Compilation and Synopsis of Literature on the Traditional Knowledge of Indigenous Peoples in the Northwest Territories Concerning Dolly Varden

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Byers, T., Reist, J.D., and Sawatzky, C.D. 2019. Compilation and synopsis of literature on the Traditional Knowledge of Indigenous Peoples in the Northwest Territories concerning Dolly Varden. Can. Manuscr. Rep. Fish. Aquat. Sci. 3177: vi + 63 p.

There is evidence from both fisheries science and Indigenous Traditional Ecological Knowledge (TEK) that stocks of northern form Dolly Varden in the northwestern corner of Arctic Canada had been in decline, however, some presently appear to be recovering. The status of these stocks is of particular relevance to Indigenous fishers who have used this fish for subsistence for generations. Before the Canadian government, through the *Species at Risk Act*, can implement measures to halt a species decline, the species must have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Threatened or Endangered. COSEWIC used both the best available science and TEK to make an informed determination and assess the western Arctic populations of Dolly Varden as Special Concern in 2010. The purpose of this report is to compile and summarize the literature regarding TEK on Dolly Varden in the NWT and Yukon North Slope (YNS) for consideration by COSEWIC and others in the future re-assessment process. Documented TEK obtained from harvesters and elders from communities in the Inuvialuit Settlement Region (up to 2018), Gwich'in Settlement Area (up to 2010), and Sahtu Settlement Area (up to 2009), and a verification workshop held in Aklavik in 2010 is synthesized. The TEK describes both the species and its habitat requirements as well as habitat changes that may impact Dolly Varden. It also considers how the fish is harvested and the traditional uses of this species. Inuvialuit and Gwich'in fishers are in agreement that Dolly Varden harvests began declining in the latter half of the 20th century, with Inuvialuit seeing this decline in the Big Fish River beginning in the 1970s, while Gwich'in observed a similar decline in the Rat River-Husky Channel system beginning in the 1980s. There are signs that harvests were rebounding beginning in the last half of the 2000s. One observed trend in habitat changes that is common to all communities is the reduction in water level in spawning streams; this is attributed to diverse causes. Changes to coastal landscapes and weather patterns, likely due to climate change, that could affect Dolly Varden migration and feeding areas are also summarized.

RÉSUMÉ

Byers, T., Reist, J.D., and Sawatzky, C.D. 2019. Compilation and synopsis of literature on the Traditional Knowledge of Indigenous Peoples in the Northwest Territories concerning Dolly Varden. Can. Manuscr. Rep. Fish. Aquat. Sci. 3177: vi + 63 p.

Tant les sciences halieutiques que les connaissances écologiques traditionnelles (CET) des Autochtones prouvent que les stocks de la forme nordique du Dolly Varden dans l'angle nord-ouest de l'Arctique canadien sont en déclin, bien que certains semblent actuellement en voie de rétablissement. L'état de ces stocks est particulièrement important pour les pêcheurs autochtones qui utilisent ce poisson à des fins de subsistance depuis des générations. Avant que le gouvernement canadien, en vertu de la *Loi sur les espèces en péril,* puisse mettre en œuvre des mesures visant à mettre fin au déclin d'une espèce, celle-ci doit avoir été évaluée par le Comité sur la situation des espèces en péril au Canada (COSEPAC) comme étant menacée ou en voie de disparition. Le COSEPAC a utilisé à la fois les meilleures données scientifiques disponibles et les CET pour prendre une décision éclairée et évaluer les populations de Dolly Varden de l'ouest de l'Arctique comme étant préoccupantes en 2010. Ce rapport a pour but de compiler et de résumer la documentation concernant les CET sur le Dolly Varden dans les T.N.-O. et sur le versant nord du Yukon pour examen par le COSEPAC et d'autres intervenants dans le cadre du processus de réévaluation futur. On a fait un résumé des CET documentées obtenues auprès des pêcheurs et des aînés des collectivités de la région désignée des Inuvialuit (jusqu'en 2018), de la région désignée des Gwich'in (jusqu'en 2010) et de la région désignée du Sahtu (jusqu'en 2009), et d'un atelier sur la vérification tenu à Aklavik en 2010. Les CET décrivent à la fois l'espèce et ses besoins en matière d'habitat, ainsi que les changements d'habitat qui peuvent avoir une incidence sur elle. Les CET tiennent également compte de la façon dont le poisson est pêché et des utilisations traditionnelles de cette espèce. Les Inuvialuit et les Gwich'in s'entendent pour dire que les prises de Dolly Varden ont commencé à diminuer dans la deuxième moitié du 20^{e} siècle. Les Inuvialuit ont constaté ce déclin dans la rivière Big Fish à partir des années 1970, tandis que les Gwich'in ont observé un déclin semblable dans le réseau de la rivière Rat et du chenal Husky à partir des années 1980. Certains signes indiquent que les récoltes ont rebondi à partir de la deuxième moitié des années 2000. Une tendance observée dans les changements de l'habitat par toutes les collectivités est la réduction du niveau d'eau aux endroits où l'espèce fraye; cette réduction est attribuable à diverses causes. Les changements dans les paysages côtiers et les conditions météorologiques, probablement dus au changement climatique, qui pourraient toucher les zones de migration et d'alimentation du Dolly Varden sont également résumés.

INTRODUCTION

Dolly Varden is an anadromous species inhabiting north-draining coastal waters west of the Mackenzie River, Canada and coastal regions of northwestern Alaska. It is sympatric with Arctic Char (*Salvelinus alpinus*) in the northernmost extent of its range, and sympatric with Bull Trout (*Salvelinus confluentus*) in the south. Two forms of Dolly Varden have been recognized as occurring in North America: southern form Dolly Varden, *Salvelinus malma lordi* (Günther, 1866) and northern form Dolly Varden, *Salvelinus malma malma* (Walbaum, 1792) (Behnke 1980).

In the southern part of its range in the Northwest Territories (NWT), taxonomic confusion between northern form Dolly Varden and Bull Trout has generated uncertainty in the reporting of Dolly Varden in harvest reports in the Sahtu Settlement Area. Reist et al. (2002) suggest that the distribution of both species may overlap in the Sahtu between Great Bear Lake and Peel River, which is the northernmost periphery of Bull Trout distribution (Figure 1). The two species have been found to be sympatric (i.e., co-occur in at least one stream (Gayna River) in the Mackenzie Mountains about 100 km northwest of Norman Wells, however, they are not syntopic (i.e., not occupying the same habitats within the stream) (Mochnacz and Reist 2007). Although this system is the southern-most location along the Mackenzie River where Dolly Varden has been documented (isolated non-migratory population in upstream reaches especially in the tributary basins of the Peel and Arctic Red rivers), relevant sampling in locations south of here has not been conducted thus the southern geographic limit of northern form Dolly Varden along the Mackenzie River is uncertain. Physical characteristics that fisheries scientists use to differentiate the two species are detailed in Reist et al. (2002). Throughout this document where appropriate, Dolly Varden is variously referred to as Dolly Varden, char, charr, trout, or river trout.

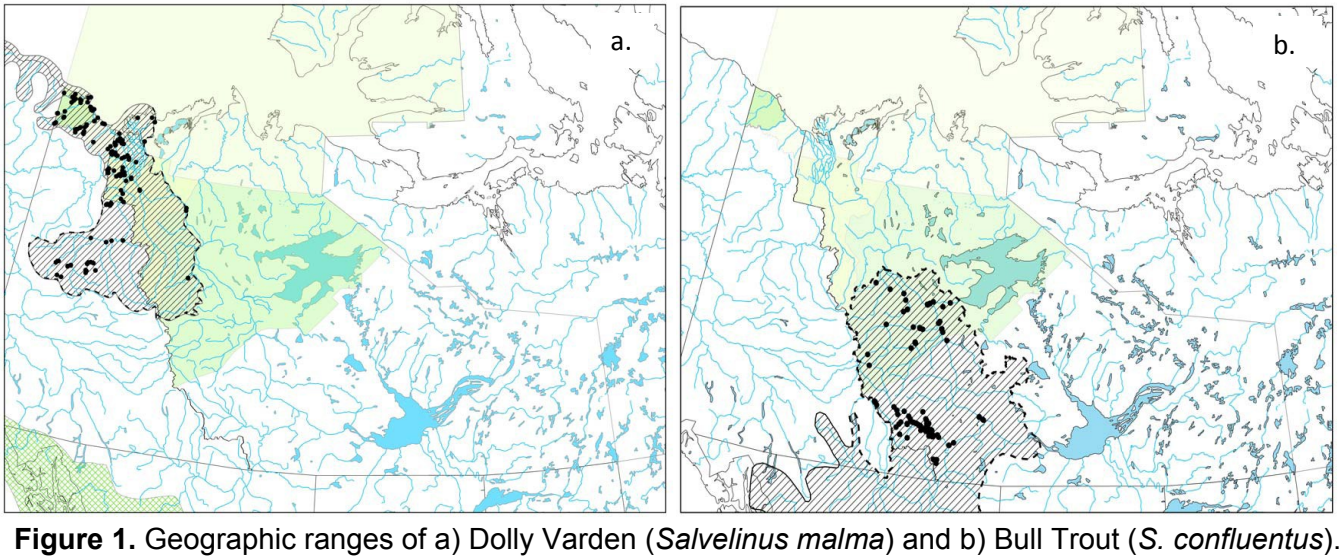

Figure 1. Geographic ranges of a) Dolly Varden (*Salvelinus malma*) and b) Bull Trout (*S. confluentus*). Black dots identify collection sites. Reproduced from Reist and Sawatzky (2010).

OBJECTIVES

Since 2010, northern form Dolly Varden has been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a species of Special Concern, defined as a species that may become threatened or endangered because of a combination of its biological characteristics and

identified threats in its environment. This was based on declines in stock abundance and a limited area of essential habitat (COSEWIC 2010). COSEWIC has a legal obligation under the federal *Species at Risk Act* (SARA) for identifying species at risk of becoming extirpated within Canada. The SARA, which came into force in June 2004, was enacted to identify threatened species and their habitat, and help declining populations to recover. The evaluation of a species by COSEWIC must use both science and Indigenous traditional knowledge in making the assessment. Incorporation of TEK at an early stage of an assessment ensures no undue delay in formal consultations leading to a final decision on the status of a species at risk.

A 2008 pre-COSEWIC meeting on northern form Dolly Varden convened by Fisheries and Oceans Canada determined that a synthesis of TEK was needed before its status as a possible 'at-risk' species could be determined. Further, in its 2016 Science Advisory Report assessing the Babbage River stock of Dolly Varden, DFO indicated:

> "*it is suggested to gather local knowledge/observations in association with the coastal harvest data to better understand how environmental conditions affected catches and effort in the fishery*" (DFO 2017: 12).

A substantial amount of work has been conducted over the last three decades in documenting both Inuvialuit and Gwich'in TEK on fish, including Dolly Varden. TEK literature describes the regional distribution, natural history, habitat and harvest of this Arctic salmonid. The purpose of this report is to compile and summarize the literature regarding documented TEK on Dolly Varden in the NWT and Yukon North Slope (YNS) for consideration by COSEWIC and others in the future re-assessment process. As such it is not an integrated TEK/Science report where one body of knowledge corroborates or complements the other. This report is a stand-alone TEK compilation, supplemented with relevant scientific information where TEK does not exist in the literature. Thus, there may be some inconsistencies with scientific knowledge.

