Impacts to the Health and Wellness of The Jean Marie River First Nation in the Face of a Changing Climate:

Final report

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Acknowledgements

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The Jean Marie River Climate Change Working Group and the Project Lead, Margaret Ireland, allocated resources and provided direction for this project.

Margaret Ireland, members of the Climate Change Working Group, and residents of the community of Jean Marie River, including Elders, worked together to identify those individuals who utilised the land and were knowledgeable about climatic and environmental changes to the land and the community. Margaret Ireland also provided translation services during the interviews. Ryan Brown and Sara Cook of PACTeam Canada Inc. provided professional advice and technical service in support of the project.

Last, but certainly not least, we would like to thank the community members of Jean Marie River for their support, encouragement and participation in this project, which was essential for the completion of this project.

1. Introduction

Climate change has become an issue of global concern, and this is especially the case in Arctic and sub-Arctic regions. Research on the current and potential impacts of a warming climate in the Canadian North have focused mainly on ecosystems, resources, and Aboriginal communities in the High Arctic above the tree line. One of the key findings by scientists and communities conducting this research has been the identification of health related impacts directly and indirectly related with climate change and the need to develop mitigation strategies, and more importantly adaptation strategies, to prevent and minimize health risks and other impacts associated with climate change.

With comparatively less research regarding climate change impacts on Aboriginal communities and ecosystems above 60°N, but below the tree line in northern Canada, the Jean Marie River First Nation (JMRFN) in the Northwest Territories is concerned with this issue and the necessity to assess the JMRFN's vulnerability to health related impacts associated with climate change, and what adaptation strategies are available to the community of Jean Marie River (JMR) to respond to these impacts, has become increasingly important.

Prior to starting this project JMR's key concerns regarding climate change are identified in the proposal to Health Canada included:

- Food security/safety;
- Access to Safe Drinking Water and Traditional Medicines;
- Travel Safety;
- Extreme Weather Events;
- Increased exposure to UV-B rays and diseases associated with environmental changes, and;
- Negative impacts to the health of plants and animals.

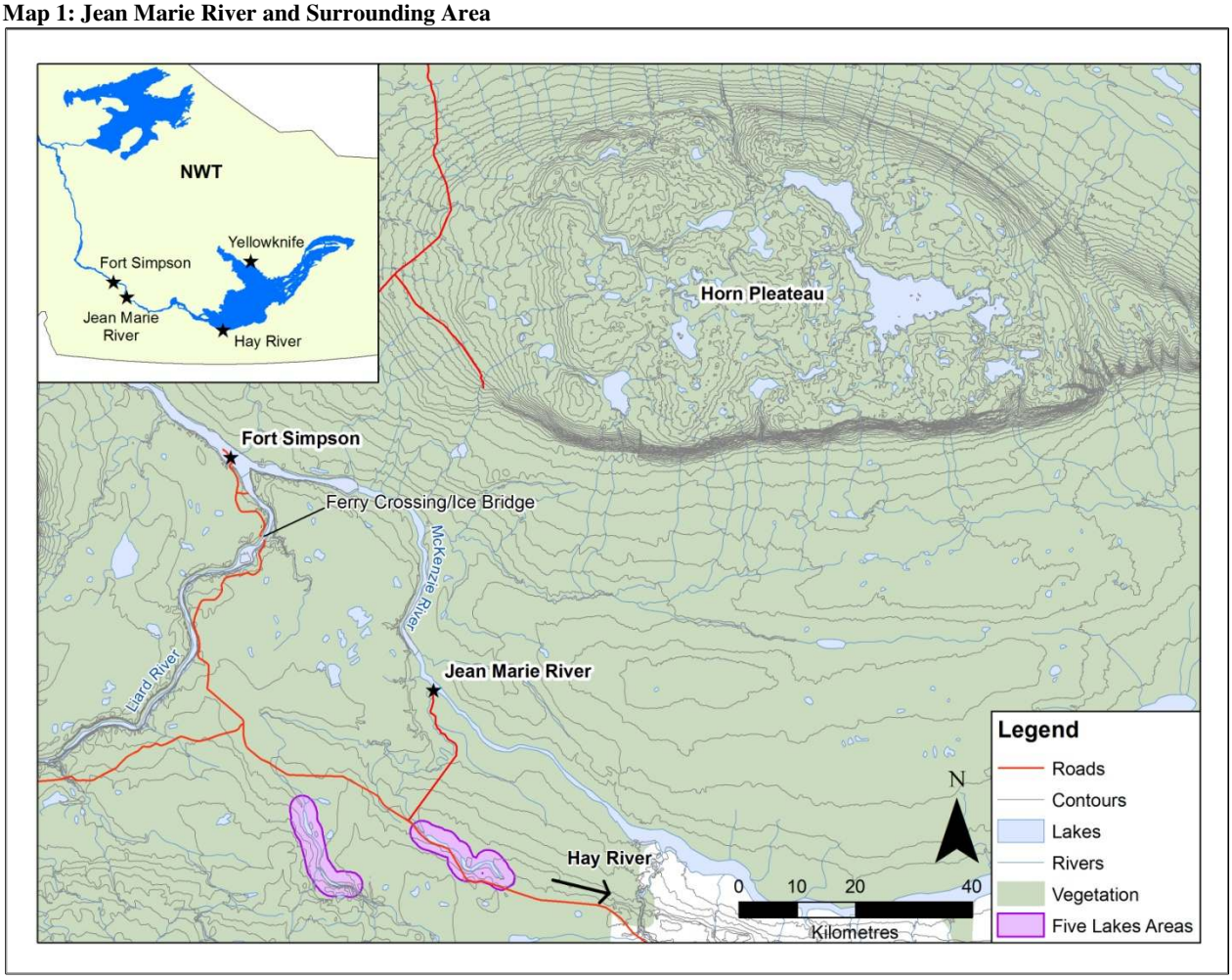
In order to collect baseline data about observations and experiences of climate change impacts, and to assess some initial affects on the health of individuals, the community, and the environment the JMRFN applied for and received funding from Health Canada's Climate Change and Health Adaptation in Northern First Nations and Inuit Communities Program to conduct the project: *Impacts to the Health and Wellness of the Jean Marie River First Nation in the Face of a Changing Climate.*

2. Community Background

General Information

The settlement of Jean Marie River is situated at the confluence of the Jean Marie and Mackenzie Rivers, at approximately 61° 31' North Latitude and 120° 38' West Longitude. It is 127 kilometers East of Fort Simpson and about 360 kilometers West of Hay River (see Map 1). It is located in the Great Slave Plain eco-region, which consists of low rolling marsh lands and willows; and dense spruce, pine, and poplar forests.

Map 1: Jean Marie River and Surrounding Area



Data source: Geogratis, Environment Canada

Development of the Settlement

Traditionally, the *Tthets'éhk'e Délî got'ine* (the people who traditionally occupied the Jean Marie River area) lived and traveled over a very wide area within what is now called the Dehcho region of the Northwest Territories. For countless generations, people pursued a traditional lifestyle: hunting, fishing, trapping, and gathering plants and craft materials; moving with the seasons and resources throughout our traditional territory. The *Tthets'éhk'e Délî got'ine* had major family camps along the Mackenzie River from Mills Lake to Fort Simpson, in the Horn Plateau, at McGill Lake, at a traditional area called Selero, and at the 'three lakes': Ekali Lake, Sanguez Lake, and Gargan Lake. No camps were permanent and people moved according to the seasons, often returning to the same general areas year after year.

In the early 1920s, the transition from a nomadic lifestyle to living in a more permanent settlement began on the recommendation of the Elder Norwegian. He recommended people settle at the mouth of the Jean Marie River (*Tthets'éhk'e Délî*), a traditional gathering and fishing spot. A permanent settlement slowly grew over the years, but people still pursued a traditional lifestyle for decades, traveling out from the settlement on a seasonal basis to camps spread out over our traditional territory. Some families remained at outlying lakes for years, only traveling into Jean Marie River and Fort Simpson for special occasions and supplies. The 5 Lakes Areas displayed in Map 1 were particularly important places for families in the JMR area during their seasonal rounds. These two areas are still important and are used today and the JMRFN is in the process of designating these areas as a protected area under the NWT PAS.

The JMRFN began as an independent band under the Indian Act in 1992. Prior to that, it was considered a sub-band of the Fort Simpson's *Líídlîî Køç* First Nation, even though it has been functioning as an independent settlement for over 80 years (JMRFN, 2005:10).

Early Economic Development

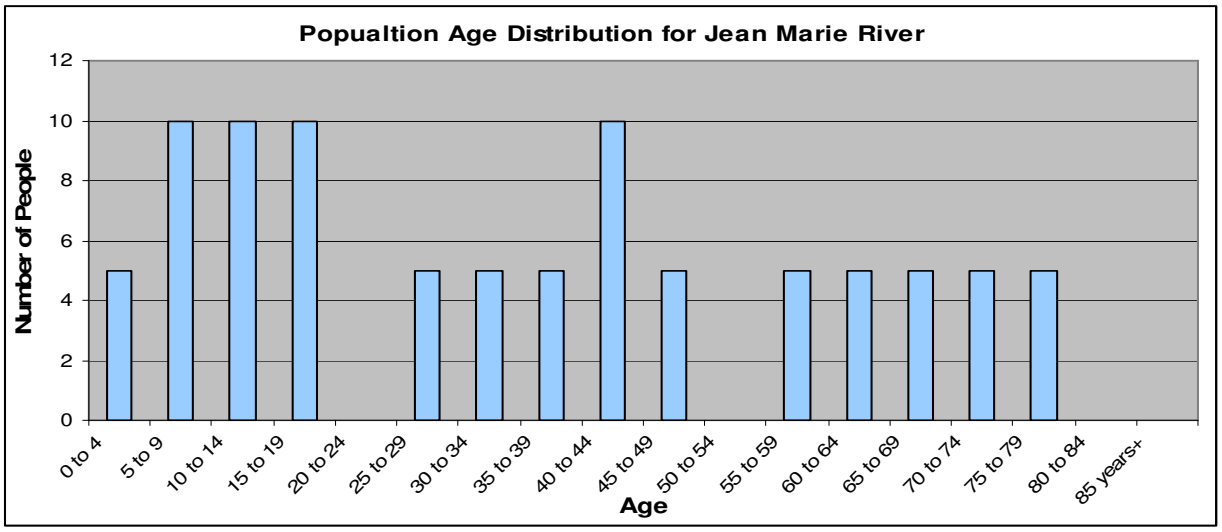
By the 1950s, the settlement of Jean Marie River had begun to develop a non-traditional economy based around river transportation and logging. Collectively, the community members bought and operated a small tug boat for fishing trips to Beaver Lake, hauling firewood, installing channel buoys and hauling fuel (operating from the 1950s to 1980s); and a portable sawmill to produce lumber for local use and for export to other communities along the Mackenzie River. A sawmill is still in operation today. They also managed a community garden, producing cabbages, carrots, and even tomatoes for local consumption. This garden is no longer being planted.

These economic activities complemented the traditional economy and provided a balance between a subsistence and entrepreneurial / wage economy for many years. Today, the JMRFN and the community are looking toward building greater economic sustainability through the development of greater self-sufficiency, a goal that climate change challenges, but also provides some new opportunities for economic development that will be discussed in subsequent sections (JMRFN, 2005:12-14).

Population

The current population of the community is approximately 81, with the JMRFN having a total membership of 122. The majority of the community's population, approximately 93%, identify themselves as indigenous. Approximately 75% of the population of the community is over the age of 15 with a median age of 33.5 years. With a total labour force of 40 people, people are employed in such fields as social sciences, government, education, sales, service, trades, and as transportation and equipment operators.

Figure 1: Population Age Distribution for Jean Marie River



The employment rate is approximately 58% and the unemployment rate is approximately 22%. Unfortunately, because of the small size of the community and issues surrounding privacy, income details are not readily available. The mobility rate for residents of Jean Marie River is low with 87.5% of the population having lived at the same address for at least one year and 75% having lived at the same address for the last 5 years (JMRFN, 2005).

Key Concerns

Our Community's key concerns regarding climate change are:

- Food security/safety;
- Access to Safe Drinking Water and Traditional Medicines;
- Travel Safety;
- Extreme Weather Events;
- Increased exposure to UV-B rays and new diseases associated with climatic and environmental changes, and;
- Negative impacts to the health of plants and animals.

Relevance of this Project to the Dehcho Region

The health related impacts of climate change happening in our community are similar to many of the impacts that other Dene communities are experiencing (Guyot et al, 2006; Paci et al, 2005). Thus, the results of this project could also be used to work with other Dene communities to develop their own climate change policies and adaptation strategies in the Dehcho region; and strengthen our relations with these communities by working together to possibly explore, develop, and implement adaptation strategies such as regional environmental monitoring initiatives, food-sharing networks, and economic development.

3. Project Tasks and Activities Completed

3.1. Establishment of a Project Working Group and Community Open House

The Project Lead, Margaret Ireland, organized the Project Working Group consisting of seven members from JMR, and consultants from PACTeam Canada. An initial working group meeting was held on July 13, 2010. PACTeam Canada delivered a presentation to the working group about climate change in general, and the current and potential impacts climate change may have on the people and the environment of northern Canada, to demonstrate how climate change is linked to new and existing environmental, economical, cultural, and social changes that affect the health of people, communities, and wildlife in northern Canada. The discussion at the meeting also focused on:

- The goals, and objectives, and activities of this project;
- The role of the working group;
- How health is being, and can be impacted by climate change, and;
- Some initial observations and discussions about current impacts being observed and experienced in the community or out on the land.

A community open house was arranged by the Project Working Group at the JMRFN Band Office on July 14, 2010. Posters explaining climate change and future climate projections, and its impacts to the health of the community, people, culture, and the environment of the JMRFN were displayed in the gymnasium and videos about climate change were shown. Members of the working group were also available to answer any questions members of the community who attended the open house had about the project and climate change.

A one page handout was also put into each community member's mailbox at the Band Office informing them of this project, its purpose, and the need for community support for researching and responding to climate change (see Appendix 1).

3.2. Literature Review

A literature review of primary sources pertaining to climate change and health included the following topics:

- Current and potential climate change impacts on people and ecosystems in northern Canada (Anisimov et al. 2007; Berkes and Jolly 2001; Berner et al. 2005; Environment Canada 1997; Fast and Berkes 1999; GNWT 2008; Guyot et al. 2006; Huntington et al. 2005; IISD 2000; Kochtubajda et al. 2006; Nuttall et al. 2005; Standing Committee on Energy, the Environment and Natural Resources 2009; Scott and Lemieux 2007; and Wrona et al. 2005).
- Examples of adaptation approaches and strategies available for small remote northern Aboriginal communities to respond to climate change (Berner et al. 2005; Berkes and Jolly 2001; CIER 2006; Daniel et al. 2007; GNWT 2008; Ford and Furgal 2009; Ford et al. 2010; Nuttall et al. 2005; Patino, 2010; and Séguin and Berry, 2007) .
- Future climate projections (ACIA 2005; IPCC 2007; Kochtubajda 2006; and NRC 2009).
- The interconnections of climatic, environmental, and social/cultural changes; and their impacts on health (Anisimov et al. 2007; Berner et al. 2005; Daniel et al. 2007; Fast and Berkes 1999; and Guyot et al. 2006).
- Western Medical Science and Dene perspectives regarding health (Parlee et al. 2007; and Séguin and Berry, 2007).
- The importance of traditional knowledge (TK) in climate change research for revealing how changes in climate are linked to changes in the environment and the community, and the importance of TK for developing adaptation strategies (Berkes and Jolly 2001; Newton et al.

2005; Nuttall et al 2005; Pearce et al. 2009; Séguin and Berry 2007; and Turner and Clifton 2009).

From the literature review the following environmental impacts associated with climate change were identified that were applicable to the Dehcho Region:

- More unpredictable weather and occurrences of extreme weather;
- Warmer winters and warmer temperatures in lakes in rivers;
- Changes in the amount of snow and rain;
- Increase in the number, size, and frequency of forest fires;
- Changes to migration routes of caribou, birds, and fish;
- New wildlife and plant species;
- Habitat changes for existing wildlife and plants;
- Changes in the timing of ice break-up and freeze-up;
- Increased melting of permafrost, impacting roads, bridges and buildings;
- Less predictable ice conditions, and;
- Lower water levels for lakes and rivers including the Mackenzie River.

Many of these impacts are already being observed and experienced by our people. A list of the references cited in this report is included in the form of an annotated bibliography provided in Section 8. For each source a summary is provided highlighting the climate change research that has been conducted in partnership with Aboriginal communities in northern Canada, as well as any gaps in the research.

3.3. Preparation for Interviews

Prior to conducting any interviews with community members the JMRFN applied for ethics clearance and a research permit from the Aurora Research Institute. The JMRFN ethics clearance application was approved September 10, 2010. A copy of the letter of approval and the research permit are included in Appendix 2.

An interview guide was developed that includes instructions on how to conduct the interview, and the questions to be asked. This document was reviewed and approved by the Project Lead. A standard consent form was also drafted prior to the interviews, and reviewed and approved by the Project Lead. A copy of both the finalized interview guide and the consent form are included in Appendix 3 and 4 respectively.

As part of the youth engagement strategy proposed for this project to raise awareness among youth about climate change and its impacts at the community level, PACTeam Canada prepared a presentation about climate change, an experiment to demonstrate what an enhanced greenhouse gas effect is, and a school assignment for the students to complete. A copy of the lesson plan for the experiment conducted is included in Appendix 5.

3.4. Interviews and School Presentation

Seven semi-structured one-on-one interviews were conducted with community members by Margaret Ireland and Ryan Brown (PACTeam Canada) at the JMRFN Band Office. Prior to beginning the interviews, participants were asked to review, or have translated the consent form and sign the form if they agreed to be interviewed. Four of the interviews were conducted in English, and three were conducted in Slavey. Margaret Ireland conducted the interviews in Slavey, and when necessary provided

translation services for the other interviews. The interviews were recorded using digital audio recorders, and participants were assigned a personal identification number (PIN) to protect their anonymity.

The Project Lead and PACTeam Canada coordinated with the teacher at the Jean Marie River School for a Ryan Brown to give a presentation about climate change to the students. PACTeam also provided educational materials about climate change and the environment, generously donated by Enviro Kids. The students conducted the experiment mentioned above that demonstrated how the accumulation of greenhouse gases due to pollution is creating climate change in form of global warming. The students were provided the instructions and materials to conduct the experiment and record the results. Finally, the assignment developed by PACTeam was given to the teacher to have the students complete and consisted of each student answering questions about their own observations of weather, and then to ask older family or community members about their memories of the weather in the past, in order for the student to better understand how long term weather patterns (a.k.a. climate) change over time.

The answers to these questions are not being included in the results of this project; the questions are for educational purposes only, with the purpose of engaging youth about the significance of climate change and its impacts at the community level.

3.5. Translation and Transcription of Interviews

Margaret Ireland translated and transcribed the three interviews conducted in Slavey, and transcribed another interview completed in English. PACTeam Canada transcribed the other three interviews done in English.

3.6. Thematic Analysis of Interview Results and Vulnerability Assessment

The thematic analysis of the findings from the interviews and the resultant vulnerability assessment of JMR to climate change identified six themes to categorize observations and related impacts of climate change shared by participants during the interviews, and six areas where JMR is particularly vulnerable to climate change. The observations and impacts associated directly and indirectly with climate change for each theme are summarized in the Section 4. The findings of the vulnerability assessment are listed in Section 5. Preliminary findings from the interviews were also presented at Health Canada's Environmental Health Research Division's *Climate Change and Health Pan Arctic Results Workshop* held in Ottawa on February 8-11, 2011.

