

“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.

Phase Two Report:
July 7, 2014

Funding provided by: National First Nations Environmental Contaminants Program, Health Canada, SSHRC, Mikisew Cree First Nation, and Athabasca Chipewyan First Nation

**Funding provided to:
Mikisew Cree First Nation
Athabasca Chipewyan First Nation
University of Manitoba**



**Prepared by:
Stéphane M. McLachlan, PhD
Environmental Conservation Laboratory,
Clayton H Riddell Faculty of Environment, Earth and Resources
University of Manitoba
Winnipeg, Manitoba R3T2N2**



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

Acknowledgements

This work would not have been possible without the assistance of numerous members of the Athabasca Chipewyan First Nation, Mikisew Cree First Nation, Métis Local 125, and others from Fort Chipewyan. Their willingness to participate, their generosity of spirit, and support of our presence was incredible. We are especially grateful to the leadership of both ACFN and MCFN who have facilitated and supported this work, namely MCFN Chief Steve Courtoreille and ACFN Chief Allan Adam. We remain indebted to the commitment and patience of Melody Lepine, Bruce Maclean, and Jocelyn Marten of MCFN-Government and Industry Relations; Lisa King, Jonathan Bruno, and Lionel Lepine of ACFN-Industry Relations Corporation; and Jumbo Fraser and Ora Campbell of the Fort Chipewyan Métis Local. University researchers that contributed to the project include Jenny Anderson, Alam Ashraful, Ameena Bajer-Koulack, Natalie Baird, Sheldon Birnie, Shereen Denetto, Soon-won Hwang, Odemi Ibrahim, Susanne McCrea, Diljeetpal Prar, Moneca Sinclair, Michael Tyas, and Jonathan Ventura. Community members who have helped facilitate this research include Kevin Courtoreille, Misty Marten, Nakota Marten, Teddy Marten, and Terry Marten from MCFN as well as Alan W Adam, Eriel Deranger, Lance LaViolette, Pat Marcel, Mike Mercredi, Alice Rigney, and Morgan Voyageur from ACFN, and Kendrick Cardinal from the Metis Local. Finally, we thank the eight reviewers from provincial and federal government agencies, academia, and private medical practice who provided extensive and meaningful feedback.

Disclaimer

This report remains the sole property of the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation. Citation, use or reproduction of the information contained in this document is permissible only with the written consent of the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation.

While the primary author did his best to bring forward information known to him within the scope of the study, nothing in this report should be taken as a definitive list of uses, rights or impacts, nor should it be taken as a limitation on the uses or rights of the First Nations.

TABLE OF CONTENTS

FIGURES	5
TABLES.....	8
EXECUTIVE SUMMARY	10
1. INTRODUCTION.....	14
2. BACKGROUND.....	16
2.1 TRADITIONAL KNOWLEDGE	20
2.2 COMMUNITY BASED AND COLLABORATIVE RESEARCH	21
3. WILDLIFE, PLANTS, AND THE ENVIRONMENT	24
3.1 METHODOLOGY.....	24
4. ENVIRONMENT	28
4.1 WATER	28
4.2 VEGETATION.....	30
4.3 WILDLIFE	34
5.0 ANIMAL HEALTH	36
5.1 MUSKRATS	36
5.2 BEAVERS.....	40
5.3 MOOSE.....	42
5.4 DUCKS	45
5.5 CONCLUDING REMARKS	48
6. HEAVY METALS	50
6.1 BACKGROUND	51
6.2 METHODOLOGY	52
6.3 HEAVY METAL RESULTS	53
6.3.1 Moose	55
6.3.2 BEAVER	60
6.3.3 MUSKRAT.....	64
6.3.4 DUCKS	80
6.4 CONCLUDING REMARKS	85
7. POLYCYCLIC AROMATIC HYDROCARBONS	88
7.1 BACKGROUND	88
7.2 METHODOLOGY	89
7.3 PAH RESULTS.....	90
7.4 CONCLUDING REMARKS	95
8. TRADITIONAL FOODS	108
8.1 BACKGROUND.....	108
8.2 METHODOLOGY	109
8.3 RESULTS	111
8.3.1 ATTITUDES TOWARD COUNTRY FOODS.....	111
8.3.2 FREQUENCY OF COUNTRY FOOD CONSUMPTION	112
8.3.3 DIET TRANSITION TOWARD STORE-BOUGHT FOODS	113

