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The Impact of Dietary Changes Among the Inuit of Nunavik (Canada): A Socioeconomic Assessment of Possible Public Health Recommendations Dealing with Food Contamination

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Inuit populations meet a large portion of their food needs by eating country food in which pollutants are concentrated. Despite the fact that they contain pollutants, the consumption of country food has many health, social, economic, and cultural benefits. A risk determination process was set up in order to help regional health authorities of Nunavik to deal with this particular issue. Based on Nunavik health authorities' objectives to encourage the region's inhabitants to change their dietary habits, and on both the risks and the benefits of eating country food, several management options were developed. The options aimed at reducing exposure to contaminants by either substituting certain foods with others that have a lower contaminant content or by store-bought foods. This article aims at assessing the potential economic impact of these risk management options before being implemented. Relevant economic data (aggregate income and monetary outlays for the purchase of food and equipment required for food production by households) were collected and identified to serve as a backdrop for the various replacement scenarios. Results show that household budgets, and the regional economy, are not significantly affected by the replacement of contaminated foods with the purchase of store-bought meat, and even less so if the solution involves replacing contaminated foods with other types of game hunted in the region. When financial support is provided by the state, the households can even gain some monetary benefits. Results show that public health authorities' recommended changes to dietary habits among the Inuit of Nunavik would not necessarily involve economic constraints for Inuit households.

KEY WORDS: Dietary habits; economic impacts model; food contamination; Inuit; Nunavik; risk management

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1. INTRODUCTION

1.1. Food Issues and Stakes in Inuit Communities

Although located far away from industrial areas, the Arctic regions are significantly affected by pollution. Ocean and air currents carry various pollutants to the north. Food is also a medium of contaminant exposure, as toxic substances find their way into the

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food chain.[1] Aboriginal people, especially the Inuit, whose diet comprises products from the hunting and fishing of animals, are especially exposed to contaminants. In Nunavik, Inuit populations meet a large portion of their food needs by eating the meat and fat of marine mammals, such as seal, beluga, and fatty fish, such as char, in which pollutants are bio-accumulated and concentrated. For instance, in this region where country food[4] accounts for two-thirds of all the meat and fish products consumed,[2] and of which more than 11% comes from marine resources,[3] studies conducted over the past decade have shown that the level of various persistent organic pollutant (POPs) compounds, and mercury, exceed acceptable intake levels.[4–7] These toxic chemicals are a health hazard. Recent studies suggest they may have potential effects on children's brain development, on endocrine functions, the immune system, and may be responsible for cardiovascular diseases. Furthermore, health risks may be underestimated when considering the combined effects of various toxic substances.[1]

These particular environmental problems pose a challenge to public health officials and community leaders in the Arctic. Indeed, issues of contamination management of the food chain have multiple and significant implications for the Aboriginal populations, and there is no straightforward solution such as just removing the contaminated food from the diet. First, in Nunavik, country foods are still a vital source of essential nutrients,[8] and the consumption of country meat and fish, especially marine mammals, is associated with other health benefits, despite the level of pollutants they contain.[4] For example, recent studies have shown that because of the presence of certain nutrients, such as fatty acids of the omega-3 type in fish and sea mammal products, the consumption of these foods helps to protect against cancer and heart disease, which are major causes of death in industrial societies, and may act as antidotes against some toxic substances.[4,7] Second, one must take into consideration the fact that the use of country foods is associated with fundamental aspects of the social, cultural, and economic life of the Inuit of the Canadian North. Country food is preferred over imported meats and foods,[9–11] which are very costly and represent a poor-quality alternative to country fish and game.[12,13] In Nunavik, the sale of country food still provides a significant income to many households, and the sharing of it is vital to many others who cannot afford the means to produce it.[3] Moreover, the harvesting, sharing, processing, and eating of country meat and fish are key components of their spiritual life and identity, and are intertwined.[4,14–17]

In light of all the above-mentioned factors, health risks related to country food consumption cannot be considered solely from the viewpoint of being a physical hazard. Determining health risks requires, therefore, that one assess both the risks, and the benefits, of eating country food.[18] This article will focus more specifically on the economic factors involved in the determination of risk with regard to the contamination of country food in Nunavik.

Nunavik is the northernmost region of the province of Québec in Canada (Fig. 1). In 1995, we estimated that 7,800 Inuit (of a total population of 8,700)[5] were living in 14 villages whose population varied between 160 and 1,700 people. With the exception of Kuujjuaq, whose larger population included 30% non-Inuit, and where most of the administrative offices are located, the villages do not differ significantly from one another. The economic activities revolve primarily around the provision of services to the population, and on hunting and fishing for family use.

