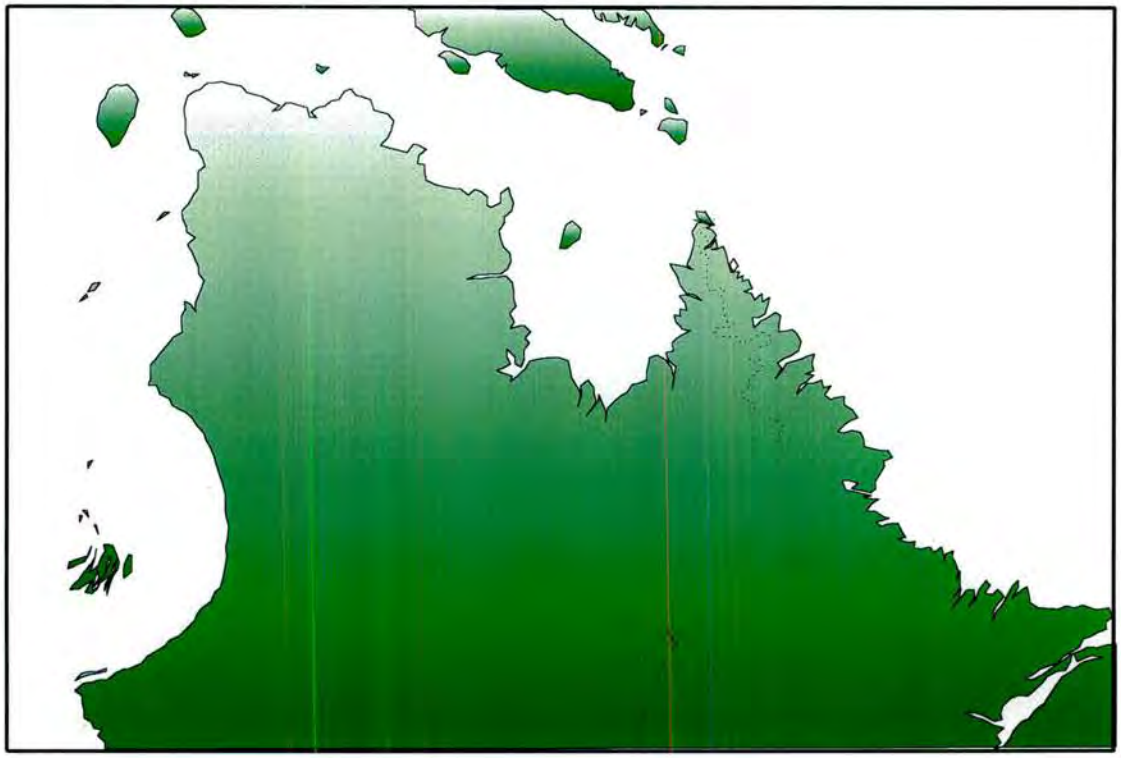
THE NUNAVIK AND NORTHERN LABRADOR CONTAMINANTS ACTION PLAN MEETING

PROCEEDINGS AND RECOMMENDATIONS



NORTHERN CONTAMINANTS PROGRAM
MAY 27-29, 1997 • KUUJJUAQ

Indian and Northern Affairs Canada and Environment Canada, 1997

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Workshop Recommendations for an Action Plan

1) A comprehensive contaminants monitoring program should be developed in Nunavik and Labrador -- with a special emphasis on studies in Labrador. The major objectives of this program would be:

- To compile data on contaminant levels in country food and determine human exposure and health effects;
- To generate baseline data for comparison with future work and with other Arctic regions;
- To identify the origin of contaminants, and whether they are local, transported over a long range, or both.

The monitoring program's sampling strategy should focus on monitoring samples in sites of interest to local communities and "background sites", particularly those that are intensively harvested. Hunters and fishers could help collect samples, and ensure they are taken at the appropriate times and locations.

Sampling both potential "hot spots" and background sites would serve a dual purpose of providing information for the local communities, as well as adding to the general picture of contaminants in the Arctic. The monitoring program should be comprehensive and focussed, rather than large-scale, in order to make best use of the funds available.

- Sampling should focus on community concerns;
- Coastlines should be a major focus;
- Sampling should focus on the tissues and organs of species that are most consumed in given areas, and should consider food preparation as well as foods that area consumed seasonally

2) A steering committee could be established to review research proposals prior to their submission to NCP . The steering committee may choose to integrate several projects into one comprehensive research project, and then submit one proposal to the NCP or could support several smaller projects. The Committee would include representatives from Nunavik and Labrador. Possible models include the Yukon Contaminants Committee and the Nunavik Health and Nutrition Committee. The Committee would ensure that the monitoring activities are not driven by personal research agendas.

3) Wherever possible, funding and resources should be sought from other agencies. Research on gaps identified could build on other proposed NCP programs such as the "Archipelago Project" and the DND radar site studies. They could also use facilities available within Nunavik/Labrador (e.g. Kuujjuaq Research Centre), and High School science programs.

DAY 1: TUESDAY, MAY 27, 1997

Introduction and Workshop Objectives and Goals

Minnie Grey, Tulattavik Health Centre; Frank Andersen, Labrador Inuit Association

Co-chairs Minnie Grey and Frank Andersen welcomed participants to the meeting. Following a round of introductions, Grey and Andersen reviewed the workshop objectives and goals, which were:

- To outline past and current research, identify gaps, and determine research priorities for the future;
- To develop an action plan in an attempt to get the research in the Labrador-Ungava Peninsula up to the same level as the rest of Canada;
- To focus on human health effects of contaminants, and simplify and communicate the results to the communities.

A delegate added that one of the objectives was to develop tangible and concrete recommendations that could be funded under the renewed Arctic Environmental Strategy (AES). Minnie Grey emphasized the importance of Inuit having a voice in controlling information gathered from specific studies of concern to Inuit.

Overview of the Results of the Canadian Arctic Contaminants Report (CACAR)

Derek Muir, National Water Research Institute, Environment Canada

Derek Muir gave a brief overview of the most significant results of the Canadian Arctic Contaminants Report (CACAR). He noted the irony in the fact that while the stimulus for the Northern Contaminants Program (NCP) in 1989 was the finding of high levels of PCBs in human breastmilk in Northern Québec, the primary emphasis of research has been on the Northwest Territories and the Yukon. Muir stated that both CACAR and a highlights report will be released shortly.

CACAR addresses the questions: What are the contaminants of concern? Where do they come from? How much is there? Are things getting better or worse? Are contaminants affecting plants and the animals? Its major findings include:

- *Contaminants:* Chemicals of concern are:
  - Organochlorines (OCs): polychlorinated biphenyls (PCBs), toxaphene and other chlorinated pesticides (DDT, chlordane);
  - Polyaromatic hydrocarbons (PAHs): benzo(a)pyrene;
  - Heavy metals (especially mercury);
  - Radionuclides (e.g. cesium-134, 137 and strontium-90).
- *Sources:* The main sources for contaminants in the Arctic are human activities in industrialized and agricultural regions of the world.
- *Pathways:* Contaminants are transported to the Arctic mainly through air and ocean currents (see Appendix I, fig. 1). Certain chemicals used can "evaporate" or enter into the air by other means (on particles, for example), and are then carried by the wind and deposited when the warmer air makes contact with the colder air in the Arctic. This effect is known as cold condensation or the

grasshopper effect. An illustration of this effect is that the highest levels of HCH – an insecticide used on rice and other crops – are found in the Arctic, where it isn't used. However, due to political pressure from the international community, some countries – such as India – are starting to use purer chemicals, which is resulting in decreasing levels of contamination by cold condensation in the Arctic. HCH levels have been declining, and while PCB levels are lower than in the 1960s, no visible declines have been observed since the 1980s.

Muir noted that some of the water the Arctic is getting via ocean currents is up to 30 years old, and contains pollutants from 20 years ago. However, the Arctic Monitoring Assessment Program (AMAP) which is international in scope, has found that Russia is very polluted, and Canada looks very clean in comparison.

- *How persistent OCs enter the marine food web*: Persistent OCs transported over long ranges or originating in local sources are deposited into the snow. When the snow melts, the runoff goes into marine environments and OCs enter the marine food web. The substances accumulate in the lower organisms, and when organisms higher on the food chain eat those lower on the chain, the contaminants biomagnify; the chemicals don't degrade, and there are no mechanisms to excrete them. The highest concentrations of PCBs and toxaphene in the east/central Arctic marine food web are found in whale blubber. Polar bears have levels higher than those in beluga.

- *Marine mammals:* Marine mammals have been sampled across Canada (see Appendix I, fig. 2). Lots of work has taken place in the eastern Arctic: walrus has been sampled in Labrador, beluga in Hudson Bay and Baffin, and narwhal in Baffin. Ringed seal has been sampled at all these sites. While lots of activity has taken place, the sample sizes have been small.

    - *PCBs in ringed seal*: Studies of the levels of PCBs in ringed seal blubber across Canada from 1992-95 show that female seals have lower levels of PCBs probably because they excrete PCBs through lactation. Trends in PCBs and total DDT in ringed seal blubber at Holman Island show that levels are slowly decreasing. This is because DDT and PCBs were banned in Canada in the 1970s, but they are still used in some countries

    - *Mercury in beluga:* There are differences in the level of mercury found in beluga whale liver across the Arctic. Samples show that levels are higher in the western Arctic than in the eastern Arctic. While industrial activities do have an effect on mercury levels, it is important to note that mercury has always been naturally present in the Arctic. In response to a question, Muir noted that there is a chance that some beluga may migrate from the west, but that belugas off Labrador are most likely from south Baffin. However, it is not known exactly where the animals live during the winter.

    - *Mercury in marine mammal livers*: There are increasing levels of mercury concentrations in marine mammal livers, particularly in beluga, narwhal and ringed seals. This increase is not a natural phenomenon, but an outcome of industrial activities.

- *Fishes*: There has been little in the way of fish studies in Labrador. In order to test levels of PCBs, about 500 samples were collected in the Northwest Territories, and 25 in Northern Québec. More activity has taken place in Northern Québec than in Baffin on mercury levels.

- *Caribou*: Caribou have been sampled for PCBs and OCs in the Northwest Territories and the

Yukon, but not in Northern Québec and Labrador. Higher levels of OCs have been found in Baffin Island caribou and in other areas of the eastern Arctic. This might be due to air currents from polluted areas reaching these areas more directly. The contaminants are absorbed by lichen, and these lichen are eaten by caribou. However, the levels are very low compared to levels in the fat of fish, seals and whales. Levels of cadmium are higher in western herds, while mercury levels are similar to those in the east. Local sources of contaminants may account for some of the differences in levels.

- *Waterfowl and gamebirds*: Some sampling of waterfowl and gamebirds for OCs and heavy metals has been conducted in Labrador and Nunavik.

Discussion

Questions following the presentation included:

- *Do the levels of compounds in blubber samples depend on which season the animal is taken?* Muir responded that there are differences in concentrations in animals hunted in the spring and fall: the levels increase with the amount of fat. Seasonal variations in fat are particular to seals and caribou, while whales' levels remain more or less constant. It is important to have good collaboration with the hunter and trappers organizations (HTOs) in order to get information on things like blubber thickness, and location and time of sampling, Muir emphasized.

- *Do activities – including hydroelectric developments – increase levels of mercury?* Muir responded that he wouldn't attribute the increased levels directly to hydroelectric developments, particularly since mercury levels are similar in both the western and eastern Arctic, and there are no hydroelectric developments in the west. The sources of mercury contamination are probably coal-burning plants. One hypothesis suggests that atmospheric transport of mercury appears to flow along a corridor that goes through Québec.

