CANADA'S NATIONAL IMPLEMENTATION PLAN 2000
(Contaminants section)

Monitoring and Effects Studies

Project title / leader / institute	Parameters (contaminants, compartment/species, organ)	Sampling dates / Frequency	Location
Marine Ecosystem			
Temporal trends of organochlorine and organobromine contaminants in beluga from the Canadian Arctic (Gary Stern, Fisheries and Oceans Canada)	1) PBBs, BDPEs and CDPEs in beluga blubber 2) PCBs, DDT, toxaphene, coplanar PCBs, polychlorinated-*n*-alkanes (PCAs), PBBs, BDPEs, and CDPEs in beluga blubber	1) Archived samples - 1982 to 1997 2) Samples from 2000	1) Pangnirtung, SE Baffin Island, Nunavut 2) Kugmallit Bay, Hendrickson, Island, NWT
Temporal trends of persistent organic pollutants and metals in ringed seals and walrus from the Canadian Arctic (Derek Muir, Environment Canada)	POPs in blubber of ringed seals and walrus Hg, Pb, As, Se and Cd in liver and kidney of ringed seals and walrus	Seal samples collected from two to three locations per year and analysed the following year. Each location is to be repeated about every 4 years.	*Tentative seal collections:* 1998: Arviat, Grise Fiord 1999: Pangnirtung 2000: Pond Inlet (metals only), Resolute, Arctic Bay 2001: Sachs Harbour, Holman (metals only) 2002: Wakeham, George River, Arviat 2003: Grise Fiord, Inukjuaq *Tentative walrus collections:* 2001: Igloolik 2003: Inukjuaq

Temporal trends of mercury in beluga, narwhal and walrus from the eastern Arctic (Lyle Lockhart, Fisheries and Oceans Canada)	1) Total Hg, methylmercury, cadmium and selenium in liver and kidney of narwhal, beluga and walrus 2) Total Hg in growth layers in tooth cementum of beluga	1) i) Current year samples and archived samples (dating back to 1984) to be analysed in 2000/01 1) ii) Archived samples and future samples up to 2004	1) i) *Beluga*: Coral Harbour, Arviat, Sanikiluaq, Pangnirtung; *Narwhal*: Pond Inlet; *Walrus*: Igloolik, Iqaluit 1) ii) Various locations in the Canadian Arctic 2) Pangnirtung, Nunavut
Effects of POPs on polar bears (Ross Norstrom, Environment Canada)	1) PCBs, OCs in fat and blood plasma; antibodies and IgG in blood plasma 2) OH-PCBs, PCBs, OCs, pentachlorophenol, and retinols in plasma 3) OCs, PCBs, and enantiomers of oxychlordane, heptachlor epoxide, *cis*- and *trans*-chlordane, MC5, MC7, MC8, U82, and α-HCH in blubber 4) Metabolism of PCB congeners in microsomes of liver tissue	1) 1999 - 2 captures, 6 weeks apart (immuni-zation on first capture) 2) Archived samples - i) 1998; ii) 1997 3) Archived samples from 1989 to 1999 4) Archived samples from 1993	1) Cape Churchill, Manitoba 2) i) Svalbard; ii) Barrow Strait 3) Cape Churchill, Manitoba 4) Cape Churchill, Manitoba

Spatial trends and pathways of POPs and metals in fish, shellfish, and marine mammals of coastal Labrador and Nunavik (Derek Muir, Environment Canada)	PCBs and OC pesticides (incl. toxaphene) in fish, shrimp, scallops, mussels and ringed seal, bearded seal, harp seal, and walrus Co-planar PCBs in fish and ringed seal, bearded seal, harp seal, and walrus Butyl tins (mono-, di- and tri) in marine mammals, char and shellfish Heavy metals (Hg, Cd, As, Pb, Se) in all samples	1999 (project completed March 2000)	Nunavik (northern Quebec) and Labrador
Retrospective survey of organochlorines and mercury in Arctic seabirds (Birgit Braune, Environment Canada)	PCBs, OCs and metals (incl. Hg and Se) in eggs and livers of black-legged kittiwakes, northern fulmars and thick-billed murres	Archived samples from 1975 to 1998	Prince Leopold Island, Nunavut
Role of contaminants in seaduck population decline: Metals in oldsquaw (Birgit Braune, Environment Canada)	Hg, Se and Cu in liver; Cd in kidney; Pb in wing bone	Archived samples from 1991 to 1994	Canadian Arctic
Contaminant concentrations and effects in Arctic seaducks: Trace element exposure and health of eiders (Mark Wayland, Environment Canada)	1) Se, Cd, total Hg, organic Hg, Cu and Zn in kidneys, liver and blood of male and female common eiders 2) *in-vivo* cellular-mediated immunity and *in-vivo*-humoral immunity in common eiders	1) Annually (1997 to 2000) 2) 1999 and 2000	East Bay, Southampton Island, Nunavut
Fluxes of mercury from the Arctic ice surface during polar sunrise and melt conditions (Bryan Kerman, Environment Canada)	Hg in melt water, seawater and under-ice algae	1) Weekly sampling from the beginning of melting until access to the ice is not possible 2) Limited sampling	1) Ice camp about 10 km distant from Alert, Nunavut and 600 m onto the icepack 2) Further into the icepack by helicopter