1.2. Risk Determination and Economic Factors

The process of assessing risk and benefit is referred to as a *risk determination* model. The model proposed by Health Canada[18] is twofold. First, a risk assessment process takes place during which risk hazards are identified. This step is followed by the development and evaluation of management options based on objectives that aim at decreasing risk through various strategies. Second, a risk management process involves selecting the appropriate risk management option and developing strategies that will further be monitored and, in some cases, be reevaluated. It is important to stress that while the risk assessment process is based largely on scientific analysis and evaluation, risk management is a decision-making process that incorporates cultural, economic, and other socially important values.[19]

The Avativut/Ilusivut Program (Our Health/Our Environment) was set up in 1994 to help regional health authorities of Nunavik to deal with issues of country food contamination.[20] Following the model of risk determination described above, the Program initially focused on the risk assessment of pollution:

[4] Country food is the commonly used term that refers to food coming from local resources (such as wild game, fish, and plants), which is mostly produced by individuals and their families.

[5] According to the Statistics Canada 1996 census.

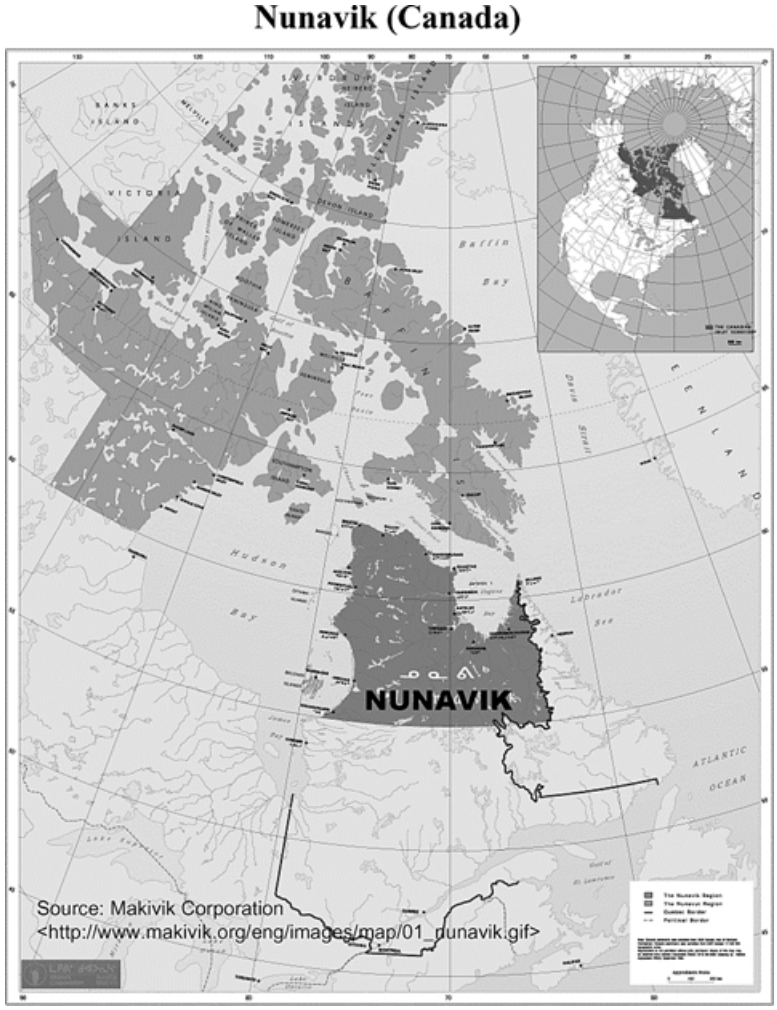

Fig. 1. Map locating Nunavik (Canada).

identification of the levels of exposure and the sources of contamination, and of the possible effects on human health. Then, four management options, or recommendations, were developed. Based on the Nunavik health authorities' objectives to encourage the region's inhabitants to change their dietary habits, the options aim at reducing organochlorine (PCBs) intake by substituting certain foods with others that have a lower contaminant content, or by increasing the consumption of foods that have special health properties. Consideration was given to health risks, as well as to the health benefits, of eating the blubber and the skin of seal and beluga, of char flesh, and by focusing on the nutritional value of key nutrients such as omega-3 fatty acids. The results of this process are described in Dewailly *et al.*[21] and detailed recommendations and scenarios are reproduced in Table I.

