Environment Canada Environnement Canada

Canada

PROCEEDINGS OF THE UPPER MACKENZIE RIVER BASIN PLANNING WORKSHOP

M.S Evans and W. Carpenter

NWRI Contribution No. 00-048

Conference Organizers

Marlene S. Evans
National Water Research Institute
11 Innovation Boulevard
Saskatoon, Saskatchewan S7N 3H5

and

William Carpenter
Metis Nation -NWT
Box 1375
Yellowknife, NWT X1A 2P1

Workshop Recorders

Madeleine d'Argencout
Mad Consulting
Box 2177 Iqaluit, NWT X0A 0H0

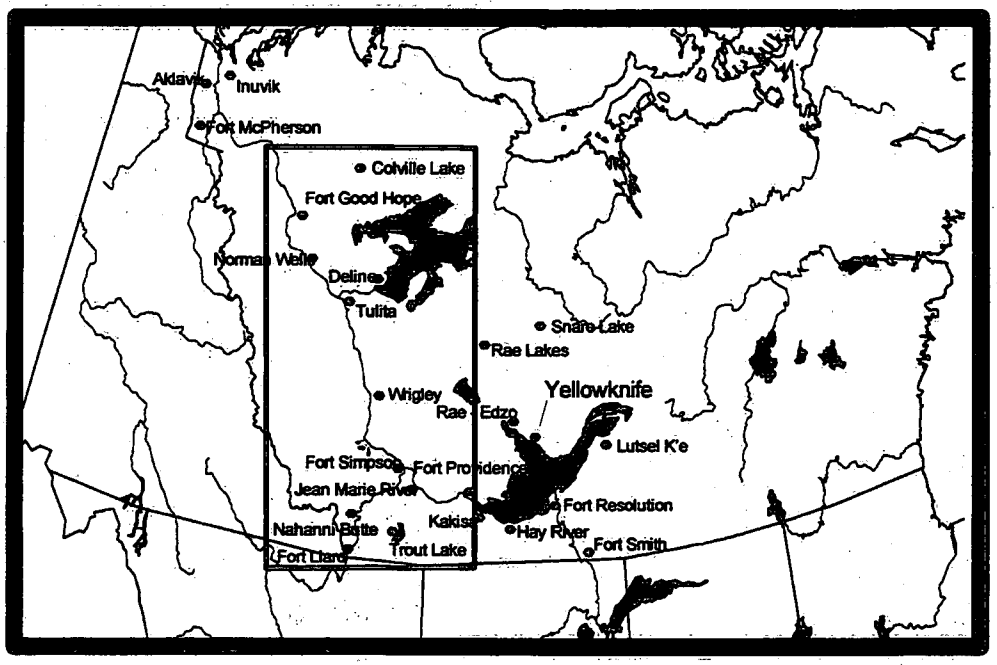
and

Stephanie Meakin
Meakin Consultants Inc.
269 Gower Drive, R.R. #2
Kemptville, Ontario K0G 1J0

PROCEEDINGS OF THE UPPER MACKENZIE RIVER BASIN PLANNING WORKSHOP

Northern Contaminants Program
August 18-20, 1997, Yellowknife NWT

N.W.R.I. Contribution Series No. 00-048
June 2000



Map of the Mackenzie River Basin, NWT, with workshop focus area highlighted.

Workshop Organizers

William Carpenter
Métis Nation-NWT
Box 1375
Yellowknife, NT. X1A 2P1
T: (867) 873-3505
F: (867) 873-3395
métisnwt@internorth.com

Marlene S. Evans
National Hydrology Research Institute
11 Innovation Blvd.
Saskatoon, SK S7N 3H5
T: (306) 976-5310
F: (306) 975-5143
marlene.evans@ec.gc.ca

Lyle Lockhart
Fisheries and Oceans
501 University Cresc.
Winnipeg, MB.
R3T 2N6
T: (204) 983-7113
F: (204) 984-2403
lockhartl@dfo_mpo.gc.ca

Carole Mills
DIAND
3rd Flr.-Bellanca Building
Box 1500
Yellowknife, NT.
X1A 2R3
T: (867) 669-2655
F: (867) 669-2833
millsc@inac.gc.ca

Derek Muir
National Water Research Institute
Environment Canada
867 Lakeshore Rd.
Burlington, ON.
L7R 4A6
T: (905) 319-6921
F: (905) 336-6430
derek.muir@cciw.ca

Stephanie Papik
Dene Nation
Box 2338
Yellowknife, NT., X1A 2P7
T: (867) 873-4081
F: (867) 920-2254
dene_nation@ssimicro.com

Workshop Recorders

Madeleine d'Argencout
Mad Consulting
Box 2177
Iqaluit, NWT
X0A 0H0

Stephanie Meakin
Meakin Consultants Inc.
269 Gower Drive, R.R. #2
Kemptville, Ontario
K0G 1J0

Management Perspective

This Contribution is a summary of presentations and discussions held during the Upper Mackenzie River Basin Planning Workshop (UMRBPW) that was held August 18-20, 1997 in Yellowknife, the Northwest Territories. The Workshop was one of several supported by the Northern Contaminants Program (NCP) of the Department of Indian and Northern Affairs. Each workshop was designed to bring researchers and community members together to establish new priorities for research and monitoring under Phase 2 of the Northern Contaminants Program. Workshops had either a geographic focus, i.e. the Mackenzie River Basin, the subject of this workshop, Labrador and northern Quebec, the Arctic Archipelago or a theme, i.e., mercury and human health. The UMRBPW was designed to exchange information on contaminant issues in the Mackenzie River Basin, to learn more about community concerns regarding contaminants in the basin and to develop priorities for future study under Phase 2 of the NCP. The Workshop was ambitious in its planning, as were the other workshops, and was most successful in providing a forum for the expression of community concerns. It also provided community members with an opportunity to meet with researchers. This contribution provides for a clear documentation of community concerns that should be of much value to others planning to conduct research in the north. A more thorough treatment of most of the scientific information presented in the Workshop can be found in the Canadian Arctic Contaminants Assessment Report.

Sommaire à l'intention de la direction

Ces actes sont un résumé des présentations et des discussions tenues lors de l'atelier de planification pour le bassin du haut Mackenzie, qui a eu lieu du 18 au 20 août 1997 à Yellowknife (Territoires du Nord-Ouest). Cet atelier s'inscrivait dans une série d'ateliers parrainés par le Programme de lutte contre les contaminants du nord (PLCN) du ministère des Affaires indiennes et du Nord canadien. Chaque atelier doit permettre à des chercheurs et à des membres des communautés locales de collaborer à l'établissement de nouvelles priorités pour la recherche et la surveillance, dans le cadre de la phase 2 du Programme de lutte contre les contaminants dans le Nord. Les ateliers portaient soit sur une région géographique, p. ex. le bassin du Mackenzie (qui fait l'objet de cet atelier), le Labrador et le nord du Québec ou l'archipel Arctique, soit sur un thème, p. ex. le mercure et la santé humaine. Cet atelier était destiné à favoriser des échanges d'informations sur les contaminants dans le bassin du Mackenzie, à en apprendre davantage sur les préoccupations des communautés concernant les contaminants dans le bassin et à élaborer des priorités pour les études qui seront effectuées dans le cadre de la phase 2 du PLCN. Comme ce fut le cas pour les autres ateliers, le programme était ambitieux. L'atelier a permis aux membres de la communauté d'exprimer leurs préoccupations et de rencontrer les chercheurs. Ce compte rendu, qui documente très bien les préoccupations des communautés, devrait être très utile à tous ceux qui planifient des recherches dans le Nord. On peut trouver une description plus approfondie de la plupart des informations scientifiques présentées à l'atelier dans le Rapport de l'évaluation des contaminants dans l'Arctique canadien.

Abstract

These proceedings reflect the deliberations of the Upper Mackenzie River Basin Planning Workshop which was held August 18-20, 1997 in Yellowknife, the Northwest Territories. The Workshop was supported under the Northern Contaminants Program (NCP) of the Department of Indian and Northern Affairs. The Workshop was designed to exchange information on contaminant issues in the Mackenzie River Basin, to learn more about community concerns regarding contaminants in the basin and to develop priorities for future study under Phase 2 of the Northern Contaminants Program. The proceedings consist of three basic parts: presentations by community representatives; presentations by researchers; and the workshop deliberations in which two basic questions were addressed. A wide variety of concerns regarding contaminants and other issues were raised by community representatives. Scientific presentations addressed some of these issues but many issues were based on specific concerns at various communities. These issues were explored more fully during the workshop deliberations. However, these issues were too complex and numerous and the time too short for any form of consensus to be reached on priority issues for the workshop as a whole. Nevertheless, the workshop provided for a first and highly informative of exchange of knowledge and concerns between researchers and community representatives.

Résumé

Ces actes portent sur les débats de l'atelier de planification pour le bassin du haut Mackenzie, qui a eu lieu du 18 au 20 août 1997 à Yellowknife (Territoires du Nord-Ouest). Cet atelier, parrainé par le Programme de lutte contre les contaminants dans le Nord (PLCN) du ministère des Affaires indiennes et du Nord canadien, était destiné à favoriser des échanges d'informations sur les problèmes de contamination dans le bassin du Mackenzie, à mieux faire connaître les préoccupations des communautés relatives aux contaminants dans le bassin et à élaborer des priorités pour les études qui seront effectuées dans le cadre de la phase 2 du PLCN. Ces actes comportent trois parties principales : les présentations des représentants des communautés, les présentations des chercheurs et les débats de l'atelier, au cours desquels on a abordé deux questions fondamentales. Les représentants des communautés ont fait état d'une grande variété de préoccupations concernant les contaminants et d'autres questions. Les présentations scientifiques répondaient à certaines de ces questions, mais de nombreuses questions concernaient les préoccupations particulières des diverses communautés. On les a examinées de façon plus approfondie au cours de débats de l'atelier, mais elles étaient trop complexes et trop nombreuses, et la période de temps prévue était trop courte pour qu'on puisse atteindre une forme quelconque de consensus sur des points jugés prioritaires par rapport à l'ensemble des travaux de l'atelier. Néanmoins, cet atelier a rendu possible un premier échange très fructueux entre les chercheurs et les représentants des communautés, qui portait tant sur les connaissances que sur les préoccupations.

Acknowledgments

This workshop was supported by the Northern Contaminants Program of the Department of Indian and Northern Affairs. Special appreciation is extended to Russell Shearer for supporting this workshop activity. Team members who played a major role in developing the workshop were: Lyle Lockhart, Freshwater Institute, Winnipeg; Carole Mills, Department of Indian and Northern Affairs, Yellowknife; Derek Muir, National Water Research Institute, Burlington; and Stephanie Papik, Dene Nation. More than thirty community representatives, researchers, and managers traveled hundreds to thousands of miles to participate in this activity, bringing ideas, enthusiasm, and interest to the workshop. Most of the names appear in Participants List (Appendix 1); others put in brief but welcome appearances to the workshop.

Many people spoke on complex issues, concerns, and subject matters. Madeleine d'Argencout (Mad Consulting, Iqaluit) and Stephanie Meakin (Meakin Consultants, Kemptville) are highly commended for recording these deliberations and preparing the first draft of the workshop proceedings which were distributed to workshop delegates and presenters on November 28, 1997. Carol Casey (National Water Research Institute, Saskatoon) performed technical editing of the proceedings, including redrawing tables and figures, and correcting some grammar.

Introduction

The Northern Contaminants Program (NCP) of the Department of Indian and Northern Affairs was initiated in 1991 in order to respond to concerns regarding the widespread occurrence of contaminants in arctic and subarctic ecosystems. NCP focused on identifying sources and pathways through which persistent organic contaminants, metals and radionuclides entered the northern regions of Canada. It also sought a scientific basis for assessing the effects of these contaminants on northern environments including wildlife and people. The culmination of this report was the publication of the *Canadian Arctic Contaminants Assessment Report* in 1997.

Phase 2 of the new, 5-year NCP was launched in 1998 and will extend to 2003. Like the original NCP, NCP-2 will work towards reducing source inputs of contaminants by working towards international agreements on emissions controls, product usage, etc. However, the emphasis is different. NCP-2 has an increased emphasis on: local sources which affect the safety of country foods; temporal trend monitoring; and education and community-based strategies. In contrast, studies which investigate sources, pathways, and fates of contaminants have been given lesser emphasis except as they relate to the safety of country foods and temporal-trend monitoring.

In 1997, i.e., the transition year between NCP-1 and NCP-2, a call was made for a greater emphasis on multi-disciplinary, multi-partner integrated studies which would focus on a particular geographic region and contaminant concern. Central to this transition year were a series of workshops which provided a forum for researchers and community members to work together to set priorities under NCP-2. Workshops were held based on geographic region (this workshop, the Nunavik and Northern Labrador Contaminants Action Plan Meeting, and the Arctic Archipelago Workshop) and by subject matter (the Northern and Arctic Contaminants Health Initiative, the Mercury Workshop).

There are several reasons for why the Mackenzie River Basin merited specific consideration under NCP-2. In brief, these are as follows.

1. The majority of the population of the Northwest Territories lives in the Mackenzie Basin including 13,000 in Yellowknife and 4,000 in Hay River. Towns with more than 1,000 people also include Fort Simpson, Fort Smith, and Rae Edzo: villages with more than 500 people include Fort Good Hope, Aklavik, Normal Wells, Fort Franklin, Fort Resolution, Fort Liard, Fort Providence, and Fort McPherson.
2. In many regions of the Mackenzie Basin, communities are concerned about the health risks associated with consuming fish (and other traditional foods) which contain inorganic and organic contaminants. Health advisories have been issued or recommended for some communities consuming some traditional foods.
3. Many communities have reported that the fish from such regions are unhealthy in appearance, are diseased, and taste differently from fish captured from regions farther away from these industries.

4. The Mackenzie Basin is exposed to various contaminants which enter the system from long-range sources. The atmosphere is a significant source, transporting significant amounts of organic contaminants such as PCBs, toxaphene, and DDT into the watershed. These contaminants enter rivers and lakes and are biomagnified by the food web. Predatory fish such as burbot and lake trout which are an integral part of the diets of many community people, are especially contaminated by these compounds. Metals such as mercury and lead also enter lakes and rivers with atmospheric deposition. The ultimate sources of these compounds are the more industrialized and agricultural regions of the northern hemisphere - North America, Europe, and Asia.

5. Contaminants also enter the Mackenzie Basin through riverine transport, especially the Peace and Athabasca Rivers. These rivers flow through highly-developed regions in Alberta and Saskatchewan. Pulp and paper mills, gas and oil extraction and processing plants, agriculture lands, and urban sites are all potentially important sources of inorganic and organic contaminants. As economic development continues in Alberta and Saskatchewan, the potential exists for the Mackenzie Basin to be further contaminated by these activities to the south. The Northern River Basins Study (NRBS) investigated these issues over 1991-1996, focusing on the Peace and Athabasca watersheds but also considered the Slave River and Great Slave Lake. NRBS continues as the Northern River Ecosystem Initiative.

6. Much of the economy of the Mackenzie Basin was or is based on the utilization of natural resources including mining (gold, diamonds, lead, zinc, uranium), oil and gas, commercial fisheries, tourism, and trapping. The mining and petroleum industries, while important sources of income to local economies, also are potential environmental polluters. In many regions of the Mackenzie Basin, local communities are concerned about the health risks associated with consuming fish (and other traditional foods) which have been exposed to metals and organic contaminants associated with these industries.

While the workshop was originally conceived to focus on contaminants and community issues in the Mackenzie River Basin, later focus was placed on the Upper Mackenzie River Basin. This region is bounded by the Great Slave Lake outflow to the south (Fort Providence) and a far north as the Colville Lake area (see front piece figure). This decision was based on the fact that extensive research had been conducted on Great Slave Lake under NCP-1 and other programs and because the Mackenzie River delta had also been extensively investigated through numerous programs. In contrast, very little research had been conducted in the Upper Mackenzie River Basin including the river itself, the numerous lakes located along the river and important to the domestic and recreational fisheries, Great Bear Lake, and the extensive land forms. Thus, it was felt that NCP-2 should focus its efforts and resources on this highly understudied area although areas to the north and south would also be given consideration, e.g., under the monitoring and/ or local concerns envelopes.

The workshop was very successful in providing a forum for researchers and communities members to come together to discuss scientific issues and concerns. This was the first time such a meeting had occurred for this region. Researchers were overwhelmed by the breadth of community concerns and interests; community members were overwhelmed by the complex nature of the research studies. As a consequence of this and the shortness of the workshop, it was not possible to develop a multi-disciplinary, multi-partner integrated study of the Upper Mackenzie River Basin which would focus on a limited number of contaminants of concern. Nevertheless, the meeting was productive with the new understandings gained by community members and researchers. These Proceedings provide a brief summary of the presentations and discussions.

Workshop Highlights

The workshop began with presentations by community representatives and researchers. This was followed by a more open series of workshop deliberations which focused on two themes. The first series of discussions focused on which contaminants and geographic regions were of most concern to the Upper Mackenzie River Basin both from a community and a researcher perspective. Priorities needed to be set for Phase II of the Northern Contaminants Program. The second series of discussions focused on building partnerships between scientists and communities. These partnerships would result in more effective programs which would address community concerns regarding contaminants in traditional foods while enabling the research community to investigate and develop long-term solutions to contaminant issues. In the following paragraphs, a brief synthesis is provided of the highlights of the issues raised during these deliberations.

Theme 1: Priorities for future research study under Phase 2 of the Northern Contaminants Program

The workshop participants agreed that there is an ongoing need to address the research gaps remaining in answering the question "Is our food safe to eat?". Specific research and monitoring needs which were identified to address this issue under the Northern Contaminant Program were as follows:

1. Workshop participants agreed that there is the need for additional research on contaminants in the Upper Mackenzie River Basin. Geographic areas mentioned included Great Bear Lake, Great Bear River, Fort Providence, Fort Simpson, and Fort Good Hope. Other areas also required consideration, i.e., including Colville Lake, Great Slave Lake, and areas to the north and west of the Upper Mackenzie River Basin.

2. A number of contaminants were identified which require further study. Metals which were of concern included arsenic, mercury, and uranium. Organic compounds which were of concern included PCBs, toxaphene and PAHs. It was also noted that consideration should be given to the new generation of toxic substances.

3. Many contaminants in the environment have natural and anthropogenic sources, e.g., various metals and PAHs. Research is required to identify the relative contributions of these sources in areas of concern, e.g., the Mackenzie River downstream of Norman Wells and metals in highly turbid rivers.

4. Research is required to determine why contaminants occur in higher concentrations in some organisms than others. This information also would assist in providing advice to communities on the consumption of these organisms. For example, contaminant concentrations in fish in a given lake may be lower in some species than others or, for a given species, smaller animals. Harvesting, by

removing larger fish, may help reduce contaminant concentrations in the fish population.

5. Many species need to be studied. Among land animals, woodland caribou, moose, beaver, muskrat, and birds including geese and mallards should be studied. Among fish, lake trout, cisco, and loche (burbot) were given high priority. Mention was also made of specific tissues which should be analyzed for the different species.

6. Further research is needed to determine if there is a connection between contaminant levels, human health effects and the health effects of animal species. Health measures should be based on traditional knowledge and scientific measures. More information is required on the dietary consumption at the community level. More information also is required on animal diseases and parasites.

7. International controls on substances of concern in the Arctic must be pursued and emphasized. Support for these initiatives should continue if we are going to reduce and eliminate the presence of these substances of concern from the Arctic environment.

There were also a number of issues raised which were of local concern. These are as follows.

1. Several communities expressed concern about contaminants buried along the Canol Trail.

2. Contamination associated with uranium mining operations of Great Bear Lake was of concern. Others were concerned by the creation of artificial islands and other activities associated with the hydrocarbon operations at Norman Wells.

3. Some communities were concerned about the environmental effects of forest fires, including effects on fish health. There also are concerns with global warming.

4. There are community concerns regarding drinking water, swimming waters, and increased incidences of impaired community health.

Theme 2: Partnership Building

In addition to discussing issues related to long-range and local sources of contaminants, a key theme of the workshop was partnership building between scientists and communities. Inherent in achieving this goal are a number of concepts, i.e., improved communication, capacity building, respect for each other's knowledge and recognition of the value of that knowledge. It was recognized that, while intentions are good, a number of barriers are impeding the achievement of this objective. Therefore, much of the workshop focused on the discussions of mechanisms for improved partnership building. These are as follows.

Communication

1. Communities need to be consulted during the early stages of project design. This will help ensure that the study design includes harvest areas and species of concern to the communities.

2. Maps designed for community distribution must include traditional names for all geographic locations. These maps should be used, as much as possible, in all other communications. Researchers consulting and communicating with communities should use traditional and common names for the species to be studied. Because common names vary from region to region, researchers must also use the scientific name and, as they judge appropriate, other traditional names. For example, the fish whose scientific name is *Lota lota* has several common names including burbot, loche, maria, ling, and freshwater cod. By following these two recommendations, researchers will be better able to enable communities to become more involved in the planning of research studies in targeted harvest areas.

3. Results must be presented to the communities in a timely manner. Communities have found that results are taking far too long to be reported back to them and this creates concern and distrust, especially when human consumption advisories are involved. Similarly, communities must provide researchers with mechanisms for communicating these results, i.e., invitations to participate in meetings that are planned sufficiently far in advance to enable the researcher to attend and in a cost-effective manner. Because travel costs are high in and to the north, consideration should be given to creative ways of reducing costs, e.g.,., community visits following workshops, field travel, etc. Community members traveling to the south are encouraged to contact researchers and visit with them and their laboratories.

4. Researchers must provide contaminant data to the appropriate agencies (e.g., Health Canada) as soon as possible so that these agencies can address a community concerns regarding contaminants, particularly in traditional foods. The submission of these contaminant data must not be postponed until after the researcher has completed the scientific study. When these researchers present the results of their scientific studies to the community, the community needs to respect the fact that the researcher must work within the mandate and area of responsibility of their agency. That is, researchers working for agencies such as Environment Canada and Fisheries and Oceans do not work directly on matters related to human health and consumption advisories. Therefore, they are not the proper authorities to provide such information and advice.

5. A Central Clearing House of information is needed regarding the general issues of contaminant research in the north. This Clearing House could be modeled after the Metis Northern Contaminants Education Program database. It should include: what contaminant studies have been conducted and by whom (NCP, Department of Indian and Northern Affairs, Environment Canada, Fisheries and Oceans, Land Claim Boards, communities, universities, etc.); when and where (i.e., lakes, rivers,

hunting areas) the studies were conducted; which species were collected and which tissues were analyzed for what contaminants; and the contact names for the scientists and community resource people involved with the study.

6. An association, possibly along the lines of the International Association for Great Lakes Research, should be established for the annual communication of results of contaminant and other studies related to the environmental protection of the north. The establishment of an northern association of environmental studies, with an annual meeting, would help facilitate northern communications. This meeting, scheduled at least nine months in advance, would allow researchers, communities, and agencies to come together to discuss results and develop new partnerships. A conference proceedings (or abstract book) would serve as a record of these presentations.

Capacity Building

1. A Mackenzie Basin Contaminants Committee should be formed and modeled after the Yukon Contaminants Committee.

2. Each new project should have provision for a community partner. This partner would work with the researcher in study design, implementation, and interpretation of results. This partner would ensure the successful contributions of the community members participating in the study. This partner could also serve as a contaminant coordinator to help make the results credible to the community members.

3. Additional opportunities need to be provided to train community members in environmental studies. The Youth Corps project should be continued and efforts made to involve students in research sampling and to work in research/analytical laboratories. Training opportunities also need to be provided to adult community members who may be less likely than youth to have opportunities to travel to academic institutes for advanced and extended training. However, these adults often are the most experienced hunters and fishers in the community and are especially well suited for being a integral part of sample collection. Training should be based on meaningful employment. Other learning opportunities include, such as educational workshops and slide shows targeted for younger children or the community as a whole should also be developed for presentation while the researcher is in the community.

Respect and Values

1. Communities want to be involved in the studies from the planning stages to the

final reporting of results. Communities representatives indicated that they would not support any further scientific studies in the Mackenzie Basin region unless they were involved.

2. The Dene Elder-Science Workshop was very successful in beginning to develop the mutual understanding and respect needed between scientists and communities. This workshop should become an annual event.

3. The communities strongly believe that Traditional Ecological Knowledge (TEK) needs to integrated with Western Science in order to better answer the many questions about contaminants in the environment, especially in animals and traditional diets. The communities indicated that the value of TEK must be reflected through the incorporation of TEK components into new project proposals. Both researchers and community members agreed that it was essential that proposals be based on sampling the appropriate organisms at appropriate times and locations to better meet community concerns. In addition, researchers and community members need to work together to better define and study measures of animal health and the suitability these organisms for human consumption.

TABLE OF CONTENTS

DAY 1: MONDAY, AUGUST 18, 1997

Welcome and Background

Mike Paulette, Métis Nation-NWT; Bill Carpenter, Métis Nation-NWT; Marlene Evans, National Water Research Institute (NWRI)

Mike Paulette, Métis Nation-NWT, began with a welcome to all participants particularly the community representatives "who most times are not invited to meetings such as this". Paulette also thanked the members of the science managers committee of the Northern Contaminants Program (NCP) for approving the workshop, and DIAND for funding the workshop. "The Métis Nation has been a partner in the original NCP for over five years and over those years we have recognized the value of working together with the various partners in the program" Paulette stated.

