Northern Contaminants Program

The Northern Contaminants Program (NCP) was established in 1991 in response to concerns about human exposure to elevated levels of contaminants in the fish and wildlife species important for the traditional/country food diets of northern Aboriginal peoples. Early studies indicated that a wide spectrum of substances – persistent organic pollutants, heavy metals, and radionuclides – many of which had no Arctic or Canadian sources, were nevertheless reaching unexpectedly high levels in the Arctic ecosystem.

The first phase of the NCP (NCP–I) (1991-1996) focussed on gathering the data required to determine the levels, geographic extent, and sources of contaminants in the northern atmosphere, environment and its people, and the probable duration of the problem. Results from NCP-I were published in 1997 in the first *Canadian Arctic Contaminants Assessment Report* (CACAR).

During its second phase, which ran from 1998–2003, the NCP focussed on:

- impacts and risks to human health that may result from current levels of contaminants in key Arctic food species
- temporal trends of contaminants of concern in important indicator Arctic species and air
- improved education and communications activities involving northern communities
- efforts to control contaminant production, use and disposal at the international level

NCP–II addressed these issues under a number of subprograms: human health; monitoring the health of Arctic peoples and ecosystems and the effectiveness of international controls; education and communications; and international policy. The results of the research and related activities conducted during NCP–II are summarized in the *Canadian Arctic Contaminants Assessment Report II* (CACAR II) series of reports, which was released in March 2003. CACAR II is a comprehensive assessment of the last five years of research and related activities on northern contaminants funded under the NCP.

Five fact sheets have been developed, one for each of the CACAR II reports. These fact sheets provide a snapshot of many of the significant NCP research results described in each report.

Canadian Arctic Contaminants Assessment Report II

Toxic Substances in the Arctic and Associated Effects – Human Health

The CACAR II technical report *Toxic Substances in the Arctic and Associated Effects – Human Health* presents the results of research on the areas of study identified at the start of NCP-II as priorities for the human health subprogram:

- assessment of human contaminant exposure
- assessment of the possible health effects of exposure to current levels of contaminants – applying appropriate toxicological and epidemiological research
- risk and benefit characterization, communication and advice

Concerns about the risks to human health from contaminant exposures are significant for northern Aboriginal peoples because a high proportion of their diet consists of traditional/country foods including marine mammals (e.g., whales, walrus, seals), fish and terrestrial wild game. The majority of the persistent organic pollutants (POPs) such as PCBs, DDT and other pesticides are lipophilic and bioaccumulate in the fatty tissues of some of these animal species. Most contaminants biomagnify up the food web, so that species at the highest trophic levels often contain the highest contaminant concentrations (Figure 1). In turn, consumption of these traditional/country foods may result in higher contaminant levels in human tissues.

Dietary patterns and trends

Northern residents consume more than 250 different species of wildlife, plants and animals as traditional/country foods. A major study of dietary intake among 1,875 Inuit in 18 communities indicates that intakes of traditional/country have not significantly changed in the last 20 years. Traditional/country food preferences vary regionally (Figure 2).

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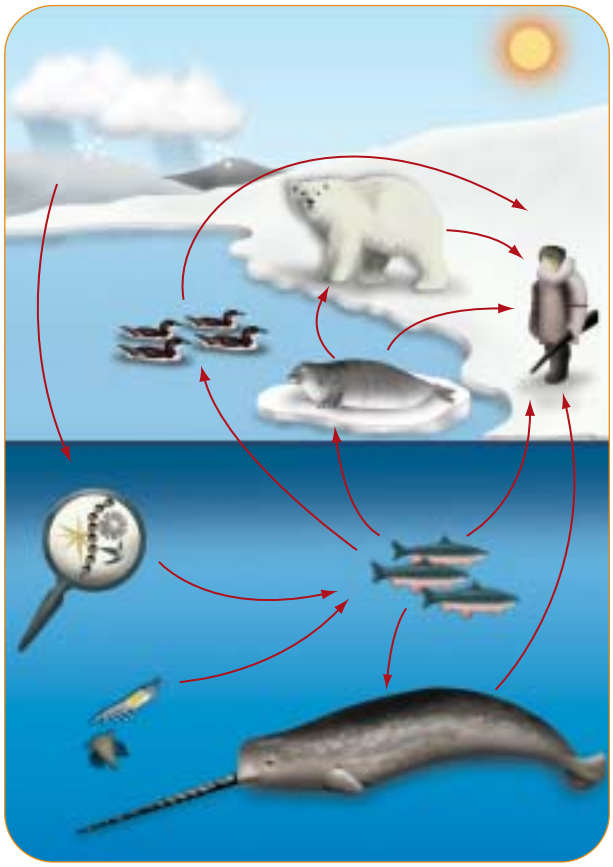


