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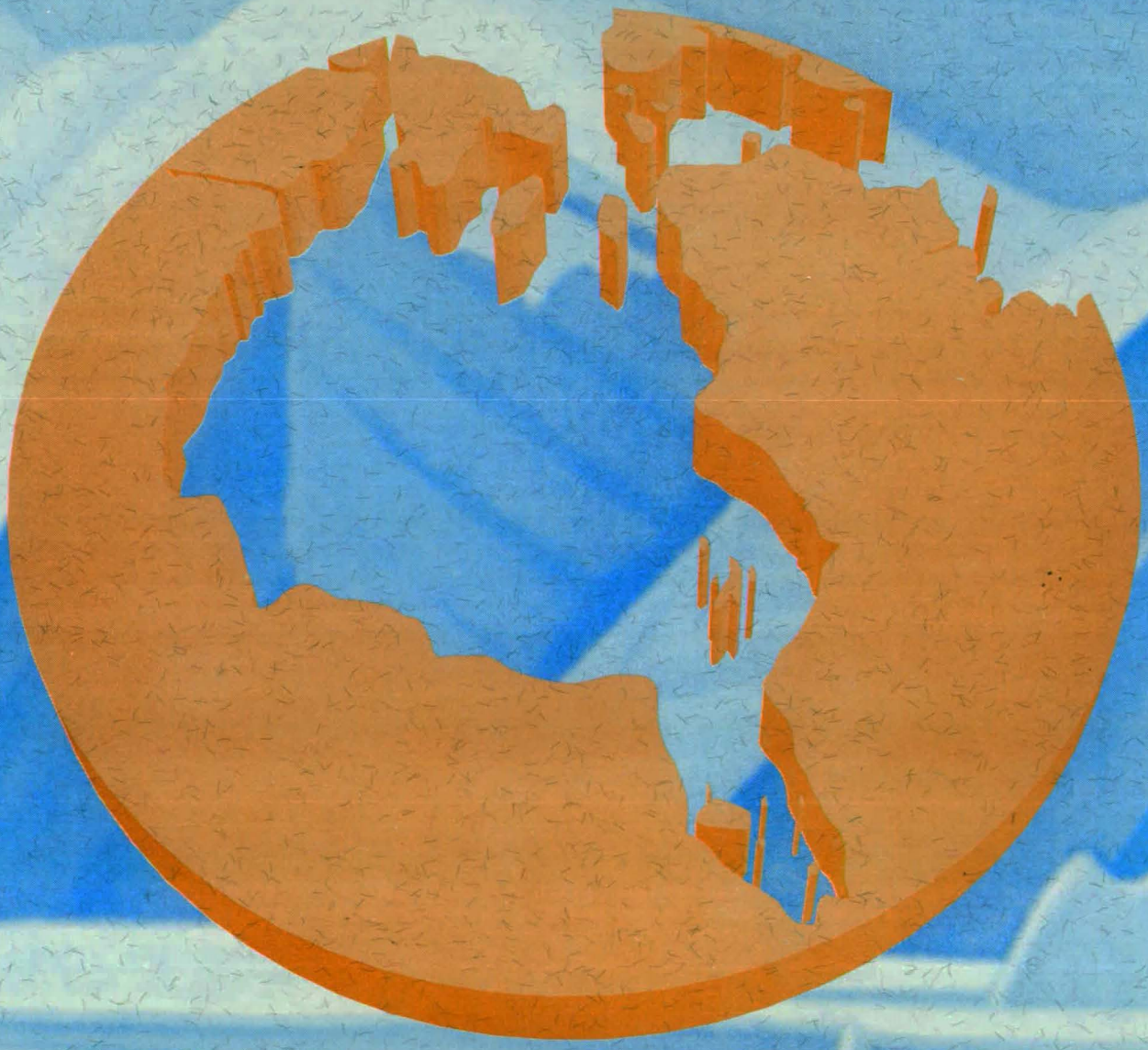

HUDSON BAY PROGRAMME SUR LA BAIE D'HUDSON

HEALTH EFFECTS OF DEVELOPMENT IN THE HUDSON BAY/JAMES BAY REGION

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ABSTRACT

This literature review indicates that although native people in the Hudson Bay/James Bay region have experienced significant improvements in health status in recent years, their health is still considerably worse than that of other Canadians. Chronic diseases such as obesity, diabetes and high blood pressure have become more prevalent, and injuries, poisonings and violence are at epidemic levels. In some native communities the prevalence and incidence of formerly infrequent chronic diseases have now surpassed those observed in non-native populations.

The evidence reviewed suggests that these trends can be attributed to a variety of positive and negative factors, the improved availability of health services, behaviours such as smoking and alcohol use, factors relating to the physical environment, and social, economic and cultural changes and possible biological differences between natives and non-natives.

The most important factors identified were the social, economic and cultural changes which have resulted from development-related contamination of the Hudson Bay/James Bay environment. Mercury contamination in relation to hydroelectric development is particularly well documented, but other contaminants, such as organochlorines and other metals, have also been detected. Native people who consume country foods are probably at greater risk of exposure. While evidence for direct toxic effects is inconclusive, decreases in consumption of these foods and increased sedentarization have been linked to the increased prevalence of chronic conditions such as obesity, diabetes, high blood pressure and dental caries. In addition, the resulting social, economic and cultural changes have profoundly affected native self-sufficiency and, in turn, identity and well-being. This has probably contributed to the very high levels of injuries, poisonings and violence in these communities.

However, social, economic and cultural changes and their consequent health effects can be at least partially attributed to development in general, rather than to contamination *per se*. Few studies have examined the relationships between the social, economic and cultural changes associated with development in native communities and individual and community psycho-social health. Indeed, most of the studies reviewed in this paper have focused on indicators of physical health, even though some indicators (e.g., injury, substance abuse, violence) suggest that the

psycho-social health effects of development may be at least as significant as the effects on physical health.

Although the severity of these effects on health is likely to vary according to the social, cultural and economic conditions in different communities, the studies reviewed in this paper suggest that health has already been affected by development activities in the Hudson Bay/James Bay region.

HEALTH EFFECTS OF DEVELOPMENT IN THE HUDSON BAY/JAMES BAY REGION

1. Introduction

In May 1993, the Hudson Bay Program of the Canadian Arctic Resources Committee, the Environmental Committee of Sanikiluaq and the Rawson Academy of Aquatic Science held a workshop on cumulative impact assessment in the Hudson Bay Bioregion (Hudson Bay Program, 1993), as part of its Phase I activities. At the workshop, the participants discussed many cumulative effects associated with development, including health. Indeed, one of the nine major issues that had already been identified in the traditional ecological knowledge component of the Program was the effects of development on health. This was discussed at the workshop and it was suggested that the Program should examine the scientific literature on health in the Bioregion. Such a literature review could be used to inform decision-makers and others about the cumulative effects of development on health. It could also be used to examine the relationship between scientific knowledge and traditional ecological knowledge. At the workshop, it was noted that this type of research, i.e., studies of the connections and complementary nature of traditional ecological knowledge and scientific knowledge, is urgently needed in Canada and elsewhere.

As a first step, this paper reviews the scientific literature on the health effects of development in the Hudson Bay/James Bay region. It should be noted that the term *"development"* refers to industrial, resource use and commercial activities that are wholly or largely owned or controlled by individuals or organisations from outside the region, usually non-natives. Figure 1 shows the geography of the study region.

2. Methods

Computerised literature searches were conducted on bibliographic databases, including Medline, Boreal, and databases assembled by the Canadian Arctic Resources Committee and Paul Wilkinson and Associates, consultant to the Moose River/James Bay Coalition. These were supplemented by manual searches of selected journals and conversations with several key informants (see Appendix 1). A substantial proportion of the relevant material consisted of

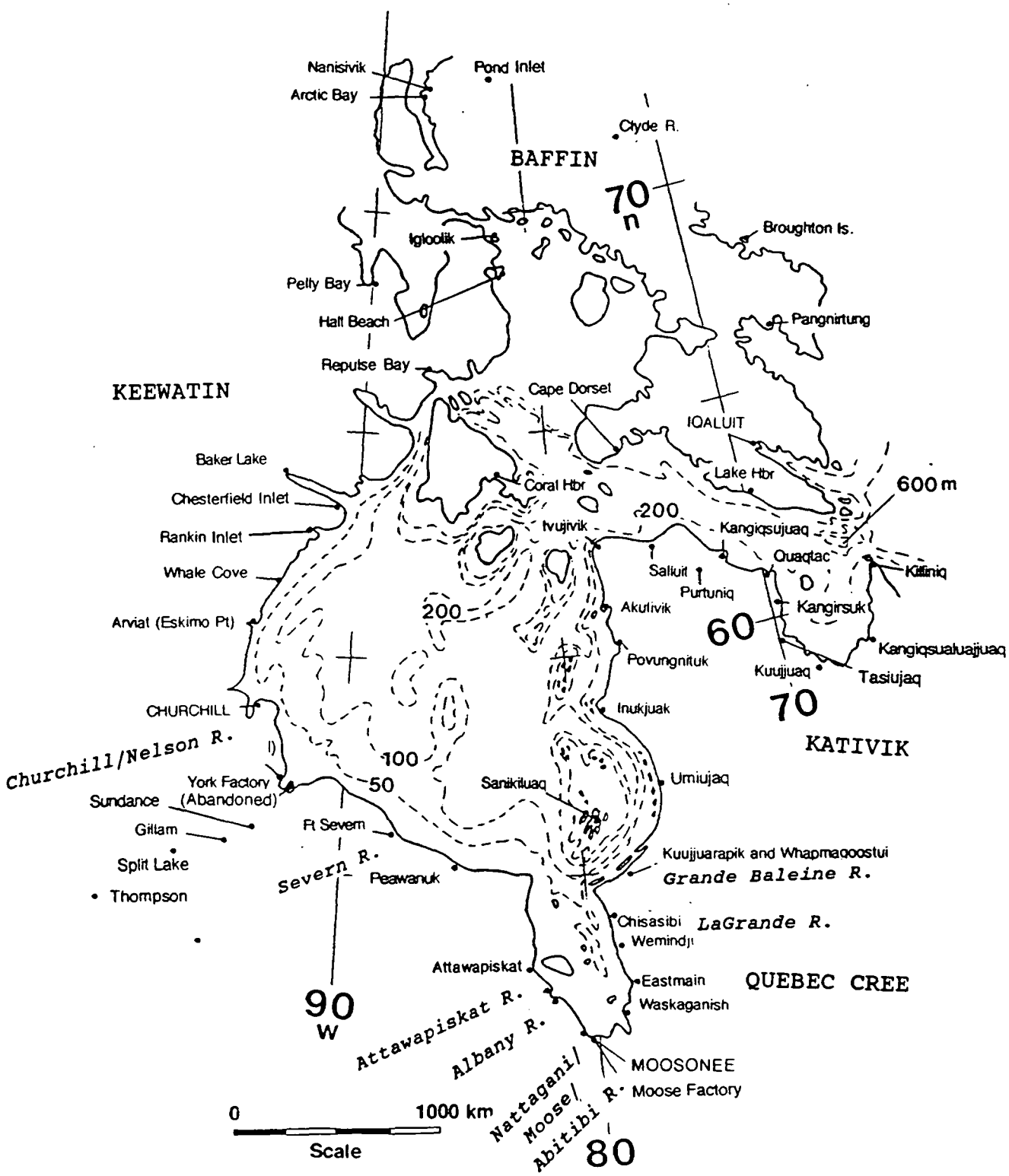

Figure 1. Communities, river systems and administrative jurisdictions in the Hudson Bay/James Bay region

(Adapted from: Sly, P.G., 1993. Human Impacts on the Hudson Bay Region, its Present State and Future Environmental Concerns. Hudson Bay Programme.)

unpublished reports and government documents. Only some of this material could be obtained. Literature in both French and English was reviewed.