SCOPE OF WORK

The distribution of northern form Dolly Varden (hereafter Dolly Varden) lies within the Inuvialuit, Gwich'in and Sahtu land settlement areas of the western Canadian Arctic (Figure 2). The majority of the information in this report is from the Inuvialuit and Gwich'in areas. It is likely that no TEK studies have ever been conducted on Dolly Varden or fishing in the Sahtu Settlement Area. Dolly Varden in the Inuvialuit and Gwich'in areas exhibit three life history strategies, namely, anadromous or sea-run (annual migrations to sea; males and females), stream-resident (riverine; non-migratory fish predominantly males co-occurring with anadromous fish in spawning and over-wintering areas), and isolated (fish of both sexes separated from marine areas by impassable barriers or distance). Anadromous Dolly Varden, the focus of subsistence fisheries in the area, live in fresh waters for approximately the first three years of life, at which time they migrate to sea in summer to feed and return to fresh water in fall to spawn and overwinter. Anadromous populations in the Inuvialuit and Gwich'in areas are known to occur in the Firth (and Joe Creek), Babbage, Big Fish, Rat and Vittrekwa rivers, and Fish Creek (draining near Komakuk Beach) (DFO 2010), however, additional populations may also be present. Stream-resident Dolly Varden co-occur with anadromous Dolly Varden in all of these rivers (DFO 2010). Isolated populations are known to occur in upstream areas (above falls) on the Babbage and Big Fish rivers. Populations of Dolly Varden occurring in upstream areas of the Arctic Red River and Peel River drainages are presumed to be non-migratory. The focus of the TEK in this report is on the Dolly Varden that are harvested (i.e., the anadromous life history type).

Dolly Varden rivers draining the north slope of the Yukon Territory are noted in much of the Inuvialuit TEK literature (Papik et al. 2003). Both Inuvialuit and Gwich'in TEK literature contain information on NWT rivers west of the Mackenzie Delta – Big Fish River and Rat River in particular. TEK information on Dolly Varden and its habitat was gained from co-management bodies, cultural institutions, industry reports and historical documents. TEK documented in both biological and anthropological literature sources is reported herein. All TEK documented was obtained from existing written material, (i.e., no additional oral information was used herein), except for a few items of TEK given orally by elders at a report verification workshop held in Inuvik in 2010. An earlier unpublished version of this report was originally produced in 2010. This updated report incorporates TEK information contained in literature produced from 2009 to 2018 for the Inuvialuit Settlement Region (ISR) only, with the exception of Benson (2010), which relates to the Gwich'in Settlement Area.

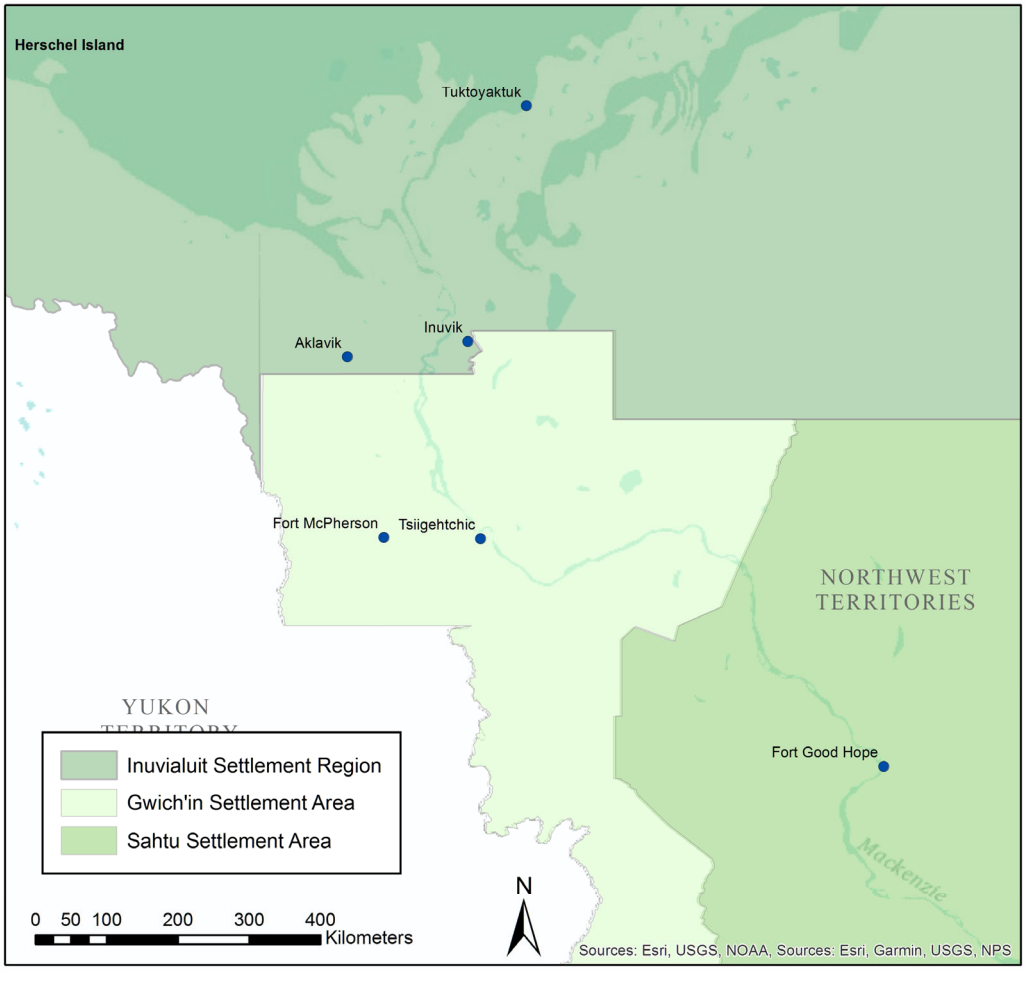

Figure 2. Locations of relevant Inuvialuit, Gwich'in and Sahtu communities.

TRADITIONAL KNOWLEDGE

According to Hartwig (2009), until at least 2008, Traditional Knowledge (TK) was *"the preferred term of the Inuvialuit in the western Arctic*" for the knowledge held by Indigenous Peoples. Current practice in

the ISR is to use the terms Traditional Knowledge and Local Knowledge. Local Knowledge is considered to be knowledge held by non-elders using contemporary observations and experiences on the land. Local Knowledge is not derived from oral transmission over generations, nor embedded in the spiritual cosmology of the Inuvialuit (C. Elliot, pers. comm., 2018). While there is no internationally accepted definition of Traditional Knowledge, the World Intellectual Property Organization defines it as: "…*knowledge, know-how, skills and practices that are developed, sustained and passed on from generation to generation within a community, often forming part of its cultural or spiritual identity*" (http://www.wipo.int/tk/en/tk/; accessed 27 November 2018). Around the world, Traditional Knowledge encompasses many areas of cultural practice and knowledge sharing including shelter construction, musical expression, writing systems, traditional healing, systems of governance and resource use. It should be noted, however, that there is a trend in Arctic political, research and resource co-management organizations to replace the term Traditional Knowledge with the term Indigenous Knowledge (Johnson et al. 2016). The Inuit Circumpolar Council of Canada, which promotes the use of science and TK together in decision-making related to research direction and policy development, uses the term Indigenous Knowledge (IK). It defines IK as:

> "*a systematic way of thinking applied to phenomena across biological, physical, cultural and spiritual systems. It includes insights based on evidence acquired through direct and long-term experiences and extensive and multigenerational observations, lessons and skills. It has developed over millennia and is still developing in a living process, including knowledge acquired today and in the future, and it is passed on from generation to generation.*" (ICC Canada website https://www.inuitcircumpolar.com/icc-activities/environment-sustainable-development/indigenous-knowledge/; accessed 09 April 2019).

TK that applies strictly to the environment, both its abiotic and biotic components, is often referred to as Traditional Ecological Knowledge (TEK). Traditional ecological knowledge has a number of facets, as described by Mailhot (1994), Neis et al. (1999), and Usher (2000). These include:

(1) knowledge about the environment itself and the natural history of organisms;
(2) knowledge about use of natural resources – the harvesting technology and practices, and resource management;
(3) morality/value judgements generally common to all members of a culture, passed down through generations, that guide peoples' attitudes to the environment and to each other; and,
(4) culturally based cosmology, that is, the processing of observations and experiential learnings into a complete knowledge and belief system melding both knowledge and spirituality.

This literature review found most information to be relevant to the first and second categories of TEK, and makes reference to various aspects of the Indigenous cosmology of relevance to the subsistence use of Dolly Varden (also referred to as Arctic Char in much of the TEK literature; note that taxonomic confusion and proper species equivalencies between northern Dolly Varden and Arctic Char and Bull Trout is clarified by Reist (1989) and Reist et al. (2002)) and fish in general. Much of Inuvialuit and Gwich'in knowledge of the abiotic environment and its wild inhabitants is inseparable from their cultures, due to a strong link between their use of the land and their philosophical constructs that make sense of it. The importance of TEK and its transmission between land users is succinctly stated by Inuvialuk Emmanuel Adam:

"*We are a people that travel, and we are a people that observe and that use the land…Our culture is to observe and go places. Pass on the information to others who you know frequent these places. It's really important*." (Bennett 2012)

METHODS

A total of 12 databases and two bibliographies were searched with over 100 information sources (documents, meeting minutes and websites) found containing information on Dolly Varden and/or its habitat as well as harvesting and preparation of the fish. No currently undocumented TEK on this subject was solicited from any of the communities. Due to time constraints, this search did not include oral histories in the collections of the Oblate missions, nor trading post managers' accounts in the Hudson's Bay Company (HBC) archives for potential sources of historic TEK on char and/or char habitats in this area. The HBC Archive houses reports from Hudson's Bay managers at 18th, 19th, and early 20th century trading posts in the lands of the Inuvialuit, Gwich'in and the Sahtu peoples. These reports document historical land and resource use of local Indigenous peoples, including inventories of fish, fur and game brought to the post. However, they do not always identify the species of fish. Thus, although a possible source of TEK information such records were not examined in the course of this work.

Databases searched in 2008, 2009 and 2018 include:

- Taiga Net: Arctic Borderlands (https://www.arcticborderlands.org/)
- Northern Gas Project Secretariat (website no longer exists)
- Arctic Science and Technology Information System (ASTIS) (http://www.aina.ucalgary.ca/astis/)
- Prince of Wales Northern Heritage Centre: archives collection and reference library (https://www.pwnhc.ca/research-publications/)
- Aurora Research Institute: permits (http://nwtresearch.com/resources/compendia-research)
- Centre for Indigenous Environmental Resources (http://www.yourcier.org/cier-publications-and-resources.html)
- Gwich'in Social and Cultural Institute (https://www.gwichin.ca/publications)
- Gwich'in Renewable Resources Board: Gwich'in Ecological Knowledge Project
- Sahtu Renewable Resources Board (http://www.srrb.nt.ca/)
- Mackenzie Valley Environmental Impact Review Board public registry (http://reviewboard.ca/registry/)
- Environmental Impact Review Board public registry (https://eirb.ca/public-registry/)
- Wildlife Management Advisory Council (North Slope) website (https://wmacns.ca/resources/)
- Inuvialuit Community Knowledge Keeper (https://inuvialuit.knowledgekeeper.ca/placenames-map)

Libraries searched (online and in person between 2008 and 2009) include:

- DFO (WAVES catalogue ; part of the Federal Science Library) (https://science-libraries.canada.ca/eng/fisheries-oceans/)
- University of Manitoba libraries (http://umanitoba.ca/libraries/)
- University of Winnipeg library (http://mercury.uwinnipeg.ca)
- Circumpolar Institute (University of Alberta online catalogue) (https://www.library.ualberta.ca/)
- University of Calgary (online catalogue) (http://library.ucalgary.ca)

- NWT Public Library Services (all libraries within NWT) (http://www.nwtpls.gov.nt.ca/)
- Joint Secretariat – Inuvik
- Gwich'in Renewable Resources Board – Inuvik
- Aurora Research Institute

Keywords used in searches include the following: Dolly Varden, char, trout, traditional knowledge, and fishing.

On-site visits were made to the following organizations in Yellowknife (Yk), Inuvik (In) and Aklavik (Ak):

- Prince of Wales Museum (Yk)
- Gwich'in Social & Cultural Institute (In)
- Gwich'in Renewable Resources Board (In)
- Inuvialuit Cultural Resource Centre (In)
- Joint Secretariat (In)
- Aklavik Hunters & Trappers Committee (Ak)
- Aklavik Renewable Resources Board (Ak)
- Mackenzie Valley Environmental Impact Review Board (Yk)

In discussions in 2009 with Jody Snortland Pellissey (former Sahtu Renewable Resources Board Executive Director), the Renewable Resources councils of Norman Wells and Fort Good Hope, and a university researcher investigating Fort Good Hope TK (Dr. Deborah Simmons, University of Manitoba), it was determined that in the Sahtu Settlement Area there have been no TEK studies ever done dedicated to Dolly Varden, Bull Trout or fishing in general. Thus, a visit to Sahtu communities did not occur.