- *With respect to DDT and other pesticides, what were your findings regarding temporal trends of the compounds' metabolites?* Muir said DDE – a metabolite of DDT – is responsible for egg shell thinning, but noted that other metabolites are excreted by the animals very quickly and are not of concern. When pesticide levels are examined, metabolites are measured as much as possible.

- *Over the last few years, there has been an observable increase in Labrador caribou that are sick. When you open caribou, sometimes the organs stick to the ribs, and sometimes the meat doesn't look good. Is this sickness natural because of the increase in population, or is it an effect of contaminants?* Muir responded that the cause of the caribou sickness is difficult to pin-point. Some toxins are low in caribou, but accumulate in humans who eat the food. There is evidence that contaminants cause stress on the animals. However, caribou sickness is more likely on account of parasites than contaminants.

- *In the late 70s/early 80s, the federal government conducted a study in Labrador. They tested caribou livers for metals. Where are the results?* Muir answered that in the mid-80s, studies were conducted on levels of radionuclides in caribou. While CACAR makes note of some studies, Muir said he didn't know the status of the results for the work described by the questioner.

Overview of Existing Contaminants Data and Identification of Data Gaps Specifically for Northern Québec and Northern Labrador

Seabirds and Waterfowl (ducks, geese)
Louise Champoux, Canadian Wildlife Service

Louise Champoux gave a brief overview of the existing contaminants information for seabirds and waterfowl, focussing on the results of a study conducted by Brigit Braune of the National Wildlife Research Centre in Ottawa. The main objective of the study was to determine whether birds commonly harvested in Canada are safe to eat based on their contaminant levels.

Champoux described the methodology of the study, noting that at least five to 10 birds per species were sampled. The edible portion of the breast muscle was analyzed for chemical residues. The contaminant data was then sent to Health Canada for an evaluation of risk to human health. Based on the results of the evaluation, Health Canada issued an advisory stating that ducks, geese and other gamebirds surveyed for contaminants are safe to eat.

The major findings of the study included:

- Plant-eating birds, such as ptarmigan, geese, mallard and pintail, had lower levels of OCs, mercury and selenuim than fish-eating birds, such as mergansers and loons;
- Plant-eating birds and bottom-feeding birds, such as eiders, had higher levels of cadmium than other species;
- Birds from the eastern Arctic generally risk greater exposure to OCs than birds in the western Arctic due to the contaminant levels in their overwintering areas in the South;
- Based on residue levels in breast muscle, there is no evidence suggesting that OCs or cadmium are affecting the health of the birds surveyed;
- Levels of mercury, selenium and arsenic may warrant further study in some species.

The major conclusions were that:

- Most birds examined had very low levels of contaminants;
- Waterfowl from eastern locations had higher levels of organic contaminants than those from western locations;
- A few species of seabirds had higher levels of some contaminants.

Champoux suggested that further research may want to consider, among other things (see Appendix I, fig. 3):

- Selenium levels in scoters;
- Lead in willow ptarmigan;
- Mercury levels in mergansers and OCs and PCBs in Old squaw.

Discussion

Questions and comments following the presentation included:

- *Over the past years we have heard that contaminants such as PCBs, mercury and cadmium, which are found in the animals, are also found in humans, but we haven't been told what levels are dangerous for human consumption. We need to let people know which levels are dangerous for human health, and where the contaminants come from.* Champoux responded that Health Canada tells people that the levels found are not of concern, and that eating country foods is healthy, notwithstanding the low levels of contaminants present. It's hard to identify the sources of the contaminants. What is known, however, is that many animals can't excrete the pesticides, so the contaminants accumulate. Minnie Grey explained to the participant in Inuktitut, that DDT, PCB and cadmium come from the industrial world, but that mercury has been found in the land. She also explained the air and ocean pathways, and that Health Canada has guidelines, and cord blood studies are in progress. Continuing to eat country food is important as this food is rich in nutrients. "In Nunavik, we need to work closely with Health Canada so we have one guideline in all of Canada," said Grey. "At this time we don't want to warn people not to eat food."

- *Are the same levels of contaminants found in birds also found in their eggs?* Champoux responded that she wasn't sure, but she thought that the levels in eggs were considered acceptable.

- *I killed black ducks in Nain, but they had white worms in them that looked like corn. Do you know what causes these worms?* Champoux said she did not know the answer.

- *What are the lead levels like in ptarmigan?* Champoux answered that there weren't enough numbers of samples in the study to test for lead in ptarmigan.

- *Have any of your studies focussed on seagulls? The majority of people wouldn't eat seagulls, but everyone eats seagull eggs.* Champoux responded that she thinks the levels are higher in eggs. The questioner commented that there should be more co-operation between researchers and the people who go out on the land.

Derek Muir noted that CACAR contains answers to some of these questions. He has also prepared a review of existing data on persistent OCs and heavy metals in Nunavik and Northern Labrador which is available to participants.

Fishes
Derek Muir, National Water Research Institute, Environment Canada;
Jocelyne Pellerin, Université du Québec à Rimouski

Derek Muir began his presentation by describing the fish samples analyzed for contaminants in Nunavik under various programs including the NCP funded by DIAND, and the Grande Baleine Monitoring Program funded by Hydro-Québec. Freshwater and anadromous fish sampled were Arctic char, lake trout, lake whitefish, brook trout, northern pike, sculpin and mussels. Examinations of PCBs and OCs in fishes were limited to three communities: Inukjuak, Salluit and Kangiqsujuaq.

Findings of the various studies include:

- Lake trout has the highest levels of mercury, OCs and PCBs, and char the lowest;
- The highest levels of PCBs are found in fish livers. Northern pike do not have high concentrations of PCBs in muscle tissue, because they have fatty livers;
- Persistent OCs are highest in top predators of the food chain.

Gaps in research on fishes in Nunavik and Labrador include:

- Lack of information on levels of OCs and metals in fishes from lakes near coastal communities;
- While toxaphene was the major contaminant in the fish analyzed, there is little data because this contaminant was not targeted in the Hydro-Québec study;
- To date, no research has been conducted in Northern Labrador on contaminants in freshwater or anadromous fish.

Muir commented that while many fish studies have been conducted in Nunavik, the geographic coverage was limited and sample sizes were generally small.

Jocelyne Pellerin reported on the results of a study led by Éric Dewailly in Eastern Ungava Bay. The main goal was to evaluate the health of Arctic char, particularly its parasitic load, level of contaminants and physiological conditions.

Sampling of char took place at Sapukkait and George River, two sites identified as important fishing sites. Pellerin noted that because the sampling locations are 100 kms apart from each other, there are reasonable doubts that the fish samples are from the same population. Anadromous Arctic char samples were also analyzed for parasites, and none of the parasites identified were harmful to human health.

Muscle tissue and fat under the skin -- tissues that are consumed by Inuit -- were measured. The study found that these tissues have low levels of OCs (below the average daily intake suggested by Health Canada), PCB congeners and heavy metals (both were lower than in the 'reference' fish, a fish that was farmed in the Rimouski area). The major conclusion was that char is good to eat and contains beneficial nutrients, and that the skin is a good source of calcium. "Indeed, Ungava Bay has the cleanest Arctic char," Pellerin stated. "It's very good to eat."

Discussion

Questions and comments following the joint presentation included:

- *Do fish first acquire substances in the liver and then the muscle? Is that temporal information relevant? With marine mammals you can tell what they've fed on by the contaminant levels in the fatty acids.* Muir responded that this temporal aspect is not relevant with PCBs, because they are distributed very quickly, within 24 hours of eating contaminated food. It may be possible to tell what marine mammals are eating from their fatty acids and PCB patterns.

- *Were fish in the studies pooled in terms of age and sex? Concentrations of heavy metals in different body parts vary with sex and age. We have found char that are at least 15 years old, and lake trout can reach up to 50 years of age. For users, these are important considerations.* Muir responded that the focus of the Grande Baliene research was not based on age class necessarily, but on the range of the fish, although fish of varying ages were sampled and their ages pooled in the results. Pellerin said that some fish in the Dewailly study were between five and eight years old: "We chose fish that were about to spawn, because it's important to compare reproductive states," she said. She noted that the age of the fish and the level of contamination do not necessarily go hand in hand; what has to be taken into account is the location and the species. Older fish may not necessarily have unsafe levels of contamination, but those that over 10 years old -- particularly

anadromous char – would probably contain large amounts of parasites. She reiterated that although these parasites are not harmful if consumed, "it's quite disgusting to open a char and see them."

- *I'm surprised you're not finding diphyllobothrium in the char.* Pellerin commented that the pattern of distribution of parasites in freshwater fish is different.

- *Can you correlate the size of the fish with the level of contamination, and are you able to draw a line regarding safe consumption levels?* Muir answered that studies in the Northwest Territories have proved that there is a correlation between size and mercury levels.

- *Can we extrapolate your data on char to other regions of Nunavik and Labrador?* "I think so," said Pellerin. Another participant disagreed with Pellerin's response, stressing that some data collected on char – such as the Falcon Bridge study – has shown high levels of mercury. While Arctic char is a species highly consumed in Nunavik, not enough data has been gathered on it, he said. Pellerin commented that there are lots of metals in sediments around mining areas, for example Deception Bay. She has noted a difference between what the mining company reports, and the sediments she has examined. Many fishermen in the area have observed deformities in fish. Muir noted that while Pellerin's data is important for East Ungava, it's important to know the local ecology of each area being tested. There is a lack of information on the effects of mining in the Deception Bay area, and it would be useful to compare samples from Deception Bay with those in Ungava.

- *Do parasites have anything to do with health?* Pellerin responded that parasites are normally found in fish muscle tissue. However, they don't affect the health of the fish or human consumers. A few parasites, such as diphyllobothrium are harmful. Over 100,000 parasites were found in the liver of some fish.

- *So, is it safe to eat the liver of fish? Because I do.* Pellerin answered that it would be best not to eat the liver.

- *Do the fish go out of the Bay? I'm wondering if all the samples are from the same population of fish.* Stas Olpinsky of Makivik noted that data going back to 1986 indicated that the fish are site-specific, and that there is a limited amount of mixing. Most feed along the shorelines, although some go offshore.

- *Why do lake trout have higher mercury levels?* Shelagh Montgomery responded that the levels of sulphate concentration in sea water and freshwater differ; concentrations in sea water reduce methylation activity, while concentrations in fresh water do not. In short, there are higher levels of contaminants in freshwater than in sea water. It was also noted that lake trout tend to feed higher on the food chain than marine fish.

- *Char do not necessarily travel the same natal routes each year, and some even change the river up and down which they travel. This phenomenon has been observed in the Payne Bay area. The Payne Bay community requested that studies be conducted on char before the Raglan mine goes ahead, because the fish of that area is considered one of the best. So before it's too late, the community is asking that studies be done to measure the levels of contaminants in those fish. That fish is very important; it's precious to us, and some people make money from it.* Pellerin responded that many sites need to be evaluated. Payne River may be one such site. "We need to choose the right

spots to verify the contaminant levels," she said. "But I don't think it will be possible to measure them all, especially because it's very costly. We need to make choices."

- *This forum is a good way for the scientists and local people to share information, something which isn't happening. There is a gap between the people out on the land, and the people who have the power to analyze.* Minnie Grey noted that at the end of the meeting a series of recommendations would be developed.

Caribou

Sophie Robillard, Veterinary Medicine, Université de Montréal

"One of the main goals of my Master's was to bring my results back up to the North, so I'm very happy to be here today," said Sophie Robillard.