8.3.4 IMPACTS OF UPSTREAM DEVELOPMENT ON COUNTRY FOODS.....	117
8.3.5 IMPLICATIONS OF UPSTREAM DEVELOPMENT FOR DIET TRANSITION.....	119
8.3.6 BROADER IMPLICATIONS OF DEVELOPMENT-ASSOCIATED CHANGES IN DIET	121
8.4 CONCLUDING REMARKS	124
9. HEALTH AND WELLBEING	130
9.1 BACKGROUND.....	130
9.2 METHODOLOGY	134
9.3 RESULTS	138
9.3.1 STATE OF HEALTH: NOW COMPARED TO THE PAST	138
9.3.2 PRIMARY CAUSES OF CHANGES IN CANCER OCCURRENCE	146
9.3.3 PRIMARY CAUSES OF CHANGES IN GENERAL HEALTH AND WELLBEING.....	150
9.3.4 SECONDARY CAUSES OF CHANGES IN HEALTH.....	159
9.3.5 HEALTH AND THE FUTURE	167
9.4 CONCLUDING REMARKS	171
10. PASSING ON THE GIFT	191
10.1 BACKGROUND	191
10.2 METHODOLOGY	194
10.3 RESULTS	195
10.3.1 OVERALL FEEDBACK.....	195
11. SHARING THE GIFT	204
12. LEARNING FROM BOTH SCIENCE AND TRADITIONAL KNOWLEDGE	209
13. CONCLUSIONS AND RECOMMENDATIONS	212
13.1 CONCLUSIONS	212
13.2 RECOMMENDATIONS	213
14. LITERATURE CITED	219
APPENDIX 1. HUNTER SAMPLE COLLECTION PROTOCOL.....	235
APPENDIX 2. ABOUT THE CONTAMINANTS.....	238
APPENDIX 3. UNDERSTANDING THE SCIENTIFIC UNITS USED IN THIS REPORT.....	240
APPENDIX 4. HOW WE CALCULATED THE DIET-RELATED VALUES REGARDING HEAVY METALS ..	241
APPENDIX 5. IARC CLASSIFICATION OF PAHS AND RELATED OCCUPATIONAL EXPOSURES	242

FIGURES

FIG 1.1. Fort Chipewyan in the evening.....	14
FIG 2.1. The Athabasca Oil Sands in operation (Suncor site)	16
FIG 2.2. Fort Chipewyan, 280 km downstream from Fort McMurray	17
FIG 2.3. Seagulls lifting off Lake Mamawi	19
FIG 2.4. Teddy Marten (MCFN) hunting ducks in fall 2012.	20
FIG 2.5. Workshop held with members of Athabasca Chipewyan First Nation and Mikisew Cree First Nation, discussing harvesting for subsequent lab testing.	22
FIG 3.1. Stef McLachlan (University of Manitoba) and Johnny Courtoreille (Mikisew Cree First Nation or MCFN) examine some willow leaves (<i>Salix</i> spp.).	24
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.	26
FIG 4.1. Archie Antoine (MCFN) shows how water levels have decreased in Egg Lake.	28
FIG 4.2. Foam on the surface of Lake Mamawi.	29
FIG 4.3. Vegetational change occurring on a former inland lake near Dog Camp.	30
FIG 4.4. Cody Marcel (ACFN) collecting willow samples along the Athabasca River.....	31
FIG 4.5. Locations of willow sampling in both Athabasca Delta (1-9) and region surrounding Lake Mamawi (10-14).	32
FIG 4.6. Concentrations of a) arsenic, b) cadmium, c) mercury, and d) selenium in willow (<i>Salix</i> spp.) sampled in the Athabasca Delta (A1-9) and Lake Mamawi (B1-5).	33
FIG 4.7. Ducks migrating in formation along the Athabasca River.	34
FIG 5.1. Muskrat swimming near the Birch Mountains in Lake St Clair.	36
FIG 5.2. Survey in winter 2012, as facilitated by the Peace Athabasca Delta Environmental Monitoring Program (PADEMP).....	37
FIG 5.3. Locations of seven muskrats that were harvested for subsequent evaluation by veterinarians and contaminant testing.....	38
FIG 5.4. Locations of three beavers that were harvested for subsequent evaluation by veterinarians and contaminant testing.	41
FIG 5.5. Beaver lodge near Prairie River, Lake Mamawi.	41
FIG 5.6. Garret Marcel (ACFN) with his first moose of the year.....	43
FIG 5.7. Location of the moose that was harvested for subsequent evaluation by veterinarians and contaminant testing.	44
FIG 5.8. Sampling moose liver for subsequent testing	45
FIG 5.9. Harvesting ducks for subsequent testing.....	46
FIG 5.10. Locations of the 10 ducks that were harvested for subsequent evaluation by veterinarians and contaminant testing.	47
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/)	50
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.	56
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.	57
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.	58

