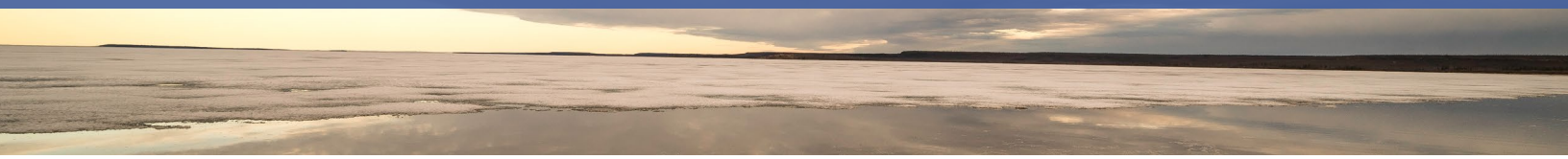
CONTINUAL CHANGE AND GRADUAL WARMING:

A summary of the North Slave Métis Alliance's recorded cultural knowledge on climate and environmental change



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The Geoscience Tools for Environmental Assessment Project is being co-led by the Geological Survey of Canada and Carleton University, in collaboration with the Government of the Northwest Territories Cumulative Impact Monitoring Program, the Northwest Territories Geological Survey, Crown-Indigenous Relations and Northern Affairs Canada, Environment and Climate Change Canada, the Canadian Museum of Nature, Queen's University, University of Leeds, Seabridge Gold, TerraX Minerals Ltd., the Yellowknives Dene First Nation, the North Slave Métis Alliance, the Tlicho Government, the Tłı̨chǫ Research and Training Institute, and Hadlari Consulting, Ltd. The study area comprises the Slave Geological Province, with a focus on the areas around Yellowknife and Courageous Lake, Northwest Territories.

Abstract

Geoscience Tools for Environmental Risk Assessment of Metal Mining was a three-year (2015–2018) project led by the Geological Survey of Canada and Carleton University (Polar Knowledge Canada Project #1516-149). The project was a collaborative effort to study the impact of climate change on the transport and fate of arsenic at two sites contaminated by legacy mining and mineral processing: Giant Mine, near Yellowknife, and Tundra Mine, northeast of Yellowknife in the central NWT. This information may be used to assess the efficacy of remediation and establish benchmarks against which potential impacts of future resource development, land use, and climate change can be determined and regulated as necessary. A hind-casting approach involving both traditional knowledge and western science offers the opportunity to further evaluate the hypothesis that climate can mediate chemical change through studies of past periods of warmth, such as the Holocene Hypsithermal and the Medieval Warm Period, as analogues for twenty-first-century warming and its projected trajectory. Traditional knowledge represents important sources of information on past climate and pre-industrial environments of the study regions. The North Slave Métis Alliance (NSMA) initiated a traditional knowledge study to contribute to a collaborative project led by the Geological Survey of Canada and Carleton University to better understand the role of climate and land-use change on the transport and fate of metal/metalloids in areas of high resource potential and contaminant loads in northern Canada. Métis cultural knowledge linked to climate and associated environmental variability in the Northwest Territories was used to provide long-term climate and environmental data necessary for evaluating records of past geochemical change. Data were extracted from

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historical interviews conducted with NSMA members and from a selection of primary and secondary literature relevant to Métis historical experience. North Slave Métis Alliance members' cultural knowledge suggests that in addition to variability in weather and corresponding environmental conditions to be anticipated year to year, climate change is producing an overall warming with impacts on seasonality, precipitation, water levels, and ice quality, and as a result, impacts on the health, behaviour, and distribution of fish and wildlife. Results of the NSMA traditional knowledge study will be integrated with western science knowledge to produce a knowledge assemblage on climate and environmental change that includes human contextual experience. This approach is expected to provide insight into past climate dynamics not discernible using paleoecological approaches alone.

Résumé

La publication *Outils géoscientifiques pour l'évaluation environnementale des mines de métaux* était un projet triennal (2015-2018) dirigé par la Commission géologique du Canada et l'Université Carleton (projet no 1516-149 de Savoir polaire Canada). Le projet était un effort de collaboration visant à étudier les répercussions des changements climatiques sur le transport et le devenir de l'arsenic à deux sites contaminés par l'exploitation minière et le traitement des minéraux passés : la mine Giant, près de Yellowknife, et la mine Tundra, au nord-est de Yellowknife, dans le centre des Territoires du Nord-Ouest. Ces renseignements peuvent servir à évaluer l'efficacité des travaux d'assainissement et à établir des points de repère permettant de déterminer et de réglementer, au besoin, les répercussions éventuelles de l'exploitation future des ressources, de l'utilisation des terres et des changements climatiques. Une approche de prévision a posteriori faisant appel à la fois aux connaissances traditionnelles et à la science occidentale offre l'occasion d'évaluer plus à fond l'hypothèse selon laquelle le climat peut agir comme médiateur du changement chimique grâce à des études sur les périodes de chaleur passées, comme l'Hypsithermal de l'Holocène et la période de réchauffement médiéval, comme analogues du réchauffement du XXIe siècle et de sa trajectoire projetée. Les connaissances traditionnelles représentent d'importantes sources d'information sur le climat passé et les environnements préindustriels des régions étudiées. L'Alliance des Métis de North Slave (AMNS) a lancé une étude sur les connaissances traditionnelles afin de contribuer à un projet de collaboration dirigé par la Commission géologique du Canada et l'Université Carleton visant à mieux comprendre le rôle des changements climatiques et de l'utilisation des terres sur le transport et le devenir des métaux et des métalloïdes dans les régions présentant un grand potentiel de ressources et des charges de contaminants dans le nord du Canada. Les connaissances culturelles des Métis liées au climat et à la variabilité environnementale connexe dans les Territoires du Nord-Ouest ont été utilisées pour fournir les données climatiques et environnementales à long terme nécessaires à l'évaluation des changements géochimiques antérieurs. Les données ont été extraites d'entrevues antérieures menées auprès de membres de l'AMNS et d'une sélection de publications primaires et secondaires pertinentes à l'expérience historique des Métis. Les connaissances culturelles des membres de l'Alliance des Métis de North Slave indiquent qu'en plus de la variabilité des conditions météorologiques et des conditions environnementales correspondantes à prévoir d'une année à l'autre, les changements climatiques produisent un réchauffement global ayant des répercussions sur la saisonnalité, les précipitations, les niveaux d'eau et la qualité de la glace et, par conséquent, sur la santé, le comportement et la répartition des poissons et de la faune. Les résultats de l'étude sur les connaissances traditionnelles de l'AMNS seront intégrés aux connaissances scientifiques occidentales afin de produire un assemblage de connaissances sur les changements climatiques et environnementaux qui comprend l'expérience contextuelle humaine. Cette approche devrait fournir un aperçu de la dynamique climatique passée qui ne peut être discernée uniquement à l'aide des approches paléoécologiques.

Introduction

There is broad agreement among Indigenous and science communities that the climate is changing, and the rate of this change and its effects and impacts appear to be accelerated in the Arctic. Many communities in the Canadian Arctic are experiencing environmental changes that differ from normal variability. Observed differences in the seasonal extent and distribution of sea ice, fish and wildlife abundance and health, permafrost thaw, and soil erosion are considered to be without precedent (Riedlinger and Berkes 2001). In equally unprecedented ways, climate change research has brought together conventional science and Indigenous knowledge. Indigenous communities, through their long occupancy and management of their territories and through their relationship with animals and other resources, are storehouses of invaluable insights into environmental trends over *la longue durée*, the long term.

In assessing the evidence of climate change in the Arctic, Hinzman et al. (2005) find that, although a wide variety of regional changes have occurred over the course of the last 400 years, many of these changes began or accelerated in the mid-1970s. Some of the changes, such as later freeze-up and earlier break-up of Arctic rivers and lakes, mirror Arctic-wide and even worldwide increases in air temperature. Others document more subtle or complex responses of the Arctic system as it adjusts to current and longer-term trends in climate. Since the Arctic system is particularly sensitive to changes in rain and snowfall, the timing of freeze-up and break-up, and the intensity of storm activity, it is likely that much of what has been documented to date (and will be documented in the future) reflects these changes. Regardless of the driving forces, the combined observations and documentation offer substantial evidence, although often diffuse, that the Arctic system may be entering a state not seen in recent history (Hinzman et al. 2005).