Conducted in response to the Québec Ministry of Health asking that levels of mercury in caribou be verified before the sale of caribou meat could be commercialized (levels of cadmium were examined in the 80s), Robillard's research focussed on testing slaughter house samples of three different caribou herds in Labrador and Nunavik: the Rivière aux Feuilles herd, which migrates north to south; the George River herd, which migrates east to west; and the Torngat Mountains herd, which is found in northeast Nunavik and Labrador. Robillard noted that there is still controversy over whether a herd of caribou is stationed in the Torngat Mountains, or whether it originates elsewhere; in other words, there is controversy about whether the Torngat herd is distinct from the George River herd. While the Rivière des Feuilles and George River herds have been well monitored, animals belonging to the Torngat Mountain herd have never been tested.

Robillard stated that caribou are exposed to contaminants through their diet, 80% of which is comprised of lichen in the winter. Airborne pollutants are found in concentrated levels in lichens because they have no roots and therefore do not take in contaminants from the soil. Moreover, lichens accumulate airborne contaminants over many years, because they have large surface areas and do not shed their leaves each year. Humans who eat the caribou are therefore also exposed to the contaminants accumulated in lichen.

Muscle tissue, kidneys and livers were tested in visibly healthy samples from four different slaughter houses. There were more male than female samples. Findings included (see Appendix I, fig. 4):

- *Cadmium*: Levels of cadmium are higher in the Rivière des Feuilles herd than in the Torngat herd; females are more contaminated than males; levels in kidneys exceed the guidelines; there are high levels of cadmium in livers -- one in three livers exceed guidelines -- and therefore livers should not be consumed.
- *Mercury:* Levels of mercury aren't high, and there is no detectable difference between herds.
- *Cesium-137:* Concentrations are lower than those calculated at the beginning of the 90s, and there are no differences among herds.
- *Lead:* There are no differences among the herds in the levels of lead in muscle and kidney tissue.

Robillard noted that it's hard to compare the animals from one herd to another if the animals are collected at different times of the year.

Discussion

Questions and Comments included:

- *Because its origin hasn't yet been determined, it might be preferable to refer to the "Torngat herd" by using the name of the community in which the slaughterhouse from which the samples were collected was located, namely George River. It is important to keep in mind the time of year at which sampling takes place because caribou migrate.* A hunter commented that there does seem to be a separate herd stationed in the Torngat Mountains.

- *Were the levels of cadmium in caribou livers acceptable for human consumption?* Robillard responded that one in three caribou livers was not acceptable for human consumption. Serge Couturier added that in many cases, parasite loads in caribou are so high that he would not recommend eating them, regardless of contaminant levels. He noted that the parasites in caribou liver are usually visible.

- *Although levels of cadmium are high in caribou livers, this information needs to be put into perspective as a health issue, because Inuit are also exposed to cadmium through smoking.*

- *Did you observe any blue livers?* Robillard answered that all the samples were in good health. While there were some parasites, no blue livers were observed.

- *Can parasites in the brain of caribou be passed down to humans?* A delegate responded that while these parasites cannot be passed on to humans, they can be passed on to other caribou.

Marine Mammals (beluga, seal, walrus)
Derek Muir, National Water Research Institute, Environment Canada

Derek Muir showed a map indicating the various places in Nunavik and Labrador where marine mammals have been sampled and analyzed (see Appendix I, fig. 5). He noted that the Department of Fisheries and Oceans (DFO) collaborated with Makivik on studies in the 80s, and some studies were also conducted in the 90s.

Studies found that there are higher levels of PCBs in the blubber of seals near Quaqtaq and Inukjuak, and that female ringed seals near Quaqtaq have higher levels than males (see Appendix 1, fig. 6). While explanations have not been fully researched, these findings are probably not a result of local pollution.

Muir then showed a chart depicting levels of OCs in marine mammals in Nunavik (see Appendix I, fig. 7). Blubber samples were collected, though not muktuk, and kidney, liver and muscle tissue were analyzed for heavy metals. He pointed out that no metals have been measured in harp seals. Walrus near Inukjuak had high levels of OCs, but the speculation is that the walrus were eating the seals, who had higher levels of contamination than shellfish, walrus' usual diet. Walrus who eat seals are therefore quite high on the food chain, compared to walrus who eat only shellfish. Muir noted that quite a bit of work has also been conducted on beluga in Nunavik.

One gap in the research is that while blubber has been examined, no analysis has yet been conducted on the tissues people are eating, especially muktuk. Moreover, more research needs to be conducted on heavy metals (OCs have been fairly well examined), as the work to date has been *ad hoc*.

Muir closed by stating that quite a lot of work has been done on marine mammals in the region, and that if anyone has questions about specific locations or animals, they can ask him and he will dig up the information.

Discussion

Questions included:

- *Do PCB levels stay high throughout the lifetime of seals?* Muir answered that they don't in females, because females excrete PCBs when they nurse their pups.
- *Were the studies done in the spring or fall?* Muir responded that the samples were gathered from the spring hunt.

Atmospheric Pathways

Laurier Poissant, Atmospheric Environmental Service, Environment Canada (Québec) (presented by Derek Muir); Shelagh Montgomery, Université du Québec à Montréal

Derek Muir presented Laurier Poissant's research on long-range transport of pollutants in the St. Lawrence Valley, which examined issues such as whether acid rain is affecting northern Québec. The classic example of long range transport of airborne pollutants is the nuclear power station of Chernobyl which exploded in 1986 releasing radionuclides. Much contamination was found in Scandinavia and Canada. Chernobyl illustrates how far heavy metals travel from their source of origin.

The major source of airborne pollution that affects the eastern Arctic is industrial activities in the south, such as mining and landfill sites. Man-made chemicals go into the atmosphere, and are transported by the air currents. Some of the chemicals have short half-lives, while others have longer half-lives, and this depends largely on how the chemicals react with rain and sunshine. Chemicals with longer half-lives are usually more persistent, particularly in the North where cold temperatures decrease the rate of reaction; for example, degradation of hydrocarbons is 10-20 times slower at 5°C than at 25°C.

Within four days, air can move from industrial sites in the St. Lawrence River valley to the northern tip of Nunavik. Existing monitoring stations in southern Québec have found that OC concentrations seem similar at all locations, with the exception of slightly higher concentrations of HCH near Québec City. Moreover, PAH concentrations decrease with distance from Montréal.

The current situation regarding airborne pollutants in Northern Québec is that no direct evaluation of airborne pollution has been conducted in Nunavik or Labrador to date. However, several indirect impacts on the environment might be related, such as contaminants in rivers and caribou.

Muir closed the presentation by listing several observations about atmospheric pollutants from a northern perspective, including that:

- In the future, lower atmospheric concentrations of man-made contaminants, such as PCBs, are expected;
- Pollutants with longer half-lives may be more persistent;
- PAHs can be transported over a long range through precipitation. However, the volume of precipitation is less in the North;
- Mercury is the most toxic species in Northern Québec, and its mass balance needs to be assessed.

Shelagh Montgomery's presentation focussed on mercury pathways. She noted that there is some concern

that mercury emissions from industry are a new source of Arctic contaminants. There is far more mercury in the environment now than before industrialization. This finding has been supported by research conducted in Lake Lusignan, Québec (north of Montréal), where cores and sediment layers were analyzed. The analysis revealed that in the early 1900s, the beginning of the Industrial Revolution, there were low levels of lead and mercury compared to levels found today.

Montgomery noted that mercury is not always transported through the air in circles that move outwards from the point of origin, as Laurier Poissant's presentation had suggested; mercury often travels in corridors. Lots of industrial activities take place around the Great Lakes in the U.S., and there is speculation that a mercury corridor exists that crosses the west side of Québec and Hudson's Bay into the Arctic (see Appendix 1, fig. 8). She also noted that this speculation is based on extrapolations from limited data.

Discussion

Questions and comments included:

- *Does mercury from coal-burning in Ohio travel North?* Muir responded in the affirmative, noting that not much goes South due to prevailing wind direction being from the west or southwest.

- *Mercury concentrations in air are similar over a broad range. How much change is due to acid species in the air?* Montgomery answered that the effect of acid rain is larger at the ground level with mercury in lakes. Mercury in the atmosphere is "rained out" over long distances, and absorbed in organic material far away from the source.

- *Do jet plane emissions have an effect, and can they change the density of the air? I remember one winter when there was a sandstorm in the South, and the snow was covered in sand.* Derek Muir answered that particles of "brown snow" from a storm that took place mid-April of 1988 in Rankin Inlet were studied. After the storm, the snow was covered in brown dust. Analysis revealed that the dirt particles originated in Mongolia and China; there were Asian plants and seeds in the soil, as well as carbon particles from burnt wood. This shows that even dust is transported over a long range.

Northern Labrador Ecosystem Study

Frank Andersen, Labrador Inuit Association

Frank Andersen gave a brief overview of the Northern Labrador Ecosystem Study. "Little or no research is being conducted in Labrador," he said, illustrating his point by referring to the lack of Labrador-specific information in the presentations that had been made at the conference. The Labrador Inuit Association (LIA) realizes that a lot of activities have taken place in other parts of Canada, and they are actively looking for people interested in working in Labrador.

In order to evaluate the priorities for research from a community perspective, the LIA convened a workshop. A survey was then developed with the assistance of the University of Waterloo, and over 230 questionnaires were completed and analyzed. A comprehensive report was then written outlining local, community and regional concerns regarding the environment and contaminants, as well as other wide-ranging issues of concern. The report is currently being translated, and will be released shortly. "We have everything prioritized," said Andersen, "so we know what needs to be done in the area."

DAY 2: WEDNESDAY, MAY 28, 1997

Plenary Discussion

Before going into breakout groups, participants discussed the costs of sampling in an attempt to focus breakout group discussions and come up with realistic recommendations and a meaningful action plan.

It was noted that the Makivik Research Centre in Kuujjuak is developing the capacity to do analysis of heavy metals, although it does not have the capacity to test for OCs. Using the Makivik lab could reduce costs that would otherwise go to travel. While testing isolated metals such as mercury is not very expensive, costs increase dramatically when mixtures of metals are tested. Costs range from $500-$1000 per sample if a private firm is engaged, to $200-$400 per sample if government labs are used. Testing for mercury in biota is approximately $10 per sample, and costs increase if the water or snow is tested or if sample collection costs are included. One rule of thumb that can be applied regarding costs is that one-third of the costs go to travel, one-third to salary, and one-third to lab testing.

A community representative expressed concern that if there is no money to conduct studies on contaminants, local people will eat contaminated food. Minnie Grey reassured the participant that the only reason the question of costs was raised was because nobody present was an expert on the issue, and that if a good proposal is made concerning the testing of contaminants, it is sure to be funded. A hunter agreed with the community representative, stating that "I don't think a dollar figure should be set on the health of Northerners."

Grey stressed that the recommendations from the groups should be based on these concerns: "The number one most important thing is the health of the consumers," she said.

Existing Programs and Local/Regional Concerns

Environment Québec

Serge Couturier, Environment Québec

Serge Couturier joked that if he had to use overheads to present what Québec has done on contaminants in the North, there would be two overheads: one would contain the title "What Québec has done on contaminants in the North", and the other would contain the word "nothing". He noted that in the mid-80s some studies were done on caribou to examine the effects of the Chernobyl accident. In particular, levels of cesium and polonium were examined. The studies concluded that while caribou muscle is fine for human consumption, caribou liver and kidney were not. Another study examined the level of cadmium in caribou. "Whatever the results, I would never recommend eating caribou liver," said Couturier, noting that over 75% of caribou livers are contaminated with liver fluke.