Figure 1: Movement of contaminants through the Arctic marine food chain.

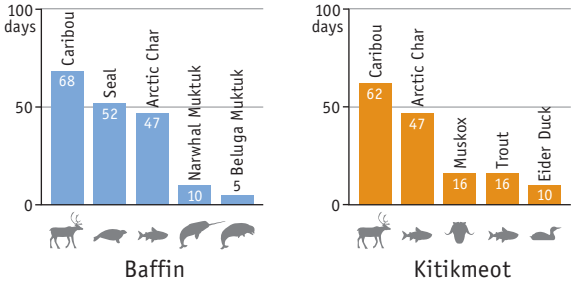


Figure 2: Top five traditional/country foods most often consumed in Baffin and Kitkmeot (days/year). Information was gathered during late winter and fall.

Traditional/country food use by women and men 20–40 years of age is highest in Inuit communities, followed by Dene and Métis in the NWT and then Yukon First Nations people. In some communities, up to 40% of total dietary energy is derived from traditional/country foods (Figure 3). Men generally consume more traditional/country food on average than women, and older people more than younger. In Baffin region, men over 60 years of age consume on average nearly 700 grams of traditional/country food daily, compared to people under 20 years of age who consume 225 grams or less.

Benefits of the traditional/country food diet

Traditional/country foods are an integral component of good health among Aboriginal peoples and provide important social, cultural, spiritual, nutritional and economic benefits. Hunting, fishing and gathering traditional/country food and subsequently sharing these items with individuals throughout the community are social activities that bring together individuals, families and generations. Food use forms and maintains an important social and cultural fabric among individuals which supports community health and well-being.

The nutritional benefits of traditional/country food are substantial. Decreasing traditional/country food is likely to have negative health consequences, partly because of decreases in the intake of micronutrients known to be important to e.g. immune function. Increases in diabetes, cardiovascular disease and obesity have also been linked to a shift away from the traditional/country food diet. To date, no simple formula or equation exists with which to simplify this process of balancing benefits and risks of consuming traditional/country foods. Instead, processes have been developed under the NCP to address the need to resolve the various perspectives and deal openly with the complexities of the problem.

