Investigating climate change impacts on Arctic Charr *(Salvelinus alpinus)* in Canada and the Circumpolar Region: Environmental and species interactions

by

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A thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfilment of the requirements of the degree of

MASTER OF ENVIRONMENT

Department of Environment and Geography

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Winnipeg, Manitoba

Abstract

One of the greatest challenges for researchers today is understanding climate change impacts on fish populations, particularly in vulnerable ecosystems such as the Canadian Arctic. Northern fish populations will undergo thermal stress as atmospheric temperatures are projected to rise globally. Models that consider both environmental factors and species interactions can help project the future distribution of a species. This thesis investigates the climate change impacts of rising temperatures and the potential northward shift of Brook Trout (*Salvelinus fontinalis*) on Arctic Charr (*Salvelinus alpinus*), Canada's highly valuable and northernmost fish species. Understanding the current distribution of Arctic Charr in Canada will help determine future projections based on warming temperatures and species interactions. A logistic regression model for Arctic Charr evaluated a baseline time period (1976-2005) using growing-degree day, longitude, latitude, and Brook Trout occurrences, correctly classified 93% of Arctic Charr occurrences in Canada. The distribution of Arctic Charr is projected to contract by 18% in Canada by the time period of 2051-2080 using a High Carbon scenario. The projected distributions only included known native populations of Arctic Charr and Brook Trout and excluded any deliberate or accidental human-induced introductions. The decrease in the projected distribution of Arctic Charr could be attributed to warming atmospheric temperatures that lengthen growing seasons in the Arctic. The Canadian high Arctic will provide refuge for Arctic Charr, where conservation efforts will need prioritizing.

Acknowledgments

Research in environmental sciences matters and is critical to finding ways to protect biotic and abiotic components, as well as a vital way to spread awareness. This work is now a part of who I am as a person, and it would not be made possible without the numerous people and organizations that supported me along the way.

First and foremost, I thank my supervisors, Ross Tallman and Rick Baydack. I thank Ross for helping inspire the idea for my project. Your expertise and knowledge in the subject have been incredibly appreciated. Thanks for going back and forth to discuss research ideas. I thank both Ross and Rick for trusting me while I carried out this research, and for being monumental supporters at every step of the way. Enjoy your retirement Rick, it has been a great pleasure to complete my undergraduate thesis and now my Masters thesis with you. Valuable comments, critiques and meeting flexibilities were provided by my advising committee: Jeff Long, David Walker, and David Deslauriers. My successes are shared with all of you.

I thank the Whiteshell Fish Hatchery, Government of Manitoba, for also contributing to inspiring this project. I still remember the first day I visited the Hatchery when I worked as Park Patrol Officer at West Hawk Lake. Everyone was so friendly, and I was amazed by the work being done – and of course the beautiful Trout. I appreciated being able to be hands-on and help at the Hatchery. I specifically thank Jeff Long and Kevin Dyck for giving students opportunities to work. It is a valuable program for our Province.

Many thanks go to Nick Mandrak and his lab for sharing his research on Arctic Charr and Brook Trout distributions in Canada. Your wealth of knowledge inspires me.

I am particularly thankful for the Research Affiliated Program with Fisheries and Oceans Canada, and for Masters of the Environment Program at the University of Manitoba. I will cherish all the professors and students I befriended throughout my degree. Thank you to graduate students – Erica Werhun, Gabrielle Grenier, and Brendan Malley for the simple check ins and for being in this together. Thank you to Michelle Wetton-Salo for the little things – like helping book a boardroom for a discussion.

Finally, my utmost thanks go to my family. My parents showed me the world from a young age. I thank them for nurturing my curiosities. A huge thanks goes to my Mother Anita for being my number one cheerleader and best friend since day one. A special thanks to my Husband Kevin for his continuous encouragement and for always believing in me and my passions. This research is dedicated to my son, Arlo – the world is your oyster! And like my Mom has always said to me – reach for the moon and even if you miss you'll land among the stars.

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List of Abbreviations

AIC – Akaike Information Criterion
COSEWIC – Committee on the Status of Endangered Wildlife in Canada
GDD – Growing degree-day
GHG – Greenhouse gas
IPCC – The Intergovernmental Panel on Climate Change
PCIC – Pacific Climate Impacts Consortium

List of Equations

Equation 1: GDD: [(max daily temp + min daily temp)/2] – base temp = GDD 24

Equation 2: $$Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$ 33

Equation 3: $$AIC = 2K - 2ln(L)$$ 35

Equation 4: **O = 59.51 – 0.005(D) + 0.73(H) – 0.72(V) – 0.28(B) – 0.01(H*V)** 37

Equation 5: P = exp(y*)/(exp(y*)+1) 55

1. Chapter 1: Introduction and Literature Review

1.1. Climate Change and Arctic Fish

Management strategies that appropriately deal with climate change impacts must consider the sustainability and adaptability of fish stocks. In Canada, the Prime Minister mandates the importance of using scientific research and the precautionary principle when deciding on climate change impacts affecting fish stocks and vulnerable ecosystems (Lennon & Perry, 2018). One major challenge researchers face is understanding the climatic effects on fish population behavior and dynamics within Arctic ecosystems (Ulvan et al., 2011). An improved understanding of climate change impacts on fish is relevant for Arctic biodiversity, ecosystem health, and food security (Van Vliet et al., 2013).

The Intergovernmental Panel on Climate Change (IPCC) has reported that many parts of the world are already experiencing the consequences of 1°C of global warming through increased climate events and rising sea levels (IPCC, 2018). Recent research documented observations of climate warming and how changes in environmental factors associated with anthropogenic climate change affect the livelihoods of communities situated in the Arctic (Pearce et al., 2015; Falardeau et al., 2022). The Arctic is becoming an emerging hot spot for frequent access to oil and gas reserves, expanding shipping routes, and other economic opportunities, including tourism in the Arctic (Jeffers, 2010). The IPCC has reported that if human activities through anthropogenic global warming continue to increase at the current rate, global warming will likely reach 1.5°C between 2030 and 2052, with the Arctic experiencing impacts two to three times faster than the global average (IPCC, 2018; Falardeau et al., 2022). Rapid temperature increases associated with climate change likely directly affect the Arctic by altering the aquatic ecosystem's environmental factors (Rouse et al., 1998). Some of these environmental factors in the Arctic include changes in water levels, varying river flow, increases in water temperatures, fluctuating nutrient supply, and changes in water quality (Van Vliet et al., 2013; Ficke et al., 2007).

Arctic communities depend on fish and wildlife for subsistence, and climate change has diminished the physical condition and availability of fish over the years (Pearce et al., 2015). Ulvan et al., (2011) described how climate change will affect the temperature dimensions at fish ecosystem boundaries and some of the most profound impacts are known to occur in the Canadian Arctic. The Arctic has the highest proportion of species potentially threatened with thermal stress, which may cause local extinctions, northward shifts of species ranges, and forced adaptation (Van Vliet et al., 2013; Rouse et al., 1998).

Charrs are of concern due to the rapidly changing Arctic environments (Reist et al., 2013). The Family Salmonidae (Charrs, Salmons, and Trouts) comprises 11 genera with about 70 species worldwide (Coad & Reist, 2017). Of those species, 42 are found in Canada, and 17 are in the Canadian Arctic (Coad & Reist, 2017). They are primarily freshwater fishes, but some are anadromous fishes that migrate to marine environments and return to freshwaters to reproduce (Coad & Reist, 2017; Johnson 1980). There are five Charr species native to North America, and they are distinguished from other salmonid genera by their light-coloured spots on their dark back and the number of their anal fin rays (Lane, 2013). Charrs are primarily cold-water adapted and sensitive to extreme warming (Coad & Reist, 2017; Johnson 1980).

1.2. Arctic Charr *(Savelinus alpinus)*

Arctic Charr are restricted to cold water environments and can survive at temperatures as low as 1°C, making them the most cold-adapted salmonid species in the world (Gerdeaux, 2011; Brannas, 1992). Arctic Charr have a circumpolar and northernmost distribution (about 84°N) more than any other freshwater or anadromous fish in the world (Reist et al., 2013; Brunner et al., 2001; Johnson, 1980). In Canada, Arctic Charr are found in the Yukon, northern Northwest Territories, and Nunavut, along the Hudson Bay, Ungava, Newfoundland, and the St. Lawrence River (Lane, 2013; Scott & Crossman, 1973; Figure 1).

Arctic Charr are a well-adapted species that survived in glaciated polar regions south of the North American ice sheets during the last glacial maximum (Moore et al. 2015). Cold waters, likely extend the southernly limit of Arctic Charr in freshwater lakes due to glaciated polar regions (Reist & Sawatzky, 2010). Within these glaciated polar regions, Arctic Charr colonized postglacial lakes and rivers where few freshwater fish species are commonly found (Moore et al., 2015; Arbour et al., 2010). Moore et al. (2015) explored the genetic makeup of Arctic Charr populations and concluded that Arctic Charr found in Canada originated from a small refugial population from the Arctic Archipelago or within Beringia. The range of this species was repeatedly impacted during Pleistocene glaciations through refugia during colder conditions and dispersal during warming conditions (Brunner et al., 2001).

Literature describes Arctic Charr as one of the most diverse fish species in northern Arctic aquatic ecosystems (Reist et al., 2013; Johnson, 1980). Arctic Charr are an example of a polymorphic salmonid that displays morphological differences depending on habitat use and diet (Skúlason & Smith 1995; Arbour et al., 2010). Ecological plasticity tactics such as varying life history traits enable Arctic Charr to survive in the coldest oligotrophic habitats (Hammer et al., 1991). Some populations complete their entire life cycle within freshwater, significantly varying in size and body morphology (Reist et al., 2013; Power et al., 2008). Arctic Charr can also be anadromous, where considerable growth occurs at sea, and they return to freshwater for reproductive purposes (Coad & Reist, 2017). In the Canadian high Arctic, Arctic Charr spawn in autumn, usually in September or October (Scott & Crossman, 1973). Arctic Charr that inhabit Canadian water systems further south are known to spawn as late as November or December (i.e., Matamek River, Quebec; Scott & Crossman, 1973). Within their distributional region, Arctic Charr are recognized for their range of functional and ecological diversity (Reist et al., 2013). Arctic Charr are considered a habitat generalist and occur in lakes, streams, rivers, and the sea across the Holarctic region (Reist et al., 2013).

Considering a situation with unlimited food supply, the optimal temperature for Arctic Charr growth and development lies between 14.4°C and 17.2°C (Hein et al., 2012). However, situational conditions where food is not readily available, the optimal water temperature for Arctic Charr growth and development is likely much lower (Hein et al., 2012). Knowing that Arctic Charr are cold-water adapted species, they have a low resistance to increased water temperatures (Reist et al., 2013). Warmer water temperatures will limit their habitat choices in the projected future. Arctic Charr may be restricted in lake habitats, where ideal habitat preferences may be lake bottom habitats (>30 meters; Reist et al., 2013). Thermal stress to Arctic Charr is one foreseeable long-term impact due to climate change.

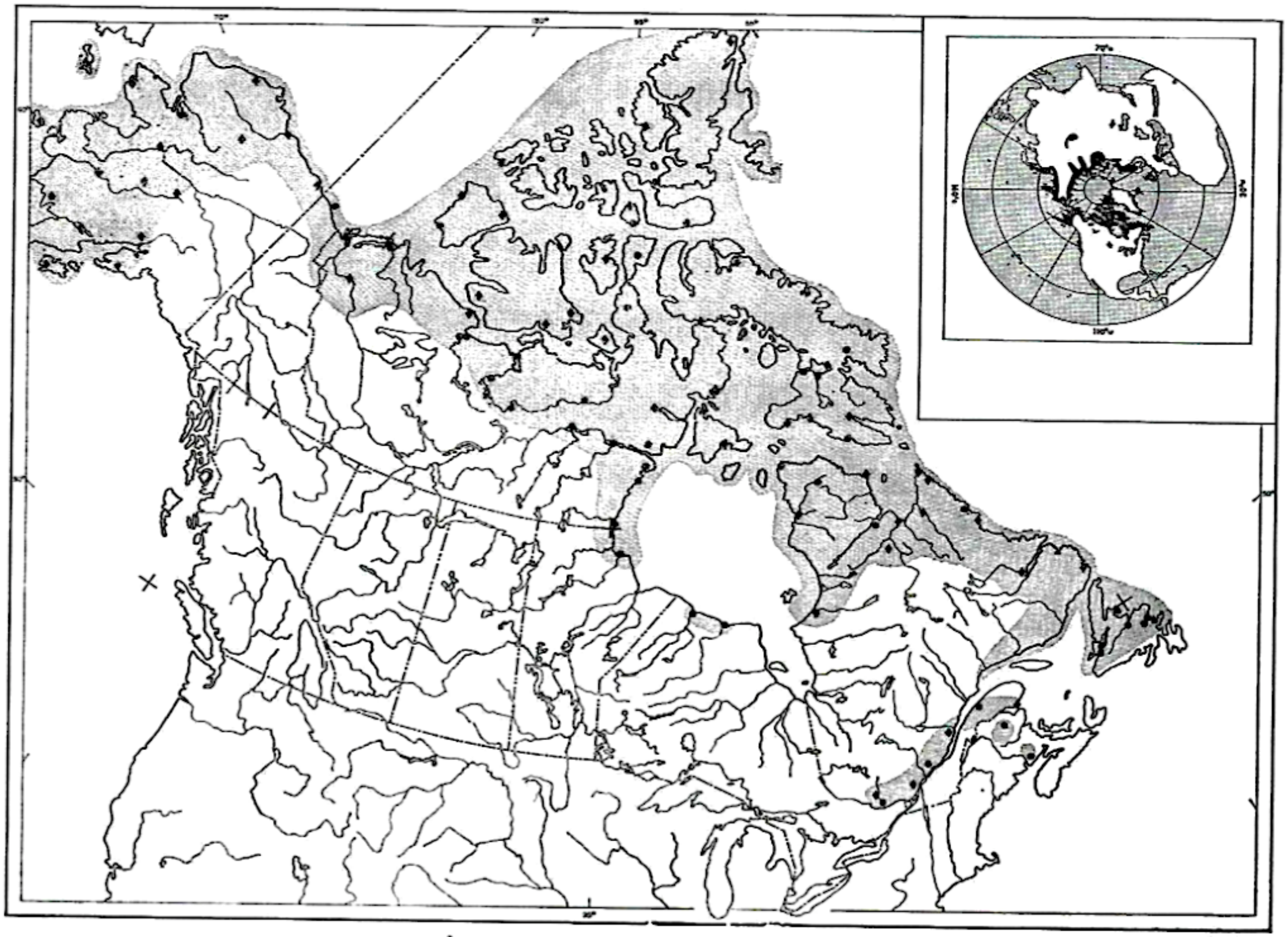

Figure 1: Canadian distributional range of Arctic Charr shaded in grey. Arctic Charr circumpolar distributional range found in the top right corner (Scott & Crossman, 1973).

1.3. Brook Trout *(Salvelinus fontinalis)*

Brook Trout *(Salvelinus fontinalis)* also often called Brook Charr, are a cold-adapted species (Maine Department of Inland Fisheries & Wildlife, 2010). Brook Trout are another endemic species to North America (Chadwick & Stephen, 2017; Scott & Crossman, 1973). Under natural conditions, Brook Trout occur only in northeastern parts of North America, southeastern parts of Canada (Scott & Crossman, 1973). In North America, the distributional range for Brook Trout consists of the Atlantic seaboard, in the Appalachian Mountains, west in the Great Lakes drainages to Minnesota, and northern parts of Manitoba to Hudson Bay (Scott & Crossman, 1973; Figure 2). Particularly in Canada, Brook Trout are widely distributed in eastern Provinces, including Newfoundland, Labrador, Quebec, through the Great Lakes drainage and northern parts of Ontario and Manitoba, including James and Hudson Bays (Scott & Crossman, 1973).

Brook Trout thrive in northern latitudes as they are limited by warm water temperatures and are known as habitat generalists found in lakes, streams, and can be known as sea-run or anadromous (Lenormand et al., 2004; Maine Department of Inland Fisheries and Wildlife, 2010). Brook Trout are not commonly a marine oriented species as anadromy can be a risky venture (Gunn & Snucins, 2010). Therefore not all Brook Trout head to marine environments as some remain freshwater residents favoring stream and lake habitats (Gunn & Snucins, 2010).

In North America, Brook Trout spawning can vary with latitude and temperature and depending on the seasonal changes such as late summer or fall (Scott & Crossman, 1973). Through southern and eastern parts of Canada, Brook Trout tend to spawn during late

September, October, or November (Scott & Crossman, 1973). Brook Trout spawning can take place in early August throughout northern parts of North America and occur late December in the southern part of Ontario (Scott & Crossman, 1973).

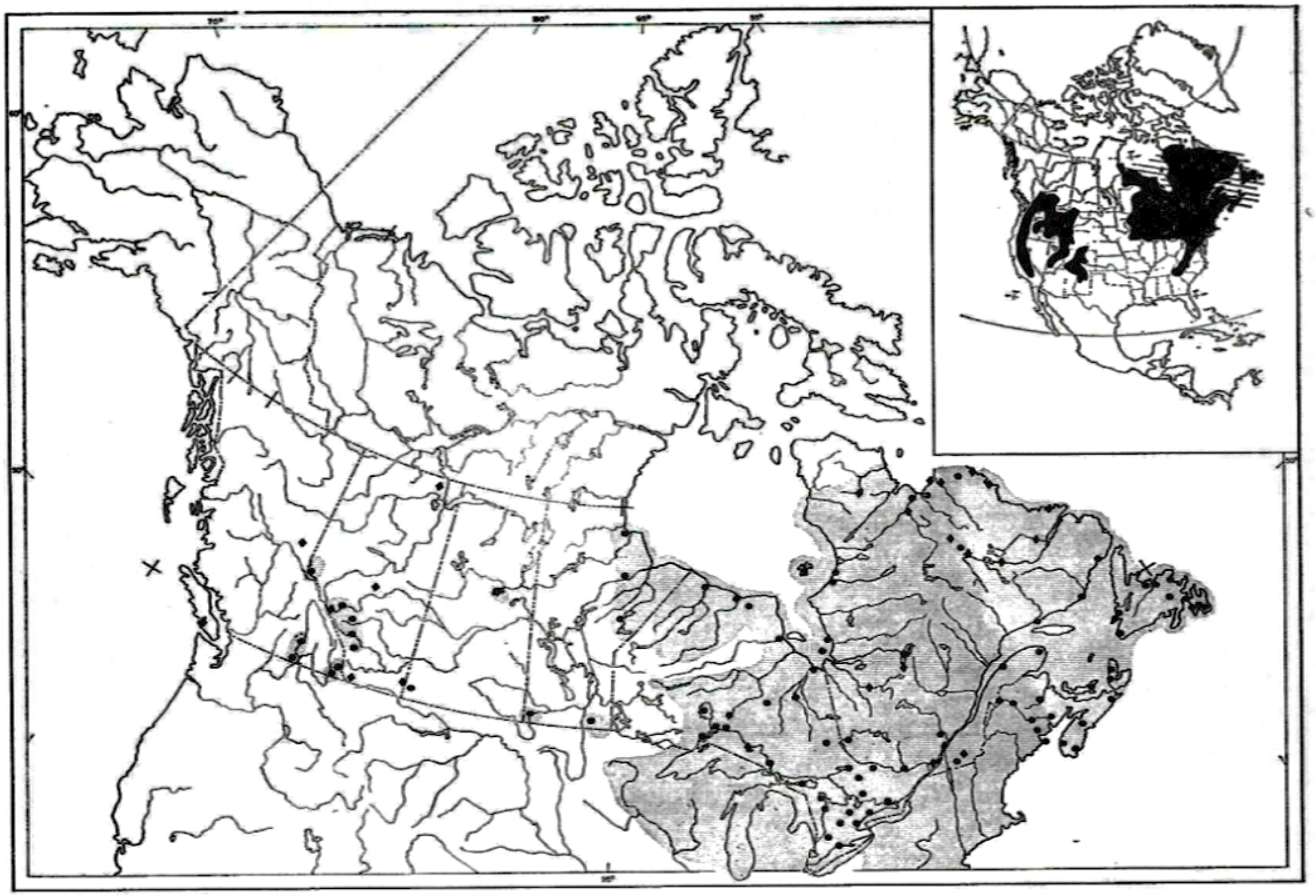

Figure 2: Canadian distributional range of Brook Trout shaded in grey. North American distributional range found in the top right corner (Scott & Crossman, 1973).

1.4. Arctic Charr and Brook Trout Interactions

Arctic Charr and Brook Trout share the same genus making them both freshwater Charr species that recolonized eastern Canada post-glaciation (Dupont Cyr et al., 2018). Arctic Charr and Brook Trout have similar morphological characteristics (Hammer et al., 1991; Scott & Crossman, 1973) and can exhibit both benthic and pelagic morphisms (Dupont Cyr et al., 2018; Skúlason & Smith, 1995). Arctic Charr and Brook Trout can be known as residents, where they have access to marine environments but prefer lake environments; landlocked, where they have no access to marine environments; or anadromous, where they make seasonal migrations between lakes and marine environments (Dupont Cyr et al., 2018). Stewart and Watkinson (2004) describe Arctic Charr, much like the Brook Trout, they can live in lakes and rivers that do not freeze to the bottom during the season of winter and can be optionally anadromous. They both use anadromy as a strategy for energetic and opportunistic marine feeding advantages to prepare for reproduction in freshwater habitats (Gunn & Snucins, 2010; Skúlason & Smith, 1995). Advantages of anadromy include increased fecundity, ovulation rate, egg size, and lipid content (Gunn & Snucins, 2010). While using the anadromy strategy, Arctic Charr and Brook Trout are considered feeding generalists and opportunists that eat suitable food that they encounter during dispersal (Dupont Cyr et al., 2018; Falardeau et al., 2022).

Native species of Arctic Charr and Brook Trout have overlapping distributions found in northeastern Canada, with Arctic Charr having a more northern distribution, and Brook Trout having more of a southern distribution (Glémet et al., 1998). Scott and Crossman (1973) consider freshwater populations of both species to be sympatric, where their distributions exist in the same geographical areas and may frequently encounter one another. Arctic Charr are considered allopatric in their northernmost distributions, where they utilize a broader niche through the life characteristic trait of anadromy because they rarely coexist with competing species (Hammer et al., 1991; Johnson, 1980). In their southern distribution, Arctic Charr tend to use a much narrower niche and are more commonly known to be landlocked or as residents (Hammer et al., 1991; Johnson, 1980). Their niche habitat preferences are mainly depicted by thermal regimes and water temperatures (Dupont Cyr et al., 2018). Arctic Charr are well adapted to harsh conditions and cold waters ranging from 5-19°C, and Brook Trout are also known as a cold-water adapted species but prefer water temperatures ranging from 8-20°C (Dupont Cyr et al., 2018).

Salmonid genera are the predominant fish group in the Canadian Arctic region. Hybridization can occur when one of the two salmonid species is introduced, when an environmental disturbance occurs, or when one species is bordering the natural ecological distributional range of another (Hammer et al., 1991; Peterson & Fausch, 2003). Hammer et al., (1991) studied the natural hybridization between Arctic Charr and Brook Trout in the Fraser River, Labrador. They concluded that hybridization might be a common occurrence in areas of Canada where the range of Arctic Charr and Brook Trout overlap naturally (Hammer et al., 1991). Environmental factors, such as similar spawning periods, drive Arctic Charr and Brook Trout to hybridize (Hammer et al., 1991; Peterson & Fausch, 2003). The effects of hybridization can impact genetics and ecosystem dynamics (Peterson & Fausch, 2003)

1.5. Distributional Range Expansions of Fish

In North America, spatially freshwater fish diversity decreases with latitude (Christiansen & Reist, 2013). Freshwater or anadromous Arctic Charr are known to have the northernmost distribution in North America (Wilson et al., 1996). Along Canada's mainland margin, Arctic Charr are found at the maximum extent of freshwater lakes and streams at about 84°N at Ellesmere Island, Canada (Christiansen & Reist, 2013). Longitudinally, the greatest fish diversity is found in regions that were unglaciated during the last glacial maximum (Christiansen & Reist, 2013).

Historically, the Pleistocene glaciations significantly impacted the evolution of fish in North America (Wilson et al., 1996). The repeated glaciations altered the genetic makeup and habitat range of many northern fish species, including Arctic Charr (Wilson et al., 1996; Johnson, 1980). The phenotypic plasticity strategies allowed Arctic Charr to disperse into glaciated polar regions after the last glacial maximum when North American ice sheets were at their greatest extent (Wilson et al., 1996; Moore et al., 2015). These glaciated polar regions provided freshwater habitats for Arctic Charr, which are required for their persistence and survival as a species (Wilson et al., 1996; Johnson, 1980).

The glacial meltwater provided freshwater lakes that Arctic Charr require as stable habitats for overwintering purposes (Wilson et al., 1996; Johnson, 1980). Arctic Charr use overwintering periods for growth and reproduction (Budy & Chris, 2014). Arctic lakes provide ideal habitats to allow Arctic Charr to grow and reproduce during the ice cover overwintering growing season (Budy & Chris, 2014). Glacial meltwaters also decreased salinity concentrations in marine environments, allowing anadromous Arctic Charr to survive and furthering their marine migration dispersal abilities (Wilson et al., 1996).

The evidence of repeated glaciations exposed Arctic Charr to a great range of natural selection forces, and the diversity among North American populations suggests that they have adaptable strategies (Reist et al., 2013; Skúlason & Smith, 1995). Wilson et al. (1996) studied the dispersal history and the genetic diversity of Arctic Charr. They found genetic differences among North American Arctic Charr, which indicated distributional dispersal patterns into separate origins of glacial refugia. The dispersal rates resulted from coastal movement or water connections overland (Wilson et al., 1996). Therefore, the persistence of Arctic Charr occurred in several refugia post-glaciation, which reflects the ecological differences among the genetic lineages (Wilson et al., 1996). Over time, the ecological pressures shaped the morphological, behavioural, and life-history characteristics of Arctic Charr populations (Skúlason & Smith, 1995). The ecological plasticity of Arctic Charr includes varying life history strategies to survive in very harsh and cold conditions (Hammer et al., 1991; Johnson, 1980).

Today, ecological pressures on fish now include climate change. The effects of climate change include a global increase in atmospheric temperature (Government of Canada, 2021). Global warming will intensify as a response to greenhouse gas (GHG) emissions from anthropogenic behaviours and activities (Government of Canada, 2021). Widespread warming in Canada can result in ecological pressures including annual global temperature rises, shorter ice cover seasons, increased nutrient availability, rising sea levels, and longer growing seasons (Government of Canada, 2021; IPCC, 2018). Climate change can disrupt the length of open-water seasons (Budy & Chris, 2014; Dunmall et al., 2022). Reist et al. (2013) explained how theoretical studies of climate change scenarios suggest that warming will create longer summer seasonal periods. This will create larger volumes of water temperatures for optimal growth in many northern fish species (Reist et al., 2013). Minor changes to the Arctic's thermal regime and the timing and durations of ice-free days, can affect fish persistence and survival of many temperate freshwater fish (Budy & Chris, 2014; Dunmall et al., 2022).

Reist et al. (2006) explored climate change impacts on Arctic freshwater ecosystems where it is very likely several fish species will extend their ranges northward, seeking preferred habitats. One scenario is in northern Quebec and Labrador and native Atlantic Salmon (*Salmo* *salar*), Brook Trout, and introduced Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*) may expand their ranges (Reist et al, 2006). In particular, Brook Trout is a species limited in their northernmost distribution by temperature (Reist et al., 2006). The southernly limits of Arctic Charr are highly likely limited in their southern range by temperature (Reist et al., 2006). However, some researchers consider the southernly distribution of Arctic Charr is likely limited by potential fish competitors (Reist et al., 2006).

Some temperate fish species are already widening their distributions northward to Canada's high Arctic regions. A climate-driven northward range expansion is common in fish species with vaster migration and dispersal abilities, increased reproductive rates, and greater ecological generalization of environmental conditions and resources (Alofs et al., 2013). Dunmall et al. (2013), studied Pacific Salmon (*Oncorhynchus spp.)* as they are considered ideal indicators of climate change because they are responding to increasing ocean temperatures in high Arctic environments. Due to rising ocean temperatures, Pacific Salmon are extending their range northward to search for thermally suitable habitats and are benefiting from increased productivity of nutrient availability (Dunmall et al., 2013; Dunmall et al., 2022). Pacific Salmon are now commonly found and tracked by fishers in the Canadian high Arctic waters (Dunmall et al., 2013; Dunmall et al., 2022). When a species expands its distribution northward, its survival of the species depends on establishing a self-sustaining reproductive population at that new latitude (Alofs et al., 2013). The continuous long-term impacts of climate change create reduced sea ice cover and longer durations of open water in the Arctic, which will allow the climate-driven marine migratory of Pacific Salmon to establish a self-sustaining reproductive population as (Dunmall et al., 2013).

Fish migrations and invasions can be by natural dispersal through drainage networks or can be human-induced by management stocking agencies and/or illegal introductions (Alofs et al., 2013). Dunham et al., (2002) reviewed Brook Trout invasions in the western United States and Canada, and their impacts on native Cutthroat Trout (*Oncorhynchus clarki*) populations. In this scenario, the Brook Trout invasion of dispersal was caused by management stocking programs in the early 1800s (Dunham et al., 2002; Peterson & Fausch, 2003). Brook Trout were introduced as a game fish and were heavily stocked in 35 states on the western side of the United States (Dunham et al., 2002). Since then, Brook Trout numbers have increased and have dispersed, while native Cutthroat Trout populations have rapidly declined (Dunham et al., 2002; Peterson & Fausch, 2003). Dunham et al., (2002) explained possibilities that suggest the rapid decline in Cutthroat Trout populations by Brook Trout being a competitor species using mechanisms of competition, predation, or disease transmission. Cutthroat Trout and Brook Trout have overlapping habitat niches (Dunham et al., 2002). Brook Trout can easily disperse in well-oxygenated rivers, lakes, and streams (Dunham et al., 2002; Peterson & Fausch 2003). Brook Trout dispersal rate can depend on habitat factors, most importantly including the direction and topography of the stream networks (Dunham et al., 2002). Peterson and Fausch (2003) looked at the dispersal ability of Brook Trout and the combination of their fast upstream movements and biological characteristics make Brook Trout effective invaders of stream headwaters, which is ideal habitat for Cutthroat Trout.

Range expansions can create interspecific competition among native and introduced species where a species' realized niche use and resources become compromised (Dunham et al., 2002; Reist et al., 2013). The ecological niche theory is where a species can carry out its life based on certain environmental conditions and resources; and is truly the basis for ecology and biogeography (Hutchinson, 1992). A species' realized niche is influenced by a multitude of factors such as growth, survival rate, reproduction, interspecific competition, predation, and parasites or diseases (Hutchinson, 1992). Management must understand a species' phylogenetic distributions through evolutionary history and the environmental conditions impacting its current distribution (Dunham et al., 2002; Figure 3). Figure 3 is a diagram that explains the successful establishment of a potential biological or climate-driven invasion, which can occur at the early stages of arrival through transport (Dunham et al., 2002). Another essential question for management is whether the species is a native or an invasive occurrence as the severity of managing the invasion could change (Dunham et al., 2002). The establishment of a potential biological or climate-driven invasion can be complex to solve and is becoming the new reality for many managers and policy makers.

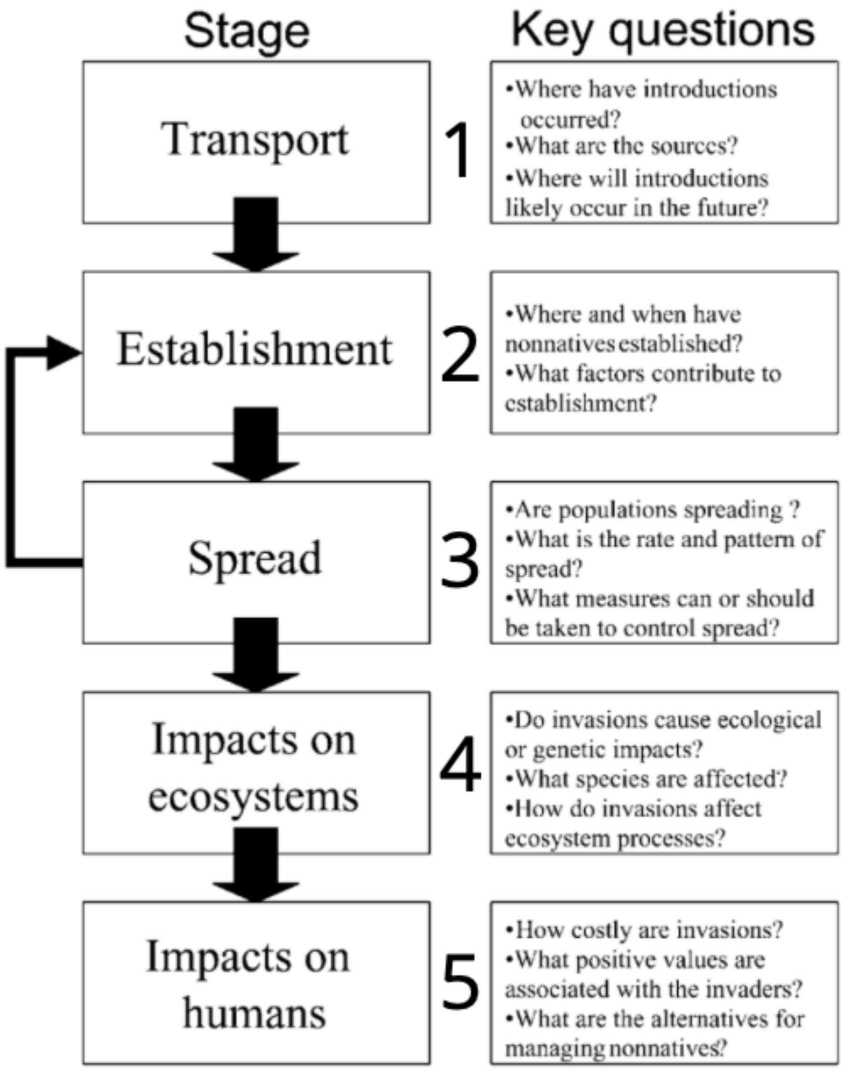

Figure 3: Generalized steps in an invasion process modified from Dunham et al., (2002). For each step, key questions should be addressed. Numbers indicate the steps but interactions among all stages are possible.

1.6. Climate Change Projections for Fisheries Management

Arctic Charr are highly valued and are considered an important subsistence and commercial fishery resource in the Arctic (Gallagher & Dick, 2010). Arctic Charr are known to be one of most valuable species in subsistence fisheries for centuries throughout parts of the Canadian Arctic, specifically Nunavut (Gallagher & Dick, 2010; Harris et al., 2016). In Cambridge Bay, Nunavut, Canada, anadromous Arctic Charr have been targeted by commercial fisheries since the 1960s (Harris et al., 2016). Fisheries management must consider the biology and ecology of a target fish species. An effective management strategy is to determine a fish stock, which is a unit of measurement that represents the demographics of fish populations (Harris et al., 2016).

In Canada's Arctic region, there are challenges with assessing and managing of fisheries for Arctic Charr (Roux et al., 2019). One challenge being the widespread distribution of stocks over vast and remote regions with the understanding of climate change impacts that will potentially affect overall stock productivity (Roux et al., 2019). Research by Harris et al. (2006) suggested that usually a regionally based management approach manages the commercial Arctic Charr fishery because of the genetic differences and reproductive isolation in the Arctic Charr samples. Fisheries stock assessment can be fundamental in detecting changes to the distribution of genetic variation and structure of Arctic Charr populations in a rapidly changing Arctic (Harris et al., 2016). Some conservation measures currently implemented include minimum gillnet mesh size and total harvest levels during a fishing season for Arctic Charr commercial fisheries (Government of Canada, 2021). Establishing an

Integrated Fishery Management Plan for commercial fisheries focuses on conserving Arctic Charr populations in Canada (Government of Canada, 2021).

A collaborative approach ensures the best available strategies to monitor and conserve the management decisions for Arctic Charr. In the Nunavut Settlement Area, Arctic Charr fisheries are co-managed by Fisheries and Oceans Canada, the Nunavut Wildlife Management Board, Regional Wildlife Organizations, and Hunter and Trapper Organizations (Government of Canada, 2021). Arctic Charr must follow the Nunavut Land Claims Agreement, the Fisheries Act, and its Regulations, and by local Hunter and Trapper Organization bylaws (Government of Canada, 2021). Roux et al. (2019) suggests that additional insights from local knowledge are important when managing Arctic Charr stocks. Local knowledge can provide additional information that can inform decision making on stock data collection on Arctic Charr; such as physical condition, parasites, migration timing and distribution shifts (Roux et al., 2019).

The Arctic is a region where ecological pressures of climate change are exemplary for other regions of Canada or other parts of the world. Canada's Arctic region deserves proactive approaches and focused attention due to the rate of climate change (IPCC, 2018; Chu et al., 2005). The precautionary principle is used for legal approaches where scientific research may be lacking; however, it is a proactive approach to designate a species as endangered before it is too late (Lennon & Perry, 2018). Chu et al., (2005) recommended modelling approaches to project a species' distribution in response to climate change and that this information should be incorporated into the selection of candidate species for conservation by COSEWIC (Committee on the Status of Endangered Wildlife in Canada). Currently, the selection process does not include modelling approaches to project a species distribution and this could be a proactive approach to conserve biodiversity in Canada (Chu et al., 2005). Another proactive and innovative example to manage the distributional range of a species is how Dunmall et al.,

(2013) studied Pacific Salmon and initiated a community-based monitoring program in the Canadian Arctic. The community-based monitoring program was an initiative from the research on Pacific Salmon being found in the Canadian high Arctic due to increasing temperatures and prey productivity (Dunmall et al., 2013). The community-based monitoring program reports any adult Pacific Salmon harvested as bycatch in subsistence fishery nets (Dunmall et al., 2013). Chila et al. (2022) research incorporated traditional knowledge and the Arctic Salmon Program; and suggested that Indigenous knowledge should be used to create and validate species distribution models. As the rate of environmental change in the Arctic increases, collaborative approaches that include traditional knowledge, political and economic scientifically based strategies will conserve vulnerable species (Chila et al., 2022; Dunmall et al., 2013). Canada must focus conservation efforts on vulnerable habitats and species diversity (Dunmall et al., 2013).

1.7. Thesis Outline

Climate change impacts can significantly affect the distribution of Arctic Charr in Canada. This thesis is arranged into two main chapters:

Chapter 2, entitled "Distribution Model for Arctic Charr," explores the development of an Arctic Charr distribution model for the time period of 1976-2005 in Canada. I hypothesized that a combination of environmental factors and species' interactions would be related to the distribution of Arctic Charr in Canada (Hypothesis 1). I predicted that the probability of Arctic Charr occurrence would be significantly related to the variables of growing degree-days and the occurrence of Brook Trout. I predicted that species' interactions would be more important/significant than growing-degree days. A model suite was performed to determine the best model to reflect the probability of Arctic Charr occurrences.

Chapter 3, entitled "Projected Distribution Model of Arctic Charr," explores the projected distributional range of Arctic Charr in Canada. I hypothesized that environmental factors, and the occurrence of Brook Trout would be related to the distribution of Arctic Charr for two future time periods of 2021-2050 and 2051-2080 (Hypothesis 2). I predicted that the change in growing degree-days and the presence of Brook Trout would be associated with a reduced likelihood of Arctic Charr occurrence. A spatial case study for Manitoba, Canada, was added to explore spatial impacts to the southernly distributional range of Arctic Charr. I predicted that the southernly distributional range of Arctic Charr in northern parts of Manitoba and Quebec would be significantly impacted in response to climate change. Insight into current barriers to conservation and future management policies within Canada was also explored.

Chapter 4, entitled "Summary and Recommendations," summarizes my conclusions and suggests future research on Arctic Charr and Brook Trout interactions.

2. Chapter 2: Baseline Arctic Charr Distribution Model

Abstract

Previous distributional model approaches used environmental factors to predict a species distribution, but more recently researchers are including species interactions in models. A model for Arctic Charr *(Salvelinus alpinus),* was developed to display the current distribution of Arctic Charr. The model included the following factors of growing-degree days, longitude, latitude, and occurrence of Brook Trout (*Salvelinus fontinalis)*. This model was created to evaluate the baseline time period of the known distribution of Arctic Charr from 1976-2005 in Canada. The model classified 93% of Arctic Charr occurrences in Canada, with growing-degree days being a driving factor.

2.1 Introduction

Across considerable scales, the distributions of fish species are largely impacted by temperature and are known to affect spawning, development, growth, survival, and community structures in northern fish species (Alofs et al., 2013; Dunmall et al., 2022). Charr species are of concern because of their northern life cycles that are adapted to cold water conditions and can be largely impacted by rapidly changing environments (Reist et al., 2013; Moore et al., 2015). In particular, Arctic Charr and Brook Trout have freshwater and anadromous forms that likely aided them in recolonizing Canada post glaciation (Moore et al., 2015; Dupont Cyr et al., 2018). Arctic Charr and Brook Trout share similar morphological characteristics and are ecologically distinct species (Dupont Cyr et al., 2018). Arctic Charr are the world's most northerly adapted fish species (Gerdeaux, 2011; Brannas, 1992; Reist et al., 2013). Brook Trout occupy well-oxygenated stream networks in south-eastern parts of Canada (Chadwick & Stephen, 2017; Dupont Cyr et al., 2018).