This report details Métis cultural knowledge linked to climate and climate change within the North Slave Métis Alliance (NSMA) members' traditional territory north of Great Slave Lake, Northwest Territories, including cultural knowledge of climatic and corresponding environmental conditions and environmental variability, and cultural knowledge of climate change and corresponding environmental impacts. Data were extracted by the project team from interviews previously conducted with NSMA members and from a selection of primary and secondary literature that overlaps with the Métis historical experience. This notion of the Métis historical experience and what it means in terms of climate research and archival work requires some explication. Typically, climate change research with Indigenous communities focuses exclusively on traditional knowledge, with researchers (usually non-Aboriginal) looking to Indigenous oral traditions and personal observations to supply qualitative information on climate trends. This methodology reinforces the idea that Euro-Canadians have science and Indigenous Canadians have traditional knowledge. But the Métis historical experience, occurring as it does at the crossroads of Indigenous and Euro-Canadian encounters, involves unique Indigenous-European modes of subsistence, labour, and knowledge production. Métis individuals were involved in the fur economy, exploration, and science as well as traditional land use, including subsistence. As a result, the Métis traditional knowledge of climate change complements climate observations of fur traders, post workers, and explorers.

Methodology and sources

The NSMA holds a variety of records pertaining to the history of Métis in the Northwest Territories and the role of Métis in the development and operation of the fur trade on Great Slave Lake. Among these are digital copies of Warburton Pike's account of his travels to the Barren Grounds with his Métis guide King Beaulieu. It was published in 1892 as *The Barren Ground of Northern Canada*. Pike provided a day-by-day account of his journey with Métis guide Beaulieu to the east end of Great Slave Lake and then north to the Barren Grounds. In describing the party's route and decisions made along the way about when, where, and how to travel, shelter, harvest food, and gather supplies, Pike frequently revealed cultural knowledge held by his Métis companions. The project team reviewed Pike's work to extract relevant examples of Métis cultural knowledge embedded in the text.

The NSMA also holds digital copies of Hudson's Bay Company (HBC) journals that were kept by employees at Old Fort Rae on Great Slave Lake (Hudson's Bay Company Archives). Old Fort Rae is described by NSMA members as a culturally, spiritually, and historically important place for their families and ancestors. The earliest remaining HBC journals for Old Fort Rae begin in 1888. Hayden (2010) cautions that the journals for Old Fort Rae "*must be read with an understanding that the emphasis and sequence of events are representations of experiences and not a description of the experience themselves.*" However, a preliminary review of the available journals suggests her contention that "*Métis cultural perspectives are mostly missing from these documents*" may be less accurate. These records represent the experience of daily life and living conditions at an isolated outpost populated by both European and Métis individuals, and therefore, some of the journals could have been written by Métis, reflecting Métis attitudes and culture. The journals span the years 1888 to 1912, including the movement of the post and the Métis community surrounding it north from Old Fort Rae to Fort Rae (present-day Behchokǫ̀). They provide occasional data describing weather and climatic conditions at Old Fort

Rae. The climate data were extracted by the project team and plotted on spreadsheets for analysis according to date, temperature, and qualitative descriptions of climatic conditions, such as impressions of wind force and direction, precipitation, and cloud cover. These qualitative weather descriptions, including "*cold*," "*warm*," "*cloudy*," "*rainy*," and "*snowing*," were assigned numerical keys (i.e., cold = 1, warm = 2, mild = 3). The spreadsheets were then graphed and analyzed for patterns and insights into climate and environmental change during the years represented. For this report, the project team also reviewed NSMA's previous interviews for references to climate and environmental change. Although climate and the environment were not the focus of those interviews, analysis of the transcripts revealed participants sharing extensive cultural knowledge related to climate and the environment. In many cases, this knowledge was conveyed in passing as participants responded to questions about harvesting activities, travel, and other land use activities pursued throughout their lifetimes. In these instances, and where no further questions were posed during the interview to elucidate the knowledge shared, the project team's analysis included a limited amount of interpretation in order to draw out the knowledge being revealed. Further research focused on gathering Métis cultural knowledge related to climatic and environmental change, and new interviews with NSMA's entire membership are recommended. The project team also conducted a literature review of sources describing observations of climate change on Indigenous populations in the Canadian Arctic, and the Northwest Territories in particular. These included Hinzman et al. (2005), Riedlinger and Berkes (2001), Downing and Cuerrier (2011), Guyot et al. (2006), NWT Environment and Natural Resources (2008), Tam et al. (2013), James and Tristan (2010), and Duerden (2004). Further research is recommended to collect and analyze existing Métis observations of climate change.

Historical overview

The weight of evidence suggests an eighteenth-century origin for the Métis community in the Great Slave Lake area. Jones notes that "*it seems reasonable to state that [Métis] were already living in the Great Slave Lake area at the very beginning of the period of European trader residency there*" (Jones 2005:12). Records indicate that by 1800, the Great Slave Lake area was home to a burgeoning population of first-generation children of mixed ancestry, born of unions between French men and local Aboriginal women (Jones 2005:19). Métis history is firmly linked to the fur trade, and the first fur-trading post in the region was established on the southern shore of Great Slave Lake in 1786. From this post, the initial trading journey on Great Slave Lake went up through the North Arm and into Dogrib country around Lac la Martre, where another post was established in 1789. In 1790, a post was also built on the North Arm near the Yellowknife River — Old Fort Providence served as the centre of North West Company activities for the next few years (Bellman and Hanks 1998). Recent research and archaeological evidence now suggest that a post at Old Fort Rae, on the eastern shore of the North Arm, may also have been established at the same time as or even earlier than Old Fort Providence (Stevenson 2001:12,15). A map produced by Aaron Arrowsmith in 1795, and amended in 1802, makes reference to the presence of 'Canadian Settlements' on the North Arm, [and] in a footnote to Philip Turnor's 1791–92 journals, J.B. Tyrell notes that in 1789, or "*a little earlier … Laurent Leroux … built a house on the north arm of Great Slave lake, about where Fort Rae is now situated*." An even earlier reference to a possible Métis presence in the North Arm comes from Alexander Mackenzie when he noted in 1789 the remains of an old fort on Old Fort Island (Stevenson 2000). Hanks notes that François Beaulieu II, the Métis son of François Beaulieu and his wife, Ethiba, was born during the time that European fur traders first arrived in the Great Slave Lake area. As a youth, François Beaulieu II would have seen the European traders shift from the traditional route (from Great Slave to Great Bear Lake via the Marian and Camsell Rivers) to the more westerly Mackenzie River route north. As a free trader, Beaulieu would exploit European neglect of the traditional route throughout his life (Hanks 2000). According to Hanks, local knowledge and use of the North Arm proved beneficial to the Métis as the fur trade around Great Slave Lake developed. The Métis were "*prized as fur trade employees for their language ability, skills in living on the land, and influence in the Indian population*" (Jones 2005:128). By early in the 1800s, "*an identifiable cadre of mixed-ancestry individuals affiliated with the North West Company, familiar with the country and well-connected with the local Indian population, had emerged in the Great Slave Lake region*" (Jones 2005:33).