3. Background

3.1 *Concepts of Health and its Determinants*

A broad view of health and its determinants is required to understand the effects of development on health in the Hudson Bay/James Bay region. The *Ottawa Charter for Health Promotion* (1986), defined health as:

> *a state of complete physical, mental and social well-being which is achieved through the ability to identify and realize aspirations, satisfy needs and change or cope with the environment; a positive concept emphasizing social and personal resources as well as physical capacities; and a resource for everyday life, rather than the objective of living.*

Native peoples' notions of health, while similarly broad in scope, put greater emphasis on health as a state of balance or harmony (Adelson & Young, 1987; O'Neil, 1990; Wheatley, M. A., 1993) and on the interdependence of individuals and the community (O'Neil, 1990). Cree concepts of health have recently been explored by Adelson (1990).

Although a variety of alternative models of the determinants of health have been proposed, current thinking favours a socio-environmental model, as opposed to earlier medical (health as the absence of disease) and behavioural (health as a function of lifestyle) models. The socio-environmental model recognizes the important impacts on health status of the physical environment as well as social, economic and cultural factors, in addition to the roles of biological factors, behaviour and the availability of health services (Ontario Premier's Council, 1991; O'Neil, 1990; Wheatley, B., 1993).

The socio-environmental model is particularly relevant for understanding the health effects of development in the Hudson Bay/James Bay region, given the unique relationship of native populations with the land, both in a physical sense, as a source of food, and in a social, economic and cultural sense, as the very basis of the subsistence way of life (O'Neil, 1990; Wheatley, M. A., 1993). Within this socio-environmental framework, there appear to be several variables which mediate the health effects of development in native communities, as identified by O'Neil (1990):

- The balance between subsistence and wage economies;

- The level of socio-political integration (i.e., equity of distribution of power; the level of self-determination; and comprehension and familiarity with external sources of power); and

- The incidence of health problems such as injuries and violence, associated with social disintegration (*ibid.*).

In other words, communities with a predominant subsistence economy, less sociopolitical integration, and a higher incidence of health problems related to social disintegration are likely to be more vulnerable to adverse health effects associated with development (*ibid.*).

4. Methodologic Issues

It is not easy to examine the links between development and health status in native populations epidemiologically. While many epidemiologic problems can be expressed in terms of a "population", an "exposure" and an "outcome", development clearly consists of a variety of exposures, and a multitude of health outcomes are of interest.

A common approach, and the one with which this review begins, is to examine trends in health outcomes first and then to attempt to explain these in relation to trends in development and other determinants of health. This "ecologic" approach has some serious shortcomings, in particular, the inability to distinguish the effects of various confounding factors (Walter, 1991a, 1991b). Fortunately, there is some literature which documents the effects of development more directly in individuals, particularly with respect to development-related changes in contaminant exposure and diet. These data help to solidify the associations suspected on the basis of an ecologic approach alone.

5. Health Effects of Development in the Hudson Bay/James Bay Region

5.1 *Patterns of Health and Disease*

5.1.1 *Demographic and Epidemiologic Transitions*

It has been observed that changes in birth rates, death rates and causes of death in societies conform to certain patterns that are, to some degree, reproducible. These patterns have been called the demographic and epidemiologic "transitions" of populations (Tyler & Herold, 1992). The original demographic model emphasized changes in broad demographic and health indicators, and the more recent epidemiologic model expanded on this to include changes in causes of death and disease (*ibid.*). There is, however, a degree of correspondence between the

two models, each of which recognizes three primary stages in societal evolution. The features of, and parallels between, these models are summarized in table 1.

Table 1: Features of Demographic and Epidemiologic Transitions

STAGE	DEMOGRAPHIC TRANSITION	EPIDEMIOLOGIC TRANSITION
Early	birth rate high death rate high	widespread epidemics and famine
Middle	birth rate high death rate decreasing	receding epidemics
Late	birth rate low death rate low	emergence of degenerative disease

While some trends observed amongst native people in the Hudson Bay/James Bay region are consistent with these models, there are important discrepancies (Young, 1988). The intent here is to identify these discrepancies and to attempt to account for them with reference to development and other determinants of health.

5.1.2 *General Demographic and Health Trends*

Table 2 summarises several demographic and health indicators in James Bay and Hudson Bay native populations, as compared with non-native populations in Quebec.

As shown in table 2, there is a much larger proportion of young people in Hudson Bay/James Bay native populations, compared to non-natives (Blanchet *et al.*, 1992; Clarkson *et al.*, 1993; Moffatt *et al.*, 1991). This is attributable to a birth rate which, although lower than in the past (Young, 1988), remains significantly higher than amongst non-natives (Blanchet *et. al.*, 1992).

Table 2: Demographic and health indicators: Hudson Bay/James Bay (HB/JB) natives compared to non-natives

	POPULATION			
	HB/JB NATIVES		NON-NATIVES	
INDICATOR	TREND	CURRENT STATUS	TREND	CURRENT STATUS
% of population < 20 years of age	↓	~50	↓	~30 (Quebec)
birth rate (/1000)	↓	34 (Quebec Inuit)	↓	13 (Quebec)
infant mortality rate (/1000)	↓	30 (Quebec Inuit) 27.4/49.2 (Quebec Cree; coast/inland)	↓	7 (Quebec)
life expectancy (yrs.)	↑	62 (Quebec Inuit) 69.8/73.2 (Quebec Cree; male/female)	↑	69.9/78.2 (Quebec; male/female)
avoidable deaths (% of all deaths)	?	19 (Quebec Inuit) 16 (Quebec Cree)	↓	9 (Quebec)

While infant mortality has decreased (Robinson, 1988; Young, 1988), it persists at levels much higher than those seen in non-native populations (Foggin & Lauzon, 1987; Blanchet *et al.*, 1992). Similarly, while life expectancy has improved, it remains lower amongst natives, particularly the Inuit, than amongst non-natives (Foggin & Lauzon, 1987; Blanchet *et al.*, 1992). Finally, the burden of avoidable mortality (i.e., avoidable as a result of prevention or early detection and treatment) is also higher in natives, compared to non-natives (Pampalon, 1993).

These data suggest that health status is likely to be worse in native populations in the Hudson Bay/James Bay region than in non-native populations in Quebec. Furthermore, they show that

demographic and health indicators of native populations in the Hudson Bay/James Bay region have evolved in a manner consistent with the model of demographic transition, although current patterns reflect an "earlier" demographic stage (according to the model) than that observed in non-natives.

5.1.3 *Infectious Diseases*

Like the trends observed in general demographic and health indicators amongst Hudson Bay/James Bay native populations, downward trends in the incidence of infectious diseases are consistent with the epidemiologic transition model, while at the same time incidence rates remain above those observed in non-native Canadians.

As predicted by the model, high incidences of smallpox, measles, influenza, pertussis and tuberculosis, which characterized the early (post native-European contact) epidemiology of native people, have now decreased significantly (Young, 1988). For example, a substantial decrease in the incidence of tuberculosis was observed between 1970 and 1981 (16% per year for Inuit, 10% per year for non-natives, and 4% per year for Indians) (Enarson & Grzybowski, 1986). However, the incidence of tuberculosis remained more than ten-fold higher in both Inuit and Indians in 1980 (*ibid.*). Between 1984 and 1991, the incidence of tuberculosis among Quebec Cree remained several fold higher than that observed in the population of Quebec as a whole (Smeja, 1992).

Other infectious diseases are also more common in native people in this region, including, among Inuit, middle ear infections, which have resulted in higher rates of significant hearing loss than in other Canadians (Moffatt *et al.*, 1991; Blanchet *et al.*, 1992; Baxter *et al.*, 1986; Julien *et al.*, 1987), as well as *Haemophilus influenzae* type b meningitis (Moffatt *et al.*, 1991). Gastrointestinal infections (Brassard *et al.*, 1985; Tanner *et al.*, 1987), including outbreaks attributed to inadequate sewage disposal (Robinson & Moffatt, 1985), as well as sexually transmitted diseases such as *Chlamydia trachomatis* infections (Kordová *et al.*, 1983) also appear to be prevalent. Data for the Quebec Cree indicate that the incidence of chlamydia and gonorrhoea is several fold higher than that observed in Quebec as a whole, even after adjustment for the younger average age of the Cree population (Smeja, 1992). However, surveillance data and incidence studies relating to these conditions tend to be limited and/or unreliable because

of non-specific symptoms (in the case of gastrointestinal infections) as well as under-reporting.

5.1.4 *Chronic Diseases*

Also in keeping with the epidemiologic transition model, chronic degenerative diseases are now more prevalent in native populations in the Hudson Bay/James Bay region. What is curious, however, is that the incidence and prevalence of some conditions have surpassed those observed in non-native populations. For example, a study of cancer incidence in the central arctic (including Keewatin and Netchilik Inuit) indicated that between 1950 and 1980, "traditional" cancers for these populations, including tumours of the salivary glands, nasopharynx, kidney and oesophagus, had given way to "modern" cancers of the lung, cervix and colorectum, typical of European populations (Hildes & Schaefer, 1984). Rates of salivary gland cancer were formerly 82 to 360 times higher, and rates of nasopharyngeal cancer 10 to 50 times higher than in other Canadians, matched for age and sex (*ibid.*). However, since the incidence and prevalence of these diseases have decreased, lung cancer is now twenty times more common in this central arctic population relative to the rest of Canada. It has also been estimated that cervical cancer is now 3 to 15 times more common in Indians and Inuit than in other Canadian women (*ibid.*). Tumours are currently the second most common cause of death among Quebec Inuit (Blanchet *et al.*, 1992).