3.7. Climate Change Focus Group Session

Posters for each theme identified in the thematic analysis were created showing the observations and related impacts for each of these themes. In order to verify the results from the interviews, clarify any potential misinterpretations of the knowledge shared by interviewees, and to identify any gaps a focus group was organized in the community and was conducted on March 8-9, 2011 at the JMR Administration Office. Each poster has a matrix and participants were asked to prioritize the importance of health related climate change impacts based on four criteria; vulnerability, magnitude, duration, and ability to adapt. Results of the focus groups are described in Section 4. Participants included members of the Working Group, interviewees, Elders, and other interested community members for a total of eight participants.

A presentation was also given at the school to follow up with the students about the climate change activity left with them in September of 2010. Students discussed how the weather is changing and could change in JMR, and how this could affect the community.

3.8. Climate Change Workshop

This workshop was organized to disseminate the results of the project to the community, and was conducted on April 27-28, 2011 at the JMR Administration Office. The combined information from the interviews and focus group was condensed into influence diagrams for participants to visualize the observations and impacts of climate change and make sense of the connections amongst the themes; as people in the community better relate to the interconnectedness of climate, nature, and people rather than viewing them in separate contexts (i.e. thematic posters). The workshop also provided another opportunity for community members to provide feedback concerning the project.

After verifying and clarifying the priority ranking of the health related climate change impacts, the workshop participants, using the influence diagrams, discussed how people in the community have been responding in a reactive manner to these impacts, and brainstormed some initial adaptation strategies that the community may want to pursue to respond more proactively to health related climate change impacts. For more details about the adaptation strategies and recommendations for responding to climate change see Section 6.

4. Climate Change Observations and Experiences in Jean Marie River

The objective of the interview process was first, to ask participants who have lived in JMR for most of their lives how the climate or weather in the last 15-20 years is different from the climate 20-50 years ago, depending on the age of the participant. Secondly, participants were asked how the changes in climate have impacted (i.e. caused changes to) the environment; as well as the people, community and culture of the JMRFN.

Observations of climate change and their associated impacts were categorized into six themes. The process for selecting these themes is primarily based on the observations common among most, if not all, of the interviewees; and from major climate change topics identified in the literature review related to changes in the weather and the environment, such as thinner ice cover on lakes and rivers and melting permafrost. The six themes identified for this project are:

- Seasonal Weather Patterns
- Rivers, Lakes, and Water Quality
- Permafrost
- Wildlife
- Vegetation
- Community and Culture

For each theme observations of any changes that are directly or indirectly related to climate change were documented, along with any associated potential or existing impacts. Further, from these impacts the relation to health, if applicable, was identified as the first step in assessing the vulnerability of our community to health related impacts of climate change. In the context of this research means, vulnerability to climate change refers to: "the degree to which a system (community) is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes." (Séguin and Berry, 2008:5; *parentheses added*).

The second step in preparing the vulnerability assessment was to review, verify, discuss, and clarify the climate change observations and impacts documented in the interviews. This step was accomplished through a focus group session, where community participants were presented thematic posters showing the documented observations and impacts. Participants discussed each impact on the posters and provided feedback to confirm, clarify, and/or add any other information to the posters.

During the focus group session participants were also asked to rank which health related impacts were most significant based on:

- The vulnerability of, or how at risk is, the community to the impact *(high, medium, low)*;
- The magnitude (i.e. seriousness/severity) of the impact to the community *(strong, medium, weak)*;
- The perceived duration of the impact *(long, intermediate, short)*, and;
- The capacity of the community to adapt to the impact *(difficult, moderate, easy)*.

These categories were used to display a matrix on the posters where the participants ranked each impact according to these categories using low, medium, and high type scales (see Tables 1-6 in the subsequent sections). This method for prioritizing climate change impacts was adapted and modified from Smit et al. 2008, and from the six *Climate Change Planning Tools for First Nations Guidebooks* (2006) produced by the Centre of Indigenous Environmental Resources (CIER).

From the answers and stories shared by the interviewees a brief collective account of JMR's climate from the mid 1950s to the 80s, from a local cultural perspective, is presented below. This account is important

to understand how significant recent changes in the climate are, or may be, to the health of the environment and of the people and culture of JMR.

4.1. The Climate in Jean Marie River from the 1950s to 1980s

The weather in the JMR area from the time of settlement until the 1970s was typically characterized with long and very cold winters, short cool springs, short and hot summers, and longer falls in comparison to the climate in the last 15-20 years.

Although the weather has always been unpredictable to a certain degree, the people of JMR, especially the Elders, usually knew when seasons started changing and when extreme weather events would occur well in advance of these changes or events happening. The people of JMR knew how to predict these changes based on the traditional knowledge (TK) that has accumulated over the generations of the Slavey people who have lived in this area. Observing the weather and anticipating how this will affect the environment and wildlife was an important aspect of our TK, as this was essential for our survival and for maintaining the health of our people physically, mentally, spiritually, and emotionally; as well as to maintain the health of the community and its culture.

Interviewees mentioned that when they were youth and young adults they remembered the seasonal weather patterns, for the most part, happening like clockwork.

> "And we still have ice flows in June on the river (referring to the 1950s). At that time it never fails. You know, every spring after all the – sometime after the leaves come out we have a big – sometimes we have a big snowfall… We move out of our houses in the winter, and in spring set up a tent outside – you could hear all the spruce trees with wet snow on it, just cracking like somebody shooting. That's the kind of spring. And then the summertime only gets really warm in July, not in June. July is our warmest month – summer month. And then right around the end of July we have a big storm. It's just like clockwork. Everybody knows its coming. It would storm pour rain and wind for about three days… August it's pretty good. You know, that's the time they called it Indian summer, in August, it's really hot." (*Ernest Hardisty*, *September 2010; parenthesis added*).

Part of this perception of timing of the seasons was based on the ability of Elders in the past to predict weather in the short term, and also when seasons would change; for instance, if winter would come earlier or later.

> "They (the Elders) were amazing. They looked at the stars and if the stars are blinking faster it means there will be a wind, they used a set of stars to tell time. I am not sure if this method could be used these days. I've travelled and was taught by all the men in the community. They observed everything; sometimes when we settled at our camp and we heard lots of owls they would say that it's going to snow, these sorts of things they had used to predict the weather. I don't know whether people are still using these methods. People are no longer on the land in the winter….
>
> During the time when I was young the winters were very cold, very cold. During those cold days there would be ice fog all along the river. During the summer it was very hot and it used to rain for several days. Theses rains have names (such as) berry ripening rain, that's how it used to be but now things are different… In the fall, sometimes the people would say that the fall would be long. The Elders would predict what the weather would be like and usually they were right. Most times the fall weather would last a long time, where there is no snow on the ground but the ground was well frozen. Sometimes they would predict that the fall would be short and so it was. We would get early snowfall. Elders would predict what the weather would be like and that's what the people

> went by." (*Billy Norwegian*, *September 2010; translated by Margaret Ireland; parenthesis added*).

Basically, weather was one of the first factors to consider when conducting many types of traditional land use (TLU) and cultural activities, and still is today, and the ability to predict weather mediated the relationships that members of our community had with nature, with each other, and with other communities. As the weather and climate have changed over the seasons and years, our people have adjusted to these changes using our TK that we have particularly adapted to our traditional territory.

However, since the 1970s, and especially in the last 15-20 years, the climate has begun to change noticeably in JMR, with the weather in all seasons becoming generally warmer. There is more snow in winter, particularly in late autumn/ early winter, and less rain in the summer; however, it is the more subtle shifts in the timing of seasonal weather changes and the associated changes to the environment that are having the most pronounced impacts on the land and on our community. A typical year before the 1970s will be briefly described to better understand how significant some of the recent changes to the climate are, or will be, to our community.

Starting in the autumn the season was usually from late September to early/mid November. During the fall it would become cold; freezing the ground and water, but usually little snow would be on the ground until after Christmas. Many birds were seen flying south and there was always an abundance and variety of ripe berries. Before snow accumulated significantly the ground, rivers, and lakes were frozen allowing our trappers to safely travel anywhere to set up their trap lines.

Winters were very cold, with temperatures around -50°F not uncommon. There was lots of snow in the winter, but usually not before Christmas. The thickness of the ice on the Mackenzie River was about seven to eight feet thick, and all waterways could be safely used as travel routes for hunting and trapping.

> "Back in those days it was really cold. We try to dig our heals into the snowdrift, we wouldn't even make a little dent. That's how cold it was. It was so cold, we had to go to the Mackenzie River to retrieve water to drink, but the ice was so thick, about eight feet thick back then." (*Stanley Sanguez*, *September 2010*).

Spring marked the end of the trapping season as trappers needed to get their traps out before the rivers and lakes started to breakup. With the gradual warming in the spring months – late March to mid/late May – the ice on the rivers would crack loudly as the ice broke up. After the ice in the rivers and lakes had melted many types of birds came to the area, filling the air with the sounds of birds and frogs.

> "Spring was also the same. The Elders predicted when spring would arrive. Spring brought major changes; breakups were great, lots of water, if there was lots of snow during the winter, there would be lots of water. Breakups along the Jean Marie River were very powerful and the ice would clear out of the Jean Marie River leaving the shore clear of ice. For the last several years breakups along the Jean Marie River are very quiet, the ice almost melts away so the shore is overgrown with shrubs. Judging by the past river activities, things have changed considerably." (*Billy Norwegian, September 2010; translated by Margaret Ireland*).

Summers were short but they were usually hot, but not too hot, and according to the interviewees, rain would usually fall around the same time each summer. Thunderstorms in the summer during this time period were infrequent and not very intense when they did happen.

> "In the summer it didn't rain that much and it wasn't that hot, for me it wasn't that hot. And there were many birds, you could hear all the birds, and in the spring you would also hear the frogs, lots of frogs. Now you very seldom hear a bird and in the spring you don't hear frogs." (*Yvonne Norwegian, November 2010; translated by Margaret Ireland*).

The approximate timing of seasonal changes and the indicators used to predict these changes had become a pattern that had remained fairly constant over many generations. When to go out trapping, and when to harvest certain animals or plants at certain times of the year was primarily mediated by the season and the weather. In a sense what is perceived as 'good weather' is a basic factor for the health of the body, community, and environment. Changes and restrictions imposed by governments and industry have also interfered significantly with our people's connection with the land, but the weather remains one of the most important factors in determining when we can practice particular TLU activities and other cultural activities.

Many participants recalled when they were younger the Elders told them that negative changes would occur to the weather, the animals and to the vegetation in the future; brought upon by the disrespectful treatment of the world by industrialized societies and cultures. The changes associated with climate that these Elders spoke of have started to be noticed by the eldest of interviewees as early as the 1970s, and have become particularly noticeable to other community members in the last 15-20 years.

> "My late father, sometimes he would sit at the table and speak of things to come. He talked about things as we know them to be, how the earth is going to change, how all things would change in the future. I remember thinking, I was a young man then, and I wondered how the earth will change, it was hard for me to believe that the earth, which has been in existence for time immemorial, would change. This is how he spoke with us, he also said that the animals eventually would change and we would notice when it becomes quite noticeable. I used to wonder what is he talking about, how would the earth change, the animals change, not only that but he also spoke of the white people exploiting the earth, depleting the earth of its life force, which eventually would put people in a very difficult existence. These were the things he spoke of. I used to think that this earth is our land and there is no way it would be destroyed. I am amazed that my late father spoke of things that would be several years ago and now we are living these changes." (*Douglas Norwegian, November 2010; translated by Margaret Ireland*).

The predictions by these Elders of major changes to the climate and environment, and how this will impact our community, are becoming reality. The older generations and Elders in our community today have begun to observe these changes with great concern, and people have also started experiencing impacts related to climate change. These observations and impacts will be discussed in separate, but overlapping themes in the following sections.

> "People know of the changes in the weather. People are aware of the changes on the land, with wildlife, water and the trees, but people do not understand why this is happening. In the future this will be felt more; it will create great changes… the Elders talked about the future, changes would occur for everything and how it's going to be very difficult for the people, people will experience hardship. What they predicted will come to be, there's no changing it; it is the truth… The Elders of the past had powerful knowledge and when they predicted something it usually is the truth and it comes to be." (*Billy Norwegian, September 2010; translated by Margaret Ireland*).

4.2. Seasonal Weather Patterns

Based on the observations of the community members interviewed, seasonal weather patterns in the last 15-20 years have changed quite noticeably. The most common trends observed for all seasons has been a general warming, especially in winter, and the weather in all seasons has become increasingly unpredictable.

The warming trend being observed and experienced by our community is causing environmental changes that are impacting the plants and animals, as well as our community, that are a part of the ecosystem and our culture. Table 1 lists the observations and impacts associated with changes in seasonal weather patterns. Many of the observations and impacts in Table 1 overlap with the other themes, as it is the changes in the seasonal weather patterns that are causing many of the changes to the environment and our community.

One of the more significant observations is the change in the timing of freeze up and major snowfalls in late fall/ early winter. In the past, freeze up happened earlier and quicker than it does now and usually well before any significant amount of snow had fallen. Now freeze up occurs about 2-3 weeks earlier, and there is a lot more snowfall before the ground, rivers, and lakes freeze solid. We have also noticed that this increased snowfall early in winter acts like an insulator keeping the ground from freezing, and the ice cover on rivers and lakes from thickening, like it did in the past.

The change in the timing of freeze up and precipitation alone has caused many impacts to both the environment and members of our community. For our hunters and trappers access to TLU areas is becoming more restricted because travelling out on the land in late autumn, before everything freezes, is becoming more difficult and dangerous to do. Even in winter travelling over land is more risky, and people need to pay particular attention when crossing the ice.

> "In the past there would be just a few centimeters of snow and then it gets very cold, which freezes the ground very solid and as a result people could go anywhere on the land. In the last recent years the ground does not freeze, and we get a very heavy snowfall, which makes it very difficult to go on the land, you see for yourself what it is like right now; the lakes are not frozen. When you travel in the bush you have to follow trails, the ground is too mushy under the snow." (*Douglas Norwegian, November 2011; translated by Margaret Ireland*).

There have also been increased cases of community members going through ice on lakes and rivers. Thankfully nobody has suffered any serious injuries, but there is the increased potential for these incidences to be more serious, and it also makes rescue efforts in the area more difficult to do because of the softer ground and thinner ice cover.

The increased unpredictability of the weather in all seasons is also a common observation, especially since our TK that we use to predict the weather is not working anymore. The inability for us to predict the weather is not just a concern for our community and culture, but this is also a concern for the environment. Many of the indicators we use to predict the weather are based on observations of animals. We are unable to predict the weather because the animals we observe are not behaving the same, as if they are confused about what season it is. This observation is also supported by people saying their pets are shedding at unusual times in the year.

> "In the past few years I observed that the winters are mild with a few cold spells, this suits me fine. There are pros and cons to the mild winter. A couple of years ago, I had my cat and dog to the vet. I was complaining to the veterinarian that my cat and dog are

> steadily shedding hair all year round. He told me that the unpredictable weather is confusing the animals as well. It makes me wonder if the unpredictable weather is baffling the domestic pets than what is truly happening to the animals in the wild." (*Margaret Ireland, September 2010*).

> "At the same time too, back in those days when Dad and… and then the Elders were still with us, they would look up in the sky and they would predict the weather. They'll see and say tomorrow is going to be sunshine… so the Elders used the sky and the surroundings to predict what the weather is like. But within the last 10-15 years the Elders were saying we can't predict our weather anymore because the weather is changing up here, so it's hard for them to predict it." (*Stanley Sanguez, September 2010*)

It is also important to note that the many of the changes observed in seasonal weather patterns play a major role in the observations and impacts documented for the other themes, such as Rivers and Lakes.

Table 1: Climate Change Observations and Impacts Associated with Changes in Seasonal Weather

Theme	Observations	Impacts	Relation to Health	Vulnerability Ranking	Magnitude	Duration	Ability to Adjust
Weather							
Fall	• There is more rain and snow (record breaking snowfall on October 14, 2010) • Fall is more unpredictable • Milder temperatures • The ground and lakes and rivers take longer to freeze.	• Travel overland is more difficult and dangerous because the ground does not freeze through and ice on lakes and rivers is thinner and covered by snow – harder to predict weather using TK • Trapping season start about a month later • Reduced access to country foods and less time spent out on the land	• Increases in injuries and deaths caused by travelling accidents	**Medium**	**Medium**	**Long**	**Easy**
			• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**Medium**	**Medium**	**Long**	**Moderate**
			• Less opportunities to practice and pass on traditional knowledge and cultural practices	**Medium**	**Medium**	**Long**	**Moderate**
Winter	• Milder temperatures • More snow, especially at the start of winter • Snow acts like an insulator not allowing the ground or ice to freeze through • Cold spells are not as long • More mid-winter melting	• Travel overland is more difficult and dangerous because the ice on lakes and rivers is thinner and covered by snow • Increased exposure to extreme weather (e.g. cold spells) – harder to predict weather using TK • Use less fuel to heat homes • More difficult to maintain trap lines and hunt • Reduced access to country foods and less time spent out on the land	• Increases in injuries and deaths caused by travelling accidents	**Medium**	**Medium**	**Intermediate**	**Moderate**
			• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**Medium**	**Medium**	**Intermediate**	**Moderate**
			• Less opportunities to practice and pass on traditional knowledge and cultural practices	**High**	**Strong**	**Long**	**Moderate**
Spring	• More snow in the spring • Starts cold, warms up quickly, and then gets cold again • Break up starts earlier and is quicker	• Increased chance of rivers flooding into the community and roadsides creating greater potential of road closures due to rapid melting • Trapping season ends about a month sooner • Travel overland is more difficult and dangerous	• Increases in injuries and deaths caused by travelling accidents	**Medium**	**Weak**	**Intermediate**	**Moderate**
			• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**High**	**Medium**	**Long**	**Moderate**
			• Less opportunities to practice and pass on traditional knowledge and cultural practices	**Medium**	**Medium**	**Long**	**Difficult**
			• Health risks and physical and emotional stress associated with flooding and road closures	**Medium**	**Medium**	**Intermediate**	**Difficult**
Summer	• Longer and hotter • More heat waves that last longer • Violent storms not seen before • Less rain • Ground and trees are drier	• Increases in cases of sun stroke, and skin and eye problems • People avoid going outside • Longer growing season • Children swimming in rivers • Damage to buildings from severe wind storms • Increase chances of forest fires near the community	• Increased exposure to UV radiation causing more skin and eye problems	**High**	**Medium**	**Intermediate**	**Easy**
			• Increased cases of heat stroke	**High**	**Medium**	**Intermediate**	**Easy**
			• Health benefits and risks associated with swimming	**Medium**	**Weak**	**Short**	**Easy**
			• Increase in injuries and emotional stress from extreme weather events	**Medium**	**Medium**	**Short**	**Easy**
			• Health risks associated with forest fires	**High**	**Medium**	**Short**	**Easy**

4.3. River, Lakes & Water Quality

The most apparent impact to rivers being caused by climate change is the timing and duration of when rivers and lakes freeze up and breakup. Freeze up is happening approximately 2-3 weeks later and takes longer. Spring breakup happens about 2-3 weeks earlier and is quicker. One of the more significant impacts is that when freeze up takes longer JMR is cut off from Fort Simpson, the nearest community with a grocery store, medical facilities, and other essential services. To reach Fort Simpson from JMR by vehicle the Liard River needs to be crossed, either by ferry when the water is open or by an ice bridge in the winter. During freeze up and breakup Fort Simpson is only accessible via air transport, and the second closest community is Hay River, about a four hour drive from JMR. This means that people need to stock up on food and water before freeze up begins. Moreover, with access to harvesting areas being more difficult and dangerous in the fall, people are becoming more dependent on store bought foods.