Unpublished research by Ross Tallman explored the climate-induced competition between Arctic Charr and Brook Trout. Ross Tallman proposed Brook Trout to be a cold-water adapted freshwater invader candidate fish species that have the potential to shift their distributional range northward. Ross Tallman looked at various freshwater fish species distributions within Canada using Scott and Crossman (1973), and selected freshwater fish as potential climate-driven invaders. These freshwater fish species appeared to have thermal limits that mirrored glacial retreat (Tallman, unpublished research). Ross Tallman found that growing-degree days (GDDs) interpreted thermal limits of freshwater fish in Canada. Within a growing season, water temperature can directly influence the onset of physiological changes for fish maturation. Generally, fish mature earlier in water bodies with higher average temperature.

Ross Tallman examined a map from the Atlas of Canada, which included GDD trends that ultimately are used to determine the likelihood of successful agriculture (Government of Canada, 2021; Figure 4). The intensity of the map's colours range from dark green to pale yellow, where the darker green coloured regions indicate warmer temperatures and longer growing seasons within Canada (Government of Canada, 2021). Ross Tallman found that the spatial trends of GDDs did not match Canada's latitude lines. The western and southern parts of Canada experiences increases in GDDs while the eastern and northern parts of Canada experiences decreases in GDDs, implying that the north-eastern part of Canada is typically colder. Ross Tallman then compared Canada's GDDs boundary lines with the distributional range of Brook Trout (Scott & Crossman, 1973; Figure 4). A single GDDs boundary line matched the northernmost distributional range of Brook Trout (Tallman, unpublished research). This GDDs boundary line acts as an indicator of tracking the current distributional thermal limits of Brook Trout (see the GDD boundary line clearly in Hudson Bay, Canada; Tallman, unpublished research).

Globally, the annual mean temperature is projected to rise in response to climate change in the foreseeable future (IPCC, 2018; Tallman, unpublished research). Atmospheric temperature range within a season or year over a geographical area is an imperative aspect of climate (Climate Atlas of Canada, 2021). Fish have an optimal water temperature for proper functioning and a critical thermal maximum and minimum for vital bodily functions. As climate change increases atmospheric temperatures, the Arctic winters will still be cold, and summer temperatures will not significantly vary in a single year (Falardeau et al., 2022; Tallman, unpublished research). However, with earlier ice breakup advancing spring and delaying the onset of winter, the effect of climate change on a species' growing season will be profound (Falardeau et al., 2022; Tallman, unpublished research).

For decades, agriculturalists and entomologists have recognized growing seasons, known as the GDD (or heat or thermal) units, as a reliable predictor of growth and development (Neuheimer & Christopher, 2007; Climate Atlas of Canada, 2021). GDDs are the accumulation of daily mean temperatures (including the minimum and maximum daily temperatures) above a specified threshold base temperature (Neuheimer & Christopher, 2007; Climate Atlas of Canada, 2021). The base temperature is considered the threshold temperature, where the minimum development threshold must be exceeded for growth to occur (Neuheimer & Christopher, 2007; Climate Atlas of Canada, 2021). Neuheimer and Christopher (2007) explain that GDDs is a relevant metric providing greater explanatory power than solely using annual mean temperature data and is a physiologically relevant measure of temperature and considers the timing of a season (i.e., seasonal temperature responses of fish maturity; size-at-age recruitment). The technical description of GDDs is the annual sum of the number of degrees Celsius that each day's mean temperature is above a specified base temperature (Climate Atlas of Canada, 2021; Eq. 1).

Equation 1: $$GDD: [(max\ daily\ temp + min\ daily\ temp)/2] - base\ temp = GDD$$

GDDs are a good indicator of the potential maturity of a particular species and can be applied to all ectotherms, including fish (Neuheimer & Christopher, 2007). Explaining or predicting growth and development in fish is often essential to population dynamics and ecosystem studies on topics such as food web relationships or determining fishing practices suitable for sustaining a fishery (Falardeau et al., 2022; Neuheimer & Christopher, 2007).

A warmer climate can change the phenology and recruitment of fish. A fundamental component of Charr's life history traits is their overwintering periods. This period is used to conserve energy and growth for reproductive purposes (Johnson, 1980). Spring is a thermal threshold indicator of potential maturity onset, where Arctic Charr uses energy for recruitment (Reist et al., 2013; Falardeau et al., 2022). Climate change impacts can alter Arctic Charr life cycles by increasing water temperatures and pushing thermal thresholds earlier during the onset of spring from the winter seasonal transition (Falardeau et al., 2022; Tallman, unpublished research). In North America, particularly in the Southern Appalachians, Brook Trout are known to be fall spawners (Flebbe et al., 2011). The seasonal timing of spawning can vary with temperature and latitude (Scott & Crossman, 1973). Flebbe et al. (2011) explained that the southern Appalachians is a warmer climate threshold environment for Brook Trout, allowing them to spawn later in the fall and hatch earlier.

Studying the impacts of climate change is a complex task due to multiple interlaced impacts across ecological systems linked to fish (Falardeau 2022). An assortment of factors operating at different scales, such as regional and local scales, influence the current distribution of freshwater fish (Chu et al., 2005). For example, at a regional scale of Canada environmental factors (annual mean temperature) can influence the distributional range of freshwater fish (Chu et al., 2005).

Species distribution models use various environmental factors to better understand climate change impacts on various species. Species distribution models that include interaction scenarios with various fish species are receiving more attention lately (Alofs et al., 2013; Jackson & Mandrak, 2002; Chu et al., 2005; Hein et al., 2012). For example, researchers have produced a model to predict the climate change impacts of Smallmouth Bass (*Micropterus dolomieu*; Alofs et al., 2013; Jackson & Mandrak, 2002). As Smallmouth Bass shift their distributional range northwards, they could potentially extirpate over 25,000 populations of cyprinid species from Ontario, Canada (Alofs et al., 2013; Jackson & Mandrak, 2002).

The purpose of this study is to use a modelling approach to explore climate change impacts on Arctic Charr and the relationship between Arctic Charr and Brook Trout. The distributional range of Arctic Charr may contract substantially under a warmer climate (Hein et al., 2012; Reist et al., 2006). This is because Arctic Charr hold the northernmost distributional range in Canada and there is little opportunity to expand their range northward in response to climate change (Hein et al., 2012; Chu et al., 2005). Fish may adapt through shifting their distributional range to preferred habitats, become extirpated, or go extinct in a particular region as temperatures rise and alter their seasonal life cycles (Hein et al., 2012). As temperatures warm, southernly populations of Brook Trout may experience habitat loss due to climate warming (Chadwick & Stephen, 2017). Brook Trout are known to be exceptional habitat colonizers due to vast dispersal ability (Alofs et al., 2013), and therefore, Brook Trout are likely to re-distribute northward, invading Arctic Charr habitats.

The current distribution of Arctic Charr is contingent on various factors. This study aims to develop a baseline time period (1976-2005) model to reflect the current distribution of Arctic Charr. The model will explore a combination of environmental factors and a Brook Trout species interaction to see if variables are important/ significant to the distributional range of Arctic Charr in Canada. I hypothesized that a combination of environmental factors and species' interactions would be related to the distribution of Arctic Charr in Canada (Hypothesis 1). I predicted that the probability of Arctic Charr occurrence would be significantly related to the variables of growing degree-days and the occurrence of Brook Trout. I predicted that species' interactions would be more important/significant than growing-degree days. I predicted that the occurrence of Brook Trout would be an important variable because researchers suggest the southernly limits of Arctic Charr in Canada may be controlled by potential fish competitors (Reist et al., 2006). The development of the distribution model for Arctic Charr would consider ecological and evolutionary insights.

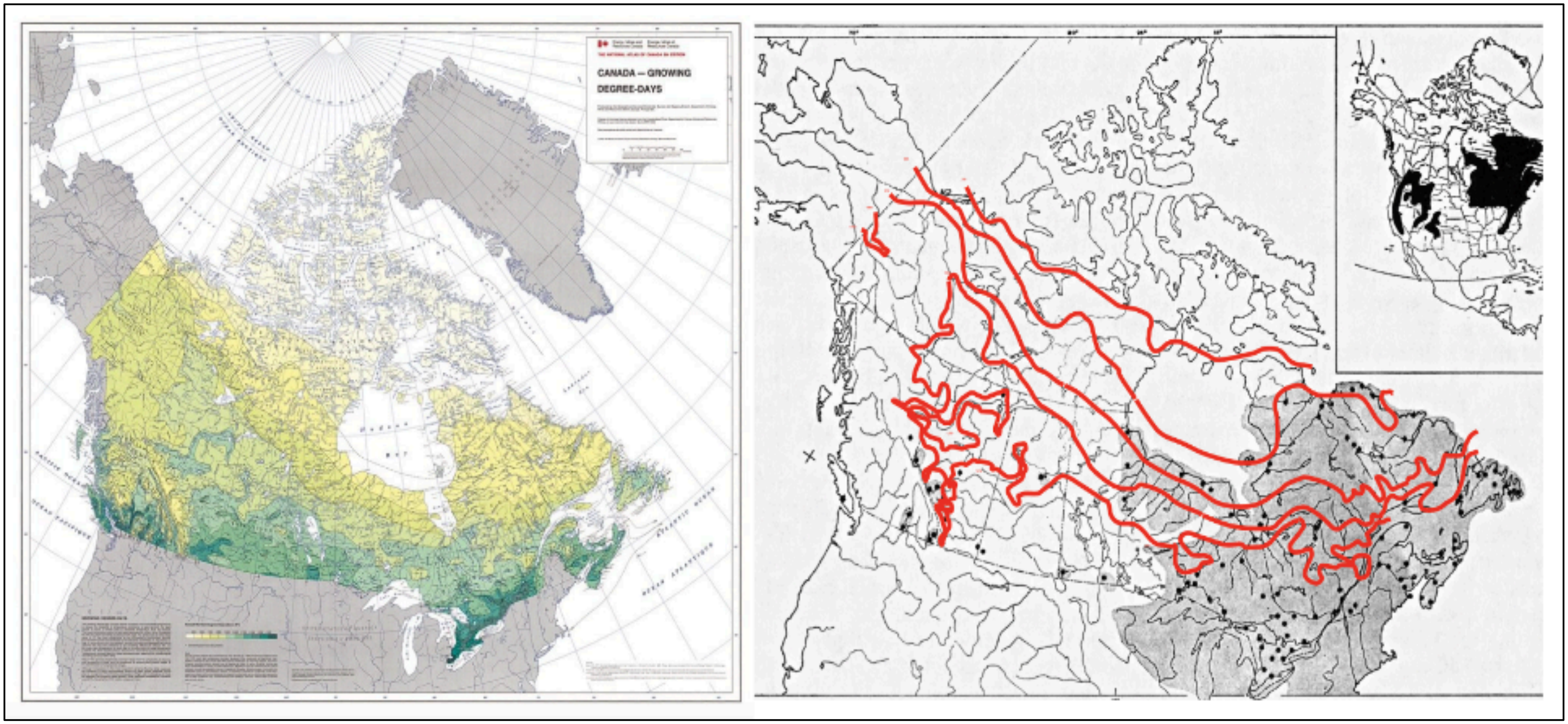

Figure 4: Growing degree-day map (left) from the Atlas of Canada (Government of Canada, 2021). Brook Trout Canadian distributional range map (left; Scott & Crossman, 1973) modified to include growing degree day lines (red) by Ross Tallman

2.2 Materials and Methods

2.2.1 Study Area

This study explored the distribution of Arctic Charr and Brook Trout within Canada and the Canadian high Arctic. This research is relevant to a wide range as Arctic Charr have a circumpolar distributional range. Canada's climate ranges from temperate to sub-Arctic temperatures. Scott and Crossman (1973) was used to explore the distributions of Canada's freshwater fishes. Many of Canada's lakes and streams are interconnected; and most major rivers flow to the Arctic, Atlantic, or Pacific Oceans, or to Hudson Bay and James Bay (Scott & Crossman, 1973). Canada's mean annual air temperature for the year 2021 was 2.1℃ (Government of Canada, 2021). According to climate scenario projections the annual air temperature from 2081 to 2100 ranges from 1.8℃ in a low carbon emission scenario to 6.3℃ considered in a high carbon emission scenario (Bush & Lemmen, 2019). Bush and Lemmen (2019) project that in the Arctic, sea ice cover will see a 50% chance of ice-free conditions, and a global rise in sea levels ranging from 28 cm to 98 cm by 2050 under a high carbon emission scenario.

2.2.2 Data Collection

The Climate Atlas of Canada (https://climateatlas.ca/) is an online software that operates as a standard grid square and was used to compile climate data (Appendix 1). The Climate Atlas of Canada uses Pacific Climate Impacts Consortium's (PCIC's) climate data (Constructed Analogues and Quantile mapping, Version 2; BCCAQv2), which originates from global climate models (Climate Atlas of Canada, 2022). The Climate Atlas of Canada projects two carbon emission scenarios at varying time periods, where RCP4.5 is considered the low carbon scenario, and RCP8.5 is considered the high carbon scenario (Climate Atlas of Canada, 2022). The low carbon scenario was used for the time period of 1976-2005 to reflect the baseline distribution for Arctic Charr.

The complete dataset equated to 832 regions within Canada based on the Climate Atlas of Canada online software, and included climate variables of growing degree-days (GDDs, base 4°C) and annual mean temperature (°C) for the time period of 1976-2005. This research assumed close correspondence between air temperature and water temperature. GDDs are known as heat or thermal units for growth and maturation of plants and animals (Climate Atlas of Canada, 2022; Neuheimer & Christopher, 2007). The base temperature of 4°C was used to capture heat or thermal demands of Arctic Charr and Brook Trout (Climate Atlas of Canada, 2022). Then for each region, corresponding latitudes (+) and longitudes (-) were collected using Google Maps (https://www.google.ca/maps).

The study area looked at the continuous range distributions of Arctic Charr and Brook Trout across Canada. The distributional maps reflect broad sweeps where Arctic Charr and Brook Trout occur over landscapes and water bodies. The distributional maps for Arctic Charr and Brook Trout were acquired from Nick Mandrack's lab database (Figure 5 & 6; Mandrak, 2020). The database included records of native (in blue) and introduced (in red) occurrences of both Arctic Charr and Brook Trout (Figure 5 & 6). Only native occurrences of Arctic Charr and Brook Trout were included in the dataset. Independent occurrence data of Arctic Charr and Brook Trout was not acquired. The presence data reflects the presence of occurrence in the water bodies within a region of Canada. The dataset was manually created where 832 regions within Canada and Canada's high Arctic reflected the presence (*presence* = 1) or absence (*absence* = 0) of Arctic Charr and Brook Trout.

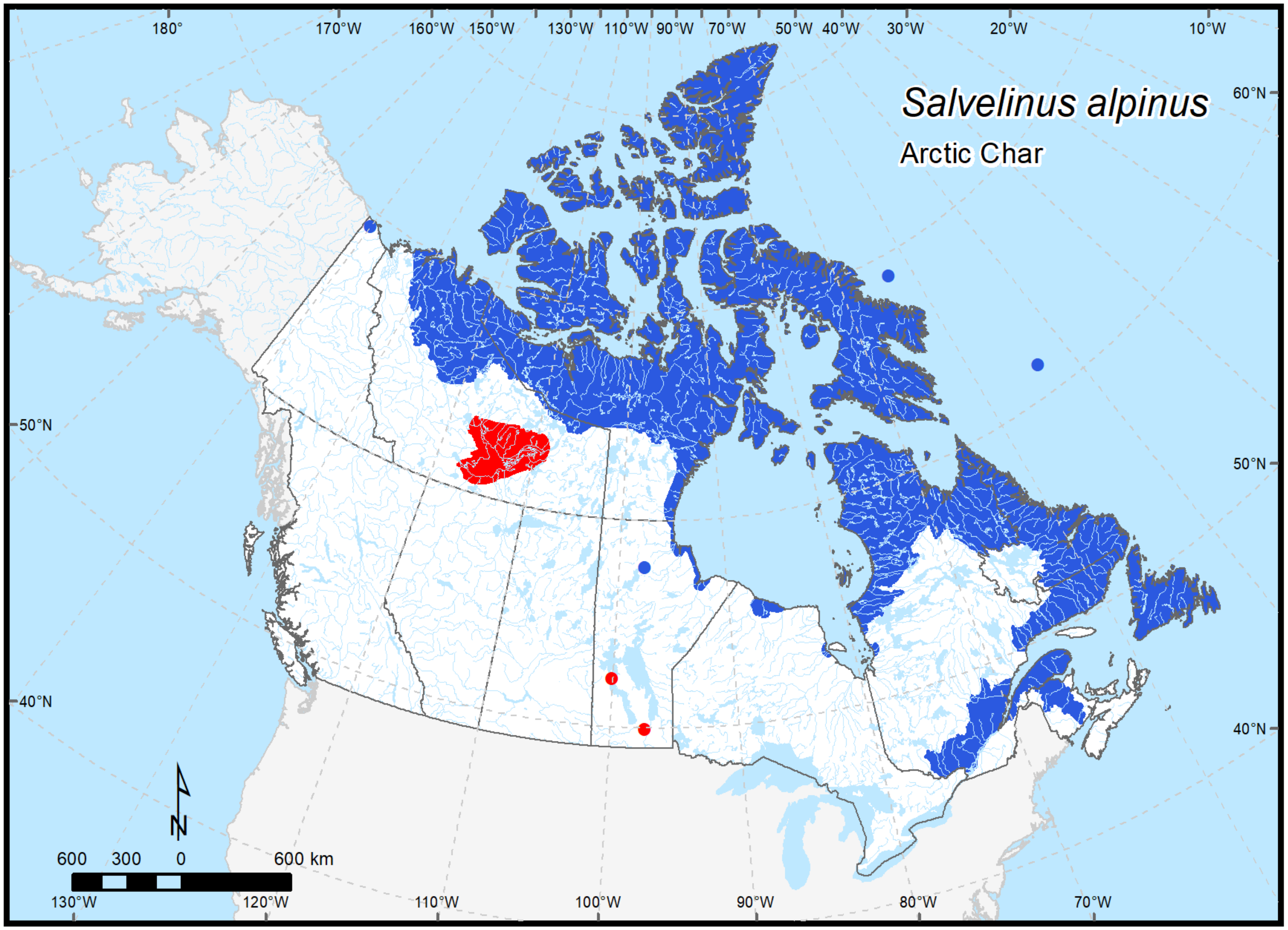

Figure 5: Continuous distributional range of Arctic Charr in Canada. Distribution highlighted in blue are known native occurrences and distribution highlighted in red are known introduction occurrences (Mandrak, 2020).

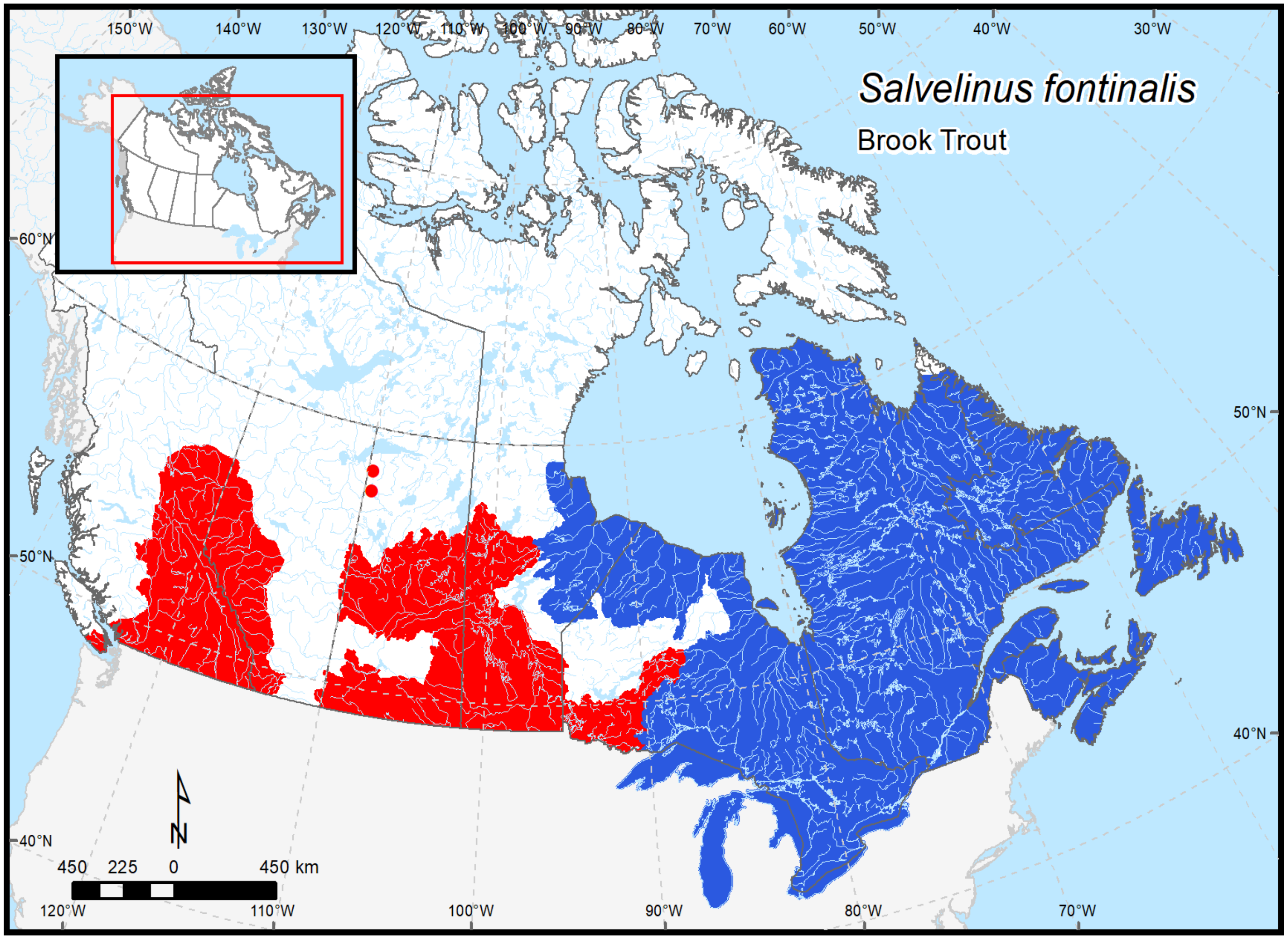

Figure 6: Continuous distributional range of Brook Trout in Canada. Distribution highlighted in blue are known native occurrences and distribution highlighted in red are known introduction occurrences (Mandrak, 2020).

2.3 Data Analysis

The function used to create the regression model is the generalized linear model function. One very important application of generalized linear models in biology is to model binary response variables (e.g., presence or absence). In general, an equation is created and called a model where independent parameters are plugged into the equation to generate the dependent variable's output, which is a prediction (Quinn & Keough, 2002). Regression is known as a statistical relationship between two or more parameters where a change in the independent parameter is associated with a change in the dependent variable outcome (Quinn & Keough, 2002). Thus, an independent parameter drives the probability of the dependent variable. The logistic model equation is:

Equation 2:

$$Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

where *Ln* is the natural log odds (native Arctic charr occurring in a region) against various predictor variables (*X*) and their corresponding coefficients (β; Eq. 3). β_0 and β_1 are parameters to be estimated (Quinn & Keough, 2002). With the predicted one unit change in the predictor parameters there is a change in the probability outcome in the dependent variable (Quinn & Keough, 2002). Logistic regression answers the question, *will it happen or not* (Quinn & Keough, 2002). Logistic regression uses a Sigmoid function, which uses the Sigmoid curve

(Quinn & Keough, 2002). The error terms project a binomial distribution because the response variable is binary (Quinn & Keough, 2002). A binomial logistic regression attempts to predict the probability of the dependent parameter based on one or more continuous or categorical independent parameters (Quinn & Keough, 2002).

The library for generalized linear models (glm) in R version 2022.07.2 (2009-2022 R Studio, PBC) was used for this research. The baseline time period ranged from 1976-2005 at Low Carbon Scenario. Models were specified with a binomial distribution and a logistic link function. The full dataset was randomly divided by Arctic Charr occurrence data into a training dataset (321 presences, 345 absences) and a testing dataset (86 presences, 80 absences; Appendix 2). The training dataset fit the logistic regression model, and the testing dataset was used to evaluate model performance. A correlation matrix including all variables was performed.

The training dataset developed a model suite, which involved variations of the parameters chosen to predict the Arctic Charr present within their distributional range:

- GDD (base 4°C, 1976-2005)
- Annual mean temperature (°C, 1976-2005)
- Longitude (-)
- Latitude (+)
- Presence (1) or absence (0) of Brook Trout

To begin the model suite (Appendix 3), exploring the null model is the first step, where this model includes no independent variables in the model. The hypothesis would read: no parameters would influence Arctic Charr distribution in Canada (abundance of Arctic Charr equals the intercept). All model suites must include a null to compare to additional scales of influence to the model (Burnham & Anderson, 2002). Assurance of model assumptions included large sample size, and no excessively influential observations. GDD is a function of annual mean temperature and is a logical example of multicollinearity. Including annual mean temperature and GDD in a single model would cause multicollinearity, where two or more independent parameters are highly correlated (Burnham & Anderson, 2002).

The performance of the Akaike's Information Criterion (AIC) was used to find the best predictor model:

Equation 3: $$AIC = 2K - 2ln(L)$$

where K is the number of parameters in the model and *ln*(L) is the likelihood (natural log-likelihood) evaluated at the maximum likelihood estimates to determine which model performed best (Hein et al., 2012; Burnham & Anderson, 2002; Eq. 3). An AIC is an information theory that compares the relative fit of a model suite including various models to see which one fits the data best and is most likely closest to the truth (Burnham & Anderson, 2002). To emphasize further, the AIC is the idea that each model reflects a particular hypothesis and selects a model that fits the best (Burnham & Anderson, 2002). The model with the smallest AIC*c* value is known as the best model (Burnham & Anderson, 2002). The calculation on the test dataset to assess model performance was percent correctly classified, sensitivity (percent presences correctly classified), specificity (percent absences correctly classified), and kappa (Burnham & Anderson, 2002).

2.4 Results

For the climate data at a Low Carbon Scenario, the annual mean temperature for the period 1976-2005 describing the baseline time period (1976-2005) distribution of Arctic Charr were: (mean = -5.7 °C, range = -22.6 – 9.4). GDD for the period 1976-2005 describing the baseline distribution of Arctic charr were: (mean = 826.85, range = 7.8 – 2591). Latitude was: (mean = 60.19, range = 43.45 – 82.32), and longitude was: (mean = -95.24, range = -139.84 – -53.76).

Within Canada, Arctic Charr had a total of 401 presences and 431 absences, and Brook Trout had a total of 266 presences and 566 absences. Arctic Charr and Brook Trout were found present in 113 regions simultaneously. Co-occurrence patterns of Arctic Charr and Brook Trout included 248 regions that contained Arctic Charr and no Brook Trout, whereas 113 regions contained Arctic Charr and Brook Trout. Arctic Charr and Brook Trout do not occur in 318 regions.

The logistic regression analyzed the relationship of environmental, spatial, and species interactions parameters to predict Arctic Charr occurrence probability. The chosen model included GDD as a predictor variable rather than annual mean temperature because of the literature review and unpublished research by Ross Tallman. Including both parameters in the model, the model would experience multicollinearity. GDD and annual mean temperature have a logical correlation because GDD is derived from annual mean temperature data. A correlation matrix was used to determine the correlation between all parameters (Table 1). GDD was used as a climate variable in the logistic regression models.

The logistic regression model with the best score (AIC*c* = 232.33) included four predictor variables (GDD, longitude, latitude, and Brook Trout) and two interactions (between longitude and latitude; and between GDD and latitude; Table 2; Appendix 4). The model with the lowest AIC score was not chosen based on the simplicity of understanding the model biologically. The model chosen to predict the current occurrences of Arctic Charr had the second-best model score (AIC*c* = 235.99; Appendix 5). This logistic regression model included four predictor variables (GDD, longitude, latitude, and Brook Trout) and one interaction (between longitude and latitude; bolded in Table 2). Interaction terms address variance and can make the model stronger as one variable may be dependent on another variable. The model is summarized here with corresponding coefficients:

Equation 4:

$$\boldsymbol{O = 59.51 - 0.005(D) + 0.73(H) - 0.72(V) - 0.28(B) - 0.01(H*V)}$$

Where ***O*** is Arctic Charr occurrences, ***D*** is growing-degree days (Base 4°C), ***H*** is for longitude, ***V*** is for latitude, and ***B*** is for the occurrence of Brook Trout (present = 1). The reason for choosing this model included dropping one interaction term (between GDD and latitude), making the model simpler. The interaction between GDD and longitude, and between longitude and latitude could be interpreted as the same meaning. Four coefficients were significant ($p < 0.05$), except for Brook Trout ($p > 0.704$).

The training dataset produced the logistic regression model where 80% of the source data correctly classified as Arctic Charr presence or absence, with detection probability $P = 0.93$ (95% confidence interval = 0.91 – 0.95), sensitivity 93%, specificity 93% and kappa 0.86 (Appendix 6). The training dataset and the testing dataset reached a similar conclusion. The testing dataset had 40% of the source data and correctly classified as Arctic Charr presence or absence, with detection probability $P = 0.94$ (95% confidence interval = 0.89 – 0.97), sensitivity 92%, specificity 96%, and kappa 0.88 (Appendix 7).

Table 1: Correlation matrix of mean climate data (growing degree-days and temperature), species interactions of Arctic Charr and Brook Trout, and spatial data of latitude and longitude for Canada measured from 1976-2005.

Row	Column	Correlation	*P*-value
Latitude	AMT	-0.945	<.001****
Latitude	GDD	-0.859	<.001****
AMT	GDD	0.915	<.001****
Latitude	Arctic Charr	0.5	<.001****
AMT	Arctic Charr	-0.61	<.001****
GDD	Arctic Charr	-0.683	<.001****
Latitude	Brook Trout	-0.504	<.001****
AMT	Brook Trout	0.358	<.001****
GDD	Brook Trout	0.242	<.001****
Arctic Charr	Brook Trout	0.133	<.001***
Latitude	Longitude	-0.236	<.001****
AMT	Longitude	0.042	.453^{ns}
GDD	Longitude	-0.014	.692^{ns}
Arctic Charr	Longitude	0.457	<.001****
Brook Trout	Longitude	0.737	<.001****

Table 2: Akaike's Information Criterion (AIC) and difference in AICc (AICi – AICmin, ΔAICc) for candidate models predicting the presence of Arctic Charr. The full model included the following predictor variables: growing degree-days (D), longitude (H), latitude (V), and Brook Trout (B). The model in bold is the chosen model used to predict the future distribution of Arctic Charr in Canada.

MODEL	AIC*C*	ΔAIC*C*
D + H + V + B	285.22	52.90
D + H + V + B + D:H	236.82	4.49
D + H + V + B + D:H + H:V	232.33	0
D + H + V + B + D:B + H:B + V:B	259.47	27.15
D + H + V + B + H:V	**235.99**	**3.67**
D + H + V + B + D:B	266.12	33.80
D + H + V + B + D:B + H:V	236.78	4.46

2.5 Discussion

Models are a tool to understand and forecast climate change impacts. Researchers include specific environmental data depending on the scales of the species distribution model. Including variables that are independent of one another captures the current distribution of a species and considers its niche habitat. Many aquatic-related models are under the assumption of a close correspondence between air temperature and water temperature. Spatially it is challenging to estimate an aquatic species distribution compared to a terrestrial species distribution (Neuheimer & Christopher, 2007). When considering climate change impacts, aquatic environments can be variable due to reasons of fish mobility and the fact that aquatic environments have high heat capacities (Neuheimer & Christopher, 2007). This research considered a large spatial scale and was under the assumption of the close correspondence between air temperature and water temperature, exploring GDDs as an environmental variable for considering climate change impacts.

Temperature and precipitation are the most common environmental variables found in models (Moore et al., 2015). Much of the environmental data for this research was collected from the Climate Atlas of Canada. The Climate Atlas of Canada is an online software used by researchers, politicians, and the public (Climate Atlas of Canada, 2022). Precipitation pattern data was not collected for this research. It is important to acknowledge that climate change is to cause environmental changes, such as changes to precipitation patterns. To capture the impacts of climate change, including precipitation patterns as an additional independent variable may have been beneficial to the model. Fish need water to survive, and changes in precipitation patterns affect water availability. In response to climate change, the impacts of lack of water on Arctic Charr would be considered a greater impact than increased water temperatures.

The study aimed to consider the interaction between Arctic Charr and Brook Trout. The literature suggests that Brook Trout is an exceptional colonizer in new habitats, known as a habitat generalist, and a fish competitor (Reist et al., 2006). This study could have considered other fish interactions with Arctic Charr, such as Lake Trout and Pacific Salmon. However, this study kept focused solely on the interaction between Arctic Charr and Brook Trout.

When conducting research on climate change, it is essential to understand which variables are meaningful and to be mindful of their effects on the model. A correlation matrix determined the pairwise relationships among the chosen variables of annual mean temperature, GDDs, latitude, longitude, Arctic Charr and Brook Trout. GDDs and annual mean temperature are logically positively correlated (0.915) because GDDs are derived from annual mean temperature data. As latitude increases, GDDs (-0.859) and annual mean temperature (-0.945) decrease, displaying a strong negative relationship. The relationship between Brook Trout and GDDs is slightly positive (0.242) because the distribution of Brook Trout increases where more GDDs accumulate in a region. The relationship between Arctic Charr and GDDs is negative (-0.683) because of the distribution of Arctic Charr in a region. Longitude and latitude should be independent of one another and have a value of 0, but the relationship is slightly negative (-0.236). The pattern between longitude and latitude is driven by the data.

It was important to choose a model that best represents the baseline time period (1976-2005) distribution data on Arctic Charr in Canada. The performance of the AIC helped with choosing a model, although the model with the lowest AIC was not chosen. The final model selected was based on the performance of AIC and the simplicity of understanding the model's effects. The decision to choose the model that performed the second best was based on the AIC calculation and ensuring that the model was both biologically and statistically easily understood.

The relationship of the model is generally negative. When the intercept (59.51) is considered the first level, the predictor values add additional levels of information to the model. In this model, there is a temporal scale focused on GDDs. GDDs is recognized as a strong predictor variable, even though at first glance it could be interpreted as the least. The GDD coefficient is very small (-0.005) because GDD values are a very large unit scale (in the thousands). For example, in Churchill, Manitoba (High Carbon Scenario), the GDD mean for the time period of 1976-2005 was 811.9 (base 4°C). For the time period of 2021-2050, GDD is projected at 1076 (base 4°C; +263.9 from the time period of 1976-2005), and for the time period of 2051-2080, GDD is projected at 1392 (base 4°C; +580.4 from the time period of 1976-2005). Understanding the thermal tolerances of Arctic Charr related to their growth and life cycles is monumental to their diversity, adaptability, and survival.

The model considered the diversity of anadromous and landlocked Arctic Charr. Many landlocked post-glacial regions in North America serve as a refuge for Arctic Charr (Wilson et al., 1996). Arctic Charr are mostly found in the northeast of Canada. Geographically, the only option for anadromous Arctic Charr is to disperse north. Anadromous Arctic Charr are restricted and cannot disperse through marine environments from east to west of Canada. Arctic Charr might increase their range further north into the Canadian Arctic refugia if climate change were to deglaciate Baffin Island and forms new habitats. Arctic Charr currently have their backs up against the wall (Chu et al., 2005), and their distributional range is northernly restricted.

The current distribution of Arctic Charr is partly relatable to the glacial history of North America (Wilson et al., 1996). It is known that a large portion of the current distribution of Arctic Charr was once covered by ice (Moore et al., 2015; Wilson et al., 1996). Arctic Charr now occupies the post-glacial lakes that were created by large ice sheets (Moore et al., 2015;

Wilson et al., 1996). Arctic Charr are exceptional colonizers and are known to be a highly mobile species through the evidence of dispersal into post-glacial regions (Moore et al., 2015; Wilson et al., 1996). This reflects the geographic opportunities and/or limits of the current distribution of Arctic Charr. Arctic Charr are prevalent in the eastern part of Canada, found in the northern parts of Labrador and Quebec, and throughout the Canadian Arctic ranging northmost into the Archipelago Islands (Scott & Crossman, 1973). Currently, on the eastern side of Canada, polar conditions are more prevalent, such as in the north-eastern part of Canada, where glaciers are still found on Baffin Island. In the north-western part of Canada, unless in high mountainous regions, glaciers are not as commonly found. Evidence suggests that the current distribution of Arctic Charr is based on the post-glacial history and has shaped the genetic diversity and adaptability of Arctic Charr (Moore et al., 2015; Wilson et al., 1996).

Variables of latitude and longitude relate to the glacial history of the distribution of Arctic Charr in Canada. The interaction between longitude and latitude is a north-eastern probability of Arctic Charr reflecting glacier recession. The coefficients of latitude (-0.72) and longitude (0.73) are bound by a smaller unit scale (degrees) compared to GDDs (base 4°C). Latitude values were imputed as positive values, and longitude values were imputed as negative values (i.e., Churchill, Manitoba: latitude = 58.77072 and longitude = -94.16928). The longitude coefficient value is truly a negative correlation. It is most likely to see Arctic Charr in the north-eastern parts of Canada based on the latitude and longitude predictor variables.

It was intriguing not seeing a positive latitude coefficient in the model. This is most likely a sampling issue. There were speculations of a positive correlation for latitude as a predictor variable because Arctic Charr are known as the northernmost species of Canada. Another observation is that GDDs and latitude are inheritably correlated, and the factors should portray the same meaning. Therefore, one could be under the assumption that GDDs and latitude variables would be competing factors and cause multicollinearity. The model negative latitude coefficient (-0.72) conveys the density of the current distribution of Arctic Charr ranges from 60°N-70°N in Canada. Little sampling of Arctic Charr occurs in the Canadian high Arctic where post-glacial lakes are more commonly found. The Canadian Government has travelled twice to Ellesmere Island, northernmost Canada, for Arctic Charr sampling. Travelling to Ellesmere Island is a huge undertaking because of the harsh conditions. Arctic Charr are known to exist there, but most of the Island is frozen and a lake may only be open once every ten years for sampling to occur. Arctic Charr can survive in very harsh conditions, unlike Brook Trout. Most of the reporting of Arctic Charr occurrences are from Northern Communities that report to Fisheries and Oceans Canada. The majority of Northern Communities are situated by coasts or the southernly distributional range of Arctic Charr. For example, Cambridge Bay is situated on the coast, and local communities monitor Arctic Charr occurrences. Anadromous Arctic Charr are more commonly sampled because most Northern Communities live near marine coastal waters.

The model indicates that the probability of Arctic Charr occurrence decreases with the presence of Brook Trout occurrence. The coefficient unit scale of Brook Trout (-0.28) is smaller than other predictor variables because the unit scale range is bounded between 0-1. Occurrence and absence data were collected where one was noted as an occurrence and 0 was noted as an absence. The number zero can be meaningful or cause challenges in the occurrence dataset. It is important to ensure that the zero is described meaningfully, where a species can be found but is not, or the species is impossible to exist. The dataset may have shared zeros (double zeros) that can affect the relationship among variables. Fish species can be found in the same area but not co-occurring in the same body of water. The relationship is only slightly negative and suggests that the occurrence of Brook Trout decreases the odds of Arctic Charr occurrence. The coefficient is not a strong negative relationship and therefore reflects the baseline spatial relationship between Arctic Charr and Brook Trout. Arctic Charr and Brook Trout are currently found in an overlapping north-eastern region of Canada. Arctic Charr and Brook Trout don't heavily overlap in their distributional ranges and can portray that Brook Trout currently do not cause much stress on Arctic Charr populations. Brook Trout was not significant to the model ($p<0.704$), while all other predictor variables were found significant ($p>0.05$). Brook Trout was kept in the model, and the uncertainty in the significance of the coefficient of Brook Trout is noted as a concern moving forward in the research. The purpose of this research was to explore the relationship between Arctic Charr and Brook Trout.

This model incorporated data at a regional scale of Canada, exploring the distributional ranges of Arctic Charr and Brook Trout. This model is a stepping stone in understating the relationship between Arctic Charr and Brook Trout. Another layer to this research could involve exploring modelling at a local scale. Modelling only lakes where Arctic Charr and Brook Trout are found and compiling variables such as lake surface area and depth. In response to climate change, lake surface area and depth would reflect how a lake would warm over time. Hypothetically speaking, modelling results may include the scenario where you find Brook Trout excluding Arctic Charr. In the lake habitat, Arctic Charr may be more commonly found at the lake's bottom, which would allow both species to coexist. It is valuable research to acknowledge that research can be performed in multiple ways and to consider different approaches.

This research allowed for the development of an Arctic Charr distribution model for the time period of 1976-2005 in Canada. I hypothesized that a combination of environmental factors and species interactions would be related to the distribution of Arctic Charr in Canada (Hypothesis 1). A model suite was performed to determine the best model to reflect the probability of Arctic Charr occurrences. Through the performance of AIC, a logistic regression model was chosen, and included variables of GDDs, longitude, latitude, and the occurrence of Brook Trout. The development of the distribution model for Arctic Charr considered the environmental, ecological, and post-glacial effects of evolutionary insights. I predicted that the probability of Arctic Charr occurrence would be significantly related to the variables of growing degree-days and the occurrence of Brook Trout. I predicted that species interactions would be more important/significant than growing-degree days. Growing-degree days was the driving factor in the model. Chapter 3 will use the chosen logistic regression model to predict the distribution of Arctic Charr in response to continuous climate change impacts of increasing atmospheric temperatures.

