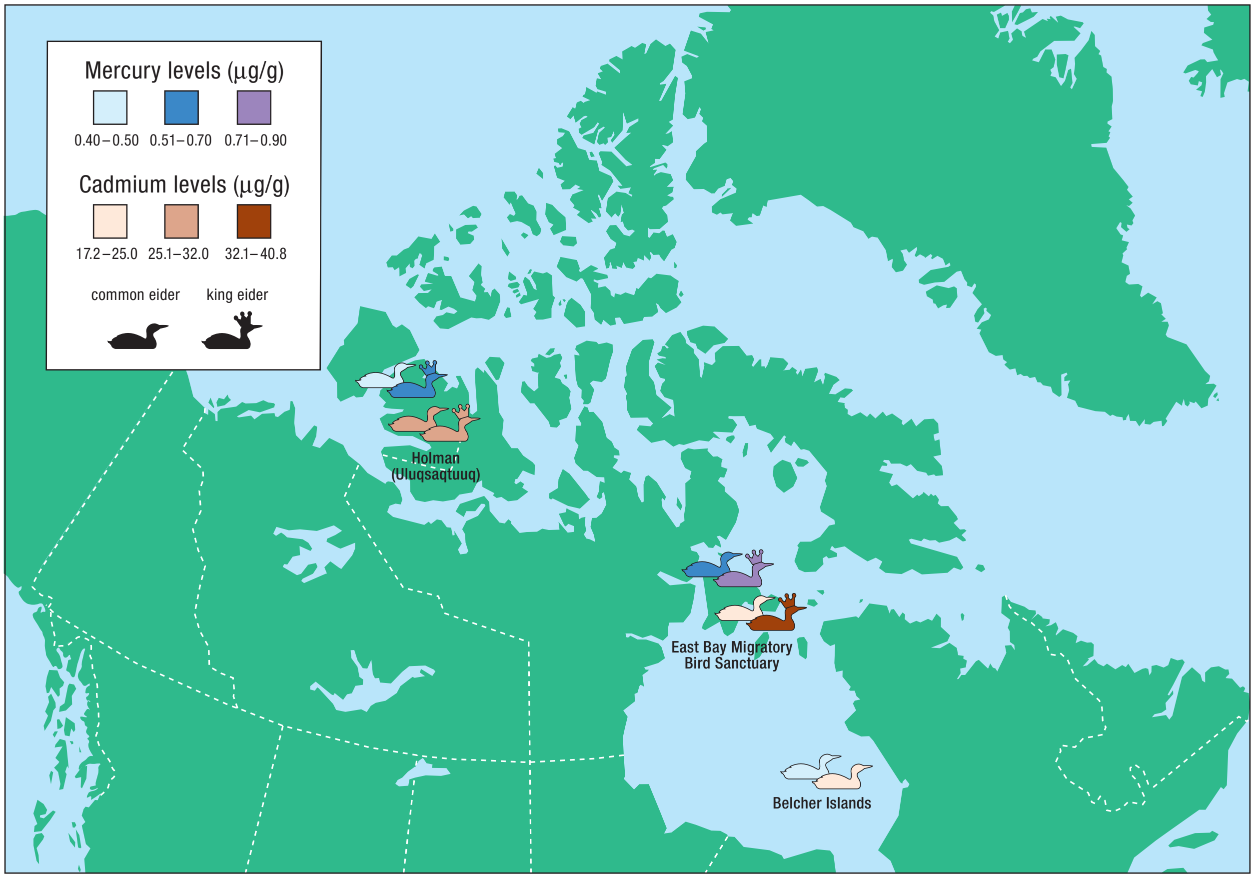
3.3.3 Waterfowl and game birds

King and common eider ducks are important traditional foods of Aboriginal people in some northern communities, especially in the Kitikmeot region. The populations of eiders have plummeted in the last few years, and there are now concerns about whether harvests can continue to be sustainable.

Though the rapid decline of eider ducks is thought to be caused primarily by parasites, contaminants, especially some of the heavy metals, may also be partly responsible. High levels of cadmium and mercury are being found in the livers and kidneys of eider ducks.

ITK/Eric Loring

ITK/Eric Loring



Levels of mercury and cadmium in the livers and kidneys of common and king eider ducks
Compared to common eiders, king eiders have higher levels of both metals in their livers and kidneys. The higher mercury levels may be because king eiders winter in areas containing higher levels of mercury; they also have a somewhat different diet than common eiders. The cadmium is thought to come from local, natural sources.

At the East Bay Migratory Bird Sanctuary on Southampton Island, levels of cadmium in the kidneys of king eider ducks were some of the highest ever measured in eiders (31-57 µg/g), and more than four times the levels in European eiders. The high levels of cadmium fit with the high levels also seen in marine animals from Nunavut, and may be coming from the local underlying rocks. In contrast, common eiders have relatively low levels of cadmium in their kidneys. Scientists think that perhaps the age of the ducks is the reason for the difference in cadmium levels, with older ducks having higher levels.

Mercury levels in common eider ducks are relatively low and this may be because they overwinter in low-mercury areas such as the northern Bering and southern Chukchi Seas. King eiders, on the other hand, have much higher levels of mercury (including methylmercury) and zinc. A difference in diet may be the main reason why the two types of eider ducks contain different mercury levels. While common eiders prefer mussels (which contain only low levels of metals), king eiders eat not only mussels but also a variety of bottom-dwelling invertebrates which may contain higher levels which are passed on to the eiders.

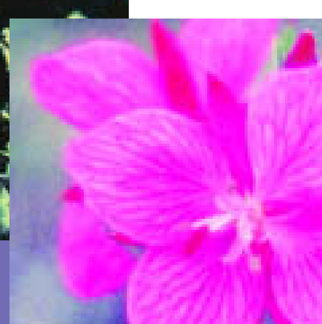
Eider ducks from Holman (Uluqsaqtuuq) have much higher levels of selenium in their livers than those from either the East Bay Migratory Bird Sanctuary or the Belcher Islands. This is the same as the pattern found for marine mammals and may be because the eider ducks from Holman (Uluqsaqtuuq) have a different diet. Selenium is believed to protect eiders from some of the effects of mercury.

3.3.4 Northern plants

As with most land-based birds and mammals, plants in northern Canada contain only low levels of POPs and heavy metals. However, some plants near local contaminant sources (e.g., some gold mines) may contain high levels of local contaminants.

Several plants are used as traditional/country foods by the Weledeh Yellowknives Dene. These Dene are concerned about levels of arsenic in some of these plants. Blueberries, cranberries, raspberries, rose hips and gooseberries from areas close to gold mines and from Yellowknife itself (Sǫ̀mbak'è) all contain higher levels of arsenic. Some of the levels are above the guideline level for consumption of 0.1 µg/g. Berries from sites such as Dettah (T'èʔehda), which are located away from the mines, have lower levels of arsenic.

Section 2.1.3 discusses some local contaminant issues, including those around Yellowknife (Sǫ̀mbak'è), in more detail.



ITK/Eric Loring

3.4 Knowledge gaps and future work

Because of Phase II of the NCP, good progress has been made in many of the priority research areas identified after the first phase. This chapter has summarized the main results. However, some priority areas continue to need work, and other areas have come to light that require urgent attention.

Many contaminants are now banned or restricted at the national and international levels (see Chapter 6). Monitoring needs to continue of those contaminants restricted under these agreements to check whether restrictions are working. As the old contaminants disappear, new contaminants are now being found in northern fish and wildlife. In some cases little is known about the toxicity of the new contaminants, their levels or possible effects in wildlife. Monitoring of these new contaminants is needed in a wide variety of animals including freshwater fish and marine mammals, as well as in freshwater environments as a whole.

Levels of metals also need to continue to be monitored. Mercury levels appear to be increasing in some fish and wildlife, but are decreasing in others, and overall temporal trends are difficult to determine (similar to uncertain trends of mercury in the atmosphere). It is not yet possible to say whether human-made mercury is responsible for the increases seen in certain fish and wildlife.

In some cases, it is possible to identify priority areas for particular fish and wildlife. Contaminants in freshwater fish are a particular priority. For example, there is little information about arsenic or selenium levels in fish, or variations in these levels from place to place. Another metal, thallium, is known to be highly toxic and bioaccumulating in fish. However, little information is available about other metals in land-locked Arctic char in Resolute Lake and other nearby lakes.

Regarding POPs in freshwater fish, there are much data that still need to be analyzed and interpreted taking into account lake size, year of data collection, and the possible influence of meltwater from glaciers. While some POPs (e.g., chlordane, DDT and toxaphene) appear to be decreasing slowly in both loche (burbot) and lake trout in Great Slave Lake (Tucho), these results are very preliminary and more work is needed to confirm this trend. Similar additional work is required to confirm that toxaphene levels have indeed dropped dramatically in lake trout from Lake Laberge.

Some geographic patterns of mercury in freshwater fish are still perplexing scientists and monitoring of metals should continue. A particular question concerns the higher than normal mercury levels in fish from the Mackenzie River (Dehcho) compared to fish elsewhere in the North. High lake-to-lake variability of mercury in fish continues to be inadequately explained. The reasons for variable levels of mercury found in fish from across the North continues to be a knowledge gap. For example, scientists cannot yet explain why mercury levels are apparently increasing in burbot liver from Fort Good Hope (Rádeyı̨lı̨kǫ́é) and possibly also from Lake Laberge, but there are no similar changes in mercury levels in fish from all other lakes in the Northwest Territories and Nunavut.

Marine mammals, including ringed seals and polar bears should also continue to be given high priority in future work. The large variations in mercury levels in livers from seal to seal cannot yet be explained. Work needs to be done on relating mercury levels to the gender and age of the seal. It may then be possible to say whether mercury levels are increasing or decreasing in ringed seal liver.

The high levels of PCBs in polar bears, and the potential biological effects, are of particular concern to scientists. Work is needed on the effects of these high levels on polar bears — in particular on their thyroid functions, and ability to fight disease and infection.

Even relatively low levels of PCBs (75 ng/g) are thought to cause liver damage in black guillemots from Saglek (an area with PCBs from local sources). Research is needed to assess the levels of PCBs in the livers of black guillemots across northern Canada, and whether these levels pose a threat to the health of these birds.

GNWT/NWT Archives

The biological effects of contaminants on fish and wildlife in the Canadian North was identified after the first phase of the NCP as an important knowledge gap. This gap persists and needs to be addressed. Future studies should focus on identifying thresholds for effects (e.g., the levels known to cause effects, and levels known not to cause effects) for northern species. The biological effects of new contaminants and the persistent, toxic forms of PCBs also need to be assessed.

While these recommendations for further work look primarily at specific fish and wildlife species, Phase II of the NCP has also identified gaps in knowledge about the movement and effects of contaminants in ecosystems and food webs. In particular, there is a need to assess new contaminants in a wider range of species than covered to date. The behaviour of these new contaminants in the food web and their possible biological effects need to be better understood. The rate and ability of these new contaminants to biomagnify, bioaccumulate and transform to other forms (which may be more or less toxic) are only poorly understood. The link and transfer of contaminants between the physical environment and animals at the bottom of the food web also need to be understood better in both marine and freshwater environments.

It is also important to spend more effort on determining the forms of metals being measured (e.g., mercury versus methylmercury). This will help scientists tell more about exposure levels, and the pathways and sources of the metals.

Climate change is now occurring and is especially noticeable in northern regions. Climate change is a priority for future work relating to contaminants in the physical environment and the influence of climate change on levels of POPs and metals in northern fish and wildlife is not well understood. Some studies have found that changes in climate (e.g., higher temperatures) may result in higher levels of some contaminants in animals. Computer models need to be developed, and scientists need to study which aspects of climate (e.g., temperature, rain, snow, ice, permafrost) affect contaminants in fish and wildlife.

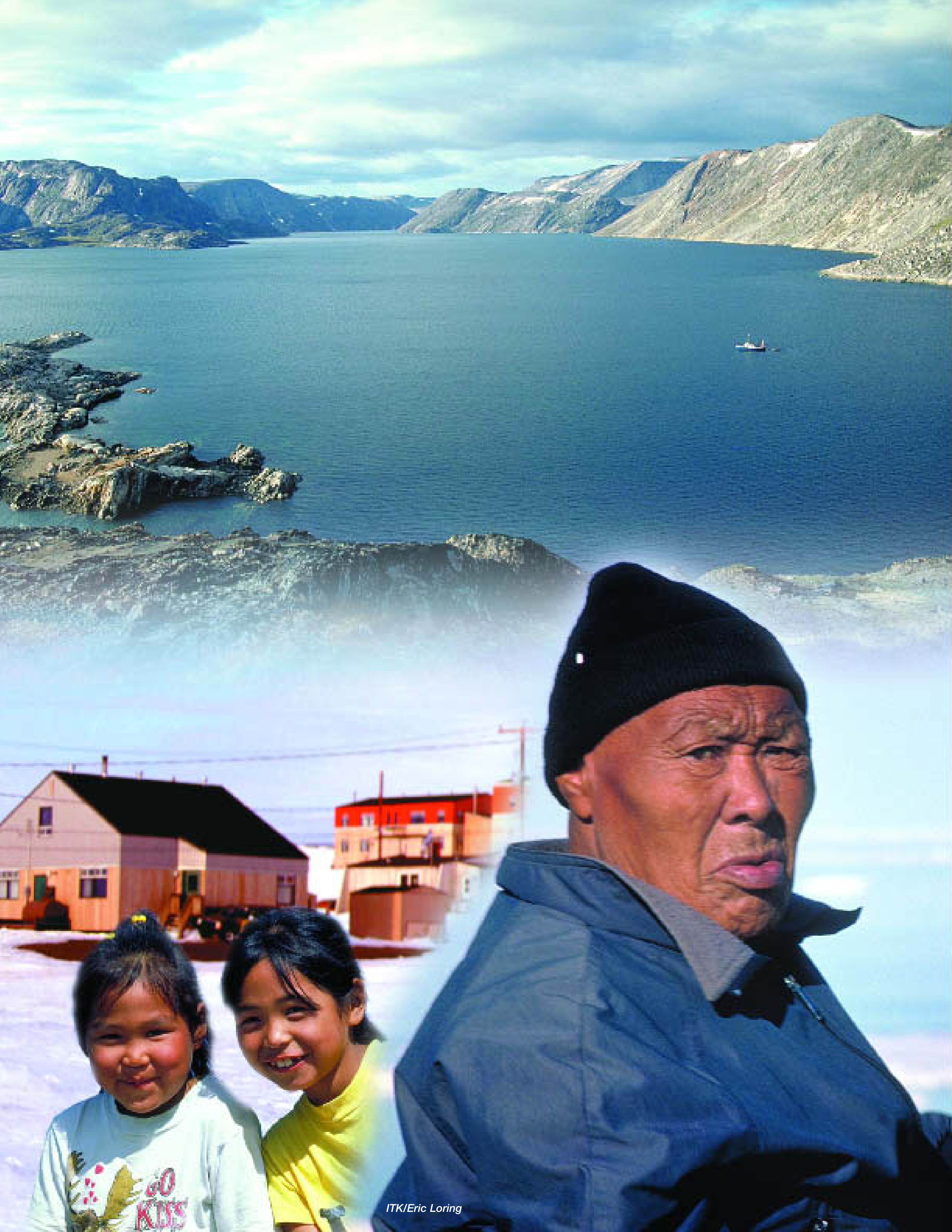
The research carried out under both the first and second phases of the NCP has relied heavily on strong and credible scientific methodology and analysis. Much research has been able to take advantage of fish and wildlife samples that were archived from previous projects. These archives are valuable, both in terms of limiting the numbers of new animals that must be taken, and in terms of providing additional data. They should continue to be supported.

Different laboratories are used to analyze samples. Future monitoring programs for contaminants should continue to require laboratories to participate in a quality assurance program. Quality assurance programs for sampling strategy and sample collection should also be developed.

Another area identified as a key priority is to ensure that researchers are able to fully analyze the data that have been produced. Data analysis enables proper interpretation of the contaminant levels and what they mean for fish and wildlife. Analysis of POPs data should make use of all relevant and available biological data (e.g., size, gender, age) and new monitoring programs should include these biological measurements. To ensure that the results of research are made public and subject to rigorous scientific review, peer-reviewed publication of government-funded work should be encouraged and made an important criteria for continued and future funding.