Usher[22] has identified certain difficulties with regard to the implementation of a risk management plan. Indeed, to be effective, special consideration must be given to other factors, such as the public perception of risk; social, political, and economic implications of the options; and the uncertainties in risk estimation. As we can see, the scenarios of Table I imply significant changes in eating habits. They are likely to influence the way monetary resources are allocated; for instance, whether or not money is used to either buy more means of production (more gasoline, equipment maintenance, etc.), or more imported food. They also entail further changes in hunting and fishing practices. Any decision about the contamination of food that conflicts with subsistence and economic needs may result in undesired outcomes. For instance, solutions determined to prevent health risks can place additional stress upon the household budget, which in

Recommendations	Scenarios
1. 46% reduction in PCB consumption and increase in omega-3 fatty acids consumption	1.1: Replace beluga skin with store-bought meat 1.2: Replace beluga blubber with seal fat
2. 65% reduction in PCB consumption	2.1: Replace beluga skin and blubber with store-bought meat 2.2: Replace beluga skin and blubber with other types of game
3. 86% reduction in PCB consumption	3.1: Replace beluga skin and blubber as well as seal fat with store-bought meat 3.2: Replace beluga skin and blubber as well as seal fat with other types of game
4. Increased consumption of omega-3 fatty acids by pregnant women	4.1: Daily consumption of arctic char by pregnant Inuit women

Table I. Risk Management Options: Food Replacement Recommendations and Scenarios[a]

[a]For Recommendations 1–3, see Dewailly *et al.*[22]; for Recommendation 4, see Fréchette *et al.*[23]

turn can affect people's health and well-being. Weighing health risks against economic risks is no simple task. However, health hazards are imposed, and are often difficult to control, while economic factors can be alleviated by political decisions. Mitigations can include financial relief to hunters and families, importing food from other regions, etc.

This article aims at evaluating the economic impact of these risk management options before their implementation by the Nunavik public health authorities. In addition, this study seeks to provide the scientific community with an operational model of economic assessment in risk management of environmental pollution.

This study relies on an evaluation of the Nunavik economy and on a simulation model of the economy. The methods used to deal with these two tasks will be described in the next section. Then, the results regarding the simulation of the economic impact of the various management scenarios will be presented and discussed. For each scenario, the economic impact will be measured by considering, or not considering, financial support from higher levels of government designed to encourage changes in eating habits.[6]

2. METHODOLOGY

2.1. Evaluating the Household Economy

The Nunavik economy comprises commercial activities (e.g., purchase of imported foods in stores, wage work, etc.), as well as customary activities (i.e., production, distribution, exchange, and consumption of game). In Nunavik, both types of activities are closely related and affect all other sectors of the regional economic life. However, customary activities, which mainly involve individuals and households, are usually excluded from official economic statistics. This means that the part of the economy that is especially connected with the contamination issue cannot be estimated without a special investigation of Inuit household economics.[7]

Data on household economics (budget) were collected from a sample of households selected in two villages of Nunavik. In this study the household is the basic unit of analysis. Household economics consists of (1) income comprising monetary revenues from various sources (wages, sales of production, transfer payments) as well as nonmonetary revenues (nonmarket exchange of meat, production); and (2) expenditures that comprise all monetary outlays for the purchase of food and equipment required for hunting.

A quota sample was used to determine the number of households selected in each village. Although nonprobabilistic in nature, this type of sampling allows representation of the distribution of specific characteristics of a population. This method is especially relevant when distribution of these characteristics is well known, and when tests of significance are not to be performed, which was the case here.[23] The quotas were fixed at two levels. First, at the village level, one large (~1,000 inh.) and a smaller village (~500 inh.) were selected, each representing the typical distribution of Nunavik villages. The population

[6] For a detailed account of the study done on the economic impact of management options within the Avativut/ Ilusivut Program, see Duhaime.[3]

[7] For clarifications on the methodology used, see Duhaime[3] (pp. 53–83).

size of a village was assumed to affect economic activities. At the household level, quotas were set according to the presence of a male head, and his occupation. Considering the traditional division of labor among the Inuit, the presence and the occupation of a male head of the household are considered valid indicators of the ability to engage in harvesting activities and, consequently, to influence economic practices.[2,24–26]

These two variables were used to construct a typology of three types of households within which all households of each of the two villages were distributed, namely: (1) households with a male head as wage earner; (2) households with a male head without regular employment; and (3) households headed by a woman. Using a consumption survey questionnaire modified to include customary economic activities, interviews were conducted during the summer of 1995 with 47 heads of households (27 households in the larger village and 20 households in the smaller village). The budget of 40 households was reconstructed and data were imputed to all the households of the two villages according to the quota characteristics of the three household types. Then, results for each village were imputed to the other villages according to their size.[8] Additional information was obtained from various official local and regional sources, mostly statistics, surveys, and lists from organizations and businesses. These were to be used either to control data, or to supplement them at the household level (e.g., age or composition of a household compared with official population lists) as well as at the village level (e.g., number of walrus killed).

The final result of these operations was a quantitative profile of an average Inuit household's annual budget whose data were integrated in the Nunavik economic portrait for simulation.

