ORIGINAL RESEARCH ARTICLE

COACTION PUBLISHING

The role of Indigenous knowledge in environmental health risk management in Yukon, Canada

Katelyn A. Friendship[1]* and Chris M. Furgal[2]

[1]Canadian Studies-Indigenous Studies, Trent University, Peterborough, Canada; [2]Indigenous Environmental Studies, Trent University, Peterborough, Canada

Objectives. This project aimed to gain better understandings of northern Indigenous risk perception related to food safety and to identify the role that Indigenous knowledge (IK) plays in risk management processes to support more effective and culturally relevant benefit-risk (B-R) management strategies.
Study design. The project used an exploratory qualitative case study design to investigate the role and place of IK in the management of environmental contaminants exposure via consumption of traditional foods in Yukon First Nations (YFNs).
Methods. Forty-one semi-directive interviews with Traditional Food Knowledge Holders and Health and Environment Decision-makers were conducted. A review and analysis of organizational documents related to past risk management events for the issue was conducted. Thematic content analysis was used to analyze transcripts and documents for key themes related to the research question.
Results. There was a recognized need by all participants for better collaboration between scientists and YFN communities. YFNs have been involved in identifying and defining community concerns about past risk issues, setting a local context, and participating in communications strategies. Interviewees stressed the need to commit adequate time for building relationships, physically being in the community, and facilitating open communication. Conducting community-based projects was identified as critical for collaboration and for cooperative learning and management of these issues.
Conclusions. The perception of "effective" benefit-risk management is significantly influenced by the efforts made to include local communities in the process. A set of common guiding principles within a process that brings together people and knowledge systems may provide a more effective way forward in cross-cultural, multiple knowledge system contexts for complex benefit-risk issues than a prescriptive rigid framework.

Keywords: *risk management*; *risk perception*; *traditional foods*; *contaminants*; *Indigenous knowledge*; *collaboration*

Received: 13 February 2012; Revised: 4 June 2012; Accepted: 5 June 2012; Published: 27 July 2012

Environmental health risk management is the overall process of identifying, assessing, and optimizing exposure to an environmental health hazard for an individual or population (1). This includes risk assessment, which is the process of evaluating the magnitude of and probability of adverse effects from exposure to an identified hazard or from the absence or loss of beneficial effects associated with the exposure (2). Conventionally, assessing risk follows a step-wise process of hazard assessment involving hazard identification and dose-response assessment, exposure assessment, and risk characterization (Fig. 1).

Traditionally, environmental health risk assessments have focused on characterizing risks associated with hazards that are often identified through the analysis of biological, chemical or physical data (1). The conventional approach to assessments focuses on determining the probability of injury or death, and may not accurately represent an affected individual's own estimate of risk (3–6). The overall goal of the risk assessment process is to provide the best possible information to support effective risk management decision-making. However, many risk issues are complex, whereby there are a multitude of variables to take into account, and there are usually many uncertainties related to the characterization of the risk or assessment of the probability of harm associated with exposure (7). Often, a simple, straightforward answer of whether or not a specific exposure is "safe" or "unsafe" cannot easily be determined, creating significant challenges when

Citation: Int J Circumpolar Health 2012, **71**: 19003 - http://dx.doi.org/10.3402/ijch.v71i0.19003

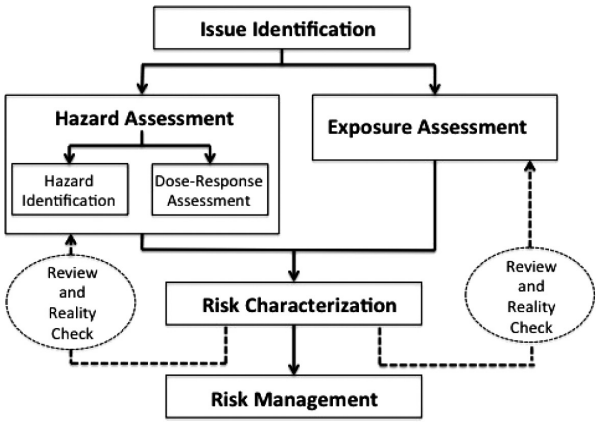

Fig. 1. Stepwise approach to environmental health risk assessment [from (7, p. 24)].

communicating environmental health risk information to affected communities.

Since the early 1990s, programs such as the Northern Contaminants Program (NCP) in Canada and the Arctic Council supported Arctic Monitoring and Assessment Program (AMAP) have furthered the understanding of environmental contaminants in the Arctic and the nature of human exposure to these hazards. The results from work under NCP and AMAP, and the results of community and regional risk assessments, have more recently been delivered to northern communities by regional health and Aboriginal authorities instead of external sources, in order to support informed decision-making (8). The contamination of traditional/country foods[1] is an especially complex case for risk management as many northerners depend on these resources for critical elements of their health and well-being, yet they are also a major source of exposure to environmental contaminants for many residents (8). Furthermore, traditional foods have unique social, cultural, nutritional, and spiritual benefits, with a direct positive influence on individual and community health and well-being (8–11).

Perceptions of and responses to food-chain contamination in northern communities are diverse, and local conceptualizations of risk are not well understood. To date, misconceptions by southern-based researchers and scientists of local perceptions related to risk have influenced the effectiveness of risk management approaches employed in northern communities. Conventional environmental health risk management processes have typically followed a linear framework to determine the potential risks to an individual or population, not accurately reflecting or incorporating northerners perspectives (e.g. social, cultural and economic factors) and perceptions of risk (1,9). More progressive frameworks and models have been generated and now exist representing the evolution in this process, and include consideration for other aspects of health (e.g. social, cultural, economic), and explicit consideration for benefits. This is the case in the management of environmental contaminants and traditional foods benefit-risk (B-R) management in the Canadian North today (8,12,13). As depicted in Fig. 2, the process is more comprehensive and now, to some degree, explicitly considers public perception of the hazards, and both the benefits and risks of exposure through traditional food consumption.

B-R management can be especially complex when it involves Indigenous populations as there can be differing worldviews and knowledge systems used to understand the hazard and risks associated with exposure. Cultural and social differences affect the reception and comprehension of B-R messages throughout the Circumpolar North (9). Researchers and communities are faced with cross-cultural misunderstandings due to differing languages, worldviews, knowledge systems and socio-political contexts (see 14,15). These challenges can act to undermine the best intentions of health and environment professionals in B-R assessment and communication activities. Difficulties in B-R assessment and communication processes are furthermore confounded by uncertainties in estimating patterns of individual exposure, the complexities of simultaneous exposure to multiple hazards (e.g. mercury and lead and polychlorinated biphenyl [PCB]), the invisibility of contaminants to the naked eye, and the challenges that these issues represent for communication efforts. In northern Canada, the balancing of benefits and risks for environmental contaminants in the traditional food chain of many Indigenous communities now occurs at a territorial/local level through federal program-supported regional contaminants committees, which encourage participation of the affected populations or groups (including Indigenous peoples). While recognized as being progressive, to date there still has been no formal evaluation of the effectiveness of this approach, and measurement of how well Indigenous perspectives are accurately reflected in B-R assessment and communication activities undertaken by these regional committees. Indigenous representation and participation provides guidance and context for balancing the benefits and risks and communicating with the affected population, and also helps inform a more culturally appropriate process (12,13). As this is a very complex and challenging process, the use of all sources of information, including Indigenous knowledge (IK) is critical.

This project was designed to specifically examine the role of IK in environmental health B-R management processes. While the discourse on this topic recommends consideration of IK in these decision making processes,

[1]Note, in the Yukon, 'traditional foods' is the more commonly used term for foods harvested or gathered from the local environment and will be used throughout the remainder of this paper.

Citation: Int J Circumpolar Health 2012, **71**: 19003 - http://dx.doi.org/10.3402/ijch.v71i0.19003

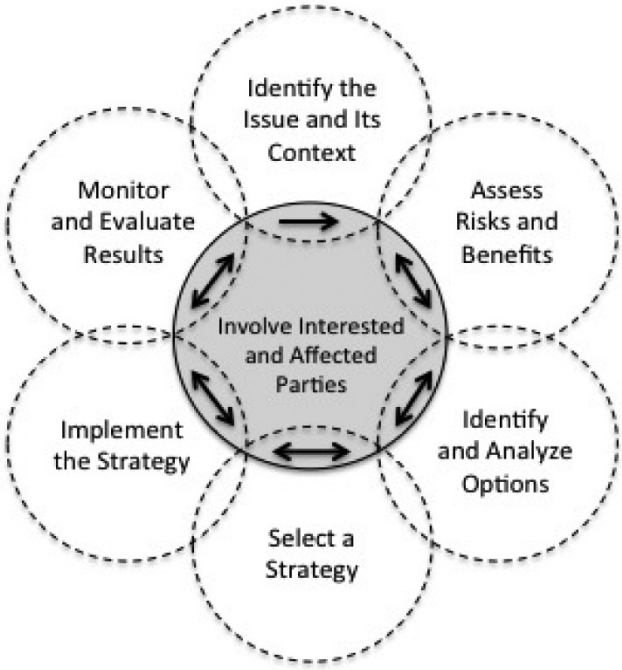

Fig. 2. Risk management framework adopted by Health Canada [from (2, p. 5–8; 11, p. 77)].

the topic of how this is achieved and what impact it has on decisions has received little attention. The project uses the case of B-R assessment and communication concerning environmental contaminants in Yukon First Nation's (YFN) traditional foods as its focus. Specifically, the project explores the role that IK has played in B-R management events on contaminants, what role it currently has, and how its involvement could be improved and supported in the future, to address the above mentioned challenges to B-R management in cross-cultural and multiple knowledge contexts.

Methods

Design

The project used an exploratory, qualitative approach to the investigation of possible contributions of IK to environmental health B-R assessment and management processes. A case study approach was used to examine a series of past decision-making events on this topic in Yukon Territory, Canada. The perspectives of representatives from 3 Yukon First Nation communities (Vuntut Gwitchin First Nation [Old Crow], Tr'ondëk Hwëch'in [Dawson City], and Champagne and Aishihik First Nations [Haines Junction]) (see Fig. 3), and Territorial Health and Environment Decision-makers (located in Whitehorse) were included in the study.

Semi-directive interviews (16) were conducted with 28 Traditional Food Knowledge Holders (TFKHs) (Table I). TFKHs were classified as First Nation persons that were actively involved in and retained specific knowledge with regards to hunting, fishing, gathering, or the preparation of traditional foods. TFKHs were selected based on their knowledge and experience with traditional foods and included elders, women and hunters. Individuals were identified via a community knowledge referral system where previously identified participants identified other individuals to participate based on their experience and knowledge with the issue as outlined in the above stated criteria (17). Interviews with TFKHs focused on perceptions of food safety and past and potential future roles of IK in B-R management processes (Table II).

Semi-directive key-informant interviews (16) were also carried out with 13 Territorial Health and Environment Decision-makers (HEDMs). HEDMs were identified as those individuals having specific responsibility in the Yukon for B-R assessment and/or communications, and also any relevant research pertaining to contaminants and traditional foods. These included government health and wildlife representatives, public health communicators, members of the Yukon Contaminants Committee (Territorial multi-stakeholder committee including representation from government, citizens' groups and Territorial First Nations, designed to address the issue of environmental contaminants in the region), as well as key researchers involved on this topic. The majority of HEDMs were identified in cooperation with members of the Yukon Contaminants Committee and other regional contacts for the case study. Interviews with HEDMs focused on past, current and potential future involvement of IK in risk management related to environmental

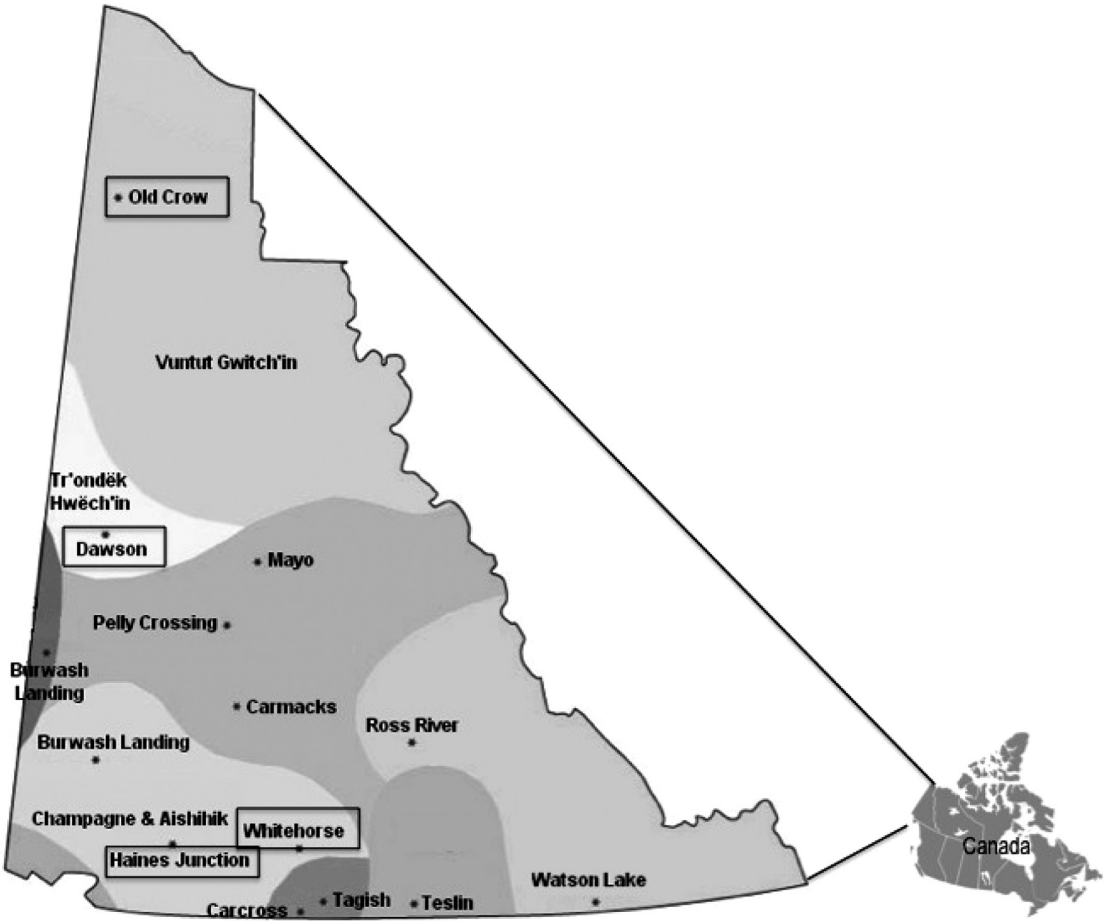

Fig. 3. Map of the Yukon identifying participant communities for the study (in boxes) [adapted from (55)].

health issues in the Yukon (Table II). Among those individuals participating in the interviews, 4 were identified as fitting the criteria and being recognized as able to fit into either category (TFKH or HEDM). They were identified as key individuals to interview for the project and therefore were included and provided insight through answering questions relevant to both categories. All other participants identified and interviewed were exclusive to 1 of the 2 categories presented in Tables I and II.

All interviews were conducted in the fall-winter of 2008/2009. As many available TFKHs and HEDMs in the Yukon were interviewed from those identified through the informed referral process. Interviews were conducted until the point of saturation was reached in the scope of qualitative perspectives on the research subjects (16). A saturation point was determined through an ongoing analysis of the interviews as data was being collected. Interviews were recorded via digital audio recorder (when permitted) or note taking and then transcribed. For results validation, after preliminary analysis, all participants were given the opportunity to provide feedback and clarify any discrepancies with the data interpretation and proposed quotes to be used. This was done on a one-on-one basis through personal meetings, or via community visits, as well as through mail-out of

Table I. Summary of sources contributing to the research

Source categories	Total number of sources/respondents
Traditional Food Knowledge Holder interviews	28
Health and Environment Decision-maker and researcher interviews	13
Case study documents	160

Citation: Int J Circumpolar Health 2012, **71**: 19003 - http://dx.doi.org/10.3402/ijch.v71i0.19003

Table II. Selection of interview questions used with Health and Environment Decision-makers and Traditional Food Knowledge Holders

Interviewee	Question
Health and Environment Decision-makers and researchers	1. Were you involved in the risk assessment/communications event that is being reviewed? (a) If yes, how were you involved? What role did you play? (b) If no, then what was your experience of the assessment/communications event? 2. What information was included in the risk assessment/risk communication event? 3. Did IK/local perspectives have a role in the risk management process? In what form was the knowledge that was included? (i.e. Technical risk assessment model, public perspectives, inclusion of perspectives from Indigenous community members?) 4. When, and for what stages was IK involved or Indigenous perspectives included? How? (i.e. Person providing information, focus groups in the community, existing Indigenous knowledge reports?) 5. Were there any challenges incorporating IK or perspectives? (a) What were they? (b) How were those challenges addressed? 6. Did you see value in the collaboration of IK/perspectives and conventional means of risk management for the specified case study? (a) If so, how? (b) If not, why? 7. Do you see value in the collaboration or involvement of IK/perspectives within conventional means of risk management for environment and health issues? (a) If so, can you explain the value you think it adds? (b) If not (you don't think it is a valuable inclusion), why?
Traditional Food Knowledge Holders	1. Are you involved in the hunting, fishing, gathering, or preparation of traditional foods? (Traditional role in the food process). How often do you eat traditional foods? 2. Are there benefits/values to eating traditional foods? What are they? 3. Has anything changed about your traditional food eating habits in recent years? (a) Are there foods you eat more of? (b) Are there foods you eat less of? 4. Are there general rules or IK as to what you should and should not hunt or collect? Can you explain what the rules are/what the knowledge is? (e.g. Are there species you should not take at certain times of the year?) 5. Have you ever not taken an animal because you were concerned with its health or safety to eat? Please explain. (a) What was it? (b) Why/how did you know it was unsafe? 6. When do you make decisions about the safety of an animal for food and if it is appropriate to eat? (i.e. Before/during the hunt, while preparing). How do you tell? 7. Do you consider health advisories or warnings regarding traditional food safety or do you rely on your own judgments? Why/Why not? 8. Have you ever been approached or asked to share your knowledge about health or the environment? (e.g. the values or any concerns related to traditional food) If so, please elaborate. (a) Who asked you for this advice? (b) Do you know what was done with this knowledge that you shared? 10. Do you think that IK should be a part of decisions made by health and environment officials? How do you think this could be done? Or if it already is, how could it be done better?

materials to participants after preliminary analysis of the data. Participants were also given final results in a summary report with the opportunity to provide feedback. No major revisions to preliminary results were required based on feedback, and only minor revisions were made to clarify quotes at the preliminary results stage.

Field research also involved collection and review of documentation pertinent to the case study and specific First Nation communities (Table I). Documents gathered included primary and secondary literature and archival materials. Document review was used to inform the specific case study, provide contextual data, and address the greater themes of environmental health B-R assessment and communication processes in the Yukon. Documents were found on the Internet via scholarly search portals, at the Yukon libraries, Yukon Archives, Yukon College, and in some instances, were also provided by participants and key regional contacts.

Ethics

The initiation of this project and the development of relationships with key contacts in the region began approximately 1 year before the field research started. For every participating community, support was sought for the project by talking to key contacts and making presentations to the First Nations community during an initial field visit. Ethical processes included gaining a Scientists and Explorers Act Research license from the Yukon government and a Vuntut Gwitchin First Nation researcher's license in Old Crow. The Trent University Ethics Board, as well as Trent's Aboriginal Education Council also reviewed and approved the project. All ethical principles including those recognized by the Canadian Institutes of Health Research (CIHR) Guidelines for Aboriginal Health and the Association of Canadian Universities for Northern Studies (ACUNS) were followed.

Analysis

Data analysis took place throughout the research process using the constant comparison method (grounded theory), which also helped to inform and shape aspects of the project interviews and document analysis (16,18). Analysis consisted of a thematic content analysis of the interviews using QSR International NVivo 8 qualitative software (19). Following interview transcription, common responses to questions were compiled and codes were developed inductively through identifying patterns in the information (20). For each theme, results were organized into charts and/or tables that summarized the interview results quantitatively; quotes selected from the qualitative analysis were also included to provide greater detail. An independent analyst checked the coding for inter-coder reliability, and participants were provided opportunities to review and validate the analysis and ensure that interpretations of their data were accurate. Documents were reviewed for data on past involvement and the role of IK in risk-benefit decisions in the Yukon.

Results

Case characteristics

For Yukon communities, traditional foods play a central role in the life of the individual, household and the community (21). Traditional foods are important sources of nutrition, energy, and have important spiritual, social, cultural and economic significance. In the Yukon, there have been several common concerns persisting among the public related to contaminants and traditional foods during the last 2 decades. Though the health risks have not been as significant as in other areas of the North [e.g. PCB contamination and the potential health risks to Inuit populations of the Eastern Arctic (22)], there have been communication errors that have led to contaminant scares in some Yukon communities. For example, in the early 1990s, warnings were issued to stop the consumption of livers of *Lota lota* (Burbot/Ling cod) in Lake Laberge because of high concentrations of PCBs and dichlorodiphenyltrichloroethane (DDT). This warning was later expanded to include *Salvelinus namaycush* (Lake trout) because of high levels of toxaphene in that species. The advisories consequently led to the closure of the lake's commercial fishery and caused great alarm among residents who used the lake for fishing, including 2 First Nation communities. The Council of Yukon First Nations (then Council of Yukon Indians) reacted to the advisory by releasing a statement in 1992, warning all Yukon First Nations to refrain from eating any Yukon fish (23–25). There was uncertainty related to the safety of consuming Yukon fish because this was the first time an advisory like this had been issued in the Territory. Overall, this uncertainty created a great lack of trust of health professionals associated with this advisory process, which inhibited the government from reassuring the First Nations about the safety of other fish species (26).

By 2002, toxaphene levels dropped in lake trout but levels of methylmercury were of concern. In 2007, a health risk assessment for mercury levels in fish in Yukon lakes was conducted. The risk assessment used samples collected from 1992 to 2007, and fish consumption patterns for YFN communities from a dietary study conducted in the mid-1990s. Overall, most fish had low mercury levels on average, and based on consumption patterns, the YCC decided that no fish consumption advisory was necessary (27). Today, the YCC continues to conduct fish surveys and monitor contaminants levels in Yukon lakes.

In 1992, high levels of cadmium in the livers and kidneys of the Porcupine caribou herd and Finlayson caribou herd were reported (28,29). In 2 separate cases, 2 First Nation user-groups were not informed of the results of this research and the information was leaked to the public before official release. In Old Crow, residents did not find out the results of the studies until 2 years after the research was conducted. In addition to community outrage, this also spurred the Chief of that First Nation to encourage the community to stop eating caribou kidneys and livers, and to be tested for cadmium levels themselves (29–31).

The current project explored the topic of IK and B-R management and communication process in the context of 3 contaminant events and the First Nations communities in the Yukon. More specifically, the project looked at the event of Lake Laberge and PCBs and toxaphene in fish in the early 1990s, cadmium in caribou and moose in the early-mid 1990s, and the event of mercury (Hg) in Yukon fish from the early 2000s to present. Each event was distinct and had some unique features, yet there were several similarities between them, such that they added

Citation: Int J Circumpolar Health 2012, **71**: 19003 - http://dx.doi.org/10.3402/ijch.v71i0.19003

to a larger sample size of experiences upon which the interview participants were able to draw while still discussing the central topic to this project. The presentation of results is divided into 2 sections, following the major themes of the data analysis from the interviews and document review.

Yukon First Nations' perspectives on food

Interviews with TFKHs revealed that there were several major practices and processes for IK generation on food safety. Observation, experience, direct teachings and cultural laws were all mentioned as implicitly or explicitly contributing to one's knowledge and skills for identifying whether something was "safe to eat". These in turn, influence conceptual understandings of risk and drive risk perceptions related to food safety, and indirectly, reactions to health advisories coming from government agencies. The majority of TFKHs were confident in their own ways of determining the safety of food items. The majority of the respondents referred to physical or observable characteristics as being the primary mode of safety analysis. Data analysis indicated that the time of year, location, the behaviour of an animal, and the physical quality of prepared meats were important indicators. As one Tr'ondëk Hwëch'in participant discussed:

> . . . If everything looks healthy and firm, and in good shape, full, and not too oversized or mushy . . . And where the animal-the area that it seemed to be inhabiting is probably pretty important. Other than that, just really making sure that the meat is clean and firm and fresh and smelling good.

Sixty percent of TFKHs who reported frequently consuming traditional foods (at least once a week; n = 30) reported being worried about contaminants in their food. Of those individuals who were concerned, 67% had never changed their eating patterns because of the concern, while 22% reported that they had changed in some way. As one Tr'ondëk Hwëch'in participant said:

> I know my immediate family listens to those warnings and well, some of them have to do with the fish livers, and different toxins that they find in fish. Yeah, we tend to listen to those and abide by them.

This is different from one Tr'ondëk Hwëch'in Elder's response who stated that "The fish are not as healthy as they used to be, but we still eat it." Similarly, a Vuntut Gwitchin participant responded, "I probably wouldn't listen (to health advisories). But I'll be careful". Thus, it is important to note that some variation in perspectives on this issue exists in YFN communities.

Role of Indigenous knowledge in risk management in the Yukon

The HEDM interviewees participating in this study reported varied levels of experience of including IK in risk management processes previously. HEDM and YFN participants each discussed multiple ways in which IK has been or could be used in environmental health risk management processes in the Territory (Table III).

Identifying and defining the community's perception and concern about a hazard, identifying and understanding the local context (e.g. frequency of consumption for a particular fish species or mammal organ), and participating in the communications process were the primary ways in which YFNs were reported to have been actively involved in the past.

Participation on the Yukon Contaminants Committee (YCC), whether through Aboriginal representation from the Council of Yukon First Nations (CYFN) or via individual representation from an individual affected community, were common ways involvement was reported to have been facilitated previously. Health-decision makers and those involved in contaminants and traditional food

Table III. Experience of the inclusion of Yukon First Nation perspectives and Indigenous knowledge in benefit-risk assessment with respect to contaminants in traditional foods. Synthesis of responses from all respondents as to how this has been/currently is/could be done in the Yukon

Involvement type	Action
Participation	Consultation with communities.
	Direct involvement of the Council of Yukon First Nations in Yukon Contaminants Committee (YCC).
	YFN membership (e.g. individual community member) on the YCC.
	Listening to YFN communities and taking action based on communications.
	Using key community contacts in communities to work on issues together.
Community ownership[a]	Community-based/community driven projects to identify and understand contaminant issues (risk/benefits).
	Through formal, political process with self governing YFNs.
	Following YFN protocols (e.g. traditional knowledge guidelines).
Community relevance[b]	Community reporting (e.g. community tours/workshops specific to contaminants).

[a]Whereby the community has control over the research process and the research is community driven.
[b]Whereby the issue is of direct interest and applicability to the community.

research have previously invited First Nations to participate in projects when they had the potential of being directly impacted by the study results. Generally, within the YCC there is a greater reliance on the Aboriginal representation by CYFN for IK and any input on Aboriginal perspectives than directly by local community members.

Overall, knowledge sharing in the future was recommended to occur specifically by involving IK holders in the research process. Much of the qualitative data gathered for this project spoke to the need for better participation and collaboration between Aboriginal representatives and scientists or government decision-makers, not just improved processes for knowledge contribution. The involvement of key community contacts or enhanced Aboriginal participation on the YCC was identified as ways that helped to facilitate the inclusion of YFN perspectives in B-R management processes. As YCC member Mary Gamberg advised:

> You should make it a point to talk to key people in the community – the people that others go to for information. They will often have a good idea of the best communication strategy.

YCC member Ron Pearson also reiterated,

> That's the common sense way and if you have the First Nation participate, they can tell you what's realistic to say and what's not realistic to say.

Both TFKHs and HEDMs reported that one of the best ways to involve IK in B-R management processes was through direct collaboration with IK holders throughout the process. Different ways of collaboration recommended included: networking, building partnerships and relationships, spending extended periods of time in the affected community, being open to community perspectives and input, facilitating and maintaining consistent 2-way modes of communication, and having community-based projects or collaborations on research related to the risk topic in question. It is important to avoid research "validation" of IK though as Marvin Frost, a TFKH from Old Crow explained:

> I think in a lot of ways, the traditional knowledge, it will help. Help out in lots of ways. There are lots of stories that the Elder's know and can pass on. They know and they pass it on to researchers, and even that researcher still goes out and studies the same thing, the story that was told. Double-check on it is all they're doing.

TFKH and Chair of the Porcupine Caribou Management Board, Joe Tetlichi explained his perspective on collaboration:

> And the statement I made before about traditional knowledge versus scientific knowledge, it's not one or the other trying to beat one another. It's trying to incorporate the two and trying to look at, I guess, looking at the end result.

The Yukon Chief Medical Officer of Health, Dr. Brendan Hanley also emphasized:

> So, when it came back to what are the determinants of these issues or problems it always came back to traditional knowledge, that we have to go back to traditional knowledge, traditional ways of eating, traditional ways of living on the land, traditional ways of social networks; it's clearly something that is seen as a very strong fabric. It makes total sense to echo that and to use some of that in risk communications.

Discussion

It is increasingly recognized that benefit-risk assessments are conducted by all individuals and the determinations of whether something is safe to eat or not involves a complex, locally-sensitive assessment that is founded, in part, on personal value systems (32). Some health risk assessors fail to recognize or value this complex personal and social system of assessment, maintaining a level of distinction between the eurocentric scientific knowledge holder and Indigenous communities.

Yukon First Nation perspectives on food and perceptions of risk

As with many Aboriginal communities, traditional foods are a very important part of YFN's lives and great value is put on being able to access and eat traditional food items. The importance of traditional foods to YFNs will influence perceptions of health risk advisories and the safety of food. Because of this unique relationship, weighing the various benefits of traditional food consumption with the risks of contaminant exposure is extremely difficult and involves considerations across nutritional, toxicological, social, cultural, economic, environmental policy, and public health disciplines (33).

Contamination is not a new concept for northern Indigenous communities and there is knowledge of contaminants in traditional foods and their potential effects (34). The problem is in information communities are receiving about risks which is fragmented, unclear, irrelevant to the local perception, or in contradiction to IK constructs and modes of understanding. In order to rationalize risk, YFNs are creating their own explanations and understandings of risk and how to manage it.

TFKHs rely on historical and orally transmitted knowledge, personal experience and the powers of observation, and other senses to detect the safety of food items. Many will not go against the knowledge of Elders when choosing between science and IK regarding food or other issues; however, long-range contaminants cannot be detected by typical sensory

Citation: Int J Circumpolar Health 2012, **71**: 19003 - http://dx.doi.org/10.3402/ijch.v71i0.19003

methods (smell, taste, visual changes). Regional biologist Dorothy Cooley noted:

> And contaminants you know, it's almost like a 'touch' word or something. People are afraid of contaminants, but they're not quite sure what it is.

Indeed, it can be found throughout the risk literature and in other areas of the North (9,35) that fear of the unknown, incomprehension, and misunderstanding of an issue increase the perception of risk associated with that phenomenon (36,37). This is somewhat contradicted in the responses from YFN interviewees here. Of those people who were concerned about contaminants and traditional foods, a majority indicated they had never changed their eating patterns because of a fear of contaminants.

This lack of action in response to concern of contaminants may be explained by a number of factors. YFN communities are reliant on and trust in their abilities of observation-based assessment of wildlife health and behaviour for the safety of consuming their traditional foods (38). Experience is one of the most important factors for assessing risk in land-use activities (39). Hunters have been assessing the health of their food for thousands of years and communities have great confidence and trust in the abilities of local hunters and Elders; overriding externally-based health advisories (34,36,40). As reported by Myers and Furgal (14), Inuit communities in Nunavut and Labrador tended to interpret contaminant risk messages through the perspective of their own experiences and observations. O'Neil et al. (41) also found that Inuit may be resistant to knowledge of invisible phenomena such as contaminants that cannot be seen, tasted, or smelled as it is a source of cognitive dissonance for them in regards to assessing food safety. An additional reason in our study may be due to the unique relationship YFNs have with their food. Participants acknowledged numerous values and benefits of the connections with elements of the natural world outside of nutritive contributions these foods provide. This may further explain the strength of dissonance suggested by the presence of an invisible contaminant and thus the resistance to accept and act on health advisory information. The source from which individuals receive this contaminant information is another likely factor influencing their reaction and response (42). Because of poor communications and management of contaminant issues in the Territory in the past [e.g. cadmium and caribou contaminant scare – see Whitehorse Star January 13, 1993 (43)], in addition to a long history of mistreatment of First Nations in Canada by state authorities, there is a long-standing mistrust among YFNs of the regulatory bodies typically providing this information. Moreover, in some cases, YFNs participants expressed that they had not been substantially active in the contaminants B-R assessment and communications work leading to the generation of these messages.

A community's perception of risk is dependent on several factors, including their awareness of the issue. Further, some argue that a group will be more inclined to respond or comply with risk messages and proposed risk management strategies, if they are involved in their formation (42,44). Overall, we cannot assume that people will change their behaviour even if they are concerned about a risk. The relationship between understanding and action is complex. In some instances individuals may not have the choice to change or comply with a suggested risk minimization or B-R optimization strategy. Without this detailed knowledge of a population's perceptions, understandings, motives, and circumstances, it is a difficult task to "manage" a B-R exposure to which they are subjected. Therefore, considering the many factors implicated in this study, it is argued that without direct engagement early in the process it is less likely that risk management approaches will be effective in such communities in the future.

Effective risk management and the inclusion of Indigenous knowledge

The risks which societies choose to manage or attempt to avoid, are not solely those things seen as threats to health, safety, or the environment, but rather they are reflective of choices grounded in beliefs, values, social institutions, human nature, and moral behaviour (45). While conventional assessment processes have come to explicitly acknowledge social, cultural, spiritual, political, and economic elements, they are still more often "additions" or "contextual" factors to be considered, and as a result are rarely central to the assessment process (46,47). In many Indigenous approaches to risk assessment, they are recognized as being central or equally important to assessment and management decisions. All knowledge is socially influenced and subject to bias (48). Bradbury (48) criticizes that Western society relies too heavily on scientific and technological approaches for measuring risk which are conducted and interpreted through a filter of values, and that this process devalues other, legitimate ways of knowing. Indeed, this can be seen within the Arctic context and misunderstandings of IK systems with regards to their potential contributions to understanding environment and health risks. Historically, little recognition, understanding, or use of Indigenous methodologies of B-R assessment existed, but over the last few decades there has been greater support for collaborative partnerships including Indigenous perspectives in risk assessment and management processes (34,49). This participation, however, has mostly involved integrating aspects of IK into standard eurocentric-based models and with IK measured and validated against criteria set by scientific standards (50,51).

"Effective" risk management was reported by study participants to be dictated by the effort given to include the affected communities or populations in the process. Inclusiveness and building partnerships were deemed critical. In order for IK to make an effective contribution to risk management, the findings from this study suggest that all knowledge must be treated with respect and given credibility through inclusion, despite any contradictions or complexities it may introduce into the understanding of the issue. It is argued that through appropriate processes to build strong and trusting relationships, the different ways of viewing and understanding the world can more readily be accepted by all parties involved. As YCC member, Philip Merchant explained in this study:

> I would begin with a relationship with people and communities and build those relationships. You open those pathways of trust and understanding and then knowledge will flow back and forth. That seems awfully short and simplistic but I really think that that is the key ...

The B-R management approach is still an embedded process whereby affected populations do not yet have complete ownership of the assessment and they are still attempting or being provided an opportunity to fit and participate within an existing framework. By trying to fit into the general model and process of assessment and decision-making, YFN perspectives and conceptualizations of the risks of contaminants and the benefits of traditional foods are at risk of being misinterpreted and their potential contributions to the B-R assessment process overlooked. The findings here report that the process of conventional (technically-based and driven) B-R assessment is not well understood by many YFN community residents. It is argued that were the communities to better understand how this process works, they themselves may be able to identify where they could contribute most effectively. As deduced from this study, several significant contributions are possible throughout the conventional steps of the decision making process. For example, IK may contribute by providing context to the issue when framing the hazard and determining exposure, incorporating cultural and local perspectives and behaviours with respect to harvesting and consumption. IK may also provide insight on cultural conceptions of risk, informing risk communication strategies and approaches. Further, IK may provide insight on potentially effective modes of action and evaluation criteria for assessing the impact of decisions. Table IV provides a summary of these results, characterized in terms of specific contributions to typical risk management steps. It illustrates the potential specific contributions IK may have in conventional processes. Its purpose is to demonstrate where Indigenous perspectives fit into the existing framework; however, it is not a preferable approach and it can be argued that we need to work towards decision-making processes that are appropriate for an Indigenous context instead, that is a "new model or framework".

Table IV. Potential contributions of Indigenous knowledge to the specific steps of the conventional risk management process

Knowledge needs in the risk management process	Knowledge contribution from Indigenous knowledge
Risk characterization	
Confirm identification of hazard	Using own methods of assessing food safety identify deformities, disease, etc. [Note: this will be limited as long-range contaminants cannot be identified following typical assessment (smell, taste, visual) processes.]
Framing of hazard	Provide context to the issue.
Risk evaluation (Benefit-risk assessment)	
Dietary exposure	Identify patterns of consumption.
Dose-response assessment	Species consumed.
	Mode of preparation.
Exposure assessment	Rules of which animals are taken.
Benefit assessment	Cultural context.
Risk communication	
Risk perception	Cultural context and local relevancy.
	Insight on effective modes of communication.
Risk options	
	Inform on effective modes of action.
Monitoring and evaluation	
	Inform on effectiveness of strategies.
	Evaluate management process using own criteria of relevancy and success.

Citation: Int J Circumpolar Health 2012, **71**: 19003 - http://dx.doi.org/10.3402/ijch.v71i0.19003

As the universal application of a formal step-by-step framework is not likely possible for all cases, as is seen in the Yukon context, a set of common guiding principles within a process that brings together people and different knowledges may provide an effective way forward. As YCC member Ron Pearson stated, "You've got to find a way of making it just as easy for First Nations to participate as it is for you and I to participate."

Within the NCP, Aboriginal involvement and partnerships are an integral component of its operations. The NCP has developed Guidelines for Responsible Research, which is a flexible framework which researchers are meant to follow when implementing their projects in northern communities. The guidelines include: consultation, community participation, partnerships and relationship building, communications, and data reporting (52). These guidelines are, in principle, to be applied to all activities under the program including assessment and management processes resulting from and using data generated through NCP funded research. However, as was found in this study, the qualitative factors (social, cultural, economical contexts) may provide context to an assessment but are not yet completely and explicitly integrated into the assessment or may not directly shape the assessment process itself. In the Yukon, explicit inclusion of IK has often come near the end of the B-R management process. As a result, it can be argued that YFN perspectives, when included, are at risk of being misinterpreted in regards to their contributions to the conventional, technical risk assessment process.

All things considered, a participatory approach that includes cross-cultural exchange and collaboration is better enabled to help ensure that IK and the principles of Indigenous assessment are used effectively. A multifaceted, integrative framework that uses a broad source of information and incorporates IK with both qualitative and quantitative data coming from toxicology, epidemiology and ecological sciences, and that is flexible and accommodating to culturally-based and community specific contexts is required (53). Within such an approach, IK could be accepted as "an equal but different source of knowledge, not measurable through a Western worldview" (54, p. 291), and Indigenous ways of assessment could provide a greater context and capacity to environmental health decision processes once they were understood and accepted among all participants.

Conclusions

This study interviewed TFKHs and HEDMs in Yukon Territory, Canada on the topics of IK inclusion and contributions to B-R management and communication processes in the past. It provides recommendations as to how IK can better contribute and inform assessment and communication processes on topics such as environmental contaminants and traditional foods in this and other regions in the future. It argues that IK is not just an add-on to assessment processes, but must be recognized as an integral, valuable, and equal component to the entire process. Further it reports that IK is not best squeezed into a Western framework of identifying, assessing and decision-making on strategies to minimize risk (41). A more balanced approach that recognizes how these IK and science concepts are intrinsically linked, in addition to integrating cultural and community specific contexts will best contribute to the success of risk management paradigms in the future (53). If researchers, health decision-makers, and Indigenous communities understand the necessity of moving beyond what they know, and how things should be done, to see the opportunity of creating a broader and deeper understanding of the issues confronting them through cooperative inquiry and decision-making, then the process of bringing different knowledges together may be better facilitated.

Acknowledgements

A warm thank you to the First Nation Communities of Old Crow, Dawson, and Haines Junction, as well as to all other interviewees who participated in this project. Thank you to Pat Roach and the Yukon Contaminants Committee as well as to Cindy Dickson, of the Council of Yukon First Nations for your support and facilitation during the research project. We gratefully acknowledge the Nasivvik-Centre for Inuit Health and Changing Environments, Canadian Institutes of Health Research, Trent University, and the Northern Scientific Training Program of Aboriginal Affairs and Northern Development Canada for their financial contributions to this project. Finally, we thank reviewers of the earlier version of this paper for their helpful and constructive comments.

Conflict of interest and funding

The authors have not received any funding or benefits from industry or elsewhere to conduct this study.

References

1. Health Canada. Health Canada decision-making framework for identifying, assessing, and managing health risks. Ottawa: Minister of Health; 2000. 75 p.
2. Health Canada. Canadian handbook on health impact assessment volume 2: approaches and decision-making. Ottawa: Minister of Health; 2004. 158 p.
3. Elias BD, O'Neil J. A study into the social, cultural, and disciplinary understanding of risk perceptions and risk acceptability of contaminants in the Canadian Arctic. Winnipeg: Centre for Aboriginal Health Research; 1995. 59 p.
4. Kasperson RE, Renn O, Slovic P, Brown H, Emel J, Goble R, et al. The social amplification of risk a conceptual framework. Risk Anal. 1988;8:177–87.
5. Oltedal S, Moen BE, Klempe H, Rundmo T. Explaining risk perception: an evaluation of cultural theory. Trondheim: Rotunde Publishing; 2004. 40 p.
6. Slovic P. Trust, emotion, sex, politics, and science: surveying the risk-assessment battlefield. Risk Anal. 1999;19:689–701.
7. EnHealth. Environmental health risk assessment: guidelines for assessing human health risks from environmental hazards.

Commonwealth of Australia: Australian Department of Health and Ageing and enHealth Council; 2002. 227 p.
8. Donaldson S, Van Oostdam J, Tikhonov C, Feeley M, Armstrong B, Ayotte P, et al. Environmental contaminants and human health in the Canadian Arctic. Sci Total Environ. 2010;408:5165–234.
9. Furgal C, Powell S, Myers H. Digesting the message about contaminants and country foods in the Canadian north: a review and recommendations for future research and action. Arctic. 2005;58:103–14.
10. Myers H, Fast H, Berkes F. Feeding the family in times of change. In: Berkes F, Huebert R, Fast H, Manseau M, Didcuk A, editors. Breaking ice: integrated ocean management in the Canadian North. Calgary: University of Calgary Press; 2005. p. 23–45.
11. Van Oostdam J, Donaldson S, Feeley M, Tremblay N. Human health; Canadian Arctic contaminants assessment report II. Ottawa: Minister of Indian Affairs and Northern Development; 2003. 127 p.
12. Furgal C, Kalhok S, Loring E, Smith S. Knowledge in action; Canadian Arctic contaminants assessment report II. Ottawa: Minister of Indian Affairs and Northern Development; 2003. 90 p.
13. Van Oostdam J, Donaldson S, Feeley M, Tikhonov C. Human health 2009; Canadian Arctic contaminants assessment report III. Ottawa: Minister of Indian Affairs and Northern Development; 2009. 183 p.
14. Myers H, Furgal C. Long-range transport of information: are Arctic residents getting the message about contaminants? Arctic 2006;59:47–60.
15. O'Neil JD, Elias B, Yassi A. Poisoned food: cultural reflections on the contaminants discourse in Northern Manitoba. Canada: Centre for Aboriginal Health Research; 1996. 23 p.
16. Starks H, Trinidad SB. Choose your method: a comparison of phenomenology, discourse analysis, and grounded theory. Qual Health Res. 2007;17:1372–80.
17. Davis A, Wagner JR. Who knows? On the importance of identifying ''experts'' when researching local ecological knowledge. Hum Ecol. 2003;31:463–89.
18. Charmaz K. Grounded theory: objectivist and constructivist methods. In: Denzin N, Lincoln Y, editors. Handbook of qualitative research. Thousand Oaks: Sage Publications; 2000. p. 509–31.
19. NVivo qualitative data analysis software; QSR International Pty Ltd. Version 8, 2008.
20. Boyatzis R. Transforming qualitative information: thematic analysis and code development. Thousand Oaks: Sage Publications; 1998. 184 p.
21. Receveur O, Kassi N, Chan H, Berti P, Kuhnlein H. Yukon first nations' assessment dietary benefit/risk. Quebec: Centre for Indigenous Peoples' Nutrition and Environment, McGill University; 1998. 160 p.
22. Dewailly E, Nantel A, Weber JP, Meyer F. High levels of PCBs in breast milk of Inuit women from Arctic Quebec. Bull Environ Contam Toxicol. 1989;43:641–6.
23. Davison S. Don't eat any Lake Laberge fish, CYI warns all Yukoners. The Whitehorse Star 1991 May 10;91:4.
24. Gamberg M, Cunningham E. Yukon Contaminants Committee: a decade in review. Whitehorse: Yukon Contaminants Committee; 2003. 27 p.
25. Stevens M. Contaminated fish scare warning call. Dännzhà': Yukon – The Voice of a Nation 1992 March 27;P1.
26. Nordin K, Burns B, Lendrum B. Use, disposal and transportation of selected contaminants in the Yukon. Arctic Environmental Strategy, Ottawa: Indian and Northern Affairs Canada; 1993. 116 p.
27. Dickson C. Regionally relevant health risk assessments for mercury levels in fish in the Yukon. Ottawa: Northern Contaminants Program; Synopsis Report; 2007–2008. p. 20–5.
28. Davison S. Porcupine caribou found with high cadmium levels. The Whitehorse Star 1992 Dec 18;P5.
29. McLaughlin A. Letter to Minister of Health and Welfare, Benoit Bouchard from NDP MP. Held on file in the office of the INAC contaminants program and Yukon Contaminants Committee in Whitehorse YK. Yukon; 12 January 1992.
30. Mostyn R. Chief encourages urine tests for cadmium levels. Yukon News 1992 Dec 23;P5.
31. Porcupine Caribou Management Board. Cadmium revisited. Timeline summary. Whitehorse: Porcupine Caribou Management Board; 1993. 2 p.
32. Hansen J, Holm L, Frewer L, Robinson P, Sandoe P. Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. Appetite. 2003;41:111–21.
33. Kuhnlein HV, Chan HM. Environment and contaminants in traditional food systems of northern Indigenous peoples. Annu Rev Nutr. 2000;20:595–626.
34. Usher P, Baikie M, Demmer M, Nakashima D, Stevenson M, Stiles M. Communicating about contaminants in country food: the experience in Aboriginal communities. Ottawa: Inuit Tapirisat of Canada; 1995. 238 p.
35. Furgal C, Rochette L. Qanuippitaa? How are we? Perception of contaminants, participation in hunting and fishing activities, and potential impacts of climate change. Nunavik: Nunavik Regional Board of Health and Social Services; 2007. 24 p.
36. Kraus N, Malmfors T, Slovic P. Intuitive toxicology: expert and lay judgments of chemical risks. Risk Anal. 1992;12: 215–32.
37. Slovic P. Perception of risk. Science 1987;236:280–6.
38. Roach P. Yukon Contaminants Committee. 2004. In: Smith, S., Stow, J., Watkins, J., and Carillo, F. editors. Synopsis of Research Conducted Under the 2004–2005 Northern Contaminants Program. Ottawa: Indian and Northern Affairs Canada; 2005. p. 282–88.
39. O'Neil J, Elias B, Fletcher C, Yassi A. Cultural rationality and environmental health risk perception in Northern Canada. In: Oaks J, Riewe R, editors. Issues in the North Vol III. Edmonton: Canadian Circumpolar Institute; 1998. p. 13–28.
40. Poirier S, Brooke L. Inuit perceptions of contaminants and environmental knowledge in Salluit, Nunavik. Arctic Anthropol. 2000;37:78–91.
41. O'Neil J, Elias B, Yassi A. Poisoned food: cultural resistance to the contaminants discourse. Arctic Anthropol. 1997;34:29–40.
42. Jardine C. Development of a public participation and communication protocol for establishing fish consumption advisories. Risk Anal. 2003;23:461–71.
43. The Whitehorse Star. And if this was beef in supermarkets? The Whitehorse Star 1993 Jan 13. 8 p.
44. Stone J. Public participation in environmental management: seeking participatory equity through ethnographic inquiry. Tampa: University of South Florida; 2002. 323 p.
45. Covello V, Johnson B. The social and cultural construction of risk: issues, methods, and case studies. In: Johnson B, Covello V, editors. The social and cultural construction of risk. Dordrecht: D. Reidel Publishing Company; 1987. p. vii–xiii.
46. Braaf R. Improving impact assessment methods: climate change and the health of indigenous Australians. Global Environ Change. 1999;9:95–104.
47. Giles B, Haas G, Findlay C. Incorporating First Nations health perspectives and traditional knowledge into health risk assessment models; final report. Ottawa: The Institute of the Environment, University of Ottawa; 2005. 37 p.

Citation: Int J Circumpolar Health 2012, **71**: 19003 - http://dx.doi.org/10.3402/ijch.v71i0.19003

48. Bradbury JA. Expanding the rationale for analysis and deliberation: looking beyond understanding risk. Hum Ecol Rev. 1998;5:42–4.
49. Wheatley B, Wheatley M. Methylmercury and the health of indigenous peoples: a risk management challenge for physical and social sciences and for public health policy. Sci Total Environ. 2000;259:23–9.
50. McGregor D. Coming full circle: Indigenous knowledge, environment, and our future. Am Indian Q. 2004;28:385–410.
51. Bocking S. Perceptions of Indigenous knowledge in Northern Canada. In: Lischke U, editor. Walking a tightrope: Aboriginal people and their representations. Waterloo: Wilfred Laurier University Press; 2005. p. 215–47.
52. Northern Contaminants Program. Northern Contaminants Program operational management guide. Canada: Northern Contaminants Program; 2006. 55 p.
53. Arquette M, Cole M, Cook K. Holistic risk-based environmental decision making: a native perspective. Environ Health Perspect. 2002;110:259–64.
54. Cajete G. Native science: natural laws of interdependence. Santa Fe: Clear Light Publishers; 2000. 352 p.
55. Yukon Government. Traditional territories of Yukon First Nations. Map. Yukon: Environment Yukon; 2008 [cited 2010 May 9]. Available from: http://www.environmentyukon.gov.yk.ca/geomatics/maps.html.

***Katelyn A. Friendship**
Canadian Studies-Indigenous Studies
Trent University
RavenQuest Consulting
PO Box 33173
Whitehorse, YT Y1A 6S1
Canada
Email: katelyn@ravenquest.ca