3 Chapter 3: Projected Distribution Model for Arctic Charr

Abstract

To manage and conserve native fish populations, Canada must consider how climate change may impact distributions of cold-water adapted fishes. There is an urgency to uncover the thermal tolerances of cold-water adapted fishes to conserve native fish populations endemic to Canada. As atmospheric temperatures rise, seasonal cycles may alter and become suitable for adaptable fish species. The potential northward shift of Brook Trout may cause additional stress on Canada's most northern endemic fish species, Arctic Charr. A model was developed to reflect Canada's distribution of Arctic Charr in response to climate change. The model from the baseline time period ranging from 1976-2005 was used to predict Canada's future distribution of Arctic Charr for two 30-year time periods ranging from 2021-2050 and 2051-2080. The Arctic Charr distribution model explores several climate change impact scenarios that include environmental data and Brook Trout as a species interaction. With this analysis, I predicted that Arctic Charr will lose 18% of its distributional range at a high carbon scenario during the time period of 2051-2080. This information can be used by managers and policy makers to identify thermally vulnerable ecosystems that are essential for conservation of native species in Canada. Managers and policy makers must assess the risks associated with climate-driven distributional shifts by invasive or native, and potentially colonizing fish species.

3.1 Introduction

Forecasting climate change effects is pivotal for conserving Canada's northern endemic fish populations. Proceeding with a precautionary principle and scientific research are fundamental ways to make decisions on climate change impacts (Lennon & Perry, 2018). Environmental responses to climate change may significantly impact fish behaviour and dynamics, including the timing of migrations, immigrations, and recruitment (Murdoch et al., 2014). In the Canadian high Arctic, cold-water adapted fish have specific spatial, thermal, and temporal characteristics in aquatic ecosystems (Reist et al., 2006).

Charrs are at risk of climate change because they are a cold-water adapted fish species (Reist et al., 2013). The cold-water adaptations and the spatial patterns of northern Canadian fish are most likely a reflection of the historical patterns of glaciation in North America (Loewen et al. 2021; Moore et al., 2015). As atmospheric temperatures warmed, post-glacial lakes allowed fish to disperse and persist through adaptable abilities (Loewen et al., 2021).

Arctic Charr are the northernmost freshwater fish species and are currently found in the Canadian high Arctic, Yukon, northern Northwest Territories and Nunavut and along the Hudson Bay (Lane, 2013; Scott & Crossman 1973). Arctic Charr are known to adapt and persist with environmental changes based on the evidence of their survival in post-glacial refugia (Moore et al. 2015). During the glaciations, it is likely that Arctic Charr repetitively used refugia during colder conditions and dispersed during warming conditions (Brunner et al., 200; Moore et al. 2015). Arctic Charr are sensitive to potential climate change impacts, such as shifts in temperature. Increasing atmospheric temperatures could contract the availability of thermally suitable habitat for Arctic Charr, resulting in shifting the southern thermal boundary of Arctic Charr northward (Hein et al., 2012).

Brook Trout may be another fish species to shift their distributional range northward. Under natural conditions within Canada, Brook Trout are widely distributed in the Maritime Provinces, including Newfoundland, Labrador, Quebec, through the Great Lakes drainage, northern parts of Ontario and northeastern Manitoba (Scott & Crossman, 1973). Brook Trout thrive in northern temperate latitudes as they are limited by warm water temperatures (Lenormand et al., 2004; Maine Department of Inland Fisheries and Wildlife, 2010). Brook Trout have high dispersal rates and can disperse through freshwater and marine networks (Dunham et al., 2002). The dispersal rate of Brook Trout relies heavily on factors such as topography of the aquatic system networks and the location of its source population (Dunham et al., 2002). Brook Trout are known to be aggressive as they displace other fish species for preferred habitat and food (Dunham et al., 2002). For example, Brook Trout have invaded aquatic systems in the western United States and have caused the rapid decline of native Cutthroat Trout (*Oncorhynchus clarki*) populations (Dunham et al., 2002). The distributional range of Brook Trout is thought to be limited in their northern distribution by temperature, but Arctic Charr are likely limited in their southern range by potential competitors (Reist et al., 2006).

Arctic Charr and Brook Trout distributional ranges overlap in the northeastern parts of Canada (Glémet et al., 1998; Scott & Crossman, 1973). In Canada, the Fraser River, Labrador is an example of where their distributional ranges overlap and natural hybridization occurs among Arctic Charr and Brook Trout (Hammer et al., 1991). Hybridization is considered a source of novel adaptive variation and may be more commonly found with the continuing impacts of climate change forcing species into more frequent sympatry. Fish hybrids are less common in areas where fish species have evolved together over time (Hammer et al., 1991), and Arctic Charr and Brook Trout don't commonly overlap in niche habitats (Dupont Cyr et al., 2018).

Long-term impacts of continuing climate change could result in fish species becoming extirpated or extinct if temperatures exceed their thermal range (Falardeau et al., 2022; Dunmall et al., 2022). Habitat disruptions in lower latitudes of Canada have caused a variety of species to move northward. Continuing climate change impacts could increase the availability of thermally suitable habitats in the Arctic for fish species that are more commonly found in southern parts of Canada. This is already happening in the Arctic, where reduced sea ice extent and longer open water seasons are facilitating the marine migrations of Pacific Salmon into Arctic areas where they were once not found (Dunmall et al. 2013; Dunmall et al., 2022).

Species distribution models are a management tool to project the future distribution of a species in response to climate change impacts. One logistic regression model predicts that Arctic Charr will lose 63% of its distributional range in Canada by 2050 (Chu et al., 2005). Another model predicts that Arctic Charr will lose 73% of its distributional range in Sweden by 2100 (Hein et al., 2012). Predicted extirpations of Arctic Charr populations could be attributed to precipitation patterns, atmospheric temperature increases and species interactions (Chu et al., 2005; Hein et al., 2012).

Using a modelling approach, this research explores climate change impacts on the distribution of Arctic Charr in Canada. I hypothesized that environmental factors, and the occurrence of Brook Trout would be related to the distribution of Arctic Charr for two future time periods of 2021-2050 and 2051-2080 (Hypothesis 2). I predicted that the change in growing degree-days and the presence of Brook Trout would be associated with a reduced likelihood of Arctic Charr occurrence. A spatial case study for Manitoba, Canada, was added to explore spatial impacts to the southernly distributional range of Arctic Charr. I predicted that the southernly distributional range of Arctic Charr in northern parts of Manitoba and Quebec would be significantly impacted in response to climate change. Insight into current barriers to conservation and future management policies within Canada was also explored.

3.2 Materials and Methods

The chosen logistic regression model from Chapter 2 (Eq.4) predicted the baseline time period of 1976-2005. The baseline time period model was used for the projected Arctic Charr distributions for two future 30-year time periods of 2021-2050 and 2051-2080. In this data set, GDD values (base 4℃) were compiled from the Climate Atlas of Canada (https://climateatlas.ca/), which is an online software that uses layers of mapping and integrates environmental factors as projections for how climate change will affect Canada (Climate Atlas of Canada, 2022). GDD values were compiled at two emissions scenarios RCP4.5 and RCP8.5 (Climate Atlas of Canada, 2022). RCP4.5 is the low carbon scenario and RCP8.5 is the high carbon scenario (Climate Atlas of Canada, 2022). The high carbon scenario is considered to have more carbon or greenhouse gas emissions in the atmosphere resulting in severe global warming (Climate Atlas of Canada, 2022).

The future (2021-2050 and 2051-2080) distributions of Arctic Charr looked at the distributional continuous range of occurrences (n = 401) from Nick Mandrack's lab database (Figure 5). For each region from the Climate Atlas of Canada the corresponding latitudes (+) and longitudes (-) were compiled in the dataset using Google Maps (https://www.google.ca/maps). Predictions for future distributions of Brook Trout were not found, therefore Brook Trout occurrences were kept constant based on their distributional continuous range of occurrences from Nick Mandrack's (University of Toronto) lab database (Figure 6).

3.3 Data Analysis

The regression model was used from Chapter 2:

$$\boldsymbol{O} = \mathbf{59.51 - 0.005(\boldsymbol{D}) + 0.73(\boldsymbol{H}) - 0.72(\boldsymbol{V}) - 0.28(\boldsymbol{B}) - 0.01(\boldsymbol{H}^*\boldsymbol{V})}$$

where ***O*** is the predicted Arctic Charr occurrences (1), ***D*** is growing-degree days (Base 4°C), ***H*** is longitude, ***V*** is latitude and ***B*** is the occurrence of Brook Trout (1 = present) to project the distributions of Arctic Charr for two future time periods (2021-2050 and 2051-2080) within Canada.

The baseline time period and the future projections time periods only reflect native individuals. I used the logistic model to project the following scenarios for the distributional continuous range of occurrences of Arctic Charr (n = 401):

- Baseline data 1976-2005 w/o *B* (without occurrence of Brook Trout)
- Low carbon 2021-2050 w/o *B* (without occurrence of Brook Trout)
- Low carbon 2051-2080 w/o *B* (without occurrence of Brook Trout)
- High carbon 2021-2050 w/o *B* (without occurrence of Brook Trout)
- High carbon 2051-2080 w/o *B* (without occurrence of Brook Trout)
- Baseline data 1976-2005 w/ *B* (with occurrence of Brook Trout)

- High carbon 2051-2080 w/ *B* (with occurrence of Brook Trout)

I included the Brook Trout coefficient for the time period of 2051-2080 at a high carbon scenario. Logistic regression was used to project the future projections of Arctic Charr distributional range:

$$Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

where the natural log of *P* over 1 minus *P* is the dependent variable and the remainder of the expression looks like a linear model. If the expression:

$$Ln\left(\frac{P}{1-P}\right)$$

is written using a:

$$y*$$

then it looks like a linear expression:

$$y* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

,

knowing that there are similarities between logistic and linear expression. Therefore, taking the exponent of $y*$ calculated by:

Equation 5: $P = exp(y^*)/(exp(y^*)+1)$

projects a percent of the odds of the occurrence.

In linear expressions you interpret the magnitude of coefficients, but in a binomial logistic model you can predict the odds of the dependent variable. The model baseline time period (1976-2005) model is interpreted as:

59.5: the constant term.

(D): its coefficient is **– 0.005.** Note the negative value. Keeping all other variables constant, for each unit increase in GDD, the odds of Arctic Charr occurrence decreased by a factor = exp (-0.005).

(H): its coefficient is **0.73.** Note the positive value is not truly a positive value relationship. For this model, longitude values were imputed as negative values (i.e., Churchill, Manitoba: latitude = 58.77072 and longitude = **-94.16928**). Therefore, keeping all other variables constant, for each unit decreased in longitude, the odds of Arctic Charr occurrence increased by a factor = exp (0.73).

(V): its coefficient is **-0.72.** Note the negative value. Keeping all other variables constant, for each unit increase in latitude, the odds of Arctic Charr occurrence decreased by a factor = exp (-0.72).

(*B*): its coefficient is **-0.28.** Note the negative value. Keeping all other variables constant, when Brook Trout are present, the odds of Arctic Charr occurrence decreased by a factor = exp (-0.28).

(*H*V*): its coefficient is **-0.01.** Note the negative value. Keeping all other variables constant, when longitude and latitude are in an interaction term, the odds of Arctic Charr occurrence decreased by a factor = exp (-0.01).

In excel, the beta coefficients from the baseline time period (1976-2005) model were used for the projected independent variables to estimate the likelihood of Arctic Charr occurrence. The exponent (exp) value from the log odds value (*O)* value were calculated. The average percent of the odds of Arctic Charr occurrence was calculated for each projected scenario. Using the spatial parameters of longitude and latitude, a case study for Manitoba, Canada was developed to explore the projected distributional range Arctic Charr.

3.4 Results

The projected change to the distributional range of Arctic Charr is derived from the baseline time period (1976-2005) model developed in Chapter 2 (Eq. 4). The projected distribution of Arctic Charr were caused by increases in GDDs (a factor of temperature; Hypothesis 2). The distributional range of Arctic Charr will contract by 18% in the future time period of 2051-2080 at a high carbon scenario (Table 3). The probability of occurrence of Arctic Charr contracted in all the future time period scenarios.

The baseline time period of 1976-2005 was a low carbon scenario (*GDD mean = 413.28, range = 7.8 - 1945*). The projected time period of 2021-2050 explored a low carbon scenario (*GDD mean = 559.23, range = 17.5 – 2311*) and a high carbon scenario (*GDD mean = 578.38, range = 18.2 - 2359*). The projected time period of 2051-2080 explored a low carbon scenario (*GDD mean = 644.64, range = 23.9 – 2518*) and a high carbon scenario (*GDD mean = 796.63,* *range 40.9 - 2835*).

Two additional scenarios explored including the occurrence of Brook Trout. The baseline time period 1976-2005 scenario was a low carbon scenario (*GDD mean* = 413.28, *range* = 7.8 - 1945). The projected time period of 2051-2080 explored a high carbon scenario (*GDD mean = 796.63, range 40.9 - 2835*).

The low carbon scenario for the time period of 2021-2050 only contracted the distributional range of Arctic Charr by 6% (*mean O = 3.0372, P = 0.8437)* from the baseline time period of 1976-2005 (*mean O = 3.8449, P = 0.9040)*. The low carbon scenario for the following time period of 2051-2080 contracted the distribution of Arctic Charr by 10% (*mean O = 2.7174, P = 0.8039)* from the baseline time period. The two high carbon scenarios further contracted the distribution of Arctic Charr, 7% (*mean O = 3.0408, P = 0.8349)* for 2021-2050 and 18% (*mean O = 1.9758, P = 0.7253)* for 2051-2080.

For the Brook Trout scenario for the time period of 2051-2080, at a high carbon scenario projected the distribution of Arctic Charr to contract by 21% (*mean O = 1.6985, P = 0.6985)* from the baseline time period of 1976-2005 (mean *O = 3.7388, P = 0.8982)*.

If the distributional range of Arctic Charr is projected to contract, it would be expected that the southernly limits of Arctic Charr would be severely impacted. Spatial exploration of the southernly limits of the distributional range of Arctic Charr were explored in Manitoba, Canada.

Table 3: The table includes the projected probability of Arctic Charr occurrence in Canada. Future time periods (2021-2050, 2051-2080) were explored at low and high carbon scenarios without the Brook Trout interaction and including the Brook Trout interactions for the time period of 2051-2080.

ARCTIC CHARR MODEL	AVERAGE LOG ODDS (*O*)	PROBABILITY (*P*)	Δ PROBABILITY (*P*)
BASELINE DATA 1976-2005 W/O B	3.8449	0.9040	-
LOW CARBON 2021-2050 W/O B	3.0372	0.8437	0.0603
LOW CARBON 2051-2080 W/O B	2.7174	0.8039	0.1001
HIGH CARBON 2021-2050 W/O B	3.0408	0.8349	0.0691
HIGH CARBON 2051-2080 W/O B	1.9758	0.7253	0.1787
BASELINE DATA 1976-2005 W/ B	3.7388	0.8982	-
HIGH CARBON 2051-2080 W/ B	1.6948	0.6985	0.2132

3.4.1 Spatial Case Study: Distribution of Arctic Charr in Manitoba, Canada

This thesis was primarily focused on northern latitudes (60°N and above) of Canada, although this study is relevant to Manitoba. While more prominent in the Canadian high Arctic, native occurrences of Arctic Charr are found in northern Manitoba (Figure 7). Manitoba claims Arctic Charr as one of their endemic species. In Manitoba, Arctic Charr are recorded as far south as the Churchill River (Stewart & Watkinson, 2004). Manitoba stocks Arctic Charr in lakes in Duck Mountain Provincial Park, and in human-made ponds at the Fort Whyte Centre for Outdoor Education in Winnipeg (Stewart & Watkinson, 2004). Manitoba holds the southernly distributional range of Arctic Charr (Figure 7) and that is why the province of Manitoba was chosen for this spatial case study. Five regions in northern Manitoba (*mean latitude* = 58.517285, *mean longitude* = -95.021868) are within the distributional range of Arctic Charr (n = 5; Table 4).

At a regional scale for Canada, it was projected for the time period of 2051-2080 under a high carbon scenario with including the Brook Trout, the distributional range of Arctic Charr will contract by 21% (*mean* $O = 1.6985$, $P = 0.6985$). I projected for Manitoba (n = 5) during the time period of 2051-2080 under a high carbon scenario with Brook Trout, the probability of Arctic Charr distributional range occurrence would be left at 2% (*mean* $O = -4.0484$, $P = 0.017$). This is a 20% (*mean* $O = -1.2756$, $P = 0.2200$) decrease from the baseline time period of 1976-2005.

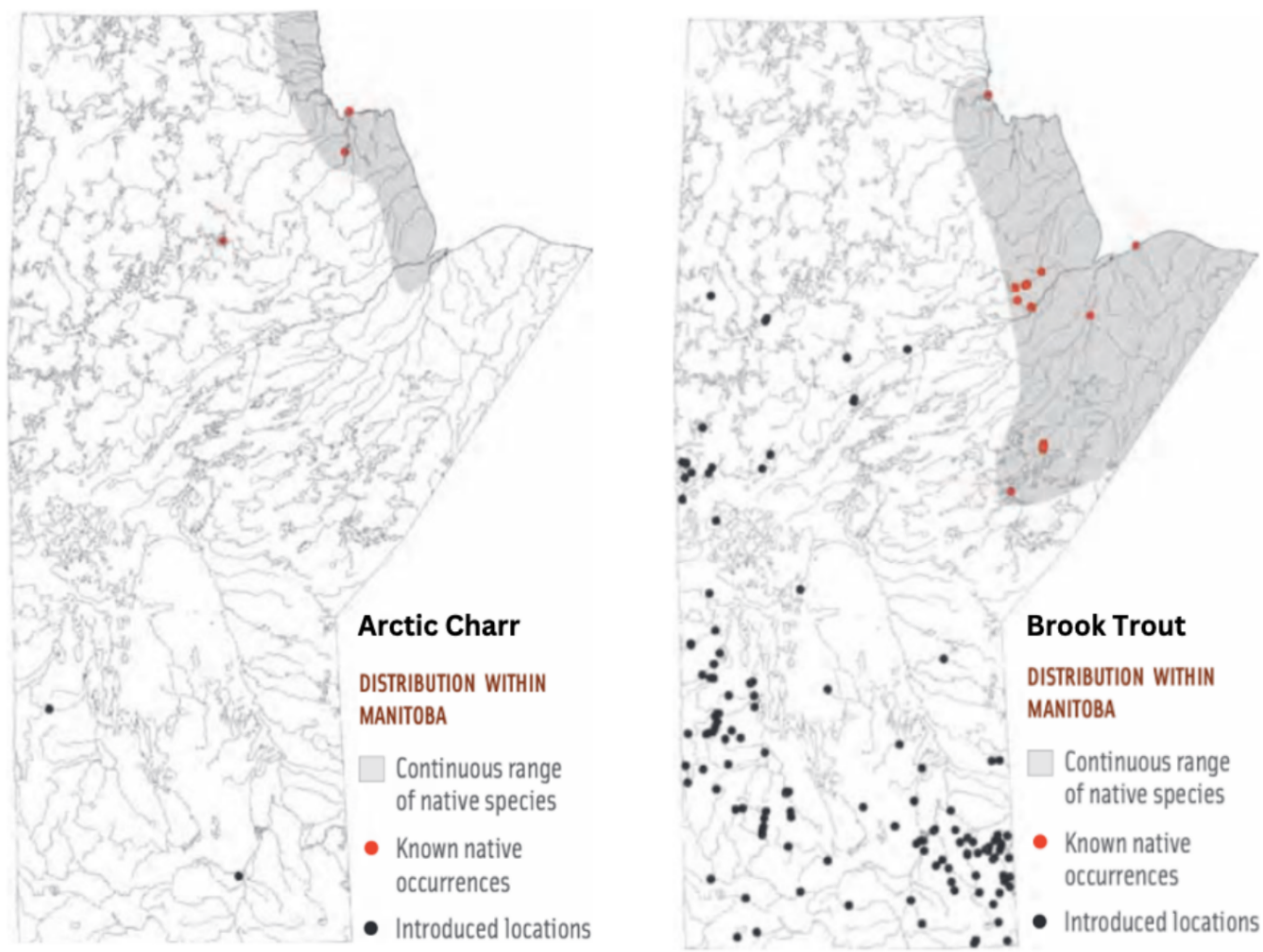

Figure 7: Arctic Charr (left) and Brook Trout (right) distribution within Manitoba, modified from Stewart and Watkinson (2004)

Table 4: The table includes a spatial comparison of Arctic Charr distribution within Manitoba, under a high carbon scenario for time period of 2051-2080 with the Brook Trout interaction. The average probability of Arctic Charr occurrence is 2% at the time period of 2051-2080.

REGION	LATITUDE	LONGITUDE	PROBABILITY (*P*)
CAPE CHURCHILL	58.7625	-93.21207	0.019
CARIBOU RIVER	59.47007	-95.71333	0.0232
CHURCHILL	58.77072	-94.16928	0.013
YORK FACTORY	57.005511	-92.3015	0.014
SHETHANEI LAKE	58.82324	-97.90336	0.016
MEAN	**58.517285**	**-95.021868**	**0.0175**

3.5 Discussion

Humans are now responsible for a new global warming trend never experienced in history (Climate Atlas of Canada, 2022). The model chosen in Chapter 2 (Eq.4) predicted the distributional range of Arctic Charr for two future 30-year time periods ranging from 2021-2050 and 2051-2080 in Canada. In research, the IPCC recommends exploring projected climate trends at various levels of carbon in the atmosphere scenarios (IPCC, 2018). This research explored low and high carbon scenarios which reflected global temperature change. The high carbon scenario reveals more carbon emissions released into the atmosphere from anthropogenic activities (Climate Atlas of Canada, 2022). The model displayed a contracting effect where the availability of thermally suitable habitat for Arctic Charr contracted in response to climate change impacts for all the projected model scenarios.

For the low carbon scenarios, the distributional range of Arctic Charr contracted 6% (*mean* $O = 3.0372, P = 0.8437$) by the time period of 2021-2050 from the baseline time period of 1976-2005 (*mean* $O = 3.8449, P = 0.9040$). The low carbon scenario for the following time period range of 2051-2080 further contracted the distributional range of Arctic Charr by 10% (*mean* $O = 2.7174, P = 0.8039$) from the baseline time period. For the high carbon scenarios, the distributional range of Arctic Charr contracted 7% (*mean* $O = 3.0408, P = 0.8349$) by the time period of 2021-2050 and by 18% (*mean* $O = 1.9758, P = 0.7253$) by the time period of 2051-2080. Two additional scenarios were explored by adding the baseline occurrence of Brook Trout in Canada. At a high carbon scenario, the distributional range of Arctic Charr contracted 21% (*mean* $O = 1.6985, P = 0.6985$) by the time period of 2051-2080 from the baseline time period of 1976-2005 (mean $O = 3.7388, P = 0.8982$). There was a 3% difference when including the occurrence of Brook Trout for the time period of 2051-2080. This research did not directly test a climate-driven expansion of Brook Trout. Therefore, I cannot conclude if the 3% increase by including the occurrence of Brook Trout in the model further contracted the distribution of Arctic Charr through means of competition.

It would be beneficial to explore the climate-driven Brook Trout invasion theory through the development of a Brook Trout distribution model, where Brook Trout is the dependent variable. Warmer water temperatures are known to bring new species that seek out thermally preferred habitats. If a competitor fish species shifted its range northward, Arctic Charr might be exposed to new pathogens (Lehtonen, 1996; Falardeau et al., 2022). The combination of the arrival of new species and pathogens can eliminate regional Arctic Charr diversity (Lehtonen, 1996). One logistic regression model by Chu et al. (2005) considered the natural expansion or contraction of a species range in Canada. They predicted a 49% decrease in the native southeasternly region of Quebec and Labrador, Canada distributional range of Brook Trout by the year 2050 (Chu et al., 2005). Therefore, they did not predict that Brook Trout have the potential to expand their distributional range northward (Chu et al., 2005). However, researchers suggest that Brook Trout are to expand their distributional range northward in response to climate change (Reist et al., 2006; Tallman, unpublished research). Chu et al. (2005) discussed how there is potential for Brook Trout to shift their range in two directions, northeasternly away from central Canada towards the Quebec-Labrador region, and westernly towards British Columbia. Native Brook Trout populations could migrate northward from Quebec to Baffin Island or along Hudson Bay, colonizing brackish water systems as temperatures rise. These potentially expanding migration routes could be challenging for Brook Trout as they are not commonly known as a marine-oriented species.

There needs to be more modelling research on the impacts of non-native Brook Trout in Canada. Brook Trout that were introduced through stocking or accidental means are commonly found in the southwestern region of Canada (Scott & Crossman, 1973; Hammer et al., 1991). Non-native Brook Trout could move into the Mackenzie River Basin, where they would primarily disperse through freshwater systems. For long-term management purposes, it is critical to acknowledge regions where non-native populations of Brook Trout were introduced. Brook Trout were heavily stocked in the western United States in the 1800s, and negatively impacted native fish populations (Dunham et al., 2002; Peterson & Fausch 2003). Brook Trout are known to display competitive characteristics towards other salmonids when competing for resources of preferred habitat and food (Dunham et al., 2002; Peterson & Fausch 2003). Much of the western United States now restricts the stocking of Brook Trout in areas where Brook Trout are not expected to encounter native salmonids because of the irreversible damage they caused (Dunham et al., 2002). Human-induced introductions may aid in the climate-driven expansion of species through stocking programs or accidental introductions (Hammer et al., 1991; Chu et. al., 2005). Arctic Charr and Brook Trout coexist and overlap in southeastern parts of Canada, such as the Fraser River, Labrador, where natural hybridization occurs (Hammer et al., 1991). The hybrid between Arctic Charr and Brook Trout is called the Sparctic Charr (Hammer et al., 1991), and knowing that they can hybridize, it may be a common occurrence heading into the future as they are thrust into closer contact.

The interaction between Arctic Charr and Brook Trout cannot be fully understood by modelling research alone. Interspecific competition between fish species, such as Arctic Charr and Brook Trout would be relatively straightforward to study under a controlled environment in a lab or field enclosure setting (Reist et al., 2006). The model research served as a stepping stone. To test the model's predictions, a laboratory setting would be ideal to explore the behavioural interactions between Arctic Charr and Brook Trout.

An additional research case study explored the spatial components of the distributional range of Arctic Charr in Canada. The research looked at Manitoba as Manitoba is the only prairie province that can claim Arctic Charr as one of their species. It was suspected that under a high carbon scenario for the time period of 2051-2080, Manitoba's distribution of Arctic Charr would be greatly affected. Manitoba was a region of interest because Manitoba is an indicator of the southern limits of Arctic Charr in Canada. The model predicted that in Manitoba during the time period of 2051-2080 under a high carbon scenario with Brook Trout, the probability of Arctic Charr occurrence would be 2% (*O = -4.0484, P = 0.017).* This is a 20% (*O = -1.2756, P = 0.2200)* decrease from Manitoba's baseline time period of 1976-2005. Therefore, Manitoba's distribution of Arctic Charr is predicted to be a tenfold decrease from 1976-2005 to 2051-2080. This tenfold decrease suggests that the distributional range of Arctic Charr will be greatly affected in Manitoba, leading to potential extirpation from Manitoba by the time period of 2051-2080. Arctic Charr may not be found in Manitoba with continuous impacts of climate change because they are sensitive to extreme warming.

Continuous long-term impacts of climate change could negatively affect the current distributional range of Arctic Charr through increased growing seasons, which is a factor of GDDs. The model predicted that as GDDs increase, the presence of Arctic Charr decreases in Canada. Long-term impacts of increasing temperatures can cause physiological impairment to Arctic Charr as a species if temperatures exceed their thermal range, leading to extirpation or extinction (Falardeau et al., 2022). This research expected that landlocked Arctic Charr to be the most affected as temperatures rise. In the Canadian high Arctic, many lakes inhabited by Arctic Charr are found are shallow depressions. Arctic Charr are particularly sensitive to oxygen content and water temperature within a water body, which plays a major role in determining survival. Increased water temperatures will thermally limit habitat choice as Arctic

Charr will move and disperse warm water temperatures. As water temperatures rise in lake habitats, Arctic Charr will likely avoid warm littoral zones and move to lake bottom habitats which are deep and cold (Reist et al., 2013; Power et al., 2008). The thermal stress would push Arctic Charr out of lakes in post-glacial Arctic regions and reduce the overall abundance of Arctic Charr. Another factor to consider in response to climate change is migration dispersal rates for anadromous Arctic Charr. It will be difficult for Arctic Charr to access freshwater and marine systems due to low water levels and changing tides (Falardeau et al., 2022). Thermal stress is a factor for anadromous Arctic Charr, as increasing temperatures will cause physiological impairment for seasonal migrations (Falardeau et al., 2022).

Recent research has shown that short-term climate change impacts may positively affect Arctic fisheries. In the short-term, climate change will likely increase productivity by creating longer open water seasons, which includes advancing spring and delaying the onset of winter (Falardeau et al., 2022). Warming temperatures will increase productivity suggesting an array of readily available food resources for Arctic Charr. Arctic Charr are highly variable in colour depending on what they eat as they are opportunistic feeders (Reist et al., 2013; Falardeau et al., 2022). In marine environments, Arctic Charr may increase their consumption of shrimp, krill, or pelagic zooplankton, which can cause higher-quality Arctic Charr meat for subsistence and commercial fisheries (Falardeau et al., 2022). Longer open water seasons also may mean that anadromous Arctic Charr can reach a greater physiological condition and become larger in size as there is an increase in feeding opportunities (Falardeau et al., 2022; Grenier & Tallman, 2021). Through an Indigenous and local knowledge study by Falardeau et al. (2022), some Inuit fishers commented that they are currently meeting commercial quotas of Arctic Charr faster than ever before. A research study by Grenier and Tallman (2021) explored the difference between resident and anadromous Arctic Charr regarding their growth patterns before migrating to the sea. Grenier and Tallman (2021) found that the faster-growing fish were more likely to become anadromous. A warmer lake habitat will lead to a higher proportion of anadromous Charr (Grenier & Tallman, 2021). Anadromous Charr had a significantly higher maturity and fecundity; and lived longer than resident Charr (Grenier & Tallman, 2021). Climate change can positively impact Arctic Charr if they do not reach their thermal limits in a particular region.

This research focused on Arctic Charr. Arctic Charr are highly valued in the Canadian Arctic. Determining the selective advantages of Arctic Charr is critical for conservation and their persistence in Canada. Arctic Charr are highly adaptable and mobile, proven through the historic post-glacial events of their dispersal in North America (Moore et al., 2015; Wilson et al., 1996). Arctic Charr are considered fish morphs, and populations can differ in life cycle growth patterns, such as differences in maturity, niche shifts or migratory behaviours (Skúlason & Smith, 1995). Typically, in Canada, the northern populations of Arctic Charr can be anadromous, making seasonal migrations from freshwater lakes to marine environments. The diversity of Arctic Charr allows them to adapt to seasonal changes that include water temperatures, salinity, and other environmental changes. The southern populations of Arctic Charr in Canada are known to be more landlocked and are found in freshwater lakes. In northern regions of Canada, Arctic Charr use a broader niche in contrast to landlocked southern populations. The Canadian Arctic has notably experienced less anthropogenic habitat fragmentation and disruption than the southern regions of Canada (Christiansen & Reist, 2013). Are Arctic Charr well equipped for environmental changes in response to climate change and human interventions? The Arctic faces new environmental changes caused by human activities and the interventions of today's world. Arctic Charr diversity may provide resilience allowing Arctic Charr to adapt to rapid and continuous environmental changes.

There is a certainty that climate change is affecting the nature of northern habitats. How a species will respond is notably an area of research where much uncertainty remains (Budy & Chris, 2014). When thinking critically about climate change and the model's predictions, has the distribution of Arctic Charr (currently in the time period ranging from 2021-2050) decreased since the time period ranging from 1976-2005? Northern communities situated by subsistence and recreational fishing sites near Cambridge Bay have observed rapid warming in the past five years and have witnessed effects on Arctic Charr (Falardeau et al., 2022). An Inuit Elder spoke to the current distribution of Arctic Charr in research done by Falardeau et al. (2022):

> "that's a major, major, change that I've seen over my lifetime, is that lot of Charr certain times, when it is 20 to 30°C, the Charr quits being on shore, it's too warm for them. The shorelines are really warm, the water, and the Charr don't like the warm water so they're moving out into deeper water, so it is harder to harvest summer-round Charr now. We can get them in early season, in end of June, early, July while it's cool (pg. 11)."

Therefore, the effects of climate change on Arctic Charr are noticeable. Particularly, the warming water temperatures are affecting the seasonal migration routes of fish and fisheries (Falardeau et al., 2022).

Arctic Charr are considered a candidate species when studying climate change because they are vulnerable to diverse environmental pressures. Additional stressors on Arctic Charr include polluted environments, barriers to migration, and overfishing (Reist et al., 2013; Maitland, 1995). It is essential to assess the negative and positive climate change impacts on Arctic Charr for management purposes and to inform policy. The continuous long-term effects of climate change project a decrease in the distribution of Arctic Charr. There is a need for increased conservation regulations for species in the Arctic whose geographical niche can be drastically disturbed by climate change projections. Modelling research is a management tool for conserving biodiversity. Modelling can determine the size of a predicted effect, and depending on the outcome, the size of the effect can inform and trigger conservation measures (Chu et al., 2005). Suppose it was found through modelling that the future distribution of Arctic Charr will decrease substantially in a particular region. In that case, management should be triggered for the proactive establishment of conservation and recovery efforts (Chu et al., 2005). In terms of managing the impacts of climate change, little can be done now to affect species dispersal. However, management actions on limiting a species interaction through stocking or other dispersal means is a daily decision for most governments.

Community-based research and programs are vital for the appropriate adaptation and management strategies to conserve Arctic species, such as Arctic Charr (Dunmall et al., 2013; Falardeau et al., 2022). Dunmall et al. (2013) established a community-based monitoring program in the Canadian Arctic to preserve Arctic fisheries from climate-driven fish expansions. Since the program's establishment, Northern communities have negotiated a ban on certain fishing practices in the Arctic Ocean until appropriate science and management are in place to evaluate the noticeable increase in sightings of Pacific Salmon (Dunmall et al., 2013; Dumall et al., 2022). Many Northern communities situated by the coast are witnessing the effects of climate change today, and their knowledge is monumental to conserving Arctic species.

I hypothesized that environmental factors, and the occurrence of Brook Trout would be related to the distribution of Arctic Charr for two future time periods of 2021-2050 and 2051-2080 (Hypothesis 2). I predicted that the change in growing degree-days and the presence of Brook Trout would be associated with a reduced likelihood of Arctic Charr occurrence. I can conclude that in response to climate change impacts, the distributional range of Arctic Charr will contract in all the five predicted model scenarios by: 6% (low carbon scenario) and 7% (high carbon scenario) for 2020-2051; and 10% (low carbon scenario), 18% (high carbon scenario), and 21% (high carbon with the occurrence of Brook Trout scenario) for 2051-2080. A spatial case study for Manitoba, Canada, was added to explore spatial impacts to the southernly distributional range of Arctic Charr. I predicted that the southernly distributional range of Arctic Charr in northern parts of Manitoba and Quebec would be significantly impacted in response to climate change. Manitoba's distribution of Arctic Charr is predicted to be a tenfold decrease from 1976-2005 to 2051-2080. This tenfold decrease suggests that the distributional range of Arctic Charr will be greatly affected in Manitoba, leading to potential extirpation from Manitoba by the time period of 2051-2080. Research of competition characteristics of Brook Trout needs further exploration in a lab or experimental setting. Insight into current barriers to conservation and future management policies within Canada was also explored. Increased scientific modelling techniques and conservation regulations for Arctic fish are necessary as their geographical niche can be disturbed by the impacts of climate change. The Canadian government mandates the precautionary principle, and modelling research is a useful tool to conserve Arctic fisheries.

4 Chapter 4: Summary and Recommendations

I developed a model to reflect the occurrence of Arctic Charr in response to climate change in Canada. Model variables included growing-degree days (GDDs), longitude, latitude, and the occurrence of Brook Trout. All but one predictor variable (Brook Trout, $p>0.704$) was found significant (GDDs, longitude, latitude, $p<0.05$) in the model. The model reflected where Arctic Charr and Brook Trout do not overlap, and overlapping was not found to be significant in the model. The model classified 93% of Arctic Charr occurrences in Canada for the baseline time period ranging from 1976-2005.

This model predicted the future distribution of Arctic Charr in the Canadian Arctic under climate change scenarios, which included environmental changes and Brook Trout interactions. The model predicted the distribution of Arctic Charr for two 30-year time periods into the future: 2021-2050 and 2051-2080. The model displayed a contracting effect on the distribution of Arctic Charr in all future scenarios. Climate change will contract the availability of thermally suitable habitats for Arctic Charr in Canada. I predicted that Arctic Charr will lose 18% of their distributional range under a high carbon scenario (GDD mean = 796.63, range 40.9 - 2835) during the time period of 2051-2080. I predicted that Arctic Charr will lose 21% of their distributional range under a high carbon scenario (GDD mean = 796.63, range 40.9 - 2835) during the time period of 2051-2080 when including the occurrence of Brook Trout.

It is recommended that future research takes place in a laboratory setting to explore the relationship (predator-prey) between Arctic Charr and Brook Trout. Researching the aggressive characteristic traits that Brook Trout display when in competition with another species for resources of preferred habitat and food. This research could test the prediction that a Brook Trout invasion would occur in response to climate change, and that Brook Trout can displace

Arctic Charr through competitive characteristic traits. Researching the interaction between Arctic Charr and Brook Trout would be empirical evidence that the species' interaction is either a meaningful variable or not to be included in a model. Specifically, if climate change induces a Brook Trout invasion northward into previously exclusive Arctic Charr habitats, would Brook Trout be capable of pushing Arctic Charr out? If Brook Trout do not, then the climatic imperative is less of a concern in a model. Conversely, if the interaction shows Brook Trout as winners when it comes to competition, then the climate imperative is very high for the long-term success of Arctic Charr.

It is reasonable to suggest that climate change has already impacted most species on Earth in some way or another. Continuous climate change impacts are projected to cause thermal stress on Arctic Charr. The Canadian high Arctic will serve as a refuge for Arctic Charr. Species distribution models use scientific evidence to project a distributional range based on various factors. Models displaying a substantial decrease in a species distribution should trigger management and policy for conservation measures and recovery efforts. Collaborative management approaches with Northern communities are critical to conserving Arctic Charr. Collaborative community-based research efforts will build adaptation to management strategies when responding to climate change impacts.