In 1995, the annual monetary income (gross income) from wages was estimated at $26,000, representing 70% of the total monetary income. Transfer payments, the second most important source of income, provided an average of almost $10,000 (or 27%) per household. Finally, sales of household production, namely, country food and handicrafts, brought around $1,000 per household, of which $400 came from the sale of game.[9] Nonmonetary income was estimated at $2,200 per household annually. This amount was based on the replacement value of country food (meat, fish, and berries at market price locally) that was directly consumed by households without having been exchanged on the market.[10] As regards to consumer expenditures, food purchases accounted for 55% of the total household expenditures, including 44% for groceries,[11] and 11% for household production activities (these include equipment, gasoline, maintenance, camping, hunting and fishing gear, ammunition). As a matter of fact, each household was spending almost $4,000 on hunting and fishing operations.

The evaluation of the consumption of country food by species, based on the 1992 Santé Québec dietary survey,[12] was used to calculate the total quantity of country food consumed in Nunavik to be substituted in each of the management scenarios. The

[8] Detailed methodology is described in Duhaime.[3] Our sampling methodology poses at least two problems that relate to the representation of the sampled units. First, in this study, it is assumed that households with similar characteristics behave alike. As a matter of fact, we have found numerous similarities from one household to another, based on the two variables (composition and occupation of the male head), which justifies the use of generalization from quotas. It should be noted that households headed by a male without a regular job are overrepresented (49% in our sample vs. 38% of villages households), whereas households headed by a male wage earner are underrepresented (30% vs. 36%). The special effort made to gather data from active hunters may explain these sample characteristics. Thus, the data may tend to overrepresent the number of families that were more intensively engaged in traditional activities. Second, with regards to the sampled villages, our methodology supposed that data apply to another village with same population size. However, results for Kuujjuaq should be read carefully, since it is the regional administrative center, with a population of more than 2,000 inhabitants.

[9] All figures are in 1995 Canadian dollars. The survey conducted in 1995 showed that the annual harvest (in edible weight) was close to 1,300 kg per household. The proportion allocated to food consumption is estimated at 27% (including 13% sold on the market, and 14% circulating within the customary networks), with the proportion not used for human food, and the destination of which cannot be determined, estimated at 73%.[3] Many factors can explain this high figure for nonconsumption of food. It could be the result of the overestimation of the edible weight. Differences can be highly significant depending on the method used (e.g., total edible weight of production is 20% lower when using Smith[27] edible weight figures). Another 25% can be explained by waste associated with the normal preparation of meals and we have estimated that another 10% of the food is given to dogs. Both uses have not been taken into consideration. See Chabot[28] (e.g., p. 278) for a thorough discussion. With respect to less incomplete use of hunting production, see Myers[29] or Cooch.[30]

[10] We have considered the value of the food used by the household that had never been exchanged on the market, including the Hunter Support Program, which reduced considerably the value of country food. Chabot[28] revisited some of the premises of this hypothesis and came up with a higher replacement value ($3,233).

[11] By comparison, 1992 data show that Canadian households devoted an average of 12% of their total expenditures to food.[3,31]

[12] Data are borrowed from the food preferences survey based on the consumption of 178 women aged 18–74 years. Consumption for men is based on that of women adjusted according to Lawn and Langner,[13] whose data derive from the same survey.

results are as follows: 33,000 kg of beluga skin (with a little bit of blubber); 5,500 kg of beluga blubber; 4,100 kg of seal blubber.

This study's methodology used to estimate the household budget has limitations. Some are related to the difficulties regarding the use of interviews to evaluate the customary sectors of the economy, such as the annual harvest and the costs of production. There are also limits to ascribing data from a small sample to a large and diverse population, which could lead to over- or underestimation, without knowing the margin of error. Data collection and processing impose a series of choices and assumptions, although it is believed that these choices do not limit the validity of results.[13]

2.2. Nunavik Economy and Regional Simulation Model

One of the tools used to assess the economic impact of changes in behavior regarding regional production and standard of living is the Nunavik socioeconomic simulation model.[14] The two basic components of this model are a Social Accounting Matrix (SAM) and the Computable General Equilibrium Model (CGEM). The SAM provides a profile of the total economy of Nunavik, where expenditures and revenues represent the value of the transactions between economic agents. In every instance, total revenues must correspond to total expenditures in order to ensure the coherency of results.

The first Nunavik SAM was developed in 1987 by Duhaime.[32] It was subsequently revised and updated for 1991 by Robichaud,[33] and for 1998 by Duhaime *et al.*[34] As for the CGEM, it is made up of a series of equations, parameters, and data pertaining to the regional economy. This series of data, developed on the basis of the SAM, contains one equation for each selected variable, and each equation (there are 409 of them for the Nunavik economy) defines the relationship between this variable and the rest of the regional economy. When a change is introduced in the CGEM, it alters the total demand for goods and services in the region. The 409 equations in the regional model can then be solved simultaneously by using an appropriate software program (GAMS-MINOS).