Other chronic diseases have also been more prevalent. Obesity is now more common in native populations in the Hudson Bay/James Bay region, particularly among Indian women of northern Manitoba, Ontario and Quebec (Foggin & Lauzon, 1987; Young & Sevenhuysen, 1989; Clarkson *et al.*, 1993); to a lesser extent in Cree men (Young & Sevenhuysen, 1989; Clarkson *et al.*, 1993; Foggin & Lauzon, 1987) and Quebec Inuit of both sexes (Blanchet *et al.*, 1992); but only in older Inuit women in Keewatin (Moffatt *et al.*, 1991). The appearance of obesity is important because of its relationship (observed in Indians of northern Manitoba and Quebec) with diabetes and high blood pressure (Young, 1991; Young & Sevenhuysen, 1989).

There is limited evidence that diabetes is more common in Indian populations than in non-natives (Young *et al.*, 1990a and b), although this has not been observed among Inuit (Moffatt *et al.*, 1991; Young *et al.*, 1992).

There is a similar pattern for high blood pressure. In the Quebec Cree health survey, the prevalence of high blood pressure was higher in Cree (15%) than in other Canadians (11% for males and 9% for females) (Clarkson & Foggin, 1990). In a study of Indians in northern Ontario and Manitoba, compared to other Canadians, mean diastolic blood pressure was higher in all age groups, and systolic blood pressure higher in younger age groups (Young *et al.*, 1991). Among the Inuit, the prevalence of high blood pressure was lower in Quebec Inuit (4%) than amongst other Canadians (Blanchet *et al.*, 1992), while in Keewatin Inuit the prevalence was higher only for males aged 25-44 years (Moffatt *et al.*, 1991).

With respect to blood cholesterol levels, another risk factor for cardiovascular disease, the 1983/4 Quebec Cree health survey found that the prevalence of elevated cholesterol levels was lower than that observed for other Canadians, for all age groups (Clarkson & Foggin, 1990). In the Keewatin health survey, the proportion of Inuit with elevated blood cholesterol levels was higher than that observed in other Manitobans, but levels of both high density (desirable) lipoproteins and low density (undesirable) lipoproteins were elevated (Moffatt *et al.*, 1991).

Dental health is also a significant problem in many native communities. A study conducted in Chisasibi in 1985 found that the number of decayed, missing or filled tooth surfaces was dramatically higher than in children participating in similar studies in New Brunswick and Newfoundland, and that the level of treatment (essentially the ratio of filled to decayed surfaces) was less than half that observed in Alberta, Ontario and Quebec (Shaw 1987). In the Keewatin health survey, 50-100% of children of various ages, and 90% of adults were found to be in need of dental treatment (i.e., having at least one decayed surface) (Moffatt *et al.*, 1991).

5.1.5 *Injuries and Violence*

Probably the most significant divergence of the Hudson Bay/James Bay population from the epidemiologic transition model is the emergence of epidemic rates of violence and injury (Young, 1988). Among James Bay Cree, rates of hospitalization for injuries are 1.5 to 2 times greater than the Quebec average, and rates of death from injury and drowning are 2 and 10 times greater, respectively (Robinson, 1988). In Quebec and Northwest Territories Inuit populations, accidents, poisonings and trauma are the most common causes of death (Blanchet *et al.*, 1992; Young 1983), while cardiovascular disease tops the list for the Canadian population

as a whole (Brancker, 1992). Significant increases in suicide, homicide and motor vehicle accidents have been noted from the 1950s up to 1986 in the Northwest Territories, far exceeding levels observed elsewhere in Canada (Moffatt *et al.*, 1991). Violence against women and children has also been identified as a significant problem by Inuit women (Billson, 1990; Sammons, 1990; Sutherland, 1990).

5.2 *Interpreting the Trends: The Determinants of Health and Disease*

An examination of trends in demographic, health and disease patterns in the native population of the Hudson Bay/James Bay region indicates some consistency with what would be expected, based on the models of demographic and epidemiologic transition. Observed changes in birth and death rates, and in the incidence of infectious and chronic diseases, are partially consistent with these models. However, these disease trends diverge from the models in important ways (Young, 1988). First, birth and death rates and the incidence of infectious diseases remain above those observed for non-natives, on the one hand, while on the other, the incidence of chronic diseases has risen and surpassed that observed in non-native populations, in some cases. The most troubling difference, however, is the significant excess of violent death and injury in native versus non-native populations. The following discussion will attempt to account for these differences, in particular, what role, if any, development might play. In attempting to answer this question, the role of each of the determinants of health will be considered.

5.2.1 *Health Services*

The delivery of health services to native people has been a responsibility of the Medical Services Branch (MSB) of Health and Welfare Canada for many years (Young & Smith, 1992). However, in 1975, the James Bay-Northern Quebec Agreement (JBNQA) was signed. The agreement transferred the responsibility for health services in this area to the Cree and Inuit, although the actual transfer did not occur until the early 1980s. Health services were transferred to the Cree and Kativik Regional Boards of Health and Social Services respectively, while fiscal responsibility was transferred from the federal to provincial government (Moffatt, 1987; Hydro-Quebec, 1993). By 1986 and 1987, a similar process had been completed for the Northwest Territories, and the Baffin and Keewatin Regional Health Boards were created (Moffatt *et al.*, 1991; Young & Smith, 1992). It has been noted that the degree of native control and autonomy differs among these various boards (Young & Smith, 1992). The remainder of the Manitoba and

Ontario portions of the Hudson Bay/James Bay region receive health services from MSB, including nursing stations that provide primary care and federal and provincial hospitals (Personal communication, Dr. M. Moffatt, University of Manitoba, 1993, and Mr. R. Kapasheesit, Queen's Moose Factory Program, 1993).

Universities and other non-government institutions are also important, with the Cree and Kativik Health Boards maintaining formal arrangements with the Montreal General Hospital and Centre Hospitalier de l'Université Laval Departments of Community Health, respectively, while the University of Manitoba Northern Health Research Unit has worked closely with the Keewatin Board. Queen's University, the University of Toronto and McGill University are also involved in the provision of medical and dental services in the region.

Considerable resources have, therefore, been committed over the years to the provision of health services to native populations in the Hudson Bay/James Bay region. This represents one aspect of development which might be expected to have a positive impact on health. Indeed, the reduced incidence of tuberculosis in Canadian Inuit has been attributed to intensive control programs, including case-finding, treatment and immunization with BCG vaccine (Enarson & Grzybowski, 1986). At the same time, ongoing issues include attracting and maintaining a sufficient number of qualified health professionals (Moffatt *et al.*, 1991), and the provision of culturally appropriate care (O'Neil *et al.*, 1990a), including the integration of traditional and western medicine (Young & Smith, 1992; Wheatley, M. A., 1990).

One prominent controversy is the effect of increased use of medical services during childbirth on maternal/child health. In Keewatin, for example, a dramatic change in the location of deliveries was noted between 1971 and 1985 (see table 3), but the actual impact of these changes on perinatal death rates is unclear. Rates of perinatal death have ranged from 0 to over 50 per thousand over this period, but the small number of total births (107 to 168) and deaths (0-7), makes it difficult to interpret these rates (Kaufert *et al.*, 1990). At the same time, dissatisfaction with care received in southern hospitals and a preference for community births have been noted among many Inuit women (O'Neil *et al.*, 1990b; Paulette, 1990), and there is some evidence that health problems of other children are not attended to in their mothers' sometimes prolonged absence during evacuation to southern hospitals (O'Neil *et al.*, 1990b).

Table 3: Trends in location of deliveries in Keewatin, NWT (1971 and 1985)

	PROPORTION OF DELIVERIES (%)	
LOCATION OF DELIVERY	1971	1985
Community	35	12
Churchill	54	55
Winnipeg	< 9	33

Source: Kaufert *et al.*, 1988.

The increased use of medical services may also affect knowledge and attitudes toward health. Evidence from interviews with older Inuit women in Keewatin and elsewhere indicates a perceived decrease in knowledge in younger women about female sexuality and reproductive health (Daviss-Putt, 1990; Kilunik, 1990; Paulette, 1990) and a reduced sense of personal responsibility (versus the responsibility of health professionals) for healthy childbirth (O'Neil *et al.*, 1990b). It is possible that such changes in knowledge and attitudes may play a role in the increased incidence of sexually transmitted diseases and of teen pregnancy, which in turn have been implicated in the increased incidence of cervical cancer (Hildes & Schaefer, 1984). Other social and cultural factors (see section 5.2.4) have probably also played a significant role.

One final issue with respect to health services is that they probably play a minimal role in reducing excesses of injuries and violence, which appear to be related much more closely to other determinants of health (see section 5.2.4).

5.2.2 *Behaviour*

Two behaviours with well-known health effects are smoking and alcohol use. Several health surveys have shown that smoking is significantly more prevalent in native communities in the Hudson Bay/James Bay region than in the rest of Canada, particularly among Quebec Inuit (this is also true of most northern communities and among native people in general). This is shown in table 4. The dramatic increase in lung cancer incidence among Inuit of the central Arctic is most certainly attributable to the extremely high prevalence of smoking in this group, although the use of open oil lamps has also been implicated as a risk factor for lung cancer (Hildes &

Schaefer, 1984). Open oil lamps are no longer in use. Smoking also increases exposure to contaminants found in cigarette smoke, such as cadmium. While smoking is clearly an individual behaviour, it is also strongly socially determined, its prevalence being much higher among individuals with lower socio-economic status (Haan *et al.*, 1987; Marmot *et al.*, 1987). To the extent that development causes social deterioration and other economic and cultural changes that result in a lower socio-economic status (see section 5.2.4) and effects on psycho-social health, there is a plausible link between development and the adverse effects of smoking on health.

Table 4: Prevalence of smoking in Hudson Bay/James Bay natives and comparison groups

POPULATION	% CURRENT SMOKERS (regular or occasional)	REFERENCE
Quebec Inuit (1983/4)	75	Blanchet *et al.*, 1992
Keewatin Inuit (1990)	60	Moffatt *et al.*, 1991
Quebec Cree (1991) males females males + females (1983/4)	 58 49 51	Clarkson *et al.*, 1993 Clarkson & Foggin, 1990
Quebec	38	Clarkson & Foggin, 1990
Manitoba	32	Moffatt *et al.*, 1991
Ontario (1990) males females	 32 28	Ontario Ministry of Health, 1992

Data on alcohol consumption are also available from various health surveys in the Hudson Bay/James Bay region, but differences in survey questions make comparison impossible. There is widespread agreement among native people, however, that alcohol is a serious problem. In the 1991 Quebec Cree health survey, for example, alcohol topped the list of serious problems identified by respondents (Clarkson *et al.*, 1993). Similarly, a survey conducted by an

interdepartmental committee of the Government of Quebec which collected information from Cree, Inuit and Naskapi health and social service agencies, as well as legal and correctional authorities and police, identified alcohol abuse as both an outcome and a cause of a variety of serious social problems in native communities (Government of Quebec, 1989). Survey respondents questioned the effectiveness of social workers, police and the National Native Alcohol and Drug Abuse Program in responding to native alcohol and drug abuse problems, and identified a lack of support from authorities for community initiated prohibition of alcohol in native communities (*ibid.*).