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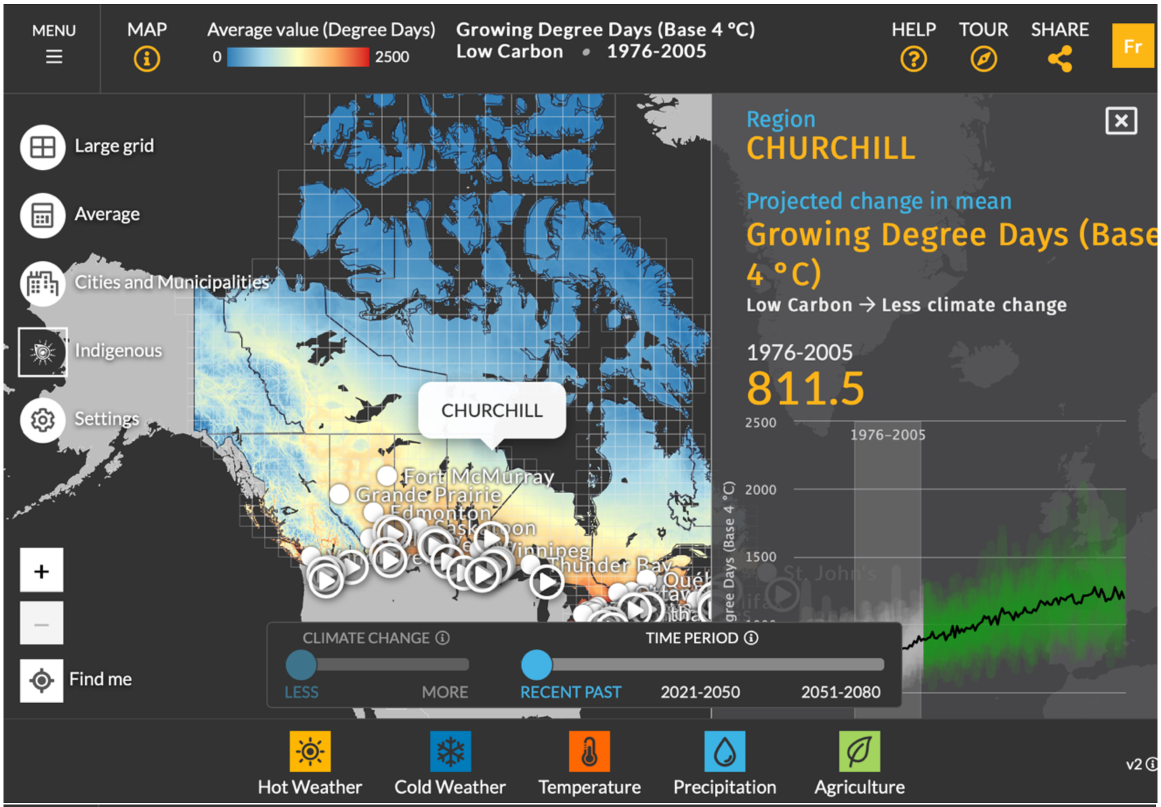
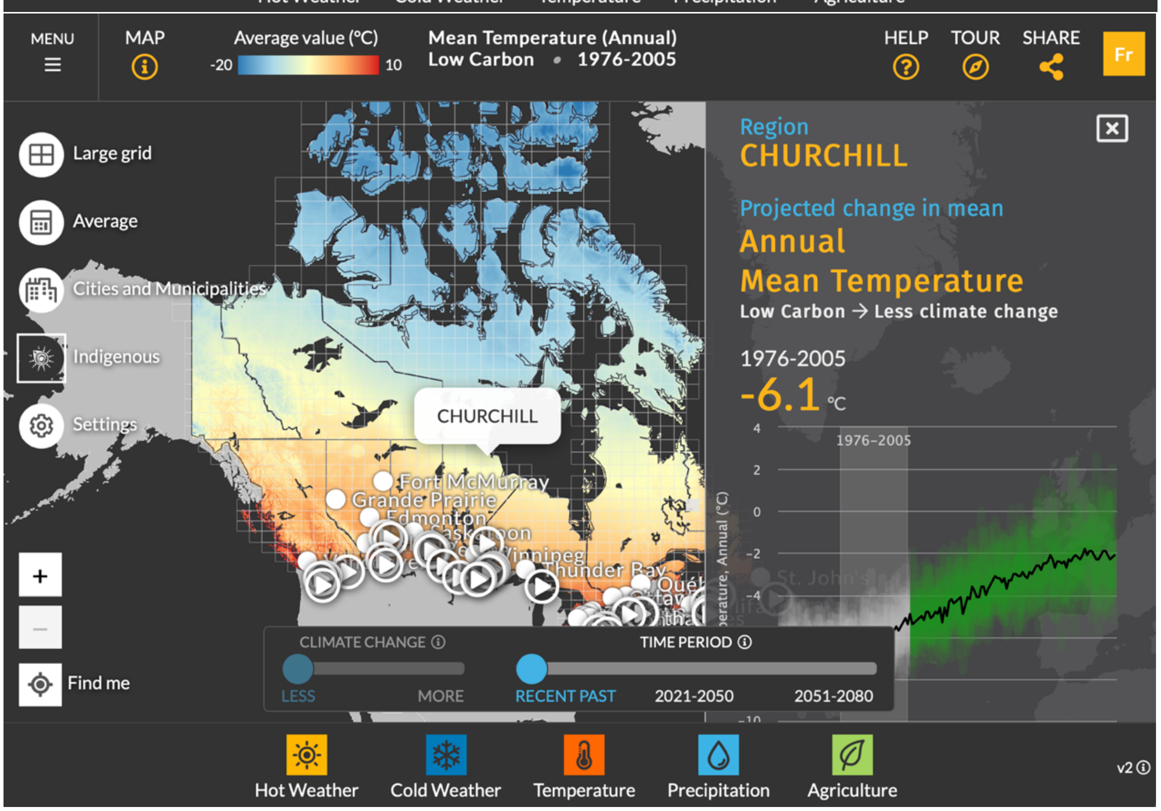
Appendix 1: The Climate Atlas of Canada





Appendix 2: Summary Training & Test Dataset in R

```
> summary.data.frame(training_set)
    Region            Province           Latitude          AMT         
 Length:666         Length:666         Min.   :43.45   Min.   :-22.600  
 Class :character   Class :character   1st Qu.:53.09   1st Qu.:-11.100  
 Mode  :character   Mode  :character   Median :59.97   Median : -5.000  
                                       Mean   :60.35   Mean   : -5.689  
                                       3rd Qu.:66.63   3rd Qu.: -0.200  
                                       Max.   :83.01   Max.   :  9.400  
      GDD          ArcticCharr      BrookTrout       Longitude      
 Min.   :   7.8   Min.   :0.000   Min.   :0.0000   Min.   :-139.84  
 1st Qu.: 282.3   1st Qu.:0.000   1st Qu.:0.0000   1st Qu.:-115.50  
 Median : 802.9   Median :0.000   Median :0.0000   Median : -97.16  
 Mean   : 827.7   Mean   :0.482   Mean   :0.3078   Mean   : -96.86  
 3rd Qu.:1277.5   3rd Qu.:1.000   3rd Qu.:1.0000   3rd Qu.: -78.11  
 Max.   :2591.0   Max.   :1.000   Max.   :1.0000   Max.   : -52.71  
> summary.data.frame(test_set)
    Region            Province           Latitude          AMT         
 Length:166         Length:166         Min.   :44.74   Min.   :-22.300  
 Class :character   Class :character   1st Qu.:52.51   1st Qu.:-11.450  
 Mode  :character   Mode  :character   Median :59.34   Median : -5.350  
                                       Mean   :60.03   Mean   : -5.769  
                                       3rd Qu.:66.09   3rd Qu.:  0.325  
                                       Max.   :82.32   Max.   :  8.600  
      GDD          ArcticCharr       BrookTrout       Longitude      
 Min.   :  17.4   Min.   :0.0000   Min.   :0.0000   Min.   :-140.93  
 1st Qu.: 302.5   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:-110.15  
 Median : 745.7   Median :0.0000   Median :0.0000   Median : -97.44  
 Mean   : 823.3   Mean   :0.4819   Mean   :0.3675   Mean   : -95.06  
 3rd Qu.:1308.0   3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.: -76.86  
 Max.   :2003.0   Max.   :1.0000   Max.   :1.0000   Max.   : -53.76  
```

Appendix 3: Confusion Matrix performed on Train and Test Datasets in R

```
> confusionMatrix(tab1)
Confusion Matrix and Statistics

         Actual
Predicted   0   1
        0 320  22
        1  25 299

               Accuracy : 0.9294
                 95% CI : (0.9073, 0.9477)
    No Information Rate : 0.518
    P-Value [Acc > NIR] : <2e-16

                  Kappa : 0.8587

 Mcnemar's Test P-Value : 0.7705

            Sensitivity : 0.9275
            Specificity : 0.9315
         Pos Pred Value : 0.9357
         Neg Pred Value : 0.9228
             Prevalence : 0.5180
         Detection Rate : 0.4805
   Detection Prevalence : 0.5135
      Balanced Accuracy : 0.9295

       'Positive' Class : 0
```

```
> confusionMatrix(tab2)
Confusion Matrix and Statistics

         Actual
Predicted  0  1
        0 79  3
        1  7 77

               Accuracy : 0.9398
                 95% CI : (0.892, 0.9707)
    No Information Rate : 0.5181
    P-Value [Acc > NIR] : <2e-16

                  Kappa : 0.8796

 Mcnemar's Test P-Value : 0.3428

            Sensitivity : 0.9186
            Specificity : 0.9625
         Pos Pred Value : 0.9634
         Neg Pred Value : 0.9167
             Prevalence : 0.5181
         Detection Rate : 0.4759
   Detection Prevalence : 0.4940
      Balanced Accuracy : 0.9406

       'Positive' Class : 0
```

Appendix 4: AIC*c* in R

```
> library(AICcmodavg)
> aictab(cand.set = models1)

Model selection based on AICc:

     K   AICc Delta_AICc AICcWt Cum.Wt
Mod3 7 232.33       0.00   0.73   0.73
Mod5 6 235.99       3.67   0.12   0.84
Mod7 7 236.78       4.46   0.08   0.92
Mod2 5 236.82       4.49   0.08   1.00
Mod4 8 259.47      27.15   0.00   1.00
Mod6 6 266.12      33.80   0.00   1.00
Mod1 5 285.22      52.90   0.00   1.00
          LL
Mod3 -109.08
Mod5 -111.93
Mod7 -111.31
Mod2 -113.36
Mod4 -121.63
Mod6 -127.00
Mod1 -137.57
```

Appendix 4: AIC*c* = 0 Model in R

```
> summary(model3)

Call:
glm(formula = ArcticCharr ~ GDD + Longitude + Latitude + BrookTrout +
    GDD * Longitude + Longitude * Latitude, family = binomial(link = "logit"),
    data = training_set)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.2941  -0.1028  -0.0009   0.1841   3.3948

Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)        2.894e+01  1.634e+01   1.771   0.0766 .
GDD                3.123e-03  3.568e-03   0.875   0.3814
Longitude          3.714e-01  1.816e-01   2.045   0.0409 *
Latitude          -3.418e-01  2.288e-01  -1.494   0.1351
BrookTrout         2.526e-01  7.732e-01   0.327   0.7439
GDD:Longitude      9.823e-05  4.423e-05   2.221   0.0264 *
Longitude:Latitude -5.386e-03  2.467e-03  -2.183   0.0290 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 922.41  on 665  degrees of freedom
Residual deviance: 218.16  on 659  degrees of freedom
AIC: 232.16

Number of Fisher Scoring iterations: 8
```

Appendix 5: Baseline Model in R

```
>summary(model6)

Call:
glm(formula = ArcticCharr ~ GDD + Longitude + Latitude + BrookTrout +
    Longitude * Latitude, family = binomial(link = "logit"),
    data = training_set)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.4183  -0.1181  -0.0023   0.1751   3.4279

Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)        59.5108988 10.9051529   5.457 4.84e-08
GDD                -0.0048915  0.0009255  -5.285 1.25e-07
Longitude           0.7289708  0.1046456   6.966 3.26e-12
Latitude           -0.7239434  0.1725835  -4.195 2.73e-05
BrookTrout1        -0.2809740  0.7405901  -0.379    0.704
Longitude:Latitude -0.0098504  0.0016287  -6.048 1.47e-09

(Intercept)        ***
GDD                ***
Longitude          ***
Latitude           ***
BrookTrout1
Longitude:Latitude ***
---
Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 922.41  on 665  degrees of freedom
Residual deviance: 223.87  on 660  degrees of freedom
AIC: 235.87

Number of Fisher Scoring iterations: 7
```

```
> confint(model12, level = 0.95)
Waiting for profiling to be done...
                        2.5 %       97.5 %
(Intercept)        39.260312848 81.932227001
GDD                -0.006825505 -0.003195621
Longitude           0.536578852  0.948606455
Latitude           -1.073061831 -0.399225691
BrookTrout1        -1.728870118  1.180279650
Longitude:Latitude -0.013244195 -0.006832888
```

Appendix Raw Data: Low Carbon Data Set

					Low Carbon Scenario						
Region	Province	Latitude	Longitude	1976-2005 AMT	2021-2050 AMT	2051-280 ATM	1976-2005 GDD	2021-2050 GDD	2051-2080 GDD	Arctic charr	Brook Trout
Kananaskis Lakes	AB	50.69818	-115.11467	1.1	2.8	3.9	985.9	1266	1454	0	0
Whitesand River	AB	59.58449	-115.51874	-3.2	-1.1	0	1114	1357	1489	0	0
Calgary	AB	51.04539	-114.05809	1.4	3.2	4.3	1099	1389	1581	0	0
Bistcho Lake	AB	59.75999	-118.78485	-2.6	-0.6	0.5	1210	1462	1604	0	0
Steen River	AB	59.36158	-117.77723	-2.4	-0.4	0.7	1257	1514	1653	0	0
Chinchaga River	AB	57.90274	-118.63645	-0.9	1	2.1	1240	1511	1669	0	0
Wapti	AB	54.9553	-119.19551	1.7	3.4	4.5	1225	1516	1700	0	0
John D'or Prairie	AB	58.49995	-115.14866	-1.3	0.7	1.9	1348	1620	1772	0	0
Clear Hills	AB	56.5087	-119.12221	0.3	2.1	3.2	1323	1607	1777	0	0
Zama Lake	AB	58.7391	-119.10144	-0.9	1	2.1	1369	1644	1800	0	0
Wadlin Lake	AB	57.73523	-115.60308	-0.4	1.6	2.7	1378	1659	1820	0	0
Peerless Lake	AB	56.64914	-114.65244	0.4	2.3	3.4	1374	1658	1831	0	0
Lesser Slave Lake	AB	55.4554	-115.07976	1.2	3	4.1	1393	1684	1867	0	0
Whitecourt	AB	54.14054	-115.68455	1.7	3.5	4.6	1394	1693	1882	0	0
Rocky Mountain House	AB	52.37447	-114.92192	2.5	4.3	5.4	1368	1684	1887	0	0
Fort Chipewyan	AB	58.71964	-111.1407	-1	1	2.1	1474	1747	1901	0	0
Winefred Lake	AB	55.48728	-110.55131	0.6	2.5	3.7	1441	1730	1910	0	0
Bitumount	AB	57.3929	-111.62803	-0.3	1.6	2.8	1474	1757	1919	0	0
Fort Mcmurray	AB	56.72563	-111.37628	0.4	2.3	3.4	1474	1763	1936	0	0
Grand Prairie	AB	55.17281	-118.7884	1.8	3.6	4.7	1461	1764	1949	0	0
Sand River	AB	54.97084	-111.0565	1.3	3.2	4.3	1521	1819	2009	0	0
Wabamun Lake	AB	53.55869	-114.47319	2.7	4.5	5.6	1505	1826	2026	0	0
Vermilion	AB	53.487	-110.85255	1.9	3.8	5	1619	1927	2126	0	0
Wainwright	AB	52.83311	-110.85048	2.6	4.5	5.6	1711	2029	2234	0	0
Oyen	AB	51.3586	-110.47889	3.1	4.9	6	1798	2122	2331	0	0
Lethbridge	AB	49.69455	-112.83338	5.2	7	8.1	1834	2213	2450	0	0
Foremost	AB	49.47908	-111.44075	5.1	6.9	7.9	1988	2355	2584	0	0
Medicine Hat	AB	50.04104	-110.6782	4.6	6.5	7.6	2031	2387	2613	0	0
Tatshenshini River	BC	59.81353	-137.26488	-2.3	-0.5	0.6	532.9	766.4	904.6	0	0
Spatsizi River	BC	57.53127	-128.58724	-2.2	-0.4	0.7	540.3	786.3	941.7	0	0
Toodoggone River	BC	57.40206	-126.84545	-2.6	-0.8	0.3	570.7	809	954.2	0	0
Cry Lake	BC	58.74269	-129.04245	-2.9	-1.2	-0.1	594.1	838.8	986.6	0	0
Jennings River	BC	59.43763	-131.42347	-3.2	-1.4	-0.3	617.3	866.2	1010	0	0
Ware	BC	57.42265	-125.62964	-2.5	-0.8	0.3	666	900.7	1044	0	0
Tuchodi Lakes	BC	58.16877	-124.5826	-3.4	-1.6	-0.5	685	912.5	1049	0	0
Kechika River	BC	58.83727	-127.23252	-2.9	-1.2	-0.1	664.9	905.7	1049	0	0
Mcconnell Creek	BC	56.88378	-126.46062	-1.2	0.6	1.7	651	904.8	1061	0	0
Tulsequah	BC	58.73461	-133.60758	-1.1	0.7	1.8	664.6	930.8	1088	0	0
Telegraph Creek	BC	57.91573	-131.14504	-0.8	0.9	2.1	653.2	920.8	1088	0	0
Dease Lake	BC	58.62726	-130.03902	-1.7	0.1	1.2	693.2	962.3	1122	0	0
Iskut River	BC	56.80464	-130.56556	0.6	2.3	3.4	682.9	954.8	1129	0	0
Atlin	BC	59.57506	-133.70262	-1.7	0.1	1.2	714.8	984.1	1139	0	0
Mount Robson	BC	53.03414	-119.23108	-0.4	1.3	2.3	738.3	982.8	1142	0	0
Bowser Lake	BC	56.45347	-129.57716	0.1	1.8	2.9	708.9	983.1	1158	0	0
Mount Waddington	BC	51.20435	-125.82521	1	2.6	3.6	730.9	992.2	1166	0	0
Canoe River	BC	52.73251	-119.37786	0.1	1.8	2.8	772.9	1028	1195	0	0

Mesilinka River	BC	56.33024	-125.25437	-1	0.7	1.8	798	1053	1211	0	0
Mcdame	BC	59.18642	-129.2261	-2.8	-1	0.1	836.3	1097	1249	0	0
Whitesail Lake	BC	50.22243	-116.03211	1.7	3.3	4.3	811.3	1085	1262	0	0
Anahim Lake	BC	52.51183	-125.35962	0.9	2.5	3.5	832.8	1106	1282	0	0
Manson River	BC	55.61746	-124.04862	0.1	1.8	2.9	877.3	1145	1313	0	0
Halfway River	BC	56.52236	-122.28885	-0.4	1.3	2.4	940.8	1201	1363	0	0
Pemberton	BC	50.32056	-122.80841	2.1	3.7	4.7	902.9	1180	1363	0	0
Trutch	BC	57.73345	-122.94622	-1.2	0.6	1.7	964.9	1222	1378	0	0
Mcbride	BC	53.30101	-120.16318	1.3	3	4	933	1208	1384	0	0
Smithers	BC	54.77899	-127.17583	1.7	3.4	4.4	921.2	1211	1394	0	0
Hazelton	BC	55.26002	-127.64733	1.2	2.9	4	924.1	1215	1396	0	0
Monkman Pass	BC	54.60337	-121.19047	0.8	2.5	3.6	958.5	1227	1399	0	0
Rabbit River	BC	58.85025	-125.23265	-2.2	-0.4	0.7	989.9	1257	1410	0	0
Nass River	BC	55.93684	-129.04774	2.5	4.1	5.2	952.4	1255	1448	0	0
Pine Pass	BC	55.4	-122.633	0.7	2.4	3.5	1010	1282	1453	0	0
Taseko Lakes	BC	51.16802	-123.55295	1.9	3.5	4.6	1006	1301	1489	0	0
Terrace	BC	54.46591	-128.55577	3.5	5.1	6.1	992.7	1297	1496	0	0
Bella Coola	BC	52.3729	-126.76258	3.5	5	6	999.7	1298	1498	0	0
Toad River	BC	58.85025	-125.23265	-2	-0.2	1	1094	1358	1510	0	0
Seymour Arm	BC	51.23781	-118.94567	2.1	3.7	4.8	1042	1335	1523	0	0
Nechako River	BC	54.00508	-123.9114	1.9	3.5	4.6	1046	1342	1528	0	0
Fort Fraser	BC	54.06197	-124.5528	2	3.6	4.7	1115	1414	1602	0	0
Petitot River	BC	59.64798	-120.8116	-2.1	-0.2	0.9	1262	1522	1670	0	0
Beatton River	BC	57.18734	-121.2461	-0.3	1.5	2.6	1238	1517	1682	0	0
Rivers Inlet	BC	55.59591	-127.53349	4.9	6.4	7.3	1144	1468	1692	0	0
Fort Nelson	BC	58.80603	-122.69731	-0.8	1	2.1	1272	1546	1706	0	0
Dawson Creek	BC	55.76676	-120.22457	1.5	3.2	4.3	1235	1528	1711	0	0
Quesnel	BC	52.97484	-122.4978	2.7	4.3	5.4	1216	1532	1732	0	0
Mcleod Lake	BC	54.98266	-123.04586	2.5	4.1	5.2	1246	1548	1740	0	0
Fernie	BC	49.50394	-115.06235	2.9	4.7	5.7	1243	1558	1764	0	0
Maxhamish Lake	BC	58.8129	-122.70632	-1.5	0.4	1.5	1342	1613	1768	0	0
Hope	BC	49.37969	-121.44183	4.1	5.7	6.8	1258	1584	1797	0	0
Douglas Channel	BC	53.38643	-129.19313	5.5	6.9	7.9	1235	1574	1805	0	0
Prince George	BC	53.9123	-122.74556	3.1	4.7	5.8	1293	1609	1809	0	0
Bonaparte Lake	BC	51.26053	-120.5589	3.4	5.1	6.2	1288	1618	1826	0	0
Fontas River	BC	58.2594	-120.46942	-0.6	1.3	2.4	1389	1669	1829	0	0
Charlie Lake	BC	56.32681	-120.97242	1.1	2.9	4	1353	1651	1832	0	0
Bute Inlet	BC	50.57139	-124.92422	5.8	7.3	8.3	1423	1776	2014	0	0
Prince Rupert	BC	54.31219	-130.32708	6.8	8.2	9.2	1430	1815	2077	0	0
Graham Island	BC	53.31506	-90.46822	7.4	8.6	9.5	1453	1813	2080	0	0
Dixon Entrance	BC	54.39164	-132.09741	7.7	9	9.8	1539	1919	2193	0	0
Alert Bay	BC	50.58039	-126.92058	7.5	8.8	9.7	1561	1937	2202	0	0
Hecate Strait	BC	53.07516	-130.28997	7.7	9.1	10	1586	1982	2260	0	0
Moresby Island	BC	52.59355	-131.75285	8	9.2	10.1	1610	1988	2269	0	0
Laredo Sound	BC	52.47984	-128.87611	7.6	9	9.9	1609	2005	2277	0	0
Nootka Sound	BC	49.61881	-126.56869	7.9	9.2	10.1	1681	2054	2322	0	0
Vancouver	BC	49.26041	-123.11395	6.9	8.5	9.4	1683	2069	2326	0	0
Port Alberni	BC	49.23387	-124.80554	7.8	9.2	10.1	1739	2113	2375	0	0

Cape Scott	BC	50.78276	-128.42787	8.7	9.9	10.8	1819	2223	2511	0	0
Queens Sound	BC	51.89813	-128.35039	8.6	10	10.8	1830	2253	2543	0	0
Victoria	BC	48.4281	-123.36527	9.4	10.8	11.7	2130	2568	2868	0	0
Kamloops	BC	50.67587	-120.33899	8	9.7	10.7	2305	2719	2977	0	0
Caribou River	MB	59.47007	-95.71333	-7.1	-4.9	-3.6	718.4	923	1051	1	0
Cape Churchill	MB	58.7625	-93.21207	-6.1	-3.8	-2.5	782.8	993.9	1130	1	1
Churchill	MB	58.77072	-94.16928	-6.1	-3.9	-2.6	811.5	1026	1162	1	1
York Factory	MB	57.00511	-92.3015	-5.2	-3	-1.7	904	1129	1273	1	1
Big Sand Lake	MB	49.01738	-100.30577	-4.4	-2.3	-1.1	1065	1302	1451	0	0
Nejanilini Lake	MB	59.6244	-97.73683	-7.2	-5	-3.8	739.7	945.1	1073	0	0
Munroe Lake	MB	59.18894	-98.54935	-6.9	-4.7	-3.5	814.2	1024	1155	0	0
Shethanei Lake	MB	58.82324	-97.90336	-6.1	-4	-2.7	842.7	1059	1195	1	0
Kasmere Lake	MB	59.61539	-101.21975	-6.4	-4.3	-3.1	878.5	1091	1224	0	0
Cape Tatnam	MB	57.26321	-91.00391	-5	-2.7	-1.4	894.4	1118	1268	0	1
Herchmer	MB	57.36924	-94.1864	-5.3	-3.1	-1.9	914.5	1140	1282	0	1
Tadoule Lake	MB	58.62003	-98.38599	-5.6	-3.5	-2.3	932.9	1155	1295	0	0
Kaskattama River	MB	56.63541	-90.5986	-4.6	-2.4	-1.1	946.4	1176	1330	0	1
Northern Indian Lake	MB	57.36518	-97.23587	-5	-2.9	-1.6	976.7	1207	1351	0	0
Whiskey Jack Lake	MB	58.38706	-101.90911	-5.2	-3.1	-1.9	991.1	1217	1357	0	0
Hayes River	MB	55.57496	-93.68154	-4.2	-2	-0.8	1047	1285	1439	0	1
Kettle Rapids	MB	56.34799	-94.7101	-4.1	-2	-0.8	1093	1334	1487	0	1
Brochet	MB	57.88063	-101.66943	-4	-1.9	-0.8	1128	1371	1521	0	0
Split Lake	MB	56.14167	-96.20411	-3.7	-1.6	-0.5	1137	1384	1539	0	0
Gods River	MB	55.33766	-92.84278	-3.1	-1.1	0.1	1185	1437	1600	0	1
Uhlman Lake	MB	56.67749	-98.39845	-3.2	-1.1	0.1	1212	1465	1624	0	0
Knee Lake	MB	55.00521	-94.73397	-2.8	-0.8	0.4	1251	1510	1673	0	1
Granville Lake	MB	56.2966	-100.41124	-2.7	-0.6	0.5	1270	1531	1691	0	0
Sipiwesk	MB	55.06773	-97.63783	-2.4	-0.4	0.8	1309	1575	1741	0	0
Nelson House	MB	55.82652	-98.83489	-2	0	1.2	1348	1617	1783	0	0
Oxford House	MB	54.92778	-95.2883	-1.7	0.3	1.5	1398	1677	1847	0	1
Kississing Lake	MB	55.18942	-101.31087	-1.4	0.6	1.7	1410	1687	1855	0	0
Cross Lake	MB	54.61206	-97.69803	-1.3	0.7	1.9	1448	1732	1904	0	0
Weskusko Lake	MB	54.77193	-99.84884	-0.9	1.2	2.3	1484	1769	1942	0	0
Island Lake	MB	49.80453	-94.31986	-0.8	1.1	2.3	1477	1769	1944	0	1
Norway House	MB	53.98206	-97.83293	-0.4	1.6	2.7	1526	1824	2002	0	0
Cormorant Lake	MB	54.22461	-100.60171	-0.3	1.7	2.9	1546	1838	2013	0	0
Grand Rapids	MB	53.18023	-99.2683	0	2	3.2	1570	1868	2047	0	0
The Pas	MB	53.825	-101.25333	0.4	2.5	3.6	1621	1923	2105	0	0
Berens River	MB	52.34083	-97.02133	0.4	2.5	3.6	1617	1928	2113	0	0
Swan Lake	MB	52.53266	-100.75838	0.8	2.9	4	1633	1944	2133	0	0
Waterhen Lake	MB	51.83016	-99.53786	0.8	2.9	4.1	1665	1980	2167	0	0
Carroll Lake	MB	51.09411	-95.19386	0.9	3	4	1677	1997	2185	0	0
Duck Mountain	MB	52.50538	-100.52382	1.2	3.2	4.4	1684	2003	2200	0	0
Hecla	MB	51.1346	-96.66517	1.3	3.4	4.5	1747	2076	2268	0	0
Riding Mountain	MB	50.53194	-99.4686	1.8	3.9	5.1	1777	2107	2310	0	0
Dauphin Lake	MB	51.21814	-99.73902	1.7	3.8	5	1803	2136	2333	0	0
Pointe Du Bois	MB	50.29745	-95.5524	2.1	4.1	5.2	1826	2165	2362	0	0
Neepawa	MB	50.22623	-99.46656	2.2	4.4	5.5	1871	2212	2417	0	0

Selkirk	MB	50.14364	-96.88248	2.3	4.4	5.5	1906	2250	2452	0	0
Virden	MB	49.85098	-100.93189	3	5	6.2	1958	2305	2516	0	0
Brandon	MB	49.84317	-99.95009	3	5.1	6.2	1983	2336	2546	0	0
Winnipeg	MB	49.89927	-97.13883	3	5.1	6.2	2017	2373	2581	0	0
Campbellton	NB	48.007399	-66.6722057	3	4.9	5.9	1599	1931	2123	1	1
Woodstock	NB	46.1522	-67.5983	4.3	6.2	7.2	1812	2165	2366	1	1
Bathurst	NB	47.6183507	-65.6513357	4.6	6.5	7.5	1822	2171	2372	1	1
Moncton	NB	46.0878165	-64.7782313	5.4	7.3	8.3	1945	2311	2518	1	1
Edmundston	NB	47.369013	-68.326674	3.1	5	6	1634	1976	2171	0	1
Fredericton	NB	45.9635895	-66.643115	5.6	7.5	8.4	1927	2304	2515	0	1
Grenfell Sound	NL	60.285189	-64.44185	-5.8	-3.8	-2.5	262.8	364.1	442.4	1	1
Cape White Handerchief	NL	59.266667	-63.383333	-5.9	-3.9	-2.7	278.9	391.9	471.8	1	1
Hebron	NL	58.199124	-62.625914	-5.8	-3.8	-2.6	319.7	445	531.4	1	1
North River	NL	53.820399	-57.099136	-5.1	-3.2	-2	402.7	551.8	650.6	1	1
Tasisuak Lake	NL	56.640334	-62.755882	-4.5	-2.6	-1.4	515	688	800.4	1	1
Nain	NL	56.541682	-61.696889	-2.8	-1	0.2	605.6	777.5	894.5	1	1
Mistastin Lake	NL	55.883333	-63.33333	-4.3	-2.4	-1.2	605.1	792	913.5	1	1
Nutak	NL	57.466667	-61.866667	-3.7	-1.9	-0.7	486.9	665.5	914.9	1	1
Hopedale	NL	55.457954	-60.211485	-2.3	-0.6	0.6	690.2	878.3	1003	1	1
Makkovik	NL	55.086168	-59.176434	-1.3	0.4	1.5	760.7	939.3	1061	1	1
Battle Harbour	NL	52.273627	-55.585215	-0.2	1.4	2.4	766.6	964.9	1099	1	1
Red Wine Lake	NL	54.08042	-62.3762	-3.3	-1.5	-0.3	767.4	976.5	1112	1	1
Rigolet	NL	54.179922	-58.428833	-1.2	0.5	1.6	800	989.7	1117	1	1
Groswater Bay	NL	54.311621	-57.762627	-0.3	1.2	2.2	836.1	1012	1135	1	1
Cartwright	NL	53.707009	-57.023317	-0.2	1.4	2.4	830.4	1018	1148	1	1
Snegamook Lake	NL	54.54712	-61.436057	-2	-0.2	0.9	810.6	1019	1156	1	1
Woods Lake	NL	54.50807	-65.23927	-3.7	-1.8	-0.7	805.7	1021	1157	1	1
Schefferville	NL	54.824559	-66.817479	-4.1	-2.2	-1	811.3	986	1161	1	1
St. Augustin River	NL	51.999709	-59.37833	-0.9	0.9	1.9	831.1	1052	1197	1	1
Lake Melville	NL	53.741378	-59.571554	-1	0.7	1.8	860.3	1072	1212	1	1
Shabogamo Lake	NL	53.168583	-66.600813	-3.5	-1.6	-0.4	877.6	1106	1249	1	1
Winokapau Lake	NL	53.166667	-62.833333	-2.5	-0.6	0.5	901.4	1128	1274	1	1
Ossokmanuan Reservoir	NL	53.497661	-65.075915	-3	-1.1	0	905.2	1135	1282	1	1
St Anthony	NL	51.3704156	-55.5958649	1.6	3.1	4	953.4	1153	1290	1	1
Lac Opocopa	NL	53.038738	-66.629339	-2.8	-0.9	0.2	930.2	1172	1322	1	1
Minipi Lake	NL	52.4667	-60.8333	-1.1	0.7	1.8	954.4	1190	1344	1	1
Goose Bay	NL	53.3016828	-60.3260842	-1.1	0.7	1.8	1001	1233	1385	1	1
Port Saunders	NL	50.648957	-57.287479	2.2	3.8	4.8	1063	1306	1463	1	1
Sandy Lake	NL	49.241387	-56.983032	3.1	4.8	5.7	1270	1543	1713	1	1
Trepassey	NL	46.736116	-53.360278	5.1	6.5	7.3	1283	1566	1753	1	1
Port aux Basques	NL	46.196919	-59.957004	4	5.7	6.6	1251	1564	1753	1	1
Red Indian Lake	NL	48.725812	-56.870429	3.4	5.1	6	1294	1583	1757	1	1
Burgeo	NL	47.613413	-57.610491	4.2	5.8	6.7	1288	1593	1777	1	1
Wesleyville	NL	49.148145	-53.5569	4.7	6	6.9	1421	1662	1821	1	1
Stephenville	NL	48.5479718	-58.58153529	3.9	5.6	6.6	1327	1636	1825	1	1
St. Lawrence	NL	46.925167	-55.395229	5.3	6.8	7.7	1346	1656	1851	1	1
Bay of Islands	NL	49.161664	-58.218371	3.9	5.6	6.6	1367	1671	1857	1	1
Botwood	NL	49.142298	-55.344085	4.4	5.9	6.8	1449	1711	1879	1	1

Belleoram	NL	47.52675	-55.414973	5	6.5	7.4	1392	1694	1883	1	1
St. John's	NL	47.5605413	-52.7128315	5.3	6.7	7.5	1426	1703	1887	1	1
Bonavista	NL	48.6533449	-53.11182489	5.1	6.4	7.1	1465	1728	1898	1	1
Gander Lake	NL	48.929709	-54.756103	4.5	6	6.9	1456	1741	1951	1	1
Eastport	NL	48.651764	-53.757846	6.8	8.5	9.4	1864	2267	2486	0	1
Glace Bay	NS	46.196919	-59.957004	6.2	7.9	8.8	1745	2112	2324	1	1
Canso	NS	45.336285	-60.994442	6.1	7.9	8.8	1790	2157	2370	1	1
Amherst	NS	45.816667	-64.216721	5.9	7.7	8.6	1919	2296	2505	1	1
Truro	NS	45.3657733	-63.2869407	6.1	7.9	8.8	1926	2301	2513	1	1
Sydeny	NS	46.13679	-60.194224	5.5	7.3	8.3	1708	2064	2272	0	1
Shelburne	NS	43.76358	-65.324023	7.2	8.9	9.7	1904	2305	2514	0	1
Hailfax	NS	44.6488625	-63.5753196	6.6	8.4	9.3	1927	2310	2518	0	1
Annapolis Royal	NS	44.742226	-65.515822	6.9	8.6	9.5	2003	2394	2602	0	1
Jenness Island	NT	78.29793	-113.94129	-18.5	-15.5	-13.6	27	42.1	50.2	1	0
Ballantyne Strait	NT	77.48546	-114.16461	-18.1	-15.1	-13.2	30.7	51.8	64.1	1	0
Satellite Bay	NT	77.37265	-117.23288	-17.8	-14.8	-12.9	36.1	61	74.5	1	0
Intrepid Inlet	NT	76.47137	-118.29558	-17.4	-14.4	-12.6	39.9	71.8	88.6	1	0
Murray Inlet	NT	75.18161	-114.09064	-17.7	-14.7	-13	31.5	68.5	89.4	1	0
Hardinge Bay	NT	76.47042	-121.59033	-17	-14	-12.3	46.8	75.5	89.7	1	0
Emerald Isle	NT	76.8	-114.16667	-17.4	-14.4	-12.6	39.3	75.5	96.2	1	0
Dyer Bay	NT	76.001	-121.86499	-16.6	-13.6	-11.9	52.9	87.6	104.5	1	0
Eglinton Island	NT	75.8	-118.5	-17	-14	-12.2	44.8	85.8	106.9	1	0
Dundas Peninsula	NT	74.68518	-112.5927	-16.7	-13.7	-11.9	50.9	101.9	131.3	1	0
Winter Harbour	NT	74.77002	-110.50793	-16.5	-13.6	-11.8	55.4	108	139.2	1	0
Cape McClure	NT	74.54067	-121.23739	-15.4	-12.5	-10.8	83.7	144.8	173.2	1	0
Mercy Bay	NT	74.10644	-118.92285	-15.7	-12.8	-11.1	79.5	145.6	178.4	1	0
Gore Islands	NT	74.31928	-124.88597	-14.9	-11.9	-10.2	105.9	169.4	196.1	1	0
White Sand Creek	NT	63.54312	-123.71048	-15.3	-12.4	-10.7	96.1	173.1	212.5	1	0
Bernard River	NT	73.41555	-122.19895	-14.7	-11.8	-10.2	108.5	186.9	225.7	1	0
Peel Point	NT	73.37729	-114.51597	-15.2	-12.3	-10.5	102.4	183.1	226.3	1	0
Wynniatt Bay	NT	72.80646	-110.89032	-15.6	-12.8	-11	100.1	185.1	233.4	1	0
Bernard Island	NT	73.59695	-124.23706	-14.2	-11.2	-9.5	131.2	211.6	247.9	1	0
Richard Collinson Inlet	NT	72.89483	-113.71635	-15	-12.1	-10.4	113.9	204.7	254.3	1	0
Jesse Harbour	NT	72.25984	-120.1998	-13.8	-10.9	-9.3	139.2	233.7	282.7	1	0
Saneraun Hills	NT	71.41771	-113.42073	-14.8	-12	-10.3	124.2	226.1	283.5	1	0
Deans Dundas Bay	NT	72.27907	-118.27221	-14.3	-11.4	-9.7	139.5	237.7	289.1	1	0
Lennie River	NT	72.28572	-125.06626	-13.4	-10.4	-8.8	161.2	256.9	301.1	1	0
De Salis Bay	NT	71.40071	-121.73483	-13.2	-10.3	-8.7	154.1	255.7	310.1	1	0
Sachs Harbour	NT	71.98521	-125.24199	-12.9	-10	-8.3	175.2	279.2	328.8	1	0
Walker Bay	NT	71.5617	-118.24048	-13.6	-10.8	-9.1	172.4	285	345.4	1	0
Prince Albert Sound	NT	70.50336	-114.37574	-13.7	-11	-9.4	177.8	300	369.4	1	0
Kargloryuak River	NT	70.24676	-110.42831	-14.4	-11.7	-10	184.1	306.5	376.5	1	0
Kagloryuak River	NT	70.24676	-110.42831	-14.3	-11.7	-10	184.1	306.5	376.5	1	0
Holman Island	NT	70.65087	-117.72955	-13	-10.2	-8.5	208.1	334.1	403.3	1	0
Brock River	NT	69.34637	-122.53353	-11.2	-8.5	-7	278.9	417.8	488.4	1	0
Penny Bay	NT	69.62961	-116.85817	-11.6	-9	-7.4	278.6	422.1	499.4	1	0
Malloch Hill	NT	70.01243	-126.96934	-11.1	-8.2	-6.7	301.5	444	512.1	1	0
Erly Lake	NT	68.21321	-122.14139	-11	-8.5	-7	318.1	462.1	534.6	1	0

Franklin Bay	NT	69.91074	-125.9536	-10.6	-7.9	-6.4	353.8	507.5	581.1	1	0
Stanton	NT	69.80013	-128.68648	-10.3	-7.5	-6	465.9	633.1	707.3	1	0
Bloody River	NT	67.20455	-120.55325	-9.7	-7.2	-5.8	466.8	636.7	724.6	1	0
Simpson Lake	NT	64.95998	-125.1409	-9.9	-7.3	-5.9	477.9	648.9	732.1	1	0
Horton Lake	NT	67.48171	-122.44674	-9.3	-6.9	-5.5	523	701	791	1	0
Point Lake	NT	65.27551	-113.10938	-9.9	-7.6	-6.3	553	719.7	815.3	1	0
Mackenzie Delta	NT	68.94079	-134.73482	-9.8	-6.9	-5.5	554.3	738.6	819.7	1	0
Crossley Lakes	NT	68.54855	-129.58021	-9.5	-6.9	-5.5	603.4	787.3	873.1	1	0
Aubry Lake	NT	67.31107	-126.40617	-8.9	-6.5	-5.1	683.9	878.2	972.5	1	0
Travaillant Lake	NT	67.5706	-131.7156	-8.3	-5.8	-4.5	820	1028	1125	1	0
Cape Dalhousie	NT	70.25339	-129.67219	-10.9	-8	-6.5	369.9	520.9	588.9	0	0
Hepburn Lake	NT	66.33745	-115.28342	-10.5	-8.1	-6.8	464.2	624.5	714.4	0	0
Glacier Lake	NT	62.08163	-127.55648	-8.1	-6.1	-5	502.9	702.3	809.8	0	0
Sloan River	NT	66.58251	-116.74887	-9.3	-7	-5.6	555.7	729.5	822.9	0	0
Healey Lake	NT	64.31783	-106.73726	-10.2	-7.9	-6.5	558.3	731.1	834.7	0	0
Clarke River	NT	63.56024	-104.08382	-10.1	-7.8	-6.4	575.1	749.5	855.4	0	0
Aylmer Lake	NT	64.11259	-108.52327	-9.7	-7.4	-6.1	592	768.1	871.7	0	0
Redrock Lake	NT	65.46385	-114.12315	-9.1	-6.8	-5.6	620.2	794.2	892.7	0	0
Lac Maunoir	NT	67.47643	-124.9417	-8.9	-6.5	-5.1	618.2	806.6	900.3	0	0
Lac De Gras	NT	64.46596	-110.47888	-9.3	-7	-5.7	627.6	804.1	906.8	0	0
Hanbury River	NT	63.59879	-105.30212	-9.4	-7.1	-5.8	633.6	813.2	922.6	0	0
Wrigley Lake	NT	63.8506	-126.21421	-8.1	-6	-4.9	619	826	935.7	0	0
Takaatcho River	NT	66.47614	-119.44655	-8.2	-5.8	-4.5	658.4	851.4	952.3	0	0
Artillery Lake	NT	63.17387	-107.87282	-8.9	-6.7	-5.4	659.3	842	953	0	0
Carey Lake	NT	62.22467	-102.81841	-9	-6.8	-5.5	662.9	846.6	959.4	0	0
Winter Lake	NT	64.486	-112.97901	-8.6	-6.4	-5.1	690.5	871.1	975.6	0	0
Avlavik	NT	68.21992	-135.00779	-9	-6.3	-4.9	708.2	906.8	997.8	0	0
Walmsley Lake	NT	63.41915	-108.55076	-8.3	-6.1	-4.8	709.2	896.8	1010	0	0
Kilekale Lake	NT	66.65489	-123.92496	-8	-5.7	-4.4	709.7	910	1012	0	0
Cape Macdonnel	NT	66.40047	-120.53682	-7.8	-5.4	-4.1	712.1	915.7	1021	0	0
Beaverhill Lake	NT	62.8095	-104.35936	-8.3	-6.1	-4.8	718.7	907.9	1024	0	0
Flat River	NT	61.48436	-126.61458	-6	-4.1	-3	678.8	903.2	1026	0	0
Calder River	NT	65.77491	-116.44378	-7.9	-5.6	-4.3	741.5	932	1036	0	0
Mackay Lake	NT	63.84543	-111.48013	-7.8	-5.6	-4.3	751.5	940.9	1054	0	0
Boyd Lake	NT	61.48183	-103.40841	-8	-5.8	-4.5	749.7	941.9	1061	0	0
Lynx Lake	NT	62.45066	-106.38552	-7.6	-5.4	-4.2	770.4	966.8	1086	0	0
Indin Lake	NT	64.33891	-114.94942	-7.8	-5.5	-4.3	793.1	984.8	1092	0	0
Lac Des Bois	NT	66.81966	-125.20981	-7.8	-5.4	-4.1	803.9	1012	1116	0	0
Rennie Lake	NT	61.55294	-105.50145	-7.3	-5.1	-3.9	804.2	1002	1124	0	0
Carcajou Canyon	NT	65.28348	-126.82724	-7.5	-5.4	-4.2	813.5	1028	1140	0	0
Upper Carp Lake	NT	63.76419	-113.72399	-7.2	-5	-3.8	833	1028	1142	0	0
Ramparts River	NT	66.02495	-130.54195	-7.5	-5.3	-4.1	822.9	1039	1147	0	0
Leith Peninsula	NT	65.51513	-119.07228	-7	-4.7	-3.5	832.7	1041	1149	0	0
Root River	NT	62.93066	-124.43621	-6.5	-4.5	-3.4	807.9	1033	1154	0	0
Fort Mcpherson	NT	67.43436	-134.88326	-8	-5.5	-4.2	844.4	1057	1157	0	0
Snowbird Lake	NT	60.65892	-102.97752	-6.9	-4.7	-3.5	843.2	1047	1173	0	0
Grizzly Bear Mountain	NT	65.33752	-121.00825	-6.9	-4.6	-3.4	852.6	1067	1178	0	0
Reliance	NT	62.71626	-109.16561	-6.6	-4.4	-3.2	865.9	1072	1195	0	0