While the NCP focusses primarily on contaminants that travel long distances from areas further south to the North, many northerners continue to be concerned about local sources of contaminants. In particular, harbours and military sites may be important local sources of contaminants. Only a few studies have been carried out on contaminant levels in fish and wildlife near local contaminated sites, e.g., Saglek in Labrador. Generally these studies show elevated contaminant levels in the physical environment and in wildlife. In Saglek, biological effects were found in seabirds near sites of former PCB use. It is recommended that the health of fish and wildlife near other sources of local contaminants should also be assessed.

ITK/Eric Loring



ITK/Eric Loring

Contaminants and Human Health

4.1 Introduction

A significant and important part of the NCP is evaluating and communicating the benefits of traditional/country foods and the risks from contaminants, so that residents are able to make informed decisions about food use.

The first phase of the NCP showed that contaminants are present in the northern physical environment, and in fish and wildlife. The levels of most contaminants were too low to cause any concern for either human health or for the animals themselves. However, certain contaminants were found at higher levels in specific locations and wildlife populations. As a result, there was some concern about what this would mean for the health of people harvesting animals from these populations and locations.

It was clear from the first phase of the NCP that certain areas relating to human health and contaminants needed more research. These areas formed the basis for NCP human health research under Phase II:

- the diets of northern peoples in Canada, and the nutritional value of these diets
- the levels of contaminants found in these diets
- the levels of certain contaminants in people, especially in mothers (e.g., in hair, blood, or in the umbilical cord)
- health effects of certain contaminants, especially on pregnant mothers and children
- the effects of contaminants and the possible positive effects of certain vitamins, minerals and fatty acids on the health of laboratory animals such as rats and pigs

For the latter area of research, animals were used since it is not acceptable to carry out these types of feeding experiments with humans. Animals are too different from humans for scientists to conclude that humans will experience the same effects as the animals. However, the results can provide researchers with some useful clues about potential effects.

Research in the priority areas was carried out by the Government of the Northwest Territories, Health Canada, the Centre hospitalier de l'Université du Québec (CHUQ) in Québec City, and the Centre for Indigenous Peoples' Nutrition and Environment (CINE) at McGill University in Montreal. These studies have provided valuable information on human exposure to contaminants, diet, and levels of contaminants such as PCBs, mercury, toxaphene and chlordane, in maternal and umbilical cord blood.

The message has been consistently clear:

Traditional/country foods are healthy, very nutritious and provide many benefits not available from other foods or practices. Contaminants may sometimes be present in fish and wildlife at levels that cause concern for human health. The health risks from contaminants, however, are currently outweighed by the benefits of continuing to harvest, prepare and consume traditional/country foods.

Breastfeeding should continue, and in fact be promoted further, since the benefits to both mother and child outweigh the currently known risks.

ITK/Eric Loring

There are major health issues in the Canadian North such as smoking, alcohol and substance abuse, suicide and other social and economic problems. Contaminants, are also a health issue.

4.2 Are contaminants the biggest health concern? What about other health issues in the North?

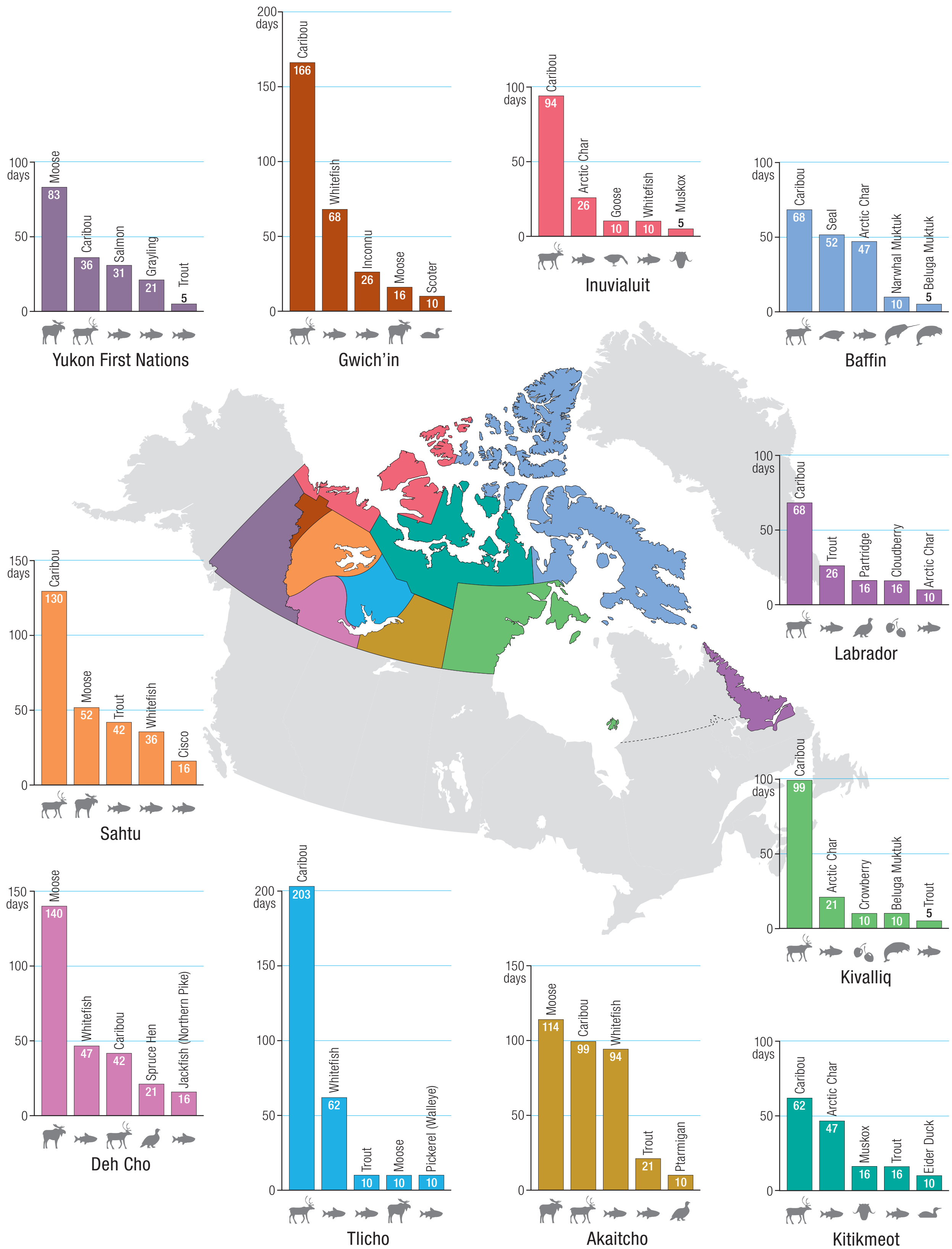
There are major individual and community health issues in the North such as smoking, alcohol and substance abuse, suicide and other social and economic problems. Contaminants are also a health issue.

In general, the overall health of northerners has improved over the last 25 years. People now live longer than before, and fewer infants die at or shortly after birth.

There is considerable variation, however, in the health of people among different communities across the Canadian North. Those with low incomes, less education and little or no employment tend not to be as healthy as those with good jobs, education and incomes. The greatest challenge over the next few years will be to improve social conditions for the most disadvantaged communities, families and individuals.

Health research is full of uncertainty

It is difficult to draw firm conclusions about the effects of contaminants on the health of northerners. It is similarly not yet possible to say with confidence that some health conditions are caused by contaminants. Health professionals and researchers have, in some cases, found associations between health problems and contaminant levels. Research is now underway and, while some results are expected over the next few years, more research is still needed.



Top five traditional/country foods most often consumed (days/year)
Information was gathered during late winter and fall and different species may dominate in other seasons. Inuit consume the greatest amount of traditional/country food, about 0.8–2 cups per day per person (194–440 grams). Yukon First Nations consume about 0.5–1 cup (106–236 grams) of traditional/country food per day per person, and Dene and Métis consume about 0.6–1.5 cups per day per person (144–343 grams). Women aged 20–40 consume the least traditional/country food, followed by men aged 20–40 and women over 40. Men over 40 consume the greatest amount.

Particularly important health issues are deaths from injuries (e.g., from accidents of all kinds), cancer and suicide. An underweight newborn baby is more likely to become ill or die than an average or heavy infant. In the Northwest Territories and Nunavut, the major health concerns are preventable injuries, the use of alcohol and tobacco, and unsafe sexual practices. In the Northwest Territories the major cancers which cause death are lung cancer and digestive cancer. Both of these are linked to smoking and a diet lacking in the necessary nutrients.

A diet high in saturated fats and sugars (found in many of the popular market foods) is known to increase the risk of diabetes and heart disease.

A diet high in saturated fats and sugars (found in many of the popular market foods) is known to increase the risk of diabetes and heart disease.

Across the Canadian North, more than 250 different species of fish, wildlife and plants are consumed by Yukon First Nations, Dene, Métis, and Inuit. This wide range of traditional/country foods reflects the diversity of ecosystems across the North, as well as cultural preferences.

4.3 Benefits of traditional/country foods and dietary patterns across northern Canada

Traditional/country foods are an integral part of being healthy for many northerners, Aboriginal people in particular. A substantial part of the diet of many Aboriginal people consists of traditional/country foods.

During Phase II of the NCP, comprehensive surveys were undertaken of Inuit eating habits by the Centre for Indigenous Peoples' Nutrition and Environment (CINE). CINE had previously studied the dietary habits of Yukon First Nations, Dene and Métis during the first phase of the NCP. These earlier studies are not reported here except for comparison purposes.

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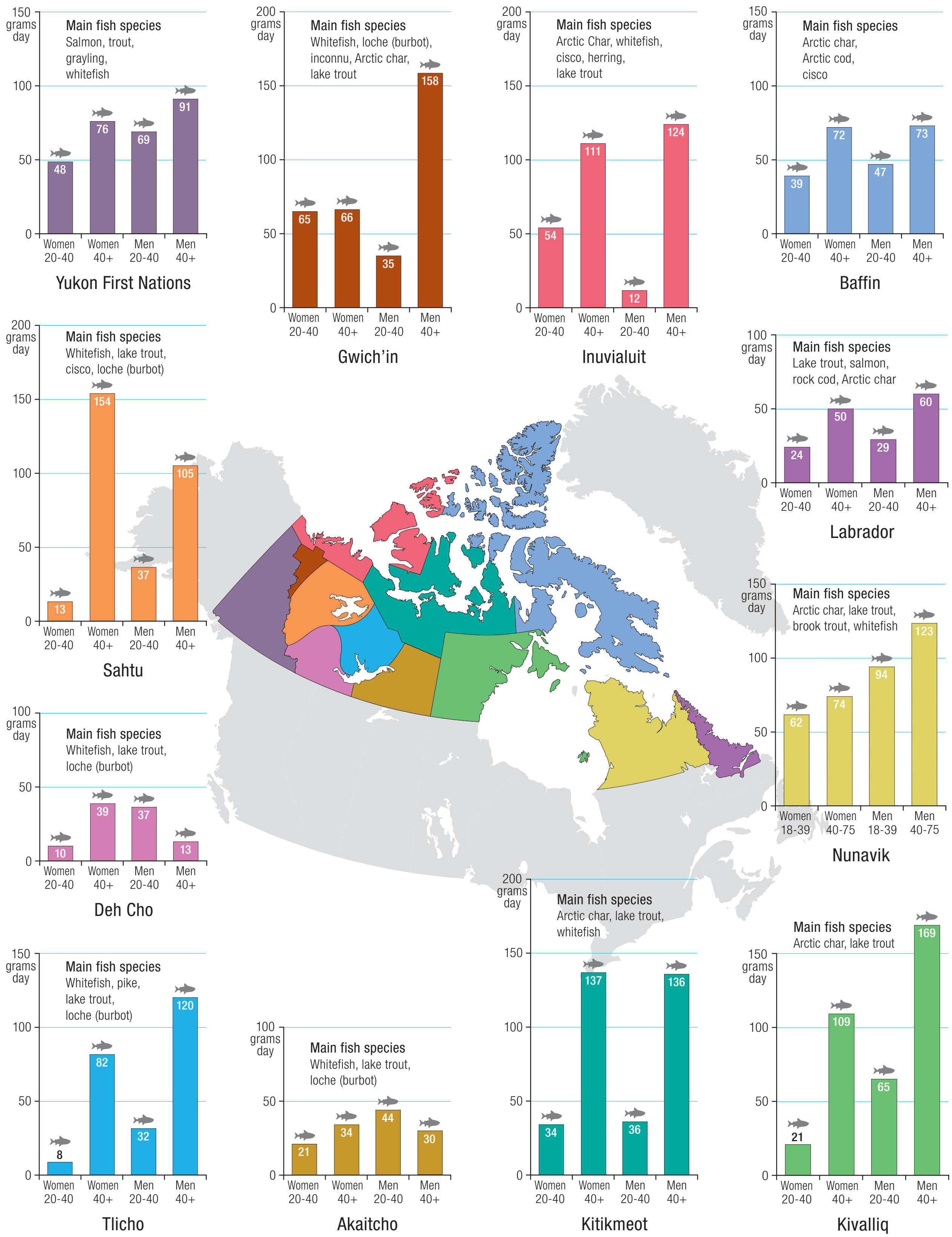
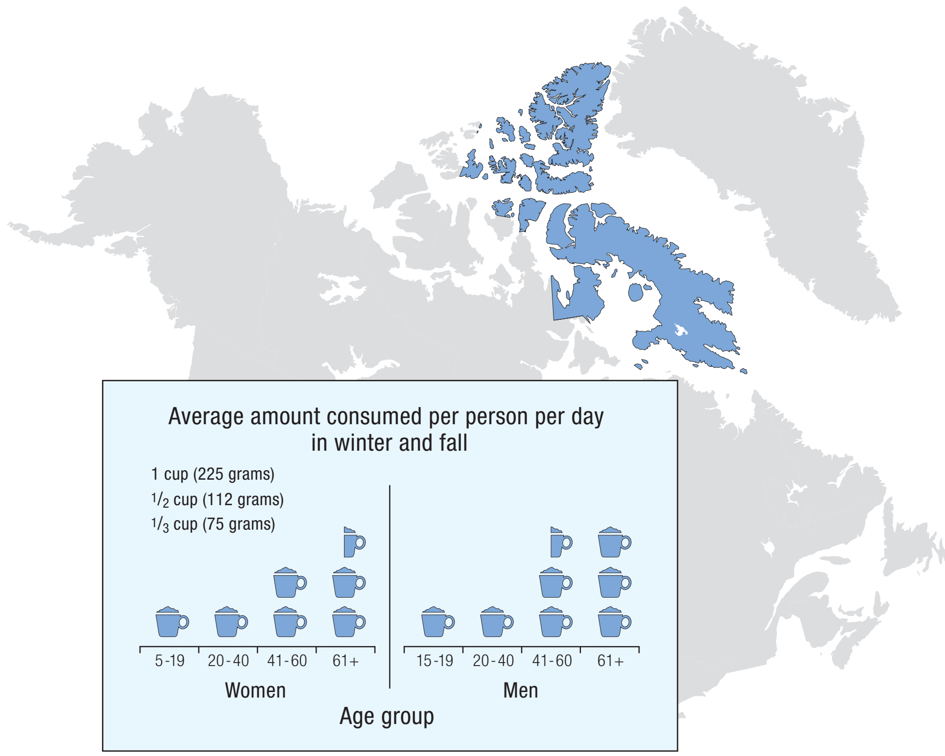


Amount of fish eaten daily by women and men of different ages

In general women and men over 40 consume the most fish, though there are important regional differences. Fish contain important nutrients, especially the omega-3 fatty acids, which help keep the heart healthy.



Amount of traditional/country food being consumed in Baffin region by women and men in different age groups
Older people consume more traditional/country food than young people, with men over 60 consuming nearly 700 grams (3 cups) per day.