While talking about impacts to lakes and rivers caused by climate change all the interviewees voiced their concern about the deteriorating water quality in both natural and treated sources of drinking water. Most people in JMR will not drink water from natural sources anymore, or from melted snow because it is murky and does not look clean; instead people drink bottled water when on the land and at home. The Mackenzie River in particular was mentioned, and people no longer drink water from lakes and rivers in the area because, even when boiled, the water does not taste right and leaves a film in cups.

> "... in the olden days people wandered all over the land and when they came to a pond of water, they thought nothing of getting a cup full and drink. Now all these little ponds of water scattered around the land are covered with green, slimy film. Water does not taste good anymore and it's scary to drink water. The lake, the five fish lakes in the last two years I am noticing a difference in the water if you use the water in the lakes... if you make tea and the water from the lake, it looks dark. In the past when you make tea with the water from the lakes it looks very clear, bright coloured tea, now the tea looks very dark and has a scum on top. There's a dark scum marks inside your cup, it does not look good." (*Douglas Norwegian, November 2010*; *translated by Margaret Ireland*).

The actual cause of this film in the water is unknown, but the temperature in the Mackenzie has been monitored and it is becoming warmer, which could be causing major changes to the ecosystem. The role of climate change in the deterioration of water quality in the region remains unknown, but research has shown that warmer water temperatures can alter northern aquatic habitats (e.g. out migration of cold water fish species) and become more inviting to warm water species, and to vector and water borne diseases (Furgal and Prowse, 2008:102; Séguin and Berry, 2008:327; Wrona et al., 2005:383-384).

Other observations and impacts regarding lakes, rivers, and water quality associated with climate change such as flooding, changes to navigation routes and damage to roads are summarized in Table 2.

There is also the issue of warming temperatures in rivers and lakes contributing to the accumulation of contaminants in the water table via melting permafrost, development activities, and pollution from southern regions. The leaching of contaminants such as heavy metals (e.g. mercury) into water sources as surface and water temperatures rise is well documented in the literature (Furgal and Prowse, 2008:80,98; Berner et al., 2005; 891; Wrona et al., 2005:379,430); however, in the local context of JMR the link between warming temperatures, melting permafrost, contaminants, and water quality needs to be better explored as there has already been an increase in heavy metal contaminants, such as increased mercury levels in popular fishing lakes near the community.

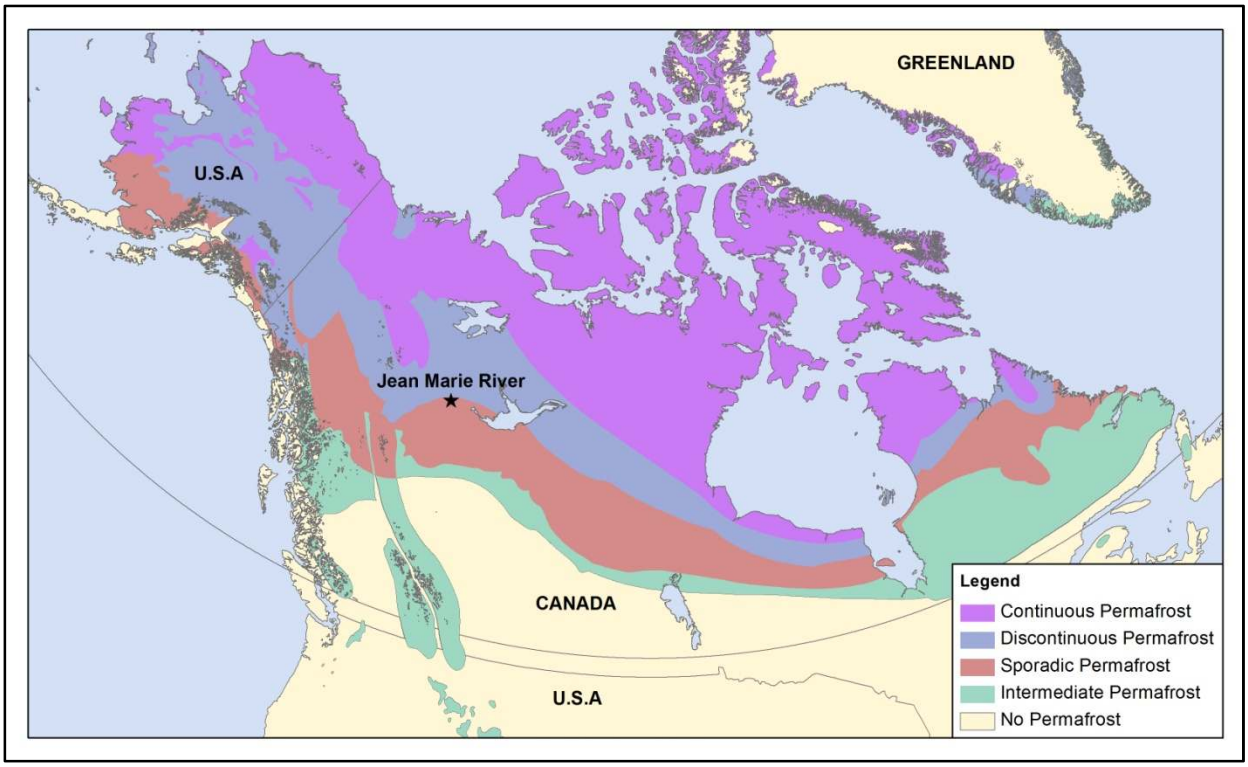
Table 2: Climate Observations and Impacts Associated with Rivers, Lakes, and Water Quality

Climate Change Observations and Health Related Impacts in Relation to Rivers, Lakes, and Water Quality							
Theme	**Observations**	**Impacts**	**Relation to Health**	**Vulnerability Ranking**	**Magnitude**	**Duration**	**Ability to Adjust**
Rivers, Lakes and Water Quality	• Freeze up takes longer and happens slower (late October to early November)	• Trapping season starts around a month later because ice on lakes and rivers is too thin to travel across • Road to Fort Simpson is closed until the Liard River freezes thick enough to drive over	• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**Medium**	**Medium**	**Long**	**Easy**
			• Increases in injuries and deaths caused by travelling accidents	**High**	**Medium**	**Intermediate**	**Easy**
			• Less opportunities to practice and pass on traditional knowledge and cultural practices	**Medium**	**Medium**	**Intermediate**	**Easy**
			• Road closures block access to the nearest grocery stores and medical facilities in Fort Simpson	**High**	**Strong**	**Long**	**Difficult**
	• Ice on lakes and rivers is much thinner than in the past	• Ice in winter does not freeze as thick, making travel more difficult and dangerous	• Increases in injuries and deaths caused by travelling accidents	**Medium**	**Medium**	**Intermediate**	**Moderate**
	• Break up is shorter and happens quicker (early May)	• Trapping season ends about a month sooner • Increased chances of flooding of roads and in the community (e.g. air strip) in the spring	• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**High**	**Medium**	**Long**	**Moderate**
			• Less opportunities to practice and pass on traditional knowledge and cultural practices	**Medium**	**Medium**	**Intermediate**	**Easy**
			• Health risks and physical and emotional stress associated with flooding and road closures	**Medium**	**Medium**	**Intermediate**	**Difficult**
	• Water is warmer in lakes and rivers and they are ice free for longer	• More children swimming in the summer • Longer boating season • Need to check fish nets more often so fish do not spoil	• Health benefits and risks associated with swimming	**Medium**	**Weak**	**Short**	**Easy**
			• More opportunities to harvest fish; however, more time and energy needed to monitor fish nets	**High**	**Strong**	**Short**	**Moderate**
	• Water from the Jean Marie River and Mackenzie River leaves a film in cups, as well as water from melted snow	• Water is murkier and gray in colour • Water from the rivers and lakes is not suitable for drinking, and even treated water in the community is not a trustworthy source of drinking water	• Potential for increases in gastro-intestinal and other water borne diseases from water contamination	**High**	**Strong**	**Intermediate**	**Difficult**
			• Less safe water sources on the land	**High**	**Medium**	**Long**	**Difficult**
	• Lower Water level in Mackenzie River, and other lakes and rivers	• Changes when navigating the Mackenzie River to avoid any new hazards such as shoals and sand bars	• Potential for increased boating accidents resulting in injury or death	**Medium**	**Medium**	**Long**	**Moderate**

4.4. Permafrost

The area where JMR is located is approximately where sporadic and discontinuous permafrost zones meet. Most members of our community do not know exactly where every permafrost zone is located, including within or in close proximity to JMR. However, there are geographic features, such as permafrost heaves that are quite large and are home to a number of different animal species, particularly smaller furbearers. These permafrost heaves are important places for hunting, trapping, camping, and as landmarks for those familiar with the area.

Map 2: Permafrost Areas in Canada



Data source: National Snow and Ice Data Center, 2001

With warming temperatures in the last 15-20 years there are some observable impacts to some permafrost areas. Riverbanks in these areas are especially susceptible to erosion, as this has become an increasingly common sight along rivers and creeks. Another common observation in permafrost areas is that certain species of trees (e.g. pine and tamarack) are dying and collapsing (a.k.a. drunken trees) because the permafrost that these trees are rooted is melting and then drying up; making the soil unstable for these trees, causing them to die and collapse.

In certain areas the collapse of trees has completely blocked access to trails. Harvesters in our community have also observed dramatic changes to the landscape where permafrost heaves have melted and flattened out completely. These areas have become even swampier and the animals that depend on these permafrost heaves as part of their habitat are declining in numbers. Further, community members who rely on these permafrost heaves to harvest animals report that it can be quite disorienting when a permafrost heave disappears. Some older harvesters expressed concern that these changes may cause younger harvesters to become lost if these landmarks keep disappearing.

> "... at times when we were out beaver hunting there's a lot of permafrost heaves and there's – you know, sometimes we sit on top of it. Some of them are about 20 feet high, and they are just like an island, there is some moss on there, there are trees, there is black spruce and there's feeding are for caribous, and a lot of dens for martens and minks.
>
> (One of these permafrost heaves)... flattened out, and there is a – the only thing that's sticking out of there is a big birch. You get big birch, they're the only ones you see, half of the way out... so the landscape has changed quite a bit." (*Ernest Hardisty, September 2010; parenthesis added*).
>
> "There are many changes that have occurred. People are talking about climate change. They are right – there are changes that are occurring, which is causing differences in the landscape. When I was young I used to go with my father on his trap line. What we call frost heaves, which are usually big and round. He had trapped among these heaves. During those days there were no martins in the area, but there were lots of mink and their habitat were among the heaves. To this day my older brother Douglas and I are still using the trail. Birch trees used to grow on these heaves and now the frost heaves are no longer there, all you can see are the tips of the birch trees in the water. There were many of these frost heaves and now the land in that area is almost smooth." (*Billy Norwegian, September 2010; translated by Margaret Ireland*).

Although not mentioned by many of the interviewees, there is also the question of how much contaminants are being released into lakes and rivers when permafrost melts. It is well documented that melting permafrost can leach contaminates, such as heavy metals into groundwater, lakes, and rivers; which then becomes more concentrated as it passes up the food chain (Furgal and Prowse, 2008:80,98; Berner et al., 2005; 891; Wrona et al., 2005:379,430). Moreover, many interviewees mentioned that they were told by scientists to eat only a limited amount of certain fish species per week from certain lakes fished frequently by members of our community because of the increase mercury levels being found in these lakes. Scientists told our community that the increased mercury levels are happening naturally, but no explanation was provided by the scientists of what this natural process is, how it works, and why it is happening.

Table 3: Climate Change Observations and Impacts Associated with Permafrost

Theme	Observations	Impacts	Relation to Health	Vulnerability Ranking	Magnitude	Duration	Ability to Adjust
Permafrost	• Ground is softer all year round	• Hinders travelling over the land on foot, ATV, and snowmobiles • Increased risk of heavy metals leaching into groundwater and into lakes and rivers (e.g. mercury)	• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**Medium**	**Medium**	**Intermediate**	**Easy**
			• Increased risk of exposure to contaminants indirectly through eating certain country foods (e.g. fish and moose organs)	**High**	**Strong**	**Intermediate**	**Moderate**
	• Permafrost heaves flattening out • More erosion of riverbanks • More dead and dying trees because soil has become unstable (e.g. drunken trees)	• Dramatic changes to landscape/terrain • Some traditional travel routes have become blocked or otherwise inaccessible and landmarks are disappearing (e.g. old mail trail to Fort Simpson) • Reduced access to country foods and culturally important areas	• Erosion of traditional knowledge about the local areas that have changed	**High**	**Medium**	**Intermediate**	**Moderate**
			• Increased risk of becoming disoriented and lost when out on the land.	**High**	**Medium**	**Short**	**Easy**
			• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**Medium**	**Weak**	**Intermediate**	**Medium**
	• High water table in the ground spring; however, water is quickly absorbed into the ground	• Flooding along roadsides during spring run-off • More frequent road maintenance and possible road closures and community air strip	• Road closures in spring block access to the nearest medical facilities and grocery store in Fort Simpson	**High**	**Strong**	**Short**	**Moderate**
			• Expenditure of community resources to maintain roads	**High**	**Medium**	**Intermediate**	**Moderate**

4.5. Wildlife

Securing access to country foods is always an important issue in our community as the availability and abundance of harvestable species fluctuates annually. Country foods such as moose, caribou, berries, and fish are essential for maintaining a healthy diet for members of our community. In fact, according to Statistics Canada, 50% of the households in Jean Marie River obtain 75% or more of their meat from the land (moose, caribou, furbearers, waterfowl, etc.).

With changes to seasonal weather patterns, to the conditions and quality of rivers and lakes, and to permafrost being caused or compounded by climate change; animals are also being directly and indirectly impacted by these changes. Most notably has been the decline of many small mammals common to the area such as beaver, rabbit, muskrat, and porcupines; and the small predators that feed on these animals such as foxes and weasels. Members of JMR have also noticed the decline in the number of migratory birds returning to the JMR area. There have also been increased sightings of animals rarely seen in the area, such as whitetail deer, cougars, crows, magpies, and skunks.

Fish are also being reported to be less abundant from lakes and rivers in the area, and more fish from the Mackenzie River are being found dead, or have sores and other deformities. Moreover, fish from this river are very soft and when cooked the meat turns mushy. People in our community will no longer eat fish from the Mackenzie River because they consider the fish to be unhealthy and inedible.

> "The fish from the lakes are still good, but the fish from the Mackenzie River are very different, the flesh is watery, does not taste good. During the summer Douglas sets out nets and we noticed that many fish have sores, big sores and sometimes they looked like they have something that looks like bubbles." (*Yvonne Norwegian, November 2010; translated by Margaret Ireland*).

> "In the fall time we used to harvest lots of our fish, but now the fish now it's not so firm anymore, their flesh. 'Cause we make – 'cause our Elders used to boil fish and meat, but sometimes the meat just taste like... you end up making fish soup, 'cause the meat is not so firm anymore, so you could tell it has to do with the – what DFO was telling us was the warming of the water has to do with it (*Stanley Sanguez, September 2010*).

> "The flesh (of fish) used to be good and firm. I set out fish nets mainly for my dogs; many of the fish that I've caught have sores. Healthy fish have healthy reddish colour gills and most fish caught do not have healthy reddish coloured gills, they are whitish in colour. Even the whitefish caught in the nets are not good to eat, their flesh are very soft, which makes the fish taste very different. Fish are not good anymore. My father used to go fish-netting at Mills Lake, so two years ago Billy and I spent six days in the area. We caught several fish that have white gills and reddish marks on their bodies. Many fish have sores over their body and many of them do not have any fat." (*Douglas Norwegian, November 2010; translated by Margaret Ireland; parentheses added*).

> "The Mackenzie River, and its tributaries and surrounding lakes once had abundant fish, which were once a staple of most family's diets are also very scarce. Most JMR people are buying fish from Hay River now. People are reporting that they are catching deformed fish, and there's mercury in the fish." (*Margaret Ireland, September 2010*).

In relation to big game animals, participants did not seem to notice much difference in their numbers or behaviour, with the exception of predatory animals, especially black bears. During the fall there has been

increasing sightings of black bears in the community. The black bears are usually spotted around garbage containers. Every year it appears that the bears are becoming less fearful of people and the community is forced to kill some of these bears. The increased sightings of black bear in fall may be linked to the significant decline in the abundance of berries during this season (see the next theme).

> "For the last three or four years we are experiencing bear problems. They tend to come into the community. JMR did not experience wolves coming into the community and eating dogs, but our neighbouring community had this problem for several years. Cougar was sighted along the JMR access road. People are frightened of cougar and are saying that the cougars are following the whitetail deer into the region... Bears coming into the community are also not good; I don't feel comfortable while working in my flower and vegetable garden." (*Margaret Ireland, September 2010*).

> "... the bears have made a comeback, so I think they – they were – there's one year there was nothing at all. We didn't see nothing. Another two more years down they come back. Now it's even more. We had two in the communities we had to just destroy. Too close to the community, and for kids' safety reasons. And these bears have a lack of berries. There was hard to... berries, that's why they were so – they are not ready for fall time, they're just going in the garbage." (*Angus Sanguez, September 2010*)

The cause(s) for the decline in the numbers of small mammals and birds is not known; however, with the changes to the landscape (e.g. changing ice conditions, melting permafrost, drying up of wetland areas) the habitats for these small mammals and birds is changing significantly, potentially causing these animals to die out or move to other areas with a more suitable habitat.

Table 4: Climate Change Observations and Impacts Associated with Wildlife

Theme	Observations	Impacts	Relation to Health	Vulnerability Ranking	Magnitude	Duration	Ability to Adjust
Wildlife	• Increased sightings of animals that rarely come so far north (e.g. whitetail deer, coyote, crows, magpies, swans, cougars, and skunks) • Decreased abundance of some animals common to the area (e.g. rabbit, muskrat, beaver, porcupines, foxes,) • Increased sightings of black bears in the community	• New species to harvest • Increased competition with animals common to the area • Decreased abundance of primary and secondary country foods • Reduced abundance of country foods • Bears are becoming a threat to the safety of community members and pets	• Alternative species to harvest to supplement diet of country foods	**Medium**	**Strong**	**Short**	**Difficult**
			• Certain animals preferred as country foods may be pushed out by animals moving into northern ecosystems	**Low**	**Weak**	**Long**	**Easy**
			• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**High**	**Weak**	**Intermediate**	**Easy**
			• Potential increase in injuries and deaths caused by black bear attacks, and emotional stress from encountering black bears in the community	**High**	**Weak**	**Short**	**Difficult**
	• Poor quality fur of fur bearing mammals that are trapped. In recent years the quality of fur improves near the end of the trapping season	• Reduced resources for clothing and income from trapping activities	• Less income to cover costs of healthcare	**Medium**	**Weak**	**Long**	**Difficult**
			• Less resources to make traditional clothing and other cultural items	**Medium**	**Weak**	**Short**	**Moderate**
	• Many fish are being found dead, deformed, and generally unhealthy • Decreased abundance of fish in the 5 Lakes areas • Scientific observations confirm mercury contamination in popular fishing lakes (e.g. McGill Lake, Ekali Lake) • Fish in Mackenzie River are mushy and not edible	• Decreased abundance and diminished quality of important country foods (e.g. arctic grayling, suckers, loche)	• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**High**	**Medium**	**Long**	**Difficult**
			• Increased risk of contamination from heavy metals (e.g. mercury)	**High**	**Strong**	**Long**	**Difficult**
			• Erosion of cultural relationship with the environment	**High**	**Medium**	**Long**	**Difficult**
	• Very few migratory birds (e.g. ducks, geese, terns, black birds) are returning to Jean Marie River in the spring	• Reduced abundance and availability of country food • Evidence of changes to the boreal ecosystem	• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**Low**	**Weak**	**Long**	**Easy**
			• Erosion of cultural relationship with the environment	**Medium**	**Weak**	**Long**	**Easy**

4.6. Vegetation

The changing climate has had visible impacts on vegetation, trees in particular. There is the above-mentioned issue of 'drunken trees' in permafrost areas, but there is also the concern of the northward spread of spruce bud worm. This issue, along with drier summers, could significantly impact the ecosystem, as well as increase the risk of forest fires. With drier summers some participants remarked the vegetation is looking wilted, more yellow, and generally unhealthy, and one particularly well known wetland area where many birds used to come to nest in the spring is now very dry, with noticeably less water and vegetation growing in the area; and almost no migratory birds are returning in the spring.