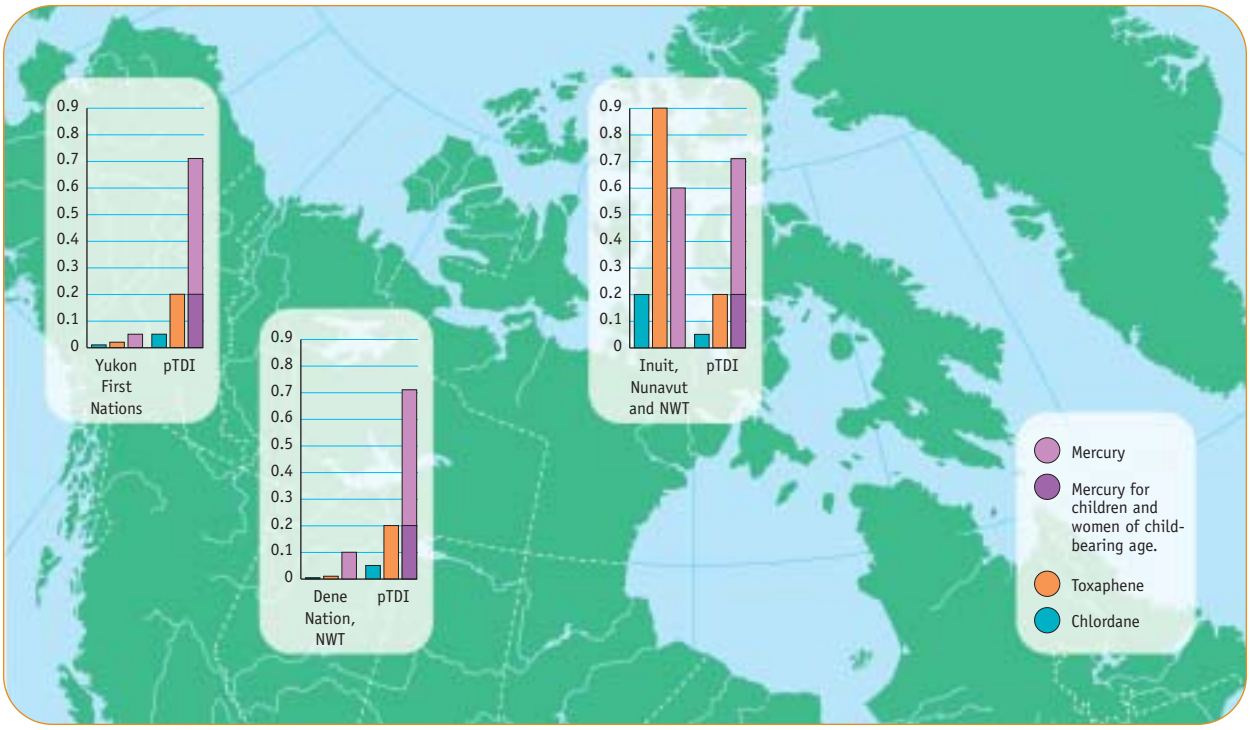


Figure 4: Mean contaminant intakes (μg/kg/day) of northern Aboriginal peoples compared to provisional tolerable daily intakes (pTDIs) from Health Canada.

Contaminant exposures from traditional/country food

The primary contaminants of concern are the POPs, including PCBs, chlordane and toxaphene, and the toxic metal mercury. The highest exposures to POPs and mercury are found in Inuit communities (Figure 4). Mean intakes by 20–40-year-old adults in Baffin, Kivalliq and Kitikmeot communities exceed the provisional tolerable daily intakes (pTDIs) for chlordane and toxaphene, while high consumers exceed many times the pTDIs for toxaphene, chlordane and PCBs.

The Inuit populations with the highest contaminant intake levels also correspond to those found to have the highest levels of PCBs in maternal blood (see below). Average intakes of mercury by Inuit in several different age groups in Baffin and Kivalliq exceed the pTDI and may be a significant concern. In one Inuit community, a trend assessment of intake levels suggests the traditional diet has not changed much over the past 10 years though specific foods consumed do vary from year to year.

Radionuclides with anthropogenic sources (such as ^{137}Cs) have decreased to very low levels and are no longer considered a significant source of human exposure

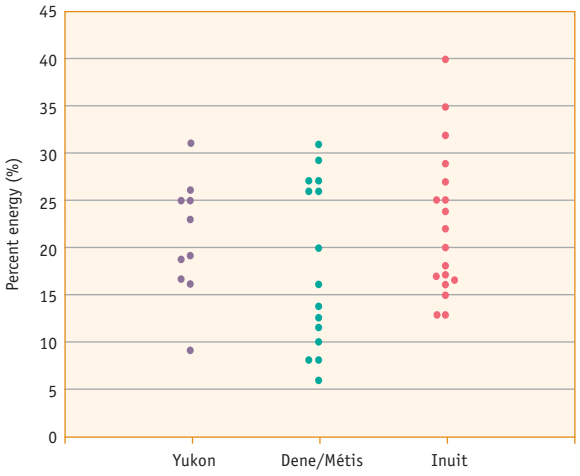
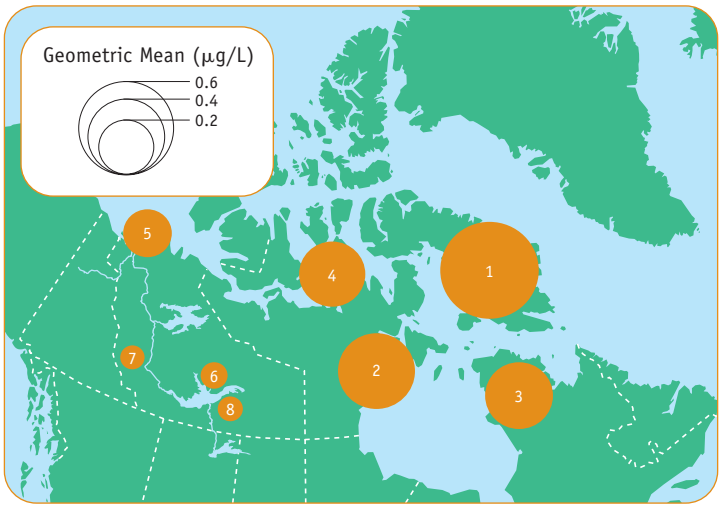