The seasonal cycle of organochlorine concentrations in the Canadian Basin (Rob Macdonald, Fisheries and Oceans Canada)	Toxaphene in water samples; organochlorines in sediment samples (Previous measurements have been completed of pesticides, including toxaphene, and PCB congeners in plankton, fish and seals)	One year, starting September 1997	Along drift path of SHEBA in the southern Canada Basin

Freshwater Ecosystem			
Temporal trends of organochlorine, organobromine and heavy metal contaminants in burbot from Fort Good Hope, NWT (Gary Stern, Fisheries and Oceans Canada)	Hg, Se, As, PCBs, coplanar PCBs, DDT, toxaphene, polychlorinated-*n*- alkanes (PCAs), PBBs, BDPEs, and CDPEs in burbot liver	Annually (start date: 1999)	Mackenzie River at Fort Good Hope, Northwest Territories
Mercury in fish from stock surveys of lakes in the western Northwest Territories: Investigations into factors affecting mercury levels (Lyle Lockhart, Fisheries and Oceans Canada)	Hg, Se, As, and methyl Hg in fish muscle Hg in water and sediments	Ongoing - once from each lake, several lakes per year	Numerous lakes in the western Northwest Territories
Temporal trends of persistent organic pollutants and metals in landlocked char (Derek Muir, Environment Canada)	PCBs, coplanar PCBs, OC pesticides (incl. toxaphene), and Hg in muscle+skin homogenates of char Hg, Pb, Cd, Se, As, and Zn in muscle of char	1) Annually (1997 to 2002) 2) 2000	1) Char Lake and Resolute Lake, Cornwallis Island, Nunavut 2) Amituk Lake

An investigation of factors affecting high mercury concentrations in predatory fish in the Mackenzie River Basin (Marlene Evans, Environment Canada)	1) Hg, As, Se, Cd, and stable isotopes (to infer food web pathways) in predatory fish Hg, MeHg, As, Pb and Cd in sediment cores MeHg in plankton, benthic invertebrates and forage fish 2) Hg in water, zooplankton and forage fish	1) 1999 and 2000 2) 2000	1) Cli Lake and Little Doctor Lake in the Mackenzie River Basin, NWT 2) Tsetso, Sibbeston, Willow and Trout Lakes in the Mackenzie River Basin, NWT
Spatial and long-term trends in organic contaminants and metals in fish species important to the commercial, sports, and domestic fisheries of Great Slave Lake and the Slave River ecosystem (Marlene Evans, Environment Canada)	POPs (incl. PCBs, DDT, dieldrin, toxaphene, dioxins and coplanar PCBs) in burbot liver and in muscle of lake trout and pike Hg, Se, As, and stable isotopes in muscle of burbot, lake trout and pike	Annually (start date: 1999) Also in archived samples from the 1990s	Great Slave Lake and Slave River, NWT
Yukon traditional foods monitoring program (Mark Palmer, Indian and Northern Affairs Canada)	40 chlorinated pesticides (incl. toxaphene) and 100 PCB congeners in burbot liver, trout flesh and salmon flesh	Rotating basis: Kusawa Lake (1999/2000), salmon sampling (2000/01), Quiet Lake (2001/02), Kusawa Lake (2002/03), etc.	Quiet and Kusawa Lakes (burbot and trout); Klukshu River (sockeye salmon); Yukon River (king salmon); Fishing Branch River near Old Crow (chum salmon) - all in the Yukon
Mercury and other contaminants in a laminated sediment core from Devon Island (Lyle Lockhart, Fisheries and Oceans Canada)	Hg, Pb, organochlorines, and combustion-related hydrocarbons in sediment core slices	June 1999 (project completed March 2000)	Lake DV09, Devon Island, Nunavut