The Nunavik socioeconomic simulation model follows traditional economic assumptions. For instance, it is taken for granted that consumers maximize their utility function according to their disposable income, whereas businesses maximize their profits based on the technology that they have at their disposal. In this simulation, the budget share of the utility function allocated to each type of good consumed (Cobb-Douglas function) remains constant. In the case of businesses, the intermediary inputs are first combined according to fixed shares (Leontief-type function) and then the number of workers and capital used are determined according to a Cobb-Douglas function.[15] Wages, rate of return on capital, and the price of goods (bought and sold outside the region) are exogenous to the model, as the region has little impact on the setting of prices.

The simulation model also presupposes that products in replacement are socially equivalent (e.g., beluga fat and seal) and that costs of production per kilogram are similar, whatever the species.[16]

This study deliberately takes on a restrictive perspective of the economy limited to monetary transactions, and transactions to which a monetary value could be estimated. For instance, in-kind production (meat, fish, etc.) is included in this study, but its monetary replacement value was used. This perspective makes advancing knowledge in a limited area possible. Thus, broader aspects of the economy, such as social, cultural, and symbolic aspects of production, as well as exchange and consumption processes, are not included in the model. This should be taken into account when discussing the results.

3. ECONOMIC IMPACT OF FOOD REPLACEMENT SCENARIOS WITHOUT FINANCIAL SUPPORT FROM THE STATE

3.1. Impact on Households and the Regional Economy

In Scenarios 1.1, 2.1, and 3.1, recommendations aim at reducing 46–86% of PCB consumption by replacing game meat with store-bought food (Table I). Within such a scenario, each household[17] would have

[13] For a detailed discussion on these limitations, see Duhaime[3] (pp. 84–87).

[14] See Duhaime[3] (pp. 157–186).

[15] The parameters of both functions (Cobb-Douglas and Leontief) were estimated using data from the Nunavik social accounting matrix.[26,27]

[16] The costs of production vary according to the species and seasons in Nunavik and have been estimated in great detail elsewhere.[27] For consideration linked to the scope of our study, these variables have been excluded. Consequently, we cannot say if and how they affect the results.

[17] In 1995, the number of Inuit households in Nunavik was estimated at 1,691.[3]

Table II. Impact of Reducing PCB Consumption on the Nunavik Regional Economy According to Management Scenarios, Without Government Subsidies, 1995 (in $ and %)

	Scenarios						
Indicators	1.1	2.1	3.1	1.2	2.2	3.2	4.1
Regional GDP at market prices	−$3,077	−$3,571	−$3,942	−$935	−$1,049	−$1,158	$5,665
Total Nunavik GDP (%)	−0.002	−0.002	−0.002	−0.001	−0.001	−0.001	0.004
Net indirect taxes	$2,122	$2,464	$2,719	$644	$723	$799	−$3,909
Value added (GDP) at factor cost	−$5,199	−$6,035	−$6,661	−$1,579	−$1,772	−$1,956	$9,573
Total Nunavik GDP (%)	−0.004	−0.004	−0.005	−0.001	−0.001	−0.001	0.007
Labor income	−$7,599	−$8,822	−$9,736	−$2,308	−$2,590	−$2,860	$13,994
Total Nunavik earned income (%)	−0.006	−0.007	−0.008	−0.002	−0.002	−0.002	0.012
Capital income	$2,400	$2,787	$3,076	$729	$818	$903	−$4,421

to spend an additional $195 to $250 annually on imported meat at the grocery store to replace the contaminated food (i.e., beluga skin and blubber and seal blubber, which represents 25 kg of food consumed per household annually). Table II presents the results of the simulation on household budgets and the regional economy when the state does not contribute financially to the loss of revenue.

In order to obtain more store-bought food, Inuit consumers will have to spend between $330,000 and $420,000 annually, according to the various scenarios ($329,470 and $422,950). It is assumed that all purchases are made locally. This implies that more food will have to be imported and sold in community stores. On the other hand, the Inuit will spend less on goods for country food production.[18] Lower spending for hunting and fishing goods explains the small reduction in the regional GDP of $3,077 (a decrease of 0.002%), but also the increased economic activity in stores. Since households spend less to buy goods for country food production, labor income decreases, but the increase in spending in stores for imported food leads to an increase in business profits (capital income). The impact on households is the sum of the increase in spending on store-bought food and the decrease in labor income. Increase in capital income is not taken into account because ownership of the stores is located outside the region, or they are co-ops, i.e., nonprofit organizations. The impact on households represents a decrease of $200 and $256 in revenue, and is more likely to be greater for single-parent families.[19]

Scenarios 1.2, 2.2, and 3.2 recommend substituting some traditional foods with other types of game (Table I). Depending on the degree of PCB reduction, the Inuit would have to modify their hunting practices and increase the number of catches of other species[20] in order to remove the contaminated foods and replace them with safer foods. Unlike the previous scenarios where the Inuit would have to purchase more food in stores, these scenarios imply an increase in country food production and therefore the need to buy more hunting and fishing equipment and fuel. As a result, it is estimated that each household would spend on average $62 to $77 more on hunting and fishing equipment, which will result in an increase in imports. This explains the lower decrease in the regional GDP (from $935 to $1,158) and in labor income (from $2,308 to $2,860) found in Table II. The reduction in labor income amounts to a little more than $1 on average per household. The impact appears to be quite small.