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.	59
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.	60
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.	61
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.	62
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.	63
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.	76
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.	77
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.	78
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.	79
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.	81
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.	82
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.	83
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.	84
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.	91
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.	92
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.	93
FIG 7.4. Cancer risk associated with benzo[a]pyrene toxic equivalents based on the mean food consumption. Zeros values are excluded.	94
FIG 7.5. Cancer risk associated with benzo[a]pyrene toxic equivalents based on the maximum food consumption.	94
FIG 8.1. Terry Marten (MCFN) cutting up moose meat in the fall.	111
FIG 8.2. Shooting a Lesser Scaup (<i>Aythya affinis</i>) duck for subsequent sampling in the fall.	112
FIG 8.3. Frequency of consumption of traditional foods over a two-month period, as classified according to gender.	114
FIG 8.4. Frequency of consumption of traditional foods over a one-week period, as classified according to gender.	115
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.	116
FIG 8.6. Drying and smoking whitefish out on the land.	117
FIG 8.7. ACFN members crossing Lake Athabasca by boat.	119
FIG 8.8. Archie Antoine (MCFN) digs up a muskrat push-up: empty again.	120
FIG 8.9. Expensive and low quality watermelon purchased in Fort Chipewyan.	122

FIG 8.10. Drayden Bruno (ACFN) sets a snare.....	124
Fig 9.1. Cemetery of Fort Chipewyan in foreground, and community school in the back	138
FIG 9.2 Body map showing distribution of all illnesses reported by the health study participants (n=94).	141
FIG 9.3. Body map of distribution of the 23 cancer cases reported by the health study participants (n=94).....	143
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.	144
FIG 9.5. Collecting seagulls for testing following large-scale kill-off.....	150
FIG 9.6. Healing Walk protest in the foreground and Oil Sands development in the background.	152
FIG 9.7. Small plane leaving Fort Chipewyan airport for Fort McMurray.	158
FIG 9.8. New medical center in Fort Chipewyan.....	164
FIG 9.9. Rene Bruno (ACFN) takes his grandchildren on a walk looking for medicines	171
FIG 10.1. Drilling to test water levels during muskrat winter survey.....	192
FIG 10.2. Students accompany Elder George Wandering Spirit (MCFN) behind the camp.	195
FIG 10.3. Youth examine old leg-hold traps as Johnny Courtoreille (MCFN) speaks.....	196
FIG 10.4. Parks Canada staff show students how to use GPS units.	197
FIG 10.5. Students test water sample for acidity	199
FIG 10.6. Young students look at traps in the gym session.....	201
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.....	202
FIG 10.8 Students attend the school assembly and watch the 20-min film that documented the 2012 Youth Elder camp.	203
FIG 11.1. Presentation of preliminary results of this Phase Two study at the large community meeting and feast in Fort Chipewyan.	205
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.....	206
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.	207
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.	208
FIG 12.1. Abandoned commercial fishing boats in Fort Chip	210
FIG 13.1. Youth from MCFN and ACFN cutting up a moose on the Athabasca River.	212
FIG 13.2 Lake Athabasca during a spring rain.....	218