Mccann Lake	NT	61.1932	-106.58254	-6.5	-4.3	-3.1	874.2	1082	1207	0	0
Riviere Grandin	NT	64.11739	-118.88431	-6.7	-4.5	-3.2	893.9	1104	1216	0	0
Hardisty Lake	NT	64.56519	-117.77451	-6.7	-4.5	-3.2	915.6	1123	1235	0	0
Wholdaia	NT	60.68785	-104.29319	-6.1	-4	-2.8	903.3	1113	1241	0	0
Lac Belot	NT	66.89285	-126.29087	-7.5	-5.2	-3.9	918.8	1135	1242	0	0
Snowdrift	NT	62.24268	-110.31757	-5.8	-3.6	-2.4	961.1	1175	1300	0	0
Wecho River	NT	63.39753	-114.80766	-6.3	-4.1	-2.9	973.7	1184	1301	0	0
Johnny Hoe River	NT	64.16263	-121.42773	-6.2	-4	-2.8	964	1184	1302	0	0
Mahony Lake	NT	65.50984	-125.36313	-6.6	-4.4	-3.2	973.9	1196	1309	0	0
Nonacho Lake	NT	61.72831	-109.43469	-5.5	-3.4	-2.2	965.1	1181	1309	0	0
Abitau Lake	NT	60.43106	-107.17354	-5.4	-3.3	-2.1	963.8	1181	1312	0	0
Blackwater Lake	NT	63.93686	-123.15867	-6.2	-4	-2.8	981.4	1207	1325	0	0
Hearne Lake	NT	62.34643	-113.12698	-5.4	-3.3	-2	1003	1219	1344	0	0
Dahadinni River	NT	63.60885	-125.02855	-5.9	-3.9	-2.7	993.1	1229	1354	0	0
Ontaratue River	NT	66.41545	-131.04656	-6.7	-4.5	-3.2	1021	1250	1360	0	0
Lac La Martre	NT	63.31619	-117.95567	-5.6	-3.4	-2.2	1042	1266	1386	0	0
Marian River	NT	63.41929	-116.65117	-5.6	-3.4	-2.2	1058	1279	1399	0	0
Taltson Lake	NT	61.47632	-110.27045	-4.7	-2.5	-1.4	1060	1285	1415	0	0
Norman Wells	NT	65.28281	-126.82936	-6.3	-4.1	-2.9	1076	1306	1423	0	0
Keller Lake	NT	63.92981	-121.55564	-5.5	-3.3	-2.1	1072	1303	1426	0	0
Hill Island Lake	NT	60.50078	-109.83445	-4.4	-2.3	-1.2	1075	1303	1436	0	0
Willow Lake	NT	62.17511	-119.16576	-5	-2.9	-1.7	1092	1321	1444	0	0
Wrigley	NT	63.18528	-123.3331	-5.5	-3.4	-2.2	1082	1318	1445	0	0
Yellowknife	NT	62.454	-114.37639	-4.8	-2.6	-1.4	1131	1360	1485	0	0
Rae	NT	64.20301	-117.27729	-4.7	-2.5	-1.3	1144	1374	1499	0	0
Fort Resolution	NT	61.17011	-113.67172	-3.8	-1.7	-0.5	1156	1393	1524	0	0
Bulmer Lake	NT	62.79771	-120.75391	-4.5	-2.3	-1.2	1198	1441	1569	0	0
Sulphur Bay	NT	61.3855	-116.01781	-3.5	-1.4	-0.2	1203	1447	1577	0	0
Fort Smith	NT	60.00545	-111.88268	-3.3	-1.2	-0.1	1216	1456	1592	0	0
Camsell Bend	NT	62.28347	-123.36986	-4.4	-2.3	-1.2	1207	1457	1597	0	0
Kakisa River	NT	60.79176	-117.69528	-3.1	-1.1	0	1227	1474	1609	0	0
Tathlina Lake	NT	60.55338	-117.5154	-3.1	-1	0.1	1237	1485	1617	0	0
Falaise Lake	NT	61.46414	-116.23476	-3.5	-1.4	-0.2	1247	1492	1621	0	0
Sibbeston Lake	NT	61.73484	-122.76579	-3.6	-1.6	-0.5	1231	1487	1625	0	0
Buffalo Lake	NT	60.2262	-115.44087	-2.8	-0.7	0.5	1258	1510	1643	0	0
Mills Lake	NT	61.45908	-118.33062	-3.4	-1.3	-0.2	1280	1527	1659	0	0
Klewi River	NT	60.32668	-113.24317	-2.7	-0.6	0.6	1290	1540	1676	0	0
Fort Liard	NT	60.23998	-123.47417	-2.6	-0.7	0.4	1276	1538	1685	0	0
Fort Simpson	NT	61.86281	-121.3494	-3.2	-1.1	0	1329	1584	1718	0	0
Antoinette Glacier	NU	80.86474	-77.6517	-22.1	-19.6	-18.1	7.8	17.5	23.9	1	0
M'Clintock Inlet	NU	83.01219	-78.00701	-22.6	-19.8	-18.2	9.4	18.4	24.9	1	0
Kennedy Channel	NU	80.97749	-66.17259	-20.4	-17.9	-16.4	9.9	20	27	1	1
Tanquary Fiord	NU	81.04456	-78.94348	-21.9	-19.3	-17.7	8.7	19.7	27.3	1	0
Clements Markham Inlet	NU	82.36289	-72.8591	-20.9	-18.3	-16.6	13.4	22.1	28.1	1	1
Ekblaw Glacier	NU	81.66548	-75.87158	-20.4	-17.9	-16.5	8.4	20.9	29.2	1	0
Lady Franklin Bay	NU	80.10908	-73.98386	-19.6	-17.1	-15.6	17.4	30.9	40.6	1	1
Sawyer Bay	NU	79.32057	-77.45794	-20.3	-17.8	-16.3	13.4	31	43.4	1	0
Dobbin Bay	NU	79.83396	-74.10781	-19.1	-16.6	-15.2	17.5	36.8	48.9	1	0

Cape Isachsen	NU	79.32132	-105.46	-18.8	-15.7	-13.8	27.6	40.3	49	1	0
Borden Island	NU	78.50379	-111.30154	-18.6	-15.5	-13.6	25.8	41.5	50.6	1	0
Otto Fiord	NU	81.03506	-87.14387	-22.3	-19.5	-17.9	19.6	38.4	50.7	1	0
Perley Island	NU	80.17183	-99.24924	-19.4	-16.3	-14.5	27	40.5	51.3	1	0
Meighen Island	NU	79.91667	-99.5	-19.1	-16.1	-14.2	28.1	42.5	54.7	1	0
Peary Channel	NU	79.52532	-100.90861	-18.7	-15.7	-13.8	28.8	43.9	54.8	1	0
Yelverton Inlet	NU	82.32302	-82.78314	-21.6	-18.8	-17.1	24.7	43.5	55.1	1	0
Deer Bay	NU	78.69423	-104.27764	-18.4	-15.3	-13.4	29.5	45.1	56.4	1	0
Lady Ann Strait	NU	75.63993	-79.51053	-18.7	-15.9	-14.1	16	38	57.1	1	0
Strand Fiord	NU	79.18226	-92.35856	-21.5	-18.7	-17.1	17.2	39.3	57.3	1	0
Bukken Fiord	NU	80.73599	-95.09454	-20.9	-18	-16.3	24	44.1	58.4	1	0
Ellef Ringnes Island	NU	78.63692	-102.24158	-18.5	-15.3	-13.4	29	49	64.4	1	0
Hazen Strait	NU	77.16458	-110.18602	-18.2	-15.1	-13.2	29.3	51.1	64.5	1	0
Cape Stallworthy	NU	81.37694	-93.54044	-20.5	-17.5	-15.8	35.9	58.6	73.2	1	0
Lougheed Island	NU	77.43333	-105.1	-17.7	-14.6	-12.6	33.5	56.6	76.1	1	0
King Christian Island	NU	77.78532	-101.80854	-17.8	-14.7	-12.7	33.7	58.7	79.5	1	0
Hassel Sound	NU	78.3287	-98.82552	-18.2	-15.1	-13.2	33.9	59.4	80.2	1	0
Strathcona Fiord	NU	78.73152	-82.97361	-19.5	-17	-15.5	27.2	63.6	89.2	1	0
Glacier Fiord	NU	78.28098	-89.4542	-19.7	-16.8	-15.1	31.4	65.3	89.3	1	0
Talbot Inlet	NU	77.9117	-78.11196	-17.7	-15.2	-13.8	31.6	67.7	90	1	0
Helena Island	NU	76.68013	-100.95454	-17.4	-14.2	-12.3	35.6	68.5	93.3	1	0
Craig Harbour	NU	76.20694	-81	-17.6	-14.9	-13.3	28.3	65.5	94.5	1	0
Domett Point	NU	76.06145	-106.65093	-17.2	-14.1	-12.2	39.1	71.1	95.7	1	0
Sabine Peninsula	NU	76.19008	-109.02219	-17.4	-14.3	-12.4	38.8	74.3	96.9	1	0
Clarence Head	NU	76.82062	-77.7655	-17	-14.5	-12.9	35.5	72.1	97	1	0
Cape Nathorst	NU	77.79256	-99.84993	-17.6	-14.5	-12.6	39.2	71.7	97.3	1	0
Canon Fiord	NU	79.92603	-81.99271	-19.5	-17	-15	31.7	71.6	99.3	1	0
Byam Channel	NU	75.09666	-106.27211	-17.1	-14	-12.1	41.4	78.6	103.6	1	0
Graham Moore Bay	NU	75.45888	-101.09198	-17	-13.8	-11.9	41.4	78.7	105.7	1	0
Vendom Fiord	NU	77.75684	-83.0116	-18.1	-15.5	-14	33.2	76	106.1	1	0
Penny Strait	NU	76.61113	-96.9284	-17.3	-14.2	-12.3	38.5	78	106.6	1	0
Elmerson Peninsula	NU	80.65239	-82.1338	-20.1	-17.4	-15.9	44.4	87.5	116.5	1	0
Sabine Bay	NU	75.72494	-110.25775	-17	-14	-12.2	45	90.4	117.1	1	0
Baad Fiord	NU	76.45833	-86.50661	-18	-15.1	-13.4	34.4	83.3	118	1	0
McDougall Sound	NU	75.20011	-96.9181	-16.7	-13.6	-11.7	46	90.5	121	1	0
Bylot Island	NU	73.27103	-78.46651	-16.6	-14	-12.4	41.9	93.7	127.6	1	0
Dundas Harbour	NU	74.54723	-82.42024	-16.1	-13.3	-11.6	48.9	102	140.5	1	0
Bear Bay East	NU	75.65541	-86.69688	-16.7	-13.7	-11.9	43.9	101.4	144.1	1	0
Trold Fiord	NU	78.04584	-85.57043	-18.7	-16	-14.5	48	106.7	145.9	1	0
Lowther Island	NU	74.55152	-97.50185	-16.1	-13	-11.1	58.1	110.5	146.8	1	0
Cardigan Strait	NU	76.65077	-90.64485	-17.1	-14	-12.2	51.1	110.9	149.2	1	0
Powell Inlet	NU	74.53546	-85.43414	-16.3	-13.3	-11.5	49	110.2	151.2	1	0
Nedlukseak Fiord	NU	68.120475	-65.917106	-12.7	-10.4	-9	62.3	121.8	157.5	1	1
Baumann Fiord	NU	77.93619	-86.23382	-17.6	-14.8	-13.2	53.4	117.4	158.1	1	0
Pangnirtung	NU	66.146558	-65.701218	-12.2	-9.9	-8.5	64.4	122.7	158.6	1	1
Bear Bay West	NU	75.24759	-95.63727	-16.5	-13.4	-11.5	55.5	118.2	158.6	1	0
Clyde Inlet	NU	70.47519	-68.57684	-13.8	-11.3	-9.9	59.9	121.2	161.4	1	1
Okoa Bay	NU	67.91758	-65.91353	-12.4	-10	-8.6	70.7	128.3	163.2	1	1

Somerset Island	NU	73.49332	-93.39341	-16.1	-13.1	-11.2	60.3	124	165	1	0
Graham Island	NU	77.43736	-132.42953	-17	-14	-12.2	65.8	127.4	166.7	1	0
Nova Zembla Island	NU	72.200003	-74.81017	-15.2	-12.7	-11.1	59.3	125.8	167.1	1	0
Baldwin Head	NU	73.68474	-101.05169	-16	-12.9	-11	67.8	126.1	167.3	1	0
Slidre Fiord	NU	79.91498	-84.64501	-19.2	-16.5	-14.9	63.7	126.6	168.6	1	0
Baring Channel	NU	73.78631	-99.10762	-16.1	-13	-11.1	64.5	128.8	170.8	1	0
Buchan Gulf	NU	71.77583	-74.33123	-14.9	-12.4	-10.9	57	128.3	172	1	0
Maxwell Bay	NU	74.63725	-88.71045	-16	-12.9	-11.1	63.9	132.3	175.2	1	0
Stefansson Island	NU	73.43313	-105.52285	-16	-13	-11.1	77.6	140.3	178.7	1	0
Scott Inlet	NU	71.05298	-71.38479	-13.8	-11.3	-9.8	68.1	137	181	1	1
Navy Board Inlet	NU	72.98441	-80.36448	-15.5	-12.8	-11.1	61.3	135.9	181.1	1	0
Conn Lake	NU	70.53827	-73.71859	-14.7	-12.2	-10.7	62	138.3	185.3	1	0
Mcbeth Fiord	NU	69.61981	-68.71004	-13.4	-10.9	-9.4	70.2	140.4	185.4	1	0
Cape Dyer	NU	66.665374	-61.358524	-10.9	-8.7	-7.4	86.3	148.6	186.2	1	1
Pond Inlet	NU	72.70022	-77.96166	-15.6	-13	-11.4	63.6	139.8	186.5	1	0
Cape Clarence	NU	73.90117	-90.16065	-15.7	-12.6	-10.8	75	146.8	193.1	1	0
Mount Cowie	NU	72.51806	-101.41843	-15.7	-12.6	-10.7	88	156.6	203.5	1	0
Icebound Lakes	NU	71.70841	-79.47053	-15.2	12.5	-11	67.6	158.1	211.5	1	0
Arctic Bay	NU	73.03639	-85.1525	-15.1	-12.2	-10.5	80.4	163.9	214.5	1	0
Fisher Lake	NU	72.19169	-97.98028	-15.7	-12.7	-10.9	86	165.6	215.4	1	0
Cape Hewett	NU	70.266667	-67.75	-11.6	-9.2	-7.7	98.6	168.9	219.4	1	1
Creswell Bay	NU	72.68861	-93.36173	-15.6	-12.6	-10.9	88	169.2	219.5	1	0
Campsall Lake	NU	72.53249	-106.86429	-15.8	-12.8	-11.1	98.5	178.5	224.5	1	0
Milne Inlet	NU	72.24903	-80.44894	-18	-15.2	-13.5	78.5	171.7	226.7	1	0
Cape Henry Kater	NU	69.083333	-66.73333	-11.3	-8.9	-7.4	107.7	181.9	233.5	1	1
Franklin Strait	NU	71.33483	-97.47798	-15.4	-12.5	-10.8	105.2	191.4	245.7	1	0
Home Bay	NU	68.75176	-67.24672	-11	-8.6	-7.1	118.3	199.2	249	1	1
Home Bay	NU	69.10803	-67.39177	-11	-8.6	-7.1	118.3	199.2	249	1	1
Fitzgerald Bay	NU	72.14749	-89.69622	-14.8	-11.8	-10	111	201.9	258.5	1	0
Padloping Island	NU	67.103716	-62.619148	-9.9	-7.7	-6.3	131.7	211.8	258.9	1	1
Chidliak Bay	NU	64.950283	-66.665971	-10.6	-8.3	-6.9	107.1	200.5	260.7	1	1
Hoare Bay	NU	65.287727	-63.092545	-9.3	-7.2	-5.9	132.3	213.9	263.3	1	1
Isurtuq River	NU	67.2398	-68.83759	-11.5	-9.1	-7.6	114.7	210.8	266.5	1	1
Brentford Bay	NU	71.85847	-94.30406	-15.5	-12.6	-10.9	117	210.6	266.8	1	0
Beekman Peninsula	NU	63.5	-64.666667	-8.8	-6.7	-5.4	126.7	267.1	267.1	1	1
Moffet Inlet	NU	72.19006	-84.72599	-14.5	-11.6	-9.9	108.1	209.5	267.9	1	0
Abraham Bay	NU	65.11732	-64.43047	-9.7	-7.5	-6.2	127.8	216.6	270.2	1	1
Ekalugad Fiord	NU	68.75943	-68.44064	-11.9	-9.4	-8	121.3	218.8	276.8	1	1
Burns Lake	NU	71.39162	-109.99338	-15.3	-12.6	-10.9	121.6	221.8	278.8	1	0
Thom Bay	NU	70.14696	-92.22984	-15.7	-12.8	-11.1	132.3	231.7	290	1	0
Steensby Inlet	NU	70.07129	-78.3974	-13.7	-11.1	-9.6	111.2	224.9	290.3	1	0
Cape Stang	NU	71.35275	-104.28038	-15.2	-12.4	-10.7	139.4	238.4	295	1	0
Leybourne Islands	NU	64.25	-64.666667	-9.1	-7	-5.6	140.6	235.5	296.2	1	1
Phillips Creek	NU	71.79244	-80.6351	-14.1	-11.3	-9.7	112	228.6	297.9	1	0
Lake Gillian	NU	69.47033	-75.6708	-13	-10.5	-9	128.2	231.9	298.2	1	0
Bourassa Bay	NU	71.52174	-89.97701	-14.4	-11.4	-9.7	139.6	240.4	300.7	1	0
Ward Inlet	NU	63.470545	-67.579517	-9.6	-7.4	-6	139.3	238	305.5	1	1
Grinnell Glacier	NU	62.583328	-66.833328	-8.7	-6.5	-5.1	150.5	242.8	312.1	1	1

Clearwater Fiord	NU	66.55	-67.3333	-10.3	-8	-6.5	146.4	250	312.5	1	1
Pasley Bay	NU	70.59337	-96.15012	-15.2	-12.3	-10.6	147.2	250.9	313.9	1	0
Denmark Bay	NU	70.6017	-103.43526	-14.9	-12	-10.3	156.9	255.8	315.7	1	0
Loks Island	NU	62.471998	-64.606582	-7.5	-5.5	-4.1	172.5	260.5	328.5	1	1
Erichsen Lake	NU	70.66276	-80.62022	-13.6	-10.9	-9.3	132.7	256.7	328.7	1	0
Hall Lake	NU	68.68026	-82.24954	-13.4	-10.6	-9	154.7	277.8	344.4	1	0
Barrow River	NU	67.38712	-82.34386	-13.3	-10.6	-9	155	278.8	344.5	1	0
Resolution Island	NU	61.5087	-64.9475	-6.7	-4.8	-3.5	189.1	273	345	1	1
Encampment Bay	NU	69.80067	-85.4667	-13.6	-10.8	-9.2	162.6	282.4	348	1	0
Koch Island	NU	69.61616	-78.3005	-12.6	-9.9	-8.4	156	277.7	350.1	1	0
Igloolik	NU	69.37878	-81.78518	-13.3	-10.5	-8.9	155.3	280.9	351.7	1	0
Washburn Lake	NU	70.06341	-107.40281	-14.9	-12.1	-10.5	174.9	288.1	353.6	1	0
Armshow River	NU	63.70527	-69.36078	-9.9	-7.5	-6.1	166.3	279.6	354.3	1	1
Sylvia Grinnell Lake	NU	64.02813	-68.85873	-10.2	-7.8	-6.4	161.3	280.5	354.4	1	1
Easter Cape	NU	70.91257	-89.42013	-14	-11.1	-9.4	180.3	293.1	357.5	1	0
Admiralty Island	NU	69.4667	-101.167	-14.5	-11.7	-10	184.7	296.5	362.3	1	0
Mckeand River	NU	64.51335	-68.21681	-10.2	-7.8	-6.3	165.8	288.1	363.1	1	1
Committee Bay	NU	68.74262	-86.84909	-13.5	-10.8	-9.1	179.9	302.1	367.3	1	0
Cape Felix	NU	69.90322	-97.95253	-14.7	-11.9	-10.2	184.2	300.5	369.4	1	0
Miertsching Lake	NU	67.17828	-85.2805	-13.4	-10.8	-9.1	176.4	304	371.6	1	0
Lake Harbour	NU	62.83169	-69.85366	-8.8	-6.5	-5	189.2	300.4	377.8	1	1
Spicer Islands	NU	68.62067	-78.75264	-11.7	-9.1	-7.5	185.1	311	386.1	1	0
Amittok Lake	NU	66.36464	-69.09317	-9.9	-7.5	-6	189.2	315.5	391.6	1	1
Prince Charles Island	NU	67.78878	-76.1532	-11.2	-8.6	-7	196.5	321.8	396.2	1	0
Irvine Inlet	NU	65.666664	-66.666664	-9.3	-7	-5.6	193.8	320.9	399.3	1	1
Spence Bay	NU	69.46212	-93.666	-14.8	-12	-10.3	210	334.9	405.3	1	0
Cape Dorset	NU	64.17851	-76.48198	-9.7	-7.1	-5.4	198.7	326.8	407.4	1	0
Foley Island	NU	68.52941	-75.08456	-11.4	-8.8	-7.3	200	329.2	408	1	0
Queen Maud Gulf	NU	68.23285	-101.58747	-14.1	-11.3	-9.7	214.8	337.3	408.7	1	0
Read Island	NU	69.2055	-113.82976	-13.1	-10.4	-8.8	212.3	343.4	418	1	0
Harrison Islands	NU	69.3623	-90.0455	-14.7	-11.3	-9.6	224.6	349.9	418.4	1	0
Air Force Island	NU	67.92298	-74.03383	-10.9	-8.3	-6.7	213.6	344.5	422.5	1	0
Ellice Hills	NU	67.8343	-88.49953	-13.8	-11.2	9.6	217.9	352.2	423.5	1	0
Cape Dorchester	NU	65.44965	-77.43554	-9.7	-7.1	-5.5	214.9	345.9	426.8	1	0
Winter Island	NU	66.28793	-83.20113	-12.3	-9.6	-8	212.9	352.6	427.2	1	0
Hantzsch Bay	NU	67.59852	-72.50249	-10.5	-7.9	-6.4	218.5	352	430	1	0
Curtis Lake	NU	66.71794	-89.18963	-13.7	-11.1	-9.5	218.3	357.1	431.3	1	0
Simpson Strait	NU	68.39658	-96.70551	-14.3	-11.6	-9.9	226.6	357.2	432	1	0
Arrowsmith River	NU	67.68148	-91.18253	-14.3	-11.7	-10.1	227.2	363.7	435.8	1	0
Bluegoose River	NU	65.59421	-72.97652	-9.6	-7.1	-5.6	219.1	356.8	437.9	1	0
Mingo Lake	NU	64.59196	-72.15562	-9.3	-6.8	-5.2	219.2	355.7	438.8	1	0
Koukdjuak River	NU	66.68436	-72.18198	-9.9	-7.4	-5.8	224.1	361.1	440.9	1	0
Pelly Bay	NU	68.73868	-90.21997	-13.8	-11.1	-9.5	239.6	373.2	443.8	1	0
Cambridge Bay	NU	69.12098	-105.05626	-14.2	-11.5	-9.9	239.9	372.5	449.3	1	0
Cory Bay	NU	65.3757	-74.51018	-9.4	-6.8	-5.2	230.5	368.1	450.1	1	0
Andrew Gordon Bay	NU	64.45094	-75.50277	-9	-6.5	-4.9	232.9	371.9	456.1	1	0
Nottingham Island	NU	63.31829	-78.00504	-8.9	-6.3	-4.6	231.7	368	456.5	1	0
Walker Lake	NU	66.65868	-90.57277	-14	-11.4	-9.8	238.6	381	456.9	1	0

Banning Lake	NU	69.59312	-110.1742	-13.6	-11	-9.4	243.6	382.2	460.5	1	0
Darby Lake	NU	67.81202	-92.44301	-14.5	-11.8	-10.3	246.5	386.3	461.5	1	0
Rae Strait	NU	68.81079	-94.94537	-14.5	-11.8	-10.2	250.1	387.5	462.4	1	0
Hurd Channel	NU	66.18122	-84.54199	-12.4	-9.7	-8.1	235.3	383.6	463	1	0
Repulse Bay	NU	66.52881	-86.23756	-12.7	-10.1	-8.5	247.1	394.2	474	1	0
Laughland Lake	NU	66.10498	-92.72687	-14.1	-11.5	-10	262.1	407.8	486.3	1	0
Vansittart Island	NU	65.87691	-83.92342	-11.7	-9.1	-7.5	257.8	406.7	487.5	1	0
Macdonald Island	NU	63.71952	-72.6482	-8.5	-6	-4.5	258.1	398.3	488.2	1	0
Coral Harbour	NU	64.13955	-83.1576	-11.5	-8.8	-7.2	264.1	407.7	489.3	1	0
Ogden Bay	NU	67.72028	-101.5899	-13.4	-10.8	-9.2	272.7	410.7	491.2	1	0
Mcloughlin Bay	NU	67.83823	-98.52376	-13.6	-10.9	-9.3	272.4	412	491.6	1	0
Cape Barclay	NU	68.23434	-88.14948	-14.1	-11.4	-9.8	281.6	428.8	509.5	1	0
Wager Bay	NU	65.52621	-88.91758	-13.2	-10.6	-9.1	279	432.2	515.5	1	0
Sherman Basin	NU	67.81352	-97.53696	-13.7	-11.1	-9.5	291	437.9	520.6	1	0
Caribou Island	NU	64.2094	-81.45084	-10.3	-7.7	-6	290.2	435.3	522.7	1	0
Douglas Harbour	NU	65.66417	-88.78168	-12.5	-10	-8.4	284.5	439.5	524	1	0
White Island	NU	65.83333	-84.83333	-11.7	-9.1	-7.5	284.9	443.3	529.9	1	0
Bell Peninsula	NU	63.85109	-81.35215	-9.9	-7.3	-5.6	294.4	440.1	529.9	1	0
Cape Dobbs	NU	65.23744	-87.01087	-12	-9.4	-7.9	289.8	448.6	534.6	1	0
Mistake River	NU	66.70896	-95.31139	-13.8	-11.2	-9.6	305	456.5	539.5	1	0
Perry River	NU	67.00385	-102.09665	-13.2	-10.5	-9	308.8	453.4	539.6	1	0
Boas River	NU	64.40616	-85.09587	-11.4	-8.8	-7.2	299.6	455.5	541.8	1	0
Bluenose Lake	NU	68.44728	-119.74546	-11.2	-8.7	-7.2	319.1	466.2	544.5	1	0
Pennington Lake	NU	65.49512	-93.46736	-13.3	-10.7	-9.2	305.7	463.2	548.4	1	0
Akpatok Island	NU	60.416238	-68.141236	-6.5	-4.3	-2.9	326.6	459.2	552.4	1	1
Joe Lake	NU	66.30232	-98.47083	-13.3	-10.6	-9.1	322.9	472.1	559.4	1	0
Cape Krusenstern	NU	68.39782	-113.89177	-11.7	-9.1	-7.6	320	473.8	560.6	1	0
Daly Bay	NU	64.07426	-89.85868	-11.9	-9.3	-7.8	316.7	474.1	561.3	1	0
Elu Inlet	NU	68.52161	-106.17109	-13.3	-10.6	-9.1	324.6	474.4	562.4	1	0
Armark Lake	NU	66.48128	-100.8112	-13.1	-10.5	-9	325.8	473.4	562.5	1	0
Mansel Island	NU	61.99379	-79.80535	-8.4	-5.9	-4.2	307	461.8	562.9	1	0
Richardson Islands	NU	68.54188	-110.55136	-12.7	-10.1	-8.5	324	476.9	564	1	0
Yellow Bluff	NU	64.38288	-87.84974	-11.3	-8.7	-7.2	330.8	492.4	580.8	1	0
Ian Calder Lake	NU	66.49539	-97.39654	-13.3	-10.7	-9.1	340.6	495.4	583.1	1	0
Native Bay	NU	63.89311	-82.62378	-10.2	-7.6	-6	339.8	495.4	585.8	1	0
Brichta Lake	NU	67.80393	-104.88294	-12.9	-10.4	-8.8	349.5	501.3	592.9	1	0
Bear Cove	NU	63.58289	-84.25598	-10.5	-8	-6.4	347.5	506.8	596.9	1	0
Kikerk Lake	NU	67.31965	-113.19365	-11.7	-9.2	-7.7	354.6	508.6	597.1	1	0
Macalpine Lake	NU	66.53282	-102.70033	-12.8	-10.2	-8.7	354.8	505.9	598.1	1	0
Armit Lake	NU	64.14787	-91.60072	-12	-9.5	-8	346.1	510.2	601.3	1	0
Hepburn Island	NU	67.88129	-110.98515	-12.1	-9.6	-8.1	360.3	514.8	604.3	1	0
Coats Island	NU	62.61909	-82.90067	-9.5	-7	-5.4	355.6	514.2	611.8	1	0
Cape Kendall	NU	63.60029	-87.1958	-10.7	-8.1	-6.6	361.6	522.3	612.2	1	0
Woodburn Lake	NU	65.51039	-95.45407	-13	-10.4	-8.9	361.8	523.7	613.1	1	0
Kathawachaga Lake	NU	66.19505	-110.91933	-11.9	-9.4	-8	391.2	543.5	630.6	1	0
Overby Lake	NU	66.67758	-105.68593	-12.5	-10	-8.5	385.5	540.3	634	1	0
Rideout Island	NU	67.17	-107.39	-12.5	-10	-8.4	384.5	541.4	634.4	1	0
Cape Fullerton	NU	63.9823	-88.75434	-11	-8.5	-7	379.8	544.8	637.7	1	0

Mara River	NU	65.95551	-108.6747	-12.1	-9.6	-8.2	401.1	556.7	646.4	1	0
Coppermine	NU	66.72157	-115.31305	-11	-8.5	-7.1	401.8	561.1	649.8	1	0
Tehery Lake	NU	64.4301	-93.10294	-12	-9.5	-8	388.8	558.3	652.6	1	0
Deep Rose Lake	NU	65.72112	-98.66142	-12.5	-10	-8.5	396.7	557.4	652.8	1	0
Chesterfield Inlet	NU	63.947	-94.03115	-11.1	-8.6	-7.2	391.2	558.9	654.4	1	0
Arctic Sound	NU	67.57053	-108.81929	-12.1	-9.6	-8.1	402.9	564	656.8	1	0
Napaktulik Lake	NU	66.22732	-113.16811	-11.2	-8.9	-7.5	414.9	569.6	657.8	1	0
Amer Lake	NU	65.61254	-97.19056	-12.6	-10.1	-8.6	401.1	565	659	1	0
Pelly Lake	NU	65.92324	-101.36395	-12.3	-9.8	-8.3	406.3	565.4	662.7	1	0
Dismal Lakes	NU	67.43303	-117.08016	-10.5	-8	-6.6	421.5	582.7	670	1	0
Tinney Hills	NU	66.83407	-107.61884	-11.9	-9.5	-8	430.1	590.2	685.4	1	0
Marble Island	NU	62.67515	-91.12271	-10.6	-8.1	-6.7	421.1	592.7	693	1	0
Bebensee Lake	NU	67.48285	-118.54785	-9.9	-7.5	-6.1	445.9	611.9	699.5	1	0
Jervoise River	NU	65.27611	-103.34334	-11.9	-9.4	-8	439.3	601.2	700.9	1	0
Gibson Lake	NU	63.49296	-93.24297	-11.1	-8.6	-7.1	433.2	606.7	706.5	1	0
Baker Lake	NU	64.16969	-95.38976	-11.8	-9.3	-7.8	449.6	623.6	721	1	0
Duggan Lake	NU	65.57618	-104.93806	-11.6	-9.1	-7.7	459.9	623.6	722.9	1	0
Nose Lake	NU	65.42641	-108.97815	-11.1	-8.8	-7.4	475.8	639.7	734.1	1	0
Tavani	NU	62.06851	-93.1098	-10.3	-7.9	-6.5	455.7	630.9	736	1	0
Schultz Lake	NU	64.73251	-97.4267	-11.7	-9.2	-7.8	474.9	646.4	745.4	1	0
Beechey Lake	NU	65.3213	-106.65314	-11.2	-8.8	-7.4	482.5	648	746.5	1	0
Macquoid Lake	NU	63.46925	-94.71746	-11.1	-8.7	-7.2	471.7	646.3	746.6	1	0
Aberdeen Lake	NU	64.48782	-98.74724	-11.5	-9	-7.6	479.7	648.5	748.8	1	0
Contwoyto Lake	NU	65.59639	-110.58321	-10.7	-8.4	-7.1	497.1	659.5	752	1	0
Beverly Lake	NU	64.60755	-100.49182	-11.3	-8.9	-7.4	489.8	657.7	760.1	1	0
Thirty Mile Lake	NU	63.59483	-96.64533	-11	-8.5	-7.1	511.6	682.9	783.8	1	0
Dawson Inlet	NU	61.83386	-93.41682	-9.6	-7.2	-5.8	501	680	791	1	0
Tammarvi River	NU	64.62956	-102.50704	-10.8	-8.5	-7.1	526.5	697.9	802.8	1	0
Baillie River	NU	64.86396	-105.26252	-10.6	-8.2	-6.9	538.1	709.4	813.3	1	0
Inukjuak	NU	58.45512	-78.1051	-6.2	-3.7	-2.1	492	684	821	1	1
Ferguson Lake	NU	62.91738	-96.88905	-10.2	-7.8	-6.4	546.2	720	825.3	1	0
South Henik Lake	NU	61.52916	-97.39348	-9.3	-7	-5.7	590.5	770.4	881.8	1	0
Hyde Lake	NU	60.59526	-95.29501	-8.3	-6	-4.7	621.7	813.2	932	1	0
King George Islands	NU	57.18631	-78.31883	-5.3	-2.8	-1.1	596.4	809.9	969.3	1	1
Edehon Lake	NU	60.41403	-97.33065	-8.3	-6	-4.7	660.5	853.1	973.1	1	0
Tukarak Island	NU	56.25948	-78.75561	-4.5	-2.1	-0.5	683.7	910.2	1084	1	1
Snape Island	NU	55.73359	-79.31184	-4	-1.6	0	750.2	985.4	1168	1	1
Akimiski Island North	NU	53.00476	-81.31219	-1.9	0.3	1.8	1127	1400	1605	1	0
Kaminak Lake	NU	62.27141	-94.92415	-10.3	-7.9	-6.5	499.6	675.7	781.3	0	0
Tebesjuak Lake	NU	63.73524	-98.87132	-10.9	-8.5	-7.1	515.8	683.4	783.7	0	0
Dubawnt Lake	NU	63.09001	-101.53339	-10.5	-8.2	-6.8	539.1	709.9	813.6	0	0
Arviat	NU	61.10867	-94.05854	-9.3	-7	-5.6	548.6	729.4	841.4	0	0
Tulemalu Lake	NU	62.92806	-99.41571	-10	-7.7	-6.4	574.2	746.7	852.1	0	0
Watterson Lake	NU	61.21464	-99.37973	-9.1	-6.9	-5.6	634.9	815.1	927.2	0	0
Ennadai	NU	61.13333	-100.883333	-8.7	-6.5	-5.2	697.6	883.5	999.4	0	0
Nueltin Lake	NU	60.44064	-99.54159	-8	-5.8	-4.6	715.9	910.1	1032	0	0
Ennadai Lake	NU	60.88178	-101.23389	-7.6	-5.4	-4.2	779	976.9	1101	0	0
Kamilukuak Lake	NU	62.34043	-101.52599	-9.6	-6.9	-4.1	618.9	833.1	1105	0	0

Winisk	ON	55.26667	-85.2	-3.8	-1.6	-0.2	927.2	1165	1345	1	0
Fort Severn	ON	55.98802	-87.6391	-4	-1.8	-0.4	951.9	1187	1357	1	1
Fort Albany	ON	52.21473	-81.6829	-1.4	0.8	2.2	1218	1498	1701	1	0
Black Duck River	ON	56.44734	-89.43249	-4.6	-2.4	-1	911.2	1139	1298	0	1
Cape Henrietta Maria	ON	55.109	-82.25353	-3.7	-1.4	0.1	892.1	1134	1322	0	1
Lakitusaki River	ON	54.34464	-82.76118	-3.3	-1	0.4	956	1206	1397	0	1
Sutton Lake	ON	54.3638	-84.69924	-3.4	-1.3	0.1	983.7	1228	1409	0	0
Island River	ON	55.40372	-89.0828	-3.8	-1.7	-0.4	1019	1258	1424	0	1
Clendenning River	ON	54.21239	-87.09111	-3.1	-1.1	0.2	1071	1319	1494	0	1
Sturgeon Lake	ON	55.38747	-90.8757	-3.5	-1.4	-0.1	1099	1345	1508	0	1
Ekwan River	ON	53.75352	-85.01958	-2.3	-0.2	1.2	1096	1360	1556	0	1
Matateo River	ON	53.51637	-84.57849	-2.4	-0.3	1	1138	1400	1586	0	0
Fawn River	ON	54.34382	-88.58672	-2.8	-0.8	0.5	1159	1416	1589	0	1
Winiskisis Channel	ON	54.0382	-87.08773	-2.2	-0.2	1	1208	1473	1654	0	1
Thorne River	ON	54.73078	-91.35721	-2.5	-0.5	0.7	1229	1491	1663	0	1
Asheweig River	ON	53.58871	-88.37843	-2	0	1.2	1275	1547	1727	0	1
Kapiskau River	ON	52.09176	-83.70596	-1.3	0.7	2	1251	1531	1728	0	1
Missisa Lake	ON	52.31213	-85.19534	-1.5	0.5	1.8	1268	1546	1734	0	0
Stull Lake	ON	54.42126	-92.59016	-2.1	-0.1	1.1	1314	1583	1753	0	1
Makoop Lake	ON	53.39778	-90.81955	-1.7	0.3	1.5	1339	1618	1795	0	1
Lansdowne House	ON	52.2206	-87.88537	-1.3	0.7	1.8	1333	1613	1797	0	1
Moosonee	ON	51.26973	-80.64506	-0.5	1.5	2.8	1343	1635	1832	0	1
Wunnummin Lake	ON	52.92783	-89.08996	-1.1	0.8	2	1387	1673	1855	0	1
Ghost River	ON	48.57967	-79.87986	-0.5	1.5	2.8	1381	1675	1870	0	1
Opasquia Lake	ON	53.29354	-93.56552	-1.2	0.7	1.9	1413	1697	1872	0	1
Ogoki	ON	51.6298	-85.94519	-0.5	1.5	2.7	1413	1710	1899	0	1
North Caribou Lake	ON	52.81535	-90.74221	-0.9	1.1	2.2	1431	1722	1903	0	1
Fort Hope	ON	51.55763	-87.90649	-0.5	1.4	2.6	1428	1724	1909	0	1
Schreiber	ON	48.81048	-87.26125	2.3	4.3	5.4	1386	1730	1929	0	1
Miminiska Lake	ON	51.57723	-88.55795	-0.5	1.5	2.6	1452	1750	1934	0	0
Moose River	ON	50.69817	-81.82712	0.1	2.1	3.3	1441	1745	1939	0	1
White River	ON	48.63772	-85.77137	1.5	3.5	4.6	1432	1765	1955	0	1
Longlac	ON	49.78128	-86.53483	0.9	2.9	4	1454	1776	1960	0	1
Nakina	ON	50.17604	-86.70692	0.1	2.1	3.2	1475	1785	1970	0	1
Armstrong	ON	50.30433	-89.04153	0.1	2.1	3.2	1481	1792	1977	0	1
North Spirit Lake	ON	52.51049	-92.91778	-0.4	1.6	2.7	1501	1799	1979	0	1
Smoky Falls	ON	50.06074	-82.16364	0.4	2.3	3.5	1505	1815	2009	0	1
Lake St Joseph	ON	50.9868	-91.27161	0	2	3.1	1531	1835	2019	0	0
Cochrane	ON	49.06306	-81.02816	0.7	2.7	3.8	1523	1842	2033	0	1
Michipicoten	ON	47.93884	-84.82596	3	4.9	6	1473	1829	2033	0	1
Hornepayne	ON	49.2181	-84.77726	0.9	2.9	4	1523	1848	2037	0	1
Deer Lake	ON	52.58178	-94.09534	0	1.9	3	1554	1854	2038	0	1
Nipigon	ON	49.01464	-88.26302	1.2	3.2	4.3	1535	1860	2048	0	1
Kenogami River	ON	50.23034	-85.31586	0.5	2.5	3.6	1534	1849	2049	0	1
Thunder Bay	ON	48.38249	-89.24598	2.3	4.3	5.4	1552	1892	2089	0	1
Trout Lake	ON	51.20624	-93.29932	0.5	2.5	3.6	1600	1913	2098	0	1
Foleyet	ON	48.24389	-82.43972	1.6	3.6	4.7	1595	1930	2123	0	1
Sioux Lookout	ON	50.09302	-91.91652	0.9	2.9	4	1624	1945	2134	0	0