He stressed that scientists need to enhance their communication skills in order to communicate more effectively with other scientists, as well as with the communities. Scientists often forget to ask communities in Nunavik for research permits. Moreover, the ecology of the animals need to be considered in studies (i.e., sex, age, season taken), and samples should be larger than in past studies. Caribou have different levels of contaminants in the winter and summer, and this needs to be kept in mind. Couturier also noted that caribou have reached their maximum population levels.

Couturier closed his comments with a warning to scientists: "It's very complicated for community people to understand fancy words like PCBs, and sometimes people are lost. This causes major problems. When you talk about problems in caribou belonging to the George River herd, it has nothing to do with contaminants: rather it's an overgrazing problem which causes a decline in the population. We must ensure that these aren't mixed up."

Minnie Grey responded to Couturier by noting that since the 80s, a basic vocabulary has been developed to speak about contaminants in Inuktitut. For example, DDT is known as bug spray, and cadmium as cigarette poison. The contaminants are translated as literally as possible.

Comments and questions following the discussion included:

- *With regards to caribou, the most frequently asked questions are: Why are caribou livers sometimes blue? Why are the innards stuck to the cavity? Are these related to contaminants? However, there aren't answers to these questions.* Couturier responded that the reason livers are sometimes blue or brown is because they are infested with the fluke parasite that destroys liver tissue. The high level of infestation is because the herds are large. He said he had never seen organs sticking to the body cavity in caribou, and suggested that the phenomenon might have something to do with a low fat reserve problem rather than with contaminants.

- *Over the last decade Québec has done some work on drinking water. While this research has not focussed on contaminants, it does tie in with the issue of local sources of contamination. Local sources include generators, vehicles, and solid waste disposal sites where garbage is burned because Québec does not allow incinerators. These sources need to be examined more carefully.* Minnie Grey pointed out that Nunavik is farther ahead than Labrador on the issue of local pollutants. But, she said, people in Labrador and Nunavik have to consider themselves lucky because they aren't in the Chukotka region of Russia, where there aren't any labs to measure contaminants. Instead, Chukotkan hunters who catch animals with deformities – such as pink, hairless seals – gauge whether they can eat the meat by feeding it to their dogs and observing the effects.

Government of Newfoundland and Labrador

Richard Martin, Department of Environment and Labour, Government of Newfoundland and Labrador

Richard Martin said the Government of Newfoundland and Labrador is also not doing anything related to contaminants. However, informal discussions have taken place with LIA and with the DFO at Memorial University. There is an interest to pursue research in the area of contaminants, and the various parties have agreed to collaborate and partner in the analytical components of the research. "I'm here to tie in that program with a national or regional program," said Martin. "Hopefully at the end of the day we'll get ideas for fine tuning an approach that we can implement."

Kativik Regional Government

Mike Barrett, Kativik Regional Government

Mike Barrett noted that there are two different ways that the Kativik Regional Government (KRG) is involved: at an overall level, through the Kativik Environment Advisory Committee, a forum of federal, provincial and regional representatives that aims at communicating issues to Nunavik; and at the local level, through the Kativik Environmental Quality Commission. This Commission consists of four local and four

provincial representatives, and has been in operation for 15 years. The Commission reviews proposals, and is in the process of developing guidelines for resource development projects. KRG has two coordinators on staff to deal with issues around drinking water, waste water and oil spills. It is currently engaged in a number of projects, such as DEW line cleanups and monitoring activities a number of which overlap with Labrador.

Questions following the presentation included:

- *Who is conducting the assessment on the Raglan mine?* Barrett responded that the assessment for the Raglan mine is mandated under the James Bay/Northern Québec Agreement, which states that any new mine is subject to a review.

Makivik
Daniel LeClair, Makivik Research Centre

Determining baseline information on levels of contaminants is important for risk assessment, commercializing meat and toxicological monitoring, said Daniel LeClair. Devising a profile of information about contaminants in many species would be helpful for monitoring activities. He noted that at this stage people in Nunavik are only beginning to talk about monitoring programs, whereas down South they are identifying problems based on the monitoring findings.

In 1995, Makivik offices in Kuujjuak moved to a new building that has a lab. DIAND, Kuujjuamit Corporation and Makivik Corporation provided funding for buying equipment to measure heavy metals, and for a ventillation system to reduce contamination in the lab itself. LeClair stressed the need for participants at the workshop to identify community-level projects. "We need to focus on specific projects, because we don't have enough samples," he said.

LeClair identified several areas that need to be researched, including:

- *Local pollution*. Communities are developing fast and there's a build-up of local pollution. In the North there is no recycling of wastes, and this is something that needs to be addressed. One project that was refused by the AES was a study of lead in cord blood. The reason it was refused is because it related to local pollution: "We need to address this and identify the source," LeClair said. Suzanne Bruneau noted that the Centre Hospitalier de L'Université de Laval measured lead in cord blood. While an initial proposal to identify the source of the lead pollution was refused, the project will probably be funded this year. "We think the contamination is probably due to lead bullets," Bruneau said. Louise Champoux of CWS noted that lead shot will be banned in the fall.
- *Human health effects and harvested species* such as caribou, ringed seals, Arctic char, lake trout and ptarmigan.
- *Environmental monitoring of mining sites* such as Deception Bay, in order to assess the levels of contaminants before the project, so the data can serve as a baseline for monitoring activities.

Other concerns mentioned in a discussion following the presentation included:

- *Lack of long-term, ongoing institutional and funding support for monitoring activities*. People get bounced back and forth between organizations. For example, in 1980, Makivik tried to get ongoing funding to study trichinosis parasites in walrus meat. However, they were told that if the research was focussing on the effect on the walrus itself, the appropriate funding organization would be(DFO. If the research was examining human health effects, the funding organization would be Health

Canada or the Ministère de Alimentation, Pêcherie et la Agriculture de Québec (MAPAQ). However Health Canada told Makivik it dealt with commercial rather than subsistence consumption. So it was a catch-22 situation.

- *Lack of local organizations to deal with local pollution issues* such as disposal of old batteries and rusting cars.

- *The appearance of cancer in Northern people; increasing cancer levels might be related to mining activities*. While smoking is part of the cause, research should take place on other possible sources. There are one or two communities in Nunavik that have particularly high rates of cancer. These rates of cancer might be due to mining activities that have taken place in the past.

- *In Labrador, caribou is a big concern as it is a large part of the diet*. LIA has conducted studies, but the results haven't been disseminated. Information on contaminant levels of various sites should be compiled, and then information could be exchanged with organizations monitoring levels at other sites in order to get a broad picture.

- *Cadmium in caribou liver*. Livers have naturally high levels of cadmium. The benefits of eating the liver should be considered. However, there is no baseline of information for cadmium. It was noted that levels of cadmium in liver are not as elevated as levels in kidney.

- *Confounding issues with epidemiological studies*. There are more confounding issues that have to be dealt with in epidemiological studies, and toxicology studies are even more picky. Health Canada won't fund toxaphene studies because they are expensive; it is closing labs and attempting to get results from studies in other countries. The problem is that toxaphene isn't found in other countries, so no studies are being conducted. It was also noted that it is very difficult to identify toxicity at low contaminant levels, and that health studies tend to be highly intrusive as they ask questions about effects, among other things, which complicated matters further.

Centre Hospitalier Université de Laval and Nunavik Board of Health and Social Services, Nutrition and Health Committee

Minnie Grey, Nunavik Nutrition and Health Committee and Tulattavik Health Centre; Suzanne Bruneau, Centre Hospitalier Université Laval

Suzanne Bruneau reviewed human milk studies that the Centre Hospitalier Université de Laval (CHUL). In 1988/89, a study led by Éric Dewailly found higher levels of contaminants in human milk in Northern women compared to levels in human milk in women in the South. This finding led to a study on human milk levels and the health of infants in their first year of life. However, levels in the North still do not exceed guidelines. The conclusion of this study was that it is still very important to continue breastfeeding particularly because there is a tentative link between maternal contamination levels and risk of otitis. Some infants with otitis had higher levels of contaminants. However, this was only the case with a few individuals, so the results have to be interpreted carefully. The benefits of breastfeeding are well known, but the risks are hypothetical.

A cord blood monitoring study was then undertaken, and the results have yet to be released. Preliminary results show that contaminants are four to 10 times higher than in the South, but don't exceed guidelines. The conclusion of this study is that people should continue eating country foods as the nutrients in them are

very high, and the benefits of eating the foods far outweigh the risks. For example, fish oil helps against heart infarcts, and selenium, which is found in country foods, is a natural anti-toxin for mercury. The message given to women of procreative age is that they should eat more char. A program has been established in Nunavik in which women are given fish for free.

The next step in the research will be to focus on the fetus. A study was initiated in Kuujjuak, Povungnituk and Inukjuak to examine whether prenatal exposure can have an effect on development and psychomotor skills, a topic which has been very controversial in the U.S.. This study will be completed by 2001.

Minnie Grey recommended that participants read the document *The Health of Nunavik*, prepared by Stephen Hodgins. She asked that interested participants give her their names so she can distribute the document.

Grey then spoke about the Nunavik Health and Nutrition Committee. The Committee was formed in response to the "quiet panic" that set in when the communities started hearing about contaminants in country food in the 80s. The Committee started working with scientists and the Université de Laval, specifically Éric Dewailly. "We decided we needed to communicate all the studies and results," Grey said. "We decided we'd take local people in the field and interpret the results back to the people." Since the 80s, much progress has been made.

The Committee has membership from all the organizations in the region. It's role is to link research to the communities, and to communicate research results in common terms, and it's goal is to make sure the people can make informed decisions. "We're trying to say, 'eat your country foods, not hot dogs'," Grey said. The Committee deals with local economies and helps directors make decisions.

The Committee is involved in several projects, including the Eco-Research Project and the study by Gina Muckle of CHUL. "We want to make sure all the research goes through our Committee, and that the projects meet our guidelines," Grey said. Individuals in the communities must be part of the project, not "guinea pigs", and the community has to be in control. Grey concluded by noting that the Committee is a good way to link the local and scientific communities, and that it is a model that Labrador might consider.

Université du Québec à Montréal: Mercury in Food Webs

Shelagh Montgomery, Université de Québec à Montréal

Shelagh Montgomery pointed out that the first consideration that mercury might be a serious problem occurred after Minimata, where clinical signs of neurological disease were obvious. She briefly described a project conducted by Jean Labelle of the Université du Québec à Montréal (UQAM) in the Amazon of Brazil on low-level concentrations of mercury. The main diet in the project area consisted of fish, and levels of mercury there were 10-30 ppb, which is below World Health Organization Guidelines. Labelle found a correlation between mercury levels and a reduced performance on visual and motor skills tests. Montgomery suggested that low-level exposure to mercury might be something to study in Nunavik and Labrador.

Points raised in response to Montgomery's description of the Brazil project included:

- *High levels of mercury were found in Inuit living in Salluit, and they are interested in a follow up.* Exposure to mercury might be one of the reasons why so many Inuit wear glasses.

- *It's difficult to transpose the results from the Brazil project.* CHUL has conducted tests to see what would happen if Inuit consumed less country food. The results showed that while the levels of contaminants would decrease, so would levels of Omega 3, which would have a direct effect on health. Because the effects of contaminants are as of yet unknown, CHUL tries to focus on nutritional benefits and to deliver positive messages.

- *Tests have been conducted on Cree. The problem with these studies is that there are several confounding factors to control.* It's more difficult to control for these factors in adults, as adults cannot recall what type of foods they ate 15 years ago; they usually have only up to 24 hour recall. It's much easier to control for confounding factors in newborns. Confounders to keep in mind in Inuit adults include tremors caused from long-term use of skidoos and alcohol use.