The local English common names for a fish species are indicated within quotation marks, and place names and words in Indigenous languages are in bold print. Valid scientific names and English common names are provided in standardized accepted format. For example, Arctic Cisco, *Coregonus autumnalis*, is locally termed "herring" and is caught at Shingle Point (**Tapqaq**). Direct quotes within the text are italicized. Where relevant, interpretive comments are inserted by the authors of this report – these are indicated as such by being enclosed with square brackets, i.e., [ ].

The information from the original draft report of this literature review was presented to a group of Inuvialuit and Gwich'in elders knowledgeable about Dolly Varden and fishing in general. This TEK verification workshop (DVTK) took place in Inuvik, NWT on April 12–13, 2010 and will hereafter be referred to as DVTK Verification Workshop 2010. Elders from Aklavik, Inuvik, Fort McPherson and Tsiigehtchic participated. The elders were given the opportunity to assess the accuracy of the information as presented. This report contains TEK from their communities as documented by several literature sources, and as such, they had an interest in ensuring the accuracy of that TEK in this report. The elders did not hesitate to challenge any information that did not seem correct or required clarification to make sense. Consequently, there was much constructive discussion by the participants on the following topics:

- historical fish use, fishing techniques and equipment;
- harvest sites;
- temporal trends in harvest;

- Dolly Varden migrations;
- spawning locations and their physical properties;
- predators and natural mortality;
- traditional fish management techniques; and
- changes to Dolly Varden habitats (rivers and coastal areas) and possible causes.

Also, the spelling of certain Inuvuialuktun and Gwich'in words and place names was corrected. Part of the need for these corrections is that the orthography (i.e., the structure and spelling conventions of words) of Inuvialuktun and Gwich'in words has changed over the decades.

It is important to note that there are a few instances of tributaries having the same place names in different watersheds, such as Fish Creek. This points to the need for not only readers of this report but also northern fisheries scientists, stock managers and academics working in the field to know the local Indigenous language names for water bodies. This can avoid confusion when discussing and reporting on different lakes and waterways having the same English names.

COMMUNITIES

There are four primary communities in the NWT that harvest Dolly Varden, while another two have harvested it incidentally when fishing for other species (Figure 2). Historically, harvesting of this species on the Beaufort Sea coast was also done at a whaling community on Herschel Island in the early part of the 20th century. This island community no longer exists due to the demise of the whaling industry, its inhabitants moving to the Mackenzie Delta. However, a few Inuvialuit families still travel there in summer to fish.

- Aklavik ("place of the grizzly bear") is a Mackenzie Delta community of 635, 90% of whom are Inuvialuit and Ehdiitat Gwich'in residents. These two Indigenous Peoples share the same fish resource. It is located on the Peel River channel of the Mackenzie River on the west side of the Mackenzie Delta. Aklavik was established in 1912 as a fur trading centre, with people trapping muskrat in the Mackenzie Delta. After a population decline in the late 1950s with emigration to the new town of Inuvik, its population has increased at a slow rate beginning in 1961 with a further period of decline in 1977–1981. Aklavik's population has increased slowly since then, with an average of only 1% annual increase from 1982 through 1992 (Byers 1993) and 0.6% in the last 10 years of population statistics ending in 2017. Sixty percent of Aklavik residents 15 years of age and older report that they hunt and/or fish (NWT Bureau of Statistics 2017).

- Inuvik ("place of man") is an administrative, business and government centre. It is a relatively young town, coming into existence in 1958 on the East Channel of the Mackenzie River. Many Aklavik people moved there as Aklavik was often subject to flooding. It is home to about 1,300 Inuvialuit (40% of population) and over 600 First Nations (20% – mostly Nihtat Gwich'in) people. Forty-five percent of residents (equal to the NWT territorial average) report that they hunt and/or fish.

- Fort McPherson (**Teetł'it Zheh** = "place where Teetł'it Gwich'in lived") is a town of 776 people, located on the lower Peel River. Over 85% of the community are Gwich'in, the largest Gwich'in population in the region. It was originally a trading post established by the Hudson's Bay Company in 1840 to trade directly with Inuvialuit rather than using the Gwichya Gwich'in (who now reside largely in the community of Tsiigehtchic) as intermediaries between the Inuvialuit and the trading companies. Since the 1950s, the Teetł'it Gwich'in ("Gwich'in who live at the headwaters [upper Peel drainage]") have spent more of their time in the permanent settlement

of Fort McPherson. There are family camps upstream on the Peel River, between Fort McPherson south to the Yukon border (Parlee 2006). Over half (54%) of the residents report that they hunt and/or fish.

- The site of **Tsiigehtchic**, meaning “mouth of the Iron River”, was originally a fish camp. Archaeological evidence shows the immediate area to have been used continuously in summer and fall for at least 1,300 years (Nolin and Pilon 1994). In 1868 a Roman Catholic mission was established there followed by a trading post. Families who had wintered upstream on the Arctic Red River or the Mackenzie River around the Travaillant Lake or the Tree River areas, would travel to the Mackenzie Delta (**Eedyee tat**) with a brief stop in Tsiigehtchic in the spring to attend Easter mass, visit with friends and relatives, and buy supplies. They would then head to the Delta by dogteam for muskrat trapping. In early summer after trapping season, they went to Tsiigehtchic or Aklavik to sell their furs and replenish their supplies and then began fishing along the Mackenzie River or at **Nichiitsii diniinlee** (Big Rock) in the East Branch to get their winter supply of fish (Kritsch and Andre 1994). Today, less than 200 people reside in the town, over 80% of whom are Gwich’in. Sixty-three percent of the residents report that they hunt and/or fish.
- Fort Good Hope (**Radili Ko** = “rapids”, referring to nearby rapids on the Mackenzie River) was established in 1805 at the mouth of Blue Fish Creek near present day Tulita, but was moved to its present site in 1839 (Innis 1962). It sits on a peninsula separating Jackfish Creek and the east bank of the Mackenzie River. More than 570 people live there, of whom over 80% are North Slavey. Forty-four percent of the residents report that they hunt and/or fish.
- **Tulita** (= "where the rivers/waters meet"), with a population of 500, is located at the junction of the Great Bear and Mackenzie rivers. Like the people of Fort Good Hope, Tulita people have traditionally hunted and fished in the mountains west of the Mackenzie River. Fifty-seven percent of the residents report that they hunt and/or fish.

TEK gathered from Aklavik, Inuvik, Fort McPherson and Tsiigehtchic (west side of Mackenzie River) most likely refers to Dolly Varden, whereas that collected from Fort Good Hope and Tulita most likely refers to Bull Trout (see Introduction).

The ISR covers over 225,000 square kilometers in the northwesternmost corner of the NWT. Its southern limits cover the YNS and the Mackenzie Delta, including the Beaufort Sea and Amundsen Gulf. The main Inuvialuktun dialect spoken in the communities that harvest Dolly Varden is Uummarmiutun, with some Siglitun speakers as well.

The Gwich’in Settlement Area (GSA) covers 57,000 square kilometers in the NWT which includes the lower Mackenzie River, part of the Peel River, and the Arctic Red River watershed (Wishart et al. 2000). Gwich’in dialects in the GSA are Teetł’it, spoken in Aklavik, Inuvik and Fort McPherson, and Gwichya, primarily spoken in Tsiigehtchic, although a few speak it in Aklavik and Inuvik.

The Sahtu Settlement Area (SSA) covers 283,000 square kilometers south of the GSA. Its Indigenous population is mainly Sahtu Dene and people speak the North Slavey language.

HISTORICAL CONTEXT

Ancestors of contemporary Inuvialuit arrived at Herschel Island from Alaska approximately 800 years ago. This island has the longest record of Inuvialuit occupancy in the entire Canadian western Arctic.

Archaeological excavations of houses at Pauline Cove and Avadlek Spit reveal that char made up a significant proportion of fish harvests since at least the 1500s. Fishing was an important subsistence activity on Herschel Island since at least the 18th century (Friesen 2012).

In 1799, Europeans first made contact with Siglit (ancestors of the Inuvialuit) living in the Mackenzie Delta area. At that time they were the largest and richest of all Canadian Inuit groups, numbering between 2,500 and 4,000 (Morrison 1988). The arrival of American whalers to the Canadian Beaufort Sea in 1888 also brought the decimation of local caribou herds. Alaskan Inupiat were hired by the whalers to provide meat for the whaling ships. The successful provisioning of the whalers meant the Mackenzie Inuvialuit had to rely on fish for the bulk of their diet as the previously abundant caribou became scarce. Stefansson (1922) reported that by 1906, Inuvialuit were subsisting almost entirely on fish. Prior to the 1930s, char fishing was concentrated on the Beaufort Sea coast between the Alaska border and the Mackenzie Delta, as that is where all the Inuvialuit lived. They also made use of a reliable source of char (Dolly Varden) found every fall in a tributary of the Big Fish River about 50 km west of present-day Aklavik. This was an especially important food source when caribou had left the area and returned to overwintering areas. With the closing of coastal RCMP and trading posts as well as a new focus on muskrat trapping due to increased fur prices, most people had moved inland to the Mackenzie Delta, settling in Aklavik in the 1940s and Inuvik a decade later. Arnold et al. (2011) provide a good overview of that time period combining both academic history and Inuviauit oral history.

Aklavik people fished more in the mountain rivers and much less on the coast. It was not until the 1980s and early '90s that people from the Mackenzie Delta (no more than 15 families) began harvesting fish from the sea again (Byers 1993; Papik et al. 2003). Dolly Varden typically occupy mountain rivers west of the Mackenzie River and also utilize the western channels of the delta and coastal areas west of the delta as migratory routes and feeding areas, respectively. Accordingly, fishers in such areas focus to a large degree upon Dolly Varden as well as coregonines and other species present in the area.

Two elders born in the 1930s told Freeman and Stevenson (1995) that there were over 200 fish camps, with thousands of dogs, spread about 10 km apart all over the Mackenzie Delta. In the 1960s, as travel technology evolved from dog teams to snowmobiles, fish were harvested mostly for human consumption as a large volume of fish for the dogs was no longer needed (Papik et al. 2003). However, that may not have played a role in temporal trends in Dolly Varden harvest as this species was generally not used for dog food. Exceptions were when individual fish were deemed unhealthy or otherwise considered unpalatable, and when a travelling fisher did not have enough caribou or other fish available. On the Firth River prior to the 1950s, dogs were fed char as there were no other fresh fish available except for grayling (i.e., Arctic Grayling, *Thymallus arcticus*) (D. Arey, pers. comm., DVTK Verification Workshop 2010).

History of Gwich'in of the NWT

The pre-contact Gwich'in population is estimated at 1,200 to 2,700 (Krech 1978). Based on a Hudson's Bay Company census of 1858, Osgood (1936) estimated the Gwich'in population at contact time was approximately 1,200. The Mackenzie Delta is filled with Gwich'in place names, testament to the historical use and importance of the Delta to Gwich'in.

Historically, although the species of fish harvested during annual cycles of land use are not documented, it is very likely that Dolly Varden figured prominently during late summer and early winter

harvests throughout the Gwich'in land use area. Particular focus of harvests would have been upon the late summer/early autumn upstream return migration of sea-run Dolly Varden through the Mackenzie Delta and lower reaches of the various rivers along the western side of the Mackenzie Basin.