Old Fort Rae

Old Fort Rae (referred to as Fort Rae after the post and Métis community moved north) is named after Dr. John Rae, an Arctic explorer associated with the HBC, although the site first appears in historical records as Mountain Island or Rae Point (Hayden 2010:2). Local knowledge and other evidence presented in Stevenson indicate a possible Métis presence at Old Fort Rae as early as 70 years before the arrival of the HBC: "*Chief among [this evidence is] the late Edward Lafferty's statements that Old Fort Rae's cemetery contains numerous graves which predate the arrival of the Catholic Church (i.e., 1859) by many decades, and that these burials were so old that no one, not even his grandparents, could remember who they belonged to*." (Stevenson 2000:6). Stevenson also cites several historical records indicating the North West Company (NWC) established a trading post at Old Fort Rae in 1804, and "*Métis freemen may have settled on the shores of Great Slave Lake and its North Arm years in advance of the NWC*" (Stevenson 2000:8). In fact, Stevenson finds it most likely that archaeological evidence found at Old Fort Rae points to "*a pre-1780 occupation of Métis freemen formerly associated with the Company of the Sioux, or a late-1780s/early 1790s occupation of Métis dating to the heyday of NWC trading activity on the North Arm*" (Stevenson 2000:10). Hayden agrees that the archaeological evidence offers proof of a Métis settlement at Old Fort Rae several decades prior to the arrival of the HBC. She concludes that Métis use and occupation of the site likely began with the NWC in 1804 (Hayden 2008:8). The NWC moved into the North ahead of the HBC and first established a trading post at OFR [Old Fort Rae] in 1804 called Mountain Island Post, which was abandoned by 1820. In 1849, Dr. John Rae was granted permission by George Simpson to establish a post at Marten Lake, its main purpose to procure provisions for the other posts rather than to collect furs. In 1851, Chief Trader James Anderson, John Rae's successor at Marten Lake, requested that the HBC move a post to the mouth of the Marten River at a place called Montagne de l'Isle, which would allow for trade to occur with both the Marten Lake (Tłı̨chǫ) and the Copper Indians (Yellowknives Dene). The suggestion stemmed from advice given by freeman and independent trader Baptiste Beaulieu. By June 1852, Anderson gave Charles Gaudet instructions to build a fort at the straits of Lac Brochet, a place called Fort Rae, and appointed Alexander McKenzie to its charge. That summer, Mr. Gaudet, Cadien, the interpreter, and five Indians built the fort near the old "Post of Montagne de l'Isle" and called it Fort Rae (Hayden 2010:4). According to Bellman and Hanks (1998:53), Anderson also sought advice from François Beaulieu on where best to locate the new HBC fort, but opted to follow Baptiste Beaulieu's recommendation for the east side of the North Arm instead. In addition to wood supplies and a reputation as a good fishing area, this location boasted two particular assets: direct access to caribou during their spring and fall migrations (Stevenson 2001:16) and proximity to important spiritual/cultural sites, which made it easier for "*local hunters and trappers to remain within culturally significant territory while participating in the new economic trade system*" (Hayden 2010:26–27). Stevenson notes that the fort was 150 miles "*off the 'beaten track' of the main fur trade route*" (Stevenson 2001:16), and therefore received very few travellers. He asserts that this geographical isolation led to the development of a distinct Métis identity, marked by its hybridization of French-Canadian and local Dene cultural and economic practices. Stevenson describes how a shared sense of community and cultural identity likely crystallized among the Métis inhabitants at the fort:

> *At Old Fort Rae the Métis language was dominant, Métis clothing was worn, and the Catholic religion and burial traditions of the Métis were practised. The social organization of work was distinctly Métis, with its division and specialization of labour. The permanent homes around the fort reflected a unique Métis architecture: they were permanent structures with root cellars and intricate dove-tailed corners which differed from the semi-permanent Dene homes. (Stevenson 2001:17)*

The list of early HBC employees at the fort begins with Louison Cadien, the interpreter mentioned above, who "*appears to have lived at Old Fort Rae throughout most of the 1850s and was responsible for re-opening the fort in 1852, when he built five log huts there*" (Stevenson 2001:16). Cadien, or Cayen, also known as Old Cayen, was most likely the Métis son of a Parisian who had worked for the HBC and lived among the Chipewyan several decades earlier (Bellman and Hanks 1998:41). Jones observes that during the mid-nineteenth century, while some Métis moved in and out of HBC employment, and in and out of residence at HBC forts, "l*ong-time mixed-ancestry employees like Pierre Blondin and Louis Cadien continued to make their living as workmen, boatmen, interpreters and emissaries to the Indians, and*

new mixed-ancestry families were formed from year to year around the HBC posts" (Jones 2005:71). Assessing marriage and baptism records made by Roman Catholic church officials at Forts Resolution and Providence during the mid-1800s, Jones observes that "*the links between old and new mixed-ancestry and (primarily) French-ancestry families are evident, as well as some continuing, but limited outmarriage to Dene women*" (Jones 2005:78).

Louison Cadien, Oliver and Louison Laferté, and Alexis and King Beaulieu, are all listed as HBC employees in the Old Fort Rae account books for 1853 to 1863, along with Pascal and William Houle, Baptiste Bouchez dit Lamalice, and Baptiste Mainville (Jones 2005). Several names "*associated with French-Canadian or mixed-ancestry employees of the Company in earlier years*" are listed among Old Fort Rae's "Indian" accounts for this same period, including Beaulieu, Robillard, and Marseillais (Jones 2005:79). The account books for the 1870s and 1880s include Baptiste Bouvier as an employee, along with names such as Laferté, Beaulieu, Hoole, Camsell, Norn, Villeneuve, and Laviolette (Jones 2014:14). Henry Cadien is listed at different times as an employee, middleman, and interpreter, and as an "*Indian*" or having "*Indian debt*," along with "'*Small Man Beaulieu' and 'Beaulieu's 1st son*'" (Jones 2014:15). Jones surmises that "*Indian debt*" was perhaps "*more a type of economic relationship than an ethnic attribute*" (Jones 2014:18). Hayden also provides a snapshot of people at Old Fort Rae:

> *The mostly Métis men and boys working as post servants spent the majority of their days hauling wood for heat, building materials, and fuel; transporting furs; fetching, drying and preparing meat; constructing and maintaining post buildings, sleds, coffins and other necessary equipment; repairing nets; fishing; and hunting. The women of the posts are rarely mentioned in the journals aside from their journeys to the Syrup Camp in May and some berry-picking and trapping trips, but they presumably played a major role in raising the children and carrying out other household and community duties. (Hayden 2010:34)*

The workers performed the same types of construction and manual labour tasks as their counterparts did at Fort Providence. In the winter, the employees and Antoine Laferté made several trips with dogsleds to locations within a few days' travel of the post to collect furs and meat from the HBC's trading partners. They also travelled about the same distance to cut wood to heat the post buildings and to supply the steamer Wrigley on its summer visits. Fishing was done every day for about six months of the year in open water or under the ice near the fort. David Villeneuve, Henry Cadien, and other employees operated fisheries for the post, especially in the fall, at Jackfish River, Smith's Island, the "*Island Fishery*," "*the point*," and other unnamed locations. The HBC's customers, such as Beaulieu and his sons, Tom Cook's son, and Rabasca, visited the fort once or twice a year to trade meat or furs (Jones 2014:15–16).

Arthur Camsell's post journal from Old Fort Rae offers a glimpse of life at the fort during the late 1800s, including the marriage of Antoine Laferté to Madeleine Beaulieu in October 1890 and the birth of Alexis Beaulieu's son in November of the same year. He notes a number of celebratory dances lasting until the early hours of the morning and records a variety of Métis harvesting activities, including hunting and making birch syrup (Jones 2014:16). A declaration of Marie Laferté (wife of Alexis Beaulieau), dated February 28, 1894, concerning her "*claim to participate in any grant to Half-Breeds living in the North West Territories*" records the dates of the births and deaths of her children: "*Isabelle born in Fort Resolution in 1879, died in Fort Rae aged 1 year, one died at birth nine years ago … he was born and died at Fort Rae + Maria Rosa born at Fort Rae 7 years ago died … 1893*." Jones's review of the post journals "*for the years 1892-1899 and 1900-1904 shows similar patterns of trading, local resource harvesting, and labour*," and the accounts for the same period show a similar assortment of Métis names (Jones 2014:18).