The dietary surveys have provided better information about how much traditional/country food (and market food) people consume, and the nutritional value of these foods. The surveys also provide information on the levels of contaminants people take in from these foods. Information on both nutrient and contaminant levels is necessary if people are to make informed choices and decisions about food use.

Across the Canadian North, more than 250 different species of fish and wildlife, including plants, are consumed by Yukon First Nations, Dene, Métis, and Inuit (see Appendix A). This wide range of traditional/country foods reflects the diversity of ecosystems across the North, as well as cultural preferences.

When people eat traditional/country food, they generally eat less sugar, and more of the healthy types of fat, vitamin E, iron and zinc. Overall the traditional/ country food diet is healthier than a typical northern market food diet and keeps people active.

During the surveys, not only did people relate which traditional/country foods they ate the most, but also which are their favourites. For example, among people from Baffin region, favourite foods include: caribou (especially the meat, fat, stomach and stomach contents), seal (especially the meat, liver and heart), muktuk from beluga and narwhal, Arctic char, and walrus meat. Dene and Métis report that caribou, fish and moose are particularly good for you, though all traditional/country food is considered to be healthy.

On the days when people eat traditional/country food, the diet generally contains less sugar, more of the healthy types of fat (but less total fat), and more vitamin E, iron and zinc. Overall the traditional/country food diet is healthier than a typical northern market food diet and keeps people active.

However, not all store-bought food is unhealthy. For example, fruits and vegetables are good sources of vitamins, minerals and fibre. These help the digestive system and intestines function properly.

> ***Scientists have found that traditional/country foods have remarkable nutritional value. Many traditional/country foods help people fight illness, injury and disease better than the popular market foods.***

Some general trends can also be seen. For example, more traditional/country food is eaten in remote communities than in urban areas. Traditional/country food use is highest in Inuit communities, followed by Dene and Métis, and then by Yukon First Nations. Older people tend to eat more traditional/country foods than young people, and men consume more than women.

4.3.1 Nutritional value of traditional/country foods

Through their research with the NCP, scientists have found that traditional/country foods have remarkable nutritional value. Many traditional/country foods help people fight illness, injury and disease better than the popular market foods. Traditional/country foods strengthen bones and teeth, and help keep the heart, lungs and blood healthy.

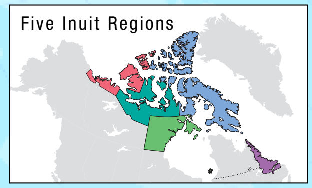
In the Inuit regions, traditional/country foods are clearly very important for nutrition. These foods are the most important sources of vitamins, minerals and other nutrients, though some of the store-bought foods are also a good source of certain nutrients.

Denendeh National Office/Resource Centre

Traditional/country foods are full of nutrients

Nutrient	Why it is good	Foods found in Inuit regions that are good sources of this nutrient
vitamin A	can help fight illness	caribou liver and meat, beluga muktuk, narwhal blubber, walrus liver, ringed seal liver and kidney
omega-3 fatty acids	good for the heart	Arctic char and salmon flesh, caribou meat, beluga muktuk, walrus blubber, ringed seal broth
vitamin E	helps the heart and lungs work well	caribou meat, bannock, narwhal blubber
calcium	strong bones and teeth	bannock
zinc	helps wounds to heal quickly; can help fight illness	caribou meat (including dried meat), beluga and narwhal muktuk, ringed seal meat
iron	good for the blood	caribou meat (including dried meat), ringed and bearded seal meat, walrus meat, partridge meat

Top three sources of selected nutrients in five Inuit regions (fall and late winter). Traditional/country foods are very important sources of nutrients. Of the 90 sources listed, more than half are traditional/country foods.
(shaded areas indicate traditional/country foods)



Inuit Region	Inuvialuit	Kitikmeot	Kivalliq	Baffin	Labrador
Vitamin A **1.**	Caribou liver	Caribou liver	Carrots	Walrus liver	Carrots
2.	Carrots	Carrots	Beluga blubber	Ringed seal liver	Margarine
3.	Beef liver	Mixed frozen vegetables	Caribou meat	Narwhal blubber	Ringed seal kidney
Omega-3 Fatty Acids **1.**	Margarine	Arctic char flesh	Arctic char flesh	Arctic char flesh	Margarine
2.	Arctic char flesh	Caribou meat	Caribou meat	Walrus blubber	Salmon flesh
3.	Beluga blubber	Margarine	Beluga blubber	Ringed seal broth	Salad dressing
Vitamin E **1.**	Margarine	Caribou meat	Caribou meat	Caribou meat	Margarine
2.	Potato chips	Bannock	Potato chips	Bannock	Potato chips
3.	Caribou meat	Margarine	Bannock	Narwhal blubber	Caribou meat
Calcium **1.**	White bread	Bannock	Bannock	Bannock	Evaporated milk
2.	2% milk	Pizza	Pizza	2% milk	2% milk
3.	Pizza	White bread	White bread	Pizza	White bread
Zinc **1.**	Caribou meat	Caribou meat	Caribou meat	Caribou meat	Caribou meat
2.	Ground beef	Ground beef	Ground beef	Ringed seal meat	Ground beef
3.	Caribou dried meat	Caribou dried meat	Beluga muktuk	Narwhal muktuk	Chicken
Iron **1.**	Caribou meat	Caribou meat	Caribou meat	Ringed seal meat	Caribou meat
2.	White bread	Ringed seal meat	Bearded seal meat	Caribou meat	Partridge meat
3.	Ground beef	Caribou dried meat	Ringed seal meat	Walrus meat	White bread

Traditional/country food is almost always much cheaper than imported food and is an economic necessity for many northerners. Most Inuit state that they would not be able to feed their families based only on store-bought food.

Preparing and sharing food helps individuals to feel part of the group, and reinforces a sense of distinct culture. Young people are provided with skills necessary for living off the land and develop qualities such as responsibility, patience and respect.

A diet based on traditional/country food is clearly highly nutritious and it also provides the necessary dietary intake of most vitamins, essential elements and minerals. Another benefit is that harvesting traditional/country food is physically demanding and helps people stay fit.

4.3.2 Social, cultural and spiritual benefits

The nutritional value of traditional/country foods is not the only important benefit to northern peoples. There are also significant cultural and spiritual benefits to harvesting, preparing, sharing and consuming these foods.

For example, preparing and sharing food helps individuals to feel part of the group, and reinforces a sense of distinct culture. The views and values of many northern peoples, and sense of identity, are gained through activities such as harvesting which requires spending much time on the land.

Harvesting also plays a key role in bringing up young people. Through harvesting, young people are provided with skills necessary for living off the land. Young people also develop qualities such as responsibility, patience and respect.

4.3.3 Economic necessity

Finally, there are clear economic reasons which support continued and extensive use of traditional/country foods. Traditional/country food is almost always much cheaper than imported food and is an economic necessity for many northerners. Store-bought food for a family of four costs approximately $150 per week in Labrador, and nearly $240 per week in Baffin. This translates to $8,000–12,000 per year, much more than it costs a family in the south. Most Inuit (up to 78%) state that they would not be able to feed their families based only on store-bought food. This is also true for most Yukon First Nations people, Dene and Métis.

GNWT/NWT Archives/Fran Hurcomb

4.3.4 Market foods

Most market foods consumed in northern Aboriginal communities do not provide adequate nutrition. The nutritional value of market food is often questionable because the foods available (or selected) may not be the healthiest, and "due by" dates may have expired. There are fewer nutrients in products that are too old.

Of particular concern are the health risks associated with switching to a non-traditional diet. Health professionals believe that eating more of the popular market foods and less traditional/country food is causing health problems. The CINE studies show that when people do not eat traditional/country food, they consume more sugar, unhealthy fats, and carbohydrates than usual. This often results in people becoming overweight, and developing "western-style" health problems such as diabetes and heart disease. Yukon First Nations, Dene, Métis, and Inuit are now suffering much more from these "western" diseases and conditions than before. Younger people especially are putting themselves at risk by consuming levels of sugar that are too high. In the Baffin region, two out of every five women (40%) who are over 40 years old may develop health problems because they are too heavy. For women under 40 years of age, and for men over 40 years of age, one out of every five may develop problems from being overweight.

Benefits of traditional/country foods

Nutrition and Physical Health

- *A diet based on traditional/country food is highly nutritious and provides the necessary dietary intake of most vitamins, essential elements and minerals, even if only 6–40% of total dietary energy comes from this food source.*
- *Many traditional foods contain excellent sources of vitamin C, omega fatty acids, vitamins A, D and E, as well as iron, zinc, selenium, copper, magnesium and manganese.*
- *Marine mammals contribute significant amounts of protein, iron and zinc to the diets of children.*
- *Any decrease in fish consumption among the younger generation in particular is expected to have negative health consequences.*
- *The nutritional value of the popular market foods is often questionable because the types of foods available may not be particularly nutritious, and "due by" dates may have expired — shelf lives are short.*
- *Switching to a non-traditional diet is likely to cause different and more "western-style" health problems (e.g., diabetes and heart disease) than would occur by staying with the traditional diet, as intakes of total fat, saturated fat and sucrose rise above recommended levels.*
- *Harvesting traditional/country food is physically demanding and helps people stay fit.*

Cultural Benefits

- *Preparing and sharing food is an important means for individuals to feel they belong with the group, and affirms cultural distinctiveness.*
- *The values of the Aboriginal peoples, views of the world, and sense of identity are moulded by a close and complex relationship with the land — this is gained through activities such as harvesting.*
- *Through harvesting, young people learn skills necessary for living off the land, and they also develop qualities such as patience and respect, not only for the individual but for other people.*
- *Harvesting helps to protect the land and its resources as people out on the land observe conditions and changes in the land and wildlife, and are therefore able to maintain and enhance knowledge (monitoring).*
- *Harvesting maintains ties to the land, and promotes sustainable use of the land and resources, which lies at the heart of the Aboriginal perspective on health.*

Economics

- *Traditional/country food is almost always much cheaper than imported food and is an economic necessity for many northerners.*

Switching to popular market foods often results in people becoming overweight, and developing "western-style" health problems such as diabetes and heart disease.

ITK/Eric Loring

4.4 Contaminants in traditional/ country foods and in people

Research under Phase II of the NCP looked not only at the dietary benefits of the traditional/country foods consumed, but also at the levels of contaminants found in these foods. Although there are many important benefits of these foods, the picture is not always so clear when it comes to the levels of some contaminants. Information on the risks from contaminants needs to be provided to food users, along with information on benefits, so that these users can make informed decisions.

Studies carried out by the Centre hospitalier de l'Université du Québec (CHUQ) in Québec City and the Government of the Northwest Territories looked at the levels of contaminants found in people in the Northwest Territories, Nunavut and Nunavik. These studies analyzed contaminants found in maternal blood, maternal hair, and in umbilical cords.

It is often difficult to determine the levels of various contaminants in people, or to know whether and how these levels may be a risk to health. In the North, health studies can be particularly difficult to carry out. Many studies have focussed on one contaminant at a time. However, people are exposed to mixtures of contaminants and the effects of mixtures may differ from those of a single contaminant.

Other difficulties with health research arise because the population of the North is small and rare diseases or conditions may not be seen even if contaminants are known to cause such health problems. It is also difficult to draw general conclusions from studies with a small population. Contaminants and nutrients may interact in ways not completely understood, e.g., to make effects stronger, or to reduce them. Finally, the genetic makeup and exposure of Canadian northerners to contaminants are quite different compared to other peoples. This makes it difficult to draw conclusions from studies which have been carried out elsewhere in the world.

A key concept is that of tolerable daily intake (TDI). This is the amount of a contaminant that, on average, scientists and health professionals believe people can safely take in every day.

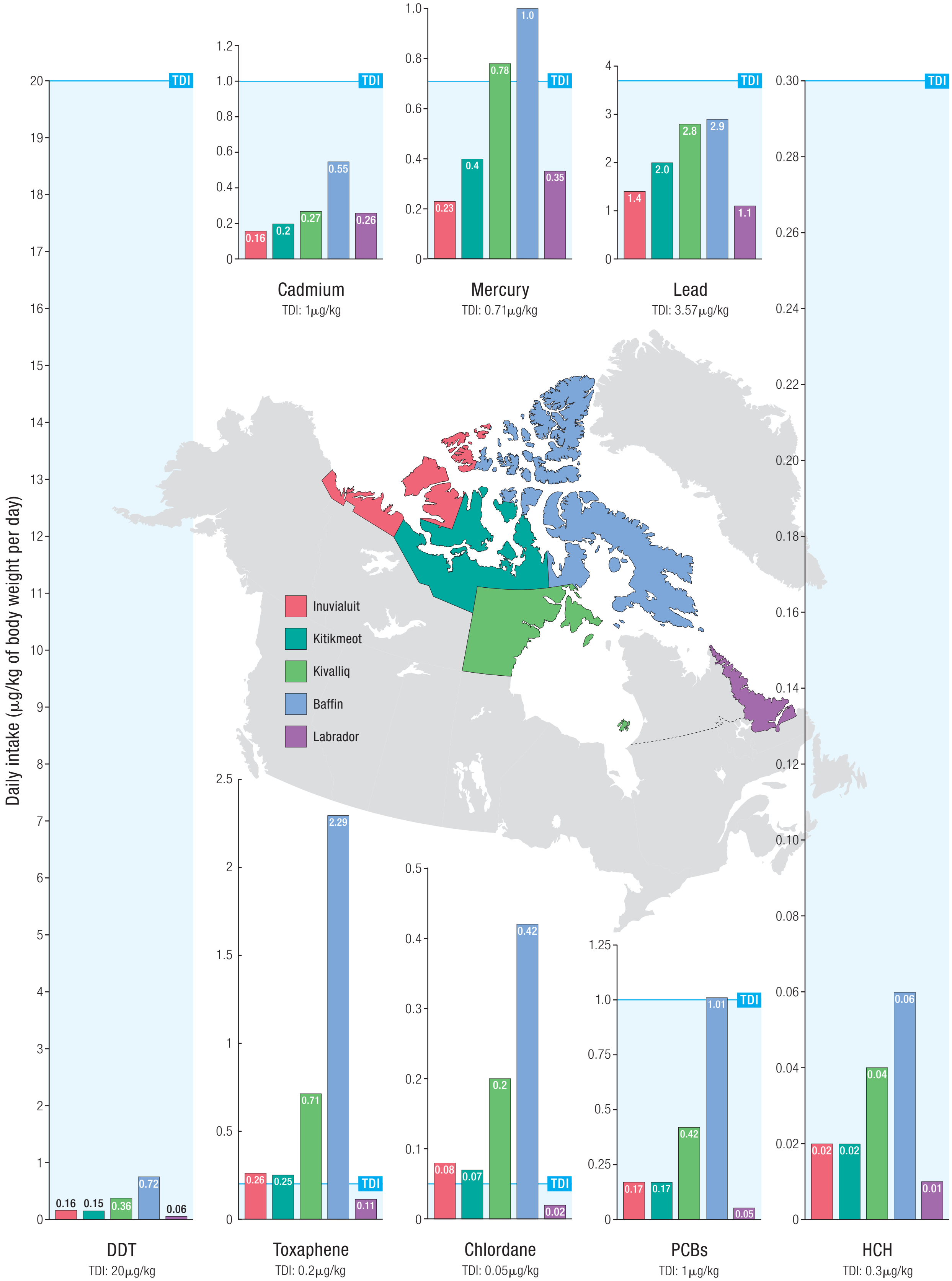
What is the tolerable daily intake (TDI)?

Tolerable daily intake, or TDI, is the amount of a contaminant that scientists have estimated is safe for humans to take in every day for an entire lifetime (i.e., long-term exposure). Levels are calculated based on data for large groups of people.

There is a considerable amount of uncertainty in the calculation of a TDI, and a large safety factor is built in that takes that into account. The bigger the uncertainty (e.g., only a small amount of data are used in the calculation), the bigger the safety factor. If someone has an intake higher than the TDI it does not necessarily mean that health problems will develop. It means only that the margin of safety is reduced, and there is a greater risk of developing a health problem. TDIs are developed with a high degree of caution.