Alcohol, together with social, economic and political factors, has also been implicated in the excess of injuries and violence in native communities (Young, 1988; Thouez *et al.*, 1989; Billson, 1990). As is the case with smoking, to the extent that development increases the availability of alcohol and creates a social, economic and cultural environment which contributes to alcohol abuse (see section 5.2.4), there is a plausible link between development and alcohol related health and social problems within native communities in the Hudson Bay/James Bay region.

5.2.3 *Physical Environment*

a) Housing and Community Infrastructure

There is considerable evidence that housing and community infrastructure in native communities in the Hudson Bay/James Bay region is poor compared to the rest of Canada. The mean number of occupants per household, for example, was 7 in the 1983/4 Quebec Cree health survey (Foggin & Lauzon, 1987) and 4.6 in the Keewatin health survey (Moffatt *et al.*, 1991), compared to a Canadian average of 2.8 (*ibid.*). In the 1983/4 Quebec Inuit health survey, 71% of respondents lived in households with 5 to 10 members (Blanchet *et al.*, 1992). The proportion of houses lacking bathrooms and central heating is also much greater in native communities in the Northwest Territories, Manitoba and Ontario, compared to non-native communities (Young *et al.*, 1991).

The availability of high quality drinking water varies considerably from one native community to another. In the 1983/4 Quebec Cree health survey, 80% of households had running water, although this proportion ranged from 0% in one community (Whapmagoostui)

to 100% in others (Chisasibi and Waswanipi) (Foggin & Lauzon, 1987). In many cases, even when running water was available, it was not used for drinking because of its chlorinated taste (*ibid.*). Bacteriologic quality of drinking water (not necessarily tap water) was poor (>10 coliforms, >0 fecal coliforms, or >0 fecal streptococci per 100 mL) in 7-74% of samples (Foggin & Lauzon, 1987). In another study, bacterial contamination of municipally treated water was reported in Kuujjuaq, and recommendations were made for improved disinfection and maintenance at several stages in treatment and distribution including the treatment plant, pumps, water trucks and residential reservoirs (Benoit *et al.*, 1989). Similarly extensive operational and maintenance problems, with potential for significant contamination, were noted in a study conducted in northern Manitoba (Huebert, 1982). Only the Keewatin health study noted the lack of fluoridation in drinking water (Moffatt *et al.*, 1991).

Facilities for sewage disposal vary from one community to another. In the Keewatin health study it was reported that 4 to 12% of households used a "honey bucket" system in which waste is collected in a bucket lined with a plastic bag, the contents of which are dumped in a pit outdoors (Moffatt *et al.*, 1991), while the entire community of Wemindji was using such a system at the time of an outbreak of gastroenteritis (Robinson & Moffatt, 1985).

Several studies conducted in northern Manitoba, as reviewed by Young and coworkers (1991), have evaluated the association between housing, community infrastructure and health. A variety of associations were reported in this review, including correlations between increased water consumption and reduced skin and gastrointestinal infections; crowding/disrepair and increased hospitalization; the availability of treated water and reduced rates of gastrointestinal infections; the type of sewage disposal and rates of skin and gastrointestinal infection (honey bucket > pumpout > pipe/sewer); crowding and respiratory, skin and eye disease; heating/toilets/hygiene and a variety of health indices; and crowding/poor water supply/poor hygiene and perinatal and infant mortality. In several of the reviewed studies, the relationship between housing/infrastructure and health could have been confounded by other factors, such as access to health services. Positive relationships between good housing/infrastructure and better health were still observed, however, when such confounders were accounted for.

It is likely, therefore, that poor housing and community infrastructure in the Hudson Bay/James Bay region contribute significantly to poor health. The role of development in this

relationship is not clear. However, there is some evidence that in communities where native people controlled the labour and capital involved in housing construction, quality was superior to that seen in communities where government funding was relied upon exclusively (Ekos Research Associates, 1985). This suggests that the degree of self-determination in housing and community infrastructure is an important factor. Under Canada's Green Plan, the Assembly of First Nations has received funding for a Drinking Water Safety Program, to increase native control of infrastructure development, and to improve water testing and the training of water plant personnel in native communities (Personal communication, Mr. Jim Ransom, Coordinator, Drinking Water Safety Program, Assembly of First Nations, 1993).

b) Environmental Contaminants

i) mercury

Mercury is the best documented contaminant in the Hudson Bay/James Bay region. Chronic and acute exposure to mercury has been associated with tremor, memory loss, changes in personality and behaviour, salivation, depression, etc. The release of mercury into Minamata Bay in Japan and subsequent consumption of contaminated fish led to an epidemic of methylmercury poisoning so-called *"Minamata Disease"* (Kurland *et al.*, 1960).

"Background" levels observed in the Hudson Bay/James Bay region are largely attributable to long range atmospheric transport and naturally occurring mercury in the Canadian Shield (Lockhart, 1990). In addition to these sources, it is now known that impoundments of water in hydroelectric reservoirs increase levels of methylmercury in fish, particularly piscivorous (predatory) fish. This is because of enhanced bacterial activity stimulated by decomposing organic material produced by flooding. This effect has been reported in a variety of climates, but appears to be more severe in boreal areas (Bodaly & Johnston, 1992). Monitoring has been conducted in the vicinity of large hydroelectric systems in northern Quebec and Manitoba, as well as small reservoirs in northern Ontario. Current recommended limits and levels for mercury content in fish are summarized in table 5.

Table 5: Current recommended limits and levels for mercury content in fish

TYPE OF LIMIT/LEVEL	MAXIMUM MERCURY CONCENTRATION (ppm, mg/kg or μg/g)
Commercial Limit (Canada)	0.5
Commercial Limit (U.S.)	1.0
Recommended Level for Populations Consuming Large Quantities of Fish (Health and Welfare Canada)	0.2

Source: Bodaly & Johnston, 1992.
Note: Limits are legally enforceable; levels are not.

Monitoring in reservoirs in northern Quebec has shown that among non-piscivorous species such as sucker and lake whitefish, mercury levels increased rapidly by a factor of four, peaking in some reservoirs five years after flooding and then decreasing. In other reservoirs, levels had not peaked seven years after flooding (Verdun *et al.*, 1991). In piscivorous species such as pike, walleye and lake trout, mercury levels increased more slowly and were still rising up to nine years after flooding (*ibid.*). In the La Grande 2 reservoir, for example, mercury levels in lake whitefish increased from 0.1 to 0.6 parts per million (ppm) between 1978 (prior to flooding) and 1984, decreasing slightly in 1986; and levels in pike increased from 0.6 ppm to 2.7 ppm over the same period, also decreasing slightly in 1986 (Dumont & Kosatsky, 1991). Increased mercury levels have also been reported downstream of reservoirs (Verdun *et al.*, 1991), with mean levels in pike below La Grande 2 reaching 3.49 ppm in 1988 (Bodaly & Johnston, 1992). Levels in lake cisco, lake whitefish and brooktrout along the James Bay coast at the edges of the La Grande River plume ranged from 0.06 to 0.17 ppm, while levels in anadromous (migratory) fish of the same species in the mouth of the River were 0.24 to 0.38 ppm (Roy, 1990).

Monitoring in reservoirs in northern Manitoba has indicated similar trends. Prior to completion of the Churchill-Nelson diversion, which changed the surface area of some lakes by up to 435%, mean levels of mercury in pike and walleye ranged from 0.2 to 0.3 ppm in South Indian Lake (Bodaly *et al.*, 1984). After flooding, mean levels in these species reached 0.5 to 1.0 ppm by 1979 in South Indian Lake, and 1.15 to 2.90 ppm (1978-1982) in Rat and Notigi

Lakes, which experienced the greatest flooding (*ibid.*). Although levels in South Indian Lake walleye have since decreased, mean levels in pike in the same lake have remained between approximately 0.8 and 1.0 ppm (Hecky *et al.*, 1991). Bodaly et al. (1984) noted that mean concentrations in walleye and pike exceeded the Canadian, and usually the U.S., commercial limit in every lake on the Churchill, Rat and Burntwood Rivers that was flooded as a result of the Churchill diversion.

Although existing hydroelectric development in the Ontario section of the Hudson Bay/James Bay region (primarily on the Abitibi and Mattagami Rivers) is much smaller in scale than the projects already described, Ontario Hydro's Demand/Supply Plan (recently withdrawn) proposed most of Ontario's future hydroelectric development for the Moose River and tributaries (Headon & Pope, 1990). Monitoring in these river systems between 1975 and 1986 has shown that there are statistically significant differences between mercury levels in fish from the Abitibi, Moose and Mattagami Rivers, with the highest geometric mean levels (0.95 ppm) occurring in walleye from the Abitibi River (*ibid.*). Ninety-two per cent of fish sampled from the Abitibi exceeded the Canadian commercial limit (*ibid.*). Other data from specific sites along these systems included a mean concentration in walleye downstream of the Iroquois Falls generating station of 1.60 ppm and a mean concentration in pike in the Lake Abitibi reservoir of 1.21 ppm (*ibid.*). The contribution of natural sources of mercury as compared to hydroelectric facilities and other sources was not clear in this study. However, it was suggested that given the already elevated levels in this system, mitigative measures such as removal of vegetation prior to flooding may be relatively ineffective in terms of protecting fish-eating populations (*ibid.*).

Although increased levels of mercury in fish following hydroelectric development are well documented, there is considerable uncertainty regarding the expected duration of these effects. Current evidence indicates that the amount of time required to return to pre-development levels is sixteen years in lake whitefish in Quebec (Roy, 1990) and 15 to 20 years for pike in Finland (Verdun *et al.*, 1991). Similarly, estimates range from 20 to 30 years for pike in the La Grande complex to 150 years for pike in Manitoba (*ibid.*). Enhanced bacterial methylation of mercury has been demonstrated for as long as 60 years in some reservoirs in northern Manitoba (Hecky *et al.*, 1991).