Voisey's Bay Environmental Assessment

Frank Andersen and Ronald Webb, Labrador Inuit Association

Frank Andersen gave a brief overview of the Voisey's Bay environmental assessment. There was no room for collaborative effort in the assessment. At present, the scoping process and development of guidelines is taking place. The whole process will take longer than expected, and may be completed in one year. LIA's opinion is that the area impacted is greater than the company states. A memorandum of understanding (MOU) has been drawn up between the federal and provincial governments, LIA and the Innu Nation, and a panel has been established consisting of members of all four parties. "From our perspective, the company has been trying to minimize things, so they're bargaining in bad faith under the MOU," said Andersen. "If development does take place in Voisey's Bay, there needs to be ongoing assessment, and background levels need to be determined."

Ronald Webb outlined some local concerns regarding the Voisey's Bay development, including:

- Oil spills and other effects of ice-breakers travelling to the site;
- Pollutants issuing from the mine, such as acids, that could be transported through air currents;
- Dust from the open-pit mine settling on snow. During snow melt, the dust could affect fish and drinking water;
- Contamination of lichen, which could in turn contaminate the caribou;
- Exposure of local people hired by the mining company. People who have never been exposed to mining "poisons" could get very sick;
- Increased air traffic in the area, and the effect of fumes;
- Oil drums being hauled into the river. If one drum were to break in a spawning river, it could devastate the char, which is a major food source;
- Garbage dumps and their hazardous emissions;
- Contamination of migratory species.

"We don't have any information," said Webb. "We need more to quiet our fears."

Points of discussion following the presentation included:

- *Becky Sjare of DFO (Newfoundland) briefly described DFO's role in the Voisey Bay assessment.* In the fall and early spring, DFO was given some time to familiarize itself with the area and to gather baseline information. "While this is a small start, baseline information was collected for

toxicological studies in the area, which means that some samples will be available (e.g., marine mammals, fish habitats) and that a baseline exists for monitoring activities," said Sjare. One of the major recommendations in the assessment process is to have a strong monitoring program, and hopefully this recommendation will not be watered down.

- *The mine will not start its activities for another two years, an LIA representative said. However, air traffic has increased from two flights a day to over one hundred, and this is seriously affecting nesting sites for ducks*. Nain is one of the main nesting sites for eider and other ducks, particularly harlequin ducks. Inuit people are very frustrated: "The only baseline information is from the people," the LIA representative said. "I started digitizing this for the CWS. The authorities have become interested only because of the mining development." She emphasized that the development is affecting eider programs in Eastern Canada and the U.S., as it is taking place in these ducks' nesting site.

  Sjare (DFO) responded that there is no doubt more scrutiny on account of the development, and that there are gaps in data. Whether or not these can be bridged is the issue. But for some species like char, long-term studies have been in place, so there is more data.

  The LIA representative cautioned that the Inuit might soon end up protesting like the Innu Nation if there isn't more co-operation on issues such as transporting oil drums. "When the provincial government gets up and says studies have been done, it's like a joke," she said. "I tried to do studies on Arctic char and build on the [government's] studies, but nothing was done."

- *Stas Olpinsky of Makivik extended an offer to share Makivik's research capacities and experiences with LIA*. The size of the Voisey's Bay project and the scoping sessions are based on the project as it was originally conceived; however, the scope of the project is expanding, and the guidelines are not being revisited. Weak guidelines such as those developed at the Falcon Bridge Project would be of great concern. Olpinsky pointed out that the environmental process is being fragmented, and this is of concern to both Labrador and Nunavik as Voisey's Bay will set a precedent for future projects.

Frank Andersen pointed out that LIA does not agree with the relationship between the company and the province. "We know that the province is facing tough times economically, but it's helping the company get permits to the exclusion of the LIA," he said. The company is trying to treat shipping as "advanced exploration infrastructure", a separate category from the actual operations of the mine itself. "We don't know how to get around this," said Andersen. "It's been discussed at the political level...Who knows, it may end up in the courts."

Saglek Bay and Other Military Site Cleanups
Jennifer Rogers, Royal Military College

Jennifer Rogers described the cleanup process taking place in Saglek Bay, Labrador. In the 1940s, "polevault" radar sites were built on the coast of Labrador. Saglek Bay, the most northern site, has a contamination problem related specifically to an antenna. Samples from the antenna hill and one particular site on the beach were tested, and 1500 ppm of PCBs were found, a level which exceeds Environmental Protection Act guidelines. In response to this finding, a cleanup is currently underway. Sculpin and char samples were also collected in order to determine whether the contamination had entered the marine environment: 50,000 ppb were found in the sculpin livers, and 7000 ppb in the muscle tissue; levels in char

did not exceed guidelines. "The results show that the site is having an impact on the immediate offshore area," said Rogers. The area will be excavated this summer, and material will be removed. Rogers noted that the fish sample sizes were small -- only five sculpin and five char -- so more questions were raised than answered. This week a meeting will take place with LIA and the province to design a marine study to determine the extent of the contamination.

Comments and questions following the presentation included:

- *What do you do with the excavated material?* Rogers responded that the excavated material will be contained and left on the site. A contract to remove it from the site has not yet been negotiated, because the volume of the material to be removed has not yet been determined. "Our group will be researching methods of destroying PCBs," she said. "We hope we can destroy PCBs onsite without having to ship them away."

- *Why weren't caribou and hare tested? They also migrate.* Rogers answered that many of the areas around the site are bare gravel. The hilltop was bulldozed, and there is very little vegetation. It's unlikely that caribou are feeding there, although it would probably be a good idea to test caribou, Rogers said.

Mercury in Snow Project

Derek Muir, National Water Research Institute, Environment Canada, on behalf of Buster Welch, Department of Fisheries and Oceans (Winnipeg)

Derek Muir presented a project that Buster Welch is conducting in collaboration with high schools to examine sources of mercury contamination and how mercury gets into the ocean environment. He needed an inexpensive way of getting samples, and so he asked high school students to help with the project. Welch sends two Teflon bottles to each school that has agreed to participate: one bottle is filled with snow, and the other is a "control" bottle that is brought to the sampling site but is not filled with anything. The samples are then sent back to Winnipeg for analysis. This project illustrates one way of collaborating on projects with local people. To date, the project is working very well.

Welch needs contacts for Nunavik and Labrador, and would appreciate suggestions from participants. Sampling in Nunavik and Labrador could start as early as this spring.

DFO's Activities in the Laurentian Region

Michel LeBeuf, Institut Maurice-Lamontagne, Department of Fisheries and Oceans (Laurentian Region)

Michel LeBeuf reviewed DFO's activities in the Laurentian Region. The Laurentian Region DFO started a monitoring program on marine fish and sediments for organic and inorganic contaminants. It has the appropriate facilities, as well as the mandate to cover part of Northern Québec. "There's an interest in our institute to collaborate, but focussing on marine mammals and sediments," LeBeuf said. "One of the problems is sampling. But we're willing to introduce that area in our monitoring program."

CWS's Studies on Wildlife in the North

Louise Champoux, Canadian Wildlife Service (Québec)

CWS has conducted several studies on wildlife in the North. One study was conducted to determine mercury levels in osprey in the James Bay region Studies were also conducted to determine the dissemination of heavy metals in Québec in several species. CWS tests samples taken by organizations such as Hydro-Québec. "We'd like to get more projects in the North," Champoux said. "We're concerned about the effects of contaminants on people, but also on wildlife itself."

Comments and questions in the discussion following the presentation included:

- *Makivik has met with DFO and the CWS to discuss research priorities. The issue is always lack of funding. Will CWS have money to conduct studies in the North?* Champoux responded that the CWS is hoping to get funding from the NCP.

- *DFO (Newfoundland) collects information on aging and diet, and it wouldn't be a problem to take extra samples for testing. This might be a cost-effective way of going about sampling; it's a case of setting priorities and working with local hunters.*

Funding

Derek Muir, National Water Research Institute; Siu-Ling Han, NCP Programs, Department of Indian Affairs and Northern Development

A discussion ensued about funds available under the NCP. Derek Muir noted that the total budget for measurement-type projects for 1997/1998 was $900,000. This does not include human health or communication projects. One half of this funding went to water and air monitoring, and the other half went to measuring animals and biological effects. Five workshops are being held this year to plan for research in different regions on a variety of contaminants issues. The deadline for accessing NCP funding is January, 1998. The amounts of money available are therefore quite small, Muir said. While the possibility exists that one-third of the budget could go to Nunavik and Labrador, other funding sources could be tapped into, such as Environment Canada (Québec).

Siu-Ling Han said Muir was right to point out the lack of funding. Right now there is money for one year from the Department of Indian Affairs and Northern Development (DIAND), but DIAND is talking with other Departments to try and get funding to support the NCP beyond 1997/98. "By having a meeting like this one with a clear action plan, it makes it easier to have a strategy to apply for funding," she said. "DIAND is more than responsive to community concerns." The current meeting is a valuable exercise that will help build Nunavik and Labrador's case, Han said.

Minnie Grey added that the meeting can also highlight the gaps in research, which underscore the fact that Nunavik and Labrador have been left out of the NCP in the past.

Comments from participants included:

- *Government Departments need to invite people to put forward integrated programs, because the new buzzword in the government is "sustainable development".* "That's the Liberal buzzword," one participant said.

- *The $900,000 for 1997/98 has been divvied up already. What will the scope of funding be under the renewed AES ?* Han answered that the amount of funding under the renewed AES is still unknown as of yet. "We only know we'll have money until next March," she said. Muir added that there are some election promises concerning funding research in the North that are fairly specific: "Organizations can be held accountable for what's in the Red Book," he said. Another delegate pointed out that $10 million had been promised for toxics research, and a commitment to address Arctic contaminants issues was specifically made in the Red Book, although no dollar amount was specified. He suggested that while no formal commitment has yet been made to continue the NCP for the next five years, the success of the NCP to date should influence decision-makers.

- *Is it possible to get a list of the projects that have been accepted under the NCP for 1997/98?* Han responded in the affirmative. Muir added that part of the project planning should be to get a list of the projects funded to see what has already been covered.

Working Groups

Participants broke out into two working groups, one facilitated by Craig Boljkovac of the Inuit Tapirisat of Canada (ITC), and the other by Claude St-Charles of Environment Canada (Québec). Each group considered the following issues:

- Information gaps on contaminants in country foods;
- Local concerns about contaminants including human health concerns;
- Information gaps on pathways, sources and time trends of contaminants;
- Communication issues;
- Preliminary recommendations for an action plan.

The following is a thematic summary of the major points raised by the two groups.