The fourth recommendation suggests increasing the consumption of char for each pregnant woman (Table I). Following this recommendation, each household will have to spend $153 more for additional fishing equipment and fuel, a total of $259,560 in imports for the region. Conversely, an increase in char consumption will have a negative effect on the

[18] This is based on the hypothesis that hunters would reduce their production effort for these two particular species. Although this scenario may appear questionable (hunters might rather increase their effort on other species or they could hunt the animal but refuse the contaminated parts), this assumption represents the worse-case scenario.

[19] Single-parent households account for more than a quarter of all households.(3)

[20] For example, it is estimated that in order to reduce PCB absorption by 46%, it is necessary to reduce the amount of beluga fat consumed by 5,345 kg. The number of additional seals that must be hunted as replacement food is 2,386 animals. To obtain the equivalent of 5,345 kg of beluga fat, one needs 34,120 kg of seal—since fat represents 15.66% of the edible weight of seals.(3)

Table III. Impact of Reducing PCB Consumption on Nunavik Economic Sectors According to Management Scenarios, Without Government Subsidies, 1995 (in $)

	Scenarios						
Sectors of Activity	1.1	2.1	3.1	1.2	2.2	3.2	4.1
Hunting and fishing	1,617	1,876	2,072	491	551	608	−2,977
Mines	0	0	0	0	0	0	−3
Manufacturing	318	369	408	96	100	119	−586
Construction	−64	−75	−82	−20	−22	−24	116
Transportation	−6,466	−7,505	−8,283	−1,964	−2,203	−2,432	11,906
Communications	−1,650	−1,916	−2,115	−501	−562	−621	3,040
Energy	−171	−199	−220	−52	−58	−64	316
Retail	14,369	16,681	18,409	4,364	4,897	5,407	−26,461
Finance and real estate	−712	−827	−912	−216	−243	−268	1,311
Services	−646	−750	−828	−196	−220	−243	1,191
Public administration	−11,794	−13,690	−15,109	−3,582	−4,021	−4,439	21,719

grocery business, whose products consist mainly of imports. Table II shows that the substantial switch of imports would lead to a $5,665 increase in the regional GDP and a $13,994 increase in labor income ($8 per household).

3.2. Impact on Economic Sectors

Table III presents the results of the simulations regarding each economic sector.[21] Following Scenarios 1.1, 2.1, and 3.1, the retail sector shows the greatest increase, ranging from $14,000 to $18,000. The food purchased in Nunavik is, for the most part, imported from outside the region, and changes in household spending habits clearly affect the retail sector. An increase in expenditures for store-bought food, having the opposite effect on spending for hunting and fishing equipment and maintenance, leads to a decrease in some sectors of activity, such as transportation.

When traditional food is replaced with other types of game (Scenarios 1.2, 2.2, and 3.2), an increase in the retail sector and the hunting and fishing sector is found (ranging from $4,000 to $5,000 for the retail sector and averaging about $550 for the hunting and fishing sector). This also results in reduction in other sectors of activity, especially the public administration sector.

[21] Some clarifications are necessary regarding the definitions of the economic sectors of Tables III and V. "Hunting and fishing" covers commercial activities only and excludes the production consumed, given, or sold under the Hunter Support Program (HSP). Handicrafts are included in the manufacturing sector, whereas the "public administration" sector represents all regional government activities, whether federal, provincial, or at the local level.

The effects on regional economic activities differ when the fourth recommendation is implemented. The retail sector tends to undergo a decrease in activity, while transportation and other sectors show an increase in production.

4. ECONOMIC IMPACT OF FOOD REPLACEMENT SCENARIOS WITH FINANCIAL SUPPORT FROM THE STATE

4.1. Impact on Households and the Regional Economy

The central governments in Canada, both federal and provincial, have the power to define new policies, strategies, and programs to overcome social inequities and regional disparities; this is particularly true and relevant in Nunavik, where the James Bay and Northern Québec Agreement bound them with the obligation to do so, and where inequities and disparities are important.[35] This capacity is the foundation on which the following simulations have been built. In these simulations, potential changes in dietary habits and in hunting and fishing practices are mitigated by financial compensation from the federal and provincial governments. In other words, simulations have included potential transfer payments from governments to Nunavik households in order to cover 100% of additional costs, or possible losses of revenues, they would have to face when complying with these risk management scenarios. The results for the household and regional economy are presented in Table IV.