> "In the early 70s, I remember the Elders sitting with my mother and they were talking about the differences they were noticing. They talked about the differences they noticed with the trees. If you take a good look around you would say they were right. They were talking about the berries at that time and the grasses were also different, they noticed the grass was not fully green and that it appears to be dry. Even back then, the Elders were talking about the changes that were happening so we start to pay more attention to things, we realized that they were right, the grass looks unhealthy." (*Yvonne Norwegian, November 2010; translated by Margaret Ireland*).

Another change many people in JMR believe is connected with climate change is the significant decline in abundance and quality of many types of berries harvested by the community. Many of these berries ripen in the summer or fall and are harvested at this time, but in recent years there are fewer berries to pick, and many are still not ripe in the fall.

> "In the summer there were many berries and there are many things that are different, they're no berries and there are many things that are different, there are no berries in the fall. At Rabbitskin, where I grew up, there use to be lots of Saskatoon berries and there's hardly any, my younger brothers and sisters are telling me that there's hardly any Saskatoon berries in the area; occasionally there's one or two hanging from the branches." (*Yvonne Norwegian, November 2010; translated by Margaret Ireland*).

> "Last summer there was hardly any rain, but this year was different again. This summer we are getting more rain, there's lots of thunder and rain. Everybody thought there will be lots of berries, but there are hardly any berries. There were blueberries, which people had harvested and there were some high bush cranberries. What I noticed about these berries was that they didn't last very long, they fell off almost immediately. What is causing this? Perhaps changes in climate, even though we had a fair amount of rain there were hardly any berries." (*Billy Norwegian, September2010; translated by Margaret Ireland*).

These berries are an important source of vitamins and anti-oxidants that are freely and easily obtained; whereas, fruits and vegetables in the grocery store are expensive and are often of low quality. Moreover, people in the community believe that there is a correlation between the decline in the abundance and quality of berries and increased sightings of black bears in the community during the fall.

However, with spring starting earlier and the summers ending later there is a longer growing season, evidenced by the increase in underbrush growth along riverbanks and trap lines, as well as the increased quality and quantity of flowers and/or vegetables in some people's home gardens.

Table 5: Climate Observations and Impacts Associated with Vegetation

Theme	Observations	Impacts	Relation to Health	Vulnerability Ranking	Magnitude	Duration	Ability to Adjust
Vegetation	• Trees and grasses are looking more unhealthy • Trees are getting leaves about a month earlier • Decreased abundance of many types of berries (e.g. cloudberries, high/low bush cranberries, Saskatoon berries, raspberries, and soap berries)	• Indicative of an unhealthy ecosystem and habitat loss for animals common to the area • Reduced availability and abundance of country foods	• Erosion of TK and cultural practices in relation to plant species	**Medium**	**Weak**	**Intermediate**	**Moderate**
			• Reduced availability of country foods to community resulting in more dependence on store bought foods	**Medium**	**Weak**	**Intermediate**	**Difficult**
	• More trees are dead or dying as a result from permafrost melting, especially tamarack, poplar, and spruce • Northward spread of spruce bud worm infestations	• Infestation of spruce bud worm killing off more trees • Fallen trees are blocking access to harvesting areas • Higher risk of forest fires	• Reduced habitat for animals with northward spread of spruce bud worm	**High**	**Medium**	**Short**	**Moderate**
			• Reduced availability of country foods in the community resulting in more dependence on store bought foods	**Medium**	**Strong**	**Medium**	**Difficult**
			• The community is more susceptible to suffer negative personal and community health impacts caused by forest fires	**High**	**Weak**	**Short**	**Easy**
	• Increased sightings of new plants, especially along road ways (e.g. Canadian thistle, hog weed, sweet clover)	• Invasive plant species may start to dominate over native plant species	• Increased potential for more community members to develop allergies and/or asthma	**Low**	**Weak**	**Long**	**Easy**
	• Underbrush along riverbanks, trails, and trap lines become overgrown in the summer • Longer growing season	• More time, money and energy to maintain travel routes and trap lines, less time to harvest animals • More varieties and abundance of flowers, fruits and vegetables are being grown in gardens; however, gardens cannot be started until June instead of late May	• More difficult to access harvesting areas to gather country foods	**Medium**	**Weak**	**Long**	**Easy**
			• Increased potential for more community members to develop allergies and/or asthma	**Low**	**Weak**	**Long**	**Easy**
			• Increased opportunities to grow local fruits and vegetables, and reduce dependency on store bought foods	**Medium**	**Weak**	**Intermediate**	**Easy**

4.7. Community and Culture

The observations and impacts associated with climate change for this theme overlap with many of the observations and impacts described in the previous themes. This redundancy is intentional to show how interrelated the impacts caused by climate change to our community are with the other themes. The observations and impacts described in this theme specifically summarize how our community and culture are being directly and indirectly impacted by climate change. Direct impacts are primarily those associated with extreme and unpredictable weather events/changes. Indirect impacts are mainly associated with environmental changes caused by climate change, such as changes to ice conditions, wildlife, plants, etc.

Generally, climate change is contributing to the erosion of our cultural values and activities, as people are unable to go out on the land as much. This also means that there are fewer opportunities to pass on TK, particularly TK transmitted through teaching younger generations to speak Slavey, especially in relation to the environment and climate.

> "...when I started working on that traditional knowledge study I was having a lot of problems, and then that's when I learned that there are three levels to the language, and I was only operating at the community level, and there is more depth to the language when you talk to the land users and Elders. And so that's where I was having problems - communicating to the land users and Elders, and that's when I was told that I was only operating in the elementary." (*Margaret Ireland*, *September 2010*).

The health of our community, its members, and our culture is based on our Dene perception of health, which is based on the body being in balance physically, emotionally, spiritually, and mentally. Dene also extend this perspective to the environment and the world as a whole. So when things are out of balance, such as climate, this translates as being unhealthy; and since everything is interconnected climate change has, and will continue to have, far ranging negative health impacts to ecosystems and the biodiversity of species, including people, who inhabit these ecosystems (JMRFN, 2005; and see also Parlee et al., 2007). For instance, as a result of fewer opportunities for our people to practice TLU activities, more people in our community are experiencing more accidents, more injuries, and are at a greater risk of exposure to extreme weather. Other climate change observations and impacts related to the community and culture of JMR are listed in Table 6.

Through analysis and discussion of the above themes our community was able to identify and prioritize vulnerabilities to climate change (see next section), which led to initial discussions about what and how to explore adaptation strategies to increase the resiliency of JMR and its members to these vulnerabilities in a proactive and, when possible, a positive and beneficial manner.

Table 6: Climate Change Observations and Health Related Impacts in Relation to the Community and Culture of Jean Marie River

Theme	Observations	Impacts	Relation to Health	Vulnerability Ranking	Magnitude	Duration	Ability to Adjust
Community and Culture	• Traditional land use and cultural practices are more difficult and dangerous to do, especially trapping, during most times in the year	• TLU activities require more preparation, maintenance, resources, time, and energy • Not as many people practicing TLU activities • There is an emphasis on teaching younger generations how to read ice conditions when travelling • Less opportunities to organize culture camps	• Increase in injuries and deaths caused from travel accidents while out on the land	**Medium**	**Medium**	**Intermediate**	**Moderate**
			• Emphasis on youth learning survival skills on how to travel safely on the land, such as determining ice conditions and safe places to set up camp	**High**	**Medium**	**Long**	**Easy**
			• Less opportunities to practice and pass on traditional knowledge and cultural practices	**Medium**	**Strong**	**Intermediate**	**Moderate**
	• People spend less time on the land and not as many younger people are learning how to speak Slavey	• The changing climate has compounded this by limiting the number opportunities to do TLU activities and pass on TK because weather and/or travel conditions are too unpredictable or unsafe	• Cultural disconnect between people, the land, and animals	**High**	**Strong**	**Long**	**Moderate**
			• People eating less country and locally grown foods	**Low**	**Strong**	**Intermediate**	**Easy**
	• Weather changes are too fast now to predict the weather based on traditional observations	• Harvesters cannot predict the weather when out on the land, putting them at higher risk of being exposed to extreme weather events	• Increases in injuries and deaths associated with exposure to extreme weather events when out on the land	**High**	**Medium**	**Long**	**Medium**
	• Children get colds and the flu more often	• This may be linked to climate change with more unpredictable changes in the weather, or related to allergies	• Children are getting sick more frequently, increasing need for medicine and medical treatment	**Low**	**Medium**	**Intermediate**	**Easy**

5. Jean Marie River's Key Vulnerabilities to Climate Change

Based on the results of the literature review, interviews and the focus group session our community is particularly vulnerable to health related climate change impacts in regard to:

1. ***Food security/safety:*** Every family in Jean Marie River eats country foods, such as moose, woodland caribou, waterfowl and fish to varying degrees; however, this is being negatively impacted by climate change due to:
   - More difficult and dangerous to access harvesting areas;
   - Changes to the landscape that are causing habitats for some animals to disappear resulting in these animals leaving the area;
   - Reduced abundance of traditional country foods (e.g. berries, fish, rabbit, and beaver);
   - Fewer migratory birds that are harvested seasonally (including their eggs) are returning;
   - Some animals are unsafe to eat because of increased levels in contaminants (e.g. mercury in fish and cadmium in moose organs), and fish from the Mackenzie River are inedible;
   - New species of animals and plants are appearing that may start competing with the local animals and plants, especially if there are significant changes to particular ecosystems, and;
   - More people are relying on store bought food, which is very expensive and less healthy; however, even this is a food security issue when access to Fort Simpson by vehicle is impossible during freeze up and breakup.

2. ***Access to Safe Drinking Water:*** The fluctuation in water levels and changes in river freeze and thaw cycles, due to climate change among other factors, are bringing our water resources and quality into further question, and as such:
   - People do not drink water from natural sources, or melted snow, because of the film the water leaves behind in cups;
   - There have been a number of water advisories since 1995, and most people in the community buy bottled water rather than drinking tap water (a costly expense over a year). People need to stock up on bottled water when access to Fort Simpson is impossible by vehicle during freeze up and breakup;
   - With the water in lakes and rivers warming, this could potentially increase the risk of exposure to new water and vector borne diseases, and;
   - There is also great concern that a changing climate is causing lakes and streams to dry up and permafrost to melt; releasing contaminants into the water and land.

3. ***Cultural & Community Health and Continuity:*** Maintaining our culture and traditional practices means, in part, travelling on the land and harvesting resources, and we feel these country foods are better for our physical and mental health. Country foods have better nutritional value than processed foods bought in the store. In addition, the act of harvesting provides a means for cultural and spiritual renewal. However, impacts being caused by climate change has:
   - Provided fewer opportunities to go out on the land and practice TLU activities and pass on TK with the changes in seasonal weather patterns;
   - Caused our TK for predicting weather to become unreliable because the changes in seasonal weather patterns have been changing so rapidly that the indicators in nature we rely on for predicting weather are no longer harmonized with these changes;
   - Contributed to fewer people going out on the land, and less country foods is being consumed;
   - Contributed to fewer people learning Slavey, which requires references to the environment while on the land to fully master the language;

- Increased the chance of exposure to contaminants in, and new diseases transmitted by, air, water and animals;
- Increased damage to infrastructure and roads from severe storms, floods, and melting permafrost, and;
- Increased the potential for our youth to develop allergies to new species of trees, plants, and animals encroaching on our traditional lands.

4. ***Travel Safety:*** Travel safety is always a major concern in our community, as many of the areas we frequent are only accessible by ATV, snowmobile, boat or foot. With a warming climate we need to be observant when:
   - The ice cover is not as thick, and ice conditions are more difficult to assess due to increased snow cover, making traveling during years with mild winters increasingly hazardous;
   - Melting permafrost is causing traditional trails to become blocked or impassable, and is causing dramatic changes to the landscape, which can cause people to become disoriented in once familiar areas, especially with younger land users;
   - Traveling by boat along rivers is more risky due to lower water levels exposing hazards such as rocks, or making some parts of rivers too shallow to cross by boat, and;
   - Driving in winter because unpredictable weather events such as blizzards are happening more suddenly.

5. ***Extreme Weather & Increased Exposure to UV-B Rays:*** Extreme weather events such as blizzards, heat waves, sudden cold spells, and severe thunder and windstorms are having numerous impacts on our community and individual members. Vulnerabilities include:
   - The JMR Administration Office and other community buildings being damaged by particularly violent windstorms;
   - Certain health problems being aggravated when it becomes too hot or too cold (e.g. respiratory and heart problems), and people in the community being seriously disturbed and concerned by the severity and intensity of the thunderstorms they are seeing now, which residents do not remember experiencing in the past;
   - Unpredictable and severe weather events that are particularly discomforting to community members, and even harmful to Elders if they are unprepared for these events;
   - Increases in number of community members suffering from sunburns, skin irritations, heatstroke, and vision problems during heat waves in the summer, and;
   - Increase in number of community members getting frostbite when out on the land because extreme weather can occur with little or no warning

6. ***Negative impacts to the health of plants and animals:*** Climate change is having observable negative impacts on plants and animals common to the area, increasing JMR's vulnerability to climate change with respect to:
   - Areas where trees have died and collapsed have blocked trails to harvesting areas;
   - Northward spread of spruce bud worm and warmer drier summers will increase the risk of forest fires;
   - Decreased abundance and quality of berries;
   - Decreased abundance and quality of fish;
   - Many small mammals and woodland caribou do not have as much fat, and the quality of fur on small mammals is poor, and;
   - Habitats of certain animals that are harvested are disappearing in areas where permafrost is melting (e.g. permafrost heaves, drying up of wetland areas).

JMR's vulnerability as whole to climate change is also compounded by, and compounds pre-existing issues in our community that go back as far as first contact with Europeans in the 18th century. The major issues in our community that climate change is compounding are:

1. ***Limited Medical Facilities and Staff:*** Our community has a nursing station, but no doctors or nurses are stationed here to treat any serious injuries, or administer prescription medications for serious illnesses or infections. We must travel into Fort Simpson for all basic medical appointments and to Yellowknife, Hay River and Edmonton for more serious issues. The safety issues brought about with climate change, such as increased exposure to extreme weather, increased hazards associated with traveling, and the potential for increases in vector and water borne diseases emphasizes the importance of having medical facilities and supplies readily accessible in the community.

2. ***Water Sources, Pollution & Cancer Risks:*** Water for community use has usually been drawn from the Jean Marie River because it is clearer than the Mackenzie River, although water from the Mackenzie has also been used. Many community members believe that cancer rates are also linked to our water quality because like all things water is alive, and when its flow is slowed it is more susceptible to contamination from natural and anthropogenic sources. A warmer climate in the North will also likely introduce new diseases and increase the levels of contaminants entering into our water sources with the increased melting of permafrost and in the air from pollution from down south; increasing our risk to diseases and illnesses linked to the exposure to such contaminants (Furgal and Prowse, 2008; Séguin and Berry, 2008; Berner et al., 2005; Wrona et al., 2005). From the interviews conducted with community members an interesting, and potentially enlightening observation that many participants made was that cases of cancer in the community started to increase about 15-20 years ago, approximately the same time that most interviewees also started noticing significant changes to the climate.

3. ***Existing Health Issues such as Diabetes and Obesity:*** More and more we are relying on store bought foods that put us at higher risk to health problems such as obesity, diabetes, high blood pressure and tooth decay. Today the majority of people living in the community are already diabetic, and many are overweight and living with high blood pressure. These are common health issues in other communities in the Dehcho Region (Guyot et al., 2006; Paci et al., 2005). Managing these conditions and ensuring the cycle does not repeat itself in our younger generations is a priority. Unfortunately because our community does not have a staffed nursing station, and because of our small size, there are no local statistics related to these issues that are readily available to us. With harvesting becoming increasingly difficult and dangerous to do our members will be more susceptible to the health risks from eating store bought foods, unless alternative local food sources that are more readily available are found.

4. ***Altered Lifestyles/Cultural Activities:*** Perhaps the most prominent health issue still facing our community is the ongoing rapid social and cultural changes that have been occurring since first contact with European settlers and fur traders in the eighteenth century. We continue to struggle with the erosion of our cultural values and TK due to the shift from a nomadic to a sedentary lifestyle, and from a traditional economy to a mixed economy. Climate change is just one factor that is contributing to this erosion of our cultural values and TK.

Although our community is vulnerable in a number of ways to climate change, by identifying where we are vulnerable has enabled our community to be aware of the seriousness and range of impacts that a changing climate is causing, or may cause, to our community and surrounding area. Conducting this vulnerability assessment has also allowed our community to explore some initial adaptation strategies to respond to these impacts.

6. Adapting to Climate Change in Jean Marie River

For our community, adapting to climate change is viewed in a similar perspective as our approach to many of our community initiatives – to build and create a sustainable and healthy community. Sustainability is essential for our community to survive and thrive in the current cultural, social, economical, and political contexts our community is a part of. The impacts being caused by climate change now, and possible impacts in the future, pose some new challenges, along with compounding existing ones, to achieve our objective of a sustainable community; however, our people have a history of resiliency when it comes to adapting to climatic, environmental and socio-cultural changes.

As a first step to address the current and potential vulnerabilities of JMR to climate change, a community workshop was conducted where members of the community were presented the vulnerability assessment of JMR to climate change as influence diagrams (see Appendix 6). Community members discussed possible adaptation strategies that the community could explore to minimize and/or prevent health related risks linked with climate change, and strategies to take advantage of potential opportunities afforded by climate change.

Based on the vulnerability assessment several possible adaptation strategies were identified that could be implemented at the community and possibly regional level. Other adaptation strategies identified would require support from the territorial and federal governments and technical assistance from subject matter specialists, as JMR does not have the capacity or resources to independently develop and implement some of these strategies. These adaptation strategies have been grouped according to the key vulnerabilities identified in Section 5.

6.1. Food Security

The major climate change impacts regarding food security are primarily in relation to restricted access at certain times of the year to both country and store bought foods, and a decrease in the abundance of important country foods, such as berries and fish. To improve food security in the community many of our members suggested growing food locally. Shortly after JMR was first settled in the 1920s a community garden was created where vegetables such as cabbages, carrots, and even tomatoes were grown; and with a milder climate developing a community garden would alleviate some restrictions to access to country foods, and provide community members with local access to produce that is healthier and less expensive than store bought foods.

> "To seriously consider and plan agricultural actions (JMR needs to have a) big community garden, can grow our own food, have our own poultry business to produce meat, eggs, etc. to ensure that we are self sufficient in case we get disconnected from the South, where most of our food products are currently coming from." (*Margaret Ireland, September, 2010; parentheses added*).