Information Gaps on Contaminants in Country Foods

Type	Species (in order of priority)	Comments/Notes
Terrestrial Animals	Caribou, hare, fox, porcupine, blackbears	•Hare: Probably have lower levels of contaminants because they are lower down on the food chain. No sampling has been conducted to date. •Fox: Not eaten in Labrador; no data to date. •Blackbears: Are found particularly in the Hebron Fjord area. Not many studies have been done in the Northwest Territories. Hunters have been told there are many bugs in blackbears. In the Hebron area, they behave like polar bears and feed on seals. •Caribou: Caribou is one of the major dietary sources for Labrador Inuit, and it is mostly taken in the spring. Labrador Inuit eat a variety of different caribou organs, including stomach walls and bone marrow. There is not much information on bone marrow, although CINE has some. Stomach walls should be tested for cadmium as no tests have been conducted on them to date. •Porcupine: Eaten in Labrador.
Marine Mammals	Ringed seal, harp and bearded seals, beluga, dolphins, walrus, polar bears	•Seals: In Labrador, seal flippers, livers and kidney are eaten; seals are taken in the spring and summer, and they comprise a major dietary source. In Nunavik, seal blubber and oil are eaten; when caribou and char are not readily available, Nunavik Inuit tend to eat more seal meat. Alternative foods such as misigak/misiraq (fermented oil from seal and beluga used as a dip for caribou and other foods) should be examined. Much work has been done in seals to test for metals in NT and Northern Québec; results show that the levels are fairly good in seal (similar to caribou), but they are high in beluga. Ringed seal are a high priority because they are localized. There have been limited studies of ringed seal in Ungava and Hudson Strait. While there are bearded seal in Labrador, there aren't as many as in Nunavik. There is very little information on harp and bearded seals. Grey seals are lowest in the priority list. Harbour seals would potentially be good indicators. Studies should keep in mind the different names used for young seals in the different regions, as well as their age, sex, blubber thickness and whether the seals migrate or stay in one location.
Marine Mammals cont'd	beluga, dolphins, walrus, polar bears	•Beluga: Not eaten in Labrador, but are eaten in Hudson's Bay and Hudson's Strait (skin and oil is consumed – muktuk). Inuit used to eat the belugas that came up the rivers to feed on salmon; however, they no longer inhabit that area any more on account of hydroelectric development. PCB levels in people who eat beluga and seal are higher than levels in people in the Ungava Bay who eat more caribou and fish than seals. Beluga are high in the Arctic food chain; they feed very intensively for one season, and then not very much the rest of the year. Whales have been well examined over the last 6 years, and further work may not be required. • Walrus: Not eaten in Labrador, but harvested intensely in Hudson Strait. Aged walrus meat should be examined to see if there is a change in contaminants. CINE could study the difference between fresh and aged walrus meat as part of their upcoming project on food preparation. •Dolphins: In Labrador these are eaten in September. •Polar bears: Inuit in Nunavik submitted polar bear samples for analysis, but the results were never brought back to the community level. In Northern Labrador only four tags for hunting polar bear are distributed (to cover five communities).

Fish	Char, lake trout, rock cod or whitefish, brook trout	•Char: Studies should focus on the Kovik and Payne River Systems, as well as landlocked char. Lots of work has been done on George River and Deception Bay regarding char. Sampling char is easy, and local people could be used. Char and rock cod are major dietary sources for Labrador Inuit. The Koksoak Monitoring Program has funds available for sampling salmon. Because Arctic char is a relatively clean fish with low contaminant levels, it might be beneficial to conduct further sampling on a lake fish such as trout or whitefish.
Shellfish	Mussels, clams, scallops, sea and freshwater sculpins, sea urchins	•Scallops: Arctic scallops have been examined for heavy metals in Deception Bay. However, gonads are the only part of the scallops that have been tested for contamination, even though these aren't eaten; other parts of scallops need to be tested. •Mussels: Work on mussels could be linked to the work currently being conducted under the "Musselwatch" program in the Maritimes.
Seabirds and Gamebirds	Birds: ptarmigan, Canada geese, snow geese, eider ducks, seagulls, Arctic tern, murre, loon, scoter, mergansers Eggs: Gulls, eider, murres, terns, loons, ducks, geese, old squaw and guillemots	•Birds: Which birds you eat depends on where you are. Old squaw and guillemots are rarely eaten. Labrador Inuit mostly eat black ducks, common loon, guillemot, scoter and mergansers. Little sampling has been done on snow geese. •Eggs: Not a lot of sampling has been conducted on eggs, and none has been done on murre eggs.
Berries	Blueberries, bake apples (also known as akpiks), blackberries, redberries, cranberries	Not much sampling has been done on berries in the Arctic, although they have been studied in the Yukon. The metal content in berries could vary regionally. Point sources of pollution should be considered when sampling berries.

Local Concerns Regarding Contaminants Including Human Health Concerns

Concerns in Labrador

- *Past and future mineral development is a large concern in Labrador.* There is much fear about Voisey's Bay, and about uranium exploration that took place in two communities in the late 1970s. These explorations may be affecting the water supply, and this is a big concern for Inuit. Baseline information needs to be collected and analyzed on which metals are present in watershed areas. Inuit are very concerned with wildlife and the deformities that have been found recently. More information is needed on metals and OCs in all species that Inuit take.

  Contaminants issued from open mine pits include acids in the waste rock, tailing ponds and pit. It was noted that the NCP would likely not cover local issues such as contaminants issuing from Voisey's Bay development activities, as they will be addressed through the environmental assessment. Major concerns about the Voisey's Bay project are the fact that the environmental assessment is being rushed through, and that it only covers a small part of the site affected.

Other comments about Voisey's Bay:

- *There are 15 years of data on char near Voisey's Bay.* While there aren't many data on contaminants, there are lots on growth rates, habitats, etc. Data also exist on marine mammals, and skin and muscle samples date back to 1992. There is information from two sources: the long-term studies in the area, and the new information based on samples taken in response to community concerns.

- *An ongoing frustration for Inuit is that they help biologists do their research, and then the results of that research ends up collecting dust on a shelf.* Nothing is done to address the findings because of lack of funding, and local people cannot access the information.

- *More communication is needed between scientists and local people.*

Other Local Concerns

- *The handling of local toxic wastes in Nunavik needs to be reviewed*; they are presently disposed of at the local dump. Local hospital wastes are stored in containers and then shipped out because there is no local incinerator.

- *Local containment of solid wastes needs to be prioritized*; for e.g., the metal body of a car is less important than the disposal of the car's battery.

- *Local education and initiatives need to be developed on recycling*, reducing consumption of plastic materials, and handling of old appliances such as fridges and freezers. A video could be produced showing the effects of non-biodegradable wastes and dumps on communities; this video would essentially make the case for the importance of incinerators and recycling programs. Recycling centres are needed, and a local government department should be established to implement these. The issues of who is responsible for recycling programs, who will implement them, and who will fund them needs to be addressed. KRG tried to start a recycling program, but it never got off the ground due to lack of funding. Labrador Inuit are trying to start a recycling centre, and a recycling program

for cans is currently under way in local schools in which students are rewarded three cents per can recycled.

- *Cleanups of contaminated sites need to take place*. The wastes from mining companies who come to communities on a shoe-string and don't clean up their mess and wastes due to a lack of funds, as is happening with Voisey's Bay, needs to be addressed. While funds have been received from DIAND for small local cleanups of contaminants, there are still more sites that require work, including outpost camps, old geological survey sites like Cape Hope's Advance site. Coast Guard has a portable PCB and PAH tester that can be transported to remote sites by small aircraft, and it could donate time to transport the tester to contaminated sites.

Concerns about health advisories and guidelines

- *Regardless of health warnings about parasites or high levels of cadmium in caribou liver, Inuit will eat the liver as long as it is not blue and full of worms*. If Inuit are just eating livers that are high in cadmium and not in parasites, it doesn't mean they will get sick immediately.

- *Once a health advisory was issued warning Inuit about contaminants in seal livers. It was an awful time for Inuit* who consider seal liver a delicacy and important to their traditional diets; it's very hard to switch your lifestyle because of a warning.

- *Rather than using a single guideline for food, Health Canada tries to calculate acceptable intakes of contaminated foods according to contaminant levels, consumption rates and the size and weight of the consumer. However, it's hard for Inuit to follow this guideline* because for Inuit food intake is based on availability: Inuit tend to eat a large amount of one type of food at once because they eat the food that is available seasonally. Moreover, some Inuit depend on country foods because they can't afford to buy store-bought foods.

Information Gaps on Pathways, Sources and Time Trends of Contaminants

Long Range Transport

- *The issue of pathways has been fairly well documented, and the priority for Labrador and Nunavik is getting baseline information*. However, while the issue of pathways is not a priority, knowing the trends might be. Information on pathways has played an important role in international negotiations on persistent organic pollutants (POPs), and it could continue to help target negotiating tactics.

  Although one participant suggested setting up monitoring stations in three locations in the region (Kuujjuarapik, Kuujjuak and Shefferville), others argued that this option would be far too costly. In light of this, a number of suggestions were made about alternative methods of monitoring pathways, including:

  - Analyzing data collected at the Cape Dorset (Baffin Island) monitoring station. The question of whether this data applies to Nunavik and Labrador would have to be addressed;
  - Testing snow and rain samples in the region on a regular basis, using the Buster Welch model. One site could be the Nunavik crater where no water other than rain water accumulates; the levels of the crater could be examined for trends in contaminants;

- Expanding the Archipelago Project – which is being discussed at the "Archipelago Workshop" in Iqaluit in July – to include Labrador and Nunavik;
- Conducting core sampling of sediments which might be more cost-effective than water sampling.

Local Sources

- *Local sources of contamination include exhaust from cars, burning wood for fuel (in Labrador), and burning garbage. Pressure should be put on Québec to change the regulation mandating the burning of all garbage in Nunavik and Labrador (Québec does not allow incinerators).* Burning garbage could be a major source of dioxins and PAHs. It was suggested that Makivik could lobby Québec to change this regulation.

Communication Issues

- *Results should be communicated back to the communities through intermediaries.* Intermediaries between scientific institutions and the communities, such as the Nunavik Health Centre, are important. Research results need to be communicated back to the community using a multidisciplinary approach. People who are trusted in the community could explain the results to the community, and the researcher could be present to answer questions (as is done in Labrador), or else a regional contaminants coordinator could be identified to help communicate results back to the community (as has been done in Nunavik). Continuity in who is communicating results back to the community is key.

- *Results should be linked to human health.* Results need to be linked with human health, and community members should be given enough information to make an informed decision, rather than being told what to do. People want to know what the results *mean to them*, and research papers and results need to be simplified so that local people can understand them.

- *Appropriate research agreements should be drawn up stipulating that researchers should bring their results back to the communities.* Moreover, projects could be designed in such a way that the communities get their results back in a timely fashion.

- *Local people should be involved in research.* The communities must be involved from the beginning to the end. "Communication through participation" is an important concept that can be further developed now that Makivik has a research centre based in Kuujjuak.

- *Effective vehicles for communication that are relevant to Inuit in Nunavik and Labrador should be used.* Effective vehicles for communicating results back to the communities include radio shows and brochures in plain language.

- *Region-specific information needs to be available to answer peoples' questions.* A major problem for Labrador researchers is that there is a lack of Labrador-specific information to communicate to people who ask about contaminant levels in certain species. The gaps in research are therefore affecting communication.

Preliminary Recommendations for an Action Plan

a) Develop a comprehensive monitoring program

A comprehensive monitoring program should be developed in Nunavik and Labrador – with an emphasis on research in Labrador – with three major objectives:

- To compile data on contaminant levels in country food and determine human exposure and health effects;
- To generate baseline data for comparison with future work and with other Arctic regions;
- To identify the origin of contaminants, and whether they are local, transported over a long range, or both.

The monitoring program's sampling strategy should focus on monitoring samples in:

- "Hot spots", such as Voisey's Bay, Deception Bay and radar sites. DND's work on radar sites could be expanded, and projects could be set up to dovetail with DND's work (for e.g., effects on seals).
- "Cold spots" or "background sites", particularly those that are intensively harvested (such as Kovic and Payne Rivers). Hunters and fishers could help collect samples, and ensure they are taken at the appropriate times and locations.

Sampling both hot and cold spots would serve a dual purpose: it would provide information for the local communities, and add to the general picture of contaminants in the Arctic. The monitoring program should be comprehensive and focussed rather than large-scale in order to make best use of the funds available.