TABLES

Table 3.1. Total numbers of samples and types of analyses conducted	25
Table 4.1. Differences in concentrations of arsenic, cadmium, mercury, and selenium in willow (<i>Salix</i> spp.) between the Athabasca Delta (A1-9) and Lake Mamawi (B1-5), according to one-tailed t-tests.....	34
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 $< x \leq 1.0$ kg/wk).....	67
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 $\leq x < 2.0$ ug/kg BW/day).....	69
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 $\leq x < 2.0$ ug/kg BW/day).....	72
Table 7.1. Comparative concentrations of total PAH (ug/Kg) as reported in various studies around the world.....	96
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).	97
Table 7.3. Comparative concentrations of carcinogenic PAHs (ug/Kg) as reported in various studies around the world.....	98
Table 7.4. Comparative concentrations of benzo[a]pyrene (ug/Kg) as reported in various studies around the world.....	99
Table: 7.5. Dietary intake of total PAHs (ug/day) as reported in various studies around the world.	100
Table: 7.6. Dietary intake of carcinogenic PAHs (ug/day) as reported in various studies around the world.....	101
Table 7.7. Dietary intake of benzo[a]pyrene (ug/day) as reported in various studies around the world.	102
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.....	103
Table 7.9. Maximum daily dietary actual intake (ug) of PAHs for the liver, kidney, and muscle of moose, beaver, duck, and muskrat as well as beef liver.....	104
Table 7.10. 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 included.	105
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.....	106
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.....	107
Table 8.1. Consumption of traditional foods and Aboriginal culture.....	126
Table 8.2. Consumption of traditional foods.	126
Table 8.3. Frequency of consumption of various traditional foods.	126
Table 8.4. Frequency of consumption of various store-bought foods.	127

Table 8.5. Impacts of hydro development and Oil Sands on traditional foods.	127
Table 8.6. Changes in water levels and flooding by the Bennett dam has affected my access to the following traditional foods.	127
Table 8.7. Worries and concerns about traditional foods.	128
Table 8.8. Pollution from the Oil Sands has negatively affected the quality of the following traditional foods.	128
Table 8.9. I now eat less of the following traditional foods because of industrial pollution and contaminants.	128
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.	129
Table 8.11. Implications of traditional foods for community health and wellbeing.	129
Table 9.1. State of individual and community health in the past and in the present.	175
Table 9.2. Numbers of cancers and non-cancerous illnesses as experienced by survey participants (n=94).	175
Table 9.3. Numbers and types of neurological illnesses as experienced by participants (n=94).	176
Table 9.4. Numbers and types of respiratory illnesses as experienced by survey participants (n=94)	176
Table 9.5: Numbers and types of circulatory illnesses as experienced by survey participants (n=94)	177
Table 9.6. Numbers and types of gastrointestinal illnesses as experienced by survey participants (n=94)	177
Table 9.7. Numbers and types of reproductive illnesses as experienced by survey participants (n=94)	178
Table 9.8. Degree to which participants agreed that people in Fort Chipewyan suffer <i>much more now</i> from the following illnesses than they did in the <i>past</i>	178
Table 9.9. Number of times that these different health concerns were mentioned in the focus group discussions held Oct 15-17, 2014.	179
Table 9.10. Numbers of cancer cases, according to cancer type and gender	180
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).	181
Table 9.12. Descriptive cancer statistics with respect to independent variables used in logit analysis and AIC.	182
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.	183
Table 9.14. Outcomes of logit regression analysis examining the relationships between independent variables and occurrence of cancer in Fort Chipewyan ^a	184
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 $w_+ \geq 0.50$ are bolded.	185
Table 9.16. Number of model parameters, differences in Akaike information criterion (Δ -AIC _c), and AIC _c weights (w) for candidate models developed to predict cancer occurrence of residents of Fort Chipewyan.	186
Table 9.17. Causes of any declines in individual and community health as evaluated by participants.	187
Table 9.18. Correlation amongst the 12 independent variables used to model the impacts of the socio-environment on cancer occurrence in Fort Chipewyan	188
Table 9.19. Number of times that these references to the existing health care were mentioned in the focus group discussions held Oct 15-17, 2014.	189
Table 9.20. Quality of health care in and outside Fort Chipewyan.	189

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 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.

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.
 -

- 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 nutrient-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.
 - 4.1.4 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.
 - 4.1.5 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.
-



FIG 13.2 Lake Athabasca during a spring rain.