Paulette also stated that the new Phase II of the NCP holds even more potential for partnerships, and as an example of these partnerships, this workshop is not just the work of the Métis Nation but is in partnership with the National Water Research Institute (NWRI). "Over the last few months our Environmental Director, Bill Carpenter has worked closely with Marlene Evans from the NWRI and various other members of a steering committee which include the Dene Nation, DIAND, Fisheries and Oceans and others to prepare for the workshop; it has been a partnership right from the beginning" Paulette stated. In preparation for the workshop, Bill Carpenter started a series of consultations with the communities from Fort Providence and along down the valley to Fort Good Hope where he expanded the partnership even further. Due to his work, we now have at this workshop Métis and Dene delegates representing their communities.

Paulette emphasized that the next step in building partnerships is the task of bringing the scientists and the communities into a cooperative environment and to develop a close working relationship so that communities and scientists can jointly design research proposals. If this task can be accomplished, projects that are funded, may then have a new community-based partnership to solve some of the problems that are identified.

In closing, Paulette asked that participants be made aware that the goal of eliminating some contaminants on the international level begins at the community level and that over the next three days scientists and community delegates will work hard at "developing a much needed partnership link that will be the basis for future integrated studies under Phase II of the NCP".

Bill Carpenter, Métis Nation-NWT, relayed the background history of the workshop which stemmed from the Canadian Arctic Contaminants Assessment Report (CACAR) which identified the necessity to recognize the data gaps. Community consultations (with the exception of Wrigley) were conducted prior to the workshop to ensure input from Dene and Métis communities of the Mackenzie Basin area. From these consultations it was found that there was a lot of awareness, understanding and thought in the area of contaminants thanks in part to work done under the NCP. The new Phase II work plan must be done at the

community level which would result in the development of a partnership between the communities and scientists.

Marlene Evans, NWRI, began with a welcome to all participants on behalf of NCP. Evans stated she has worked extensively in the surrounding Mackenzie Basin area and has gained a real appreciation for the beauty of the land. "Over the next three days, we will be learning a lot from each other and we have challenging tasks ahead of us."

Overview of the Northern Contaminants Program - Phase II

Carole Mills, DIAND

Carole Mills, DIAND, gave an overview of the first phase of the NCP, which resulted in the acknowledgment that contaminants are a concern in the Arctic. Many of the contaminants of concern found in the Arctic are produced in other parts of the world and are dispersed to the Arctic vis-à-vis the "grasshopper effect" (see Appendix III, Figure 1). The majority of pollutants in the Arctic (90%) are present due to long range atmospheric transport (LRTAP) and need elimination not just at a local level but global as well. Contaminants are transported to the Arctic and subarctic. The contaminants then move through terrestrial and aquatic systems to the food chain. Once in the food chain, the contaminants biomagnify. The longer the food chain, the more concentrated the contaminants become.

The Upper Mackenzie Basin area is exposed to contamination in the terrestrial and aquatic systems from local sources (industrial development) and LRTAP. An increased effort toward international negotiations to control the contaminants at their source is necessary because the majority of contaminant input to the Arctic is from LRTAP. Community concerns regarding contaminants are incorporated in these international efforts.

The next phase of the NCP, Phase II, will focus on communication and education, implications of contaminants on human health, and international controls. In November, 1996, community representatives and scientists came together for an "Ideas Workshop". This workshop resulted in the new focus of NCP which is to be; multi-disciplinary, community driven, integrated and scientifically defensible (see Appendix III, Figure 2). To achieve this integration, over the past year, NCP funded five workshops; Nunavik and Northern Labrador workshop, Arctic Archipelago workshop, Upper Mackenzie Basin workshop, Northern Health Initiative workshop and a Mercury workshop (set for December, 1997). The purpose of these workshops was to develop focused and integrated research plans for the new Phase II of the NCP.

Session 1

Community and Industry Presentations from Previously Studied Areas

Community Involvement with Previous Studies and New Work Underway

Pat Simon, Fort Resolution, NWT

Pat Simon thanked the workshop organizers for the invitation to attend the workshop. Simon felt that this workshop was an important forum, especially for community members, because "this starts the ground work for building an understanding". Simon expressed several themes; how your personal approach to life affects your understanding of the connection to all people(s) that share the environment noting that "we have a special relationship to our environment, everything you do in any part of the world affects the environment", caring for our environment, partnership, and honesty (which has real substance and real value). "A lot of people in the room have special gifts that can contribute to our common goals - we have to take advantage of the funding and the people with the special talents to get the best value for our dollar or the best information to our questions" Simon stated.

Simon asked that the community representatives not feel intimidated by the technical aspect of the workshop for they have their own expertise and the ability to communicate results back to the communities. The power that community representatives have is the ability to make the information credible for communities. In past experiences, at the early stages there was a naïveté in what was possible, "we didn't know that one question would lead to other questions and not just in the area of contaminants but what contaminants lead to" stated Simon. Community representatives need to utilize all the resources in their communities to begin to build partnerships. For example, Simon remarked that he consults with his father, who notices minute and subtle changes in the environment. Simon also stated that "we integrate our skills, we do not separate our abilities, we use a holistic approach for it is important to look at the whole picture and not just a sample in a bottle for example".

Previously, studies were conducted on fish, water, caribou, buffalo, and birds. Sample studies on water and fish were done around the Fort Resolution area involving the community and the work of Marlene Evans. Simon noted "in dealing with scientists, I have found a commonality for the love of the land and caring of the land". Due to this work, the community wants to play a more leading role in research, "Dene people are bringing something to the table that will become more and more necessary to the NCP. Finding the answers is not just the solution - sometimes when you find the answers, where the real work begins is in making the results credible to the people you are answering to" Simon stated.

In closing Simon stated "the essence of what I bring here is a partnership, but it has to be built on equality, it has to be built on honesty and it has to be built with justice, we have to play a role or we are not going to have a planet".

Inuvik Regional Contaminants Monitoring Program

Jody Walker (On behalf of Inuvialuit)

Jody Walker was asked by the Inuvialuit Regional Corporation to present the Inuvik Regional Contaminants Monitoring Program (IRCMP) project. The IRCMP was developed to determine what contaminants are being detected in aboriginal women of this region and was coordinated with the CINE dietary survey. Hair samples from participants of the project are being tested for mercury levels to complete a territorial-wide study. In May 1997, a workshop was held to exchange information on contaminants and how the project should be developed. Two working groups were formed comprised of Gwich'in, Sahtu, Inuvialuit members, as well as technical people.

Questions following the presentation included:

- *What contaminants are you studying from the blood and umbilical cord?* Walker replied that the contaminants HCB, DDE and PCBs, as well as, mercury were studied.

- *I am concerned that there should be more research on people in the Deline area because some concerns about dietary surveys is that they do not represent true fish intake. We would like to be consulted in this current study as we were overlooked in previous studies.* Walker responded that she would be happy to discuss this possibility with Deline representatives and Laurie Chan from CINE.

Contaminants Monitoring within the Commercial Fishery on Great Slave Lake

Paul Harrington, Great Slave Lake Advisory Committee

Paul Harrington stated the nature of the work that is conducted by the Great Slave Lake Advisory Committee (GSLAC) revolves around all aspects of fish and water quality management; "the work that we do with biologists is in relation to quality and quantity of fish stocks and regarding what sampling should be done. The quality of the water and fish stocks has yet to be determined; it is important how we manage Great Slave Lake". Harrington further noted, "over the years I have gone to many meetings with CINE and other workshops regarding contaminants, and I am finding that the levels of contaminants are low yet the word contaminants is a scary word and aboriginal people are afraid of the issue and equate the word contaminants with cancer".

Due to changes in the environment of the Great Slave Lake area, concerns have been raised with the GSLAC regarding; the lake temperature increasing (possibly due to effects of the depletion of the ozone layer), rivers feeding into the Great Slave Lake being flushed due to water release from dams, the appearance of yellow fungus in the water from contaminants, and the forestry industry cutting trees right down to the river which increases the sedimentation runoff into the river, which acts as a contaminant to fish. "A stronger monitoring program would help to investigate these effects to the environment", stated Harrington.

Harrington expressed agreement with Pat Simon's statement that "it is one thing to find where the contaminants are but we need to know how to fix it - this is important - a lot of people in the north are interested in keeping it clean".

Questions following the presentation included:

- *How often does your committee meet?* The committee meets twice a year; once in the fall, and once in the spring.

- *Would it be possible for a participant from this workshop to attend your next meeting?* Harrington responded that this was a good suggestion and he will keep it in mind and extend an invitation to the appropriate participant. Harrington also noted that a commercial fisher should have been invited to this meeting as fishers have asked a lot of questions regarding the issue of contaminants.

- *I just wondered if the Great Slave Lake Advisory has made any efforts to record the changes in the water temperature of the lake and if this might be a way for us to start an interaction?* Most of the work we undertake deals with stock management and not contaminants, but we need to change this. However we feel that we are managing the lake quite well.

- *It might be beneficial to catch younger fish and not just the older fish that the commercial fishery catches, as well as, other species that commercial fishers do not catch. I would like to discuss with you a program we can design together.* Harrington responded that this program could be achieved.

Session 2

Community Concerns and Priorities on Contaminants within the Upper Mackenzie River Basin

Greg Nyuli, Fort Providence

Greg Nyuli, Fort Providence Resource Board (FPRB), stated that the FPRB was started four years ago and that the main objective of the FPRB was to manage their own land program. The land program is in its fourth year now and has developed projects such as digitizing maps of the local area through the use of geographical information systems (GIS).

"When we were establishing our boards, the KRIMP program, which is our resource management program we consulted with our hunters. What we hoped to achieve was to start up one board to deal with all the issues. We were successful. We now have just one resource management board", stated Nyuli. The share holders of the board are the Dene, Métis and hamlet people which represent the community. The stakeholders have been supporting contaminant studies of mink and lynx species, at Fort Liard. The results of these studies show high contamination in mink.

"We also worked with George Low of the Department of Fisheries and Oceans and a local person who collects samples to see if deformities are being observed in fish species. To date, we have not yet seen deformities", Nyuli stated. "We also worked with Francis Jackson of DIAND during a water study and we are pleased with the results of that study". Nyuli also noted; "I was interested to hear Paul Harrington's presentation. Some of our people have lived on the shores of the Great Slave Lake. I would like to know who sits on that advisory board and how they were appointed".

In conclusion, Nyuli stated that the FPRB is continuing to do fish sampling, and they would like to continue to investigate PCB levels in mink which are high, as well as sample for mercury and OCs in fish, and monitor the levels of cadmium in caribou and moose.

Questions following the presentation included:

- *I would like if it is possible to have Brett Elkin, GNWT, comment further on the contaminant levels in mink?* Brett Elkin responded that he would address this issue later in his presentation.

Cheryl Bonnetrouge, Fort Simpson

Cheryl Bonnetrouge is the pre-natal technician in Fort Simpson and is just beginning to learn about the issue of contaminants. Bonnetrouge stated, "that CINE researchers visited Fort Simpson to study traditional food intake. The results of the research showed that Fort Simpson is the community with the lowest traditional food intake". This is a concern for the community. Bonnetrouge also emphasized a community concern with respect to the effects of the Diamond mine. Community members are asking questions such as "will it affect our fish, will it affect us?"

Chief Tim Lennie, Wrigley

Chief Lennie, stated that although Wrigley is a small community of 200, they have many concerns regarding contaminants. Lennie explained that there is a connection between the issue of contaminants and resources. This issue is seen as a major problem, for the community feels that if contaminants are in the surrounding environment, resources must be contaminated as well.

The community has been conducting and participating in research on contaminants not only on resource effects but of the effects on community members. Lennie identified problems in conducting research in communities. Many community members are beginning to feel that they are being "studied to death". Community members also are having difficulty with the research papers scientists are producing because of the problems in translating these documents.
Recently Wrigley has been receiving a lot of research proposals for studies in various areas under their jurisdiction. Yet the community is hesitant to commit to these research proposals without a commitment from the researchers to involve the community. The community

would very much appreciate a commitment from scientists to meet the needs of Wrigley youth for training opportunities. Another factor in obstructing the community from making decisions regarding research studies, is that previous studies were not completed due to lack of or cuts to funding.

A large part of the community depends on traditional food for 90% of their daily intake on a regular basis. This fact makes hunters very aware of changes in the animals in their harvest areas. For example, observations have been made concerning two lakes near the community where there are fish species that have sores. The community would like to know why the fish have these sores? Lennie feels this phenomenon may be due to their fish species experiencing lack of oxygen due to a high loading of ashes in the lake from forest fires.

Lennie stated his main desire is "that scientists utilize our knowledge. We want to be consulted because we live here. Most of the scientists live elsewhere, such as Toronto - so please consult with us as we have a stake in this. If you do not come to our communities and consult with us, we will continue to refuse to support your proposals".

Finally, Lennie asked that scientists and funding organizations such as the NCP please try and develop long-term programs, more than 3 or 4 years. This is because "just when you get your foot wet the plug gets pulled. We can't continue like this".

Bertha Lennie, Tulita (previously known as Fort Norman)

Bertha Lennie began with a thank-you for the invitation to attend the workshop. Unfortunately Lennie did not have as much information to share with the participants due to lack of time for consultation with the community regarding contaminant concerns. Although Lennie did not feel well informed, one of the main concerns which she felt should be discussed was with regards to the CACAR Highlights report and the absence of information on the Sahtu region in that document.

The concerns she did table were regarding Kelley and Mahon Lakes (where caribou and fish are harvested at these lakes). Studies also are needed for the outflow from Great Slave Lake, Great Bear Lake, and the Mackenzie River. Lennie noted that "whatever is upstream of the Mackenzie River or at the Great Bear Lake affects us". We also are worried because our children have started to get rashes when they swim in the river. Is this from a contaminant and where does it come from? We also have a solid waste disposal problem. We want to know if leaching is occurring from the land into the water. Could these old out-houses be affecting us?"

In closing, Lennie stated she agreed with Pat Simon's comments "I like the idea of what Pat Simon said about working with the community. I would like to reiterate that".

Questions and comments following the presentation included:

- *I just wanted to add that people from these communities have noticed a taste of oil/gas in the fish and watery flesh of the fish in the Norman Wells area. Funding is also a*

consideration because we need adequate funding and more integration of these studies. Just when communities are starting to get involved the funding is cut.

- *Do you have a water treatment plant?* Lennie responded that at this time it is undergoing repairs.

- *You may have had leakage from the water treatment plant which may explain the problems with the health of children playing in the river.* Lennie was not in agreement with this comment as the water treatment plant is upstream from the community.

- *What studies have been undertaken in the Sahtu Region?* George Low, DFO, replied that DFO have collected fish samples in the Sahtu Region using land claim money. DFO is working with the communities to sample fish in the lakes used by the communities. We will be testing these fish samples for mercury, selenium and arsenic. To date, we have sampled fish in the Mackenzie River and Lake Turton. This year, DFO-community sampling will be conducted with Norman Wells while next year, it will be with Deline. DFO is trying to tie in contaminant assessment with the stock assessment work.

- *What is the status of NCP funding?* Regarding funding, it is a well known fact that we have been funded for the past five years. We have put together another five-year program but we only have a commitment for funding for one more year. We do not know what will happen after this next year.

Gina Bayha, Deline (previously known as Fort Franklin)

Gina Bayha presented the concerns from the community of Deline. One of the concerns is in response to information from the CACAR regarding the past six years collection of data on contaminants. The community feels that the CACAR is not a complete collection. The community also would like to know when the NCP will be collecting data using TEK in communities. Bayha strongly emphasized the point that "we need to have data collection from both sides of the picture (western science and TEK), so when we look at certain information about wildlife we have both views." The communities need baseline data regarding certain species, such as moose, using TEK. The communities have also noticed there is not much information on different species in the Sahtu region, and that they have not seen any information on population levels of caribou and moose.

A concern from Deline is that there has not been any sampling or testing in Great Bear Lake. They are requesting that studies be proposed in Great Bear Lake and Great Bear River. Sampling for mercury levels is lacking in Lac Ste Therese. There was random sampling in local lakes but without community consultation. If the community had been consulted, they could have directed this research to the lakes that are harvested the most by the community. In terms of mercury levels in Lake Therese, published levels exceed the safe levels for human consumption. Bayha stated that "we want to know what is naturally occurring and what is deposited by long-range transport and other man-made sources". Another community concern is uranium mining near Port Radium. The community currently is doing background

studies on Hottah Lake near Port Radium. This is an area where the community traditionally harvests caribou. The community needs to know the effects of mining on the caribou.

In terms of recommendations for future research, Bayha suggested: (1) avoid having the research extremely focused. For example, you cannot look at burbot livers as just one species to examine. When you know there is a problem with burbot livers from one lake, there will be problems with other fish species in that same lake; (2) Generalizations are being made across the whole territory so communities have to ask what does this mean to Deline. For example, when we looked at the results for the dietary studies done by CINE, we had to extract what was appropriate for Deline; and (3) Science managers are also recommended to look at geographic distribution. Why has there not been a lot of fish sampling in the Sahtu? What is happening with all the contaminants regarding spatial and temporal trends - is it getting better or worse? The community needs to know this. Local people have been helpful because they know their daily intake of fish and the quality of their fish. The communities have also noted changes in the temperature of Great Bear Lake.

Questions and comments following the presentation included:

- *One comment was made in reference to how much mercury is natural or attributable to long range transport (LRTAP) in Great Bear Lake.* Lyle Lockhart, FWI, noted that we have one sediment core sample from the lake and the results of that core sample are available. The mercury levels are not that high but there is an indication of an LRTAP signal.

- *Are there any plans to sample mercury at Lac Ste Therese?* Lockhart noted that we have two core samples from that lake that show some recent increase of mercury due to LRTAP. However, this lake has high natural background levels. We will try and find out if the fish also have high mercury levels.

Mary Le Blue, Norman Wells

Norman Wells has concerns regarding industrial, airborne and natural contaminants. Mary noted that our environment is very important to the Dene and other people because it affects our way of life and our harvesting needs. We have quite a number of lakes that are used regularly for fishing such as Doctor, Mahony, Three Day, Mier, Turton and Kelly lakes. These lakes were identified as main harvesting areas for the Tulita District. From the reports, a few studies have shown high levels of mercury. One source of mercury is from forest fires, so the community needs more information on this as we had a huge forest fire a few years ago in the Sahtu Region. We would like to sample lakes where we harvest fish for recent mercury exposure due to this fire.

Canol Road (Trail) is an other area of concern. There was some clean-up work by the Métis Nation of oil drums and other industrial wastes but we need to know about the contaminants that are still buried there. Great Bear Lake is another concern. Recent observations of the

change in water temperature raise a number of questions. Norman Wells Oil Field has to be tested for contaminant levels from oil spills and leakage into the Mackenzie River and how these leakages might affect the fish in the surrounding area. Esso should sponsor a fish sampling study. Local hunters and trappers have asked to be included in studies obtaining and testing fish samples.

Questions and comments following the presentation included:

- *You have made comments on the Canol Road (Trai). We need to know about well waste sites on the Yukon side. Waste sites do not stop at the border. Could someone please comment if they have any information?* Bob Van Dijken, Yukon Contaminants Committee, responded that YCC has transportation issues of contaminants, including transboundary issues.

- DIAND is now involved with the clean up of abandoned military sites and the Canol Road (Trail) was targeted to have an inventory done by a Sahtu company. So, we do have some information on this problem. In the past, the GNWT did not have the same disposal policy as the Yukon. Burial of waste is allowed in Yukon but not in the NWT.

Mardy Semmlar, Fort Good Hope - Introduction to Jonas Kakfwi, Elder from Fort Good Hope

Fort Good Hope's concerns are similar to the other river communities. Moose is an important food source and is harvested all year round, whereas caribou are supplementary and are only harvested from April to December. All parts of the animal are consumed, especially the fat which is eaten raw or dried, and we know that OCs collect in the fat. This is a community concern that should be investigated. Geese is another animal harvested. All parts of the goose are eaten especially in the spring when the geese get fat from feeding on grain as they migrate north. Woodland caribou are harvested from mountain ranges and should be sampled for cadmium as study results from the Yukon have shown high levels of cadmium in caribou kidneys. Fish, such as loche (burbot), are harvested almost all year round. Some studies have shown contamination in loche livers. We need new studies to see if these contamination levels are increasing or decreasing.

Jonas Kakfwi, Fort Good Hope, expressed his primary concern with the creation of the artificial islands in the Norman Wells area. Kakfwi used the analogy "when you have dirty hands you have to clean them and after you have washed your hands in water you can't drink that water. To me this is like those artificial islands. After they blasted rock, they built these islands and what happened to the fish? We look at our loche livers now and ask why are the livers black, brown and skinny after these islands were created and we related it to the creation of the artificial islands." The islands are situated in the Mackenzie River and this river runs down to Fort Good Hope. In the last year, it has become better but now they are talking about a new hydroelectric development on Great Bear River. This is a big concern especially after our experiences with the construction of these artificial islands. Regarding

mercury in fish and water, we need to know more, because when hunters are trapping, they do not boil the water they drink. Mercury in the water is a concern.

Questions and comments following the presentation included:

- *What do the results of mercury mean regarding human health effects? What does it mean to us, we want to know? We need to look at this issue in partnership with Health Canada.*

- *It has been 16 years since the construction of the Esso Arctic islands and 13 years since they have been completed. Can we get results of any testing?*

- *Communication is a major issue which needs to be addressed. How can the communities keep informed of research results, particularly contaminant levels in water and food species?*

- *We are waiting for an advisory regarding some research results from a study we did last September. Health Canada takes a long time to present results to scientists and the communities. This impedes communication efforts regarding safe and unsafe levels of contaminants in water and food species.* DIAND is developing a new process to curtail the delay of transfer of information on research results back to the communities, which are being held up by advisories.

Session 3

Contaminant Sources and Pathways - Introduction

Derek Muir, National Water Research Institute

Derek Muir, NWRI, introduced the session which will provide answers to the following questions on contaminant sources and pathways.

- How do contaminants get into lakes and rivers?
- Where are the contaminants coming from?
- Are things getting better or worse?
- What action can we take to stop emissions of persistent organics or mercury?

Contaminants found in the Mackenzie Basin are from both natural and anthropogenic (man-made sources). Contaminants enter the Arctic via the atmosphere and through the water. In the Mackenzie River drainage basin (from Inuvik to Fort Smith including the Peace and Athabasca rivers), water-borne pollutants are a major source to the river system. The contaminant sources include tar sands, oil seeps and upstream industries and municipalities. Once deposited into the river drainage basin, the contaminants can enter both the terrestrial food web and aquatic food web, through various exchange processes on the land and in the water column (Figure 3).

The most easily demonstrated usefulness of the contaminants research in Canada is in its support of international negotiations. Much of the Arctic contaminants research in Canada has provided the justification for the negotiation of a POPs protocol under the United Nations Economic Commission for Europe's Convention on Long-range Transboundary Air Pollution. It is hoped that this protocol will reduce the manufacture and use of POPs in other countries and therefore their presence in the Arctic. Further to the international work, the current research has raised other outstanding questions such as "what is the influence of Athabasca and Peace River on the Mackenzie Basin environment?" This and other questions emphasize the need for continued research and monitoring of contaminants in the Mackenzie Basin.

Long Range Transport of Organic Contaminant Pathways

W. M. J. Strachan, NWRI, Canada Centre for Inland Waters

One of the more significant findings (or confirmations) of the recently released CACAR (Canadian Arctic Contaminant Assessment Report) was that persistent organic pollutants (POPs) found in food and other biota of the region were delivered there by atmospheric transport. The original sources of these contaminants were in other regions perhaps thousands of kilometers away and probably, in some cases, not even from the North American continent. This means that the present Northern Contaminants Program must keep, as an important focus, the control of such compounds through international controls. In order to do this, the program must have a strong scientific data base demonstrating how these compounds

behave in the environment. We also need to know how they reach the Canadian Arctic despite the fact that they were never or seldom used there.

The compounds we are concerned about are the organochlorine pesticides (HCHs, DDT and its breakdown products, chlordane, dieldrin, heptachlor and its breakdown product, and others) and industrial compounds such as the PCBs and HCB. These compounds are very persistent in the environment. They also have well established effects on many organisms at low levels. This persistence may be even greater in the north as there may be effects of these compounds. We see these substances in the north in very low levels in the air and water. There are few or no known effects at these levels. However, these compounds accumulate in the various food chains. This is because they adsorb to solid materials in water and soil, and are "eaten" by animals and small aquatic creatures which in turn are consumed by larger ones. The chemicals are stored in the fat and in the body and the consumers do not eliminate them easily. Eventually, depending on how "long" the food chain is, they may reach concentrations in the organism that can have effects on the organism. In test organisms, these effects are often related to the reproduction cycle and other "non lethal" effects.