At the time of European contact the "Peel River people", the Teetł'it Gwich'in, spent most of the winter months hunting caribou in the mountains of the upper Peel drainage (particularly the Richardson and Ogilvie mountain ranges). During early spring the band gathered at **Khatainlaii ehdi**, located near the mouth of the Bonnet Plume River and constructed skin boats which, after the break-up of ice, they used to descend the Peel (**Teetł'it gwinjik**) to an area near Road River (Slobodin 1962; Ritter 1976). During the summer months the people fished, using traditional traps made of willow, at various places along the Peel River. Isbister (1845), an employee of the Hudson's Bay Company, provides an early first-hand account of one of these fish trap sites about 25 km upstream from the Rat River inflow where the river constricts at the first rapids above the Rat River junction. Gwich'in were catching an anadromous species there during summer which may have been Dolly Varden. Accounts of fish harvests by early explorers or non-indigenous persons typically referred to any char species as 'trout'.

As time passed, members of the band began to visit the trading post at Fort Good Hope more regularly during the summers and many families began to fish at points further upstream than had been their custom (Slobodin 1962). Gwichya Gwich'in and people of Fort Good Hope maintain close connections to this day (A. Thompson, pers. comm., 2009).

During the Klondike Gold Rush of 1898, Teetł'it Gwich'in moved their land-based activity to the upper Peel. They guided southern prospectors travelling through the mountain passes of the Rat River area (**Ddhah Zhìt Han**) and sold meat to the prospecting camps (Ritter 1976). Gwich'in often stayed in **Ddhah Zhìt Han** for Christmas (Benson 2010).

By approximately 1912 Gwich'in once again shifted their centre of activity back to the lower Peel River region. Winter hunting took place in the area of the Northern Richardson Mountains; trips to the upper Peel drainage and upper Mackenzie River became less frequent (Ritter 1976). It is said that fishing in the area of Fort Good Hope was not as productive back then as it is today and Gwichya Gwich'in chose to fish in the Tsiighetchic area in summer (John Norbert, pers. comm., DVTK Verification Workshop 2010). For two decades beginning in the 1920s, high fur prices drove many Gwich'in to travel to the Delta to trap muskrats, a harvest that was not previously conducted. During WWII (1939-1945), trapping activity moved to the mountains to take advantage of sharply rising prices for marten fur. By 1946 the people had returned to the lower Peel River and Mackenzie Delta, their main harvesting area to this day, although even within the last quarter of the 20th century, a few family groups spent a part of the winter months trapping in the upper Peel River drainage (Ritter 1976; Heine et al. 2007).

SPECIAL SIGNIFICANCE OF NORTHERN FORM DOLLY VARDEN

Dolly Varden has been rated highly in the food preferences of Aklavik people for at least the past three decades. Freeman et al. (1992) found that adults in Aklavik rated char in the top three preferred food species of 21 different local plant and animal food species. This appears to still be the case today (Brewster et al. 2016). McGill University and the federal Department of Health and Welfare nutrient data as reported by Freeman et al. (1992) showed that among eight northern animal species commonly eaten by Gwich'in and Inuvialuit, Arctic Char [which may refer to both Dolly Varden and Arctic Char] is one of the leading sources of thiamin (an important B-vitamin) and calcium, and is second only to sea

mammal blubber in providing Omega-3 polyunsaturated fats which provide valuable protection from heart disease and arteriosclerosis.

In addition to nutritional value of Dolly Varden, there are economic and cultural benefits. The socio-economic value of fishing at Shallow Bay and Shoalwater Bay on the Beaufort Sea coast has been rated as high (Kavik-Axys Inc. 2003).

Dolly Varden harvesting also played a role historically in the survival of Inuvialuit ancestors from Alaska (Inupiat) who began colonizing the Mackenzie Delta and estuary in the late-19th and early 20th centuries. It was a staple in their diet when caribou were scarce or absent.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The government of the NWT considers Dolly Varden a sensitive species under its General Status Ranks of Wild Species in the NWT (GNWT-RWED 2004; GNWT-ENR 2016), while COSEWIC classified it in 2010 as a species of Special Concern and in 2017 it was listed as Special Concern under the Federal *Species at Risk Act*.

Inuvialuit believe that all coastal fishing zones in the Beaufort Sea need protection (Papik et al. 2003). Dolly Varden habitat in the westernmost watersheds (Fish Creek, Malcolm, Firth and Babbage rivers) is protected within Ivvavik National Park. Babbage River forms the eastern border of Ivvavik National Park. The Babbage River watershed in the park and 1 km east of the river, including the Canoe River, as well as the Firth River watershed, are designated as Management Category D (Site No. 721D) by the Aklavik Inuvialuit Community Conservation Plan (Aklavik HTC et al. 2016). This designation identifies the lands and waters where renewable resources are of particular significance and sensitivity throughout the year. The entire coastal zone of the Yukon North Slope from the Alaska border to Shingle Point (Site No. 726E) is designated as Category E protected area. Aklavik's Conservation Plan states (p. 21) Category "E" lands are *"Land and waters where culture or renewable resources are of extreme significance and sensitivity. There shall be no development on these areas. These lands and waters shall be managed to eliminate, to the greatest extent possible, potential damage and disruption. This category recommends the highest degree of protection in this document."* Under both Aklavik's Plan and the Gwich'in Land Use Plan (Gwich'in Land Use Planning Board 2003), the riparian areas of the Big Fish River and the Fish Hole are protected from development. Aklavik's Plan identifies Fish Hole/Little Fish Creek and Big Fish River (Site No. 720DE), as well as the Mackenzie Bay/Shallow Bay area from Shingle Point east (Site No. 716CE), as also requiring the highest level of protection from development (Overlapping Lands of Territorial, National, and International Conservation Interest).

The Gwich'in Land Use Plans (Zone 10) also designate the Husky Channel-Rat River system, including the Fish Creek tributary, for protection from development based on its cultural heritage and biodiversity. Its primary importance is in providing spawning, rearing and migration habitat for Dolly Varden as well as a harvest area where fish, furbearers, caribou and Dall's sheep are obtained (Gwich'in Land Use Planning Board 2003).

The Gwich'in Land Use Plans also list the James Creek/Vittrekwa River region which is bisected by the Dempster Highway, as in need of legislative protection. Important reasons for protection from development include:

- spawning and nursery area for Dolly Varden charr on the Vittrekwa River; and

- a source of drinking water for people from Fort McPherson and Tsiigehtchic.

Inuvialuit and Gwich'in have been supportive of the fishery management initiatives of their local management bodies – Fisheries Joint Management Committee (FJMC), Gwich'in Renewable Resources Board (GRRB), Aklavik Hunters & Trappers Committee, and Renewable Resources councils of Aklavik and Fort McPherson. These initiatives have included fish net restrictions and closure of the Big Fish River (by DFO under the *Fisheries Act*) and Rat River (voluntary) overwintering sites to fishing. Inuvialuit have also specifically recommended that spawning Dolly Varden not be harvested (Papik et al. 2003; Benson 2010). Closure of the Big Fish River was initiated in 1987 and extended along the entire river from the spawning grounds at "Fish Hole" downriver to the river mouth in the Mackenzie Delta. A DFO Variation Order allowed fishing at the mouth of the Big Fish River in August of 2012 and 2013, and from 2014 to 2016 a DFO Aboriginal Communal Fishing Licence permitted fishing at the Fish Hole under specific conditions (e.g., harvest limit, methods) and specific sites.

An initiative of the FJMC, the West Side Working Group (WSWG) was established in 2001 to advise on fisheries management of rivers west of the Mackenzie River to the Alaska border. It is charged with developing management plans for the Dolly Varden stocks. Both science and TEK are used as Indigenous harvesters, co-management boards and DFO all sit on the WSWG. Since 2013, both science and TEK indicators of Dolly Varden stock health are being developed by the WSWG. These indicators will be used in developing Recommended Annual Harvest (RAH) levels for the Big Fish River. Indicators based on science are assessed with equal weight to those based on TEK, although an indicator that has greater sensitivity to change will be assessed with greater weight than will a less sensitive one, regardless if it is a science or a TEK developed indicator (WSWG 2018).

Similar to the WSWG, the Rat River Working Group (RRWG), established in 1995, deals with Dolly Varden management of the Rat River stock with input from Gwich'in communities. It recommended a voluntary closure of Rat River to Dolly Varden fishing from 2006 through 2008 along with net restrictions that community RRCs (Renewable Resource Councils) and HTCs (Hunter-Trapper Committees) were free to enact bylaws to enforce. (Rat River Char Fishing Plan: 2010-2013). The RRWG meets once per year in late winter to review results of scientific research and monitoring from the previous summer as well as Traditional Knowledge. Informed by these information sources along with community input, the RRWG recommends voluntary sustainable harvest levels for the Rat River stock (GRRB Spring 2017 newsletter).

The WSWG and the RRWG contribute to the ongoing development of the Integrated Fisheries Management Plan (IFMP) for Dolly Varden led by Fisheries and Oceans Canada (Fisheries Management), which informs the co-management of the species in the Big Fish, Babbage, Firth, Rat, Vittrekwa and other rivers of the area. Aside from DFO, signatories of the IFMP are the GRRB, FJMC, and Parks Canada Agency.

Under the IFMP, a key component of fishing plans for individual stocks is comprehensive annual harvest enumeration monitoring. This is important to provide accurate catch data and other information that may indicate whether positive or negative changes are occurring in Dolly Varden stocks and the harvests depending on them. Community harvest monitors collect information on numbers of harvesters, numbers of fish they caught and their fishing effort as well as fish size, sex and maturity.

A weakness of harvest enumeration studies is that they are subject to bias that may underestimate a community's true total harvest. During the 1987-96 period of the Inuvialuit Harvest Study, some harvesters declined to be interviewed or otherwise participate in the harvest study. In some instances it

is believed that some of those were among the most active harvesters whose individual harvest of a target species would constitute a significant portion of the overall community total. Harvesters refusing to participate was determined to be a very small percentage of all harvesters approached during the 10-year study period, Non-response bias was determined to have likely occurred during the study, although it is not entirely quantifiable. While it is not reported whether Dolly Varden harvests specifically were subject to non-response bias, it can be surmised from the 10-year summary that enthusiasm for Dolly Varden reporting among Aklavik fishers was highest in the first two study years, assuming active fishers on the coast remained constant during the closure of the Big Fish River. During the first two years the number of participating fishers was above the 10-year mean of 14 (highest in the first year at 21), while the number of participants in five of the following eight years was below the mean (lowest in 1991 at 9 fishers) (Joint Secretariat 2003).

One factor that can explain non-response bias, particularly in long-running studies over consecutive years, is interviewer fatigue. This was likely experienced in both the Inuvialuit and the Gwich'in harvest studies. The final report of the 10-year Gwich-in Harvest Study noted that the final three years suffered from a significantly low harvester response rate (GRRB 2009b).

In recall studies such as these, determining exact harvest numbers of fish can be more challenging than for harvested species of land animals due to the often much higher numbers of fish caught (GRRB 2009b). Some fishers may not be in the habit of tallying the total number of fish they catch each day, although that is presumably encouraged by the community researchers/monitors. Therefore, monthly interviews in which surveyed fishers must try to remember how many fish of each species they caught may not always result in recording a precise number of Dolly Varden for these particular fishers.

It is beyond the scope of this literature review to assess methodologies of the harvest studies in the ISR and the GSA. It is advisable, however, to keep the above noted harvest enumeration challenges in mind when examining the Dolly Varden harvest numbers summarized in Appendix B. Readers who are interested in learning more on this subject are encouraged to read the 10-year harvest summaries produced by the Joint Secretariat (2003) and the GRRB (2009b) which detail the methods used.

MORPHOLOGICAL DESCRIPTION OF DOLLY VARDEN (Figure 3 a–d)

Char are called **iqaluaqpik**, pronounced « ika-looak-pik » in the Inuvialuktun Siglit dialect of Sachs Harbour and Holman, or **qalukpik** « ka-look-pik » in the Ummarmiut dialect of the Mackenzie Delta Inuvialuit (Harwood et al. 2012). The char caught at Herschel Island a century ago were described by Stefansson (1913:453) as "*back dull grayish green, sides pale silvery green, with numerous round, pale pink spots, and belly silvery white*." That was the most common type, with another described as having "*back very dark olive, almost black, with very faint, small, obscure, pinkish spots, some irregular, some comma-shaped…sides bright olive-green, with brilliant vermillion spots; belly bright vermillion, sometimes inclined to crimson, slightly pale along median line, and fading to salmon color on breast and throat; pectoral and ventral fins with anterior border white. Females were duller colored, belly pink or rosy, sometimes with a yellowish tint, and the lower jaws were less strongly hooked*." He found most of the char were spawning on Sept. 11, 1908. [These two descriptions likely refer to non- or pre-spawning Dolly Varden and spawning Dolly Varden, respectively].