Sometimes the term provisional tolerable daily intake (pTDI) is used instead of TDI. A pTDI is the same as a TDI except that it is provisional, i.e., it is not yet definite and certain, and may still change.

TDI and pTDI are usually expressed in terms of how many micrograms (millionths of grams; µg) of a contaminant can be safely taken in for every kilogram of a person's weight. A TDI of 1 µg/kg is about the same as the ratio of the weight of a teaspoon of sugar (4 grams) to the weight of 2000 (2-tonne) trucks.



Average intake levels of various contaminants in five Inuit regions

The tolerable daily intake (TDI) levels are included for comparison. While the average intake levels of HCHs and DDT are very low compared to the TDIs, a significant number of people in four of the regions take in chlordane and toxaphene at levels above the TDIs. Many people in Baffin and Kivalliq take in mercury at levels that exceed the TDI, while Baffin residents also take in levels of PCBs that exceed the TDI.

4.4.1 Intake patterns, and levels of contaminants in mothers

In general, most people in the Canadian North are taking in levels of heavy metals in traditional/country foods that are below the TDIs. However, there are some exceptions. A significant number of people are taking in higher levels of mercury and the other heavy metals than the TDIs. In most Kivalliq and Baffin communities, more than 25% of the population is taking in levels of mercury higher than the TDI. Fewer than 5% of the people in Labrador, Kitikmeot and Inuvialuit, however, are taking in levels of mercury that exceed the TDI. The TDI is the level of intake known to be quite safe. Above this level, people will not necessarily develop health problems but their risk is higher.

In Kivalliq and Baffin regions, more than 25% of the population is taking in levels of mercury higher than the TDI, the intake level known to be safe.

Tolerable daily intake (TDI) levels for various contaminants

The recommended maximum levels listed here have been developed by Health Canada. Other agencies (e.g., the World Health Organization, and the U.S. Environmental Protection Agency (EPA) may have different recommended tolerable daily intakes. Sometimes tolerable intakes are expressed in terms of amounts per week, rather than per day.

	Tolerable Daily Intake (µg/kg body weight per day)	Total amount if a person weighing 75kg took in the TDI amount for 80 years (g) *
arsenic	2	~4
cadmium	1	~2
mercury	0.71	~1.5
lead	3.57	~8
toxaphene	0.2	~0.5
chlordane	0.05	~0.1
DDT	20	~44
HCH	0.3	~0.67
PCBs	1	~2

* One teaspoon of sugar weighs about 4 grams.

Most of the mercury taken in by the residents of Kivalliq comes from eating caribou meat, beluga muktuk and lake trout muscle. For Baffin residents, most of the mercury comes from eating ringed seal meat, narwhal muktuk and caribou meat. Despite this, the benefits of using traditional/country food are still considered to outweigh the risks from mercury, especially given the health risks of switching to popular market foods.

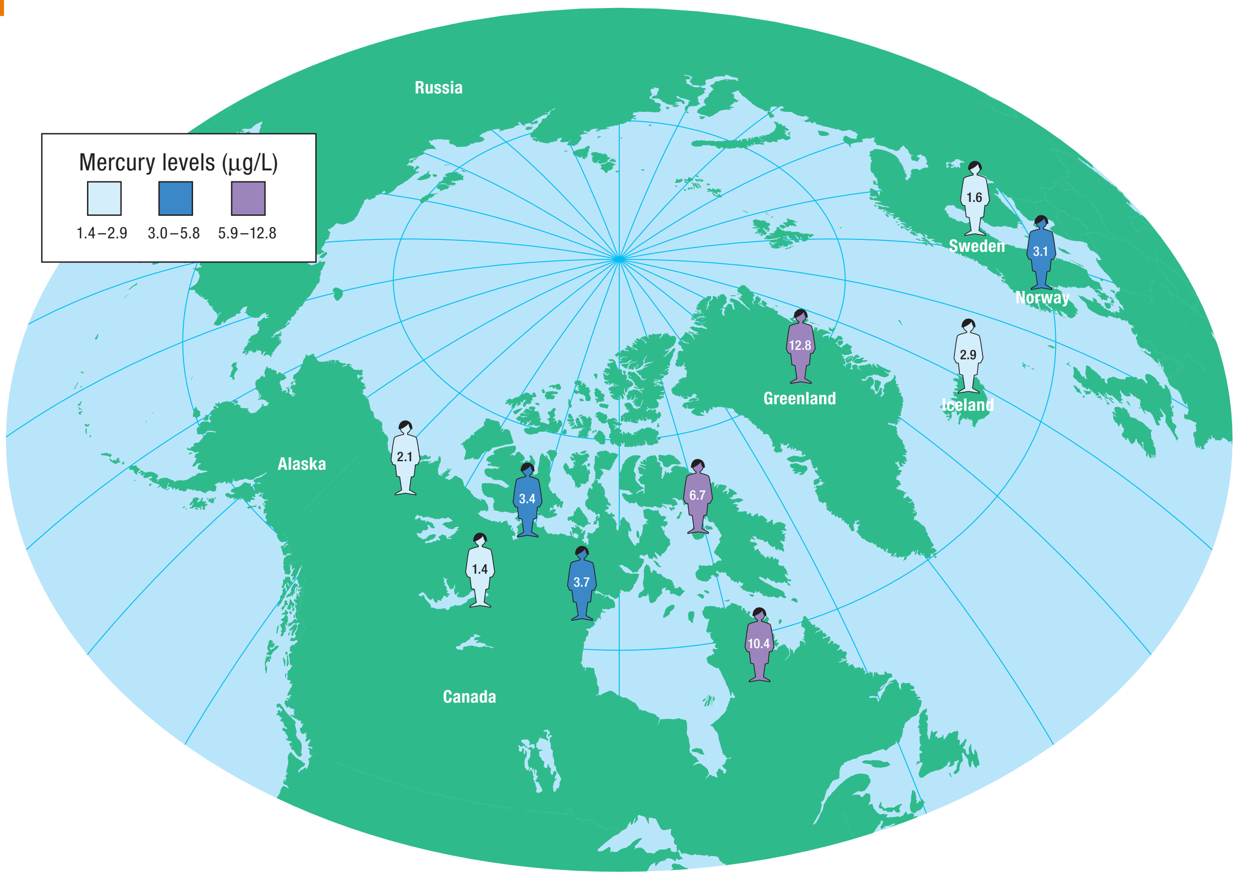
The studies of mercury in maternal blood, hair and umbilical cords show a similar geographic pattern as the levels of mercury being taken in through the diet. Levels are higher in Inuit mothers from Baffin and Nunavik compared to other regions. For example, 10% of Baffin mothers and 16% of Nunavik mothers have mercury blood levels that fall in the "increasing risk" range. All Dene, Métis and non-Aboriginal mothers have blood levels in the acceptable range of below 20 µg/litre. No mothers have blood levels in the "at risk" range of over 100 µg/litre.

A new maternal blood guideline of 5.8 µg/litre has recently been derived based on studies in the United States. This level has been set to protect those most vulnerable to contaminants — the fetus and breast-feeding infant. While only a few Dene, Métis or non-Aboriginal women in the North have mercury blood levels above this level, the blood levels are above this new guideline in many Inuit mothers. For example, 79% of mothers from Nunavik and 68% of those

Mercury levels in blood

Health Canada developed blood guidelines for mercury in the 1970s. Blood levels below 20 µg/litre of blood are classified as being in the acceptable range, 20–100 µg/litre as "increasing risk", and levels greater than 100 µg/litre as "at-risk".

Ten percent of Baffin mothers and 16% of Nunavik mothers have mercury blood levels that fall in the "increasing risk" range. An ongoing study is looking at the health effects of these levels of mercury on the mothers, fetus and infants.



Average levels of mercury in the blood of mothers across the circumpolar Arctic
Greenland mothers have the highest levels of mercury followed by Nunavik and Baffin mothers. Dene and Métis, Swedish and Inuvialuit mothers have lower levels. Health Canada considers mercury blood levels below 20 µg/litre to be in the acceptable range. The United States has recently developed a new maternal blood guideline of 5.8 µg/litre.

from Baffin regions have blood levels above the 5.8 µg/litre guideline.

Scientists do not yet know whether these high mercury levels are affecting the health of the mothers, fetuses, or infants. A study is now taking place that will hopefully provide some answers to these questions.

The studies of mercury levels in blood do not indicate if the mercury is coming from natural or human-made sources. It may have come from contaminants in traditional/country food, or it may have come from other sources. However, Inuit regional populations having the higher average blood mercury levels are also those with the highest intake levels of mercury, so it is likely that the mercury comes from traditional/country foods.

For people living in Nunavik, the long-term levels of mercury in mothers are staying about the same. Levels in mothers from some communities in the Northwest Territories may have been decreasing since the 1970s but more work is needed to confirm this.

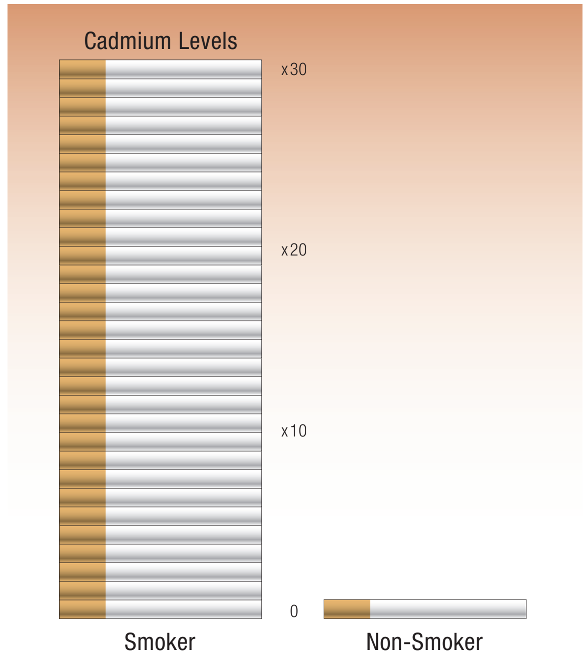
Inuit in Greenland have higher levels of mercury than those in northern Canada. This is because Inuit in Greenland eat more pilot whales and blubber compared to Canadian Inuit. People in the Faroe Islands (who also eat marine mammals) also have quite high mercury levels.

Lead and cadmium are other heavy metals which are taken in at higher levels than the recommended TDIs by some individuals. Lead levels are elevated in Dene and Métis mothers as well as in Inuit mothers. Scientists believe that the lead comes mostly from the lead shot used in hunting (i.e., local sources). The lead from the shot is absorbed by the animal which is later consumed. Bismuth, steel, tungsten/iron, and tungsten/polymer shots are safer alternatives. Lead levels in the northern atmosphere have decreased since lead was banned from gasoline.

Most cadmium is believed to come from smoking cigarettes.

Like lead, cadmium levels are elevated in some Inuit mothers (both in Canada and Greenland) as well as in Dene and Métis mothers. Most cadmium is believed to come from smoking cigarettes. For some people (especially smokers), the additional cadmium obtained from traditional/country foods may be significant.

As with many heavy metals, the intake of most POPs is not a major concern. However, the average intake levels of chlordane and toxaphene by the Inuvialuit, Kitikmeot, Kivalliq and Baffin populations are higher than the TDIs and may, therefore, be of concern. In certain communities in Baffin and Kivalliq regions, 25–50% of residents take in more chlordane and toxaphene than the TDIs. PCBs are also being taken in at a higher level on average than the TDI in Baffin region.



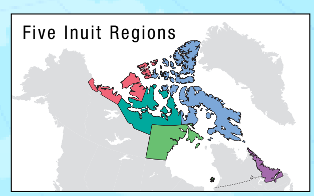
Typical cadmium levels in smokers and non-smokers
Smokers have 20–30 times the cadmium levels of nonsmokers. For some people (especially smokers), the additional cadmium obtained from traditional/country foods may be significant.

Average intake levels of chlordane and toxaphene are higher than the TDIs in people from the Inuvialuit, Kitikmeot, Kivalliq and Baffin regions. In certain communities in the Baffin and Kivalliq regions, 25-50% of residents take in more chlordane and toxaphene than the TDIs. PCBs are also being taken in at a higher level than the TDI in Baffin region.

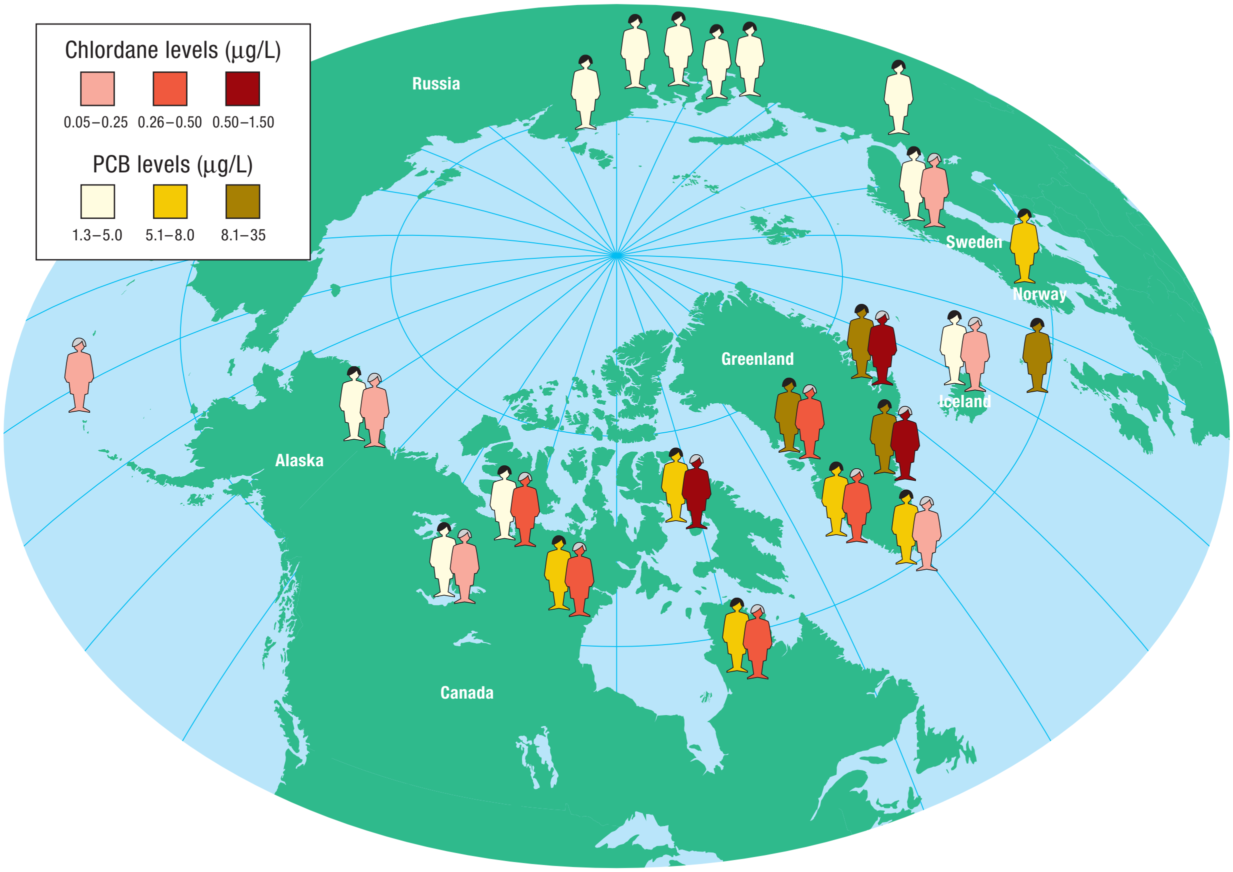
Levels of PCBs are elevated in the blood from mothers in Baffin, Kivalliq, and Nunavik. This matches the geographic pattern of higher intake levels of PCBs in Baffin and Kivalliq. No mothers in any of the regions in Nunavut (Baffin, Kivalliq or Kitikmeot), Nunavik or in the Inuvialuit region have PCB levels in blood that are higher than Health Canada's "action level" of 100 µg per litre of blood, though nearly half have levels above the level of concern of 5 µg/litre.