It is important that we know what are the concentrations of these contaminants in country foods. We need this so that people can make informed decisions on whether the benefits of continued eating of a particular food compensates the health risk posed by the chemicals incorporated in the food. It is also important that the knowledge base concerning the contaminants be strong enough that regulators and legislators in distant lands are persuaded that it is appropriate that they control the use of the chemicals in their lands - perhaps with the benefits to them being only our well-being. The case needs to be well made!

The case against POPs requires that Canada describe how the chemicals get to our Arctic regions, what happens to them when they do, and what is the exposure of our people and the resident biota to these chemicals. Much of the non-biological work centers on what is called "mass balance" or the quantitative determination of how much of each chemical enters, leaves or stays in water and terrestrial systems. By adding up these quantities, we are able to say what mechanism(s) of transport is responsible for delivery of the chemicals and therefore what is the most appropriate means of control. By presenting the information as a function of time, it is possible to make mathematical "models" which describe the behaviour of the chemical. Therefore we can estimate when the concentration of the chemical will fall to a particular level when smaller and smaller amounts of the chemical are transported into the Canadian Arctic by the air and by the water.

Questions following the presentation included:

- *On your slide of contaminant deposition into Great Slave Lake (GSL), if you had this data over many years, would it show the amount of increase every year, and can this be done for Great Bear Lake ?* In principle, yes. You could do that by sampling the deposition of contaminants into the lake over a number of years. However, it is questionable how precise this answer would be if you only made that determination from a couple of years of sampling.

Because Great Bear Lake is such a large lake, this deposition would be hard to measure precisely. This is because there is a lot of variability in HCH concentrations in the snowfall.

- *Are you saying that in years of heavy rain fall, contaminant concentrations are higher?* What I am saying is we need more information from rain.

- *Are the geological differences between the east and west of GSL an issue?* Not really. Contaminants that are showing up in top levels are mainly from anthropogenic sources.

Depositional History of Contaminants, Discussing Latitudinal Gradients

Derek Muir, NWRI

Studies involving sediment core investigations in lakes can address the following questions about contaminants such as PCBs and mercury.

1. Where do contaminants go once they get into snow, meltwater or river water?
2. What are current inputs of contaminants to lake bottom sediments? These contaminants may be available to be taken up in the aquatic food chain (see Appendix Figure 3).
3. What are geographic trends in contaminant input? Are inputs to lakes higher in the south?
4. Are things getting better or worse?

Sediments preserve a record of the input of POPs and heavy metals. Sediments records however, are only good for sediments that bind to particles in the water column. HCH is not a good one to analyze for in sediment cores as it does not bind easily to particles. PCBs, on the other hand, do bind easily to sediments. If the researcher can get find a region when the sediments are not disturbed by strong water currents, then the researcher can collect an undisturbed sediment core in that region. The core can then be carefully sliced and each slice dated (an age assigned to it) and contaminant concentrations measured. The dating is done with Pb-210, a natural isotope, and with Cs-137, a result of nuclear bomb testing. After all this is done, the researcher can get a good record of contaminant inputs over time into the lake.

Dr. Lyle Lockhart of DFO has done much of this work in cooperation with the communities (see Appendix III, Figure 4). Sediment samples have been taken from Inuvik through to Yellowknife under the NCP program. Great Slave Lake and Lake Athabasca sediments cores have been collected under the Northern River Basin Study while Slave River suspended sediment samples have been collected under the Slave River program supported by DIAND-Yellowknife.

Concentrations of PCBs in surface sediments of temperate and Arctic lakes can provide much information. Many lakes have been studied in the north and in the south. Time trends which have emerged from coring studies show a definite latitudinal trend in flux. Flux is the amount of chemical being deposited in the sediments in an area in a given year. Flux

concentrations may be expressed as ng/m^2/y. Sometimes flux is expressed cm/m^2/y - for example rainfall. The highest fluxes for total PCB are seen in Lake Ontario and the lowest in Lake Hazen on northern Ellesmere Island (see Appendix III, Figure 5). Further, this information can be used in models, e.g., models of latitudinal gradients in flux. A mathematical model for Lake Superior has shown that the majority of the contaminant input is from the atmosphere and this is similar to Arctic lakes.

A complication to the latitudinal model which shows a decrease in flux rates as one moves north is the possible influence of ice cover. For example, as the ice melts to form spring runoff, large amounts of this water may be rapidly flushed out of the lake without staying there for very long. Thus, contaminants which were deposited in the watershed and on the lake during periods of prolonged ice-cover, may not stay in the lake long enough to be deposited in the sediments. Therefore, sediment coring studies may not be providing good information on latitudinal gradients in contaminant loadings on an annual basis. However, sediment coring studies still provide useful information on the history of contaminant inputs. For example, we can tell that PCBs began appearing in increased concentrations in the NWT in the 1950s. We also can tell when contaminants start decreasing in concentration as bans on their use are put in place.

Summary:

- Sediment cores provide a record of current and past inputs of contaminants to lakes.
- Arctic lakes may be less efficient at trapping contaminants due to periods of prolonged ice cover.
- Inputs of PCBs decline with increasing northern latitude (about 5X over 35° latitude).
- More volatile di- and tri-chloro-PCBs and persistent OCs predominate in high Arctic sediments ("cold condensation").
- Mackenzie River Basin lakes had maximum inputs of PCBs in the 1970-80's.
- Current PCB inputs into lakes in the Mackenzie River Basin are similar to those in north western Ontario.

Questions following the presentation included:

- *Over the past couple of years, as you may have read, we have had many members of our people affected by stomach problems and concerns and we are wondering why? What are the long term effects on humans and animals of PCBs?* NCP was started to answer these questions. Jay Van Oostdam of Health Canada was asked to respond to this question. He noted that PCBs, like all POCs, are toxic. However, what is important is the dosage. Furthermore, these substances persist for long periods in the environment. At high concentrations and dose, PCBs can cause health effects, e.g., cancers. However, at levels seen in the environment, we do not feel there will be any immediate toxic effect. In the Kitikmeot Regional Study, mothers and babies (through the maternal blood cord study) were

analyzed for levels of POCs. The results of this study indicate that the Dene and Métis people in the study had the same levels as non-aboriginal people studied. This means there is not a higher concentration of these contaminants in these aboriginal people.

- *When you say north west Ontario does that include Lake Superior, because we would not be happy to know that we have the same levels as Lake Superior?* No, Lake Superior is not included but you do have the same relative levels as Lake Superior.

- *Have you done sampling near the mouths of rivers feeding into lakes?* Due to sediment mixing in these areas, sediment cores are not very useful.

Slave River Environmental Quality Monitoring Program

J. D. Saunderson, Water Resources Division, Indian and Northern Affairs Canada

The Slave River Environmental Quality Monitoring Program was a multimedia sampling program established in 1990 to characterize baseline conditions of the aquatic ecosystem in the Slave River at Fort Smith, NWT, Canada (see Appendix III, Figure 6). The comprehensive nature of the program made it the first of its kind in the Northwest Territories. The Slave River watershed drains an area of 600,000 km^2, including the Peace and Athabasca Rivers, with the territorial portion being the furthest downstream. Increases in upstream development prompted concerns by northern residents. In order to answer the questions of "can we drink the water?" and "can we eat the fish?", the program took an ecosystem approach and analyzed water, suspended sediment and fish for contaminants. In addition, benthic surveys, stable isotope work and delta coring were carried out in conjunction with this study. Samples were collected in both winter (at air temperatures as cold as -40°C and under the ice) and summer. Samples were analyzed for organic and inorganic compounds including mixed function oxygenases (MFOs), dioxins, furans and other organochlorines. There was an emphasis on those contaminants most likely to result from anthropogenic developments upstream, namely pulp and paper mills, agricultural activities and hydrocarbon developments.

The comprehensive database that resulted suggests contaminant levels in the water and sediment are very low. Several organochlorines were detected in fish but only toxaphene was at a level above consumption guidelines. Compounds detected appear to be a result of natural sources, long-range atmospheric transport and upstream development. This information will aid in transboundary negotiations and monitoring future changes in the aquatic environment. The presentation reviewed the major findings of the study, with an emphasis on the study design.

Questions following the presentation included:

- *How long has this study gone on for?* This study was from 1990-95.
- *How do we get a copy of the report and when is it due?* The Slave River Report is due to be released December 1997 and it is available through Juanetta Saunderson (see Appendix II for address).

The Influence of the Slave River on Contaminant Loading and Deposition to Great Slave Lake

Marlene Evans, NWRI

Slave River Facts:

- The total water inflow is 33 cubic miles/year and this represents 87% of Great Slave Lake water inflow.
- Water replacement time is approximately 7.2 years for the West Basin.
- The drainage basin is 384,000 square miles and the sediment load is 6-15 million tonnes per year.

There are two basic sources of organic contaminants to Great Slave Lake. The first source is the atmosphere with contaminants falling into the lake with rain, snow, and dust. The second source is through river inflow. We hypothesized that the Slave River was a major source of contaminants to Great Slave Lake, especially the West Basin. This is because the river drains a very large area. We also thought the Slave River may bring more contaminants into Great Slave Lake than are entering directly from the atmosphere.

We investigated these hypotheses in two ways:

1. We measured the concentration of contaminants such as PCBs and PAHs in the surface sediments in the West Basin and East Arm. We found that these contaminants occurred in greater concentrations near the Slave River outflow than further away.
2. We also conducted special studies, involving collecting sediment cores, to estimate how much contaminant is being deposited on the lake floor each year. We found that more contaminants were being deposited to the lake floor offshore of the river mouth than in the East Arm and near the outflow from Great Slave Lake.

Thus, we have shown that the Slave River is a major source of some organic contaminants to Great Slave Lake. We also have shown that most of these river-born contaminants appear to be deposited near the river mouth and do not travel as far into the East Arm or out of Great

Slave Lake. We believe that most PCBs originated from the atmosphere, fell onto the land (mainly in British Columbia, Alberta, and Saskatchewan) and then were washed into the Peace and Athabasca rivers and then into the Slave River. For PAHs, it is probable that some originated in the watershed from natural sources.

Knowledge gaps that we believe require further research for Great Slave Lake are as follows:

1. Contaminant deposition rates in the East Arm and west end of the lake, especially offshore Hay River need to be measured.
2. We need more information on contaminant deposition rates in the Slave River Delta.
3. Contaminant budgets, i.e., inputs (rivers and atmosphere) and losses (outflow, sedimentation, and to the atmosphere) need to be developed for Great Slave Lake, including on a regional basis.

Knowledge gaps that we believe require further research for the Mackenzie River are as follows.

1. Contaminants inputs from Great Slave Lake outflow, the Liard and other tributaries.
2. Atmospheric input rates.
3. Contaminant movement down the Mackenzie River and sedimentation in the river.

Questions following the presentation included:

- *I was looking at the sites and all the sites were in the Fort Resolution Bay Area. Did you sample the Slave River Delta?* Yes, we did sample the Slave River Delta (two water samples) and in the West Basin. However sediment coring results are not great because there was too much movement and mixing of the sediments. A number of years ago Alena Mudroch, from NWRI, collected cores from three sites in the West Basin. She could not date these cores. Her contaminant concentrations were similar to what we observed in our study.

- *This is where TEK comes in, because if you had consulted Fort Resolution people you would have known that some of the tributaries have dried up.*

DOE Water, Sediment, and Fish Tissue Quality programs: Deh Cho District and Nahanni NPR

D. R.. Halliwell, Environment Canada

Since 1960, Environment Canada (EC) has carried out long-term monitoring and short-term studies involving water and sediment quality in partnership with DIAND, Parks Canada, GNWT and DFO along the Mackenzie and Liard River reaches of Deh Cho District. Earlier contaminant studies focused on the Mackenzie Delta (e.g., NOGAP) and Hay River. In the

Nahanni, NPR, EC and its partners have carried out water, sediment, and fish tissue quality studies since 1988 as an intensive (1988-91) study and as a less intensive five-year (1992-97) follow-up monitoring program.

The initial study focused on characterization of water quality at five of the 13 sites studied within the Park, documenting seasonal variability and setting long-term and short-term objectives (LTOs, STOs) for 28 water quality variables. The more recent monitoring refines initial water quality objectives at five sites using a larger data set collected for seven years over a wide range of river flows. The monitoring program also established additional objectives for water quality at two new sites, and sediment quality at one site. Spatial and temporal (seasonality, trend analysis) variability are dealt with, and values are compared with CCME Canadian Water Quality Guidelines and (draft) Canadian Sediment Quality Guidelines.

In related 1992 and 1994 studies, DFO assisted with the fish tissue sampling and analyses at two sites. Aquatic quality baseline monitoring is justified within this portion of the Taiga Cordillera Ecozone because the NWT's most visited national park is downstream from the mothballed Tungsten (W-Cu) and Cadillac (lead-zinc-silver) mines and dozens of undeveloped mineral occurrence claims are described in a recent GSC Open File. The Cadillac Mine area in Prairie Creek is actively being explored, developed and an environmental impact assessment is underway. Slightly elevated metals levels were detected in stream waters and sediments and in fish tissue. There may be linkages with elevated metals levels at higher trophic levels (e.g. caribou). Data gaps in contaminants research exist, including air quality, water quality, sediment quality, soil quality, invertebrate, riparian vegetation, fish tissue, and higher food chain level sampling. Future Mackenzie Basin contaminant studies and ecological monitoring and assessment network (EMAN) programs would fill many of these data gaps.

Questions following the presentation included:

- *Metals occur naturally. How can you determine whether the metals you found are natural or man-made (anthropogenic)?* This is a natural environment with little to no past history of anthropogenic input due to lack of exploration activity. Therefore, the metals found are assumed to be of natural origin.

- *Sediment core samples were not done, so how can you say the metals (i.e. lead) present are natural and not from LRTAP?* Sediment coring will tell you a historical perspective on the contaminant loading for the water body. You would have to check back over a hundred years ago to get a baseline. Then you would check the core for more recent decade levels.

Session 4

Biomagnification of Contaminants - Introduction

Birgit Braune, Canadian Wildlife Service

Biomagnification is an increase in contaminant concentration from food to animal. This occurs when an animal takes up a contaminant but does not get rid of it very quickly. Some contaminants (for example HCH) often do not biomagnify in higher animals because their bodies can get rid of them easily. PCBs and DDE (a breakdown product of DDT) are among those contaminants which take a long time to leave the body. Biomagnification of PCBs and DDE in fat is about 10X at each trophic level in the food chain. Therefore, the more levels in the food chain, the higher the concentration of contaminants at the top level. Thus, plant-eaters tend to have lower levels of most contaminants than animal-eaters such that animal-eaters have higher levels of contaminants than their prey. The lowest levels of organochlorines are found in plant eaters such as caribou, ptarmigan, hare and muskox.

Things work a little differently in water than they do on land. Contaminants are brought to the north by air and end up either on the land or in the water. Most contaminants are easily taken up in an aquatic food chain, whereas most contaminants are not taken up by plants from the soil. Contaminants that are deposited on the outside surface of plants may be washed off into the soil.

Food chains on land are generally short, often 2 or 3 steps from plants at the bottom of the chain to animal-eaters at the top of the chain. The number of levels in the aquatic food chain are large, usually 4 or more. Therefore, birds and mammals that eat fish are expected to have higher levels of most contaminants than similar species that eat rabbits or mice.

In summary, because it is more difficult for contaminants to get into the food chains on the land, and because land food chains have fewer trophic levels in the chain, contaminant levels are generally much lower in land food chains than in aquatic food chains.

An Overview of the Biological Studies Reported in CACAR with a focus on the Mackenzie River Basin and Freshwater Biota

Derek Muir, NWRI

At the beginning of the study (1990), communities were not consulted as to which species should be sampled and how. Plants and animals were collected in the region from the Mackenzie River Delta to the Slave River and were analyzed for PCBs, other organochlorines, and metals.

In fish, more measurements were made of metals than POPs. This was due to considerations of cost and the time-frame for results being made available. PCBs and toxaphene were studied in lake trout and compared to data from across the north (Yukon and NWT). The presentation focuses on these two contaminants because they are the most important from a

human health point of view. Toxaphene concentrations were higher in the west than in the east. PCB concentrations were lower in the north than in northern Quebec, with the exception to Lac Laberge which had extremely high levels of both PCB and toxaphene. Lac Laberge is a mountain lake and has higher levels than in any other lake. We do not know why this is happening. Ideally, POP concentrations should also be expressed on a fat and lipid basis because lipid-rich fish tend to have higher POPs concentrations than lipid-poor fish.

Great Slave Lake whitefish have higher levels of toxaphene than whitefish from other regions of the north. Toxaphene is higher in burbot liver from Lutsel K'e than in other lakes. However, only ten fish were analyzed so this may not be a good population estimate. High contaminant levels which were high in fish from Alexie (burbot) and Peter (lake trout) lakes are due to the effects of the number of food chain links and not contamination levels.

High levels of dioxins and furans (2,3,7,8-TCDD and TCDF) were found in burbot collected from Grand Prairie and Peace River. This is due to a site influence from the pulp and paper mills in northern Alberta. In recent years, these mills have changed their pulp processing (bleaching) procedures, reducing dioxin and furan formation rates. PCB, toxaphene and mercury concentrations in inconnu muscle were very low with regards to health assessments. Concentrations were higher on a lipid than wet weight basis.

Knowledge Gaps - Contaminants in Mackenzie Basin Fishes

1. Spatial coverage of contaminant measurements in fish muscle samples is much less detailed in NWT than in the Yukon:
   a) The upper Mackenzie River Basin (between Great Slave Lake and Fort Good Hope) has received less study than GSL and Slave River.
   b) There is less information is available on contaminants in other tissues (e.g. eggs, liver, head) than muscle. These other tissues are part of the traditional diets.
   c) Not all important food species have been examined.
2. There is limited information available on changes in concentrations of contaminants in fish over time:
   a) Almost all measurements were taken in the last 5-10 years.
3. The high lake-to-lake variability within a species (e.g. lake trout and burbot) of both mercury and persistent OCs has not yet been adequately explained.

Questions following the presentation included:

- *You referred to adjusted lipid content. Is this reflective of the types of fish that most people prefer to eat (such as those which have more fat)?* No. It is based on wet weight.
-
- *Can you comment on levels of toxaphene and PCB found in this area compared to levels in the Great Lakes.* Lake trout in Great Slave Lake were analyzed and found to contain

approximately 25 ppb PCB and 100 ppb toxaphene. In the Great Lakes (Lake Superior) the average is about 10X higher than these figures. However, if you were to take samples from Lake of the Woods or a similar lake in Ontario north of the Great Lakes, you would find the levels are very close to Arctic lakes.

• *Are the PCBs and toxaphene naturally produced? Are most of these toxins transferred from one fish or organism to another? How can you say where contaminants come from if they can be transferred through an animal's eating habitats?* PCBs and toxaphene are not naturally occurring. However, many metals are. Doug Halliwell was studying metals in the Tungston area and found that they are naturally occurring.

Muir displayed an overhead listing some important environmental chemicals and how they were formed.

Mercury: natural element (used extensively by man).

PCBs, Toxaphene, DDT, and others: exclusively man-made organochlorines.

Dioxins: chlorinated compounds made by man with possible natural synthesis.

Hydrocarbons: many compounds, both natural and produced by man.

Lead, Arsenic, Cadmium: natural elements used extensively by man.

Strontium - 90, Iodine - 131, Polonium - 210: natural radioactive elements not used by man but widespread in the environment.

Contaminant Biomagnification Studies in Great Slave Lake

Marlene Evans, NWRI

We are conducting studies investigating the biomagnification of organic contaminants such as PCB and toxaphene in Great Slave Lake food webs. We have focused our research on fish which people eat. We originally thought that contaminant concentrations might be higher in fish collected near Fort Resolution, at the Slave River outflow, than at Lutsel K'e, in the East Arm. We thought this because we believed that the Slave River was bringing significant amounts of organic contaminants into this region of the lake. In addition to studying the fish, we studied other animals in the food web. We did this because fish obtain most of their organic contaminants from their diet.

In our presentation, we show or discuss how these samples were collected. We determined that PCB and toxaphene concentrations increased from the invertebrates (small, insect-like animals) to the whitefish (muscle) that eat these small animals to lake trout (muscle) which eat other fish. But, we were surprised to see that animals living in Lutsel K'e tended to have higher concentrations of contaminants than animals living near the Slave River outflow. We believe that this happens because the suspended sediments in the water (which make the water brown) act as a sponge. Thus, in turn, dilutes how many contaminants the fish and invertebrates living near the Slave River outflow can absorb from the water.

We also compared PCB and toxaphene concentrations in burbot muscle, burbot liver, and lake trout muscle. We found that while burbot (ling, loche, maria) liver have high concentrations of these contaminants, they have low concentrations in their muscle. In fact, burbot muscle has lower concentrations of toxaphene and PCB than lake trout muscle. This is important to know when people are deciding what fish and what tissues they want to eat. Our work is not complete and we are still obtaining new data on other fish such as pike (jack), walleye (pickerel) and inconnu (connie).

In conclusion, research studies which investigate food webs and other aspects of lakes (or rivers) can help us better understand why contaminants occur in higher concentrations in fish from one region than other.

Questions following the presentation included:

- *Has any work been done similar to Karen Kidd's investigations on trophic levels?* Yes, we have looked at nitrogen levels in fish and found that the fish in both areas studied were just as predacious.

- *The fact that lake trout has the higher levels is not surprising to us (community of Deline). We know of a study which tested mothers who had a diet of marine animals and fish. They received their high levels of contaminants from their dietary intake of the lake trout. Are there any size or age conditions of fish that we should base our consumption on?* Lake trout is a fish in which the PCB levels increase with age and that can help to make informed decisions on which size/age lake trout to eat.

Mercury in Fish and Lake Sediments from the Mackenzie Basin Region

Lyle Lockhart, Department of Fisheries and Oceans

When mercury is present in fish at high enough levels, it can be toxic to humans who consume those fish. Health agencies have tried to keep human intakes of mercury low by recommending that fish with more than 0.5 parts per million of mercury not be eaten.

Mercury is emitted to the air by processes of burning fuels that contain small amounts of mercury, especially coal, and it is then dispersed throughout the hemisphere by movements of air. Mercury is also emitted to the air by natural processes. There is still some debate among scientists about how much of the mercury in the air is of natural origin and how much results from human activities.

Mercury has been measured in fish from a number of lakes and from the Mackenzie River and the results indicate differences among species and locations. These analyses are being done as part of the stock assessment process by which fish populations are selected by communities and are then examined for their potential to support commercial or domestic fisheries. Results to date generally indicate that those species that feed at the top of the food

web, especially large, old individuals, have higher levels of mercury than those that feed nearer the bottom. That is, walleye that prey on other fish have higher mercury levels than whitefish that do not. To date the lakes where high proportions of predator species exceed 0.5 parts per million include; Giauque, Ste Therese, Jacques, Turton, Mahoney, Cli, Little Doctor, and Sanguez. Those where very few of the predator species exceeded 0.5 parts per million were; the Mackenzie River in the reach from the Ramparts to Little Chicago, Lakes Belot, Colville, Ekali, Yaya and possibly Manuel, Tagatui and Gargan.

Why do lakes have such different levels of mercury in the fish, especially when the lakes are close together?

- Geology of the lake and drainage?
- Different sources from outside the basin?
- Lake characteristics (lake area, depth, volume, drainage area, type, water circulation, water quality - water type; brown, clear ?
- Sedimentation - organic carbon?
- Biology of the fish - food habits, growth rates?

Sediment cores have been taken from a few sites within the region because they record the history of inputs of mercury to the lakes over periods of time ranging back to several hundred years ago. These records tell us the natural, geological range of inputs to the lakes and also show us whether there has been any recent contributions over and above the geological sources. Sediment records have not been done for many lakes within the region but the few we have indicate that some of the lakes are receiving increasing inputs of mercury now relative to pre-industrial periods. For example, the natural levels in Colville Lake sediments are low but both our cores suggest small but increasing loadings, probably as a result of increasing fallout from the air. Most striking is the case of Giauque Lake, where extremely high inputs to the sediments have occurred in parallel with operations at the Discovery mine.

In some animals, selenium ameliorates the toxicity of mercury and we have measured selenium in a number of fish and also in some tissues of beluga whales from the Mackenzie Delta. There appears to be little relationship between mercury and selenium in fish but a very striking relationship in whales, at least in organs like the brain and spinal cord which are thought to be sites of toxic action of mercury, although not in blood which is probably not a site of toxic action. This raises the possibility that whales may have a mechanism to detoxify brain mercury by sequestering it with selenium.

Questions remaining about mercury:

1. How much of the mercury present currently is the result of natural processes and how much is reflective of human activities?
2. Are inputs of mercury changing?
3. Can the amount of mercury in fish be predicted from the nature of the lakes and the fish?

4. What is the biological availability of mercury from natural and anthropogenic sources?
5. Are mercury levels in people or animals harmful to them?
6. What is the trade off between benefits of eating fish or marine mammals and exposure to the mercury in them?
7. Is the toxicity of mercury ameliorated by selenium?
8. Are northern animals or people protected from mercury poisoning by special detoxification mechanisms?