Figure 3: Percentage of energy from traditional/country foods in Yukon, Dene and Métis, and Inuit communities.

in the Canadian North. The natural radionuclides ^{210}Pb and ^{210}Po accumulate in the lichen→caribou→human food chain and have been present in the Arctic environment for thousands of years at more or less the same concentrations as found today.



1	0.58 µg/L	Inuit – Baffin
2	0.36 µg/L	Inuit – Kivalliq
3	0.30 µg/L	Inuit – Nunavik
4	0.29 µg/L	Inuit – Kitikmeot
5	0.15 µg/L	Inuit – Inuvik
6	0.05 µg/L	Caucasian
7	0.04 µg/L	Dene/Métis
8	0.04 µg/L	Other

Figure 5: Maternal contaminant levels in Arctic Canada: oxychlordane (µg/litre plasma)

Levels of contaminants in humans

Levels of oxychlordane (a metabolite of chlordane) and *trans*-nonachlor in Inuit maternal/cord blood are 6–12 times higher than in Caucasians, Dene and Métis, or mothers of other ethnic backgrounds (Figure 5). Inuit mothers from Baffin region have the highest levels. Similar patterns are observed for PCBs, HCB, mirex and toxaphene.

Up to 73% of the mothers in the Inuit regions have PCB blood levels that exceed the Health Canada PCB Level of Concern of 5 µg/litre (Figure 6). No mothers have PCB levels in their blood above the Action Level of 100 µg/litre.

Recent maternal/cord blood contaminant monitoring studies in the NWT, Nunavut and Nunavik provide an assessment of spatial variations in mercury levels. Significantly higher levels of mercury have been found in the maternal blood of Inuit women (especially those from Baffin and Nunavik) compared to other northern women (Figure 7). Nevertheless, these levels of mercury are lower than those found in the 1970s and 1980s.

Based on a new US Environmental Protection Agency evaluation of the health risks of mercury, a higher proportion of Inuit women would exceed the new US guideline set to protect the fetus. This may indicate that even though exposure levels may be lower, the associated health concerns still exist.

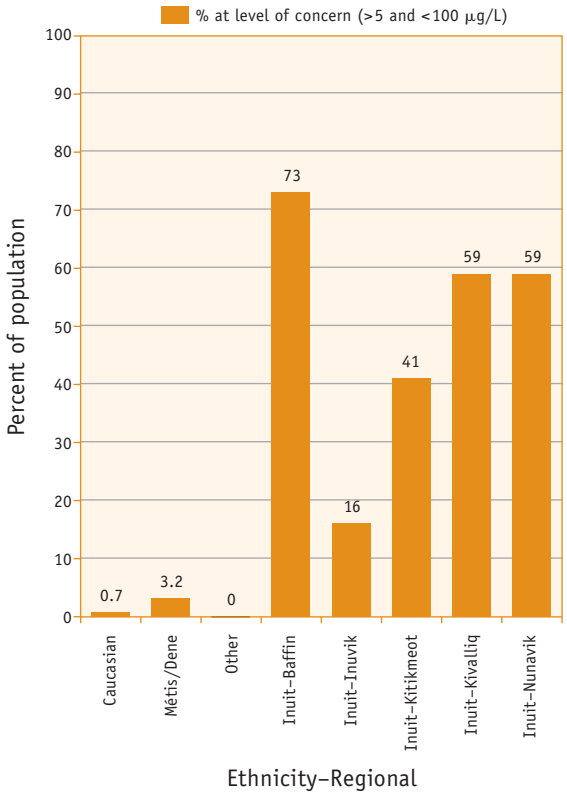


Figure 6: Maternal blood guideline exceedances for PCBs (Aroclor 1260) in Arctic Canada, by region and ethnicity.