In 1893, the HBC trading post faced new competition from a neighouring outpost that was established by Hislop and Nagle less than 20 miles to the north. Acting on the advice of Alexis Lafferty from Old Fort Rae, "*Hislop set up a post near the Willow River - a location the Dogrib had previously recommended to the Hudson's Bay Company, since it was at the centre of Dogrib territory*" (Bellman and Hanks 1998:66). The 1901 census combined residents of the two posts together, enumerating six mixed-ancestry families at Old Fort Rae and at nearby Willow River. Family members were recorded as having been born at Fort Rae and at other outposts on Great Slave Lake (Jones 2005:105). By about this time, however, the movement of Métis families away from Old Fort Rae to Willow River and eventually to the new HBC post in Rae had begun. Stevenson (2001:21) has the move beginning in 1901 and concluding in 1906, with HBC continuing to operate at Old Fort Rae until 1911. Hayden places the move in 1905, with HBC journal entries at that time detailing the ongoing construction of the new fort at Rae as well as providing "*evidence of the Old Fort still being inhabited by the 'Old Fort Indians'*" (Hayden 2010:39). According to Stevenson, by 1916 the considerable number of Lafferty family members, "*headed by Henri Lafferty,*" were the sole residents of Old Fort Rae (Stevenson 2001:21).

Hayden writes of Alice Lafferty and her family:

> *Although Alice [Lafferty] was not alive to witness the trading practices of the HBC at [Old Fort Rae], her family and life history highlight the continued use of that area by the Métis families that once served there … Even though the hub of economic activity had shifted slightly, to Fort Rae and Yellowknife, many families remained on the land to pursue more traditional lifestyles. (Hayden 2010:39)*

Historical climate data from traditional Métis territory

Hudson's Bay Company journals

The purpose of the journals maintained at every HBC post was to record an objective account of operations for managerial and reporting reasons; however, "*often in the course of doing this, journals would also present information considered vital to understanding the larger world in which the HBC placed itself and its business enterprise*" (Province of Manitoba 2015). Included in this type of information were measurable observations of climate and related environmental conditions, such as temperatures, and qualitative observations, such as wind and seasonal changes. Posts were not required to record meteorological information; rather, it was noted according to the whims and interests of the journal keepers. As a result, the regularity and frequency with which the journals provided weather data differ greatly from post to post, author to author, and even day to day. For this report, the project team reviewed all of the HBC journals currently held by NSMA, namely those from Old Fort Rae, because of the post's importance to NSMA members and its central role in the lives of their families and ancestors. With respect to future research, it is recommended that the HBC journals for the posts at Fort Simpson, Fort Providence, and Fort Resolution, at a minimum, be reviewed, and data analyzed and amalgamated with the data provided here for Old Fort Rae, as well as a review of account books, which may contain information on fur conditions that could be correlated with climate data and traditional knowledge. Of Old Fort Rae's data sets, temperature is the most consistently available because it was sometimes recorded on an almost daily basis, and therefore proved the most useful for analysis. However, even temperatures were recorded inconsistently over the course of each year, with many days, weeks, and months entirely unaccounted for, so the project team focused its analysis on two select periods during which temperatures were well represented over multiple years. The two periods selected for analysis were November-December and January-February, because unlike most other periods covered by the journals, temperatures during these months were recorded on an almost daily basis over multiple years between 1888 and 1896. Available temperatures for these months/years were first plotted in tables for comparative analysis, and then used to generate graphs to illustrate the variability and fluctuation of daily temperatures during the same periods from year to year (Fig. 1, 2). The graphs for both periods appear to describe continual change in temperatures during each period and between the same periods each year. The available data suggest what might be described as "consistent inconsistency" in temperatures and corresponding climatic conditions for the periods analyzed. Temperatures appear to fluctuate within a range of 6°F to 8°F within each period, and without adhering to any predictable pattern.

John Franklin's expeditions

During the 1820s, the British explorer John Franklin made two expeditions to the north coast of Canada, aided on both journeys by the local knowledge and physical labour of Métis individuals, referred to throughout the accounts as "*half-breeds*," "*voyagers*," and "*Canadians*." During each of these voyages, "*regular measurements were made several times each day of temperature, wind direction, and compass variation, as well as observations of wind speed, precipitation, sky cover, and the occurrence of the aurora*" (Hopper 1985:684). Much of this early climate data is preserved in the expedition journals that were kept by Franklin for the purpose of publication and in the personal journals kept by the naturalist John Richardson, who accompanied Franklin on his first expedition (Hudson's Bay Company

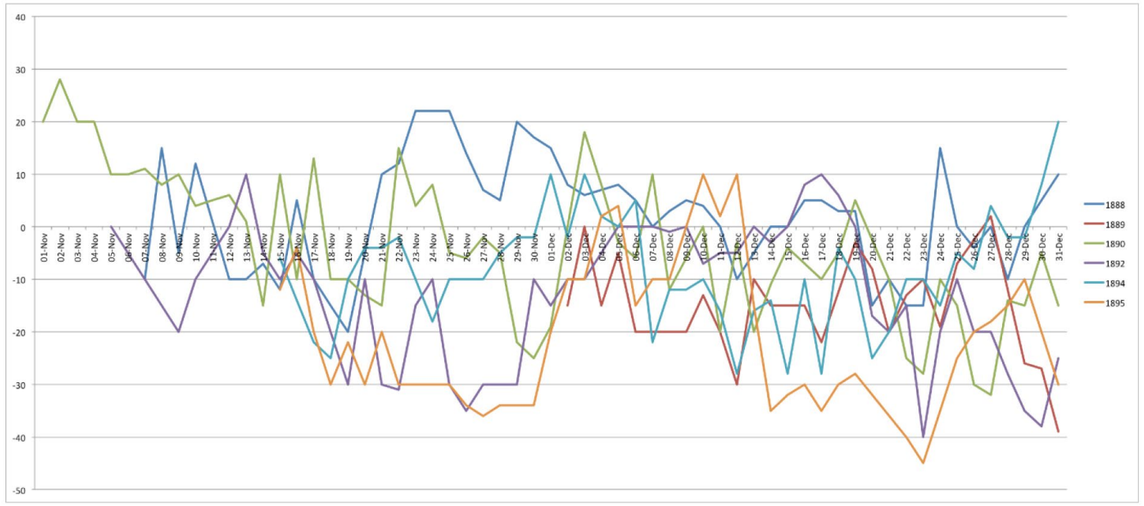

Figure 1: Available temperatures (°F) extracted from HBC journals for November-December 1888, 1889, 1890, 1892, 1894, and 1895 (Hudson's Bay Company Archives).

Archives). Existing analyses of these data underscore the day-to-day and year-to-year variability of temperatures recorded at outposts close to Old Fort Rae and located within NSMA members' traditional territory in the region north of Great Slave Lake. For example, Hopper gives the following analysis for December 1820 and January 1821:

> *The meteorological observations at Fort Enterprise suggest a typical winter in many respects … except for an unusually cold December the expedition experienced mean temperatures which were normal or higher than normal. January 1821 was by contrast unusual … There was a short cold spell followed by return of the mild weather in the middle of the month. No rain fell at Fort Enterprise, but the expedition experienced several days of 'a kind of damp fog approaching very nearly to rain.' (Hopper 1985:686)*

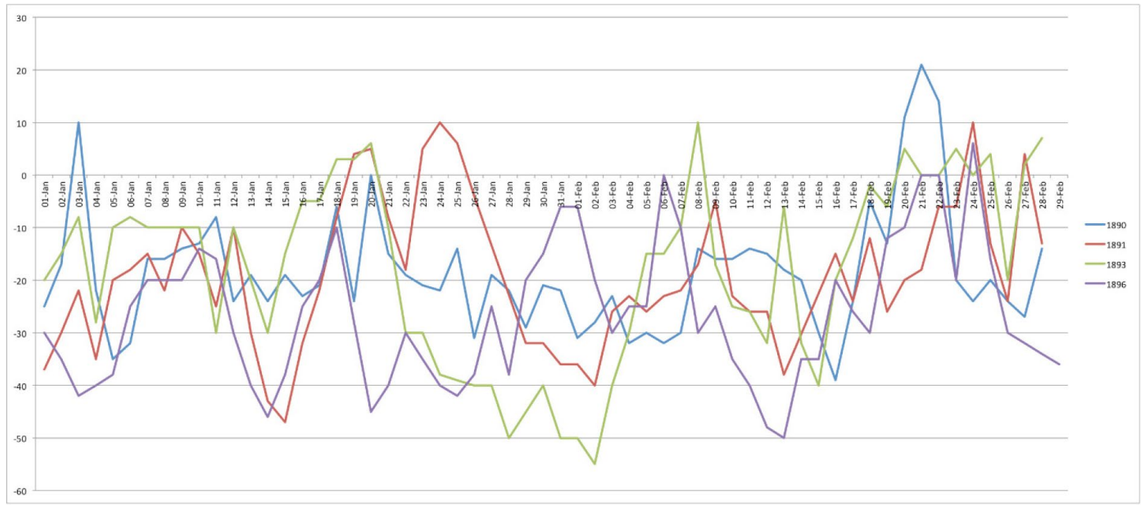

Figure 2: Available temperatures (°F) extracted from HBC journals for January-February 1890, 1891, 1893, and 1896 (Hudson's Bay Company Archives).