Contaminants In Birds Harvested in the North

Birgit Braune, Canadian Wildlife Service

To answer the communities question: Are the Birds Safe to Eat? The Canadian Wildlife Service (CWS), Environment Canada, in cooperation with Health Canada, undertook a study from 1988 to 1995 to determine the amount of contaminants in ducks, geese and other game birds. Ducks and geese most frequently shot by hunters were examined (see Appendix III, Figure 7). In total 30 communities across the Arctic participated (including communities from northern Quebec and Labrador). The communities in the western Arctic included Old Crow, Kendall I, Tuktoyaktuk, Inuvik, Fort Good Hope, Holman Island, Coppermine and Yellowknife. Each community participating was asked for 5 to 10 birds of each species hunted. There were 21 different species of birds (eider, oldsquaw, scoter, scaup, teal, ring-necked duck, pintail, canvasback, wigeon, mallard, bufflehead, loons, swans, ptarmigan, geese, brant, grouse) collected from the area along the Mackenzie River. Many of these species have migration routes that take them far to the south (see Appendix III, Figure 8). We measured the amount of contaminants in parts of the birds that are eaten most, such as breast muscle. We analyzed these tissues for PCBs, organochlorines, mercury, cadmium, lead, selenium and arsenic. The contaminants data was then evaluated by Health Canada for any risk to human health from eating those birds.

Most birds had very low levels of contaminants in them. Plant-eating birds such as ptarmigan, geese, swans, mallard and wigeon contained lower levels of PCBs, organochlorines, mercury and selenium than fish-eating birds such as mergansers and loons. Plant-eating birds such as ptarmigan, and bottom feeding birds such as eiders, had higher levels of cadmium than other species. Health Canada has advised that, because only very small amounts of contaminants were found in almost all ducks, geese and other game birds, they are healthy to eat.

If you want to reduce your exposure to chemical contaminants in the birds that you eat:

- Remove the skin and all visible fat before cooking.
- Get rid of as much fat as possible during cooking, especially for fish eating birds.
- If you still use lead shot to hunt, remove any visible shot pieces from the carcass before cooking or freezing.

Questions following the presentation included:

- *Are the health assessments based on the amount of birds that southerners consume or that northerners consume?* The advisory is usually calculated for the average consumer in the south and that the birds for example are the only source of contaminants. There is, however, a substantial safety factor built into these advisories, but it is recognized that food advisories in the north for northerners should reflect northern diets.

- *People at the Kuujjuaq meeting said that the consumption of eggs was important. Have you studied eggs?* We do not have a lot of data on eggs. We do know that glaucous gulls are high on the food chain and their eggs are deemed unsafe to eat in large numbers and Health Canada issued this advisory for Nunavik.

Metals in Caribou

Brett Elkin, Government of the Northwest Territories

A study of mink was initiated by the GNWT because mink was a species trapped and we knew that mink experience effects to PCBs at low levels and are high on the food chain (consuming fish and small land mammals). The objectives of the mink study was to determine the spatial trends in the NWT for organochlorines.

Seven communities participated along river. Over the four years of the study we had 90 trappers collect over 1000 carcasses. Overall we found PCB and DDT at levels that were quite low and decreased as you went up the system. The levels of PCBs in Fort Providence were a bit high, our upper range was 73 ng/g. However, they are very low compared to other mink populations studied in southern Canada and the United States.

We also looked at the levels of these contaminants in the mink's prey animals. Martens were also studied, as they share a lot in common with mink - except they only eat from land so we could determine the input from fish alone.

The patterns were very similar. We saw the same types of contaminants at the same levels in both species. We conclude that most OC input into the basin is from LRTAP rather than being river borne. Further, there is no gross evidence of any effect in these populations from these exposures. These animals were very healthy with no visible reproductive impairment.

Next we looked at caribou. Most importantly, caribou is a major food consumption species across the territory and provides an interesting food chain investigation. We primarily looked at barren ground caribou, so we do not have many samples from the Mackenzie Valley - we looked at tissues, kidneys, liver and fat. Contaminants come in via LRTAP and are deposited on land in lichen, which live many years. Moose eat fresh green growth, whereas, the caribou feed on the lichens. What we found was that most OCs were due to LRTAP and the east had higher levels which decreases as you move west. We did not find any geographic pattern for metals. Moose and woodland caribou data are poor and represents a knowledge gap.

Questions following the presentation included:

- *Why are levels higher in the caribou in the east than west?* Because more atmospheric input of OCs in east than west; this spatial variation is also seen in whales.

- *Have you looked at bone marrow and what is in it?* Yes, and levels are almost the same as fat as bone marrow is almost 90% fat.

- *Wouldn't radionuclides be a concern in the marrow?* Actually that will be targeted in a new study next year.

- *Do you have any information on the cesium studies after Chernobyl in caribou?*

DAY 2: TUESDAY, AUGUST 19, 1997

Session 5

Measures of Human and Ecosystem Health - Introduction
Jack McKinnon, GNWT

Fish Quality and Petroleum Hydrocarbons in the Lower Mackenzie River
Lyle Lockhart, Department of Fisheries and Oceans

Over the past decade or so northerners have reported abnormalities in fish from the lower Mackenzie River, and some people have asked whether those observations could be related to the expansion of oil production at Norman Wells. The reports have generally concerned the appearance of liver of burbot and the texture of whitefish (see Appendix III, Figure 9). Burbot livers have been regarded as too small and too dark in colour while whitefish flesh has been too watery. We have confirmed the burbot liver observations and we are trying to investigate the whitefish texture question. A third observation on the taste of the fish would also be expected if the fish were exposed to significant quantities of oil, but that observation has only been reported rarely. A survey by the Rawson Academy in 1990 showed that about one third of families in the northern Mackenzie area had reports of at least some abnormal

fish in their catches and that some families regarded half or more of their catch as abnormal, especially in fall and winter.

We have conducted laboratory experiments with young rainbow trout showing that Norman Wells crude oil is toxic to fish at nominal mixing rates of about 30 μL/L which produces an actual exposure of only about 1-2 percent of nominal concentrations. Fish treated with oil show a strong response in their liver biochemistry, namely their mixed-function oxygenase enzymes. However, when we look at fish from the lower Mackenzie River, we do not see that response; indeed the area that shows the response is in the lower Athabasca River in Alberta, downstream from the oil sands deposits. Fish from the laboratory exposures show increased water content which would be consistent with the reports from wild catches. We have noted that fish exposed to oil stop feeding and we are trying to work out the lowest oil dosages required to interfere with feeding. Responses to reduced feeding include the mobilization of fat reserves and as fat is used up, water content increases. Field data on whitefish does not indicate that northern catches have a higher water content than catches from further south. Within the Mackenzie River, catches from Ramparts and Little Chicago can be compared for their water content and these suggest that there is no difference. However, there does appear to be a difference between catches taken in summer (July) with those taken in September, with the September values being higher.

Taste testing of fish exposed to oil in the laboratory show that bad taste can be induced very quickly, in a few hours, and is surprisingly persistent. Fish were exposed for 72 hours and then transferred to clean water for several hundred hours. In one experiment we allowed fish to remain in clean water for 840 hours and the taste difference was still evident.

We have analyzed fish from a number of locations for one group of hydrocarbons, namely the polycyclic aromatic hydrocarbons. These compounds are readily metabolized and excreted by fish, but if intake is recent we should still expect to find small amounts that had not yet been metabolized at the time of capture. Residues in the fish were very low with the highest values being in the Slave River and Liard River and, surprisingly, Lac de Gras.

Human Dietary Studies

Laurie Chan, CINE

Environmental contaminants such as organochlorines and heavy metals have been reported to bioaccumulate in the Arctic and subarctic wildlife. The Indigenous peoples in northern and Arctic Canada rely on local wildlife as an important food source, and it is thus hypothesized that they may have high intakes of these contaminants. Herein, an assessment of dietary exposure to selected organochlorines and heavy metals for Indigenous Peoples of the western Northwest Territories is presented.

Dietary data were collected from 1012 adults with 24-hour recalls in 16 communities in the western NWT (Denedeh). A comprehensive survey of the literature, as well as in-house analysis, formed the basis of a large traditional food-contaminant database. By combining

the dietary and contaminant data, dietary exposure to 11 chemical contaminants was calculated.

Dietary exposure to chemical contaminants in Denedeh is generally low and there is little, if any, associated health risk. However, there are specific contaminants in certain communities for which exposure approaches the tolerable daily intake levels (see Appendix III, Table 1). These situations are detailed and monitoring needs are described.

Human Health Cord Study Results

Jody Walker, GNWT

A program to measure the levels of organochlorine and metal contaminants in cord blood from newborn babies (see Appendix III, Figure 10), and in aboriginal women from these regions who volunteered to participate, was completed in 1995. Preliminary results indicate that organochlorine concentrations in Dene/Métis were similar to those found in non-aboriginal peoples, and consistently lower than in Inuit from the Kitikmeot Region. Mercury levels appeared to be lower than those measured in the 1980s, however, more data are required to confirm if this is so. Cadmium concentrations were related to smoking, as cigarettes are a source of cadmium. There are many factors that contribute to our health. It is important to eat a balanced diet, including traditional foods, to receive nutrients important for overall health.

CACAR: Circumpolar Blood and Related Studies

Jay Van Oostdam, Health Canada

Several groups of people in the Arctic are highly exposed to environmental contaminants. Persistent contaminants derived from long range transport or local sources, accumulate in animals that are used as traditional foods. Thus variation in human exposure depends on a combination of (1) varying environmental concentrations of contaminants, (2) local physical and biological pathways which make contaminants available, and (3) the local dietary habits of the people.

In a first ever circumpolar study, The Arctic Monitoring and Assessment Program (AMAP) a working group of the Arctic Environmental Protection Strategy (AEPS) undertook a "Circumpolar Maternal Blood Monitoring Study (1995-1996). Six countries including Canada, Denmark, Finland, Norway, Russia, Sweden and Iceland particpated representing ten regions in the Arctic. The information from Finland is not available yet and discussions are still on-going with the United States. AMAP's Circumpolar Health Assessment addresses eight persistent organic pollutants, three heavy metals, several radionuclides, and ultraviolet radiation (complete results to date are reported in the AMAP Report, *Arctic Pollution Issues: A State of the Arctic Environment Report* (1997).

The AMAP Maternal Blood Monitoring Study reflects what the mother can potentially transfer to her fetus in the womb or to her child during breast feeding. The sample size was at

least 30 test subjects (n=30) for each country, whose informed consent was obtained to sample and complete a questionaire which included age, residence and date of sampling. The reported values are averages (goemetric means). There will thus be women with higher and lower contaminant levels. To date, the results are preliminary, and little of the supporting demographic data has been analyzed.

Some results included the maternal blood and plasma concentrations for a number of substances (see Appendix III, Figures 11 & 12). Overall the levels in Greenland women were much higher than any other country with Canada a distant second. Conclusions from these studies are hard to confirm at this point in time but this land mark study does begin to answer some of the questions about contaminants in Arctic residents. A few conclusions from the study could include:

- The AMAP evaluation is a preliminary study;
- Consistent - Traditional Foods; and
- These inputs are from atmospheric vs. local sources.

The next step will be to confirm these findings and to assess whether traditional foods are responsible for these high levels.

Northern Health Initiative Workshop

Jay Van Oostdam, Health Canada

What is The Northern Health Initiative?

What The Northern Health Initiative is not, is a Health Canada Plan. The Northern Health Initiate is:

- a cooperative plan;
- a multi-agency plan (GNWT, Yukon, Quebec and Labrador-NFLD Government), Health Canada (Environmental Health, Food , Medical Services);
- DIAND-NCP;
- University (CINE, University of Alberta);
- Aboriginal Groups.

The goal of the NHI is to, through research, provide useful advice to Northerners on the significance of exposure to contaminants through traditional foods.

The funding for implementing such a plan is still in question but would be the responsibility of multiple agencies. A workshop was organized by Health Canada June 26-27, 1997 to examine the question of how a NHI would be developed and implemented. The participants were from academia, government and from the communities and regions. The participants

examined exposure, toxicology, epidemiology studies, as well as, risks and benefits and guidelines and advice. A draft NHI was drafted and circulated for comments and input.

The exposure studies section examined and made a number of conclusions:

- Inuit Communities Concerns - additional studies are needed (initiated and additional);
- Métis/Dene Communities Concerns
- Have an established baseline which needs to be fine-tuned (data gaps: Yukon-Back Bay and specific villages);
- Inuvialuit region needs a complete baseline;
- Re-evaluate (re-test, new contaminants).

The toxicological studies section concluded that more research was needed on toxaphene, chlordane, modeling, and mixtures.

The epidemiological studies identified a number of outstanding research needs. For example:

- more neurobehavioral studies are needed;
- AMAP II needs to focus on trends;
- the NCP (CACAR) and AMAP reports provide baseline information;
- need to investigate cancer risk-factors for Inuit and Dene and case controlled studies.

The risk benefit studies examined:

- Inuit - nutrient contaminant modeling;
- traditional food usage - chronic disease - ecological comparison;
- sustainable development - food security; and
- collaborative risk assessment (GNWT).

The development of advice/guidelines study identified a number of existing needs including:

- update and develop blood guidelines (maternal and fetal);
- need to support ongoing international negotiations (UNECE- LRTAP POPs and metals Protocols);
- Health Canada needs to provide technical advice to GNWT and Yukon Government's);
- need to review the Health Risk Assessment Process.

To get as broad and comprehensive a review as possible, the draft NHI was circulated widely for comment.

Session 6

Other and New Ways of Investigating Contaminants - Introduction

Carole Mills, DIAND

Mills introduced the session very simply by saying in these times of fiscal restraint and declining resources we have to build, support and rely on new partnerships.

PAH Concentrations and Profiles in the Mackenzie River and Beaufort Sea

Mark B. Yunker, Department of Fisheries and Oceans

Why study PAHs?

- PAHs can induce biological effects, including toxicity.
- PAHs are good tracers. Distributions can tell us about transport pathways and areas of accumulation.
- PAHs associate with sediments in the same manner as PCBs and other OCs.

Study Objectives:

- To measure PAH concentrations - water column and sediment.
- To determine where the PAHs are coming from?
- To determine which PAHs are natural and which are from anthropogenic sources.
- To determine if PAHs are a significant problem in the Arctic.

The Mackenzie River delta and the Mackenzie shelf of the Beaufort Sea have higher PAH (polycyclic aromatic hydrocarbon) concentrations than other remote areas of the Arctic Ocean (Chukchi, Barents, Kara and Laptev Seas, Eurasian and Canadian Basins). PAH concentrations decrease only slightly from the Mackenzie delta to the edge of the Mackenzie shelf, while most PAH profiles remain unchanged.

Combustion PAHs are only present in low concentrations in the Mackenzie River and shelf and anthropogenic inputs are low (see Appendix III, Figure 13). Alkyl PAH distributions demonstrate that a significant component of the lower molecular weight PAH fraction is petrogenic (petroleum derived). The majority of the high molecular weight PAHs, together with the petrogenic PAHs, have a principal, natural source in the Mackenzie River. To maintain the observed PAH concentrations and distributions on the Mackenzie shelf the flux of natural PAHs from the river must be substantial and relatively constant. Only a few PAHs in Mackenzie sediments are above the concentration level believed to induce toxic effects on biota, but PAH concentrations would be well above the threshold level when fresh oil is present, and the high natural concentrations make this region of the Arctic sensitive to additional PAHs from human activities.

PAH conclusions from the Mackenzie Delta:

- The Mackenzie Delta has the highest PAH concentrations in the Arctic.
- The PAHs present in the Mackenzie Delta are from natural sources.
- The levels of PAHs in the environment have not changed for 100-1,000's of years and are present at threshold levels of biological effects.
- The PAHs present are well mixed, and therefore, we conclude the source is upstream.

Data Gaps:

- The PAH source.
- The bioavailability of these PAHs.
- How important are oil seeps?

Questions following the presentation included:

- *Are PAHs in the Mackenzie Basin natural or from Norman Wells?* Natural seeps which we are finding all up and down the river tend to be the PAHs with lower molecular weights. Higher molecular weight PAHs we really do not know the sources; they may be coming from oil or oil-like sources, but we are just not sure. This would be a good question to try and answer with the help of TEK.

- *What would be the distance from Norman Wells (NW) and down river that NW PAHs would have an influence?* That is hard to answer - if the PAHs are coming from NW they

would not travel that far as they would volatilize. We are finding PAHs in the Beaufort which would suggest there are other sources.

- *On a number of substances i.e. including metals etc. most of data from the US data set is based on mixtures, even though there are individual components. It is therefore, a little risky implying there might be an effect based on a mixture.* PAH in fish and sediment data show that the PAH concentrations are coming from a fair distance up/down the river.

- *Do you pick-up PAHs from forest fires*? From the samples in the river and Mackenzie area, PAHs from forest fires contribute a small amount.

Yukon Contaminants Study Program

Mark Palmer, DIAND (in absentia presented by Bob Van Dijken)

The Yukon Contaminants Program Committee Membership is quite diverse and includes - Council for Yukon First Nations, Environment Canada, Yukon College, YTG Renewable Resources, Dept. of Fisheries and Oceans, Yukon Conservation Society, YTG Health and Social Services, Health and Welfare Canada, and DIAND.

The goal of the Contaminants Committee is to try and answer questions northerners have about the environment and environmental issues. The key questions we had to try and answer were:

- Can we eat our country foods?
- Where are the contaminants coming from?
- Are the animals being affected?
- Can we stop the pollution?

The original committee focused its work on the concerns with sewage especially from Whitehorse. Studies were initiated on Lake Laberge and what we found was not a sewage problem but a contaminant problem. Communications and data were released to the media. This created a host of problems - at one point there was the proposal that the membership of the committee would have to take an oath of confidentiality. We decided, however, that our data would not be available to the public until a health advisory was ready. This made for its own set of concerns, as the public had the right to know but at the same time concerns of First Nations about the health of the fish of Lake Laberge resulted in First Nations stopping fish consumption due to lack of information. Burbot livers are a concern, and Lake Laberge was thought at first to be a smoking gun, as there is an old military site, so the first goal was to look for a point source. No point source for the contamination was found so the whole area was examined. The first study of Lake Laberge was a complete disaster, short of law suits, but we learned from this - the real art is to design a system that partners with the communities in order to provide the information they need to make informed decisions.

The Program is driven by the community from the bottom up to DIAND who is represented by Mark Palmer who acts as a match-maker to help with coordination of resources and funding as opposed to administrator. The community has played a large part in directing the research. CINE has been involved to look at the overall diet of First Nations. The Committee understands the importance of informing the community, so they hired a consultant to go to the communities and ask where sampling should take place. With health studies you cannot just go in and drop off a questionnaire, you have to inform the community of the issue and consult with them.

The Outstanding Concerns:

- The perception that fish are badly contaminated, especially in Lake Laberge, persists.
- Inconsistency of the Lake Laberge/Atlin 1991 Health Advisory with recent health advice. This makes it hard to communicate the appropriate message to the communities. Should the Lake Laberge advisory be re-visited?
- Outstanding samples sets with very low levels have not yet been evaluated - can we then say that fish are safe to eat in any quantity?

Questions following the presentation included:

- *We have been hearing in the Territories that if the communities are involved there is an added cost. What is your experience with the cost aspect in the Yukon by including communities?* You have to consider the cost-benefits if you spend the available money on answering the concerns of the communities - in the long term you will end up saving money.

Studies at Fort Resolution related to the Decommissioned Pine Point Mine

Marlene Evans, NWRI

The community at Fort Resolution is concerned that, although the Pine Point mine is decommissioned, its past operations have contaminated the water, sediments, and fish in the vicinity of Resolution Bay.

Community Concerns:

1. Elevated copper, cadmium, lead, and zinc in water and sediment near tailings pond.
2. Slightly higher zinc and copper concentrations in some fish collected offshore of Presqu'île Point.

Study Objectives:

1. Metal concentrations in Great Slave Lake water relative to the distance from the mine site.
2. Metal concentrations in sediments relative to the distance from the mine site.

3. Water quality relative to the distance from the mine site.
4. Metal concentrations in pike (jack), burbot (ling, maria), inconnu (connie), and walleye (pickerel) muscle, liver and kidney.

The community and researchers worked together to investigate these issues. Water and sediments were sampled at five sites in Great Slave Lake, one site in the Slave River, and one in the Little Buffalo River.

- Water was analyzed for water quality indicators and for metals.
- Sediments were analyzed for metals and sediment type. Pike (pickerel) were caught from the Little Buffalo River and burbot (ling, maria) from the Slave River.
- Muscle, liver, and kidney were analyzed for metals.
- In addition, liver and kidney were analyzed for a protein called metallothionein which can occur in greater concentrations when fish are exposed to high concentrations of some metals. Other fish (burbot, pike, walleye, and inconnu) caught in summer 1996 were also analyzed for metals (and organochlorines).
- Finally, a sediment core collected offshore of Pine Point in March 1994 was analyzed for metals. This allowed us to determine whether or not metal concentrations increased when the mine was operational and then declined when it was shut down.

Highlights of the study, which is still ongoing, are presented. Analysis to date provides no evidence that water, sediments, and fish in the vicinity of the mine site (that is in the Resolution Bay area) have been contaminated with metals by the mine. Although metals were present in all samples, they appear to be at natural, background values. We concluded that communities and researchers can work together to investigate a community concern and provide answers to important questions.

Temporal Trend Studies in Western N.W.T.

Gary A. Stern, Freshwater Institute

Criteria for Designing Temporal Trend Studies:

- Use traditional ecological knowledge (TEK) to help predict trends and to identify how, where and when to monitor (e.g. cysts on wildlife and fish or changes in migratory patterns).
- Choose research sites that are close to communities, and get community members involved in conducting the research.
- Study fish species and animals which are consumed by the communities thereby integrating both community and scientific needs.

Ultimately, the monitoring data would be used to help communities make informed decisions with regard to consumption of country foods and support Canada's case for better international controls.

The lack of temporal trend information of most contaminants has been identified as one of the most significant knowledge gaps going into Phase II of the Northern Contaminants Program (Muir *et al,* Ecosystem Uptake and Effects, Chapter 3 of the Canadian Arctic Contaminants Assessment Report, 1997). In western NWT, the only temporal trend data available for organochlorines is for mink liver collected over a period of three years (1992 - 1994) (Muir *et al.* 1997; Pool *et al.,* Environmental contaminants in wild mink in the Northwest Territories, Canada., Sci. Total Environ., 160/161, 1995, 473-486.) and for burbot from Fort Good Hope, collected in 1985, 1988 and again in 1993 (Muir *et al.* 1997) (See Appendix III, Table 2). The latter study was initiated to try and explain the reports made by local residents about the poor quality of some burbot livers (Lockhart *et al,* Studies to determine whether the condition of fish from the lower Mackenzie River is related to hydrocarbon exposure, Environmental Studies No. 61, 1989). Although some variation was observed in the EPCB and EDDT concentrations in the mink liver, no real trend was observed. This most likely can be attributed to the shortness of the time series.

Analysis of the lipid normalized data from the Fort Good Hope burbot liver showed declines in HCH, toxaphene and chlorolum. These results, however, suffer from problems associated with infrequent sampling, a limited time series and from variation due to biological factors such as age and sex.

The possibility that the observed decrease in the contaminant concentrations noted above is real and not the result of a short-term chance fluctuation can only be confirmed by making more measurements, preferably on an annual basis, over the next four or five years. Walleye from Lac Ste. Therese (1975, 1980, 1992) and burbot liver from Fort Good Hope (1985, 1993) were analyzed for mercury. In both cases, the mean lengths of the fish did not differ significantly among years and the mean mercury concentrations were also not significantly different. This result is in contrast to the sediment core results for Lac Ste. Therese which showed an increase in the loadings of mercury during the past century relative to historical loadings (Lockhart *et al.,* 1998. Fluxes of mercury to lake sediment in central and northern Canada inferred from dated sediment cores. Biogeochemistry, 40:163-173).

Concluding Remarks:

- There is a very definite lack of temporal trend information on OCs and metals in aquatic biota and terrestrial animals in the western NWT.
- Although analysis of individual samples is usually preferred, because of limited budgets, and assuming a sufficient number of samples (fish) can be collected, analysis of composite samples should be considered.
- Continued analysis of burbot liver and muscle from Fort Good Hope would result in time series information dating back to 1985.

Questions following the presentation included:

- *You showed three years of data from Lac Ste Therese for walleye - could you use that?*

Linking Fish Assessment with Contaminant and Fish Health Studies

George Low, Department of Fisheries and Oceans

Fisheries management programs can be more efficient and effective if several studies are run cooperatively. Stock assessment studies are conducted in various parts of the Northwest Territories from time to time. They are usually focused on fish stocks important to communities. Often, with little additional cost or effort samples for contaminant and fish health studies can be collected along with stock assessment data. For example, many of the samples for the mercury study in the Mackenzie Valley were collected under such a scheme. Aside from cost savings, there are other advantages. Size and age data are collected during stock assessments and the fisheries studied are usually those most important to the communities. Also, fisheries management studies are now run with the involvement of an aboriginal organization in the community; from choice of the water bodies to participation in collecting and recording data. Training and employment of field workers is of direct benefit to the community and the program benefits through the participation of aboriginal participants.