Spatial trends in loadings and historical inputs of mercury inferred from Arctic lake sediment cores (Ven Cheam, Environment Canada)	Hg, Pb, Mn, Fe and Pb in sediment cores	Cores collected from 1998 to 2002	Various lakes in Nunavut (e.g. Ellesmere Is., Baffin Is., Axel Heiberg Is., Cornwallis Is.), NWT (near Yellowknife, Nahanni National Park), and Northern Quebec

Terrestrial Ecosystem			
Heavy metal and radionuclide contaminants in caribou (Brett Elkin, Government of Northwest Territories)	Al, Cd, Cr, Cu, Fe, Pb, Mn, total Hg, Ni, and Zn in caribou liver and kidney Cs^{137}, K^{40}, and Sr in caribou liver and muscle Po^{210} in caribou bone	Every 5 years	Bluenose and Beverly herds, NWT; south Baffin Island and north Baffin Island herds, Nunavut
Assessment of organochlorine and metal levels in Canadian Arctic fox (Birgit Braune, Environment Canada)	PCBs, including coplanar PCBs, organochlorines and toxaphene in fat; Hg and a suite of metals, including Se and Ag, in liver; and Cd in kidney.	1) Foxes collected between November 1999 to March 2000 2) Wolverines collected in winter/spring 2000	1) Ulukhaqtuuq (Holman), Northwest Territories 2) Qurluqtuuq (Coppermine), Nunavut

Atmosphere			
Northern contaminants air monitoring: Organochlorine measurements (Pierrette Blanchard, Environment Canada)	OCs (incl. PCB congeners, toxaphene, chlordane, HCB, HCH, oxychlordane, heptachlor, heptachlor epoxide, DDT, DDE, endosulfan, dieldrin, tetrachloroveratrole, pentachloroanisole) and PAHs in air	Weekly samples: 1) Since January 1992 2) 1999 (summer) to 2001 3) 2000 to 2002	1) Alert, Nunavut 2) Amderma, Russia 3) Kinngait (Cape Dorset), Nunavut
Northern contaminants air monitoring: Mercury Measurements (William Schroeder, Environment Canada)	Total gaseous Hg, ozone, soot, and black carbon in ambient air	Continuous samples: 1) Since January 1995 2) 2000 to 2005	1) Alert, Nunavut 2) Amderma, Russia

Atmospheric mercury transport, oxidation and fallout in northern Quebec (Nunavik): An important potential route of contamination (Laurier Poissant, Environment Canada)	1) Total gaseous Hg and ozone in air 2) Total and reactive Hg, bromide and chloride in precipitation 3) Hg in snow and soil	1) Monthly (since August 1999) 2) Monthly 3) Once in winter 2000	Kuujjuarapik, Hudson Bay, Quebec
New persistent chemicals in the Arctic environment (Terry Bidleman, Environment Canada)	1) BDPEs, CDPEs, decabromobiphenyl and brominated bisphenol A, polychlorinated naphthalenes (PCNs), pentachlorophenol (PCP), coplanar PCBs, and pesticide enantiomers, including chlordanes, α-HCH and toxaphene congeners (as source indicators), in air samples 2) Short-chain chlorinated paraffins, PCNs, coplanar PCBs, BDPEs, and haloacetic acids (HAAs) in seawater samples 3) Endosulfan, toxaphene enantiomers, short-chain chlorinated paraffins, chlorinated phenols/anisoles, BDPEs, CDPEs, and PCNs in marine sediments 4) PCNs, coplanar PCBs, BDPEs, and CDPEs in lake sediments	1) Archived air samples from 1994 2) Archived seawater samples from the SHEBA (1997/98) and North Water (NOW) (April to July 1999) programs and the 1997 JOIS cruise. 3) Archived sediment samples from 1997, 1998 4) 1998	1) Tagish, Yukon; Alert, Nunavut; Dunai, Russia 2) Canada Basin (SHEBA); Baffin Bay and Kane Basin (NOW) 3) 1997 and 1998 JOIS cruises in Canadian Arctic Archipelago 4) Resolute, Nunavut