By contrast, Houston observes that later in 1821 at Fort Enterprise, Franklin and his officers documented an early winter:

> *In October 1820 at Fort Enterprise "there had been very little snow on the ground, and we were surrounded by vast herds of reindeer… Winter River was then open." In October 1821 "there were but few recent tracks of these animals, and the snow was upwards of two feet deep… Winter River… was frozen two feet thick." G. C. Jacoby's unpublished tree-ring studies from the Coppermine Mountains confirm that Franklin encountered a major dip in temperatures in 1821. (Houston 2014:208)*

In their analysis of historical Arctic climate data, including Franklin's, Przybylak and Vizi suggest the 1820s were warmer overall, particularly during the winter months, than the 1850s, when Old Fort Rae was established (Przybylak and Vizi 2005:1512). They also note, however, that even these warmer winters were considerably colder than those the region experiences today. Additionally, they report that variances between mean daily temperatures were greatest during winter and summer months, and that these variances have increased in both frequency and severity from the past to the present. The greatest changes in the day-to-day variability of mean daily air temperature (MDAT) from historical to present times occur in winter and especially in summer. In both seasons, increases in variances were noted. This means that at present, the occurrence of large day-to-day MDAT variability (exceeding 5°C in winter and 3°C in summer) is more frequent, while small variability (0°C to 1°C) is less frequent (Przybylak and Vizi 2005:1515).

The tables from Franklin's *Narrative of a Second Expedition to the Shores of the Polar Sea in the Years 1825, 1826, and 1827* illustrate the daily changeableness of temperatures recorded at Fort Franklin on the southwestern tip of Great Bear Lake during the same months selected for analysis from the HBC data for Old Fort Rae, namely November-December and January-February for the years 1825 to 1827 (Franklin 1828).

The Meteorological Council of Great Britain

In 1879, the British Meteorological Council published Contributions to our Knowledge of the Meteorology of the Arctic Regions, which "*collected together the information as to the climate of the Polar Regions, especially of the portion in the vicinity of the American Continent, contained in the log books and journals of the various British Arctic Expeditions up to the year 1874*." This included the temperature data recorded by John Rae at Fort Confidence in the Northwest Territories during the winter of 1850–51 and by Lieutenant W. J. S. Pullen at Fort Simpson from the fall of 1849 to the spring of 1851.

Fort Simpson

During the summers of 1849 and 1850, W. J. S. Pullen led expeditions by boat to search for the Franklin expedition that had gone missing four years previous. During the remaining months of both years and until the spring of 1851, Pullen returned to pass the winters at Fort Simpson, an HBC post, near the confluence of the Mackenzie and Liard Rivers, east of Great Slave Lake. Here Pullen made regular temperature recordings with "*no less than twenty-two thermometers in the open air*" (Meteorological Council 1879:345). Tables from *Contributions to our Knowledge of the Meteorology of the Arctic Regions* show the monthly temperatures recorded by Pullen during the same months selected for analysis from the HBC data for Old Fort Rae, namely November-December and January-February, for the years 1849–50 and 1850–51. In November-December of 1849, temperatures ranged from 9.1ºF to –15.7ºF and in the same months in 1850, temperatures ranged from 15.4ºF to –9.4ºF. In January-February of 1850 and 1851, temperatures ranged from –30.5ºF to 1.4ºF and –23.1ºF to –4.5ºF respectively (Meteorological Council 1879).

Fort Confidence

Fort Confidence was established on the northeastern shore of Great Bear Lake in the mid-1830s. Although financed by the HBC, the Fort was not a trading post but a base station for Arctic expeditions, such as the one John Richardson and John Rae led in 1849, also in search of the missing Franklin expedition. When the two returned to Fort Confidence in 1850, John Rae remained at the fort throughout the winter, where he recorded meteorological data, including temperatures, from October 2, 1850, to June 6, 1851 (Johnson 1975:239; Meteorological Council 1879;11). In publishing Rae's data, the Meteorological Council notes that the climate in the territory surrounding Fort Confidence is "*subject to sudden and great changes of temperature*" (Meteorological Council 1879:11). In

contrast to the temperatures recorded by Franklin and his officers during the 1820s, which showed the greatest change in daily temperatures occurred during the winter and summer, Rae's records show that for the winter of 1850–51, "*the mean daily range of temperatures was very small in November, December and January, and very large in February, March and April*" (Meteorological Council 1879:11).

International Polar Year

1882–83 marked the first International Polar Year (IPY), during which "*scientists from 11 countries ran 12 expeditionary stations in the Arctic or sub-Arctic and two in the sub-Antarctic for about 13 months*" in order to collect meteorological data systematically for the purposes of scientific analysis and publication (Bulkeley 2010:1). Despite some initial reluctance on the part of the British Royal Navy to participate, due in part to the opinion that it was impractical and counterproductive to have researchers stationed in one place for a year rather than exploring an area for the same duration, the Meteorological Council eventually won out and selected Old Fort Rae as the site for its IPY base (Barr 2010:61). The fort was "*not only the northernmost of the HBC stations, it was also nearest to the Magnetic Pole and thus advantageous for the IPY programme*" (Barr 2010:61). Captain Henry P. Dawson was selected to lead the expedition to Old Fort Rae. Owing in no small part to the infrastructure, fish, and game that Dawson and his men were supplied with there, it was among the least hazardous or difficult of all the IPY expeditions (Barr 2010:61,63). Perhaps indicating Métis cultural knowledge of climate, HBC personnel reported that the winter of 1882–83 "*was an unusually mild winter with a very late start, much lighter snowfall than usual and unusually few severe storms*" (Barr 2010:62). Dawson reported that there was scarcely any ice at all in the Mackenzie River at the end of November, "*whereas it is usually full of drifting ice in October, and frozen over in November*" (Wood and Overland 2006:8). According to Wood and Overland, "*the median freeze date for the Mackenzie River at Fort Simpson, based on 44 yrs. of observations between 1931 and 1985, is 25 November, but dates range from as early as 31 October to as late as 15 December*" (Wood and Overland 2006:8). Just as these reports and analyses suggest the variability of seasonal conditions from one year to the next, Dawson's further description of the 1882–1883 winter speaks to the variability of temperatures from day to day and week to week within NSMA members' traditional territory:

> *It was not until the beginning of December that our winter really set in, but when it did so there was no mistake about it, as the 1st of the month began with the thermometer at –34F, and except for some mild weather at Christmas, the cold continued through that month. January was colder still, the thermometer once or twice approaching –50F, but in the early part of February a violent storm was accompanied by a remarkable rise of temperature (to +20F), and followed by some mild weather, since which the thermometer has again fallen, reaching –39F a couple days ago. (Barr 2010:61–62)*

Daily surface air temperatures (SAT) and sea-level pressures (SLP) recorded at Old Fort Rae during the IPY document a range of SAT of approximately –5ºC to –39ºC in the months of November and December and –15ºC to –40ºC in the months of January and February. Large fluctuations in temperature in a short period are rare from April to October and no greater than approximately 15ºC from November to March. Documented SLP ranges from approximately 1000 hPa to 1040 hPa for the entire year (NOAA Arctic Research Office). As Wood and Overland point out, "*these observations span only a single year, but offer a unique glimpse of the circumpolar environment from a period before the present era of Arctic warming*" (Wood and Overland 2006:11).