Gwich'in describe Dolly Varden (**dhik'ii** – pronounced « thik ee' ») as growing up to 15 pounds (7 kg), although fishers no longer catch **dhik'ii** of that size. Since at least 1995, 10 to 12 pounds has been considered a big **dhik'ii** (Harwood et al. 2009; DVTK Verification Workshop 2010). Their colouring is bluish-gray dorsally, silver ventrally, with small freckle-like pinkish spots on the flanks. They change colour when at or near to the spawning grounds, becoming greenish dorsally, and pink, gold or red

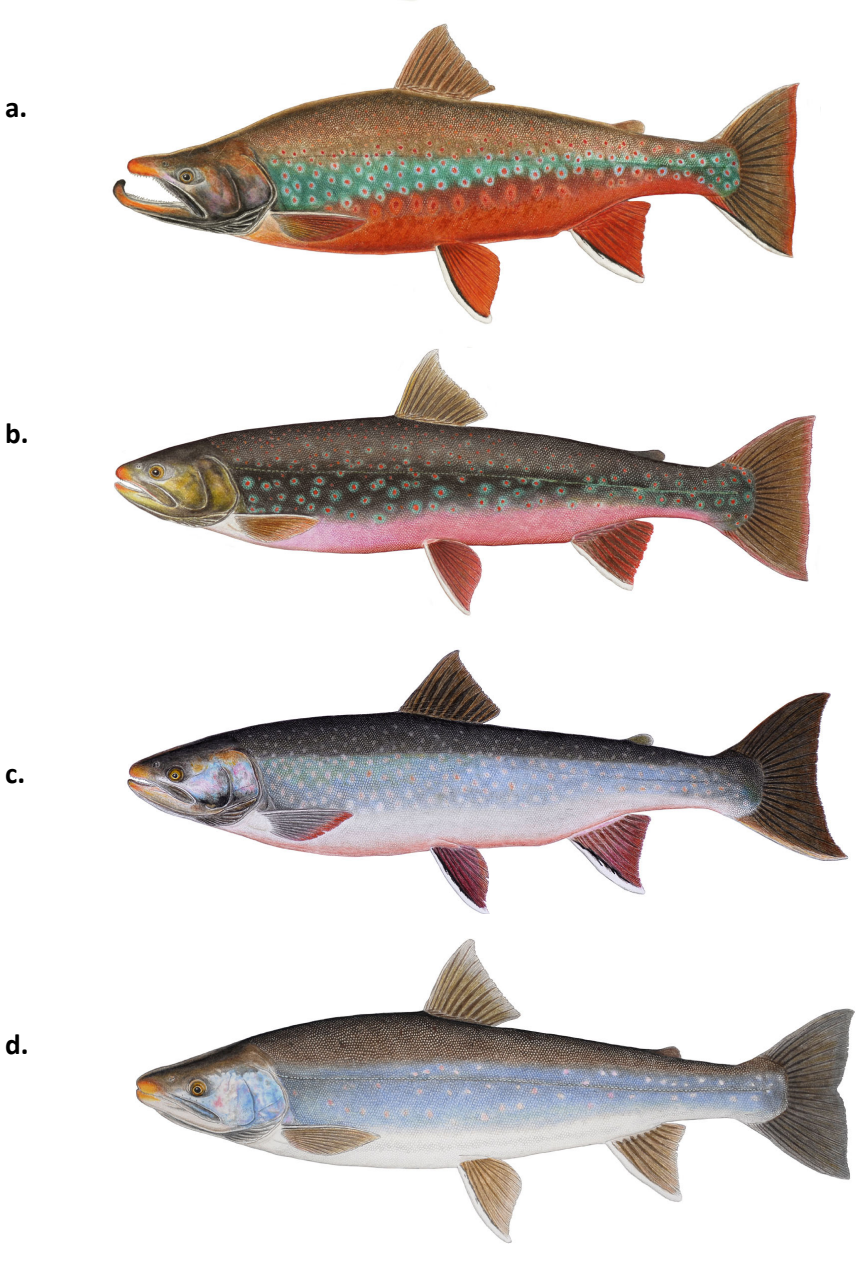

Figure 3. a) Male Dolly Varden in spawning colouration sampled from the Firth River, Ivvavik National Park, Yukon Territory. **b)** Female Dolly Varden in spawning colouration sampled from the Firth River, Ivvavik National Park, Yukon Territory. **c)** Male Dolly Varden in non-spawning colouration sampled from Babbage Falls, Babbage River, Yukon North Slope. **d)** Female possible Dolly Varden in non-spawning colouration sampled from the Tree River, Nunavut (non-spawning females from the Yukon North Slope are morphologically similar). Illustrations by Dr. Paul Vecsei for Dr. Jim Reist, Fisheries and Oceans Canada.

ventrally. The males (**dhik'ii dinjii**) develop an upturned hook at the tip of the lower jaw (reference to it being the upper jaw is likely an error in GRRB and Gwich'in Elders (1997:162)) and are usually larger than females (**dhik'ii tr'ik**). Dolly Varden have red meat, not the pale meat of other fish species (GRRB and Gwich'in Elders 1997). Their bones are softer than those of Lake Trout [*Salvelinus namaycush*] (Simon 1996).

Dolly Varden change colour when moving between fresh water and salt water (DVTK Verification Workshop 2010). During the migration run prior to arriving at the spawning creeks, the sexes can be distinguished by most fishers only after being opened up. However, a few elders have reported certain morphological differences:

> "*Well, the male is [a] little darker than the female...the female they got little tongue, you see quite a difference you know*." (A. Semple 1996:2).

MIGRATION, SPAWNING AND POST-SPAWNING DISPERSAL

Following summer feeding along the coastal areas and perhaps also offshore on the shelf west of the Mackenzie Delta, Dolly Varden that make their way to the Delta start running eastward through brackish water along the Beaufort Sea coast in July. Prior to the migration from the westernmost Yukon coast, juveniles congregate in protected bays, coves and stream mouths of Herschel Island (Harwood et al. 2012). Dolly Varden caught at Shingle Point are believed to be heading to Big Fish River or Rat River (Byers 1993). Norton (1997) reported that fishers believe that the larger Dolly Varden run when winds are strong, but smaller ones are impeded from travelling through rough coastal waters and may delay migration until the wind abates. However, this point is disputed by elders today who cannot conceive of a way to determine this without setting nets, and nets are never set or left in during strong winds (DVTK Verification Workshop 2010).

In the most recent TEK study, some Inuvialuit observed earlier-than-normal coastal migration (WMAC[NS] and Aklavik HTC 2018a). It is not clear from the reporting when this change in migration timing began but warming seawater is believed to cause cold-water loving char to migrate earlier in the season to avoid passing through warmer seawater later (Brewster et al. 2016).

When they reach the Mackenzie Delta over the last two weeks of July, Dolly Varden begin swimming upstream towards the Big Fish River and Rat River (Figures 5 and 6). A more recent TEK study pegged the first migrating fish entering the rivers from the ocean as occurring at the end of August for all Dolly Varden rivers (WMAC[NS] and Aklavik HTC 2018a: 39):

> "*Thirteen individuals described rivers bearing Dolly Varden char, noting that migration* ***typically began at the end of August*** [emphasis added]***,*** *with Dolly Varden char reaching their spawning grounds later in the fall*."

But this may reflect a confusion in report wording, at least for the Mackenzie river channels. This start of migration most likely refers to when Aklavik fishers net the leading migrants that reach their fishing sites further upriver, rather than when the fish first enter the river system from Mackenzie Bay (B. Archie, pers. comm., 2018). The Mackenzie Delta run reaches Aklavik by the first week of August and then arrives at the mouth of Rat River about a week later (Rat River community fish monitors begin fishing in the first week of August), although they have been seen running in both Big Fish and Rat

rivers in some years as early as July. They will not migrate through murky water in the Big Fish River (Byers 1993). Normally, the migration run is complete in Rat River by mid-September to the end of September at the latest (Osgood 1936; Benson 2010). From 2000 to 2008 a majority of Inuvialuit fishers reported the timing of the Dolly Varden upstream run did not change from that normally expected, with the only deviation being in the direction of later-than-normal runs in 2000 and 2002 (ABEKS 2011).

Most Gwich'in informants say that when the water gets colder, the char run. One of the community fish monitors said this happens when it gets to be around 10 to 13°C. Water temperature and water levels probably trigger migration through the Delta. Water clarity is another indicator (Byers 1993; DVTK Verification Workshop 2010). Gwich'in elders in Fort McPherson say when the leaves start to turn yellow it means that char are coming up the Rat River (Benson 2010). Dolly Varden movements are also affected by ice. They move inland upstream usually when there is no ice; but if rivers are ice-covered when they reach the river mouths they will run beneath the ice.

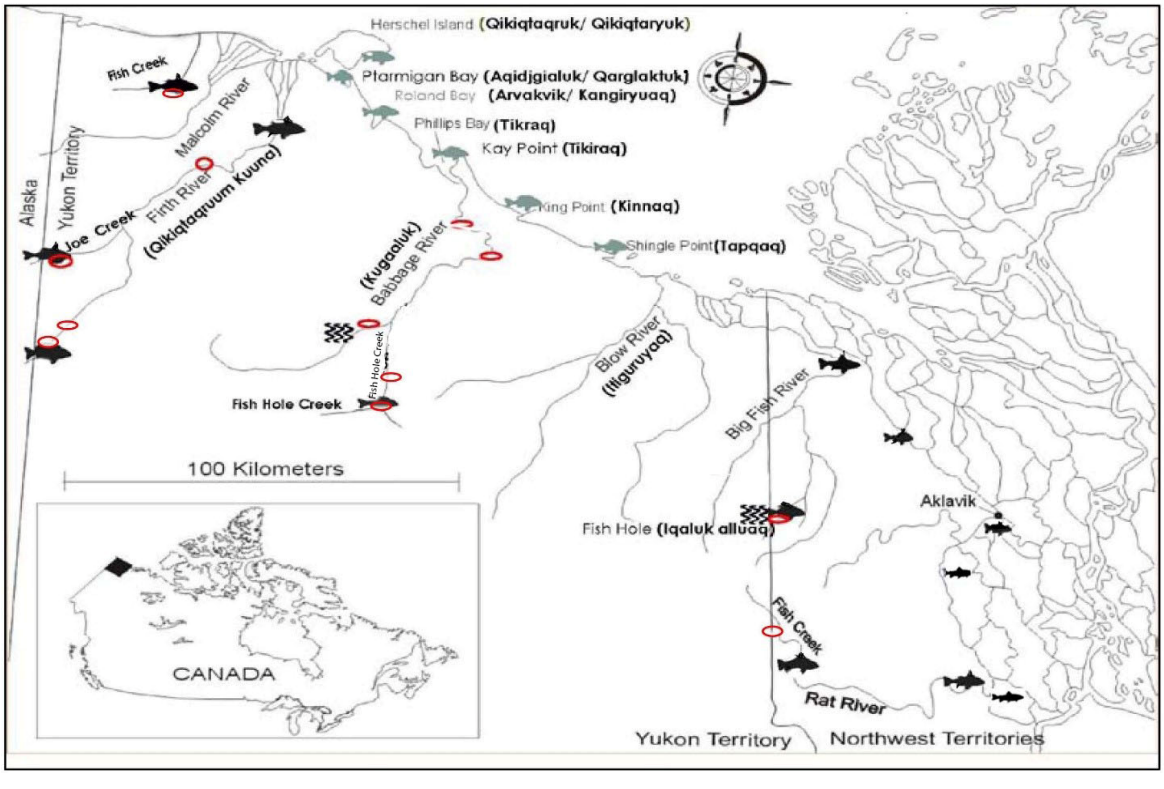

Figure 4. Dolly Varden fishing sites (fish symbols) on the Beaufort Sea coast, North Slope rivers and in Husky Channel and Rat River, with Inuvialuktun names (after Papik et al. 2003 and Sandstrom et al. 2009). Red ovals on rivers designate spawning sites. The hatched-line locations designate waterfalls. Black fish icons denote harvest sites at inland waterways; paler fish icons denote coastal harvest sites. The Vittrekwa River south of Rat River is not shown.