In addition to monitoring of mercury levels in fish, levels have also been measured in fish-eating populations. Evidence from around the world indicates that levels in these populations are considerably higher than in non fish-eating groups (Brune *et al.*, 1991). In Canadian native populations, widespread monitoring began in the early 1970s (Wheatley, B., 1979). Various threshold hair and blood levels for mercury are summarized in table 6.

Table 6: Threshold levels for mercury in hair and blood

NATURE OF THRESHOLD	TISSUE	
	BLOOD (ppb)	HAIR (ppm or mg/kg)
Health and Welfare Canada:		
normal acceptable range	< 20	< 6
increasing risk	20-100	6-30
at risk (risk relates to potential neurologic effects)	> 100	>30
Cree Board of Health & Social Services:	-	
dietary counselling provided to adults		> 30
dietary counselling provided to women 15-39 years of age		> 15
medical examination recommended		> 60

Source: Wheatley, B., 1979; Dumont & Kosatsky, 1991, undated.
Note: Based on Canadian data, a factor of 300 is used to convert blood and hair levels of mercury.

The most detailed data for the Hudson Bay/James Bay region come from northern Quebec, where hair mercury levels are now monitored by the Cree Regional Board of Health and Social Services of James Bay. Before the transfer of health services, Health and Welfare Canada monitored mercury levels. Hair monitoring data indicate that levels vary significantly from one

community to another and among individuals, depending on diet. Monitoring in 1986 showed the highest mean levels in Whapmagoostui and Oujebougoumou at approximately 15 mg/kg and the lowest in Eastmain, at less than 5 mg/kg (Dumont & Kosatsky, undated). In 1984, the community with the greatest proportions of individuals above both the 30 and 60 mg/kg thresholds was Chisasibi, at the mouth of the La Grande River, with a significant increase in levels observed between 1977 and 1984, after completion of the reservoirs (Dumont & Kosatsky, 1991). In Wemindji, non-trappers had the lowest mean levels (6 mg/kg), followed by coastal trappers (8 mg/kg), with higher mean levels among interior trappers at a distance from reservoirs (approximately 10 mg/kg) and the highest amongst interior trappers near reservoirs (13 mg/kg) (*ibid.*). Among Wemindji trappers, median levels increased from 15 to 30 mg/kg between 1982 and 1985 (Dumont & Kosatsky, undated). Over time, there appears to have been a gradual decrease in mean levels in five Cree communities from approximately 20 mg/kg in 1984 to less than 10 mg/kg in 1989. This could be attributed to dietary changes resulting from counselling and the increased availability of other traditional food sources (Dumont & Kosatsky, 1991). A multivariate analysis of the Quebec data between 1975 and 1988 confirmed many of these findings. This showed that age, village, trapping activity, time period when testing was done (i.e., peak in 1984) and reservoir flooding (non-trappers only) were the most significant determinants of mercury levels, while the effects of gender and reservoir flooding (trappers) were less clear once these other factors were taken into account (Perrault, 1992).

Data for northern Manitoba communities affected by the Churchill-Nelson diversion are less extensive, but it is known that between 1971 and 1986, 35.3% and 24.7% of blood mercury levels exceeded 20 ppb in South Indian Lake and Nelson House, respectively. These percentages were higher than four other northern Manitoba communities, somewhat lower than Mistassini and Waswanipi, Quebec, and comparable to Chisasibi, Quebec, and Grassy Narrows and Whitedog, Ontario (Canada-Manitoba Mercury Agreement, 1987). In both of the aforementioned communities, several women of childbearing age had levels exceeding 20 ppb, including one woman in each community with a level exceeding 100 ppb. In Inuit communities where at least a hundred blood samples were taken between 1971 and 1982, the proportion of samples greater than 20 ppb ranged from 32% (Kuujjuaq) to 80-85% (Inukjuaq and Quaqtac) (Canada Health and Welfare, 1984). In Kinloch *et al.* (1992), the authors note that 58.6% (119

individuals) and 1.5% (3 individuals) of 203 Broughton Island residents sampled had blood mercury levels of between 20 and 99, and greater than 100 ppb, respectively.

Despite the fact that these data suggest significant relationships between hydroelectric development and mercury levels in native populations, it is unclear whether exposure to methylmercury has caused clinically apparent neurologic disease in these groups (Wheatley, B. *et al.*, 1979). Health and Welfare Canada's national monitoring program reported that, between 1971 and 1982, 599 individuals had blood levels greater than 100 ppb, most of whom were from Quebec and Ontario (Canada Health and Welfare, 1984; Wheatley, B., 1979). Of these, 99 underwent physical examinations, 27 of these had neurologic abnormalities not attributable to mercury, and 11 had neurologic abnormalities potentially, but not definitively, attributable to mercury (*ibid.*). On this basis it was concluded that "severe methylmercury poisoning ("Minamata Disease") had not been found in Canada [although] milder forms of mercury poisoning ... are possibly occurring" (*ibid.*).

A study of adults from Mistassini found that, with an increase of 20 mg/kg in hair mercury levels, males were 5.9 times as likely and females 2.1 times as likely to have clinically apparent neurologic deficits (McKeown-Eyssen & Ruedy, 1983). In Whapmagoostui, with the same increment in hair mercury levels, males and females were 3.3 and 1.6 times as likely to have deficits, respectively, but the results were not statistically significant (*ibid.*). These results correct for the important effects of age, and for females in one community, alcohol consumption. In male children from these two communities as well as Waswanipi and Chisasibi, an increase of 10 mg/kg in hair levels resulted in a seven-fold greater probability of mild abnormalities of reflexes and muscle tone (McKeown-Eyssen et al., 1983).

Another study among northern Quebec Cree in the vicinity of a chloralkali plant compared individuals who felt they had deficits related to mercury exposure (self-designees) to controls within and outside their own community (Spitzer *et al.*, 1988). Results were somewhat conflicting, but adjusting for age and sex, self-designees' mean hair mercury concentrations exceeded those of controls by 5.04 to 11.39 ppm. As well, the prevalence of neurologic abnormalities was greater in self-designees, and several neurologic outcomes were more common as hair mercury concentrations increased. However, the investigators could not reach any

conclusions about the existence of a causal relationship between self-reported health effects and the presence of the chloralkali plant.

ii) Other contaminants

Although mercury is probably the best documented of contaminants in the Hudson Bay/James Bay region, high levels of other contaminants have also been identified in the area. A study conducted among Inuit women in Povungnituk showed that there were significantly higher mean levels of PCBs in breast milk, as compared to caucasian women from southern Quebec. Mean levels were 111.3 μg/L and 3.60 mg/kg in whole milk and milk fat respectively, compared to levels of 28.4 and 0.77 in the caucasian women from southern Quebec (Dewailly *et al.*, 1989). Further data reported by Dewailly and co-workers have indicated similar results, while at the same time identifying higher levels of other organochlorines, including DDE, hexachlorobenzene, dieldrin and mirex in the milk of Inuit women, compared to other Quebec women (Dewailly *et al.*, in press). Differences in dioxin and furan levels between these two groups were smaller (Dewailly *et al.*, 1992). Dewailly *et al.* (1989) cited one study which found lower levels of PCBs in breast milk in native than non-native women. Kinloch *et al.* (1992) in their study in Broughton Island, NWT, found that approximately 60% of children had blood PCB levels exceeding the maximum *"tolerable level"* set by Health and Welfare Canada. Benedetti (1990) also reported blood levels of PCBs and DDE which were higher than international comparison groups. High levels of PCBs in body fluids have been attributed to contamination of the arctic food chain resulting from the long-range atmospheric transport of PCBs and other organochlorines from industrialized areas (Dewailly *et al.*, 1989).

It is unclear whether there are clinically significant health consequences for infants in relation to pre- and post-natal exposure to organochlorines (i.e., *in utero* and through breast milk, respectively). Conflicting results were obtained in a study of the relationship between organochlorine levels in maternal breast milk and birth weight, height, head circumference and levels of thyroid stimulating hormone (Dewailly *et al.*, 1993). With respect to exposure through breast milk, Dewailley *et al.* (1989) estimated that at levels measured in their study, blood levels in infants would reach the lowest level at which health effects have been observed (150 μg/kg) by 18 months of age.

Cadmium has also been identified as a potentially important contaminant in northern diets, particularly in relation to its concentrations in the kidneys and livers of caribou and moose. A risk assessment for Quebec Cree estimated that cadmium intake for this group ranged from 0.47 to 1.52 times the World Health Organization limit, depending on smoking and the consumption of liver and kidney. Total intake was most dependent on consumption of these organ meats (Archibald & Kosatsky, 1991). However, in a study of blood cadmium levels in Kuujjuaq, smoking appeared to be a more important determinant than diet (Benedetti *et al.*, 1992). Nevertheless, the Department of Community Health at McGill University has suggested that people under 50 years old not eat caribou and moose kidney because of cadmium contamination (Archibald *et al.*, 1988).

In a study of blood lead concentrations in children in northern Ontario, children in Moosonee had higher mean levels than those in Thunder Bay and North Bay (Goss, Gilroy and Associates, 1989), although recent data suggest levels may be decreasing (Lesbia Smith, Ontario Ministry of Health, Personal communication).

Contaminants originating in abandoned military and Distant Early Warning (DEW) line sites have also been identified as a potential source of PCBs to the environment (Government of Canada, 1990).

5.2.4 *Social, Economic and Cultural Factors*

As indicated in section 3, to understand the vulnerability of native communities in the Hudson Bay/James Bay region to adverse health effects of development, it is important to consider their pre-development characteristics in terms of subsistence activity, the degree of sociopolitical integration, and the incidence of health problems attributable to social disintegration.

With respect to subsistence activity, the 1983/4 Quebec Cree and Inuit health surveys reported that 60% of Inuit and 70% of Cree 15 years and older engaged in traditional non-wage activity, and 74% and 57%, respectively, were self-sufficient (i.e., not receiving transfer payments) (Foggin & Aurillon, 1989). Although socio-political integration is obviously difficult to measure directly, education, income and employment are probably important (recognizing also that income figures and unemployment rates cannot be compared directly between subsistence and wage economies). In the Keewatin health survey, the proportion of adults who had

completed some high school ranged from 14 to 49% in various age groups (Moffatt *et al.*, 1991), while overall, 58% of those 15 years and older in the 1991 Quebec Cree health survey reported having begun or completed high school (Clarkson *et al.*, 1993). Results from the 1983/4 Quebec Cree and Inuit health surveys indicated that 90% of those 15 years and older had less than ten years of education (Foggin & Aurillon, 1989). At the same time, one-half of men and two-thirds of women in the Keewatin health survey reported personal income (after deductions) of less than $10,000 and 30% of males were unemployed (Moffatt *et al.*, 1991). Thus, although there are likely to be important differences between individual communities with respect to these three factors, these data suggest that many communities in this region may be vulnerable to adverse health effects of development.