If a community garden is successful and produces a surplus of food a root cellar could be built to store the surplus food, and community members could can and dry foods, to store over the winter months. Moreover, a warmer climate may allow for a longer growing season and more varieties of produce could be grown. Another food source that could be available to the community locally is chickens and geese that could be raised in the community.

A step further could be the possible coordination of more formalized food sharing networks with other small communities in the area, such as with Trout Lake and Nahanni Bhutte. Communities that have a

healthy supply and quality of certain country foods could share surplus with the other communities for their surplus in other country foods. In the long term a store and warehouse could be built in JMR as a central point for distributing food amongst the communities, which may eventually lead to a commercial enterprise if there is enough food grown and/or harvested locally to have a surplus for other communities and temporary work camps in the area to purchase. Such an enterprise also has the potential to create job sharing opportunities with the communities involved.

Another adaptation strategy to address food security is to change harvesting locations where species are less abundant and/or unhealthy, including areas where scientists have identified increased levels of contaminants, such as at Ekali Lake and McGill Lake. People are already reducing their consumption of fish from these lakes, based on the recommendations of scientists. There is also the potential to harvest new species that are being seen in the area, but most of the animals and birds seen so far are not considered food by community members, with the possible exception of whitetail deer.

6.2. Access to Safe Drinking Water

In regard to adaptation strategies to address the challenges of accessing safe drinking water, there are a number of factors that are contributing to the deterioration of the water quality in the area. Pollutants and contaminants are prime contributors to this; however, the warming of lakes and rivers can also affect the quality of the water and cause contaminants trapped in the ground to leach into the water table. Without more information it is difficult to elucidate the connections between a warming climate and its effects on the water quality in the Dehcho region.

At this stage our community needs a contaminants study conducted for the area, and we also need improved methods for monitoring the quality of drinking water and for treating it. People have already started adapting to the lack of quality drinking water in the community by buying bottled water for the grocery store. This is an expensive adaptation strategy, but a necessary one, as many people consider drinking water in the community and out on the land not to be safe.

6.3. Cultural Continuity & Community Sustainability

The climate change impacts affecting the health of our culture and community are intertwined and developing adaptation strategies that promote cultural continuity includes promoting a sustainable community and vice versa. The adaptation strategies initially explored regarding the climate change impacts that are affecting these aspects of our health are principally initiatives that can be planned, developed, and implemented by the community with little or no outside assistance. However, there are other potential adaptation strategies specific to addressing climate change impacts at the community and regional levels that would require collaborative approaches with other communities and researchers; as well as regional, territorial, and federal governments.

At the community level a number of adaptation strategies can be developed in the form of education and communication initiatives to inform community members about the health risks associated with climate change, and what actions people can take to prevent or minimize these risks. For example, education strategies about how to prevent heatstroke and sunburn (e.g. drink plenty of fluids, sunscreen, limit time in direct sunlight, etc.), or a community fire education strategy in case of a forest fire could be developed by the community and implemented in the form of community workshops or information sessions, as well as in the school. Community initiatives that address climate change related issues when out on the land could be developed as part of youth learning survival skills and learning about their spiritual connection with the land, such as at culture camps and ecology camps, and through the passing on of TK from older family members and Elders.

In regard to the impacts to our TK, our community needs to revisit the objective in the community plan (see Appendix 7) about maintaining our TK, in particular, how we can adapt our TK to the changes being caused to seasonal weather patterns, and the subsequent changes to the environment, so we are able to recognize the signs that indicate weather changes like our Elders did in the past. We have already been re-focusing our TK, putting emphasis on learning how to judge ice conditions on lakes and rivers as a reactive and necessary response to climate change. Community members also emphasized teaching youth outdoor survival skills, as well as teaching youth about important places that may disappear due to changes to the landscape with a changing climate and environment (e.g. permafrost heaves).

In terms of maintaining and promoting community sustainability in the face of a changing climate, the adaptation strategies mentioned for food security apply to community sustainability. Additionally, having an inventory of non-traditional medicines and medical supplies on hand at the nursing station that do not require a nurse or a doctor to administer them, would allow our community to be better prepared to deal with increases in accidents, injuries, and other health issues; whether they are related to climate change or not. With hotter and drier summers steps are already being taken to build a fire break around the community to protect it from forest fires. Our community is also concerned if any of the houses and other buildings in our community are located in permafrost zones. The community is also interested in knowing if there are zones of permafrost within the vicinity of JMR so that we can be aware of these areas if the community decides to build more houses or facilities, such as a root cellar. To identify where areas of permafrost are located in the vicinity of JMR, a permafrost specialist would be needed to map out these areas.

Other community members suggested adaptation strategies related to improving the standards for constructing and maintaining buildings and roads that take into account climate change related impacts on infrastructure. Upgrading roads and creating more drainage systems to reduce the chance of roads being washed out in a flood is one adaptation strategy mentioned that could be shared between communities and may lead to potential job sharing between these communities. However, most of the climate change adaptation strategies aimed at maintaining and enhancing community sustainability would need government support, which would require negotiating policy changes regarding how funding for taking action on climate change impacts and related environmental issues is allocated by the Federal and Territorial governments that also includes resources for communities to conduct projects to address these issues at local and regional levels.

6.4. Travel Safety

Our community has been experiencing the negative impacts of climate change on traveling, either out on the land or by vehicle, for a number of years now, and we have already started adapting strategies to minimize hazards while traveling. Now, when out on the land we always travel in pairs for safety and we bring extra supplies and first aid kits in the event we are caught suddenly by inclement weather. Our harvesters are becoming quite adept at assessing ice conditions and identifying potential hazards, and they are passing this knowledge on to younger generations. However, our community needs to review its policy on emergency funding with the potential likelihood of increases in travel accidents.

Inherent in the passing of TK to younger generations is the teaching of outdoor survival skills, but general first aid training could also help prevent and minimize accidents and injuries that happen in the community or out on the land. Another potential adaptation strategy to improve travel safety is for hunters and trappers to GPS trails and mark where travel hazards are, and keep an updated map and database in the community to inform other members of these hazards before they go out on these trails. If

trails become blocked, disappear, or become too dangerous to travel it is recommended that new trails could be cleared where there is less potential to have hazards.

Travel by boat is also riskier due to low water levels, and community members need to be careful not to damage or capsize their boats. One relatively inexpensive strategy suggested to avoid low water levels in the rivers and lakes is to have a depth finder in the boat. In regard to bigger vessels traveling along the Mackenzie River, navigation routes are becoming more restricted each year, and it was suggested that regularly updated navigation maps are needed because of the fast pace that these routes are changing.

6.5. Exposure to Extreme Weather & UV-B Rays

Many of the initial adaptation strategies related to exposure to extreme weather and UV-B rays have been mentioned above, such as community education strategies and taking extra precautions and supplies when traveling. One other recommendation concerning extreme weather events is to have an early weather warning system of some sort in the community. Having small scale satellite weather stations in the community, and out at the 5 Lakes areas, would give our community more time to prepare for extreme weather, or to let our harvesters know the weather conditions before going out to harvest, or while out harvesting. Weather stations would also allow our community to collect weather related data over time for use in future research. A less expensive alternative to weather stations for an early weather warning system, but a less reliable one, is through local media such as the radio (Fort Simpson) or the internet.

6.6. Negative Impacts to Plants and Animals

Although many changes and impacts to plants and animals associated with climate change have been observed, the direct links are at times hard to elucidate, and when they are apparent developing an adaptation strategy that can be implemented at the community level is a difficult and complex undertaking requiring collaborative research efforts between our community and other communities, and with researchers from various fields. In the absence of collaborative efforts our community will continue to monitor and report on the changes in the weather and environment we are observing and experiencing, and adapt as best we can.

As a result of this project our community has identified four such studies that if conducted would help our community greatly in knowing why some environmental changes are happening, and how climate change is connected to these environmental changes, or not. These four studies include:

- Mapping of permafrost areas within the proximity of the community;
- A study on migratory birds that were once common to the area, and any changes in their habitats in the JMR area where they used to return to in the spring;
- More research is needed to identify the connections between a changing climate, melting permafrost, increased exposure to contaminates, deterioration of water quality, and any associated impacts to the ecosystem, and;
- A study to monitor and assess the spread of spruce budworm.

However, for these collaborative efforts to be organized and for these studies to be conducted this would require policy changes regarding how funding for taking action to address climate change impacts and related environmental issues is allocated by the Federal and Territorial governments; including resources for communities to conduct projects to address these issues at the local and regional levels.

7. Conclusions and Next Steps

From the results of this project, the JMRFN is more aware of the far ranging impacts of a changing climate on different aspects of health. In comparison to other Aboriginal communities above the tree line in northern Canada, JMR has not been as severely impacted by climate change (see Berkes and Jolly, 2001; Ford et al., 2010; Huntington et al, 2005; IISD, 2000; Martin et al., 2007; Nuttall et al., 2005; and Pearce et al. 2009). However, from the changes our people are observing and experiencing many of these changes can be directly or indirectly linked with climate change. By conducting this project our community has taken the first step towards a proactive approach to identifying current and potential impacts associated with climate change, as well as thinking about how to respond to these impacts before they become too severe.

Furthermore, by exploring initial ideas for adaptation strategies our community can prioritize where the community is most vulnerable, how severe impacts are (or will be), and the ability for the community to adapt to reduce our vulnerability to climate change. (see Table 7).

Table 7: Climate Change Vulnerabilities, Impacts, and Adaptation Strategies

Vulnerability (low, medium, high)	Climate Change Related Impacts (weak, medium, strong)	Adaptation Strategy (easy, moderate, difficult)
Food Security	• More difficult and difficult and dangerous to access harvesting areas in the fall • Less country foods available in the community; increased dependence on store bought foods • Potential for increased consumption of contaminants from country foods • Restricted access to grocery stores and medical facilities	• Store medicines and medical supplies at the nursing station • Community initiatives to raise livestock, develop community & home gardens, build a root cellar, and store more canned and dried food. • Establish formalized intercommunity food sharing networks • Job sharing with other communities • Limiting the amount of country foods consumed from areas with high levels of contaminants • Change fish harvesting areas where fish are healthier (e.g. Horn Plateau)
Access to Safe Drinking Water	• Potential for increase in cases of gastro-intestinal and other water born diseases with a deterioration in water quality • Potential for increased consumption of contaminants through country foods and local water sources	• Increase consumption of bottled water • Improved standards for monitoring the quality of drinking water • More research needed to investigate the impacts and linkages of permafrost, contaminants, and the quality of

		water and fish species with a warming climate
Cultural Continuity & Community Sustainability	• Direct and indirect health and community problems associated with forest fires • Potential for increases in allergies and asthma • Less opportunities to practice and pass on TK • Erosion of TK used to predict weather • Erosion of TK linked to the landscapes that have changed • More money and resources to repair wind damaged buildings • More money and resources needed to repair flood damage and to maintain roads	• Revisit community plan in relation to maintaining TK • Re-focusing of TK to better assess ice conditions • Review JMRFN policy for emergency funding • Community fire education strategy and the construction of a fire break around the community • Increase use of traditional medicines • Store medicines and medical supplies at the nursing station • Find other cultural activities to do • Pass on TK to younger generations about areas that may disappear or change dramatically • Upgrade roads & more drainage systems for roads • Job sharing with other communities • Improve building codes so that structures can withstand high winds • Negotiate policy changes • regarding how funding is allocated by the Federal and Territorial Governments • Mapping of permafrost areas within the proximity of the community

Travel Safety	• Increased chance of becoming lost and disoriented in once familiar landscapes • Higher risk of injuries and accidents when travelling on the land • Potential for increase in boating related accidents and injuries	• Clear trails in the fall and wear waterproof footwear • Travel in pairs and bring first aid/ emergency kits and extra supplies when out on the land • First aid training • Use overland routes more often, clear new trails for ATVs • Re-focusing of TK to better • assess ice conditions • Have depth finder on boats • Need for updated maps for the Mackenzie River to account for changes in navigation routes • Pass on TK to younger generations about areas that may disappear or change dramatically • Hunters & Trappers GPS Trails to Identify Dangerous Travel Locations
Exposure to Extreme Weather and UV-B Rays	• Increase in injuries related to cold exposure • Increase in emotional stress and personal injuries due to increase in • number and severity of windstorms in the summer • Increase in personal healthcare to avoid, or to minimize health risks associated with heat/sun exposure and frostbite	• Increase in the use of sunscreen, medical supplies for sunburns and heatstroke, and sunglasses • Education strategy to minimize the health risks of sun and heat exposure, and other extreme weather conditions • Weather warnings through local media (e.g. Fort Simpson) • Satellite weather stations in the community and the 5 Lakes Areas
Negative Impacts to Plants and Animals	• More trees are dead or dying as a result from permafrost melting, especially tamarack, poplar, and spruce • Decreased quality and abundance of some country foods (e.g. fish , berries, and water fowl) • Northward spread of spruce bud worm infestations	• A study on migratory birds that were once common to the area, and any changes in their habitats where they use to return to in the spring • More research is needed to identify the connections between a changing climate, melting permafrost, increased exposure to contaminates and any associated impacts to the ecosystem • A study to monitor and assess the spread of spruce budworm

The JMRFN now has a baseline study to use as a platform to address and respond to climate change impacts that provides direction and concrete recommendations for our community. For example the table above provides some possible next steps to address and take action to prevent and/or minimize the negative impacts of climate change. However, when JMR begins to develop and implement climate change adaptation strategies; we do not want to develop and implement these strategies as separate projects or initiatives, nor do we want short term solutions to a long term issue.

The JMRFN needs to go beyond just developing and implementing adaptation strategies; our community needs to move towards adaptive management. According to the Millennium Ecosystem Assessment, adaptive management is:

> "A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In active adaptive management, management is treated as a deliberate experiment for purposes of learning." (Millennium Ecosystem Assessment, 2005: 599; quoted from Patino, 2010:1).

Adaptive management allows for adaptation strategies to be integrated into applicable aspects of our community planning, land use planning, health initiatives, culture camps, education, etc. In addition, by managing our adaptive capacity we can monitor and address the efficacy of the strategies we implement and modify them if necessary. Adaptive management elevates the organization of adaptation strategies in an integrated fashion that would allow our community to 'mainstream' climate change issues and adaptation strategies with other aspects of our community plan that promote cultural continuity and community sustainability. In this context mainstreaming refers to, "The integration of climate change considerations into a range of policies, programs, and decision-making processes." (Patino, 2010:1).

However, for all that can be done at the community level, and even at the regional level, major changes still need to happen in how industrialized nations treat the earth. We need to respect and sustain the earth so that it can sustain us.

> "(Climate change)… had happened in the past and people had adapted, but this time around there are more people on earth, more people to feed, more condensed buildings in the cities, more destruction to the environment, and I am afraid there will more lives lost as the severity of the weather increases and becomes more and more unpredictable. We are not taking care of Mother Earth, and we should be to ensure the existence of the generations to come." (*Margaret Ireland, September 2010; parenthesis added*)

8. Annotated Bibliography and Literature Review of Climate Change

1. Climate Change in General

IPCC (2007): *Climate Change 2007: Synthesis Report*. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A.(eds.)]. IPCC, Geneva, Switzerland, 104 p.

This synthesis report summarizes the extensive research results of the three working groups that contributed to this fourth Assessment report of the Intergovernmental Panel on Climate Change. The three working groups: Working Group 1 – The Physical Science Bases; Working Group 2 – Impacts, Adaptation, and Vulnerability; and Working Group 3 – Mitigation of Climate Change, have all produced extensive documents separate from this synthesis report. For example, the report from Working Group 1 goes into great detail about the science of climate change and its past, current and future impacts on the environment and weather patterns; and climate change projections for the next 20, 50, and 100 years.

The Working Group 2 report explores how climate change is impacting, and may impact peoples in their local environments in various geographical locations of the world, including the Circumpolar North (see Anisimov et al. 2007). This report also elaborates on the importance of ascertaining the vulnerabilities of peoples/communities to climate change and how these peoples/communities can adapt to impacts caused directly or indirectly by climate change. Included in this report is a chapter dealing with the health impacts of climate change on people in various localities around the world.

Recommendations and options for mitigating the impacts of climate change are discussed in the report produced by Working Group 3, with an emphasis on the mitigation of climate change impacts on resource development, infrastructure, and on residential and commercial buildings.

2. Climate Change in the North

ACIA (2005): *Arctic Climate Impact Assessment: Scientific report*. Cambridge University Press: Cambridge, United Kingdom, 1042p.

This comprehensive scientific report is an excellent resource that explores the many facets and interconnections of climate change with the ecosystems, as well as cultural systems, of Arctic and sub-Arctic regions from all eight circumpolar nations. Each chapter in this assessment report looks at different aspects of climate change applicable to most northern regions (forestry, agriculture, land management, terrestrial and marine ecosystems, the cryosphere, conservation, vegetation, wildlife, etc.), including two chapters (Chapters 3 and 12) dedicated to the identification and assessment of climate change impacts on, and adaptation strategies available to indigenous peoples living in the North. Further, Chapter 15 of the ACIA addresses in detail the health impacts that are, or may be, associated with climate change in Northern communities. Each of these chapters is referenced below with its own annotation.

Anisimov, O.A.; Vaughan, D.G.; Callaghan, T.V.; Furgal, C.; Marchant, H.; Prowse, T.D.; Vilhjálmsson, H.; and Walsh, J.E. (2007): Polar regions (Arctic and Antarctic), *in* Climate Change 2007: *Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*; Cambridge University Press, Cambridge p. 653-685.

This is a summary of the wide range of scientific (both natural and social) research that has been conducted by scientists pertaining to the vulnerability of Arctic and Antarctic ecosystems and communities to the impacts of climate change, and their capacity to adapt to these impacts. Traditional knowledge is also mentioned as a facet of indigenous cultures that will be impacted by climate change, as well as a means of developing adaptation strategies for indigenous communities to respond to climate change. A brief overview of the direct and indirect health related impacts associated with climate change in circumpolar regions is included in this summary. Further, projected changes to the climates in circumpolar regions and the associated major changes projected for marine and terrestrial environments in these regions are summarized in this chapter.

Berner, J.; Furgal, C.; Bjerregaard, P.; Bradley, M.; Curtis, T.; DeFabo, E.; Hassi, J.; Keatinge, W.; Kvernmo, S.; Nayha, S.; Rintamaki, H.; and Warren, J. (2005): Human Health; *in Arctic Climate Impact Assessment*, Cambridge University Press, Cambridge, United Kingdom, p. 863-906.

This chapter of the ACIA provides a brief overview of the health of Arctic peoples, and explains that socio-economic and environmental conditions are linked with the physical, mental, emotional, and cultural health of these peoples. More importantly, this chapter summarizes the most common and prominent health impacts associated with climate change in the North, from direct impacts (e.g. exposure to extreme weather events, increased exposure to UV-B radiation, and health stresses associated with cold and hot temperatures) to indirect impacts (e.g. changes in the availability, abundance, and quality of country foods; increases in vector and water borne diseases; changes to water quality; and increased accidents on the land due to thinner ice on rivers and lakes in the winter). This source also has recommendations on how communities can identify and monitor indicators of a changing climate and their connections with health related impacts in order to develop effective adaptation strategies to respond to these impacts.