Three main food sources contributing mercury to the Inuit diet in five regions

Caribou meat contains only low levels of mercury but because so much of it is eaten, caribou meat contributes much of the mercury in the Inuit diet. Marine mammals often contain much higher levels of mercury than caribou and eating even a small amount of certain marine mammal foods may contribute a lot to the diet.



Inuit Region	Inuvialuit	Kitikmeot	Kivalliq	Baffin	Labrador
Food Item (Mercury) 1.	Caribou meat	Caribou meat	Caribou meat	Ringed seal meat	Caribou meat
2.	Beluga muktuk	Arctic char flesh	Beluga muktuk	Narwhal muktuk	Lake trout flesh
3.	Lake trout	Caribou ribs	Lake trout flesh	Caribou meat	Ringed seal kidney



Average levels of chlordane and PCBs in maternal blood across the circumpolar Arctic
Levels of chlordane are highest in mothers from Greenland and Baffin, while PCBs are highest in mothers from Greenland and the Faroe Islands. PCB blood levels above 5 µg/litre fall within Health Canada's "level of concern". On average, mothers from Greenland, the Faroe Islands, parts of Scandinavia, and Baffin, Kivalliq and Nunavik regions have PCB levels in their blood above this guideline.

Internationally, mothers from Nunavik contain levels of PCBs similar to those found in mothers in the Netherlands, and higher than levels found in mothers in southern Québec. Levels are 2–3 times higher in mothers from Greenland compared to Canadian Inuit mothers, possibly because there are more marine mammals in the traditional Greenland diet. Levels are also higher in people from the Faroe Islands.

Most chlordane and toxaphene comes from eating marine mammals. Research shows that levels of chlordane are increasing in the blubber of some ringed seals and beluga in specific locations (see Section 3.2.1).

What do the high levels of toxaphene and chlordane mean?

The higher intake levels of toxaphene and chlordane (above the TDIs) do not necessarily mean people will experience adverse health effects — just that the risk is somewhat higher. Nonetheless, the NCP is supporting important studies that will help to further define the risk to human health from these contaminants.

The benefits of using traditional/country foods are currently considered to outweigh the known risks from contaminants, especially given the health risks of switching to popular market foods.

Northern Canadian mothers have lower levels of chlordane than people from eastern Greenland or the Archangelsk area of Russia. Levels in northern Canadian mothers, however, are higher than those in many northern Europeans. This may be related to the amount of marine mammals in the diet.

Traditional/country foods such as beluga, caribou and fish have well-known and important benefits, many of which cannot be replaced by switching to available and affordable market foods. Health officials and community members currently believe that it is better to continue to eat traditional/country foods than to switch to the popular market foods.

4.4.2 Mercury and health

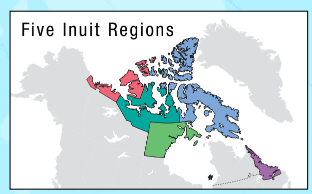
There have been very few studies on the health effects of mercury on Canadian northerners. An ongoing study in Nunavik should soon provide useful information. The partnership between researchers, other technical experts and community residents in Nunavik is an important component of this study. Researchers working with pregnant women in Nunavik have trained and employed numerous community members year-round to collect data. Their skills in translation and interviewing allow the project to tap into the local community's knowledge. These community members also add to the success of the project by building good relationships and promoting cooperation with the study participants. This relationship-building aspect of the program greatly adds to its success.

Studies with people living elsewhere (e.g., in the Faroe Islands) are being used to provide researchers with some preliminary ideas as to the potential effects of mercury on people. While the Faroe Islands research shows that mercury may lead to slower development in children, other studies from other parts of the world do not show any health problems caused by these low levels of mercury. More research is clearly needed to find out if and how mercury in the blood of northern Canadian mothers affects their children's health.

There is some evidence that certain minerals or nutrients can reduce the effects of mercury in people or animals. Some animal studies show that selenium does provide a protective effect but other studies do not. Human studies have also not

Three main food sources contributing chlordane and toxaphene to the Inuit diet in five regions

Blubber from marine mammals contains higher levels of chlordane and toxaphene than found in other traditional/country foods. Even though only small amounts are consumed, the higher intake levels of chlordane and toxaphene in Baffin and Kivalliq come largely from marine mammal blubber. In Labrador, intake levels of these contaminants are lower. Most chlordane and toxaphene comes from eating caribou meat and various fish which contain much lower levels of these contaminants.



Inuit Region	Inuvialuit	Kitikmeot	Kivalliq	Baffin	Labrador
Food Item (Chlordane) 1.	Beluga blubber	Beluga blubber	Beluga blubber	Narwhal blubber	Caribou meat
2.	Caribou meat	Arctic char flesh	Beluga muktuk	Walrus blubber	Lake trout flesh
3.	Beluga muktuk	Caribou meat	Walrus blubber	Beluga blubber	Salmon flesh
Food Item (Toxaphene) 1.	Beluga blubber	Beluga blubber	Beluga blubber	Walrus blubber	Salmon flesh
2.	Beluga muktuk	Arctic char flesh	Walrus blubber	Narwhal blubber	Lake trout flesh
3.	Arctic char flesh	Ringed seal flesh	Arctic char flesh	Ringed seal flesh	Arctic char flesh

produced clear results about the ability of selenium or fish (fatty acids or protein) to protect people from the toxic effects of mercury. More research is needed to clarify these effects.

There is some early evidence based on animal research that vitamin E, and a combination of vitamin E and selenium may provide some protection against mercury. This needs further investigation. Vitamin E is found in caribou meat, bannock and narwhal blubber.

Certain fatty acids and fish protein may also help reduce the effects of methylmercury. These nutrients are commonly found in fish and marine mammals.

Research in the Faroe Islands shows that mercury may lead to slower development in children. However, other studies from other parts of the world do not show these health effects. More research is clearly needed.

ITK/Eric Loring

There is some early evidence from animal studies that vitamin E, and a combination of vitamin E and selenium, may provide some protection against mercury. Certain fatty acids and fish protein may also help.

4.4.3 Persistent organic pollutants and health

Research carried out under Phase II of the NCP shows that PCB levels in maternal blood may be as important as drinking alcohol and smoking cigarettes in causing adverse health effects.

For example, in Nunavik, mothers with higher levels of PCBs in their blood gave birth to smaller infants, and this may also be true elsewhere in the Canadian North. Lower birth weights are known to sometimes affect the ability of newborns to fight disease.

Certain nutrients and vitamins are thought to help protect people from the effects of PCBs. Vitamin E may provide some protection from PCBs, as may the omega-3 fatty acids. Vitamin E is found in caribou meat, bannock and narwhal blubber, and omega-3 fatty acids are found in Arctic char and salmon flesh, caribou meat, beluga muktuk, walrus blubber and ringed seal broth.

Intake levels of DDT are well below the TDI on average across the Inuit regions, and very few if any people are taking in levels of DDT above the TDI. Research in Nunavik, however, shows that infants exposed to DDT (e.g., in breast milk) tend to suffer more ear and respiratory (breathing) infections.

Very little is known about the potential effects of chlordane and toxaphene on the health of northern peoples. There have been some laboratory experiments with rats and monkeys at high doses of these contaminants. However, there is much uncertainty about what the laboratory results tell us about effects of lower doses in people.

The health of monkeys was only affected when they were fed toxaphene at levels about 10 times higher than even the highest intake levels found in Baffin and over 250 times higher than the average intake level in Baffin. Rats suffered health effects only when they were fed very high doses of chlordane (nearly 300 times higher than even the highest intake levels in Baffin). These research results cannot be extended

ITK/Eric Loring

Breastfeeding is very beneficial and should continue

The recently released Arctic Monitoring and Assessment Programme (AMAP) report "Arctic Pollution 2002" recommends that breastfeeding should continue. Recent research confirms that there are substantial benefits to both mother and child from breast-feeding, even though breast milk can contain most of the POPs found in the Canadian North. The effects of contaminants on children are thought to be due more to their exposure before birth than through breast milk. Breastfeeding helps the mother and child to bond, provides important nutrients, and also helps the child to develop a stronger immune system.

Vitamin E and omega-3 fatty acids may help protect people from the effects of PCBs. PCBs in pregnant mothers may lead to their babies having lower birth weights, while DDT in breast milk may lead to more infections in infants and children.

to humans, however, and more research on the effects of toxaphene and chlordane on northerners needs to be done.

Typical mixtures of POPs can interfere with growth, reproduction and development, and lead to infections (particularly ear infections in babies). The NCP is concerned about the potential risks from mixtures of contaminants and is now supporting several relevant studies.

The interactions between vitamin A and POPs are now being studied more closely by scientists, since some POPs may affect vitamin A. Scientists and health professionals believe that vitamin A may be important for fighting infectious diseases. It is found in caribou liver and meat, beluga muktuk, narwhal blubber, walrus liver, ringed seal liver and kidney. In Nunavik, the daily intake of vitamin A is less than the recommended level. Vitamin A levels are now being measured in preschool children and newborn babies as part of a study to assess how vitamin A and POPs together affect the frequency of infections.

4.4.4 Radionuclides in traditional/country foods and health

Northerners are exposed to higher levels of natural radionuclides than those who live in the south. These natural levels have remained about the same over thousands of years and reach humans through the lichen→caribou→human food web. To date no significant health risks have been associated with radionuclides in northerners. There may be a link between radiation and heart and stroke diseases but this is not yet understood and more research is needed.

There is still some debate over whether health effects only occur beyond a minimum level of radiation exposure. While research needs to continue, some scientists now believe that there is no risk of cancer if the radiation level is below 100 millisieverts over a lifetime, or below 50 millisieverts in any one year. This level is higher than even the maximum levels northerners are exposed to from eating caribou and other natural sources (about 5–7 millisieverts per year).

Natural levels of radionuclides have remained about the same for thousands of years. To date, no significant health risks have been associated with radionuclides in northerners.

4.5 How do we talk about and deal with the benefits and risks of traditional/country food?

The NCP has the responsibility to communicate the results of contaminant and health research to communities and individuals in a responsible way. Benefit-risk information is perhaps most important for Canadian northerners and most difficult to obtain and communicate. The ultimate goal is to provide information to help Canadian northerners make informed decisions about food use.

The Aboriginal Partners in the NCP and territorial health departments have taken the lead in providing such information and advice to northerners.

Communicating benefits and risks — lessons from Qikiqtarjuaq (Broughton Island)

Before the NCP was put in place, information about the benefits of traditional/country foods and the risks from contaminants was sometimes communicated in ways that led to misunderstandings, confusion and unnecessary changes in harvesting and eating practices. An example of such communication occurred with studies that took place during the mid-1980s in Qikiqtarjuaq (Broughton Island). These studies showed that Inuit had high intake levels of PCBs coming from their diet of marine mammals. Levels of PCBs were also high in Inuit residents' blood and breast milk. The risk assessment information which was presented by researchers and sensationalized by the media led to anxiety, confusion and controversy among local residents.

Information was later presented to the community that the nutritional benefits of traditional/country food outweighed the health risks and that people should continue to consume these foods and breastfeed their infants. However, because the earlier information had not been communicated very well, this positive and principal message from the study was met with scepticism and confusion that lasted over three years. Some hunters decided to change their hunting practices when it was not necessary. Contaminants were also wrongly blamed for a vast array of ailments. The situation highlighted how, in the absence of good communication, rumours can develop and spread rapidly through local informal communication networks.

This example of early benefit-risk communication could have been improved by including the particular benefits together with the risks of traditional/country food consumption and a communication plan developed together with the community. Lessons were learned from these early communication efforts which have resulted in great improvements today, led by the NCP Aboriginal Partners and the communities themselves.

Mercury levels in the livers of northern waterfowl

In the summer of 2001, Health Canada released a health hazard assessment for mercury and selenium levels in the livers from waterfowl harvested in northern Canada. The livers had been collected from communities across the North between 1988 and 1994.

This work resulted from an earlier message in 1995 that the muscle and eggs of waterfowl were safe to eat. Community members then asked if the livers were also safe, since they too are eaten.

The scientific results showed that the selenium levels were not of concern. However, scientists thought that the mercury levels in the livers might be of concern for those who consume certain waterfowl species including ducks. Health Canada suggested the maximum weight of livers that should be consumed by men, women and children.

However, this information was not made public immediately, as might have happened before the NCP was put in place. Instead, a broad set of northern representatives, including the territorial contaminants committees, received this information. They met with government representatives to discuss the results in more detail. The group came to the following conclusions:

- *actual consumption by Aboriginal people was already lower than the maximum recommended by Health Canada*
- *consumption was seasonal, not daily*
- *women of child-bearing age and children were not high consumers of duck livers*
- *issuing an consumption advisory could have the following unintentional negative effects:*
  - *people might stop consuming bird livers entirely*
  - *people might limit consumption of bird livers from all species*
  - *people might stop consuming, or limit consumption of bird/duck muscle tissue*
  - *people might start to question whether other traditional/country foods are safe to eat*
  - *people might switch to a non-nutritious, non-traditional/country food diet and be exposed to the associated health risks from this change in diet (nutritious and affordable alternatives to waterfowl livers were not available)*

As a result, the group decided not to issue advice to limit the consumption of waterfowl livers. Instead, they decided to update communications materials and draft fact sheets showing that elevated levels of mercury were found in the livers of some waterfowl species. The fact sheets contained a balanced message with information on both the benefits of eating waterfowl as well as the levels of contaminants found in waterfowl in the North.

Health professionals and environmental managers must consider both sides of the issue when providing health or consumption advice.

ITK/Eric Loring

Health professionals and environmental managers must consider both sides of the issue when providing health or consumption advice. Assessing the benefits and risks of contaminants in traditional/country food means considering the type and amount of food consumed; knowledge of the toxicity of the contaminant in the food item; and the social, cultural, nutritional, economic, and spiritual benefits associated with traditional/country foods. It is not easy to weigh the many benefits and risks as these involve several quite separate areas of knowledge (nutrition, toxicology, traditional knowledge, environmental policy and public health practice).

People may understand or misunderstand messages depending on how benefit-risk information is communicated. If an issue is communicated poorly, or misunderstood, then there is a risk that people will change their behaviour and activities in inappropriate ways. To avoid this, benefit-risk management decisions are taken together with the communities affected. All aspects are taken into account to arrive at an option that will provide the most protection and be least detrimental to the communities.

Benefit-risk communications regarding diet are as specific as possible. Recommendations cover specific geographic regions and communities as well as which fish or wildlife population or herd is concerned. The recommendation also identifies the species and which part of the animal (e.g., liver, blubber, kidney, or muscle) contains the highest levels of contaminants.

As the NCP research shows, in some specific cases there may be health risks associated with exposure to contaminants. In the North, experts currently believe that the known risks are virtually always outweighed by the benefits of continued consumption of traditional/country foods.

Mercury in Salluit, Nunavik

During Phase II of the NCP, a follow-up study was done on the levels of mercury in residents of Salluit, Nunavik. This study was requested by the Municipal Council of Salluit, and the focus was on residents who had been tested for mercury during the late 1970s.

The earlier study by Health Canada had shown that 17% of the residents of Salluit contained levels of mercury above the "action level" of 100 µg/litre. At the time, residents received letters informing them that the fish, and possibly also the whales and seals were "poisoned". Coverage of the issue by the media, as well as an unconnected issue about contaminant intake levels elsewhere in the world led residents to stop harvesting and eating traditional/country food, even though no acceptable and affordable healthy foods were available.

Further research in the original study showed that the main sources of the mercury were beluga and lake trout, and that residents should continue to eat traditional/country foods on the "safe" list. To protect the fetus, pregnant women were advised to avoid beluga meat and muktuk, large lake trout and seal liver, if other traditional/country foods were available. The study year, 1978, turned out to be an abnormally high year for mercury levels because of the large beluga harvest the previous year.

In the follow-up study, researchers found that people remembered some of the information communicated in the 1970s, but that over time they had returned to normal eating habits. Nearly 40% of the residents of Salluit are still concerned about mercury levels, but nearly all say that eating traditional/country food is healthy.