There is, nonetheless, conflicting evidence on the role of social, economic and cultural factors in mediating the effects of development on native health in the Hudson Bay/James Bay region. In one analysis based on the 1983/4 Quebec Cree health survey, there was some correlation between the proportion of "non-traditional" versus "traditional" individuals in a community and better respiratory health, as measured by pulmonary function and the lack of symptoms of chronic obstructive pulmonary disease (Foggin & Aurillon, 1989).

In another study of the Cree of Whitefish Lake, Manitoba, which was flooded by the Churchill-Nelson diversion, a community which was initially largely self-sufficient became increasingly dependent as the quality of the commercial fishery declined and traplines were flooded (Waldram, 1985). In this community, the number of social assistance claimants and mean per capita payments rose by 26 and 73 per cent, respectively, after the diversion was completed. A general process of sedentarization was also noted. In another study in Igloolik, sedentarization was associated with lower levels of physical fitness and a more rapid decline in physical fitness with age, compared to earlier measurements in the same population (Rode & Shephard, 1985; Shephard & Rode 1985). Significant dietary changes were also observed by Waldram, with increasing reliance on store bought foods, particularly for those families living in the community, as opposed to those living in the bush (see table 7).

Table 7: Dietary changes in Whitefish Lake, Manitoba, following the Churchill-Nelson diversion

	PROPORTION OF HOUSEHOLDS REPORTING COUNTRY FOOD AND STORE AS PRIMARY FOOD SOURCE (%)			
	PRE-DIVERSION		POST-DIVERSION	
HOUSEHOLD LOCATION	COUNTRY FOOD	STORE	COUNTRY FOOD	STORE
Community	86.7	13.3	17.8	82.2
Fishing Camp	82.2	17.8	60.0	40.0
Trapline	95.6	4.4	91.1	8.9

Source: Waldram, 1985.

In this study, a nutritional analysis of "country" versus store bought food showed significantly higher protein content and lower fat content in, for example, bear, hare, goose, ptarmigan and whitefish, compared to beef steak, roast and burger, wieners, pork roast and chicken (Waldram, 1983). Waldram also cited evidence of greater vitamin A and C content in country food, as compared with store bought fruits and vegetables (*ibid.*). Other relevant factors noted were increased consumption of sweets, and significantly greater food costs at local versus southern stores, potentially limiting choices to cheaper meat cuts and excluding the purchase of fruit and vegetables (*ibid.*). In a general sense, therefore, development appears to affect the self-sufficiency of communities, as well as resulting in the substitution of less nutritious store bought foods for traditional country foods.

Other dietary studies of native communities in the Hudson Bay/James Bay region suggest that the acculturation and changes in life style that accompany development affect diet, as reflected by increased consumption of store bought food in younger age groups. In the Keewatin health survey, more than 80% of adults over 55 years ate wildmeat daily, while only 45% of those between 18 and 34 did so (Moffatt *et al.*, 1991), and a similar trend was observed in Big Trout Lake, Ontario (Lawn, 1989). In the 1991 Quebec Cree health survey, 90% of those 65 years

and over thought country food was healthier than store bought food, while the figure for those 15 to 24 years was about 50% (Clarkson *et al.*, 1993).

It has been hypothesized that the increased consumption of less nutritious store bought food has contributed to the increased prevalence, as noted in section 5.1.4, of several chronic disease conditions, including obesity, diabetes, high blood pressure and dental caries. In one study of Quebec Cree and Inuit, the number of nutritional problems (deficiencies, elevated blood cholesterol and glucose and obesity) per survey respondent was correlated with lower levels of self-sufficiency in food as well as with greater tobacco and alcohol consumption and increased weight (Thouez *et al.*, 1989). In another study, Keewatin Inuit women with a lower consumption of fish had twice the incidence of pregnancy-induced high blood pressure (Popeski *et al.*, 1991). Other studies on country food consumption have examined the changing patterns of wild food use by the Cree (Berkes and Farkas, 1978) and the eating habits of Cree children (Bernard and Lavallée, 1993).

While it appears that development has significant effects on health, particularly as mediated by diet, the identification of contaminants in country foods has even more dramatic effects. For example, in Grassy Narrows and Whitedog, Ontario, it was estimated that fish consumption decreased by as much as 90% between 1970 and 1978, after mercury contamination was identified (Usher, 1990), and similar trends have been documented in several other native communities (LePage, 1991; Waldram, 1985; Weinstein, 1990; Wheatley, M. A., 1993). To some degree, these reflect the advice provided by health authorities. In 1975, for example, Health and Welfare Canada recommended that James Bay Cree communities temporarily suspend subsistence fishing (Lepage, 1991). This resulted in an 80% decrease in fish consumption in Waswanipi, Mistassini and Nemiscau (Perrault, 1992). Similarly, in 1984, the Cree Board of Health warned Chisasibi Cree to stop fishing in reservoirs, and most of this activity had ceased by 1986 (*ibid.*). More importantly, the decrease in fish consumption reflects diminishing confidence in the "purity" of country foods (Lepage, 1991; Wheatley, M.A., 1993), which in turn has wide-reaching social, economic and cultural ramifications. As noted by Usher (1990):

> For native northerners, country food is not only nutrition; it is the basis of ... subsistence ... as a *socioeconomic system* ... To the extent that native identity and sense of well-being in northern communities is based on subsistence as a social system and activity, as well as a dietary staple, loss of confidence in the very fish and animals that constitute its resource base undermines confidence in identity and society. (emphasis in the original)

Weinstein (1990) drew similar conclusions:

> ...the role of animal and natural environment transcends economics in modern native societies ... meaning, culture, historic continuity, and spirituality in such societies are all involved with life on the land.

A sense of "disorientation and anxiety" (Lepage, 1991) and loss of control (Usher, 1990) have also been identified, leading some native people to describe the process as the socio-cultural equivalent of rape.

So while development-related dietary changes appear to be associated with increased risks of chronic diseases such as obesity, diabetes and high blood pressure, these changes also have profound social, economic and cultural implications which in turn may contribute substantially to alcohol and drug use and epidemic levels of injury, poisoning and violence (Wheatley, B., 1993). Observations in Grassy Narrows and Whitedog, where rates of violence increased relative to neighbouring communities unaffected by mercury contamination (Usher, 1990), are consistent with this hypothesis.

5.2.5 *Biological Factors*

Biological factors probably play a limited role in explaining the observed differences between native health trends and the demographic and epidemiologic models. Nonetheless, there is good evidence that Inuit infants differ in their ability to mount immune responses to *Haemophilus influenzae* type b infections (Stieb *et al.*, 1990), which may partially account for the excess incidence of these infections in this population. Similarly, there is speculation that newly emerging chronic conditions, particularly obesity and diabetes, may represent a group of related disorders attributable to the combined impacts of acculturation, changing lifestyles (see section 5.2.4) and a basic metabolic defect (Young & Roche, 1990). The increased incidence of

cervical cancer in Inuit women has been attributed to earlier age of onset of menstruation, as well as other social and cultural factors (see sections 5.2.1 and 5.2.4).

6. Conclusions

The literature indicates that although native people in Hudson Bay/James Bay have experienced significant improvements in health status in recent years, their health is still considerably worse than that of other Canadians. Chronic diseases such as obesity, diabetes and high blood pressure have become more prevalent and injuries, poisonings and violence are at epidemic levels. In some native communities, the prevalence, and incidence of formerly infrequent chronic diseases have now surpassed those observed in non-native populations.

The studies reviewed in this paper suggest that these trends can be attributed to a variety of factors, the improved availability of health services, behaviours such as smoking and alcohol use, factors relating to the physical environment, social, economic and cultural changes and possibly biological differences between natives and non-natives.

The most important factors identified were the social, economic and cultural changes which have resulted from development-related contamination of the Hudson Bay/James Bay environment. Mercury contamination, in relation to hydroelectric development, is now well documented, but other contaminants, such as organochlorines and other metals, have also been detected. Native people who consume country foods are probably more highly exposed to contaminants than people who do not consume them. While evidence for direct toxic effects is inconclusive, the evidence for indirect effects is much stronger. For example, decreases in consumption of these foods and increased sedentarization have been linked to the increased prevalence of chronic conditions such as obesity, diabetes, high blood pressure and dental caries. In addition, the resulting social, economic and cultural changes have profoundly affected native self-sufficiency and, in turn, identity and well-being. This, in turn, may have contributed significantly to the very high levels of injuries, poisonings and violence in these communities.

Few studies have examined the relationships between the social, economic and cultural changes associated with development in native communities and individual and community psycho-social health, aside from those related to contaminants. Furthermore, most of the studies reviewed in this paper have focused on indicators of physical health, even though some indicators (e.g., injury, substance abuse, violence) suggest that the indirect and psycho-social

health effects of development may be at least as significant as the effects on physical health. This suggests that further research is needed on the social, economic and cultural changes associated with development in native communities, and especially effects on individual and community psycho-social health.

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REFERENCES

Adelson, N., 1990. Being alive well. Ph.D. Dissertation. McGill University. Montreal, Quebec.

Adelson, N. & T.K. Young, 1987. Introduction. In T.K. Young (ed.), *Diabetes in the Canadian native population: biocultural perspectives*. Canadian Diabetes Association, Toronto.

Archibald, C., Dumont, C., Kosatsky, T., Rich, H. and E. Robinson, 1988. Health recommendations regarding cadmium in caribou and moose. Department of Community Health. McGill University. Montreal, Quebec.

Archibald, C.P. & T. Kosatsky, 1991. Public health response to an identified environmental toxin: managing risks to the James Bay Cree related to cadmium in caribou and moose. Canadian Journal of Public Health 82:22-26.

Baxter, J.D., Julien, G., Tewfik, T.L., Ilecki, H.J. & M.B. Crago, 1986. Observations on the prevalence of ear disease in the Inuit and Cree Indian school population of Kuujjuaraapik. The Journal of Otolaryngology 15(1):25-30.

Benedetti, J.L., Turcotte, F., Lefebvre, M., Thernen, R., & J.P. Weber, 1992. Blood and urinary cadmium levels of Inuit living in Kuujjuaq, Canada. The Science of the Total Environment 127: 167-172.

Benedetti, J.L., 1990. The present status of the study on biological impregnation by contaminants in a sample of native residents of Kuujjuaq. In *Contaminants in the marine environment of Nunavik*. pp. 61-65. Proceedings of the conference, Montreal, September 12-14.