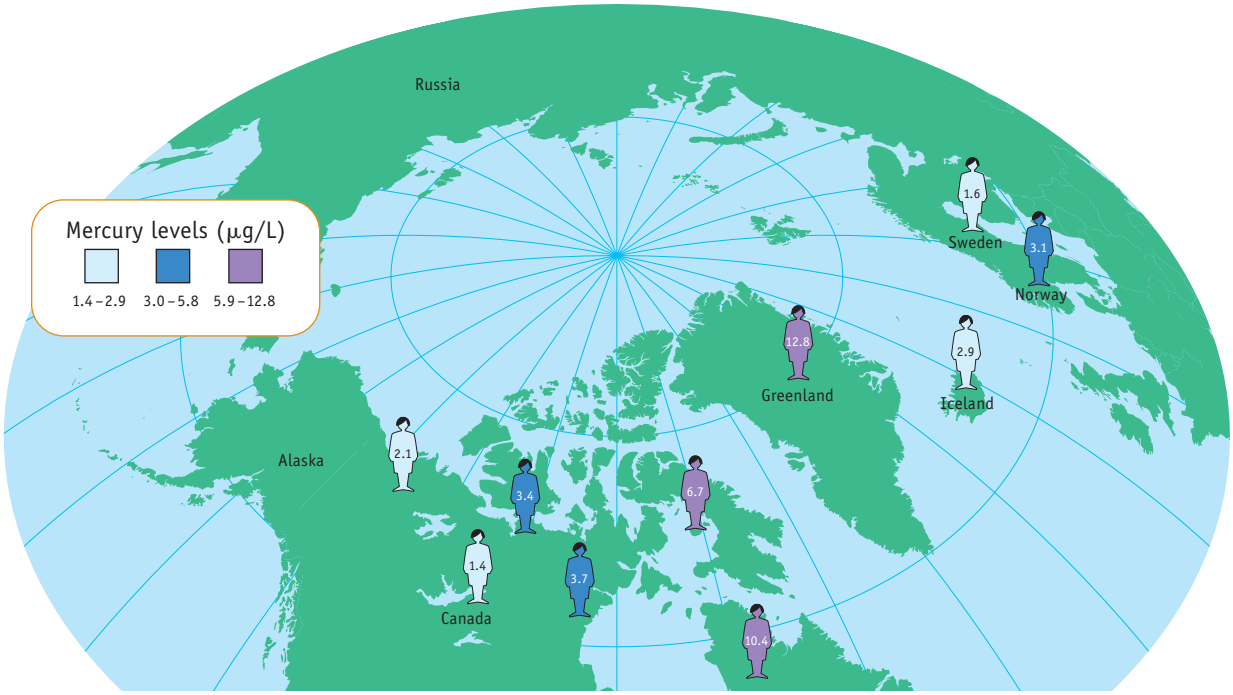


Figure 7: Average levels of mercury in maternal blood across the circumpolar Arctic.

Health Effects

It is very difficult to determine the adverse human health effects caused by contaminants in traditional/country foods as many factors contribute to the health of an individual. Lifestyle (e.g., alcohol consumption, smoking, and substance abuse), diet, socioeconomic status and genetic predisposition are important health determinants that need to be considered when evaluating the results of contaminants research.

The ongoing Nunavik cohort study is helping to shed light on contaminant exposure and potential related health effects in the areas of neurodevelopment and immune function. Very recent early results from this study demonstrate subtle negative health effects in infants at 11 months of age[1]. Prenatal exposure to PCBs had subtle effects on birth weight, duration of pregnancy and visual memory. Prenatal fatty acid exposure partially reduced these adverse effects. The only effect associated with prenatal exposure to mercury was a subtle decrease in the infant's ability to remember things while being distracted.