Ignace	ON	49.41232	-91.6553	1.5	3.4	4.5	1649	1980	2172	0	0
Chapleau	ON	47.84439	-83.40411	2.4	4.4	5.5	1637	1982	2176	0	1
Timmins	ON	48.47614	-81.32903	1.8	3.7	4.8	1651	1988	2181	0	1
Quetico	ON	48.73333	-90.91667	2.2	4.2	5.3	1685	2029	2225	0	0
Lac Seul	ON	50.31843	-92.28462	1.7	3.7	4.8	1751	2083	2277	0	0
Gogama	ON	47.67449	-81.72343	2.7	4.6	5.7	1743	2093	2289	0	1
Sault Ste Marie	ON	46.50677	-84.33352	4.4	6.4	7.4	1778	2152	2363	0	1
Kapuskasing	ON	49.41594	-82.42978	0.9	3.2	5.7	1562	1948	2375	0	1
Dryden	ON	49.78206	-92.83439	2.4	4.4	5.5	1834	2181	2380	0	0
Blind River	ON	46.18629	-82.96087	4.2	6.2	7.3	1838	2209	2416	0	1
Kenora	ON	49.76526	-94.47769	2.6	4.7	5.8	1898	2250	2453	0	0
North Bay	ON	46.30891	-79.46111	4	6	7	1897	2270	2476	0	1
Sudbury	ON	46.48968	-80.99139	4.2	6.2	7.3	1926	2302	2510	0	1
Huntsville	ON	45.32424	-79.21072	4.6	6.5	7.6	1926	2308	2520	0	1
Tobermory	ON	45.25332	-81.66449	5.8	7.8	8.8	2032	2434	2660	0	1
Pembroke	ON	45.82701	-77.11162	5.1	7.1	8.1	2087	2474	2689	0	1
Ottawa	ON	45.42001	-75.68954	5.7	7.6	8.6	2191	2584	2801	0	1
Owen Sound	ON	44.5643	-80.94248	6.7	8.7	9.7	2171	2584	2814	0	1
Lake Simcoe	ON	44.44469	-79.34988	6.4	8.3	9.3	2207	2615	2839	0	1
Kingston	ON	44.22979	-76.48021	6.7	8.7	9.7	2299	2710	2937	0	1
Kitchener	ON	43.4523	-80.49217	7.3	9.3	10.3	2335	2754	2983	0	1
Toronto	ON	43.65161	-79.38313	8.2	10.2	11.2	2481	2920	3161	0	1
Erie	ON	43.77009	-80.0667	8.7	10.6	11.6	2591	3035	3276	0	1
Charlottetown	PE	46.23824	-63.1310704	6	7.8	8.8	1936	2310	2525	0	1
Cratere Du Nouveau-Quebec	QC	61.283333	-73.6666	-8.9	-6.5	-4.9	205.9	331.6	416.1	1	1
Lacs Nuvilic	QC	61.52843	-74.75083	-8.7	-6.2	-4.7	231	369	460.6	1	1
Cap Wolstenholme	QC	62.58141	-77.51165	-8.8	-6.3	-4.6	230.9	370.1	462	1	1
Point Le Droit	QC	59.750606	-65.531956	-6.3	-4.3	-3	274.5	386.6	465.5	1	1
Cap De Nouvelle-France	QC	62.47947	-73.67282	-8.4	-5.9	-4.4	245.3	380.8	471.2	1	1
Salluit	QC	62.20417	-75.64832	-8.4	-5.9	-4.3	249.3	390.1	483.4	1	1
Lac Klotz	QC	60.5172	-73.71239	-7.8	-5.4	-4	291.9	483.3	536.6	1	1
Kovik Bay	QC	61.55913	-77.67348	-8.1	-5.6	-4	291.3	444	545.2	1	1
Riviere Koroc	QC	58.709781	-64.686665	-6.3	-4.2	-2.9	339.2	474.4	564.6	1	1
Lac Couture	QC	46.31936	-78.35687	-7.6	-5.2	-3.7	322	478.6	583.5	1	1
Povungnituk	QC	59.93038	-78.10238	-7.3	-4.8	-3.2	368.1	534.3	646.8	1	1
Lac Du Pelican	QC	59.80866	-73.62708	-6.7	-4.4	-3	404.5	572.3	684.6	1	1
Lac Anuc	QC	59.32515	-75.14563	-6.7	-4.4	-2.9	412	583.4	699.8	1	1
Lac Henrietta	QC	57.3081	-64.576981	-5.8	-3.8	-2.5	436.4	598.2	702.2	1	1
Kogaluk Bay	QC	59.36453	-77.8302	-6.6	-4.2	-2.6	434.6	611.4	734.5	1	1
Hopes Advance Bay	QC	59.34506	-69.59134	-5.7	-3.5	-2.1	477.9	640.3	750.1	1	1
Lac Vernon	QC	58.89649	-74.27228	-6.3	-4	-2.5	469.5	649.2	772.8	1	1
Lac La Potherie	QC	58.84584	-72.3787	-9.9	-7.6	-6.1	481.5	659.5	778.5	1	1
Riviere Innuksuac	QC	58.52877	-76.74674	-6.2	-3.8	-2.2	481	666.9	799.5	1	1
Lac Ralleau	QC	58.029223	-66.667938	-4.9	-2.9	-1.5	565.1	734.7	846.4	1	1
Lac Nedlouc	QC	57.40344	-72.74012	-5.8	-3.6	-2.3	545.4	730.4	854.5	1	1
Lac Minto	QC	48.83069	-69.30934	-5.7	-3.5	-2	539.6	729	861.3	1	1
Lac Brisson	QC	49.458773	-68.292819	-5.1	-3.1	-1.9	566.7	750.1	866.1	1	1
Kuujjuaq	QC	58.102996	-68.418839	-5.4	-3.2	-1.8	586.9	761.7	878.2	1	1

Broughton Island	QC	57.35787	-76.77428	-5.6	-3.2	-1.7	547.2	743.5	884.5	1	1
Lac Saffray	QC	57.597186	-67.062641	-5	-2.9	-1.6	612.9	798.6	917.9	1	1
Lac Des Loups Marins	QC	56.11938	-73.2189	-5.2	-3.1	-1.7	635.6	832.2	964.1	1	1
Lac A L'eau Claire	QC	46.54398	-73.08716	-5.1	-2.9	-1.5	623.2	823.9	964.6	1	1
Lac Herodier	QC	57.362851	-68.693526	-5.1	-3	-1.6	663.9	856.2	981.3	1	1
Lac Jeannin	QC	56.495467	-66.416686	-4.8	-2.8	-1.5	674	871.2	995.4	1	1
Lac Resolution	QC	55.2561	-64.47451	-4.5	-2.6	-1.3	684.1	882.7	1009	1	1
Lac Guillaume-Delisle	QC	54.92195	-67.42364	-4.7	-2.4	-0.9	658.5	870.3	1024	1	1
Lac Cambrien	QC	56.408692	-69.110064	-4.8	-2.7	-1.4	715.5	917	1046	1	1
Lac Wakuach	QC	55.562778	-67.54056	-4.6	-2.6	-1.4	729.3	933.1	1060	1	1
Lac Montrochand	QC	55.22562	-74.79126	-4.6	-2.4	-1.1	705.2	917	1064	1	1
Lac Bienville	QC	55.01345	-72.78317	-4.7	-2.6	-1.3	720	927.5	1066	1	1
Poste-De-La-Baleine	QC	55.28085	-77.75468	-4.3	-2	-0.6	715.7	936.7	1101	1	1
Lac Kinglet	QC	54.74187	-75.04303	-3.8	-1.7	-0.4	828.8	1058	1218	1	1
Blanc-Sablon	QC	51.4264451	-57.13131479	0.9	2.5	3.5	875.7	1096	1242	1	1
Riviere Denys	QC	55.00444	-77.11948	-3.5	-1.3	0.1	840.2	1078	1252	1	1
Lac Fournier	QC	45.951823	-75.868875	-2.2	-0.3	0.8	880.7	1121	1275	1	1
Lac Joseph	QC	46.220034	-71.52373	-2.6	-0.8	0.3	917.5	1155	1306	1	1
Lac De Morhiban	QC	51.816463	-62.870178	-1.5	0.4	1.5	909.3	1152	1308	1	1
Riviere Natashquan	QC	50.117113	-61.800425	-0.6	1.2	2.2	912.9	1156	1313	1	1
Lac Brule	QC	46.101194	-74.282312	-2	-0.2	0.9	932.7	1168	1321	1	1
Pointe Louis-XIV	QC	54.6308	-79.75405	-3.2	-0.9	0.7	881.1	1132	1326	1	1
Saint-Augustin	QC	51.232769	-58.651544	0.3	2.1	3.1	926.8	1171	1329	1	1
Lac Fouquet	QC	48.879356	-73.821334	-2.2	-0.3	0.8	935.1	1184	1339	1	1
Lac Sakami	QC	53.27974	-76.72769	-2.6	-0.5	0.9	1001	1258	1439	1	1
Eastmain	QC	52.24633	-78.50043	-1.4	0.7	2.1	1172	1172	1452	1	1
Lac Manitou	QC	46.059654	-74.36939	0	1.8	2.9	1023	1289	1457	1	1
Harrington Harbour	QC	50.5	-59.483333	1.4	3.1	4.2	1036	1303	1474	1	1
Musquaro	QC	50.230409	-61.063852	1	2.8	3.9	1036	1305	1478	1	1
Havre-Saint-Pierre	QC	50.243284	-63.599712	0.6	2.4	3.5	1058	1329	1501	1	1
Riviere Au Castor	QC	53.31809	-78.30739	-2.2	0	1.4	1040	1306	1505	1	1
Sept-Iles	QC	50.213297	-66.375792	-0.2	1.7	2.7	1095	1369	1538	1	1
Lac-Berte	QC	50.77279	-68.50161	-0.9	1	2	1122	1396	1565	1	1
Reservoir Opinaca	QC	52.79203	-76.13804	-1.8	0.3	1.5	1121	1392	1572	1	1
Lac Nemiscau	QC	51.37883	-76.83395	-1.1	1	2.2	1233	1519	1704	1	1
Cap-Chat	QC	49.094066	-66.685739	1.6	3.5	4.5	1291	1595	1777	1	1
Gaspe	QC	48.831635	-64.486902	2.7	4.6	5.6	1419	1732	1915	1	1
Matane	QC	48.844516	-67.530576	2.2	4.1	5.1	1438	1756	1942	1	1
Deep River	QC	46.10132	-77.48619	3.7	5.7	6.7	1863	2229	2434	1	1
Riviere Serigny	QC	56.00017	-68.663744	-4.7	-2.7	-1.5	744.7	950.1	1080	0	1
Caniapiscau	QC	54.866667	-69.916667	-4.3	-2.3	-1.1	801.9	1016	1150	0	1
Lac Mistanukaw	QC	54.77041	-72.617	-4	-2	-0.8	826.1	1048	1194	0	1
Lac Bermen	QC	53.583333	-68.916667	-3.7	-1.8	-0.6	870.1	1097	1239	0	1
Lac Vallard	QC	52.821961	-68.972345	-3.1	-1.2	-0.1	921.1	1159	1308	0	1
Lac Sauvolles	QC	53.42548	-72.96407	-3.3	-1.3	-0.1	940.2	1180	1334	0	1
Lac De La Fregate	QC	47.14993	-73.92292	-2.9	-0.8	0.4	973.5	1223	1388	0	1
Lac Rossignol	QC	52.69803	-73.77091	-2.6	-0.7	0.5	1022	1275	1437	0	1
Reservoir Manicouagan	QC	51.38333	-68.7	-1.8	0	1.1	1040	1300	1461	0	1

Lac Lichteneger	QC	52.27937	-75.21549	-2.2	-0.2	1	1073	1335	1506	0	1
Lac Baudeau	QC	51.81361	-73.08709	-1.8	0.1	1.3	1126	1395	1565	0	1
Lac Mesgouez	QC	51.40141	-75.16635	-1.3	0.7	1.9	1200	1479	1658	0	1
Ile D'anticosti	QC	49.549519	-62.955532	2.3	4.2	5.2	1208	1498	1679	0	1
Baie Abatagouche	QC	50.52623	-73.84309	-0.9	1	2.1	1233	1519	1697	0	1
Baie Du Renard	QC	47.38241	-61.8843	2.9	4.7	5.7	1232	1528	1715	0	1
Lac Assinica	QC	50.50231	-75.24663	-0.5	1.4	2.6	1306	1601	1784	0	1
Port -Menier	QC	49.818815	-64.352681	2.4	4.2	5.3	1323	1626	1807	0	1
Fort-Rupert	QC	45.69037	-75.98934	-0.5	1.6	2.8	1320	1615	1809	0	1
Baie-Comeau	QC	49.221297	-68.150394	0.9	2.8	3.8	1325	1629	1810	0	1
Lac Evans	QC	50.83749	-77.03094	-0.3	1.7	2.8	1344	1644	1830	0	1
Riviere Harricana	QC	49.00563	-78.14032	-0.2	1.8	3	1373	1675	1865	0	1
Riviere Mistassini	QC	48.72299	-72.3069	0.2	2.1	3.2	1387	1697	1884	0	1
Chibougamau	QC	49.91365	-74.36994	0.4	2.3	3.4	1418	1732	1920	0	1
Joutel	QC	49.45803	-78.30586	0.4	2.4	3.5	1447	1764	1951	0	1
Lac Waswanipi	QC	49.53561	-76.39785	0.6	2.5	3.7	1462	1781	1970	0	1
Reservoir Gouin	QC	48.60751	-74.81008	0.9	2.9	4	1460	1784	1974	0	1
Roberval	QC	48.5183	-72.22176	1.1	3.1	4.2	1495	1822	2011	0	1
Rimouski	QC	48.43898	-68.53497	2.5	4.4	5.5	1510	1843	2036	0	1
Senneterre	QC	48.3935	-77.23518	1.2	3.2	4.3	1528	1859	2050	0	1
Lac Kempt	QC	46.92281	-74.29202	1.8	3.8	4.8	1558	1894	2088	0	1
Rouyn-Noranda	QC	48.23748	-79.01701	1.4	3.4	4.5	1585	1921	2111	0	1
La Tuque	QC	47.44097	-72.78156	2.3	4.2	5.3	1617	1961	2156	0	1
Iles de la Madeleine	QC	47.38241	-61.8843	5.2	6.9	7.9	1608	1951	2158	0	1
Grand-Lac-Victoria	QC	46.07662	-75.9542	2.2	4.1	5.2	1645	1990	2186	0	1
Ville-Marie	QC	47.33184	-79.43689	2.7	4.7	5.8	1752	2108	2304	0	1
Mont-Laurier	QC	46.55039	-75.49599	3.3	5.2	6.3	1761	2120	2322	0	1
Trois-Riviers	QC	46.3434	-72.5436	4	6	7.1	1899	2269	2476	0	1
Montreal	QC	45.5077	-73.55446	6.9	8.8	9.9	2425	2834	3059	0	1
Phelps Lake	SK	59.18527	-103.19889	-5.8	-3.7	-2.5	934.2	1151	1282	0	0
Stony Rapids	SK	59.25771	-105.84133	-4.8	-2.7	-1.6	1039	1266	1403	0	0
Wollaston Lake	SK	58.23898	-103.30403	-4.5	-2.5	-1.3	1051	1284	1427	0	0
Fond-Du-Lac	SK	59.32099	-107.19435	-3.9	-1.8	-0.6	1140	1378	1520	0	0
Pasfield Lake	SK	58.37104	-105.32337	-3.7	-1.7	-0.5	1136	1377	1523	0	0
Compulsion Bay	SK	57.66243	-103.40656	-3.3	-1.3	-0.1	1178	1431	1584	0	0
Geikie River	SK	57.32422	-104.61541	-3	-1.1	0.1	1178	1432	1585	0	0
Livingstone Lake	SK	58.58691	-107.29606	-3	-1	0.1	1198	1448	1597	0	0
Tazin Lake	SK	59.83043	-109.21512	-2.8	-0.8	0.4	1259	1508	1653	0	0
Cree Lake	SK	57.48715	-106.46874	-2.3	-0.3	0.9	1248	1512	1666	0	0
Numabin Bay	SK	56.64944	-103.09109	-2.2	-0.2	0.9	1278	1546	1707	0	0
Upper Foster Lake	SK	56.85092	-105.29853	-2	0	1.2	1278	1547	1709	0	0
William River	SK	58.53254	-108.8453	-1.9	0.1	1.2	1331	1594	1747	0	0
Fitzgerald	SK	54.97657	-102.12806	-2.1	-0.1	1	1356	1612	1755	0	0
Llyoyd Lake	SK	57.34679	-108.98069	-1.4	0.6	1.7	1334	1605	1761	0	0
Mudjatik River	SK	56.58957	-107.37054	-1.2	0.8	1.9	1352	1628	1790	0	0
Pelican Narrows	SK	55.17726	-102.93517	-1.1	0.9	2	1419	1701	1870	0	0
Lac La Ronge	SK	55.12278	-104.96178	-0.6	1.3	2.5	1438	1722	1893	0	0
La Loche	SK	56.482	-109.43506	-0.2	1.7	2.9	1451	1735	1902	0	0

Wapawekka Hills	SK	54.92545	-104.6371	-0.1	1.8	2.9	1469	1756	1930	0	0
Ile-A-La-Crosse	SK	55.45034	-107.9048	-0.1	1.9	3	1473	1761	1932	0	0
Buffalo Narrows	SK	55.86349	-108.48052	0.4	2.3	3.4	1476	1766	1939	0	0
Green Lake	SK	54.16973	-107.71211	0.4	2.3	3.4	1490	1781	1960	0	0
Waterhen River	SK	54.46972	-108.45645	0.7	2.6	3.8	1501	1794	1976	0	0
Shellbrook	SK	53.22183	-106.3885	0.8	2.8	3.9	1555	1855	2043	0	0
Amisk Lake	SK	54.57061	-102.23892	0.1	2.1	3.2	1584	1880	2056	0	0
St Walburg	SK	53.62991	-109.20022	1.1	3	4.2	1571	1871	2063	0	0
Prince Albert	SK	53.20337	-105.75434	0.7	2.7	3.8	1614	1913	2095	0	0
Hudson Bay	SK	52.85927	-102.39118	0.7	2.8	3.9	1610	1916	2106	0	0
Pasquia Hills	SK	53.14889	-102.76961	0.6	2.6	3.7	1632	1935	2116	0	0
Melfort	SK	52.87088	-104.60962	1.4	3.4	4.6	1717	2030	2226	0	0
Yorkton	SK	51.21206	-102.45996	1.5	3.6	4.7	1710	2037	2238	0	0
North Battleford	SK	52.78545	-108.29903	2.1	4	5.1	1733	2047	2247	0	0
Saskatoon	SK	52.13079	-106.66095	1.9	3.9	5.1	1776	2094	2294	0	0
Wynyard	SK	51.7622	-104.17914	2.2	4.2	5.4	1824	2149	2354	0	0
Melville	SK	50.92973	-102.80496	2.3	4.4	5.5	1815	2148	2356	0	0
Cypress Lake	SK	49.47169	-109.47811	3.9	5.8	6.8	1825	2170	2387	0	0
Kindersley	SK	51.47494	-109.14482	3	4.9	6	1862	2188	2396	0	0
Rosetown	SK	51.55256	-107.99263	2.9	4.9	6	1898	2228	2436	0	0
Wood Mountain	SK	49.37118	-106.38229	3.8	5.7	6.8	1911	2256	2472	0	0
Regina	SK	50.44727	-104.61589	3.2	5.1	6.2	1939	2277	2489	0	0
Swift Current	SK	50.28505	-107.79831	3.7	5.6	6.7	1937	2278	2493	0	0
Weyburn	SK	49.66832	-103.85819	3.2	5.2	6.3	1945	2291	2504	0	0
Willow Bunch Lake	SK	49.39173	-105.6376	3.7	5.6	6.7	1956	2304	2519	0	0
Prelate	SK	50.85237	-109.40652	4.3	6.2	7.3	2010	2361	2582	0	0
Hershel Island	YT	69.59384	-139.06343	-10.5	-7.6	-6.1	401.8	572.5	652.1	1	0
Mount St Elias	YT	60.29333	-140.93018	-6.6	-4.8	-3.7	300.4	468.2	565.8	0	0
Bonnet Plume Lake	YT	65.21475	-134.33307	-9	-7	-5.8	473.5	660.7	758.2	0	0
Blow River	YT	68.73258	-137.42403	-10.2	-7.5	-6	497.4	674	758.7	0	0
Nadaleen River	YT	64.1823	-132.90921	-7.6	-5.5	-4.4	582.8	786.7	890.6	0	0
Niddery Lake	YT	63.29022	-131.34104	-7.3	-5.3	-4.1	568.8	781.2	891.9	0	0
Bell River	YT	67.426	-136.93511	-9.3	-6.8	-5.4	612.9	801.7	894	0	0
Kluane Lake	YT	61.30768	-138.77624	-5.7	-3.8	-2.7	558.3	780.9	898.6	0	0
Larsen Creek	YT	60.13555	-125.57928	-7.1	-5	-3.8	609.3	823.2	931.3	0	0
Nash Creek	YT	64.56952	-134.51683	-6.8	-4.7	-3.6	634	846.8	954.7	0	0
Quiet Lake	YT	61.04167	-133.055902	-4.7	-2.9	-1.8	604.5	838.7	964.3	0	0
Dawson	YT	64.06099	-139.42952	-7.4	-5.4	-4.2	636	853.1	965.3	0	0
Ogilvie River	YT	65.36665	-138.45441	-8.3	-6.2	-5	651.4	862.8	970.7	0	0
Old Crow	YT	67.56841	-139.8355	-9.1	-6.6	-5.3	673.2	878.3	977.8	0	0
Dezadeash Range	YT	60.80885	-136.94462	-3.1	-1.3	-0.2	608.8	853.8	991.9	0	0
Finlayson Lake	YT	61.69462	-130.65309	-5.1	-3.2	-2.1	651.9	887.8	1015	0	0
Frances Lake	YT	61.44085	-129.38999	-5.6	-3.6	-2.5	658.8	890.2	1016	0	0
Wolf Lake	YT	60.64232	-131.66717	-4.1	-2.3	-1.2	652.9	897.3	1034	0	0
Porcupine River	YT	67.55823	-138.22348	-8.4	-6.1	-4.9	720.8	933.5	1039	0	0
Aishihik Lake	YT	61.44964	-137.14764	-4.3	-2.4	-1.3	665.2	911.4	1042	0	0
Sheldon Lake	YT	62.69139	-131.0498	-5.5	-3.6	-2.5	697.8	933.9	1057	0	0
Snake River	YT	65.37545	-133.38642	-7.5	-5.3	-4.2	741.9	952	1058	0	0

Hart River	YT	65.63758	-136.65145	-7.1	-5	-3.8	751.7	969.9	1080	0	0
Whitehorse	YT	60.72069	-135.05224	-2.7	-0.8	0.3	689	948	1092	0	0
Tay River	YT	62.67722	-133.91332	-4.6	-2.7	-1.6	748.6	991	1117	0	0
Eagle River	YT	66.69628	-137.04435	-7.3	-5	-3.8	803.8	1020	1127	0	0
Lansing Range	YT	63.85007	-132.81514	-5.2	-3.3	-2.1	780.3	1017	1138	0	0
Teslin	YT	60.16844	-132.71133	-2.6	-0.8	0.3	763.9	1029	1176	0	0
Trail River	YT	66.55689	-135.0209	-7	-4.8	-3.5	870.5	1090	1197	0	0
Stevenson Ridge	YT	62.5728	-138.894	-5.1	-3.2	-2.1	818.3	1073	1205	0	0
Wind River	YT	65.06194	-134.95948	-6.2	-4	-2.8	874	1101	1215	0	0
Mayo	YT	63.59557	-135.899611	-4.5	-2.5	-1.4	856.6	1104	1229	0	0
Glenlyon	YT	62.40498	-134.50037	-3.8	-1.9	-0.7	865.2	1123	1255	0	0
Lake Laberge	YT	60.98225	-135.12707	-3	-1.1	0	852.5	1120	1262	0	0
Mcquesten	YT	63.56367	-137.42411	-4.7	-2.7	-1.6	898.6	1154	1282	0	0
Carmacks	YT	62.08762	-136.29189	-4.3	-2.3	-1.2	889.4	1153	1285	0	0
Coal River	YT	60.5528	-127.49959	-3.8	-2	-0.8	898.6	1151	1292	0	0
La Biche River	YT	60.32469	-124.39216	-4.1	-2.1	-1	925.1	1169	1307	0	0
Stewart River	YT	63.32832	-139.43763	-5.1	-3.2	-2	926	1184	1317	0	0
Watson Lake	YT	60.10368	-128.78635	-2.5	-1.6	-0.5	923.2	1187	1335	0	0

Appendix Raw Data: High Carbon Data Set

					High Carbon Scenario						
Region	Province/Territory	Latitude	Longitude	1976-2005 AMT	2021-2050 AMT	2051-280 ATM	1976-2005 GDD	2021-2050 GDD	2051-2080 GDD	Arctic charr	Brook Trout
M'Clintock Inlet	NU	83.01219	-78.00701	-22.6	-19.4	-15.9	9.4	18.8	40.9	1	0
Clements Markham Inlet	NU	82.36289	-72.8591	-20.9	17.9	14.4	13.4	22.7	43	1	1
Antoinette Glacier	NU	80.86474	-77.6517	-22.1	19.2	-16	7.8	18.2	43.3	1	0
Kennedy Channel	NU	80.97749	-66.17259	-20.4	-17.5	-14.3	9.9	21.2	48.2	1	1
Tanquary Fiord	NU	81.04456	-78.94348	-21.9	-18.9	-15.6	8.7	20.8	48.2	1	0
Ekblaw Glacier	NU	81.66548	-75.87158	-20.4	-17.6	-14.4	8.5	22	56.5	1	0
Ellef Ringnes Island	NU	78.63692	-102.24158	-18.5	-15.3	-13.4	29	49	64.4	1	0
Lady Franklin Bay	NU	80.10908	-73.98386	-19.6	-16.7	-13.4	17.4	32.8	64.8	1	1
Cape Isachsen	NU	79.32132	-105.46	-18.8	-15.1	-11.3	28.1	42.6	78.8	1	0
Sawyer Bay	NU	79.32057	-77.45794	-20.3	-17.4	-14.2	13.4	32.6	79	1	0
Jenness Island	NT	78.29793	-113.94129	-18.5	-14.9	-11	26.9	44.6	82.6	1	0
Otto Fiord	NU	81.03506	-87.14387	-22.3	-19.2	-15.7	19.6	38.2	83.1	1	0
Borden Island	NU	78.50379	-111.30154	-18.6	-14.9	-11	25.8	44.1	83.7	1	0
Perley Island	NU	80.17183	-99.24924	-19.4	-15.8	-12.1	27.3	43.3	84.4	1	0
Yelverton Inlet	NU	82.32302	-82.78314	-21.6	-18.4	-14.8	24.6	43.9	86.1	1	0
Dobbin Bay	NU	79.83396	-74.10781	-19.1	-16.2	-13.1	17.4	38.8	87.3	1	0
Peary Channel	NU	79.52532	-100.90861	-18.7	-15.1	-11.3	29.2	46.5	87.8	1	0
Meighen Island	NU	79.91667	-99.5	-19.1	-15.5	-11.8	28.4	45.7	90.4	1	0
Deer Bay	NU	78.69423	-104.27764	-18.4	14.8	-10.9	29.8	47.7	91.2	1	0
Bukken Fiord	NU	80.73599	-95.09454	-20.9	-17.5	-13.9	24.1	45.3	96.8	1	0
Strand Fiord	NU	79.18226	-92.35856	-21.5	-18.3	-14.8	17.3	40	97.7	1	0
Lady Ann Strait	NU	75.63993	-79.51053	-18.7	-15.4	-11.9	15.9	39.9	103.4	1	0
Ballantyne Strait	NT	77.48546	-114.16461	-18.1	-14.5	-10.6	30.5	55.6	106	1	0
Hazen Strait	NU	77.16458	-110.18602	-18.2	-14.5	-10.6	29.1	55.2	107.2	1	0
Cape Stallworthy	NU	81.37694	-93.54044	-20.5	-17.1	-13.4	36	60.3	112.9	1	0
Satellite Bay	NT	77.37265	-117.23288	-17.8	-14.2	-10.4	35.7	63.8	117.3	1	0
Lougheed Island	NU	77.43333	-105.1	-17.7	-14	-10	33.3	61.1	125.1	1	0
King Christian Island	NU	77.78532	-101.80854	-17.8	-14.1	-10.1	33.5	63.5	132.6	1	0
Hassel Sound	NU	78.3287	-98.82552	-18.2	-14.5	-10.7	33.8	64.3	133.5	1	0
Hardinge Bay	NT	76.47042	-121.59033	-17	-13.5	-9.8	46.5	77.9	139.3	1	0
Intrepid Inlet	NT	76.47137	-118.29558	-17.4	-13.9	-10.1	39.6	74.9	140.5	1	0
Glacier Fiord	NU	78.28098	-89.4542	-19.7	-16.4	-12.8	31.4	66.5	146.7	1	0
Strathcona Fiord	NU	78.73152	-82.97361	-19.5	-16.6	-13.3	27.5	66	147	1	0
Talbot Inlet	NU	77.9117	-78.11196	-17.7	-14.8	-11.7	31.9	71.6	147.6	1	0
Murray Inlet	NT	75.18161	-114.09064	-17.7	-14.2	-10.4	31.3	73.2	152.8	1	0
Domett Point	NU	76.06145	-106.65093	-17.2	-13.5	-9.5	38.6	76.8	157.7	1	0
Helena Island	NU	76.68013	-100.95454	-17.4	-13.7	-9.7	35.1	74.3	158	1	0
Craig Harbour	NU	76.20694	-81	-17.6	-14.5	-11.1	28.3	68.2	158	1	0
Clarence Head	NU	76.82062	-77.7655	-17	-14.1	-10.9	35.5	75.9	158.1	1	0
Emerald Isle	NT	76.8	-114.16667	-17.4	-13.8	-10	38.9	80.6	158.6	1	0
Sabine Peninsula	NU	76.19008	-109.02219	-17.4	-13.7	-9.8	38.2	80.4	160.3	1	0
Cape Nathorst	NU	77.79256	-99.84993	-17.6	-14	-10.1	38.9	77.6	161.3	1	0
Dyer Bay	NT	76.001	-121.86499	-16.6	-13.1	-9.4	52.5	90.2	162.5	1	0
Canon Fiord	NU	79.92603	-81.99271	-19.5	-16.6	-13.4	31.9	73.7	164	1	0
Vendom Fiord	NU	77.75684	-83.0116	-18.1	-15.1	-11.9	33.5	79	171.5	1	0
Byam Channel	NU	75.09666	-106.27211	-17.1	-13.4	-9.5	40.9	84.2	172.3	1	0

Eglinton Island	NT	75.8	-118.5	-17	-13.5	-9.7	44.5	90.1	174.3	1	0
Graham Moore Bay	NU	75.45888	-101.09198	-17	-13.3	-9.4	40.9	84.8	177.4	1	0
Penny Strait	NU	76.61113	-96.9284	-17.3	-13.6	-9.7	37.9	84.6	179.1	1	0
Elmerson Peninsula	NU	80.65239	-82.1338	-20.1	-17	-13.7	44.5	89.5	181.9	1	0
Sabine Bay	NU	75.72494	-110.25775	-17	-13.4	-9.6	44.7	97	192.5	1	0
Baad Fiord	NU	76.45833	-86.50661	-18	-14.7	-11	34.3	86.2	195.1	1	0
Bylot Island	NU	73.27103	-78.46651	-16.6	-13.6	-10.2	41.9	97.2	198.1	1	0
McDougall Sound	NU	75.20011	-96.9181	-16.7	-13.1	-9.2	45.5	97.1	201.8	1	0
Dundas Peninsula	NT	74.68518	-112.5927	-16.7	-13.2	-9.4	50.9	108.9	214.9	1	0
Dundas Harbour	NU	74.54723	-82.42024	-16.1	-12.9	-9.3	48.8	105.9	224	1	0
Winter Harbour	NU	74.77002	-110.50793	-16.5	-13	-9.2	55.2	115.7	225.7	1	0
Nedlukseak Fiord	NU	68.120475	-65.917106	-12.7	-9.9	-7	61.8	127.3	226.6	1	1
Okoa Bay	NU	67.91758	-65.91353	-12.4	-9.6	-6.7	70.1	132.1	227.1	1	1
Trold Fiord	NU	78.04584	-85.57043	-18.7	-15.7	-12.2	48.2	109.1	227.6	1	0
Pangnirtung	NU	66.146558	-65.701218	-12.2	-9.5	-6.7	63.8	129	227.9	1	1
Clyde Inlet	NU	70.47519	-68.57684	-13.8	-10.9	-7.8	59.5	126.6	236.9	1	1
Bear Bay East	NU	75.65541	-86.69688	-16.7	-13.3	-9.5	43.7	105.4	237.1	1	0
Cardigan Strait	NU	76.65077	-90.64485	-17.1	-13.6	-9.7	50.7	115.5	238.2	1	0
Lowther Island	NU	74.55152	-97.50185	-16.1	-12.5	-8.5	57.3	118.6	241.6	1	0
Baumann Fiord	NU	77.93619	-86.23382	-17.6	-14.4	-10.9	53.5	120.4	246.9	1	0
Powell Inlet	NU	74.53546	-85.43414	-16.3	-12.9	-9.1	48.7	113.5	247.7	1	0
Nova Zembla Island	NU	72.200003	-74.81017	-15.2	-12.3	-9	59.3	131.4	248.2	1	0
Slidre Fiord	NU	79.91498	-84.64501	-19.2	-16.1	-12.7	64	130.1	254.4	1	0
Bear Bay West	NU	75.24759	-95.63727	-16.5	-12.9	-9.1	55	122.9	255.1	1	0
Buchan Gulf	NU	71.77583	-74.33123	-14.9	-12	-8.8	56.7	134.5	255.4	1	0
Cape Dyer	NU	66.665374	-61.358524	-10.9	-8.3	-5.6	85.6	154	257.9	1	1
Cape McClure	NT	74.54067	-121.23739	-15.4	-12	-8.3	83.2	150.1	258.5	1	0
Graham Island	NU	77.43736	-132.42953	-17	-13.6	-9.7	65.6	132.7	259.4	1	0
Mcbeth Fiord	NU	69.61981	-68.71004	-13.4	-10.5	-7.5	69.9	147.6	265.3	1	0
Scott Inlet	NU	71.05298	-71.38479	-13.8	-10.9	-7.8	67.8	143.2	266.1	1	1
Baldwin Head	NU	73.68474	-101.05169	-16	-12.3	-8.5	67.3	135.8	266.4	1	0
Somerset Island	NU	73.49332	-93.39341	-16.1	-12.6	-8.7	59.7	131.8	266.5	1	0
Baring Channel	NU	73.78631	-99.10762	-16.1	-12.4	-8.6	63.9	138.5	271.9	1	0
Mercy Bay	NT	74.10644	-118.92285	-15.7	-12.3	-8.6	79	153	272.9	1	0
Conn Lake	NU	70.53827	-73.71859	-14.7	-11.8	-8.6	62	146.4	274.1	1	0
Pond Inlet	NU	72.70022	-77.96166	-15.6	-12.6	-9.3	63.5	146.5	277.2	1	0
Maxwell Bay	NU	74.63725	-88.71045	-16	-12.5	-8.6	63.3	137.4	278.9	1	0
Navy Board Inlet	NU	72.98441	-80.36448	-15.5	-12.3	-8.9	61.3	141.2	279.7	1	0
Stefansson Island	NU	73.43313	-105.52285	-16	-12.4	-8.6	76.7	150.3	280	1	0
Gore Islands	NT	74.31928	-124.88597	-14.9	-11.4	-7.8	105.3	174	284.1	1	0
Steensby Inlet	NU	70.07129	-78.3974	-13.7	-11.1	-9.6	111.2	224.9	290.3	1	0
Cape Clarence	NU	73.90117	-90.16065	-15.7	-12.1	-8.3	74.2	153.7	304.8	1	0
Cape Hewett	NU	70.266667	-67.75	-11.6	-8.8	-5.8	97.8	175	309.3	1	1
Mount Cowie	NU	72.51806	-101.41843	-15.7	-12	-8.3	87.4	166.9	311.3	1	0
Icebound Lakes	NU	71.70841	-79.47053	-15.2	-12.1	-8.9	67.4	167.3	315.7	1	0
White Sand Creek	NT	63.54312	-123.71048	-15.3	-11.9	-8.3	95.5	182.1	318	1	0
Cape Henry Kater	NU	69.083333	-66.73333	-11.3	-8.4	-5.4	106.8	188.8	324.4	1	1
Fisher Lake	NU	72.19169	-97.98028	-15.7	-12.2	-8.4	85.6	176.1	325.5	1	0

Bernard River	NT	73.41555	-122.19895	-14.7	-11.3	-7.8	108.2	194.8	327.8	1	0
Arctic Bay	NU	73.03639	-85.1525	-15.1	-11.7	-8.1	80.4	169	329.4	1	0
Creswell Bay	NU	72.68861	-93.36173	-15.6	-12.1	-8.4	87.4	178.9	333.3	1	0
Campsall Lake	NU	72.53249	-106.86429	-15.8	-12.3	-8.7	97.4	191	335.4	1	0
Milne Inlet	NU	72.24903	-80.44894	-18	-14.7	-11.2	78.5	180	338.3	1	0
Home Bay	NU	69.10803	-67.39177	-11	-8.1	-5.2	117.7	206.3	340	1	1
Home Bay	NU	68.75176	-67.24672	-11	-8.1	-5.2	117.7	206.3	340	1	1
Peel Point	NT	73.37729	-114.51597	-15.2	-11.8	-8.1	101.5	194.1	341.9	1	0
Padloping Island	NU	67.103716	-62.619148	-9.9	-7.2	-4.4	130.9	217.4	343.6	1	1
Wynniatt Bay	NT	72.80646	-110.89032	-15.6	-12.2	-8.6	99.4	198.4	346.7	1	0
Bernard Island	NT	73.59695	-124.23706	-14.2	-10.7	-7.2	130.8	217.8	351.4	1	0
Hoare Bay	NU	65.287727	-63.092545	-9.3	-6.7	-4.1	131.4	222.6	355.1	1	1
Franklin Strait	NU	71.33483	-97.47798	-15.4	-12	-8.3	105.2	201.4	359.1	1	0
Beekman Peninsula	NU	63.5	-64.666667	-8.8	-6.3	-3.7	126.7	220.1	370.2	1	1
Abraham Bay	NU	65.11732	-64.43047	-9.7	-7.1	-4.3	126.8	227.7	370.8	1	1
Isurtuq River	NU	67.2398	-68.83759	-11.5	-8.6	-5.6	114.7	222.3	373.6	1	1
Richard Collinson Inlet	NT	72.89483	-113.71635	-15	-11.6	-8	113.1	216.4	373.9	1	0
Chidliak Bay	NU	64.950283	-66.665971	-10.6	-7.8	-5	106.4	214.7	375.7	1	1
Ekalugad Fiord	NU	68.75943	-68.44064	-11.9	-9	-5.9	121.3	230	381.6	1	1
Fitzgerald Bay	NU	72.14749	-89.69622	-14.8	-11.3	-7.6	110.4	209.5	382	1	0
Brentford Bay	NU	71.85847	-94.30406	-15.5	-12.1	-8.4	116	220.3	384	1	0
Moffet Inlet	NU	72.19006	-84.72599	-14.5	-11.1	-7.6	108.1	216.4	392	1	0
Burns Lake	NU	71.39162	-109.99338	-15.3	-12.1	-8.6	120.5	236.9	400.1	1	0
Jesse Harbour	NT	72.25984	-120.1998	-13.8	-10.4	-6.9	138.9	243.3	400.2	1	0
Thom Bay	NU	70.14696	-92.22984	-15.7	-12.3	-8.8	131.3	240.5	405.6	1	0
Saneraun Hills	NT	71.41771	-113.42073	-14.8	-11.5	-8	123.3	238.3	406.8	1	0
Leybourne Islands	NU	64.25	-64.666667	-9.1	-6.5	-3.8	139.8	248	408.7	1	1
Lake Gillian	NU	69.47033	-75.6708	-13	-10	-6.9	127.9	245.6	412.1	1	0
Deans Dundas Bay	NT	72.27907	-118.27221	-14.3	-10.9	-7.4	138.7	248.3	413.4	1	0
Lennie River	NT	72.28572	-125.06626	-13.4	-9.9	-6.5	161	264.1	417	1	0
Cape Stang	NU	71.35275	-104.28038	-15.2	-11.9	-8.3	138.2	253.1	417.8	1	0
Bourassa Bay	NU	71.52174	-89.97701	-14.4	-11	-7.3	139	247.8	426	1	0
Ward Inlet	NU	63.470545	-67.579517	-9.6	-6.9	-4.1	138.5	253.9	427.3	1	1
Grinnell Glacier	NU	62.583328	-66.833328	-8.6	-6.1	-3.3	149.8	257.7	427.8	1	1
Phillips Creek	NU	71.79244	-80.6351	-14.1	-10.9	-7.5	112	241.2	428.1	1	0
Clearwater Fiord	NU	66.55	-67.3333	-10.3	-7.5	-4.6	145.7	264.4	428.2	1	1
De Salis Bay	NT	71.40071	-121.73483	-13.2	-9.8	-6.4	153.9	266.4	433.7	1	0
Loks Island	NU	62.471998	-64.606582	-7.4	-5.1	-2.5	171.4	273.7	436.1	1	1
Pasley Bay	NU	70.59337	-96.15012	-15.2	-11.8	-8.2	146.4	261.3	438.1	1	0
Denmark Bay	NU	70.6017	-103.43526	-14.9	-11.5	-7.9	155.8	268.2	438.8	1	0
Resolution Island	NU	61.5087	-64.9475	-6.7	-4.4	-1.8	187.9	286.1	448.1	1	1
Sachs Harbour	NT	71.98521	-125.24199	-12.9	-9.5	-6.1	175.1	287.9	452.5	1	0
Erichsen Lake	NU	70.66276	-80.62022	-13.6	-10.4	-7	132.5	269.4	466.5	1	0
Repulse Bay	NU	66.52881	-86.23756	-12.7	-10.1	-8.5	247.1	394.2	474	1	0
Barrow River	NU	67.38712	-82.34386	-13.3	-10.1	-6.8	154.6	285.8	476.2	1	0
Walker Bay	NT	71.5617	-118.24048	-13.6	-10.3	-6.8	171.3	295.6	477.2	1	0
Hall Lake	NU	68.68026	-82.24954	-13.4	-10.2	-6.8	154.2	285.1	478.1	1	0
Encampment Bay	NU	69.80067	-85.4667	-13.6	-10.4	-6.9	162.2	288.4	478.6	1	0