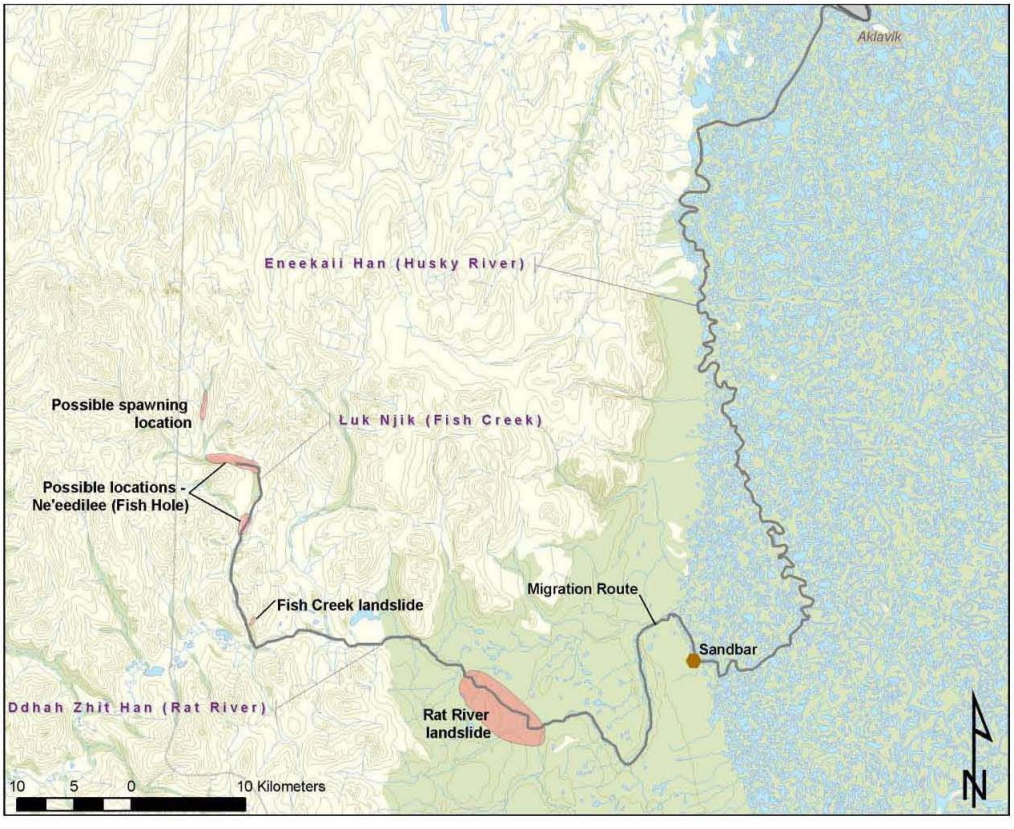

Figure 5. Dolly Varden migration route to Rat River spawning grounds, with locations of major landslides on the Rat River (reproduced from Benson (2010) with permission from the author and Gwich'in Social & Cultural Institute).

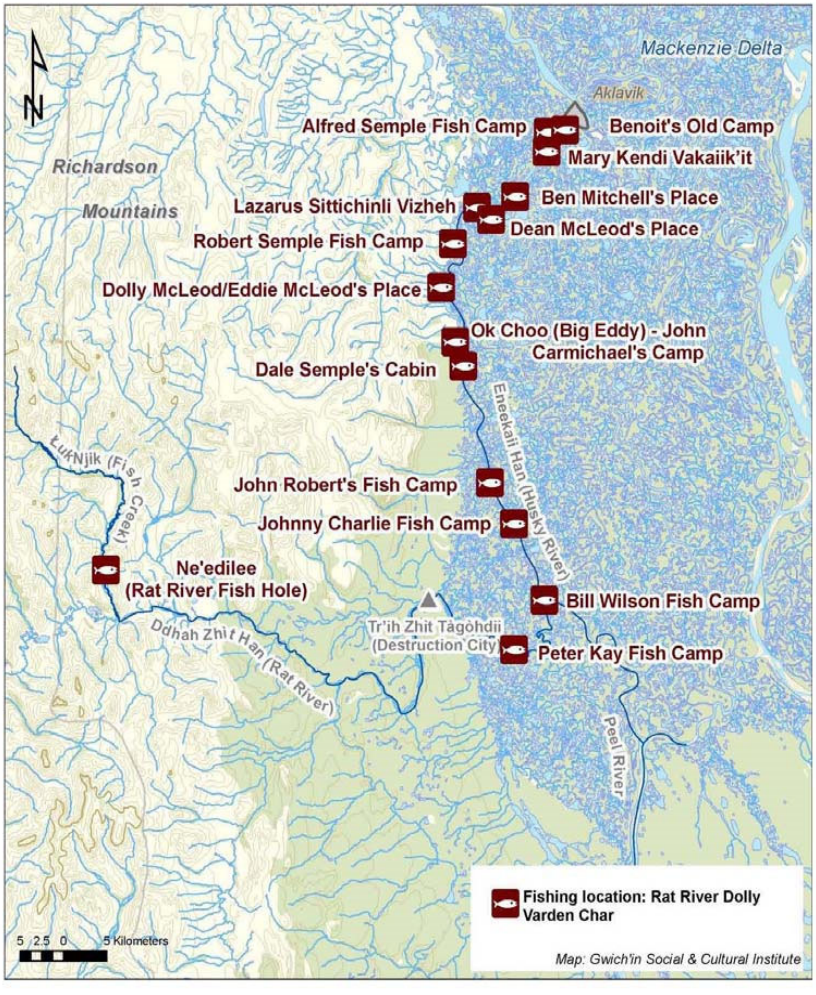

Figure 6. Harvest sites for Dolly Varden near the Mackenzie Delta (reproduced from Benson (2010) with permission from the author and Gwich'in Social & Cultural Institute).

According to Teetł'it Gwich'in, Dolly Varden show fidelity to the watersheds in which they were hatched. However, a catastrophic change in migration corridors can alter their migration habitat as was observed when a landslide washed into a section of the Rat River (Benson 2010).

Dolly Varden run upstream mostly at night; evidence of this is the larger catches in early morning net checks than during the rest of the day. This is true both on the coast and in the rivers (DVTK Verification Workshop 2010).

Females migrate upstream first, followed by a more concentrated run of males and immatures for the last one or two weeks of the migration in late August or early September. It is in the last portion of the migration run that people catch the largest fish (DVTK Verification Workshop 2010). Dolly Varden normally arrive in the vicinity of Aklavik by the first week of August and take one to two weeks to get from Aklavik to the mouth of the Rat River. Juveniles between 6 and 10 inches (15–25 cm) long are occasionally caught in shallow pools in Husky Channel and Rat River at the end of August, and are

also seen in the fall at the “Fish Hole”[1] (**Ne’eedilee**) in Fish Creek (**Łuk njik**) (J. Carmichael and A. Peterson as reported in Benson 2010). Dolly Varden travel the Mackenzie Delta (West Channel and Husky Channel) and Rat River from eddy to eddy to rest on the long upstream route to their spawning grounds. Consequently, Gwich’in set their nets at eddies, although it is also known that nets set in the main current in Rat River yield higher catch-per-unit-effort (CPUE) for Dolly Varden than those set in an eddy (GRRB and Gwich’in Elders 1997). However, nets set in the main current run the risk of picking up more debris and need to be pulled and cleaned out more often (DVTK Verification Workshop 2010). Dolly Varden go upstream in the Peel basin at least as far as the Vittrekwa River. [Dolly Varden occur in upstream areas of the Peel River basin, but these populations appear to be non-migratory].

It is speculated that the largest Dolly Varden arrive at **Ne’eedilee** first, and presumably after spawning move further up the creek to spend the winter (H. Firth, as reported in Benson 2010).

On Little Fish Creek (also known as Cache Creek), a Dolly Varden spawning and overwintering site is situated about 40 km upstream from the Mackenzie Delta mouth of the Big Fish River and is known locally as “Fish Hole”. It is called **Iqaluk alluaq** in Inuvialuktun (literally “big, deep hole”). This is the only tributary of Big Fish River that is known to contain spawning and over-wintering grounds for sea-run Dolly Varden. [An isolated population of Dolly Varden occur upstream of these falls]. Spawning areas for sea-run fish are in a series of ice-free warm-water pools (Figure 7) situated in a braided area immediately downstream of waterfalls (Figure 8) on Little Fish Creek. Perennial thermal springs keep these pools open all winter and maintain the falls. Rocks in the thermal springs are coated with algae, but the rocks below the falls are bare. There may be a seasonal component to this observation, however, for in the Babbage River, Inuvialuit see more algae in spring/summer than in fall/winter. The water of **Iqaluk alluaq** used to be very salty but became noticeably more dilute. This trend may be reversing.

It is said that at **Iqaluk alluaq** spawners (**ivitaarut** [Kuptana 1999]) and non-spawners are found together in the same pools. However, one elder who had been there once in the 1970s observed some segregation of spawners and non-spawners – the "red ones" (spawners) in the two pools immediately below the falls and solely "silvers" (non-spawners) in the next downstream pool.

Two Aklavik elders also knew of resident Dolly Varden in pools below the falls (different from those known to be isolated in pools above the falls) that do not return to the sea every year with the anadromous fish but stay all year round in Little Fish Creek. These are likely resident or residual males that mature in fresh water without ever going to the sea to feed, and they have been found downstream of the falls at **Iqaluk alluaq** by fish biologists as well (Reist 1989; Gallagher et al. 2013). Another elder discovered a deep pool of char in a barely accessible location between 5 and 10 km downstream from **Iqaluk alluaq**, but he did not know if there was any spawning occurring there (Byers 1993).

[1] Designation of places in association with a key resource such as fish often results in unofficial English place name synonyms. Thus, within the geographic area under consideration in this report there are at least two ‘Fish Holes’, one on the upper Rat River and one on the Big Fish River. There are also at least two ‘Fish Creeks’, one on the upper Rat River and one on the YNS in Ivvavik National Park. The location being referred to is explicitly designated herein, but some information sources may not be explicit, thus care is required to determine specific meaning from the context in such reports.

Figure 7. Pools at "Igaluk alluak" in November 1992 (photo credit: Tim Byers).

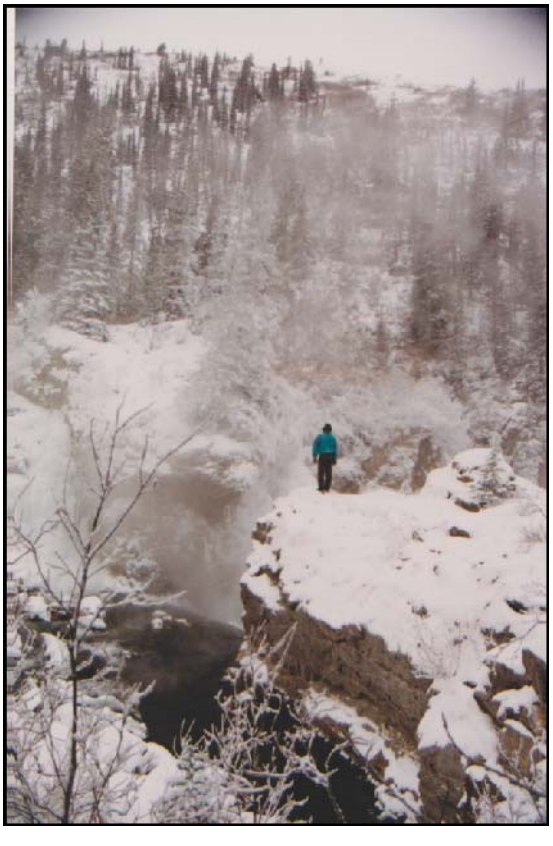

Figure 8. Top of falls on Little Fish Creek in November 1992 (photo credit: Tim Byers).