Huntington, H.; Fox, S.; Berkes, F.; Krupnik, I.; Whiting, A.; Zacharoff, M.; McGlashan, G.; Brubaker, M.; Gofman, V.; Dickson, C.; Paci, C.; Tsetta, S.; Gargan, S.; Fabian, R.; Paulette, J.; Cazon, M.; Giroux, D.; King, P.; Boucher, M.; Able, L.; Norin, J.; Laboucan, A.; Cheezie, P.; Poitras, J.; Abrahan, F.; T'selie, B.; Pierrot, J.; Cotchilly, P.; Lafferty, G.; Rabesca, J.; Camille, E.; Edwards, J.; Carmichael, J; Elias, W.; de Palham, L.; and Norwegian L.; Qujaukitsoq, U.; Moller, N.; Mustonen, T.; Nieminen, M.; Eklund, H.; Helander, E.; Zavalko, S.; Terva, J.; Cherenkov, A.; Henshaw, A.; Fenge, T.; Nickels, S.; and Wilson, S. (2005): The changing Arctic: Indigenous perspectives; *in Arctic Climate Impact Assessment*, Cambridge University Press, Cambridge, United Kingdom, p. 61-98.

This chapter of the ACIA summarizes the importance of indigenous knowledge when researching climate change, as well as the vulnerabilities and resilience of indigenous knowledge to climate change impacts. Throughout this chapter several case studies are presented, highlighting the perceptions, observations, and experiences certain Arctic indigenous peoples have reported with respect to climate change. One of these case studies (Paci et al. 2005) focuses on the work the Dene Nation's Denendeh Environmental Working Group has done to record Dene observations of climate change. Some examples of climate change observations documented by the DEWG are changes in the distribution and abundance of certain plant and animal species, 'wet' trees in the winter, thinner ice on lakes and rivers, and warmer winters; however, permission from the Dene Nation is needed to access the actual documents that this case study is based on.

Nuttall, M.; Berkes, F.; Forbes, B.; Kofinas, G.; Vlassova, T.; and Wenzel, G. (2005): Hunting, herding, fishing and gathering: Indigenous peoples and renewable resource use in the Arctic; *in Arctic Climate Impact Assessment*, Cambridge University Press, Cambridge, United Kingdom, p. 649-690.

This chapter of the ACIA speaks to the importance of renewable resources to the traditional lifestyles and livelihoods of Arctic indigenous peoples, and what role climate change plays in mediating the relationships indigenous peoples have with the renewable resources they depend on for food and cultural continuity. Indigenous observations of climate change are mentioned; however, the focus of this chapter is on the impacts that climate change is having, or may have on the traditional resource use activities of Arctic indigenous peoples; and the capacity of these peoples to adapt to the environmental and cultural changes associated with climate change. The case studies presented by the authors in this chapter refer to the traditional lifestyles and livelihoods of indigenous peoples who live in the High Arctic, with little mention of climate change impacts on indigenous peoples living in sub-Arctic regions. However, the indirect and direct impacts of climate change, and the adaptation strategies described in this chapter provide invaluable insight for identifying impacts (e.g. changes in certain plant and animal migrations, increased accidents on the land) in sub-Arctic regions, as well as for developing adaptation strategies.

Smit, B.; Hovelsrud, G.;and Wandel, J: (2008). *CAVIAR: Community Adaptation and Vulnerability in Arctic Regions*; University of Guelph, Department of Geography, Occasional Paper No. 28.

This document provides a framework for conducting research related to community adaptation and vulnerability in the Arctic for research projects conducted under the International Polar Year Project: *Community Adaptation and Vulnerability in Arctic Regions* (CAVIAR). Integral to this framework is an approach based on identifying and assessing current and future exposure sensitivities to various environmental, climatic, social, economical, and cultural changes taking place in the Arctic; as well as current and future adaptive strategies available to Arctic communities to adapt and/or mitigate exposure sensitivities. This document also provides a methodological approach for researchers working with northern communities that incorporates expertise from the natural and social sciences, and from traditional ways of knowing. Aspects of the CAVIAR framework and methodological approach have been incorporated in the development of the Health Canada sponsored Jean Marie River climate change project.

Wrona, Frederick J.; Prowse, Terry D.; and James D. Reist (2005): Freshwater Ecosystems and Fisheries; *in Arctic Climate Impact Assessment*, Cambridge University Press, Cambridge, United Kingdom, p. 353-452.

This chapter of the *Arctic Climate Impact Assessment* is very informative regarding baseline information about how climate change impacts various aspects of freshwater ecosystems, and the organisms that inhabit these ecosystems. This source also provides good information pertaining to the impacts of warmer temperatures in lakes and rivers on fisheries.

3. Climate Change in Northern Canada

Berkes, Fikret; and Jolly, Dyanna (2001): Adapting to Climate Change: Socio-Ecological Resilience in a Canadian Western Arctic Community; *Conservation Ecology* 5(2): 18-32.

The research presented in this article is one of the first and best known case studies of climate change research conducted with the community as the subject of, as well as a partner in, the research. The

authors collected accounts of climate change observations and impacts from the Inuvialuit of Sachs Harbor, NWT. Warmer winters, reduction of multi-year sea-ice, changes in animal migration and reproductive behavior, the appearance of new species, and changes in the timing of ice freeze-up and break-up on lakes and rivers were common observations by community members. Impacts caused by climate change identified by the Inuvialuit included unsafe travel routes, reduced access to harvesting areas, changes in the distribution and abundance of wildlife, and an increase in extreme weather events. Berkes and Jolly also describe coping, or short-term, strategies and adaptation, or long-term, strategies that the Inuvialuit have developed to respond to the environmental and cultural changes caused by climate change. Adaptation strategies include food sharing and trading networks with other communities, while coping strategies include changing the times and areas of where animals are harvested, and the species harvested in some cases.

Center for Indigenous Environmental Resources (2006): *Climate Change Planning Tools for First Nations*; Center of Indigenous Environmental Resources, Manitoba.

This is an excellent resource comprising of six guidebooks that outline, step-by-step, how Aboriginal communities can conduct climate change projects to identify and assess climate change impacts, and to develop community adaptation strategies to respond to these impacts. Various methods and activities for starting a climate change project, researching climate change observations and impacts, presenting research results to communities, and developing adaptation strategies are presented that community members (and their research partners) can use to develop and conduct their own climate change projects. Further, research activities that engage youth and Elders are also mentioned, which are important aspects of conducting community research on an issues such as climate change and health. These guidebooks were an essential resource for developing the methodology of this project.

Environment Canada (1997): *The Canada Country Study: Climate Impacts and Adaptation, Canadian Arctic Summary*; Environment Canada, Canada.

This report is about the potential impacts that climate change may have on the people and animals living in the Canadian Arctic, and how people and animals will adapt to climate change. The focus of this report is on what the potential effects a warmer climate will have on the inhabitants of the Canadian Arctic. It is worth mentioning that this source emphasizes potential advantages that a warmer climate might present to industrial and commercial activities. According to this report, as Arctic and sub-Arctic regions become warmer; it could be easier to advance industrial, commercial, and even agricultural interests. However, the traditional cultural activities of northern Aboriginal peoples will for the most part be negatively impacted, especially if there is a decline in the availability and accessibility to traditional country foods. Interestingly, this report indicates that the most sensitive areas to climate change in Canada will be the Mackenzie River Basin and the northern prairies.

Fast, Helen; and Berkes, Fikret (1999): Climate Change, Northern Subsistence, and Land-based Economies, *in Securing Northern Frontiers: Developing research partnerships;* Circumpolar Institute Press, Edmonton: p. 9-24.

This is one of a few available articles that focus on climate change in non-coastal communities living below the tree line, but north of 60°C. In particular, health related impacts of climate change on both the subsistence and wage based economies of northern Aboriginal communities are analyzed. The most significant impact noted is changes to diet, as these communities' subsistence economies account for one quarter to one half of the total economy. With climate change, it is projected that the health of traditional species such as caribou and moose will be impacted directly (e.g. heat, increased snowfall, early freezing

in autumn), or indirectly through environmental changes connected to climate change (e.g. increases in diseases and parasites, competition with new species, changes in water quality). Further, although the tree line is expected to expand 100-250 km, the extent of boreal forest is projected to decrease due to increases in forest fires and insect infestations. In general, small plant and animal species will flourish with a warmer climate (e.g. flowering plants, grasses, insects, beavers), while larger animals and plants will have a much harder time adapting to a warmer climate (e.g. moose, caribou, trees, shrubs).

The health risks related to eating less country foods are also discussed, such as increases in diabetes, obesity, and cardiovascular disorders; as well as the erosion of cultural values when traditional cultural practices linked with the subsistence economy cannot be practiced because of ecosystem changes caused by climate change. Other health risks associated with climate change mentioned include an increase in UV-B radiation, melting of permafrost, and increases in diseases such as tuberculosis.

Ford, James D.; and Furgal, Chris (2009): Foreword to the special issue: climate change impacts, adaptation and vulnerability in the Arctic; *Polar Research* 28: 1-9.

The concepts of adaptation and vulnerability in relation to climate change are discussed in this article, with an emphasis on the fact that the vulnerability and adaptive capacities of Arctic communities are also heavily influenced by other factors such as livelihoods, access to resources, community assets, globalization, institutional networks, education, gender, ethnicity and socio-economic status. These other factors should be accounted for when assessing the vulnerability and adaptive capacity of the Jean Marie River First Nation to climate change.

Ford, James D.; Pearce, Tristan; Duerden, Frank; Furgal, Chris; and Smit, Barry (2010): Climate change policy responses for Canada's Inuit population: The importance and opportunities for adaptation; *Global Environmental Change* 20: 177-191.

Issues of vulnerability and adaptation in relation to climate change and other environmental and cultural changes in Inuit communities are discussed in this article; however, the central theme of this source is that adaptation strategies can be better developed by northern Aboriginal communities if there is policy intervention at local, regional, and national levels to reduce barriers to adaptation. This information provides a framework for communities that have developed local adaptation strategies and are looking for support (e.g. training, financial, facilities, services, infrastructure, management, research, etc.) from different levels of government to implement short-term and long-term adaptation strategies.

Furgal, C.; and Prowse, T.D. (2008): Northern Canada, *in From Impacts to Adaptation: Canada in a Changing Climate 2007;* Government of Canada, Ottawa, ON, p. 57-118.

Focusing exclusively on climate change in Northern Canada, this source explores the implications that climate change will have on the physical environment, economic sectors, natural resources, and people in Northern Canada. Socioeconomic and health demographic trends for the Canadian territories are also provided in a separate section (e.g. life expectancy, infant mortality, physical activity, lung cancer, heart attacks, accidents/injuries, suicide, etc). There is a specific section that elaborates on the direct and indirect health impacts that climate change is causing, or may cause to individuals and communities, as well as on the development of adaptation strategies to minimize the negative impacts of climate change in northern community contexts.

Guyot, Melissa; Dickson, Cindy; Paci, Chris; Furgal, Chris; and Chan, Hing Man (2006): Local Observations of Climate Change and Impacts on Traditional Food Security in Two Northern Aboriginal Communities; *International Journal of Circumpolar Health* 65(5): 403-415.

This is an excellent resource about how climate change impacts the traditional harvesting activities of Aboriginal people in the Yukon and the Northwest Territories, and provides some initial data about climate change impacts in the Deh Cho Region of the NWT. These observations provide important information about climate change impacts connected with health in the Deh Cho Region, one of only a few sources of this type of information available outside of the Dene Nation. Four major themes were identified – water, weather, changes in harvested species, and ice – based on the observations of informants from the Deh Gah Got'ie First Nation (Fort Providence, NWT), and from the White River First Nation (Beaver Creek, Yukon). These case studies demonstrate the importance of country foods (moose, geese, caribou, fish, berries, etc.) to Aboriginal communities both culturally and nutritionally, and how access to and availability of, country foods is being impacted by climate change. These impacts are not all negative; however, they do mean that harvesters from these two first nations are gradually adjusting what species they harvest, where they harvest these species, and how even how they harvest. Community members are also noticing changes in weather, permafrost zones, waterways, and ice that has delayed or impeded access to traditional harvesting areas during certain times of the year.

Practical indicators for assessing the health impacts to these communities due to changes in food security (such as changes to protein, zinc, and fiber intake based on increase or decrease of harvestable species) as a result of climate change are also presented in this article, and can be applied to other climate change projects linked to health in Aboriginal communities, such as Jean Marie River. The impacts caused by climate change that affect a community's food security impact more than just physical health. Cultural and community health are also affected, as traditional harvesting methods and knowledge change due to the unreliability of previous indicators of climatic and environmental changes, and the availability of country foods also changes in abundance and type.

International Institute for Sustainable Development (2000): *Sila Alangotok: Inuit Observations on Climate Change*. International Institute for Sustainable Development, Winnipeg, Full-Length Version (42 minutes), Video recording.

This is a video about the impacts of climate change in the Inuvialuit community of Sach's Harbour, on Banks Island, N.W.T. The information in this video is based on what the Inuvialuit have observed in relation to climate change on Banks Island. The most important climatic changes that the Inuvialuit have observed are warmer temperatures, melting permafrost, lack of sea ice, various changes in animals, and an increasing unpredictability of seasonal weather year after year. There are three preliminary documents that preclude this video, and explain in detail the objectives of the IISD scientists' research project. These documents are the *Inuit Observations on Climate Change: Sachs Harbour, Northwest Territories; Trip Reports: 1, 2, and 3.*

Jean Marie River First Nation (2005): *Tthets'éhk'e Délî Traditional Knowledge Study Regarding the Proposed Mackenzie Gas Project.* Jean Marie First Nation: Northwest Territories.

This study is an in-house document that contains valuable information about Jean Marie River and our experiences with oil and gas development in the Dehcho Region. This study also documents TK of our traditional territory as told in stories from community members who were interviewed for this study. The information gathered also includes stories about changes to the environment and weather, and this study was a major impetus in moving forward to address climate change.

Kochtubajda, B.; Flannigan, M.D.; Gyakum, J.R.; Stewart, R.E.; Logan, K.A.; and Nguyen, T.V. (2006): Lightning and Fires in the Northwest Territories and Responses to Future Climate Change; *Arctic* 59(2): 211-221.

The results of the research presented in this article measured the lightning storm severity in the Northwest Territories in connection with the frequency and severity of forest fires from 1994-1999. July was recorded as the month with the most storm activity and occurrences of forest fires. With a projected warming trend in the NWT to last well into the 21st century, the authors conclude that boreal forest regions will experience increases in the frequency and severity of lighting storms and forest fires, which will have serious consequences for some northern communities. This is based on projections that boreal forest regions will become warmer and drier for longer periods of time in a year. Although Jean Marie River is in a zone that is predicted to have only a slight increase in forest fires in comparison to other regions of the NWT, there are other health impacts that forest fires burning in other areas can cause, such as increased air pollution (and associated health consequences) due to the smoke produced from these fires.

Lemmen, D.S., Warren, F.J., Lacroix, J., and Bush, E., editors (2008): *From Impacts to Adaptation: Canada in a Changing Climate 2007*; Government of Canada, Ottawa, ON, p. 448.

This publication by Natural Resources Canada is an excellent source of information regarding the observed and potential impacts of climate change on the major regions in Canada, including Northern Canada. Although only one chapter is devoted to the discussion of climate change in Northern Canada (Chapter 3), the other chapters are very informative when looking at climate change beyond the regional level, to see how changes at local and regional levels in one region are interconnected with other regions and ecosystems.

Martin, Daniel; Bélanger, Diane; Gosselin, Pierre; Brazeau, Josée; Furgal, Chris; and Déry, Serge (2007): Drinking Water and Potential Threats to Human Health in Nunavik: Adaptation Strategies under Climate Change Conditions; *Arctic* 60(2): 195-202.

The authors of this research investigated how the quality of untreated and treated water supplies is affected by a warming climate, and how this impacts communities in Nunavik that rely on these water supplies for drinking water. Increasingly, the quality of water throughout northern Canada is deteriorating, especially in continuous and discontinuous permafrost zones where the permafrost is melting. The focus of this article is on the correlation between gastro enteric diseases and the deteriorating quality of certain drinking water sources, and locally observed impacts to aquatic environments associated with climate change. In terms of adaptation strategies, proposed strategies for monitoring water quality, raising community awareness regarding water quality and health, water testing, and the collection of health information when gastro enteric diseases are most frequent are provided that can be modified for implementation in other Aboriginal communities in northern Canada.

Natural Resources Canada (2009): The Atlas of Canada: Climate Change; Available at: http://atlas.nrcan.gc.ca/auth/english/maps/climatechange. Accessed: August 26, 2010.

This website provides maps showing how climate change will impact seasonal temperatures, precipitation, forest fires, etc. for the next 50-100 years globally and for Canada; based on projections compiled by the Canadian Centre for Climate Modeling and Analysis's global climate model (GCM).

Newton, John; Paci, C.D. James; Ogden Aynslie (2005): Climate Change and Natural Hazards in Northern Canada: Integrating Indigenous Perspectives with Government Policy; *Mitigation and Adaptation Strategies for Global Change* 10: 541-571.

In this source the authors argue the need for government policy concerning climate change and natural hazards in northern Canada to be focused on the development of adaptation strategies that help communities to live with climate change, rather than the creation of government programs and initiatives focused on mitigation measures to reduce a community's contribution of greenhouse gases. The authors also mention the importance of including indigenous perspectives in the formulation of adaptation strategies at local, territorial, and national government levels. A brief history of the Dene Nation's involvement in researching Dene perspectives of climate change, and how TEK plays a major role in this research, is also included.

Northwest Territories Environment and Natural Resources (2008): *NWT Climate Impacts and Adaptation Report 2008;* Government of Northwest Territories, NWT.

This concise document is an excellent source of information concerning the impacts of climate change in the Northwest Territories, adaptation strategies that the territorial government is considering developing to respond to impacts, and future planning of adaptation strategies in response to future impacts caused by the continued trend of a warming climate. The impacts being caused by climate change are categorized in this report under the following themes: permafrost, ice conditions, precipitation and water, forests, wildlife, culture and heritage, and human health. These categories provide pertinent themes for analyzing the accounts provided by interviewees from Jean Marie River. Moreover, recommendations on how to adapt to some of the impacts being caused by climate change are given, including adaption strategies recommended by the NWT's Department of Health and Social Services (HSS) to promote good physical health. For example, if caribou populations in traditional harvesting areas are decreasing, then concentrating more on fish can offset the lack of essential nutrients that are usually obtained from caribou.

Parlee, Brenda; O'Neil, John; and Lutsel K'e Dene First Nation (2007): "The Dene Way of Life": Perspectives of Health from Canada's North; *Journal of Canadian Studies* 41(3): 112-133.

This source is not about climate change, but rather a look at trying to define what health means to the Dene of Lutsel K'e First Nation. While some people interviewed associated health with injuries and disease, many others thought of health as leading a healthy life by following "The Dene Way of Life". The results of this research identified three themes that indicators of health provided by community members can be grouped under. These themes are self-government, healing, and cultural preservation; and the indicators are related to many aspects of daily life in Lutsel K'e, linking health to tangible elements and processes present at individual, household, and community levels. Included in the accounts provided by community members are narratives that make up a discourse about the significance of Dene values, knowledge, and institutions. The work also exemplifies how small and remote northern Aboriginal communities are resilient to the social, economic, and cultural pressures in relation to the development of natural resources.

The importance of this document to the Jean Marie River climate change research project is that this work provides indicators of what it means to be healthy from a Dene perspective, which is important when determining how climate change is, or may affect the individual, community, cultural, and environmental health of a Dene First Nation, such as Jean Marie River.