At the end of 1999, communications activities were planned and carried out together with the Community Health Representative of Salluit, the researcher involved in the 1998–1999 data collection, and the Nunavik Nutrition and Health Committee. Various methods were used to communicate the main messages, and feedback from community residents indicates that these were well received. The opportunity for researchers, Nunavik Nutrition and Health Committee representatives, regional health officials and local representatives to provide feedback on and fine-tune the message, before it was delivered, was a critical step in the communication.

4.6 Knowledge gaps and future work

A significant and important part of NCP human health research is evaluating and communicating the benefits of traditional/country foods and the risks from contaminants, so that residents are able to make informed decisions about food use. In northern Canada, currently known risks are outweighed by the benefits of continuing to eat traditional/country foods. The uncertainty surrounding risks and benefits will continue to influence this large and complex public, moral and political health issue.

It is very difficult to assess the effects of contaminants found in traditional/country foods on human health. Many factors contribute to the health of an individual such as lifestyle (e.g., alcohol, smoking, and substance abuse), diet, social and economic conditions, and genetics. Contaminants are also a health issue in the North.

Traditional/country foods are and continue to be an important and integral part of good health among Aboriginal peoples. These foods have remarkable nutritional value providing much of the daily diet of Aboriginal northerners. These foods help people fight illness, injury and disease better than do the popular market foods. Hunting, preparing and sharing traditional/country foods bind Aboriginal people together and allow sharing and teaching of traditional values. The social, cultural, spiritual and economic benefits of these foods must be considered together with the risks of contaminant intake.

Switching to popular market foods often results in people becoming overweight, and developing "western-style" health problems such as diabetes and heart disease. Further, a diet of healthy market foods is beyond the means of most Aboriginal northerners. More research is needed on the negative health consequences of not consuming traditional/country food.

The main contaminants of potential concern in traditional/country foods are mercury, PCBs, chlordane and toxaphene. These biomagnify and bioaccumulate in the food web.

ITK/Eric Loring

In the Kivalliq and Baffin regions, more than 25% of the population is taking in levels of mercury higher than the TDI, the level known to be safe. The risks of these higher levels of mercury intake need to be studied further, especially in the Baffin and Nunavik regions. Currently, the benefits of using traditional/country foods are still considered to outweigh the risks from mercury. This is especially true given that a diet of the popular market foods is generally unhealthy and that the healthy market foods are often unaffordable for many Aboriginal northerners.

It is difficult to draw conclusions about whether contaminant levels are increasing or decreasing in the northern population. Regular monitoring should continue, especially for mercury and selenium, using standard methods that allow comparisons to be made.

The slightly higher lead levels in the blood of some northerners are likely due to the use of lead shot for hunting. The lead from the shot is absorbed by the animal and later consumed. Most cadmium is believed to come from smoking cigarettes. For some people (especially smokers), the additional cadmium obtained from traditional/country foods may be significant.

Average intake levels of chlordane and toxaphene are higher than the TDI values in mothers from the Inuvialuit, Kitikmeot, Kivalliq and Baffin regions. Intake levels of PCBs in Baffin region are also higher than the TDI. Despite this, health officials and community members have concluded that it is still healthier to eat these traditional/country foods than to switch to the often poor quality and expensive market foods.

GNWT/NWT Archives/Tessa Macintosh

It is important to continue monitoring the intake patterns in communities consuming the most traditional/country foods containing contaminants. The levels of mercury, chlordane, toxaphene, PCBs and other POPs in the northern population should also continue to be monitored. This will provide information on: the intake levels of contaminants; the levels found in people; regional variations in these levels; and if the levels are increasing or decreasing.

A major gap in contaminants human health research concerns the toxic effects of contaminants on northern peoples, and if and how contaminants are related to health problems. While research in the Faroe Islands shows that mercury may lead to slow development and behavioural problems in children, other studies elsewhere in the world do not show such effects. The ongoing study with mothers and children in Nunavik should shed more light on the intake of contaminants and how these may be affecting children's development and ability to fight infection and disease.

There is early evidence that vitamin E, and a combination of vitamin E and selenium may provide some protection against mercury. Certain fatty acids and fish protein may also help. Vitamin E and omega-3 fatty acids may also help protect people from the effects of PCBs. A controlled human study of the effects on methylmercury of various nutrients such as omega-6 fatty acids, selenium and vitamin E would be useful to confirm the results obtained from animal experiments.

It is very difficult to draw conclusions about the health effects of POPs on people based on experiments with animals. More research is needed on how the levels and effects of chlordane on experimental animals can be related to effects in people.

The only recent study on the health effects of contaminants in the Canadian North is being carried out in Nunavik. This study suggests that the levels of POPs in pregnant mothers are associated with infections in their infants during their first year of life. However, it has been difficult to find ways to predict the effects. New prediction methods should be explored in the Nunavik study as well as in studies elsewhere in the circumpolar Arctic.

The Nunavik study should help researchers separate the effects of PCBs and those of mercury. There are opportunities to look at the effects of other contaminants on the development of the fetus, the infant and older children.

It is recommended that the research funded by the NCP and Health Canada on toxaphene be published as peer-reviewed literature. More research is needed on how the various types of toxaphene bioaccumulate and behave in animals, including people. This will shed light on the potential health effects of toxaphene on, for example, the ability of people to fight infection and disease, and the size of infants (as underweight babies may experience more health problems). The information will also help health officials decide on the appropriate safe intake levels (TDIs) for the various forms of toxaphene.

More work is also needed on the effects of mixtures of POPs in addition to the effects of individual POPs. Mixtures may interact with one another and cause stronger, weaker, or different health effects than expected. Particular attention needs to be given to the effects of mixtures on the development of the fetus and on breastfeeding infants. The effects of mixtures on the development and reproductive system of children, as well as their ability to fight disease and infection, should also be studied further.

Some radionuclides are naturally occurring and are responsible for most of the radiation experienced by consumers of traditional/country food. These radionuclides have been present in the Arctic environment for thousands of years at more or less the same levels as today and accumulate in the lichen→caribou→human food web.

There is ongoing concern about the effects of naturally occurring polonium-210. Research is being conducted to see if this radionuclide affects the cells of animals and people. This work needs to be completed, either to show that there are no effects, or to serve as an early warning long before health effects become obvious.

Effective communication is fundamental to the aims of the NCP. Communications include traditional knowledge on the nutritional benefits and risks associated with the consumption of traditional/country foods and of market foods, and on the importance of a traditional lifestyle to overall health and well-being. There is a need to formally evaluate the effectiveness of health advice and advisories. Not enough is known about which communication methods are the most effective, or what effect the release of contaminant information has on people.

Health professionals and environmental managers must consider both sides of the issue when providing health or consumption advice. If an issue is not communicated well, or is misunderstood, then there is a risk that people will change their behaviour and activities in inappropriate ways. To avoid this, benefit-risk management decisions are taken together with the communities affected. All aspects are taken into account to arrive at an option that will provide the most protection and be least detrimental to the communities. These efforts provide northerners with the appropriate information to make more informed decisions about harvesting and consumption of both traditional/country foods and market foods.

Few projects have yet been conducted under the NCP that focus on public perceptions of contaminants in traditional/country foods. The perception of risk, how the issues are understood (or misunderstood), and how individuals behave as a result need to be studied further. For example, research is needed on how women of childbearing age use information to make informed decisions about the consumption of traditional/country foods, especially those known to contain PCBs and mercury.

Another area for improvement is the language in which benefit-risk information is communicated. Written material would become easier to understand if different community dialects were taken into account during development.

Overall, it is now known that in some limited and specific cases, there may be health risks associated with contaminant intake. In the Canadian North, these risks are usually outweighed by the benefits of continuing to eat traditional/country foods, especially as no other healthy and affordable options are available.

ITK/Eric Loring

ITK/Eric Loring and ITK/Scot Nickels

Chapter 5

Education, Training, Capacity Building and Communication

The NCP recognizes that any information northerners receive about contaminants in traditional/country foods may have significant impacts on their diet, economy and way of life. The NCP, therefore, invests considerable time and resources for education, training, capacity building and communication.

Several methods and activities have been used in the NCP to provide education and training and capacity building in the Canadian North. These include specific educational materials for the school curriculum, Regional Contaminants Coordinators, frontline training courses, community tours, and Elder-scientist retreats.

Of the many ways that the NCP communicates with community members, one-on-one communications and small groups have proven very effective. The various methods used in communication, training, education and capacity building need to be formally evaluated. While informal experience-based evaluation has been ongoing, sometimes important points can be missed.

Another area that needs to be evaluated is the effect that the information communicated has on people. There are various communication activities and materials now being developed which are new and innovative and based on a better understanding of what works locally.

The NCP has put forth significant effort to ensure that messages based on both scientific and traditional knowledge have been delivered in a culturally appropriate, accessible, and understandable manner. The lessons learned from experience are invaluable in the ongoing delivery and exchange with northern residents on these issues.

5.1 Curriculum development for northern schools

The Aboriginal Partners and NCP identified the need for environmental education to support the capacity of communities and regions to deal with contaminants issues. Teachers in the Yukon, Northwest Territories and Nunavut were open to including such information. As a result, educational materials were developed to teach children and youth about contaminants in the North.

The Metis Nation–NWT developed materials for Northwest Territories classrooms based on information relating to the NCP. The project model was developed with the involvement of teachers, school boards, and the Government of the Northwest Territories Department of Education.

Materials subsequently developed for schools in the Yukon differed from those in the Northwest Territories, to reflect the regional situation. School children were also involved in developing these materials.

The curriculum projects have brought the contaminant issue into northern classrooms where they have reached northern youth and will continue to be used for many years.

Frontline training courses	
Iqaluit February 1998	32 participants from the Baffin Region
Aklavik (Akłarvık) March 1998	11 participants from Mackenzie (Dehogà) Delta communities (Inuvialuit, Dene and Métis)
Yellowknife (Sǫ̀mbak'è) November 1998	24 participants from the Kitikmeot Region and Yellowknife
Kangiqtinq (Rankin Inlet) January 2000	21 participants from Kivalliq communities
Whitehorse February 2001	over 20 participants from 14 Yukon First Nations communities
Nain (Nunaingak) March 2000	18 participants from the 5 north coast communities
Total	**126 participants**

Denendeh National Office/Resource Centre

5.2 Regional Contaminants Coordinators

Regional Contaminants Coordinators (RCCs) are another new and successful channel of communication set up under Phase II of the NCP. With the support of the Aboriginal Partners, RCCs act as community and regional coordinators for some research activities, as well as communicators and program representatives at the community level. The development of Regional Contaminants Coordinator (RCC) positions has been an important step in achieving two-way communication between the NCP and Canadian northerners.

Positions for one year were created in regions where there were human safety concerns relating to contaminants. Not every region in the North has received a RCC. Individuals who have been hired as RCCs take on increasing responsibility when possible. They provide a bridge between community members and the NCP scientists and committees. As these individuals are often local residents, they have been able to forge relationships of trust with their communities.

Because the RCC positions are successful in providing experience and supporting interest in contaminant issues, many RCCs have been able to move on to positions of greater responsibility, or higher education.

5.3 Frontline training courses

In the small northern communities, people are most likely to turn to people such as community health workers, wildlife officers, fisheries officers, renewable resource representatives, regional and local Aboriginal organization representatives, Elders etc. for information. These people are therefore in the "front line" for communicating and/or discussing contaminant information. These frontline workers have an immense responsibility — the whole community looks up to them, and makes decisions potentially based on their advice.

To respond to these needs, frontline training courses on contaminants were provided to northern community professionals, Elders and youth in Labrador, Nunavut and the Northwest Territories. The courses were based on materials developed by the Metis Nation–NWT which also helped to run the courses.

Locations of frontline training courses and community tours that took place in northern Canada during Phase II of the NCP.

"I am really glad that you guys are here today because before this meeting I've been concerned about eating country foods because of contaminants. This meeting puts a smile back on my face. And I can continue eating country food again".

Elder from the HTO in Ausuittuq (Grise Fiord), from the 2000 Eastern Arctic Tour

In 2001 the Dene Cultural Institute carried out an evaluation of the materials and how they were used. This involved interviewing environmental science teachers in the Northwest Territories and Yukon, and resulted in recommendations to improve the materials.

Since the first course in 1997, over 100 northerners have participated in the courses. This has greatly increased the awareness of contaminant issues at the grassroots level.

The frontline training course brought community Elders and staff from different government departments together to discuss a common issue. Participants were exposed to different aspects of contaminants, and gained a greater understanding of the issues.

5.4 Community tours

Community tours were a new and well-received method of communication developed during Phase II of the NCP. Small teams of experts were brought to 32 Inuit communities, four Gwich'in communities and seven Dene and Métis communities between 1999 and 2002. The teams were composed of an Aboriginal Partner, a health expert, a scientist, and a Regional Contaminants Coordinator. The purpose of the tours was to present information about contaminants and related topics.

The community tours have had considerable success, with the crucial factor being the people involved. There needs to be someone involved who is accountable and trusted by the community. It is vital that crosschecking with communities takes place to ensure that tours will not compete with social activities like bingo, a local hockey game, church services or other important meetings.

Denendeh National Office/Resource Centre

ITK/Eric Loring

5.5 Elder-scientist retreats

Retreats that bring Elders and scientists together is another way in which the NCP has built relationships among these groups with diverse views of the world.

"A perfect setting for thought-provoking discussions on how traditional knowledge is being applied to environmental contaminant crises. It gave me an opportunity to experience Dene culture first-hand, and consequently has changed the way that I implement southern standards in the North."

(from a written evaluation of the 1999 retreat)

Elder-scientist retreats

Though northern communities in the NWT were becoming more involved in the planning and implementation of research in their region, there was still a gap between western science and Dene knowledge. The Dene Nation realized that for these two groups to benefit from each other, a relationship of trust and respect was needed, and that familiarity was the key to building this relationship. The idea of retreats was developed as a way for Elders and scientists to gain a better understanding of each other, thus laying the groundwork for effective two-way communication. Additionally, many researchers expressed the wish to involve communities and incorporate traditional knowledge (TK) in their research, and saw the retreats as an opportunity to learn more about TK.

In total, there have been four Elder-scientist retreats, each entitled "Strengthening the Ties". The first took place in February of 1997, with subsequent retreats held approximately one year apart. The retreats were intended to have an informal atmosphere in which Elders, scientists, and youth could spend time together and form personal relationships. Retreat locations, time frames, and activities combined to contribute to building trust and respect between Elders and scientists.

Communication was identified as key to building trust and respect between community members and scientists. To this end, time was devoted in each retreat to finding ways to improve communication between groups. Elders commented that scientists need to know how to make initial contact with a community for proposed research.

ITK/Eric Loring, ITK/Scot Nickels, Denendeh National Office/Resource Centre

Chapter 6

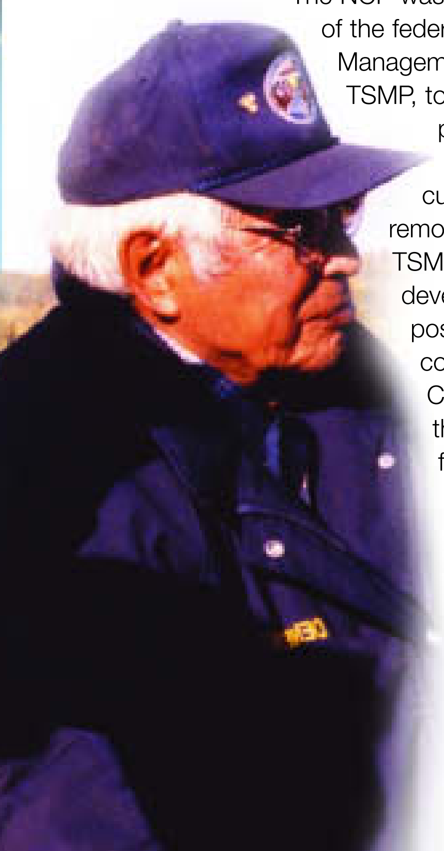
Action at the National and International Levels

The NCP has led Canada to produce world-class science on the past and current sources of metals and POPs, and in predicting their movement through the atmosphere. Canadian scientists are monitoring the accumulation of these contaminants up the food web and in people, and studying their potential effects on human health.