Koch Island	NU	69.61616	-78.3005	-12.6	-9.5	-6.2	155.4	290.3	484.1	1	0
Washburn Lake	NU	70.06341	-107.40281	-14.9	-11.6	-8.2	173.5	304	484.2	1	0
Easter Cape	NU	70.91257	-89.42013	-14	-10.6	-7.1	179.6	299.7	487.9	1	0
Armshow River	NU	63.70527	-69.36078	-9.9	-7.1	-4.1	165.5	297.6	488.6	1	1
Sylvia Grinnell Lake	NU	64.02813	-68.85873	-10.2	-7.4	-4.4	161.3	298.9	490.7	1	1
Igloolik	NU	69.37878	-81.78518	-13.3	-10.1	-6.7	155	290.6	490.7	1	0
Admiralty Island	NU	69.4667	-101.167	-14.5	-11.2	-7.7	183.5	310.3	493.6	1	0
Committee Bay	NU	68.74262	-86.84909	-13.5	-10.3	-6.9	179.3	307.4	496.5	1	0
Mckeand River	NU	64.51335	-68.21681	-10.2	-7.3	-4.3	165.1	307.2	500.5	1	1
Cape Felix	NU	69.90322	-97.95253	-14.7	-11.4	-7.9	183.3	313.8	502.1	1	0
Miertsching Lake	NU	67.17828	-85.2805	-13.4	-10.3	-6.9	175.8	310.6	504.3	1	0
Prince Albert Sound	NT	70.50336	-114.37574	-13.7	-10.5	-7.1	176.6	313.8	509.2	1	0
Lake Harbour	NU	62.83169	-69.85366	-8.8	-6	-3.2	188.5	317.8	511.6	1	1
Kargloryuak River	NT	70.24676	-110.42831	-14.4	-11.1	-7.7	182.8	323.1	514.1	1	0
Kagloryuak River	NT	70.24676	-110.42831	-14.3	-11.1	-7.7	182.8	323.1	514.1	1	0
Spicer Islands	NU	68.62067	-78.75264	-11.7	-8.6	-5.4	185.1	322	519.6	1	0
Prince Charles Island	NU	67.78878	-76.1532	-11.2	-8.1	-4.8	195.6	331.3	528.9	1	0
Amittok Lake	NU	66.36464	-69.09317	-9.9	-7	-4	188.6	334.2	530	1	1
Irvine Inlet	NU	65.666664	-66.666664	-9.3	-6.5	-3.7	193	341.5	541.3	1	1
Spence Bay	NU	69.46212	-93.666	-14.8	-11.5	-8	208.9	345.5	541.5	1	0
Foley Island	NU	68.52941	-75.08456	-11.4	-8.3	-5.2	200	344.7	542.4	1	0
Holman Island	NT	70.65087	-117.72955	-13	-9.7	-6.3	207	345.4	543.9	1	0
Cape Dorset	NU	64.17851	-76.48198	-9.7	-6.6	-3.3	198.1	339.2	547.4	1	0
Queen Maud Gulf	NU	68.23285	-101.58747	-14.1	-10.8	-7.5	213.7	353	547.9	1	0
Harrison Islands	NU	69.3623	-90.0455	-14.7	-10.8	-7.3	223.6	356.9	554	1	0
Air Force Island	NU	67.92298	-74.03383	-10.9	-7.8	-4.6	212.6	355	558.1	1	0
Ellice Hills	NU	67.8343	-88.49953	-13.8	-10.7	-7.4	216.7	360.2	560.7	1	0
Cratere Du Nouveau-Quebec	QC	61.283333	-73.6666	-8.9	-6	-2.9	205	354.7	565.4	1	1
Grenfell Sound	NL	60.285189	-64.44185	-5.8	-3.4	-0.9	262.2	381.2	566.3	1	1
Read Island	NU	69.2055	-113.82976	-13.1	-9.9	-6.7	211.1	358.6	566.8	1	0
Cape Dorchester	NU	65.44965	-77.43554	-9.7	-6.6	-3.4	214.2	358.2	568.4	1	0
Hantzsch Bay	NU	67.59852	-72.50249	-10.5	-7.5	-4.3	218	368.1	570.3	1	0
Winter Island	NU	66.28793	-83.20113	-12.3	-9.2	-5.8	212.5	360.7	571.5	1	0
Simpson Strait	NU	68.39658	-96.70551	-14.3	-11.1	-7.7	225.4	373.4	574.1	1	0
Curtis Lake	NU	66.71794	-89.18963	-13.7	-10.6	-7.4	217	368	574.1	1	0
Arrowsmith River	NU	67.68148	-91.18253	-14.3	-11.2	-7.9	225.9	373.4	574.7	1	0
Pelly Bay	NU	68.73868	-90.21997	-13.8	-10.6	-7.2	238.5	380.3	582.1	1	0
Koukdjuak River	NU	66.68436	-72.18198	-9.9	-6.9	-3.7	223.8	378.4	587.7	1	0
Mingo Lake	NU	64.59196	-72.15562	-9.3	-6.3	-3.1	218.4	374.7	588.5	1	0
Bluegoose River	NU	65.59421	-72.97652	-9.6	-6.6	-3.5	218.4	375.6	588.7	1	0
Cambridge Bay	NU	69.12098	-105.05626	-14.2	-11	-7.7	238.5	389.6	592.2	1	0
Cory Bay	NU	65.3757	-74.51018	-9.4	-6.3	-3.1	229.7	383.4	598.8	1	0
Point Le Droit	QC	59.750606	-65.531956	-6.3	-3.9	-1.3	273.9	408.2	601.3	1	1
Nottingham Island	NU	63.31829	-78.00504	-8.9	-5.8	-2.5	230.8	380.4	602.1	1	0
Walker Lake	NU	66.65868	-90.57277	-14	-11	-7.7	237.2	393.6	602.7	1	0
Darby Lake	NU	67.81202	-92.44301	-14.5	-11.4	-8.1	245	398.2	605.2	1	0
Rae Strait	NU	68.81079	-94.94537	-14.5	-11.3	-7.9	248.8	398.9	606.1	1	0
Andrew Gordon Bay	NU	64.45094	-75.50277	-9	-6	-2.8	232.1	388	606.4	1	0

Banning Lake	NU	69.59312	-110.1742	-13.6	-10.5	-7.2	243.6	398.7	608.3	1	0
Cape White Handerchief	NL	59.266667	-63.383333	-5.9	-3.5	-1	278.4	413.7	609.1	1	1
Hurd Channel	NU	66.18122	-84.54199	-12.4	-9.3	-5.9	234.7	393.7	614.5	1	0
Cap Wolstenholme	QC	62.58141	-77.51165	-8.8	-5.8	-2.6	229.9	388.5	615	1	1
Lacs Nuvilic	QC	61.52843	-74.75083	-8.7	-5.7	-2.6	231	395.3	618.8	1	1
Cap De Nouvelle-France	QC	62.47947	-73.67282	-8.4	-5.5	-2.3	244.2	401.1	625.1	1	1
Laughland Lake	NU	66.10498	-92.72687	-14.1	-11.1	-7.8	260.6	422.5	636.1	1	0
Coral Harbour	NU	64.13955	-83.1576	-11.5	-8.4	-5.1	264	418.3	636.6	1	0
Vansittart Island	NU	65.87691	-83.92342	-11.7	-8.6	-5.3	257.4	417.2	638.6	1	0
Brock River	NT	69.34637	-122.53353	-11.2	-8	-4.9	278.9	430.5	639.5	1	0
Macdonald Island	NU	63.71952	-72.6482	-8.5	-5.6	-2.4	257.2	417.7	640.3	1	0
Salluit	QC	62.20417	-75.64832	-8.4	-5.4	-2.2	248.3	411.7	640.8	1	1
Ogden Bay	NU	67.72028	-101.5899	-13.4	-10.3	-7	271.5	433.1	644.6	1	0
Mcloughlin Bay	NU	67.83823	-98.52376	-13.6	-10.5	-7.2	271.2	433.3	644.8	1	0
Penny Bay	NU	69.62961	-116.85817	-11.6	-8.5	-5.3	277.9	435.7	654.4	1	0
Cape Barclay	NU	68.23434	-88.14948	-14.1	-11	-7.6	280.1	444.4	662.6	1	0
Malloch Hill	NT	70.01243	-126.96934	-11.1	-7.8	-4.5	301.3	456.4	668.2	1	0
Caribou Island	NU	64.2094	-81.45084	-10.3	-7.2	-3.9	289.9	445.9	672.4	1	0
Wager Bay	NU	65.52621	-88.91758	-13.2	-10.2	-7	277.6	448.7	674.2	1	0
Sherman Basin	NU	67.81352	-97.53696	-13.7	-10.6	-7.3	289.5	457.4	675.6	1	0
Bell Peninsula	NU	63.85109	-81.35215	-9.9	-6.8	-3.5	293.6	452	681.4	1	0
Hebron	NL	58.199124	-62.625914	-5.8	-3.4	-0.9	319.2	471.1	681.7	1	1
Douglas Harbour	NU	65.66417	-88.78168	-12.5	-9.5	-6.3	283.2	454.5	683.3	1	0
Erly Lake	NT	68.21321	-122.14139	-11	-8	-5.1	317.5	476.2	690.4	1	0
White Island	NU	65.83333	-84.83333	-11.7	-8.6	-5.3	284.1	457.3	690.6	1	0
Cape Dobbs	NU	65.23744	-87.01087	-12	-9	-5.7	289.8	463.1	695.4	1	0
Mistake River	NU	66.70896	-95.31139	-13.8	-10.7	-7.5	303.4	474.5	696.4	1	0
Perry River	NU	67.00385	-102.09665	-13.2	-10.1	-6.8	307.6	477.5	697.6	1	0
Boas River	NU	64.40616	-85.09587	-11.4	-8.4	-5.1	298.8	469.6	699	1	0
Bluenose Lake	NU	68.44728	-119.74546	-11.2	-8.2	-5.1	318.1	481.8	704.1	1	0
Akpatok Island	NU	60.416238	-68.141236	-6.5	-3.9	-1.1	325.6	481.4	707.2	1	1
Lac Klotz	QC	60.5172	-73.71239	-7.8	-4.9	-2	219.1	470.8	707.5	1	1
Pennington Lake	NU	65.49512	-93.46736	-13.3	-10.3	-7.1	305.7	482.1	710.2	1	0
Kovik Bay	QC	61.55913	-77.67348	-8.1	-5.1	-1.9	290.3	469.8	712.5	1	1
Mount St Elias	YT	60.29333	-140.93018	-6.6	-4.5	-2.6	300.4	485.8	715.8	0	0
Elu Inlet	NU	68.52161	-106.17109	-13.3	-10.1	-6.9	323.2	495.6	719	1	0
Joe Lake	NU	66.30232	-98.47083	-13.3	-10.2	-7	321.6	497.1	720	1	0
Daly Bay	NU	64.07426	-89.85868	-11.9	-8.9	-5.8	315.6	488.8	720	1	0
Riviere Koroc	QC	58.709781	-64.686665	-6.3	-3.8	-1.2	338.5	504.7	721.5	1	1
Armark Lake	NU	66.48128	-100.8112	-13.1	-10	-6.9	324.6	499.9	723.8	1	0
Richardson Islands	NU	68.54188	-110.55136	-12.7	-9.6	-6.4	322.6	496	723.8	1	0
Mansel Island	NU	61.99379	-79.80535	-8.4	-5.4	-2.1	306.3	478	724.5	1	0
Cape Krusenstern	NU	68.39782	-113.89177	-11.7	-8.6	-5.5	318.6	493.1	728.3	1	0
Yellow Bluff	NU	64.38288	-87.84974	-11.3	-8.3	-5.1	329.6	506.7	741.2	1	0
Native Bay	NU	63.89311	-82.62378	-10.2	-7.2	-3.9	339.7	507.9	744.1	1	0
Franklin Bay	NT	69.91074	-125.9536	-10.6	-7.5	-4.4	353.4	520.9	744.3	1	0
Ian Calder Lake	NU	66.49539	-97.39654	-13.3	-10.2	-7	339.1	517.8	745.4	1	0
Cape Dalhousie	NT	70.25339	-129.67219	-10.9	-7.5	-4.3	370.1	530	746.4	0	0

Brichta Lake	NU	67.80393	-104.88294	-12.9	-9.9	-6.7	348.1	526.7	754.5	1	0
Bear Cove	NU	63.58289	-84.25598	-10.5	-7.6	-4.4	347.1	521.5	755.5	1	0
Lac Couture	QC	46.31936	-78.35687	-7.6	-4.7	-1.7	312.2	513.4	761.7	1	1
Macalpine Lake	NU	66.53282	-102.70033	-12.8	-9.8	-6.7	353.6	533.5	762.9	1	0
Kikerk Lake	NU	67.31965	-113.19365	-11.7	-8.7	-5.8	353.4	531	763.6	1	0
Hepburn Island	NU	67.88129	-110.98515	-12.1	-9.1	-6.1	359.1	537.6	767.3	1	0
Cape Kendall	NU	63.60029	-87.1958	-10.7	-7.7	-4.6	360.6	535.5	768.2	1	0
Armit Lake	NU	64.14787	-91.60072	-12	-9	-5.9	344.9	529	771.2	1	0
Coats Island	NU	62.61909	-82.90067	-9.5	-6.5	-3.3	355.5	529.7	771.9	1	0
Woodburn Lake	NU	65.51039	-95.45407	-13	-10	-6.8	360.4	545.5	780.3	1	0
Kathawachaga Lake	NU	66.19505	-110.91933	-11.9	-9	-6.1	390.2	565.8	793.9	1	0
Rideout Island	NU	67.17	-107.39	-12.5	-9.5	-6.4	383.2	566.6	798.5	1	0
Overby Lake	NU	66.67758	-105.68593	-12.5	-9.5	-6.5	384.3	567.9	801.5	1	0
Cape Fullerton	NU	63.9823	-88.75434	-11	-8.1	-5	379.1	559.9	802.3	1	0
Hershel Island	YT	69.59384	-139.06343	-10.5	-7.2	-4.1	402.1	583.4	806.8	1	0
Mara River	NU	65.95551	-108.6747	-12.1	-9.2	-6.2	400.1	580.7	811.6	1	0
Coppermine	NU	66.72157	-115.31305	-11	-8.1	-5.1	401.8	582.2	821.2	1	0
North River	NL	53.820399	-57.099136	-5.1	-2.8	-0.4	402.2	583.5	822.6	1	1
Arctic Sound	NU	67.57053	-108.81929	-12.1	-9.1	-6	401.8	587.5	823	1	0
Deep Rose Lake	NU	65.72112	-98.66142	-12.5	-9.5	-6.4	395.5	586	825	1	0
Napaktulik Lake	NU	66.22732	-113.16811	-11.2	-8.4	-5.6	413.9	592.5	826	1	0
Chesterfield Inlet	NU	63.947	-94.03115	-11.1	-8.2	-5.2	390.6	579	827.5	1	0
Tehery Lake	NU	64.4301	-93.10294	-12	-9	-5.9	387.7	581.2	829.7	1	0
Povungnituk	QC	59.93038	-78.10238	-7.3	-4.3	-1.2	367.4	567.2	830	1	1
Amer Lake	NU	65.61254	-97.19056	-12.6	-9.6	-6.5	399.8	591	830.6	1	0
Pelly Lake	NU	65.92324	-101.36395	-12.3	-9.3	-6.3	405.2	595.2	836.4	1	0
Dismal Lakes	NU	67.43303	-117.08016	-10.5	-7.6	-4.6	420.4	602.5	843	1	0
Tinney Hills	NU	66.83407	-107.61884	-11.9	-9	-6	428.9	617.9	856.5	1	0
Marble Island	NU	62.67515	-91.12271	-10.6	-7.7	-4.7	420.6	615	867.9	1	0
Stanton	NT	69.80013	-128.68648	-10.3	-7	-4	465.9	642.8	873.1	1	0
Bebensee Lake	NU	67.48285	-118.54785	-9.9	-7	-4.1	445.1	631	873.5	1	0
Lac Du Pelican	QC	59.80866	-73.62708	-6.7	-3.9	-1.1	403.8	612.3	873.7	1	1
Jervoise River	NU	65.27611	-103.34334	-11.9	-9	-6	438.3	631.8	878.3	1	0
Lac Henrietta	QC	57.3081	-64.576981	-5.8	-3.4	-0.9	435.7	635.7	879.4	1	1
Hepburn Lake	NT	66.33745	-115.28342	-10.5	-7.7	-4.9	463.2	647.4	888.9	0	0
Gibson Lake	NU	63.49296	-93.24297	-11.1	-8.1	-5.1	432.5	632.6	890.6	1	0
Lac Anuc	QC	59.32515	-75.14563	-6.7	-3.8	-0.9	411.2	624.4	893.7	1	1
Bloody River	NT	67.20455	-120.55325	-9.7	-6.8	-3.9	466.3	655	900.1	1	0
Duggan Lake	NU	65.57618	-104.93806	-11.6	-8.7	-5.7	458.8	654	901.9	1	0
Baker Lake	NU	64.16969	-95.38976	-11.8	-8.8	-5.8	448.6	649	901.9	1	0
Simpson Lake	NT	64.95998	-125.1409	-9.9	-6.9	-4	477.1	663.5	904.3	1	0
Nose Lake	NU	65.42641	-108.97815	-11.1	-8.3	-5.5	474.9	666.1	909.9	1	0
Nutak	NL	57.466667	-61.866667	-3.7	-1.5	0.9	486.9	665.5	914.9	1	1
Blow River	YT	68.73258	-137.42403	-10.2	-7.1	-4.1	496.9	685.1	916.4	0	0
Bonnet Plume Lake	YT	65.21475	-134.33307	-9	-6.7	-4.4	473.3	676	920.2	0	0
Tavani	NU	62.06851	-93.1098	-10.3	-7.4	-4.5	455.2	659.9	922.7	1	0
Beechey Lake	NU	65.3213	-106.65314	-11.2	-8.4	-5.5	481.5	677.5	926.1	1	0
Contwoyto Lake	NU	65.59639	-110.58321	-10.7	-8	-5.2	496.4	684.2	926.5	1	0

Schultz Lake	NU	64.73251	-97.4267	-11.7	-8.8	-5.7	474.1	674.9	927.3	1	0
Kogaluk Bay	QC	59.36453	-77.8302	-6.6	-3.7	-0.7	434	649.3	929.8	1	1
Hopes Advance Bay	QC	59.34506	-69.59134	-5.7	-3.1	-0.4	477.9	673.9	929.9	1	1
Aberdeen Lake	NU	64.48782	-98.74724	-11.5	-8.6	-5.6	478.9	679.3	931.9	1	0
Macquoid Lake	NU	63.46925	-94.71746	-11.1	-8.2	-5.2	471.2	674.4	933.1	1	0
Beverly Lake	NU	64.60755	-100.49182	-11.3	-8.4	-5.5	489.1	689.9	944.5	1	0
Tebesjuak Lake	NU	63.73524	-98.87132	-10.9	-8.1	-5.2	515.4	714.1	970.4	0	0
Horton Lake	NT	67.48171	-122.44674	-9.3	-6.5	-3.7	522.5	719.4	970.8	1	0
Thirty Mile Lake	NU	63.59483	-96.64533	-11	-8.1	-5.2	511.2	712.8	971	1	0
Lac Vernon	QC	58.89649	-74.27228	-6.3	-3.4	-0.6	468.8	695.2	973.7	1	1
Kaminak Lake	NU	62.27141	-94.92415	-10.3	-7.4	-4.5	499.2	707.5	973.8	0	0
Lac La Potherie	QC	58.84584	-72.3787	-9.9	-7.1	-4.1	480.9	704.9	975.1	1	1
Dawson Inlet	NU	61.83386	-93.41682	-9.6	-6.8	-3.9	500.9	713	980	1	0
Glacier Lake	NT	62.08163	-127.55648	-8.1	-5.8	-3.6	502.9	722.5	983.4	0	0
Mackenzie Delta	NT	68.94079	-134.73482	-9.8	-6.5	-3.4	554.7	748.3	987.1	1	0
Tammarvi River	NU	64.62956	-102.50704	-10.8	-8	-5.1	525.7	731.3	991.2	1	0
Tasisuak Lake	NL	56.640334	-62.755882	-4.5	-2.2	0.2	514.5	725.4	991.2	1	1
Point Lake	NT	65.27551	-113.10938	-9.9	-7.2	-4.5	552.4	746	996.3	1	0
Baillie River	NU	64.86396	-105.26252	-10.6	-7.8	-4.9	537.2	742.3	1002	1	0
Riviere Innuksuac	QC	58.52877	-76.74674	-6.2	-3.3	-0.3	480.6	708.6	1002	1	1
Dubawnt Lake	NU	63.09001	-101.53339	-10.5	-7.8	-4.9	538.8	742.7	1003	0	0
Sloan River	NT	66.58251	-116.74887	-9.3	-6.6	-3.8	555.7	751.2	1006	0	0
Ferguson Lake	NU	62.91738	-96.88905	-10.2	-7.4	-4.5	545.9	752.2	1019	1	0
Inukjuak	NU	58.45512	-78.1051	-6.2	-3.3	-0.1	492.2	716	1021	1	1
Healey Lake	NT	64.31783	-106.73726	-10.2	-7.4	-4.6	557.5	763.1	1023	0	0
Lac Ralleau	QC	58.029223	-66.667938	-4.9	-2.4	0.2	564.6	772.8	1028	1	1
Arviat	NU	61.10867	-94.05854	-9.3	-6.5	-3.7	548.6	765.3	1040	0	0
Crossley Lakes	NT	68.54855	-129.58021	-9.5	-6.5	-3.6	602.8	799.7	1046	1	0
Tulemalu Lake	NU	62.92806	-99.41571	-10	-7.3	-4.5	573.9	779.3	1046	0	0
Clarke River	NT	63.56024	-104.08382	-10.1	-7.3	-4.5	574.7	784	1050	0	0
Lac Nedlouc	QC	57.40344	-72.74012	-5.8	-3.2	-0.5	544.8	779.7	1055	1	1
Bell River	YT	67.426	-136.93511	-9.3	-6.4	-3.7	612.1	813.9	1058	0	0
Aylmer Lake	NT	64.11259	-108.52327	-9.7	-7	-4.3	591.2	798.9	1059	0	0
Lac Brisson	QC	49.458773	-68.292819	-5.1	-2.7	-0.3	566	791.5	1059	1	1
Nadaleen River	YT	64.1823	-132.90921	-7.6	-5.2	-3	582.4	802.5	1063	0	0
Kuujjuaq	QC	58.102996	-68.418839	-5.4	-2.8	-0.1	586.4	800.7	1065	1	1
Lac Minto	QC	48.83069	-69.30934	-5.7	-3	-0.2	539.6	780	1069	1	1
Niddery Lake	YT	63.29022	-131.34104	-7.3	-4.9	-2.8	569.1	800.7	1070	0	0
Redrock Lake	NT	65.46385	-114.12315	-9.1	-6.5	-3.8	619.5	821.2	1081	0	0
Kluane Lake	YT	61.30768	-138.77624	-5.7	-3.5	-1.5	558.3	798.1	1081	0	0
Lac Maunoir	NT	67.47643	-124.9417	-8.9	-6	-3.3	617.5	824	1083	0	0
South Henik Lake	NU	61.52916	-97.39348	-9.3	-6.6	-3.8	590.3	806.8	1085	1	0
Nain	NL	56.541682	-61.696889	-2.8	-0.6	1.7	605.8	812.9	1090	1	1
Lac De Gras	NT	64.46596	-110.47888	-9.3	-6.6	-3.9	627	833.9	1094	0	0
Broughton Island	NU	57.35787	-76.77428	-5.6	-2.8	0.2	546.7	792.2	1097	1	1
Tatshenshini River	BC	59.81353	-137.26488	-2.3	-0.2	1.8	533.4	796.6	1101	0	0
Kamilukuak Lake	NU	62.34043	-101.52599	-9.6	-6.9	-4.1	618.9	833.1	1105	0	0
Larsen Creek	YT	60.13555	-125.57928	-7.1	-4.7	-2.4	609.3	840.7	1107	0	0

Lac Saffray	QC	57.597186	-67.062641	-5	-2.5	0	612.3	842	1109	1	1
Wrigley Lake	NT	63.8506	-126.21421	-8.1	-5.7	-3.4	619	846	1113	0	0
Mistastin Lake	NL	55.883333	-63.33333	-4.3	-2	0.3	604.4	833.6	1114	1	1
Hanbury River	NT	63.59879	-105.30212	-9.4	-6.7	-3.9	633.1	849.3	1121	0	0
Nash Creek	YT	64.56952	-134.51683	-6.8	-4.4	-2.2	633.5	862.8	1131	0	0
Watterson Lake	NU	61.21464	-99.37973	-9.1	-6.5	-3.7	634.6	851.8	1132	0	0
Hyde Lake	NU	60.59526	-95.29501	-8.3	-5.6	-2.8	621.7	853.5	1139	1	0
Dawson	YT	64.06099	-139.42952	-7.4	-5	-2.7	636.2	870.9	1142	0	0
Ogilvie River	YT	65.36665	-138.45441	-8.3	-5.8	-3.5	651.5	880.6	1143	0	0
Takaatcho River	NT	66.47614	-119.44655	-8.2	-5.4	-2.7	657.8	872.2	1144	0	0
Old Crow	YT	67.56841	-139.8355	-9.1	-6.2	-3.5	672.2	891.1	1148	0	0
Artillery Lake	NT	63.17387	-107.87282	-8.9	-8.9	-6.3	658.7	877.4	1151	0	0
Aubry Lake	NT	67.31107	-126.40617	-8.9	-6.1	-3.3	683.1	893.8	1154	1	0
Spatsizi River	BC	57.53127	-128.58724	-2.2	-0.1	1.9	540.3	821.8	1160	0	0
Carey Lake	NT	62.22467	-102.81841	-9	-6.4	-3.6	662.5	884.3	1162	0	0
Quiet Lake	YT	61.04167	-133.055902	-4.7	-2.5	-0.5	605.1	862.7	1164	0	0
Winter Lake	NT	64.486	-112.97901	-8.6	-6	-3.3	690	901.7	1169	0	0
Toodoggone River	BC	57.40206	-126.84545	-2.6	-0.5	1.5	570.5	840	1169	0	0
Avlavik	NT	68.21992	-135.00779	-9	-5.9	-3	708	918	1172	0	0
Lac Des Loups Marins	QC	56.11938	-73.2189	-5.2	-2.6	0	635.1	883.6	1172	1	1
Lac Herodier	QC	57.362851	-68.693526	-5.1	-2.5	0.1	663.3	901.9	1178	1	1
Lac A L'eau Claire	QC	46.54398	-73.08716	-5.1	-2.4	0.3	622.7	877.2	1179	1	1
Edehon Lake	NU	60.41403	-97.33065	-8.3	-5.6	-2.9	660.4	894.6	1187	1	0
King George Islands	NU	57.18631	-78.31883	-5.3	-2.3	0.8	597.7	846.3	1187	1	1
Lac Jeannin	QC	56.495467	-66.416686	-4.8	-2.4	0.1	673.5	916.2	1194	1	1
Dezadeash Range	YT	60.80885	-136.94462	-3.1	-1	1	608.8	881.4	1197	0	0
Cry Lake	BC	58.74269	-129.04245	-2.9	-0.9	1.2	594.2	869.8	1200	0	0
Kilekale Lake	NT	66.65489	-123.92496	-8	-5.3	-2.6	709.5	930.7	1206	0	0
Ennadai	NU	61.13333	-100.883333	-8.7	-6.1	-3.3	697.6	922.7	1206	0	0
Walmsley Lake	NT	63.41915	-108.55076	-8.3	-5.7	-3	708.6	931.3	1209	0	0
Porcupine River	YT	67.55823	-138.22348	-8.4	-5.8	-3.3	720.3	948.9	1212	0	0
Lac Resolution	QC	55.2561	-64.47451	-4.5	-2.2	0.2	683.5	927	1212	1	1
Lac Kinglet	QC	54.74187	-75.04303	-3.8	-1.7	-0.4	828.8	1058	1213	1	1
Hopedale	NL	55.457954	-60.211485	-2.3	-0.2	2.1	690.2	918.9	1213	1	1
Frances Lake	YT	61.44085	-129.38999	-5.6	-3.3	-1.2	659.6	914.4	1214	0	0
Finlayson Lake	YT	61.69462	-130.65309	-5.1	-2.9	-0.8	652.9	912.7	1216	0	0
Cape Macdonnel	NT	66.40047	-120.53682	-7.8	-5	-2.3	712	937	1218	0	0
Flat River	NT	61.48436	-126.61458	-6	-3.8	-1.6	679.1	927.1	1221	0	0
Jennings River	BC	59.43763	-131.42347	-3.2	-1.1	1	618	895.9	1222	0	0
Beaverhill Lake	NT	62.8095	-104.35936	-8.3	-5.7	-3	718.2	947.3	1231	0	0
Calder River	NT	65.77491	-116.44378	-7.9	-5.2	-2.6	740.8	957.4	1232	0	0
Snake River	YT	65.37545	-133.38642	-7.5	-5	-2.6	741.4	967.4	1234	0	0
Wolf Lake	YT	60.64232	-131.66717	-4.1	-2	0.1	653.8	924.9	1241	0	0
Aishihik Lake	YT	61.44964	-137.14764	-4.3	-2.1	0	665.6	934.3	1244	0	0
Nueltin Lake	NU	60.44064	-99.54159	-8	-5.5	-2.8	715.9	952.3	1248	0	0
Lac Guillaume-Delisle	QC	54.92195	-67.42364	-4.7	-1.9	0.9	658.3	923.9	1248	1	1
Lac Cambrien	QC	56.408692	-69.110064	-4.8	-2.3	0.2	715	964.5	1249	1	1
Mackay Lake	NT	63.84543	-111.48013	-7.8	-5.2	-2.6	750.9	975.2	1254	0	0

Sheldon Lake	YT	62.69139	-131.0498	-5.5	-3.3	-1.2	698.8	957.1	1255	0	0
Tuchodi Lakes	BC	58.16877	-124.5826	-3.4	-1.3	0.8	684.9	941.5	1257	0	0
Hart River	YT	65.63758	-136.65145	-7.1	-4.6	-2.2	751.7	987.5	1259	0	0
Ware	BC	57.42265	-125.62964	-2.5	-0.5	1.6	666	932.7	1260	0	0
Lac Wakuach	QC	55.562778	-67.54056	-4.6	-2.2	0.2	728.9	977.6	1262	1	1
Kechika River	BC	58.83727	-127.23252	-2.9	-0.9	1.2	664.8	935	1262	0	0
Makkovik	NL	55.086168	-59.176434	-1.3	0.7	2.9	761.2	973.9	1267	1	1
Caribou River	MB	59.47007	-95.71333	-7.1	-4.5	-1.8	718.6	967.9	1270	1	0
Boyd Lake	NT	61.48183	-103.40841	-8	-5.4	-2.8	749.4	983.8	1273	0	0
Lac Bienville	QC	55.01345	-72.78317	-4.7	-2.2	0.3	719.7	978.8	1280	1	1
Riviere Serigny	QC	56.00017	-68.663744	-4.7	-2.3	0.2	744.4	996.4	1284	0	1
Lac Montrochand	QC	55.22562	-74.79126	-4.6	-2	0.6	705.2	970.1	1285	1	1
Mcconnell Creek	BC	56.88378	-126.46062	-1.2	0.9	2.9	650.7	940.1	1287	0	0
Indin Lake	NT	64.33891	-114.94942	-7.8	-5.2	-2.5	792.6	1016	1295	0	0
Lynx Lake	NT	62.45066	-106.38552	-7.6	-5	-2.4	769.8	1006	1296	0	0
Nejanilini Lake	MB	59.6244	-97.73683	-7.2	-4.6	-1.9	739.6	991.3	1298	0	0
Eagle River	YT	66.69628	-137.04435	-7.3	-4.7	-2.1	803.2	1035	1305	0	0
Travaillant Lake	NT	67.5706	-131.7156	-8.3	-5.4	-2.7	819.2	1041	1307	1	0
Lac De Morhiban	QC	51.816463	-62.870178	-1.5	0.4	1.5	909.3	1152	1308	1	1
Lac Des Bois	NT	66.81966	-125.20981	-7.8	-5	-2.4	803.9	1031	1309	0	0
Tulsequah	BC	58.73461	-133.60758	-1.1	1	3	664.6	966.2	1312	0	0
Whitehorse	YT	60.72069	-135.05224	-2.7	-0.5	1.6	690.2	977.2	1313	0	0
Tukarak Island	NU	56.25948	-78.75561	-4.5	-1.7	1.4	685.2	950.6	1313	1	1
Telegraph Creek	BC	57.91573	-131.14504	-0.8	1.3	3.3	653.7	960.9	1317	0	0
Ennadai Lake	NU	60.88178	-101.23389	-7.6	-5.1	-2.4	778.8	1021	1318	0	0
Tay River	YT	62.67722	-133.91332	-4.6	-2.4	-0.3	748.9	1013	1319	0	0
Carcajou Canyon	NT	65.28348	-126.82724	-7.5	-5.1	-2.7	813.8	1048	1326	0	0
Red Wine Lake	NL	54.08042	-62.3762	-3.3	-1.1	1.2	766.7	1024	1328	1	1
Ramparts River	NT	66.02495	-130.54195	-7.5	-5	-2.6	822.1	1055	1329	0	0
Lansing Range	YT	63.85007	-132.81514	-5.2	-2.9	-0.8	780.5	1038	1332	0	0
Poste-De-La-Baleine	QC	55.28085	-77.75468	-4.3	-1.6	1.2	715.9	989.3	1332	1	1
Battle Harbour	NL	52.273627	-55.585215	-0.2	1.7	3.8	766.6	1013	1333	1	1
Rigolet	NL	54.179922	-58.428833	-1.2	0.8	3	800	1031	1334	1	1
Fort Mcpherson	NT	67.43436	-134.88326	-8	-5.1	-2.4	844	1069	1336	0	0
Rennie Lake	NT	61.55294	-105.50145	-7.3	-4.7	-2.1	803.7	1045	1341	0	0
Groswater Bay	NL	54.311621	-57.762627	-0.3	1.5	3.6	836.1	1048	1344	1	1
Upper Carp Lake	NT	63.76419	-113.72399	-7.2	-4.6	-2	832.4	1063	1349	0	0
Dease Lake	BC	58.62726	-130.03902	-1.7	0.4	2.5	693.8	997	1349	0	0
Leith Peninsula	NT	65.51513	-119.07228	-7	-4.4	-1.7	832.3	1063	1350	0	0
Cape Churchill	MB	58.7625	-93.21207	-6.1	-3.5	-0.7	783.6	1040	1350	1	1
Root River	NT	62.93066	-124.43621	-6.5	-4.2	-1.9	807.8	1057	1351	0	0
Caniapiscau	QC	54.866667	-69.916667	-4.3	-2	0.4	801.7	1062	1360	0	1
Iskut River	BC	56.80464	-130.56556	0.6	2.6	4.6	683	999.5	1363	0	0
Atlin	BC	59.57506	-133.70262	-1.7	0.4	2.5	715.5	1018	1366	0	0
Schefferville	NL	54.824559	-66.817479	-4.1	-1.8	0.6	811.1	1072	1371	1	1
Woods Lake	NL	54.50807	-65.23927	-3.7	-1.4	0.9	805.1	1068	1371	1	1
Cartwright	NL	53.707009	-57.023317	-0.2	1.7	3.8	830.4	1061	1372	1	1
Trail River	YT	66.55689	-135.0209	-7	-4.4	-1.8	870	1104	1378	0	0

Mount Robson	AB	53.03414	-119.23108	-0.4	1.6	3.6	737.6	1024	1378	0	0
Grizzly Bear Mountain	NT	65.33752	-121.00825	-6.9	-4.3	-1.6	852.6	1090	1379	0	0
Snegamook Lake	NL	54.54712	-61.436057	-2	0.2	2.4	810.2	1066	1380	1	1
Munroe Lake	MB	59.18894	-98.54935	-6.9	-4.3	-1.7	814	1072	1385	0	0
Churchill	MB	58.77072	-94.16928	-6.1	-3.5	-0.8	811.9	1076	1392	1	1
Snowbird Lake	NT	60.65892	-102.97752	-6.9	-4.4	-1.8	842.8	1093	1396	0	0
Bowser Lake	BC	56.45347	-129.57716	0.1	2.2	4.2	708.8	1027	1396	0	0
Mount Waddington	BC	51.20435	-125.82521	1	2.9	4.8	730.6	1036	1398	0	0
Teslin	YT	60.16844	-132.71133	-2.6	-0.5	1.6	764.9	1060	1399	0	0
Wind River	YT	65.06194	-134.95948	-6.2	-3.7	-1.3	873.6	1118	1401	0	0
Stevenson Ridge	YT	62.5728	-138.894	-5.1	-2.9	-0.8	818.6	1092	1406	0	0
Snape Island	NU	55.73359	-79.31184	-4	-1.2	1.9	751.7	1030	1406	1	1
Reliance	NT	62.71626	-109.16561	-6.6	-4.1	-1.5	865.3	1111	1412	0	0
Lac Mistanukaw	QC	54.77041	-72.617	-4	-1.6	0.9	825.9	1100	1418	0	1
Riviere Grandin	NT	64.11739	-118.88431	-6.7	-4.1	-1.5	893.2	1130	1420	0	0
Mccann Lake	NT	61.1932	-106.58254	-6.5	-3.9	-1.4	873.6	1125	1429	0	0
Mayo	YT	63.59557	-135.899611	-4.5	-2.2	0	856.4	1124	1430	0	0
Shethanei Lake	MB	58.82324	-97.90336	-6.1	-3.6	-1	842.6	1110	1432	0	0
Lac Belot	NT	66.89285	-126.29087	-7.5	-4.8	-2.2	918.6	1154	1435	0	0
Canoe River	BC	52.73251	-119.37786	0.1	2.1	4.1	772.4	1074	1438	0	0
St. Augustin River	NL	51.999709	-59.37833	-0.9	1.2	3.4	830.7	1105	1439	1	1
Mesilinka River	BC	56.33024	-125.25437	-1	1	3	797.6	1091	1443	0	0
Hardisty Lake	NT	64.56519	-117.77451	-6.7	-4.1	-1.5	915	1152	1444	0	0
Lake Melville	NL	53.741378	-59.571554	-1	1.1	3.3	859.9	1121	1446	1	1
Kasmere Lake	MB	59.61539	-101.21975	-6.4	-3.9	-1.3	878.3	1141	1455	0	0
Lac Bermen	QC	53.583333	-68.916667	-3.7	-1.4	0.9	870.9	1144	1459	0	1
Shabogamo Lake	NL	53.168583	-66.600813	-3.5	-1.2	1.1	877.4	1153	1468	1	1
Wholdaia	NT	60.68785	-104.29319	-6.1	-3.7	-1.1	902.7	1160	1469	0	0
Glenlyon	YT	62.40498	-134.50037	-3.8	-1.5	0.6	865.6	1148	1469	0	0
Mcdame	BC	59.18642	-129.2261	-2.8	-0.7	1.4	836.4	1128	1470	0	0
Lake Laberge	YT	60.98225	-135.12707	-3	-0.8	1.3	853.6	1147	1484	0	0
Mcquesten	YT	63.56367	-137.42411	-4.7	-2.4	-0.2	898.8	1175	1486	0	0
Blanc-Sablon	QC	51.4264451	-57.13131479	0.9	2.8	4.9	875.7	1148	1492	1	1
Riviere Denys	QC	55.00444	-77.11948	-3.5	-0.9	1.8	840	1134	1494	1	1
Carmacks	YT	62.08762	-136.29189	-4.3	-2	0.1	889.6	1175	1496	0	0
Havre-Saint-Pierre	QC	50.243284	-63.599712	0.6	2.4	3.5	1058	1329	1501	1	1
Cape Tatnam	MB	57.26321	-91.00391	-5	-2.3	0.4	894.3	1170	1501	0	1
Whitesail Lake	BC	50.22243	-116.03211	1.7	3.6	5.5	812	1129	1502	0	0
Winokapau Lake	NL	53.166667	-62.833333	-2.5	-0.3	2	900.8	1179	1504	1	1
Ossokmanuan Reservoir	NL	53.497661	-65.075915	-3	-3	1.5	904.7	1185	1507	1	1
Johnny Hoe River	NT	64.16263	-121.42773	-6.2	-3.7	-1.1	963.7	1211	1508	0	0
Coal River	YT	60.5528	-127.49959	-3.8	-1.7	0.5	898.7	1178	1508	0	0
York Factory	MB	57.00511	-92.3015	-5.2	-2.6	0.1	904	1182	1509	1	1
Mahony Lake	NT	65.50984	-125.36313	-6.6	-4	-1.5	974	1217	1511	0	0
Lac Fournier	QC	45.951823	-75.868875	-2.2	0	2.3	880.7	1173	1517	1	1
Wecho River	NT	63.39753	-114.80766	-6.3	-3.7	-1.1	973.3	1218	1518	0	0
Phelps Lake	SK	59.18527	-103.19889	-5.8	-3.3	-0.8	933.9	1201	1518	0	0
Stewart River	YT	63.32832	-139.43763	-5.1	-2.8	-0.6	926.6	1205	1521	0	0