Other comments about sampling included:

- Sampling should be expanded, and should focus on community concerns;
- Coastlines should be a major focus;
- Whole fish analyses should take place, as well as analyses of specific organs (specific organ analysis enables the targeting of advice about consumption);
- Existing samples from the Falcon Bridge Project should be analyzed;
- Baseline data should be collected in areas such as Voisey's Bay before mining activities start;
- Sampling should focus on the tissues and organs of species that are most consumed in given areas, and should consider food preparation. Some foods are seasonal, so there isn't an opportunity to eat them in large quantities; others are consumed year-round;
- Analysis on human effects should consider the fact that contaminants are probably more present in older Inuit, because the younger generations are eating less country food;
- Animals should be monitored on an ongoing basis, rather than stopping and starting research constantly.

Suggestions about specific projects included:

- Examining sulphur and acid rain in Nunavik and Labrador;
- Conducting baseline work on marine mammals in both Labrador and Northern Québec. Deception Bay could be a sampling site. This would enable both a local and a general picture;
- Expanding DND's work on radar sites so that more "background" sites are included.

b) Establish a steering committee

A steering committee could be established to vet NCP research proposals. The steering committee could integrate the various components of a comprehensive research project, and then submit one proposal to the NCP. The Committee would include representatives from Nunavik and Labrador. Possible models include the Yukon Contaminants Committee and the Nunavik Health and Nutrition Committee. The Committee would ensure that the monitoring activities are not driven by personal research agendas.

c) Seek ongoing funding from other sources

Wherever possible, funding should be sought from other agencies. Research on gaps identified could build on research programs already in place, such as the Archipelago Project. Ongoing funding is important to ensure that there is consistency in the research conducted. This is particularly important with regards to the Eco-Research project in Labrador, as so little research is conducted in that region. Currently three researchers are working on the Eco-Research Project, but funding will not be available for these researchers after the project ends in November 1997. Ongoing funding is key here, as the researchers have gained specific skills and expertise that would be very hard to replace if they lose their positions.

Plenary Discussion

Following summary reports from the working groups, participants briefly discussed how to proceed with the recommendations emerging from the breakout groups, particularly the idea of establishing a steering committee. Points arising from the discussion included:

- The idea of a steering committee is good, as it will prevent the regions working against each other to compete for funds. A funding agency would want to fund projects if there is consultation and consensus. The issue of how to achieve consensus needs to be resolved.
- A "mini-structure" process is needed to develop the planning stage. Community participation will come into place when research takes place, but it's important to involve local people right from the beginning, and to "walk with them until the end".
- Representatives from both Labrador and Nunavik would sit on the joint committee. The Eco-Research Program in Nunavik and Labrador could serve as a model.
- Part of the NCP research budget should be set aside for the committee. The committee could then decide what to fund. It would be a "power-sharing" relationship. Siu-Ling Han noted that right now the funds are not divided up between the Yukon and the Northwest Territories. Dividing the money regionally would most likely not fly with the Science Managers Committee, as it would defeat the idea of a Canadian Arctic-wide program.
- A certain amount of flexibility needs to be built into the steering committee. In the Yukon, proposals are submitted both through the Contaminants Committee as well as on an individual basis.
- The organizing committee could be renamed the planning committee. It could finalize the report and make recommendations for future work and the membership of the committee.

- Criteria need to be developed for a steering committee.

Participants agreed to extend the workshop, and to meet again in the morning to flesh out these ideas.

DAY 3: THURSDAY, MAY 29, 1997

Plenary Discussion

Following a summary presentation of the previous day's discussion, participants addressed the issue of how to proceed which establishing a steering committee and concretizing recommendations from the workshop.

Establishment of a Steering Committee

Discussion on establishing a steering committee centred on the following points:

- *Regional integration*. Nunavik and Labrador need to be integrated as much as possible, but Labrador needs to be emphasized as no baseline information exists for that area. The work needs to be done in close collaboration with the Nunavik Health and Nutrition Committee, which receives funding from the NCP.

- *Membership*. Membership on the committee should just be Aboriginal partners so that there is no conflict of interest. Ultimately, the membership should be decided by the communities. One participant stressed the need for the committee to take into consideration the scope of international work on contaminants, as well as other programs in Canada and the U.S. "You have to take advantage of this network, and you can then address the concerns both at the local and international level," he said. Another delegate suggested that the final report contain a recommendation that membership be made up of representatives from Labrador and Nunavik, and then individuals from these regions should decide who should sit on the committee.

- *Model*. The Yukon Contaminants Committee and the Nunavik Health and Nutrition Committee could be used as models: they have Aboriginal representation and are arms-length.

- *Work plan*. Emphasis should be placed on getting baseline information on contaminants in Labrador, particularly since the Eco-Research Project might come to an end in September. Cumulative impacts of contaminants is another area that needs to be highlighted. The work outline could encompass two or three projects. Derek Muir noted that he was going to submit a proposal that would address some of the gaps identified.

- *Role*. The steering committee could direct researchers to the right authorities, and inform them how things work in the communities. Members could also ensure that work isn't being duplicated, and that integration of projects is taking place. The steering committee would screen proposals and submit those that are acceptable to the NCP. The Technical Committee of the NCP would then vet the proposals coming from the steering committee.

- *Operations and funding*. Members would have to communicate via teleconferences, and an operating budget would be needed. It was noted that the Yukon Contaminants Committee has a

budget. NCP could be asked to fund the steering committee, and ITC or Makivik could be the contact. Minnie Grey noted that KRG will most likely be Nunavik's contact, although this has not yet been finalized. It was noted that the precedent for the NCP funding a committee in the region has been set with the Nunavik Health and Nutrition Committee, and so there shouldn't be any administrative difficulties. Other sources of funding should be sought besides the NCP.

Next Steps and Process Regarding Drafting Recommendations

The organizing committee will finalize the workshop report and draft the workshop recommendations. The draft report will be circulated back to participants for comment. The report will be translated into French and Inuktitut. The workshop recommendations will then be followed up. Participants will be informed about the results of follow-up activities by mail. A proposal regarding funding a steering committee in Nunavik and Labrador will be submitted to the NCP in September.

Other comments made by participants included:

- *The workshop did not focus enough on the human health component, which is what happened at a recent Canadian Polar Commission Meeting in Iqaluit. "We're looking at what's in the environment, but we want to focus on the people and priorities from a medical health perspective."* Minnie Grey noted that Suzanne Bruneau from CHUL and herself were at the workshop because they were concerned with human health. Siu-Ling Han added that the human health issue cuts across the NCP, and is not being focussed regionally as health information is applicable across the Arctic. She noted that Health Canada will be holding a meeting at the end of June to discuss specific human health issues.

- *The report should be posted on the Internet.*

Closing Remarks

Mike Barrett, Kativik Regional Government; Frank Andersen, Labrador Inuit Association

Mike Barrett thanked the members of the organizing committee, as well as the participants. "I've learned a lot from your presentations," he said.

Frank Andersen said the meeting was very encouraging and promising for Labrador: "This will be something useful and helpful," he commented.

The meeting was adjourned.

APPENDIX I: FIGURES FROM THE PRESENTATIONS

Fig. 1. Pathways of long range transport of contaminants to the Arctic

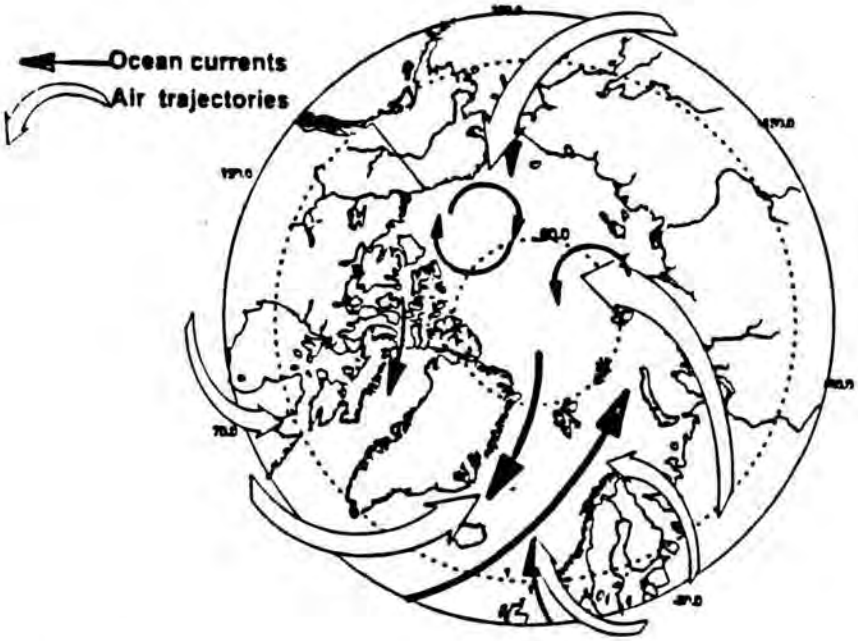


Fig. 2. Sampling locations for marine mammals

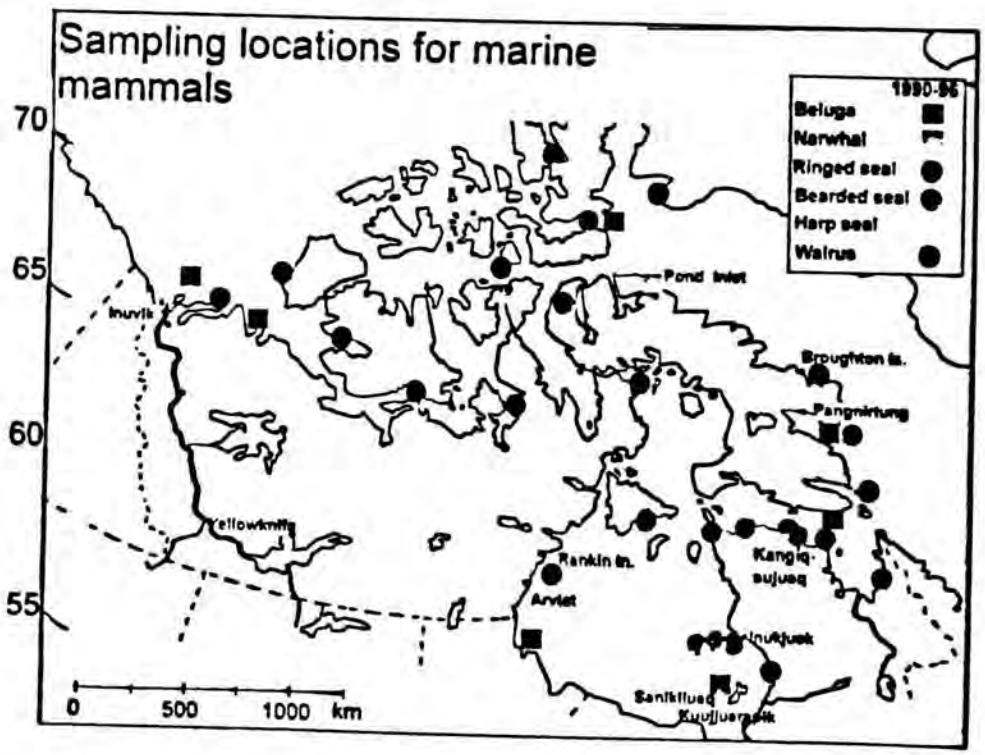


Fig. 3. Priority species of birds for future monitoring programs in Northern Quebec

Species	Contaminants	Location
Common Merganser Hooded Merganser	Mercury, PCBs, mirex	Eastmain River NBR Rivers Rupert Bay
Red breasted Merganser	PCBs, mirex	Kangiqsualuujjuaq
White-winged Scoter Black Scoter Surf Scoter	Selenium	
Oldsquaw	PCBs, dieldrin, mirex	
Common Goldeneye	Lead	NBR Rivers
Common Loon	Mercury, PCBs	Inukjuaq, Salluit, NBR Rivers
Willow Ptarmigan	Lead	Kangiqsualuujjuaq
Glaucous Gull	Chlordane, nonachlor	Inukjuaq
Herring Gull	PCBs, mirex	Inukjuaq, Kuujjuarapik
	Chlordane, nonachlor	Kangiqsualuujjuaq