Cultural knowledge on climate and environmental change

Warburton Pike

When the British gentleman-adventurer Warburton Pike set out to hunt muskox in the Barren Grounds of the Northwest Territories in 1889, he hired King Beaulieu as his guide (despite his assertion that "*nobody could give him a very good character*"), because Beaulieu was known to be a "*first-rate traveller, besides having made a successful musk-ox hunt in the previous year.*" Pike then elaborated on Beaulieu's qualifications, describing him as "*expert in all the arts of travel with canoes or dog-sleighs, [and] quick in emergencies*" (Pike 1892:18). The "*arts of travel*," part of what we would call traditional knowledge today, would have included extensive knowledge related to climate and the environment. The modes of transportation described indicate that Beaulieu's knowledge extended to all the seasons and weather conditions northern travellers might encounter. Later in his account, Pike provided the following description of Beaulieu and the other Métis deploying their specialized knowledge to respond to seasonal weather-related changes in the terrain:

> *I now saw an example of the readiness of idea which King possessed in devising shifts and expedients to get out of difficulties … Before I thoroughly understood his scheme we commenced operations, by lashing together all the poles and paddles into a rough sort of ice-raft; on the top of this we placed the loads that we had carried so many miles, forming a smooth bed, two feet above the level of the ice, on which to rest the canoe. The bay had evidently frozen and broken up once, and the second freezing had left a rough surface; many of the floes were piled on top of each other, while the rest had been turned on edge, and it was necessary to keep the canoe clear of these sharp edges, which wsould have ripped the tender birch-bark like a knife. One man ran ahead, trying the strength of the ice with an axe, while the others hauled on the raft, and our method of progressions was so satisfactory that just before dark, after much ominous cracking of the ice but no disaster, we camped on the east point of the bay close to the edge of open water. The half-breeds showed great knowledge of ice, and, with an occasional tap of the axe, picked out the safest route without making a mistake. The canoe propped on her side gave us the best shelter we had had for many a night, and, finding willows enough for a fire, we all felt jubilant at the idea of reaching the first clump of pines on the following day. (Pike 1892:68–69)*

Upon reaching the Barren Grounds, Pike's Métis companions demonstrated cultural knowledge of winter camp construction, including the dual purpose given to snowshoes and sleds, which the Métis employed as tools and structural enhancements:

> *A spot being chosen where the snow is light and the ground clear of rocks, a ring of the requisite size is marked out. Snowshoes are taken off and used as shovels for throwing away the snow from the inside of this ring, making a wall varying in height according to the depth of snowfall. Outside this circle the sleighs are turned on edge, the poles planted behind them, and the deerskin lodge spread round, forming as comfortable a camp as can be expected in such a country. (Pike 1892:94)*

Jones provides a summary of some of the early action described in Pike, which offers insight into the nature and range of the cultural knowledge Beaulieu held:

> *King Beaulieu took the party on a chain of lakes route Pike speculated had not been travelled by white men before, east of the Yellowknife River and west of the route taken by Back to the headwaters of the river that now bears his name. They camped on a lake called by the Beaulieus "du Rocher" (now known as Warburton Bay), which "the half-breeds … have always found a certainty for caribou at this time of year." About a day's travel away, Beaulieu's sons found a herd of caribou. (Jones 2014:39–40)*

Pike himself characterized the route Beaulieu selected as a part of Beaulieu's cultural knowledge, indicating the existence of places previously named by the Métis along the way, and more importantly, Pike illustrated Beaulieu's knowledge of caribou behaviour related to climate and seasonal environmental conditions. Pike wrote:

> *We continued our journey as before, pushing on as quickly as possible to reach the Lac du Rocher, where the half-breeds were confident of meeting the caribou, or, at the worst, to camp at a spot well known to them where we might catch fish enough for temporary support … On September 13th we reached the Lac du Rocher … Others explored the surrounding hills for caribou tracks, but without success. The half-breeds were all much put out by this failure, as they have always found the Lac du Rocher a certainty for caribou at this time of year, and were unable to account for it, except by the theory that the animals had altered the usual course of their autumn migration and were passing to the east of us. (Pike 1892:36–37)*

It is evident that the Métis travelling with Beaulieu knew where the caribou had traditionally been according to seasonal and climatic conditions. Their certainty about where to find them, disappointment at their failure to do so, and their theorizing that the herd had altered its course, all led to Pike's subsequent assertion that "*the caribou are extremely uncertain in their movements, seldom taking the same course in two consecutive years*" (Pike 1892:46). However, the experience at Lac du Rocher that Pike recounted, as well as the following observation, suggest at least developing Métis knowledge of changes to caribou behaviour related to environmental change.

I think there is really much truth in the statement that they keep a more easterly route than formerly, as they seldom come in large quantities to the Mackenzie River, where they used to be particularly numerous in winter. This is in great measure accounted for by the fact that great stretches of the country have been burnt, and so rendered incapable of growing the licken [sic] so dearly beloved by these animals. The same thing applies at Fort Resolution, where, within the last decade, the southern shore of the Great Slave Lake has been burnt and one of the best ranges totally destroyed. (Pike 1892:46)

According to Pike, Beaulieu often shared traditional stories with him, "*usually some tradition handed down from the time when all the animals and birds could converse together*" (Pike 1892:78). Pike called one of the stories "*the Deluge*," and transcribed it from Beaulieu's telling. It is an origin story that hinges on climatic events, suggests cultural knowledge of continual change in seasonal climatic conditions, and is embedded with examples of climate-related cultural knowledge such as the ptarmigan turning white when the snow begins to fall:

Many years ago, so long ago in fact that as yet no man had appeared in the country of the Slave Lake, the animals, birds, and fishes lived in peace and friendship, supporting themselves by the abundant produce of the soil. But one winter the snow fell far more heavily than usual; perpetual darkness set in, and when the spring should have come the snow, instead of melting away, grew deeper and deeper. This state of affairs lasted many months, and it became hard for the animals to make a living; many died of want, and at last it was decided in grand council to send a deputation to Heaven to enquire into the cause of the strange events, and in this deputation every kind of animal, bird, and fish was represented. They seem to have had no difficulty in reaching the sky, and passing through a trap-door into a land of sunshine and plenty. Guarding the door stood a deerskin lodge resembling the lodges now in use among the Yellow Knives; it was the home of the black bear, an animal then unknown on the earth. The old bear had gone to a lake close at hand to spear caribou from a canoe, but three cubs were left in the lodge to take care of some mysterious bundles that were hung up on the cross-poles; the cubs refused to say what these bundles contained and appeared very anxious for the return of the old bear.

Now the idea of spearing caribou did not find favour with the deputation from below, and as the canoe was seen lying on the shore of the lake, the mouse was dispatched to gnaw through the paddle, and as he had nearly accomplished this feat the bear came running down in pursuit of a band of caribou that had put off from the far shore. When he was close up to his intended victims and was working his best, the paddle suddenly broke, the canoe, capsized, and the bear disappeared beneath the water. Then the animals, birds, and fishes grew bold, and pulling down the bundles, found that they contained the sun, moon, and stars belonging to the earth; these they threw down through the trapdoor to lighten the world and melt the snow, which by this time covered the tops of the tallest pine-trees. The descent from Heaven was not made without some small accidents. The beaver split his tail and the blood splashed over the lynx, so that ever afterwards till the present day the beaver's tail is flat and the lynx is spotted; the moose flattened his nose, and many other casualties occurred which account for the peculiarities of various animals, and the little bears came tumbling down with the rest.