Benoit, D., Delisle, C.E. & M. Lapointe, 1989. *Analyses bactériologiques de l'eau brute, potable et usée de la municipalité de Kuujjuaq, Québec*. Le Centre d'Ingénierie Nordique de l'École Polytechnique de Montreal, Montreal, Québec.

Berkes, F. and Farkas, C.S., 1978. Eastern James Bay Cree Indians: changing patterns of wild food use and nutrition. Ecology of Food and Nutrition 7:155-172.

Bernard, L. and C. Lavallée, 1993. Eating habits of Cree schoolchildren: a pilot study. Community Health Department, Montreal General Hospital. Montreal, Quebec.

Billson, J.M., 1990. Violence Toward Women and Children. In M. Crnkovich (ed.), *"Gossip": a spoken history of women in the north*. pp. 151-162. Canadian Arctic Resources Committee, Ottawa, Ontario.

Blanchet, C., Cousineau, D., Foggin, P.M. & P. Lafontaine, 1992. *Highlights of the health survey conducted among the Inuit of northern Québec, 1983-1984*. Gouvernement du Québec, Ministère de la Santé et des Services Sociaux.

Bodaly, R.A., Hecky, R.E. & R.J.P. Fudge, 1984. Increases in fish mercury levels in lakes flooded by the Churchill River Diversion, northern Manitoba. Canadian Journal of Fisheries and Aquatic Sciences 41:682-691.

Bodaly, R.A. and T.A. Johnston, 1992. The mercury problem in hydro-electric reservoirs with predictions of mercury burdens in fish in the proposed Grande Baleine Complex, Quebec. James Bay Publication Series, Potential Environmental Impacts Series, paper No. 3 (November).

Brancker, A., 1992. Causes of Death 1990. Health Reports 4(2):185-189.

Brassard, P., Hoey, J., Ïsmail, J. & F. Gosselin, 1985. The prevalence of intestinal parasites and enteropathogenic bacteria in James Bay Cree Indians, Quebec. Canadian Journal of Public Health 76:322-325.

Brune, D., Nordberg, G.F., Vesterberg, O., Gerhardsson, L. & P.O. Wester, 1991. A review of normal concentrations of mercury in human blood. The Science of the Total Environment 100:235-282.

Canada Health and Welfare, 1984. *Methylmercury in Canada: exposure of Indian and Inuit residents to methylmercury in the Canadian environment.* Minister of National Health and Welfare, Ottawa, Ontario.

Canada-Manitoba Mercury Agreement, 1987. *Summary report: Canada-Manitoba Agreement on the study and monitoring of mercury in the Churchill River Diversion.* Governments of Canada and Manitoba.

Clarkson, M. & P.M. Foggin, 1990. *Highlights of the Cree health survey (1983-1984).* Gouvernement du Québec, Ministère de la Santé et des Services Sociaux.

Clarkson, M., Lavallée, C., Légaré, G. & M. Jetté, 1993. *Santé Québec health survey among the Cree of James Bay: features.* Gouvernement du Québec, Ministère de la Santé et des Services Sociaux.

Daviss-Putt, B.A., 1990. Rights of passage in the North: from evacuation to the birth of a culture. In M. Crnkovich (ed.), *"Gossip": a spoken history of women in the North.* pp. 91-114. Canadian Arctic Resources Committee, Ottawa.

Dewailly, E., Bruneau, S., Ayotte, P., Laliberté, C., Gingras, S., Belanger, D. and L. Ferron, 1993. Health status at birth of Inuit newborn prenatally exposed to organochlorines. Chemosphere 25(7-10):359-366.

Dewailly, E., Nantel, A., Bruneau, S., Laliberté, C., Ferron, L. & S. Gingras, 1992. Breast milk contamination by PCDDs, PCDFs and PCBs in arctic Quebec: a preliminary assessment. Chemosphere 25:1245-1249.

Dewailly, E., Nantel, A., Weber, J.P. & F. Meyer. 1989. High levels of PCBs in breast milk of Inuit women from arctic Quebec. Bulletin of Environmental Contamination and Toxicology 43:641-646.

Dumont, C. & T. Kosatsky, undated. Methylmercury in northern Canada. Cree Board of Health and Social Services of James Bay and Department of Community Health, Montreal General Hospital. 25 pp.

Dumont, D. & T. Kosatsky, 1991. Évolution de l'exposition au mercure chez les trappeurs cris de la Baie James. Colloque, Les Enseignements de la Phase I du Complexe La Grande, mai.

Ekos Research Associates, 1985. *Summary report: evaluation of the on reserve housing program.* Ekos Research Associates, Ottawa. Cited in Young, T.K., Bruce, L., Elias, J., O'Neil, J.D. & A. Yassie, 1991. *The health effects of housing and community infrastructure on Canadian indian reserves.* Northern Health Research Unit, Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.

Enarson, D.A. & S. Grzybowski, 1986. Incidence of active tuberculosis in the native population of Canada. Canadian Medical Association Journal 134:1149-1152.

Foggin, P.M. & N. Aurillon, 1989. Respiratory health indicators and acculturation among the Inuit and Cree of northern Quebec: a regional approach using geographic seration analysis. Social Science and Medicine 29(5):617-626.

Foggin, P.M. & H. Lauzon, 1987. *État de santé et facteurs de risque: les cris du nord Québecois.* Département de Géographie, Université de Montréal, Montréal, Québec.

Goss, Gilroy and Associates, 1989. Blood level concentrations and associated risk factors in a sample of northern Ontario children. Report prepared for the Ontario Ministries of the Environment and Health. Toronto, Ontario.

Government of Canada, 1990. *Canada's green plan.* Minister of Supply and Services, Ottawa.

Government of Quebec, 1989. *Drugs and alcohol abuse in Cree, Inuit and Naskapi communities: report by the interdepartmental committee on drug and alcohol abuse.* Government of Quebec, Quebec City.

Haan, M., Kaplan, G.A. & T. Camacho, 1987. Poverty and health: prospective evidence from the Alameda County study. American Journal of Epidemiology 125(6):989-98.

Headon, C.M. & G.F. Pope, 1990. *Cumulative impact of mercury contamination of fish in the Moose River System - a review of MOE data.* Ontario Ministry of Environment, Environmental Studies and Assessments Department.

Hecky, R.E., Ramsey, D.J., Bodaly, R.A. & N.E. Strange, 1991. In T. Suzuki *et al.* (eds.), *Advances in mercury toxicology.* pp. 33-52. Plenum Press, New York.

Hildes, J.A. & O. Schaefer, 1984. The changing picture of neoplastic disease in the western and central Canadian Arctic (1950-1980). Canadian Medical Association Journal 130:25-32.

Hudson Bay Program, 1993. Proceedings of the workshop on cumulative impact assessment in the Hudson Bay Bioregion. Draft. Canadian Arctic Resources Committee, Environmental Committee of Sanikiluaq and Rawson Academy of Aquatic Science, Ottawa, Ontario.

Huebert, E.J., 1982. *The functioning of environmental health delivery systems in remote northern Manitoba communities* (Dissertation). University of Manitoba, Winnipeg, Manitoba. Cited in Young, T.K., Bruce, L., Elias, J., O'Neil, J.D. & A. Yassie, 1991. *The health effects of housing and community infrastructure on Canadian Indian reserves.* Northern Health Research Unit, Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.

Hydro-Québec, 1993. *Grande-Baleine Complexe feasibility study: part 2 hydroelectric complex, book 2 description of environment, Volume 3, Human Environment.* Groupe Équipement, Hydro Québec.

Julien G., Baxter, J.D., Crago, M., Ilecki, H.J. & F. Therien, 1987. Chronic otitis media and hearing deficit among native children of Kuujjuaraapik (northern Quebec): a pilot project. Canadian Journal of Public Health 78:57-61.

Kaufert, P., Moffatt, M., O'Neil, J., and B. Postl. 1990. The epidemiology of obstetric care in the Keewatin district: methodological issues. In O'Neil, J., and P. Gilbert (eds.), Childbirth in the Canadian North: epidemiological, clinical, and cultural perspectives. Northern Health Research Unit. University of Manitoba Monograph Series 2:5-11.
Kilunik, M., 1990. (Dogs Barking). In M. Crnkovich (ed.), *"Gossip": a spoken history of women in the North.* pp. 115-118. Canadian Arctic Resources Committee, Ottawa.

Kinloch, D., Kuhnlun, H. and D.C.G. Muir. 1992. Inuit foods and diet: a preliminary assessment of benefits and risks. Science of the Total Environment 122:247-278.

Kordová, N., Wilt, J.C., Selka, L., Stackiw, W., Feltham, S., Postl, B. & L. E. Nicolle, 1983. High prevalence of antibodies to *chlamydia trachomatis* in a northern Canadian community. Canadian Journal of Public Health 74:246-249.

Kurland, L.T., Faro, S.N. and H. Siedler. 1960. Minamata disease. The outbreak of a neurological disorder in Minamata, Japan, and its relationship to the ingestation of seafood contaminated by mercuric compounds. World Neurology 1:370-395.

Lawn, J., 1989. PCB dietary survey, Big Trout Lake (preliminary report). Cited in Davies, K., 1992. Proposed approach for a study to determine contaminant intakes from food by native peoples in the Great Lakes basin (draft). Prepared for Medical Services Branch, Health and Welfare Canada, Ottawa.

LePage, L., 1991. *Economic and socio-cultural aspects of the mercury problem among the Cree of the James Bay Region: progress report (draft).* Castonguay, Dandenault and Assoc., prepared for the Cree Board of Health and Social Services.

Lockhart, W.L., 1990. Mercury and other stable contaminants in northern ecosystems. In *Contaminants in the marine environment of Nunavik.* pp. 27-31. Proceedings of the conference, Montreal, September 12-14.

Marmot, M.G., Kogevina, M. & M.A. Elston, 1987. Social/economic status and disease. Annual Reviews in Public Health 8:11-35.

McKeown-Eyssen, G.E. & J. Ruedy, 1983. Methyl mercury exposure in northern Quebec I. neurologic findings in adults. American Journal of Epidemiology 118(4):461-469.

McKeown-Eyssen, G.E., Ruedy, J. & A. Neims, 1983. Methyl mercury exposure in northern Quebec I. neurologic findings in children. American Journal of Epidemiology 118(4):470-479.

Moffatt, M.E.K., 1987. Land settlements and health care: the case of the James Bay Cree. Canadian Journal of Public Health 78:223-227.

Moffatt, M.E.K., O'Neil, J.D., Young, T.K., Brown, R., MacDonald, W., Postl, B.D., Russell, F. & G.W. Thompson. 1991. *Keewatin health status assessment study.* For the Keewatin Regional Health Board by Northern Health Research Unit, Deptartment of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.