La Biche River	YT	60.32469	-124.39216	-4.1	-1.9	0.3	924.9	1197	1522	0	0
St Anthony	NL	51.3704156	-55.5958649	1.6	3.4	5.3	954.4	1195	1522	1	1
Anahim Lake	BC	52.51183	-125.35962	0.9	2.8	4.7	833.2	1150	1522	0	0
Snowdrift	NT	62.24268	-110.31757	-5.8	-3.2	-0.6	960.7	1214	1523	0	0
Herchmer	MB	57.36924	-94.1864	-5.3	-2.8	-0.1	914.6	1196	1524	0	1
Blackwater Lake	NT	63.93686	-123.15867	-6.2	-3.7	-1.2	981.5	1231	1531	0	0
Black Duck River	ON	56.44734	-89.43249	-4.6	-2	0.8	911.3	1193	1534	0	1
Nonacho Lake	NT	61.72831	-109.43469	-5.5	-3.1	-0.5	964.4	1223	1537	0	0
Lac Vallard	QC	52.821961	-68.972345	-3.1	-0.8	1.5	921.1	1208	1539	0	1
Tadoule Lake	MB	58.62003	-98.38599	-5.6	-3.1	-0.5	932.8	1208	1539	0	0
Lac Joseph	QC	46.220034	-71.52373	-2.6	-0.4	1.9	917.4	1206	1540	1	1
Abitau Lake	NT	60.43106	-107.17354	-5.4	-3	-0.5	963	1227	1543	0	0
Ontaratue River	NT	66.41545	-131.04656	-6.7	-4.1	-1.5	1021	1267	1554	0	0
Lac Opocopa	NL	53.038738	-66.629339	-2.8	-0.5	1.7	930.1	1221	1554	1	1
Manson River	BC	55.61746	-124.04862	0.1	2.1	4.1	877.3	1186	1556	0	0
Watson Lake	YT	60.10368	-128.78635	-2.5	-1.3	0.8	923.9	1216	1557	0	0
Dahadinni River	NT	63.60885	-125.02855	-5.9	-3.5	-1.2	993.1	1254	1558	0	0
Lac Brule	QC	46.101194	-74.282312	-2	0.2	2.4	932.5	1221	1560	1	1
Riviere Natashquan	QC	50.117113	-61.800425	-0.6	1.5	3.7	912.8	1210	1565	1	1
Cape Henrietta Maria	ON	55.109	-82.25353	-3.7	-1	2	893	1188	1567	0	1
Hearne Lake	NT	62.34643	-113.12698	-5.4	-2.9	-0.3	1002	1258	1568	0	0
Lac Sauvolles	QC	53.42548	-72.96407	-3.3	-0.9	1.5	940.2	1233	1569	0	1
Kaskattama River	MB	56.63541	-90.5986	-4.6	-2	0.7	946.4	1232	1571	0	1
Pointe Louis-XIV	QC	54.6308	-79.75405	-3.2	-0.4	2.5	881.6	1186	1577	1	1
Lac Fouquet	QC	48.879356	-73.821334	-2.2	0	2.3	935	1235	1584	1	1
Saint-Augustin	QC	51.232769	-58.651544	0.3	2.4	4.6	926.7	1226	1587	1	1
Winisk	ON	55.26667	-85.2	-3.8	-1.2	1.6	927.9	1221	1587	1	0
Minipi Lake	NL	52.4667	-60.8333	-1.1	1.1	3.3	954.1	1245	1590	1	1
Fort Severn	ON	55.98802	-87.6391	-4	-1.4	1.3	952.5	1247	1598	1	1
Northern Indian Lake	MB	57.36518	-97.23587	-5	-2.5	0.1	976.6	1263	1601	0	0
Lac La Martre	NT	63.31619	-117.95567	-5.6	-3.1	-0.6	1041	1296	1602	0	0
Whiskey Jack Lake	MB	58.38706	-101.90911	-5.2	-2.8	-0.2	991.1	1270	1602	0	0
Halfway River	BC	56.52236	-122.28885	-0.4	1.6	3.7	940.4	1241	1603	0	0
Pemberton	BC	50.32056	-122.80841	2.1	4	5.9	901.9	1227	1611	0	0
Trutch	BC	57.73345	-122.94622	-1.2	0.9	3	964.7	1259	1612	0	0
Marian River	NT	63.41929	-116.65117	-5.6	-3.1	-0.5	1058	1312	1620	0	0
Norman Wells	NT	65.28281	-126.82936	-6.3	-3.8	-1.3	1076	1326	1623	0	0
Goose Bay	NL	53.3016828	-60.3260842	-1.1	1.1	3.3	1001	1287	1627	1	1
Lac De La Fregate	QC	47.14993	-73.92292	-2.9	-0.5	2	973.3	1279	1632	0	1
Rabbit River	BC	58.85025	-125.23265	-2.2	-0.1	2	989.8	1287	1638	0	0
Keller Lake	NT	63.92981	-121.55564	-5.5	-3	-0.5	1071	1332	1640	0	0
Mcbride	BC	53.30101	-120.16318	1.3	3.3	5.2	933	1255	1642	0	0
Smithers	BC	54.77899	-127.17583	1.7	3.7	5.6	921	1255	1644	0	0
Stony Rapids	SK	59.25771	-105.84133	-4.8	-2.4	0.1	1038	1316	1645	0	0
Hazelton	BC	55.26002	-127.64733	1.2	3.2	5.2	932.8	1258	1647	0	0
Lakitusaki River	ON	54.34464	-82.76118	-3.3	-0.6	2.2	956.6	1266	1648	0	1
Taltson Lake	NT	61.47632	-110.27045	-4.7	-2.2	0.3	1060	1327	1650	0	0
Monkman Pass	BC	54.60337	-121.19047	0.8	2.8	4.8	968.5	1272	1652	0	0

Wrigley	NT	63.18528	-123.3331	-5.5	-3.1	-0.7	1082	1346	1657	0	0
Sutton Lake	ON	54.3638	-84.69924	-3.4	-0.9	1.8	984.1	1290	1657	0	0
Willow Lake	NT	62.17511	-119.16576	-5	-2.5	0	1092	1354	1668	0	0
Island River	ON	55.40372	-89.0828	-3.8	-1.3	1.4	1019	1318	1670	0	1
Knee Lake	MB	55.00521	-94.73397	-2.8	-0.8	0.4	1251	1510	1673	0	1
Hill Island Lake	NT	60.50078	-109.83445	-4.4	-2	0.5	1075	1348	1673	0	0
Wollaston Lake	SK	58.23898	-103.30403	-4.5	-2.1	0.4	1051	1337	1673	0	0
Lac Rossignol	QC	52.69803	-73.77091	-2.6	-0.3	2.1	1023	1330	1682	0	1
Hayes River	MB	55.57496	-93.68154	-4.2	-1.6	1	1046	1343	1689	0	1
Lac Sakami	QC	53.27974	-76.72769	-2.6	-0.1	2.6	1001	1316	1692	1	1
Pine Pass	BC	55.4	-122.633	0.7	2.7	4.7	1010	1326	1705	0	0
Nass River	BC	55.93684	-129.04774	2.5	4.5	6.4	952.4	1304	1705	0	0
Big Sand Lake	MB	49.01738	-100.30577	-4.4	-1.9	0.6	1065	1359	1708	1	0
Kananaskis Lakes	AB	50.69818	-115.11467	1.1	3.1	5.1	985.4	1317	1711	0	0
Reservoir Manicouagan	QC	51.38333	-68.7	-1.8	0.4	2.7	1040	1352	1712	0	1
Yellowknife	NT	62.454	-114.37639	-4.8	-2.2	0.3	1131	1397	1717	0	0
Port Saunders	NL	50.648957	-57.287479	2.2	4.1	6.1	1063	1354	1720	1	1
Lac Manitou	QC	46.059654	-74.36939	0	2.1	4.4	1023	1345	1724	1	1
Rae	NT	64.20301	-117.27729	-4.7	-2.2	0.4	1143	1410	1730	0	0
Whitesand River	AB	59.58449	-115.51874	-3.2	-0.8	1.6	1113	1395	1734	0	0
Toad River	BC	58.85025	-125.23265	-2	0.1	2.3	1093	1389	1740	0	0
Kettle Rapids	MB	56.34799	-94.7101	-4.1	-1.6	0.9	1093	1394	1741	0	1
Harrington Harbour	QC	50.5	-59.483333	1.4	3.4	5.6	1036	1357	1741	1	1
Musquaro	QC	50.230409	-61.063852	1	3.1	5.3	1036	1358	1743	1	1
Clendenning River	ON	54.21239	-87.09111	-3.1	-0.7	1.9	1071	1383	1744	0	1
Taseko Lakes	BC	51.16802	-123.55295	1.9	3.8	5.8	1006	1351	1751	0	0
Terrace	BC	54.46591	-128.55577	3.5	5.4	7.2	992.6	1347	1756	0	0
Bella Coola	BC	52.3729	-126.76258	3.5	5.3	7.1	999.5	1350	1757	0	0
Lac Lichteneger	QC	52.27937	-75.21549	-2.2	0.1	2.6	1073	1393	1760	0	1
Sturgeon Lake	ON	55.38747	-90.8757	-3.5	-1	1.6	1099	1406	1762	0	1
Fond-Du-Lac	SK	59.32099	-107.19435	-3.9	-1.5	1	1139	1427	1766	0	0
Riviere Au Castor	QC	53.31809	-78.30739	-2.2	0.4	3.2	1040	1364	1767	1	1
Fort Resolution	NT	61.17011	-113.67172	-3.8	-1.3	1.2	1156	1435	1768	0	0
Pasfield Lake	SK	58.37104	-105.32337	-3.7	-1.4	1.1	1136	1430	1774	0	0
Brochet	MB	57.88063	-101.66943	-4	-1.6	0.9	1128	1427	1778	0	0
Nechako River	BC	54.00508	-123.9114	1.9	3.8	5.8	1046	1389	1789	0	0
Seymour Arm	BC	51.23781	-118.94567	2.1	4	6	1042	1388	1793	0	0
Bulmer Lake	NT	62.79771	-120.75391	-4.5	-2	0.4	1197	1473	1794	0	0
Split Lake	MB	56.14167	-96.20411	-3.7	-1.3	1.3	1138	1445	1799	0	0
Sept-Iles	QC	50.213297	-66.375792	-0.2	2	4.3	1095	1426	1809	1	1
Camsell Bend	NT	62.28347	-123.36986	-4.4	-2	0.4	1207	1488	1814	0	0
Ekwan River	ON	53.75352	-85.01958	-2.3	0.2	3	1096	1425	1818	0	1
Sulphur Bay	NT	61.3855	-116.01781	-3.5	-1.1	1.5	1203	1485	1822	0	0
Lac Baudeau	QC	51.81361	-73.08709	-1.8	0.5	2.9	1126	1451	1824	0	1
Lac Evans	QC	50.83749	-77.03094	-0.3	1.7	2.8	1344	1644	1830	0	1
Lac-Berte	QC	50.77279	-68.50161	-0.9	1.3	3.6	1122	1450	1831	1	1
Geikie River	SK	57.32422	-104.61541	-3	-0.7	1.7	1178	1484	1838	0	0
Reservoir Opinaca	QC	52.79203	-76.13804	-1.8	0.6	3.2	1121	1451	1838	1	1

Fort Smith	NT	60.00545	-111.88268	-3.3	-0.9	1.6	1215	1501	1839	0	0
Compulsion Bay	SK	57.66243	-103.40656	-3.3	-0.9	1.5	1177	1485	1841	0	0
Fawn River	ON	54.34382	-88.58672	-2.8	-0.4	2.1	1160	1478	1844	0	1
Matateo River	ON	53.51637	-84.57849	-2.4	0.1	2.7	1138	1465	1844	0	0
Calgary	AB	51.04539	-114.05809	1.4	3.4	5.5	1099	1441	1846	0	0
Bistcho Lake	AB	59.75999	-118.78485	-2.6	-0.3	2	1210	1501	1847	0	0
Livingstone Lake	SK	58.58691	-107.29606	-3	-0.7	1.7	1197	1499	1848	0	0
Kakisa River	NT	60.79176	-117.69528	-3.1	-0.8	1.6	1227	1512	1851	0	0
Sibbeston Lake	NT	61.73484	-122.76579	-3.6	-1.3	1	1231	1520	1855	0	0
Gods River	MB	55.33766	-92.84278	-3.1	-0.7	1.8	1184	1500	1861	0	1
Tathlina Lake	NT	60.55338	-117.5154	-3.1	-0.7	1.8	1237	1523	1866	0	0
Falaise Lake	NT	61.46414	-116.23476	-3.5	-1	1.5	1247	1529	1867	0	0
Fort Fraser	BC	54.06197	-124.5528	2	3.9	5.9	1114	1462	1868	0	0
Akimiski Island North	NU	53.00476	-81.31219	-1.9	0.7	3.5	1128	1457	1871	1	0
Uhlman Lake	MB	56.67749	-98.39845	-3.2	-0.8	1.8	1212	1526	1890	0	0
Buffalo Lake	NT	60.2262	-115.44087	-2.8	-0.3	2.1	1258	1549	1897	0	0
Mills Lake	NT	61.45908	-118.33062	-3.4	-1	1.4	1280	1563	1900	0	0
Tazin Lake	SK	59.83043	-109.21512	-2.8	-0.4	2	1258	1556	1904	0	0
Steen River	AB	59.36158	-117.77723	-2.4	-0.1	2.3	1257	1553	1905	0	0
Petitot River	BC	59.64798	-120.8116	-2.1	0.1	2.3	1262	1561	1909	0	0
Winiskisis Channel	ON	54.0382	-87.08773	-2.2	0.2	2.7	1209	1538	1912	0	1
Chinchaga River	AB	57.90274	-118.63645	-0.9	1.3	3.5	1240	1553	1918	0	0
Fort Liard	NT	60.23998	-123.47417	-2.6	-0.4	1.9	1276	1573	1919	0	0
Chibougamau	QC	49.91365	-74.36994	0.4	2.3	3.4	1418	1732	1920	0	1
Cree Lake	SK	57.48715	-106.46874	-2.3	0	2.4	1248	1562	1920	0	0
Eastmain	QC	52.24633	-78.50043	-1.4	1.1	3.8	1172	1512	1921	1	1
Thorne River	ON	54.73078	-91.35721	-2.5	-0.1	2.4	1229	1555	1925	0	1
Lac Mesgouez	QC	51.40141	-75.16635	-1.3	1	3.5	1200	1539	1925	0	1
Klewi River	NT	60.32668	-113.24317	-2.7	-0.2	2.3	1290	1584	1933	0	0
Beatton River	BC	57.18734	-121.2461	-0.3	1.9	4	1238	1559	1933	0	0
Fort Nelson	BC	58.80603	-122.69731	-0.8	1.3	3.4	1272	1584	1949	0	0
Ile D'anticosti	QC	49.549519	-62.955532	2.3	4.4	6.6	1208	1541	1952	0	1
Fort Simpson	NT	61.86281	-121.3494	-3.2	-0.8	1.5	1328	1619	1956	0	0
Granville Lake	MB	56.2966	-100.41124	-2.7	-0.3	2.2	1270	1591	1958	0	0
Baie Abatagouche	QC	50.52623	-73.84309	-0.9	1.3	3.7	1233	1576	1969	0	1
Wapti	AB	54.9553	-119.19551	1.7	3.7	5.7	1225	1567	1969	0	0
Rivers Inlet	BC	55.59591	-127.53349	4.9	6.6	8.3	1114	1529	1969	0	0
Upper Foster Lake	SK	56.85092	-105.29853	-2	0.4	2.8	1278	1602	1970	0	0
Fort Albany	ON	52.21473	-81.6829	-1.4	1.2	3.9	1219	1558	1972	1	0
Numabin Bay	SK	56.64944	-103.09109	-2.2	0.1	2.6	1278	1603	1973	0	0
Lac Nemiscau	QC	51.37883	-76.83395	-1.1	1.3	3.8	1234	1579	1974	1	1
Dawson Creek	BC	55.76676	-120.22457	1.5	3.5	5.5	1235	1574	1975	0	0
Sandy Lake	NL	49.241387	-56.983032	3.1	5	7.1	1270	1588	1981	1	1
Baie Du Renard	QC	47.38241	-61.8843	2.9	4.9	7.1	1233	1567	1985	0	1
Asheweig River	ON	53.58871	-88.37843	-2	0.4	2.8	1275	1612	1988	0	1
Kapiskau River	ON	52.09176	-83.70596	-1.3	1.1	3.8	1251	1596	1998	0	1
Missisa Lake	ON	52.31213	-85.19534	-1.5	0.9	3.4	1269	1611	1999	0	0
William River	SK	58.53254	-108.8453	-1.9	0.4	2.8	1330	1643	2003	0	0

Maxhamish Lake	BC	58.8129	-122.70632	-1.5	0.7	2.9	1342	1650	2009	0	0
Sipiwesk	MB	55.06773	-97.63783	-2.4	0	2.5	1309	1639	2010	0	0
Fitzgerald	AB	54.97657	-102.12806	-2.1	0.2	2.7	1355	1659	2011	0	0
Quesnel	BC	52.97484	-122.4978	2.7	4.6	6.6	1216	1585	2011	0	0
Mcleod Lake	BC	54.98266	-123.04586	2.5	4.4	6.4	1245	1599	2015	0	0
Llyoyd Lake	SK	57.34679	-108.98069	-1.4	0.9	3.3	1333	1654	2020	0	0
Stull Lake	ON	54.42126	-92.59016	-2.1	0.3	2.7	1314	1649	2024	0	1
John D'or Prairie	AB	58.49995	-115.14866	-1.3	1.1	3.4	1347	1663	2027	0	0
Red Indian Lake	NL	48.725812	-56.870429	3.4	5.3	7.3	1294	1625	2027	1	1
Port aux Basques	NL	46.196919	-59.957004	4	5.8	7.9	1252	1600	2031	1	1
Clear Hills	AB	56.5087	-119.12221	0.3	2.4	4.5	1323	1654	2033	0	0
Fernie	BC	49.50394	-115.06235	2.9	4.9	6.9	1242	1612	2040	0	0
Trespassey	NL	46.736116	-53.360278	5.1	6.6	8.5	1284	1603	2040	1	1
Mudjatik River	SK	56.58957	-107.37054	-1.2	1.1	3.5	1351	1681	2052	0	0
Zama Lake	AB	58.7391	-119.10144	-0.9	1.3	3.5	1369	1686	2054	0	0
Nelson House	MB	55.82652	-98.83489	-2	0.4	2.8	1349	1681	2058	0	0
Burgeo	NL	47.613413	-57.610491	4.2	6	7.9	1289	1634	2059	1	1
Lac Assinica	QC	50.50231	-75.24663	-0.5	1.7	4.2	1306	1659	2060	0	1
Makoop Lake	ON	53.39778	-90.81955	-1.7	0.7	3.1	1339	1683	2064	0	1
Lansdowne House	ON	52.2206	-87.88537	-1.3	1	3.5	1333	1678	2064	0	1
Cap-Chat	QC	49.094066	-66.685739	1.6	3.8	6.1	1291	1654	2073	1	1
Port -Menier	QC	49.818815	-64.352681	2.4	4.5	6.7	1323	1676	2076	0	1
Wadlin Lake	AB	57.73523	-115.60308	-0.4	1.9	4.1	1377	1707	2078	0	0
Fontas River	BC	58.2594	-120.46942	-0.6	1.6	3.8	1389	1710	2080	0	0
Wesleyville	NL	49.148145	-53.5569	4.7	6.2	8	1422	1697	2080	1	1
Hope	BC	49.37969	-121.44183	4.1	6	7.9	1257	1640	2082	0	0
Fort-Rupert	QC	45.69037	-75.98934	-0.5	1.9	4.5	1320	1677	2088	0	1
Charlie Lake	BC	56.32681	-120.97242	1.1	3.2	5.3	1353	1694	2092	0	0
Douglas Channel	BC	53.38643	-129.19313	5.5	7.2	8.9	1234	1636	2092	0	0
Prince George	BC	53.9123	-122.74556	3.1	5	7	1293	1662	2093	0	0
Peerless Lake	AB	56.64914	-114.65244	0.4	2.6	4.8	1374	1714	2096	0	0
Baie-Comeau	QC	49.221297	-68.150394	0.9	3.1	5.4	1324	1687	2101	0	1
Stephenville	NL	48.5479718	-58.58153529	3.9	5.8	7.9	1327	1675	2101	1	1
Moosonee	ON	51.26973	-80.64506	-0.5	1.8	4.5	1344	1697	2109	0	1
Bonavista	NL	48.6533449	-53.11182489	5.1	6.6	8.4	1467	1765	2110	1	1
Bonaparte Lake	BC	51.26053	-120.5589	3.4	5.4	7.4	1289	1677	2119	0	0
Oxford House	MB	54.92778	-95.2883	-1.7	0.7	3.2	1397	1740	2120	0	1
Wunnummin Lake	ON	52.92783	-89.08996	-1.1	1.2	3.6	1387	1738	2127	0	1
Kississing Lake	MB	55.18942	-101.31087	-1.4	0.9	3.3	1410	1749	2132	0	0
Lesser Slave Lake	AB	55.4554	-115.07976	1.2	3.3	5.4	1393	1741	2135	0	0
Bay of Islands	NL	49.161664	-58.218371	3.9	5.8	7.9	1368	1713	2136	1	1
Pelican Narrows	SK	55.17726	-102.93517	-1.1	1.2	3.6	1419	1761	2146	0	0
Riviere Harricana	QC	49.00563	-78.14032	-0.2	2.1	4.6	1373	1736	2146	0	1
Botwood	NL	49.142298	-55.344085	4.4	6.1	8	1450	1751	2147	1	1
Whitecourt	AB	54.14054	-115.68455	1.7	3.7	5.8	1394	1747	2147	0	0
Ghost River	ON	48.57967	-79.87986	-0.5	1.9	4.4	1381	1739	2148	0	1
Opasquia Lake	ON	53.29354	-93.56552	-1.2	1.1	3.5	1413	1763	2149	0	1
St. Lawrence	NL	46.925167	-55.395229	5.3	7	8.8	1347	1695	2149	1	1

La Tuque	QC	47.44097	-72.78156	2.3	4.2	5.3	1617	1961	2156	0	1
Fort Chipewyan	AB	58.71964	-111.1407	-1	1.3	3.7	1474	1796	2163	0	0
Rocky Mountain House	AB	52.37447	-114.92192	2.5	4.5	6.6	1368	1738	2164	0	0
Lac La Ronge	SK	55.12278	-104.96178	-0.6	1.6	4	1437	1780	2167	0	0
St. John's	NL	47.5605413	-52.7128315	5.3	6.8	8.6	1427	1740	2168	1	1
La Loche	SK	56.482	-109.43506	-0.2	2	4.4	1450	1788	2169	0	0
Riviere Mistassini	QC	48.72299	-72.3069	0.2	2.4	4.8	1387	1756	2173	0	1
Winefred Lake	AB	55.48728	-110.55131	0.6	2.8	5.1	1440	1788	2175	0	0
Belleoram	NL	47.52675	-55.414973	5	6.7	8.6	1393	1738	2176	1	1
Ogoki	ON	51.6298	-85.94519	-0.5	1.9	4.4	1414	1774	2177	0	1
North Caribou Lake	ON	52.81535	-90.74221	-0.9	1.4	3.9	1431	1787	2179	0	1
Cross Lake	MB	54.61206	-97.69803	-1.3	1.1	3.6	1447	1795	2180	0	0
Bitumount	AB	57.3929	-111.62803	-0.3	1.9	4.3	1474	1807	2183	0	0
Fort Hope	ON	51.55763	-87.90649	-0.5	1.8	4.2	1428	1788	2187	0	1
Gander Lake	NL	48.929709	-54.756103	4.5	6.2	8.1	1456	1782	2193	1	1
Fort Mcmurray	AB	56.72563	-111.37628	0.4	2.6	4.8	1473	1818	2203	0	0
Ile-A-La-Crosse	SK	55.45034	-107.9048	-0.1	2.2	4.5	1472	1817	2204	0	0
Buffalo Narrows	SK	55.86349	-108.48052	0.4	2.6	4.8	1475	1820	2207	0	0
Wapawekka Hills	SK	54.92545	-104.6371	-0.1	2.1	4.4	1468	1816	2207	0	0
Gaspe	QC	48.831635	-64.486902	2.7	4.8	7	1419	1780	2207	1	1
Miminiska Lake	ON	51.57723	-88.55795	-0.5	1.8	4.2	1452	1815	2215	0	0
Weskusko Lake	MB	54.77193	-99.84884	-0.9	1.5	3.9	1484	1833	2222	0	0
Moose River	ON	50.69817	-81.82712	0.1	2.4	4.9	1442	1809	2223	0	1
Island Lake	MB	49.80453	-94.31986	-0.8	1.5	3.9	1476	1832	2224	0	1
Grand Prairie	AB	55.17281	-118.7884	1.8	3.9	6	1461	1819	2225	0	0
Green Lake	SK	54.16973	-107.71211	0.4	2.6	4.9	1490	1843	2236	0	0
Joutel	QC	49.45803	-78.30586	0.4	2.6	5.1	1448	1822	2238	0	1
Matane	QC	48.844516	-67.530576	2.2	4.3	6.6	1438	1809	2239	1	1
Waterhen River	SK	54.46972	-108.45645	0.7	2.9	5.2	1500	1853	2248	0	0
Schreiber	ON	48.81048	-87.26125	2.3	4.6	7	1386	1795	2250	0	1
Nakina	ON	50.17604	-86.70692	0.1	2.4	4.8	1475	1847	2257	0	1
Longlac	ON	49.78128	-86.53483	0.9	3.2	5.6	1455	1838	2258	0	1
Lac Waswanipi	QC	49.53561	-76.39785	0.6	2.8	5.2	1463	1840	2259	0	1
White River	ON	48.63772	-85.77137	1.5	3.8	6.2	1433	1826	2261	0	1
North Spirit Lake	ON	52.51049	-92.91778	-0.4	1.9	4.3	1501	1865	2264	0	1
Armstrong	ON	50.30433	-89.04153	0.1	2.4	4.8	1481	1856	2266	0	1
Reservoir Gouin	QC	48.60751	-74.81008	0.9	3.1	5.5	1460	1844	2271	0	1
Sand River	AB	54.97084	-111.0565	1.3	3.5	5.7	1521	1883	2284	0	0
Norway House	MB	53.98206	-97.83293	-0.4	1.9	4.4	1525	1889	2287	0	0
Cormorant Lake	MB	54.22461	-100.60171	-0.3	2	4.4	1547	1902	2297	0	0
Smoky Falls	ON	50.06074	-82.16364	0.4	2.7	5.2	1505	1878	2297	0	1
Wabamun Lake	AB	53.55869	-114.47319	2.7	4.7	6.8	1505	1879	2303	0	0
Lake St Joseph	ON	50.9868	-91.27161	0	2.3	4.7	1530	1900	2306	0	0
Roberval	QC	48.5183	-72.22176	1.1	3.4	5.7	1496	1881	2312	0	1
Bute Inlet	BC	50.57139	-124.92422	5.8	7.6	9.4	1422	1841	2316	0	0
Shellbrook	SK	53.22183	-106.3885	0.8	3	5.4	1554	1918	2319	0	0
Cochrane	ON	49.06306	-81.02816	0.7	3	5.4	1523	1904	2323	0	1
Deer Lake	ON	52.58178	-94.09534	0	2.3	4.7	1553	1923	2328	0	1

St Walburg	SK	53.62991	-109.20022	1.1	3.3	5.6	1571	1932	2332	0	0
Kenogami River	ON	50.23034	-85.31586	0.5	2.8	5.2	1535	1912	2332	0	1
Grand Rapids	MB	53.18023	-99.2683	0	2.3	4.8	1570	1933	2333	0	0
Hornepayne	ON	49.2181	-84.77726	0.9	3.2	5.6	1523	1909	2336	0	1
Amisk Lake	SK	54.57061	-102.23892	0.1	2.4	4.8	1584	1942	2341	0	0
Nipigon	ON	49.01464	-88.26302	1.2	3.5	5.8	1535	1924	2348	0	1
Rimouski	QC	48.43898	-68.53497	2.5	4.7	7	1510	1903	2348	0	1
Senneterre	QC	48.3935	-77.23518	1.2	3.4	5.8	1528	1919	2349	0	1
Michipicoten	ON	47.93884	-84.82596	3	5.2	7.6	1473	1891	2358	0	1
Graham Island	BC	53.31506	-90.46822	7.4	8.9	10.3	1451	1888	2366	0	0
Kapuskasing	ON	49.41594	-82.42978	0.9	3.2	5.7	1562	1948	2375	0	1
Prince Albert	SK	53.20337	-105.75434	0.7	3	5.3	1613	1976	2378	0	0
Trout Lake	ON	51.20624	-93.29932	0.5	2.8	5.2	1600	1978	2391	0	1
Hudson Bay	SK	52.85927	-102.39118	0.7	3	5.4	1610	1980	2392	0	0
The Pas	MB	53.825	-101.25333	0.4	2.7	5.1	1621	1989	2393	0	0
Prince Rupert	BC	54.31219	-130.32708	6.8	8.5	10.2	1429	1888	2395	0	0
Lac Kempt	QC	46.92281	-74.29202	1.8	4	6.4	1558	1955	2397	0	1
Thunder Bay	ON	48.38249	-89.24598	2.3	4.6	7	1552	1955	2399	0	1
Vermilion	AB	53.487	-110.85255	1.9	4.1	6.3	1619	1989	2401	0	0
Pasquia Hills	SK	53.14889	-102.76961	0.6	2.8	5.2	1633	1999	2402	0	0
Berens River	MB	52.34083	-97.02133	0.4	2.8	5.2	1616	1993	2407	0	0
Rouyn-Noranda	QC	48.23748	-79.01701	1.4	3.7	6.1	1585	1978	2410	0	1
Swan Lake	MB	52.53266	-100.75838	0.8	3.1	5.5	1634	2008	2424	0	0
Campbellton	NB	48.007399	-66.6722057	3	5.1	7.4	1599	1985	2427	1	1
Foleyet	ON	48.24389	-82.43972	1.6	3.9	6.3	1595	1993	2428	0	1
Sioux Lookout	ON	50.09302	-91.91652	0.9	3.2	5.6	1624	2010	2430	0	0
Iles de la Madeleine	QC	47.38241	-61.8843	5.2	7.1	9.2	1610	1985	2452	0	1
Waterhen Lake	MB	51.83016	-99.53786	0.8	3.2	5.6	1665	2043	2460	0	0
Ignace	ON	49.41232	-91.6553	1.5	3.7	6.1	1649	2045	2473	0	0
Edmundston	NB	47.369013	-68.326674	3.1	5.3	7.5	1633	2033	2481	0	1
Timmins	ON	48.47614	-81.32903	1.8	4	6.4	1651	2048	2482	0	1
Carroll Lake	MB	51.09411	-95.19386	0.9	3.3	5.6	1677	2062	2484	0	0
Chapleau	ON	47.84439	-83.40411	2.4	4.6	7	1637	2042	2486	0	1
Duck Mountain	MB	52.50538	-100.52382	1.2	3.4	5.8	1685	2064	2490	0	0
Dixon Entrance	BC	54.39164	-132.09741	7.7	9.2	10.7	1537	2000	2492	0	0
Grand-Lac-Victoria	QC	46.07662	-75.9542	2.2	4.4	6.8	1646	2051	2498	0	1
Melfort	SK	52.87088	-104.60962	1.4	3.7	6	1718	2092	2506	0	0
Wainwright	AB	52.83311	-110.85048	2.6	4.7	6.9	1711	2087	2511	0	0
Alert Bay	BC	50.58039	-126.92058	7.5	9.1	10.7	1560	2010	2511	0	0
North Battleford	SK	52.78545	-108.29903	2.1	4.3	6.5	1732	2105	2520	0	0
Yorkton	SK	51.21206	-102.45996	1.5	3.8	6.2	1716	2098	2526	0	0
Quetico	ON	48.73333	-90.91667	2.2	4.5	6.8	1686	2092	2530	0	0
Moresby Island	BC	52.59355	-131.75285	8	9.5	10.9	1607	2068	2559	0	0
Hecla	MB	51.1346	-96.66517	1.3	3.6	6	1747	2138	2566	0	0
Sydeny	NS	46.13679	-60.194224	5.5	7.4	9.5	1710	2089	2566	0	1
Hecate Strait	BC	53.07516	-130.28997	7.7	9.3	10.9	1586	2062	2570	0	0
Saskatoon	SK	52.13079	-106.66095	1.9	4.2	6.5	1777	2156	2574	0	0
Lac Seul	ON	50.31843	-92.28462	1.7	4	6.4	1751	2149	2580	0	0

Laredo Sound	BC	52.47984	-128.87611	7.6	9.2	10.9	1608	2083	2600	0	0
Gogama	ON	47.67449	-81.72343	2.7	4.9	7.3	1743	3041	2602	0	1
Riding Mountain	MB	50.53194	-99.4686	1.8	4.1	6.5	1778	2165	2605	0	0
Oyen	AB	51.3586	-110.47889	3.1	5.1	7.3	1797	2177	2609	0	0
Ville-Marie	QC	47.33184	-79.43689	2.7	4.9	7.3	1752	2167	2621	0	1
Nootka Sound	BC	49.61881	-126.56869	7.9	9.5	11	1680	2127	2627	0	0
Glace Bay	NS	46.196919	-59.957004	6.2	8	10	1748	2136	2630	1	1
Dauphin Lake	MB	51.21814	-99.73902	1.7	4.1	6.5	1803	2196	2631	0	0
Wynyard	SK	51.7622	-104.17914	2.2	4.5	6.8	1824	2210	2641	0	0
Mont-Laurier	QC	46.55039	-75.49599	3.3	5.5	7.8	1762	2181	2646	0	1
Melville	SK	50.92973	-102.80496	2.3	4.6	6.9	1815	2204	2647	0	0
Vancouver	BC	49.26041	-123.11395	6.9	8.7	10.6	1682	2139	2654	0	0
Pointe Du Bois	MB	50.29745	-95.5524	2.1	4.4	6.7	1826	2230	2667	0	0
Kindersley	SK	51.47494	-109.14482	3	5.1	7.3	1862	2246	2674	0	0
Cypress Lake	SK	49.47169	-109.47811	3.9	6	8.1	1824	2222	2674	0	0
Canso	NS	45.336285	-60.994442	6.1	8	10	1790	2189	2674	1	1
Woodstock	NB	46.1522	-67.5983	4.3	6.4	8.6	1812	2220	2680	1	1
Bathurst	NB	47.6183507	-65.6513357	4.6	6.8	9	1822	2223	2685	1	1
Dryden	ON	49.78206	-92.83439	2.4	4.7	7	1833	2246	2687	0	0
Port Alberni	BC	49.23387	-124.80554	7.8	9.4	11.1	1738	2183	2689	0	0
Sault Ste Marie	ON	46.50677	-84.33352	4.4	6.6	8.9	1779	2211	2692	0	1
Neepawa	MB	50.22623	-99.46656	2.2	4.6	7	1871	2271	2718	0	0
Rosetown	SK	51.55256	-107.99263	2.9	5.1	7.4	1898	2287	2722	0	0
Blind River	ON	46.18629	-82.96087	4.2	6.4	8.8	1838	2267	2740	0	1
Selkirk	MB	50.14364	-96.88248	2.3	4.6	7	1906	2311	2756	0	0
Kenora	ON	49.76526	-94.47769	2.6	4.9	7.3	1898	2312	2757	0	0
Lethbridge	AB	49.69455	-112.83338	5.2	7.2	9.3	1834	2266	2761	0	0
Wood Mountain	SK	49.37118	-106.38229	3.8	5.9	8.1	1910	2309	2764	0	0
Deep River	ON	46.10132	-77.48619	3.7	5.9	8.2	1864	2293	2764	1	1
Regina	SK	50.44727	-104.61589	3.2	5.4	7.7	1939	2333	2782	0	0
Swift Current	SK	50.28505	-107.79831	3.7	5.8	8	1936	2334	2786	0	0
Weyburn	SK	49.66832	-103.85819	3.2	5.4	7.7	1945	2343	2799	0	0
Trois-Riviers	QC	46.3434	-72.5436	4	6.2	8.5	1900	2327	2802	0	1
North Bay	ON	46.30891	-79.46111	4	6.2	8.6	1897	2333	2808	0	1
Truro	NS	45.3657733	-63.2869407	6.1	8	10.1	1926	2338	2810	1	1
Willow Bunch Lake	SK	49.39173	-105.6376	3.7	5.8	8.1	1956	2354	2813	0	0
Virden	MB	49.85098	-100.93189	3	5.3	7.6	1958	2360	2817	0	0
Eastport	NL	48.651764	-53.757846	6.8	8.7	10.7	1865	2313	2820	0	1
Cape Scott	BC	50.78276	-128.42787	8.7	10.2	11.7	1816	2305	2822	0	0
Amherst	NS	45.816667	-64.216721	5.9	7.9	10	1919	2345	2826	1	1
Hailfax	NS	44.6488625	-63.5753196	6.7	8.5	10.4	1927	2345	2828	0	1
Shelburne	NS	43.76358	-65.324023	7.2	9	10.9	1905	2335	2832	0	1
Moncton	NB	46.0878165	-64.7782313	5.4	7.5	9.7	1945	2359	2835	1	1
Charlottetown	PE	46.23824	-63.1310704	6	8	10.1	1938	2349	2836	0	1
Sudbury	ON	46.48968	-80.99139	4.2	6.5	8.8	1926	2362	2838	0	1
Fredericton	NB	45.9635895	-66.643115	5.6	7.7	9.8	1927	2359	2840	0	1
Huntsville	ON	45.32424	-79.21072	4.6	6.8	9	1927	2369	2851	0	1
Brandon	MB	49.84317	-99.95009	3	5.3	7.7	1984	2393	2852	0	0

Queens Sound	BC	51.89813	-128.35039	8.6	10.2	11.8	1830	2338	2874	0	0
Prelate	SK	50.85237	-109.40652	4.3	6.4	8.6	2010	2416	2876	0	0
Foremost	AB	49.47908	-111.44075	5.1	7.1	9.2	1987	2406	2883	0	0
Winnipeg	MB	49.89927	-97.13883	3	5.3	7.7	2017	2434	2888	0	0
Medicine Hat	AB	50.04104	-110.6782	4.6	6.7	8.8	2031	2440	2907	0	0
Annapolis Royal	NS	44.742226	-65.515822	6.9	8.8	10.7	2003	2429	2917	0	1
Tobermory	ON	45.25332	-81.66449	5.8	8	10.3	2033	2497	3007	0	1
Pembroke	ON	45.82701	-77.11162	5.1	7.3	9.6	2088	2538	3028	0	1
Ottawa	ON	45.42001	-75.68954	5.7	7.8	10.1	2192	2635	3142	0	1
Owen Sound	ON	44.5643	-80.94248	6.7	8.9	11.1	2172	2642	3156	0	1
Lake Simcoe	ON	44.44469	-79.34988	6.4	8.5	10.7	2207	2674	3178	0	1
Victoria	BC	48.4281	-123.36527	9.4	11.1	12.7	2129	2653	3224	0	0
Kingston	ON	44.22979	-76.48021	6.7	8.9	11.1	2300	2773	3287	0	1
Kitchener	ON	43.4523	-80.49217	7.3	9.5	11.6	2336	2810	3316	0	1
Kamloops	BC	50.67587	-120.33899	8	10	12	2305	2792	3330	0	0
Montreal	QC	45.5077	-73.55446	6.9	9	11.3	2425	2893	3405	0	1
Toronto	ON	43.65161	-79.38313	8.2	10.4	12.5	2482	2982	3520	0	1
Erie	ON	43.77009	-80.0667	8.7	10.8	12.9	2592	3096	3628	0	1