There is room for improving coordination between the various parties partnering in a study. For example, it is DFO policy that contaminant data be taken back to the community as soon as it is available. This may create some confusion since specific risk assessments for human health are not available for quite some time after the release of raw data. Even general health guidelines which are made available to communities require interpretation by an expert if risks are to be properly understood. There is a need for continued community involvement in including the explanation of how to treat preliminary results. A balanced and coordinated response to the community is necessary to avoid scaring people from eating healthy nutritious fish. There is an obvious need for quicker response on human health issues from Health Canada. Also, at the conclusion of contaminant studies researchers need to present their findings to the communities through the relevant resource management boards, councils or committees.

To control costs, communities should establish priority lists of water bodies for contaminant analysis based on use. Researchers should include all commonly consumed species, at least on a one time only basis, even though these species may not be known to greatly biomagnify contaminants. People may then have a safe alternate choice if harmful levels of contaminants are found in species closer to the top of the food web.

In conclusion, partnering is a logical way of maximizing program delivery and can lead to informed participation of all the various groups and agencies.

Questions following the presentation included:

- *It seems that scientists here have problems accessing or using TEK. We want the scientists to come to the communities and talk to the leaders and the band councils and ask us what we know. It is simple - we live in this area, we know things, maybe not scientific things, but we know where fish spawn, feed, etc. We also have computers and maps etc. so there is information we can share - you have shared with us, we would like to share with you.* We have done that but you never see the community input in the reports, it's always through the back door.

- *Scientists need to keep track of who they speak to and give credit to the people they talked to and who contributed.*

Traditional Ecological Knowledge and Science

Carole Mills, DIAND (in absentia for Stephanie Papik, Dene Nation)

There is an ever increasing role for the marriage of traditional ecological knowledge (TEK) and science, the Northern Contaminants Program recognizes the importance of incorporating TEK. There are many examples of international and national documents that have also recognized the importance of TEK i.e. the United Nations Convention on Biological Diversity, the Rio Declaration, and the Canada's Oceans Act.

It is very interesting when you examine the commonalties between TEK and Science:

- They are both sets of knowledge.
- They both takes years to collect the information.
- They both take years to learn what it is and how to apply the information.
- They both have a set of experts trained in the subject i.e. scientists and elders.
- They are both predictive, repeatable, verifiable, and peer-reviewed.
- The information obtained cannot be taken out of context.
- The knowledge is not free (intellectual property).
- TEK and Science can be used to detect changes (good and bad) in the environment, predict these changes and determine solutions.

Last year the Dene Nation organized an Elders Scientists Retreat. There were a number of recommendations that came out of this experience where eight scientists and sixteen elders came together on the land to talk, learn from each other and share their ideas.

The recommendations included:

- Should have another retreat as the first one was extremely successful and to continue to build bridges of trust and respect.
- Should include youth at the next one.
- Should have a women's workshop.
- Need more workshops held on the land.
- Need guidelines for research in the communities.
- Scientists would like more tangible results.

Some conclusions are that Dene look at animals as individuals rather than as populations and each animal deserves respect as individuals. This is a problem as Dene believe you do not touch an animal unless you are going to eat it. The scientists need to tell communities how to handle animals for sampling. Dene would also like more information on the various changes and effects on the bioavailability of different cooking techniques. All in all we must continue to build trust between scientists and the communities so we need to encourage continuity of people and programs.

Environmental Youth Corps - Introduction

Bill Carpenter, Métis Nation-NWT

To try and involve our youth more in environmental issues we put a proposal into Human Resource Canada for a youth training program. The objective of the program was to expose northern youths to the value and benefit in science and for these youths to bring this knowledge back to their communities. Six weeks of training was offered in Fort Smith in the hopes that this would encourage northern youth to pursue environmental careers and possibly offer them some entry level training. The ages of the youth range from 16-24. Each youth needed a community sponsor and organized themselves into their own disciplinary committee to handle problems. The program has a zero tolerance policy for alcohol, drugs and violence and offenders are tried before a sentencing circle. Recognition and thanks were given to Gary Bonet, and Ethel Blondin Andrew for their support.

Two youth representatives, John Paul Bourke and Jennifer Bailey, attended the workshop and gave presentations to the group.

Presentation by *John Paul Bourke*:

John Paul Bourke participated in the Environmental Youth Corps which is a Youth Internship Canada Project of the Métis Nation-NWT, being delivered by Northern Life Museum in Fort Smith. Twenty youth, aged 16 to 24 came to Fort Smith in July to spend six weeks acquiring skills to obtain entry level jobs in environmental industries.

As communities expand, urban areas come into contact with wild-lands. This urban/wild-land interface is a great risk to the community in the event of a wildfire. The community of Fort Smith is surrounded by mature stands of jack pine, white spruce and mixed forest. A lot of

fuel has collected, and houses have been built right up to, and under stands at high risk of wildfire. While the stakeholders, in cooperation with the Department of Resources Wildlife and Economic Development, have addressed some of these problems, at present the community is still far from safe.

In the course of our program we watched videos of how this problem was addressed in other centres and learned the ways homeowners and municipalities can minimize the risk. We sampled mature jack pine, white spruce and aspen stands to determine age, the fuel available and the susceptibility to fire. By recognizing fire scars on trees, determining the types of plants in the under-story and estimating the amount of ladder fuels we were able to gather information which is used to estimate the risk of wildfire and to determine what pre-suppression activities will be most effective. One half of the group learned the technique, then they would teach it to the other half. In this way we acquired the skills and learned how to pass them on at the same time.

There was a traditional knowledge component to the program. Pat Burke told us about the spiritual aspects of sweetgrass, and we had the opportunity to collect it in the field and learn how respect is central to taking anything from the earth. We also learned the steps required to tan caribou hide, and helped Vina Champagne tan a bison hide. We learned Web-Page design at the South Slave Research Institute and took CPR, Emergency First Aid and WHMIS training. We learned how to use a GPS Satellite Navigator, and entered the data we collected in the SPANS EXPLORER Geographical Information System. By using state of the art instrumentation and software, we learned the latest techniques in gathering and organizing data and making it available to the public and other researchers.

One of the great experiences of the course was meeting and working with youth from other communities. The program had terms of reference determined by the sponsors - zero tolerance of alcohol, drugs and violence. When a discipline problem arose the whole group met. Pat Burke explained community justice and the sentencing circle concept. Clarence Rhymer and Pat Burke led the first session. The people who were causing problems had to confront the group and explain their actions. The group then deliberated privately and determined the consequences. While the leaders supplied the structure, the decision of the group was final. As a result of the process two individuals were sent home.

The group selected one of the participants to lead the second discipline committee. The whole group took the process very seriously, was respectful of the offenders, and debated at great length to ensure that the results were fair.

Before I came to this workshop, Clarence Rhymer brought me up to speed on the techniques that the rest of the group is learning this week in their wilderness camp, sampling techniques and statistical methods. We have learned some methods of obtaining a representative sample whether it is from a gravel pile, a field of grain, a forest or a lake. We learned the difference between destructive and non-destructive testing, the whole population and a sample, and how to ensure that samples are not contaminated during collection or transportation to the laboratory. We learned how to maintain field journals and to perform reliable work so that

researchers will be confident that the samples we provide meet reproducible standards. The group is compiling a manual of the techniques learned that participants can take back to their communities to keep as a record of their achievement and to use to acquaint community members with the methods used by researchers.

I would like to thank Human Resources Development Canada and the Métis Nation, Northwest Territories for making this learning opportunity possible.

Presentation by *Jennifer Bailey*:

Jennifer Bailey was fortunate to be able to accompany Barbara Sander, a Ph.D. candidate from the Department of Renewable Resources, University of Alberta, on one of her field collection trips. We were sampling coarse woody material, that is, snags and downed logs found after fires in the boreal forest. coarse woody material provides diverse habitat for fungal, invertebrate, and vertebrate species. Since ecological management of the boreal forest requires that operations mimic natural structures as closely as possible, and since managed forest plantations have reduced levels of diversity, it is important to measure the impact of plantations on bio-diversity. This project measured the number of snags, downed logs, their biomass, and the vertical distribution of their biomass in different stand types and areas of the boreal forest.

From selected sites around Fort Smith we used a random number table to get a random sample of the forest. We recorded the number and height of snags and thirty snags were sampled to calculate biomass. The number of downed logs was recorded to determine the volume, and wood cylinders were taken from these downed logs. Ten samples of living trees were collected to account for un-decomposed conditions. When I returned to Fort Smith I explained the technique we used to the rest of the group.

We reviewed the work done under the Arctic Environmental Strategy Northern Contaminants Program and were pleased to find that most country food in most of the North is very safe to eat and also very nutritious. The effects of bioaccumulation and biomagnification were studied. It became very clear that continual monitoring must be maintained to ensure that any new sources of contamination are discovered and eliminated before they damage the very sensitive northern ecosystem.

In other work we learned how to take water samples and how to determine dissolved oxygen, pH, temperature and electrical conductivity in the field. We learned the sources of contamination which might be introduced during sampling and how these are avoided in order to obtain unbiased samples.

Sources of contamination of the samples, such as smoke from cigarettes, salt and bacteria from finger prints, gasoline and oil from outboard motors and bilge water, and foreign material floating on the surface or sediments disturbed by the sampling technician were identified and methods tested to show how they can be avoided. Much of the technique is common sense. However, when trace contaminants of organochlorines, for example, are being determined, the slightest source of contamination can render the results meaningless

and the study useless. Worse still, contaminated samples could lead to expensive and needless measures being undertaken. We learned that the results of any analysis depend, in the first instance, on reliable sample collection. Since communities, governments and industry rely on test results to make decisions about our economy and health, the sampling technician carries a great responsibility to supply accurate initial information. Procedures for ensuring that the integrity of samples is maintained from the field to the laboratory were discussed. We found that even a perfectly collected sample could become useless if it is mislabeled, its supporting documentation is lost, or if it is contaminated by a shipper, handler or passer-by.

The course stressed resourcefulness in field work. We all learned to use circular saws and basic carpentry equipment to make wood presses for botanical samples. We learned how to prepare copper fittings and solder them together, and we produced our own soil sampling equipment from locally available materials. While some of the equipment we used was highly sophisticated, we learned that very reliable and accurate equipment can often be produced in the field. This is especially important if a researcher finds that a vital piece of gear is missing or out of order far from the lab. Last week we took an intensive Interpretation Canada Workshop, in which we learned how to present information to the public in a clear and enjoyable forum, and how to deal with inquiries and complaints from tourists and researchers. The course ended with an interpretive walk of Fort Smith which was created by the participants. This Thursday the group will be taking a one-day resume writing workshop provided by Education Culture and Employment, so we can learn how to inform employers of our newly acquired skills.

I have decided to continue my education and will be traveling to Mount Allison University in Sackville, New Brunswick this Saturday. I am sure that the skills I have learned this summer will help me in my studies and future career. I would like to thank Human Resources Development Canada and the Métis Nation, Northwest Territories for making this learning opportunity possible.

Questions following the presentation included:

- *How long will the program be offered?* The program will be offered as long as funding is available.

- *Lyle Lockhart commented that he would like to see the program's participants take the samples and follow them right through the analysis process in the laboratory and he would be pleased to host some of these youth.*

WORKSHOP

With the oral presentations sessions having been concluded, the formal workshop then began. Participants were asked to consider the following questions.

Question 1: From a local community perspective, what are the major issues of concern regarding contaminants and contaminant research in the Upper Mackenzie River Basin? What are the priorities?

Question 2: From a science/research perspective, what are the major issues of concern regarding contaminants and contaminant research in the Upper Mackenzie River Basin? What are the priorities?

Question 3: How can we work together more effectively to address community concerns while also meeting science/research needs to resolve these contaminant problems?

Question 4: How can we integrate an Upper Mackenzie River Basin study with other studies in the Lower Basin, Great Slave Lake, Slave River, Liard, etc.?

Participants broke into four working groups, each consisting of researchers and community representatives. The first group was facilitated by Bill Strachan, NWRI, the second group was facilitated by Laurie Chan, CINE, the third group was facilitated by Carole Mills, DIAND, and the fourth group was facilitated by Jay Van Oostdam, Health Canada. Each group came up with several responses to question 1 which were entered onto a flip chart. The four groups then came together and presented their results. This was followed by question 2. Because of time considerations, questions 3 and 4 were not dealt with separately but many issues related to both questions were brought up during the question 1 and 2 deliberations.

Highlights of the response to questions 1 and 2 are as follows:

QUESTION 1. FROM A COMMUNITY PERSPECTIVE, WHAT ARE THE MAJOR ISSUES OF CONCERN REGARDING CONTAMINANTS AND CONTAMINANT RESEARCH IN THE UPPER MACKENZIE BASIN?

The priorities are as follows:

- Need an inventory of resources, a "Central Clearing House", which could catalogue projects, resource/contact people, land claim resources boards, and government organizations which deal with environmental issues (NCP, DIAND, GNWT, Yukon Conservation Society)
- Need for the development of a database of community members' observations, specifically families which use the same trap lines yearly, to help in targeting areas of concern in their surrounding environment. The knowledge and years of observations can help in focusing research direction

- Inter-link between TEK and scientific studies; TEK must be inter-linked in the design, delivery and reporting of studies
- Need to establish a Denedeh Contaminants Committee such as the Yukon Contaminants Committee
- Contaminant research needs to be driven "bottom-up"
- There needs to be less repetition of studies, among communities, and among government departments
- There needs to be a clearer understanding and agreement of the concerns and desires between communities and scientists and the ownership of data must be made clear to both parties (acknowledgment for traditional intellectual property of community members)
- Need new alternative funding sources (exploration of other funding agencies) to provide long term commitments to research projects
- Community members only control is their traditional lifestyle and diet - this control should not be compromised by fears from food advisories or results from studies, and in this area, communication is key
- Communication must go in both directions (consultations/workshops in communities) to eliminate conflicting messages - food advisories must bring together all contaminant information
- Communication of the results of studies must be presented in an understandable manner and must utilize traditional names for species and places (maps of traditional names, lakes/species/communities)
- Results are taking too long to be reported back to the communities
- Policy makers and scientists must keep in mind that there are other pressing issues in the communities which need immediate attention such as the effects of suicide as opposed to the long-term health effects of toxaphene
- There is a definite need for appropriate contacts, and where and who to ask questions ("Environmental/Contaminant Liaison Officer")
- Communities could undertake much of the extended monitoring sampling if training was more available
- Need specific studies at the community level (both dietary surveys and contaminants data) rather than at the regional level as there are many differences between communities within the same region
- Communities need to be consulted as to which areas (i.e. lakes) and which species are of interest (concern) to communities will be targeted for future study
- Need more research and baseline data on the effects of industrial development such as mining and oil production (Norman Wells Oil Field)

- It is important to sample fish in the communities above and below Norman Wells Oil Field for comparison studies and to confirm the effects (oil seepage and air emissions) of the Oil Field
- The new Diamond Mine must be carefully monitored
- Canol Road (Trail) and the buried contaminants need to be further investigated
- Need an environmental impact assessment for the proposed hydro towers at Great Bear River
- Overall health of Mackenzie Basin residents needs to be documented as severe reactions to insect bites and other allergic reactions has increased in the last few years as well as higher incidences of sicknesses in children (asthma, Multiple Sclerosis, Lou Gehrig's Disease)
- When sampling for mercury in lakes, lakes which are harvested must be targeted first. Are mercury problems in individual lakes or in regions? Community input would be beneficial to help interpret results
- Selection of locations, species and sampling times must be consistent and represent/provide information to each whole region
- Moose makes up 75% of diet of peoples along the Mackenzie River
- Key species of concern and areas of study; moose and woodland caribou (sample meat, fat, kidneys, liver, heart, marrow, tongue, brain), bison (Ft. Providence), waterfowl (Canada Geese, Snow Geese, Mallards), rabbit, muskrat, beaver, Dall Sheep (Tulita Mountains), whitefish, trout, grayling (Great Bear Lake and mouth of Great Bear River, Uranium docks, Bennet Field), whitefish, loche, inconnu (Mackenzie River)
- Ft. Good Hope should be a key location for loche liver sampling because of current time trends data
- Fish data are important to confirm which species are "clean"
- Fort Providence/Great Bear Lake need areas of study
- Need baseline data on contaminants in fish between Fort Providence and Fort Simpson
- Toxaphene and mercury data are missing. There are still a lot of mercury questions. We need to fill in the gaps as the communities are concerned about mercury. There is a data gap of temporal trend information and source factors
- Need more water quality data and monitoring, general water quality data for Great Bear Lake and for the Mackenzie River is needed
- Select species, locations and sampling times in a manner that is consistent so that information that is collected can be used in all areas along the Mackenzie River
- Food sampling programs must understand that there are other factors (parasites, disease) affecting the quality of food. TEK can contribute to this understanding and it is a good place where TEK and science can be inter-linked

- Need time trend series for Fort Good Hope
- Need to train northern youth to participate in studies and monitoring (involvement of community-environmental, coordinator-resource officer from sampling through communication of results). The communities want more informed involvement i.e., through a committed environmental coordinator (resource officer) all the way through the study process from sampling through to communicating the results
- Need to be able to recognize the health of food species i.e. parasites in fish, disease, contamination. Further, need education in the communities to recognize relevance to observed levels i.e. "safe" and "unsafe"
- When sampling, the general health of species must be noted and incorporated into studies such as the presence of parasites or other diseases and not just the contaminant effect or levels
- Ft. Providence to Ft. Simpson need baseline studies to help to develop a holistic view of contaminants in this region

QUESTION 2. FROM A SCIENCE/RESEARCH PERSPECTIVE, WHAT ARE THE MAJOR ISSUES OF CONCERN REGARDING CONTAMINANTS AND CONTAMINANT RESEARCH IN THE UPPER MACKENZIE BASIN?

- Scientists and researchers recognize the need to address community concerns and want their research agenda to reflect what the communities want to know. Consultation with the communities is important in sampling and monitoring, focus is needed on species and locations relevant to communities and communities need to be consulted from the beginning to end of studies
- Need to use an inter-link approach to TEK in science as opposed to an incorporation
- There is a need for research guidelines for both the communities and scientists
- Current research proposal review processes need to be reassessed
- Each community should have one or two specific priorities
- Need to understand the factors that control the variables between e.g., lakes and caribou
- More information on contaminant mixtures is required for a holistic view of contaminant effects in the Mackenzie Basin
- Predictive models need to be developed
- Community observations need to be linked to contaminants and their effects
- Need more information on the effects of contaminants and not just their toxicity levels e.g., are the feeding habits or reproduction cycles of certain animal species being affected
- An annual meeting for research results would aid communities and scientists in decimating information
- CINE's bird consumption data need to be updated

- Fish studies upstream and downstream from the Norman Wells Oil Field need to be conducted to show contaminant effects from oil seepage
- Need to develop a research inventory on what has already been done, where, and recommendations from scientists as to what needs to be continued ("Registry of Research and Project Leaders")
- Temporal and spatial trends are needed to answer "are things getting better or worse?"
- Monitor species which communities harvest in large amounts to keep monitoring studies cost-effective
- Implementation of DIAND, DOE and First Nations, GNWT regarding Environmental/ Ecosystem Maintenance Indicators (EMI)
- Need to know where the PAHs in the Mackenzie River are coming from
- The issue of what mercury is natural vs. man-made remains important and unanswered
- Is global warming creating effects seen such as; low water levels, damage to fish species (fish in Fish Lake showing burns). Some work on the effects of global warming has been done in northern Ontario, i.e. trout like cold water, if more water on the top layer is warmer, the cold layer shrinks and this would effect cold-water fish. Climate models show the most damaging effects of global warming will be at higher latitudes
- Communities need to support scientists to obtain funding to answer questions, to lobby industry in order to curb problem of contaminants
- Great Bear Lake has been identified as a location data gap
- Is the Canol Road (Trail) on the Carcajou River (which feeds into Mackenzie River) affecting the Upper Mackenzie Basin? Need to monitor/sample other rivers influenced by the Carcajou River
- Need to locate, identify and remove contaminants buried in the Canol Road (Trail)
- Each contaminant effect is looked at in isolation and food advisories are issued in a similar manner. We need to look at cumulative or synergistic effects (more than one chemical or factor, i.e. cadmium from smoking)
- New generation substances such as pesticides need further study
- Need to look at arsenic levels in fish. There are varying levels of arsenic in fish downstream of Fort Good Hope (arsenic levels high in some fish species and not in others); could this be due to anadromous nature of some species?
- There is a question of what is natural vs. man-made, natural elements such as arsenic can be harmful. Arsenic in fish in the inorganic form is not bioavailable, but arsenic in berries and water is bioavailable and toxic
- There are data on how much mercury is in certain fish species and the results of certain effects of mercury - needed are projects to link these two concerns together
- Questions remain regarding inputs of mercury from natural sources, since increases of Hg levels are being found in sediment cores. The Geological Survey of Canada (GSC) claims

that natural levels of fluxes of mercury are so high that we would not see man-made inputs. Sediments do reflect activity when we know history i.e. these support each other

- We cannot dispute the fact that mercury levels are increasing globally
- There are many factors which affect the amount of mercury present e.g., the biology of the organism (fish). Further, many factors affect how much is in the fish, such as the size of the lake, and the size of the watershed. This is an area where TEK can help to answer these questions
- Mercury in some lakes are over mercury guidelines - are guidelines based on southern or northern dietary consumption levels?
- Need to link stock and quality assessments
- Do we need to answer how much mercury is in the body (mercury levels in human hair samples) if we can link to effects we are seeing in people. We still need to know the trends of mercury levels in people (good to couple to dietary information)
- Need time/trend studies for more than just mercury i.e. persistent OCs need to be assessed in lakes (species) that communities use and in which they have an interest. Need a well designed study, using monitoring, once a year, if possible
- Study "Radionuclides Associated with Port of Radium" - there is some concern that the wrong fish species at the wrong time were analyzed - to avoid this problem in the future, communities can collect the appropriate fish samples and scientists can analyze the samples
- Are PAHs a human health concern? Currently there is a lack of data linking PAHs and human health effects for the Upper Mackenzie Basin
- A reliable method to distinguish between natural and anthropogenic PAHs is needed. PAHs from oil differ from PAHs produced by forest fires but it is hard to separate PAHs from oil seeps from pumped oil (Norman Wells)
- Sampling is needed upstream and downstream of Norman Wells - with a control of Mackenzie River upwind and downwind.
- Further human health effects research is needed to give better blood contaminant level guidelines, and this should also include health assessments to answer communities concerns

DAY 3: WEDNESDAY, AUGUST 20, 1997

Summary of Community Representatives Meeting

Following the group discussions, the community representatives at the workshop decided that it would be beneficial to the scientists, and the workshop as a whole, to meet as a separate group and discuss their community's concerns and priorities.

After a lengthy discussion, the community representatives reported their common concerns as well as each specific community's concerns and priorities. Their summaries are listed here:

Common Concerns of the Community Representatives

Concerns

- Some projects involving community input were not completed because funding ran out - there must be longer and stronger funding commitments made to long-term studies.
- There is a need for training so that community members may contribute to the projects underway and to future projects.
- Improved communication strategies.
- Establishment of a Denedeh Contaminants Committee. Presently information is not coordinated, it stops at the Band Office or land claim groups. In the future, a meeting should be arranged between communities representatives and the D.C.C. and it would then represent a larger area of communities.
- What is happening with the community concerns raised during the workshop?
- Contaminants in the Mackenzie River need to be monitored, monitoring stations in the Sahtu need to erected, and more studies are needed in the Mackenzie Delta.

Fort Resolution

- If you want to know our concerns and issues come to our communities.
- Direction on contaminant issues comes from the community.
- Fort Resolution wants to know who is approving research projects for that community.
- An inventory of who is doing what regarding research is needed.
- When research proposals reach the community the projects are ready to go and this does not give the community enough time to have a committed input to the project.
- Respect for animals is really crucial to communities and must be stressed to scientists.
- Respect is very important to help us to absorb the research results, a partnership must be developed based on mutal respect and understanding.
- The appropriate representatives must be selected for the science managers committee of the NCP so that the representative would have the support of the community or there will be no approval of research from the community.
- Fort Resolution does not want to be spoon-fed information from the scientists. The community wants to be part of the process.
- If the NCP is going to fund projects it should fund the whole project and not just two thirds of the project.
- NCP should only approve funds for research which will use community consultation from the beginning to the end of projects.

Fort Simpson

- The community representative for Fort Simpson did not have community concerns because there was not enough time for community consultation prior to the workshop.

Deline

- Uranium contamination and are the rivers a transport route?
- Great Bear Lake: we need fish sampling and baseline studies on water quality, water temperature, fish quality.
- Mercury contamination is a concern for the community.
- Arsenic in Arctic cisco, has there been a follow up to current data?

Tulita

- Concerns are similar with Deline, Norman Wells and Fort Good Hope.
- There is a lot of concern regarding the forest fire that happened two years ago. Chemicals were used to extinguish the fire and since the fires, there has been an increase in rashes and respiratory problems.
- There needs to be more involvement from the communities. A Sahtu Regional Board Member should have been invited to the workshop.