When households are given financial support to offset additional grocery expenditures (Scenarios 1.1, 2.1, and 3.1), they do not have to reduce their other

Table IV. Impact of Reducing PCB Consumption on the Nunavik Regional Economy According to Management Scenarios, with Government Subsidies, 1995 (in $ and %)

	Scenarios						
Indicators	1.1	2.1	3.1	1.2	2.2	3.2	4.1
Regional GDP at market prices	$195,818	$227,584	$251,375	$59,185	$66,421	$73,366	$153,711
Total Nunavik GDP (%)	0.12	0.14	0.15	0.03	0.04	0.04	0.09
Net indirect taxes	$60,724	$70,575	$77,954	$18,353	$20,597	$22,750	$39,660
Value added (GDP) at factor cost	$135,094	$157,009	$173,421	$40,832	$45,824	$50,615	$114,051
Total Nunavik GDP (%)	0.09	0.11	0.12	0.03	0.03	0.03	0.08
Labor income	$92,832	$107,890	$119,168	$28,059	$31,490	$34,782	$88,853
Total Nunavik earned income (%)	0.07	0.09	0.10	0.02	0.02	0.02	0.07
Capital income	$42,262	$49,119	$54,253	$12,772	$14,335	$15,833	$25,198

purchases. Regional production increases, as does the demand for employment. Government assistance also leads to an increase in income linked to employment. Analysis of data in Table IV shows that labor income increases from $55 to $118 per household.

The regional GDP at market prices increases only slightly, from 0.122% to 0.157% of the annual Nunavik GDP. Such minor growth is attributable to the fact that the subsidies would not be entirely spent on local goods and services. The Inuit might in fact use an important part of these subsidies to import products from outside the region. As a matter of fact, Nunavik produces few goods that are sold in the region. Therefore, despite an influx of funds, the economic impact is much less significant than expected.

Table IV also provides information on impacts on households when people are encouraged to replace country foods with other types of game (Scenarios 1.2, 2.2, and 3.2). Results show, when government support is involved, an increase in the GDP at market prices ranging from 0.037% to 0.046%, and an annual increase in labor income of $17 to $27 per household. An increase in regional production is also observed when the government subsidizes the changes of habits in these scenarios. The growth ranges from $59,000 to $73,000.

When the fourth recommendation is implemented, governmental support also has positive effects on household income, which rises to about $53 on average.

4.2. Impact on Economic Sectors

Results in Table V show the impact of management scenarios on economic sectors when government support is provided.

In scenarios that suggest a substitution of country food by store-bought food (1.1, 2.1, 3.1), retail, hunting and fishing, and manufacturing sectors are the prime beneficiaries. In all cases, increases range from 0.634% to 0.814%.

When traditional food is replaced with other types of game, as in Scenarios 1.2, 2.2, 3.2, and 4.1, hunting and fishing activities are increased, which has

Table V. Impact of Reducing PCB Consumption on Nunavik Economic Sectors According to Management Scenarios, with Government Subsidies, 1995 (in $)

	Scenarios						
Sectors of Activity	1.1	2.1	3.1	1.2	2.2	3.2	4.1
Hunting and fishing	11,584	13,463	14,871	3,501	3,928	4,339	4,412
Mines	11	13	16	3	4	4	4
Manufacturing	2,286	2,657	2,935	691	775	857	872
Construction	26	30	33	7	8	9	184
Transportation	12,088	14,047	15,515	3,654	4,102	4,530	25,821
Communications	630	731	808	191	214	237	4,765
Energy	1,100	1,278	1,412	332	373	412	1,264
Retail	102,955	119,661	132,172	31,114	34,919	38,569	39,211
Finance and real estate	278	323	357	84	94	105	2,059
Services	2,206	2,564	2,832	667	749	827	3,325
Public administration	1,930	2,242	2,472	587	658	727	32,134

a positive effect on the regional economy. In this case, economic sectors such as retail, hunting and fishing, and manufacturing are the most likely to benefit from changes in eating habits and household production activities. Increases in these sectors range from 0.192% to 0.237%.

5. DISCUSSION

Simulations of these various management scenarios show that potential change in the dietary habits of the Inuit has a rather small monetary impact on the household budget. When households replace contaminated food with store-bought food, that is to say when part of their monetary resources is used to purchase food rather than to buy means of production, the overall loss of income is only $5 per household. On the other hand, when contaminated game is substituted with safer game, the loss of income is about $1 per household. This variation, albeit minor, can be explained by the difference between the price of a kilogram of meat at the store ($10 per kilogram) and the cost to produce the same amount of food, which has been estimated at $3 per kilogram.[3] When both federal and provincial governments subsidize the loss of revenue due to the dietary changes, the compensation may increase the household income (an average annual increase of $22 to $78), depending on the scenario. Similarly, the fourth recommendation also has positive outcomes on household income (an increase of $8 or $53, depending on potential government support).