O'Neil, J.D., 1990. Environmental health impact assessment in northern Canada: a discussion paper. Northern Health Research Unit, Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.

O'Neil, J.D., Kaufert, J.M. & W.W. Koolage, 1990a. *Final report: a study of medical interpreters and health communication in Inuit communities.* Departments of Community Health Sciences and Anthropology, University of Manitoba, Winnipeg, Manitoba.

O'Neil, J.D., Kaufert, P.L., Postl, B.D., Binns, B., Brown, R., Brown, P., Ernerk, P., Moffatt, M. & E. Voisey. 1990b. *A study of the impact of obstetric policy on Inuit women and their families in the Keewatin Region, NWT: final report.* Northern Health Research Unit, Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.

Ontario Ministry of Health, 1992. *Ontario health survey: highlights.* Ontario Ministry of Health.

Ontario Premier's Council on Health Strategy, 1991. *Nurturing health: a framework on the determinants of health.* Queen's Printer for Ontario, Toronto.

Ottawa Charter for Health Promotion. 1986. Canadian Journal of Public Health 77:425-473.

Pampalon, R., 1993. Avoidable mortality in Quebec and its regions. Social Science and Medicine 37(6):823-831.

Paulette, L., 1990. The family centre maternity care project. In M. Crnkovich (ed.), *"Gossip": a spoken history of women in the North.* pp. 71-88. Canadian Arctic Resources Committee, Ottawa.

Perrault, A., 1992. *Factors affecting methylmercury levels among the Cree of James Bay: an analysis of surveillance data from 1975 to 1988.* Cree Board of Health and Social Services of James Bay.

Popeski, D., Ebbeling, L.R., Brown, P.B., Hornstra, G. & J.M. Gerrard, 1991. Blood pressure during pregnancy in Canadian Inuit: community differences related to diet. Canadian Medical Association Journal 145(5):445-454.

Robinson, E., 1988. The health of the James Bay Cree. Canadian Family Physician 34:1606-1613.

Robinson, E. & M.E.K. Moffatt, 1985. Outbreak of rotavirus gastroenteritis in a James Bay Cree community. Canadian Journal of Public Health 76:21-24.

Rode, A. & R.J. Shephard. 1985. "Future shock" and the fitness of the Inuit. In R. Fortuine (ed.), *Circumpolar health 84: proceedings of the sixth international symposium on circumpolar health.* pp. 41-44. University of Washington Press, Seattle and London.

Roy, D., 1990. Concentration en mercure des salmonidés de la région de l'embouchure de La Grande Rivière. In C.E. Delisle & M.A. Bouchard (eds.), *Collection environnement et géologie.* Vol. 9:93-118.

Sammons, S., 1990. Band-aid solutions for family violence. In M. Crnkovich (ed.), *"Gossip": a spoken history of women in the North.* pp. 121-124. Canadian Arctic Resources Committee, Ottawa.

Shaw, L., 1987. The oral health status of Cree children living in Chisasibi, Quebec. Journal of the Canadian Dental Association 3:201-205.

Shephard, R.J. & A. Rode, 1985. Acculturation and the biology of aging. In R. Fortuine (ed.), *Circumpolar health 84: proceedings of the sixth international symposium on circumpolar health.* pp. 45-48. University of Washington Press, Seattle and London.

Smeja, C., 1992. Notifiable infectious diseases report region 10B 1984-1991. Northern Quebec Module, Department of Community Health, Montreal General Hospital. Montreal, Quebec.

Spitzer, W.O., Baxter, D.W., Barrows, H.S., Thomas, D.C., Tamblyn, R., Wofson, C.M., Dinsdale, H.B., Dauphinee, W.E., Anderson, D.P., Roberts, R.S., Palmer, W.H., Hollomby,

D., Reiher, J., Alleyne, B.C. & B.E. Helliwell, 1988. Methylmercury and the health of autochotones in northwest Quebec. Clinical and Investigative Medicine 11(2):71-98.

Stieb, D.M., Frayha, H.H., Oxman, A.D., Shannon, H.S., Hutchison, B.G. & F.S.S. Crombie, 1990. Effectiveness of h*aemophilus influenzae* type b vaccines. Canadian Medical Association Journal 142(7):719-733.

Sutherland, M.A., 1990. Tawow society reaches out to families in need. In M. Crnkovich (ed.), *"Gossip": a spoken history of women in the North.* pp. 121-124. Canadian Arctic Resources Committee, Ottawa.

Tanner, C.E., Staudt, M., Adamowski, R., Lussier, M., Bertrand, S. & R.K. Prichard, 1987. Seroepidemiological study for five different zoonotic parasites in northern Quebec. Canadian Journal of Public Health 78:262-266.

Thouez, J.P., Rannou, A. & P. Foggin, 1989. The other face of development: native population, health status and indicators of malnutrition - the case of the Cree and Inuit of northern Quebec. Social Science and Medicine 29(8):965-974.

Tyler, C.W. & J.M. Herold, 1992. Public health and population. In J.M. Last & R.B. Wallace (eds.), *Maxcy-Rosenau-Last public health and preventive Medicine*, 13th Editionm Appleton & Lange, Norwalk, Connecticut.

Usher, P.J., 1990. Socio-economic effects of elevated mercury levels in fish in sub-Arctic native communities. In *Contaminants in the marine environment of Nunavik.* pp. 45-50. Proceedings of the conference, Montreal, September 12-14.

Verdun, R., Schetagne, R., Demers, C., Brouard, D. & R. Lalumière, 1991. Évolution de la concentration en mercure des poissons du complexe La Grande. Colloque, Les Enseignements de la Phase I du Complexe La Grande, mai.

Waldram, J.B., 1983. *The impact of hydro-electric development upon a northern Manitoba native community* (Ph.D. Dissertation). University of Connecticut.

Waldram, J.B., 1985. Hydroelectric development and dietary delocalization in northern Manitoba, Canada. Human Organization 44(1):41-49.

Walter, S.D., 1991a. The ecologic method in the study of environmental health. I. overview of the method. Environmental Health Perspectives 94:61-65.

Walter, S.D., 1991b. The ecologic method in the study of environmental health. II. methodologic issues and feasibility. Environmental Health Perspectives 94:67-73.

Weinstein, M., 1990. Notes for understanding the impact of contaminants on native subsistence economies. In *Contaminants in the marine environment of Nunavik.* p. 51. Proceedings of the conference, Montreal, September 12-14.

Wheatley, B., 1993. A new approach to assessing the effects of environmental contaminants on aboriginal peoples. Paper presented to the 9th International Congress on Circumpolar Health, Reykjavik, Iceland.

Wheatley, B., 1979. Methylmercury in Canada: exposure of Indian and Inuit residents to methylmercury in the Canadian environment. Department of National Health and Welfare. Ottawa, Ontario.

Wheatley, B., Barbeau, A., Clarkson, T.W. & L. Lapham, 1979. Methylmercury poisoning in Canadian Indians - the elusive diagnosis. Canadian Journal of Neurological Sciences 5(4):417-422.

Wheatley, M.A., 1993. Aboriginal health and the environment. Paper presented to the 9th International Congress on Circumpolar Health, Reykjavik, Iceland, June 20-25.

Wheatley, M.A., 1990. Developing an integrated traditional clinical health system in the Yukon. Proceedings of the VIII International Congress on Circumpolar Health. Whitehorse, Yukon.

Young, D.E. & L.L. Smith, 1992. *The Involvement of Canadian native communities in their health care programs: a review of the literature since the 1970's.* Canadian Circumpolar Institute and Centre for the Cross-Cultural Study of Health and Healing, University of Alberta, Edmonton, Alberta.

Young, T.K., 1983. The Canadian North and the Third World: is the analogy appropriate? Canadian Journal of Public Health 74:239-241.

Young, T.K., 1988. Are subarctic Indians undergoing the epidemiologic transition? Social Science and Medicine 26(6):659-671.

Young, T.K., 1991. Prevalence and correlates of hypertension in a subarctic Indian population. Preventive Medicine 20:474-485.

Young, T.K. & B.A. Roche, 1990. Factors associated with clinical gallbladder disease in a Canadian Indian population. Clinical and Investigative Medicine 13(2):55-59.

Young, T.K. & G. Sevenhuysen, 1989. Obesity in northern Canadian Indians: patterns, determinants and consequences. American Journal of Clinical Nutrition 49:786-793.

Young, T.K., Sevenhuysen, G.P., Ling, N. & M.E.K. Moffatt, 1990a. Determinants of plasma glucose level and diabetic status in a northern Canadian Indian population. Canadian Medical Association Journal 142(8):821-830.

Young, T.K., Szathmary, E.J.E., Evers, S. & B. Wheatley, 1990b. Geographic distribution of diabetes among the native population of Canada: a national survey. Social Science and Medicine 31(2):129-139.

Young, T.K., Bruce, L., Elias, J., O'Neil, J.D. & A. Yassie, 1991. *The health effects of housing and community infrastructure on Canadian Indian reserves.* Northern Health Research Unit, Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.

Young, T.K., Schraer, C.D., Shubnikoff, E.V., Szathmary, E.J.E. & Y.P. Nikitin, 1992. Prevalence of diagnosed diabetes in circumpolar indigenous populations. International Journal of Epidemiology 21(4):730-736.

Appendix 1.– List of Key Informants and their Affiliations

Contact	Organization
	Baffin Regional Health Board
Dr. Eric Dewailly	Department of Community Health Centre Hospitalier de l'Université Laval
Dr. Charles Dumont	Cree Board of Health and Social Services of James Bay
Dr. Peter Foggin	Department of Geography, University of Montreal
Mr. Randy Kapasheesit	Moose Factory Program Queen's University
Mr. Robert Kielly	Keewatin Regional Health Board
Ms. Claudette Lavallée	Montreal General Hospital, Department of Community Health
Mr. Andrew Matthewson	Moose Factory, Ontario
Dr. Michael Moffatt	Department of Community Health Sciences, University of Manitoba
Dr. John O'Neil	Department of Anthropology, University of Manitoba
Ms. Mary-Anne Pietrusiak	Ontario Ministry of Health, Ontario Health Survey
Mr. Jim Ransom	Drinking Water Safety Program, Assembly of First Nations
Ms. Lesbia Smith	Ontario Ministry of Health
Ms. Ann Snider	Department of Indian Affairs and Northern Development (Canada)

Dr. Brian Wheatley	Health Canada
Dr. Margaret Wheatley	Consultant
Dr. Paul Wilkinson	Paul Wilkinson and Associates
Dr. T. Kue Young	Northern Health Research Unit, University of Manitoba