Human Health			
Assessment of dietary benefit:risk in Inuit communities (Harriet Kuhnlein, Centre for Indigenous Peoples' Nutrition and Environment)	Hg, Cd, As, Pb, and organochlorines in traditional food as prepared and consumed by Inuit Protein, moisture, ash, total fat, carbohydrate, iron, calcium, zinc, copper, manganese, magnesium, selenium, sodium, potassium, phosphorus, fatty acids and vitamins A, D and K in Inuit traditional foods Survey to derive quantitative estimates of traditional and market food intake among Inuit	1998-2000 (project completed March 2000)	Five Inuit regions: Inuvialuit, Kitikmeot, Keewatin, Baffin and Labrador
Estimation of site specific dietary exposure to contaminants in two Inuit communities (Laurie Chan, Centre for Indigenous Peoples' Nutrition and Environment)	51 PCB congeners, chlorobenzene, lindane, dieldrin, heptachlor epoxide, chlordane, DDT, mirex, toxaphene, As, Hg, Cd, and Pb in key dietary items	2000	Two Inuit communities that have been identified as having higher exposure in an earlier study of 19 Inuit communities (see previous project above)
Nutrient benefits of Arctic traditional/country food (Harriet Kuhnlein, Centre for Indigenous Peoples' Nutrition and Environment)	1) Vitamin C, vitamin E, vitamin B6, folate, niacin, and folic acid in traditional food items consumed by Inuit 2) Protein, total fat, carbohydrate, fibre, moisture, ash, n-3, n-6, monounsaturated and polyunsaturated fatty acids, iron, copper, zinc, calcium, phosphorus, magnesium, manganese, sodium, potassium, selenium, retinol/carotene, tocopherol, ascorbate, folate, pyridoxine, niacin, riboflavin, and vitamins A, C, D, and E in traditional foods	1) 1999 2) 2000	1) Five Inuit regions: Inuvialuit, Kitikmeot, Keewatin, Baffin and Labrador 2) Dene, Métis, Yukon and Inuit communities

Follow-up of preschool-aged children exposed to PCBs and mercury through fish and marine mammal consumption (Gina Muckle, Quebec Public Health Centre)	Since 1993, PCBs, MeHg and Pb have been measured in cord blood from almost all Inuit newborns in Nunavik. Using this data, 100 Nunavik Inuit children, aged 4.5 years, have been divided into two groups of *in utero* PCB exposure level (low and high). Fine neuromotor function, the visual system, and the cognitive and attention function will be assessed in these children.		Nunavik (northern Quebec)
Transplacental exposure to PCBs and infant development/human exposure assessment (Gina Muckle, Quebec Public Health Centre)	PCBs, chlorinated pesticides, and heavy metals in cord serum at birth. Thyroid hormone levels, tonus, reflexes, physical maturity and anthropometric characteristics in newborns. Neurobehavioural and cognitive development, physical growth, neuromotor and neurological functions, and overall health status at 6.5 and 11 months of age.	1995 to 2003	200 Inuit newborns from Nunavik (northern Quebec) and 100 from Greenland
Effects of prenatal exposure to organochlorines and mercury on the immune system of Inuit infants (Éric Dewailly, Laval University Medical Research Centre)	In Inuit mothers and their newborns: - retinol in maternal and cord blood - OCs and Hg in cord blood and breast milk - OCs and Hg in peripheral blood from infants at 6 months of age - immunological parameters (antibody response following vaccination, complement C' system, cytokine production by Th1/Th2 cells) in infants during the first 12 months of age	Ongoing study from 1998 to 2002	Nunavik (northern Quebec)

Mercury in Salluit: Temporal trend and interaction with selenium and effects of mercury on oxydative status and sensorimotor functions (Éric Dewailly, Laval University Medical Research Centre)	1) Mercury in urine, venous blood, hair and alveolar air of Inuit; and Selenium in plasma, whole blood, hair and urine 2) Biochemical assessment of oxidative stress markers in plasma and/or urine 3) Sensorimotor measures (postural sway, reaction time, eye-hand coordination, rapid alternating movement, etc.)	1) 1998 to 1999 (mercury was assessed in these same individuals in 1978) 2) 2000 3) 2000	Salluit in Nunavik (northern Quebec)
Inuvik regional human contaminants monitoring program (Valoree Walker, Inuvik Regional Health and Social Services Board)	Organochlorines and heavy metals in maternal and umbilical cord blood MeHg in hair of mothers Also recorded: traditional foods eaten by the mothers, and lifestyle factors, including smoking.	Samples collected from June 1998 to June 1999 (104 participants)	Inuvik region, NWT