In addition, the study demonstrated that there are several beneficial effects of traditional/country food consumption on infant development. Polyunsaturated fatty acids were beneficial for infants' birth weight, memory, vision, ability to communicate or solve problems, and their ability to sit, stand and walk.

Otitis media (middle ear infection) during the first year of life is associated with prenatal exposure to p,p'-DDE, HCB and dieldrin and the relative risk of recurrent *otitis media* increased with prenatal exposure to these contaminants. The high incidence of infections observed in Inuit children (mostly respiratory infections) may be partly attributable to elevated prenatal exposure to persistent organic pollutants (POPs).

Toxicology

Toxicological studies of toxaphene, chlordane, and contaminant mixtures typically found in a marine mammal diet were carried out with laboratory animals. While it is difficult to extrapolate the results of animal studies to humans, such studies can help support and elucidate mechanisms for subtle effects seen in epidemiological studies. These studies may also guide the direction for future epidemiological research on

[1] Note: Results from this study only became available in early 2003 and were therefore not included in CACAR II.

the human health effects of contaminants. Monkeys exposed to toxaphene at levels similar to those found in certain Inuit populations experienced effects on immune function and infant size. There is also some indication that chlordane may also pose an increased risk to the health of some Inuit populations.

Dietary nutrients such as polyunsaturated fatty acids, fish protein, selenium and Vitamin E may influence the magnitude of methylmercury toxicity, with some nutrients possibly providing protection from methylmercury (MeHg) neurotoxicity.

Risk and benefit characterization, assessment and advice

Benefit and risk assessment and management relating to contaminants in traditional/country food involves a consideration of the type and amount of food consumed and the sociocultural, nutritional, economic, and spiritual benefits associated with traditional/country foods. Benefit and risk management assessments have evolved as the community now helps decide what action will provide the greatest protection and be the least detrimental to the communities (Figure 8). Regardless of the decision taken, some health risks associated with exposure to contaminants may remain. The uncertainty over risks and benefits will continue to pose a large and complex public, moral and political dilemma.

Effective communication is fundamental to the aims of the NCP. Communication efforts incorporate western scientific and Aboriginal traditional knowledge on the nutritional benefits and risks associated with the consumption of traditional/country foods as well as imported foods, and on the importance of a traditional lifestyle to overall health and well-being. These efforts provide northerners with the information to make informed decisions about harvesting and consuming both traditional/country foods and imported foods. No one method of communication is best – a variety of methods and materials are available to communities to use as appropriate.

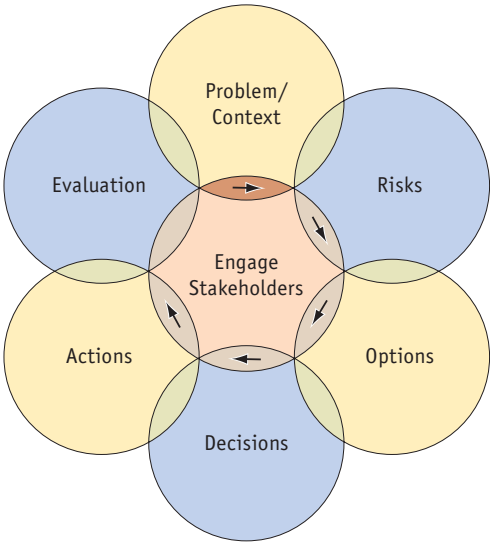


Figure 8: Framework for environmental health risk management.

The practice of risk communication has progressed over the past 14 years. In place of one-way models of information distribution, NCP-II strove to implement shared decision making through partnerships involving territorial health departments and regional contaminants/health committees, community representatives and representatives of Aboriginal organizations at all stages of the risk management and risk communication process.

For more information on *Toxic Substances in the Arctic and Associated Effects – Human Health* please consult the CACAR II series of reports, available from the Northern Contaminants Program Secretariat:

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