And now the snow began to melt so quickly that the earth was covered with water, but the fish found for the first time that they could swim, and carried their friends that could not on their backs, while the ducks set to work to pull up the land from beneath the water. But it was still hard to make a living, so the raven, then the most beautiful of birds, was sent to see if he could find any place where dry land was showing; but coming across the carcass of a caribou he feasted upon it, although the raven had never before eaten anything but berries and the leaves of the willow. For this offence he was transformed into the hideous bird that we know, and to this day is despised of every living thing; even omnivorous, man will not eat of the raven's flesh unless under pressure of starvation. The ptarmigan was then sent out and returned bearing in his beak a branch of willow as a message of hope; in remembrance of this good action the ptarmigan turns white when the snow begins to fall in the Barren Ground, and thus warns the animals that winter is at hand. But the old life had passed away and the peace that had reigned among all living things was disturbed. The fish, as the water subsided, found that they could no longer live on the land, and the birds took to flying long distances. Every animal chose the country that suited it best, and gradually the art of conversation was lost. About this time too, in a vague and indefinite manner about which tradition says little, the first human being appeared on the shore of the Great Slave Lake. (Pike 1892:78–81)

Pike indicated that "*King and his son François were the best linguists of the party*," and were in fact, two of only "*three or four*" Métis he could understand at all (Jones 2014:40; Pike 1892:26). Pike occasionally credited King with having provided place names, stories, or other information, as when he referred to sleeping without shelter and "*finding ourselves covered with an extra blanket of snow (le couvert du bon Dieu, as King called it) in the morning*" (Pike 1892:58). But his account is frequently coloured with specific and elaborate information for which he did not provide a source. It is possible then, and perhaps likely, that highly specific local climate and environment-related knowledge displayed in passages such as the one below was provided to Pike by Beaulieu:

In the afternoon we put out in a calm to paddle across the open traverse to the first of a group of islands about fifteen miles to the north. This traverse is the terror of the lake for canoes, both in summer on account of the heavy sea which gets up suddenly, and in winter when the drifting snow in stormy weather obscures everything and makes it a difficult matter to keep the course over the ice. (Pike 1892:25–26)

A similar passage offered an unattributed explanation for the name of a place that was a Métis camping and fishing site strategically located where they had been windbound, as Pike (1892) writes, "*we were wind-bound again, and indeed for several days made very little headway against the northerly gales that seem almost incessant at this time of year*" (28).

A hard day's paddling brought us to a spot known as the Inconnu Fishery, situated on an island halfway to Fond du Lac. The Inconnu, or Unknown Fish, is … named by the early voyageurs of the Company, who were unable to classify it, and even to this day there is a great variety of opinion as to what family it is a member of … At this particular island it will take a bait readily, but I never heard of its doing so in any other part of the lake, although large numbers are caught in nets. There is some peculiarity in the water which may account for this, as, even in the dead of winter, there is generally an open hole in the ice; and, in passing the Inconnu Fishery, one must keep right ashore to avoid the treacherous spot. (Pike 1892:27–28)

Pike's account is peppered with this contextual climate- and environment-related knowledge, presumably gleaned from but only occasionally attributed to his Métis guides, which provides a late-nineteenth-century snapshot of existing and evolving Métis cultural knowledge.

North Slave Métis Alliance transcripts

As mentioned earlier, an analysis of the transcripts of interviews conducted for NSMA's previous traditional land use studies revealed NSMA members sharing extensive cultural knowledge related to climate and the environment. In many cases, this knowledge was conveyed in passing as participants responded to questions about harvesting activities, travel, and other land use activities pursued throughout their lifetimes. In these instances, and where no further questions were posed during the interview to elucidate the knowledge shared, the project team's analysis included a limited amount of interpretation in order to draw out the knowledge being revealed. The transcripts demonstrate NSMA members' extensive knowledge of the winds and corresponding wave action on Great Slave Lake, and the North Arm specifically. Participants reported planning travel routes according to their knowledge of winds and wave action in the North Arm, as well as selecting destinations, timing, and even modes of transportation based on this knowledge:

In this area here, the North Arm, the lake water can go up and down four feet depending on wind direction, and that's just daily occurrence and that. There's people that've gone in, take a motorboat in some of those bays, and wind change direction, starts blowing out of the north, and then their boat is stranded out on the mud flats. So you've got to be careful where you park… When you get past Old Fort there, that whole North Arm there north of Old Fort Island is only about 12 feet deep. There's not any really deep places in it. And if you get a good north wind coming out of there to push all that water past Old Fort Point, and it'll just suck it out into all of these bays up in here. Which is part of what makes it such a good area in there, it's flushing in and out all the time… In the fall there is really good, I don't know, quality fish. I've only taken

a few out of there, but you get a pretty good volume of whitefish running up through there, like to the falls and rapids. (TUS#694, 2015)

For these weather-related reasons, Old Fort Island on the west side of the North Arm is a traditional landmark and destination for Métis travellers and harvesters:

[At] Old Fort Island we looked around a bit. There was some signs of people having camped there. Some people go down moose hunting there in the fall. It's a pretty good area actually along that side. But you know in the fall you can get some wind too, so you have to have a good boat to get there and back. (TUS#694, 2015)

Other participants indicated knowledge of the challenging wind and water conditions in the area when they reported avoiding the North Arm altogether, specifically because of these factors:

I don't like traveling on the North Arm 'cause it's dangerous water in there. It's really unpredictable, and it actually has a tide too. You know where Bear Healing rock is? Well, right at the end, it's on this side of Behchoko, or Frank's Channel, couple kilometres on the lake side, the water goes down about this much when it's at the bottom end. I couldn't believe it either. So, it affects the whole North Arm, and so at the top of your waves, and they can get pretty big out there, you got ground on the bottom, and boats don't float on ground. So there's been a lot of accidents out there, and they still haven't found a lot of people because of that. Plus there's a lot more reefs in there, it's not as deep as the other side. So, and there's no trout in that area. There's whitefish and jackfish and conies and things like that, but there's no trout in that area. (TUS#817, 2015)

Interview participants described a practice of making offerings of matches or tobacco to the waves near Old Fort Rae. Indeed, displaying knowledge of environmental change, they indicated that because water levels in the North Arm had gone down and wave action had diminished, such offerings then made passage possible beyond points that historically required portaging near Old Fort Rae. NSMA's interview transcripts suggest the practice of leaving offerings to protect from storms and bad weather and to ensure favourable conditions for safe travel, particularly by boat, is common throughout its membership:

[Métis] always leave something behind, you know, as an offering. Yeah, even when you fish, like, or when you are going out in a boat. Like, you can offer tobacco to the water for a giving, to give you a safe trip, you know. And ask for, to the spirits, to guide you there safely and bring you home safely [because] you're going out to put food on your table and feed your family and that kind of thing. Yeah, usually, like, you would offer, when you do catch something, you offer some of that food to the fire because the fire is the one that is sort of feeding you, that is going to feed you. So, whenever I go out on a boat I always give tobacco to the water, and when I'm out and if we get ducks or something like that I'll give some to the fire… That's like your role in the whole grand scheme of things, like… trying to be respectful to the land. (TUS#5, 2001)

With respect to climate change, interview respondents reported knowledge of a general warming of both weather and water temperatures, which had driven fish deeper in search of colder water. Respondents indicated that they had adapted to this change by fishing in deeper water for the same fish they had caught previously in shallower water at the same time of year. They also reported decreasing water levels on Great Slave Lake beginning in the 1970s, with water levels at the time of the interviews measuring three to four feet lower than in the past. Interviewees reported that weather patterns had changed considerably, bringing warmer, shorter winters that were marked by less snow and more wind. Historically, seasonal weather conditions had driven the development and selection of different Métis fishing techniques, some of which, participants explained, were no longer practised due to environmental impacts associated with climate change. The following exchange between the interviewer and one participant described a traditional Métis fishing technique that was developed when "the ice used to be thick":

Participant: *In the wintertime, about after Christmas, the ice is thick, cold. Used to be four or five feet deep, eh. So they used to put a hook there and another one, the length of the net, eh. Put another one there, so trout gets caught there and gets caught over there. Then together they would swim around, they get caught, together. So, when you come to pull on it, you know they are together, so you put another line on it, and then pull it out there and you got a line under the ice, eh. Now all you got to do is put your net on there, and set your net. (laughs) They used to set a net that way. That's how they used to do it. Smart, eh?*

Interviewer: *The Métis would do this?*

Participant: *Yeah, they used to do that, yeah. Sure, the ice was thick so all you had to do was punch two holes. Otherwise you have to punch about five or six holes, eh, take you all day to set one net. You get two holes, eh, a string and a hook then the trout gets caught together. Then pull it out one, tie a rope on the other side and take your trout out, and your line, and your line, and tie a net onto it, and put it back in and the net is set.*

Interviewer: *Is that a typical way of, Métis way of setting nets?*

Participant: *Yeah, that's the way they used to do it. In fact, Dad's got a picture down here at the Northern, him and Phillipe … They got a big trout there. Cold there, they are all dressed up. I seen his picture down there.*