Supporting Studies

Project title / leader / institute	Project description
Marine Ecosystem	
An assessment of sources of HCH isomers to wildlife and humans in the Canadian Arctic (Derek Muir, Environment Canada)	The objectives of this study (completed March 2000) were: • to examine sources, fate and bioaccumulation of hexachlorocyclohexane isomers, including lindane, from seawater and air to human milk using existing data; • to review the literature on possible isomerization of HCH isomers, particularly lindane to α- and β-HCH; and • to prepare an exposure assessment of the elevated levels of β-HCH in humans in the Canadian Arctic.
Assessment of spatial and temporal patterns of HCH isomers in the Arctic environment (Birgit Braune, Environment Canada)	The hypotheses of this study are that: • there is a gradient of HCH concentrations and β- to α-HCH ratios in Arctic marine biota which follows the surface seawater trends, decreasing from west to east; • the ratio of β-HCH to α-HCH has been increasing over time; and • HCH levels in top predators are now on the decline due to decreased inputs and losses by advective outflow, degradation and outgassing. These hypotheses will be examined by: i) A review and synthesis of existing data for HCH isomers and their ratios in air, water and biota from the Canadian Arctic, both spatially and temporally. ii) Analysing the air and water samples from the TNW-99 expedition for HCHs, including β-HCH. iii) Determining the Henry's law constant of β-HCH as a function of temperature. The ratios of α/β HCHs in arctic air and surface water are quite different, implying differences in gas exchange behaviour. iv) Development of emission factor for β-HCH for use in air/surface exchange model. v) Using the results of the bioisomerization study (project by D. Muir above) to help interpret the spatial and temporal patterns in the biota.

Atmosphere	
Global gridded emission inventories (Yi-Fan Li, Environment Canada)	The objectives of this study are to create global gridded emission inventories for various persistent organic pollutants and to study the linkage between the global use trends and the concentration trends in the Arctic for these compounds. An inventory has been previously carried out for toxaphene and the current work is on γ-HCH and endosulfan. The following are five major tasks for this 2000/01: • To extract information about the restriction status, usage, and contamination by γ-HCH and endosulfan in different compartments worldwide from various sources. • To create a gridded global usage inventory of lindane and endosulfan by using gridded global crop land and other surrogate data. • To create emission factors for γ-HCH and endosulfan for different application modes and different areas in the world based on the data from Canadian Global Emissions Interpretation Centre. • To generate a gridded global γ-HCH emissions database with 1° x 1° lat/long resolution for 1980 and 1990 by combining γ-HCH emissions from the use of both technical HCH and lindane. Emission inventories of endosulfan will also be compiled. • To study the relationship between global use trends of γ-HCH and endosulfan and concentration trends in the Arctic environment.
Quantifying and reducing uncertainty in model calculations of global pollutant fate (Frank Wania, Wania Environmental Chemists Corp.)	The main objective of this project is to describe quantitatively with model calculations the global distribution behaviour of persistent organic contaminants, and to establish credibility in the results of these simulations. The specific tasks in the current year are to: • bring to completion and publish a comprehensive uncertainty analysis of the global model calculations for α-HCH and PCBs to increase credibility in the descriptive and predictive capabilities of the model; • use the global model in an evaluative fashion to investigate the global distribution behaviour of organic chemicals as influenced by their physical-chemical properties, their persistence in various media and climates, and hypothetical environmental, and emission scenarios; and • compare results obtained with the zonally averaged global distribution model with those obtained by other global modelling studies for POPs.