People from Aklavik say that spawning for the Big Fish River stock occurs in late October into November. One fisherman said that gravid females (i.e., carrying eggs) and fry were found simultaneously at **Iqaluk alluaq** in September and October. Nursery sites for young-of-the-year (YOY) fry are seen to be near shore and in the shallows but not in the deeper pools where the spawned-out females occur. Fishers can differentiate the YOY and 1+ year-old fingerlings, but not the 1+ and 2+ year classes (Byers 1993; DVTK Verification Workshop 2010).

Timing of YOY smoltification and the dispersal of juveniles out of the spawning grounds at **Iqaluk alluaq** is generally unknown. According to some Aklavik fishermen, juveniles leave Little Fish Creek when between 4 and 12 inches (10–30 cm) long (i.e., YOY and 2–3 year-olds), but the month when this happened was not mentioned (Byers 1993).

Teetł'it Gwich'in say that spawning habitat requires warm water, a fast current providing oxygenated water, lots of shoreline cover and vegetation, with abundant insect larvae for fry and juvenile feeding (Benson 2010). There is thought to be two distinct spawning sites in Fish Creek, upper Rat River (Figure 5). These have a 5°C difference in water temperature. Spawning occurs in fall, from the first week of September to as late as November. Females containing ripe eggs (**k'in**) have been caught in September. Both spawners and "silvers" are found in the same pools at **Ne'eedilee** (Benson 2010). After spawning at **Ne'eedilee**, the ice on tributaries gets thick – 7 to 8 feet – with the water depth receding. Dolly Varden reportedly go to places in Fish Creek (**Łuk njik**) that are free of ice to overwinter.

The Aklavik Community Conservation Plan (p. 164) states that there is a "*Strong community interest in winter habitat research for the Big Fish River char*." For both Big Fish and Rat rivers, there is no TK on Dolly Varden natural history in winter, although some Gwich'in believe some spawners die after spawning and others believe they survive and leave the spawning grounds soon after. Sarah Simon of Ft. McPherson told the Gwich'in Ecological Knowledge Project that Gwich'in have been known to catch Dolly Varden in winter through the ice after freeze-up (most likely at **Ne'eedilee** but not specifically reported) using hook and line at a large eddy, but did not catch many this way.

Adult Dolly Varden leave both Little Fish Creek and Fish Creek at spring break-up (Papik et al. 2003; Benson 2010). Gwich'in knowledge of this in Fish Creek has been reported in the literature at least since the 1930s (Osgood 1936). They leave Rat River in May and June, depending on ice conditions. They are seen to be thinner at this time of year. Water clarity is certainly not a hindrance to the post-spawning/overwintering spring migration as most Gwich'in have caught Rat River Dolly Varden moving through the murky water at break-up. These are usually incidental catches of one or two per fishing camp, however, it is difficult to harvest Dolly Varden in those conditions – the debris in the surface waters during freshet causes nets to clog up and the Dolly Varden to move deeper in the water column (GRRB and Gwich'in Elders 1997; Benson 2010). This lack of fishing success is also reported to occur when August rains are heavy. The ensuing runoff results in high murky water full of shoreline debris (Caroline Kay as reported in Benson 2010). Included in this shoreline debris during high water are logs and sometimes entire trees (Greenland and Walker-Larsen 2002).

There is not as much documented TEK for Dolly Varden migration, spawning and dispersal in rivers of the Yukon North Slope compared to the wealth of documented TEK for rivers of the Mackenzie Delta, although recently published land use maps show historic and contemporary harvesting and travel routes along the entire North Slope to be extensive (WMAC[NS] and Aklavik HTC 2018b). One 80 year-old elder who fishes the Babbage River says Firth River Dolly Varden spawn in August and September

(WMAC[NS] and Aklavik HTC 2018b). A waterfall keeps char from running very far up the Babbage River. They spawn in Fish Hole Creek (also known as Canoe River in some reports; see Fig. 4), a tributary of the Babbage (Papik et al. 2003)[2]. A resident population lives above the falls.

A respected Aklavik elder, Danny C. Gordon, told the Berger Pipeline Inquiry in 1975 that char that spawn in the Firth and Babbage are the same as those that occur in the Mackenzie Delta [interpretation clarified by the authors]:

> "*people in Aklavik, they catch the Arctic Char right off the river out here, and the same fish that spawn up these creeks down below, Firth River, Babiche* [Babbage] *River, are the same fish that come to the Delta.*" (Mackenzie Valley Pipeline Inquiry 1975b:101).

FISHING

COASTAL FISHING

Inuvialuit fish for char at their whale-hunting camps at Herschel Island (**Qikiqtaqruk**[3]), King Point (**Kingaq**) and Shingle Point (**Tapqaq**).

Currently, King Point is not as heavily fished as are other fishing sites along this coastline due to recent inaccessibility.

> "*There used to be a harbour* [at King Point]*, but the buildup of gravel has closed the harbour off. Danny C.* [Gordon] *saw a big iceberg push the gravel across the opening. There's so much gravel here now he doesn't think it will open again. There used to be cabins here, but now people come fishing on day trips and camp at Shingle Point.*" (Inuvialuit Community Knowledge Keeper website 2018).

Similarly, Phillips Bay and the Firth River delta are shallower now than decades ago. In the early to mid-20th century, when large schooners were in use, Inuvialuit were able to dock their schooners at the shore of both of these locations but now, even with the much shallower-draught boats used today, people have to pole their way in (Papik et al. 2003).

Inuvik Inuvialuit have also infrequently caught char at Kendall Island (**Ukiivik**) on the eastern side of the Mackenzie River estuary, but it is not known if any of that harvest is Dolly Varden (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006). Char populations that occur east of the Mackenzie River basin and Tuktoyaktuk Peninsula are recognized as Arctic Char by biologists (see Introduction). Norton (1997) reported these are caught in a fishery occurring from the end of July through to the beginning of September. TEK reports that Dolly Varden are also rarely found east of Kendall Island, in Kugmallit Bay near Tuktoyaktuk (Hartwig 2009).

The locations of Inuvialuit fishing places have been known for generations, possibly for hundreds of

[2] A map in Mochnacz et al. (2010) mistakenly labels a tributary of the Fish Hole/Canoe Creek waterway — Wood Creek — as Canoe River.

[3] Not to be confused with another island of the same spelling, a Siglit name for a small island in the East Channel of the Mackenzie River known as Burial Island on government maps (Hart 2011).

years in some cases. Exploration for new fishing sites was not felt necessary. The frequency and duration of occupancy of several fishing sites is attested to by the fact that ancestors are buried there. Berkes (1981) stated that native subsistence fishermen such as the Inuvialuit tend to be what ecologists call optimal foragers. That is, fishing takes place for the most part where and when the CPUE is expected to be high, hence they return year after year to fishing sites shown to produce dependable fish yields. This suggests the long-term reliability and sustainability of the fish resource at these locations. As one Aklavik elder stated:

> "*Peoples been fishing there before, before my time, we never ever think of trying a different place, because peoples always in the same place. There's fish there, catch fish where, in the same spot, where everybody goes to that, people still go to the same places. We never think of going to new spots.*" (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006:11-213).

The waters surrounding Herschel Island have been fished by Inuvialuit for several centuries. One Aklavik family, the Gordons, have caught char there continuously in July and August since 1946. The most heavily used site for fishing is Pauline Cove, where Delta Inuvialuit and Alaskan Inupiat use gill nets and rod-and-reel angling. Char are also caught in Workboat Passage and Ptarmigan Bay between Herschel Island and the mainland (Harwood et al. 2012).

Sweep netting – seining with gill nets – in bays or at river outlets on the coast produced a good catch of char in summers of the 1950s and 1960s, as Lily Lipscombe of Aklavik explained:

> "*And then just before it was time to sweep fish, especially the char,…we go over there [Roland Bay] very briefly, like we'll just sweep for one or two days… every sweep you may get about 100, 200 fish at [a] time. So you could do it, four or five maybe six times a day and you got enough there*." (Lipscombe 1991: Interview tape LL81-25B:10).

A short-lived commercial fishery for char and Arctic Cisco that sold fish from Herschel Island and Shingle Point occurred in 1960 and 1961. It was deemed to be unsustainable given the short fishing period and low numbers of fish to market, producing a combined total for both species of 8,165 and 5,443 kg in 1960 and 1961, respectively (Papik et al. 2003; Harwood et al. 2012).

Inuvialuit notice significant differences in seawater properties and in Dolly Varden sizes at Herschel Island compared to Shingle Point. Water is clearer and saltier at Herschel Island than at Shingle Point. Papik et al. (2003) reported that Dolly Varden caught at Herschel Island are generally larger than those caught at Shingle Point and that was one of the reasons some Inuvialuit made the trip to Herschel Island every season. But this may not be true in recent years (DVTK Verification Workshop 2010).

Several Inuvialuit reported to Papik et al. (2003) that char caught on the coast are generally larger than those caught in the rivers. Several also stated that "char and herring" [that is, ciscoes, likely Arctic Cisco] have been getting smaller over the years at Shingle Point and Herschel Island, while others believe size fluctuates year to year. While not categorized by location, ABEKS (2011) reported that from 1998–2008 a greater than expected number of Inuvialuit informants reported "normal" sized Dolly Varden. Also, while approximately 70% of respondents reported larger-than-average Dolly Varden in 1998 and 1999, less than 20% (and none in 2003–2005) reported large fish throughout the 2000s. As this study took place during the years of Big Fish River closure and prior to the partial re-opening of the

fishery by DFO in 2012, it is assumed that the size information reported was from Dolly Varden caught exclusively in coastal fisheries. Thus, impressions of size trends of Dolly Varden on the coast appear to be best categorized as not changing temporally at least until 2009, although possibly with a decrease in abundance of above-average sized fish. Observations in recent years are that larger size Dolly Varden are being caught again at Shingle Point and possibly inland (B. Archie, pers. comm., 2018).

Sea-ice conditions are observed to be changing, which can affect fishing success. At Herschel Island (Ptarmigan Bay), King Point and Shingle Point there are larger char harvests when sea ice is closer to shore. Char tend to hug the shoreline when sea ice drifts or is wind-blown towards shore, as is often the case at Ptarmigan Bay (Harwood et al. 2012), although some Inuvialuit believe char are attracted to sea ice due to the abundance of ice-associated invertebrate prey (WMAC[NS] and Aklavik HTC 2018a). There was no ice seen from shore at Shingle Point in 2003-2005, which is considered abnormal (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006). This lack of visible ice seems to have persisted until at least 2015, with an increased area of open water and less nearshore drift ice (WMAC[NS] and Aklavik HTC 2018b). Ice within the Shingle Point bay behind the spit as well as seaward is not as prevalent in summer as it was two or three decades ago. It is more difficult now than in the past to travel between Shingle Point and Herschel Island when winds are from the north and northwest due to the lack of nearshore ice that normally provides a protected travel corridor that prevents or dampens wind-driven waves (WMAC[NS] and Aklavik HTC 2018b; Pollard et al. 2012).