The results of these NCP studies have provided the basis for policy decisions and action in Canada and on the international stage. Many of the actions taken at the national level have been used to take action at the international level.

Canadian northern Aboriginal organizations have played a particularly key role over the years, especially at the international level.

6.1 National initiatives



The NCP was influential in the development of the federal Toxic Substances Management Policy (TSMP). Under the TSMP, toxic contaminants which result primarily from human activities, and are persistent and bioaccumulative, are targetted for removal from the environment. The TSMP was particularly useful in developing Canada's international position on specific toxic contaminants of concern to Canada. It is no coincidence that the contaminants targetted for control under the United Nations POPs Convention (the Stockholm Convention), the United Nations Economic Commission for Europe Long-range Transboundary Atmospheric Pollution Convention (UN/ECE LRTAP Convention) POPs Protocol, and the TSMP are the same main contaminants of concern in the Canadian North.

The Canadian Environmental Protection Act (CEPA) requires that new chemicals be evaluated for their persistence, tendency to bioaccumulate, and toxicity. Canada is now deciding which new POPs will be next ones evaluated under CEPA. The NCP, by working to identify "new" persistent contaminants in the northern environment and their potential effects on people and ecosystems, has played an important role in identifying many of these new contaminants. Research under the NCP has shown that flame retardants such as the polybrominated diphenyl ethers (PBDEs), short-chain chlorinated paraffins, short-chain polychlorinated n-alkanes (PCAs) and polychlorinated naphthalenes (PCNs) are now being detected in the Canadian North. These are likely to undergo CEPA assessments.

Another initiative that was strongly influenced by the NCP was the domestic control of lindane (a type of HCH). The Pest Management Regulatory Agency (PMRA) began a special review of lindane in 1999 after Canada signed the UN/ECE POPs Protocol under the LRTAP Convention. The largest use of lindane in Canada was for seed treatment in canola. With the cooperation of the PMRA, the Canola Council of Canada and the Canadian Canola Growers Association successfully negotiated with lindane users to voluntarily stop using lindane. As part of this agreement, lindane-treated canola seed has not been used in Canada since July 2001. The last remaining above-ground uses of lindane stopped in late 2001. The NCP played a significant role which led to the PMRA special review of lindane. The NCP had reported levels of HCHs that were of concern in humans as well as in the animals important to the diets of northerners, such as marine mammals.

The Toxic Substances Research Initiative (TSRI) provides research results to decision makers who then use this information when developing toxic substance regulations, legislation and policies in Canada. The NCP managers helped to set TSRI scientific priorities based on NCP results, and to develop the management structure based on the effective shared management approach used in the NCP. The NCP managers continue to sit on the TSRI Management Committee where they provide direction and review scientific priorities based on recent NCP results.

The particular vulnerability of children to a wide range of environmental contaminants is now recognized in Canada and throughout the world. Results and data from NCP studies on contaminants and their effects on the developing fetus, infants and preschool children has helped to set the federal agenda on children's health. As a result, the federal government now gives special attention to the ways in which northern Aboriginal children are exposed to contaminants, and to the levels and effects of these contaminants on their health. This information also feeds into a Canada–United States–Mexico initiative under the North American Free Trade Agreement (NAFTA) Commission for Environmental Cooperation (CEC) on North American Children's Health and the Environment. This initiative considers chemical pollutants, pesticides and toxic metals as some of the key environmental threats to children's health. The NCP continues to provide direct input and direction to both the federal and CEC initiatives through consultation and representation on a federal interdepartmental working group on children's environmental health.

The "Dirty Dozen" POPs

The UNEP Global POPs Convention covers what have become known as the "Dirty Dozen" POPs: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene, PCBs, dioxins and furans.

Under the convention, governments are obliged to restrict, phase out and ban the production and use of POPs pesticides and industrial chemicals, and minimize releases of by-product POPs.

6.2 International agreements

By the late 1980s several northern countries were detecting POPs. Aboriginal peoples living a traditional way of life in northern regions were being affected by contaminants produced mostly in the south. This information rapidly caught the attention of the media, the general public and politicians.

International agreements to restrict emissions were recognized as the only long-term solution. To reduce or eliminate contaminants in the North required concerted and cooperative global action. The NCP had a strong influence on international agreements, concluded in 1998 and 2001, to significantly reduce emissions of key POPs to the environment.

The NCP research results contributed to the UN/ECE LRTAP Convention negotiating sessions in Geneva in 1997 and 1998 for protocols addressing heavy metals and 16 POPs, all of which are of concern in the Canadian North. The objective of the POPs Protocol is "to control, reduce or eliminate discharges, emissions and losses" of 11 pesticides, two industrial chemicals, and three by-products. It makes special reference to the distinct concerns of Arctic and Indigenous peoples. Both protocols were signed by 36 countries in Aarhus, Denmark in June 1998 and will enter into force when ratified by 16 countries. As of October 2002, the POPs Protocol had been ratified by 13 countries, as had the Heavy Metals Protocol. Canada ratified both protocols in December 1998.

Northern Canadian Aboriginal leaders together with Nelson Mandela at the United Nations POPs negotiations in Nairobi, Kenya. *ICC/Terry Fenge*

The NCP data also contributed significantly to the United Nations Environment Programme (UNEP) Global POPs negotiations which were held in several world cities in the late 1990s and the year 2000. The purpose of the UNEP Global POPs Convention is to:

- eliminate or severely restrict the production and use of certain POPs;
- ensure environmentally sound management and disposal of POPs waste; and
- prevent the emergence of new chemicals with POPs-like characteristics.

Like the UN/ECE LRTAP POPs Protocol, the preamble of the convention specifically acknowledges the special situation and risks faced by the Arctic and Aboriginal peoples. The resulting convention was signed in Stockholm in May 2001 by 114 countries. As of October 2002, 151 countries had signed the convention, and 22 had ratified it. Canada was the first country to ratify the convention.

The Canadian Arctic Indigenous Peoples against POPs (CAIPAP) group was formed in March 1997 to influence Canada's position in the ongoing UN/ECE LRTAP negotiations and the proposed UNEP Global POPs negotiations. Members of CAIPAP were the NCP Aboriginal Partners (Inuit Circumpolar Conference Canada, Inuit Tapiriit Kanatami, Dene Nation, Metis Nation– NWT, and Council of Yukon First Nations). It is widely accepted that CAIPAP participated actively and very successfully in the global POPs negotiations. This was possible, in part, due to the intellectual and financial support provided by the NCP.

An Inuit carving of a mother and child was presented to the Executive Director of UNEP (Mr. Klaus Topfer). Mr. Topfer then suggested that Indigenous peoples symbolized by the carving were the "conscience" of the negotiations and that the world was obliged to take their concerns seriously. The carving sat on the chair's table at all subsequent negotiations and now has pride of place at UNEP's headquarters.

Canadian Arctic Indigenous Peoples Against POPs (CAIPAP)

Sheila Watt-Cloutier, President of ICC Canada, spoke to the UNEP Global POPs negotiating team:

"…imagine for a moment if you will the emotions we now feel: shock, panic, grief — as we discover that the food which for generations nourished us and keeps us whole physically and spiritually, is now poisoning us. You go to the supermarket for food. We go out on the land to hunt, fish, trap, and gather. The environment is our supermarket… As we put our babies to our breasts, we feed them a noxious chemical cocktail that foreshadows neurological disorders, cancers, kidney failure, and reproductive dysfunction. That Inuit mothers — far from areas where POPs are manufactured and used — have to think twice before breastfeeding their infants is surely a wake-up call to the world."

In May 2001, Prime Minister Jean Chrétien wrote to Inuit leaders: "As you are aware, Canada is the first country to announce that it will both sign and ratify the UNEP Global Convention on Persistent Organic Pollutants in Stockholm on May 23. Canada's leading role in concluding this treaty reflected the strong engagement of Northern Aboriginal leaders such as yourselves, early Arctic Council work and the importance of the Northern dimension of our foreign policy."

The Arctic Monitoring and Assessment Programme (AMAP) of the Arctic Council draws heavily upon NCP research in northern Canada and elsewhere in the circumpolar Arctic. In 1997, following recommendations by AMAP, the ministers for the Arctic Environmental Protection Strategy (which later evolved to become the Arctic Council) committed in Alta, Norway to make a stronger effort to promote international cooperation to address serious risks from contaminants. They also committed to make a determined effort to gather support for international action to reduce contaminants in the circumpolar Arctic.

It took less than 15 years (light speed for international diplomacy) to move from initial research that identified a POPs-related problem in the Canadian North to a global convention that addresses the issue. The role played by the NCP during this period was crucial. Not only did the NCP generate scientific data to convince skeptics of the nature of the problem, it educated and equipped Aboriginal peoples so they could effectively represent their interests on the international stage.

The NCP model is now well-known and is being copied in the circumpolar Arctic. Aboriginal peoples in northern Canada also view the NCP as a model for other research and monitoring programs to address issues such as climate change and biodiversity conservation, which are of international importance in the Arctic.

Inuit Circumpolar Conference and AMAP

The Inuit Circumpolar Conference Canada helped to develop the following policy recommendations for AMAP in 1997–1998. Many of these recommendations were based on the NCP experience.

"To ensure the interest and active knowledge of Arctic Indigenous peoples and other Arctic residents, the Arctic countries should:

- *Improve the use of indigenous knowledge in environmental research, including local participation, and policy.*
- *Establish a long-term communication program to provide public information concerning envi-ronmental contaminants, linked to AMAP, which gives access to sound and regularly updated information in an understandable language.*
- *Integrate contaminants issues for different educational levels in order to raise general environmental and scientific literacy among Arctic residents, including indigenous peoples."*

Appendix A

A partial listing of traditional/country foods consumed by northern Aboriginal peoples

Traditional/ Country Food	Yukon First Nations	Dene and Métis	Inuvialuit	Kitikmeot	Kivalliq	Baffin	Labrador
Marine mammals							
bearded seal			•	•	•	•	•
beluga		•	•	•	•	•	•
bottlenose dolphin							•
bowhead			•	•	•	•	
elephant seal						•	
harbour porpoise							•
harp seal					•	•	•
hooded seal						•	
narwhal			•	•	•	•	
polar bear			•	•	•	•	•
ranger seal (harbour seal)					•		•
ringed seal (jar seal)			•	•	•	•	•
walrus			•	•	•	•	
Land mammals							
barrenland caribou	•	•	•	•	•	•	
beaver	•	•	•				•
bison	•	•					
black bear	•	•		•			•
Dall's sheep	•	•	•				
fox			•	•			
ground squirrel (gopher)	•		•	•			
hoary marmot (groundhog)	•						
lynx	•	•	•				•
moose	•	•	•	•			•
mountain goat	•						
mountain sheep (bighorn)	•						
mule deer	•						
muskox			•	•	•	•	
muskrat	•	•	•				
porcupine	•	•					•
rabbit		•	•	•	•	•	•
snowshoe hare	•						
woodland caribou	•	•	•				•

A partial listing of traditional/country foods consumed by northern Aboriginal peoples

Traditional/ Country Food	Yukon First Nations	Dene and Métis	Inuvialuit	Kitikmeot	Kivalliq	Baffin	Labrador
Birds (land and marine)							
Arctic tern	●		●	●	●	●	●
black guillemot					●	●	
blue goose	●						
blue grouse	●						
brant goose	●						
Canada goose	●	●					
canvasback		●					
eider duck			●	●	●	●	●
fish duck		●					
goose (unspecified)			●	●	●	●	●
long-tailed duck		●				●	
loon		●	●	●			
mallard duck		●					
marsh duck			●	●		●	●
merganser							●
murre (turre)					●	●	●
owl			●				
partridge							●
pintail duck		●					
ptarmigan (rock or willow)	●	●	●	●	●	●	
sandhill crane	●		●	●			
seagull (herring gull)	●		●	●	●	●	●
sharp-tailed grouse (prairie chicken)		●					
snow goose	●	●					
spruce grouse	●						
spruce hen		●					
surf scoter (black duck)	●	●	●				●
swan (trumpeter or tundra)	●	●					
whistling duck		●					
white-fronted goose	●						
white-winged scoter (black duck)	●	●	●				●
wood duck		●					
yellow-leg goose		●					

A partial listing of traditional/country foods consumed by northern Aboriginal peoples

Traditional/ Country Food	Yukon First Nations	Dene and Métis	Inuvialuit	Kitikmeot	Kivalliq	Baffin	Labrador
Fish and seafood (land and marine)							
Arctic char	●	●	●	●	●	●	●
Arctic grayling (bluefish)	●	●	●	●	●		
Atlantic mackerel							●
capelin							●
cisco		●	●	●			●
clams					●	●	●
cod (Arctic or rock)		●	●	●	●	●	●
crab			●	●	●	●	●
flounder			●			●	●
grenadier							●
halibut	●						●
herring			●				
herring (least cisco)	●						
eulachon (ooligan)	●						
inconnu (connie)	●	●	●			●	
jackfish (northern pike)	●	●			●		
loche (burbot, ling cod)	●	●	●				
longnose sucker	●	●					
mussels			●	●	●	●	●
pickerel (walleye)		●					
redfish							●
salmon (chinook/king, chum/dog/keta, coho/silver, or sockeye/red)	●	●	●				●
scallops					●	●	●
sculpin			●	●	●	●	●
sea cucumber						●	
sea urchin					●	●	●
seaweed/kelp			●		●	●	●
shrimp					●	●	●
smelt							●
snails						●	
squid							●
trout (brown, Dolly Varden, lake or rainbow)	●	●	●	●	●	●	●

A partial listing of traditional/country foods consumed by northern Aboriginal peoples							
Traditional/ Country Food	**Yukon First Nations**	**Dene and Métis**	**Inuvialuit**	**Kitikmeot**	**Kivalliq**	**Baffin**	**Labrador**
turbot							●
whitefish (broad, lake or round)	●	●	●	●	●	●	●
winkles							●
Land plants							
Arctic dock (rhubarb)	●		●				●
balsam fir	●						
“banana” yellow flower			●				
beach peas							●
bear root	●						
bearberry (kinnikinick)	●				●		
birch	●	●					
black spruce	●						
blackberry		●					
blueberry (bog, Canada, highbush, or low)	●	●	●	●	●	●	●
bristly black currant	●	●					
caribou weed	●						
caribou moss	●						
carrot root						●	
cloudberry (bakeapple)	●	●	●	●	●		●
cranberry (bog, highbush, lowbush or rock)	●	●	●	●	●	●	●
crowberry (black berry)		●	●	●	●	●	●
dandelion	●	●				●	●
dwarf dogwood							●
fireweed	●	●					
gooseberry (green or purple)	●	●					●
honeysuckle	●						
juniper	●						●
Labrador tea	●	●	●				●
lodgepole pine	●						
maliksuargait					●		
marshberry							●
mint	●						
mountain sorrel			●	●	●	●	
mushoo (bearroot or eskimo potato)			●				
mushrooms	●	●					●

A partial listing of traditional/country foods consumed by northern Aboriginal peoples

Traditional/ Country Food	Yukon First Nations	Dene and Métis	Inuvialuit	Kitikmeot	Kivalliq	Baffin	Labrador
muskeg tea		•					
northern black currant	•	•	•				•
poplar	•						
rat root (wild ginger)	•	•					
red currant	•	•	•				•
rice root (Indian rice)	•						
rosebuds	•						
rosehips	•	•					
rose leaves		•					
sage	•	•					
salmonberry	•						
saskatoon berry	•	•					
saxifrage			•			•	
soapberry	•						
spruce		•	•				•
spruce lichen	•						
spruce tea		•					•
squashberry				•		•	•
tulligununaks							•
wild chives (wild onions)	•	•					
wild greens		•					
wild parsnip		•					
wild peppermint		•					
wild red raspberry	•	•	•				•
wild rhubarb	•	•					
wild strawberry	•	•					•
willow	•	•				•	
wood sorrel (purple/red)			•	•	•	•	
yarrow (stink flower)	•	•					

Appendix B

Contact List

The following are the members of the Northern Contaminants Program Secretariat, the Aboriginal Partners, and the regional contacts for program in Indian and Northern Affairs Canada. Please contact these people for further information on the program or visit the NCP website:
http://www.ainc-inac.gc.ca/NCP/index_e.html

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Appendix C
Glossary

abiotic
An abiotic environment refers to the non-living natural environment made up of things such as air, water, snow, ice, permafrost, soil, rocks and minerals.