Wrigley

- Contaminants is not just a local or regional issue.
- There has been only one study conducted in Wrigley which was regarding watery fish, and Wrigley was sent a graph without an explanation of the meaning of the results.
- There are concerns regarding PCBs, mercury, and health and environmental effects of lead shot that is used in hunting animals.
- We have a concern with forest fires and the effects of forest fires on fish. A lot of lakes are full of soot, black soot is covering the bottom of certain lakes (Fish Lake and Black Water Lake near Wrigley). How are the fish able to access their feeding grounds if the feeding grounds are covered in black soot?
- Rabbits, chicken and moose are hunted seasonally e.g., rabbits and chicken are hunted in spring and fall.
- Chickens are being found with sores and tumors. Could this be from the calcium used on the roads?
- The effects of industry, what are they?
- Wrigley will no longer sponsor scientific research in the Wrigley area without the community's consent and involvement. Wrigley must be involved in future research projects.

Fort Good Hope

- Why is no one representing Colville?
- Need beaver/muskrat contaminant levels studies.
- Continue monitoring from previous studies (Loche Lake mercury levels, geese contamination levels) to determine if levels are up or down and to answer are things getting better or worse?
- Moose is an important food source and should be sampled. We also need to determine contaminant levels in caribou.
- We need to study the effects from the construction of the Esso Islands (specifically the blast rock-sediment loading in the Mackenzie River) at Norman Wells as our drinking water comes from the river.
- Traditional names should be used in research instead of given names.
- We need funds for travel to attend meetings as there is no highway and air transportation costs are expensive.
- Environmental coordinators from SSI should be representing the Sahtu region.
- Education and training for students/college graduates in environmental issues is needed
- There are many studies that have been conducted in our region that we have not yet heard the results from.

Norman Wells

- Norman Wells Oil Field; we need studies to determine the contaminant effects/levels from oil seepage. We also need fish studies upstream and downstream on the Mackenzie River to determine industry effects on fish species.
- Need to locate, identify and remove all buried contaminants and wastes from the Canol Road (Trail).
- The whole carcass of moose and woodland caribou must be sampled and not just parts of these animals (RWED/SRRB/RRC's).
- For the main community fishing lakes, we need studies on mercury levels as well as other contaminants.
- CINE's bird consumption data should be updated

Communities need to be consulted and informed, and information needs to come back to the communities.

Fort Providence

- One main concern is that previously, studies were just conducted and there was no explanation as to why the study was being conducted, and there was no consultation with community members.
- Fort Providence has a resource management community members' system in place to be used on a consultative basis.
- A resource management plan is currently being developed and this will provide an inventory of all available resources. It would be ideal to also have an inventory of what are the contaminants of concern and this would involve consultation between the scientists and the community.
- All previous research in the Fort Providence area involved the input of a community assistant.
- We need respect for traditional and land use rights as well as intellectual property rights. We are going to copyright our traditional knowledge and we are even selective with traditional knowledge distribution within band to band use.
- Fort Providence is also going to deal with the transboundary issue and the effects of contaminants coming from up river.
- There will also be a continuation with our bird study.
- Consistent research and monitoring on water quality is needed.
- Continued regulation on policies on production of contaminants is crucial.

Concluding Remarks

Bill Carpenter, Métis Nation-NWT, Marlene Evans, NWRI

A report of these proceedings will be available shortly following the workshop and participants will receive a copy of the recommendations and proceedings of the workshop. Bill and Marlene each thanked participants for their attendance and involvement.

Bill Carpenter concluded the workshop by addressing a couple of questions and comments:

- Where do we go from here?

From preliminary results from question one of the group discussions we know that the communities want more consultation and partnerships with the scientists. They want more consultation within the community. We know that the subject of communications is very important. Currently regional organizations are consulted and it is often difficult to inform each community about all the studies and the results. However, the NCP, in year two, identified communication as a major problem.

A communication tool that should be utilized is a central clearing house of information that the communities would know how and where to access, and the clearing house would have a

listing of all the past, present and proposed information on contaminant research and results. This would begin to help the communities become more informed and allow communities to see what work is underway, where, and how they could participate. The Métis Nation has started a database which includes all research from the past five years using the synopsis results produced annually from the NCP and from local water studies. This database is called the Northern Contaminants Education Program Database. A Métis Nation information flyer entitled "Contaminants in Northern Canada - Want to Know What's Going on?" is available for distribution. For more information about the database or to request searches you can contact:

Judy Farrow, Project Coordinator
Métis Nation Northern Contaminants Education Program
Box 1375 Yellowknife, NT X1A 2P1
phone: (867) 873-3505 fax: (867) 873-3395
e-mail: *métisnwt@internorth.com*

Other avenues for funding and capacity building (IRMP)

There is a new program and $1.5 million for non-land claim areas to access. The NWT interim research program has funds available through the IRMP, the contact person is Brenda Kuzak (867) 669-2995.

The proposed Mercury Workshop and who should attend:

At the close of the workshop Lyle Lockhart, Fisheries and Oceans, commented about the development of an up-coming Mercury Workshop. Lockhart stated that last winter scientists and community representatives met to talk about proposals for this fiscal year, and a request was made to organize five workshops, (1) Northern Health Initiatives Workshop, (2) Nunavik and Labrador Workshop; (3) Arctic Archipelago Workshop; (4) Upper Mackenzie Basin Workshop; and, (5) Mercury Workshop.

The final workshop focuses on mercury and is scheduled to be held in October, 1997. Individual communities have not been invited as the workshop is Arctic-wide and not specific to a region, however, representatives from the umbrella aboriginal organizations have been invited. "During the course of this workshop I have heard that the communities want more control in research from the beginning and not at the end. I would like go back to NCP and ask if it would be possible to have any communities that are interested to attend and I am wondering if the workshop should be post-poned to accommodate the communities?" stated Lockhart.

Comment: Or you can go ahead but invite the regional contaminant coordinators.

Question: What is the aim of the workshop?

Answer: The aim of the workshop is to give science managers a direction in which they should take in the next coming years with regards to mercury research.

Comment: Could you get one or two representatives from each region?

Answer: I think, if it is acceptable to everyone, we will go ahead and include the regional coordinators.

The role of the work of the NCP in successful international action:

Craig Boljkovac, ITC, gave a brief overview of the work underway at the United Nations Economic Commission for Europe (UNECE) on the POPs Protocol. One of the NCP objectives is to support international efforts to reduce and where possible eliminate the production and use of the contaminants of concern. With support from the NCP and Environment Canada, a POPs Coordinating Committee was formed which includes the five northern aboriginal groups (Yukon Council of First Nations, Dene Nation, Métis Nation-NWT, ITC and ICC).

A technical advisor was hired on a part-time basis to attend the negotiation sessions in Geneva and report back to the five northern aboriginal groups. The coordinating committee has been working hard to ensure the Canadian negotiation position is strong and to ensure that the international community recognizes the needs and concerns of northern aboriginal people.

The information that is generated through the NCP is critical to support these initiatives as is the presence of northern aboriginal interests in these forums. The Coordinating Committee has been so successful and internationally recognized that there is some discussion about forming a circumpolar Committee to ensure the circumpolar aboriginal perspective is incorporated into the global negotiations to begin in 1998 on POPs through the United Nations Environment Program.

The workshop closed with a prayer by Jonas Kakfwi.

APPENDIX I: GLOSSARY (from Han and Adare 1997)

Airborne Contaminants
Contaminants that are transported long distances by air currents are called airborne contaminants. Most of the organochlorines (OCs), heavy metals, and radionuclides can be airborne contaminants, although the distances they can travel differ.

Algae
A type of plant that lives in water but needs sunlight. Most algae are tiny in size. Some are made of many cells, such as kelp and seaweed. Algae make up most of the tiny floating plants in the lakes and oceans. Most algae are green in colour, but other kinds can be red, yellow or orange.

Bioaccumulation
The build-up or storage of substances (contaminants) in the bodies of animals over time as the animals continue to eat food or drink water containing the contaminant. Contaminants that bioaccumulate are very slow to change or do not change to a form that can be eliminated by the animal.

Biomagnification
When an animal eats a plant or another animal, it consumes all the contaminants stored in that food. Contaminants can biomagnify in animals that eat other animals. This is because the contaminant concentration increases with each step from prey to predator.

Cadmium
Cadmium is a type of heavy metal found naturally in soils and rocks. It is soft and has a silvery color. It is often found with another metal called zinc. Cadmium is mined and used in some industries to make items such as batteries, some pesticides, some types of paint, and certain equipment that generates nuclear power.

Cesium-137 (Cs-137)
Cesium-137 is a human-made radioactive element produced by the breaking up of uranium atoms in a nuclear power plant or in atomic weapons. It remains in the environment for a long time. This is because it takes 30 years for half of the cesium to change (decay) into another substance. Cesium-137 is an airborne contaminant.

Chlordane
An organochlorine pesticide made by humans to kill insects. It was used a lot in the 1960s and the 1970s to kill cockroaches in peoples' homes but is not used very much any more. Its use is banned in Canada.

Contaminant
A substance that is found in a place where it should not be. This does not necessarily mean that it is harmful, but depending on what it is and the amount that is present, it may be.

DDT
DDT stands for dichlorodiphenyltrichloroethane. DDT is an organochlorine (OC) pesticide developed in the 1940s to kill lice and biting-insects that carry diseases such as malaria, yellow fever, and typhus. DDT also was heavily used as a pesticide to kill insects that consumed farmers' crops in the 1950s and 1960s until it was found to be harmful to other forms of life. DDT use is banned in Canada.

Distant Early Warning (DEW) line
The DEW line is a series of 58 military radar stations located at the 70th parallel (latitude 70° north) in northern Canada built between 1955 and 1957. Many of the stations are now abandoned.

Elements
A natural substance that cannot be separated into smaller parts. For example, gold is an element; it contains nothing but gold. Water is not an element; it is made up of two elements, the gas-hydrogen and the gas-oxygen. Most elements are either gases or minerals. There are 103 elements, which combine in various ways to form everything in the world.

Food Chain
Plans and animals can be linked together in feeding relationships called food chains. At the bottom of food chains are green plants that convert sunlight into food energy for the rest of the chain. Animals that eat the plants are then eaten by another animal, and so on up the chain. The number of animals involved can vary. For example, in the north, the lichen→caribou→human food chain has fewer feeding links, and is much shorter than the algae→fish→seal→polar bear→human food chain. In nature, food chains overlap to form food webs.

Food Web
A series of connected food chains.

Grasshopper Effect
The "grasshopper effect" explains the series of 'hops' of certain contaminants that are transported to the Canadian north from warmer regions of the globe. Some contaminants, including organochlorines, evaporate at warmer temperatures and are transported in the winds and clouds until they reach cooler temperatures where they condense back to earth. Once back on land, they may evaporate again to the air when temperatures rise, be transported through the air, and re-condense when the temperatures become cooler. Since the major air currents in the northern part of the earth tend to move towards the Arctic, it means that these contaminants are eventually carried to the Canadian north through the 'hops' of evaporation-transportation-condensation.

Guidelines

A recommended limit for a substance or an agent in environmental media (air, water, sediment, soil, food, people) that is estimated to be safe and is intended to protect human health or the environment. It is not legally enforceable.

Health Risk Assessment
A study that calculates the amount of contaminant in a food and compares that to the amount of contaminant that we know is safe to eat over a lifetime.

Heavy Metals
These are naturally-occurring metals that are found in rocks and soils that do not break down into smaller elements. Heavy metals can also be released to the environment by human activities. They generally do not break down and therefore persist in the environment. Examples of heavy metals are: mercury, cadmium, and lead.

Insecticide
This is a chemical poison designed to kill insects. An example of an insecticide is hexachlorocyclohexane (HCH).

Iron (Fe)
A metal that is naturally found underground and mined. Iron is also released to the environment by the activities of people. Iron is silvery in color but rusts easily and turns orange when exposed to air and water. Iron is the most widely used of all the metals. Iron is magnetic, which means it responds to Earth's magnetic field and to where the north and south poles are located. Compasses contain iron in order to find specific directions (north, east, west, and south). People must include small amounts of iron in their diets to stay healthy.

Lead (Pb)
Lead is a soft, blue-gray, easily-worked and easily-melted heavy metal that is naturally present in rocks and soils. It is used to make some kinds of glass, shot for shotguns, and combined with other metals for use in a variety of metallic items. Lead may be released to the environment by human activities, including the former use of leaded-gasoline. In North America, lead was added to gasoline until the 1980s. Leaded gas is still used in other regios of the world. Lead can be toxic to living things. In animals and people, lead accumulates in the brain and bones.

Mercury (Hg)
Mercury is a heavy metal that is naturally-occurring in rocks and soils in combination with other chemicals. It is the only metal that is liquid at room temperature. It is silvery in color and flows easily so it is sometimes used in thermometers. There are many human-made sources of mercury that are released to the atmosphere. Also, mercury may be released when soils are flooded in the creation of reservoirs for making electricity. Mercury is toxic to most living things. It accumulates in the liver, kidneys, hair and skin of animals and people.

Methylmercury
Mercury, like other metals, can be found in different chemical forms in the environment. Methylmercury is the form of mercury that is most likely to cause effects. Methylmercury can also bioaccumulate and biomagnify in food webs. Methylmercury can accumulate in the brain.

Organochlorines (OCs)
These are chlorine-containing chemicals made by humans. Organochlorines dissolve in fats and oils, and therefore are stored in the fat and blubber of animals (they bioaccumulate) and are passed on through the food chain (they biomagnify). Examples of OCs include toxaphene, DDT, and chlordane. Organochlorines can be toxic or poisonous to living things.

Polycyclic aromatic hydrocarbons (PAHs)
These are organic compounds which are composed mostly of hydrogen and carbon. They are called aromatic because some of them have a smell. PAHs are a major component of oil and tars. PAHs also are produced when wood and other organic matter are burned.

PCBs
Polychlorinated biphenyls (PCBs) are a group of human-made, industrial organochlorine (OC) chemicals. There are many different kinds of PCBs. Because they do not conduct electricity, PCBs were used in electrical transformers as insulators in the 1930s. They do not break down easily in the environment and there is concern that PCBs may be harmful to living things. Some kinds of PCBs are thought to cause cancer and may contribute to other subtle effects in unborn children. The use of PCBs was banned in many countries, including Canada, in the 1970s.

Persistent Organic Pollutants (POPs)
POPs are organic chemicals that take a long time to break down, can be transported long distances in the atmosphere, and can biomagnify in food chains. Most POPs are human-made, and many are organochlorines.

Pesticides
Are chemical poisons designed to kill pests. Pests are plants or animals that are considered a nuisance in some situations and/or are harmful. There are two main types of pesticides. Insecticides are used to kill insects such as mosquitoes and grasshoppers. Herbicides are used to kill weeds, mold and fungus. Chlordane, toxaphene, and DDT are examples of pesticides.

Polonium (Po)
Polonium is the most commonly found natural radionuclide and occurs in the rocks and soils of the north.

Radiation
Radiation is the energy that is emitted from substances that are radioactive. People are naturally exposed to radiation from the sun and from natural sources in rocks and soils. They may also be exposed to radiation from x-rays. Nuclear weapons and power plants are other possible sources of radiation. Exposure to high levels of radiation can cause cancer or cellular changes that may affect future generations.

Radionuclides
These are small particles that emit radiation. Radionuclides are naturally present in rocks and soils, but can also be introduced to the environment by the activities of people, such as the testing of nuclear weapons, dumping of nuclear wastes, and nuclear accidents (such as the accident at Chernobyl). Radionuclides tend to accumulate in the bones and muscles of animals and people. Natural radionuclides in the Canadian north include lead-210 and polonium-210. Radionuclides made by humans include strontium-90, iodine-129, and cesium-137.

Sediments
The material (fine particles of sand, silt, clay and plant/animal remains) that is found at the bottom of lakes, rivers, streams, ponds, seas, and oceans.

Toxaphene
An organochlorine chemical that was used as a pesticide from the 1950s to 1970s. Toxaphene was found to be very poisonous to living things, especially fish. Toxaphene has never been licensed for use in Canada, and in 1982, its use was banned in the United States.

APPENDIX II: PARTICIPANTS LIST

Jennifer Bailey
Youth Environmental Corps
Northern Life Museum
Fort Smith, NT.
X0E 0P0
F: (867) 872-5808

Gina Bayha
Box 144
Deline, NT.
X0E 0G0
T: (867) 589-4722
F: (867) 589-3022

Craig Boljkovac
Inuit Tapirisat of Canada
170 Laurier Ave. West, Suite 510
Ottawa, ON.
K1P 5V5
T: (613) 238-8181
F: (613) 234-1991
itc@magi.com

Cheryl Bonnetrouge
Box 205
Fort Simpson, NT.
X0E 0N0
T: (867) 695-3215
F: (867) 695-3126

John Paul Bourke
Fort Smith Métis Nation
Box 492
Fort Smith, NT.
X0E 0P0
T: (867) 872-5409

Birgit Braune
Environment Canada
100 Gamelin Blvd.
Hull, PQ.
K1A 0H3
T: (819) 953-5959
F: (819) 953-6612
birgit.ec.braune@gc.ca

William Carpenter
Métis Nation-NWT
Box 1375
Yellowknife, NT. X1A 2P1
T: (867) 873-3505
F: (867) 873-3395
métisnwt@internorth.com

Laurie Chan
CINE, McGill University
21, 111 Lakeshore Rd.
Ste-Anne-de-Bellevue, PQ.
H9X 3V9
T: (514) 398-7765
F: (514) 398-1020
chan@agradm.lan.mcgill.ca

Brett Elkin
GNWT Resources, Wildlife & Economic Development
600, 5102-50th Ave.
Yellowknife, NT.
X1A 1Y3
T: (867) 873-7761
F: (867) 873-0293
brett_elkin@gov.nt.ca

Marlene S. Evans
National Hydrology Research Institute
11 Innovation Blvd.
Saskatoon, SK S7N 3H5
T: (306) 976-5310
F: (306) 975-5143
marlene.evans@ec.gc.ca

Doug Halliwell
Environment Canada
3rd Floor, Diamond Plaza
5204 Franklin Ave.
Box 2970
Yellowknife, NT.
X1A 2R2
doug.halliwell@ec.gc.ca

Siu-Ling Han
DIAND
10 Wellington St., Rm. 657
Hull, PQ.
K1A 0H4
T: (819) 997-3109
F: (819) 953-9066
hansl@inac.gc.ca

Stephen Harbicht
Environment Canada EPB
Box 2970
Yellowknife, NT.
X1A 2R2
T: (867) 669-4733
F: (867) 873-8185
stephen_harbicht.ec.gc.ca

Paul Harrington
South Slave Métis Tribal Council
Box 129
Fort Smith, NT.
X0E 0R0
T: (867) 872-2404
F: (867) 872-4044

Jill Jensen
DIAND
10 Wellington St., 6th Floor
Hull, PQ.
K1A 0H4
T: (819) 997-0663
F: (819) 953-9066
jensenj@inac.gc.ca

Jonas Kakfwi
Box 74
Fort Good Hope, NT.
X0E 0H0
T: (867) 598-2626

Mary Le Blue
Box 187
Norman Wellls, NT.
X0E 0V0
T: (867) 587-2455

Bertha Lennie
General Delivery
Tulita, NT.
X0E 0K0
T: (867) 588-4019
F: (867) 588-4928

Chief Tim Lennie
Pehdzeh ki First Nation
Wrigley, NT.
X0E 1EO
T: (867) 581-3321
F: (867) 581-3229

George Low
Fisheries and Oceans
42043 Mackenzie Hwy.
Hay River, NT.
X0E 0R9
T: (867) 874-5575
F: (867) 874-6922
lowg.dfo_mpo.gc.ca

Derek Muir
National Water Research Institute
Environment Canada
867 Lakeshore Rd.
Burlington, ON.
L7R 4A6
T: (905) 319-6921
F: (905) 336-6430
derek.muir@cciw.ca

Stephanie Papik
Dene Nation
Box 2338
Yellowknife, NT., X1A 2P7
T: (867) 873-4081
F: (867) 920-2254
dene_nation@ssimicro.com

Juanetta Saunderson
DIAND, Water Resources
3rd Flr., Bellanca Bldg.
Box 1500
Yellowknife, NT.
X1A 2R3
T: (867) 669-2663
F: (867) 669-2716

Lyle Lockhart
Fisheries and Oceans
501 University Cresc.
Winnipeg, MB.
R3T 2N6
T: (204) 983-7113
F: (204) 984-2403
lockhartl@dfo_mpo.gc.ca

Carole Mills
DIAND
3rd Flr.-Bellanca Building
Box 1500
Yellowknife, NT.
X1A 2R3
T: (867) 669-2655
F: (867) 669-2833
millsc@inac.gc.ca

Greg Nyuli
Fort Providence Resource Management Board
General Delivery
Fort Providence, NT.
X0E 0L0
T: (867) 699-3314
F: (867) 699-3210

Grant Pryznyk
Great Slave Lake Advisory Committee
c/o Box 2310
Yellowknife, NT.
X1A 2P7
T: (867) 920-6635
F: (867) 873-8871

Mardy Semmler
RWED-GNWT
Box 73
Fort Good Hope, NT.
X0E 0H0
T: (867) 598-2271
F: (867) 598-2708

Patrick Simon
Akaitcho Territory Tribal Council
Fort Resolution, NT.
X0E 0M0
T: (867) 394-3313
F: (867) 394-3413

Gary Stern
Fisheries and Oceans
Freshwater Institute
501 University Cres.
Winnipeg, MB.
R3T 2N6
T: (204) 984-6761
F: (204) 984-2403
sterng@dfo_mpo.gc.ca

Bill Strachan
Environment Canada
National Water Research Institute
867 Lakeshore Rd.
Burlington, ON.
L7R 4A6
T: (905) 336-4775
F: (905) 336-6430
william.strachan@cciw.ca

Bob Van Dijken
Yukon Contaminants Committee
c/o Yukon Conservation Society
Box 4163
Whitehorse, YT.
Y1A 3T3
T: (867) 668-5678
F: (867) 668-6637
ycs.polarcom.com

Jay Van Oostdam
Health Canada
Environmental Health Directorate
Rm 1139, Main Statistics Building
Tunney's Pasture PL0301A1
Ottawa, ON.
K1A 0L2
T: (613) 941-3570
F: (613) 954-7612
jay_van_oostdam@inet.hwc.ca

Jody Walker
GNWT Health & Social Services
Box 1320
Yellowknife, NT.
X1A 2L9
T: (867) 920-8868
F: (867) 873-7706
jody_walker@gov.nt.ca

Rob Walker
DIAND
Box 1500
Yellowknife, NT.
X1A 2R3
T: (867) 669-2593
F: (867) 669-2701
walker@inac.gc.ca

Mark Yunker
7137 Wallace Dr.
Brentwood Bay, BC.
V8M 1G9
T: (250) 652-9968
yunker@pinc.com

Recorders

Madeleine d'Argencout
Mad Consulting
Box 2177,
Iqaluit, NT.
X0A 0H0
T/F.: (819) 979-2813
mad@nunanet.com

Stephanie Meakin
Meakin Consultants Inc.
269 Gower Dr. R.R. #2
Kemptville, ON.
K0G 1J0
T: (613) 258-9471
F: (613) 258-7621
smeakin@netcom.ca

APPENDIX III

SELECTED PRESENTATION OVERHEADS

Table 1. Summary of level of intake and monitoring needs for each contaminant.