Human Health	
Decision-making and diet in the North: Balancing the physical, economic and social components (Chris Furgal, Laval University Medical Research Centre)	This project addresses the needs of northern health professionals in promoting healthy food choices through organizing and presenting benefits and risks, and factors influencing northerners' food habits, in a balanced and understandable way. It is intended to support the role of Inuit health organizations, government agencies, and advisory bodies in providing balanced and accessible information to Inuit and other northerners on traditional foods, nutrition and health.
Sociodemographic factors influencing nutrition and contaminant exposure in Nunavik (northern Quebec) (Éric Dewailly, Laval University Medical Research Centre)	The main objective of this project is to examine sociodemographic factors affecting the contaminant exposure and nutritional status of Inuit. The specific objectives are to: • examine the relationship between the makeup/structure of Inuit households and the intakes of foods, contaminants and nutrients; • establish the link between contaminant intake, the quantity, quality and source of Inuit food (traditional vs. market food) consumed and a number of sociodemographic variables (level of education, household income, occupation, residence) considering the combined effects of some factors such as age and sex; and • examine food and nutrient intakes among Inuit considering socio-economic status and reported status of individual food availability.
Food choice decisions by western Arctic aboriginal women and children (Harriet Kuhnlein, Centre for Indigenous Peoples' Nutrition and Environment)	The overall objective of this study is to understand the larger picture of factors influencing food choice decisions by Arctic women and children so that risks and benefits messages can be placed in relevant and appropriate context for effective educations messages. The specific objectives are: • to understand the factors involved in making choices among selected traditional and market food items; • to better understand children's traditional and market food use in Dene/Métis and Yukon First Nation communities, and children's food preference factors; and • to derive a personal food choice research tool that will be tested by interviews with Dene/Métis and Yukon First Nation women in communities with existing dietary data. The long-term goal is to develop relevant food education strategies for women and children that will guide family food choices. Improved knowledge of how nutrient and socio-cultural benefits and contaminant risk information affects the food decision process will lead to more effective communication efforts. This project provides essential information for the success of these initiatives.

Dietary effects on methylmercury toxicity in rats (Laurie Chan, Centre for Indigenous Peoples' Nutrition and Environment)	Mercury accumulates in fish and marine mammals. Therefore, Inuit people may be exposed to higher level of mercury form the traditional diet. However, the traditional diet also contains rich sources of beneficial nutrients such as protein, oil, vitamins and mineral. There is some evidence that these nutrients may protect against mercury toxicity. The overall objective of this project is to study the effects of dietary factors on methylmercury toxicity. Specifically, the objectives are to study the effects of the following on methylmercury kinetics and toxicity: ringed seal oil, selenium, omega-3 fatty acid, vitamin E, and the combined of all of these dietary factors, by feeding rats diets containing different nutrient compositions. Results will be useful for characterisation of the health risk of mercury in the Inuit diet.
A comparison of time-related changes in *trans*-nonachlor, oxychlordane and *trans*-chlordane (γ-chlordane) residues in rat tissues and the relationship between tissue residue levels, functional changes and gender (Genevieve Bondy, Health Canada)	The objective of this project is to compare changes in *trans*-nonachlor, oxychlordane and *trans*-chlordane residues over time in fat and other tissues (using the rat model), and to relate fat and tissue residue levels to clinical changes in male and female rats. This project is being undertaken to provide current information on the toxicity of chlordane metabolites and constituents. The data will be used to reduce uncertainty factors used in the calculation of TDIs for chlordane-related food contaminants.
Toxicology of mercury and selenium in ringed seal tissues (Laurie Chan, Centre for Indigenous Peoples' Nutrition and Environment)	The overall objective of this study (completed March 2000) was to study the interactions between mercury and selenium in ringed seal tissues and elucidate the potential protection of methylmercury toxicity by selenium in the traditional diet. The specific objectives of this project were: • to isolate and characterize the different species of Hg and Se in muscles, livers, brain and kidneys of ringed seals; and • to conduct an animal feeding experiment to study the toxicity of co-ingestion of the biological Hg and Se found in seal meat using a rat model.
Adverse developmental effects in pigs following *in utero* and lactational exposure to organochlorines: Effects on male reproductive function (Pierre Ayotte, Quebec Public Health Centre)	The objective of this study (completed March 2000) was to assess the impact of pre- and postnatal exposure to organochlorine mixtures found in the Arctic on the development and function of the male reproductive system, using the pig as the animal model. This toxicology study aimed at investigating the possible relationship between exposure to an organochlorine mixture similar to that found in the Arctic aquatic food chain and adverse developmental effects on the male reproductive tract.