AMAP
The Arctic Monitoring and Assessment Programme (AMAP) is an international organization established in 1991 to implement parts of the Arctic Environmental Protection Strategy (AEPS). Now a program group of the Arctic Council, AMAP's current objective is "providing reliable and sufficient information on the status of, and threats to, the Arctic environment, and providing scientific advice on actions to be taken in order to support Arctic governments in their efforts to take remedial and preventive actions relating to contaminants".

archived
Archived samples are samples (e.g., organs or other parts of animals) that are stored, usually in freezers, for future analysis.

Aroclor 1260
Aroclor 1260 is a type of polychlorinated biphenyl (PCB) marketted under the trade name Aroclor. The number indicates an average 60% chlorination.

arsenic
Arsenic is a steel-grey metallic element that is found naturally in rocks and soil. When it combines with other elements, it can become poisonous, which makes it useful as an agricultural insecticide and poison. Arsenic can bioaccumulate in plants and animals.

bioaccumulation
Bioaccumulation is the buildup or storage of substances (such as contaminants) in the bodies of animals over time. Bioaccumulation takes place through eating other animals and drinking water containing these contaminants. Contaminants that bioaccumulate either do not change or are very slow to change into a form that can be digested and eliminated by the animal.

biomagnification
When an animal eats a plant or another animal, it consumes all the contaminants stored in that food. Contaminants can biomagnify in animals that eat other animals because the amount of the contaminant increases with each step from prey to predator.

biomonitoring
Biomonitoring is a method of testing and watching what happens to different contaminants in living organisms. For example, parts of polar bears may be analyzed to biomonitor POPs in the Arctic marine environment.

bromine
Bromine is a naturally occurring element. It is a dense, deep reddish brown liquid that is easily vaporized into a brownish-red vapour. Metal bromides occur in small amounts in seawater and salt deposits as well as in water from mineral springs. One of the most common uses of bromine is in the manufacture of gasoline. Bromine compounds are also widely used in pesticides and for treating plastic material and textiles to make them fireproof. When bromine reacts and combines with other substances, they become brominated.

cadmium
Cadmium is a heavy metal found naturally in soils and rocks. It is soft and has a silvery colour. It is mined and used in some industries to make things such as batteries, some pesticides, and some types of paint.

Canadian Arctic Contaminants Assessment Report – Phase II
This report, also referred to as CACAR-II, is a comprehensive assessment of contaminants in the Arctic. CACAR-II contains detailed results of all the research that was conducted since 1997 under Phase II of the NCP.

cancer
Cancer is a disease that results in uncontrolled, abnormal growth of the body's cells resulting in tumours (large masses of cells).

cell
The cell is the smallest living unit in the body. All living things, animals and plants, are made up of cells.

cesium
Cesium-137 is a human-made radioactive element produced by breaking up uranium atoms, such as in a nuclear power plant or in atomic weapons. It remains dangerous for a long time because it takes 30 years for it to lose half of its radiation.

chlordane
Chlordane is a colourless, odourless persistent organic pollutant used as an insecticide. It can affect the nervous system of humans and wildlife. Chronic exposure to humans can cause liver damage and possibly cancer. It is currently restricted in use for such things as termite control and non-food plants. It was used extensively in the 1960s and 1970s to kill cockroaches in peoples' homes but is used much less now.

chlorine
Chlorine is a naturally occurring, poisonous greenish-yellow non-metallic gas used to purify water, for bleaching and in the manufacture of many organic chemicals. It occurs naturally only as a component of salt, e.g., in sea water.

consumption advisories
Food consumption advisories are sometimes issued by the territorial government health departments in consultation with Health Canada when they determine that the level of contaminants in a traditional/country food may risk the health of those who eat this food. Such an advisory may recommend, for example, that people should only eat a certain number of livers from a particular fish species in a year.

contaminants
A contaminant is a substance that is found in a place where it should not be. It may not be harmful but it could be depending on what it is and the amount that is present. The types of contaminants that are found in the Canadian North include:

- Persistent Organic Pollutants (POPs), a group of mostly human-made chemicals which can stay in the environment for many years without changing. They can be transported over long distances in the atmosphere.
- Heavy metals such as mercury, cadmium, and lead.
- Radionuclides such as cesium, strontium, and polonium.

DDT
DDT stands for dichlorodiphenyltrichloroethane. It is a POP developed in the 1940s to kill lice and to kill biting insects that carry diseases such as malaria, yellow fever and typhus. DDT was heavily used to kill insects feeding on crops in the 1950s and 1960s in the Great Lakes region until it was found to be harmful to other forms of life. DDT is banned in Canada.

dioxins/furans
Dioxins and furans are highly toxic chemical substances. Dioxins and furans are known to cause serious health problems, including cancer, in laboratory animals. The biggest source of dioxins and furans in Canada is from the large-scale burning of municipal waste.

disease resistance
Disease resistance refers to the ability of animals and plants to withstand the attack of a disease.

ecosystem
An ecosystem is a system that is formed by the interactions of organisms with their non-living environment. The organisms and the environment work together as a unit, called an ecological unit.

element
An element is a natural substance that cannot be separated into smaller parts. For example, gold is an element; it contains nothing but gold. Water is not an element; it is made up of two elements: hydrogen and oxygen. Most elements are either gases or minerals. There are 109 elements, which combine in various ways to form everything in the world.

endosulfan
Endosulfan is a POP generally used as an insecticide in the control of crop insects and mites.

fatty acid
Fats are combinations of saturated (unhealthy) and unsaturated (healthy) fatty acids. The "essential" fatty acids (omega-3 and omega-6) are not made by the body and must be obtained from food. Omega-3 fatty acid (fish oil) is a healthy type of fat found in seafood, particularly fish that is fatty. Omega-6 is important for the growth and development of infants. Fatty acids help to control blood pressure, blood clotting, inflammation, and other body functions.

fetus
The unborn young of an animal or human that is still inside the womb of the mother.

food chain
Plants and animals can be linked together in feeding relationships called food chains. At the bottom of food chains are green plants that convert sunlight into food energy for the rest of the chain. Animals that eat the plants are then eaten by another animal, and so on up the chain. The number of animals involved can vary. For example, in the North, the lichen➔caribou➔human food chain has fewer feeding links, and is much shorter than the algae (a small plant that lives in water but needs sunlight)➔fish➔seal➔polar bear➔human food chain. In nature, food chains overlap to form food webs.

food web
A food web is a series of overlapping food chains. Food chains involve a series of organisms that eat one another. Food webs are more complex than chains as organisms often form part of more than one chain. This complicates the flow of contaminants and energy from one species to another.

grasshopper effect
The "grasshopper" effect explains the transport of certain contaminants to the Canadian North from warmer regions of the globe. Sometimes this transport occurs in a series of "hops". Some contaminants evaporate at warmer temperatures and are transported on winds and in clouds to the North where it is cooler. Here they may condense and fall to the surface. If temperatures rise, sometimes the contaminants will evaporate again and be transported even further north until they again reach cooler regions and condense and fall to the surface.

guidelines
A recommended limit for a contaminant in the environment (air, water, soil, food, wildlife, people) that is thought to be safe for people or the environment. A guideline is not legally enforceable.

heavy metals
Heavy metals are naturally occurring elements found in rocks and soils. They are also released to the environment by human activities. They generally do not change into other forms and therefore persist in the environment. Examples of heavy metals are mercury, cadmium and lead.

hexachlorocyclohexane (HCH)
Hexachlorocyclohexane (HCH) is a POP used to kill insects (insecticide). It does not break down easily in the environment, and can be transported great distances in the atmosphere.

inorganic
Inorganic material is inanimate (e.g., non-living) in nature and makes up the abiotic environment.

insecticide
A poison that kills only insects. An example of an insecticide is hexachlorocyclohexane (HCH).

iron
Iron is a metal that is naturally found underground and mined. Iron is also released to the environment by human activities. Iron is silvery in colour but rusts easily and turns orange when exposed to air and water. It is the most widely used of all the metals. People must include small amounts of iron in their diets to stay healthy.

lead
Lead is a soft, blue-grey, easily worked heavy metal that is naturally present in rocks and soils. It is used to make some kinds of glass, shot for shotguns, and combined with other metals for use in a variety of metallic items. Lead may be released to the environment by human activities, including the use of leaded-gasoline (in North America, lead was added to gasoline until the 1980s). Lead can be toxic to living things. In animals and people, lead accumulates in the brain and bones.

lichen
Lichen is a plant-like growth that is actually a result of a fungus and algae living together. It grows very slowly, lives for a long time, looks like moss or a crusty dry leaf and can grow on bare rock or soil. Lichen is an important food source for caribou.

long-range transport
Long-range transport refers to the movement of contaminants through the atmosphere or the ocean from distant sources. Many contaminants that are detected in the Arctic have been used in places rather far away but travel through the air and ocean currents eventually reaching the Arctic where they are deposited.

mercury
Mercury is a heavy metal that is naturally found in rocks and soil in combination with other chemicals. It is the only metal that is liquid at room temperature. It is silvery in colour and flows easily so it is sometimes used in thermometers. There are many human-made sources of mercury that are released to the atmosphere. Also, mercury may be released when soils are flooded for creating reservoirs

(e.g., reservoirs for hydroelectric dams). Mercury is toxic to most living things. It accumulates in the liver, kidneys, hair, and skin of animals and people.

methylmercury
Mercury, like other metals, can be found in different chemical forms in the environment. Methylmercury is the form of mercury that is most likely to cause adverse health effects. Methylmercury can also bioaccumulate and biomagnify in food webs. Methylmercury can accumulate in the brain.

micrograms per gram (µg/g)
This is a very small unit used to measure concentrations. It is also sometimes called parts per million (ppm). The amount is about one drop in a fuel drum.

nanograms per gram (ng/g)
This is a very small unit used to measure levels, 1000 times smaller than µg/g. It is also sometimes called parts per billion (ppb). The amount is about one drop out of all the water in nine full water trucks.

millisieverts
The sievert (Sv) is the unit used to measure radiation doses. A millisievert (mSv) is a thousandth of a sievert.

Northern Contaminants Program (NCP)
The Northern Contaminants Program (NCP) has been developed through consultation with the scientific community, Northern Aboriginal organizations, other governmental departments, and Northern communities. Its goal is to reduce and wherever possible eliminate contaminants in traditional/country food. This goal is supported by involving Northerners in the program, and by providing them with the tools and information for making their own informed decisions on food consumption.

organic
Organic material is derived from living organisms and is made up of carbon-based compounds.

PBDEs/BDPEs
Polybrominated diphenyl ethers and brominated diphenyl ethers are a group of human-made chemicals that are used as flame retardants in various plastic materials, such as polystyrene.

PCBs
Polychlorinated biphenyls (PCBs) are a group of human-made industrial POPs. There are many different kinds of PCBs. Because they do not conduct electricity, PCBs were used as insulators in electrical transformers starting in the 1930s. PCBs do not break down easily in the environment and there is concern that they may be harmful to living things. Some kinds of PCBs are thought to cause cancer and may contribute to other subtle effects in unborn children. The use of PCBs was banned in many countries, including Canada, in the 1970s.

perfluorinated acids (PFAs)
Perfluorinated acids (PFAs) have no known route of degradation or change under normal environmental conditions, meaning that they are extremely persistent in the environment. Examples of PFAs are perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).

perfluorooctane sulfonate (PFOS)
Perfluorooctane sulfonate is an example of a perfluorinated acid (PFA) that has recently been found in the liver and blood of polar bears and seals in the Arctic, including some samples from Nunavut. There is concern about the presence of this chemical in the environment as it is highly persistent and not known to degrade. PFOS can cause cancer, lead to enlarged livers as well as affect the fertility of wildlife.

perfluorooctanoic acid (PFOA)
Perfluorooctanoic acid (PFOA), is a perfluorinated acid (PFA) that has recently been identified in the liver and blood of polar bears and seals in the Arctic, including some samples from Nunavut. There is concern about the presence of this chemical in the environment as it is highly persistent and seems not to degrade. It can cause cancer, lead to enlarged livers as well as affect the fertility of wildlife.

persistent
Persistent, when referring to chemicals, is the resistance of a chemical to degrade or disappear. A persistent chemical, once introduced, stays in the environment for an indefinite length of time.

persistent organic pollutants (POPs)
Persistent organic pollutants (POPs) are a group of human-made chemicals used as pesticides and as industrial chemicals. POPs can be transported long distances in the atmosphere and can stay in the environment for many years.

pesticides
Pesticides are poisons used to kill pests (plants or animals that are considered to be a nuisance or harmful). There are two main types: insecticides, used to kill insects; and herbicides, used to kill weeds, mold, and fungus. Chlordane, toxaphene, HCH, and DDT are examples of pesticides.

pollutant
A pollutant is any human-made substance that can damage the environment (air, water, or on the land).

polonium
Polonium is the most commonly found natural radionuclide. It occurs in the rocks and soils of the North.

polychlorinated n-alkanes (PCAs)
Polychlorinated n-alkanes are a group of toxic chemicals. Their most common applications include use as high temperature lubricants in metal-working machinery.

polychlorinated naphthalenes (PCNs)
These chemicals are a group of 75 compounds which have been used as lubricants, fungicides, insecticides, and as insulators which pre-date PCBs. They are similar in structure to PCBs, and are toxic.

quality assurance/quality control
Because research is conducted by many different people in many regions across the country, it is often difficult to ensure that data is produced according to the same standards. Quality assurance/quality control is a system of procedures and corrective actions that attempt to ensure that the different research studies, environmental monitoring and sampling, and other technical and laboratory activities can be compared and that the data reported are of the highest quality.

radionuclides
Radionuclides are atoms that emit radiation and, like heavy metals, are naturally present in rocks and soils. They may also be human-made. Radionuclides tend to accumulate in the bones and muscles of animals and people. Natural radionuclides in the Canadian North include polonium and uranium.

risk assessment
The qualitative and quantitative study of the risk posed to human health and the environment by the presence and/or use of specific contaminants.

selenium
Selenium is a nonmetallic element that resembles sulphur. It can be naturally found in rock and soils in certain regions. It is thought that at the right level, it may reduce the effects of mercury, but this has not yet been proven.

smelting
Smelting is the process of removing metals, such as lead and gold, from rocks through melting. Smelting may result in the unwanted release of metals to the environment.

strontium
Strontium is a naturally occurring radioactive element which is used to find out the age of rock and sediments.

temporal trends
Temporal trends are changes over time.

tolerable daily intake (TDI)
Tolerable daily intake, or TDI, is the amount of a contaminant that is safe for humans to take in every day for an entire lifetime (i.e., long-term exposure). TDI levels are calculated based on data for large groups of people. An acceptable intake level for an individual person may be somewhat different than the (group) TDI. If a person takes in an amount higher than the TDI it does not necessarily mean that health problems will develop. It means only that the margin of safety is reduced, and there is a greater risk of developing a health problem. TDIs are developed with a high degree of caution and a very large safety factor. Only extremely low risk is associated with taking in contaminants up to the TDI level.

toxaphene
Toxaphene is a POP that was used as a pesticide from the 1950s to 1970s. It is very poisonous to living things, especially fish. Toxaphene has never been licensed for use in Canada, and it was banned in the United States in 1982.

toxic (toxicity)
Toxic (toxicity) refers to the capability of a substance to cause harm or be poisonous to humans, animals, or other living things. In common usage, the term toxic substances refers to chemical substances that are capable of causing harm at very low levels of exposure.

toxicology
Toxicology refers to the scientific study of the effects, chemistry, and treatment of poisonous (toxic) substances.

zinc
Zinc is a metal found naturally in the environment and released by the activities of humans. People must include small amounts of zinc in their diet to stay healthy.

zooplankton
The passively floating or weakly swimming usually extremely tiny animal life in a body of water.