In 1992, most char fishing by Aklavik residents took place at Shingle Point (**Tapqaq)** and the town site in Aklavik (similar to fishing during the 1987–1991 Big Fish River closure). Papik et al. (2003) report that 10 to 15 families fished at **Tapqaq**. Noticeably fewer char and Arctic Cisco (**qaaqtaq** or “herring”) were seen at Shingle Point in the early 2000s compared to the 1970s. Declines in harvests there began in 1998 according to Stephenson (2003), although this does not align with harvest statistics (DFO 2010) showing the second highest harvest recorded there (541) in 1998. In a qualitative survey of Aklavik Inuvialuit fishers, fewer Dolly Varden were reported for the 2000–2008 upstream migration period (ABEKS 2011). However, the survey data were not categorized by river or coastal locations. At an RRWG meeting in March 2009, Billy Archie of Aklavik stated that 29 Dolly Varden were caught at Shingle Point in 2008. The IHS has shown up to 3,000 were harvested at Shingle Point in the past while more recent harvest statistics (DFO 2010) show hundreds per year taken there from 1996-1999. Inuvialuit do not necessarily view this as a sign of a smaller population, but rather that fishermen may have missed the run. Many believe that Dolly Varden migrated further away from the shore, out of reach of the fishing gear. It is believed that they went further out to sea due to either changing sea-ice conditions or siltier nearshore water caused by shoreline erosion from strong onshore wave action (Papik et al. 2003; Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006). One Inuvialuk told of how the sea ice was very thick in about 2006 (coastal fishing site not revealed), resulting in a good catch of char:

> “*And it was really good fishing… you could see the char coming, you could see their little ripples… along the edge of the water… That’s what the normal used to be back then.*” (WMAC[NS] and Aklavik HTC 2018a: 42).

Thus, it appears Inuvialuit fishers have concluded that decreased coastal harvests of this species are not necessarily a function of smaller populations. The latest documented TEK study (WMAC[NS] and Aklavik HTC 2018a) reported that 77% of 13 Aklavik Inuvialuit believe populations are stable. While the catches of char and “herring” have decreased at Shingle Point, catches of Northern Pike (*Esox lucius*),

Burbot (*Lota lota)* and Broad Whitefish (C*oregonus nasus*), are becoming more frequent, possibly due to less brackish nearshore waters (Brewster et al. 2016; WMAC[NS] and Aklavik HTC 2018a).

Currently there are community-based Dolly Varden harvest monitoring programs along the coast at Herschel Island (2001) and Shingle Point (2011) (C. Gallagher and K. Howland, unpublished presentation given in 2011).

INLAND FISHING

The Rivers

The Big Fish River flows approximately 85 km from headwaters in the Richardson Mountains to the Mackenzie Delta. The four major tributaries that feed Big Fish River — Fish River, Little Fish Creek (= Cache Creek[4]), Canoe, and Sheep creeks[5] (Gillman et al. 1985) — are 1–5 m wide and shallow with gravel substrates. From the foothills Big Fish River flows northeast for 15 km into the delta, emptying into Moose Channel. In the delta, the current slows over a mud river bed and depth increases (Gillman et al. 1985). Its banks are lined primarily with willow (*Salix* spp.) and alder (*Alnus* spp.), with occasional black spruce and poplar stands (Fehr and Archie 1989; Byers 1993).

People only started fishing the lower reaches of Big Fish River in the 1960s with the introduction of outboard motors to the Delta (Byers 1993), and by 1973 four families fished at the mouth of the Big Fish River (Bissett 1974). However, Inuvialuit and Ehdiitat Gwich'in have fished at **Iqaluk alluaq** for generations, at least since the 1890s (Usher 1976; Byers 1993). Aklavik residents fished there annually from the 1950s through to the mid-1980s when the Dolly Varden fishery on Big Fish River was closed. Fishers observed a decline in their Dolly Varden catches in the early 1980s, when many juveniles were observed but not many fish of harvestable size (Papik et al. 2003).

The Rat River (**Ddhah zhit han)** is 130 km long running from its source in the Richardson Mountains to Husky Channel. Its water is clear, its channel shallow and narrow, passable only by light canoe upstream of the rapids at **Tr'ih zhìt Tàgòhdi**, locally known as Destruction City. The river broadens and becomes siltier downstream of **Tr'ih zhìt Tàgòhdi**, translated as Canoe Landing which it was known as prior to the Klondike Gold Rush. The name Destruction City refers to the remains of the prospectors' boats which they had to dismantle and rebuild into smaller boats before continuing the journey upstream on the Rat River to the Yukon (Haszard and Shaw 2000).

The Rat River is used not only for fishing but also as a travel corridor to access caribou, moose and sheep hunting areas. Fish Creek (**Łuk njik**), a mountain tributary of Rat River, contains a **dhik'ii** spawning and overwintering site known as "Fish Hole" (**Ne'eedilee)**. The water here has always been fresh, not salty as **Iqaluk alluaq** used to be. In the fall, Teetł'it Gwich'in harvested **dhik'ii** at **Ne'eedilee**.

[4] There is confusion in the literature as to the proper name for this creek. While Gillman et al. (1985) list Little Fish River and Cache Creek as separate tributaries, Stephenson (2003) states that they are different names for the same creek, the one that contains the falls and spawning area known as "Fish Hole". Other authors also refer to this creek as Little Fish River (Gallagher et al. 2013), while still others refer to it as Cache Creek (Clark et al. 2001; Papik et al. 2003) as does the Aklavik Community Conservation Plan (Aklavik HTC et al. 2016).

[5] As mentioned in the Methods section, this is an instance of the same place name for tributaries in two different watersheds, as there is also a tributary named Sheep Creek that flows into the Firth River.

People would go by dogteam to the **Ne'eedilee** in October and fish in the three deep eddies there. Fishing has not been done there since the mid-1980s (J. Francis, as reported in Harwood et al. 2009).

The Vittrekwa River flows from the Richardson Mountains south of the Dempster Highway, emptying into the lower Peel River. It is navigable for only 500 m upstream of its mouth. People used to trap there all winter (DVTK Verification Workshop 2010). One elder told Simon and Elias (1998) of good catches of **dhik'ii** in an eddy at the Vittrekwa mouth in the 1940s, but fishing has not been conducted on this river since then. The mouth of the river is shallower now, making fishing for **dhik'ii** difficult (A. Peterson, reported at DVTK Verification Workshop 2010). The GRRB caught four **dhik'ii** in gillnets set on September 3 and 4, 1997 one km upstream of the mouth of the river (Simon and Elias 1998). James Creek (**Dachan dha'aii njik)**, a headwater tributary of Vittrekwa River (Figure 9), is an important source of drinking water for many Gwich'in from Fort McPherson and Tsiigehtchic (Gwich'in Land Use Planning Board 2003). In 2007 a knowledgeable Gwich'in elder, William Teya, showed a GRRB fishery biologist how to get to the **dhik'ii** spawning grounds in Ne'eedilee Creek, a mountain tributary of the Vittrekwa (Dolgin 2008). Incidental catches of **dhik'ii** occur at the following locations: Eight Mile (**Nataiinlaii** = "water flowing over rocks") in fall (this site is south of Fort McPherson and slightly southeast of the Dempster Highway ferry crossing on the Peel River at Waterfall Creek) (Figure 9), and the Peel Channel in the Mackenzie Delta in spring and fall (October) (Benson 2010).

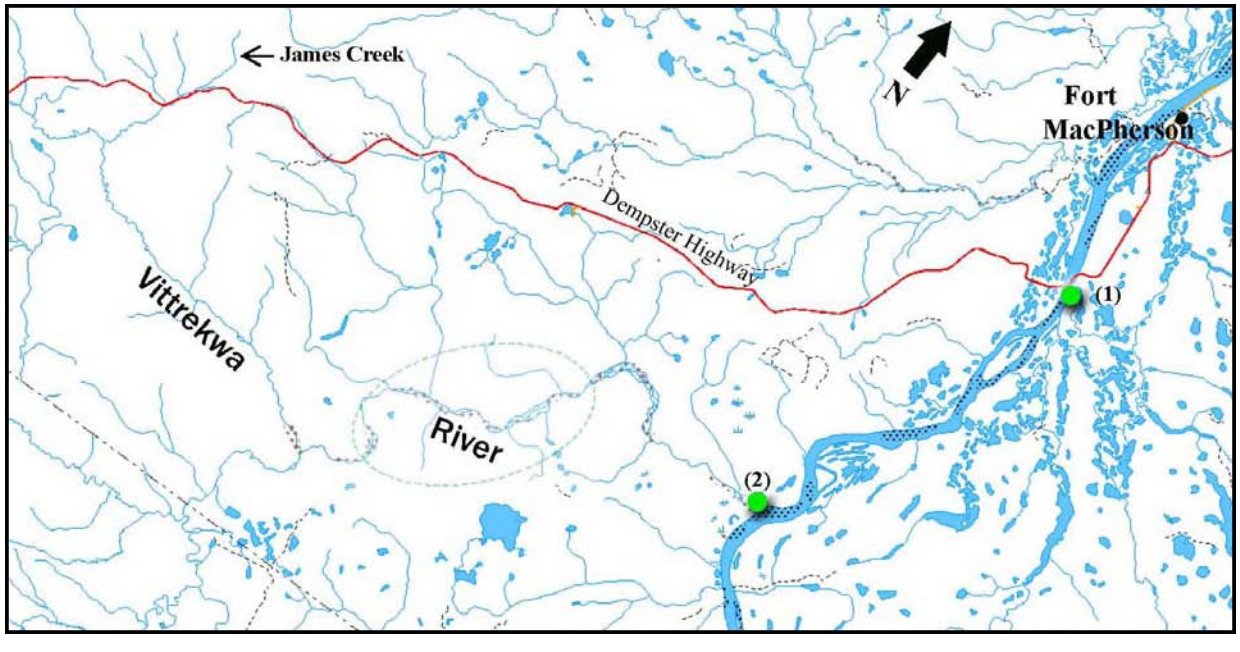

Figure 9. Suspected Dolly Varden spawning and wintering grounds (dashed oval) and historic harvest sites south of Fort McPherson – 1) Eight Mile, and 2) mouth of the Vittrekwa River.

Road River (**Vihtlòo Njik)** and Trail River (**Tr'atr'aataii tshik** = "at the mouth of People's trail") flow out of the Richardson Mountains south of the Vittrekwa River, emptying into the Peel River (Figure 10). People reportedly catch **dhik'ii** in these rivers (DFO 2001), but documented TK was not found on this activity. **Tr'atr'aataii tshik** is an especially important trail, one of the oldest still used. It leads to Caribou Mountain and Hungry Lake, an important winter hunting and fishing area for Teetł'it Gwich'in. Walter and Robert Alexie grew up in this area; their grandfather's fish camp was across the river from the mouth of Trail River. The Alexie's report that people used to live at the mouth of Trail River and set their

nets in a large eddy there. The eddy is no longer there as the mouth is now very shallow. The Alexie's continue to camp there (Gwich'in Social and Cultural Institute 2003).

On the Mackenzie River the only place fishers from Tsiigehtchic see **dhik'ii** is at the mouth of Arctic Red River (Thompson and Millar 2007). In the six years of the Gwich'in Harvest Study, starting in 1995, only two **dhik'ii** were reported as harvested from Tsiigehtchic (see Appendices), although 2008 and 2009 may have seen rare catches there (DVTK Verification Workshop 2010).

Harvesting areas used historically on the Yukon North Slope are Malcolm River, Firth River and the Phillips Bay/Babbage River system. The latter was fished in late summer/early fall when char were beginning their spawning migration. Char could be caught not only in the Babbage River, but in small lakes connected by creeks to the river. As one elder reported:

> "*up at King Point … [in lakes] … just go on top, King Point and down there you see that lakes got, a creek at the end, its attached to Babbage River, we get char there*" (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006:11-201).

A "fish hole" also exists 15 km inland from Komakuk Beach on Fish Creek in the western part of Ivvavik National Park. This is only used for fishing by Inuvialuit travelling to Barter Island, Alaska (Papik et al. 2003).

The Firth River seems to have been a char harvesting river for millennia. A fishing site on the river in an area called **Iggitchiarq**, or **Engigstciak** ("new mountain") was used by Inuvialuit ancestors between 8,000 and 11,000 years ago, according to archaeological evidence (MacKay et al. 1961; Cinq-Mars et al. 1991; Papik et al. 2003). **Iggitchiarq** is on the east side of Firth River at the approach of the mountains. People cached meat and fish there and it has a high point of land which provides an excellent lookout for animals. