"Water is a living thing"

Environmental and Human Health Implications of the Athabasca Oil Sands for the Mikisew Cree First Nation and Athabasca Chipewyan First Nation in Northern Alberta.

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Dedication

We dedicate this work to the residents of Fort Chipewyan, Alberta who aspire to livelihoods that at once are grounded in their traditions and the present, and that enable them to adapt in the future

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EXECUTIVE SUMMARY

Oil sands development in northern Alberta has generated much economic prosperity for Canada. The Athabasca Oil Sands represent the largest reservoir of crude oil (bitumen) and the only oil sands deposit in the world that is suitable for large-scale surface mining. Yet many argue that this intensive and fast-growing industrial activity has adverse and poorly understood implications for environmental and human health. Indigenous People, including members of both the Mikisew Cree First Nation (MCFN) and Athabasca Chipewyan First Nation (ACFN), live downstream from these industrial activities on the Athabasca River, activities that continue to escalate in scale and impact. These and other downstream Indigenous communities are especially vulnerable to these impacts, in part because their traditional livelihoods, cultures, and wellbeing are so closely linked to the environment. Although these impacts continue to grow in scale, any existing monitoring has been widely criticized as inadequate by scientists, community members, and the broader public alike.

The overall goal of the Phase Two component of this long-term project has been to characterize the impacts of upstream industrial activity associated with the Athabasca Oil Sands for wildlife, environmental and especially human health as it affects the MCFN and ACFN.

Our specific objectives were:
(i) to evaluate contaminants levels by testing the environment and culturally important wildlife;
(ii) to identify potential exposure of community members to contaminants by documenting the consumption of wild-caught foods;
(iii) to explore any implications of these changes for community health and wellbeing;
(iv) to promote capacity in community-based monitoring to address any environmental concerns; and
(v) to facilitate effective cross-cultural risk communication that incorporates both western science and TEK in sharing the outcomes of this project.

This project emerges from a collaboration initiated by the MCFN and ACFN in northern Alberta and with scientists from University of Manitoba and University of Saskatchewan. Outcomes of this community-based participatory research have been shaped and controlled throughout by ACFN and MCFN. Phase Two of this project built on the strengths and expanded on the results of the previous phase, which had documented Traditional Knowledge of the complex environmental change in the region and the factors responsible for these changes, as well as contaminant levels in wildlife.

In Phase Two, wildlife was again evaluated by veterinarians and tested for environmental contaminants including heavy metals and polycyclic aromatic hydrocarbons (PAHs). Interviews were also conducted with community members regarding ongoing impacts of upstream development. We documented consumption patterns of wild-caught (traditional or country) foods and assessed to what degree any changes in concern and consumption patterns were attributable to industry-associated declines in the environment. Changes in community health and wellbeing as well as likely causes of and responses to these changes were identified by group interviews with community members. The role of community-based monitoring and cross-stakeholder engagement in building capacity among local youth and in addressing shortcomings in existing governmental monitoring plans was documented in the form of a Youth-Elder Camp. Finally, the impacts of the Oil Sands and other upstream development were communicated to community members and a broader audience in the form of a feature-length documentary film.

Outcomes regarding contaminant levels in wildlife largely reflected those of Phase One, with some important differences. Harvesting was more strategic and broadened to include beavers, which are recognized as a more effective indicator species than muskrats, which have been effectively extirpated from the Athabasca Delta by upstream development. Arsenic levels were high enough in in muskrat and moose muscle; duck, moose, and muskrat livers; and moose and duck kidneys to be of concern for young children. Cadmium levels were again elevated in moose kidney and liver samples but also those of beaver and ducks, although muskrat samples were again low. Mercury levels were also high for duck muscle, kidneys, and livers as well as moose and muskrat kidneys, especially for children. In contrast to the last phase of the study, selenium levels were high enough in the muscle, kidney, and livers of all wildlife species to be of concern for adults and children alike. Yet human exposure rates to these contaminants were generally not of health concern. This reflects the relatively low amounts of traditional foods that are now consumed as community members transition towards store-bought foods. These high levels of heavy metals are also consistent with impacts from the upstream Oil Sands, which have become Alberta's greatest emitters of mercury and cadmium.

Total levels of PAHs and levels of carcinogenic and alkylated PAHs were very high relative to other food studies conducted around the world. The mean concentrations of benzo[*a*]pyrene, a relatively well understood carcinogenic PAH, were about mid-way compared to studies conducted elsewhere in the world. The daily intake of total PAHs in our study was also high, almost 3X that of the next highest study. However, the daily dietary intake of carcinogenic PAHs was lower than the other two comparable studies. Indeed, dietary intake of benzo[*a*]pyrene and its equivalents was effectively zero. This again reflects the relatively low consumption levels of traditional foods compared to the past.

Our diet study shows that ACFN and MCFN members still consume a wide diversity of traditional foods, albeit at lower levels than in the past. The mostly frequently consumed kind of food was moose in the previous two months, about equal to all the other traditional foods combined. Moose was followed, in descending order, by ratroot, duck, wild mint, spruce gum, pickerel, caribou, and Labrador tea. Participants were concerned about declines in the quality of these foods, in the greatest part because of environmental pollutants originating from the Oil Sands. It was notable how many participants no longer consumed locally caught fish, because of government-issued consumption advisories and associated human health concerns. Muskrat consumption had also declined precipitously, along with muskrat populations, a decline that was attributed to changes in hydrology and contaminant levels associated with the WAC Bennett Dam and the Oil Sands. The only effective alternatives to traditional foods are store-bought foods. The latter consist of either healthy options that are cost-prohibitive and low in quality or convenience options that, while cheaper, are relatively high in fats, sweeteners, and salts. Consumption of convenience foods was most prevalent among younger community members, and is already having adverse health implications. Most participants anticipated that these trends would continue into the future as the Oil Sands expanded and as wildlife species decline in availability and safety.

All participants were worried about ongoing declines in the health and wellbeing of their community. They generally viewed themselves as less healthy than their parents, who rarely got sick. Neurological illnesses (e.g. sleeping disorders, migraines, and stress) were most common followed, in descending order of frequency, by respiratory illnesses (e.g. allergies, asthma) as well as circulatory (e.g. hypertension, coronary) and gastrointestinal (e.g. gallbladder, ulcers) illnesses. Yet, everyone was most concerned about the current and escalating cancer crisis. Indeed, of the 94 participants, 20 (21.3%) had experienced 23 cases of cancer. Cancer types included four cases of breast cancer, two each of lung, cervical, colon, gallbladder, kidney, prostate, and stomach cancer, as well as one case of cholangiocarcinoma or bile duct cancer. Cancer occurrence increased with age and was most frequent in women. For the first time, we showed that upstream development and environmental decline are affecting cancer occurrence. Thus, cancer occurrence increased significantly with participant employment in the Oil Sands and with the increased consumption of traditional foods and locally caught fish.

When human health was examined as a whole, participants identified the Oil Sands as the cause of health decline, followed in descending order of importance by upstream agriculture, substance abuse, and the WAC Bennett dam. Widespread increases in type 2 diabetes and obesity were attributed to the increased consumption of processed foods from the South, declines in physical activity, and depression. These declines in health and wellbeing were aggravated by poor risk communication, inadequate health care in Fort Chipewyan but also an overdependence upon often-inferior health care in urban centres to the south. Many felt that the continued expansion of the Oil Sands would continue to undermined health and wellbeing into the future, especially as related to cancer.

The inadequacy of existing and mostly culturally inappropriate and exclusively science-based monitoring was also emphasized by many participants, and seen by some as putting these communities further at risk. A highly successful Youth-Elder camp was held in spring 2012. Local youth engaged with and learned from Elders and outside scientists regarding environmental monitoring on the land as did younger children at the local community school. The development of these skills, at once grounded in both Traditional Knowledge and western science, will play a key role in enabling young community members to further engage in an already effective community based-monitoring program, which is documenting changes in water and wildlife health and which is informed by both knowledge systems.

These cross-cultural monitoring programs will also help address community concerns regarding existing risk communication. Typically, most outside scientists fail to adequately communicate their research outcomes with community members, much less adequately involve community members in the research projects. This communication gap combined with inaccessible governmental consumption advisories help foster fear and worry regarding traditional foods, which are still much more desirable than most high-cost, store-bought alternatives. A 60-minute documentary film was developed that will facilitate such communication within Fort Chipewyan and with other impacted communities, but also with outside stakeholders including government, industry, civil society, and the public as a whole. The film documents the above changes and decline in environmental and human health as experienced and communicated by community members. Yet, it further argues that this development also represents many opportunities for community members and, regardless of outcome, asserts that that these communities need to be centrally involved in any future decision-making. Finally, a news aggregator web site has been launched that increases the visibility of these northern views.

In conclusion, represented here is a perfect storm of decline and opportunity, a storm that places these and other downstream communities at progressively increased risk. Substantial employment opportunities are generated by the Oil Sands. However, this development, as well as upstream hydro projects, compromises the integrity of the environment and wildlife, which in turn adversely affects human health and wellbeing. Associated changes in land use as well as decline in access to and concerns regarding the quality of traditional foods act to separate community members from these food sources and from their livelihoods and traditions. These changes and inadequate outsider-controlled monitoring programs and risk communication just aggravate these concerns and further displace their traditions. The failure of the healthcare system to address and mitigate ongoing adverse impacts and plans for rapid expansion of the Oil Sands in the future only act to ensure that an already grave situation will worsen. Recommendations included in this report focus on the increased role of these communities in decision-making and management of Oil Sands development as well as the need to conduct additional health research that build on this study, recommendations that will work towards the benefit of these communities and all Canadians alike.

1. INTRODUCTION

The Athabasca Oil Sands have been the focus of much attention and controversy over the last decade. On the one hand, they are widely seen as an essential “driver” for the economy of Alberta and of Canada as a whole, attracting billions of dollars of investment by multinational corporations from around the world. But the Oil Sands have also received a great deal of international criticism regarding their possible adverse effects both on the environment and human health. In part, this concern reflects the extremely rapid and, some would argue, unregulated growth of this industry as well as the effective absence of independent monitoring regarding possible environmental and especially human impacts.

The growth of the controversy has occurred at a rate that matches the growth of development. The controversy is polarizing, which undermines proactive research as well as communication between proponents and critics of the Oil Sands. Indeed, this impasse acts to place these downstream and mostly Indigenous communities at risk, communities that are almost entirely excluded from decision-making regarding these issues.

There has been a substantial amount of development-related environmental research conducted in this region of northern Alberta. Much of the work conducted in the 1970s and 1980s focused on the hydrological impacts of the W.A.C Bennett dam completed on the Peace River in northern British Columbia in 1968. Research over that time period also focused on the implications of upstream deforestation and agriculture for mercury levels in wildlife and the environment. More recent research has focused on the implications of climate change for the region. In contrast, much less independent research has been conducted regarding the Oil Sands, arguably because of the extreme financial stakes and controversy surrounding this industry.

FIG 1.1. Fort Chipewyan in the evening

What is certain is that very little of the past research has focused on the socio-environmental much less health implications of these changes. Indeed, to our knowledge no published research projects have adequately incorporated the knowledge of or even meaningfully involved downstream communities. Moreover, few if any of these research outcomes, regardless of their focus, have been adequately shared with these communities.

This is a nasty legacy, one that characterizes much outsider research on issues that pertain to Indigenous communities and one we hope to help address through this collaborative research project. But, first, some background on the environmental and health implications of the industry.

2. BACKGROUND

In western and northern Canada, large-scale changes in land use have occurred over the last 100 years as affected by agriculture, forestry, mining, and now oil and gas extraction (NAHO 2008). These changes and equivalent ones elsewhere in the world are resulting in increased contaminant loads in the environment, with substantial implications for wildlife, environmental, and human health. Of special concern in north-western Canada are environmental changes associated with the recent advent and rapid expansion of the Oil Sands.

By 2012, the Oil Sands in Alberta accounted for 56% of Canada's total oil production, and represents a volume that is roughly equivalent to the world supply of conventional petroleum (Pembina 2014). The largest reservoir of bitumen (crude oil) is the Athabasca, which is the only oil sands deposit in the world that is suitable for large-scale surface mining. These deposits and associated facilities are concentrated along the Athabasca River. Opening in 1967, the Athabasca Oil Sands initially produced 30,000 barrels per day; production of bitumen then tripled by 2008 (ERCB 2009) and may again double by 2020 (CAPP 2011). This increased development may have grave and still poorly-understood implications for downstream communities and the environment.

FIG 2.1. The Athabasca Oil Sands in operation (Suncor site)

By 2008, mining related to the Oil Sands had disturbed 530 km^2 of the boreal forest and muskeg, and associated tailings ponds covered more than 130 km^2 of land (Price 2008). Many argue that these ponds represent a severe threat to migratory birds and to the Peace Athabasca Delta. In 1970, a Suncor pipeline break spilled three million L of oil, which then flowed to Lake Athabasca. In 1982, there was another large spill from Suncor, which closed down commercial fishing on Lake Athabasca and caused illness in the nearby community of Fort McKay (Timoney and Lee 2009). In October 2013, a substantial spill from the Obed coal mine in Hinton occurred, releasing 670 million L of "coal slurry" that ended up in the Athabasca River with adverse implications for downstream environments and communities (HP 2013).

Yet, any impacts of these earlier spills were never publicly reviewed much less mitigated (Timoney 2008). Much of the concern focuses on the potential adverse effects of related environmental contaminants. Many contaminants generated by industrial development can contribute to physiological, neurological, and health problems in wildlife and humans. Deposited in water and on soils as well as on snow and ice, some environmental contaminants are concentrated (biomagnified) as they move through the food web. Contaminants of broad concern include heavy metals (e.g. mercury, arsenic, cadmium) as well as toxins such as polycyclic aromatic hydrocarbons (PAHs) and naphthenic acids. Although some of these contaminants already naturally occur in the region, there is much concern that development associated with the Oil Sands increases their concentrations to unacceptable levels, placing communities and wildlife at risk in the combined Peace-Athabasca-Slave River Basins.

Mercury levels vary widely in wildlife due to the flooding of soils that contain inorganic mercury associated with upstream development. Mercury as well as cadmium and arsenic occur at high concentrations in waterfowl, moose, and muskrats (McLachlan and Miller 2012) and mercury levels are high in gull and tern eggs (Hebert et al. 2013). Although these levels might still be a legacy of the WAC Bennett Dam, since these effects may extend over many decades, the Oil Sands have also become the largest emitters of mercury in the province (Gosselin et al. 2010). Selenium is also magnified, and found in increased concentrations downstream from uranium mines (Muscatello et al. 2008).

Sediments from the lower Athabasca River and the Peace Athabasca Delta can be toxic to invertebrates and also contain high levels of PAHs. Levels of PAHs in sediment of the Athabasca River are double those observed to induce liver cancers in fish (Timoney and Lee 2009). They have increased with industrial activity from 2001-2009 (Timoney and Lee 2011). Important studies on snow transport (e.g. Kelly et al. 2009, 2010) indicate that the Oil Sands now increase loadings of toxic PAHs to the Athabasca River through water and air. Levels of PAHs have increased since the 1960s, especially C1-C4-alkylated PAHs associated with industry (Kurek et al. 2013). While concentrations of PAHs in snow, in tributaries, and in the Athabasca River have yet to exceed drinking water quality guidelines, their deposition still has worrisome implications for human health, especially since alkylated PAHs, unlike their parent compounds, bioaccumulate in wildlife (Kelly et al. 2010). Indeed, a recent study indicates that PAH emissions may be greatly underestimated, by at least 2-3 orders of magnitude (Parajulee and Wania 2014).

There is widespread community concern that elevated cancer rates in communities located downstream from the Oil Sands are related to exposure to environmental contaminants such as arsenic, mercury, and PAHs (Chen 2009). Thus, it is essential to better understand these changes, especially as they relate to animals and plants that are harvested for food and for cultural purposes.

FIG 2.2. Fort Chipewyan, 280 km downstream from Fort McMurray

It is increasingly recognized that any changes in environmental, wildlife and human health along the Peace-Athabasca-Slave River Basin associated with upstream industry should be effectively monitored and evaluated. These outcomes should, in turn, inform decision-making by government, by industry, and by the downstream communities themselves. However, environmental impacts associated with the Oil Sands have yet to be adequately evaluated using the Canadian Environmental Assessment Act (CEAA) (Kelly et al. 2010). The CEAA has also been widely criticized as promoting evaluation that is dominated by techno-scientific thinking and as excluding meaningful input by affected Indigenous communities (Booth and Skelton 2011), especially as it relates to the Peace Athabasca Delta (Lawe et al. 2005). Moreover, the federal Harper government recently introduced widely criticized changes to the CEAA, which will make any environmental assessment more discretionary and reliant on provincial processes (Doelle 2012) and further reduce levels of public participation (Gibson 2012).

The Cumulative Environmental Management Association (CEMA), which is a multi-stakeholder group including at least some Indigenous communities, has the potential to play an important role in Oil Sands monitoring. However, it has been criticized as being too tightly aligned with industry and has yet to synthesize any cumulative impacts (Timoney and Lee 2009). Until recently, most of the science-based monitoring in the region was conducted under the auspices of the Regional Aquatic Monitoring Program (RAMP). However, RAMP was also strongly criticized by the Royal Society of Canada (Gosselin et al. 2010), as part of a scientific, peer-review process (Burn et al. 2010), and by an advisory panel to the Minister of Environment (Dowdeswell et al. 2010). In part due to these shortcomings, the Alberta and Canadian governments most recently designed and began implementing an integrative “world-class” Joint Oil Sands Monitoring program (JOSM) to assess any changes in air, water, and biodiversity (JOSM 2014). Yet, the great majority of the research and monitoring conducted as part of the JOSM is still techno-scientific in orientation, and most has yet to adequately involve affected communities much less incorporate their Traditional Knowledge. Indeed, the many attempts on the part of affected Indigenous groups to become actively involved in JOSM have been repudiated to such a degree that both Athabasca Chipewyan First Nation and Mikisew Cree First Nation recently withdrew from participating further in the program (HP 2014). There is clearly much need for and local interest in having cross-cultural monitoring that at once builds local capacity in science, that respects and gives a central role to cultural traditions and Traditional Knowledge in any monitoring activities, and that gives Indigenous communities a meaningful and much-needed voice in decision-making.

Indigenous communities are especially vulnerable to environmental contaminants (Harper and Harris 2008). Wild-caught “country” food is central to many Indigenous cultures and traditions (Arquette et al. 2002). Key to many diets, these foods represent an important way of addressing health problems arising through the ready availability and increasing consumption of processed, store-bought foods in many northern communities (Haman et al. 2010). Yet, these country foods, and in turn cultural traditions and human health are threatened by contaminants associated with industrial activity (Rudolph and McLachlan 2013). Implications of contaminants for environmental, and wildlife health have thus been the focus of much scientific study over the last 30 years. Unfortunately, the great majority of these research outcomes still have uncertain and often negative implications for Indigenous communities, in large part because they generally continue to exclude local needs, cultural traditions, and worldviews (Brook and McLachlan 2008).

Outreach with affected Indigenous communities regarding any identified or potential risks is also often hampered by ineffective communication (Suk et al. 2004). There is a widespread distrust of outsider university, government, and industry scientific experts in most of these communities, whose activities are generally viewed as parasitical in nature (Epp and McLachlan 2010). The resulting "communication crisis" in part reflects the technical nature of most influential scientific risk research (Corburn 2002). Much environmental and health research is still conducted *on* rather than *with* marginalized communities (Mitchell and Baker 2005, Brugge and Missaghian 2006). Thus, as Maori scholar Linda Tuhiwai Smith argues, the term 'research' is "*probably one of the dirtiest words in the Indigenous world's vocabulary*... [and] *is implicated in the worst excesses of colonialism*" Tuhiwai Smith, 1999 (p.1) There is little in the techno-scientific research conducted in and around the Oil Sands that could function as an antidote to these concerns.

FIG 2.3. Seagulls lifting off Lake Mamawi

Much of the environmental and wildlife health literature pertaining to Indigenous communities is thus criticized as ineffective and culturally inappropriate (Simpson 2004, Donatuto and Harper 2008). Much employs reductionist, standardized, and quantitative methodologies while largely overlooking the socioeconomic, cultural, and especially spiritual and political implications of environmental and human health (Brook and McLachlan 2008). Most studies are still driven by outsider techno-scientific priorities. Most have little meaningful community involvement in priority setting or in the evaluation and dissemination of outcomes (Brook and McLachlan 2005). Technical advisories on environmental contamination thus underemphasize the dietary (Scherer et al. 2008), cultural, and socioeconomic importance of fishing and hunting (O'Neil et al. 1997). Much of the outreach is text-based, laden with techno-jargon, and only available in English. Research scientists spend little time within the communities sharing and clarifying the outcomes of their work, much less incorporating local experience, expertise, and priorities. Because of this poor communication, the outcomes of many contaminant studies themselves often generate much uncertainty and fear. Ironically, this fear in turn may ironically further alienate these communities from their otherwise healthy traditional diets and livelihoods (Kuhnlein and Chan 2000).

This communication crisis has been recognized since the 1970s. However, the shortcomings of research communication have yet to be adequately evaluated, much less acted upon (Jardine and Furgal 2010). There is little insight into what information Indigenous communities have received, much less what they need or want. Past practice and recommendations regarding outreach with these communities effectively amount to approaches in "how-not-to-communicate" (Furgal et al. 2005). To our knowledge, none of the previous studies relating to environmental or human health associated with the Oil Sands have explicitly reflected Indigenous knowledge systems. Few if any have been conducted in active collaboration with downstream Indigenous communities

Yet, Traditional Knowledge (TK) provides tremendously valuable spatial and temporal insights into changes in environmental and human health and can identify potential causes of these changes especially as they relate to surrounding industrial development. It also provides an appropriate cultural and spiritual context within which all these changes occur. Incorporating TK increases the relevance and accessibility of research outcomes to affected communities. As such, it may help address the larger "crisis in communication" that still characterizes much of the contaminants literature. That said, it is important to recognize that the inclusion of TK is only appropriate to the degree that affected Indigenous communities are involved in any research, monitoring, and decision-making regarding these issues (Brook and McLachlan 2005). Without this community involvement, the use of TK is, at best, likely to be inappropriate and ineffective and, at worst, amounts to the theft of intellectual property (Brook and McLachlan 2008).

2.1 TRADITIONAL KNOWLEDGE

Traditional Knowledge (TK) reflects the experiences and rich insights that Indigenous Peoples gain from interacting with their local environments. It includes the knowledge, beliefs, practices and traditions of these environments. Imparted from generation to generation, it is adaptive and evolves continually along with the environments and cultures that give it context and meaning (Berkes 2008, p8).

With respect to Cree culture, for example, TK reflects and is grounded in larger Indigenous worldviews that are used to guide how people interact with one another and the larger environment. One such concept shows humans as having close relationships and obligations with the larger environment. These relationships are based on reciprocity and respect, amounting to what the Cree refer to as *mino pimatisiwin* or leading the good life (FLCN 2012).

FIG 2.4. Teddy Marten (MCFN) hunting ducks in fall 2012.

Yet TK should not be essentialized among communities much less among different First Nations cultures. It is as diverse and varied as the cultures and environments that give it meaning. Over the last 20 years it has received increased attention by managers and environments, in part because of the increase influence of and attention to the needs of Indigenous Peoples and in part because it helps address some of the shortcomings of western science in addressing complex environmental problems (Johannes 1998). The ways that TK is conceptualized by outsider and usually non-Indigenous managers and policy-makers have been criticized (McLachlan 2013). To the degree that TK has played a role in environmental decision-making at all, reflects the emergence of a bureaucratic form that is generally treated as data, that is amenable to manipulation, and that is seen as separate from the knowledge holders themselves (Nadasdy 2005).

It is becoming apparent that the inclusion of TK in decision-making is peripheral, if it is used at all, and that most key environmental and health-related decisions remain rooted in techno-scientific reasoning. Few development projects meaningfully incorporate TK much less the knowledge holders themselves. Indeed, with respect to the Oil Sands, Indigenous communities and their knowledge systems continue to have little sway

2.2 COMMUNITY BASED AND COLLABORATIVE RESEARCH

Community based participatory research (CBPR) is increasingly seen as an effective and, indeed, necessary response to the shortcomings of outsider environmental and health research when working with Indigenous communities (Mitchell and Baker 2005; Suk et al. 2004). As sovereign nations, these communities increasingly and rightly assert their influence on research having implications for their treaty rights, livelihoods, and wellbeing (Schrag 2006). The tri-council policy on human research thus recognizes that Aboriginal communities “should have an opportunity to participate in the interpretation of data and the review of conclusions drawn from the research to ensure accuracy and cultural sensitivity of interpretation” (CIHR 2010). Yet some, including this author, feel that this consultative approach is inadequate, as it still gives researchers ultimate control over the research and its outcomes. In contrast, an OCAP approach enables self-determination in research, as is highlighted through Indigenous “Ownership, Control, Access and Possession” of any cultural knowledge and any ensuing research outcomes (Schnarch 2004).

Key elements of CBPR include equitable partnerships between community members and researchers; research relevance; recognition of multiple determinants of environmental and human health; iterative processes; and long-term commitment to partnerships (Israel et al. 2003; Strickland, 2006). This is achieved by community involvement throughout the research; development and implementation of acceptable research protocols; identification of all expectations; creation of employment opportunities and capacity building for communities; and the meaningful sharing of outcomes with communities (Macaulay et al. 2007; Minkler and Wallerstein 2003). Although still rare with respect to research on environmental contaminants, CBPR is becoming increasingly prevalent in health research related to Indigenous communities, including diabetes (e.g. Macaulay et al. 2007; Satterfield et al. 2002), cancer (e.g. Burhansstipanov et al. 2005; Strickland 2006), lead exposure (Peterson et al. 2007; Singer and Kegler 2004), and levels of mercury and cadmium in wildlife (McLachlan and Miller 2012). These studies provide direction for CBPR on contaminant-related health research, especially since human health and environmental health are inseparable for most Indigenous cultures (Simpson 2004), and thus shape the research proposed here. Our work as presented here is firmly grounded in the tenets provided by both CBPR and OCAP.

This multi-phase project was initiated and has subsequently been shaped and controlled by the MCFN Government Industry Relations (GIR) and the ACFN Industry Relations Corporation (IRC). They established the research priorities reflected in this work and have provided funding, advice and guidance as well as provided logistical support and feedback on any plans and outcomes throughout. It was always the intent of these organizations and the outsider researchers to make this research as open to community input and as responsive to community needs as possible. This has been reflected in our approach to interacting with the grassroots, incorporating community priorities at all stages of the project, supporting capacity throughout the work, and employing a wide diversity of media and plain languages to communicate research results.

Our last series of visits to Fort Chipewyan built on trust-based relationships that began emerging during Phase One. Typically these visits are not ethnographic or sustained in approach, but focus on pragmatic research outcomes. Yet "off-camera" meetings and social interactions are still tremendously important as they help provide a context for the work, and are frequently sources of research insight and meaning. These experiences and connections have played, and will continue to play, a fundamental role in shaping this work and helped us appreciate the challenges and tremendous resilience embodied in Fort Chipewyan, in ways that would otherwise not have been possible.

FIG 2.5. Workshop held with members of Athabasca Chipewyan First Nation and Mikisew Cree First Nation, discussing harvesting for subsequent lab testing.

Community input was received in many ways and at multiple stages through this research. Early on, we discussed with Elders and community harvesters which species should be sampled for subsequent veterinary and toxicological analysis and how and where they should be sampled. Community members also provided many invaluable insights for refining the scientific research during community meetings. As a result, there was much interest and support on the part of both ACFN and MCFN members in this work. We also adjusted the scope of our inquiry into human and environmental health to extend beyond our initial focus on the Oil Sands. Most recently, we held a series of small-group meetings, focused primarily on participants in the research, in order to present the sensitive health-related outcomes and to facilitate feedback and future priority-setting in a more intimate setting. These meetings were followed by a large community meeting and feast that featured traditional food and was attended by over 150 community members.

Community members also directly participated in the project through interviews and by harvesting animals for subsequent lab testing and analysis. Semi-directed interviews were responsive to the framing of concerns by community members. These audio- and video-recorded interactions enabled participating community members to share and discuss what they saw as important. Indeed, the film documentary that was in part funded by this project was screened many times within the community, and changed in substantial ways to better reflect local feedback.

Sensitivity to and reflection of community priorities were also reflected in the wide diversity of communication approaches that we incorporated, ranging from regular updates to GIR and IRC, meetings with Elders and the wider community, workshops that focused on sampling, newsletters that were distributed to Fort Chipewyan and other communities along the Peace-Athabasca-Slave River basin, and video-based outreach with both ACFN and MCFN. This commitment to community participation and outreach helps address a longstanding communication crisis in the region, where researchers generally fail to provide feedback to community members.

3. WILDLIFE, PLANTS, AND THE ENVIRONMENT

3.1 METHODOLOGY

From June 2012 to September 2013, wildlife samples were collected from across the traditional territories of both MCFN and ACFN in order to conduct health assessments through veterinary analysis and to test for environmental contaminants.

Elders and harvesters had initially been especially interested in having us test muskrats. These muskrats have been of great importance for community members as food, clothing, ceremony, and for generating income. According to Elders, the presence of muskrats also indicated that wetlands were healthy. Repeatedly we heard that community members were greatly concerned that muskrat populations had declined so dramatically throughout the region, especially in areas that were close to the Athabasca River (Chapter 4). Many suggested that contaminants associated with the Oil Sands as well as declines in water levels associated with upstream hydro development played a key role in this decline. In total, eight muskrat were sampled (Table 3.1).

We also tested waterfowl and moose, these suggested by Elders because of their cultural importance and the continued and central role they play in local diets (Chapter 8). In total, four moose and 23 ducks were sampled (Table 3.1). We were also advised to sample beaver since they are found in both clean and polluted regions, unlike muskrat that are only found in clean-water regions. In total, three beavers were harvested and tested for contaminants (Table 3.1).

Willows (*Salix* spp.) had been sampled in Phase One because of their well-documented ability to absorb and retain environmental contaminants from soil and water over the lifetime of the plant (Dickinson and Pulford 2005), their importance to browsers like moose and beaver, and their use in ceremony and cooking. In total, willows from 14 sites were sampled (Table 3.1). The analysis of these plants was delayed until Phase Two, and so these data are included here.

FIG 3.1. Stef McLachlan (University of Manitoba) and Johnny Courtoreille (Mikisew Cree First Nation or MCFN) examine some willow leaves (*Salix* spp.).

Although fish play a key role in local diets and while community members are concerned about the declines in fish populations (Chapter 8), we did not sample any here, in large part because of a complementary fish study lead by environmental toxicologist Paul Jones of the University of Saskatchewan (Jones et al. 2012). His study extends from Fort McMurray in Alberta to Fort Resolution in NWT, also including the Peace Athabasca Delta, and has been conducted in parallel to this project. Preliminary outcomes of this study have been reported in our project-related newsletters and websites.

In all cases, community members decided which species should be harvested and where and when this sampling should occur. Harvesters had participated in an earlier (June 2011) training workshop where sample collection protocols were refined and distributed (Appendix 1). At that time, a video was also prepared that would provide further instruction to those that had not participated in the workshops. Harvests of moose, beavers, muskrats, and waterfowl were located in maps and also by using GPS units that were included in sampling kits as signed out by harvesters. Harvesters also identified any concerns they might have regarding the health of the harvested animals.

Table. 3.1. Total numbers of samples and types of analyses conducted

	Total sampled	Veterinary analysis	Heavy metals (As, Cd, Hg, Se)	PAH	Muscle	Liver	Kidney
Moose	4	4	4	4	4	3	3
Duck	23	23	23	23	23	23	23
Muskrat	8	8	8	8	8	8	8
Beaver	3	3	3	3	3	3	3
Willow	14	-	13	-	-	-	-

Sampling in this first phase was opportunistic in approach, in large part to facilitate community interest in the project, and to build relationships between researchers and harvesters. When the outcomes of these Phase One tests were presented in a community meeting in September 2012, they were soundly criticized by attendees. In part this reflected our early focus on the food stream, where we had assessed whether these animals that were otherwise destined for the dinner table exhibited any signs of illness or high levels of contaminants. Attendees recognized that it is a longstanding practice to abandon animals that look sick in the wild, which would normally and which had in this case selected for and thus biased the sample towards healthy animals.

Although we attempted to use a stratified sampling approach in Phase Two, whereby sampling effort would be split between clean and polluted areas as identified by community members, this was largely unsuccessful. Community members hunt in familial areas, and seemed to be willing to sample animals as long as it did not interfere with their primary purpose of being on the land. While we attempted to hire land users to harvest select species in other specified (and polluted) areas, this was also largely unsuccessful. Despite these set backs, many animals (n=38) were still collected by community members (Table 3.1).

Moose, waterfowl, beaver, and muskrat samples were frozen and later shipped to the Canadian Cooperative Wildlife Health Centre (CCWHC) at the University of Saskatchewan. The purpose of the CCWHC is to "*apply the veterinary medical sciences to wildlife conservation and management in Canada. The organization is also dedicated to developing and using knowledge of wildlife health and disease to improve human health and the health of domestic animals*" (http://www.ccwhc.ca/about_us.php).

Veterinary doctors analyzed the body condition of the animals, and looked for external and internal signs of ill health. These signs included the presence of external sores (lesions), injuries, the amount of fat, and any other signs of disease. At that point, additional samples were prepared and then shipped to the Alberta Innovates - Technology Future, a province-owned Crown corporation located in Vegreville Alberta, for the testing of heavy metals and polycyclic aromatic hydrocarbons (PAHs).

Muskrat, moose, and ducks had already been the focus of the Phase One of this project (McLachlan and Miller 2012), which had focused on animal health, as viewed by veterinarians as well as environmental contaminants, namely heavy metals and PAHs. Generally speaking, during that phase the veterinarian found that *"(t)here is no obvious cause for concern for human consumption based on what was seen in* [muskrat, moose and waterfowl] *samples. None of the observed individuals appear to exhibit obvious ill health that could be associated with contamination."* (McLachlan and Miller 2012). Likewise, PAHs in the tissues of muskrats, moose, and waterfowl were all found to be below "detectable limits" (McLachlan and Miller 2012).

Below, we analyse each the outcomes of the heavy metal testing for willow species as well as the veterinarian evaluations (i.e. necropsies) and the testing for heavy metals and PAHs as they relate to muskrat, beaver, moose, and ducks.

FIG 3.2. Bruce Maclean and Jonathan Bruno (ACFN) monitoring temperature and wind speed on the Athabasca River as part of the community based monitoring program.

Importantly, we take a three-track approach in this study, rather than the two-track process that was earlier adopted in Phase One. The two-track approach, still rare enough in environmental and health research, involves the separate collection of scientific data (first track) and documentation of

Traditional Knowledge (second track). In addition, the third track reflected here consists of an analysis that incorporates the outcomes of both the scientific and TK, thus grounding the scientific data in the holistic and generally much richer TK wherever possible (McLachlan 2013).

4. ENVIRONMENT

4.1 WATER

Substantial changes in both the levels and quality of water have been observed over the last 40 years,

> *"… my dad noticed that, he said 'there is something wrong, the water levels are dropping.' We used to get a flood, not every year, but say about every 2-3 years, we would have a big flood that would replenish all the snyes and all the inland lakes to the brim. The muskrats would just explode! You could go paddling in any direction, just you and the birds and animals and the moose, and everybody just minding their own."*
>
> Alice Rigney, ACFN

FIG 4.1. Archie Antoine (MCFN) shows how water levels have decreased in Egg Lake.

These changes were initially seen as a by-product of the construction of the WAC Bennett dam in the early 1960s on the Peace River in northern BC, and the impact that subsequent water impoundment had on the hydrology of the Peace Athabasca Delta (PAD),

> *"The delta has dried out so fast in the past years. Ever since the Bennett Dam was closed. The muskrat, it was good for maybe two, three years after that. With the water tables dropping, the spring floods, it's all polluted water getting to our lakes. It affects our muskrat. Killed them right off. The water table is so low that the lakes can't contain their own water. It just drains out..."*
>
> Joe Marcel, ACFN

The other major driver of change as it affects wildlife in the PAD is Oil Sands development, approximately 200 miles upstream from Fort Chipewyan. In addition to using substantial amounts of water, the Oil Sands also contribute substantial amounts of pollutants to the region. Indeed, they are the largest contributors of mercury and cadmium in the province (Gosselin et al. 2010), to say nothing of polycyclic aromatic hydrocarbons (PAHs) (Parajulee and Wania 2014), many of which are receiving increased attention as carcinogens,

> *Oct 16, SR: "About 75 miles away from here, man is it ever beautiful out there. You come this way, as you get closer and closer to Chip, you can just notice things are different. Like the water is brown, it's always been brown, then you go in the rivers and you see all that foam that's coming down and, it's all pollution. Thirty years ago, I never seen, I've never seen that kind of stuff on the river. The rivers were always blue all year round. The waters were nice, I mean green-like, you can see your hand in the water. But now you look, you put your hand, even under the surface this far and you can't even see your hands"*

FIG 4.2. Foam on the surface of Lake Mamawi.

Together, hydro development and the Oil Sands have had substantial, and perhaps irreversible, adverse effects on the Delta as a whole,

> *"Not enough water. Not enough water. The water's got to mobilize itself. It's got to run before animals can live in there. If there's no movement of water, animals will die. Same thing with the freshwater. It's got to be fresh. Keep going. When you keep a fish in a glass bottle, well the water circulates, right? That's the only way it'll stay alive. Same thing with animals. If there's not enough water and it's not moving, nothing will live in there. The rats will never come back. There's got to be enough water so that it flows. All the lakes got to keep moving. Then, then it'd be ok."*
>
> Billy Whiteknife MCFN

Changes were especially evident for fish. Some populations declined in number, like lingcod or maria (normally associated with cold and deep water), whereas many of the remaining species showed symptoms of sickness, including lesions and tumours, and, in some cases, deformities,

> *"There were some times when I used to go fishing last year, used to go to King Creek, Richardson, stuff like that. Fish for pickerel. Sometimes you'll catch fish with growths on them. Like the size of the tip of your finger. Like a big puss sticking right out of them. You're like, 'Uh oh, can't eat that.' Throw it away"*

Jonathan Bruno, ACFN

Although we did not test for fish, in part because of a large scale fish study that was being conducted while this study was underway (e.g. Jones et al. 2012), fish play a key role in the diet (Chapter 8) and health (Chapter 9) of community members, and function as a local "lightening rod" about what is going wrong with the environment.

4.2 VEGETATION

The changes in hydrology have affected the vegetation in the region. As inland lakes have dried, they have been replaced by grasslands, which are then colonized by shrubs such as willows and poplars (*Populus* spp.),

> *"It's made a big, big difference. It kind of restricts where we can go. We're people of the water. We're willow people. Willows always grow in water. Even our vegetation, where we had our swamp lands. They're getting taken over by hay. Once the hay takes over, the willow will take over on hay. Pretty soon you have poplar growing where a few years ago you had water."*
>
> Morgan Voyageur, ACFN

FIG 4.3. Vegetational change occurring on a former inland lake near Dog Camp.

These drying conditions have also facilitated the introduction of many hereto unknown exotic plant species from the South, including Canada thistle (*Cirsium arvense)*,

> *"There is not enough water. See like I told you, those bulrushes are way back in the bush. There's another kind of grass that goes in between the water and the bulrushes that's never been there before. It's all that stuff that sticks to your clothes. Little seeds and that. So is the rat going to get his feed? To make rat houses with? There's some of the stuff too that's strange, for us. Little pokeys. Little green leaves. We never had that. As far as I remember. When we were kids, we'd come on the*

lakeshore and run around with no shoes. Now you can't go in the bush. They're just thick. Little needles. They're green. It's an unusual thing. I don't know from what."

George 'GM' Marten, MCFN

These exotic species may have been introduced by upstream agriculture, urban development, or even in the fill used in Oil Sands-related construction, which then take advantage of the recently established and thus sparsely vegetated, former lakes when they are carried downstream.

The decline in water levels has also adversely affected the production of berries, which would normally have been picked by many community members.

"Nothing. Dried up. Right over my cabin used to be blueberries. Nothing now. Just walk in the back. Nothing now. I don't know why there's no berries. Just a few. But not like it used to be."

Marlene Bruno, ACFN

Yet, many of the traditional berry patches are no longer accessible by boat because of these low water levels, These changes are only likely to be further aggravated should the plans to build an additional hydro dam on the Peace River (Site C) proceed,

"Can't even get in sometimes. Can't get out a lot of the time. That is how bad it is, our water. Looks like we go over to Fort Bay, I am talking about Richardson Lake. Found it there years ago to go and pick berries a few years back, they can't even get in there. Lake Athabasca or they can go in there, but you have to jump in the water, low water. Leave your boat out there. Everything is bad. Now they are talking about putting another dam out in BC. What is going to happen if that one goes ahead? "

Rene Bruno, ACFN

Willows were sampled at the junction between Lake Athabasca and Athabasca River along with its tributaries, which are recognized by community members as suffering from greater pollution because of the downstream flow of contaminants from the Oil Sands. We also sampled willows near Lake Mamawi, which is viewed by community members as less affected by pollution.

FIG 4.4. Cody Marcel (ACFN) collecting willow samples along the Athabasca River.

In total, willows (*Salix* spp) were sampled from nine sites in the Athabasca Delta and five sites along and near Lake Mamawi area (Fig 4.5). Leaves were collected from plants growing right along the rivers that were readily accessible by boat, dried in paper bags, and then shipped to the ALS Laboratory in Alberta for subsequent testing for heavy metals.

FIG 4.5. Locations of willow sampling in both Athabasca Delta (1-9) and region surrounding Lake Mamawi (10-14).

Levels of arsenic, calcium, mercury and selenium varied substantially among sites (Fig 4.6). Interestingly, willows that were harvested in the Athabasca Delta had significantly (p=0.05) higher levels of arsenic and tended (p=0.09) to have higher levels of selenium (Table 4.1) than in the Lake Mamawi area. Conversely, willows sampled in Lake Mamawi had significantly (p<0.03) higher levels of cadmium (Table 4.1).

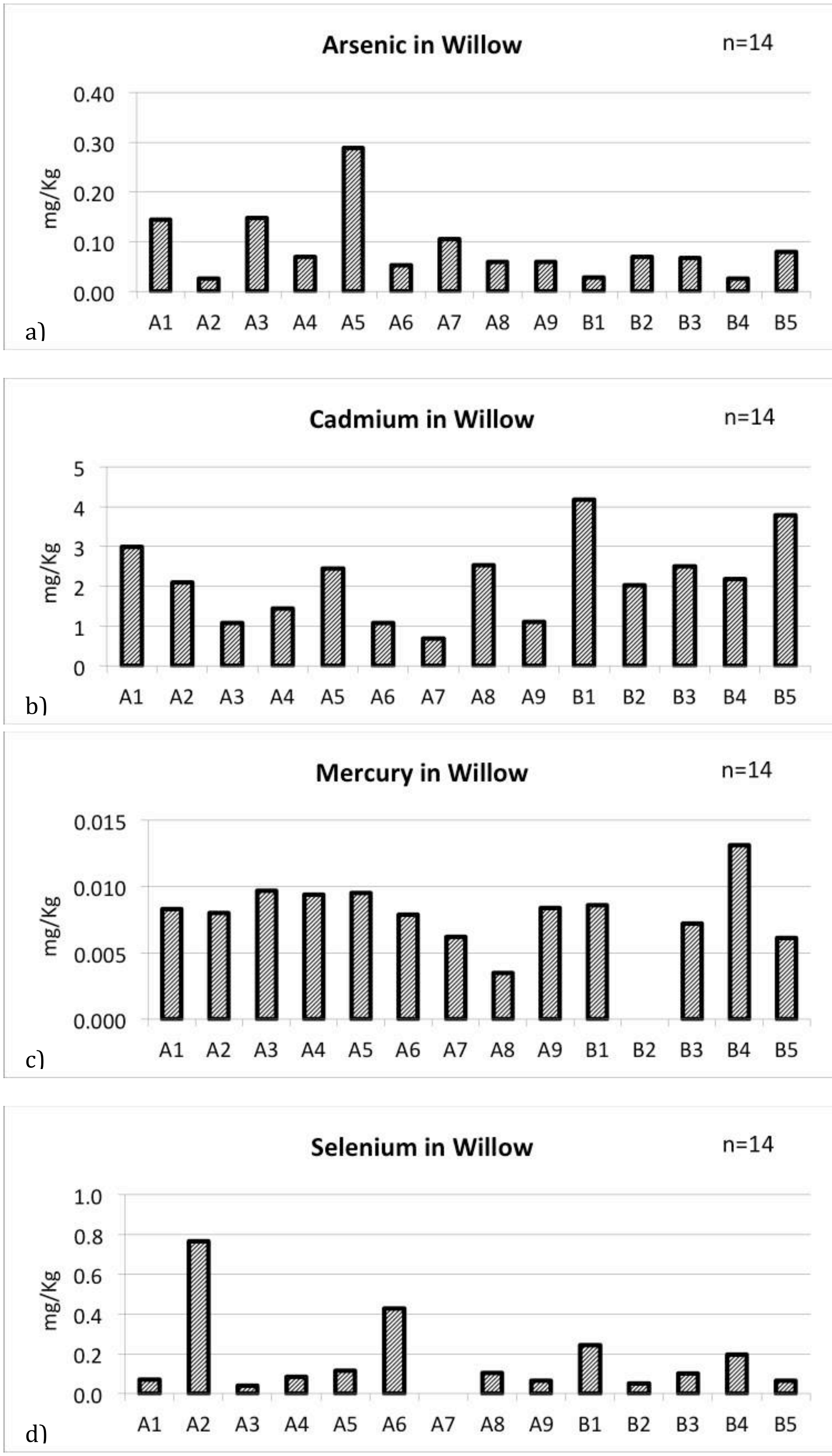

FIG 4.6. Concentrations of a) arsenic, b) cadmium, c) mercury, and d) selenium in willow (*Salix* spp.) sampled in the Athabasca Delta (A1-9) and Lake Mamawi (B1-5).

Table 4.1. Differences in concentrations of arsenic, cadmium, mercury, and selenium in willow (Salix spp.) between the Athabasca Delta (A1-9) and Lake Mamawi (B1-5), according to one-tailed t-tests.

Metal	Locations					
	Athabasca Delta		Lake Mamawi			
	Mean	SE	Mean	SE	t Stat	P(T<=t) one-tail
Arsenic	0.11	0.03	0.05	0.01	1.79	**0.0520**
Cadmium	1.72	0.27	2.93	0.44	-2.35	**0.0254**
Mercury	0.01	0.00	0.01	0.00	0.36	0.3654
Selenium	0.21	0.09	0.13	0.04	1.47	0.0905

4.3 WILDLIFE

These changes in water and vegetation have, in turn, affected a wide diversity of animal species. Although this decline has occurred for many species, it has been most dramatic for muskrat, which even in the 1960s had populations that numbered in the hundreds of thousands,

> *Oct 16, SR: "Years ago was a lot of animals too…Muskrats, lot of changes. Everything changed. Animals and things like that. Chickens, there used to be a lot of chickens. Rabbits, moose. Everything is disappearing. Even today, ducks and muskrats and beavers and cranberries"*

Moreover, many of the species that remain in the region have populations that are declining in number and in health,

> *Nov 23: "Because you look at it. Twenty years, thirty years, you didn't have this, right? All the animals were in good health. But now, they got sicknesses too. Don't kid yourself. They have it. You see some coyotes down the road here once in a while. Man, they're ugly!"*

Some of these animal species are the focus of this report, i.e. moose, muskrats, beavers and ducks. Yet, we have been pressed by some Elders to increase the scope of the sampling to include other species, including chickens, rabbits, and foxes.

FIG 4.7. Ducks migrating in formation along the Athabasca River.

Participants also spoke about their deep and longstanding relationship with the biophysical environment including the soils and water, as well as the animals, which at once gives rise to rich insights into these changes but also makes them feel vulnerable,

> *NOV 23: "Like biopsy on the animal, you know. When you do biopsy too, I think you have to... just pick them out, you know? Because it's pretty hard to tell which ones are healthy, right... in different areas too. If you were to get the mud from under, to see what's under there, because* [the contaminants] *have got to go down, you know*?"

Community members spoke authoritatively about the vast changes in physical environment and in wildlife health that are taking place across the region. These observations reflect changes in the quality and quantity of water and of many wildlife species, most notably muskrats and some fish. All were interested in the role that evaluation for changes in animal health and testing for contaminants might play in affirming and helping explain the changes that so many residents are witnessing across the region. These results will be reviewed below, for animal health (Chapter 5), for heavy metals (Chapter 6), and for PAHs (Chapter 7).

5.0 ANIMAL HEALTH

5.1 MUSKRATS

As indicated above, all participants recognized that muskrats had been effectively extirpated from the region,

> OCT 16, SR: *"In 1986, on my trap line, I had tons of muskrats. In the past five years, I haven't seen any of them. In the last two years, I only found about 10 rat houses in the whole area. Everything changed."*

FIG 5.1. Muskrat swimming near the Birch Mountains in Lake St Clair.

The extent of this decline has been great enough that few community members even eat muskrat anymore, although they were a mainstay of the local diet in the near past (Chapter 8). This species was important enough to both Cree and Dene cultures in the region that it arguably amounted to a "cultural keystone" species (Garibaldi 2009, McLachlan and Miller 2012). Hundreds of thousands of muskrats thrived throughout the delta, and it played a valuable role because of its dependability in trapping and thus economic return and as a key source of food, to say nothing of its value for clothing and ceremony. Indeed, some thought that the decline in muskrat populations was severe enough that the resulting loss of livelihood was in part responsible for pushing people off the land into town, which in turn helped prompt a diet-transition away from country foods to ones that are store-bought,

> Oct 17, SR: *I think the water quality is affecting the wildlife. One thing is the water quantity has resulted in the disappearance of the muskrats. That starts the whole huge change of life. Because no one can make a living trapping and then everybody had to move to town and with that comes store-bought food and more difficulty getting wild food."*

Currently, few if any muskrats remain, especially in areas that are seen by community members as contaminated by the Oil Sands. A winter survey for muskrat is conducted each year by Parks Canada together with the Mikisew Cree First Nation, Athabasca Chipewyan First Nation and the Métis Local 125 under the umbrella of the innovative and cross-cultural Peace Athabasca Delta Environmental Monitoring Program (PADEMP). In 2012 and again in 2013, surveys were conducted throughout the region for muskrat activity, focusing on lodges and “push ups”, to no avail. Indeed, the 2012 survey failed to find a single active lodge or push up (Miller and McLachlan 2012). This for a region that was teeming with hundreds of thousands of muskrats only 50 years before.

FIG 5.2. Survey in winter 2012, as facilitated by the Peace Athabasca Delta Environmental Monitoring Program (PADEMP).

Results from the February 2013 survey were slightly more positive; 66 push ups were found, likely reflecting the atypically high water levels from the previous July (MacMillan pers. comm.). Yet some Elders question the ability of these populations to rebound in substantial ways, given the absence of muskrat “seeds”. Although decreases in water levels and in spring flooding play a central role in this decline, community members also saw contaminants arising from the Oil Sands as a key driver in these changes,

> Oct 16, BR: Partic1: *“One of the changes I noticed, there used to be thousands and thousands of muskrats, and now there is hardly any…I haven’t seen a muskrat in years. My grandma used to get muskrat all the time. It’s been years now since she has had one.”*
> SM: *“What do you think the cause of that is?”*
> Partic1: *“Pollution probably or maybe the Bennett dam, pollution, and lack of water.”*

Indeed, some community members wondered if young muskrats were especially vulnerable to contaminants. Some also had observed changes in the colours of muskrat meat, which is consistent with disease. They had also seen mass deaths in the past as the population was in decline.

Any remaining muskrats in the region, especially those residing in polluted areas, might thus show declines in health and high levels of contaminants. Some land users had observed that muskrat activity was restricted to clean muskeg-fed inland lakes and largely absent from polluted river-fed ones.

As indicated above, we tried to address the bias shown in Phase One, by harvesting animals from areas that are known to be contaminated by pollutants (i.e. near or on the Athabasca River) as well as maintaining the current focus on relatively unpolluted areas. In total, eight muskrats were harvested for sampling this year. This number actually declined from Phase One, where we sampled 23 muskrats. However, the sampling effort was about the same between the phases, as most of the animals harvested last year came from one population in the relatively pollution-free Birch Mountains area (McLachlan and Miller 2012).

The harvest locations of seven of these animals were mapped (Fig 5.3) and then all eight animals were delivered for analysis at CCWHC. Once evaluated by the veterinarians, samples were then shipped to the Alberta Innovates - Technology Future where they were subsequently tested for heavy metals and for PAHs.

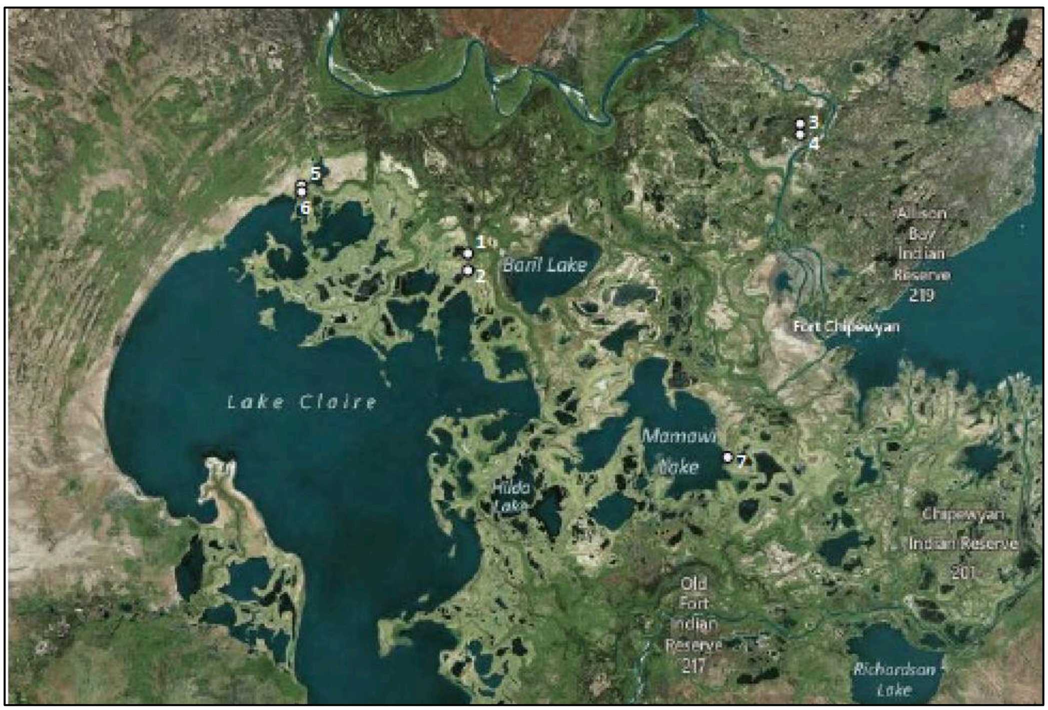

FIG 5.3. Locations of seven muskrats that were harvested for subsequent evaluation by veterinarians and contaminant testing.

Specimens at CCWHC were examined for external signs of ill health (parasites, lesions, injury etc.) and dissected under laboratory conditions. The lack of subsequent microscopic examination is unfortunate, however, and departs from the necropsies conducted in Phase One, which provided additional information on the condition of the animals.

Of the eight muskrats that were examined, seven were male and one was female. On average, they weighed 853.3g. The necropsy showed that all eight animals were "in excellent body condition", according to scientific standards. All suffered "various lesions of trauma associated with euthanasia", that is all were injured when trapped. The most common injuries were fractured limbs, including the tibia and fibula, as well as the ulna and radius. No non-trauma related lesions in major organs were observed, although one animal (the female) had a “pale” liver.

Again, it is important to note that all eight of the muskrats came from a location far (~60km) from the mouths of the Athabasca and Peace Rivers, which are the focus of community concerns (Fig 5.3). Elders indicate that the contaminants associated with the Oil Sands would be at the greatest concentrations in the Athabasca, and thus any effects of these contaminants would be most evident there. The absence of any muskrat from these rivers is also consistent with the outcomes of interviews and from the winter surveys, which showed that changes in water level and flooding had already negatively affected muskrat populations.

In contrast, any muskrats that are currently observed by community members occur in areas where water quality is recognized as higher and where trapping of muskrats still also occurs. Harvesters were thus unable to trap any such animals. These tests thus speak to the health of these eight muskrats and to populations occurring in healthier regions. However, they say little about the health of the muskrat populations in polluted areas and about the health of the larger muskrat population in this region, to the degree that this population exists at all.

There is no doubt that participants in this study and in community meetings recognized that muskrat populations had declined precipitously. This was categorically attributed to the reductions in water levels associated primarily with the WAC Bennett Dam but also the Oil Sands development. In the absence of adequate water levels that are needed to avoid predation, any remaining muskrats relocate to river banks, where these “bank rats” become much harder to locate and to trap. Decades later, they have been eliminated because of the drying of lakes and the loss of food sources due to vegetational succession.

Muskrat populations had declined to the degree that they were ineffective indicators of change. This in turn points out the problem of using indicator species that have been decimated by the very same factors that they are supposed to reflect. Thus, there is a need to identify more suitable indicators, ones that are still seen as culturally relevant and important by community members and that are widespread and common enough that they also generate useful scientific data.

It should be noted, however, that these outcomes and those from Phase One still have meaningful implications. That these muskrats were seen as healthy, at least according to scientific criteria, shows that these remnant populations do not appear to suffer from any illnesses that would present any risk for these populations. Nor did they suffer from any illness that would present risk to humans that use them as sources of food.

It should also be noted that data on the concentrations of heavy metals and PAHs will be better indicators of contamination by the Oil Sands, along with any other sources of pollutants, and whether they are safe to eat. In contrast, these coarse veterinary examinations may not be useful for detecting relatively low levels of environmental contaminants. Symptoms of contamination that manifest themselves as tumours and lesions may only become visible to veterinarians when they occur at very high levels.

5.2 BEAVERS

Beavers were recognized by community members as more widely distributed across the landscape than muskrat and more resilient,

> "*Those beavers, beaver meat. Must be tough beavers. Nothing wrong with them. You don't see a spoiled beaver. You put it in the oven, you smell it. Smells good. Still tastes like it used to.*"
>
> George Wandering Spirit, MCFN

Their ability to build dams arguably makes them better able to control water levels that would otherwise become prohibitively low and increase their vulnerability to predation, as occurs with muskrats. That said, beavers are still vulnerable to hydro development, and more specifically to the subsequent changes in flooding. Floods associated with hydro development generally occur in the winter when formerly impounded water is released in order to generate power required by consumers for heating rather than during the spring when flooding naturally occurs. This winter flooding results in widespread drowning and thus increases the mortality of beavers. Or in some cases, the subsequent impoundment in the spring also results in increased mortality,

> "*So I'd like to see the government say, "What's happening? What's killing the fish?" But no, scientists just say low water. They died. Ice was too low. Of course it's going to be too low. No water. Like last spring, it killed all the beavers right from here right down the Peace River. All the beavers, beaver houses, their feeding. They didn't drop the water out in that dam. The Bennett Dam. They didn't drop it. So the water dropped here. So the ice fell about 7 or 8 feet down. So the beaver, their feet are hanging way up there in the ice. They all died. Starvation.*"
>
> Billy Whiteknife, MCFN

Despite these impacts, beavers are still widespread enough that they can be used as effective indicators of change. Other studies, for example in Europe, have used them as effective indicators of environmental contamination (e.g. Fimreite et al. 2001, Zalewski et al 2012).

In total, tissue samples from three beavers (unknown sex, unknown age) were delivered for analysis at CCWHC. Once evaluated by the veterinarians, samples were then shipped to the Alberta Innovates - Technology Future where they were subsequently tested for heavy metals and PAHs.

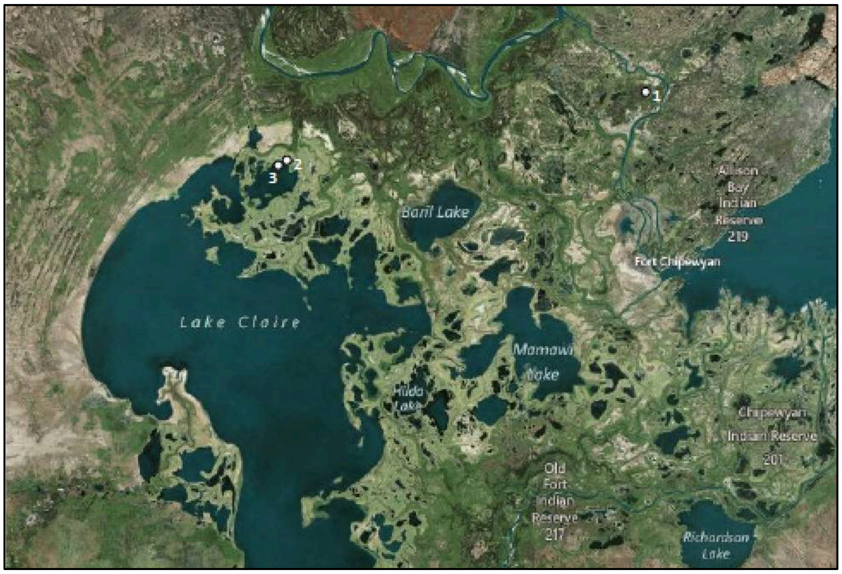

FIG 5.4. Locations of three beavers that were harvested for subsequent evaluation by veterinarians and contaminant testing.

Specimens at CCWHC were examined for external signs of ill health (parasites, lesions, injury etc.). The lack of subsequent microscopic examination is unfortunate, and departs from the necropsies conducted in Phase One, which had provided additional information on the condition of the animals.

Because of their large size, sometimes exceeding 30kg in weight, samples rather than the whole animal had been shipped for testing. In this case, for each of the three animals, a kidney, a liver, and a hind limb were submitted. Therefore, it was not possible to discern either the age or the sex of the three animals.

According to scientific veterinary criteria, all the kidneys and livers "*appeared normal*", and the muscle tissue from all three hind limbs was "f*atty*" and also "*appeared normal*". Moreover, "*no visible lesions*" were evident for any of the samples.

FIG 5.5. Beaver lodge near Prairie River, Lake Mamawi.

As with the muskrats harvested for this Phase Two study, it is important to note that all three of the beavers came from a location far (~30km) from the mouths of the Athabasca River (Fig 5.4). It is again likely the contaminants associated with the Oil Sands would be at the greatest concentrations in the Athabasca, and thus any effects of these contaminants would be most evident there. Unlike muskrats, beavers are dispersed widely across the region and occur in areas that are known to occur in polluted water as well as relatively clean water. Some community members were hesitant to consume beavers from the polluted regions because they were thought to retain water. However, we were not successful in soliciting samples from polluted areas. Indeed, the number of samples was substantially lower than that hoped for, in part reflecting the difficulty in trapping and sampling beaver compared to muskrat given their much greater size and the reluctance of community members to harvest in polluted areas.

As with muskrats, these outcomes speak to the health of these three beavers, but say little about the health of the beavers in polluted areas or, for that matter, the larger regional beaver population. They also say little about the contaminant levels in beavers that occur in polluted areas. Our hope is that beaver data will continue to be collected, especially from contaminated areas, which will allow us to better assess whether and to what degree these animals are being affected by upstream pollution.

However, as with muskrats, the outcomes are still meaningful. They show whether animals that would otherwise have been consumed as food are unhealthy. As indicated in Chapter 8, beavers are still consumed by community member (18X in the previous two months by the 100 community members that participated in the diet survey), especially by Elders.

5.3 MOOSE

Moose are of key importance to local harvesters and, as our diet data from Chapter 8 show, are the most frequently consumed traditional food by MCFN and ACFN members (1477X over the previous two months by the 111 community members that participated in the diet survey). This has long been the case, and moose along with fish and muskrats have always formed a mainstay of the diet,

> Oct 16, SR: "*I was also raised in the bush, in my younger years. Life was good, we used to eat off the land and mom and dad were very hard workers. They never really sat down that much. They had 12 kids. We had a lot of food, like moose meat and dry meat and fish. I felt like I was healthy.*"

FIG 5.6. Garret Marcel (ACFN) with his first moose of the year.

They are generally seen as still healthy and free of contaminants, and thus are not avoided because of concerns about pollutants.

> Oct 17, SR: *"That's fish, that's what you're talking about. Like, because everybody is saying there is high mercury in fish, not the moose meat. That's what I am talking about."*

That said, some participants still recognized that their meat was also changing in quality especially in closer proximity to the Oil Sands,

> "*You kill the moose around Fort McMurray area, they taste different than our moose. They're different. On account of that salt they put on the highway. That salt or whatever. That's what they eat. And animals don't taste as good. Everything is no good now."*
>
> Billy Whiteknife, MCFN

In total, tissue samples from four moose (three adult males, one unknown sex; all unknown age) were shipped to CCWHC for analysis. Although muscle tissue was submitted for all four animals, neither kidney nor liver was submitted for one of the specimens. Three cysts were submitted alongside with specimen #1 and were subject to additional testing,

> Oct 16, SR: "*Yeah, well two and half weeks, we killed a moose and we were skinning it now and we found a cyst or something on it. And I cut it off and was supposed to get it tested. But I didn't care, so ... like it doesn't change my* [views]."

Specimens at CCWHC were examined for external signs of ill health (parasites, lesions, injury etc.) and dissected under laboratory conditions Once evaluated by the veterinarians, samples were then shipped to the Alberta Innovates - Technology Future where they were subsequently tested for heavy metals and for PAHs.

Only one kill was located using maps (see 5.5 Concluding Remarks). This was situated in the Quatre Fourches area between Lake Athabasca and Lake Mamawi, an area that is seen as relatively polluted by community members (Fig 5.7).

FIG 5.7. Location of the moose that was harvested for subsequent evaluation by veterinarians and contaminant testing.

The submitted muscle samples of all four animals and the kidney and liver samples from the three animals "*appeared normal*", and "*no visible lesions*" were evident in submitted tissues. Thus, as with muskrats and beavers, subsequent microscopic examination was not undertaken for any of these animals. All of the muscle tissue appeared to be normal. One kidney appeared to be bloody, but only on the outside.

The three cysts were examined, each a discrete, firm oval mass that measured 3-5 cm in diameter. In cross-section they were homogenous in appearance, and were identified as normal lymph nodes,

> *"Cyst: within this bag there were three, discrete, firm oval masses measuring 3 to 5 cm in diameter with a slightly firm texture. On cross-section they were homogenous in appearance with a grey-white colour (lymph nodes)."*
>
> L. Bryant, DVM

FIG 5.8. Sampling moose liver for subsequent testing.

Of the four moose that were sent for analysis, all were considered unremarkable or normal, again according to scientific criteria. None appeared to have illnesses that would present any risk for human consumption according to scientific criteria. Thus, there was no cause for concern related to human consumption. None of the observed individuals appeared to exhibit obvious ill health that could be associated with contamination. As with the muskrats and beavers, it should be noted that visible veterinary examinations may not be suitable for detecting contamination, especially if these contaminants are occurring at low concentrations. Indeed, one of the moose had extremely high levels of PAHs (Chapter 7), but still seemed healthy to veterinarians.

5.4 DUCKS

As indicated in the introduction and in Chapter 8, waterfowl have long played an important role in the diets of community members. Many members talked about the excitement that the spring and fall migrations brought to all residents,

> "*Ducks, we used to go hunting for ducks and it was almost like you didn't have to shoot them. Just go scoop them up because they were so plentiful in the fall time. And bring them back and gut them and put some rock salt in there and hang them. Same with geese and swans and whatever birds. The fall migration was an awesome time.*"
>
> Alice Rigney, ACFN

Yet, there have been substantial declines in the population numbers of migrants but also of the summer residents, Oct 16, SR*: "We talk about the, the ducks the birds that are gone now. That is because of migration, which has also changed. But I remember when I was younger, went out on the lake and going on our hunts. We look in the evening and the nice red sky. When you see mosquitos, there is a whole bunch of mosquitos. Well that is what we say with all the ducks and birds. You know, I went there this summer, and you don't see that anymore. You see all those changes."*

FIG 5.9. Harvesting ducks for subsequent testing.

Many factors were responsible for these declines in waterfowl, including decreases in water levels throughout the delta, these attributed to the WAC Bennett dam and the Oil Sands,

"Well, a lot has to do with. I mentioned earlier, we used to have a lot of lakes. A lot of muskrats. And all these lakes are dry now. No water. There are just a few. Because ducks usually lay eggs in these lakes. Nest there in the spring. Now there are hardly any ducks. Big changes. On top of that, that water. The oil company coming out. So it affects them."

Big John Marcel ACFN

These declines also reflected increases in contaminant levels arising from bitumen processing and spills associated with the Oil Sands,

"*When I was a kid, I remember in spring time, there used to be millions of birds come through here. It looked like clouds. That's how many birds fly through here. In a matter of 10 days there'd be like 5 million birds. Even this year, there was only one night that I got good shooting. There were no birds. I don't know where they all went. I think it's from that oil spill. Before then, there used to be more birds. But not as much as years passed.*"

Morgan Voyageur, ACFN

Community harvesters mapped the locations of 10 of their kills on maps that were provided along with GPS units in all sampling kits (Fig 5.10).

FIG 5.10. Locations of the 10 ducks that were harvested for subsequent evaluation by veterinarians and contaminant testing.

In total, we submitted 23 ducks for veterinary analysis (4 male, 19 female). These included, in descending order, the following species: Lesser scaup (*Aythya affinis*) (12), Mallard *(Anas platyrhynchos*) (7), Northern shoveler (*Anas clypeata*) (2), Green-winged teal (*Anas carolinensis*) (1), and Common goldeneye (*Bucephala clangula*) (1).

Of these, 16 were adult females, five were hatch-year females, two were adult males, one was a hatch-year male, two were of unknown sex but adults, and one was of unknown sex but a hatch-year. The latter three were of unknown sex because of their poor post-kill preservation.

Of the 23 ducks that were sent for veterinary analysis, 12 (52%) were noted as being in excellent body condition, ten (43%) were noted as in moderate condition and one (5%) was noted as in fair body condition, these all according to scientific criteria

Again, unlike Phase 1, none of these ducks were examined microscopically. The necropsies showed that all lesions were "*associated with euthanasia*" (i.e. killing). Likewise, none of the 23 ducks that were examined showed any "*non-trauma related lesions in major organs*". None appeared to have illnesses that should present any risk for human consumption according to scientific criteria.

Thus, there was no cause for concern related to human consumption according to scientific criteria. None of the observed individuals appeared to exhibit obvious ill health that could be associated with contamination. As with the muskrats, beaver, and moose, it should be noted that visible veterinary examinations may not be suitable for detecting contamination, which would only become detectable at very high levels. That said, this information is still useful since it indicates that, from a veterinary perspective, these ducks are still appropriate for human consumption

5.5 CONCLUDING REMARKS

The intent of these analyses was not to describe the health of any of the regional populations of these wildlife species but rather to assess to what degree these animals exhibited health problems, whether and to what degree these problems might be related to environmental contaminants, and whether these and other animals that were harvested as food might represent a risk to humans.

This approach is limited by a number of factors. Sick animals typically don't remain in the environment very long, as they either die or are preferentially eliminated by predators. As a result, animals that survive long enough to be harvested and analyzed in a laboratory setting often exhibit relatively minor health problems, especially if that have been hunted or trapped rather than found dead.

That said, the decline of some of these animal populations, particularly muskrats but also migrating duck populations, is undeniable. Community members argue that these declines are due to changes in hydrology associated with the WAC Bennett dam as well as contaminants associated with the Oil Sands and other upstream development including the use of agricultural pesticides (Chapter 9).

Moreover, it is likely that these stressors are cumulative in nature and aggravate any individual impacts. As Oil Sands development continues to expand, these adverse impacts will only likely to increase further, such that moose populations that appear to be relatively unaffected at this point in time will likely decline as they appear to be doing in the area surrounding Fort McMurray. Migrating duck populations are already under stress as their habitat continues to be fragmented by agriculture in the southern US, but the Peace Athabasca Delta is clearly an important staging area for spring and fall migrations. Thus, existing changes in water levels and in environmental contaminants in this region can only add to pressures that confront these populations of waterfowl.

Veterinary outcomes in Phase One and those conducted this year have thus far largely failed to support community experiences and concerns regarding wildlife health. It is our contention that the Traditional Knowledge is much stronger than the scientific analyses in this regard. The latter are limited by small sample sizes, community harvesting practices that select for healthy animals, the limited ability of research scientists to spend extended periods on the land, the absence of any microscopic examination in this phase, and the effective extirpation of some vulnerable species, notably muskrats, from the regional landscape. Scientific impact assessment is also generally ineffective in assessing cumulative impacts (McLachlan 2013) whereas TK is much more able to document and evaluate these combined and long-term impacts.

We attempted to adapt the sampling, by including beavers and by better focusing harvesting on areas that are locally known to be polluted, as suggested during community meetings. But this approach still needs further refining. Although beavers were sampled this year, only three were submitted for analysis and harvests only occurred in unpolluted areas. Likewise moose and muskrats that were analysed were also harvested in unpolluted areas. We attempted to hire land users to harvest beavers in impacted regions, but were ultimately unsuccessful. Ironically, these difficulties may reflect the relative absence of trappers on the land as well as the intense nature of hunting in the spring and fall, the longstanding bias to hunt and trap in trusted regions, and competing interests, particularly employment in the Oil Sands.

We are hopeful, however, that these sample-harvests will continue in the future, and slowly add to a database that will eventually become large enough that the scientific wildlife health data will become more useful for monitoring any ongoing impacts on wildlife health. Feedback from community members and a growing interest on the part of harvesters will increase the meaningfulness of sampling. In the short-term, the collaboration of research scientists with community members can only work to better refine and focus the research, in turn generating science and TK-based outcomes that help us better understand and respond to the ongoing decline of these important wildlife species.

6. HEAVY METALS

Oct 16, SR*: "Everybody knows that, not just me, that animals have a higher cancer rate, in Fort Chip, it's a small community. Based on studies that they have done in the past, Oil Sands and having an effect on the environment, and the animals even the amount of food we have to eat. Like we've got to watch the amount of fish we eat...get pregnant and won't have their children, stuff like that. In my family, we, everyone has experienced cancer, cancer...And I imagine every family member here, every person has been affected one way or another by the Oils Sands."*

Nov 12: *"Whatever that's been there must have reached here by now, right? I mean, has anything been tested from here to Uranium City. Because I worked there, I worked there in the late sixties. So something is happening. Now they had to clean it up a few years ago. In Fort McMurray, where the barges used to unload the uranium. The whole thing was all contaminated."*

FIG 6.1. Abandoned barrels at Gunnar Mines in Uranium City on the north shore of Lake Athabasca, which was closed in 1964 and has since leaked 4.1 million L of radioactive waste into the lake (http://thewalrus.ca/afterglow/)

6.1 BACKGROUND

The presence of heavy metals in the environment has received much attention as it became increasingly recognized that they often have substantial and adverse implications for wildlife and human health. Levels often increase with industrial development, even in Arctic regions where there has been relatively little industrial activity because of long-range atmospheric transport. These metals are also widely recognized to bioaccumulate in animal tissue, and are biomagnified in ever-increasing concentrations in animal tissue as they make their way through the food chain. Our focus in this study is on three heavy metals and a fourth contaminant, all of which bioaccumulate among higher order predators and all of which are known to have adverse health implications for wildlife and humans alike. These contaminants are arsenic, cadmium, and mercury as well as selenium.

Mercury is a naturally occurring heavy metal that is normally released through the weathering of rock, although it is also transformed into bioavailable form through industrial activity. This activity includes waste incineration, coal combustion, smelting of metals, and the chlor-alkali industry. It is also released into the environment when soils that contain mercury are flooded, most problematically through large-scale hydro development. Its organic form (i.e. methyl mercury) represents the greatest risk because it is biomagnified as it works its way through the food chain, to the point that it can become harmful to higher-level animals. Its release in industrial wastewater in the 1950s in Japan had devastating implications for human health where it was identified as the cause of Minamata disease (Harada 1995). Indigenous communities in northwestern Ontario have similarly been affected by upstream pulp mills (Simpson et al. 2009).

Arsenic is another heavy metal of possible concern in this study. As with mercury, it is introduced into the environment through the weathering of soil and rock and by industrial activity. The latter includes the processing of gold and other base metals, coal-based power generation, and waste disposal. The inorganic form of arsenic is the most toxic, and ranges anywhere from 21% to 100% (GovCanada 1993) of total arsenic levels. Inorganic arsenic is considered to be of great concern to human health by the World Health Organization and has also been listed as a First Priority Substance by Environment Canada (EnvCanada 2012b).

In turn, cadmium is a heavy metal that occurs naturally through the weathering of rock and by forest fires. Cadmium levels of 10 μg Cd/g wt wt (wet weight) in vertebrate livers are generally suggested to be evidence of Cd contamination (Eisler 1985). Yet levels in moose kidneys often exceed 60 μg Cd/g wt wt (Arnold et al. 2006). Large-scale studies show regional differences in cadmium levels among moose populations, including those in Ontario (Glooschenko et al., 1988), Norway (Froslie et al., 1986; Scanlon et al., 1986), Québec (Crête et al, 1987; Paré et al., 1999) and Minnesota (Custer et al., 2004). Public health evaluations conducted in the Northwest Territories (Kim et al. 1998, Larter and Nagy 2000), northern Quebec (Archibald and Kosatsky 1991), and the Yukon (Receveur et al. 1998) all recognize that the highest potential exposure to cadmium from terrestrial mammal-based diets come from the liver and kidney of moose and caribou. It is now recognized that smoking can contribute as much or even more to cadmium exposure than diet (Butler Walker et al. 2005) and can interact with traditional diets to increase cadmium exposure (Fontaine et al. 2008). It has even been argued that smokers should avoid consuming moose (e.g. Jinn and Joseph-Quinn 2003). Cadmium has thus been listed as a First Priority Substance by Environment Canada because of these risks

(EnvCanada 2012a).

Finally, selenium is a non-metal that is required in trace amounts for human health, but becomes toxic at higher concentrations. As with mercury and arsenic, it is introduced into the environment through the weathering of rock and by industrial activity Normally relatively rare in nature, it is found impurely in metal sulphide ores where it partially replaces any occurring sulphur. Some is released during the refining of ores and in the production of electronics. Moreover, some studies have shown that it is released by coal, uranium, and bitumen extraction. As with the above three heavy metals, it is biomagnified through the food chain (Muscatello et al. 2008).

The muscle, liver and kidney tissues of moose, ducks, muskrats and beavers were all tested for these four high-priority environmental contaminants. Our intent here was to identify whether wild-caught foods had contaminant levels that were high enough to be of health concern and to assess to what degree these contaminant levels might explain declines in wildlife health being observed by community members. We also worked up these data as "limits to consumption", which represents an intuitive way of communicating otherwise largely unintelligible contaminant data and because most communities are already familiar with consumption advisories as issued by governmental health agencies.

Due to the technical nature of much of this testing, we have included the following information as appendices that can be used for additional information and which may facilitate the interpretation of the data that are presented below. These include background information on heavy metals and PAHs (Appendix 2); background information of the scientific units used in this report (Appendix 3); details about calculations of risk including Estimated Daily Intake, Exposure Ratios, and Consumption Limits (Appendix 4); and the IARC classification of PAHs and related occupational exposures (Appendix 5)

6.2 METHODOLOGY

Following the analysis by CCWHC in Saskatoon, muskrat, moose, beaver and duck tissue samples were prepared and sent to Alberta Innovates Technology Futures (AITF) for contaminant analysis. We had used ALS Labs, an internationally recognized laboratory that routinely conducts testing for environmental contaminants, in Phase One of this study. However, their relatively low detection limits were seen as inadequate for monitoring PAHs. The AITF also routinely conducts tests on environmental contaminants, these including the four heavy metals (arsenic, cadmium, methyl mercury and selenium) and polycyclic aromatic hydrocarbons (PAHs) that are highlighted in this project. Indeed, they have been working with the Alberta and federal government to test for changes in contaminant levels associated with a 670 million L spill of wastewater into the tributaries of the Athabasca River by the Obed Coal Mine in central Alberta on Oct 31, 2013 (HP 2013).

Consumption Limits (CL) represent the lifetime average consumption limits expressed on a weekly basis of mass (grams) per week that can be consumed without harm. It is calculated using the formula CL = pTDI*BW(7 d/wk)/C, where pTDI is provisional tolerable daily intake (µg contaminant/kg bw/d), BW is body weight (mass) in humans (kg), C (µg Hg / g fish) is the measured THg concentration in fish muscle (Appendix 4). The value for pTDI varies according to the contaminant being evaluated, and was identified from the literature.

Estimated Daily Intake (EDI) was calculated using a formula, EDI = C*IR*BF/BW, whereby IR is Ingestion Rate (i.e. the human rate of consumption (g/d)) as calculated from the food frequency data presented in Chapter 8. BF is Bioavailability Factor (assuming conservatively that 100% of the detected contaminants are available to be absorbed by organisms) and BW is average body weight in humans according to the four gender-age groups (kg) (Appendix 4). In turn, Exposure Ratios (ER) were calculated using the formula ER= EDI/pTDI, whereby EDI was calculated as above and where pTDI represented the provisional tolerable daily intake (µg contaminant/kg bw/d), as identified in the literature for each contaminant.

The pTDI for arsenic that we used in calculating both CL and ER was 2µg/khbw/day (Schmidt 2014). Although it was technically withdrawn in 2010 by the Environmental Protection Agency (EPA) to be evaluated, the revised numbers are still being debated as some industry representatives argued that the new levels might drop below natural background levels (Schmidt 2014)

The pTDI for cadmium that we used in calculating both CL and ER was 1µg/kgbw/day (as calculated from pTWIs of 7µgkgbw/week) according to the Joint FAO/WHO Expert Committee on Food Additives (FAO/WHO 2003).

The pTDI for mercury is higher for adults of the general population than for infants, children, and women of child-bearing age. Thus, the values that we used in calculating both CL and ER for infants, children and women of child-bearing age was 0.2µg/kg bw/day whereas, for adults, we used 0.47µg/kg bw/day (CHHAD 2014). This lower value was based on the pTWIs of 1.6µg/kgbw/week) according to the Joint FAO/WHO Expert Committee on Food Additives (FAO/WHO 2003). We also (conservatively) estimated that 100% of the measured total mercury levels represent methyl mercury.

Finally, the pTDI for selenium that we used in calculating both CL and ER again differs between adults and children. Thus, the pTDI for children and youth was 4µg/kg bw/day whereas for adults it was 5.7µg/kg bw/day (CCME 2009).

6.3 HEAVY METAL RESULTS

All of the heavy metals were present to some degree in the samples. Some occurred in concentrations that were of concern for human safety. Generally speaking, concentrations of arsenic, cadmium and mercury were highest in the kidneys and livers of animals, especially ducks. They were generally of greatest concern for children and women of childbearing age. In contrast, selenium levels were generally high across the board, and were of health concern for all tissues and for all species, regardless of the age or gender of the consumer.

In general, the results of this contaminant testing indicate that attention and sometimes caution should be paid to the consumption of some wild-caught meats. As will be discussed in greater detail below, the strength of these scientific data was limited by small sample sizes, unequal and non-random distribution of sampling across the landscape and unequal sample sizes across species and between sexes and ages of organisms.

With these caveats in mind, levels of all the contaminants were high enough that the consumption of some of these organs should be limited, according to scientific criteria. These organs of concern are indicated in orange (i.e. attention) or red (i.e. caution) in Table 6.1[1]. Levels of cadmium in moose kidney and liver and beaver kidney and liver were high enough to be of human health concern (Table 6.1, orange and red cells). Similarly, duck kidney also had high levels of cadmium for children (Table 6.1, orange and red cells). Moose muscle should also be eaten with caution because of high levels of cadmium (Table 6.1, red cells). Thus, the consumption of moose and beaver kidney and liver as well as moose meat should be limited for all community members, regardless of age, because of these high cadmium levels. In contrast, there was *no* health concern regarding the cadmium levels in the meat (muscle) of muskrat, beaver, and duck. Thus, community members, regardless of age, can effectively eat all the muskrat, moose, and duck meat (muscle) they want, as related to cadmium.

In addition, some tissues also had high levels of mercury. All ages should limit the amount of duck muscle, kidney and liver that they consume because of these high mercury levels (Table 6.1, red cells). Attention should also be paid with respect to moose and muskrat kidney (Table 6.1). Yet, as with cadmium, there is *no* health concern regarding mercury levels in muskrat, beaver or moose meat (muscle) (Table 6.1). Thus, community members, regardless of age, can effectively eat all the beaver, muskrat, and moose meat that they want, at least as related to mercury.

Arsenic levels were generally of less concern, and were only of concern for the kidneys of ducks (young and older children) and moose and muskrat kidneys (young children) (Table 6.1)

Unlike, Phase 1, there was a high level of concern regarding concentrations of selenium. Indeed, of all the different species and tissue combinations that were available, only muskrat was completely safe to eat because of these selenium levels, and this only by adults (Table 6.1).

Consumption limits were calculated according to mean levels of each contaminant as found in the muscle, kidney, and liver samples. Predictably, when consumption limits were calculated according to the maximum concentrations exhibited by each of these contaminants, the limits became more severe (Table 6.2).

Yet, when exposure rates were analysed, these calculated using empirical rather than estimated human intake data from Chapter 8, the information was much less foreboding than when only tissue concentration data were used, as with consumption limits (Appendix 4). Indeed, when these rates were calculated for mean intake data (including zero values) none of the exposure ratios were problematic (Table 6.3). This was even the case when the exposure to all tested animals (i.e. muskrat, beaver, moose, and duck) were combined.

Even when exposure ratios were calculated in the most conservative way (i.e. using maximum intake data for each tissue, and excluding any zero values for intake data) there was only rarely a potential problem (i.e. exposure ratio > 1.0). Indeed, this was only the case for moose consumption as it related to cadmium and for all animals, again because of the moose intake, as it related to cadmium (Table 6.4).

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[1]Cells from tables coloured in red reflect tissues that should be limited in consumption ($\leq \mathbf{0.50\ kg/wk}$) whereas those coloured in orange indicate that some caution should be shown (($\mathbf{0.50\ kg/wk < x \leq 1.0\ kg/wk}$). These cut offs do not vary with age.

Exposure ratios were thus generally not considered to be a health problem, because most community members eat less traditional foods than in the past. Moose is the most frequently consumed of all country foods, at least at this time of year (Chapter 8). The portion sizes were also greatest for moose, averaging 1,417.5g, 144.6g and 85.0g over the previous week for moose muscle (meat), kidney and liver, respectively (Table 6.5). In contrast, estimated portions of duck, beaver and especially muskrat were much lower (unpubl data). Below, we will indicate in detail what tissues should be limited when it comes to human consumption according to the species of wildlife and the age of the community members that are consuming the meat

6.3.1 MOOSE

\Generally speaking, many community members indicated that the moose occurring in the Peace Athabasca Delta were still largely healthy. However, there is some concern that the health of these animals is starting to decline,

> Oct 17, SR: "*A couple of weekends ago we were out at our camp, and this guy shot two moose. They went and butchered the moose at night and brought back the kidneys and the lungs there was a growth about the size of an egg. You didn't see it? We cut it out you know, and put it in a bag, I don't know if he brought it to town, but I was talking to a friend of mine and he said 'if he killed a moose and say anything like that on the lungs he didn't touch any of the innards, he ate the meat but not the kidneys or anything like that'. But it was the size of an egg, and on the lungs of the moose. It was a cow moose.*"

MOOSE MEAT (CONSUMPTION LIMITS RELATED TO ARSENIC)

Typically, moose kidneys had the highest contaminant levels followed by liver (Fig 6.2). In contrast, moose meat (muscle) typically showed the lowest levels of contaminants. This, in large part, this reflects the filtering role of kidneys and livers in mammals and birds, since their function is to cleanse the body of undesirable compounds, including environmental contaminants.

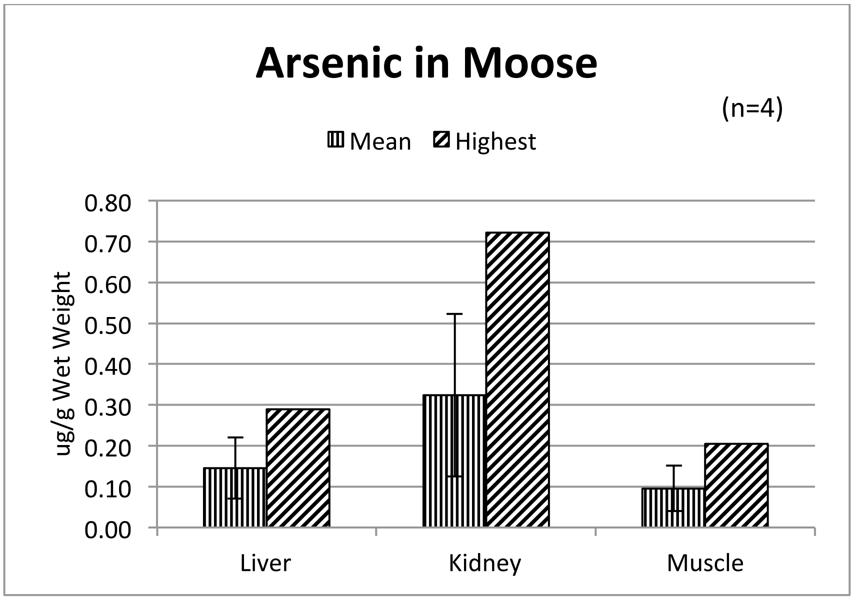

FIG 6.2. Concentration of inorganic arsenic in moose liver, kidney and meat (muscle) (n=4). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to arsenic in moose. In general, consumption of moose is not limited, except for moose kidneys and liver portions for young children. This was despite employing contaminant levels that were calculated using maximum rather than mean concentrations of cadmium in the various tissues.

- Adults community members can eat up to:
  - 10.67 kg (23.52 pounds or lb) of moose meat (muscle) per week.
  - 3.16 kg (9.95 lb) of moose kidney per week
  - 7.04 kg (15.52 lb) of moose liver per week

- Female community members who may become pregnant can eat up to:
  - 9.50 kg (20.94 lb) of moose meat (muscle) per week
  - 2.81 (6.19 lb) of moose kidney per week
  - 6.26 (13.80 lb) of moose liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 3.86 kg (8.51 lb) of moose meat (muscle) per week
  - 1.14 kg (2.51 lb) of moose kidney per week
  - 2.54 kg (5.60 lb) of moose liver per week

- Young children that are below 7 years of age can eat up to:
  - 2.11 kg (4.65 lb) of moose meat (muscle) per week
  - 0.62 kg (1.37 lb) of moose kidney per week
  - 0.39 kg (0.86 lb) of moose liver per week

See Appendix 4, 5 and 6 for additional details on the assumptions and methods used.

MOOSE MEAT (CONSUMPTION LIMITS RELATED TO CADMIUM)

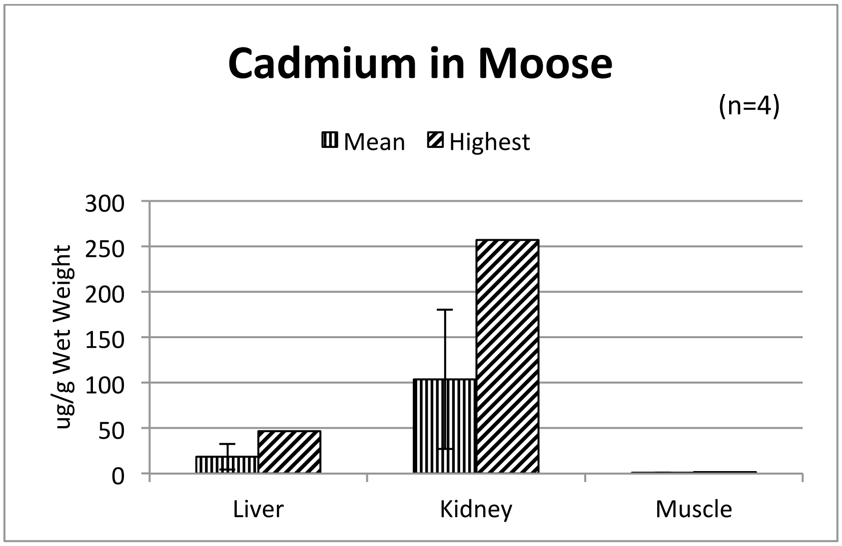

FIG 6.3. Concentration of cadmium in moose liver, kidney and meat (muscle) (n=4). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Typically, moose kidneys had the highest contaminant levels followed by liver (Fig 6.3). In contrast, moose meat (muscle) typically showed the lowest levels of contaminants. As indicated above, in large part, this reflects the filtering role of kidneys and livers in mammals and birds.

Consumption limits were calculated as they relate to cadmium in moose. In general, consumption of moose was limited for all tissues and for all ages, as these contaminant levels were calculated using maximum rather than mean concentrations of cadmium in the various tissues.

- Adults community members can eat up to:
  - 0.63 kg (1.38 pounds or lb) of moose meat (muscle) per day
  - 0.00 kg (0.17 ounces or oz) of moose kidney per day
  - 0.03 kg (0.98 oz) of moose liver per day

- Female community members who may become pregnant can eat up to:
  - 0.56 kg (1.23 lb) of moose meat (muscle) per week.
  - 0.00 (0.15 oz) of moose kidney per week.
  - 0.02 (0.87 oz) of moose liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 0.23 kg (0.50 lb) of moose meat (muscle) per week
  - 0.00 kg (0.06 oz) of moose kidney per week
  - 0.01 kg (0.35 oz) of moose liver per week

- Young children that are below 7 years of age can eat up to:
  - 0.12 kg (0.27 lb) of moose meat (muscle) per week
  - 0.00 kg (0.03 oz) of moose kidney per week.
  - 0.01 kg (0.19 oz) of moose liver per week

See Appendix 4, 5 and 6 for additional details on the assumptions and methods used.

MOOSE MEAT (CONSUMPTION LIMITS RELATED TO MERCURY)

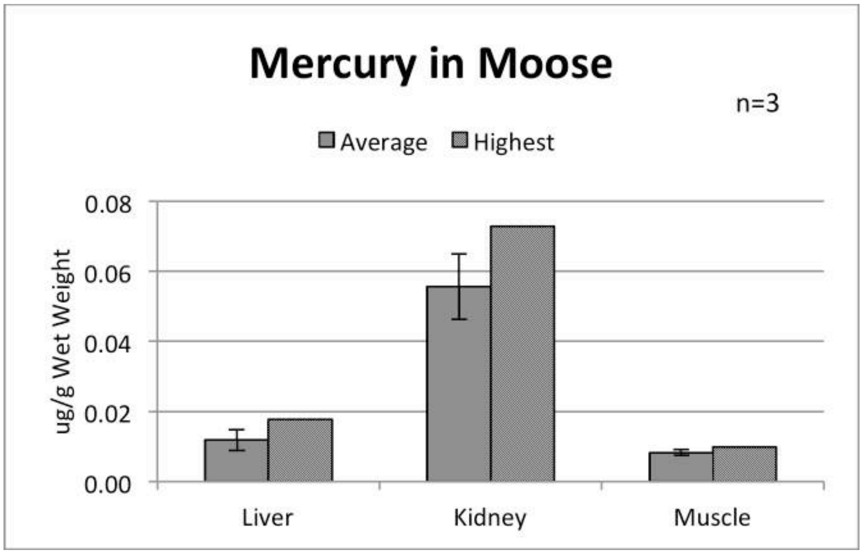

FIG 6.4. Concentration of methylmercury in moose liver, kidney and meat (muscle) (n=4). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Typically, moose kidneys had the highest contaminant levels followed by liver (Fig 6.4). In contrast, moose meat (muscle) typically showed the lowest levels of contaminants. This again, in large part, reflects the filtering role of kidneys and livers in mammals and birds.

Consumption limits were calculated as they relate to mercury in moose. In general, consumption of moose was unlimited for all tissues and for all ages, except for moose kidney when consumed by older and especially younger children.

- Adults community members can eat up to:
  - 28.94 kg (63.78 pounds or lb) of moose meat (muscle) per day
  - 4.32 kg (9.52 lb) of moose kidney per day
  - 20.30 kg (44.74 lb) of moose liver per day

- Female community members who may become pregnant can eat up to:
  - 10.96 kg (24.16 lb) of moose meat (muscle) per week
  - 1.64 (3.62 lb) of moose kidney per week
  - 7.69 (16.95 lb) of moose liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 4.49 kg (9.90 lb) of moose meat (muscle) per week
  - 0.67 kg (1.48 lb) of moose kidney per week
  - 0.36 kg (6.94 lb) of moose liver per week

- Young children that are below 7 years of age can eat up to:
  - 2.43 kg (5.36 lb) of moose meat (muscle) per week
  - 0.36 kg (0.79 lb) of moose kidney per week.
  - 1.70 kg (3.75 lb) of moose liver per week.

See Appendix 4, 5 and 6 for additional details on the assumptions and methods used.

MOOSE MEAT (CONSUMPTION LIMITS RELATED TO SELENIUM)

Typically, moose kidneys had the highest selenium levels followed by liver (Fig 6.5). In contrast, moose meat (muscle) typically showed the lowest levels of contaminants. This again, in large part, reflects the filtering role of kidneys and livers in mammals and birds.

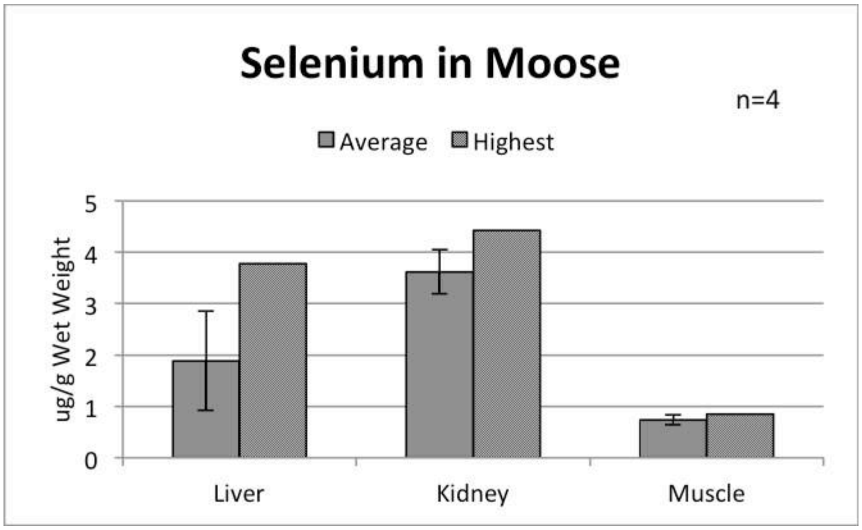

FIG 6.5. Concentration of selenium in moose liver, kidney and meat (muscle) (n=4). Standard error bars indicated for each mean value. Also indicated is maximum concentration observed.

Consumption limits were calculated as they relate to selenium in moose. In general, consumption of moose was restricted for all tissues and ages. Caution should be used for all these tissues (red) except for moose meat (meat) when consumed by adults, which still merit attention (orange) (Table 6.1).

- Adults community members can eat up to:
    - 3.94 kg (8.68 pounds or lb) of moose meat (muscle) per day
    - 0.80 kg (1.77 lb) of moose kidney per day
    - 1.54 kg (3.40 lb) of moose liver per day

- Female community members who may become pregnant can eat up to:
    - 3.50 kg (7.72 lb) of moose meat (muscle) per week
    - 0.72 (1.58 lb) of moose kidney per week
    - 1.37 (3.02 lb) of moose liver per week

- Older children that are 11 – 14 years of age can eat up to:
    - 1.00 kg (2.20 lb) of moose meat (muscle) per week
    - 0.20 kg (0.45 lb) of moose kidney per week
    - 0.39 kg (0.86 lb) of moose liver per week

- Young children that are below 7 years of age can eat up to:
    - 0.54 kg (1.20 lb) of moose meat (muscle) per week
    - 0.11 kg (0.25 lb) of moose kidney per week.
    - 0.21 kg (0.47 lb) of moose liver per week.

6.3.2 BEAVER

Generally speaking, some community members had noticed a decline in the health of beaver, to some degree in the Peace Athabasca Delta but especially in closer proximity to the Oil Sands,

> Nov 13: "*And like Lawrence said, even the animals don't taste the same. He noticed that. That's all from Industry. Even McKay, my son-in-law, killed a beaver there. And then we smoked the beaver meat. And the meat wasn't rich and red like it used to be? It's just kinda pale. And then we smoked it, and then we had some of it, and it didn't even taste the same. Way different. And then they took another beaver there - I left it over there, I didn't bother.*"

Typically, beaver kidneys had the highest contaminant levels followed by liver. In contrast, beaver meat (muscle) typically showed the lowest levels of contaminants.

BEAVER MEAT (CONSUMPTION LIMITS RELATED TO ARSENIC)

Typically, beaver kidneys had the highest arsenic levels followed by liver (Fig 6.6). In contrast, beaver meat (muscle) typically showed the lowest levels of contaminants.

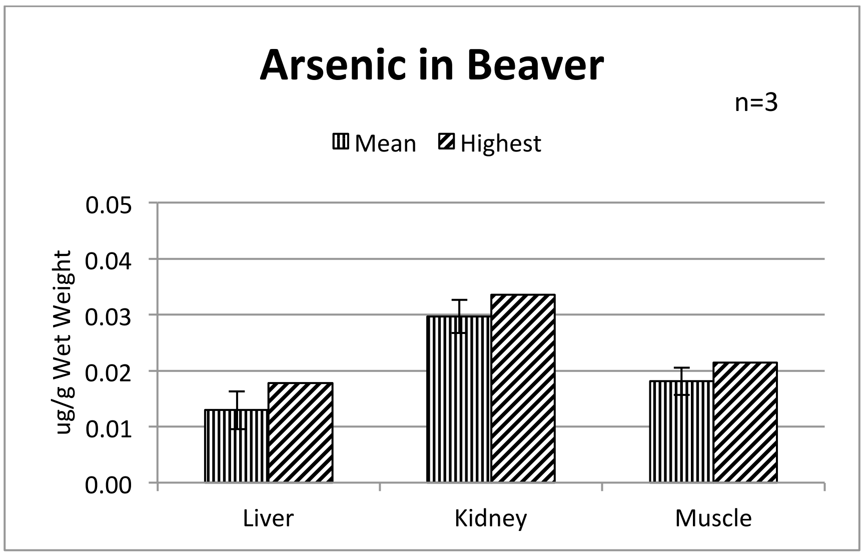

FIG 6.6. Concentration of arsenic in beaver liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum concentration observed.

This, in large part, reflects the filtering role of kidneys and livers in mammals and birds, since their function is to cleanse the body of undesirable compounds, including environmental contaminants.

Consumption limits were calculated as they relate to arsenic in beaver. In general, consumption of beaver was not restricted for any of the tissues and for any of the ages (Table 6.1).

- Adults community members can eat up to:
    - 56.57 kg (124.68 pounds or lb) of beaver meat (muscle) per week
    - 34.45 kg (75.93 lb) of beaver kidney per week
    - 79.02 kg (174.16 lb) of moose beaver per week

- Female community members who may become pregnant can eat up to:
    - 50.37 kg (111.02 lb) of beaver meat (muscle) per week
    - 30.67 (67.60 lb) of beaver kidney per week
    - 28.58 (62.99 lb) of beaver liver per week

- Older children that are 11 – 14 years of age can eat up to:
    - 20.45 kg (45.07 lb) of beaver meat (muscle) per week
    - 12.46 kg (27.46 lb) of beaver kidney per week
    - 28.58 kg (62.99 lb) of beaver liver per week

- Young children that are below 7 years of age can eat up to:
    - 11.16 kg (24.60 lb) of beaver meat (muscle) per week
    - 6.80 kg (14.99 lb) of beaver kidney per week
    - 15.59 kg (34.36 lb) of beaver liver per week

BEAVER MEAT (CONSUMPTION LIMITS RELATED TO CADMIUM)

Typically, beaver kidneys had the highest cadmium levels followed by liver (Fig 6.7). In contrast, beaver meat (muscle) typically showed the lowest levels of contaminants.

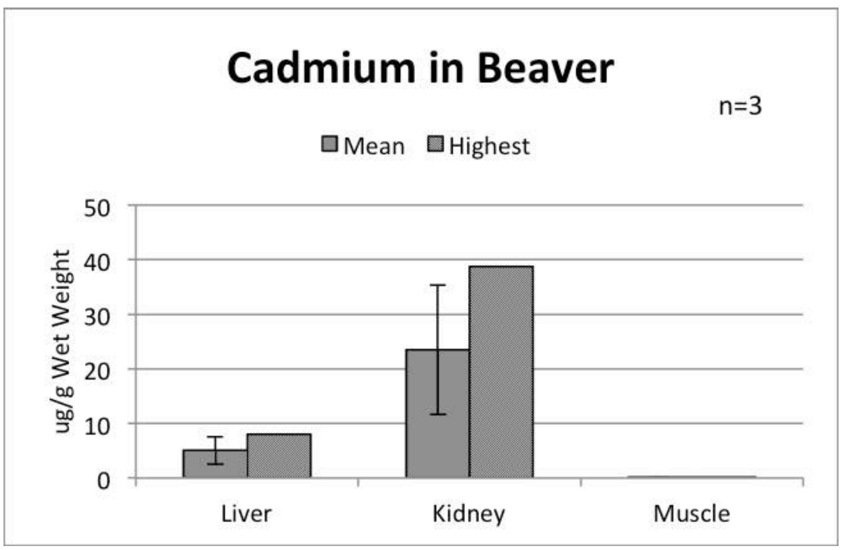

FIG 6.7. Concentration of cadmium in beaver liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum concentration observed.

This, in large part, reflects the filtering role of kidneys and livers in mammals and birds, since their function is to cleanse the body of undesirable compounds, including environmental contaminants.

Consumption limits were calculated as they relate to cadmium in beaver. In general, consumption of beaver was not restricted for muscle (meat) but caution (red) should be paid when consuming beaver liver and especially kidney, regardless of (Table 6.1).

- Adults community members can eat up to:
    - 10.26 kg (22.61 pounds or lb) of beaver meat (muscle) per week
    - 0.03 kg (1.06 ounces or oz) of beaver kidney per week
    - 0.15 kg (0.33 lb) of beaver liver per week

- Female community members who may become pregnant can eat up to:
    - 9.13 kg (20.12 lb) of beaver meat (muscle) per week
    - 0.03 (1.06 oz) of beaver kidney per week
    - 0.14 (0.31 lb) of beaver liver per week

- Older children that are 11 – 14 years of age can eat up to:
    - 3.71 kg (8.18 lb) of beaver meat (muscle) per week
    - 0.01 kg (0.35 oz) of beaver kidney per week
    - 0.06 kg (2.11 oz) of beaver liver per week

- Young children that are below 7 years of age can eat up to:
    - 2.02 kg (4.45 lb) of beaver meat (muscle) per week
    - 0.01 kg (0.35 oz) of beaver kidney per week
    - 0.03 kg (1.06 oz) of beaver liver per week

BEAVER MEAT (CONSUMPTION LIMITS RELATED TO MERCURY)

Typically, beaver kidneys had the highest mercury levels followed by liver and beaver meat, which occurred at about the same concentrations (Fig 6.8). In contrast, beaver meat (muscle) typically showed the lowest levels of mercury.

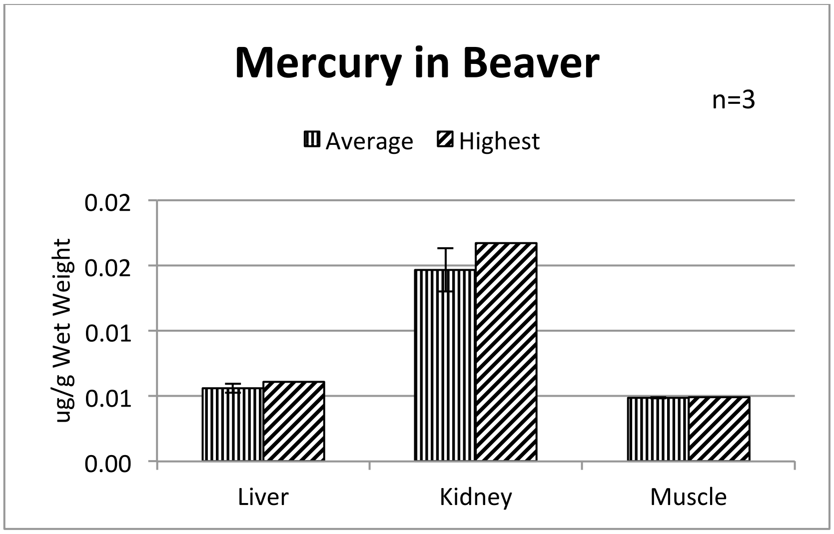

FIG 6.8. Concentration of methylmercury in beaver liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum concentration observed.

Consumption limits were calculated as they relate to mercury in beaver. In general, consumption of beaver was not restricted for any of the tissues, regardless whether it is muscle (meat), liver, or kidney (Table 6.1).

- Adults community members can eat up to:
    - 49.35 kg (108.77 pounds or lb) of beaver meat (muscle) per week
    - 16.38 kg (36.10 lb) of beaver kidney per week
    - 42.89 kg (94.53 lb) of beaver liver per week

- Female community members who may become pregnant can eat up to:
    - 18.70 kg (41.22 lb) of beaver meat (muscle) per week
    - 6.20 kg (13.67 lb) of beaver kidney per week
    - 16.25 kg (35.82 lb) of beaver liver per week

- Older children that are 11 – 14 years of age can eat up to:
    - 7.65 kg (16.86 lb) of beaver meat (muscle) per week
    - 2.54 kg (5.60 lb) of beaver kidney per week
    - 6.65 kg (14.66 lb) of beaver liver per week

- Young children that are below 7 years of age can eat up to:
    - 4.14 kg (9.13 lb) of beaver meat (muscle) per week
    - 1.37 kg (3.02 lb) of beaver kidney per week
    - 3.60 kg (7.93 lb) of beaver liver per week

BEAVER MEAT (CONSUMPTION LIMITS RELATED TO SELENIUM)

Typically, beaver kidneys tended to have the highest selenium levels followed by liver (Fig 6.9). In contrast, beaver meat (muscle) typically showed the lowest levels of selenium.

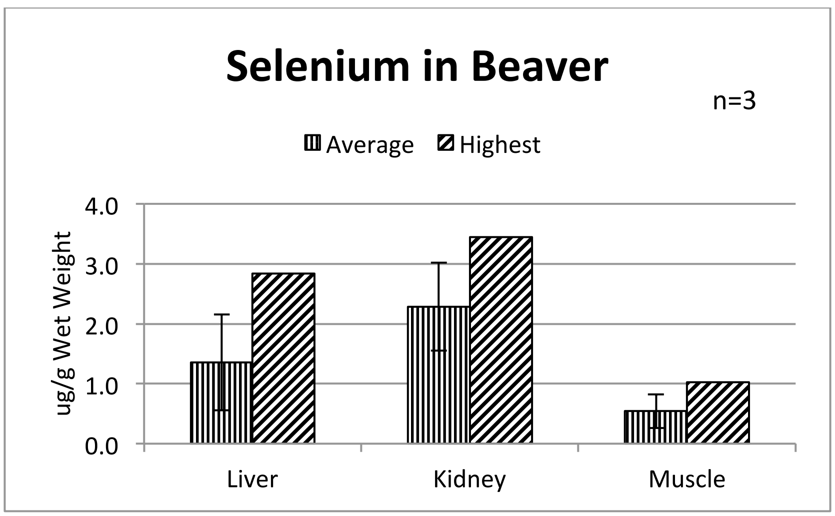

FIG 6.9. Concentration of selenium in beaver liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum concentration observed.

This, in large part, reflects the filtering role of kidneys and livers in mammals and birds, since their function is to cleanse the body of undesirable compounds, including environmental contaminants.

Consumption limits were calculated as they relate to selenium in beaver. In general, consumption of beaver was restricted for any of the tissues, and while only attention (orange) should be paid when adults consume beaver muscle (meat) for all other tissues caution (red) should be paid. Likewise, caution (red) should be paid by children regarding all tissues (Table 6.1).

- Adults community members can eat up to:
    - 5.37 kg (11.84 pounds or lb) of beaver meat (muscle) per week
    - 1.27 kg (2.81 lb) of beaver kidney per week
    - 2.14 kg (4.73 lb) of beaver liver per week

- Female community members who may become pregnant can eat up to:
    - 4.78 kg (10.55 lb) of beaver meat (muscle) per week
    - 1.14 kg (2.50 lb) of beaver kidney per week
    - 1.91 kg (4.21 lb) of beaver liver per week

- Older children that are 11 – 14 years of age can eat up to:
    - 1.36 kg (3.01 lb) of beaver meat (muscle) per week
    - 0.32 kg (0.71 lb) of beaver kidney per week
    - 0.54 kg (1.20 lb) of beaver liver per week

- Young children that are below 7 years of age can eat up to:
    - 0.74 kg (1.64 lb) of beaver meat (muscle) per week
    - 0.18 kg (0.39 lb) of beaver kidney per week
    - 0.30 kg (0.65 lb) of beaver liver per week

6.3.3 MUSKRAT

Muskrat populations have been in sharp decline throughout the Peace Athabasca Delta. They have been effectively extirpated from the regions, and thus declined in number from the hundreds of thousands since the 1970s. As indicated in the previous chapter, this decline is widely attributed to decreases in water levels associated with the WAC Bennett Dam and the Oil Sands but, importantly, also to contaminants generated by the latter development,

> Nov 13: Partic1: *"You know, years ago, it started. But nobody ever mentioned it. At the end of the day, after my brothers and I, we'd get home, and somebody would say, 'oh, I found a couple dead rats. Oh, more for me!'"*
> Partic2*: "Yeah, inside a big house."*
> Partic1*: "But we did not think what killed them. Sometimes, in a big rat house, you're trying to set your trap with some of the stuff that's in there, and you find a rat underneath there. Buried, with all that mush, you know? Nobody ever thought nothing. You throw him on the sleigh, it's one more for you."*
> Partic2*: "Yeah. I thought –"*
> *Partic1: "Have you ever thought of what caused the animal to die?"*
> Partic2: *"Cause they're always big. You can't even dry them. Of course they're different. When they're dry, it'll be this colour, the skin. Just dark red, you know. But otherwise they look normal. They're fat. It's just that they go in the house and they die, two sometimes. And, we just add it to our pile."*
> Partic1: *"That's right. We never thought of... So, you know, that gives you second thought now. Maybe it was back then, a number of years ago. Maybe it was already, contaminants were there already. But how far back though?"*

Table 6.1 Human consumption limits (kg/week) of country food, this calculated for the average contaminant levels found in muscle, kidneys and livers of ducks, moose, beavers and muskrats. Results are displayed as the amount (kg) that can be consumed per week over a lifetime without observable harm, this according to the age and average weight of the consumer. Table cells indicated in red reflect tissues that should be limited in consumption (≤ 0.50 kg/wk) whereas those in orange indicate where some caution should be shown (0.50 kg/wk < x ≤ 1.0 kg/wk).

Weekly human consumption limits (kg per week)						
Contaminant	Organ	Animal	Weight of consumer			
			adults (73 kg)	women-birth (65kg)	older children (26.4 kg)	young children (14.4 kg)
Arsenic	Muscle	Duck	16.83	14.98	6.09	3.32
		Moose	10.67	9.50	3.86	2.11
		Beaver	56.57	50.37	20.46	11.16
		Muskrat	5.15	4.58	1.86	1.02
	Liver	Duck	8.54	7.61	3.09	1.69
		Moose	7.04	6.26	2.54	1.39
		Beaver	79.02	70.36	28.58	15.59
		Muskrat	5.30	4.72	1.92	1.05
	Kidney	Duck	1.16	1.04	0.42	0.23
		Moose	3.16	2.81	1.14	0.62
		Beaver	34.45	30.67	12.46	6.80
		Muskrat	4.39	3.91	1.59	0.87
Cadmium	Muscle	Duck	161.44	143.75	58.38	31.85
		Moose	0.63	0.56	0.23	0.12
		Beaver	6.84	6.09	2.47	1.35
		Muskrat	123.50	109.97	44.66	24.36
	Liver	Duck	3.28	2.92	1.18	0.65
		Moose	0.03	0.02	0.01	0.01
		Beaver	0.10	0.09	0.04	0.02
		Muskrat	15.70	13.98	5.68	3.10
	Kidney	Duck	1.10	0.98	0.40	0.22
		Moose	0.00	0.00	0.00	0.00
		Beaver	0.02	0.02	0.01	0.00
		Muskrat	6.82	6.07	2.47	1.35
Mercury	Muscle	Duck	0.85	0.32	0.13	0.07

		Moose	28.94	10.96	4.49	2.43
		Beaver	49.35	18.70	7.65	4.14
		Muskrat	27.85	10.55	4.32	2.34
	Liver	Duck	0.25	0.09	0.04	0.02
		Moose	20.30	7.69	3.15	1.70
		Beaver	42.89	16.25	6.65	3.60
		Muskrat	16.66	6.31	2.58	1.40
	Kidney	Duck	0.33	0.12	0.05	0.03
		Moose	4.32	1.64	0.67	0.36
		Beaver	16.38	6.20	2.54	1.37
		Muskrat	8.40	3.18	1.30	0.71
Selenium	Muscle	Duck	2.85	2.53	0.72	0.39
		Moose	3.94	3.50	1.00	0.54
		Beaver	5.37	4.78	1.36	0.74
		Muskrat	8.80	7.84	2.23	1.22
	Liver	Duck	0.85	0.75	0.21	0.12
		Moose	1.54	1.37	0.39	0.21
		Beaver	2.14	1.91	0.54	0.30
		Muskrat	1.74	1.55	0.44	0.24
	Kidney	Duck	0.73	0.65	0.18	0.10
		Moose	0.80	0.72	0.20	0.11
		Beaver	1.27	1.14	0.32	0.18
		Muskrat	0.93	0.82	0.23	0.13

Table 6.2 Human consumption limits (kg/week) of country food, this calculated for the highest contaminant levels found in muscle, kidneys and livers of ducks, moose, beavers and muskrats. Results are displayed as the amount (kg) that can be consumed per week over a lifetime without observable harm, this according to the age and average weight of the consumer. Table cells indicated in red reflect tissues that should be limited in consumption (≤ 0.50 kg/wk) whereas those in orange indicate where some caution should be shown (0.50 kg/wk < x ≤ 1.0 kg/wk).

Weekly human consumption limits (kg per week)						
Contaminant	Organ	Animal	Weight of consumer			
			adults (73 kg)	women-birth (65kg)	older children (26.4 kg)	young children (14.4 kg)
Arsenic	Muscle	Duck	5.49	4.89	1.99	1.08
		Moose	5.01	4.46	1.81	0.99
		Beaver	47.76	42.52	17.27	9.42
		Muskrat	1.88	1.68	0.68	0.37
	Liver	Duck	5.21	4.64	1.89	1.03
		Moose	3.52	3.14	1.27	0.70
		Beaver	57.42	51.12	20.76	11.33
		Muskrat	2.95	2.62	1.07	0.58
	Kidney	Duck	0.12	0.10	0.04	0.02
		Moose	1.42	1.26	0.51	0.28
		Beaver	30.42	27.08	11.00	6.00
		Muskrat	2.24	1.99	0.81	0.44
Cadmium	Muscle	Duck	18.93	16.85	6.84	3.73
		Moose	0.35	0.31	0.13	0.07
		Beaver	4.41	3.92	1.59	0.87
		Muskrat	37.57	33.46	13.59	7.41
	Liver	Duck	0.37	0.33	0.13	0.07
		Moose	0.01	0.01	0.00	0.00
		Beaver	0.06	0.06	0.02	0.01
		Muskrat	5.63	5.02	2.04	1.11
	Kidney	Duck	0.12	0.11	0.05	0.02
		Moose	0.00	0.00	0.00	0.00
		Beaver	0.01	0.01	0.00	0.00
		Muskrat	3.30	2.94	1.19	0.65
Mercury	Muscle	Duck	0.27	0.10	0.04	0.02
		Moose	24.51	9.29	3.80	2.06

		Beaver	49.01	18.57	7.60	4.11
		Muskrat	16.56	6.28	2.57	1.39
	Liver	Duck	0.07	0.03	0.01	0.01
		Moose	13.57	5.14	2.10	1.14
		Beaver	39.37	14.92	6.10	3.30
		Muskrat	5.33	2.02	0.83	0.45
	Kidney	Duck	0.11	0.04	0.02	0.01
		Moose	3.29	1.25	0.51	0.28
		Beaver	14.38	5.45	2.23	1.21
		Muskrat	4.34	1.65	0.67	0.36
Selenium	Muscle	Duck	1.74	1.55	0.44	0.24
		Moose	3.94	3.50	1.00	0.54
		Beaver	5.37	4.78	1.36	0.74
		Muskrat	8.80	7.84	2.23	1.22
	Liver	Duck	0.49	0.44	0.13	0.07
		Moose	1.54	1.37	0.39	0.21
		Beaver	2.14	1.91	0.54	0.30
		Muskrat	1.74	1.55	0.44	0.24
	Kidney	Duck	0.49	0.43	0.12	0.07
		Moose	0.80	0.72	0.20	0.11
		Beaver	1.27	1.14	0.32	0.18
		Muskrat	0.93	0.82	0.23	0.13

Table 6.3. Exposure ratios based on the mean intake values for the muscle (meat), kidneys, and livers of moose, muskrats, beavers and ducks for arsenic, cadmium, mercury, and selenium. (zero values for intake data excluded). Table cells indicated in red reflect tissues that might be limited in consumption (intake ≤ 2.00 ug/kg BW/day) whereas those in orange indicate where some caution might be shown (intake 1.00 ug/kg BW/day ≤ x < 2.0 ug/kg BW/day).

Contaminant	Animal	Organ	Provisional Tolerable Daily Intake pTDI		Actual Intake ug/Kg BW/day			
			Adult Males	Youth	Adult Males 73Kg	Adult Females 65Kg	Youth 26.4 Kg	Kids 14.4Kg
			ug/kg BW/day					
Arsenic	Duck	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Moose	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Beaver	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Muskrat	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Duck	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Moose	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Beaver	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Muskrat	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Duck	Muscle	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Moose	Muscle	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Beaver	Muscle	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Muskrat	Muscle	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	All animals	All	2.00	2.00	0.00	0.00	0.00	0.01
Cadmium	Duck	Liver	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Moose	Liver	1.00	1.00	0.01	0.04	0.06	0.08
Cadmium	Beaver	Liver	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Muskrat	Liver	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Duck	Kidney	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Moose	Kidney	1.00	1.00	0.10	0.13	0.39	0.52
Cadmium	Beaver	Kidney	1.00	1.00	0.00	0.00	0.01	0.01

Cadmium	Muskrat	Kidney	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Duck	Muscle	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Moose	Muscle	1.00	1.00	0.02	0.02	0.02	0.03
Cadmium	Beaver	Muscle	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Muskrat	Muscle	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	All animals	All	1.00	1.00	0.14	0.18	0.48	0.65
Mercury	Duck	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Moose	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Beaver	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Muskrat	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Duck	Kidney	0.47	0.20	0.00	0.00	0.01	0.01
Mercury	Moose	Kidney	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Beaver	Kidney	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Muskrat	Kidney	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Duck	Muscle	0.47	0.20	0.00	0.00	0.00	0.01
Mercury	Moose	Muscle	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Beaver	Muscle	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Muskrat	Muscle	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	All animals	All	0.47	0.20	0.00	0.00	0.02	0.02
Selenium	Duck	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Moose	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Beaver	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Muskrat	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Duck	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Moose	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Beaver	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Muskrat	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Duck	Muscle	5.70	4.00	0.00	0.00	0.00	0.00

Selenium	Moose	Muscle	5.70	4.00	0.00	0.00	0.01	0.01
Selenium	Beaver	Muscle	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Muskrat	Muscle	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	All animals	All	5.70	4.00	0.00	0.00	0.01	0.02

Table 6.4. Exposure ratios based on the maximum intake values for the muscle (meat), kidneys, and livers of moose, muskrats, beavers and ducks for arsenic, cadmium, mercury, and selenium. Note: zero values omitted and maximum portions used for calculations. Table cells indicated in red reflect tissues that might be limited in consumption (intake ≤ 2.00 ug/kg BW/day) whereas those in orange indicate where some caution might be shown (intake 1.00 ug/kg BW/day ≤ x < 2.0 ug/kg BW/day).

Metal	Animal	Organ	Provisional Tolerable daily intake pTDI		Actual Intake ug/kg BW/day			
			Adult Males	Youth	Adult Males 73kg	Adult Females 65kg	Youth 26.4 kg	Kids 14.4kg
			ug/kg BW/day					
Arsenic	Duck	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Moose	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Beaver	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Muskrat	Liver	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Duck	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Moose	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Beaver	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Muskrat	Kidney	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Duck	Muscle	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Moose	Muscle	2.00	2.00	0.01	0.01	0.03	0.04
Arsenic	Beaver	Muscle	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	Muskrat	Muscle	2.00	2.00	0.00	0.00	0.00	0.00
Arsenic	All animals	All	2.00	2.00	0.01	0.01	0.04	0.05
Cadmium	Duck	Liver	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Moose	Liver	1.00	1.00	0.02	0.04	0.11	0.14
Cadmium	Beaver	Liver	1.00	1.00	0.00	0.00	0.00	0.01
Cadmium	Muskrat	Liver	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Duck	Kidney	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Moose	Kidney	1.00	1.00	0.47	0.37	1.81	2.43
Cadmium	Beaver	Kidney	1.00	1.00	0.01	0.00	0.02	0.03

Cadmium	Muskrat	Kidney	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Duck	Muscle	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Moose	Muscle	1.00	1.00	0.13	0.16	0.50	0.67
Cadmium	Beaver	Muscle	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	Muskrat	Muscle	1.00	1.00	0.00	0.00	0.00	0.00
Cadmium	All animals	All	1.00	1.00	0.63	0.58	2.44	3.29
Mercury	Duck	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Moose	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Beaver	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Muskrat	Liver	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Duck	Kidney	0.47	0.20	0.00	0.00	0.01	0.01
Mercury	Moose	Kidney	0.47	0.20	0.00	0.00	0.00	0.01
Mercury	Beaver	Kidney	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Muskrat	Kidney	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Duck	Muscle	0.47	0.20	0.00	0.00	0.00	0.01
Mercury	Moose	Muscle	0.47	0.20	0.00	0.00	0.03	0.03
Mercury	Beaver	Muscle	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	Muskrat	Muscle	0.47	0.20	0.00	0.00	0.00	0.00
Mercury	All animals	All	0.47	0.20	0.01	0.01	0.04	0.06
Selenium	Duck	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Moose	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Beaver	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Muskrat	Liver	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Duck	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Moose	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Beaver	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Muskrat	Kidney	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Duck	Muscle	5.70	4.00	0.00	0.00	0.00	0.00

Selenium	Moose	Muscle	5.70	4.00	0.02	0.02	0.01	0.01
Selenium	Beaver	Muscle	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	Muskrat	Muscle	5.70	4.00	0.00	0.00	0.00	0.00
Selenium	All animals	All	5.70	4.00	0.02	0.03	0.01	0.02

Table 6.5 Portion sizes of moose, duck, beaver and muskrat tissues, including muscle (meat), kidney, and liver according to the past two months and the past week. All zero values excluded.

	Portion over past two months (g)			Portion over past week (g)		
	All	Male	Female	All	Male	Female
Moose muscle[a]	2131.9	6789.7	4952.7	1417.5	1675.5	1261.6
Moose kidney	292.0	297.7	292.0	144.6	113.4	167.3
Moose liver	260.8	212.6	453.6	85.0	85.0	0.0
Duck muscle	1085.8	1559.2	603.8	394.1	172.9	362.9
Duck kidney	136.1	195.6	76.5	48.2	22.7	45.4
Duck liver	136.1	195.6	76.5	48.2	22.7	45.4
Beaver muscle	209.8	260.8	158.8	124.7	147.4	104.9
Beaver kidney	25.5	34.0	19.8	17.0	19.8	14.2
Beaver liver	25.5	34.0	19.8	17.0	19.8	14.2
Muskrat muscle	442.3	181.4	530.1	136.1	0	136.1
Muskrat kidney	56.7	22.7	65.2	17.0	0	17.0
Muskrat liver	56.7	22.7	65.2	17.0	0	17.0

[a]Moose muscle, kidney and liver portions were estimated directly by participants whereas muscle, kidney and liver portions were estimated as a proportion of the total portion size for ducks, beavers and muskrats: i.e. 80%, 10% and 10%, respectively, for each tissue.

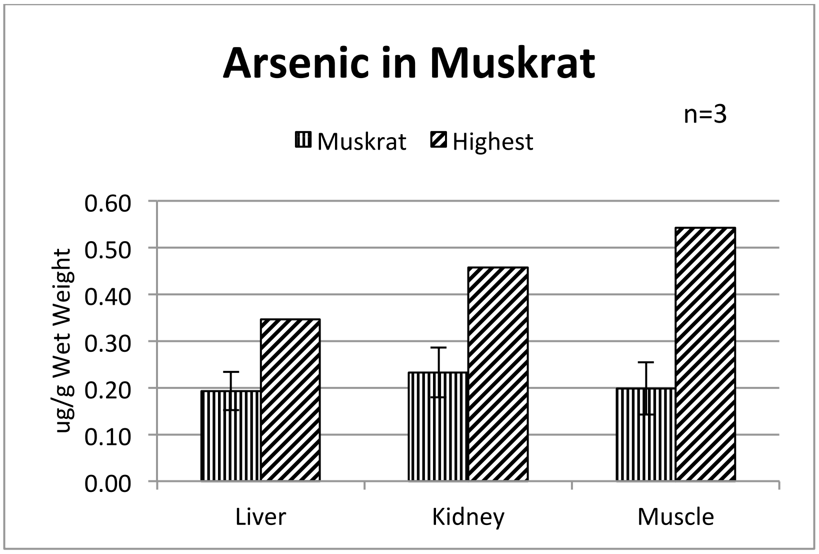

FIG 6.10. Concentration of arsenic in muskrat liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

MUSKRAT (CONSUMPTION LIMITS RELATED TO ARSENIC)

Levels of arsenic in muskrat muscle (meat), liver and kidney were all about the same, although maximum levels of arsenic in muskrat muscle tended to be highest (Fig 6.10).

Consumption limits were calculated as they relate to arsenic in muskrats. In general, consumption of muskrat was not restricted for any of the tissues and for any of the ages, except some caution (orange) should be paid by young children when eating muskrat kidney (Table 6.1).

- Adults community members can eat up to:
  - 5.15 kg (11.35 lb) of muskrat meat (muscle) per week
  - 4.39 kg (9.68 lb) of muskrat kidney per week
  - 5.30 kg (11.68 lb) of muskrat liver per week

- Women of child-bearing age can eat up to:
  - 4.58 kg (10.09 lb) of muskrat meat (muscle) per week
  - 3.91 kg (8.62 lb) of muskrat kidney per week
  -
  - 4.72 kg (10.40 lb) of muskrat liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 1.86 kg (4.10 lb) of muskrat meat (muscle) per week
    1.59 kg (3.50 lb) of muskrat kidney per week
  - 1.92 kg (4.23 lb) of muskrat liver per week

- Young children that are below 7 years of age can eat up to:
  - 1.02 kg (2.25 lb) of muskrat meat per week
  - 0.87 kg (1.92 lb) of muskrat kidney per week
  - 1.05 kg (2.31 lb) of muskrat kidney per week

Cadmium levels were highest in muskrat kidney, followed by liver (Fig 6.11). In contrast, cadmium levels in muskrat muscle (meat) were substantially lower.

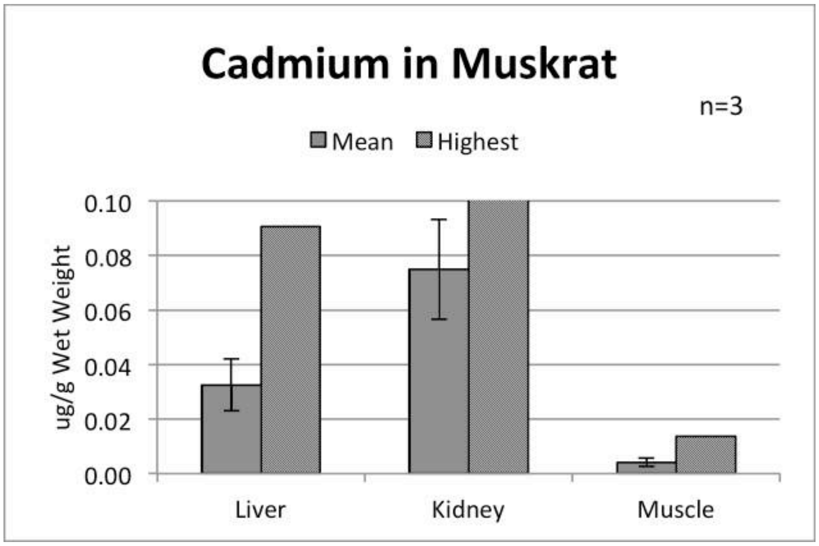

FIG 6.11. Concentration of cadmium in muskrat liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to cadmium in muskrats. In general, consumption of muskrat was not restricted for any of the tissues or for any of the ages (Table 6.1).

- Adults community members can eat up to:
  - 185.26 kg (408.31 lb) of muskrat meat (muscle) per week
  - 10.23 kg (22.55 lb) of muskrat kidney per week
  - 23.55 kg (51.90 lb) of muskrat liver per week

- Women of child-bearing age can eat up to:
  - 164.95 kg (363.55 lb) of muskrat meat (muscle) per week
  - 9.11 kg (20.08 lb) of muskrat kidney per week
  - 20.97 kg (46.22 lb) of muskrat liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 67.00 kg (147.67 lb) of muskrat meat (muscle) per week
    3.71 kg (8.18 lb) of muskrat kidney per week
  - 8.52 kg (18.78 lb) of muskrat liver per week

- Young children that are below 7 years of age can eat up to:
  - 36.54 kg (80.53 lb) of muskrat meat per week
  - 2.02 kg (4.45 lb) of muskrat kidney per week
  - 4.65 kg (10.25 lb) of muskrat liver per week

Mercury levels were highest in muskrat kidney followed by liver. In contrast, levels were substantially lower in muskrat muscle (meat) (Fig 6.12).

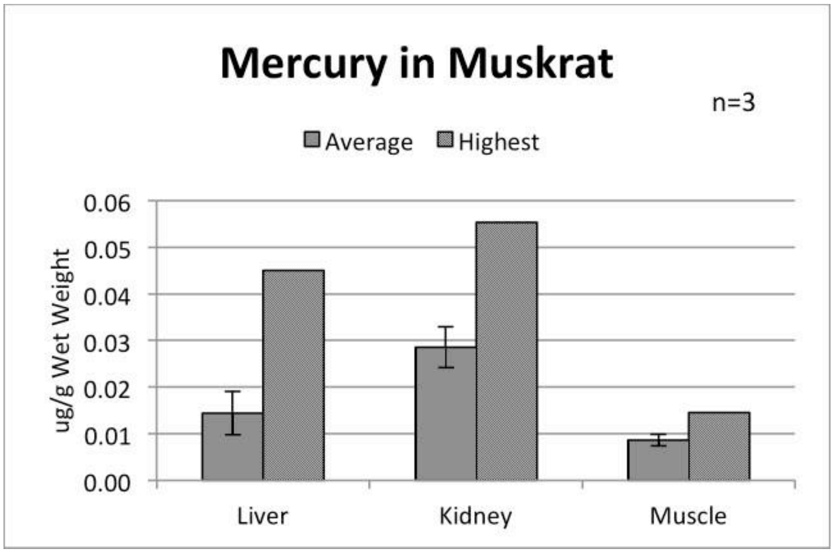

FIG 6.12. Concentration of mercury in muskrat liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to cadmium in muskrats. In general, consumption of muskrat was not restricted for any of the tissues or for any of the ages, although some attention (orange) should be paid when young children eat muskrat kidney (Table 6.1).

- Adults community members can eat up to:
  - 27.85 kg (61.38 lb) of muskrat meat (muscle) per week
  - 8.40 kg (18.51 lb) of muskrat kidney per week
  - 16.66 kg (36.72 lb) of muskrat liver per week

- Women of child-bearing age can eat up to:
  - 10.55 kg (23.25 lb) of muskrat meat (muscle) per week
  - 3.18 kg (7.01 lb) of muskrat kidney per week
  - 6.31 kg (13.91 lb) of muskrat liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 4.32 kg (9.52 lb) of muskrat meat (muscle) per week
  - 1.30 kg (2.86 lb) of muskrat kidney per week
  - 2.58 kg (5.68 lb) of muskrat liver per week

- Young children that are below 7 years of age can eat up to:
  - 2.34 kg (5.16 lb) of muskrat meat per week
  - 0.71 kg (1.57 lb) of muskrat kidney per week
  - 1.40 kg (3.09 lb) of muskrat liver per week

Selenium levels in muskrat kidney was highest, followed by muskrat liver (Fig 6.13). In contrast, levels in muskrat muscle (meat) were substantially lower.

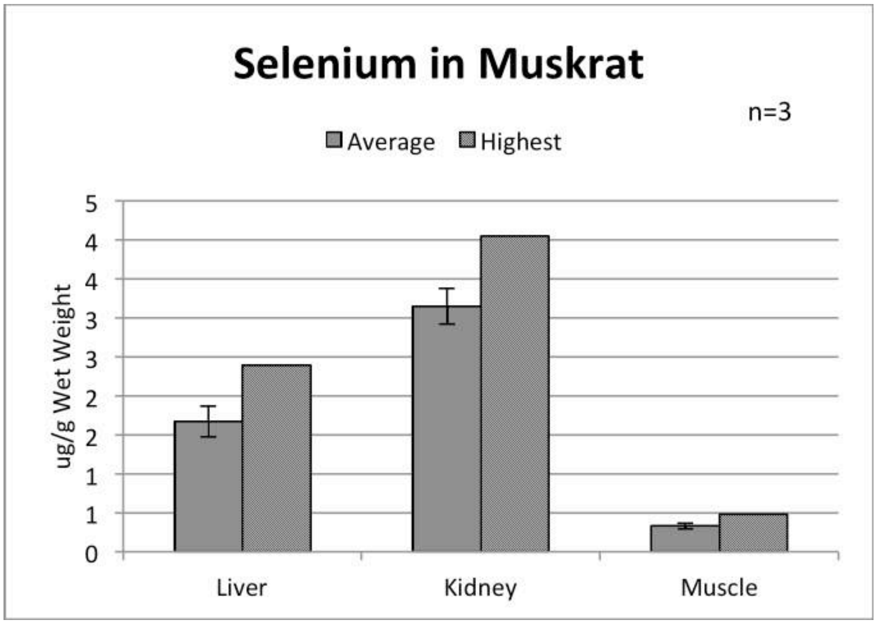

FIG 6.13. Concentration of selenium in muskrat liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to selenium in muskrats. In general, consumption of muskrat was restricted for most muskrat tissues. Indeed, caution (red) should be paid with respect to all kidney and liver by all ages whereas young children should show caution (red) when eating muskrat muscle and older children should show attention (orange). In contrast, adults can eat unlimited amounts of muskrat muscle (meat) (Table 6.1).

- Adults community members can eat up to:
    - 8.80 kg (19.40 lb) of muskrat meat (muscle) per week
    - 0.93 kg (2.04 lb) of muskrat kidney per week
    - 1.74 kg (3.84 lb) of muskrat liver per week

- Women of child-bearing age can eat up to:
    - 7.84 kg (17.28 lb) of muskrat meat (muscle) per week
    - 0.82 kg (1.82 lb) of muskrat kidney per week
    - 1.55 kg (3.42 lb) of muskrat liver per week

- Older children that are 11 – 14 years of age can eat up to:
    - 2.23 kg (4.92 lb) of muskrat meat (muscle) per week
    - 0.23 kg (0.52 lb) of muskrat kidney per week
    - 0.44 kg (0.97 lb) of muskrat liver per week

- Young children that are below 7 years of age can eat up to:
  - 1.22 kg (2.69 lb) of muskrat meat per week
  - 0.13 kg (0.28 lb) of muskrat kidney per week
  - 0.24 kg (0.53 lb) of muskrat liver per week

6.3.4 DUCKS

All participants had observed a decline in waterfowl, both with respect to migrating but also resident populations,

> *"There used to be thousands of ducks in the delta. Like I was saying, we used to live off the land. What we would do in the morning is start our little boat and go up the beach and be able to shoot 5 or 10 ducks. It was nothing to make a pot of soup or something and that was almost like daily. Every other day besides from fishing, we would be able to do that. Now, we go out and we can't even get a duck. Come home with nothing. The numbers just aren't there. Just not thriving in the that area as much, as previous years, that is what I noticed in this area."*
>
> David Campbell, MCFN

However, some had also observed a decline in the quality of the meat of those birds that were harvested in Peace Athabasca Delta,

> Nov 13, 2012: *"You know, you know years ago I remember when am young when I kill a duck it taste so good. Now it does not taste the same. Its kind of taste not like it use to, it doesn't taste good.*"

Although five different species were harvested by community members, we decided to combine all of the species together when analysing for heavy metals in order to increase sample sizes. Typically, contaminant concentrations were greatest in duck kidneys and livers and lower in duck muscle (meat). Of all the species tested, duck tissues tended to be most contaminated. Although these ducks tended to be migrants and so could have amassed these heavy metals elsewhere, young of the year that had been born in the region also had high levels of these concentrations.

DUCK MEAT (CONSUMPTION LIMITS RELATED TO ARSENIC)

Typically, arsenic levels were highest in duck kidneys followed by liver (Fig 6.14). In contrast, duck meat (muscle) typically showed the lowest levels of contaminants. One duck in particular had much higher arsenic levels than others that were tested.

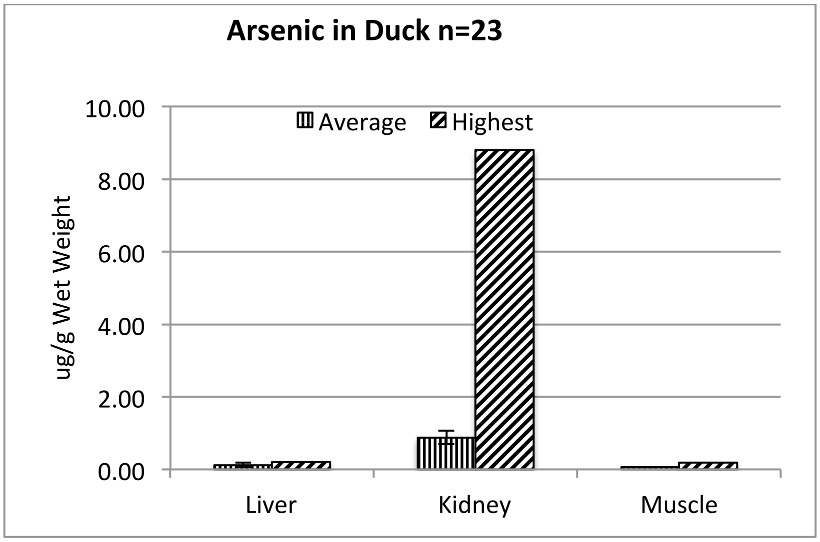

FIG 6.14. Concentration of arsenic in duck liver, kidney and meat (muscle) (n=3). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to arsenic in ducks. In general, consumption of duck was not restricted for any of the tissues and for any of the ages, except some caution (red) should be paid by children when eating duck kidney (Table 6.1).

- Adult community members can eat up to:
  - 16.83 kg (37.09 lb) of duck meat (muscle) per week
  - 1.16 kg (2.56 lb) of duck kidney per week
  - 8.54 kg (18.82 lb) of duck liver per week

- Women of child-bearing age can eat up to:
  - 14.98 kg (33.02 lb) of duck meat (muscle) per week
  - 1.04 (2.29 lb) of duck kidney per week
  - 7.61 kg (16.77 lb) of duck liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 6.09 kg (13.42 lb) of duck meat (muscle) per week
  - 0.42 kg (0.93 lb) of duck kidney per week
  - 3.09 kg (6.81 lb) of duck liver per week

- Young children below the age of 7 years of age can eat up to:
  - 3.32 kg (7.32 lb) of duck meat (muscle) per week
  - 0.23 kg (0.51 lb) of duck kidney per week
  - 1.69 kg (3.73 lb) of duck liver per week

DUCK MEAT (CONSUMPTION LIMITS RELATED TO CADMIUM)

Typically, cadmium levels were highest in duck kidneys followed by liver. In contrast, duck meat (muscle) showed the lowest levels of contaminants. Some ducks in particular had much higher cadmium levels than others that were tested. (Fig 6.15).

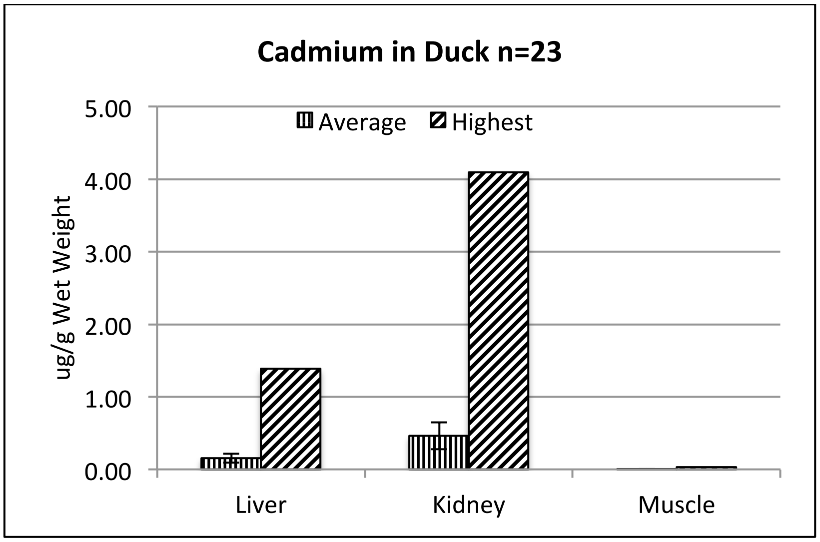

Fig 6.15. Concentration of cadmium in duck liver, kidney and meat (muscle) (n=23). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to cadmium in ducks. In general, consumption of duck was not restricted for any of the tissues and for any of the ages, except some attention (orange) should be paid by younger children when eating duck liver and attention (orange) paid by older children and caution (red) paid by younger children when eating duck kidney (Table 6.1).

- Adult community members can eat up to:
  - 242.16 kg (533.81 lb) of duck meat (muscle) per week
  - 1.66 kg (3.75 lb) of duck kidney per week
  - 4.91 kg (10.80 lb) of duck liver per week

- Women of child-bearing age can eat up to:
  - 215.63 kg (475.18 lb) of duck meat (muscle) per week
  - 1.48 kg (3.31 lb) of duck kidney per week
  - 4.37 kg (9.70 lb) of duck liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 87.58 kg (193.07 lbs) of duck meat (muscle) per week
  - 0.60 kg (1.32 lb) of duck kidney per week
  - 1.78 kg (3.97 lb) of duck liver per week

- Young children below the age of 7 years of age can eat up to:
  - 47.77 kg (15.03 lb) of duck meat (muscle) per week
  - 0.33 kg (0.73 oz) of duck kidney per week
  - 0.97 kg (2.14 lb) of duck liver per week

Typically, mercury levels were highest in duck liver followed by kidney. In contrast, duck meat (muscle) typically showed the lowest levels of mercury. Some ducks in particular had much higher mercury levels than others that were tested (Fig 6.16).

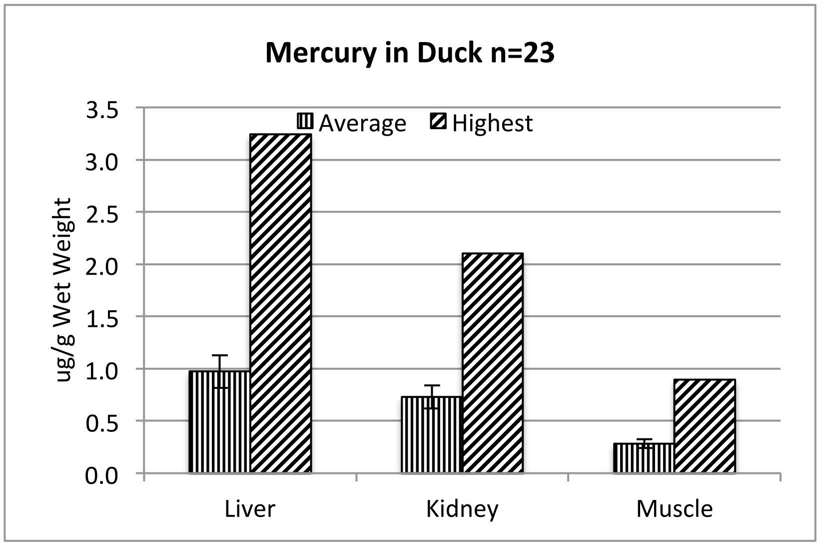

FIG 6.16. Concentration of mercury in duck liver, kidney and meat (muscle) (n=23). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to mercury in ducks. In general, consumption of duck was restricted for all tissues and for any of the ages. Thus, caution (red) should be shown by everyone when eating muscle (meat), kidney and liver, except for adults who should only pay attention (orange) to mercury levels in duck muscle (Table 6.1).

- Adult community members can eat up to:
    - 0.85 kg (1.87 lb) of duck meat (muscle) per week
    - 0.33 kg (0.73 lb) of duck kidney per week
    - 0.25 kg (0.55 lb) of duck liver per week

- Women who may become pregnant can eat up to:
    - 0.32 kg (0.71 lb) of duck meat (muscle) per week
    - 0.12 kg (0.27 lb) of duck kidney per week
    - 0.09 kg (0.20 lb) of duck liver per week

- Older children that are 11 – 14 years of age can eat up to:
    - 0.13 kg (0.29 lb) of duck meat (muscle) per week
    - 0.05 kg (1.76 oz) of duck kidney per week
    - 0.04 kg (1.41 oz) of duck liver per week

- Young children below the age of 7 years of age can eat up to:
    - 0.02 kg (0.70 oz) of duck meat (muscle) per week
    - 0.03 kg (1.06 oz) of duck kidney per week
    - 0.07 kg (2.47 oz) of duck kidney per week

Typically, selenium levels were highest for both duck kidney and liver. In contrast, duck meat (muscle) typically showed substantially lower levels of selenium. (Fig 6.17).

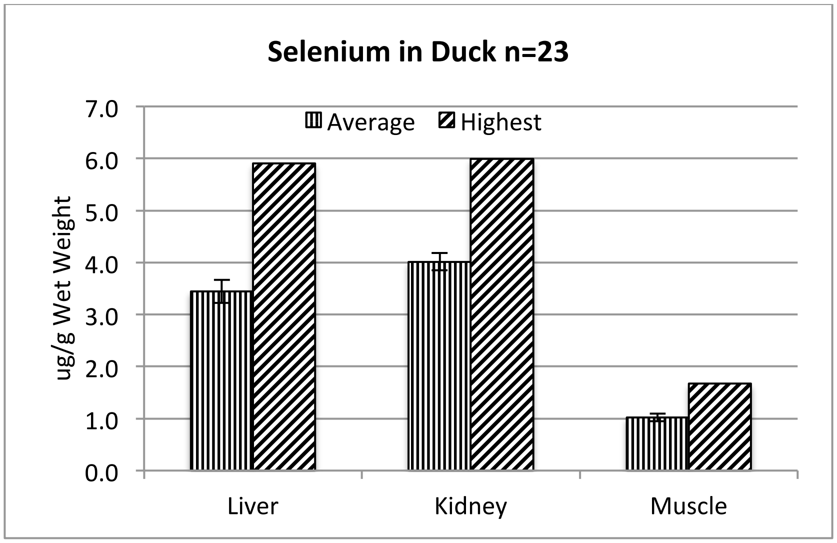

FIG 6.17. Concentration of selenium in duck liver, kidney and meat (muscle) (n=23). Standard error bars indicated for each mean value. Also indicated is maximum (highest) concentration observed.

Consumption limits were calculated as they relate to selenium in ducks. In general, consumption of duck was restricted for all tissues and for any of the ages. Thus, caution (red) should be shown by everyone when eating duck muscle (meat), kidney and liver because of the high levels of selenium (Table 6.1).

- Adult community members can eat up to:
  - 2.85 kg (6.27 lb) of duck meat (muscle) per week
  - 0.73 kg (1.60 lb) of duck kidney per week
  - 0.85 kg (1.86 lb) of duck liver per week

- Women who may become pregnant can eat up to:
  - 2.53 kg (5.58 lb) of duck meat (muscle) per week
  - 0.65 kg (1.42 lb) of duck kidney per week
  - 0.75 kg (1.66 lb) of duck liver per week

- Older children that are 11 – 14 years of age can eat up to:
  - 0.72 kg (1.59 lb) of duck meat (muscle) per week
  - 0.18 kg (0.41 lb) of duck kidney per week
  - 0.21 kg (0.47 lb) of duck liver per week

- Young children below the age of 7 years of age can eat up to:
  - 0.39 kg (0.87 lb) of duck meat (muscle) per week
  - 0.10 kg (3.5 oz) of duck kidney per week
  - 0.12 kg (3.6 oz) of duck liver per week

6.4 CONCLUDING REMARKS

In general, these results show that heavy metals were present in concentrations that were notable, especially in the kidney and liver across all tested wildlife species and especially as they relate to selenium. However, consumption limits do not incorporate ingestion (i.e. estimated daily intake) data, and are instead predicated on concentration data only (as well as the toxicity of the contaminants and body weight) (Appendix 4). In contrast, exposure ratios do incorporate the ingestion data (Appendix 4). The outcomes associated with exposure ratios are of much less health concern, in part because community members are eating less traditional food than they did in the past (Chapter 7). We will discuss these outcomes in greater detail below.

Outcomes from the lab testing for contaminants in moose, muskrat, beaver, and duck samples showed that there was strong evidence for concerns regarding selenium in all tissues in all species and for all ages of consumers. This was in strong contrast to the results of Phase One, where, with the exception of duck liver for children, no attention (orange) much less caution (red) was required with respect to this contaminant. Other studies have found high selenium levels are occurring in water and in biota in western Canada (e.g. CBC 2013) as well as the Midwest in the US (e.g. FWS 2012). It is uncertain, however, why the levels would be so much higher this year than last. Uranium City, a site of past long-term mining of uranium, is located on the northern portion of Lake Athabasca, and some studies show elevated levels of selenium associated with the extraction of uranium (Muscatello and Janz 2009, Wiramanaden et al. 2010). Gunnar Mine, located on the north shore of Lake Athabasca, was the focus of remediation in spring 2013 (SRC 2013), which may have released selenium. Moreover, selenium is also emitted during the extraction and processing of bitumen (Kelly et al. 2010). Regardless, the levels are high enough that caution is warranted. Any spatiotemporal patterns as well as the possible sources of this contaminant should be explored further.

In contrast to selenium, the results from Phase Two regarding arsenic, cadmium, and mercury levels largely resembled those found in Phase One. Concentrations of these heavy metals were generally lower in the meat (muscle) than in liver and especially kidney. Concentrations were high enough in the latter organs that caution was often warranted, especially for children. The Oil Sands are the province's greatest emitters of mercury and are fifth among all the industry and power generation categories in Canada (Gosselin et al. 2010). These results are consistent with the pollutants that many residents visually observe in the water, rain and snowfall as well as the outcomes of other studies on snowfall (Kelly et al. 2010) and lake sediments (Jurek et al. 2013). Elevated mercury levels are also consistent with the impacts of hydro development, or more specifically the WAC Bennett dam. Although built in the mid 1960s, hydro development can contribute to increased mercury levels for many decades (McCartney 2009)

Indeed, mercury is responsible for the great majority of consumption advisories that restrict consumption of country foods in the North (FNEHIN 2011), including the Athabasca watershed (Jardine 2003). Over the last 35 years, poisoning from methylmercury has plagued many northern First Nations, including the well-known case of Grassy Narrows and Wabauskang First Nations in northwestern Ontario (Simpson et al. 2009). Despite the great number of research studies, little has been done to mitigate the impacts of this key contaminant.

As with Phase One, cadmium levels were again elevated for moose meat (muscle), kidneys and livers for everyone, as well as duck kidneys and livers for children. Moose are expected to accumulate higher concentration of cadmium in their kidneys and livers over their lifetime since willow is such an important part of their diet and because willow is known to absorb cadmium. In our study, as indicated in Chapter 4, willow showed elevated levels of cadmium, especially in the Lake Mamawi area where at least one of the moose was harvested.

Sources of this cadmium are unclear and likely diverse in origin. Many other studies have also shown that the kidneys and livers of moose across North America and Europe have high levels of cadmium (e.g. Glooschenko et al., 1988, Custer et al., 2004, Gamberg et al. 2005). It is possible that the underlying geology and thus vegetation in these areas might be partially responsible, and thus that high cadmium levels in moose are long-standing. That said, cadmium is also generated by industry. The Oil Sands are the province's largest emitters of cadmium, and sixth among all the industry and power generation categories in Canada (Gosselin et al. 2010). Public health evaluations conducted in the Northwest Territories (Larter and Nagy 2000), northern Quebec (Archibald and Kosatsky 1991), and the Yukon (Receveur et al. 1998) all recognized that the highest potential exposure to cadmium from terrestrial mammal-based diets may come from the liver and kidney of moose and caribou, and that consumption of affected animals should thus often be limited (Arnold et al. 2006). These dietary sources, combined with other source especially tobacco smoking, which is commonplace in many northern communities, potentially represent a threat to human health and wellbeing (Fontaine et al. 2008).

As noted above, the exposure ratio data were of much less concern than indicated by the consumption limit data. This again reflected the relatively low levels of ingestion of these species and more generally of traditional foods. On one hand, this is positive news, since human health does not seem to be at risk. On the other hand, it is worrisome, especially if consumption of traditional foods continues to decline. As will be discussed in detail in Chapter 8, traditional foods are generally still very healthy, especially when the lack of healthy alternatives is considered. Moreover, traditional foods are about much more than nutrition, and are part of the cultural fabric of these communities and their use is ostensibly safeguarded by treaty rights.

It should also be generally noted that the strength of these scientific data was limited by small sample sizes and convenience sampling across the landscape. Mapping was also incomplete, such that only 10 of 23 ducks and only one of four moose were mapped. Moreover, as already mentioned and despite our best efforts, we were unable to focus harvesting on polluted areas. This, in part, reflects the longstanding and close relationships that hunters and trappers develop with specific areas that are generally in the relatively unpolluted regions. It can thus be argued that these test results represent conservative indicators on heavy metal since none of the animals were harvested in polluted regions. It is still our hope that we can better sample these latter areas in the future.

That said, these data are part of a larger database controlled by both MCFN and ACFN that will grow in size over time, and may also contribute to datasets that are generated through the Joint Oil Sands Monitoring program. As the data grow in number and scope, they will enable more sophisticated analysis in the future.

Outcomes of this project are worthy of a follow-up study; for example, it could be explored whether cadmium and mercury levels in moose increase as the locations of these moose harvests approach Fort McMurray. The TK reflected in this study certainly indicated that moose and beaver amongst other wildlife harvested near the Oil Sands show ill health and that they have poor flavour and colouring.

Finally, the human health implications of these levels of cadmium and mercury are uncertain according to scientific criteria. Outcomes arising from other analyses suggest that traditional foods are implicated in high rates of cancer that are occurring in Fort Chipewyan (Chapter 9). Some of this ambiguity might be addressed by testing humans for heavy metals. Although we had planned to test human hair and urine for methylmercury and cadmium, amongst other heavy metals, it was decided by the MCFN-GIR and ACFN-IRC that this testing would be premature. At some point in the future if it is seen as desirable, funding will be raised to enable this to occur. This will allow us to see what, if any, human health impacts for humans might arise from the high cadmium and mercury levels in kidneys and livers of moose and duck and the high levels of selenium in all the traditional food that was tested.

The quandary is how to communicate this effectively to community members without further undermining their confidence in traditional food, which again remain the most affordable, accessible and healthiest alternative available to most community members (Chapter 8). It is clear that consumption advisories have already scared some members from eating fish, especially larger predatory fish such as pickerel and northern pike (Jackfish) (Chapter 8). The species that are subject to consumption advisories will likely continue to grow, and most recently expanded to include gull and tern eggs as they relate to mercury levels (Wohlberg 2014b). One important development would be to collaborate on any future consumption advisories with the affected communities, which might also allow for ingestion rates and thus exposure ratios and consumption patterns to be incorporated into risk analysis and communication (Jardine 2003, McLachlan 2014) It is our hope that more effective communication can lessen the likelihood that this occurs in the future, and that our own results can help address some of the fears that arise from inadequate risk communication..

Community members and leaders alike will need to make decisions about the next logical steps. While we again acknowledge that this report does not represent an official consumption advisory, we also recognize that many community members distrust data that originate from government and especially industry. Moreover, most of these outcomes, including those presented in this report, are presented in a form that is difficult to understand when it is accessible at all.

In order to effectively protect public health in Fort Chipewyan, the provincial and federal governments will have to find ways to remedy the perception that they favour industry and to address their still poor outreach with these Indigenous communities. This will be discussed in greater detail in Chapter 10.

7. POLYCYCLIC AROMATIC HYDROCARBONS

7.1 BACKGROUND

Polycyclic aromatic hydrocarbons (PAHs) are organic compounds that are ubiquitous in the environment. They represent a class of chemicals that are rapidly released into the environment through pyrolitic processes (i.e. burning) from both natural and anthropogenic sources and are also formed through microbial (diagenic) processes. The greatest natural sources of PAHs in Canada are forest and prairie fires, and these pyrogenic PAHs are formed as a result of rapid and incomplete combustion of organic matter. The petrogenic PAHs occur naturally in bituminous fossil fuels, such as coal and crude oil deposits, formed over large geological time scales at low temperatures. These petrogenic processes give rise to a predominance of C1-C3 alkylated forms of their parental compounds (NRCC 1983), but for which there is little toxicity information (Timoney and Lee, 2011).

Fossil fuels generally contribute a relatively small volume of PAHs to the environment under natural conditions, because most oil deposits are trapped deep beneath rock, restricting any emissions to surface environments. The Oil Sands are capable of contributing PAHs to both atmospheric and aquatic surroundings, given their proximity to the surface. Although the scale of this industry is still small enough that it likely contributes little to the overall volume of PAH in the environment, PAHs emitted from this industry can be sizeable and still have substantial regional impacts (Kelly et al. 2010, Parajulee and Wania 2014).

Incomplete combustion of organic matter at high temperature is a substantial anthropogenic source of environmental PAHs. The greatest of these include aluminum smelters whereas major sources into water and soils include creosote-treated products, spills of petroleum products, and metallurgical and coking plants as well as atmospheric deposition. Other sources of PAHs include grilled and smoked foods, smoking, burning of fossil fuels (such that benzo[*a*]pyrene and other PAHs are present in vehicular exhaust), the breakdown of crude petroleum to produce hydrocarbon fuels, production of coke, high temperature treatment of coal to produce coal tars, and the incineration of municipal and industrial waste.

For people who don’t smoke or who don’t work in polluted workplaces, dietary intake is now seen as the most important source of exposure to PAHs (Cirillo et al. 2010, Martena et al. 2011). Agricultural products are contaminated with PAHs because of particulate deposition resulting from air pollution (Reinik et al. 2007). These pollutants are also readily accumulated by shellfish, which are exposed to a wide range of PAHs following oil spills at sea and then become contaminated (Yu et al. 2012).

In studies conducted in the United Kingdom and the Netherlands, the food group that made the largest contribution to the total dietary intake of PAHs was cereals, followed in descending order by sugars and sweets, and then oils and fats, whereas meat and milk played a relatively minor role (De Vos et al. 1990). Yet, Lodovici et al. (1995) found that cereals, milk products, meats, and vegetables and fruits were the groups making the largest contribution to dietary PAH intake in Italy.

About 100 PAH compounds exist, of which a subset of 16 have adequate enough data that they are included in assessment. Nine of these (acenaphthene, anthracene, benz[*a*]anthracene, benzo[*a*]pyrene (B[*a*]P), fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene) are generally used to evaluate possible impacts on the environment and on biota (Cirillo et al. 2010). An even smaller subset of seven PAHs is generally used to evaluate any potential health impacts, in part because they known to have carcinogenic (cancer-causing) effects at low concentrations (CCME 2010).This latter group includes benz[*a*]anthracene, benzo[*a*]pyrene , benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, chrysene, and dibenz[*a*,*h*]anthracene,and indeno[1,2,3-*c*,*d*]pyrene.

This subset of PAHs causes tumors in laboratory animals through inhalation and oral exposure, as well as through long periods of skin contact (Cirillo et al. 2010). Of these compounds, benzo[a]pyrene is one of the most potent and most extensively studied PAH carcinogens in experimental animals.

The objective of this component of the study was:

i) to document levels of PAHs, especially alkylated and carcinogenic PAHs, in country foods destined for human consumption in Fort Chipewyan, and

ii) to assess whether these levels might have implications for human health.

7.2 METHODOLOGY

From June 2012 to September 2013, wildlife samples were collected from across the traditional territories of both MCFN and ACFN in order to conduct health assessments through veterinary analysis and to test for environmental contaminants.

Moose, waterfowl, beaver, and muskrat samples were frozen and later shipped to the Canadian Cooperative Wildlife Health Centre (CCWHC) at the University of Saskatchewan. At that point, additional tissue samples were prepared and then shipped to the Alberta Innovates - Technology Future for the testing of heavy metals and polycyclic aromatic hydrocarbons (PAHs). In total, 38 animals were tested for PAHs, including four moose, 23 ducks, eight muskrat, and three beavers (Table 7.1). In addition, a beef liver sample provided by the lab for comparison purposes was also tested for PAHs.

Initial calibration was performed using a five-point calibration series of solutions that encompass the working concentration range. Initial calibration solutions contain the suite of labelled surrogate and recovery standards and authentic target PAHs and alkylated PAHs as determined by multiple-point calibration. Calibration procedures used the mean relative response factors determined from the initial calibration to calculate analyte concentrations. Calibration was verified a least once every 12 hours by analysis of a mid-level calibration solution.

An additional calibration solution contained the suite of labelled surrogate and recovery standards and authentic target PAHs as determined by single-point calibration. This calibration solution was analysed at the beginning and end of each batch of samples and was used to establish the relative response factors. The mean RRFs determined from the single calibration solution run before and after the samples were used for quantification of sample results.

Concentrations of target PAHs were calculated using the isotope dilution method of quantification. Compounds were described by comparing the area of the quantification ion to that of the corresponding deuterium-labelled standard and correcting for response factors. Response factors were determined daily using authentic PAHs.

Few data or for that matter benchmarks exist for PAHs and especially alkylated PAHs, unlike heavy metals whose human health implications are well characterized. We thus compared PAH levels found in these country foods to those that have been documented elsewhere in the literature.

B[*a*]P is often used as a benchmark compound, such that the toxicity of all PAHs is assumed to be equivalent to that of B[*a*]P. The risk posed by the sum of the concentrations of the individual PAHs is then compared to the risk posed by B[*a*]P. Although this approach is intuitive, it is extremely conservative since B[*a*]P is considered to be one of the most potent PAHs.

Another approach, one that we used here, is to use toxic equivalency factors (TEF). In this approach, each chemical within the group is assigned a TEF, which estimates the potency of the chemical relative to a reference compound (commonly, and in our case, B[*a*]P). The reference compound is assigned a TEF of 1. All other chemicals are assigned relative TEFs, these generally varying in orders of magnitudes compared to the reference compound. Thus, less potent chemicals are assigned a TEF of 0.1 or 0.01. The concentration of each chemical in a mixture is measured and multiplied by its TEF value, and the results are then summed to generate the total toxic equivalent (TEQ) for the mixture. The use of this TEF approach is widespread, and recommended, for example, by the World Health Organization for the risk assessment of the dioxins and dioxin-like chemicals (HPA 2010).

7.3 PAH RESULTS

When all 16 of the PAHs that were examined were compared among tissues for the different species, variation was great and none of the differences seemed meaningfully different. The means for the moose tended to be highest for muscle and kidney, but the standard errors were large due to the small sample size (n=3) and the presence of one animal that had especially high levels of PAHs (Fig 7.1). This was also true for the carcinogenic (Fig 7.2) and alkylated (Fig 7.3) PAHs, which at first glance seemed high for the moose kidney. However, the standard errors surrounding the means were once again large because of the small sample size.

Much less information exists regarding the health implications of PAHS, especially those that are alkylated, compared to, for example, heavy metals that have been the focus of much study over the last 50 years, in part reflecting the high-visibility controversies surrounding, for example, lead in paint and the link between mercury and Minamata disease. Thus, no clear benchmarks exist for PAHs as they relate to the environment and human health, in direct contrast to heavy metals that were the initial focus of this study. Thus, while PAHs and more specifically carcinogenic PAHs were found in the tissue samples, it is more difficult to assess whether they occur at concentrations that are of health and concern, much less what the sources of these PAHs might be.

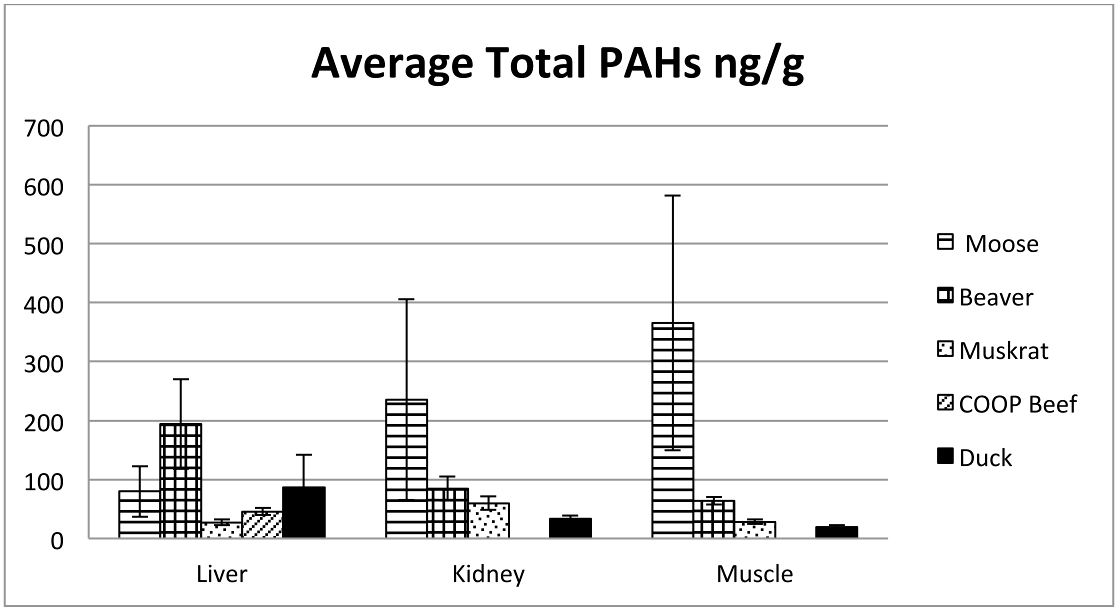

FIG 7.1. Average of all 16 PAHs in ng/g in liver, kidney and meat (muscle) of moose, beaver, muskrat, Co-op beef, and duck. SE bar indicated for each mean value.

One way of assessing meaning is to compare the concentrations of the PAHs that were present in the tested country foods in this study to those of other foods that have been conducted elsewhere. In so doing, it became clear that this is a relatively new field of study and that few other comparable studies exist, anywhere in the world. Indeed, this is the only study we have found that has characterized PAH levels in wild-caught country foods. Yet these outcomes are still meaningful.

The concentrations of all 16 PAHs that have been highlighted as a priority by the EPA were substantially higher in our study than any of the other studies we examined (Table 7.1). Indeed, the highest mean concentrations for all studies was that for all meat (1,323.9 *u*g/kg), this followed in descending order by moose muscle (365.20 *u*g/kg), moose kidney (235.4 *u*g/kg), and then beaver liver (194.2 *u*g/kg), (Table 7.1) All these values were higher than the next value, that for beef and mutton in Taiyuan, China (188.0 *u*g/kg), which was almost a factor of magnitude lower than those results for all animals in our study (Table 7.1).

We further evaluated any similarity in the patterns of PAH occurrence for all 16 PAHs in our data compared to those generated for water in and around Fort McKay (Kelly et al. 2010) as well as lake-bottom sediments in the region (Jurek et al. 2013). For each of the 16 PAHs in the three data series, data were ranked from lowest to highest concentration and then any correlation among these data sets was examined as pair-wise combinations. Interestingly there was a significant correlation between our moose and beaver data (p=0.0026), moose and muskrat data (p=0.0181), and perhaps more predictably beaver and muskrat data (p<0.0001) (Table 7.2). Interestingly, there was also a significant correlation between beaver and water data (p=0.0219) and muskrat and water data (p=0.001) as well as between beaver and lake sediment data (p=0.0325). In contrast, the correlations between water and lake sediment data were not significant (p=0.4163) (Table 7.2).

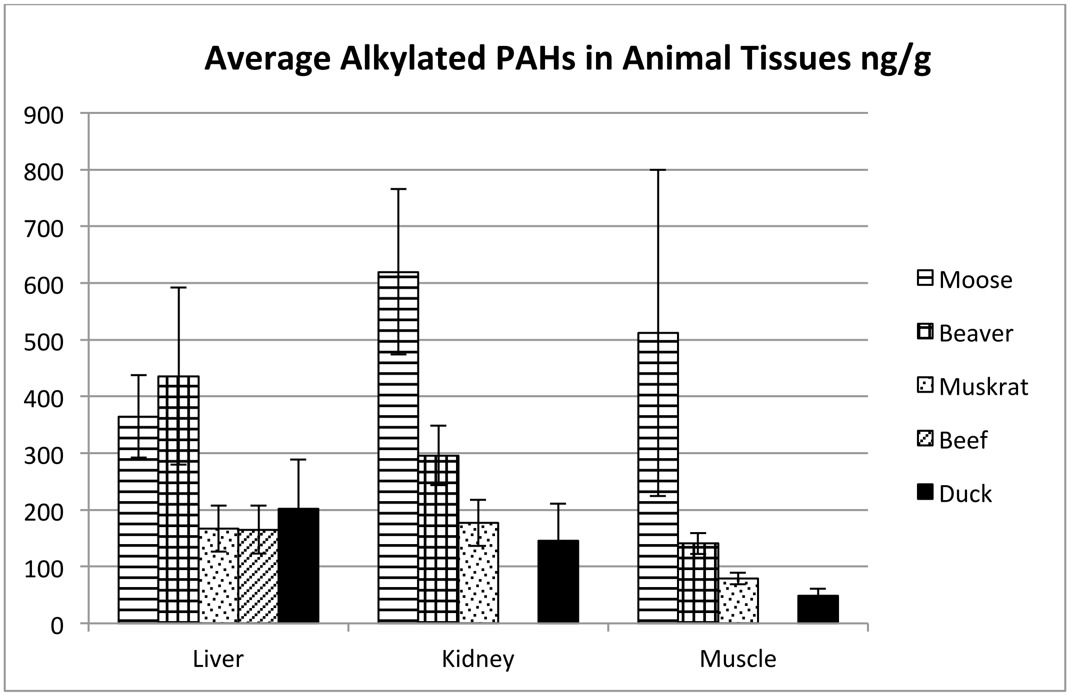

FIG 7.2. Average of alkylated PAHs in ng/g in liver, kidney and meat (muscle) of moose, beaver, muskrat, Co-op beef, and duck. SE bar indicated for each mean.

This at once indicates that these three very different studies, conducted at different times, at different locations, and for different substances show similar outcomes and patterns in relative PAH concentrations. In effect, these significant relationships triangulate one another, indicating that these PAH patterns that are downstream from the Oil Sands are real. The relationships are strongest between the aquatic mammals and surrounding water and also lake sediments, and are not as strong between the physical substances and between moose and these physical substances. Also interesting is that ducks show no such relationships, in part because so few of the birds were hatch-years and had therefore arrived from elsewhere.

When the concentrations of carcinogenic PAHs was compared to other studies conducted around the world, the PAH levels for all country meats was still relatively high (32.3 *u*g/kg), second only to Peking duck from China (54.7 *u*g/kg) (Table 7.3). Yet, in contrast, many of the values from our study (i.e. duck muscle, kidney and liver; moose liver and muscle) were the lowest of any studies that we reviewed (Table 7.3).

When the mean concentrations of benzo[*a*]pyrene, a high-priority and relatively well understood carcinogenic PAH, were examined, the concentrations of the PAHs in this study were fourth for all meats examined in other studies, almost half of the second highest concentration (chicken kebab in Malaysia). The highest was again the Peking duck from China, which was a factor of magnitude higher than the highest concentrations in our study, which arose when all the country foods that might be consumed were combined (Table 7.4). Indeed, benzo[*a*]pyrene was below detectable limits for most of the tissues that were tested in our study (Table 7.4)

Daily dietary intake of total PAHs in our study was high, almost 3X that of the next study, conducted on total diets on the Netherlands (Table 7.5). Unlike the latter study, our work only captures one component of the total diet, and thus likely underestimates the total PAHs that may have been consumed relate to the diet as a whole. Yet, the dietary intake of carcinogenic PAHs was much lower than the other two studies from Spain that were reviewed, which were almost 10X that of our highest values (Table 7.6), as was the dietary intake of benzo[*a*]pyrene (ug/day), which was zero for this study (Table 7.7).

Mean daily dietary intake of PAHs was calculated for the livers, kidneys, and muscles of moose, beaver, duck and muskrat as well as the liver of beef (Table 7.8). Total PAHs were highest for moose muscle, and male community members were highest, eating 43.4 *u*g per day. Mean daily dietary intake of alkylated PAHs was even higher at 67.9 *u*g per day for moose muscle, again consistent with upstream petrogenic sources. In contrast, mean daily dietary intake of carcinogenic PAHs was substantially (100-fold) lower at 0.05 *u*g per day, again for moose muscle (Table 7.8). When calculated using maximum values rather than means, daily dietary intake of PAHs was predictably much higher such that total PAHs and alkylated PAHs were calculated as 310.61 and 435.73 ug per day, respectively (Table 7.9). Mean dietary intake of benzo[*a*]pyrene equivalents in ug/day were also assessed for adults consuming various wild caught foods, and equalled 0.00 for all carcinogenic PAHs, thus contributing to no additional risk for cancer, except for duck liver at 0.01 per million (Table 7.10). In contrast, the additional risk represented by the beef liver sample was 25X higher at 0.50 per million (Table 7.10). There was a negligible increase in the risk for cancer when zero values were excluded in these calculations, again only for duck liver (Table 7.11), or when only maximum portion sizes were used (Table 7.12,ig 7.5).

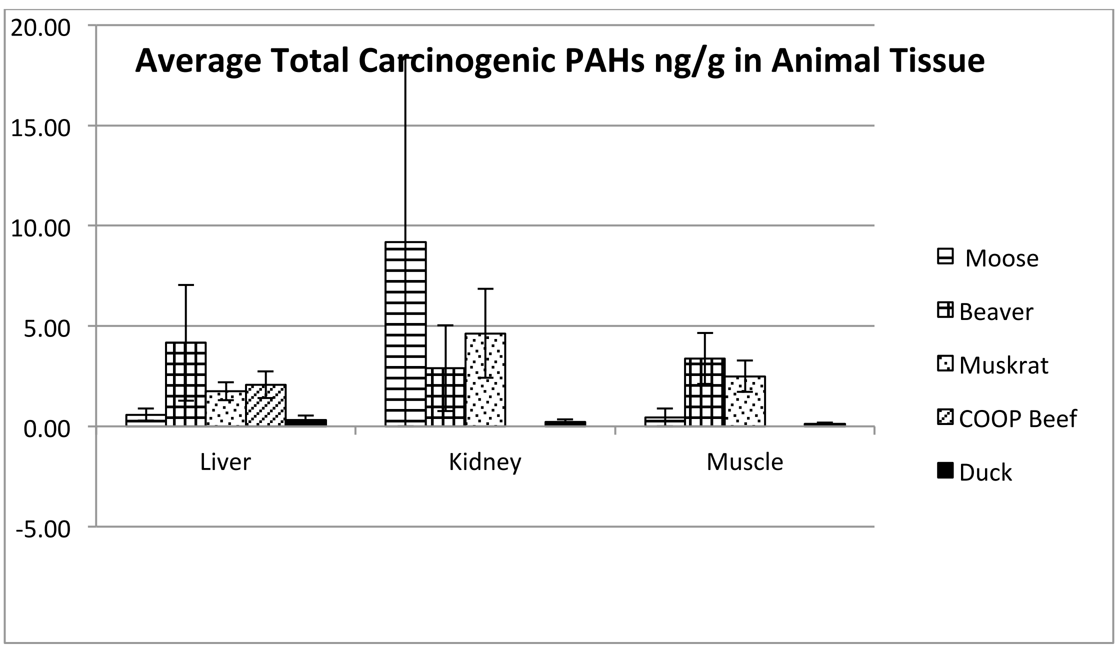

FIG 7.3. Average carcinogenic PAHs in ng/g in liver, kidney and meat (muscle) of moose, beaver, muskrat and Co-op beef. SE bar indicated for each mean value.

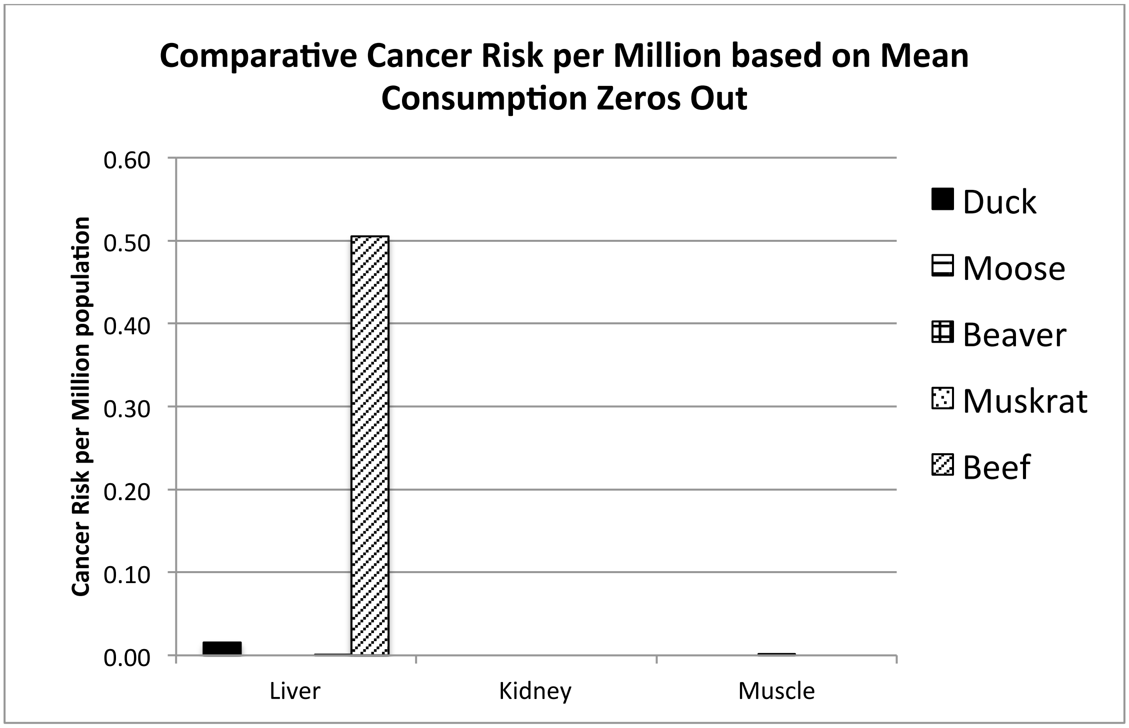

FIG 7.4. Cancer risk associated with benzo[*a*]pyrene toxic equivalents based on the mean food consumption. Zeros values are excluded.

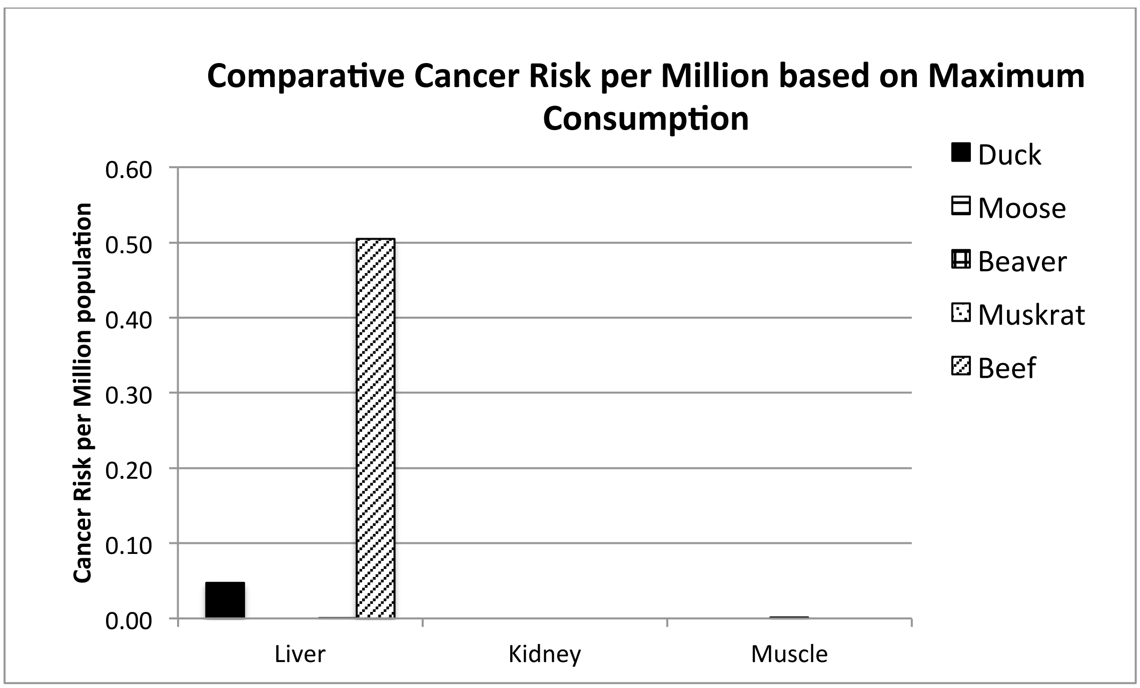

FIG 7.5. Cancer risk associated with benzo[*a*]pyrene toxic equivalents based on the maximum food consumption.

7.4 CONCLUDING REMARKS

Our results indicate that the levels of total PAHs, carcinogenic PAHs, and alkylated PAHs were all very high compared to other studies. None of the meats we tested were cooked, which would have further increased concentrations of PAHs. Indeed, they would likely have been especially high for dry (wood-smoked) moose. These high concentrations are consistent with upstream Oil Sands development, although this does not preclude the contribution of other point sources. Interestingly significant relationships in patterns of PAHs occurred between our data and those of Kelly et al (2010) and Jurek et al (2013). The relationships were intuitive and meaningful from an ecological perspective, since they were strongest for aquatic mammals (i.e. muskrats and beavers) but not as strong for moose. Moreover, the relationships were non-significant for ducks, most of which were non-residents, and between the water and lake sediments. These downstream and downwind patterns are also consistent with outcomes of a recent study that concluded that PAH emissions are likely 2-3X greater than previously estimated (Parajulee and Wanier 2014).

Yet, as with heavy metals, the exposure to carcinogenic PAHs was substantially lower when ingestion rates of country foods were incorporated into the analysis. Thus, exposure rates were very low, approaching zero in over 95% of the cases. This in part reflects the low levels of benzo[*a*]pyrene in animals tested for our study. But it also reflects the reduced role that traditional foods play in most local diets. Many other studies have characterized entire diets, finding that PAHs tend to be concentrated in grains, fruit, and dairy products and are much lower in most meats, especially if uncooked (Marti-Cid et al. 2010, Martena et al. 2011). However, we only characterized the consumption of traditional foods, which consisted mostly of meats, and so actual exposure would likely be higher if the entire diet had been included.

That said, our results show that the concentrations of total PAHs, carcinogenic PAHs, and alkylated PAHs associated with petrogenic sources (Yunker et al. 2002) were all very high. Moreover, levels will only increase further as Oil Sands development continues to expand northwards. These trends require adequate monitoring, and the implications of these changes in PAH levels and exposure merit further study. Moreover, it is essential that these outcomes be effectively communicated with downstream communities since consumption of country foods is already shifting towards store-bought foods. As we will discuss in the next two chapters, these transitions have substantial implications for traditional livelihoods and the health and wellbeing of community members.

Table 7.1. Comparative concentrations of total PAH (*u*g/Kg) as reported in various studies around the world.

Site Location	Food Type	Year of Publication	PAHs analysed	Mean Concent ug/kg	Study/ References
Northern Alberta	All animals	2013/14	US EPA 16 PAHs	1,323.87	Present study
Northern Alberta	Moose muscle	2013/14	US EPA 16 PAHs	365.24	Present study
Northern Alberta	Moose kidney	2013/14	US EPA 16 PAHs	235.44	Present study
Northern Alberta	Beaver liver	2013/14	US EPA 16 PAHs	194.16	Present study
Taiyuan, China	Beef and mutton	2008	16 PAHs	188.00	Xia et al (2010)
China	Peking duck	2011	19 PAHs (Europena Union 2005+5 simpler PAHs)	129.00	Lin et al (2011)
Northern Alberta	Duck liver	2013/14	US EPA 16 PAHs	86.22	Present study
Northern Alberta	Beaver kidney	2013/14	US EPA 16 PAHs	84.62	Present study
Northern Alberta	Moose liver	2013/14	US EPA 16 PAHs	79.67	Present study
Northern Alberta	Beaver muscle	2013/14	US EPA 16 PAHs	64.20	Present study
Northern Alberta	Muskrat kidney	2013/14	US EPA 16 PAHs	59.66	Present study
Northern Alberta	Beef liver	2013/14	US EPA 16 PAHs	45.93	Present study
Kuwait	Olive oil, Pomace oil, corn oil, sunflower oil, canola oil, peanut oil, mustard oil	2010	US EPA 16 PAHs	34.51	Alomirah et al (2010)
Northern Alberta	Duck kidney	2013/14	US EPA 16 PAHs	33.58	Present study
Northern Alberta	Muskrat muscle	2013/14	US EPA 16 PAHs	28.20	Present study
Northern Alberta	Muskrat liver	2013/14	US EPA 16 PAHs	27.15	Present study
Northern Alberta	Duck muscle	2013/14	US EPA 16 PAHs	19.80	Present study
Germany	Smoked meat	2010.00	15+1 EU priority PAHs	0.89	Jira (2010)

Table 7.2. Correlations for all pair-wise combinations of PAH data series with associated p-values. Note: duck, moose, beaver, muskrat, and thus mammal data are from this study. Lake sediment data are from Jurek et al. (2013). Water data are from Kelly et al. (2010).

Pair comparison	**Pearson r**	**Spearman rho**	**Kendall tau**
Duck;Mammal	0.168	0.168	0.1621
p-value	*-0.4436*	*-0.4418*	*-0.2944*
Duck;Moose	0.1808	0.1808	0.1225
p-value	*-0.409*	*-0.4072*	*-0.4325*
Duck;Beaver	0.1166	0.1166	0.1621
p-value	*-0.5962*	*-0.5949*	*-0.2944*
Duck;Muskrat	0.3142	0.3142	0.249
p-value	*-0.1442*	*-0.1442*	*-0.1019*
Duck;LakeSed	0.2321	0.2321	0.1688
p-value	*-0.2987*	*-0.2973*	*-0.2876*
Duck;Water	0.0672	0.0672	0.0593
p-value	*-0.7607*	*-0.7604*	*-0.7147*
Mammal;Moose	0.746	0.746	0.6126
p-value	*0*	*-1.00E-04*	*0*
Mammal;Beaver	0.9318	0.9318	0.8103
p-value	*0*	*0*	*0*
Mammal;Muskrat	0.8626	0.8626	0.7233
p-value	*0*	*0*	*0*
Mammal;LakeSed	**0.4552**	0.4523	0.29
p-value	***-0.0333***	*-0.0359*	*-0.0622*
Mammal;Water	**0.4239**	0.4239	0.3123
p-value	***-0.0438***	*-0.045*	*-0.0384*
Moose;Beaver	**0.5968**	0.5968	0.4862
p-value	***-0.0026***	*-0.0032*	*-9.00E-04*
Moose;Muskrat	**0.4881**	0.4881	0.3676
p-value	***-0.0181***	*-0.0193*	*-0.0139*
Moose;LakeSed	0.1796	0.1903	0.0996
p-value	*-0.4238*	*-0.3946*	*-0.5394*
Moose;Water	0.1077	0.1077	0.083
p-value	*-0.6247*	*-0.6236*	*-0.6013*
Beaver;Muskrat	**0.8636**	0.8636	0.7233
p-value	***0***	*0*	*0*
Beaver;LakeSed	0.3924	0.3902	0.2468
p-value	*-0.0708*	*-0.0736*	*-0.115*
Beaver;Water	**0.4753**	0.4753	0.3755
p-value	***-0.0219***	*-0.0231*	*-0.0118*
Muskrat;LakeSed	**0.4569**	0.4512	0.3247
p-value	***-0.0325***	*-0.0364*	*-0.0358*
Muskrat;Water	**0.6393**	0.6393	0.4625
p-value	***-0.001***	*-0.0013*	*-0.0016*
LakeSed;Water	0.1825	0.1869	0.0909
p-value	*-0.4163*	*-0.4032*	*-0.577*

Table 7.3. Comparative concentrations of carcinogenic PAHs (*u*g/Kg) as reported in various studies around the world.

Site Location	Food Type	Year of Publication	PAHs analysed	Mean Concent. ug/kg	Study/ References
China	Peking duck	2011	Carcinogenic PAHs	54.70	Lin et al (2011)
Northern Alberta	All animal parts	2013/15	Carcinogenic PAHs	32.30	Present study
Cape Town SA	Smoked pork	2013	BkF, BaP, IP, BghiP	19.11	Olatunji et al (2013)
Cape Town SA	Boiled pork	2013	BkF, BaP, IP, BghiP	15.04	Olatunji et al (2013
Cape Town SA	Smoked beef	2013	BkF, BaP, IP, BghiP	14.84	Olatunji et al (2013
Cape Town SA	Grilled pork	2013	BkF, BaP, IP, BghiP	11.17	Olatunji et al (2013
Cape Town SA	Grilled beef	2013	BkF, BaP, IP, BghiP	9.29	Olatunji et al (2013
Northern Alberta	Moose kidney	2013/14	Carcinogenic PAHs	9.18	Present study
Cape Town SA	Boiled beef	2013	BkF, BaP, IP, BghiP	7.20	Olatunji et al (2013
Northern Alberta	Muskrat kidney	2013/14	Carcinogenic PAHs	4.63	Present study
Northern Alberta	Beaver liver	2013/14	Carcinogenic PAHs	4.17	Present study
Northern Alberta	Beaver muscle	2013/14	Carcinogenic PAHs	3.38	Present study
Northern Alberta	Beaver kidney	2013/14	Carcinogenic PAHs	2.90	Present study
Cape Town SA	Smoked chicken	2013	BkF, BaP, IP, BghiP	2.79	Olatunji et al (2013
Northern Alberta	Muskrat muscle	2013/14	Carcinogenic PAHs	2.50	Present study
Cape Town SA	Boiled chicken	2013	BkF, BaP, IP, BghiP	2.33	Olatunji et al (2013
Northern Alberta	Beef liver	2013/14	Carcinogenic PAHs	2.07	Present study
Northern Alberta	Muskrat liver	2013/14	Carcinogenic PAHs	1.75	Present study
Cape Town SA	Grilled chicken	2013.00	BkF, BaP, IP, BghiP	0.99	Olatunji et al (2013
Northern Alberta	Moose liver	2013/14	Carcinogenic PAHs	0.59	Present study
Northern Alberta	Moose muscle	2013/14	Carcinogenic PAHs	0.45	Present study
Northern Alberta	Duck liver	2013/14	Carcinogenic PAHs	0.33	Present study
Northern Alberta	Duck kidney	2013/14	Carcinogenic PAHs	0.22	Present study
Northern Alberta	Duck muscle	2013/14	Carcinogenic PAHs	0.13	Present study

Table 7.4. Comparative concentrations of benzo[*a*]pyrene (ug/Kg) as reported in various studies around the world.

Site Location	Food Type	Year of Publication	PAHs analysed	Mean Concent. ug/kg	Study/ References
China	Peking duck	2011	Benzo[*a*]pyrene	8.70	Lin et al (2011)
Selangor Malaysia	Beef satay	2010	Benzo[*a*]pyrene	7.35	Farhadian et al (2010)
Selangor Malaysia	Chicken kebab	2010	Benzo[*a*]pyrene	1.57	Farhadian et al (2010)
Northern Alberta	All animal parts	2013/14	Benzo[*a*]pyrene	0.88	Present study
Northern Alberta	Muskrat kidney	2013/14	Benzo[*a*]pyrene	0.64	Present study
Northern Alberta	Muskrat muscle	2013/14	Benzo[*a*]pyrene	0.24	Present study
Germany, different states	Smoked meat	2010	Benzo[*a*]pyrene	0.05	Jira (2010)
Northern Alberta	Moose liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Moose kidney	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Moose muscle	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beaver liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beaver kidney	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beaver muscle	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Muskrat liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Duck liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Duck kidney	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Duck muscle	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beef liver	2013/14	Benzo[*a*]pyrene	0.00	Present study

Table: 7.5. Dietary intake of total PAHs (*u*g/day) as reported in various studies around the world.

Site Location	Food Type	Year of Publication	PAHs analysed	Intake per person ug/day	Study/ References
Northern Alberta	All animal parts	2013/15	US EPA 16 PAHs	44.64	Present study
Northern Alberta	Moose muscle	2013/14	US EPA 16 PAHs	43.39	Present study
Netherlands	Total diet	1990		17.00	De Vos et al (1990)
Catalonia, Spain	Meat and meat products, fish and shellfish, vegetables, tubers, fruit, eggs, milk, dairy products, cereals, pulses, oils and fats, industrial bakery	2008	US EPA 16 PAHs	12.05	Marti-Cid et al (2008)
Catalonia, Spain	Meat and meat products, fish and shellfish, vegetables, tubers, fruit, eggs, milk, dairy products, cereals, pulses, oils and fats,	2003	US EPA 16 PAHs	8.60	Falco et al (2003)
Spain		2005		8.40	Yoon et al (2007)
Catalonia, Spain	Meat and meat products, fish and shellfish, vegetables, tubers, fruit, eggs, milk, dairy products, cereals, pulses, oils and fats,	2010	US EPA 16 PAHs	6.70	Martorell et al (2010)
United Kingdom	Food and beverages	1999	25 PAHs	3.70	Phillips (1999)
Kuwait	Olive oil, Pomace oil, corn oil, sunflower oil, canola oil, peanut oil, mustard oil	2010	US EPA 16 PAHs	2.24	Alomirah et al (2010)
Northern Alberta	Duck muscle	2013/14	US EPA 16 PAHs	0.55	Present study
Northern Alberta	Duck liver	2013/14	US EPA 16 PAHs	0.30	Present study
Northern Alberta	Moose kidney	2013/14	US EPA 16 PAHs	0.20	Present study
Estonia*	Meat products	2007	European Comm; list 12 PAHs	0.19	Reinik et al (2007)
Northern Alberta	Duck kidney	2013/14	US EPA 16 PAHs	0.12	Present study
Northern Alberta	Beaver muscle	2013/14	US EPA 16 PAHs	0.04	Present study
Northern Alberta	Moose liver	2013/14	US EPA 16 PAHs	0.02	Present study
Northern Alberta	Beef liver	2013/15	US EPA 16 PAHs	0.01	Present study
Northern Alberta	Beaver liver	2013/14	US EPA 16 PAHs	0.01	Present study
Northern Alberta	Beaver kidney	2013/14	US EPA 16 PAHs	0.01	Present study
Northern Alberta	Muskrat muscle	2013/14	US EPA 16 PAHs	0.00	Present study
Northern Alberta	Muskrat kidney	2013/14	US EPA 16 PAHs	0.00	Present study
Northern Alberta	Muskrat liver	2013/14	US EPA 16 PAHs	0.00	Present study

Table: 7.6. Dietary intake of carcinogenic PAHs (*u*g/day) as reported in various studies around the world.

Site Location	Food Type	Year of Publication	PAHs analysed	Intake per person ug/day	Study/ References
Catalonia Spain	Meat and meat products, fish and shellfish, vegetables, tubers, fruit, eggs, milk, dairy products, cereals, pulses, oils and fats, industrial bakery	2008	Carcinogenic PAHs	0.84	Marti-Cid et al (2008)
Catalonia Spain	Meat and meat products, fish and shellfish, vegetables, tubers, fruit, eggs, milk, dairy products, cereals, pulses, oils and fats, industrial bakery	2010	Carcinogenic PAHs	0.58	Martorell et al (2010)
Northern Alberta	All animal parts	2013/14	Carcinogenic PAHs	0.07	Present study
Northern Alberta	Moose muscle	2013/14	Carcinogenic PAHs	0.05	Present study
Northern Alberta	Moose kidney	2013/14	Carcinogenic PAHs	0.01	Present study
Northern Alberta	Beaver muscle	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Duck muscle	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Beef liver	2013/15	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Duck liver	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Duck kidney	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Beaver liver	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Beaver kidney	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Moose liver	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Muskrat muscle	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Muskrat kidney	2013/14	Carcinogenic PAHs	0.00	Present study
Northern Alberta	Muskrat liver	2013/14	Carcinogenic PAHs	0.00	Present study

Table 7.7. Dietary intake of benzo[*a*]pyrene (**u**g/day) as reported in various studies around the world.

Site Location	Food Type	Year of Publication	PAHs analysed	Intake per person ug/day	Study/ References
China	Food Samples	2007.00	Benzo[*a*]pyrene	1.20	Sun Y (2007)
Catalonia Spain	Meat and meat products, fish and shellfish, vegetables, tubers, fruit, eggs, milk, dairy products, cereals, pulses, oils and fats, industrial bakery	2008	Benzo[*a*]pyrene	0.09	Marti-Cid et al (2008)
Catalonia Spain	Meat and meat products, fish and shellfish, vegetables, tubers, fruit, eggs, milk, dairy products, cereals, pulses, oils and fats, industrial bakery	2010	Benzo[*a*]pyrene	0.06	Martorell et al (2010)
Northern Alberta	All animal parts	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Moose liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Moose kidney	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Moose muscle	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beaver liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beaver kidney	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beaver muscle	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Muskrat liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Muskrat kidney	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Muskrat muscle	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Duck liver	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Duck kidney	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Duck muscle	2013/14	Benzo[*a*]pyrene	0.00	Present study
Northern Alberta	Beef liver	2013/15	Benzo[*a*]pyrene	0.00	Present study

Table 7.8. Mean daily dietary actual intake (ug) of PAHs for the liver, kidney, and muscle of moose, beaver, duck, and muskrat as well as beef liver.

PAH		**Moose (n=3)**			**Beaver (n=3)**			**Muskrat (n=8)**			**Beef (n=5)**	**Duck (n=23)**		
		Liver	Kidney	Muscle	Liver	Kidney	Muscle	Liver	Kidney	Muscle	Liver	Liver	Kidney	Muscle
Total	Male	0.02	0.20	43.39	0.01	0.01	0.04	0.00	0.00	0.00	0.01	0.30	0.12	0.55
	Female	0.01	0.18	29.77	0.01	0.00	0.02	0.00	0.00	0.01	0.04	0.12	0.05	0.21
	Youth	0.01	0.09	17.29	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00
	Child	0.00	0.04	6.91	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Carcinogenic	Male	0.00	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Female	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Youth	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Child	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alkylated	Male	0.11	0.69	67.89	0.03	0.02	0.08	0.01	0.01	0.03	0.05	0.33	0.24	0.65
	Female	0.11	0.52	60.85	0.03	0.02	0.08	0.00	0.00	0.01	0.13	0.12	0.09	0.23
	Youth	0.05	0.48	41.76	0.02	0.01	0.04	0.01	0.01	0.04	0.07	0.11	0.08	0.22
	Child	0.04	0.25	24.25	0.01	0.01	0.03	0.00	0.00	0.01	0.03	0.05	0.03	0.09

Table 7.9. Maximum daily dietary actual intake (*u*g) of PAHs for the liver, kidney, and muscle of moose, beaver, duck, and muskrat as well as beef liver.

PAH		Moose (n=3)			Beaver (n=3)			Muskrat (n=8)			Beef (n=5)	Duck (n=23)		
		Liver	Kidney	Muscle	Liver	Kidney	Muscle	Liver	Kidney	Muscle	Liver	Liver	Kidney	Muscle
Total	Male	0.51	5.72	310.6	0.24	0.10	0.62	0.01	0.02	0.09	0.29	0.91	0.36	1.68
	Female	0.65	3.58	310.6	0.16	0.07	0.42	0.04	0.10	0.37	0.37	0.56	0.22	1.03
	Youth	0.32	2.86	155.3	0.12	0.05	0.31	0.02	0.05	0.18	0.19	0.46	0.18	0.84
	Child	0.13	1.14	62.13	0.05	0.02	0.12	0.01	0.02	0.07	0.07	0.18	0.07	0.34
Carcinogenic	Male	0.00	0.22	0.38	0.01	0.00	0.03	0.00	0.00	0.01	0.01	0.30	0.12	0.55
	Female	0.00	0.14	0.38	0.00	0.00	0.02	0.00	0.01	0.03	0.02	0.12	0.05	0.21
	Youth	0.00	0.11	0.19	0.00	0.00	0.02	0.00	0.00	0.02	0.01	0.00	0.00	0.00
	Child	0.00	0.04	0.08	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Alkylated	Male	2.34	15.06	435.7	0.53	0.36	1.37	0.07	0.07	0.26	1.06	2.14	1.54	4.16
	Female	2.96	9.41	435.7	0.35	0.24	0.91	0.27	0.29	1.02	1.34	1.31	0.94	2.55
	Youth	1.48	7.53	217.8	0.26	0.18	0.68	0.14	0.14	0.51	0.67	1.07	0.77	2.08
	Child	0.59	3.01	87.13	0.11	0.07	0.27	0.05	0.06	0.20	0.27	0.43	0.31	0.83

Table 7.10. Mean dietary intake of benzo(*a*)pyrene (B[*a*]P) equivalents in ***u***g/day for adults consuming various wild caught foods. Note: Zero values for mean consumption are included**.**

		B*a*P Toxic Equivalency Factors (TEF)							
		0.10	1.00	0.10	0.00	1.00	0.10		(*0.05 ug/day)
		B(*a*)ant	B(*a*)pyr	B(*b,j,k*)f	Chry	D(*ah*)ant	I(1,2,3-*cd*)pyr	B(*a*)P eqval ug/day	Cancer Risk per million
Duck	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Moose	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beaver	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Muskrat	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beef	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.50

[a]B(*a*)ant: benz[*a*]anthracene; B(*a*)pyr: benzo[*a*]pyrene; B(*b,j,k*)f: benzo[*b*]fluoranthene; Chry: chrysene D(*ah*)ant: dibenz[*a,h*]anthracene; I(1,2,3-*cd*)pyr : indeno[1,2,3-*c,d*]pyrene.

Table 7.11. Mean dietary intake of benzo[*a*]pyrene (B[*a*]P) equivalents in ug/day for adults consuming various wild caught foods. Note: Zero values for mean consumption are excluded.

		B[*a*]P Toxic Equivalency Factors (TEF)							
		0.10	1.00	0.10	0.00	1.00	0.10		(*0.05 ug/day)
		B(*a*)ant[a]	B(*a*)pyr	B(*b,j,k*)f	Chry	D(*ah*)ant	I(1,2,3-*cd*)pyr	B(*a*)P eqviv ug/day	Cancer Risk per million
Duck	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Moose	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beaver	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Muskrat	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Beef	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.50

[a]B(*a*)ant: benz[*a*]anthracene; B(*a*)pyr: benzo[*a*]pyrene; B(*b,j,k*)f: benzo[*b*]fluoranthene; Chry: chrysene D(*ah*)ant: dibenz[*a*,*h*]anthracene; I(1,2,3-*cd*)pyr : indeno[1,2,3-*c*,*d*]pyrene.

Table 7.12. Maximum dietary intake of benzo(*a*)pyrene (B[*a*]P) equivalents in ug/day for adults consuming various wild caught foods. Note: Zero values for mean consumption are excluded.

		B*a*P Toxic Equivalency Factors (TEF)							
		0.10	1.00	0.10	0.00	1.00	0.10		(*0.05 ug/day)
		B(*a*)ant	B(*a*)pyr	B(*b,j,k*)f	Chry	D(*ah*)ant	I(1,2,3-*cd*)pyr	B(*a*)P eqval ug/day	Cancer Risk per million
Duck	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Moose	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beaver	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Muskrat	Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kidney	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Muscle	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Beef	Liver	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.50

[a]B(*a*)ant: benz[*a*]anthracene; B(*a*)pyr: benzo[*a*]pyrene; B(*b,j,k*)f: benzo[*b*]fluoranthene; Chry: chrysene; D(*ah*)ant: dibenz[*a*,*h*]anthracene; I(1,2,3-*cd*)pyr : indeno[1,2,3-*c*,*d*]pyrene

8. TRADITIONAL FOODS

8.1 BACKGROUND

A food crisis currently confronts many Indigenous communities in northern Canada. Across the North, communities have moved off the land into town sites, as prompted by residential schools and organized religion and as facilitated by the advent of technology such as the snowmobile and outboard motors, attractive employment opportunities, and the desire and need for increased purchasing power (Christensen 2012). Since the 1980s, there has been a concomitant decline in fur prices due to protests against the fur trade that have undermined the viability of hunting and trapping as a livelihood, impacts that have been aggravated by escalating costs of technology and supplies (Myers and Summerville 2004). This, in turn, has decreased access to the land, and affected the availability of traditional foods and need for store-bought foods imported from the South.

These latter changes in patterns of food consumption have been exacerbated by an ever-increasing presence of intensive resource extraction in the surrounding regions, which is adversely affecting local populations of wildlife, fish, and plants (McLachlan and Miller 2012). With respect to Fort Chipewyan, upstream development in the form of hydro development and the Oil Sands has resulted in changes in hydrology and declines in water levels, which has reduced community access to many traditional harvesting areas (Chapter 4).

Concerns regarding the quality of country foods generally increase with upstream industrial development and the inadequate government communication regarding these changes and any associated risks. Many community members are concerned about increases in the concentrations of environmental contaminants in wildlife as associated with hydro development, intense resource extraction, and long-range atmospheric transport across the North (Kuhlein and Chan 2000, Hlimi et al. 2012). Elevated levels of contaminants such as mercury result in government-issued health advisories for fish and gull and tern eggs. Outcomes of such studies and health advisories undermine confidence in the quality of wild-caught foods and in the absence of proactive plans that facilitate risk communication and that promote the importance of these traditions, in turn undermine local interest in these foods.

Indeed, these changes often undermine the ability of many communities to provide and to control their own culturally appropriate foods, that is Indigenous food sovereignty (Rudolph and McLachlan 2013). Exorbitant costs of store-bought foods, often 3-5X the price of equivalent foods in the South, and perpetual un- and under-employment in many communities also compromises the ability of community members to access affordable, healthy and desired foods (Egeland et al. 2011). This need has contributed to widespread food insecurity across northern Canada (Rosol et al. 2011), which can actually exceed 90% of the population of some remote Indigenous communities (Thompson et al. 2011). Food insecurity tends to be greatest in fly-in communities that are isolated and that have no permanent road access (Thompson et al. 2012).

Studies conducted elsewhere in northern Canada, mostly in Arctic environments, have shown that consumption patterns of traditional foods are changing, this often referred to as a “nutrition transition” (Damman et al 2008). Diets are becoming westernized and market foods are coming to replace traditional or country foods. Changes in nutrition include significantly more fat, carbohydrates (including sugars), less protein and fewer vitamins and macronutrients on days when country foods are not eaten (Kuhnlein et al. 2004).

These changes undermine regional food systems and have substantial and adverse implications for the health and wellbeing of these communities. Declines in the consumption of country foods and the increased consumption of store-bought and often nutritionally deficient and processed foods contribute to declines in human health including increases in obesity, cancer, heart disease and type 2 diabetes (Haman et al. 2010, Huet et al. 2012). In Fort Chipewyan, community members are gravely concerned about increases in the prevalence of cancer, and attribute these changes in part to increases in environmental contaminants associated with upstream industrial development and more specifically to the Oil Sands (Chapter 9). Indeed, residents have long called for a baseline study that would help document these changes in community health, a call that still goes unheeded by both provincial and federal governments (Weber 2013).

In the interim, MCFN and ACFN have generated their own funding to begin documenting ongoing changes in health, efforts that resulted in the Phase One and the current (Phase Two) component of this project (McLachlan and Miller 2012). They were also recently approached about participating in the First Nations Food, Nutrition and Environment Study, which is evaluating the implications of changing diets for First Nations across Canada (FNFNES 2014). Both of these initiatives explore the link between environmental contaminants, diet, and community health. An important step in assessing exposure to environmental contaminants through country foods is to examine consumption patterns and changing attitudes to these foods.

The documentation of these patterns, how they have changed and why, and with what impacts is clearly important in its own right. In particular, this type of work provides information that helps communities show how and to what degree of impact intensive resource extraction has on the availability and consumption of country foods and on traditional livelihoods, and how to best respond to any changes. It also allows communities to better assess and understand any food–related risks of consumption.

The goal of this component was to characterize and better understand consumption patterns of country food in Fort Chipewyan.

More specifically, our objectives were:

i) to describe consumption patterns and how these have changed
ii) to document any causes of these changes; and
iii) to identify what might be done to address these changes.

8.2 METHODOLOGY

Our primary research approach was one of mixed methodology, whereby quantitative and qualitative data were collected (Creswell and Plano Clark 2007). The primary research instrument was a 12-page questionnaire that was developed in collaboration with GIR and IRC and with community members from both ACFN and MCFN. The focus of this research was on wild-caught country foods rather than characterizing local diets as a whole. The research design was approved by the University of Manitoba Joint-Faculty Research Ethics Board, J2011:055.

Quantitative data on consumption of country foods was assessed using a series of food frequency questions that quantified consumption. Although 24-hour and 48-hour diet recalls are commonly used to assess patterns of country food consumption (e.g. Kuhnlein et al. 2004, Egeland et al. 2011, Huet et al. 2012, Jamieson et al. 2013), we were concerned that this might exclude and thus underestimate the consumption of important but less frequently consumed wild foods, especially in the absence of any follow-up surveys. Thus, we documented a diet recall for both one-week and two-month periods. The list included moose, bison, and caribou; various fish species; terrestrial and aquatic mammals including muskrat, beaver, and rabbits; waterfowl and other birds such as ptarmigan; and many plants and medicines. Information regarding moose, caribou, and bison was collected for individual organs; however, for all other species information was collected at the level of the whole organisms.

In addition to the country food frequency question, the survey consisted of both Likert-scaled and open-ended questions. These were organized according to the following themes: attitudes towards country foods, causes of changes in quality of country foods and associated attitudes, relative consumption of some processed foods, and possible changes in consumption patterns in the future.

Country food diet interviews each lasted 45-60 minutes. They were conducted at the household level in June 2013, whereby youth from both ACFN and MCFN would systematically work their way through a neighbourhood, contacting people and helping them complete the questionnaires. The youth were trained for a half-day and then conducted the first three days of interviews under the supervision of an outsider researcher. A debriefing occurred at the end of these three days. In total, 111 interviews were conducted with members of both ACFN and MCFN. Participation rates exceeded >90% of these households that were approached, and thus non-response bias was not considered to be a concern. The most commonly cited reasons for non-participation included a lack of time, lack of interest in the research, and dissatisfaction with the research efforts of other scientists in the past.

Diet-related data from other components of the larger project were also identified. Responses to open ended questions related to country foods and diets that were conducted as part of complementary focus group interviews (Nov 2012, Oct 2013) focusing on human health were also transcribed and identified (see Chapter 9), and also included where appropriate. Likewise, food and diet-related results arising from individual interviews with community members associated with Phase One (June 2010-August 2011) and Phase Two (May 2012 – Jan 2014) of this project were also included where appropriate.

All country food diet-recall and Likert responses arising from the household interviews were entered into spreadsheets and evaluated for quality and any errors were corrected. Means and standard errors for both diet-recall and Likert data were calculated and used to assess variation in responses. Qualitative responses to open-ended questions reflected in the household interviews, individual interviews and health focus groups were transcribed in their entirety. These data were coded using NVivo (QSRI 2014) and any emergent themes were identified.

8.3 RESULTS

8.3.1 ATTITUDES TOWARD COUNTRY FOODS

Traditional or country foods are much more than what people eat. They help ground community members in their Indigenous world views where everything is connected and where all life is important, a connection that was commonly linked through water,

> Oct 17, SR: *"This is my belief. I'm not a scientist or anything, but this is what I believe. The water is alive, it's a living thing. Water. Water is the most important thing in all of this world. It makes us, it grows the plants. It feeds the animals, it does everything. That's almost the source of life."*

Generally, wild-caught traditional foods still play a key role in the lives of the members of both Mikisew Cree First Nation (MCFN) and Athabasca Chipewyan First Nation (ACFN). This reflects the cultural and pragmatic use value that community members place on these foods, foods that have been harvested since time immemorial and, moreover, still intend to harvest throughout the region for many generations to come. The great majority (93%) of participants thus indicated that "*traditional foods are a key part of our Aboriginal culture*" (x= 4.66, SE = 0.08) (Table 8.1). Most (85.1%) also agreed that "*having food access to traditional foods is key to my rights as an Aboriginal person*" (x = 4.43, SE = 0.10) (Table 8.1).

FIG 8.1. Terry Marten (MCFN) cutting up moose meat in the fall.

Historically, community members have always relied on traditional foods, which were high enough in abundance and quality to ensure that everyone remained healthy,

> Oct 16, BR: *"I've lived in the bush all my life. We used to live in the bush all year around. We never ate food from the store in them days. That's all we lived on, is wild food. Moose, fish, chicken, rabbit, ducks, geese, you name it. That's all we lived on a long time ago. We never lived on any type of food a long time ago. And people were healthy, them days."*

FIG 8.2. Shooting a Lesser Scaup (*Aythya affinis*) duck for subsequent sampling in the fall.

While these foods and the ceremonies that provide context for their use are still tremendously important from a cultural and spiritual perspective, it is also clear that fish, wildlife and medicines also play an essential role in the nutrition and health of community members. The great majority of participants (88.0%) concurred that they "*eat traditional foods whenever they are available*" (x=4.48, SE=0.09) (Table 8.2),

> Oct 17, BR: *"Even in our family, we eat a lot of traditional foods, and my husband and my children are avid hunters and gathers of veggies, fruits and berries and what not. As a matter of fact that is where they are right now, they're hunting ducks and moose to put on our tables."*

8.3.2 FREQUENCY OF COUNTRY FOOD CONSUMPTION

Results from the two-month diet recall showed that moose is the most frequently consumed species (a total of 1,477X for the previous two months), almost 5X that of the next most frequently consumed food type. On average, moose was consumed 15.5X and 3.4 X over the previous two-month and one-week periods by each participant. Moose was followed, in descending order, by ratroot (312X), duck (207X), then wild mint (157X), spruce gum (150X), pickerel (144X), and Labrador tea (90X) as totals over that two-month period (Fig 8.3). There was general agreement between the two time periods, such that moose, duck, caribou and ratroot were all among the eight most frequently consumed foods in both the two-month and one-week periods. Whitefish, jackfish, and beaver displaced some of the less recently consumed plants in the one-week time period (Fig 8.4).

Yet, it was surprising how many medicines made the highest consumption-frequency categories, especially for the two-month period. Ratroot or sweet flag (*Acornus cornus*), an aquatic plant that is still widely used as a traditional medicine to treat a wide variety of ailments and to promote a healthy constitution, saw the greatest daily use of the different plants. Two teas (wild mint (*Mentha arvensis*) and Labrador tea (*Rhododendron groenlandicum*)) were also widely consumed, as was spruce gum (*Picea* spp.), which is used as a topical anaesthetic and to treat and seal cuts. Balsam fir (*Abies balsamea*), red willow bark (*Cornus sericea*), black spruce (*Picea mariana*) and birch (*Betula* spp.) are all medicines that were less frequently used but still important in maintaining health. These medicines would have been used in isolation and in combination with one another (V. Courtoreille pers. comm.).

Interestingly, there was a strong gender disparity for many of these medicines, in that they were generally, and in the case of spruce gum categorically, used by men. This might reflect the greater amount of time that men now spend out on the land where they have more ready-access to these plants. Ducks were also more likely to be consumed by men (1.95 v 1.46) in the two-month period as were goose (0.51 v 0.26) and grouse (0.96 v 0.26) whereas women were more likely to consume gold eye (0.04 v 0.11) (Fig 8.3).

The most frequently used foods, (i.e. moose, ratroot, and berries), were consumed by at least some participants every day and, in the case of the latter two foods, were most likely to be used 1-3X/week (Table 8.3). Ducks and whitefish, the latter often smoked, were also frequently consumed. Other species that were still frequently consumed included caribou and rabbit as well as pickerel (Table 8.3).

8.3.3 DIET TRANSITION TOWARD STORE-BOUGHT FOODS

A shift in diet away from these kinds of traditional foods to store-bought foods that originate from the South is increasing in prevalence. Thus, more participants disagreed than agreed (33.6% vs. 22.5%) with the statement "*now days, I eat more traditional foods than store-bought foods*" (Table 8.1),

> Oct 17, BR*: "They used to buy flour, lard, but you know the basic things, their meat, came off the land, so like rats, beavers or whatever they ate. So they were healthier. Now we'll walk into the store and get whatever we want to eat."*

The most frequently consumed store-bought foods, ones that are generally consumed everyday, included in, descending order of use: dairy products, vegetables, fruit, and eggs (Table 8.4). These store-bought foods play an important role in the diets of participants. Indeed, almost half indicated that traditional foods only comprised 1-25% of their diets (Fig 8.5a). Interestingly, the importance of these traditional foods was seen as substantially higher for Fort Chipewyan as a whole than for the individual diets of participants of this study (Fig 8.5b), perhaps indicating a belief that others were more likely to continue these traditions.

It is widely assumed that many or most of the foods purchased in northern Indigenous communities are highly processed and nutritionally deficient (Haman et al. 2010, Egeland et at. 2011). However, our results, which admittedly are much less detailed for store-bought than for traditional foods, indicated that these processed foods, including pop, TV dinners, sub sandwiches and pizza, were much less frequently consumed than the more healthy store-bought alternatives indicated above (Table 8.4). Interestingly, fish was the store-bought food type that was most likely (58.1%) to never be consumed, at first glance because it is so readily available as a local and wild-caught traditional food, although, as we will discuss below, many no longer eat fish of any sort. Other food types that were most likely to never be consumed, in descending order of frequency, included some processed foods: TV dinners (54.5%), submarine sandwiches (39.4%), lard (26.2%), pizza (24.5%), and pop (24.5%) (Table 8.4).

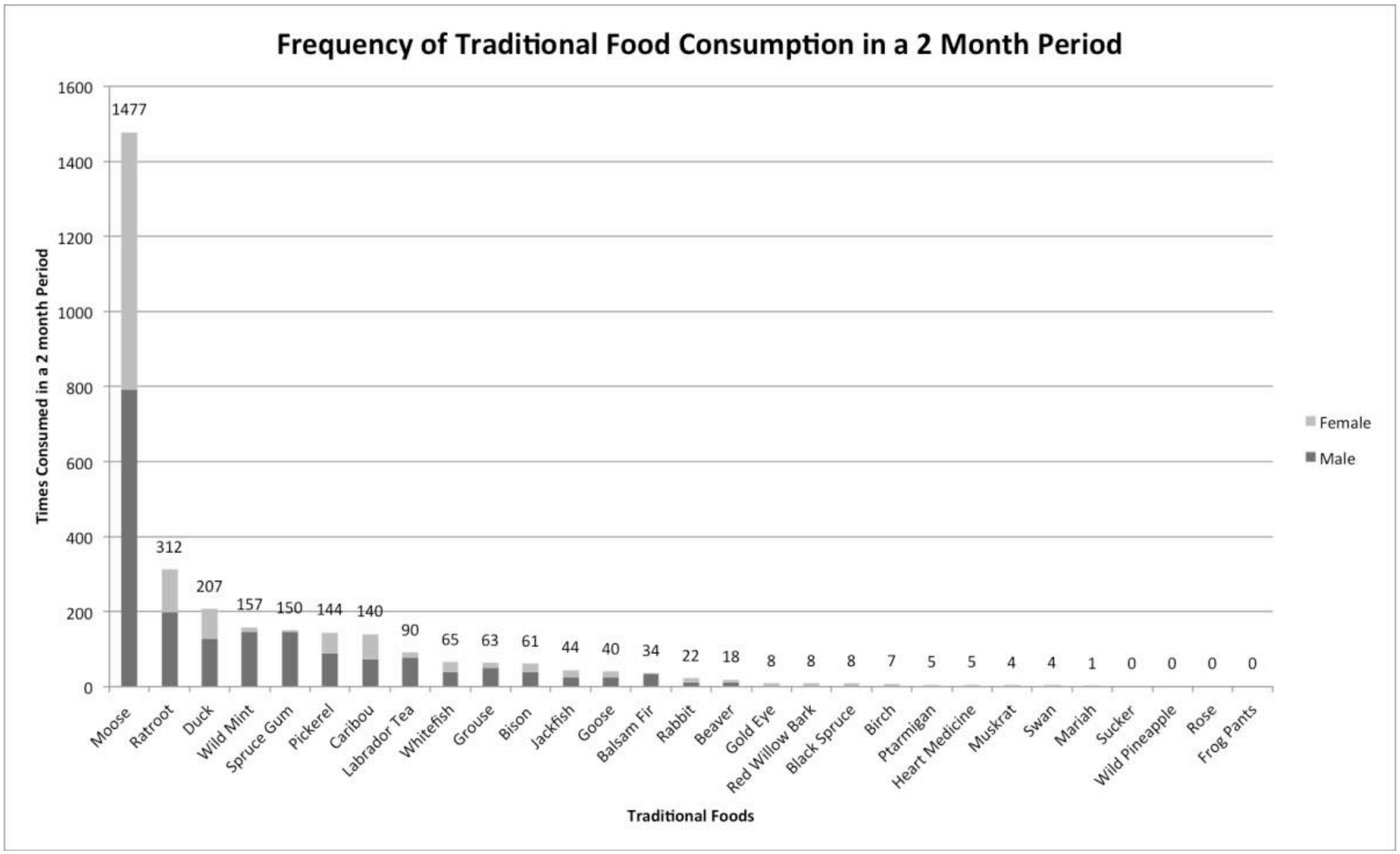

FIG 8.3. Frequency of consumption of traditional foods over a two-month period, as classified according to gender.

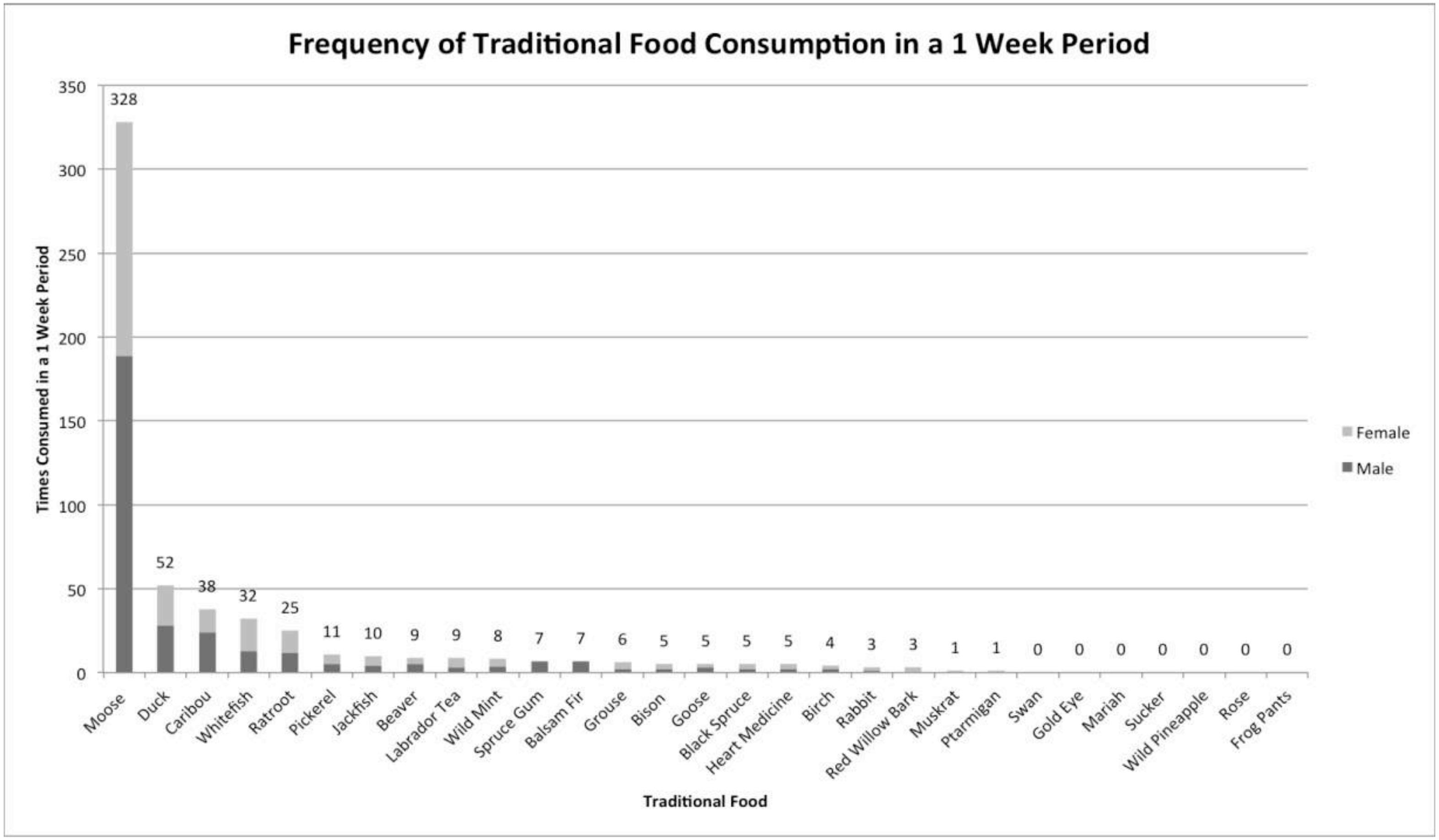

FIG 8.4. Frequency of consumption of traditional foods over a one-week period, as classified according to gender.

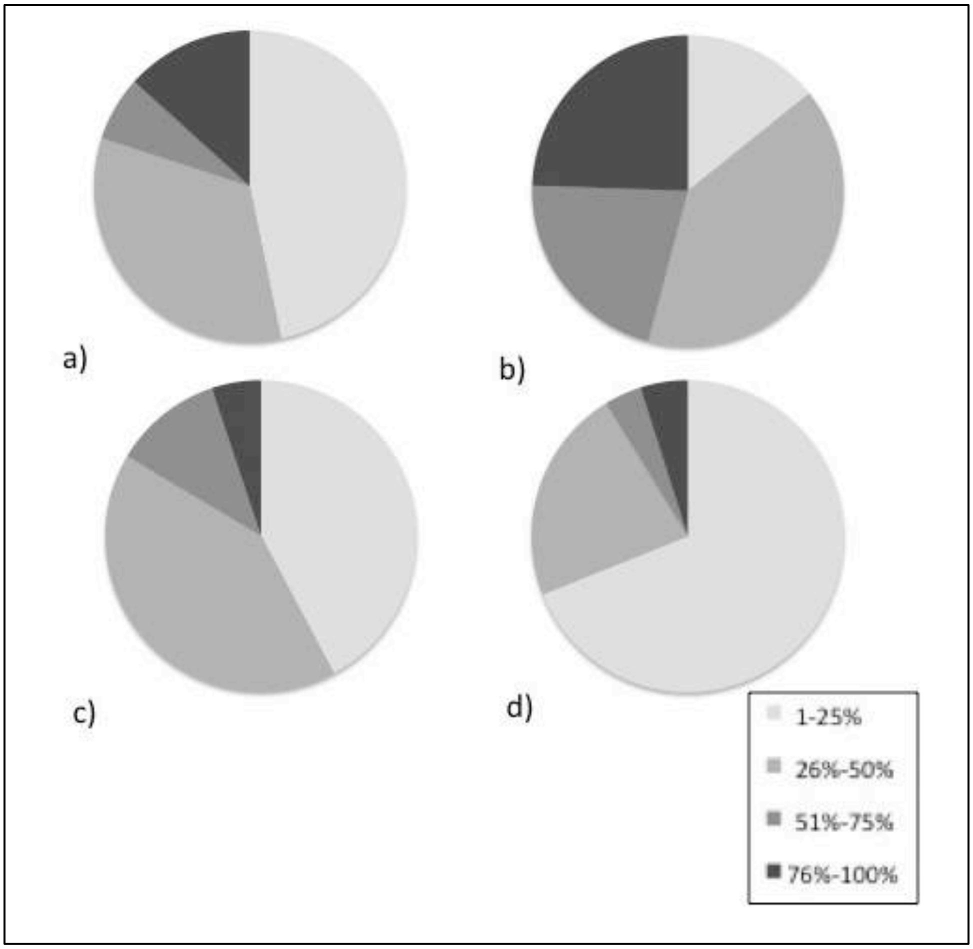

FIG 8.5. Percentage of total food consumed that is traditional food according to a) individual participants, b) residents in Fort Chipewyan today; c) children and youth in Fort Chipewyan today; and d) residents in Fort Chipewyan, 50 years into the future.

This might indicate the relatively high mean age of the participants (i.e. 58.8% were >50 yoa, and the mean age was 52.8). Many elderly members of the community do not and in some cases refuse to purchase fruit and vegetables. This is, in part, because of the high cost, low diversity of options and poor quality of these foods. But in at least some cases it is because many of these foods are seen as alien to local cultural traditions and the way people were raised on the land,

> *Oct 17, BR: "You know on the flipside of that, there's people who, like my father, never eat vegetables, fruit. He grew up just with wild stuff, getting needs from the store, potatoes whatever. But, every time we had vegetables and stuff like that, he wouldn't eat it, because it wasn't part of his growing up, part of his lifestyle, part of his diet. Right to the day he died he wouldn't, like he didn't like eating vegetables or fruit. And he could've had access to them, but he just didn't want to eat it. Just like a lot of old people. Even today probably lots of old people still don't."*

In contrast, as is widely recognized in the literature (e.g. Kuhnlein et al. 2004, Haman et al. 2010), younger people in the community were more likely to purchase their foods at the local (Northern) store and were seen by many as the least likely to have diets that were characterized by traditional foods (Fig 8.5c).

Oct 17, SR: "I think diet is a big thing. We have a granddaughter living with us and she'd rather have processed food, frozen, the instant food. You throw it in the microwave or in the oven, you know, the pizza. You see more of that on their plates."

This shift from traditional to store-bought, and in many cases processed, foods is in part enabled by their ready availability and convenience,

Nov 23, 2012: *"Back in them days they had to kill lots because you cannot come 50 miles to town to come and buy something. You lived off the land. So you did what you had to do with your ducks. They found ways to preserve it, to preserve the ducks. From the moose you made dry meat. All those things. Except things are so much easier today. You want to eat a steak, you go to the Northern."*

This diet transition also reflects global trends, whereby diets around the world are characterized by an increased consumption of fats and sweeteners (Popkin 2006). This in turn is facilitated by urbanization, by a global agricultural system that promotes the international export of foods as commodities, and by trade liberalization (Kearney 2010). It also likely reflects the increased prevalence of western popular media such as television and the Internet in these northern communities, which also act to make these foods more attractive to younger residents. This dietary shift is occurring in many Indigenous communities across northern Canada, where diets are becoming increasingly similar to those in the South (Kuhnlein et al 2004).

8.3.4 IMPACTS OF UPSTEAM DEVELOPMENT ON COUNTRY FOODS

Importantly, factors associated with the increased presence of industrial development are playing a substantial role in this diet transition. One such factor is the decline in access to country foods. Thus, the large majority (77.8%) concurred "*I would eat more traditional foods if I could*", suggesting that the current availability of country foods is inadequate (Table 8.2). Similarly, most (74.1%) participants indicated "*I would eat more traditional foods than store-bought foods if I could"* (x=4.23, SE=0.10), indicating that this shift to store-bought foods has not been entirely voluntary in nature, and has been driven by factors beyond their control.

FIG 8.6. Drying and smoking whitefish out on the land.

For Fort Chipewyan, upstream Oil Sands and hydro development have fundamentally undermined the consumption of country foods and thus enabled this dietary transition. The WAC Bennett hydro dam was constructed in northern BC on the Peace River in the mid 1960s, and over the subsequent 50 years it has contributed to high levels of methylmercury in downstream lakes and rivers, especially for long-lived fish that are higher-level carnivores such as northern pike and pickerel (Wren 1986). Hydro development has also played havoc with downstream water levels and flooding in the Peace Athabasca Delta. These hydro-associated changes in flooding patterns and declines in water levels have reduced access to traditional harvesting areas that are now no longer accessible by boat. Thus, the large majority (86.5%) of participants indicated that the "*Bennett Dam has decreased my access to traditional foods*" (X = 4.54, SE = 0.08) (Table 8.5),

> Oct 16, SR: "*And then a loss of all our water from the freakin' Bennett dam, they took all our water away from us, killed off all our ways of living, like for muskrats and things like that you know. It has a lot of effect on everything, everything and people in general too."*

More specifically, the greatest majority (91.0%) felt that muskrat populations had been adversely affected by the Bennett dam,

> *"Water was high. Always water out in the lakes and ponds and that. Lots of muskrats all over. Once the water started going down, once the water dropped. Every year after the Bennett Dam, the water is worse than ever. Now there's no muskrats anymore. They're gone. The water level is the biggest problem there."*
>
> Joe Vermillion, MCFN

Then, in substantially less and decreasing order of importance, participants also felt that whitefish (73.2%), moose (65.3%), some ducks (61.0%) and some medicines (48.4%) had also been adversely affected by the dam (Table 8.6). These adverse impacts will arguably only continue to increase in the future with the anticipated construction of the Site C dam on the Peace River in BC, which has a slated earliest in-service date of 2024 (Laanela 2014)

Decreased access to traditional harvest areas and declines in muskrat populations associated with hydro development, along with other factors including declines in fur prices, undermined trapping as a livelihood. This as well as pressures to register children in residential schools and the existence of alternate employment opportunities, prompted people to move into town, which reduced opportunities for people to access and thus to consume traditional foods,

> Oct 17, SR*: "…the water quantity has resulted in the disappearance of the muskrats, that starts the whole huge change of life. Because no one can make a living trapping. And then everybody had to move to town and with that comes store-bought food and more difficulty getting wild food. So people naturally eat a lot less wild food now days."*

Changes in access to traditional foods have been accompanied by concerns over the quality of many of these foods. Residents are concerned about the implications of these industries for country foods. Most (73.6%) participants agreed that "*I worry about the quality of some of the traditional foods I eat*" (x = 4.13, SE = 0.11) (Table 8.2). These concerns are explicitly related to industrial pollutants. A large majority (83.2%) of participants indicated that" *I worry about the environmental contaminants in the traditional foods I consume"* (x=4.45, SE=0.09) whereas most (63.4%)

disagreed with the statement "*I think concerns about environmental contaminants in traditional foods are exaggerated*" (x=2.46, SE=0.17) (Table 8.7).

FIG 8.7. ACFN members crossing Lake Athabasca by boat.

To that end, a large majority (86.5%) felt that "*pollution from the Oil Sands has decreased the quality of traditional foods*" (x=4.35, SE=0.11). Of the various wildlife species that were examined, participants felt that the Oil Sands had most negatively affected the quality of muskrats (83.7%), followed in decreasing order by whitefish (78.5%) and some duck species (76.7%). To a lesser degree, participants felt that moose (69.52%) and some medicines (59.8%) had also been affected by the Oil Sands (Table 8.8),

> *"It's got to be the water. What else can it be?!? When you start killing your muskrats off. As long as the water was feeding from the water into the lakes, there is no more muskrats. But the inland underwater muskeg, there are a few lakes we have. There is always muskrats there and they don't die off. So you got to be. What Elders are saying is that it is the water from the river. And I believe it. From the experience that I have seen."*
>
> Big John Marcel ACFN

8.3.5 IMPLICATIONS OF UPSTEAM DEVELOPMENT FOR DIET TRANSITION

As already indicated 81.9% agreed that the pollution from the Oil Sands has decreased the quality of traditional foods (Table 8.5). Importantly, a large majority (77.4%) felt that they now ate less fish "*because of industrial pollution and contaminants*" (x=4.32, SE=0.11) (Table 8.9). Fish had shown the greatest decline in consumption. Surprisingly, many (32.1%) never ate pickerel and many (20.6%) also never ate whitefish, although both species are still readily available in the adjacent Lake Athabasca and in surrounding water bodies (Table 8.3),

> Oct 15, SR: *"Oh, definitely, I am the same way. I have quit eating fish, I will not eat fish from Lake Athabasca."*

Many also felt that they ate less muskrat (70.7%) and ducks (68.6%) because of these pollutants (Table 8.9). Indeed, 75.5% of participants indicated that they never ate muskrat, and of the 11 wildlife species that were used to prompt responses, it was the least frequently consumed (Table 8.3). Yet, until the 1970s, it was a "cultural keystone" species for both ACFN and MCFN, playing a key role in supporting livelihoods and local diets, at least until it was effectively extirpated from the delta by upstream industrial development.

FIG 8.8. Archie Antoine (MCFN) digs up a muskrat push-up: empty again.

Some participants were also less inclined to eat organ meats (i.e. kidneys, livers etc.) because they are also known to accumulate contaminants,

> Oct 17, BR*: "But we, our lifestyles have changed, we don't eat fish near as what we used to. We used to spend months, in Jackfish* [an ACFN reserve], *making dried fish, and eating fish all summer long. Now we don't, we very rarely ever eat fish. Organ meats, we don't eat no more organ meats, heart, kidneys or anything because if there are any toxins and pollutants it's going to be concentrated higher in the organ meats, right? We don't eat the organ meats at all."*

This participant further suggested that they might not be eating country food at all if it were not for the exorbitant costs of store-bought meat,

> Oct 17, BR. *"We have to eat the* [wild-caught] *flesh, because we can't afford not to. The cost of meat in this town is unbelievable."*

Reduced access to traditional foods is exacerbated by, and perhaps also contributes to, changes in other values regarding food. More specifically, the sharing of foods has characterized many of these northern Indigenous communities, where harvesters, who were usually male and relatively young and able bodied, would share country foods with Elders, children, and indeed anyone in need.

However, food sharing is becoming less commonplace. More than half (55.3%) of participants indicated that "*now days, people don't share traditional foods the way they did in the past*" (x = 3.53, SE = 0.13) (Table 8.2). Thus,

> Oct 17, SR: *"Things have really changed, like the values have also changed of our family structure and how we do things. We don't share as much as we used to. You know, when we killed, my dad killed a moose or jackfish, everybody got a piece, whoever was there."*

8.3.6 BROADER IMPLICATIONS OF DEVELOPMENT-ASSOCIATED CHANGES IN DIET

These shifts in diet, which are driven by declines in access to harvesting areas and concerns over the quality and safety of country foods in turn create other problems. The cost of even basic foodstuffs in northern fly-in communities is exorbitant, often 3-5 X higher than in urban communities to the South (Peritz 2014).

A winter road that connects Fort Chipewyan to other communities to the South is normally in operation from December to April each year, which dramatically increases access for many from this fly-in community to Fort McMurray and Edmonton, and their lower food prices. Yet, this is still not an option for at least some in the community,

> Oct 17, BR: *"I think it depends on your accessibility. Not everybody can financially go to McMurray and shop."*

Although this competition with retail outlets in the South would normally lower in-town prices through the winter, the prices remain high in Fort Chipewyan, in part because of the monopoly exercised by the Northern store here and elsewhere across northern Canada (Thompson et al. 2012),

> Oct 17, BR: "*The prices do decrease a bit* [in the winter*] but overall not a lot. Our Northern stores have the monopoly on this community I guess, and really has people hooped."*

Some northern communities co-operatively own and manage grocery stores that provide food at a lower cost to residents, but this is no longer an option for Fort Chipewyan. There was one such co-op opened in the 1950s, but has been closed for the last 50 years (J. Marcel, pers. comm.).

A number of small, often home-based, convenience stores and restaurants that serve pizzas and hamburgers currently exist in Fort Chipewyan, but they tend to be transient in nature and prices are generally still at least double those in the South. There are some attempts to ensure that a wider variety of foods exist within the community, including a good fox box program that helps to subsidize costs and to make these foods more affordable,

> Oct 17, BR: *"…they've got the good food box that is limited to how much you can get. It's once a month and how long are those fruits going to last? You've got fruits for a week, two weeks."*

Ultimately, however, there was a general consensus that food costs remain prohibitively high, especially for fruit, vegetables, dairy, meats, and other healthy options. Indeed, the high price of foods was the most discussed food-related topic in focus group meetings held in October 2013 (Table 8.10). Prices are high enough that they affect the ability of people to access healthy and culturally appropriate foods, in turn leading to food insecurity. Although parents routinely privilege their children whenever they can, there are still times when access to healthy foods is restricted to all family members,

> Oct 17, SR: *Even my with kids, I have had to tell them, I'm sorry my boys, you can't have a glass of milk right now because we need to save it for breakfast. I myself hardly drink milk, because I save it for the kids because they need it growing up. Same with fresh fruits. I'll eat the canned stuff because it is a little bit cheaper or dried stuff. But fresh fruits, I will save it for the kids, because they need it more than I do, because they are growing faster than I am. So I found that myself, I don't eat as healthy as I could or I should, because I save it for the kids."*

The cost of meats, dairy, fruit and vegetables are particularly high, much higher than low-weight processed foods that are cost-effective to fly or winter-drive into town and that have indefinite shelf lives. The cost-prohibitive nature of these healthy store-bought foods combined with concerns about the risks associated with country foods, in effect forces residents to purchase this "junk food" for their families,

> Oct 17, BR: "*Who in Fort Chip can afford to buy healthy foods. It is cheaper to buy a bag of chips than a banana. It is cheaper to buy a pop than it is to buy an orange. It is cheaper to buy a chocolate bar than it is a tomato. I go into the store and buy one jug of milk and one box of cereal and it is $20."*

FIG 8.9. Expensive and low quality watermelon purchased in Fort Chipewyan.

The ready availability of these junk foods is of widespread concern, and ranked third of all the food related issues that were raised in the October focus group meetings, (Table 8.10). Those whom are most likely to be eating these unhealthy foods are youth and children,

> Oct 17, SR: "*You know, we saw a documentary on sugar…One can of pop has over 10 teaspoons of sugar. And when you see the kids, they're eating chips and pop."*

Ironically, some participants felt that the local community school also played a role in this diet shift. Country foods are generally restricted in their availability to students in the school because of prohibitive health regulations,

> Oct 17, SR: *"Yeah, because it would be a lot better if we brought in moose meat and all and made a stew from them, stew and bannock. Because the meat is not inspected, it cannot be cooked in the school. It's got to have that stamp of approval."*

These food safety regulations are inadequate to deal with country foods. The foods available to local students are thus often high in salts and other additives, and are sourced and reflect culturally inappropriate and institutional food priorities from the South,

> Oct 17, SR Partic1: *You see the kids, even the school – at the cafeteria – they're feeding the kids chicken nuggets, fries.*
> Partic2*: Oh it's awful the food there, I mean, I never used to eat, I never ate at the school. They have a menu that's sent from Peace River or wherever, and they have to follow that. Well they should just tell them there, this is not Peace River, this is our community."*

Indeed, anticipating that this double bind (i.e. the contamination of traditional foods and inability to afford health store-bought alternatives) would continue unabated, participants generally felt that community members would only be that much more likely to shift away from country foods 50 years into the future (Fig 8.3d). Ultimately, the adverse impacts of hydro development and the Oil Sands on access to country foods and the increased prevalence of low-cost and nutritionally inadequate alternatives represents a situation where food insecurity will likely only continue to grow, for all but the most privileged community members. In turn, the decline in the ability of members to provide and thus to control their own food results in a concomitant decline in food sovereignty and, indeed, the ability of community members to exercise their treaty rights.

In addition to their impacts on food insecurity and food sovereignty, the impacts of hydro development and the Oil Sands on traditional foods also have tremendous implications for human health and wellbeing (Chapter 9). A large majority (81.8%) of participants agreed that "*polluted traditional foods are a major cause of poor human health in Fort Chipewyan*" (x = 4.38, SE = 0.11) (Table 8.11). An even greater proportion (84.4%) agreed that "*polluted traditional foods are a major cause of cancer in Fort Chipewyan*" (x = 4.49, SE = 0.10) (Table 8.11). As one participant concluded,

> Oct 16, SR: *"Everybody knows, not just me, that animals have a higher cancer rate in Fort Chip, it's a small community. Based on studies that they have done in the past, I thought, like everybody always catches Oil Sands and having an effect on the environment, and the animals, even the amount of food we have to eat. Like we got to watch the amount of fish we eat. Get pregnant and won't have their children, stuff like that. In my family, everyone has experienced cancer, cancer. And I imagine every family member here, every person, has been affected one way or another by the Oils Sands."*

8.4 CONCLUDING REMARKS

Described above is a perfect double bind. On one hand, changes in the hydrology of the Peace Athabasca Delta and contaminants from the Oil Sands have reduced community accessibility to and confidence in country foods. On the other hand, the availability of store-bought foods continues to grow, especially regarding low-cost, processed foods that are generally nutritionally deficient and easy to prepare. These two factors are driving a diet transition that both undermines the traditional food systems and community health and wellbeing (Chapter 9).

The nature of this bind is arguably most clear with respect to muskrat and fish. Historically, muskrat were a cultural keystone species for both First Nations, feeding people and sustaining their land-based livelihoods. The collapse in muskrat populations driven by reduced water levels and environmental pollutants from the Oil Sands helped force many off the land. Although a key component of past diets, now muskrat is now rarely eaten, because it has been effectively extirpated from the region. Fish were also central to livelihoods in the past, especially for residents who benefited from the commercial fishery on Lake Athabasca. Now the fishery has closed, in large part because of the elimination of subsidized shipping and also consumer concern about the Oil Sands. Moreover, most residents no longer consume locally sourced fish because of concerns regarding these same environmental contaminants. These shortfalls, in turn, have been largely compensated for by store-bought foods, although most participants indicated they would still rather eat country food.

Participants recognize that this transition is occurring, that it is most evident among young community members, and that it will only continue to occur in the future. Yet, country foods still play a fundamental and largely healthy role in the diets of community members. Moose, ducks and whitefish are still frequently consumed and medicines including ratroot, spruce gum and balsam fir are still used to maintain health and wellbeing. In so doing, community members maintain their traditions while exercising their treaty rights. These foods and associated food systems play a key role in the identity of these First Peoples. Yet the ever-encroaching presence of industry will only act to further undermine additional wildlife and plant species and traditional food systems as they have already done with muskrat and some fish.

FIG 8.10. Drayden Bruno (ACFN) sets a snare.

Ideally, there are proactive responses that can mitigate at least some of these impacts, that can help ensure that country foods remain accessible to community members, and that can increase the affordability and usability of healthier store-bought alternatives. Such programs include gardening and country food sharing programs, culture camps, as well as subsidized “good food” box programs. Yet, if nothing is done, the future impacts of this industrial activity is certain to be as great and as they are adverse, and will fundamentally undermine the livelihoods, cultural wellbeing, and health of these communities in the not-so-distant future.

Table 8.1. Consumption of traditional foods and Aboriginal culture.

	Mean	N	SE	+	-
Traditional foods are a key part of our Aboriginal culture	4.66	108	0.08	93.5	3.8
Having good access to traditional foods is a key part of my rights as someone who is Aboriginal	4.43	108	0.10	85.1	8.3

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation; SE: standard error

Table 8.2. Consumption of traditional foods.

	Mean	N	SE	+	-
I eat traditional foods whenever they are available	4.48	108	0.09	88.0	3.7
I would eat more traditional foods if I could	4.33	108	0.09	77.8	2.8
I would eat more traditional foods than store-bought foods if I could	4.23	108	0.10	74.1	6.5
I worry about the quality of some of the traditional foods that I eat	4.13	106	0.11	73.6	12.2
Now days, people don't share traditional foods the way they did in the past	3.53	103	0.13	55.3	27.2
Now days, I eat more traditional foods than store-bought foods	2.87	107	0.12	22.5	33.6

Note: 5=Strongly Agree, 1= Strongly Disagree; neutral values eliminated for proportion calculation; SE: standard error

Table 8.3. Frequency of consumption of various traditional foods.

Food type	N	SE	Never	1-12x/ year	1-3x/ week	Every day
Muskrat	106	0.06	75.5	24.5	0	0
Buffalo	107	0.09	70.1	28.9	0.9	0
Beaver	104	0.11	61.5	34.6	3.9	0
Rabbit	105	0.11	35.2	61.9	2.9	0
Caribou	106	0.11	26.4	67.9	5.6	0
Whitefish	107	0.13	20.6	67.3	12.2	0
Pickerel	106	0.15	32.1	52.9	14.2	0.9
Duck	107	0.13	13.1	71.1	14.9	0.9
Berries	104	0.16	15.4	59.7	22.1	2.9
Moose	107	0.49	2.8	27.0	64.5	5.6
Ratroot	105	0.17	33.3	52.2	7.6	6.7

Note. SE: standard error

Table 8.4. Frequency of consumption of various store-bought foods.

Food type	N	SE	Never	1-12x/ year	1-3x/ week	Every day
Dairy	107	0.17	6.5	2.8	16.8	73.8
Vegetables	107	0.11	0.9	3.7	33.7	61.7
Fruit	106	0.13	1.9	4.7	37.8	55.7
Eggs	107	0.13	2.8	5.6	43.9	47.7
Meat	106	0.14	1.9	9.4	45.3	43.4
Pop	106	0.24	24.5	9.4	27.4	38.7
Lard	107	0.23	26.2	17.7	41.1	14.9
TV dinners	103	0.18	54.5	29.2	14.6	14.6
Sub sandwiches	104	0.20	39.4	32.7	22.1	5.8
Fish	105	0.15	58.1	30.5	10.5	1
Pizza	106	0.15	24.5	52.8	22.6	0

Note. SE: standard error

Table 8.5. Impacts of hydro development and Oil Sands on traditional foods.

	Mean	N	SE	+	-
The Bennett Dam has decreased my access to traditional foods	4.54	104	0.08	86.5	3.9
Pollution from the Oil Sands has decreased the quality of traditional foods	4.35	105	0.11	81.9	9.5

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation; SE: standard error

Table 8.6. Changes in water levels and flooding by the Bennett dam has affected my access to the following raditional foods.

Type	Mean	N	SE	+	-
Muskrat	4.72	100	0.08	91.0	4.0
Whitefish	4.26	97	0.10	73.2	3.1
Moose	3.99	101	0.12	65.3	8.9
Some ducks	3.91	95	0.12	61.0	9.5
Some medicines	3.76	91	0.11	48.4	5.5

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation; SE: standard error

Table 8.7. Worries and concerns about traditional foods.

Worry and concern	Mean	N	SE	+	-
I worry about the environmental contaminants in the traditional foods I consume	4.45	101	0.09	83.2	5.0
I think concerns about environmental contaminants in traditional foods are exaggerated	2.46	93	0.17	29.1	63.4

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation; SE: standard error

Table 8.8. Pollution from the Oil Sands has negatively affected the quality of the following traditional foods.

Type	Mean	N	SE	+	-
Muskrats	4.56	98	0.10	83.7	4.1
Whitefish	4.43	107	0.09	78.5	5.6
Some ducks	4.33	103	0.10	76.7	5.9
Moose	4.12	105	0.10	69.5	5.8
Some medicines	4.00	92	0.12	59.8	6.5

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation; SE: standard error

Table 8.9. I now eat less of the following traditional foods because of industrial pollution and contaminants.

Type	Mean	N	SE	+	-
Fish	4.32	102	0.11	77.4	8.8
Muskrat	4.21	99	0.11	70.7	6.0
Ducks	4.03	105	0.11	68.6	7.6
Medicines	3.75	98	0.12	51.0	10.2
Moose	3.72	105	0.12	55.2	13.4
Berries	3.66	103	0.12	48.6	15.6

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation; SE: standard error

Table 8.10. Numbers of mentions regarding factors affecting food choices of community members as raised in a series of focus group interviews held in November 2012 and October 2013.

Issue	Frequency
High price of foods	7
Quit eating fish	6
Eat processed food due to cheap price	5
Distrust store food	5
Don't care contamination of foods	3
Eat traditional food due to diet style	3
Contaminated traditional foods	3
Eat traditional foods due to low cost	2
Eat everything	2
Eat meats from store	1
Expensive Northern food	1
No vegetable in here	1
Traditional meat-eating life style	1

Table 8.11. Implications of traditional foods for community health and wellbeing.

Health	Mean	N	SE	+	-
Polluted traditional foods are a major cause of cancer in Fort Chipewyan	4.49	96	0.10	84.4	8.3
Polluted traditional foods are a major cause of poor human health in Fort Chipewyan	4.38	99	0.11	81.8	10.1

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation; SE: standard error

9. HEALTH AND WELLBEING

9.1 BACKGROUND

Members of Mikisew Cree First Nation (MCFN) and Athabasca Chipewyan First Nation (ACFN) are greatly concerned about changes in community health and wellbeing that have already occurred and that are still occurring in Fort Chipewyan. Some of these changes are common in many northern Indigenous communities, including increases in heart disease (McLaughlin et al. 2004), obesity (Bruce et al. 2011), and type 2 diabetes (Haman et al. 2010). These changes in turn reflect the substantial gap in health and mortality that exist between Indigenous and non-Indigenous people across Canada (King et al. 2009).

Indeed, Indigenous communities around the world have elevated morbidity levels (Stephens et al. 2005). Thus, life expectancy of Aboriginal Australians is 15-20 years less than those that are non-Aboriginal (Anon 2008) whereas Native Americans are 770% more likely to die from alcoholism, 420% more so from diabetes, and 280% more so from accidents (SI 2007). Such data regarding Indigenous people living in Canada are also startling. Life expectancy is 6.6 years less than for non-Indigenous Canadians (Waldram et al. 2006). Probability of survival from age 25 to 75 yoa for First Nations males is 51% and for those that are non-Indigenous 64%, whereas for women it is 62% and 69%, respectively (Lix et al. 2009). Age standardized mortality ratios are similarly higher for First Nations males (1.56) and females (1.96) compared to their non-Indigenous counterparts, these ratios greatest for younger age groups (Lix et al. 2009). Although some recent studies show that these figures are improving in Australia at least and that a recently introduced 10-year national plan has great promise (Anon 2013), the relative gap in overall mortality rates between these two groups in still widening (Pincock 2008). The situation in Canada remains similarly bleak (King et al. 2009).

Such differences in morbidity rates reflect a complex set of health determinants, which encompass environmental, socio-economic, cultural, life style, and genetic factors (Gore and Kothari 2012). Increased attention has been paid to social determinants of health, which reflect the "unequal distribution of power, income, goods, and services,…the consequent unfairness in the immediate, visible circumstances of peoples lives" (WHO 2008, p 1). These approaches are relevant for marginalized groups everywhere and especially Indigenous communities in Canada, the US, and Australia (Reading and Wein 2009). Some of these social determinants include social and economic disadvantage; food insecurity; inadequate housing; poor education, job insecurity and poor working conditions; gender, race and disability; poor access to medical care (Clark 2011); and the legacy of colonialism (Richmond 2009, Czyzewski 2012).

Indeed, 48.6% of Indigenous people aged 25-64% have less than Grade 12, in contrast to 22.5% of the general population; 27.7% of on-reserve households are less than one standard below core housing standards compared to 13.5%; and 27.7% of the on-reserve population is unemployed compared to 7.3% elsewhere in Canada (Health Canada 2010) As shown in Chapter 8, these changes also reflect diets that are transitioning from traditional to store-bought processed foods and associated declines in physical activity (Fedherau et al. 2013). Other driving factors are spatial in nature and reflect the geographical and technological isolation of many Indigenous communities, and the implications that this isolation has for food prices and thus food security as well as health care (Thompson et al. 2012).

With respect to health care, rural and northern regions of Canada are characterized by low population densities and the high turnover of family physicians and other health care professionals as well as heavy patient loads (Coyt et al. 1997, Shah et al. 2003, Yeates et al. 2009) Industrial pollutants and fears about any risks also act to distance participants from their environments, traditional foods and cultural traditions, which in turn contribute to imbalance, loss of control and further loss (Richmond and Ross 2009). That these systemic barriers confront Indigenous people across Canada, if not around the world of course needs to be addressed. Yet, something unique is happening in Fort Chipewyan.

In 2002, John O'Connor, a general practitioner working in Fort Chipewyan, brought widespread and controversial media attention to these health concerns, particularly the elevated incidence of a rare bile duct cancer, cholangiocarcinoma. He was later, and as many (including this author) feel unjustly, rebuked by Health Canada and the Canadian Medical Association for inciting fear within this community (FWB 2014). As many in Fort Chipewyan argue, he was simply responding to and addressing community concerns regarding cancer rates (S. Courtoreille pers. comm.).

Many community members are further concerned that these changes in health are related to upstream development of the Oil Sands. They have long called for a comprehensive study that would investigate these concerns, one that would be conducted in collaboration with and under the control of the affected communities (Weber 2013). Although some preliminary health studies have been conducted, most notably a broad-scope health study by Alberta Health and Wellness (AHW 2006), a cancer study by the Alberta Cancer Board (Chen 2009), and a very recent cancer study by Alberta Health Services (Anon 2014b). However, they are mostly piecemeal, have been designed and implemented without any meaningful community involvement, and have depended on existing data, namely governmental medical records. All three of these studies are thus widely and understandably seen as inadequate, in and outside of Fort Chipewyan.

The outcomes of these studies have, perhaps unsurprisingly, been largely inconclusive, even for the cholangiocarcinoma that was the center of the O'Connor controversy, in part because of the preliminary nature of the data. Moreover, it is arguable that the outcomes of any such studies will remain inconclusive because of the small sample sizes, rare nature of the illnesses (Chen 2009), distal research approach to the health concerns, and the lack of involvement on the part of the community in shaping the research.

Yet, some notable outcomes still emerged from these studies. Levels of other illnesses such as lupus, renal failure, diabetes and hypertension have increased and were found to be higher in Fort Chipewyan than comparison communities, in part reflecting the relatively high proportion (>80%) of First Nations residents in Fort Chipewyan (AHW 2006). Yet, when adjusted for these factors, the 2009 study also found higher levels of the total number of cancers, specific cancers including cholangiocarcinoma for men and lung cancer for women in Fort Chipewyan (Chen 2009). Importantly, the outcomes of these cursory health studies, and for that matter most environmental and health research conducted in the region, have not been adequately shared with the affected communities, arguably aggravating a health crisis that remains unaddressed.

Importantly, little has been done over the last five years to address this dire situation, despite recommendations in all the reports that detailed follow-up research be conducted that focused more closely on the occupational history and exposure of those who have experienced cancer (AHW 2006, Chen 2009). Long-standing community calls for a comprehensive and culturally appropriate health study that would generate high-quality baseline data and document and explore community concerns have yet to be addressed, despite the many billions of dollars in profit that are being generated 200 miles upstream. The most recent attempts to initiate such a study failed in February 2013 because of the politically charged nature of the situation, intense media scrutiny, concerns about the continued lack of community control over the process and outcomes, and the lack of trust that community members have towards the responsible health agencies and more generally the provincial and federal government regarding their health concerns (Weber 2013).

Lack of progress in this regard amounts to a stalemate between communities on one hand and governments and industry on the other. This stalemate has little chance of being resolved in the short-term, at least, and only acts to place downstream residents at ever-increasing risk as Oil Sands development continues to expand northwards.

Yet, a complementary approach to this decline in health is arguably of great potential use and much more closely resembles the community demands for a collaborative and culturally appropriate approach to this issue. It is of special relevance for situations dominated by controversy and distrust, where the infrequency of the illnesses under study and small size of the population limit interpretation, and in regions of the world where adequate scientific data simply do not exist. This approach is sometimes referred to as popular (Brown 1987), lay (Leung et al. 2004), or participatory (Toribio and Rushton 2012) epidemiology. In all cases, these inclusive and community-centered approaches require a "sharing of power", without sacrificing rigour (Schwab and Syme 1997).

Of these different approaches, most recent interest has focused on participatory epidemiology as an evolving branch of veterinary epidemiology that can be used to address gaps in scientific data or service by animal health specialists in resource-poor regions and countries and also to facilitate "co-learning" among partners (Catley et al. 2012). It has been used to better characterize and understand the impacts of disease and treatments in livestock in Ethiopia (Rufael et al. 2008), in Cambodia (Bellet et al. 2012), and Bolivia (Limon et al. 2014) as well as gender-based differences in views and management approaches in livestock and human health in Egypt (Kaoud 2008). A complementary "One Health" approach that links environmental, animal, and human health and that bridges local knowledge and the western science has also been used to better understand pressing health concerns in the Global South (Zinsstag et al. 2011). Notable examples include the relationship between malaria post-colonial irrigation, and childhood malaria in Burkina Faso (Giles-Vernick et al. 2011) as well as landuse, mosquitoes, and health impacts of dengue in India (Arunachalam et al. 2012). However, these "deep" participatory approaches to epidemiology are still effectively absent in the Global North.

In contrast, approaches using "shallow" participation are more common, taking the form of community involvement in veterinary or human epidemiological research. They are seen by some as important, as they can facilitate recruitment, retention of information, and reception (Bailey et al. 2006). They also help expand on conventional individualistic views of health and emphasize the importance of health within larger cultural, social, or structural contexts, while making sense of spatial and social inequalities of health (Twigg et al. 2000). These approaches have thus been useful in explaining the gulf between scientific information and local knowledge and viewpoints as they relate to challenging public health campaigns such as type 2 diabetes (Satterfield et al. 2003), obesity (Chomitz et al. 2010), smoking (Sowden et al. 2003), drinking (Twigg et al. 2000), and foot and mouth disease in the UK (Bailey et al. 2006). Yet, such "shallow" approaches are largely strategic in nature and are still not directly shaped by or responsive to community concerns or experiences (Sapienza et al. 2007). Epidemiological studies that are genuinely community-controlled and that can at once empower patients and facilitate social and political changes are still rare but obviously of special relevance here.

In such participatory health research, visual tools can play an essential role in helping patients communicate their health experiences and concerns to care providers (Umoquit 2008). "Such "participant diagramming" facilitates a rich depiction and understanding of body perceptions and how these might translate into symptoms and even treatments for patients (e.g. Jaswal and Harpham 1997, Kesby 2000). The use of "graphic elicitation" methods that reflect a limited number of responses as prompts can facilitate more focused outcomes and discussions in group environments (Aldridge et al. 2004). With respect to the latter, a visual approach that has great promise is "body mapping", which enables participants to visually ground their own health experiences, individually or with other group members who wish to share their own experiences (Gunther and Vogl 2010).

First used to document repetitive strain injuries and ergonomic issues (e.g. Corlett and Bishop 1976), body mapping has generated important outcomes as they relate to occupational health, and is now used to document and evaluate a much wider diversity of occupation-related injuries and diseases (Keith 2003). It can also be used to generate data that are comparable to clinically validated diagnoses. It was thus used to describe worker experiences at the Holmes Foundry, Caposite, and Insulation complex in Sarnia, Ontario. Documented illnesses included respiratory disease, respiratory cancer, asbestosis, and gastrointestinal cancer (Keith and Brophy 2004). These maps helped generate evidence that was used to argue for worker compensation, and indeed helped mobilize and empower affected employees and facilitate social change (Keith 2003).

Body mapping has also been used to document health impacts as they relate to environmental pollutants and community health. In a notable example, which is closely related to the one that confronts MCFN and ACFN, members of Aamjiwnaang First Nation live in southwestern Ontario close to Sarnia in a region widely referred to as "Chemical Valley" (MacDonald and Rang 2007). Using body mapping, they showed that community members were suffering from high rates of illnesses. Thus, 17% of adults and 22% of children had asthma; 25% of adults had high blood pressure or chronic headaches; 25% of children suffered from learning and behavioural problems; and 40% of women had experienced miscarriages or stillbirths (Scott 2010).

Body mapping generates important outcomes that are grounded in local-scale and, in at least one case, Indigenous experiences and worldviews, and are thus accessible, reflective of, and accountable to local priorities. These outcomes have also been used to help document illnesses that would otherwise be too restricted in scale to be adequately described in population-scale or epidemiological research. Moreover, as outcomes, they can be used to support further more comprehensive studies, proactive policy-making, advocacy, and indeed negotiated settlements that benefit those that have been adversely affected.

The overall goal of this component of the study was to document and better understand changes in community health and wellbeing as experienced by ACFN and MCFN members, especially as the changes relate to environmental decline. Our specific objectives were to:

i) describe the current state of community health and wellbeing;
ii) document any changes in health and wellbeing from the past;
iii) explore underlying causes of these changes, especially as they relate to declines in environmental health;
iv) explore possible individual, community, and institutional responses to any identified changes in health and wellbeing; and
v) characterize attitudes regarding the future health and wellbeing of these communities

9.2 METHODOLOGY

Our primary approach was one of mixed methodology, whereby quantitative and qualitative data were collected and evaluated (Creswell and Piano Clark 2007). When this research was originally proposed to the National First Nations Environmental Contaminants Program, we had anticipated that human hair and urine samples would be collected, and tested for heavy metals. However, it was ultimately decided by ACFN-IRC and MCFN-GIR that this approach was premature and unnecessarily intrusive, and that this testing, should it occur at all, would best follow a broader, more inclusive and cross-cultural exploration of health impacts.

An initial exploratory meeting was held with Elders and other community members in November 2012, where some of the health concerns and possible research approaches to address these concerns were explored. Eleven people participated in this three-hour meeting. Outcomes played a strong role in shaping the nature of the October 2013 health group discussions discussed below, and providing advice throughout.

A number of three-component group interviews were subsequently held over a three-day period, from Oct 15-Oct 17, 2013. The interviews were widely promoted in the community one week beforehand using posters that were displayed in a wide diversity of retail outlets and the band offices as well as through the local buy-and-sell. This approach resulted in a wide diversity of participation from MCFN and ACFN but also some participants from the Métis Local 125. Although the funding for our project arose from the First Nations Environmental Contaminants program, it was decided by the GIR and IRC that the involvement on the part of interested Métis community members was important, because they also make extensive use of country foods from the region and because many are family members and friends of the First Nations community members.

In total, 113 people participated in six group meetings: two on October 15, two on Oct 16, and two on Oct 17 2013. Generally, an afternoon and evening session was held on each of the three days, in order to best accommodate work schedules and other obligations. It was anticipated that Elders would prefer to participate in afternoon sessions, although all meetings were open to everyone. To keep the groups relatively small and intimate, meetings that were initially attended by more than 12 people were further divided in two sub-groups, resulting in a total of nine separate focus groups over this three-day period (two on Oct 15, one conducted with Elders and the other with adults and Elders; three on Oct 16, one conducted with Elders and two conducted with youth and adults; and four conducted on Oct 17, two with Elders and two with youth and adults). These sub-groups ranged in size from 7 to 12 people.

These group interviews consisted of three components: i) questionnaire; ii) individual body mapping exercises; and ii) wide-ranging group discussion. These research instruments were developed in collaboration with both GIR and IRC. They were approved by the University of Manitoba Joint-Faculty Research Ethics Board, J2011:055.

The first component consisted of a questionnaire that was ten pages in length and included both Likert-scaled and open-ended questions. It reflected the following themes: current state of individual and community health and wellbeing; changes in health and wellbeing compared to the past; possible causes of any changes in health and wellbeing; existing and future individual and institutional responses to these changes; and demographics, the latter including estimated employment in and possible exposure to pollutants associated with the Oil Sands.

The second component consisted of a body mapping exercise that prompted participants to identify ailments that they and immediate family members had experienced. Body mapping is often conducted as a group process, whereby participants locate their own ailments on a life-size shape of the human body. However, given community feedback, we decided that many of these ailments would be too sensitive in nature to be shared in a group environment, especially in context of a small community where all participants are well known to one another. Instead, a list of possible illnesses was included in the questionnaire and participants either used these lists to identify and map their medical history on an included diagram (front and back) of the human body or simply circled the relevant illnesses on the list. Illnesses were grouped according to cancers, other non-cancer ailments, autoimmune ailments; injuries; and worry and stress. Participants did this first for their own health and then for family members. They were further asked to identify any possible causes of these illnesses.

The third component consisted of a wide-ranging group discussion that elaborated on topics that had arisen over the course of the previous two components or, for that matter, any topic that participants felt was relevant to community health and wellbeing. Prompts that were used in part to focus the discussion when appropriate in part addressed three open-ended questions related to the questionnaire: changes in health and wellbeing; possible causes of these changes; and suitable responses to these changes.

Typically, each of the three-component group interviews took 2-3 hours to conduct, although one group comprising Elders lasted for four hours. Interviews were conducted at the ACFN Youth-Elder lodge, and transportation was provided to all participants as needed. Registrants were paid $150 each to participate, and also provided with refreshments and a meal at each meeting. Some Elders who participated spoke little if any English or French. Typically a younger participant helped translate the questionnaire into Cree or Dene for these Elders and provided interpretation during the group-discussion. Additional interpreters were hired as needed.

Feedback from the participants showed that these group interviews were highly successful, this in part reflecting the success of the outreach and the importance of and widespread interest in the topic. Indeed, many more people showed an interest in participating then we could accommodate. However, it was also expressly communicated by participants that meaningful follow-up by researchers was needed. Thus, three small-group sessions were held in Fort Chipewyan on January 21 and January 22 2014, which were designed to present preliminary outcomes and to facilitate feedback and further discussion.

A larger community meeting was also held in January 23 2014 along with a feast that featured country foods, where outcomes of the Phase Two project as a whole were shared with anyone in town who was interested in the outcomes. Finally, a three-hour, small-group session was held at the (Alberta) Health Canada offices in Edmonton on January 24 2013, where preliminary results were again presented and discussed with ~10 health agency staff from Edmonton and Ottawa. In addition to these focus groups, three follow-up interviews were conducted with group participants who wanted to share more experiences and concerns. Moreover, 36 interviews with both MCFN and ACFN members that had been conducted under the auspices of Phase One as well as another 11 interviews conducted as part of this phase were evaluated for health-related content.

Cancer data were subjected to additional quantitative statistical analysis. First, differences between our own study data were compared to those reflected in the Alberta Cancer Board study (Chen 2009). Using an approach taken in the 2009 report, cancer occurrence between Fort Chipewyan and a number of other communities were compared. Thus, Age Specific Incidence Rates per 100,000 were separated by age group and Age Standardized Incidence Rates per 100,000 were separated by sex. Values that were compared reflected cancer data from Fort Chipewyan as generated by this project as well as cancer data from Fort Chipewyan, Conklin/Chard/Jarvier, Fort McMurray, Fort Vermillion, Northern Lights Region, and Alberta from 1995-2006, as presented in Chen (2009).

However, extreme caution should be used when interpreting any differences between our data and those of the Chen (2009) study, in part because of the high proportion (>90%) of Indigenous participants in our focus groups. The nature of the sampling was also very different, which makes any meaningful comparison tenuous. The other studies reported the documented medical data for Fort Chipewyan as a whole, whereas our sample size was substantially smaller (n=94). Moreover, participants in our study were not randomly selected, and instead volunteered to participate. Finally, participants self-reported their medical records rather than using independently recorded and verified data as with the other study (Chen 2009).

Although these differences did limit meaningful comparison between the data sets, we feel that the strength of our approach (i.e. close community collaboration, mixed methodology, additional information on independent variables etc.) helped mitigate any limitations in comparison. Ultimately, however, we were able to circumvent these limitations, by examining in great detail the influence of independent variables on cancer occurrence among the participants in our study. Two modeling approaches were taken, one focusing on logistics (logit) analysis and the second focusing on AIC (Burnham and Anderson 2002).

Logit models are useful in that they establish the probability of various events occurring under a given set of conditions (Pindyck and Rubinfeld 1991). Logistic (logit) regression showed the influence of a wide diversity of independence variables on cancer occurrence in Fort Chipewyan.

In addition, we examined these relationships using Akaike's Information Criterion (AIC) difference with small sample bias adjustment ($\triangle$AICc). Akaike weights (w) were used to evaluate and select the model that includes the fewest number of independent variables to explain the greatest amount of variation (Burnham and Anderson 2002). The model with the lowest $\triangle$AICc is selected as the best from the set. Formal statistical inference was based on all of the models in the set as well as development of a set of *a priori* models from the literature and using insights arising from interviews with knowledgeable community members to identify the single best model (Burnham and Anderson, 2002). Akaike weights provide a normalized comparative score for all models and are interpreted as the probability that each model is the best model of the set of proposed models. Substantial support for a model occurs when $\triangle$AICc < 2. Cumulative AICc weights were then calculated for each independent variable thought to influence cancer occurrence by summing the AICc model weights of every model containing that variable (Burnham and Anderson, 2002). Variables with the highest cumulative AICc weights have the greatest influence on cancer occurrence.

The same set of independent variables was used for both modeling approaches. Cancer occurrence was treated as a binary and discrete dependent variable (i.e. yes if participant has had cancer, 0 if otherwise) (Table 9.12). Twelve independent variables viewed as potentially affecting cancer occurrence included the following: i) gender (a binary variable; 1 if participant was female and 0 if otherwise); ii) age (a continuous variable ranging from 16-78 years of age; iii) perceived quality of health care in Fort Chipewyan (ordinal variable, scale 1 (really disagree) – 5 (really agree)); iv) perceived role of traditional foods in affecting health within Fort Chipewyan (ordinal variable, scale 1 (really disagree) –

5 (really agree)); v) perceived role of the Oil Sands in affecting participant health (ordinal variable, scale 1 (really disagree) – 5 (really agree)); vi) perceived role of stress in affecting health within Fort Chipewyan (ordinal variable, scale 1 (really disagree) – 5 (really agree)); vii) perceived role of smoking in affecting participant health (ordinal variable, scale 1 (really disagree) – 5 (really agree)); viii) perceived role of Bennett Dam in affecting health within Fort Chipewyan (ordinal variable, scale 1 (really disagree) – 5 (really agree)); ix) experience working in the Oil Sands (binary variable, 1 if worked in the Oil Sands, 0 if otherwise); x) frequency of consumption of traditional foods (binary variable, 1 if participant eats traditional foods at least 2-3X per week, 0 if otherwise); xi) frequency of consumption of locally caught fish (binary variable, 1 if participant eats locally caught at most 1X per six months, 0 if otherwise); and xii) average amount of time (days) participants spends on the land (calculated as the average number of days the participants spend on the land the previous year, 10 years before, 20 years before (if appropriate) and 30 years before (if appropriate)) (Table 9.13).

These 12 independent variables were tested for multiple collinearity using Pearson's correlation indices. Because none of these correlations had $r > 0.7$, all 12 of the original independent variables were included in the logit and AIC modelling. The relationships among these independent variables were also evaluated and used to better understand their importance in affecting health (Table 9.18). For each independent variable, the mean and standard error are also reported separately for those who have contracted cancer and those not (Table 9.12).

Qualitative data arising from the group meetings, qualitative responses to open-ended questions in the surveys as well as individual interviews were transcribed in their entirety. These data were coded using NVivo (QSRI 2014) and any emergent themes identified. All Likert responses were entered into spreadsheets and evaluated for quality and any errors. Means and standard errors for Likert-scale data were calculated as were the proportions of participants that at least somewhat agreed (agree, strongly agree) or somewhat disagreed (disagree, strongly disagree), thus eliminating any neutral responses. Topics that had been raised in group interviews were identified and numbers of mentions regarding each topic were recorded.

9.3.1 STATE OF HEALTH: NOW COMPARED TO THE PAST

Participants were generally greatly concerned about the state of their own health and wellbeing, and that of their community. The great majority (91.0%) indicated that *"I worry about the current state of health of my community*" (x = 4.63, SE = 0.09) and 90.0% similarly indicated that "*I worry about the current state of health of my family"* (x = 4.59, SE = 0.10) (Table 9.1),

> Oct 17, SR: "*I couldn't believe it from 1970 until now. In 1979, my mom passed away. All the* [cemetery] *plots were all open right against the fence. That's where my mom is buried. Now, the open area there is all full. There was not that much graves before but today, holy shit! I can't believe it! But young people die of heart attacks. Many years ago there was nothing, no cancer, no nothing…But today it's not like that. There're so many things that have been going wrong since 1952. Today, I can't believe it. A lot of people my age, younger than me. All died out!*"

Fig 9.1. Cemetery of Fort Chipewyan in foreground, and community school in the back.

Most (77.4%), albeit to a lesser degree, also indicated that "*I worry about the current state of my own health"* (x=4.14, SE = 0.13) (Table 9.1).

Participants recognized that the general health and wellbeing of residents in Fort Chipewyan had declined. Thus, most (73.9%) agreed that the *"health of my community is lower now than 50 years ago"* (x = 4.22, SE = 0.14). Almost half (47.7%) disagreed with the statement that *"I am healthier than my parents were when they were my age now"* (x = 2.89, SE = 0.16) (Table 9.1).
As one participant indicated,

> Oct 17, BR: *"You know in the years back, when I first came here in '69. The people weren't sick, like now days. The older people lived longer years back then. Today, people are dying younger…And way back then, when they died young it was mostly accidental. It was never natural causes."*

On one hand, elderly community members seemed to be especially vulnerable to many of the environmental changes associated with upstream industrial development,

> Oct 16, SR: *"I remember growing up, we had a lot of old people. Now there is just a few old people. Now there is lake shore here, straight grass. I remember years ago there used to be water straight to the sand, just sand beaches. Those days, growing up, a lot of old people around, just old people, before they make that dam. Now it's just everybody that is getting affected by it."*

Yet other community members also seemed to suffer from illness in ways that never occurred in the past, especially youth and children. Some felt that the health of children would only further decline in the future,

> Oct 15, SR: *"It is a pretty scary thing, to be honest, when you see a bunch of your family members and your friends passing away. That would more in the next 20 years from now. Like little infants and stuff you know. It will be way worse than it is now. I think it's really the scariest thing to be honest."*

Outcomes of the body mapping exercises show that a wide diversity of illnesses had been experienced by participants, totalling 267 non-cancer illnesses and 23 cancers, or 290 illnesses in total (Table 9.2). These ailments were mapped and made available to community members in accessible visual formats (Fig 9.2, Fig 9.3). Neurological illnesses were most common (n=61), which in descending order included sleeping disorders (n=13), migraines (n=9), stress (n=7), strokes (n=6), depression (n=6) and anxiety (n=6) (Table 9.3). Respiratory illnesses were the second-most common (n=56), which in descending order included tuberculosis (n=13), allergies (n=9), shortness of breath (n=7), asthma (n=7), pneumonia (n=5), bronchitis (n=5), and lung cancer (n=2) (Table 9.4). Circulatory illnesses were the third-most common (n=46), and included hypertension (n=22) and heart coronaries (n=18) (Table 9.5). Arthritis was fourth (n=32) and gastrointestinal illnesses were fifth-most common (n=30), and included gallbladder disease (n=6), ulcers (n=6), liver disease (n=3), colon cancer (n=2), and stomach cancer (n=2) (Table 9.6). Reproductive illnesses were sixth-most common (n=19), including miscarriages (n=8), breast cancer (n=4), prostate cancer (n=2), and cervical cancer (n=2) (Table 9.7).

When asked which illnesses had increased most in prevalence in Fort Chipewyan, everyone saving one person (96.7%), affirmed that cancer had increased the most of all those illnesses that were used as prompts in the questionnaire (x = 4.91, SE = 0.05) (Table 9.8),

> Oct 17, BR: *"I came with, something on my mind that has been bothering me about the health of the community, some things that I have been seeing that I wanted to discuss. Like the rate, increase of cancer. It's getting to younger and younger ages, more and more people. I keep hearing 'oh its hereditary'…So of those hereditary people who have been those for years and years and years and never had cancer in their family until recently. And then boom boom, boom – three, four, five of them. I've got cancers coming out of my ears."*

Indeed, cancer was the most frequently raised illness in focus group meetings held in October 2013 (Table 9.9). Cancer is prevalent now and has dramatically increased in frequency from the past, especially as it related to younger community members, *"Oct 17, SR: "Well in the past 15 years maybe 10 years or whatever. In Fort Chip there has been a lot of people that have died of cancer. So where all of sudden does it come from? What is it from, is it from the pollution or is it from the water, or the food or whatever? If you went to the church, and you went to see that wall, where people, they have cards of people that have died. The majority of them died of cancer, or lupus, or whatever- some cancer disease. And why is it so high now? It never used to be like that long ago…I don't know, I don't know for sure. I am 40, 40 years old, and that's how it's been. But now in our younger generation, look how many of our young people have died of cancer."*

At times it seemed like everyone we interviewed and spoke to in Fort Chipewyan had been affected at some level by cancer and at progressively younger ages,

Oct 16, SR*: "One way or another we're all touched. It is either a family member or a friend. Like I said, everyone knows everyone in Chip, and we're so close here, and, one family is hurt, we all hurt. One way or the other, it all hurts...So cancer is a big issue here for us. We keep saying it is industry, industry and I know down the road like industry has a big claim, but yet they won't admit to anything. But yet we still live with it. We don't really have a choice because we live downstream… And like it is not only our Elders, it is our youth too."*

While cancer levels have definitely increased in Fort Chipewyan, they were also seen as increasing elsewhere, especially in communities that are even closer to the epicenter of oil sands development,

Oct 15, SR*: "And looking at the surrounding areas too, Fort McKay is one the closest one that is closer to the industries and you can see a high rate of cancer there too."*

Of the 94 community members who participated in the mapping study, an alarming 21.3% (20) had suffered from 23 identified cases of cancer, 10 of these contracted by male and 13 by female participants (Table 9.10). These cancers were mapped and made available to community members in an accessible format (Fig 9.3). The most frequently occurring cancer was breast cancer (four cases), which were of course all contracted by females and there were three unspecified cases of cancer, all contracted by males (Table 9.10). In turn there were two cases each of the following types of cancer: lung, cervical, colon, gallbladder, kidney, prostate, and stomach. Finally, there was one case each of bowel cancer and cholangiocarcinoma (Table 9.10).

We compared these cancer data to those collected from governmental medical record data for Fort Chipewyan, other communities and regions in northern Alberta, and Alberta a whole as reported in Chen (2009). More specifically, our results for Fort Chipewyan were compared to medical record data for Fort Chipewyan, Conklin/Chard/Jarvier, Fort McMurray, Fort Vermillion, the Northern Lights Health Region, and Alberta (Chen 2009). Some meaningful differences emerged, although as we describe below, caution should be used when interpreting any differences between the two data sets. The Age Specific Incidence Rates from our study appeared to be higher than the medical record data at 20-54 yoa and >55 yoa age categories for all the other communities and regions (Table 9.11a). Moreover, the Age Standardized Incidence Rates for males, females, and as totals from our study also seemed to be higher than those from the other locations (Table 9.11b). These differences may be real, but the differences between the two Fort Chipewyan data sets, at a Confidence Interval of 95%, suggests there may be other factors at play.

The medical record data may be incomplete or of poor quality. Indeed, we have yet to see any

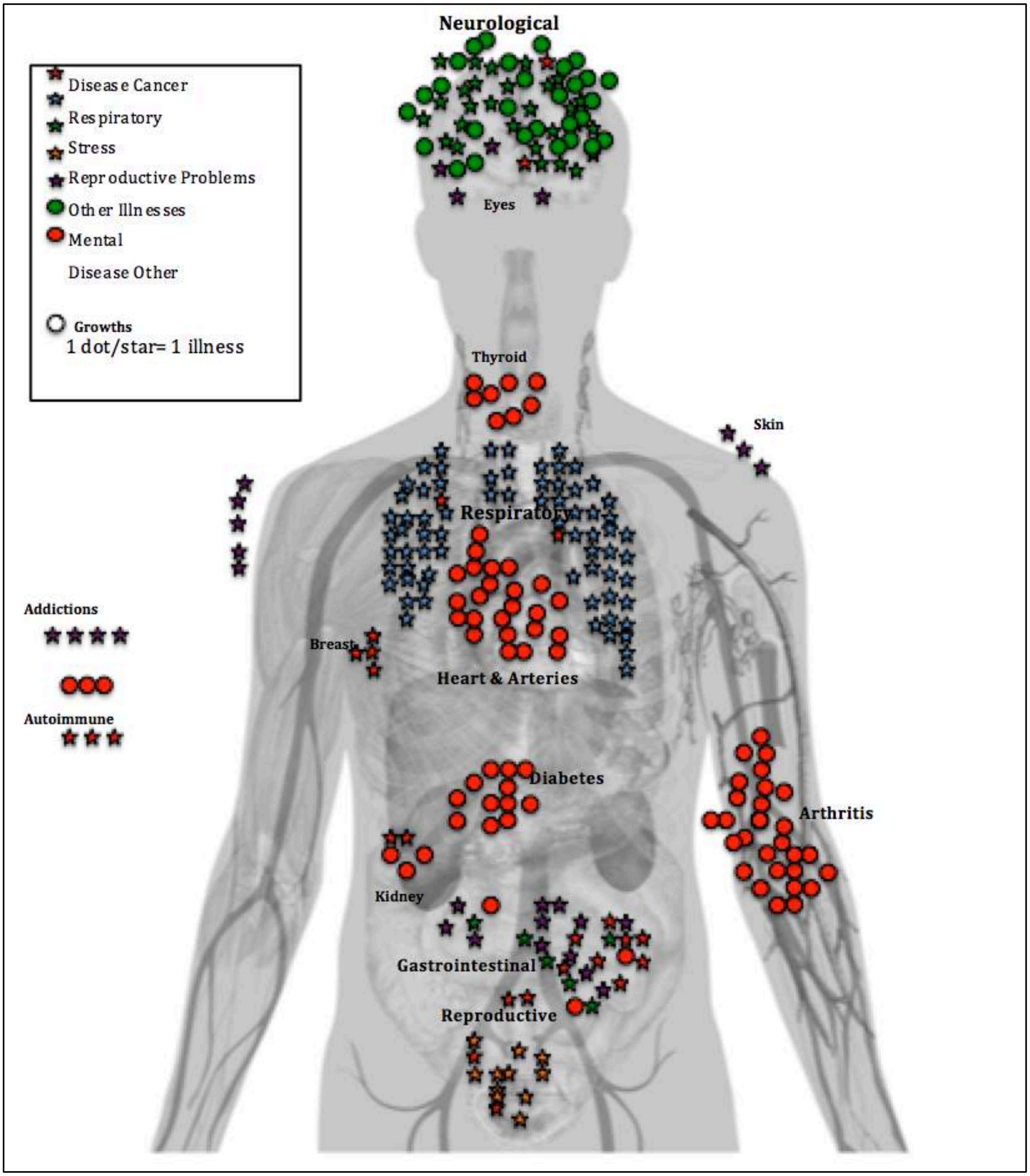

FIG 9.2 Body map showing distribution of all illnesses reported by the health study participants (n=94).

thorough evaluation or triangulation of these governmental data with those from other sources. Moreover, the participants in our study were not randomly selected. Instead, we promoted the health focus groups using posters in high-traffic areas and the local buy-and-sell website. It is possible that cancer survivors were especially highly motivated to participate in, or for that matter, likely to avoid our study, and were thus misrepresented. Youth were also under-represented in our study and no children participated at all, although typically cancer is much more rare among children. Yet, over 10% of the total population of Fort Chipewyan participated and many others (~50) were not accommodated because of our limited resources, so sampling bias is unlikely to be an issue.

These limitations can be partially addressed, if our study expanded into a third phase and as more people from the community participated. At that time, we could also get more detailed information on that nature of the cancer, any treatment, and the time of diagnosis. The latter would also facilitate comparison between the two data sets. It is also possible that this approach could be extended to other communities, allowing for more meaningful comparison. That said, it is questionable if these data sets would ever be comparable. Some sizeable portion of residents who had contracted cancer in the past 12 years would not have survived to participate in our study, under-representing the number of cases and perhaps affecting the types of cases that were reflected.

Another limitation to meaningful comparison is the composition of the participants, which affects both data sets. The great majority (95%) of participants in our study were Indigenous, and 89% were First Nation. In general, First Nations, including Albertans, have lower cancer rates as a whole and lower rates of leukemia and breast cancer than those that are non-Indigenous (Chen 2009). In contrast, rates of the rare cholangiocarcinoma is 2X that experienced by non-First Nations (Chen 2009). That observed rates documented in the 2009 report for Fort Chipewyan residents were not significantly different (within a 95% Confidence Interval) from non-First Nations Albertans and from other northern communities that were used for comparison, lead Chen (2009) to assert that there was little evidence to support community concerns. Indeed, they argued that total number of cancers observed in Fort Chipewyan was actually lower than found in Fort McMurray and the Northern Lights Health Region and most cancers fell within expected ranges. This was the case for the 2014 study as well, which found no differences in the total number of cancers among comparison communities (Anon 2014b).

Ultimately, these limitations were great enough that we chose instead to focus on the influence of selected independent variables on cancer occurrence in our data alone (Tables 9.12, 9.13). This also addresses a major shortcoming of the medical record data – the absence of any context or underlying factors that might explain differences in cancer occurrence among communities or over time. We discuss these analyses in detail below (Subsection 9.3.2. Primary Causes of Changes in Cancer Occurrence).

Moreover, there are also some potential limitations to our mapped data. It might be argued that participants may have been mistaken with respect to their past cancer diagnoses or even exaggerated their health situation. This is highly unlikely, given the close relationships most participants had with one another, the seriousness with which this topic is approached, and the demonstrated reliability of the Traditional Knowledge throughout this project and in northern research as a whole. It is also lessened by the triangulation and close similarity between these quantitative data and the qualitative data that emerged from the interviews. Moreover, many participants indicated an interest in accessing and providing their medical record data from the appropriate governmental agencies at a later date, which would allow for the comparison and evaluation of both data sets.

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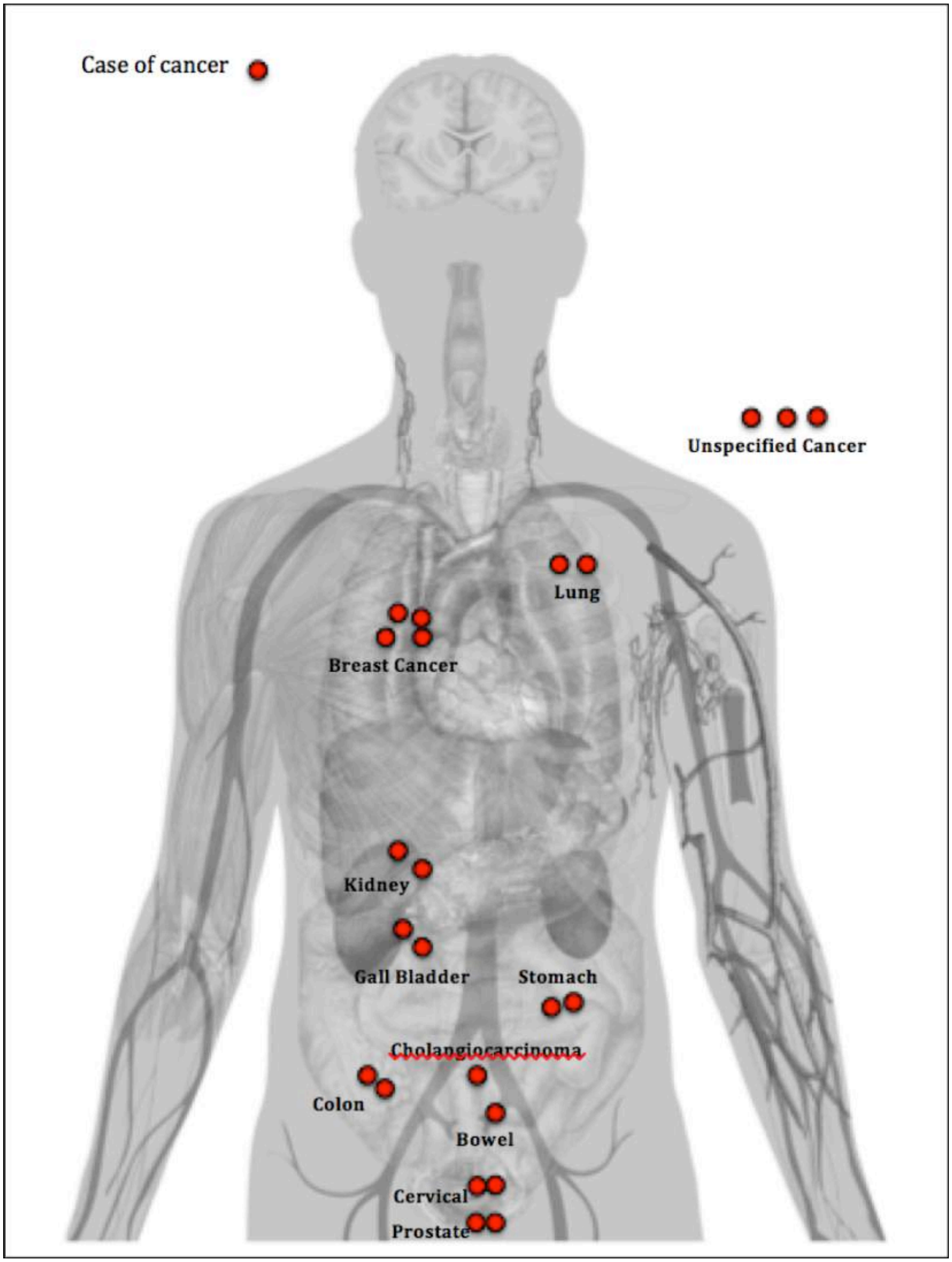

FIG 9.3. Body map of distribution of the 23 cancer cases reported by the health study participants (n=94).

FIG 9.4. Wall display in St Paul's Catholic Church in Fort Chipewyan showing community members who have died over the last 20 years.

That 21.3% of participants had suffered from cancer at least once demands follow-up research. This, in part, might be achieved by working more closely with this group of participants, comparing all 20 of the cancer survivors with an equal number and age distribution of non-cancer participants, and evaluating incidence as it relates to family history, occupational exposure, and environmental exposure among other factors. The study could also be expanded to include at least another 100 participants, ~50 whom have already shown interest in participating in this project.

Moving beyond cancer, other diseases that most (>82%) participants recognized as having increased in prevalence included type 2 diabetes (x = 4.75, SE = 0.10) and heart disease (x = 4.71, 0.09) (Tables 9.8, 9.9),

> Oct 16, SR: *"Well, my buddy lost, well basically her feet, they had to cut, amputated her feet. Most of her feet, and then her fingertips they had to cut off, because of her being scared of going to that doctor to get it checked out. Well, it was too late by then, they caught it and they had to amputated whatever".*

Diabetes was the most frequently discussed illness in focus group meetings held in October 2013 (Table 9.9). Increases in type II diabetes, obesity and heart disease are recognized as widespread in many Indigenous communities across northern Canada, such that these increases in diabetes have been described as an "epidemic in progress" (Young et al. 2000). The increases are commonly attributed to changes in diet and lifestyle (AHW 2006, Haman et al. 2011).

Asthma was also viewed by the great majority (88.8%) as having increased in prevalence (x = 4.66, SE = 0.08) (Table 9.8),

> Oct 17, SR: *"sometimes at five, if I sit like this, I'm good. As soon as I start moving, as soon as I start walking on the stairs, that's killer. I have to stand there and wait until I really catch my breath. And the only time I can really do that is when I'm on my oxygen…But I'm on the machine all day long at home, I drag that tube around all over the place"*

Many (79.1%) indicated that stress (x= 4.38, SE = 0.11) had also increased in prevalence (Tables 9.8, 9.9). Some felt that previous generations had suffered little from stress,

> Oct 16, SR: "*That's one thing that I noticed that I have a lot of stress. I am stressed out steady. My kids stress me out, and my woman stresses me out* [laughs] *....My dad, when he was 50 years old, it's the only time he started getting grey hair, cause he never ever worried about nothing. When he wanted to do something, he did it. And he never talked about it first, he just went and did it... He didn't care, he was a happy go lucky guy. Which for me, like I said I am always stressed out. That's why I think I drink beer every day. It's hard to think about. I watch my UFC. I am just like here, lay around in bed and watch TV*."

Many (74.7%) participants had also observed increases in the prevalence of arthritis (x = 4.42, SE = 0.10) (Table 9.8). This was especially true of rheumatoid arthritis, which is recognized as an autoimmune disease. Another autoimmune diseases that was of special concern for many and that was also seen as occurring at elevated levels in Fort Chipewyan (AHW 2006) was lupus,

> Oct 17, BR*: "A lot of cases of lupus now. We have two cases of ALS, my sister was one of them, she had the first case back in 1997. And now there is another case, in just a small community of just 1200 people. There's two cases, the other one is still dealing with his case. Lots of lupus."*

Finally many (73.3%) also indicated that obesity (x = 4.37, SE = 0.12) had also increased in incidence (Table 9.8), this associated with changes in lifestyle among community members, especially children,

> Oct 17, SR; Partic1: "*Yeah you're right, I've got pictures from the school in the 70s. Every kid, there was no overweight kids, there was no fat kids, except* [***]*, she was the only one. And there were no overweight kids*."
> Oct 17, SR; Partic2: "*Yeah and the games, the* [video]*games are just making the kids stay home. Some of them don't even go to school, they play their games at home*."

A number of other illnesses were identified by participants as having increased substantially in prevalence but had not been explicitly indicated in the questionnaire. These included cysts,

> Oct 17, BR: "*And there are cysts too, everybody gets cysts all over the place. You know, they pop in their breast, they pop in your ovaries, they pop up in your pancreas, they pop up all over the place, cysts."*

Non-cancerous fibroids were also seen as increasing,

> Oct 17, BR: "*It seems like there is a lot of reoccurring illnesses like, she mentioned fibroids, like there's at least three of my nieces that all got them. Two of them got a mole, yeah and then I have one too. Like I just got diagnosed not long ago that I had a fibroid, and then my other niece got diagnosed with another fibroid. And they're not cancerous."*

Likewise abscesses had increased in frequency,

> Oct 17, BR: "*But there has also been other illnesses and diseases that I have seen in this community that have caused me to raise my eyebrows and say – something has got to be looked into. Like, for example, abscesses. There has been a lot of people going into the clinic with large abscesses, to the point to where they are huge, where they've actually need to be on IV antibiotics. I had to go in with one right here on my eye. And at that time there was three other people in there with the same thing. And I 'm sitting there 'how many people is that?'"*

These abscesses, at least, seemed to cut across generations and family lines and any shared behaviours,

> Oct 17, BR: *"And these three people all had it about the same time. They are all from different walks of life. One's an Elder, one's my age, and one was a 13 year-old girl. None of them are connected genetically. None of them are connected as far as being around, or hanging around with each other where they might have picked it up from each other. And it's reoccurring, and it's reoccurring, in the same spots."*

Skin rashes such as eczema and psoriasis were also seen as having increased in prevalence. Indeed, skin problems were the second-most frequently raised illness in focus group meetings held in October 2013 (Table 9.9). At least some of the time they seemed to reflect local environmental conditions,

> Oct 17, BR: "*I have noticed a lot of people have started to complain about skin rashes, like eczema, or what ever that they got later in life. You know what I was told by a doctor, that it was psoriasis. Yet, I go to my mom's, who lives in the St. Paul area. And her water that she uses is direct from the ground. Well water, natural spring water coming right from her well. So, there's no chemicals going into whatsoever. It clears up, my rash clears up, it goes away. I come back, within two weeks of using a shower in my bathroom, it's back again. It burns. I cry sometimes when I jump in the shower just to rinse off."*

The occurrence of these skin ailments also affected others, notably newcomers to the community,

> Oct 17, BR: "*And I know a lot of people are having the same problem, I've heard a lot of it. Some of them are people that have never been here before, that just came up for seasonal work…a couple of the RCMP wives, came up here and started developing psoriasis."*

Kidney disease was also observed as increasing in incidence,

> Oct 15, SR: *"You have to go for dialysis, and it's pretty sad seeing anybody on that. People have been donating their kidneys, and then their kidneys are not, the body is not taking to the kidneys that the family members lend. So now, right now, I know a couple of people that are going on dialysis. That's what it is called. They go out of town and cleanse their body out three times a week."*

9.3.2 PRIMARY CAUSES OF CHANGES IN CANCER OCCURRENCE

All participants indicated that cancer rates were increasing in Fort Chipewyan, and for the most part seemed more concerned about these changes in cancer than any of the other illnesses that were discussed.

Most also recognized that these relatively recent declines in community health and wellbeing were inextricably linked to corresponding and also recent declines in the quality of the environment,

> Oct 16, SR: [translated] *"The big changes, she's seen, is that long ago there was no such thing. Fort Chip didn't have no illnesses like now. You know, like we have cancers and everything, all kinds. Long ago there was none. And now with everything that's happening, we figure it's from the food or the water, whatever…Fort Chip has a lot of sickness, all kinds of diseases. That's from the environment."*

With respect to this report, we focused our analysis on the cancer data, in part because this issue is of paramount concern to the community. More specifically, we modelled the impacts of various independent variables on cancer occurrence using the data that arose from the participatory body mapping exercises. Some of the independent variables were identified using the literature (e.g. age, gender, stress, smoking) but many were identified and refined using the insights and direction that emerged from the interview-based Traditional Knowledge.

The full model has significant ($p<0.001$) and substantial explanatory power for cancer occurrence (Table 9.14). Its ability to predict the results was thus very high, successfully predicting the occurrence of cancer 85.7% of the time.

Of the various independent variables we used, age was identified as significant ($p = 0.030$), such that the rates of cancer occurrence increased with age (Table 9.14). This positive relationship between cancer and the age of lab animals and humans alike is widely recognized (Anisimov et al. 2009). Gender was also significant ($p = 0.019$), such that woman were more likely to suffer from cancer then men (Table 9.14); indeed, women had suffered from 13 cases and men from 10 cases of cancer and breast cancer emerged as the dominant form of cancer among participants (Table 9.10). The prevalence of breast cancer is not surprising, as it is the most common type of cancer and the greatest cause of cancer-related mortality for women around the world (Hortobagyi et al. 2005), although Indigenous women generally show lower incidence of breast cancer than the larger population (Espey et al. 2007).

Importantly the Oil Sands had a substantial and statistically significant effect on cancer occurrence. This reflected both direct and indirect exposure, the latter mediated through wild-caught traditional foods. It is the first time that this relationship has been shown anywhere, and is also important as it affirms the long-standing community concerns and insights regarding these declines in health.

Participants that had worked or were still working in the Oil Sands were significantly ($p = 0.069$) more likely to contract cancer than those who had not worked there. Similarly, cancer survivors were significantly ($p=0.002$) more likely to agree with the statement that the "*Oil Sands are an important cause of declines in my health*",

> Oct 17, SR: *"In Fort Chip, there has been a lot of people that have died of cancer. So where all of sudden does it come from? What is it from? Is it from the pollution or is it from the water, or the food, or whatever. If you went to the church, and you went to see that wall, where people, they have cards of people that have died, the majority of them died of cancer…some cancer disease."*

Although we had also asked for some additional information regarding employment, including the number of years worked and to what degree participants had ostensibly been exposed to contaminants during their employment, we ultimately treated oil-sands employment as a dichotomous (i.e. yes, no) variable. This in part reflected the limitations of our sample size. It also indicates the importance of follow-up research that would work with participants to generate more detailed descriptions of work history, overall diet, lifestyle, familial relationships, and other information that would help explain any differences in cancer occurrence among participants. Ideally, this additional information could be documented as part of a third phase of this health research.

Cancer survivors were also significantly (p=0.002) more likely to view the Oil Sands as an important cause of decline in their own individual health (Table 9.14). In contrast, the Bennett dam was seen as having a minimal (p=0.134) effect on the health Fort Chipewyan residents, although its environmental impacts have been substantial, as we described in Chapters 3, 4 and 7 (Table 9.14).

Environmental contaminants also seemed to have an important albeit indirect effect on cancer occurrence, as mediated through traditional or country foods. Thus, participants that ate traditional food frequently (i.e. >2-3X per week) were significantly (p=0.006) more likely to contract cancer (Table 9.14). Cancer survivors were also significantly (p=0.002) more likely to view traditional foods as a major cause of their own health. It is also important to note that those who rarely ate locally caught fish (i.e. never or at most 1 X per six months), were significantly (p=0.034) less likely to contract cancer (Table 9.14). Indeed, there was widespread concern about the safety of fish caught in the Lake Athabasca,

> Oct 17, SR: *"I don't think you would see all the lesions and what not on the fish on the inland lakes as you would at Athabasca River and the lake."*

To better understand whether there was a general relationship between time spent on the land and cancer occurrence, we asked participants to document the amount of time (days) they had spent on the land in the previous year, 10 years ago and where age-appropriate, 20 and 30 years ago. However, no such relationship was evident, as the average number of days each participant had no significant (p=0.410) effect on cancer occurrence (Table 9.14).

Other studies have examined cancer rates among oil production workers, finding they had a higher risk of dying from all cancers and lung cancer and, for long-term workers, from acute myeloid leukemia (Divine and Hartman 2000). Likewise other studies have shown that uranium mine workers have increased risk of leukemia, and lung, gallbladder, and biliary duct cancers (Tomášek et al. 1993, Möhner, et al. 2006, Leuraud et al. 2007), most of which were found at elevated levels in our study as well as Chen (2009).

Admittedly the Chen (2009) study does include a sizeable subsection on the implications of "living next to an oil field", where it reviews the literature, noting similarities between its own findings and those of other studies, but it ends on a particularly weak note given the heightened concern about the Oil Sands as a possible cause of this decline in Fort Chipewyan. Indeed, the final paragraph if this much awaited study indicates that it did not explicitly investigate the role of the environmental exposure in developing cancer,

> "*Whether people living in Fort Chipewyan have an increased risk of developing cancer is still not clear. This study did not investigate the association between the risk of cancer for Fort Chipewyan residents and the effects of possible environmental exposures. Health concerns voiced by the Fort Chipewyan community, the existing evidence about the potential environmental contaminants in the area, along with an absence of a general increase in cancer rates in the comparison communities, justify further investigations that would include the analysis of many potential risk factors, such as lifestyle risk factors, family history, as well as occupational and environmental exposures. Future work on cancer investigation and control needs to be part of the overall assessment of health status in the community.*"
>
> Chen 2009, p44

The Chen (2009) report thus ascribes these changes to lifestyle, socio-cultural factors and genes. Although environmental contaminants were included in an otherwise long list of factors, other causes were given much more attention, notably smoking, obesity, changing diet, and physical activity. Other factors were also seen as indirectly affecting these outcomes: random chance, increased likelihood of detection, and (finally) increased risk. It is also curious that the 2009 report downplayed the role of environmental exposure due to the absence of childhood cancers in the community (p44). Of course, the recommended health study has yet to be acted upon by either the provincial or federal governments.

Other factors also affected cancer occurrence. Thus, stress and worry played a significant (p=0.017) role. Cancer survivors were more likely to view stress as an important cause of poor health in Fort Chipewyan. Stress and worry was wide-spread within the community, at least in part related to the cancer crisis,

> Oct 16, SR: "*I've got one more word about health. Lots of people are scared to see a doctor, if they realize that they have cancer. People should get a check up now and then to be on the safe side. Nothing was ever done like that before here. Because you see the people here, some old people, they're scared to see the doctor. They are scared even for their health.*"

A recent meta-analysis argues that stress-related psychological factors do affect cancer occurrence and survival (Chida et al. 2008). As the quote above indicates, these factors (ironically) might include the stress and worry associated with fast-expanding Oil Sands development and its impacts on human wellbeing.

Participants were also asked whether smoking had an effect on cancer occurrence. They felt that smoking had no significant (p=0.804) effect on cancer occurrence. Finally, cancer survivors were significantly (p=0.002) more likely to agree that, "*the quality of health care that I receive in Fort Chip is excellent.*" (Table 9.14). These positive sentiments, at least partially reflected the central role that local health care providers had played in the diagnosis and eventual treatment of their cancer,

> Oct 17, SR: *"To me being a survivor of breast cancer, everyday is a blessing, you know and the health care that I received from the time I was diagnosed till I was done with all my treatments, you know, I went to the cross, I went to Fort McMurray…But, as a whole like the health, the people here, They're awesome doctors: great. And you know I know what people think about the paramedics but you know in a way they are blessing."*

Indeed, when AIC regression analyses were run, all of the independent variables that had been selected, except for the perceived impacts of the Bennett Dam on community health, the amount of time spent on the land, and perceived importance of smoking for individual health, emerged as being important (Table 9.15). Our use of these complementary approaches to regression analyses acts to triangulate and thus give added credibility to and confidence in the outcomes.

The best fit model that best explained the occurrence of cancer incorporated eight of the 12 selected independent variables: age, gender, perceived role of traditional food on community health (TradFoodHealth), perceived quality of health care in Fort Chipewyan (HealthCareFC), perceived impacts of the Oil Sands on community health (OilSandsHealth), perceived importance of stress in community health (StressHealth), whether participants had worked in the Oil Sands (OilSandsWork), how frequently participants ate traditional food (TradFoodFreq), and how frequently participants ate locally-caught fish (LocalFishFreq) (Table 9.16). Thus, in summary, the amount of traditional food consumed and whether people worked in the Oil Sands both had important implications for cancer occurrence.

9.3.3 PRIMARY CAUSES OF CHANGES IN GENERAL HEALTH AND WELLBEING

Although cancer is of clear paramount concern to many community members, these changes exist in a broader context of overall community health and wellbeing, which is also important to explore further. Thus, participants were also asked to identify possible causes of general declines in health, at both the level of the individual and for the entire community (Table 9.17). As indicated above for cancer occurrence, the largest majority (81.6%) indicated that the Oil Sands were an important cause of any observed declines in overall individual health (x = 4.33, SE 0.13) and likewise (82.6%) for changes in community health (x = 4.68, SE = 0.11) (Table 9.17). Health and wellbeing was only seen as declining further as the presence of the Oil Sands continued to expand,

> Oct 15, SR: *"We keep saying it is industry, industry, and I know down the road like industry has a big claim, but yet they won't admit to anything. But yet we still live with it. We don't really have a choice because we live downstream. And the only way we can go about it is day-to-day and hopefully we can come face-to-face on how and where it is coming from. But we all know deep down inside where it is coming from. It is sure not coming from Mother Earth or her god or whomever. It is coming from somewhere and it is coming fast."*

FIG 9.5. Collecting seagulls for testing following large-scale kill-off.

Some of these changes in health also reflected the direct effects of pollutants in the water,

> Oct 15, SR: *"I have noticed kids swimming down the hill and then they come back and they have sores on their faces. Little red dots like chicken pox. They are all over, and break some puss on some of them. They go to the dock and the beaches. They go down to the big dock mostly. It could be swimmer's itch. It is all that oil gas, everything on there, all that mud and whatever and oil you see. It is pretty pathetic down there."*

Likewise, many of the pollutants from the Oil Sands were seen as being airborne and waterborne, and were noticeable by their smell and taste to residents,

> Oct 16, SR: *"Because of all the plants and what they were, even in the air, all that shit flies over here when you get a south wind. If you get up early in the morning, and you want to breath nice fresh air but really it's all from the plants. You can smell that sulphur and whatever they burn off and then, and then all that gets into our rivers"*

Some participants further identified the water treatment conducted by industry as being inadequate for dealing with many of these environmental contaminants. Extreme events such as chemical spills were seen as highly problematic,

> Oct 16, SR: *"When they had the oil spill on the river, they shut our pumps off, so that way they don't suck any more water in, until it was cleared up and what not. Then they put it back on again. So you had to save your water, and I had a bunch of freakin' plastic tubs all over, full of water!"*

This was also seen by some as true for the local municipal water treatment that had inadequate filtration systems for dealing with contaminants,

> Oct 17, BR: *"…plus all the stuff from upstream is coming down, so we are getting everything from Syncrude, Suncor. All coming down that river.,.and we drink the water from the lake here. And of course, sure it goes through a filter and it's going through that filter system. But how good is that filter system that they have here? We don't know those contaminants."*

Although the waterborne and airborne pollutants emitted by industry were widely seen as a direct threat to human health, there were also many indirect impacts associated with pollutants in the country food,

> Oct 16, SR: *"Everybody knows that, not just me, that animals have a higher cancer rate, in Fort Chip, it's a small community. Based on studies that they have done in the past...Oil Sands, and having an effect on the environment, and the animals, even the amount of food we have to eat. Like we got to watch the amount of fish we eat. Get pregnant and they won't have their children, stuff like that. And in my family, we, everyone, has experienced cancer, cancer. And I imagine every family member here, every person had been affected one way or another by the Oil Sands."*

These concerns arise from the still-prevalent use of traditional foods by most people in the community, as was shown in the previous chapter that focused on the role of country foods in diets (Chapter 8),

> Oct 17, BR: *"Yes, because that* [the Athabasca River] *is where the pollution comes in, and that's what we eat here. But we eat the animals when we use the water, nobody knows what's, what you're drinking, what you're eating. It might be polluted animals, you know. Our water is all polluted, sure it is."*

Participants observed the impacts of the contaminants on much of the wildlife, reflected as lesions, growths and tumours, especially in fish, and attributed these to the Oil Sands. They, in turn, saw the deep connections among wildlife, a food web that obviously included humans,

> Oct 17, SR: "*We go to fishing quite often, Almost every time we went fishing last summer, we caught a fish that had a great big growth on it. And it's more common you know, to pull a jack, you know, a pike, that's about that big with a great big growth like this on the side. So what do we do? I mean, we feed an eagle, does the eagle get sick? I Don't know, but we sure don't eat it."*

FIG 9.6. Healing Walk protest in the foreground and Oil Sands development in the background.

Yet, it is also critical to note that the Oil Sands have come to play a central role as the primary and direct source of employment and income for many community members over the last 20 years. Many work directly in the operations themselves whereas others benefit indirectly from the opportunities that the Oil Sands provide,

> *Oct 15, SR: "Well there has been a lot of people working in industry for a long time. It's a way of life, it's income, money for families. Because I don't think industry is going away... They don't ever stop the oil business since 30 years ago. Basically you fished in the lake, and trapped in the winter, trapped and fished, that's all it was. And you would get a handful or maybe 10 people that worked at Syncrude. That was it, out of 1,000. You know what I mean? There is a big difference, because now you've got about 300 people working out there*"

This effectively puts the community on a collision path, between the upstream benefits that the Oil Sands provide for some, in the short-term at least, and the downstream impacts and risks that these same industries create for all community members living in Fort Chipewyan. Although tensions sometimes arose between these two groups, it is essential that the communities themselves generate their own responses to these difficulties, rather than simply adopting solutions that are generated from outside by government and industry,

"…because we know the size of the industry is so enormous that it's made major, major impacts to our environment in the last 40 years. And there is little to no regulation in my estimation. So those are major, major questions that this community needs to make collectively, especially between the two First Nations who yield so much leverage, so much power because of our constitutionally protected rights to hunt, fish and to trap, which are repeatedly being infringed. So that is something we need to do."
George Poitras, MCFN

The great majority (87.6%) of participants identified the excessive use of recreational and prescription drugs as causing a decline in health at the community scale (x = 4.56, SE = 0.10) (Table 9.17). Indeed, an even greater percentage agreed that it was at least somewhat important than for any of the other listed factors, including the Oil Sands. This reflects the widespread and increasing use of these drugs in Fort Chipewyan, a problem that characterizes many northern communities in Canada, and has even been identified as "Problem No. 1" (Clibbon 2012). We did not ask about drug or alcohol or alcohol abuse at the individual level, because of the self-incriminating nature of the question, but many participants indicated in the group interviews that they were also currently struggling or had struggled with addictions to drugs and alcohol,

Oct 17, SR: *"Nowadays too many drugs and alcohol. People don't know what the hell they're doing. I drink before long ago, over 20 years and I stopped drinking. All these years that I was drinking, I didn't know what was going on. Not every day, but you know.* [laughter]*"*

A closely associated factor that was seen as third most important at the community scale and by most (75.6%) participants was smoking and addiction to tobacco (Table 9.17). That it was ranked somewhat less important in affecting the health of participants (fifth), indicates that many of those at the meetings had never or no longer smoked or were more critical about its use as it related to other community members. Tobacco has strong spiritual and other cultural connotations for most First Nations, and is regularly used in ceremonies in many of these cultures, which in part accounts for the resistance to many anti-smoking campaigns that are also seen as reflecting a broader context of oppression by dominant society (Bond et al. 2012). But given its widespread and costly use in many northern communities, including Fort Chipewyan, it was clearly seen as risk to human health here.

The long-standing impacts of the WAC Bennett Dam were also seen by many (71.3% at the individual and 74.2% at the community scale) as having broad implications for human health (x = 4.10, SE = 0.13; x = 4.54, SE = 0.12) (Table 9.17). Although the dam was built on the Peace River in northern BC in the 1960s, it is widely recognized by community members as having devastated the hydrology of this downstream delta since the water was impounded (Chapter 4, Chapter 8). Many of the implications of the dams on human health are indirect in nature, in part because associated reductions in water levels have adversely affected community access to many country foods and traditional harvest areas. However, the widespread flooding associated with hydro development and increased mercury levels in the environment and wildlife are well understood (McLachlan 2013).

Some also felt that these reductions in water flow, in turn, made it more likely that pollutants arriving from the Athabasca River would remain in the delta, Oct 17, BR*: "Because there is* [now] *only one river that is feeding the delta, where before the whole Bennett Dam, the Peace River was the main water flow to the delta... Like it's a balance. There is no pressure from the Peace River just the Athabasca River settles right in the delta. Now the delta is mud, about that high, because the Peace River is holding back. There is no water coming from there, to help the Peace River and the Athabasca River to bring into Lake Claire and all the delta, and bring it back out. The pressure of the water is, well, it's just everything. But now, it is not happening. It's just the Athabasca River that flows over there and settles over there, everything is. So I think that is where the pollution comes from."*

Thus the Bennett Dam and the Oil Sands both contributed to the high levels mercury in the wildlife, regarding which there is much community awareness and concern due to the government's health advisories regarding elevated mercury levels in fish and, most recently, gull and tern eggs (Chapter 6).

Although the Oil Sands and hydro development were seen as important causes of declines in health, intensive agriculture was also, perhaps surprisingly, seen as the second most important cause of these declines (Table 9.17). This was especially true for individual-scale health (81.6% agreeing). This, in large part, reflects the extensive use of pesticides and chemical fertilizers by upstream intensive agriculture, which are recognized as flowing into the delta. Many were thus critical of the pesticide use and intensive livestock operations that generally characterize food production in the South, since there is very little availability or consumption of organic foods through the Northern store,

Oct 17, SR: "So having wild meat is better than buying processed foods, but it's not that easy for everybody…You know some families don't have a choice, they have to go to the market. I'm sure we know, you know, all the cows, I lived on a farm with John, and so I see how they vaccinate the animals and they breed them for the best whatever, whereas the moose eats whatever it wants."

Three to seven million tons of pesticides are produced annually. Estimates of pesticide use averages about 2 kg of active substance per hectare (ha) of arable land in the Global North (Tilman 1999). They primarily encompass highly chlorinated compounds [e.g., dichlorodiphenyltrichloroethane (DDT),PCBs, polychlorinated dioxins and dibenzofu-ranes] and more recently polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs) widely used as flame retardant, and a variety of perfluoroalkyl chemicals (PFCs) that are used in many industrial applications (Schwarzenbach et al. 2010).

Although still debated vociferously in some quarters, organic pollutants have been associated with ever-increasing levels of cancers, among farmers and rural communities but also society as whole. Thus, atrazine has been associated with non-Hodgkin lymphoma (NHL) (De Roos et al. 2003) and with ovarian (Donna et al. 1989), prostate, (MacLennan et al. 2002), and thyroid cancers (Freeman et al, 2011); organophosphate and organochlorine insecticides with aggressive prostate cancer (Koutros et al. 2013); and triazine, DDT and PCBs (polychlorinated biphenyls) with breast cancer (Ferro et al. 2012), among others.

But the focus on agriculture as a cause of changes in environmental health may also have reflected concerns about the presence of these pesticides in store-bought foods, as indicated by the next highest rank cause – that of processed foods, at least as they relate to the individual health of the participants.

Some spoke about the chemical additives that are especially prevalent in processed foods that dominate the shelves in all the retail outlets in town,

> Oct 17, SR: "*But, I bet the change of diet has a lot to do with it. Processed foods and stuff. Looney ass food, that's what I call them* [laughs]."

Processed foods were seen by many (75.3%) participants as affecting their own health (x = 4.09, SE = 0.14) and were ranked fourth (Table 9.17). However, they were ranked much lower (seventh out of the eight causal factors that had been listed) as affecting health at the community scale (x=4.31, SE = 0.12).

A convincing classification scheme divides foods into three categories: unprocessed or minimally processed foods (e.g. meats, fruits, vegetables), culinary processed foods (e.g. pasta, flours, vegetable oils) and ultra-processed foods and drinks (e.g. pizza, burgers, energy drinks) (Monteiro et al. 2011). Canadian diets as a whole are dominated by the third ultra-processed group. Indeed, consumption levels exceed WHO upper limits for fat, free sugars and salts, while falling short of recommended levels of dietary fibre, with significant implications for public health including salt intake, obesity, and heart disease (Moubarac et al. 2012).

This concern over processed foods and the difference between perceptions of individual and community health reflects, as we discussed in detail in Chapter 7, a diet in transition,

> Oct 17, BR*: "Yes, you didn't go inside the store and buy canned food, you know you used to...I mean they used to buy flour, lard, but the basic things, their meat, came off the land, so like rats, beavers or whatever they ate. So they were healthier. Now we'll walk into the store and get whatever we want to eat."*

While already important enough for these participants, the adverse health implications of store-bought foods were likely viewed as a lesser problem for others in the community, who were assumed to still mostly consume traditional foods. Yet this issue will likely be even a greater problem for existing youth and children. Indeed, it was shown in the last chapter that community members felt that the purchase and consumption of these processed foods will only increase in the future (Chapter 8).

Store-bought foods were also seen as expensive and, thus, inaccessible to many community members,

> Oct 17, BR: *Berries yeah, berries and that. But fruit and vegetables weren't a big thing, they were so used to living, we are so remote out here too. That's why the things I put on my questionnaire are huge. You know, lot of deficiencies because people don't have the money to buy stuff here. They can't afford it. And then there are no government programs that subsidize food in this community. That I am aware of…*"

The high cost of these store-bought foods, especially fresh meat, vegetables, and fruit, also places people at risk. In many cases, community members are only able to afford the much cheaper processed foods such as pizza, hoagies, and canned and instant soups, which are at once nutritionally deficient and high in salts and other additives,

> Oct 15, SR*: "You know, I told one councillor, yeah sure it is good to have a swimming pool, but I said you guys are missing the big picture. Look out for your people. Something's got to be done. I said, who's going to pay $42 for 8 pork chops when you can buy half a pig for $50. Where's the justice in that?*"

Climate change was also identified as important by some,

> Oct 17, SR: "*Yeah they said that spill was not a spill it was caused by a blue algae. But that blue algae was caused, was never documented before. You know, when you look at it, it's global warming that's causing the blue algae, it had to be.*"

But it was ranked as the least important cause of declines in human and community health (66.7 % and 67.8%, respectively) (Table 9.17). This, in part, reflects of the indirect and uncertain nature of the environmental change in this region, but it may also reflect the use of climate change by outside stakeholders to try and mitigate community concerns regarding the Oil Sands and the WAC Bennett Dam, and their implications for the environment and human health.

Interestingly, stress was one of the lowest ranked causes of illness at both the individual (last) and community (second-last after processed foods) (Table 9.17). That said, many (75.6%, equal to smoking) least somewhat agreed that it was important at the community level. This may in part reflect the ambiguity of the term. Yet, stress and worry arose many times during discussions and interviews.

At least some felt that increased levels of stress reflected an increased emphasis on and need for money to purchase goods that would historically have been accessed by all on the land, money that is still in short supply for many in Fort Chipewyan,

> Oct 16, SR: *"Money, I worry about money all the time. How am I going to get money for this? Yeah There are times coming that I think will help you…The people that have lots of money and everything you know, they are so lucky to win money and that don't need it. And then the ones that need it, never get anything. But I guess that's just pure luck. And then you think about them, it stresses you out. Why can't I win it* [laughing]?"

Widespread stress was attributed by some to the loss of cultural traditions, especially among the young who, in many cases, were actively working in industry,

> Oct 17, SR: *"Our young people are going probably so much more going towards that path of depression and stress because they don't know who they are. They've lost their identity. All they know is they've got the treaty card or a Métis card. Other than that they don't know how to live off the land, they can't speak their language, they don't know their traditional history. They don't know their culture. So, no wonder. I would feel really stressed too. Well I'm glad that I was born in the 50s, because at least I had some of that knowledge that was back then. Today, you know our young people, I really feel sorry for them."*

Some younger participants explicitly spoke to being trapped between the two cultures, and how this contributed to a lack of motivation and even depression,

> Oct 16, SR: "*No energy, like I was telling you, for the past month. Maybe I just have like all of a sudden have no energy to do anything at all, like nothing. And I never felt like that before, I always had energy. Wake up and now, its just like, I don't want to do anything, I have no energy at all, I don't want to go out or anything. I am 39, it shouldn't be feeling like I am 60 or 80… I am going to have to start exercising, because all I do is drive. I have been driving since I was 13,..The energy is what I don't understand why I just have no energy at all to do anything…Yeah, I was in the bush two days and all I did was lay there. My dad's like 'what's wrong with you, I can't take you out for Chinese food'."*

Interestingly, one participant also spoke to the complementary stress experienced by Elders, who were sometimes unable to make sense of the rapid change that has occurred in the last 30-40 years, and the sometimes-diminished value that is placed on the traditions that they continued to uphold,

> Oct 16, SR: *"What changes lots today is the way things have been 30, 40, 50 years ago. All over the world, it's hard to find an answer to why these things are happening and the only people today that can adapt to the changes that are happening are the young kids. It doesn't seem to affect them, they lived with it and they're happy. And the Elders are finding it very hard to live with so they went on slowly with their age. You can even get sick from worrying about it."*

Community members that participate in workplace cultures that come to resemble those in the South, in turn are subject to the same lifestyle excesses, ones that sometimes seem to resemble urban North American lifestyles in the 1970s and 1980s,

> Oct 17, SR: "*And even adults, you know I mean, all our parents worked out in the trap line and did a honest hard work. They went and now people are sitting at desks and living an unhealthy lifestyles, eating junk food, drinking coffee and cigarettes."*

This stress might further involve the collision course that some feel between the need to make a living from the Oil Sands and the traditional values and respect that most community members still hold for the Earth,

> *"a coworker from Syncrude she called me up and from her truck one time and she was crying. And I was like, 'what is wrong, did you hit another vehicle, did you hit a ditch and are you going to get fired?' And she was like, 'no – do you see what we are doing here?' And I was, like, 'I don't know, we are working'. She was, like 'no, look around, there are no trees, there is no river, there is no water, there is no lake'. She was like, 'I just came from hauling and we went to the edge, to the edge of the mine'. And she said 'you can see all the trees and the river near by and the shovels are digging it up and we are hauling it out, and we are back in the pit now and everything was black'. And she was crying, she was crying for the land."*
>
> Mike Mercredi, ACFN

Despite the existence of innovative fly-in programs that some oil companies offer, providing employees with the opportunity to fly home on off-days, working for industry still often acts to separate people from their traditions,

> Oct 15, SR: *"…some of the people out there don't even come home for days off, or to come visit or nothing, they just stay out there and work, work, work. It's just like pounded right into them. You know, now they've got that lifestyle right, so you've got to work, work, work, work. That's what they live for to work, money, McDonalds to eat. Nothing I can do. Damn, if I had no money, I'll go fishing to feed myself and my family."*

FIG 9.7. Small plane leaving Fort Chipewyan airport for Fort McMurray.

Negative and, in at least some cases, horrific experiences as children in residential schools still underlie and aggravate many of the current day health problems, ranging from stress to mental illness, that in turn may give rise to many other problems associated with substance abuse. It was clear that these experiences continue to play havoc with peoples lives, in some cases 60 or 70 years later,

> Oct 16, SR: *"Because of the residential schools, because of the abuse we went through, that I went through myself. Because alcoholism, suicides, a lot of people went to jail. You know, like all the family problems it causes. Oh my goodness, they used to abuse us…I finally let go of it, because I went to a treatment centre. I finally let go of all that hurt that was causing my health, like stress and everything else. Yes, it was the worst place to be when you're six years old. But sometimes…*[pauses]*. You just made me cry. Talking about residential schools brought back bad memories."*

Although most of these illnesses and past experiences are difficult enough to understand and address in isolation, they intersect with and aggravate one another. This is especially problematic in a small-community environment, where everyone knows everyone else,

> Oct 15, SR: *"Sometimes when you work in oil places like that, dangerous. Big concern is the river flows back and the things that go on in the community. Because what happens is a person can die of cancer right. What will happen is it will cause stress, and stress leads to alcoholism right. And alcoholism can lead to drug addiction and then can lead to suicide or can lead to anything else. Abusing the family, could be verbal abuse, could be physical abuse. It all starts from there, when a person has a death in the family or us as a close bond as us as a small community…So, it's just like what I am trying to say. It's when these deaths happen, it has a ripple effect on everybody. You know if your family member passes on or something like that and you are always wondering whether when its going to happen to me, and you know you don't feel comfortable in your lifestyle and what's going on here."*

Although not listed in the questionnaire as a cause of changes in individual and community health, some participants indicated the lack of physical activity as being a contributing factor, especially when compared to the past, Oct 17, BR: *"Well if you think back, years ago people all they did, they never had skidoos or anything, they use to use dog team. So the men were very healthy them days, because they had to travel to the trap lines or go get their furs or whatever"*

9.3.4 SECONDARY CAUSES OF CHANGES IN HEALTH

We also identified secondary causes of changes in health and wellbeing, these often acting to aggravate the existing declines that will continue to occur, regardless. Thy have been categorized as inadequate health communication, collusion between government and industry, inadequate health infrastructure and support, and overdependence on healthcare in the South.

INEFFECTIVE AND OPAQUE HEALTH COMMUNICATION

Despite the unparalleled media attention that the Oil Sands receive as the world's greatest industrial resource extraction project, downstream communities are still confronted by an effective information and communication blackout regarding any changes in environmental health. This is especially true of potential adverse effects that the Oil Sands might have for human health and wellbeing. Not knowing about any possible impacts only acts to aggravate concern and worry,

Oct 15, SR: *"The thing that sucks is that we are in the dark whether it is exactly the oil company that's doing it. It is just like, we wish we knew exactly what is causing this cancer, when someone dies, and then you are like – oh…Our instinct is to blame the industry and maybe it is probably mostly that. But to know exactly what it was that causes it would be nicer."*

The need for more transparent and effective health communication is as important for family members and community members as it is for patients,

Oct 15, SR: *"My mother passed away in '92 from a rare form of cancer, we tried to get the doctors to pull her medical file, but the doctor on her we tried, he tried, and the government won't release her forms. She passed away, they took all her medical files and kept them in Edmonton, It's telling me they are hiding something. They are not being up front. It was a rare form of cancer, the doctors didn't even know what they were dealing with. It was a fast-killing cancer."*

Fort Chipewyan is one of the most intensively researched communities in the North. At the time of writing, there are alt least a dozen university groups doing research similar to our own, most without any effective communication with community members or, for that matter, with one another,

Oct 17, BR: "That's all we've been doing studies and studies and studies for years. But we never hear anything after it. It would be nice to know what's the cause."

Again and again, we have heard about the broken promises. Promises that communication by scientists, whether they were affiliated with government, industry, or universities, would be more effective and accountable than in the past,

Oct 17, BR: "*But, you know, I met with federal government and provincial. We met, I had meetings with them. We never ever got anything back telling us anything. Just what's the cause? Why is the water so low? We went though all of that, went with them. We never got nothing back. We never heard anything for two years*."

Although some outside experts might argue that risk communication with impacted Indigenous communities is becoming more effective over time (e.g. CAPP 2014), this, if true at all, only seems to be occurring in the most relative way. Government health advisories as they relate to mercury levels and spills are more commonplace now, especially if there has been a recent major and health–threatening accident; however, they were effectively absent until the recent past,

> Oct 17, BR"*I would be very interested in seeing how, what levels of PAHs are in me. …'79 when I moved to Chip, I damned well lived in that lake. Because that is where we spent all our summers. Eleven years old, every summer day morning to night, right there in that lake but we never had no advisories. When they had that oil spill down south there, a couple years back, you see on the news, you see these big billboards, they have posted on the lake: 'don' t swim, don't fish, there was a spill' and this and that, and contamination. There was nothing in Chip in '79, and I have talked to Elders, a lot of people in Chip never even knew there was a spill in '78. The only reason why I know there was a spill in '78 was because my mom worked there*."

Some participants felt that these breakdowns in communication reflected deliberate cover-ups on the part of industry, especially when it came to spills related to the Oil Sands,

> Oct 16, SR: *"I believe they are affected by this water. Because a few years ago, Suncor, they had a spill. So that supervisor quit right away. He doesn't say nothing happened, so lots of cover ups, eh. I figured you hired these guys from down south, you know, make them lie or that's what I think."*

Communication by industry and government was generally viewed with suspicion since any concerns or risks that were raised by community members were usually downplayed, in part by arguing that high levels of some contaminants were natural and then by arguing that any possible links to Oil Sands remained unproven. Should outsider accounts differ from community concerns grounded in Traditional Knowledge, it was clear which voice governments and industry alike valued,

> Oct 17, SR: "*And then industry will say, well you know, I mean you've got the Oil Sands have been seeping into the river ever since, you know, not to this extent. Sure our people used* [bitumen] *to patch up canoes and stuff. But this is saying it's all lies. We have to believe our Traditional Knowledge, our parents, our grandparents. We were put on this land to protect our land for the future generations, not to abuse it and destroy it like industry you know. Ever since the goddamn Columbus landed on our shore, all they've done is screwed up our land!"*

Other participants felt that the provincial and federal governments were also complicit in these cover-ups, in large part because of the great amounts of money that were at stake but also because of the relative vulnerability and marginality of any downstream communities,

> Oct 16, SR: "*Because the government is making lots of money off of the plants. That's why they will fight for the cancer before they fight for the one doc. They would rather get rid of that little small, cause that one was a little speck, than trying to make anything bigger to cause more trouble against the plants. Cause their government is all about money, that's all it is*."

The contradictory and conflicting role that government plays as both regulator and proponent of the Oil Sands was clear to many. This conflict was further seen as placing downstream communities at ever increasing risk,

> Oct 17, SR: "*Well if they're advising people not to swim and eat fish and stuff from the government, they obviously know something is wrong. Why don't they do something about it, instead of trying and give people a rough time? That's what I think. I think the government is too freaking greedy. And they want everything else for themselves and not worry about anyone else.*"

While the scale of the impacts have certainly grown over the last 40 years, the scale of this collusion and the implications for both environment and human health have also all grown correspondingly,

> *"We have had to evolve into learning really how bad this industry is, and how very much it has negatively impacted the environment over the past 40 years. And how government – the regulator, the manager of this industry – has essentially been asleep because they have not been regulating the industry for 40 years. The situation is so bad that we are not only now talking about our Fort Chipewyan-centric issues, it is now how this industry is contributing to environmental impacts globally."*
>
> George Poitras, MCFN

Such collusion between government and industry in suppressing possible Oil Sands-related health implications was especially clear to participants as it related to the John O'Connor case, a general practitioner who worked in Fort Chipewyan for many years. He was widely castigated by government for inciting fear among community members when he raised concerns about the high rates of cancer, especially rare forms such as cholangiocarcinoma,

> *Oct 17, SR:* Partic1: *I was at that meeting where* (Dr O'Connor) *spoke up. He wasn't raising alarm, it was that people wanted him so badly to come to their meetings. And he showed up at that meeting, and he just sat quietly and finally we asked him point blank "what do you think?" What he said was "As a doctor I can't explain to you why there, in such a pristine looking environment, why is there such a high incidence of these, I think he said cancers,*
> Partic2*: Leukemia*
> Partic1: *Yeah blood diseases or something and lupus and those types, arthritis, and stuff, and that's all he said. And it just blew up in his face. The province and everybody blacklisted him. So the community went to his defence. And if we hadn't he wouldn't even be a doctor anymore. It wasn't him that raised the alarm. All he did was go to this community meeting and say " I don't know why you have these diseases".*

This collusion and the lack of independent research that is conducted at arms-length from industry and government was also seen as highly problematic by some,

> Oct 17, SR: "*You know his dad died from that bile cancer you know, O'Connor's dad, so when he saw it here, he knew what it was. And it's supposed to be one in 100,000 or so. And how many* [rare cancers] *do we have in our community? It should cause alarm bells to go off.* [But] *the scientists, biologists, are all paid by industry and they say what industry wants them to say. And I think a lot of the funding comes from industry and so we don't hear. You know, they don't come back with any bad news for us, because that's not what industry wants,. Not only industry, the government, the provincial government and federal government all believe that what's happening at the Tar Sands is called development and progress."*

Pressure on the part of government and industry was seen as affecting most scientific studies conducted in the region, such that any negative results were questioned in part because these outcomes conflicted with community experiences and Traditional Knowledge,

> Oct 17, SR: "*Because if the scientists are doing that, can't they say if they were going to test for mercury, can't they say can you test for this and that, and can't they? Because I'm sure the government is telling them, this is what they're going to check and nothing else…My brother was on the river, he took pictures he showed us the oil spill and the picture that he gave them, they cut the bottom off. You're not seeing the oil spill, you're seeing the top and then the sky, but he has it on his camera. It was an oil spill!*"

There seem to be few, if any, attempts to genuinely assess environmental and socio-cultural impacts of individual Oil Sands projects, much less any cumulative impact assessment. This in part reflects the reductionist nature of most scientific research, which is arguably of limited use in explaining complex "noisy" environmental problems, especially for remote communities in northern environments, which limit opportunities for data collection. In contrast, TK is holistic in approach and is exceptionally well situated to make sense of long-term and complex problems associated with industry (McLachlan 2013),

> Oct 17, SR: *I will never trust what they call scientists. Because what the province and industry called scientists, because they muzzle their own scientists. Because scientists look at very thin slices of stuff. They don't look at the whole book, they look at one word on a page and try to define. Somebody's got to put the book together. But if you can't see the whole book, you can't do it. That's the trouble with scientists. Where the traditional knowledge is like you have the whole book. You may not be able to say exactly why, what causes this, what causes that. But you can sure see the changes. The scientists can't explain the changes, because they can't see what the changes are."*

The outcome is an ever-accelerating pace of development where destruction and downstream impacts remain poorly understood and where these impacts continue to escalate unabated,

> Oct 15, SR*: Because, even when you fly now, it is 15 minutes straight, of just industry, just bare, no trees, nothing whatsoever. That's from McMurray, and then you'll see some trees, and then again another one, another industry starting up. It's all you see. Five more approved. Oh, for goodness sake. It comes back to the government; they should be accountable to the people. Not the people accountable to the government. That's how I look at it. They're not living here, so they don't care."*

In the interim, a more precautionary approach could be taken. Where in the absence of any clear health implications, it could instead be conservatively assumed that these concerns and suspected impacts were real,

> Oct 17, SR: "*So they are not taking a precautionary approach, where they will only let things happen that won't harm the environment, well be cautious about it. They are just saying let's go ahead and plunder the earth, and if we find a whole bunch of people have died from some chemical that's coming out of that, then we'll stop polluting with that chemical. That's how they are doing it. After the fact…They're trying to suppress those incidents so that nobody knows about it. And they just keep on going…I feel that Alberta and Canada have no respect at all for north-eastern Alberta and they are prepared to sacrifice north-eastern Alberta for their prosperity."*

Although the importance of the Oil Sands for employment opportunities is recognized by most, some participants at least wanted a moratorium on future growth, at least until there was a better understanding of any downstream impacts,

> Oct 15, SR "*The government is approving all these projects, you know, they need to stop somewhere…Enough is enough, really. Enough is enough."*

INADEQUATE HEALTH INFRASTRUCTURE AND SUPPORT IN FORT CHIPEWYAN

Finally, and perhaps more obviously related to issues surrounding individual and community health, is a problem that confronts many if not most northern Indigenous communities: the lack of an adequate infrastructure for effective health care,

> *Oct 15, SR: "Our biggest issue in town right now is our health. And the facilities they have right now is not big enough for our community, and it's not wide enough. You know what I mean? So, it's not. They need to expand the health, of the health care, and focus on that, for check ups, just stuff like that I think."*

In the past, people had had little access to western-style healthcare, and instead were often reliant on traditional lifestyles and healing, often living long and health lives,

> *Oct 17, BR: My father-in-law was 84 years old when he went into the hospital for the first time in his entire life. Very first time!"*

Many participants indicated that they still routinely take traditional medicines such as ratroot; indeed, it was the second-most frequently consumed traditional food after moose over a two-month period (Chapter 8). However, traditional approaches to healing are being complemented and some would argue supplanted by western approaches to healthcare that center on a new treatment center, and the emergency-style care provided by paramedics and nurses. Although a general physician is available, this is usually only one week each month. Indeed, the absence of a physician from the community was the most frequently raised reference to existing healthcare in focus group meetings held in October 2013 (Table 9.19). There were inevitable waiting lists and delays for anyone wanting to visit the physician when she was in town (Table 9.19).

A few participants felt that the health care was better in Fort Chipewyan than in large urban centers such as Edmonton, especially with respect to the speed with which residents could generally visit with a care provider in this small community and especially if it involved commonplace ailments,

> Oct 17, SR*: Well, in my experience, living in the south, and living here, you get quicker health care here. More care, better, exceptional health care, compared to waiting hours in the hospital. Things like that. I've sat in hospital waiting rooms all day long, in terrible pain. It never happened to me here. And I have had the extremes: cancer,…, head injuries. I think for the everyday stuff, I had quicker services here than I would in Edmonton."*

Yet, the health care available to residents was much more widely criticized as inadequate - both in Fort Chipewyan and, to a lesser extent, down South (Table 9.20). Thus, few (26.4%) participants agreed that *"the quality of health care that I receive in Fort Chip is excellent"* (x = 2.52, SE = 0.13) (Table 9.20). Moreover, this showed little sign of changing. Thus, even fewer (25.8%) agreed that*"the quality of health care that I receive in Fort Chipewyan is getting better"* (x = 2.46, SE =

0.15). In contrast, more than half (64.6%) participants agreed that "*the quality of health care that people I care about receive down South is excellent*" (x = 3.76, SE – 0.15). The presence of better health care in Edmonton was also the second-most frequently raised reference to existing healthcare in focus group meetings held in October 2013 (Table 9.19).

FIG 9.8. New medical center in Fort Chipewyan.

Indeed, some people felt that the adequacy of health care in Fort Chipewyan had declined from the past,

> Oct 17, BR*: "Well, I remember the nursing station, they used to bring Dr. Wong up. A gynaecologist, obstetrician used to come up every couple of months, just to do Well-Women clinics and checks. So then, at least, we got to see those specialists. Now we're lucky if we can get in to see any of them. It's got to be an emergency to see them."*

At least some participants felt that their concerns were not receiving the attention that they deserved in town,

> Oct 15, SR: *"Chest pains aren't an emergency. Yeah, that is what they were telling me. But how can they prove that? A guy could be having a heart attack, the guy could be having a heart attack. You can't diagnose someone having chest pain on the phone."*

The current dependence in Fort Chipewyan on paramedics and other emergency-care providers instead of physicians and nurse clinicians who could provide for more sustained and proactive care was also widely criticized. Indeed, dissatisfaction with the paramedics was the fourth-most frequent reference to the existing healthcare in focus group meetings held in October 2013 (Table 9.19). Treatment in town was generally seen as cursory and focusing on addressing symptoms, rather than systematic tests that would identify any underlying causes of illness in proactive ways,

> Oct 17, BR. "*I am sitting there, but no one has actually done any test to find out if it actually is that and nobody is actually even, none of the doctors have actually even put together the possibility maybe they're related its something more bigger problem. Instead, they just throw the next thing at you: Tylenol, Metamucil, yeah."*

Once they had received this cursory care, patients were typically sent back home with minimal follow-up, Oct 16, SR: *"Someone will die one of these days and maybe that is the only time they will get it through their heads that they don't know what they are doing here. You know, they should have more people that should help, instead of sending them home every time they come around. They just make you so mad."*

These shortcomings in part reflected misplaced priorities for funding, some of which focused on recreation but which in turn failed to explore and address a wider diversity of other health priorities.

OVERDEPENDENCE ON HEALTH CARE IN THE SOUTH

Any sustained care, especially specialized care for Fort Chipewyan residents, was thus dependent upon flying down South for visits with medical specialists. This dependence on flying out of town for health care brought forth its own attendant problems,

Oct 15, SR*: "And for the amount of disease that we have here that are health problems, we don't have the equipment, the facility here for it. We always have to go out… You put it on hold every time you trying to go out, and by the time you get out there it has already gotten worse."*

Generally, health care was currently characterized by delays, especially if the ailment was not seen as life- threatening,

Oct 17, BR: *"And it's scary. They just, give you antibiotics and fill you full of antibiotics and send you on your way. And if you've got an illness that is not life threating or an emergency, to get medical outside of Fort Chipewyan is virtually impossible."*

These delays might in part reflect the rapid industry-fuelled population growth of Fort McMurray, which has arguably outpaced any corresponding growth of health care services for the larger region,

Oct 17, BR: *"One of the problems what I think is that, because we have to share with the Fort McMurray area, which in the last how many years, all of a sudden there is a huge explosion there. You know like we have to share. A lot of times we are kind of put aside. You like, you are waiting for a test to see a doctor for eight months. That shouldn't be happening in this day and age. There should be other options… TeleHealth, things like that; at least somebody, to see a physician, to see a specialist or something. It is ridiculous to have to wait to get health care. You know in the past, people used to get health care."*

These delays were systemic in nature, and sometimes resulted in the misdiagnosis of ailments or, of special concern here, delays in diagnosis that further placed patients at risk. This of course is of special significance to aggressive forms of cancer where early diagnosis is key to effective treatment,

Oct 17, BR: *"Just like that. He was fine, and now he is gone now. There is a wake in town. Well he thought he had a cold right? Because Brad was talking to him and he said 'I had this cold for about a month now and it s not getting better.' But he said he was going to a sweat or something and he went to Big Point and he got sick. He went to the clinic because he was bringing up some blood or something, and then they shipped him out. That's when they found out he was full of cancer. And he didn't last very long. Well sometimes with cancer too, there is very little way to know you have it. Because cancer don't hurt until it's in the final stage."*

The fly-in visits to hospitals in the South were especially taxing for the elderly and the infirm,

> Oct 17, BR: *"…it is really lousy, because I used to have to fly with my mother-in-law. Like she was 80+ years, and I have to take her out for medical trip and they expected you to go for your medical trip, to do your medical, and back in the same day. With an 80 year-old women that had problems walking, problems breathing, needs her nebulizer, that had an oxygen machine. Do you think they would give her a room, so she could just have a place to go and relax?!"*

Some participants talked about the culturally inappropriate and sometimes harsh way that community members from the North were sometimes treated down South in Fort McMurray and to a lesser extent Edmonton,

> Oct 17, BR: "*And there is so much insensitivity there too, with the healthcare workers who provide the service. We come from a remote community, sometimes we don't understand, we don't have high education, we don't understand some of the words and we're not allowed to take an escort. You know if you're a certain age. Even if you do take an escort, an escort should be well versed and knowledgeable in some of the things that they are going to talk to the doctor about. The concerns from the patient that they are taking."*

Visits were often stressful and rushed, especially for the elderly, which ironically would act to further undermine their ease of mind and the likelihood that any observations would reflect meaningful insights into their health status,

> Oct 17, BR: "*…I mean, treat a person with respect, kindness and care when they come to get your service. Especially if they're travelling a long way. And sometimes you're there just for the day, like you have to get up early in the morning and you leave, you're just rushing all day. How is that going to be mentally and emotionally and stable or good for anybody.*"

In part, this inadequate care was seen by some as reflecting a focus on funding and the economic bottom-line, rather than on any real wellbeing of community members – this attitude ironically the same root cause of the environmental decline that was giving rise to many of these problems,

> Oct 16, SR: *"What it comes down to is money. That's all it is. They don't want to send anybody over here, because if they do that they are going to lose out on money from when they have to go there to that. You know what I mean? I don't know, that is what I think. It's just like companies. They don't care about our land, they don't care about us out here. They don't care if one person dies, let's say, or six people. They don't care."*

Although it was hard enough to see a physician down South, being visitors made some patients vulnerable, especially if they have the audacity to question the kind of care they were receiving,

> Oct 17, BR: "*Because I questioned him, he dropped me as a patient. He didn't even have the nerve to tell me, that he is not going to see me anymore. He wrote a letter to the nursing station saying "I think you should send this patient to Fort McMurray". I have been waiting eight months to get into see a doctor in Fort McMurray, and I am still waiting. I'm right back to square one. I haven't been to work since May, because I'm in pain.*"

9.3.5 HEALTH AND THE FUTURE

Generally speaking, most of the wide diversity of health concerns that participants shared were attributed to environmental decline and, more specifically, much was directly or indirectly attributed to the Oil Sands. Yet many also recognized that oil sands development would continue to expand northwards,

> Oct 15, SR: *"I was so surprised, I was so surprised. I went to McMurray, what was it, two days ago and I left Shell landing at 8:30 at night. Me and Arty and a couple other people, we left 8:30 at night. I swear man, it was almost halfway to Chip, it looked like freakin' street lights. Walter was saying 'holy shit they should have street lights all the way to Chip by you know by a couple of years', that's how many lights there was. Finally this last light, there was a blue water intake, finally it was dark from there, Just pitch black. I was so surprised, I have never seen it like that."*

At some point in the relatively near future, oil sands development would directly encroach on Fort Chipewyan, much in the same way that it had already encroached on Indigenous communities in Fort McKay,

> Oct 15. SR. "*And within 20 years, if we look across the lake, we will probably have industry right there. It is coming fast, and we just have to live with it. We have been doing it for how many years now, and how many years more to go. So when cancer does hit you, it hits you hard."*

This expanding encroachment was seen as only increasing the exposure of community members to environmental contaminants, an exposure that would in turn increase the likelihood that community members would suffer even more from contaminant-related illnesses,

> "Oct 15. SR. *It is a pretty scary thing, to be honest when you see a bunch of your family members and you know your friends passing away that would more in the next 20 years from now. Like little infants and stuff you now. It will be way worse than it is now. I think it's really the scariest thing to be honest."*

Yet, there are currently few alternatives to the Oil Sands for community members looking for work, which arguably places workers at risk, as our above regression analysis showed, and fosters a continued dependence on this industry. Another concern was the active recruitment by industry within the schools,

> *" Seems like industry, they come for job fairs and stuff like that. At the schools, open house. …They get that in their head when they're young. You think, why should we go in the bush and live off the land when we could be working? When they're 18, 17 they finish high school. Why should I be struggling on the land, hunting for food when I could be driving a truck making $100,000 a year, $200,000 a year. Having all the toys you want and stuff like that. They get 'em when they're young. That's what I don't like. They shouldn't even be allowed to come around and bug kids in school. It's f***ing bullshit man. There should be a law against that. When they're 18, when they graduate, then talk to them."*
>
> Jonathan Bruno, ACFN

Some suggested that the current dependence on the Oil Sands might be addressed by a shift to a wider diversity of smaller-scale businesses that could operate within and help service Fort Chipewyan.

Although there is a current lack of capacity and support for such initiatives, they could ideally provide sustainable and long-term responses to unemployment and a wider diversity of career options,

> Oct 15, SR*: "Well for a smaller place like this, there are hardly any businesses owned by Aboriginal people. There are no cottage industries, and then people don't know where to access the funds because we don't have a bank account. They don't really know too much about businesses. I guess because we never really had a business. But we should have, everybody should have a backdoor business in their own houses. They should have bakeries. They should have whatever, coffee shops, Internet shops or whatever, Internet cafes. There are all kinds of businesses people could have. But how the heck do you start."*

Such barriers aside, there are a number of such cottage industries that are emerging in town, including convenience stores, sandwich shops, and even a pizzeria. Programs that provided support and advice on an ongoing basis would help support additional ventures, and help ensure that the ones that had already begun operating remained viable. Such options would help mitigate the collision course that some feel when bridging traditional values surrounding the environment and industry, to say nothing of the implications that this dependence on the Oil Sands has for the long-term wellbeing of the community.

With respect to achieving better and more effective health care within Fort Chipewyan, some participants felt that this might be accessible through an approach that focused less on medical technology and more on people-centered care,

> Oct 16, SR: "*What, they spend freakin' how many millions on our health centre, and we don't even have doctors. We should of had dentists, and everything here too. That's what they have all those freaking things in there for, not just for them to come once a month. That's what I think. I seen all their equipment in there. I went for a walk in there with my buddy, and he showed me everything. And they've got all these millions of dollars of things all laying around and nobody is even using them. They have an x-ray machine!?!"*

When prompted with a number of suggestions regarding possible ways of addressing shortcomings in healthcare provided in Fort Chipewyan and down South, all were favourably received (Table 9.21). The greatest majority (88.0%) of people agreed that "*the number of health professionals in Fort Chipewyan" should be increased"* (x = 4.49, SE = 0.11) and the large majority (83.7%) further agreed that "*the quality of health treatment in Fort Chipewyan should be increased"* (x = 4.49, SE = 0.11).

Other suggestions focused on increasing the quality and accessibility of health-related information, initiatives that would be relatively affordable and easy to achieve (Table 9.21). Thus the majority (81.3%) agreed that the amount of "*health information available to patients*" should be increased (x = 4.49, SE = 0.11) and a similar proportion (80.4%) agreed that "*how understandable health information is to patients should also be increased*" **(**x = 4.53, SE = 0.10). One participant also added that "health care information should be available in the traditional language".

Increased funding support would ideally make health care professionals and perhaps even health specialists available within Fort Chipewyan and also help decrease waiting times that otherwise place community members further at risk,

> *Oct 16, SR: "We would be there, staying there in town. At least we wouldn't have to fly out and wait a month to see him. I could wait for two hours to see him, not a month, you know what I mean?...I get that before, and I get worse in two months time before I see a doctor."*

Others suggested that in-town healthcare could focus more on more proactive approaches, which would involve screenings, especially in the case of cancer where early detection is so key to effective treatment. The kind of screening that is commonplace in the South, but rare in northern fly-in communities,

> Oct 17, BR*: "And they should have a community screening. A community screening for colorectal cancer – different kinds of things."*

Another set of suggestions focusing on ways of increasing culturally appropriate approaches to healthcare was presented to community members for feedback (Table 9.21). A large majority (82.8%) of participants agreed that *"access to traditional healers in hospitals in the South"* should be increased (x = 4.49, SE = 0.11) and an equivalent number (79.1%) also agreed that *"sensitivity of health professionals to Aboriginal issues"* should be increased" (x = 4.49, SE = 0.11). Perhaps predictably, slightly fewer, although still a majority (78.5%), agreed that *"access to traditional healing in Fort Chipewyan"* should also be increased (x = 4.40, SE = 0.12) (Table 9.21); predictably, because many still access this kind of healing in town (Chapter 8).

Emphasis on traditional healing and the return to traditional activities and living off the land would also be an effective way of helping reduce the likelihood of (re)occurrence and also help treat some other illnesses, especially type II diabetes, obesity and heart disease. Some spoke explicitly of the potential of traditional foods for treating diabetes, which is so commonplace in this community,

> Oct 16, SR: *"The other thing I wanted to talk about was the changes in lifestyle of the people. Like I was born on the land and I am not that old* [laughing] *but the change that I have seen from my parents. They have told me about their lives, and that's why we came, you know we came out here, lived in residential school. But we always went out on the land, and one of the things I've seen is the ones that stayed more on the land and the ones that came to town, the changes in the diet you know and the processed food, and there's a lot more diabetes and different kinds of diseases with the people that came to Fort Chip first before us. So my family is a little bit more diabetes-free right now, because of our diet."*

Indeed, when we were in town sharing and getting feedback on our preliminary outcomes in January 2014, an Elder from MCFN mentioned that he had been eating bison that had been just been provided to many community members. Despite suffering from type 2 diabetes for many years, his blood sugar levels had declined from a high 11 nmol/L to a much more reasonable 7 nmol/L over the last few days of eating this country food.

Some felt that this kind of proactive self-care, regardless of its tradition and origins, and accompanying education programmes, could be better promoted within the community,

> Oct 17, BR: "…*you know there is such a thing as self-care from educating your children, so they could as they get older. Then there is the management. If you get diabetes, there is self-care and management with that disease. You can still live healthy even with that disease but then your whole lifestyle has to change from what you are doing to try and make yourself better. I, myself, quit smoking but then I started again because I like smoking. And I know if I did quit smoking I probably would feel more healthy but then there is all kinds of issues that are wrong with me as well. And I am trying to deal with one thing at a time."*

Such programs centering on healthy eating and physical activity (i.e. healthy living) are becoming important strategies for addressing chronic illness in Canada (Gore and Kothari 2012).

Although it is essential to describe and better understand the adverse health implications of the Oil Sands and other upstream development, research cannot stop there. Solution-focused responses are desperately needed, in part to help identify and promote new responses to these declines in health and to help support existing capacity and responses. It is also an essential way to mitigate the stress and worry that accompanies communities that are provided with very little insight into the nature of the adverse impacts much less any ways of mitigating these stressors.

That said, a focus on the responsibilities of community members in bettering their own health situation should not alleviate the responsibility on the part of industry and government for the central role that they have played and continue to play in the continuing decline of health and wellbeing of this community,

> Oct 17, BR: *"I am really getting tired of hearing, when I mention health issues, south of Fort Mac, or even in Fort McMurray: it's hereditary, it's your lifestyle, it's this and that. I am getting tired of it because, do you know what? It's not just me, it's not just my lifestyle. And I would love to prove it and shove it in there face and say 'damn it, I have had enough, quit blaming me!'. Because that's what they do, they point the finger at you...I am tired of getting fingers pointed at me."*

However, the greatest strength of these communities is their resilience and strong sense of collective responsibility and self. This allows community members to grieve and to support one another, and ultimately to overcome yet one more phase in a whole series of oppressive acts that have sometimes intentionally and sometimes inadvertently tried to assimilate and to suppress this strength,

> Oct 15, SR: *"Well we are a small community, we are close, we all get along with each other, with Lou, that guy that passed was really close with everybody. And really, that's why, I guess. That's the way I figured, the way I see it anyways. And that happens in our community, everybody gets together. And, I guess, mourns over, and try and help everyone through rough times."*

Finding a way of persevering and moving forward despite the increased presence of industry, it is essential to ground any responses in the traditions that give these communities strength and direction,

> Oct 15, SR: *Well, coming to that point, everybody is going back to the traditional food again. For all we know, like we said, it's contaminated. So everybody's rather than going to the Northern and buying a t-bone steak for $50 bucks, you know, you pull a cut of meat of the moose and eat that. I am saying its a point right? Our fish or nothing."*

FIG 9.9. Rene Bruno (ACFN) takes his grandchildren on a walk looking for medicines

It is when people walk away from these traditions and tradition-based solutions that they begin to succumb to the threats that encroach their lands and their lives,

> Oct 17, SR: *"Well I know one thing, I will keep living on the land, eating small fish. Yeah, I'll eat the moose. That's the best way. Otherwise, if we try to live like the government is telling us, to do this and do that, they're just dictating to us to live their way. And us, we'll forget about our traditional way. We can't do that because we have to, our traditional way. We have to go on for years and years, because we are Aboriginal people."*

9.4 CONCLUDING REMARKS

Residents of Fort Chipewyan are extremely worried about declining community health and wellbeing, and, in particular, accelerating cancer rates. They have long called for a comprehensive baseline health study that could help document these changes, but also continue to insist that this baseline study be done in a way that respects their cultures and traditions and meaningfully involve community members from beginning to end.

Such a baseline study has yet to be initiated, and in the absence of these data, health continues to decline and stress and worry continue to grow. Indeed, it is unfortunate that so little effective health research has been conducted in the region regarding these issues. Although the provincial and federal government health agencies have tried to address some of the concerns, any resulting studies have been conducted in a cursory and culturally inappropriate way. As the financial stakes and controversy surrounding the Oil Sands escalate, it becomes even more unlikely that such a full-scale study will be conducted in a manner that accommodates community priorities. The resulting impasse only acts to place community members at ever-increasing risk.

In contrast, and in part as a response to this information vacuum, our study was initiated by and conducted in close and active collaboration with both ACFN and MCFN, and has built on three years of extended research and mutually respectful working relationships. This work was designed in a way that at once reflected community priorities and was accountable to and shaped by both leadership and the grassroots. Although the current study is not the long-demanded baseline health study, our results are still tremendously important in their own right.

Everyone that participated in our study was emphatic: people are dying earlier and from causes that were not evident even 50 years ago. People are clearly most worried about cancer. Of the 94 participants in the body mapping, 20 (21.3%) had contracted 23 cases of cancer. The most common type was breast cancer, although others included cervical, colon, gallbladder, kidney, lung, prostate, stomach, and biliary duct (cholangiocarcinoma) cancer.

In the recent 2014 Alberta Health study regarding Fort Chipewyan, it was found that some cancers were higher than expected when adjusted for age and gender, that is cervical, biliary duct and perhaps lung cancer (Anon 2014a). All three of these cancer types were reflected in our study. Yet this study reported there was no evidence that cancer occurrences as a whole were higher than expected in Fort Chipewyan. Moreover, the study concluded that there was no evidence that the Oil Sands had any role to play in any changes in cancer occurrence (Anon 2014a). Indeed, James Talbot, Alberta Chief Medical Officer was recently featured in the Alberta Ventures magazine as one of the 50 most influential people in Alberta, and "*influential because: he challenged the belief that the Oil Sands cause cancer*" (Anon 2014b).

In direct contrast, participants in our study further emphasized that many of these illnesses, especially cancer, were directly and indirectly linked to upstream Oil Sands development. Our analysis showed that cancer occurrence was significantly higher for those who had worked in the Oil Sands and for those that frequently consumed traditional foods and locally caught fish contaminated by heavy metals (Chapter 6) and PAHs (Chapters 7). This outcome is the first direct link between Oil Sands development and downstream health and wellbeing, in Fort Chipewyan and, for that matter, anywhere.

While cancer was of immediate and paramount importance to participants, many other ailments were also documented. Cancers were accompanied by increases in neurological illnesses including as depression and stress; autoimmune diseases including lupus and rheumatoid arthritis; respiratory illnesses including allergies and asthma; diabetes; circulatory illnesses including hypertension and coronaries; and gastrointestinal illnesses including gallbladders, ulcers, and liver disease, among others. Many of these aliments are also seen as being linked to upstream oil sands development

In addition to its effects on cancer occurrence, diet also played an important role in broader patterns of declining health and wellbeing, reflecting both an increasing level of contaminants in country foods and an increasing consumption of store-bought, nutrition-deficient convenience foods. This situation amounts to a health crisis, which is in turn aggravated by ineffective risk communication on the part of researchers, government, and industry alike as well as a health care system that was seen by many as inadequate at best. These factors, combined with the adverse effects of residential schools, long-term lived poverty, and for that matter systemic racism and oppression, create a situation such that no one health factor should be examined in isolation from the others.

Some of these ailments characterize many isolated Indigenous communities in northern Canada, including type 2 diabetes, obesity, coronary heart disease, and, according to some, addiction (Bruce et al. 2010, Haman et al. 2010, Huet et al. 2012, Young et al. 2000). Indeed, many are exhibited by Indigenous communities around the globe (Damman et al. 2008). Others, especially obesity and heart disease, are quietly becoming a pandemic everywhere (Popkin 2006).

Other health patterns revealed by this research seem to be unique to Fort Chipewyan, most notably the elevated cancer rates and their direct and indirect links to the Oil Sands

Yet, none of the above health concerns have been adequately addressed, either by governments, industry, or university researchers. Few if any studies have adequately documented these impacts and the likely drivers of this health decline. Even fewer have been inclusive and culturally appropriate in approach.

Indeed, while most community members still advocate for a large-scale baseline health study, they are also tired of being researched "to death". Fort Chipewyan is arguably one of the most researched communities and regions in the globe. But most of this work is driven by outsider agendas and little yields any tangible benefits for these communities. Any proposed health studies that are not shaped and controlled by these communities and that do not give adequate community access to the emerging data will continue to be rejected. This occurred in spring 2013 when both MCFN and ACFN withdrew from a planned baseline study for these reasons, much to the dismay of Alberta government staff (McLachlan pers. obsv.). It also occurred in February 2014, when a visit by the Alberta Chief Medical Officer, who had anticipated presenting the outcomes of the 2014 cancer study, was again cancelled by both First Nations because he refused to provide an advance copy of the report or to share the data (Wohlberg 2014a).

In the interim, however, communities are confronted by a double bind. Not only are community members made sick by upstream development, but they are also confronted with a medical infrastructure that is inadequate to deal with these added pressures. This is certainly true for healthcare in Fort Chipewyan, but also for care provided in Fort McMurray and even Edmonton. Access of Indigenous people to primary health care is substantially lower than for their non-Indigenous counterparts in remote communities (Coyt et al. 1997, Shah et al. 2003) and for hospitals in major urban centers (Chung et al. 2012, Gao et al. 2008). There is little evidence that this is changing for the better; indeed, many participants indicated that health care had been better in the past.

What is even less clear is what can be done to ameliorate the situation. Research conducted in collaboration with these communities that provides proactive and appropriate responses to these health concerns is essential to address the health crisis here and elsewhere in northern Canada (Gittelsohn et al. 1996). Yet no studies, to our knowledge, have adequately focused on solutions to these declines in health in this region. Many participants spoke to the importance of exploring solutions to some of these health problems. Some responses should target decision-making and increased community involvement in assessment and management of any industry-associated impacts as well as the monitoring of existing and future development, these amounting to long-term strategies for mitigating ongoing health declines.

Yet other more immediate responses should focus on building capacity and access to local health care, as highlighted by the ongoing construction of the Fort Chipewyan Elders Care Center, which will provide much local health care and provide employment for community members (Church 2014). Most respondents also felt that more understandable and plain language communication by health care professionals as well as the incorporation of traditional medicines and healers in larger healthcare facilities would also increase the effectiveness of treatment. Other proactive responses would address the underlying social determinants of ill health, whether these rested with poverty or chronic underemployment and unemployment.

Some participants also highlighted the importance of promoting culturally appropriate self-care and healthy food systems as ways of addressing these declines in health. Yet such collaborative and culturally sensitive studies are still under-represented in the health literature (Wilson and Young 2008). Some studies have similarly found that health care performance measurement systems in Canada as well as New Zealand and Australia are generally underdeveloped locally, do little to develop or support local services, and ultimately reflect state-generated priorities that have little to do with Indigenous priorities or concepts of health (Smylie et al. 2006). Expert-defined health care initiatives, including those surrounding anti-smoking campaigns in Indigenous communities are often ineffective and even actively resisted as they are seen paternalistic and as reflecting the longstanding colonial presence of governments (Sowden et al. 2003).

Indeed, some participants insisted on consuming fish in direct contradiction to governmental consumption advisories as a way of resisting this colonial presence and also affirming life-giving cultural traditions. Yet these very same traditions can provide context and direction for cross-cultural and inclusive responses to chronic diseases such as diabetes (Potvin et al. 2003, Pylypchuk et al. 2008). It is hoped that such culturally appropriate responses will be reflected in the next stage of this work, in part because these effective ways of mitigating these illnesses are so greatly needed, but also because they counteract a social milieu where the only news regarding health is generally bleak, or worse.

In the interim, our study shows that ongoing declines in health and wellbeing are real. Moreover, we linked these changes directly and indirectly to upstream Oil Sands development as well as the many other drivers that characterize northern communities as a whole. Outcomes of studies like this one provide enough insight into the current health status of these communities, that proactive management and decision-making can and needs to be developed inside and outside the communities that can address these health concerns on a proactive basis. Should this not occur, the communities will continue to decline in wellbeing to the degree that future Oil Sands development is allowed to expand northwards without adequate checks and balances.

Table 9.1. State of individual and community health in the past and in the present.

	Mean	SE	N	+	-
I worry about the current state of health of my community	4.63	0.09	89	91.0	4.5
I worry about the current state of health of my family	4.59	0.10	90	90.0	10.0
Health of community lower now than 50 years ago	4.22	0.14	87	73.9	14.9
I worry about the current state of my own health	4.14	0.13	93	77.4	11.8
I am healthier than my parents when they were my age	2.89	0.16	88	34.1	47.7

Note: 5=Strongly Agree, 1= Strongly Disagree; neutral values eliminated for proportion calculation

Table 9.2. Numbers of cancers and non-cancerous illnesses as experienced by survey participants (n=94).

Types of Illnesses	Cancers	Non-Cancers	Total		
Neurological	0	61	61		
Respiratory	2	54	56		
Circulatory	0	46	46		
Arthritis	0	32	32		
Gastrointestinal	8	22	30		
Reproductive	8	11	19		
Diabetes	0	12	12		
Thyroid	0	8	8		
Growths (tumours, cysts, abscesses)	0	5	5		
Kidney	2	3	5		
Autoimmune (e.g. lupus)	0	4	4		
Addictions	0	4	4		
Skin	0	3	3		
Unspecified	3	0	3		
Eye	0	2	2		
Total	*23*	*267*	*31 290*	*298 31*	*298*

Table 9.3. Numbers and types of neurological illnesses as experienced by participants (n=94)

Types of Illnesses	Number of Cases
Sleeping disorders	13
Migraines	9
Stress	7
Stroke	6
Depression	6
Anxiety	6
Attention hypertension deficit disorder (ADHD)	3
Aneurism	2
Mental illness unspecified	2
Foetal alcohol syndrome (FAS)	2
Mental dementia	2
Seizures	1
Attention deficit disorder (ADD)	1
Restless leg syndrome	1
Total	*61*

Table 9.4. Numbers and types of respiratory illnesses as experienced by survey participants (n=94)

Types of Illnesses	Number of Cases
Tuberculosis	13
Allergies	9
Shortness of breath	7
Asthma	7
Pneumonia	5
Bronchitis	5
Respiratory illness unspecified	4
Lung Cancer	2
Lungs	2
Emphysema	1
COPD	1
Total	*56*

Table 9.5: Numbers and types of circulatory illnesses as experienced by survey participants (n=94)

Types of Illnesses	Number of Cases
Hypertension	22
Coronary- heart	18
Coronary-artery	2
Palpitations	2
Unspecified heart illness	2
Total	*46*

Table 9.6. Numbers and types of gastrointestinal illnesses as experienced by survey participants (n=94)

Types of Illnesses	Number of Cases
Gallbladder	6
Ulcers	6
Unspecified gastrointestinal	3
Liver disease (hepatitis, cirrhosis)	3
Colon cancer	2
Acid reflux	2
Gall bladder cancer	2
Stomach cancer	2
Appendicitis	1
Pancreatitis	1
Cholangiocarcinoma	1
Bowel cancer	1
Total	*30*

Table 9.7. Numbers and types of reproductive illnesses as experienced by survey participants (n=94)

Types of Illnesses	Number of Cases
Miscarriages	8
Breast cancer	4
Prostate cancer	2
Cervical cancer	2
Caesarean section	1
Congenital disorders	1
Unspecified reproductive illnesses	1
Total	*19*

Table 9.8. Degree to which participants agreed that people in Fort Chipewyan suffer *much more now* from the following illnesses than they did in the *past.*

Illness	Mean	SE	N	+	-
Cancer	4.91	0.05	91	96.7	1.1
Diabetes	4.75	0.10	89	82.0	4.5
Heart disease	4.71	0.09	91	85.7	2.2
Asthma	4.66	0.08	89	88.8	1.1
Arthritis	4.42	0.10	91	74.7	1.1
Stress	4.38	0.11	94	79.1	4.6
Obesity	4.37	0.12	94	73.3	5.8

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation

Table 9.9. Number of times that these different health concerns were mentioned in the focus group discussions held Oct 15-17, 2014.

Issue	Frequency
Cancer	24
Skin problem	9
Diabetes	8
Stress	8
Tuberculosis	6
Heart disease	3
Gallbladder problem	3
Lost weight	3
Young people suffering from cancer	3
Kidney loss	3
Lupus	2
Alcoholism	2
High blood pressure	2
No energy	2
Abscesses	2
High cholesterol	2
Alzheimer's	2
Stomach problem	2
Depression	2
Arthritis	2
Asthma	2
Dialysis, no energy, asbestos, renal failure, numb, eczema, lost hair, pneumonia, drug addition, chronic pain, breathing problem	1 (each)

Table 9.10. Numbers of cancer cases, according to cancer type and gender

Type of cancer	**Male**	**Female**	**All Total**
Breast	0	4	4
Other unspecified	3	0	3
Lung	1	1	2
Cervical	0	2	2
Colon	1	1	2
Gallbladder	0	2	2
Kidney	0	2	2
Prostate	2	0	2
Stomach	1	1	2
Bowel	1	0	1
Cholangiocarcinoma	0	1	1
Total	*9*	*14*	*23*

Table 9.11. Number of cancer cases[a] and a) Age Specific Incidence Rates per 100,000 by age group, and b) Age Standardized Incidence Rates (ASIRs) per 100,000[b] by sex. These values are for Fort Chipewyan 2013 as well as Fort Chipewyan (AHS), Conklin/Chard/Jarvier (AHS), Fort McMurray(AHS), Fort Vermillion(AHS), Northern Lights Region (AHS), and Alberta (AHS) 1995-2006, as derived from Chen (2009).

a)

Location	**Age 0-19 yrs**		**Age 20-54 yrs**		**Age 55+ yrs**	
	Case	Crude rate	Cases	Crude rate	Cases	Crude rate
Fort Chipewyan	0	0	7	1182.4	13	4961.8
Fort Chipewyan (AHS)	0	0	9	135.8	42	1912.6
Conklin/Chard/Jarvier (AHS)	1	28.6	3	78.5	3	835.3
Fort McMurray(AHS)	16	10.2	482	160.1	349	967.4
Fort Vermillion(AHS)	4	20.5	18	105.1	46	1077
Northern Lights Region (AHS)	38	13.6	620	145.1	660	1081.2
Alberta (AHS)	1589	15.5	31841	167.6	104049	1556.1

b)

Location	**Male**		**Female**		**Total**	
	Case	ASIR (95% CI)	Cases	ASIR (95% CI)	Cases	ASIR (95% CI)
Fort Chipewyan	10	1456 (553-2358)	10	1814 (670-2858)	20	1615 (907-2322)
Fort Chipewyan (AHS)	33	583 (398-825)	18	354 (207-566)	51	475 (352-626)
Conklin/Chard/Jarvier (AHS)	9	349 (148-696)	2	66 (8-238)	11	234 (109-439)
Fort McMurray (AHS)	413	345 (294-402)	434	312 (272-356)	847	325 (293-359)
Fort Vermillion (AHS)	41	351 (246-486)	27	235 (150-349)	68	301 (230-387)
Northern Lights Region (AHS)	677	378 (342-417)	641	305 (277-336)	1,318	301 (230-387)
Alberta (AHS)	71,408	454 (451-458)	66,071	354 (352-357)	137,479	397 (395-399)

[a] Excludes non-melanoma skin cancer cases.

[b]1991 Canadian population was used as the standard population.

[c]Values for Fort Chipewyan are from this study whereas those for Fort Chipewyan (AHS), Conklin/Chard/Jarvier (AHS), Fort McMurray (AHS), Northern Lights Region (AHS), and Alberta (AHS) are from Chen (2009).

Table 9.12. Descriptive cancer statistics with respect to independent variables used in logit analysis and AIC.

Variable	Cancer (1)		No Cancer (0)	
	Mean	S.E.	Mean	S.E.
Gender				
Male (n=39)	0.39	0.11	0.41	0.06
Female (n=52)	0.61	0.11	0.59	0.06
Age	58.70	3.18	51.13	2.17
Affiliation				
MCFN (n=45)	0.40	0.11	0.52	0.06
ACFN (n=32)	0.40	0.11	0.34	0.06
Metis (n=9)	0.10	0.07	0.10	0.04
Other (n=5)	0.10	0.07	0.04	0.02
The quality of health care that I receive in Fort Chip is excellent (1=Really Disagree, 5=Really Agree)	3.05	0.33	2.37	0.15
Polluted traditional foods are a major cause of poor health in Fort Chip (1=Really Disagree, 5=Really Agree)	4.60	0.13	4.27	0.13
The Oil Sands are an important cause of declines in my health (1=Really Disagree, 5=Really Agree)	4.10	0.34	4.39	0.12
Stress is an important cause of declines in the health of my community (1=Really Disagree, 5=Really Agree)	4.45	0.18	4.20	0.12
Smoking is an important cause of declines in my health (1=Really Disagree, 5=Really Agree)	4.05	0.26	4.11	0.13
The Bennett Dam is an important cause of declines in the health of my community (1=Really Disagree, 5=Really Agree)	4.50	0.15	4.28	0.13
Have you worked in the Oil Sands? (1=yes, 0=no)	0.60	0.12	0.46	0.06
In general, I eat traditional foods (1=Never, 9= Every meal)	6.05	0.25	5.32	0.21
In general, I eat locally-caught wild fish (1=Never, 9= Every meal)	4.15	0.38	3.51	0.22
Roughly, how many days e*ach year* did you spend on the land 10 and (if appropriate) 20 and 30 years ago?	97.65	21.79	75.66	10.20

Table 9.13. Definition of and descriptive statistics for explanatory variables used in the logit and AIC regression analyses when examining cancer occurrence in Fort Chipewyan.

Model Term	Description	Mean	SE
Cancer (Dependent Variable)	1 if the participant has cancer; 0 if otherwise	0.22	0.04
Age	Age of the participant in years	52.79	1.85
Gender	1 if the participant is female; 0 if otherwise	0.43	0.05
HealthCareFC	The quality of health care that I receive in Fort Chipewyan is excellent 1=Really Disagree, 5=Really Agree	2.52	0.14
TradFoodHealth	Polluted traditional foods are an important cause of poor health in Fort Chipewyan 1=Really Disagree, 5=Really Agree	4.34	0.11
OilSandsHealth	The Oil Sands are an important cause of declines in my own health 1=Really Disagree, 5=Really Agree	4.33	0.12
StressHealth	Stress is important cause of poor health in Fort Chipewyan 1=Really Disagree, 5=Really Agree	4.25	0.10
SmokingHealth	Smoking is an important cause of declines in my own health 1=Really Disagree, 5=Really Agree	4.10	0.12
BennettDamHealth	The Bennett Dam is important cause of poor health in Fort Chipewyan 1=Really Disagree, 5=Really Agree	4.62	0.08
OilSandsWork	1 if participant has worked in the Oil Sands; 0 if otherwise	0.49	0.05
TradFoodFreq	1 if the participant eats traditional foods at least 2-3 X per week; 0 if otherwise	0.53	0.05
LocalFishFreq	1 if the participant eats locally caught fish at most 1 X per six months; 0 if otherwise	0.69	0.05
AvgDaysLand	How many days the participant spends on the land per year on average (days)	80.49	9.27

Table 9.14. Outcomes of logit regression analysis examining the relationships between independent variables and occurrence of cancer in Fort Chipewyan[a].

Independent variable	**Coefficient**		**Marginal Effects**		**P-Value**
	(β)	Std. Err.	dy/dx	Std. Err	
Constant	-26.90	7.84			
Age**[b]	0.06	0.02	0.01	0.01	0.030
Gender**	-2.62	1.11	-0.09	0.05	0.019
HealthCareFC *****	2.22	0.70	0.07	0.04	0.001
TradFoodHealth****	2.23	0.72	0.07	0.04	0.002
OilSandsHealth***	-1.78	0.65	-.06	0.03	0.002
StressHealth**	1.54	0.65	0.05	0.03	0.017
SmokingHealth	-0.08	0.34	-0.01	0.01	0.804
BennettDamHealth	0.87	0.58	0.03	0.02	0.134
OilSandsWork*	1.59	0.88	0.06	0.05	0.069
TradFoodFreq***	3.69	1.33	0.16	0.07	0.006
LocalFishFreq***	2.32	1.09	0.06	0.04	0.034
AvgDaysLand	-0.01	0.01	-0.001	0.001	0.410

[a]χ^2 H0: all β= 0, (df=12) 39.27 (*p*<0.001); Log likelihood value (full model) = -28.291(p<0.001); McFadden's Adj r^2 = 0.138 for full model; % of correct prediction = 85.71%; number of observation = 91
[b]**p*<0.1, ***p*<0.05, ****p*<0.01, *****p*<0.005, ******p*<0.001

Table 9.15. Cumulative AIC_c weights of variables representing the relative and decreasing importance of demographic, perceived roles of environment, and environmental variables hypothesized to influence the occurrence of cancer in Fort Chipewya.. All variables with w+ ≥ 0.50 are bolded.

Variable	Cumulative AIC_c weight
HealthCareFC	**0.99**
TradFoodHealth	**0.96**
TradFoodFreq	**0.95**
OilSandsHealth	**0.92**
StressHealth	**0.86**
LocalFishFreq	**0.76**
Gender	**0.75**
Age	**0.70**
OilSandsWork	**0.65**
BennettDamHealth	0.39
AvgDaysLand	0.26
SmokingHealth	0.24

[a] AICc, Akaike's Information Criterion with small-sample bias adjustment (Burnham and Anderson, 2002).
[b] Variables are described in Table 9.13. Cumulative AICc weight of a variable, the percent of weight attributable to models containing that particular variable and is calculated by summing the AICc model weights of every model containing that variable.

Table 9.16. Number of model parameters, differences in Akaike information criterion (Δ-AICc), and AICc weights (w) for candidate models developed to predict cancer occurrence of residents of Fort Chipewyan.

Model Structure	**-2Log (L)**	**k**	**ΔAIC_c**	**AIC_cw**
Age + Gender + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + OilSandsWork + TradFoodFreq + LocalFishFreq	80.41	10	0.0	0.097
Age + Gender + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + BennettDamHealth + OilSandsWork + TradFoodFreq + LocalFishFreq	81.10	11	0.70	0.069
Gender + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + OilSandsWork + TradFoodFreq + LocalFishFreq	81.70	9	1.29	0.051
Age + Gender + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + OilSandsWork + TradFoodFreq + LocalFishFreq + AvgDaysLand	82.01	11	1.60	0.043
Age + Gender + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + TradFoodFreq + LocalFishFreq	82.44	9	2.03	0.035
Age + Gender + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + BennettDamHealth + OilSandsWork + TradFoodFreq + LocalFishFreq + AvgDaysLand	82.72	12	2.31	0.031
Gender + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + BennettDamHealth + OilSandsWork + TradFoodFreq + LocalFishFreq	82.79	10	3.37	0.030
Age + TradFoodHealth + HealthCareFC + OilSandsHealth + StressHealth + TradFoodFreq + LocalFishFreq	84.41	8	4.00	0.013
TradFoodHealth + HealthCareFC +OilSandsHealth + StressHealth + TradFoodFreq + LocalFishFreq	85.49	7	5.08	0.007
Age + TradFoodHealth + HealthCareFC + OilSandsHealth + TradFoodFreq	87.43	6	7.02	0.003
TradFoodHealth +HealthCareFC + OilSandsHealth + LocalFishFreq	93.19	5	12.78	<0.001
TradFoodHealth + StressHealth	99.33	3	18.92	<0.001
Gender	99.45	2	19.04	<0.001

[a] AICc, Akaike's Information Criterion with small-sample bias adjustment (Burnham and Anderson, 2002).
[b] Variables are described in Table 9.13. Cumulative AICc weight of a variable, the percent of weight attributable to models containing that particular variable and is calculated by summing the AICc model weights of every model containing that variable.

Table 9.17. Causes of any declines in individual and community health as evaluated by participants.

	Individual health						Community health					
Cause	**Mean**	**SE**	**Rank**	**+**	**-**	**N**	**Mean**	**SE**	**Rank**	**+**	**-**	**N**
Oil Sands	4.33	0.13	1	81.6	11.5	87	4.68	0.11	1	82.6	7.6	92
Upstream agriculture	4.21	0.13	2	81.3	8.8	80	4.57	0.11	2	72.7	4.5	88
Drugs	-	-	-	-	-	-	4.56	0.10	3	87.6	6.7	89
Bennett Dam	4.10	0.13	3	71.3	8.8	80	4.54	0.12	4	74.2	8.6	93
Processed foods	4.09	0.14	4	75.3	13.6	81	4.31	0.12	8	72.2	7.8	90
Smoking	4.07	0.14	5	71.6	12.3	81	4.39	0.12	6	75.6	5.6	90
Climate change	4.07	0.13	6	66.7	7.1	84	4.44	0.11	5	67.8	2.2	90
Stress	4.05	0.13	7	72.5	8.8	80	4.33	0.11	7	75.6	3.3	90

Note: 1=Strongly disagree, 5= Strongly agree; neutral values eliminated for proportion calculation

Table 9.18. Correlation amongst the 12 independent variables used to model the impacts of the socio-environment on cancer occurrence in Fort Chipewyan

	Age	Gender	HthCrFC[a]	TradFdHth	OilSdsHth	StressHth	SmokHth	BenDamHth	OilSdsWork	TradFdFreq	LocFishFreq	DaysLand
Age	1											
Gender	0.145	1										
HthCrFC	0.043	**0.311*****	1									
TradFdHth	**-0.248***	-0.028	**-0.217***	1								
OilSdsHth	-0.153	-0.151	-0.088	**0.212***	1							
StressHth	-0.048	-0.134	-0.159	0.102	**0.239***	1						
SmokHth	-0.139	0.023	-0.161	0.117	**0.354*****	**0.410****	1					
BenDamHth	-0.104	-0.083	**-0.226***	**0.260***	**0.269****	**0.303****	**0.204***	1				
OilSdsWork	0.176	**0.476*****	0.192	-0.050	-0.035	-0.190	-0.069	-0.189	1			
TradFdFreq	0.057	-0.025	**-0.209***	0.079	0.117	0.179	0.085	**0.368****	-0.164	1		
LocFishFreq	**0.239***	0.192	0.061	0.059	0.149	-0.097	-0.027	0.075	0.136	0.180	1	
DaysLand	**0.356*****	**0.294*****	0.108	-0.042	-0.013	-0.048	0.021	-0.014	**0.265***	0.113	**0.238***	1

[a]HthCrFC: HealthCareFC; TradFdHth: TradFoodHealth; OilSdsHth: OilSandsHealth; StressHth: StressHealth; SmokHth: SmokingHealth; BenDamHth: BennettDamHealth; OilSdsWork: OilSandsWork; TradFdFreq: TradFoodFreq; LocFishFreq: LocalFishFreq; DaysLand: AvgDaysLand. See Table 9.* for detailed explanation of these variables.

[b]*correlation significant at $p<0.05$ (2-tailed Spearman's correlation), **correlation significant at $p<0.01$, ***correlation significant at $p<0.005$.

Table 9.19. Number of times that these references to the existing health care were mentioned focus group discussions held Oct 15-17, 2014.

Issue	Frequency
No doctor in community	10
Better healthcare in Edmonton	5
Long waiting list of doctor appointment	5
Dissatisfaction with paramedics	4
Dissatisfaction with doctors in Fort McMurray	3
Treatment by traditional healthcare	3
Try personal healthcare: exercise, quit smoking	3
Trust Doctor O'Connor in Fort McMurray	2
Distrust doctors or medicine	2
Community contract with dentist	1
No emergency healthcare	1
Paramedic's verbal abuse	1
Treat as referral, no respect	1
No quick aftercare	1

Table 9.20. Quality of health care in and outside Fort Chipewyan.

	Mean	SE	N	+
The quality of health care that people I care about receive down South is excellent	3.76	0.15	82	64.6
The quality of health care that I receive in Fort Chipewyan is getting better	2.53	0.14	93	25.8
The quality of health care that I receive in Fort Chip is excellent	2.52	0.13	91	26.4
The quality of health care that people I care about receive in Fort Chipewyan is excellent	2.46	0.15	87	26.4

Note: 5=Strongly Agree, 1= Strongly Disagree; neutral values eliminated for proportion calculation

Table 9.21. Ways of addressing shortcomings in healthcare

	Mean	SE	N	+	-
Increase how understandable health information is to patients	4.53	0.10	92	80.4	3.3
Increase the health information available to patients	4.51	0.11	91	81.3	5.5
Increase the number of health professionals in Fort Chipewyan	4.49	0.11	92	88.0	8.7
Increase the quality of health treatment in Fort Chipewyan	4.49	0.11	92	83.7	9.8
Increase access to traditional healers in hospitals in the South	4.49	0.11	93	82.8	5.4
Increase sensitivity of health professionals to Aboriginal issues	4.46	0.12	91	79.1	6.6
Increase access to traditional healing in Fort Chipewyan	4.40	0.12	93	78.5	7.5
Increase input of leadership in setting health priorities	4.40	0.11	92	77.2	4.3
Increase the quality of out-patient care in Fort Chipewyan	4.39	0.12	92	78.3	8.7
Increase input of patients in setting health priorities	4.38	0.11	93	76.3	4.3
Increase access to traditional medicines in hospitals	4.32	0.12	93	75.3	7.5
Increase the quality of hospital care in the South	4.25	0.13	91	72.5	9.9
Increase input of community in setting health priorities	4.22	0.12	93	66.8	7.5

Note: 5=Strongly Agree, 1= Strongly Disagree, neutral values eliminated for proportion calculation

10. PASSING ON THE GIFT

10.1 BACKGROUND

There is widespread recognition that any industry-related environmental changes along the Peace-Athabasca-Slave River Basin should be evaluated to examine cumulative impacts and incorporate follow up monitoring, and that these outcomes should inform decision-making. However, any projects conducted through the Canadian Environmental Assessment Act have yet to systematically evaluate any environmental impacts associated with the Oil Sands (Kelly et al. 2010). Likewise, the Cumulative Environmental Management Association (CEMA), a multi-stakeholder group including some Indigenous communities, has yet to synthesize any cumulative impacts (Timoney and Lee 2009). In the past, most of the science-based monitoring in the region was conducted under the auspices of the Regional Aquatic Monitoring Program (RAMP). However, RAMP was castigated by the Royal Society of Canada (Gosselin et al. 2010), a scientific peer review process (Burn et al. 2010) and an advisory panel to the Minister of Environment (Dowdeswell et al. 2010). A comprehensive "world-class" Joint Oil Sands Monitoring program (JOSM) has now been initiated as a response to these shortcomings (JOSM 2014).

However, none of these monitoring initiatives, including those initiated through JOSM, systematically documents TK regarding these changes and none has evaluated any associated socio-economic implications. Indeed, both Mikisew Cree First Nation (MCFN) and Athabasca Chipewyan First Nation (ACFN) recently withdrew from JOSM because it failed to meaningfully engage with downstream Indigenous communities or to reflect their priorities and concerns (HP 2014). These shortcomings arguably reflect the long-standing exclusion of Indigenous communities from Canadian federal environmental assessment, which is still explicitly grounded in techno-scientific information and outsider-driven (Booth and Skelton 2011). Due to these shortcomings, there is much need and local interest in having monitoring that is shaped and driven by downstream Indigenous communities and that reflects their concerns and traditions (Lawe et al. 2005).

Interest in community based monitoring (CBM) has grown recently as a way of addressing some of the shortcomings associated with centralized monitoring programs. Multi-party monitoring is the most common form of CBM, although others include consultative approaches, whereby governments and industry direct data collection or analysis, and also transformative approaches, which arise from crises and which are action-oriented and directed towards social change (Conrad and Hilchey 2011). The increased interest in and appeal of CBM reflects need, in part due to governmental cutbacks, a recognition that more inclusive approaches generate networking and a climate of trust that is essential when trying to resolve controversial environmental issues, and a recognition that a wide diversity of stakeholders ideally bring a diversity of perspectives and experiences that can ideally help inform decision-making (Fernandez-Gimenez et al. 2008).

Yet many barriers to effective CBM also exist (Mostert et al. 2007). There are concerns over the lack of (scientific) training, the quality of any (scientific) data that are collected, limited access to (scientific) expertise, and the problematic bias arising from the many lay (non-scientist) participants (Whitelaw et al. 2003, Sharpe and Conrad 2006). These concerns reveal a discourse still narrowly grounded in techno-science, and fail to recognize that Traditional Knowledge is often richer, more place-sensitive, and longer-term in nature than its scientific counterpart, especially when the environmental impacts at hand are regional in nature.

Recent reviews of CBM initiatives across Canada (e.g. Conrad and Daoust 2008, Pollock and Whitelaw 2005) also reflect this bias. All the examined initiatives were science-focused, few were transformative in nature, and none included much less meaningfully involved Indigenous communities. Cross-cultural or three-track approaches to CBM incorporating science and Indigenous Knowledge and reflecting Indigenous priorities and concerns remain absent from the CBM literature especially as they relate to environmental decline. Yet, CBM when conducted in a culturally appropriate way that reflects the priorities of affected communities can potentially make Indigenous concerns more visible and affirm the importance of these communities and their knowledge systems to outsider stakeholders (Lawe et al. 2005). By building on existing capacity and affirming traditions, Indigenous CBM can play a key role in affirming the importance of these traditions with youth that are less able to spend time learning on the land (Friedel 2011). They provide culturally grounded approaches to place-based learning that help youth and Elders link TK to science as environmental education (Sutherland and Henning 2009).

There are no examples of effective cross-cultural CBM in the literature, which reflects the biases that were discussed above. Ironically, one such approach does exist, within Fort Chipewyan, one that could function as an important model of best practices for Indigenous communities interested in increasing their capacity to monitor environmental change taking place on their traditional territories. The program was initiated eight years ago, and has since been coordinated and funded by both MCFN and ACFN. It is explicitly cross-cultural in approach, in that both TK and scientific data are collected and used to gain insight into the nature of changes that are taking place, the causes that underlie such changes, and ways of addressing these changes. Elders and other knowledgeable community members already represent a rich and effective body of insight into these changes and responses, and youth are trained to document these changes, an approach that is common within many Indigenous communities.

FIG 10.1. Drilling to test water levels during muskrat winter survey.

Yet, importantly there has been an equivalent attempt to build to local scientific capacity within this CBM initiative. This effort contrasts strongly with much more common approaches that rely on the expertise of outside consultants and university researchers, approaches that have been criticised as "predatory" in nature, as they often perpetuate dependence and in some cases actually work against the best interests of affected communities (Kulchyski 2013). In sharp contrast, youth and other members of MCFN and ACFN receive continued scientific training and play an essential role in collecting the scientific data, but also help in data analyses and interpretation. In turn, these data reflect the concerns and priorities of those First Nations. These CBM initiatives play an important role within the larger multi-stakeholder and regional Peace Athabasca Delta Environmental Monitoring Program (PADEMP). As coordinated by Parks Canada, this innovative program brings together the MCFN, ACFN, Métis Local 125, government agencies and university scientists to document ongoing environmental changes in the delta. In 2012, PADEMP conducted the cross-cultural winter muskrat survey, which just completed its second year of data collection (McLachlan and Miller 2012).

A key component in this cross-cultural CBM is to find ways of building interest in and capacity with local youth that are at once grounded in and affirm the importance of both TK and western science. Communities and outside stakeholders including government, NGOs, and university researchers are brought together to create opportunities to provide training and mentorship for local youth and to learn from one another. In these effective "learning communities" each actor brings unique insights, resources, priorities, and worldviews that can help enrich their own understanding and tolerance of differing positions regarding issues, and build relationships that can help shape future decision-making (Steffensen et al. 2010). Cross-cultural knowledge emerging from these interactions has the potential to at-once bridge TK, local priorities, and science. Sometimes this occurs through the establishment of so-called "boundary organizations" such as CEMA or PADEMP that exist at the interface between the science and non-science and that have lines of communications into each (Guston 2001). But it can also reflect a zone of overlap and collaboration between scientists and non-scientists that produces socially robust and transdisciplinary outcomes (Hirsch Hadorn et al. 2006, Dale and Armitage 2011).

The latter approach was reflected in the form of a Youth-Elder Camp conducted in the Spring, 2012 in a setting that was historically used by all three Indigenous groups now located in Fort Chipewyan and that is now situated in the Wood Buffalo National Park. The intent of this camp was to create an inclusive and culturally appropriate learning environment that would facilitate communication among partners, but that would also seed interest on the part of local students in engaging further in these monitoring activities, in and outside of the formal school setting. We participated in, documented, and helped evaluate the outcomes associated with this camp.

The goal of this component of the study was:

i) to document the activities as viewed by community participants,
ii) to identify the need and interest in such a camp, to identify any strengths and shortcomings of this camp, and
iii) to explore what might be done differently in the future.

10.2 METHODOLOGY

The Youth-Elder camp took place from June 5-7, 2012. The camp was situated within the Wood Buffalo National Park at Dog Camp (Quatre Fourches) and coordinated by the MCFN-GIR. This site had a long history of use by all three Indigenous communities in Fort Chipewyan: MCFN, ACFN, and Métis Local 125. From a pragmatic perspective the site was also appropriate since it was only a 20-minute boat ride from Fort Chipewyan. This was essential, since most of the students who would participate only spent the day at the camp, and thus needed to be within ready access of the town.

Most important, was the active presence of Elders who oversaw the whole project, but also taught students how to pick and to use medicines; to set fish nets, traps and snares; and also provided a long-term context for the camp itself as well as the environmental changes that had taken place over the past 100 years. Another scientist, in this case an environmental toxicologist who was conducting a multi-scale research project on the implications of the Oil Sands for fish, sat briefly with community members and, while dissecting some fish, showed them what changes he was seeing and seeking in his research.

There were a number of other outsider stakeholders involved in the delivery of the programming. Importantly, the Athabasca Community School was explicitly supportive and encouraged students to participate and also provided teachers as chaperones and to help facilitate learning. Parks Canada staff provided photos of past camps, examples of traps and furs from the past, as well as opportunities to use GPS units to map out old foundations on the site. The (Alberta) Technical Services Advisory Group, which is associated with the federal Department of Fisheries and Oceans, also participated, as a group that provides technical support for communities interested in monitoring changes in aquatic environments. They brought watershed models for students to interact with and showed students how to collect water samples and to characterize aquatic invertebrate communities. Finally, researchers from University of Manitoba showed students how to document environmental change using photographs and video and how to characterize herbaceous and shrubby plant communities with linear transects and plant identification books.

On the first day (June 5), about 15 older (Grades 11 and 12) students visited and engaged with this wide variety of approaches to learning about the environment. On the second day (June 6), 31 younger (Grades 5 to 9) students spent the day engaged with similar activities. It had been decided by the school authorities that there was too much risk in bringing very young (Kindergarten – Grade 4) students to the camp. Instead a parallel camp was set up on the third day (June 7) in the school gym, where all the above activities were conducted in this indoor and rainproof environment. Later, that afternoon, a 30-minute film that documented the land-based camp was shown to over 200 students in the school auditorium, which enabled all students of all grades to experience and celebrate the important activities and outcomes of the camp.

We video-documented and participating in a wide diversity of camp activities over the five days. After the camp was concluded, we conducted open-ended interviews with nine Indigenous adults participants, including Elders, cooks, and harvesters, to find out what had worked in the camp and what might have been done differently. They were also asked whether they would want to see such a camp held again, and if so, what other ideas might be included. These interviews were transcribed in their entirety, and then any emergent themes were identified as part of this evaluation.

10.3 RESULTS

10.3.1 OVERALL FEEDBACK

Overall impressions of the Youth-Elder camp were generally very positive, and participants felt affirmed by the opportunity to participate,

> *"I really enjoyed myself out here, you know showing them how to skin a moose and stuff like that. Like I said I am very honoured to do that, and I will do that anytime of the day and any other time."*

The students also generally responded very well to the experiences, to the point that some wanted to stay overnight with their parents before returning home,

> *"They had a wonderful time, they were very excited about everything that was going on. You know, they didn't want to, some of them, didn't want to leave. So some of them did stay behind with their parents and stuff like that. Because school was over and it was time for them to go back. But they wanted to stay longer because it was so nice out, and having really enjoyed themselves."*

Environmental changes, particularly the drying of the Peace Athabasca Delta and encroachment by vegetation on the former inland lakes provided an important and useful context for many of the teachings, as indicated by this Elder,

> "*I was invited in as an Elder, what you call train the kids, the students, about the land and what changes have I seen. So there is quite a bit of change since my time. Today, you see all this forest growing, there are no more meadows left. It is all dried up and willows have taken over.*"

FIG 10.2. Students accompany Elder George Wandering Spirit (MCFN) behind the camp.

Some Elders worried that their livelihoods and traditions were disappearing along with the water and the wildlife, a trend that would likely continue into the future,

> *"…like our livelihood is fading away, and like animal skills and getting sick and the birds that we used to kill. It's getting worse every year. There is no water and their food is gone. That is why they fly right through, they don't stop now, just a few. And the moose are disappearing, so there is not that many moose anymore. I think there quite a few things on the foods. Like the muskrats are gone, that is a main source* [of food] *you know, I could kill muskrats in March, so what food do we eat? And there is lots of animals that are gone. Today, now, there is hardly anything out there. In the future there will be nothing, if keeps drying up like that."*

Some of the harvesting activities included fishing, setting nets, shooting, as well as cultural activities including drumming and hand games,

> "*I seen quite a few Elders like Johnny, and Jim and Archie, took the young guys out and showed them how to shoot…It was good to see the Elders go out with the kids and show them what, about the lakeshore and Lake Mamawi and all the traditions and everything else.*"

There were many opportunities for the students to participate in traditional activities, such as skinning moose, and to eat country foods prepared in traditional ways,

> "*They really liked that they were able to see us skin the moose and how it was done. It was pretty good that we had a lot of wildlife out here, eagles you know and stuff like that, for the kids to see. Filleting the fish, or just even cooking the fish or whatever. We had a lot of wild meat to eat out here, the cooks were great, you know, all the staff.*"

FIG 10.3. Youth examine old leg-hold traps as Johnny Courtoreille (MCFN) speaks.

Although many of the activities were traditionally male ones (e.g. hunting, trapping, fishing), others involved traditional women's activities, such as cooking and preparing the food in ways that were of explicit interest to the students,

> "*I wanted to be there, and then explain what was all presented what was on the plate, the heart, the gut and tongue and stuff from inside of the moose. And then I had some brisket and fired meat and boiled and all that. I wanted to explain what part of the moose we had there, because there was some ladies who wanted to know what it was what we are serving and how it taste and all that.*"

While the benefits were clear for the students who participated, the Elders also benefitted, as their traditional ways of knowing were affirmed by all those involved - students and scientists alike. As this participant indicated, this kind of multi-way respect was increasingly uncommon,

> "*It was more than just the children, the Elders, they came out and showed the children how to check the nets, so it was pretty good to see. And I am honoured to see the Elders come out, and have the children and you guys* [outsider scientists] *respect them for you know them being an Elder you know. So, you don't see that very often anymore.*"

Some recognized that these opportunities to learn about traditional activities were becoming increasingly rare for young people,

> "*It is good to see the smaller children going out with the Elders and checking nets. Going and being able to experience the activities. Going for the ratroot and watching us hunt and whatever else we done here…It was good to see that because nowadays it is getting difficult for children and the youth to come and do these kinds of things, because of it not being like the way it used to be a few years ago.*"

FIG 10.4. Parks Canada staff show students how to use GPS units.

In part, this decline in access to the land reflected the lack of interest on the part of their parents. But it also reflected the contrast between traditional and modern living, and the inability on the part of some students to bridge the worldviews and to make easy transitions from the one to the other,

> *"Well its different from raising kids and then teaching them how. Because most of the kids will always say 'I am bored'. There is no way around it, you have to just keep on pushing. You know, as a kid, you always get bored at the beginning. And then you end up learning and then you are interested in doing it.*"

But this decline also reflected the lack of opportunity for the students to learn from the land and about their traditions as part of their formal schooling,

> Partic: *"I think they should, the school should, get more involved with that. Because we got a lot of knowledgeable people, traditional people living in town you know that are willing to help out students and stuff, as long as the school is up and in with it. Then, yeah, they should do a little bit more of it each spring."*
> SM: "*So when you think of your kids, and their schooling, it doesn't happen very often?"*
> Partic: *"No, no – not very often at all."*

Although this kind of learning was once available in the past, it had since become less commonplace,

> *"No, not in the last few years. I remember when I was in school, things like this used to happen. But that was years back. It was nice to start getting the kids involved again, it's good."*

Some of the students would thus have had little opportunity to go out on the land, and to participate in these traditional (and science-based) activities. Despite this, the students generally seemed open to the sometimes-unfamiliar experiences,

> "*All the kids learned something and all the guys were pretty open to being instructed... We were sure pleased to see all the kids doing everything. With some of them never been in the woods and learned lots from all of this."*

While Fort Chipewyan is located on Lake Athabasca, at least some of the students would not have had the opportunity to previously go on the water,

> *"I had them out in the boats. A lot of these kids don't get a chance to even go out in a boat, and they live in Chip, you know. I noticed that they enjoyed it, that they like taking it home."*

Many of those interviewed also appreciated the presence and willingness of government staff and university scientists to participate and to share what they knew, but to do so out on the land in a traditional camp setting. Their involvement in this traditional camp gave the knowledge, long dismissed by most outsiders, and for that matter many scientists, added gravity,

> "*You know, I thought you* [scientists] *will just tease and sit around. But, no, you helped. Anything that wanted to be done, you guys were there. You guys wanted to be there and not doing something else.*"

Some participants also saw value in the sampling and mapping techniques that were being shared, especially because it seemed of interest to the students,

> "*I could see their reaction to what you guys were doing and they were all interested. And people walk around in the bush like with the parks and look over different plants and trees and whatever bugs. Stuff like that it was really good.*"

This was also true of the science activities conducted on the water,

> *"Yeah they liked it, when I had them in my boat there. Glad to come out, they had a good time. They learned a little bit, like they were playing with the bugs and stuff there in the water. And I think they were enjoying that and testing the temperature of the water with the water monitor. So that was pretty good. It was nice to see them come out and enjoy themselves."*

FIG 10.5. Students test water sample for acidity.

Especially interesting was the cross-generational exchange of scientific information, from students to Elders,

> "*to bring a beavers and stuff like that. To actually open it up and that was good. I think that the kids were excited when they pulled out the heart and then it was away from the body. And three hours, it was still pumping. Then they were all talking about it, they were telling me. I didn't know that it could pump for hours after..It was good, it was really awesome."*

Some saw value in the science being taught in experiential ways on the land that were not restricted to in-class and book-based learning,

> "*But the older kids that were here, it was good for them to come out in the bush and feel what you guys were teaching…I think they should have more of that. It would be good, good for them, later, to experience that, instead of reading in the books and*

watching on TV. And then coming and seeing somebody cutting up the fish or whatever and then watching them taking it out from a net and putting it on a table."

This was, of course, also true for learning about the traditions,

> *"Well, maybe just trying to get the children, to let them try to fillet a fish, or even try to pull the net it, or even if you could get a moose again. Anything like that, to get them the hands-on training for the cultural and traditional. That is how I learned, I actually had to get involved. That is how my grandpa done it for me. So I was pretty impressed."*

The wide diversity of scientists was acknowledged, some travelling across the country to attend. But the many different Indigenous cultures that were present was also recognized and appreciated,

> "*Like myself, I am a Métis member from Fort Chipewyan. But Mikisew Cree Nation was the one that who put this whole thing up and I praise my, praise my half-self to them. But also the Chipewyan First Nation. There were people from Winnipeg, and Saskatchewan. There are people from Fort Smith, Hay River. So they all joined in together to make this thing a real successful turnout.*"

This kind of cross-cultural interaction goes beyond the content of the experiences and ideas themselves, and speaks to a relationship, where differences in values become less threatening, and where ideas that are perhaps at first unfamiliar can be discussed in an environment that is supportive and affirming.

It was suggested that the camp be held again the next year, but that it become larger in size, involving a larger diversity of Elders, and opportunities to camp overnight,

> *"Well, all the guys I talk to there were pretty happy. He said a few more guys wanted to come and join us next year. We said sure, come if we have it. We have seen all different faces every day. And having fun and everything. They're happy to see all this training, especially for the young guys, and pretty happy about that."*

Having it year after year, would also help generate added interest on the part of the students since participation was voluntary,

> *"I guess we have to keep on growing it, because when you do something quick, like the first time, nobody will be interested. Because it is only a matter of time. It is like going to school, you stay until you finish your grades and stuff, unless you drop out or something. But we have to keep on doing it, I think, every summer."*

Some of the activities had seemed a bit rushed, and ideally more time would be provided to enable students engage with the activities, especially traditional ones, in sustained ways,

> "*But just an hour and that is not enough time for us to explain everything. That is what I think anyway. But this time now, just the short little time I went. But you want to plan for next year, plan it so it would be better*"

Another benefit of having longer periods on the land, is that it would allow some of the students to work through the boredom associated with the transition, and to develop some tangible skills, *"Maybe little longer, but then a lot of these kids were getting bored, you could see that when we went to the Holda camp there. Some were laying around, not really wanting to do whatever. But towards evening they would be saying 'oh I'm bored, it's boring out here'. So, you have to give them just enough time to learn some, a little bit of this or that."*

Some participants, at least, were disappointed that the younger children were not allowed to visit the camp, because of fears of liability on the part of the school administration,

"Well I understand about the younger kids, the situation, and the boat. Usually some kids are hard to sit down, they are pretty excited to go somewhere so they are up and down."

Yet, all of the activities and training opportunities were transferred over to the school gym. Young students were able to sample for fish, look through microscopes, examine traps and pelts, and play with cameras and video. It was notable, however, that none of the Elders participated in this complementary experience, which was a limitation that would need to be addressed in the future.

FIG 10.6. Young students look at traps in the gym session.

By ensuring that it continued from year to year, it might be possible for the camp to attract additional participants from other towns,

"It would be really good if this keeps going on every year. It would be nice to see, even if you guys invite kids from other communities around the Delta, or anywhere else. Bring them up and make it a weekend thing, or whole week-long thing. Have them camp out here and stuff."

Some felt that developing more infrastructure would help with continuity and enable it to be used year-round, *"They should build a longhouse, it would be nice. A camp and build it good. You can use it every year. Build a nice long house, there are lots of logs nearby you know. There are some carpenters that could build a good longhouse and some place that should own it nice. Play a card game or whatever. You sit outside and it is blowing wind, you can't sit down outside. Mosquitos and there are lots of mosquitos at night. That is what I would like to see."*

FIG 10.7. Young students use microscopes to examine aquatic fauna along with staff from the Technical Services Advisory Group (TSAG) at the complementary in-school camp.

Despite the best efforts to make the camp accessible to all, adverse weather conditions might have been too much for some of the Elders. But that might also have been caution regarding a new idea, an idea that would gain traction over time,

"*It would be nice to see a little bit more of* (the Elders) *come out, but I think it was just the weather. Maybe that is why a few of them didn't come out, it was a little windy that day. Some of them don't like to travel on the lake. But, like I said, once something gets started if it progresses into the next year, you will see a bigger turn out."*

Some felt that other types of knowledge might have been better represented, especially regarding medicines that are used individually or in combination,

"If they have got the plants, like the ratroot and the barks and even these dandelions stew. That is medicine too. Tell, let them know what it is, what you can use it for. And then, like these dandelions that you can use it for eczema, you wash your body with that, and red willow."

Others felt there were additional traditional activities that might be demonstrated to the students, including the smoking of fish and moose meat, and the tanning of moose hides, *"You know, next year, it would be nice. Me and my wife stay, and most of the time in the bush. And we would like to teach them how to strip the hide, tie it up and skin it, and take all the hair off and everything and sew them. A lot of the kids have never seen it."*

Others felt that visiting other locations might be useful in the future,

"I would take them out on a hunt, show them different qualities of water. Like how you guys would go out in the boat ride next year and show the kids the different lakes and river."

This, in part, might be accomplished by rotating future Youth-Elder camps through the different traditional territories of the two First Nations and the Metis Local, finding a way to affirm the Elders and students from each of these communities.

FIG 10.8 Students attend the school assembly and watch the 20-min film that documented the 2012 Youth Elder camp.

> Oct 17, BR: *"Even though, even though you put a report together, what's going to come of it, I mean what's going to happen?...Are you going to come back? Come back. Let us know what is really happening? Come back and meet with us and tell us the outcome of what's happened."*

As indicated in the quote above, scientists generally have a terrible reputation within these communities. Consultants working for the communities at least conduct research that is accountable, and to some degree defined by their clients. In contrast, scientists generally conduct their work according to their own rather than community priorities whether they work under the auspices of government, industry, or universities. There is generally very little follow through from these researchers. Despite the many ongoing research projects that have implications for Fort Chipewyan, and despite the long history of environmental research conducted in the region that extends back to the 1970s, the refrain remains the same…once the researcher departs, no one hears anything,

> Oct 17, BR: *"That's all we've been doing studies and studies and studies for years. But we never hear anything after it. It would be nice to know what's the cause"*

In the absence of information, people are left to their fears or become influenced by sensational media coverage, which only fuels any latent fears. Equally complicit in fear generation are the government health advisories regarding contaminant levels in traditional foods, namely fish and bird eggs. Yet, there is also evidence that episodic community presentations without sustained follow up similarly contribute to fears and worries. A small subset of scientists working in the region have clearly recognized the importance of sharing their results with community members. Kevin Timoney, an ecologist generated a report for ACFN and found high levels of PAHs which supported community concerns (e.g. Timoney 2008). David Schindler, an aquatic ecologist with an international reputation has also made a series of presentations within the community over the last decade, especially regarding the outcomes of his work with a then PhD student (Kelly et al. 2009, 2010). Most recently, Craig Hebert, a scientist working with Environment Canada, made presentations to the community about mercury levels in gull and tern eggs (Hebert et al. 2013) However, these examples are much more the exception than the rule. In some cases, these presentations, along with inadequate advisories, actually seemed to aggravate worry and concern. Such that many participants no longer ate fish, because of concerns about environmental contaminants,

> Oct 17, SR: *"Yeah for years we ate big fish, because that was a delicacy, till a scientist told us a few years ago that we were poisoning ourselves with the big fish. I am 40 years old, and I have 40 years of accumulated mercury and whatever, so I'm afraid to eat a big jackfish now."*

At the other extreme is John O'Connor, who worked as a general practitioner within Fort Chipewyan for many years, being readily accessible and responding to community concerns, to the point that he was harshly (and wrongly) criticized for inciting fear and worry. Indeed, his ready presence within the community and strong sense of caring enabled him to help address existing community worries and fear, much to the alarm of some outside stakeholders.

Although of key concern within Fort Chipewyan, given the rampant concern about environmental contaminants, these impasses in communication are characteristic of many northern Indigenous communities affected by intensive resource extraction. Some people have characterized this as amounting to an effective communication crisis (Jardine and Furgal 2010). Even when there is follow up, research on contaminants tends to overlook sub groups within the population that are especially vulnerable, for example, women of child-bearing age and children, instead focusing on harvesters, which tend to be male. Optics also plays an important role. It is unlikely that any government-initiated or industry-funded project will be seen as credible: especially if the resulting outcomes indicate that there are few if any problems with local traditional foods or environments. This is of course a bitter irony.

Throughout this project, we employed four principle means of communicating our research results with community members: community meetings, community video and film, community newsletters, and most recently a multi-media website.

At each step of the research process, we have presented our plans and eventually preliminary outcomes to two advisory committees, one from MCFN made up of leadership and other knowledgeable community members and then the ACFN Elders committee. Each year we have also presented preliminary outcomes to the community as a whole, accompanying the presentation with a feast and with pamphlets that summarize the major outcomes in accessible plain language. When presenting more sensitive health outcomes, we also contacted all 100 participants in the health component of this work by phone, and invited them all to a series of meetings that were smaller in scale and that were designed to facilitate feedback and advice from participants. Although this feedback is important in its own right, it also helps strengthen the research since attendees generally have many suggestions to improve the existing science but also for new avenues of exploration.

FIG 11.1.Presentation of preliminary results of this Phase Two study at the large community meeting and feast in Fort Chipewyan.

We have undertaken the production of a feature length documentary film and series of video shorts that explore community concerns and experiences with changing environments and their implications for human health and wellbeing (Fig 11.2). During our first community meeting, we were given permission to videotape interviews and established ground rules for video and interview protocols. Many of the video clips have been shown at subsequent community meetings and any feedback was incorporated. The final draft of the film was seen by many community members in April 2013 and October 2013 and was given a final approval by the grassroots and by both band councils alike. Over 500 copies of the DVD were distributed within Fort Chipewyan in April 2014, one for each mailbox in the local post office, and are still distributed on an as-needed basis when we are contacted by community members. The film has been submitted to a number of international film festivals and will soon be distributed around the world using a designated film website (www.oneriverfilm.ca). Although it will be made available for free download, the sale of institutional copies and of DVDs to individuals will help generate funding for the community based monitoring program described in Chapter 10.

FIG 11.2. Cover of a DVD that examines environmental and health implications of the Oil Sands from an Indigenous perspective, which was distributed to all community members in Fort Chipewyan and which will be internationally distributed in 2015.

Our newsletter, *One River: Many Relations* (*OR:MR*) is a full color, multi-page cross-community newsletter assembled with contributions and feedback from communities in Alberta and the Northwest Territories (Fig 12.3). Fort Chipewyan as well as Fort Smith and Fort Resolution in the NWT are all experiencing impacts on their way of life and environments as a result of large-scale industrial development in the south. These communities are participating in fish health assessments led by Paul Jones from University of Saskatchewan. The University of Manitoba gained support from PrioNet Canada and SSHRC to extend the work being conducted in Fort Chipewyan into the Northwest Territories, especially as it relates to the exchange of knowledge arising from this and other related research. The latest issue was 12 pages in length, and profiled the results of this study and also contained reports on the last Tar Sands Healing Walk, the Slave River Delta Partnership in NWT, the ongoing Statement of Claim by Beaver Cree Nation against the Alberta Government, recipes for smoking whitefish and preliminary outcomes of a contaminant study on snow pack regarding the Oil Sands, among others. This newsletter as well as other relevant research will be made available on the Internet to a wide diversity of stakeholders including other Indigenous communities across North America, government, industry, civil society, and the public as a whole.

FIG 11.3. Most recent issue (Summer 2014) of the One River, Many Relations newsletter as well as the poster that was used to promote the October 2013 body mapping workshops.

OR:MR is written in plain language and contains excerpts from interviews with both community members and others, and results from scientific research that have been summarized in order to be accessible. We printed 5,000 copies of the third (Summer 2014) issue of *OR:MR* for distribution in Fort Chipewyan, Fort Smith and Fort Resolution and elsewhere across Canada. A fourth issue is now being prepared for a Fall 2014 distribution.

Our most recent communication initiative is the creation of a multi-media and interactive website, and associated Facebook site (www.onerivernews.ca) (Fig 12.4). The intent is to facilitate knowledge exchange between northern communities and outsider stakeholders including scientists, governments, and industry. It was launched in May 2014, and already has over 400 followers. It contains much of the same content of the *OR:MR* newsletters, albeit often involving video and always allowing for comment. However, it is interesting that many of the followers are located in northern AB and NWT, and so it is likely that these sites will facilitate communication among northern communities. To that end, the use of cellphones and tablets is widespread in these and many other Indigenous communities, especially by and among youth and much more so than computers (Odunuga 2014). It is also a news aggregator site, whereby short summaries of news linked to other sites as well as our own news coverage is also communicated. To that end, we are paying for news comments from community members and reporters from the South and the North. Our use of new social media (Facebook, Twitter) further facilitates responses to high profile articles, some of which already exceed 4,000 views.

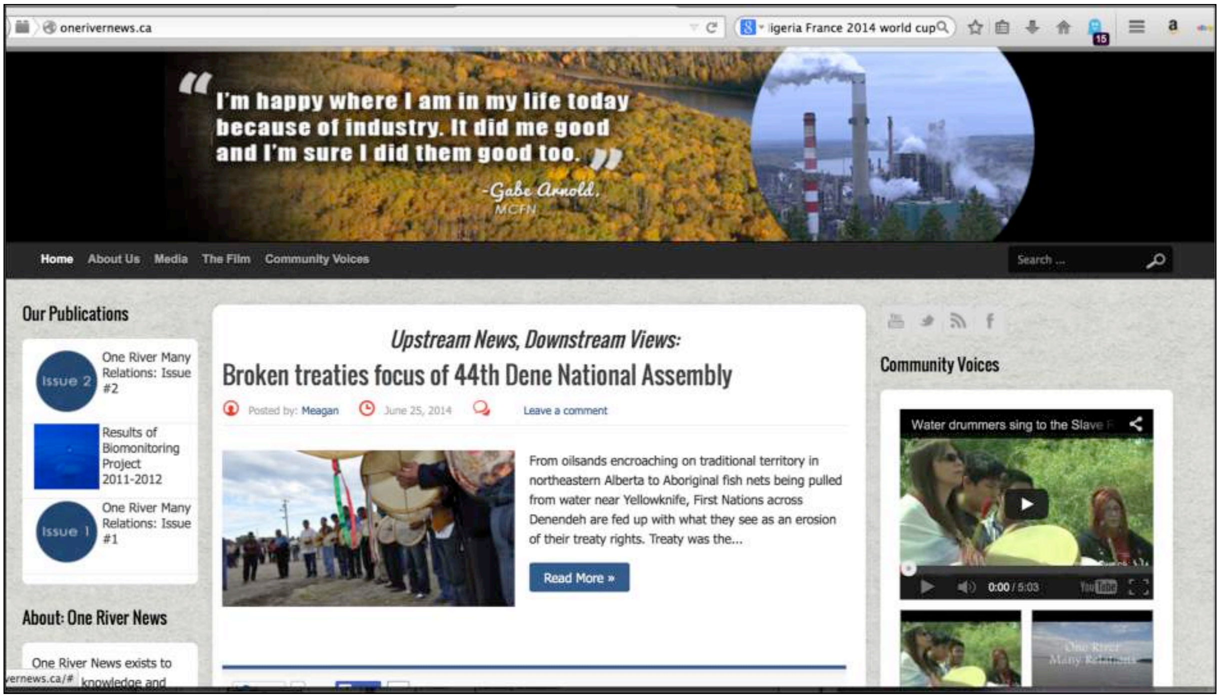

FIG 11. 4. Screen shot of the One River News site (www.onerivernews.ca), which is being used to facilitate interactive communication between northern communities and outsider stakeholders including universities, government, and industry.

Taken together, all these communication initiatives work towards multiple outcomes: facilitating multi-way sharing of information and concerns, increasing the quality and relevance of our research and that of others, and ensuring that the work has the greatest possible benefit possible, for community members of course, but also outside stakeholder including government, civil society, and industry alike. In so doing, these efforts act as a model for other collaborative work bur also to help address the legacy of past research gone wrong.

12. LEARNING FROM BOTH SCIENCE AND TRADITIONAL KNOWLEDGE

This project reflects a cross-cultural and holistic approach to evaluating the implications of the Oil Sands for wildlife, environment, and human health. Our three-track approach documents both Traditional Knowledge or TK (track one) and western science (track two) throughout. Rather than seeing these as two parallel tracks, however, an additional third track has been used that integrates both these knowledge systems, grounding the western science within the rich TK that informs and provides a context for the scientific research (McLachlan 2013). The project has been and continues to be shaped and controlled by both ACFN and MCFN at all stages and it is grounded both in TK and in the sciences, the latter more specifically in the form of veterinary, environmental, dietary, and health sciences.

The outcomes arising from TK interviews with Elders and harvesters indicate that many changes to the aquatic and terrestrial environment have taken and are still taking place. Changes in the quantity and quality of water have had devastating impacts on some wildlife populations, particularly muskrat and fish, and also dramatically affected access to traditional harvesting areas. These changes are widely attributed by community members to the WAC Bennett dam but most recently to the Oil Sands.

Changes to the health and integrity of moose, muskrat, beaver, and duck populations were assessed by interviewing Elders and other knowledgeable community members. These outcomes were then complemented by the necropsies of community-harvested moose, muskrats, beavers, and ducks by wildlife veterinarians. These same animals were then tested for contaminants (i.e. heavy metals and PAHs). That the TK did not generally concur with observations by veterinarians is in part explained by the relative absence of harvests from contaminated areas as well as the lack of microscopic examination and small samples. Moreover, these animals were diverted from the food stream, and thus already reflected a bias towards health animals as influenced by community harvesters. Yet, lab tests showed there were high levels of cadmium and mercury in the livers and kidneys of ducks and to some degree muskrats and moose, and also showed high levels of selenium in all tissues of all the animals that were tested. Willow samples from the Athabasca Delta were significantly ($p<0.05$) higher in mercury levels whereas those collected in the Lake Mamawi area had significantly higher levels of cadmium.

We also documented patterns in the consumption of traditional or country foods, how these had changed from the past, any reasons for such changes and how these consumption patterns might continue to evolve in the future. This diet work was at grounded in the experiences and concerns of local participants as well as using standard scientific tools such as dietary recall to quantify and better understand consumption. Outcomes showed that moose, ratroot, ducks and pickerel were most frequently consumed over a two-month period, but that muskrats had effectively been eliminated from local diets by upstream industrial development. A substantial proportion of participants no longer consumed locally sourced pickerel and other large fish species, in large part because of concerns regarding contaminants.

FIG 12.1. Abandoned commercial fishing boats in Fort Chip.

Finally, we evaluated changes in the health and wellbeing of community members, causes of those changes, how those changes might continue in the future and how and to what degree these future changes might be mitigated. All participants agreed that health had declined compared to the past. Body mapping was conducted, where participants documented their own medical experiences and histories. Although a wide diversity of neurological, respiratory, and gastrointestinal illnesses had been experienced, participants were most worried about cancer.

Of the 94 participants, 20 had experienced 23 cases of cancer. Preliminary analysis shows that these levels were significantly higher than those experiences by other northern communities and regions and the Alberta population, as reflected by another study (Chen 2009). Advanced regression analyses showed that the likelihood of cancer occurrence was affected by age; gender; attitudes towards the Oil Sands and health, attitudes towards stress and health, attitudes towards health care in Fort Chipewyan, attitudes towards traditional foods and health, frequency of consumption of traditional foods; frequency of consumption of fish, and employment in the Oil Sands. Cancers that were most common included lung and breast cancer, although other types also included cervical, colon, gallbladder, kidney, leukemia, prostate, and stomach cancer.

Widespread declines in health were generally attributed by community members to the contamination of the environment and country foods by Oil Sands and upstream agriculture, smoking and drugs, processed store-bought foods, and the WAC Bennett dam; poor risk communication on the part of scientists, government and industry; and inadequate health provision in Fort Chipewyan as well as Fort McMurray and Edmonton. Participants felt that this decline would only continue in the future as the Oil Sands continued to expand northwards from Fort McMurray. Ideas for mitigating this decline included more effective health communication, better access to quality health care especially in Fort Chipewyan, and proactive and culturally appropriate self-care and community programs that were grounded in the traditions and country foods.

These outcomes have been communicated with leadership and the grassroots using a wide diversity of approaches. Bi-monthly progress reports are shared with leadership. Outcomes of this work as well as that of related projects conducted by other university researchers and government scientists as well as outcomes of interviews with members of these and other northern communities have been communicated using newsletters. We also held small-group meetings with participants to share and to get feedback on preliminary outcomes as well as a larger community meeting and feast. Finally, we have summarized these project outcomes in ways that are at once accessible to community members and outside stakeholders, including other communities and university researchers, government, NGOs, and industry. This wider-scale outreach takes the form of a news aggregator website (www.onerivernews.ca) that documents these outcomes, but also other research and media coverage that seem relevant to these issues. Moreover, we are also releasing a feature length documentary film on these issues that will see worldwide distribution and that features a stand-alone website (www.oneriverthefilm.ca).

The two knowledge systems are thus complementary in nature. By integrating both in a meaningful and credible way, a clearer picture emerges of the environmental and health changes that are taking place and the causes for these changes. The TK provides a very clear depiction of the nature of these changes and how wildlife, environmental, and human health combine and interact with one another. It also helps direct the scientific data collection and provides a strong socio-environmental context for any lab-based outcomes. This context in turn helps make both types of data more accessible and credible with community members. The scientific data, on the other hand, help support the TK in ways that might have more resonance with governments and industry, at least in the short-term.

Ultimately, however, these outcomes are only meaningful to the degree that they enable community members and leadership to become meaningfully involved in decision-making regarding these issues, as they relate to these regional impacts or the broader public.

13. CONCLUSIONS AND RECOMMENDATIONS

13.1 CONCLUSIONS

- Substantial declines to the environment have taken place over the last 50 years, especially as related to heavy metals and polycyclic aromatic hydrocarbons (PAHs), and are generally associated with upstream Oil Sands development and hydro development. These declines will only continue to escalate in the future as the Oil Sands continue to expand and if the Site C dam is constructed in northern BC as planned.
- These environmental declines contribute to a change in diets as community members shift from healthy country foods to expensive and often nutritionally deficient store-bought foods, a shift that is only accelerated by concerns regarding the quality of and safety regarding locally sourced country foods.
- These declines in the environment and the quality and accessibility of country foods in turn contribute to corresponding declines in community health and wellbeing, most notably as they relate to increased rates of cancer.
- Cancer occurrence is positively associated with employment in the Oil Sands as well as the consumption frequency of traditional foods and more specifically locally caught fish.
- These notable declines in health and wellbeing are aggravated by poor communication by researchers and health agencies as well as inadequate health care in Fort Chipewyan as well in Fort McMurray and Edmonton.
- Communities are already playing an effective role in mitigating some of these declines in health and wellbeing, most notably the community based monitoring program, responses that outsider researchers can help support and facilitate.

FIG 13.1. Youth from MCFN and ACFN cutting up a moose on the Athabasca River.

13.2 RECOMMENDATIONS

1.0 Problem: existing and future decline in environment is occurring, and more specifically is affecting cultural keystone species such as muskrat and higher trophic level fish such as pickerel and jackfish.

- *1.1 Response*: mitigate the impact of these environmental declines on downstream communities.
  - 1.1.1 Background: our results show that ACFN and MCFN still have diets that center on country foods such as moose and ducks, medicines including ratroot and spruce gum, and fish including pickerel and jackfish. Oil Sands development and the WAC Bennett dam have reduced water levels in the delta. The Oil Sands are also contributing to high concentrations of heavy metals and PAHs in wildlife. These factors drive the decline of much wildlife, to the point that some species are no longer consumed by community members, that traditional livelihoods and local food systems are undermined, and that the ability of these First Nations to exercise their treaty rights is compromised.
  - 1.1.2 Recommendation: introduce credible mitigation plans to reduce the emission and impacts of heavy metals and PAHs arising from upstream Oil Sands operations.
  - 1.1.3 Recommendation: introduce regulations that establish mutually acceptable and enforceable levels of emissions arising from the Oil Sands.
  - 1.1.4 Recommendation: compensate downstream Indigenous communities for any loss of livelihoods arising from these declines in wildlife and plant populations.
  - 1.1.5 Recommendation: compensate downstream Indigenous communities for increased costs associated with purchasing foods used to replace wild-caught foods that have been or are being extirpated or that are no longer trusted.
- *1.2 Response*: address community worries and concern regarding these environmental changes.
  - 1.2.1 Background: our results show that there is much worry and concern regarding environmental decline related to environmental contaminants, including heavy metals (e.g. mercury, cadmium, arsenic) and polycyclic aromatic hydrocarbons (PAHs). This in part reflects the inadequate involvement of communities in any research and decision-making and the absence of effective risk communication.
  - 1.2.2 Recommendation: mandate meaningful involvement of affected Indigenous communities in existing and new government-funded environmental research conducted in the region surrounding Fort Chipewyan.
  - 1.2.3 Recommendation: mandate that government scientists provide outcomes at all stages in the research process, which can in turn act as best practices for industry and university scientists.
  - 1.2.4 Recommendation: require scientists conducting environmental research in the region to provide plain-language summaries of research outcomes to GIR and IRC and directly to community members in the form of relevant and accessible community presentations.
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- 12.5 Recommendation: involve leadership and the Nunee Health Board in the development of culturally sensitive and appropriate health advisories regarding traditional foods.
- 1.2.6 Recommendation: develop researcher data agreements that can be used to facilitate community-government research partnerships that generate data useful to both parties but that are controlled by ACFN and MCFN.
- 1.2.7. Recommendation: support and mentor community capacity to conduct their own environmental research, especially for youth members.

- *2.0 Problem*: our results show that industry-associated impacts on environment are occurring that are still poorly understood by outside stakeholders and community members alike.
  - *2.1 Response*: conduct further collaborative research as to better understand and respond to these changes.
    - 2.1.1 Background: wildlife species harvested in Phase Two had substantially higher levels of selenium than those tested in Phase One. These levels are high enough that consumption limits for all species are restrictive, sometimes approaching zero for liver and kidneys. Moreover, levels of total, carcinogenic, and alkylated PAH found in Phase Two were high relative to those found in other studies conducted elsewhere in the world. The sources of these contaminants and the reasons underlying the inter-year dynamics remain poorly understood.
    - 2.1.2 Recommendation: continue and even expand existing monitoring programs to augment existing data for the region by increasing sample size, which will increase the power of these studies.
    - 2.1.3 Recommendation: expand existing data collection to include other wildlife species, especially those consumed or otherwise used by downstream communities. Expand this data collection to include other areas, notably those areas close to the Athabasca River that are recognized by traditional knowledge holders as contaminated. Moreover, expand to areas that are seen as currently uncontaminated but that will be affected by development in the short-term future, notably the Birch Mountains and Lake Claire.
    - 2.1.4 Recommendation: investigate causes of high selenium concentrations, which were much higher than those found in Phase One and which may reflect spills from or remediation of existing or past uranium mining amongst other sources including bitumen mining and upgrading processes.
    - 2.1.5 Recommendation: support and expand existing scientific monitoring capacity that exist within Fort Chipewyan through youth mentorship programmes.
  - *2.2 Response*: expand community-based monitoring of these environmental changes
    - 2.2.1 Background: our results show that there is little if any community involvement occurs in existing environmental monitoring. This is also true of the science-based Joint Oil Sands Monitoring (JOSM) program, from which ACFN and MCFN recently withdrew. Yet, Traditional Knowledge (TK) regarding the Peace Athabasca Delta extends back thousands of years, and represents a rich source of information of great use for shaping management and decision-making regarding the Oil Sands. Both MCFN and ACFN have been actively engaged in community based monitoring over the last six years, a

program that is already highly effective in tracking environmental change, that reflects best practices for integrating science and TK, and that represents a reasonable and cost-effective way of addressing some of the shortcomings in the existing JOSM program.

    - 2.2.2 Recommendation: provide core funding to the existing community based monitoring program, which can serve the needs of the Peace Athabasca Delta (PAD) as well as local communities but which can also be promoted as an appropriate response to industrial development elsewhere in the North.
    - 2.2.3 Recommendation: provide added funding support for mentorship by Elders and by scientists in order to facilitate their increased involvement in community based monitoring as well as other mostly science-based monitoring initiatives.
    - 2.2.4 Recommendation: provide funding support for land-based monitoring programs and camps that cater to youth and that help build interest in and capacity surrounding both Traditional Knowledge and environmental science,
- *3.0 Problem*: a diet transition away from country foods towards store-bought foods is occurring, which is, in large part, associated with the adverse impacts of upstream Oil Sands development.
  - *3.1 Response*: support proactive programs that promote country foods
    - 3.1.1 Background: our results show that many ACFN and MCFN members worry about the quality of some country foods, particularly fish and increasingly ducks and moose. Ongoing environmental decline is adversely affecting access to some key wildlife species, notably muskrat. Yet country foods are still generally the most healthy and affordable food option for many community members.
    - 3.1.2 Recommendation: provide proactive programs that communicate the safety of country foods, in isolation or when combined with other risk communication, most notably health advisories.
    - 3.1.3 Recommendation: provide in-school meal programs that are culturally appropriate and feature country foods as well as healthy food alternatives, and address restrictive food safety regulations that are inappropriate in the North.
    - 3.1.4 Recommendation: provide programs that foster increased local control over food production, including in-town and land-based gardening programs, country food sharing programs, composting programs, and construction of three-season greenhouses.
  - *3.2 Response*: support proactive programs that increase accessibility to healthy store-bought foods.
    - 3.2.1 Background: our results show that many people are shifting from country to store-bought foods in large part because of fear about environmental contaminants. Yet, healthy options in town are expensive, poor in quality and often difficult to prepare. Thus, many residents, especially children and youth, opt for processed and nutritient-deficient alternatives. Moreover, food insecurity is increasing because of the high costs of store-bought foods.
    - 3.2.2 Recommendation: support programs that build on the existing "healthy eating" programs within Fort Chipewyan regarding food preparation and meal planning regarding store-bought foods.

        - 3.2.3 Recommendation: support food box programs, buying clubs and other ways of subsidizing store-bought foods purchases that can make food, especially healthy foods, available at a lower cost for community members.
- *4.0 Problem*: there is a continued decline of community health and wellbeing
    - *4.1 Response*: work towards a better understanding of the nature of this health decline
        - 4.1.1 Background: our results show that community members are confronted by a notable decline in health and wellbeing, especially as it relates to Elders and children. Almost everyone indicated that people are dying earlier and from different illnesses than in the past. This was seen as related to environmental contaminants arising from Oil Sands development, upstream agriculture, and substance abuse. This decline in part is characterized by increases in neurological illnesses (e.g. stress, depression), diabetes, respiratory illnesses (e.g. heart disease, asthma), and arthritis. But everyone was most alarmed by the increased rates of cancer. Our research shows that these elevated rates of cancer occurrence were positively associated with the consumption of traditional foods and locally caught fish as well as employment in the Oil Sands.
        - 4.1.2 Recommendation: support a comprehensive, and long-term baseline health study that meaningfully involves MCFN, ACFN, and Metis Local 125. This should be done in an inclusive and culturally appropriate manner with regular updates and community meetings. It should be overseen by community leaders, Elders, and well as health scientists, be holistic in nature, incorporate both health sciences and TK, and be accountable to the three communities.
        - 4.1.3 Recommendation: support additional body-mapping exercises where all interested participants record their own health experiences, and also complement these with participant health records if they see this as appropriate.
        - 4.14 Recommendation: extend existing body mapping result to focus on these cancer survivors and cancer victims to explore underlying factors through risk mapping and detailed case histories.
        - 4.15 Recommendation: better document the relationship between cancer occurrence and employment in the Oil Sands industry through a detailed study that examines the implications of work site conditions for the wellbeing of Oil Sand workers that live in Fort Chipewyan and elsewhere.
    - *4.2 Response*: provide more effective communication regarding health risks.
        - 4.2.1 Background: our results show that declines in community health are incontrovertible, especially as they relate to cancer, respiratory illnesses, arthritis, and type 2 diabetes. Yet, the lack of accessible and independent information regarding these changing health patterns aggravates community worries and fears in a needless way.
        - 4.2.2 Recommendation: develop relationship-based programs of communication between government health officials and community leaders that adequately reflect both western and traditional approaches to health. The knowledge brokers that work in these programs can help facilitate communication.
    - *4.3 Response*: increase the effectiveness of existing health care support systems.

        - 4.3.1 Background: our results show that there was widespread dissatisfaction and criticism of existing health care in Fort Chipewyan but also in Edmonton and Fort McMurray. These shortcomings fail to address and even aggravate the observed declines in community health and wellbeing. Thus, a physician is only present one week per month in Fort Chipewyan and other health professionals (e.g. physiotherapists, nutritionists, dentists) are not available at all. The infrastructure that was created to support these practices is therefore underused. These shortcomings result in long delays when identifying and treating illnesses in town and also in urban centres to the South. With respect to the latter, many characterized treatment programs as needlessly expensive, rushed, disrespectful, insensitive and in some cases racist. Earlier diagnosis of cancer and other illnesses through increased access to improved health care will benefit the communities, especially in light of anticipated expansion and impacts of the Oil Sands in the future.
        - 4.3.2 Recommendation: conduct a systematic review of the existing healthcare system as used by community members. Short- and long-term strategies for strengthening existing and expanding in-community health care should be explored. Initiatives such as the Fort Chipewyan Elder Care Centre currently under construction should serve as best practices of such approaches.
        - 4.3.3 Recommendation: conduct a proactive and community centered study that identifies and promotes effective solutions to these ongoing declines in health and wellbeing, ones that are grounded in self-care and cultural traditions and that are at once sustainable and empowering for community members. Examples would build on existing interests and capacity including culturally appropriate and evidence-based ways of mitigating type 2 diabetes, obesity, stress, smoking, and substance abuse.
        - 4.3.4 Recommendation: provide training to and mentorship programs for interested community members to address some of the needs for health care professionals in Fort Chipewyan including message therapists, nutritionists, physiotherapists, and nurses ideally in conjunction with the local school and the Keyano College.
- *5.0 Problem*: inadequate influence on decision-makers regarding these long-standing changes in environment, diet and health that place communities at risk.
    - *5.1 Response*: direct interaction with high-level decision-makers in government and industry.
        - 5.1.1 Background: the WAC Bennett dam was constructed in the mid 1960s, at the time that production in the Athabasca Oil Sands began to rapidly increase. Fifty years later, few if any outside stakeholders are responding to these declines in environmental or community health, despite much media attention and pressure by the public. This, in part, reflects the great financial stakes and controversy regarding the Oil Sands, the absence of any trust or effective channels for communication, and the isolated nature of the affected communities and environments.
        - 5.1.2 Recommendation: conduct direct outreach with politicians and appropriate government staff in Edmonton and Ottawa as well as executives in

industry and present the outcomes of this study in order to build cross-sectoral networks of communication.

- 5.1.3 Recommendation: conduct systematic outreach campaigns with media regarding this report to reach as wide an audience as possible.
- 5.1.4 Recommendation: promote worldwide distribution of the associated feature-length documentary film that presents both the impacts of but also the benefits of the Oil Sands for downstream communities as experienced and communicated by residents.
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FIG 13.2 Lake Athabasca during a spring rain.

14. LITERATURE CITED

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APPENDIX 1. HUNTER SAMPLE COLLECTION PROTOCOL.

SAMPLING MOOSE, DUCKS, BEAVER AND MUSKRATS

BIOMONITORING PROJECT

(ACFN, MCFN, UofManitoba-ECL)

General Instructions

* keep samples as free of contamination (.e.g. dirt, oil etc.) as possible

* do not wash animals or organ samples

* don't smoke when samples are being collected

* freeze as quickly as possible

* ideally drop of at MCFN-CBM office (care of Bruce Maclean or Jocelyn Marten)

* label each bag or each animal separately as indicated below

* thanks for your help!!

Moose

* one fist-sized sample each of moose kidney, liver, muscle (hindquarter with fat)

* take moose organ samples as soon after kill as possible

* wash knife between cuts on different moose organs

* wrap each prepared moose organ in tinfoil before putting in baggie

* use a different baggie for each moose organ sample (i.e. muscle, kidney, liver) that is collected

* measure back fat using cards provided

Ducks:

* entire body

* all the guts (i.e. entire viscera)

Muskrats:

* entire animal

BEAVERS:

* entire animal

* if animal is too large, remove hind leg as well as kidney and liver

* take beaver samples as soon after kill as possible

* wash knife between cuts on different beaver organs

* wrap each prepared beaver organ in tinfoil before putting in baggie

* use a different baggie for each beaver organ sample (i.e. hind leg, kidney, liver) that is collected

ANIMAL SAMPLE COLLECTION FORM

BIOMONITORING PROJECT – MCFN, ACFN, University of Manitoba

Name:	**Date:**
GPS Location of harvested animal: Longitude or North UTM	**Latitude or West UTM:**

Type of animal: (circle one)

Moose **Muskrat** **Beaver** **Rabbit**

Bird/Waterfowl (be specific – eg. Mallard)____

Other animal: ____

Sex of the animal: (circle one)

Male **Female** **Female with young** **Unknown**

Approximate age of the animal:	**Please indicate how the animal was harvested, or if it was found dead:**

Amount of fat on the animal: (circle one)

Skinny **Not too skinny** **Fat** **Very fat**

Label name/ID (example - Moose 1):	**Number of sample bags:**

General comments about the animal's health:

____

____

____

****LABEL ALL SAMPLE BAGS****

Add your name, the sample ID and date to all bags (label each bag 1 of 3; 2 of 3 etc.)

Store samples on ice in a cooler and freeze as soon as possible

APPENDIX 2. ABOUT THE CONTAMINANTS

We determined the following contaminants to be of priority for analysis because of their potential to effect human health and because of their relationship with industries currently at work in the region of upstream of Fort Chipewyan.

Arsenic (As) – Arsenic in its pure form is a metal. It is present in the aquatic and terrestrial environments because of natural weathering and erosion of rock and soil, and due to human activities including gold and base-metal processing, the use of arsenical pesticides, coal-fired power generation and the disposal of domestic and industrial waste materials (Government of Canada 1993). Arsenic occurs in organic, inorganic forms as well as part of a large number of salts. The World Health Organization considers inorganic arsenic to be toxic and of greatest concern for human health. Inorganic arsenic is listed by Environment Canada as a First Priority Substance because of its documented risks to human health (Environment Canada 2008).

ALS provided calculations for total arsenic. Because we are interested in the inorganic fraction of this total we multiplied the reported total arsenic by 0.1. This follows the advice of Dr. Weiping Chen, Alberta Health and Wellness Office. Dr. Chen has over 15 years of research experience in arsenic contamination and its impact on human health.

Cadmium (Cd) and its inorganic compounds – Cadmium is a naturally occurring metal. Although it is found in some industrial processes and products (such as in making of batteries and paints) it can also be naturally occurring. It can be present in the environment naturally due to weathering of cadmium bearing rocks and soils and release through forest fires (as well as volcanic emissions). Cadmium is listed by Environment Canada as a First Priority Substance because of its documented risks to human health (Environment Canada 2008).

Mercury (Hg) – Mercury is a naturally occurring heavy metal. Mercury can also be introduced to environments by human activities. It occurs in three forms – elemental mercury, inorganic mercury salts and organic mercury or methyl mercury (here after MeHg). We are most concerned with MeHg due to its potential to cause neurological damage to animals at relatively low levels. MeHg at low levels represents a threat because it can become concentrated to harmful levels by passing up the food chain in a process of bio-magnification. MeHg is created from elemental or inorganic mercury salts through natural processes by bacteria in soil and water.

Some studies reported that the percentage of MeHg in THg ranged from 81% to 95% (CFIA 2003). For the purposes of health risk assessments, 100% of THg is assumed to be MeHg thereby erring on the side of caution.

Selenium (Se) – Selenium is an essential element for human health but is toxic in doses larger than trace amounts. It is a non-metal that is very rare in nature. It is however released during refining of ores and in the production of electronics.

Polycyclic Aromatic Hydrocarbons (PAHs) – PAHs refer to a large group of complex hydro-carbons associated with petroleum and coal-derived products and their combustion (CCME 2010). In addition to these man-made sources, PAHs can also be created from natural sources such as forest fires and naturally occurring hydrocarbons such as bitumen. PAHs have been identified as having the potential to acting as carcinogens in humans and other mammals. There are over 100 different PAHs which commonly occur together in the environment. PAHs most commonly occur in mixtures of different molecules which have different reactions within living bodies.

APPENDIX 3. UNDERSTANDING THE SCIENTIFIC UNITS USED IN THIS REPORT

In this report we present out results for toxicology analysis in terms of micrograms (µg) per gram (g) of sampled material (µg/g). This unit is equivalent to or milligrams per kilo (mg/kg) or parts per million (1/1,000,000,000). Consumption advisories will be determined from human exposure limits and expressed as g of fish consumed per week, i.e. g/wk.

Measure	Preferred Unit	Alternative Unit	Equivalent Unit
Concentration of contaminant	microgram of contaminant per gram of tissue wet weight **µg/g**	Milligram of contaminant per kilogram of sample, wet weight **mg/kg**	1 part contaminant per million parts of sample **ppm**
pTDI of contaminant for humans	microgram of contaminant per kg of human body weight (mass) per day **µg/kg per kg bw/day**		
recommended consumption limit	gram per contaminant-containing sample consumed per week **g/wk**	oz per contaminant-containing sample consumed per week **oz/wk**	1 oz = 28.35 g

Adapted from Alberta Government 2009.

APPENDIX 4. HOW WE CALCULATED THE DIET-RELATED VALUES REGARDING HEAVY METALS

1. **Estimated Daily Intake** was calculated using the following formula:

$$EDI = C * IR * BF/BW$$

C represents contaminant concentration in tissue (µg/g).

IR is Ingestion Rate - the human rate of consumption (g/d).

BF is Bioavailability Factor. We conservatively assume that 100% of the detected contaminants is available to be absorbed by organisms.

BW is average body weight in humans (kg). The average of body weight for male and female adults in Alberta is 73 kg. The average human body weights used by Health Canada are 65 kg for women of reproductive age, 26.4 kg for 5-11 years group and 14.4 kg for 1-4 years group (Health Canada 2007).

2. **Exposure Ratio** (ER, unitless) was calculated by using the following equation:

$$ER = EDI/pTDI$$

pTDI = provisional tolerable daily intake (µg contaminant/kg bw/d).

TDI is the maximum amount of a substance that can be ingested on a daily basis over a lifetime without increased risk of adverse health effects.

3. **Consumption Limits** (also frequently expressed in the literature as Consumption Rates) is the lifetime average consumption limits expressed on a weekly basis of amount (grams) per week which can be consumed without harm.

$$CL = pTDI * BW\ (7\ d/wk) / C$$

Where pTDI is provisional tolerable daily intake (µg contaminant/kg bw/d),

BW is body weight (mass) in humans (kg),

C (µg Hg / g fish) is the measured THg concentration in fish muscle.

APPENDIX 5. IARC CLASSIFICATION OF PAHS AND RELATED OCCUPATIONAL EXPOSURES

http://www.carexcanada.ca/en/polycyclic_aromatic_hydrocarbons/
(Accessed January 14, 2014)

IARC Group	Exposure/Substance
1 (Carcinogenic to humans)	**Occupational exposure during:** Coal gasification Coke production Coal tar distillation Chimney sweeping Paving and roofing with coal tar pitch Aluminum production **Substance** Benzo[A]pyrene
2A (Probably carcinogenic to humans)	**Occupational exposure during:** Carbon electrode manufacture **Substances** Creosotes Cyclopenta[CD]Pyrene Dibenz[A,H]Anthracene Dibenzo[A,L]pyrene Dibenz[A,J]acridine
2B (Possibly carcinogenic to humans)	**Substances** 5-Methylchrysene Benz[J]aceanthrylene Benz[A]anthracene Benzo[B]fluoranthene Benzo[J]fluoranthene Benzo[K]fluoranthene Benzo[C]phenanthrene Chyrsene Dibenzo[A,H]pyrene Dibenzo[A,I]pyrene Indeno[1,2,3-CD]pyrene Dibenz[A,H]acridine Dibenz[C,H]acridine Carbazole 7H-Dibenzo[C,G]carbazole