Contaminant	Level of intake	Monitoring needs
As	Higher in Déline (10% > TD) Low elsewhere	Intake and contaminant levels of cisco
Cd	High in those eating moose and caribou liver	Intake and contaminant level of moose and caribou liver
Hg	5.7% > PTWI. Highest in Ft. McPherson (26% > PTWI)	Consider selective hair-Hg monitoring, and monitoring mercury levels in beluga (mattack), caribou (liver), loche (flesh, head, liver), trout (flesh), whitefish (flesh, head).
Pb	Low	Intake and contaminant level of moose blood
CBZ	Very low	none
CHL	Low	Intake and contaminant level of beluga in Gwich'in
DDT	Very low	none
DIE	Very low	none
HCH	Very low	none
PCB	Low	none
TOX	Low	Intake and contaminant level of: beluga, arctic char, and loche liver in Gwich'in: trout and cisco in Déline

Table 2. Sampling sites and years for fish and mink in western NWT (OCs*)

	Location	Tissue	Sampling years
Burbot	Fort Good Hope	L	1985, 1988, 1993
	Trout Lake	L	1990
	Alexie Lake	L	1993
	Great Slave Lake (E&W arms)	L	1993, 1994
	Great Slave Lake (Fort Resolution)	L	1994
Lake Trout	Lake Belot	M	1992
	Coville Lake	M	1992
	Gordon Lake	M	1990
	Great Slave Lake (E&W arms)	M	1993, 1994
	Travaillant Lake	M	1993
	Trout Lake	M	1990
Lake Whitefish	Coville Lake	M	1992
	Gordon Lake	M	1990
	Great Slave Lake (E&W sites)	M	1993, 1994
Broad Whitefish	Campbell Lake	M	1992
	Kugaluk River	M	1992
	Lake 100	M	1992
	Travaillant Lake	M	1992
	Horseshoe Bend	M	1992
Mink	Inuvik	L	1992, 1993, 1994
	Fort Good Hope	L	1992
	Fort Providence	L	1994
	Fort Resolution	L	1994

M = Muscle, L = Liver

* 3HCH, 3CHLOR, 3DDT, 3CHB, 3PCB

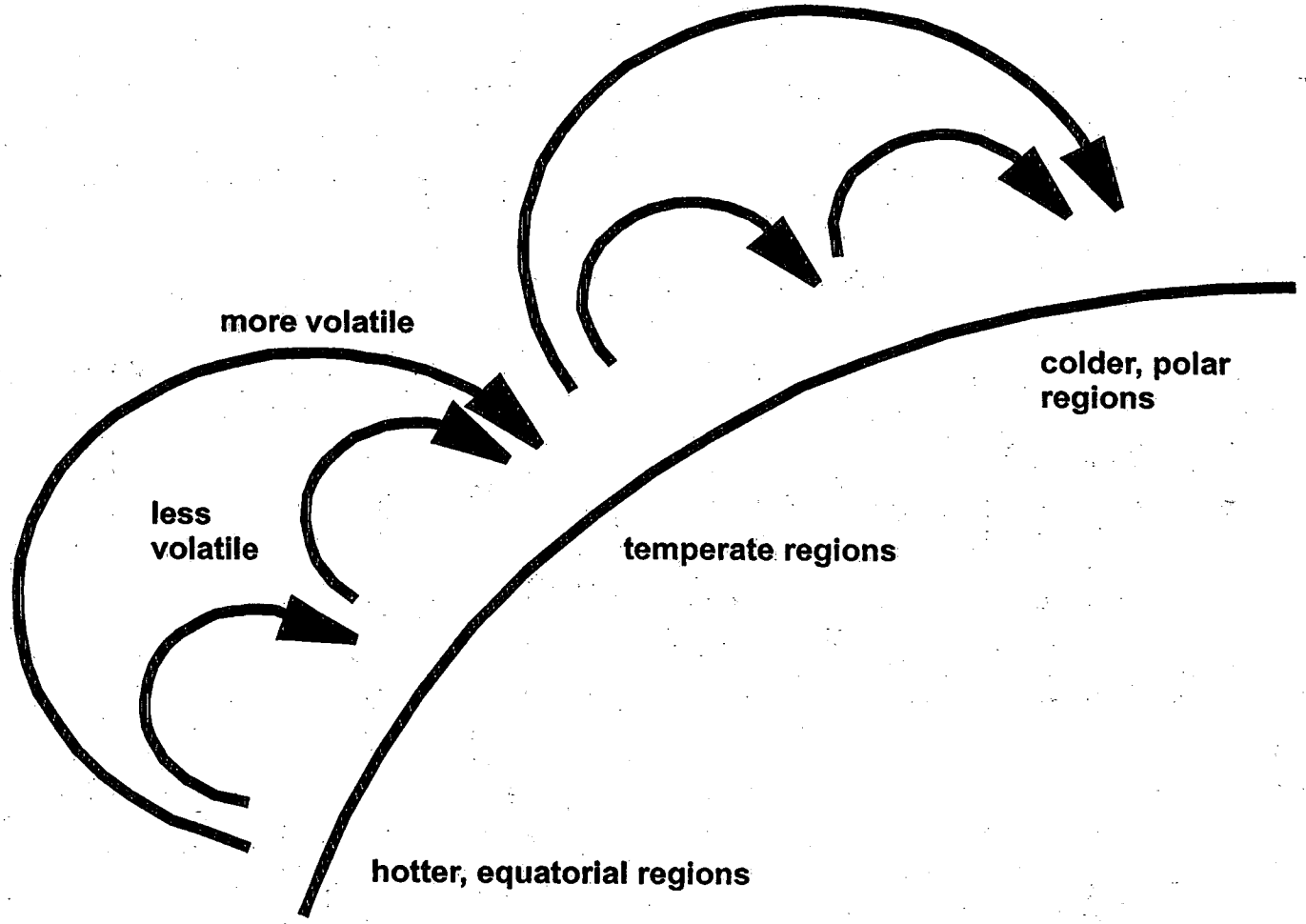


Figure 1. The grasshopper effect or global distillation

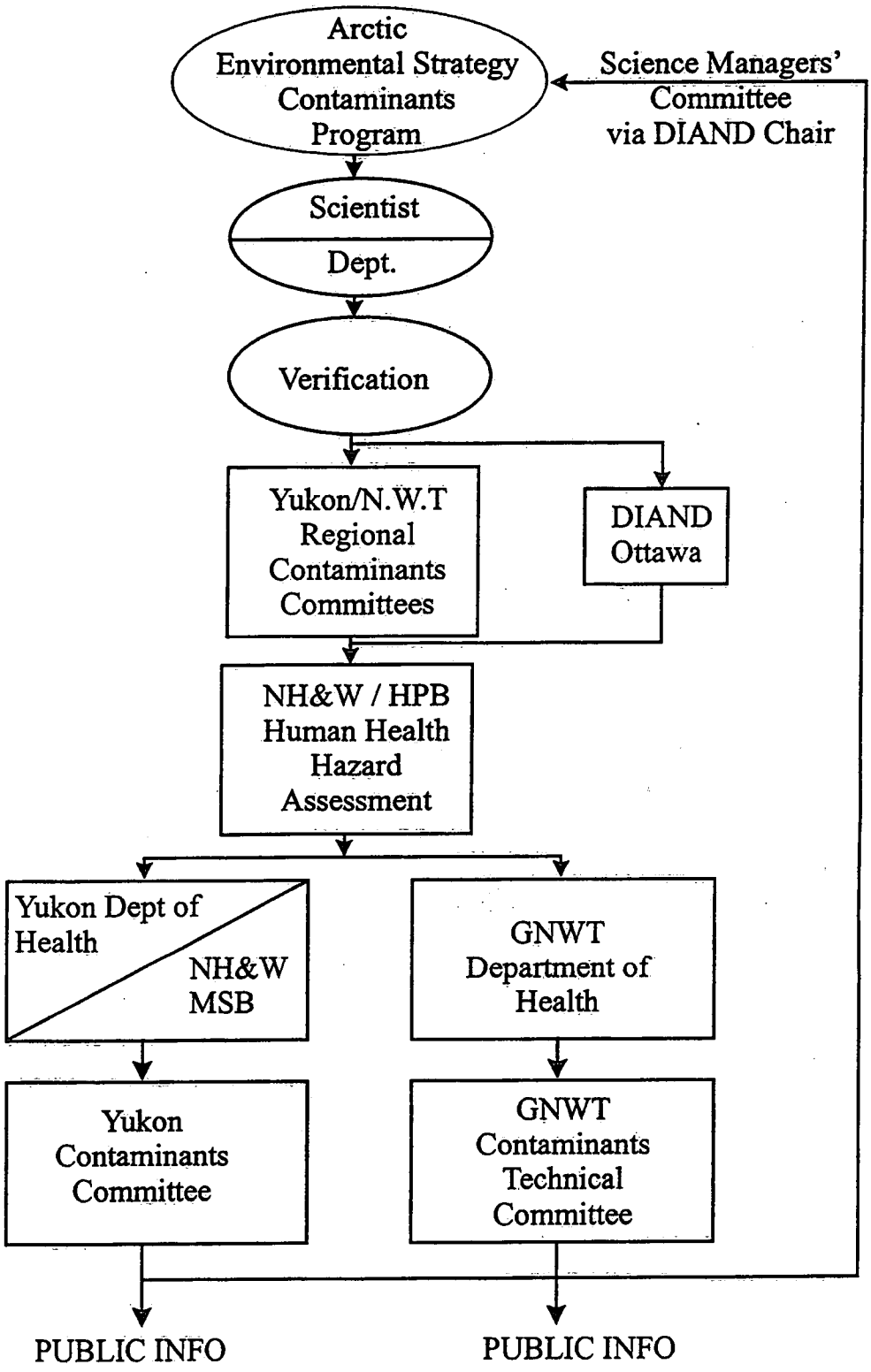


Figure 2. Protocol for contaminants health and harvest information release in NWT and Yukon

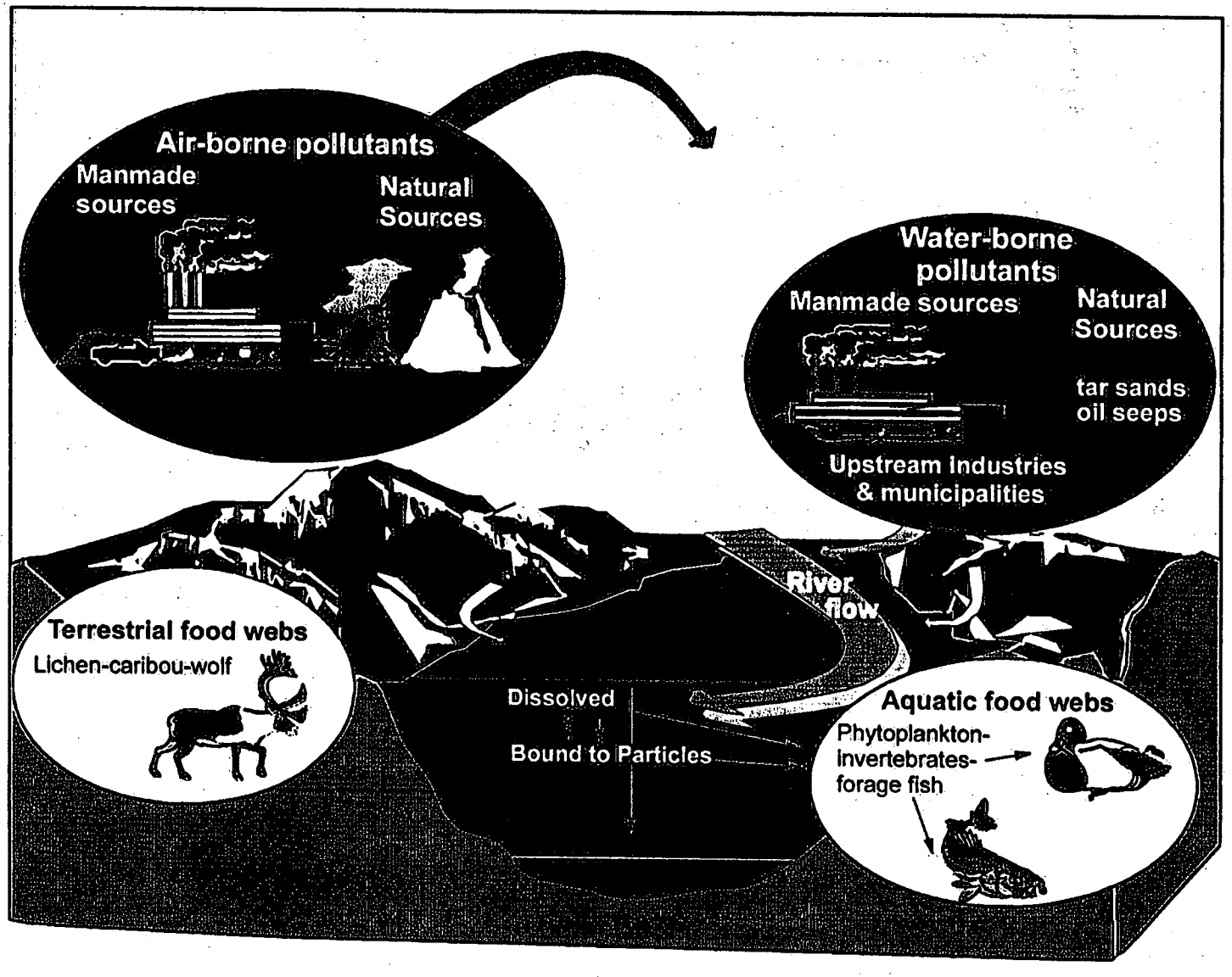


Figure 3. Contaminant process from atmosphere to terrestrial and aquatic ecosystems

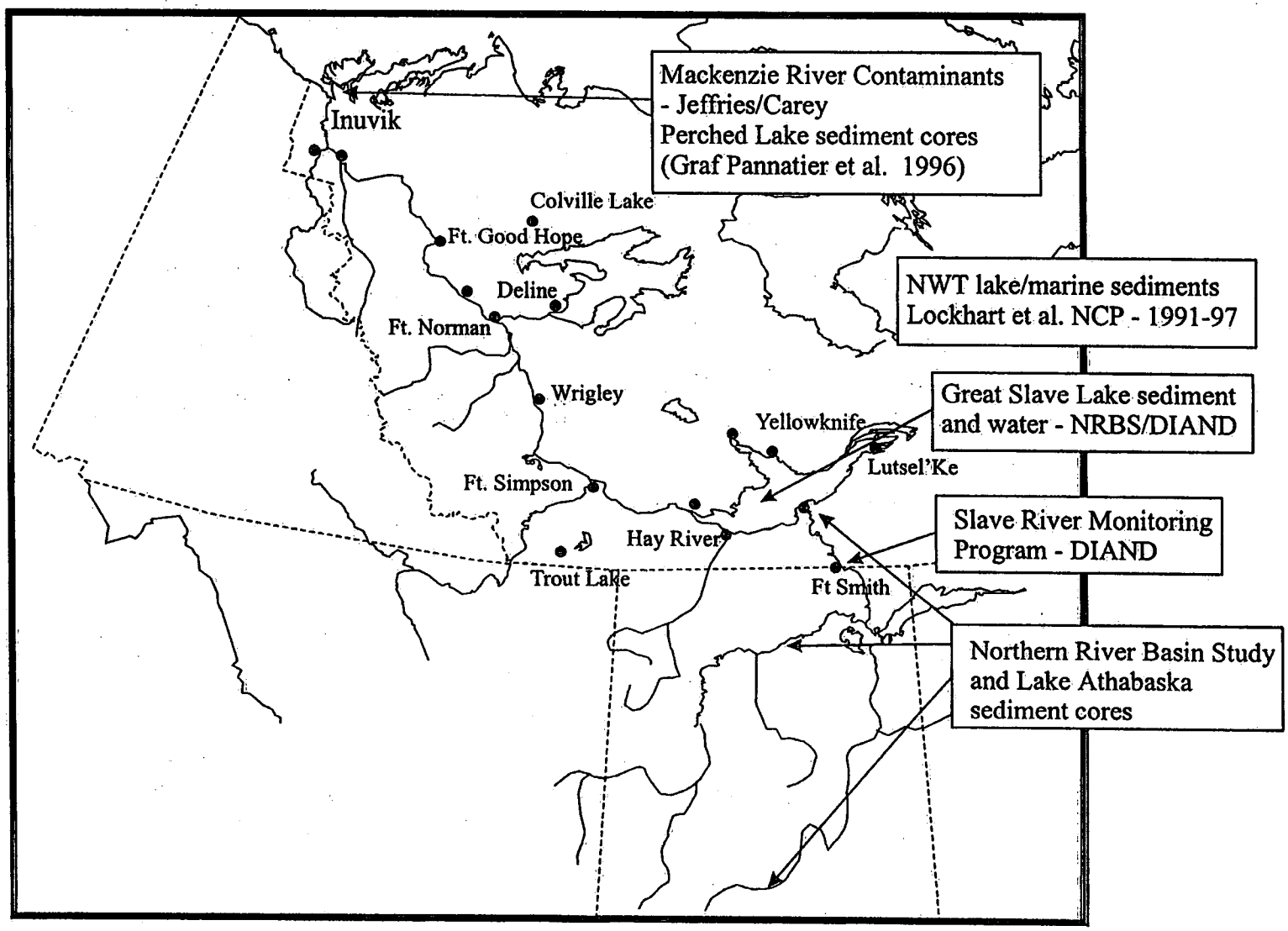


Figure 4. Location of water and sediment analysed for PCBs and hydrocarbons

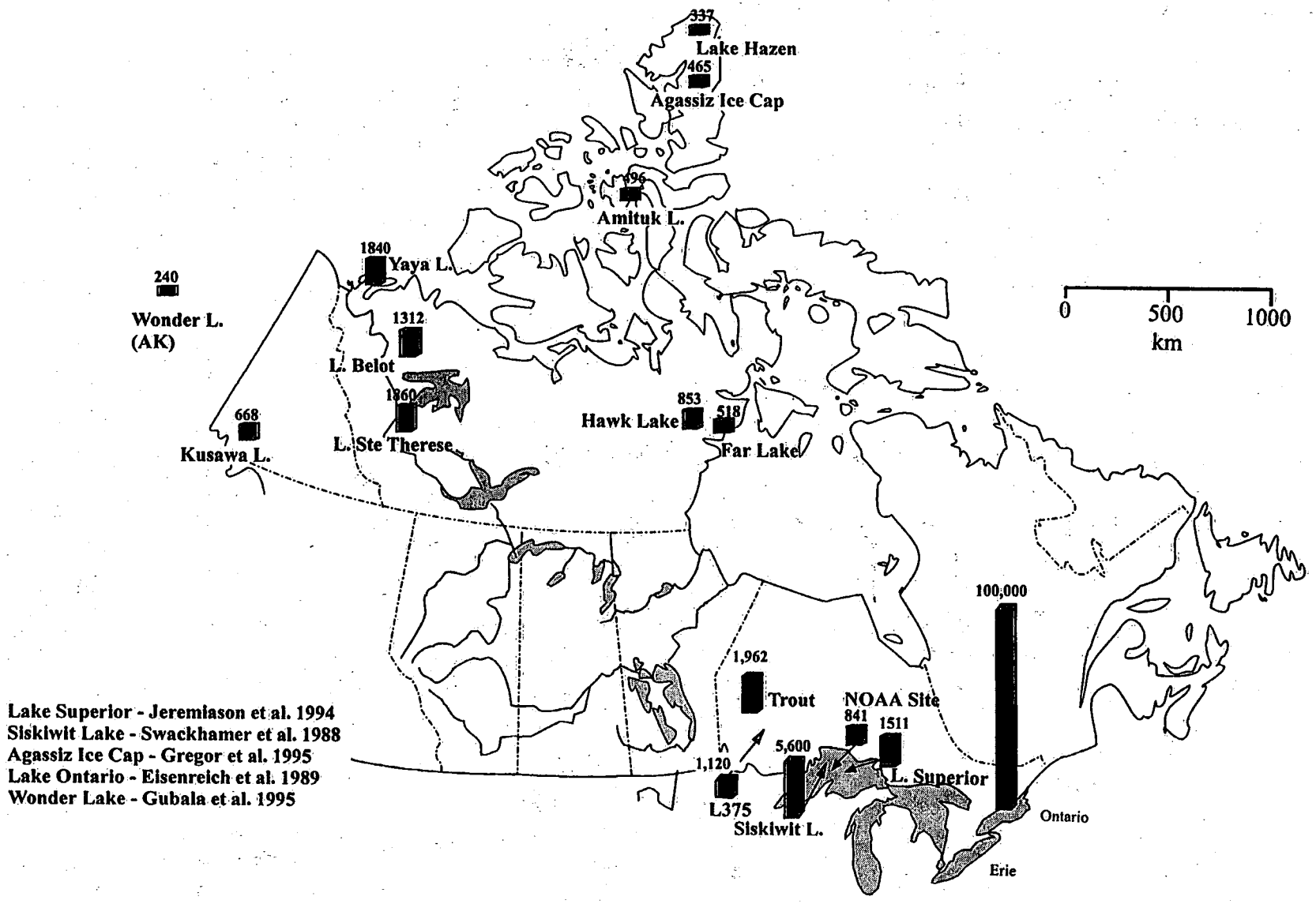


Figure 5. Recent fluxes (ng/m^2/y) of PCBs to lake sediments (1980-1990)

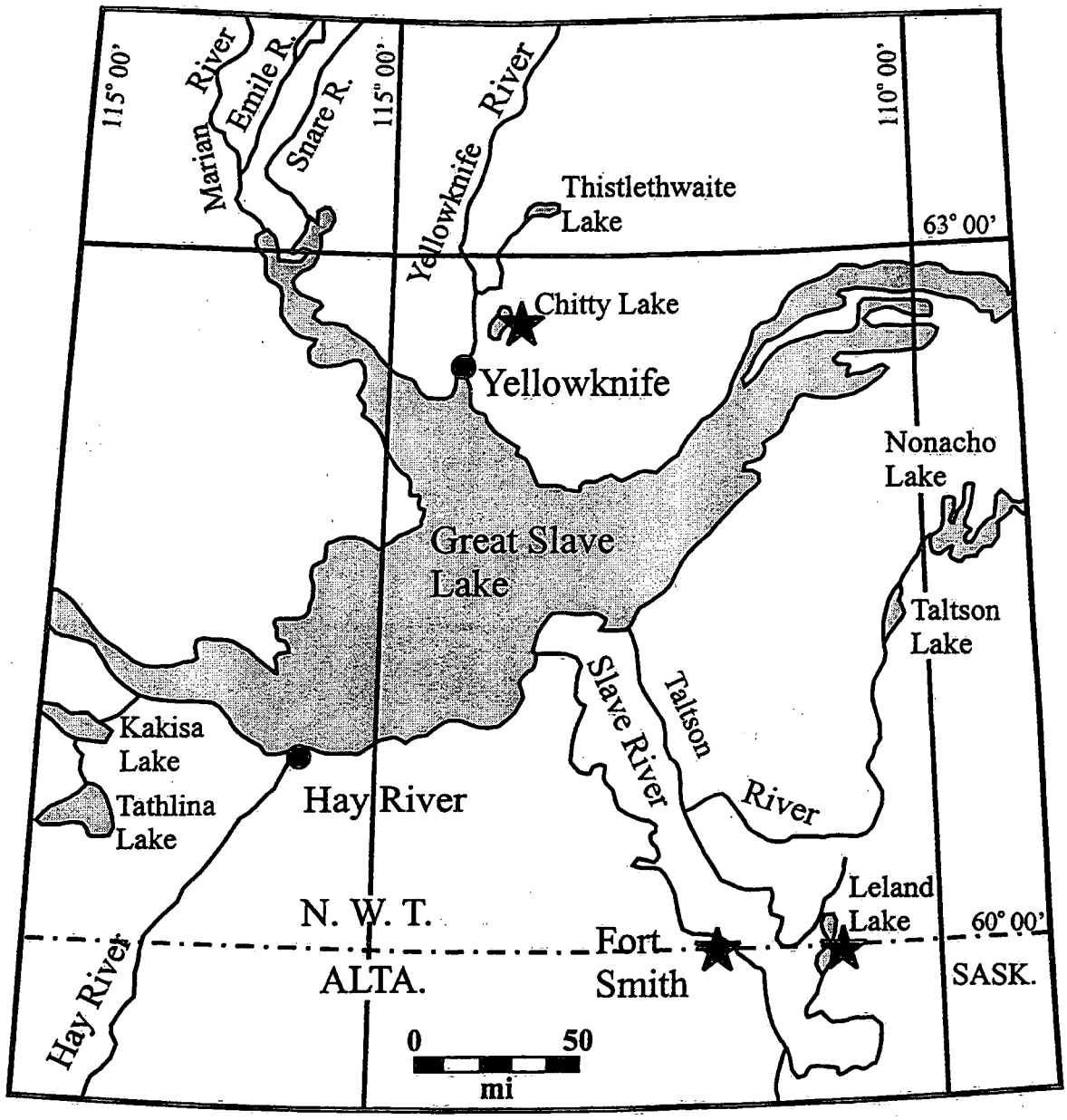


Figure 6. Sampling sites (★) in the Great Slave Region

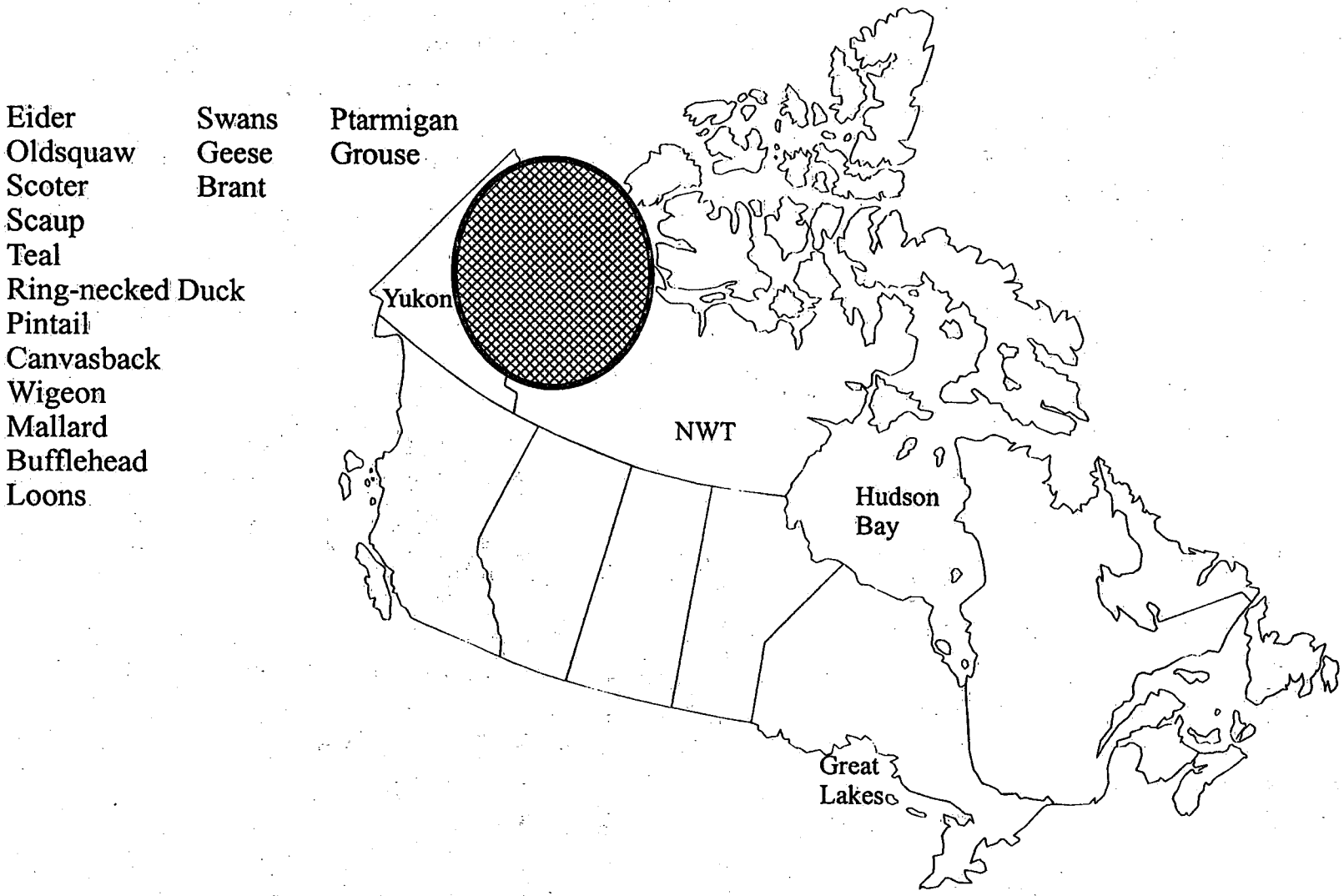


Figure 7. Birds collected in western arctic (1988-1994)