Interviewer: *So did Indians fish like that too.*

Participant: *Well, I guess the Métis taught them how to.*

Interviewer: *(laughs) Because that's a pretty neat way of doing that, eh?*

Participant: *Pretty neat way of doing it.*

Interviewer: *Is that especially when the ice was really, really thick?*

Participant: *Real thick, yeah … holy, the ice used to be thick. (TUS#52, 2001)*

Traditionally, seasonal weather conditions have not only been a critical factor in determining when species with year-round availability are harvested, but have driven the development and use of storage techniques. Interview participants shared cultural knowledge related to the selection and use of animal hides and duck feathers to fashion the warm clothing and bedding traditionally required to provide insulation against the anticipated cold of Arctic winters. For instance, they explained that winter caribou hide has longer hair that falls out too easily, and that summer hides with their shorter, denser fur are therefore better for providing warmth. Participants also recalled their parents saving the feathers from duck hunts to be used as down stuffing for comforters, pillows, and other bedding. As revealed in NSMA's interview transcripts, Métis traditional knowledge contains both practical knowledge of seasonal weather patterns and awareness of a gradual and consistent change in overall temperatures and associated conditions. Interview respondents suggested that before the middle of the twentieth century, there were comparatively fewer forest fires in the Northwest Territories, and that they were more often man-made, whereas during the second half of the century, fires were more likely caused by lightning. They also reported changes to fish habitat and movements as a result of both higher temperatures overall and warming temperatures earlier in the season:

One thing I have noticed for Pauline Bay area is these years we've had hot weather and the ice goes out early. The water really warms up a lot, so you're starting to catch pike out in Hearne Channel, which you never would get before. You'd find them in the shallow bays, maybe along the river there. But we're out trolling for trout in the deep water, we got one on, reeled it in and it was a big pike, and we'd never seen that before. I'd never seen it before… Think it just warmed up so much that they're able to just go out there. (TUS#694, 2015)

Based on their knowledge of the species they have harvested for generations and their preferred habitats, NSMA members also reported knowledge of changes to the health, behaviour, and distribution of wildlife as a result of warmer temperatures. Interview respondents observed that migration patterns for caribou had changed over the twenty years preceding the interviews, and they reported that caribou used to be fatter and the fat was distributed more evenly over the animals' backs, hips, bellies, and chests. In the following exchange, a Métis harvester described the northern migration of parasites, as a result of milder winters, and changes to caribou migration patterns and food sources due to increased forest fire activity:

Participant: *I'm starting to hear of some cases of, like, parasites on the outside of the moose, ticks, and I've seen that, where the moose gets like those big warts on them. I've seen a bit of that.*

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Interviewer: *Ticks, eh, pretty far north.*

Participant: *Yeah, that was ticks. Yeah, that's bad news if it comes up here. Like Manitoba moose population has gone… taken a real nosedive because of those things, eh? Yeah, it's really hard on a moose. You start getting mild winters and it becomes a real problem.*

Interviewer: *Yeah. So do you see any change in the number of animals at all?*

Participant: *I think there's probably, it seems like there's more moose, although looking at my success in the last few years you wouldn't think so. But, yeah, I think a sort of observation of other people [is] ... they see more moose, you know. When they are out flying or whatever.*

Interviewer: *And what about caribou?*

Participant: *Caribou I think they are about the same. But, you know, distribution changes like every year, where they will move into a different area. And I think, you know, that is starting to, with the pattern of fires that we've had and stuff, it could present some problems locally.*

Interviewer: *Yeah, people depend on that.*

Participant: *Yeah, we certainly got indications for the herds themselves, eh. They are starting to burn up all their forage out there. (TUS#81, 2001)*

North Slave Métis Alliance members also reported that warmer temperatures and changes to precipitation patterns and soil conditions were causing corresponding changes in the berries they had traditionally gathered:

I've seen a change in berries, yeah. Like, we've had bad weather. In the School Draw it was all development, totally destroyed all those berry beds down there. I find that the strawberries, not the strawberries but the raspberry bushes that we used to know and see around, the berries have gotten smaller, and they're always dusty for some reason, and they've dried up. I don't know, it's probably because of drought. Too hot and dry. And even the cranberries. Like, last year I thought it was going to have lots, but it was too hot and dry. I had no berries. The first year I was there I had lots of cranberries, but last I didn't have anything and this year I'm going to wait and see. Even off in the bush, when I would go walking off in the bush, no cranberries. I couldn't believe it! (TUS#5, 2001)

NSMA members described all of these climate change impacts in contrast to conditions that they expected to encounter based on their cultural knowledge. In this way, when Métis frame impacts, they also reveal cultural knowledge of baseline trends and expectations against which they set the impacts, as well as processes of knowledge change. Interview participants suggested that the climatic and environmental changes they observed had become considerations for them when evaluating the risks and benefits of development within their traditional territory:

You're also creating all these exits for gas, oil and gas. You create [exits] for methane gas to come out, add to the greenhouse gas in the atmosphere, which is not good. And they say that there is sufficient oil and gas on the books right now to take us well beyond the 2-degree temperature increase, which is the critical point. And they say that just the stuff that's on the books is up to six times more than what is needed to take us to that 2-degree increase. So it's quite the situation. Do we want to contribute to something like that? (TUS#694, 2015)

The NSMA's transcripts show that Métis cultural knowledge of climate change is rooted in applied knowledge of historical climatic and environmental conditions, including special practices related to these conditions, and in observation and analysis of recent and continual deviations from historical norms. Métis cultural knowledge suggests that in addition to the variability in weather and corresponding environmental conditions anticipated from year to year, climate change is producing an overall warming, with impacts on the health, behaviour, and distribution of fish and wildlife, which are related to impacts on seasonality, precipitation, water levels, and ice quality.

Conclusions

Environmental knowledge is central to Métis history insofar as it is the body of knowledge acquired through close association with traditional practices, which Métis individuals were often called upon to share in their frequent roles as middlemen. Warburton Pike's *The Barren Ground of Northern Canada*, provides a late-nineteenth-century snapshot of the importance of Métis knowledge related to climate and the environment, as demonstrated by his guide, King Beaulieu, and Beaulieu's kinsmen. As mentioned earlier, Pike's account of the party's route and decisions made along the way about when, where, and how to travel, shelter, harvest food, and gather supplies, revealed cultural knowledge held by his Métis companions. He also recorded Beaulieu's traditional stories, which are embedded with cultural knowledge of climate and environment, including awareness of seasonal and continual changes within both and indications of possible Métis knowledge regarding climatic and environmental change affecting animal behaviour.

The NSMA's interview transcripts are somewhat nuanced on the subject of changes to climate and the environment. They record knowledge of both continual changes in weather (i.e., variability in weather and corresponding environmental conditions from year to year), and also gradual but continual changes in temperatures and corresponding conditions over time (i.e., overall warming). Based on their knowledge of the species they have harvested for generations and their preferred habitats, NSMA members reported changes to the health, behaviour, and distribution of wildlife as a result of warmer temperatures. They reported changes to fish habitat and movements as a result of both higher temperatures overall and warming temperatures earlier in the season. They also described traditional Métis fishing techniques that were developed when "*the ice used to be thick*" but could no longer be practised due to environmental changes. NSMA members' observations of climate change impact, such as changes to the health, behaviour, and distribution of wildlife as a result of warmer temperatures, also revealed cultural knowledge related to climate and environment by contrasting these changes with the established norm their Métis cultural knowledge anticipated. In reporting, for example, changes to fish habitat and movements as a result of both higher temperatures overall and temperatures warming earlier in the season, participants may have also been indicating the ongoing refinement of Métis cultural knowledge related to climate and climate change. NSMA members' cultural knowledge of climate change is rooted in applied knowledge of historical climatic and environmental conditions, including special practices related to these conditions, and in observation and analysis of recent and continual deviations from historical norms. This cultural knowledge suggests that in addition to the variability in weather and corresponding environmental conditions anticipated from year to year, climate change is producing an overall warming, with impacts on the health, behaviour, and distribution of fish and wildlife, which are related to impacts on seasonality, precipitation levels, water levels, and ice quality.

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