Although the overall economic impact appears to be limited, these calculations only apply if individuals choose to abide by the recommendations. In fact, actual behavior is hard to predict. Because changes cannot be imposed, there is no assurance that individuals will comply with any public health advice. Besides, the one who follows the advice may combine scenarios, a possible course of events that has not been taken into consideration in the simulations. However, risks that management policies impinge on foraging practices remain, and may have unforeseen repercussions.[19] Access to, and sharing of, new hunting territories may be problematic. For instance, it can place an additional burden on the household budget if the costs of foraging a substitution species are higher. Furthermore, compliance with recommendations can lead to the rejection of some species as a whole, which can put pressure on other species. These potential impacts have not been measured. Moreover, because research on the contamination of the environment is currently ongoing, scientific discoveries can create further inconveniences.

Management scenarios are nonetheless bonded to the very question of food supply in peripheral regions. Increasing imported food, while benefiting retail sectors, would further increase the region's economic dependence on the South. On the other hand, it is not certain to what extent the environment, or a specific food resource (arctic char in this case), can sustain an increase in harvesting of country food.[22] However, the study confirms that promoting country food production and consumption has multiple economic benefits for both the family and the regional economy, and provides an alternative capacity for food security.[36]

6. CONCLUSION

The contamination of natural resources traditionally consumed by the Inuit has forced the Nunavik regional public health authorities to set up a risk determination process where various management options (recommendations and scenarios) were evaluated. Options, which were primarily aimed at reducing PCB intake, involved a significant modification in eating habits. The economic costs and benefits of potential changes in diet were examined. A Nunavik socioeconomic simulation model was used to calculate the economic impact for the household, and for the economic region. Original scenarios were expanded to include an assessment of the economic impact of change in food consumption behavior if income was alleviated by government financial support. Results suggest that none of the scenarios seems likely to result in either major outlays for households or upheavals in the regional economy. From a strictly monetary point of view, households might even gain, should the government agree to subsidize the changes.

Nothing indicates whether or not the implementation of these management options is feasible. As a matter of fact, aside from the financial and material dimensions, social and cultural factors must also be

[22] Arctic char cannot withstand high fishing pressure. If an average char (2 kg) can feed a woman for four days, implementation of Recommendation 4 would require about 25,000 additional chars to feed the 230 pregnant women. However, considering that pregnant women are dispersed among the 14 villages, which are scattered in a territory of 500,000 km^2 and that an average of 56% of women already eat char at least once a week, and 12% more than four times a week,[8] chances are that the impacts on the species would be relatively limited, although this will be assessed in Phase 2 of the pilot project (see footnote 20).

considered in implementing such policies, and have not been examined in this study. Indeed, household food production activities are more than a mere operation aimed at satisfying subsistence needs. They are at the heart of social and cultural life. They can contribute to the socialization of young people through the acquisition of desirable values, attitudes, and behaviors. The sharing of food is an extension of forms of sharing performed in other spheres of daily life. The production, exchange, and consumption of country food bear great symbolic meanings. For example, they are a source of motivation, prestige, and identity for the hunters.[16] The high value placed on the traditional economy in Nunavik may explain why few people have altered their lifestyle even after having heard about the risk of the presence of PCBs in the food chain, and in the breast milk of Inuit women. Indeed, only 14% reported changing their habits upon becoming aware of the contamination.[7] How important the risk is perceived as and dealt with is another crucial aspect that needs to be considered in any policy dealing with pollution.[19]

Following the risk management process implemented under the Avativut/Ilusivut Program, Nunavik regional authorities have recently received federal and provincial funding to initiate a pilot project in three communities in order to provide free access to arctic char for pregnant women (Recommendation 4). The intention is to run the program in all communities in the coming years. In doing so, the project is aimed at reducing mothers' mercury levels and, at the same time, an increase in mothers' fatty acids intake. The project's outcomes will be assessed after the first year of its implementation.[23]

Despite the complex problem of the contamination of the food chain in Nunavik, this study has succeeded in clarifying some important economic aspects related to the risk determination process. The results presented here are only part of a collection of studies examining other dimensions. By broadening the knowledge of decision makers about this multifaceted issue, and by bringing together scientists from diverse backgrounds, the Avativut/Ilusivut Program achieved its mission in promoting a more comprehensive and sensible way to take action.

[23] C. Furgal, personnal communication, February 10, 2003 and Carole Vézina, April 8, 2004. This pilot project will be carried out under the Northern Contaminant Program (2002–2003): Dewailly, É., *et al. Evaluation of a Risk Management Strategy to Protect Pregnant Women from Contaminant Exposure in Nunavik*.

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