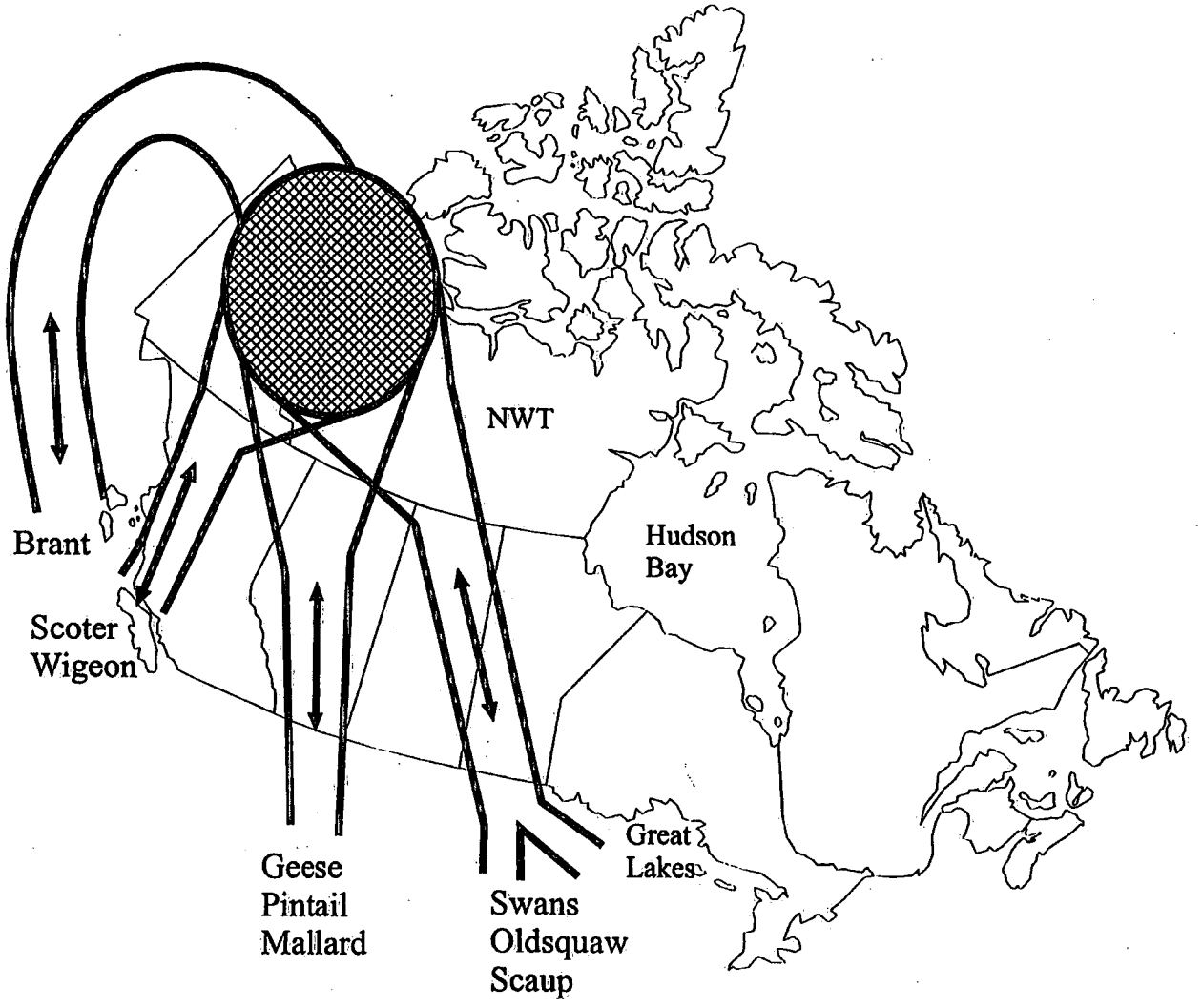


Figure 8. Bird migration pathways

Figure 9. Photo images of normal and abnormal burbot livers collected at Fort Good Hope in April 1985. Normal liver, graded acceptable for human consumption (top) and one showing the small size and dark colour graded unacceptable for consumption (bottom) (Lockhart et al. 1989).

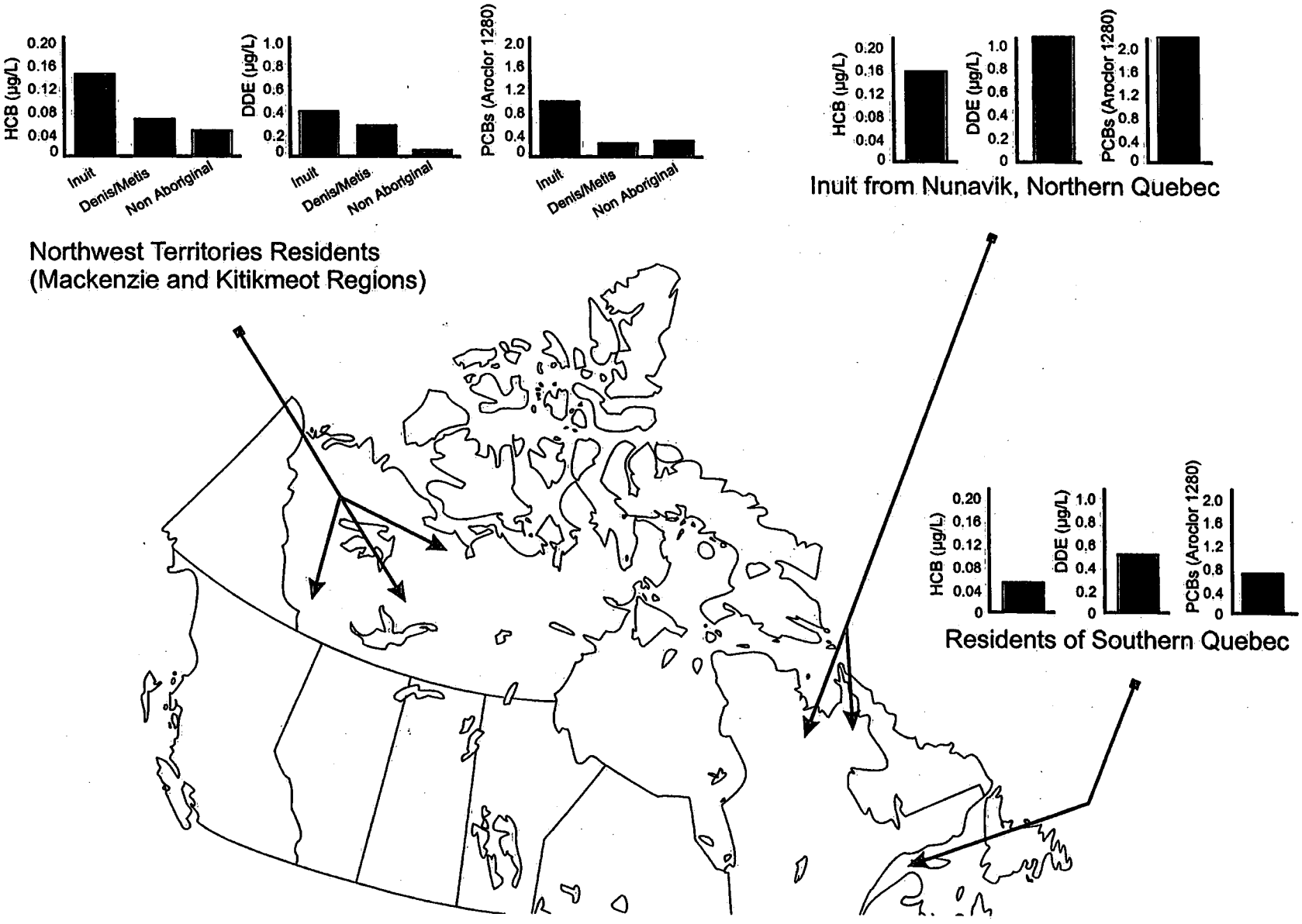


Figure 10. HCB, DDE and PCBs in cord blood of newborns

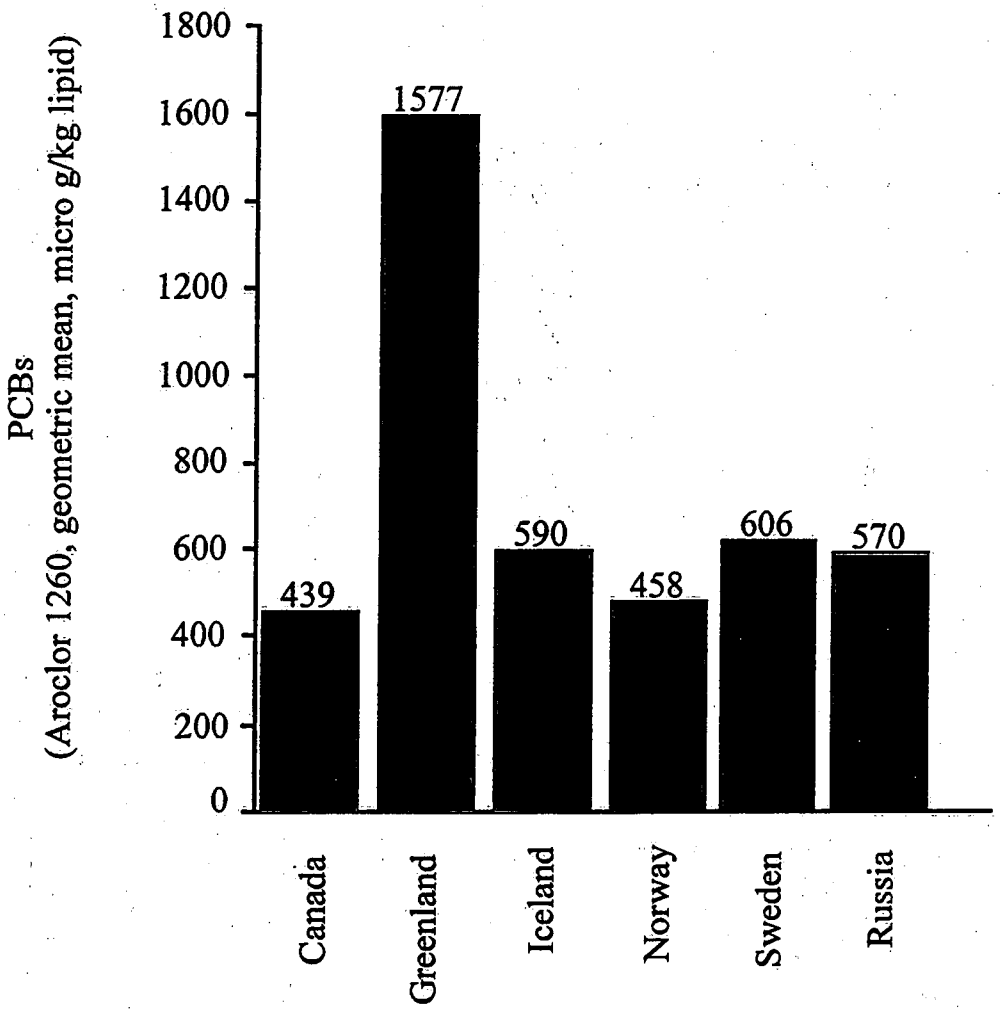


Figure 11. Maternal plasma concentration of PCBs (1995/96)

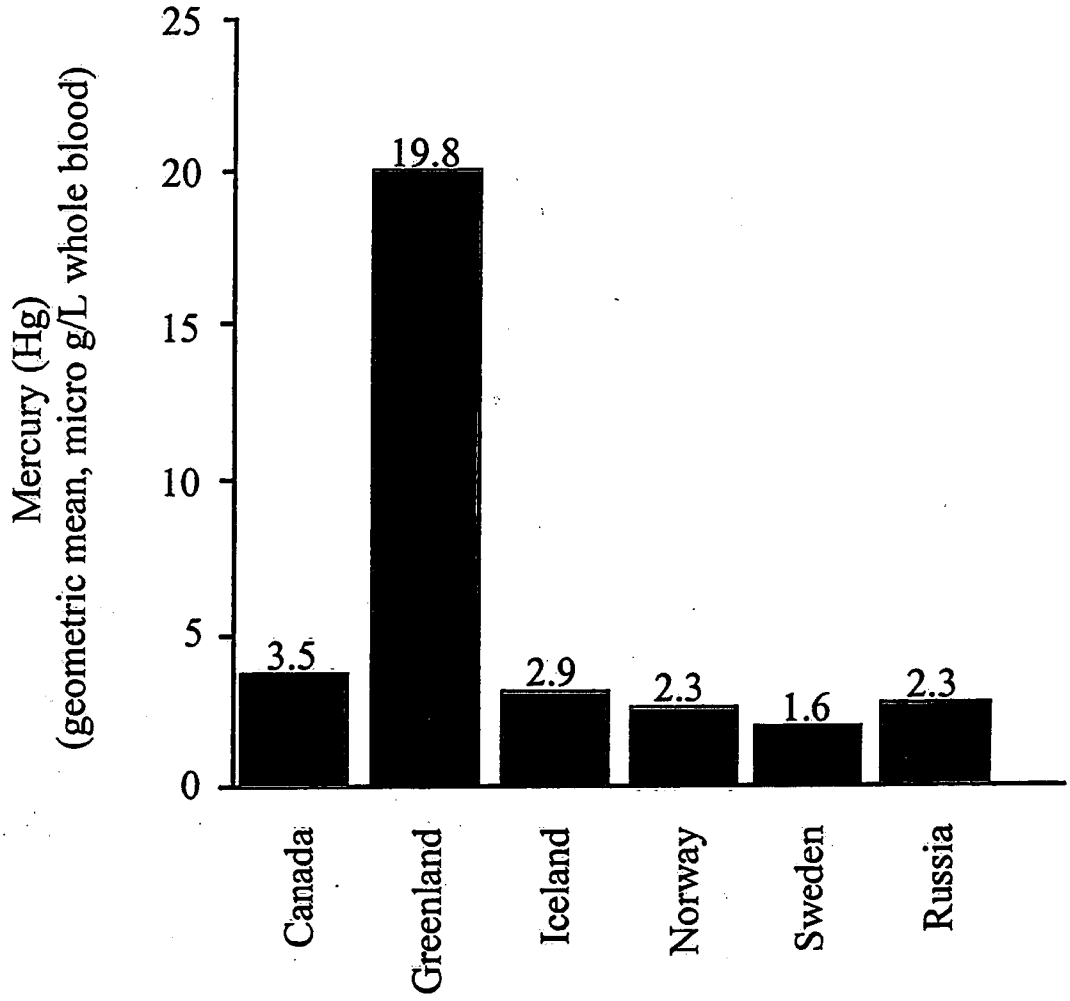


Figure 12. Maternal blood concentrations of mercury (1995/96)

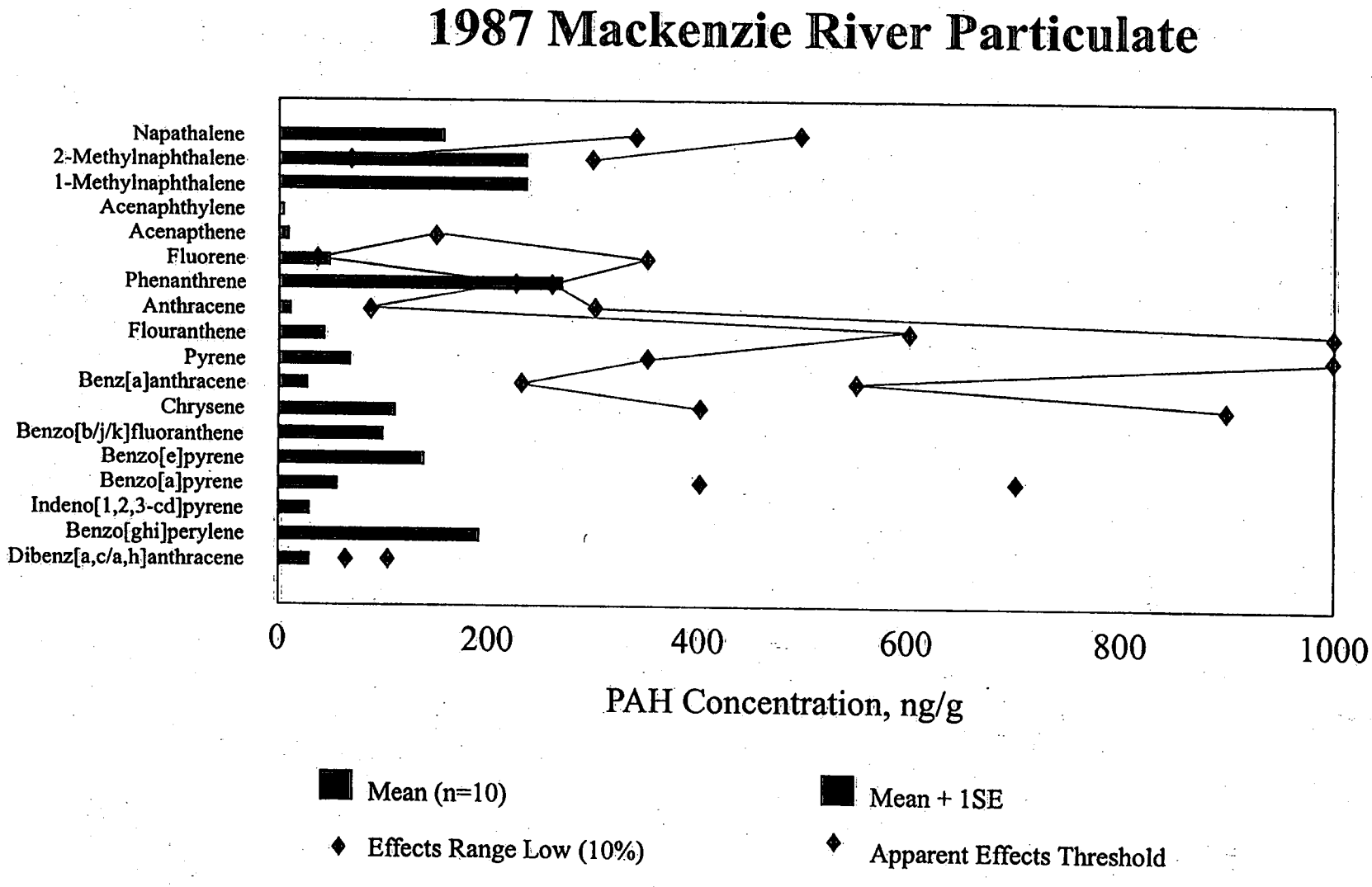
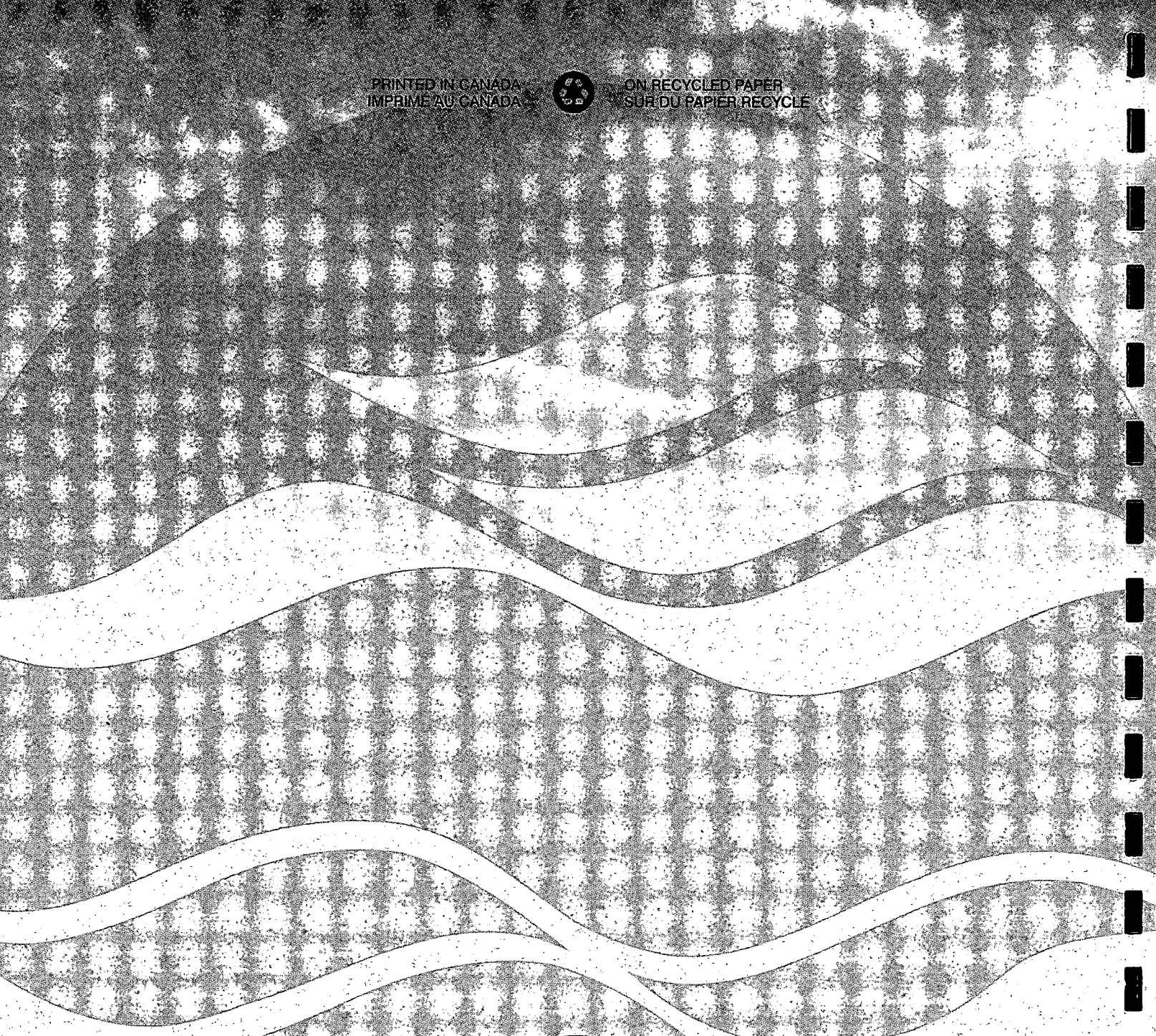


Figure 13. 1987 Mackenzie River particulate (PAH concentrations). Effects Levels from Long and Morgan (1990)

PRINTED IN CANADA
IMPRIMÉ AU CANADA

ON RECYCLED PAPER
SUR DU PAPIER RECYCLÉ



National Water Research Institute
Environment Canada
Canada Centre for Inland Waters
P.O. Box 5050
867 Lakeshore Road
Burlington, Ontario
L7R 4A6 Canada

National Hydrology Research Centre
11 Innovation Boulevard
Saskatoon, Saskatchewan
S7N 3H5 Canada

NATIONAL WATER RESEARCH INSTITUTE
INSTITUT NATIONAL DE RECHERCHE SUR LES EAUX

Institut national de recherche sur les eaux
Environnement Canada
Centre canadien des eaux intérieures
Case postale 5050
867, chemin Lakeshore
Burlington, Ontario
L7R 4A6 Canada

Centre national de recherche en hydrologie
11, boul. Innovation
Saskatoon, Saskatchewan
S7N 3H5 Canada

Environment Canada Environnement Canada

Canada