Patino, Lorena (2010) ***Understanding Climate Change Adaptation and Adaptive Capacity – Synthesis Report.*** **Government of Canada: Canada.**

This brief report provides some valuable insights on going beyond adaptation strategies and for communities to move forward with adaptive management and 'mainstreaming' the issue of climate change into other aspects of community planning that are, or will be, impacted by climate change. In addition, examples of collaborative approaches to adaptive management are provided.

Pearce, Tristan D.; Ford, James D.; Laidler, Gita J.; Smit, Barry; Duerden, Frank; Allarut, Mishak; Andrachuck, Mark; Baryluk, Steven; Dialla, Andrew; Elee, Pootoogoo; Goose, Annie; Ikummaq, Theo; Joamie, Eric; Kataoyak, Fred; Loring, Eric; Meakin, Stephanie; Nickels, Scott; Shappa, Kip; Shirley, Jamal; and Wandel Johanna (2009): Community collaboration and climate change research in the Canadian Arctic; ***Polar Research*** **28: 10-27.**

This is an excellent document for outlining important considerations for researchers to address when conducting climate change research (or any other type of environmental research) in collaboration with Aboriginal communities in northern Canada. Case studies from five Inuit communities are used to demonstrate how researchers can engage northern Aboriginal communities on climate change projects in an effective manner, which keeps the communities involved and benefits the community through such ways as raising awareness of the issue(s) and the dissemination of research results to the community. The methods of community engagement outlined in this article are seen as essential for researchers to conduct effective and successful climate change research in partnership with northern Aboriginal communities, and these methods have provided guidance in developing the Jean Marie River climate change project.

Scott, Daniel; and Lemieux, Christopher (2007): Climate change and protected areas policy, planning and management in Canada's boreal forest; ***The Forestry Chronicle*** **83(3): 347-357.**

In this article an overview of future climate change impacts on Canada's boreal forest is given. The authors describe how climate change will impact the distribution, availability and abundance of plant and animal species indigenous to boreal ecosystems, as well as species that may become new arrivals to these ecosystems due to a warming climate; providing insight into how the health of boreal forest ecosystems will be impacted by climate change. The authors suggest that a warmer climate in boreal forest ecosystems will lead to a loss of biodiversity, as pioneer and invasive species will come to dominate the currently diverse ecosystems. This will also happen in the lakes and rivers, where warm water species will encroach on the habitats of cold water species with warmer water temperatures, driving cold water species northwards.

In relation to protected areas planning, climate change will have a significant impact on the current policies, processes, and procedures used to create and manage protected areas in boreal forest ecosystems. Currently, such planning is done on the premise that landscapes are relatively static, naturally changing very little over time. However, current climate change is altering boreal landscapes at a more rapid pace and the planning of protected areas needs to account for climate change impacts in order to establish adaptation strategies that ensure the loss of biodiversity in boreal ecosystems is kept at a minimum. With Jean Marie River in the process of establishing a protected area (The Five Lakes Area of Interest), it is important for this First Nation and the NWT PAS Secretariat to identify environmental changes associated with climate change so that these changes are addressed and accounted for when establishing the boundaries and management for this potential protected area.

Séguin, Jacinthe; and Berry, Peter (2008): Human Health in a Changing Climate: A Canadian assessment of vulnerabilities and adaptive capacity – Synthesis Report. Health Canada: Canada.

This is an excellent resource that summarizes vulnerabilities and adaptive capacity to climate change from a number of community contexts from many regions throughout Canada. Moreover, the multiple ways that climate change has on a variety of aspects directly and indirectly related to health is a primary focus to show how interconnected these two issues are. There is also valuable information about enhancing the adaptive capacity of communities when responding to climate change. Chapter 7 in this report is devoted exclusively to health related climate change impacts on communities and the environment in northern Canada. Unfortunately, there is very little community specific information, especially for Dene communities.

Standing Committee on Energy, the Environment and Natural Resources (2009): *With Respect, Canada's North: Sixth Report of the Standing Committee on Energy, the Environment and Natural Resources;* the Senate of Canada, Canada.

This report summarizes the experiences and interactions of the Standing Committee on Energy, the Environment and Natural Resources Members with northern residents during a 2007 visit by this committee to Canada's Western Arctic. Issues of the development of natural resources and climate change and the impacts they are causing, or may cause to northern residents and the environment are mentioned in this report. In terms of climate change, the report highlights that northern residents and governments should be more concerned with adapting to a changing climate and environment, rather than coming up with ways to mitigate the impacts of climate change; as the anthropogenic causes of climate change are primarily due to industrial activities in non-Arctic regions. Of particular note in this report, with respect to the Jean Marie River climate change project, are the observations by northern residents of new species of animals such as magpies, crows, elk, cougars, and white tail deer in boreal forest regions. The appearance of these new species may also have negative impacts on the health of animals indigenous to the Western Arctic. For example, some white tail deer are known by biologists to carry parasites that are lethal to animal species in the North; and the mountain pine beetle infestation may expand to forested areas in the NWT and Yukon.

Turner, Nancy J. and Clifton, Helen (2009): "It's so different today": Climate change and indigenous lifeways in British Columbia, Canada; *Global Environmental Change* 19: 180-190.

Although this source is set in the context of British Columbia (northern Pacific Coast), the content of the research is very relevant to northern Aboriginal communities located within boreal forest areas of Canada, such as Jean Marie River. This article's relevancy is in relation to the importance of traditional ecological knowledge (TEK) as another way of knowing and perceiving the environment and seasonal weather patterns, as well as for observing and assessing climate change. Indigenous observations of climate change and its impacts on the land and people in the Hartley Bay area of British Columbia are included that are similar to climate change observations and impacts in northern Canada below the tree line. From these accounts, indicators based on TEK used for assessing the connections between climate change impacts and environmental health (e.g. water quality, health of wildlife and vegetation, and weather patterns and events) are discussed; indicators that could be used, with some modification, in the assessment of the environmental health of other ecosystems. Moreover, the authors provide possible recommendations on how TEK can be applied as part of developing adaptation strategies for coping with and mitigating climate change in the context of other concurrent environmental and social changes being caused by industrial development, resource management, and globalization.

The table below lists the references in the same order as listed above, and the major topics they cover.

Table 8: References and their relation to climate change and health

Title of Reference	Climate Change	Observations	Impacts Change	Adaptation Strategies	Physical Health	Community Health	Environmental Health	Cultural Health	Traditional Knowledge
Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.	✓	✓	✓	✓					✓
Arctic Climate Impact Assessment: Scientific report.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Polar regions (Arctic and Antarctic).	✓	✓	✓	✓			✓		✓
Human Health	✓		✓	✓	✓	✓	✓	✓	✓
The changing Arctic: Indigenous perspectives.	✓	✓	✓	✓			✓	✓	✓
Sila Alangotok: Inuit Observations on Climate Change.	✓	✓	✓	✓		✓	✓	✓	✓
Hunting, herding, fishing and gathering: Indigenous peoples and renewable resource use in the Arctic.	✓	✓	✓	✓	✓	✓	✓	✓	✓
CAVIAR: Community Adaptation and Vulnerability in Arctic Regions	✓		✓	✓					
Freshwater Ecosystems and Fisheries	✓	✓	✓	✓			✓		
Adapting to Climate Change: Socio-Ecological Resilience in a Canadian Western Arctic Community	✓	✓	✓	✓					✓
Climate Change Planning Tools for First Nations.	✓	✓	✓	✓		✓		✓	✓
The Canada Country Study: Climate Impacts and Adaptation, Canadian Arctic Summary	✓		✓	✓	✓		✓		
Climate Change, Northern Subsistence, and Land-based Economies	✓	✓	✓	✓	✓	✓	✓	✓	✓
Foreword to the special issue: climate change impacts, adaptation and vulnerability in the Arctic.	✓	✓	✓	✓					✓
Climate change policy responses for Canada's Inuit population: The importance and opportunities for adaptation.	✓		✓	✓		✓			
Northern Canada.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Local Observations of Climate Change and Impacts on Traditional Food Security in Two Northern Aboriginal Communities.	✓	✓	✓		✓	✓	✓	✓	✓
Tthets'éhk'e Délî Traditional Knowledge Study Regarding the Proposed Mackenzie Gas Project.	✓	✓				✓	✓	✓	✓
Lightning and Fires in the Northwest Territories and Responses to Future Climate Change.	✓	✓	✓				✓		
From Impacts to Adaptation: Canada in a Changing Climate 2007.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Drinking Water and Potential Threats to Human Health in Nunavik: Adaptation Strategies under Climate Change Conditions.	✓		✓	✓	✓	✓			
The Atlas of Canada: Climate Change.	✓		✓				✓		
Climate Change and Natural Hazards in Northern Canada: Integrating Indigenous Perspectives with Government Policy.	✓		✓	✓				✓	✓
NWT Climate Impacts and Adaptation Report 2008.	✓	✓	✓	✓	✓	✓	✓	✓	✓

Title of Reference	Climate Change	Observations	Impacts Change	Adaptation Strategies	Physical Health	Community Health	Environmental Health	Cultural Health	Traditional Knowledge
"The Dene Way of Life": Perspectives of Health from Canada's North.					✓	✓	✓	✓	✓
Understanding Climate Change Adaptation and Adaptive Capacity – Synthesis Report	✓		✓	✓		✓			✓
Community collaboration and climate change research in the Canadian Arctic.	✓			✓					✓
Climate change and protected areas policy, planning and management in Canada's boreal forest	✓		✓	✓			✓		
Human Health in a Changing Climate: A Canadian assessment of vulnerabilities and adaptive capacity – Synthesis Report	✓	✓	✓	✓	✓	✓	✓	✓	✓
With Respect, Canada's North: Sixth Report of the Standing Committee on Energy, the Environment and Natural Resources.	✓	✓	✓	✓	✓	✓	✓	✓	
"It's so different today": Climate change and indigenous lifeways in British Columbia.	✓	✓	✓	✓					✓

Appendix 1: Community Handout about Climate Change

JMRFN, HEALTH & CLIMATE CHANGE

A COMMUNITY-BASED RESEARCH PROJECT

JMRFN has received funding from Health Canada to conduct a research project that looks into the impacts of climate change on our health.

This project will explore how a changing climate is affecting our physical, cultural, environmental and community health.

Specifically we are looking at:

1. The impacts of climate change on our health;
2. Our ability to successfully cope with these impacts;
3. Developing strategies to help us successfully adapt in the future.

The support and participation of the community is very important if we want this project to be successful!

For more information, please contact:
Margaret Ireland 867-809-2000

WHAT IS CLIMATE CHANGE?

Climate Change: A long-term change in the Earth's weather patterns. This includes changes in temperature, rain and snow fall and winds.

The Greenhouse Effect: The Earth's climate is maintained by a ***natural greenhouse effect***. Greenhouse gases surround the Earth and help to keep it at the right temperature.

Fossil Fuels & Climate Change: When we burn fossil fuels by driving vehicles, flying, clearing land, and using electricity, it puts extra greenhouse gases in the atmosphere. These gases build up, and trap extra heat. This leads to the changes in climate we are witnessing today. This is called an ***enhanced greenhouse effect.***

CLIMATE CHANGE HEALTH IMPACTS & JMRFN

In Jean Marie River climate change is impacting the health of the environment, and the physical, community, and cultural well-being of our people. Knowing how our heath is being positively and negatively impacted can help us to successfully adapt to these changes.

Appendix 2: Ethics Approval and Research Licence

Aurora Research Institute - Aurora College
PO Box 1450 Inuvik NT X0E 0T0
Phone: 867-777-3298 **Fax:** 867-777-4264 **E-mail:** licence@nwtresearch.com

Notification of Research

I would like to inform you that Scientific Research Licence No. 14810 has been issued to:

Ms. Margaret Ireland
Jean Marie River First Nation
General Delivery
Jean Marie River, NT
X0E 0N0 Canada
Phone: (867) 809-2000
Fax: (867) 809-2002
Email: negotiations@jmrfirstnation.com

to conduct the following study:
Impacts to the Health and Wellness of Jean Marie River in the Face of a Changing Climate (Application No. 1462)

Please contact the researcher if you would like more information.

SUMMARY OF RESEARCH
This licence has been issued for the scientific research application No.1462.

The short-term objectives of this project are (1) the documentation of observable impacts caused by climate change in the community and surrounding area of Jean Marie River; and (2) the development of indicators based on health determinants being affected by these impacts.

The primary long-term objective of this project is the exploration, development and implementation of adaptation strategies for responding to climate change that will help minimize health related risks associated with climate change impacts for members of JMRFN; and enhance positive impacts. Initial adaptation strategies will be developed by the end of the project, based on the information collected from the literature review and first-hand accounts, ideas and desires of community members. These strategies will be further developed by our community as impacts related to climate change and the interconnections with environmental, cultural, and physical health become more apparent in the future.

JMRFN has chosen to work with PACTeam Canada on this project. PACTeam is a small consultancy company based in Edmonton, Alberta with extensive experience in working on community driven initiatives in the Northwest Territories. PACTeam will provide technical support and training to members of the community working group in using research techniques appropriate to the various activities of the project.

This project is being led by the Jean Marie River First Nation. A local Project Working Group will be established to guide the development and implementation of the overall project, and to review and provide feedback on the results, for which they will receive compensation. Community members, including youth and school children, will be engaged through interviews, community meetings, open-houses and printed materials. School children will be engaged in the classroom to provide input into the research and will be conducting interviews with family members as a class project. One or more individuals will also be hired to conduct/assist with interviews, translate interviews, and translate and transcribe audio files of interviews. The results of the research are for the community to use in developing climate change adaptation strategies so that they might take advantages of the social and economic benefits that could come with climate change, while successfully adapting to changes.

A community meeting/feast will be held at the end of the project to inform the community of the results and to get any last-minute input. All research materials including data from interviews and the final project report will remain int he community for use along side our community plan. It is possible that the final report or a summary report may also be sent to Dehcho Health and Social Services, and other government, First Nation adn community organizations, as Jean Marie River sees fit.

After this project is completed, the information collected will be expanded on to develop and implement adaptation

strategies with the purpose of addressing the most immediate and serious health related impacts associated with climate change. With individuals newly-trained in the human dimension of climate change research the information base on the health related impacts being observed will expand, and allow the JMRFN to develop additional adaptation strategies as needed.

This project will introduce the issue of climate change and its impacts to our youth through their formal education, and through the transfer of traditional ecological knowledge from Elders. This project will be sustained by incorporating the information collected from this project into other community and land use planning initiatives, including future traditional knowledge studies, and in primary and secondary schooling.

The fieldwork for this study will be conducted from October 15, 2010 to December 31, 2010

Sincerely,

*** original signed ***

Jonathon Michel,
Manager, Scientific Services

DISTRIBUTION
Deh Cho First Nations
Jean Marie River First Nation

Appendix 3: Interview Guide

INTERVIEW GUIDE

Preparing For the Interview

i. Set up the recording equipment.

ii. Assign the participant a PIN.

iii. Review the project purpose and objectives.

iv. Ask the participant to sign the consent form.

v. Check the recording equipment.

Conducting the Interview

i. Introduce the interview session.

Start each interview with the following introduction:

"Over the last 15-20 years the climate in the Northwest Territories has been changing noticeably, with a general warming trend being observed and experienced in most regions. As part of an effort to document these observations and experiences of climate change and to assess any impacts related to physical, cultural, community, and environmental health we need to collect some information about the long term changes in weather and any associated impacts these changes are having on the people and traditional territory of the Jean Marie River First Nation. This information will be used to identify and assess how long term changes in the weather are impacting the health of the community and individual community members, as well as the health of plants and animals. Today I'd like to ask you about your knowledge and observations in regard to climate change. We'll record this information using audio recorders."

After the participant has reviewed and signed the consent form proceed with the following:

"I have just reviewed the permission form with (participants name)*, which he/she has signed, and we are now going to conduct the interview. We are here in* (location of interview) *in (location) to do an interview about* (participant's name)*'s observations and experiences concerning climate change and its impacts on the environment and community of Jean Marie River with* (participant's name)*, and it is* (date)*. My name is* (your name) *and also helping with this interview is* (assistant interviewers)*.* (Translator's name) *is translating* (and mention anyone else that is present observing)*.* (Participant) *has been assigned* (PIN #)*."*

ii. Proceed through the interview guide.

Interview questions that participants will be asked are:

General Questions

1. What is your name?
2. When were you born?
3. Where were you born?

4. How long have you lived in Jean Marie River?
5. What is your livelihood?

Questions Related to Changes in Weather, the Environment, and Culture

6. What was the weather like when you were younger? *Prompts: seasons, snowfall, rainfall, storms, heat waves.*

7. Have you noticed any changes in the weather that you would consider unusual (in terms of changes in temperature, precipitation, wind direction/velocity, and storms/blizzards)—think of seasonal and yearly changes?
   A. In Spring?
   B. In Summer?
   C. In Fall?
   D. In Winter?

8. How long ago do you remember noticing these unusual changes in weather?

9. In this time period have you noticed any changes to the land, vegetation, or lake and rivers that you think may be connected to these changes in the weather? *(e.g. changes to the topography, soil, berries, medicinal plants, trees, time of freeze up and break up on lakes and rivers)*

   A. Are these changes positive? If so how?
   B. Are these changes negative? If so how?

10. Have you noticed any changes to the wildlife that you think may be connected to these changes in the weather? *(e.g. changes in the migration routes, appearance of new species, reproductive cycles, and health of large game animals, furbearers, fish, birds or insects)*

    A. Are these changes positive? If so how?
    B. Are these changes negative? If so how?

11. Do you still harvest resources from the land? Which ones? How often are you out on the land?

12. Have the changes in weather changed how you traditionally interact with the land and resources? **[Follow up questions]** If so, how have these changes affected:
    A. Harvesting times and patterns?
    B. Harvesting practices?
    C. The types of animals or plants that may be harvested?
    D. Travel conditions and access to harvesting areas?
    E. Your ability to predict weather and timing of animal migrations?

13. Have you noticed any changes in water quality? Is the water warmer/colder? Is it murkier?

14. Do you feel comfortable drinking water from lakes and rivers? If not, why? Have you heard of people getting sick from drinking the water?

Questions Related to Physical, Community, and Cultural Health Impacts Caused by Climate Change

15. Do you have any major health issues?

16. Do you think any of your health issues are related to changes in climate? How?

17. Are changes in the weather affecting your health? *(e.g. get colds or the flu more often in a year, allergies, frostbite, sunburn, cataracts, etc.)*

18. Think of your friends and family for a moment. What are some of the major health issues they are facing?
    a. Can you remember if people faced the same health issues when you were younger?
    b. Are there Dene words for these health issues (cancer, heart disease, asthma, allergies, sunburn, heat exhaustion, frostbite…)?

19. Do you think any of these health issues are related to changes in climate? How?

20. Are changes in the weather affecting activities of your life at home? *(e.g. traveling, socializing, raising children, household activities, etc.)* How are you responding to these changes?

21. Are changes in the weather affecting your livelihood? *(e.g. traveling conditions, workplace, length of seasonal work, socializing, etc.)* How are you responding to these changes?

22. List some things that you think are necessary for your community to be healthy? How are these affected by the changing weather in either a good or bad way?

23. What are some things that make your community unhealthy? How are these affected by the changing weather in either a good or bad way?

24. Are changes in the weather affecting aspects of community life in relation to community events, interactions with other communities, or the education of younger generations?

25. Are changes in the weather affecting aspects of the local economy – fisheries, forestry, tourism, etc.?

26. Is the community responding to these changes? If so, what is the community doing differently now to respond to these changes?

Questions Related to Knowledge of, and Responses to Climate Change

27. Are you concerned with changes in the weather at this time? If so, why?

28. What do you think people can do within the community or the Deh Cho region as a whole to address some of these concerns?