Fig. 4. Concentrations of heavy metals and cesium-137 in caribou tissues

Variable		Units	N	Mean	Std. Dev.	Minimum	Maximum
George River herd							
Weight		kgs	49	76.0	20.7	24.9	107
Age		years	53	4.6	2.7	0.0	10.0
Muscle	Cadmium	µg/g dw	51	0.036	0.055	0.003	0.277
Muscle	lead	µg/g dw	51	0.146	0.650	0.017	4.67
Muscle	Mercury	µg/g dw	51	0.062	0.028	0.000	0.123
Muscle	Cesium-137	µg/g w	13	92.1	19.4	64.1	126
Kidney	Cadmium	µg/g dw	17	11.8	6.73	5.00	25.7
Kidney	lead	µg/g dw	17	0.570	0.176	0.347	0.98
Liver	Cadmium	µg/g dw	51	3.08	1.98	0.61	9.67
Liver	lead	µg/g dw	51	3.26	2.22	1.05	14.0
Riviere aux Feuilles herd							
Weight		kgs	254	83.8	22.0	22.6	140
Age		years	220	5.08	2.56	0.00	12.0
Muscle	Cadmium	µg/g dw	250	0.045	0.043	0.004	0.313
Muscle	lead	µg/g dw	250	0.228	1.720	0.013	26.66
Muscle	Mercury	µg/g dw	248	0.08	0.04	0.00	0.24
Muscle	Cesium-137	µg/g w	19	97.5	34.8	51.3	164
Kidney	Cadmium	µg/g dw	186	28.2	21.8	0.676	150
Kidney	lead	µg/g dw	185	0.898	0.410	0.051	4.00
Liver	Cadmium	µg/g dw	222	4.15	2.55	0.433	16.66
Liver	lead	µg/g dw	222	3.22	2.24	0.560	12.66

Fig. 5. Marine mammal samples analysed for contaminants

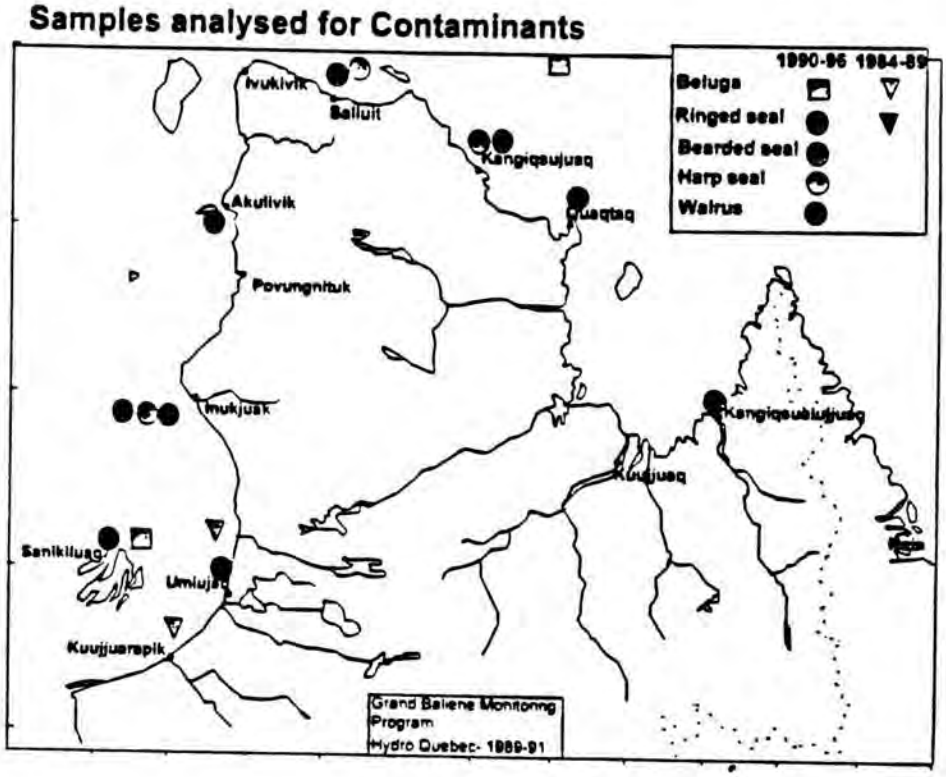


Fig. 6. ΣPCB (total PCBs) in ringed seal blubber (1992-95)

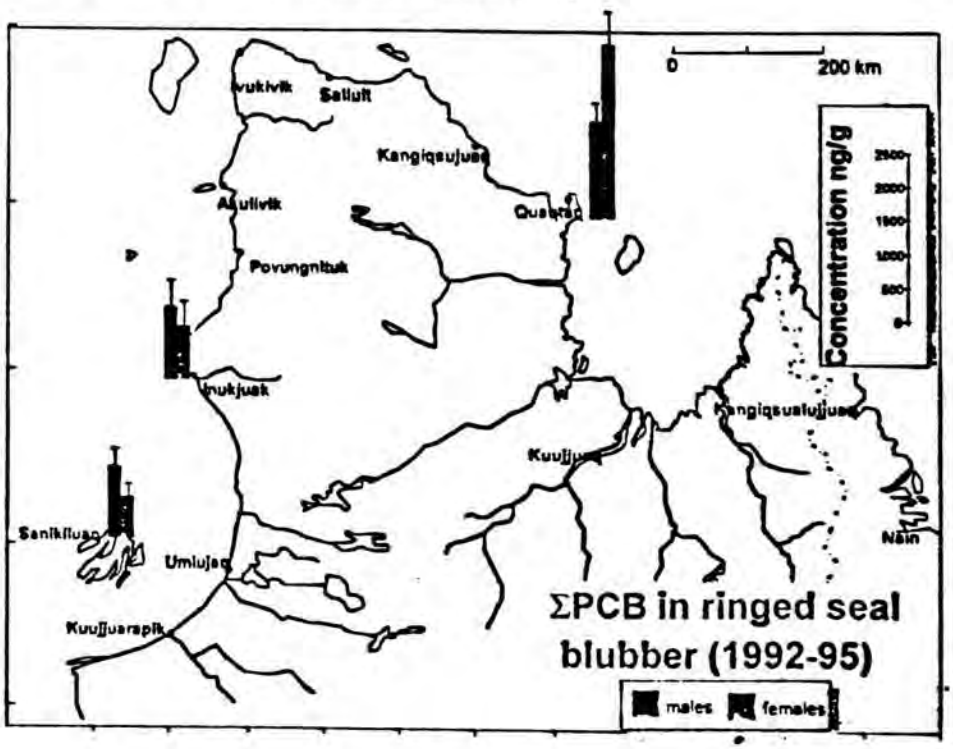


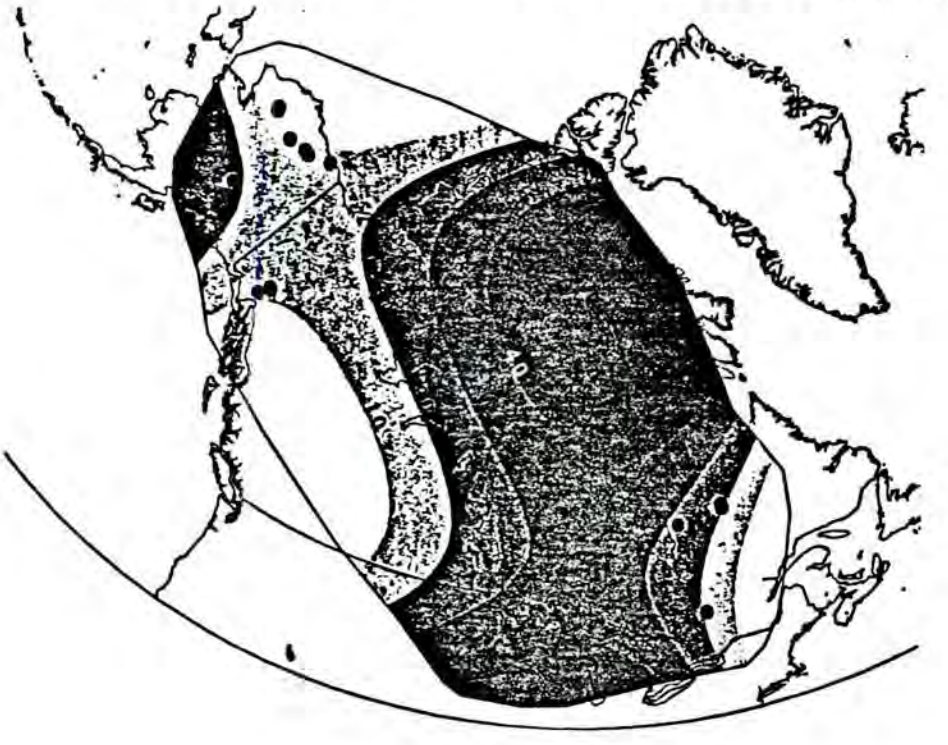
Fig. 7. OCs in mammal marine tissues from Northern Québec

Organochlorines in marine mammal tissues from Northern Quebec (ng/g wet wt)

Location	species	Tissue[1]	sex		N	ΣPCB	Toxaphene	Ref[1]
Sallut	harp seal	Blubber	F	1990	8	897 ± 295	nd	1
Inukjuaq	ringed seal	Blubber	F	1989-92	7	1301 ± 1560	307 ± 327	2
			M		4	1234 ± 636	221 ± 112	
Kangiqsujuaq	ringed seal	Blubber	M	1989	16	854 ± 1245	353 ± 500	3
			F		8	588 ± 607	294 ± 304	
Sallut	ringed seal	Blubber	F	1989	2	535	169	3
Kangiqsualujjuaq	ringed seal	Blubber	F	1989	3	432 ± 277	136 ± 82	3
			M		2	360	86	
Grande-Baliene	freshwater seal	Muscle	?	1989-90	4	225		4
Inukjuaq	bearded seal	Blubber	M	1989	3	387 ± 153	505 ± 153	3
			F		2	367	414	
Kangiqsujuaq	bearded seal	Blubber	M	1989	2	415	424	3
Inukjuak	walrus	Blubber	M	1989-92	4	11512 ± 8465	3493 ± 2443	2
			F		9	4790 ± 2376	1451 ± 954	
Akulivik	walrus	Blubber	M	1991	8	1201 ± 2056	420 ± 286	2
Grande-Baliene	beluga	Muscle	?	1989-90	5	13		4
		Blubber		1989-90	2	3370 - 3810		4
Sanikiluaq	beluga	Blubber	F	1994	10	2185 ± 1559	7185 ± 3614	5
			M		7	6768 ± 2346	14150 ± 7041	
Eastern Hudson Bay	beluga	muktuk		1995	8	828 ± 306	185 ± 91	7
Naskapoca R	beluga	Blubber	M	1984/85	8	2770 ± 510	4130 ± 820	6
			F		8	1230 ± 840	1990 ± 1100	
Naskapoca R	beluga	Blubber	M	1987	6	7990 ± 1990		6
			F		6	2530 ± 2950		
		Muscle	M	1987	6	67 ± 22		5
			F		6	26 ± 26		

1 Beck *et al.* 1994, 2 - Muir et al. 1995, 3 - Muir and Rosenberg 1991, 4 Langlois and Langis 1995, 5 - Muir et al. 1990, 6 - Muir 1996, Muir 1997

Fig. 8. Speculative mercury corridor crossing Québec (from Landers et al. 1997 in press)



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