29. From what sources do you rely on for your information concerning the weather? *(e.g. television, radio, traditional knowledge)*

30. Have you heard about climate change or global warming before? From where? What is your opinion of climate change?

iii. Introduce each new digital voice recording file.

iv. Close the interview session.

Conclude the interview with the following closing:

"We are here in the (location of interview) *and have just completed a climate change interview with* (participant name). *It is* (date). *My name is* (interviewer name) *and also helping with this interview are* (names of others helping), *and* (name of anyone else observing or translating).

v. Turn the digital voice recorder off.

Appendix 4: Consent Form

Project Title: Impacts to the Health and Wellness of Jean Marie River First Nation in the Face of a Changing Climate

Name: _____

This project is a baseline study to assess Jean Marie River First Nation's current and future vulnerability to climate change, and to begin exploring how our community can minimize the risks and maximize the benefits that climate change is bringing, with respect to our health and wellness. Our First Nation needs to know how climate change is impacting us locally so we can respond and adapt to these impacts, based on our own observations, experiences, knowledge and cultural values.

The short-term objectives of this project are (1) the documentation of observable impacts caused by climate change in the community and surrounding area of Jean Marie River; and (2) the development of strategies to help us successfully adapt to the health effects of these impacts.

The responses I give through the interview process are essential to the research. The interview will be recorded. This recording and any other materials will be used in exploring the effects of climate change on the community's health. This information will not be used for any other purpose without my permission. It will be kept in confidence by the Jean Marie River First Nation.

I _____ (participant's name) agree to participate and have the information I provide used in the "Impacts to the Health and Wellness of Jean Marie River First Nation in the face of Climate Change" project. I understand that my participation is completely voluntary and that I may withdraw from the project at any time and/or refrain from answering any questions without prejudice or consequence.

_____ _____
Signature or Mark of Interviewee Date

I agree to use the information according to the terms outlined above.

_____ _____
Signature or Mark of Interviewer Date

Appendix 5: Lesson Plan for Climate Change Experiment

LESSON PLAN – GREENHOUSE GAS EXPERIMENT

Subject:	**Grade:**	**Duration:**

Focus Outcome: **Specific Learner Outcome:**	**Focus Question:** How does the Greenhouse Gas affect our climate?

Instructional Strategies:		**Student Groupings:**	
☐ direct instruction	☐ shared reading/writing	☐ Whole Class	☐ Pairs
☐ cooperative learning	☐ guided reading/writing	☐ Small Groups	☐ Individual
☐ technology integration	☐ independent reading/writing		
☐ anticipation guide	☐ note making		
☐ inquiry process	☐ hands-on activities		

Introduction:	**Materials:**
Review the concepts of greenhouse gasses and global warming using diagrams if possible. Explain that this is a simple demonstration of global warming.	2 plastic containers with lids (or plastic wrap) 2 thermometers 1 desk lamp with a halogen light bulb *If you wish you may add a small ice cube to each container to show the difference in melting.
Concept/Skill Development: Students will gain a deeper understanding of an abstract concept such as global warming through the use of concrete visuals.	**Activities/Tasks:** Start by poking 1 hole in one lid (or plastic wrap) and about 10 holes in the other lid or (plastic wrap). The container with 1 hole represents too much greenhouse gasses trapped in the atmosphere; the other with many holes represents a healthy atmosphere. Place the containers equally close to the desk lamp, which represents the sun. Once both containers are sitting under the light, the one with many holes will let the heat out quicker resulting in a minimal temperature change. The other container will trap the heat causing the temperature to rise. Check the

	temperature at 10 or 15 minute intervals for 45 minutes.
Summary:	
Assessment Strategies:	**Assessment Records:**
☐ written assignment ☐ observation ☐ portfolio	☐ quiz, test, examination ☐ self-assessment ☐ performance task
Notes/ Reflection:	

Appendix 6: Influence Diagrams used to Stimulate Conversation about Adaptation Strategies to Climate Change

Figure 2: Influence Diagram 1 – Warmer Winters & Autumns

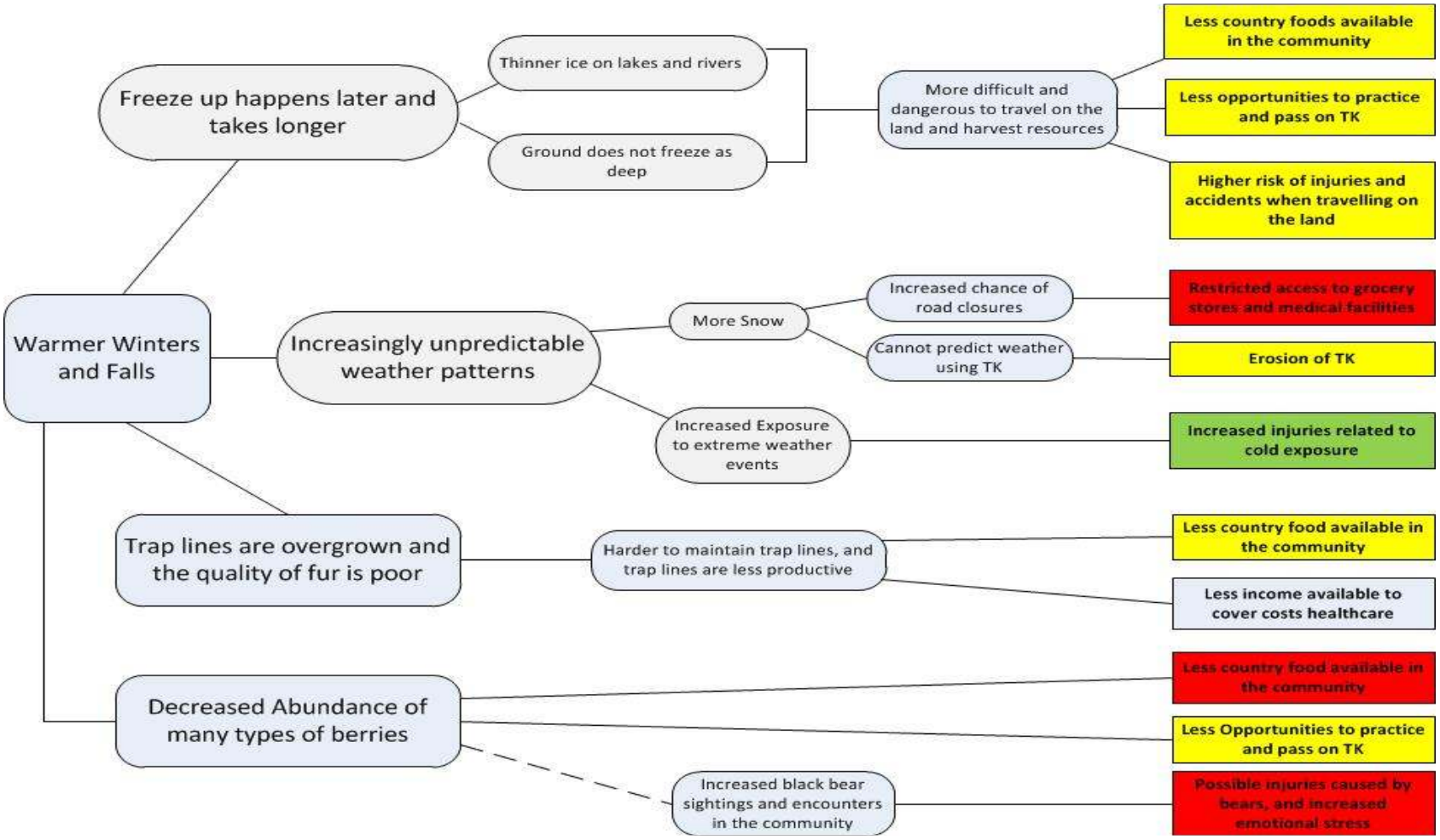


Figure 3: Influence Diagram 2 - Warmer Springs & Hotter Summers

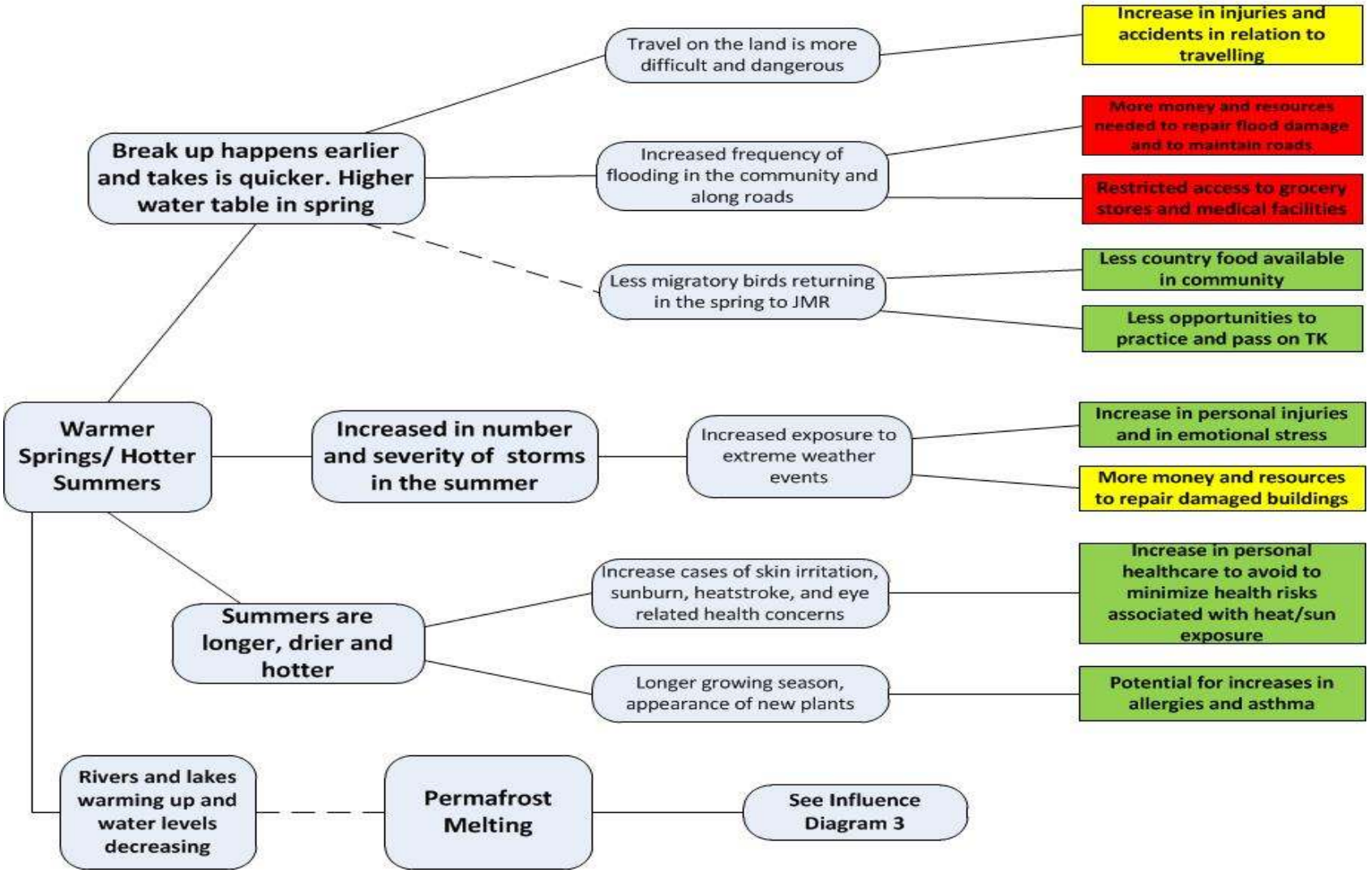


Figure 4: Influence Diagram 3 – Impacts to the Environment caused by a Warmer Climate in all Seasons

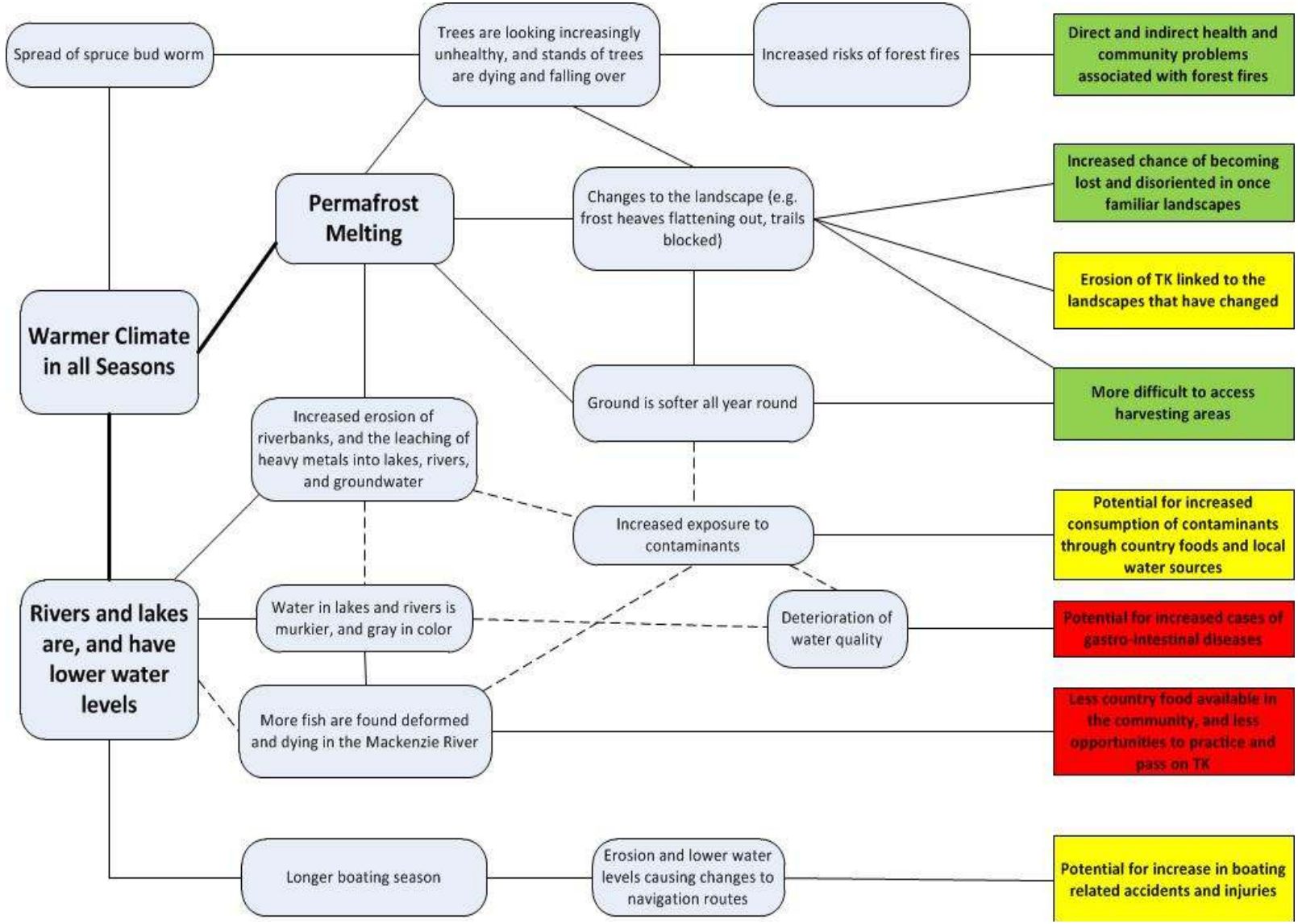
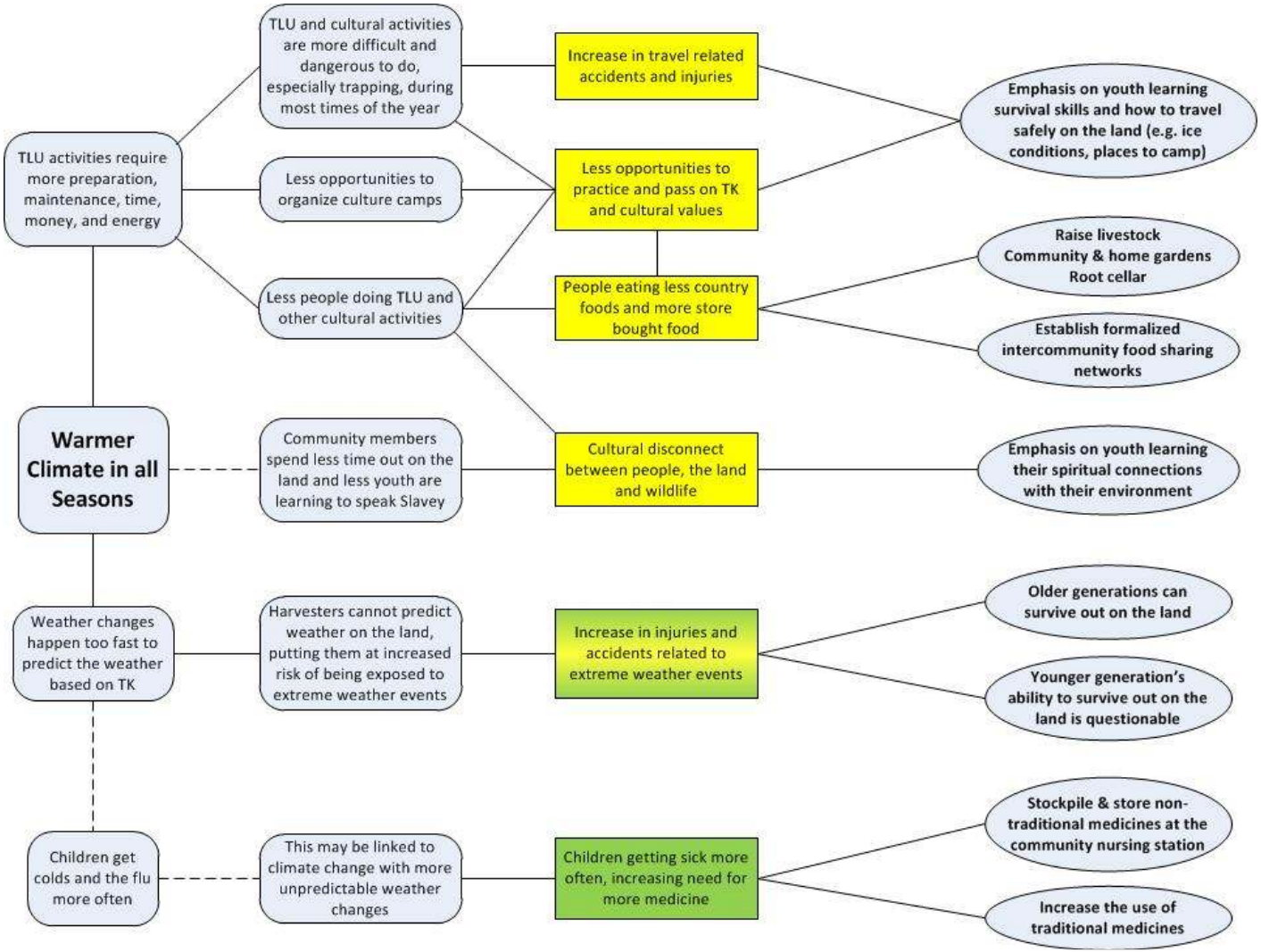


Figure 5: Influence Diagram 4 – Impacts to JMR caused by a Warmer Climate in all Seasons



Appendix 7: Jean Marie River Community Planning Wheel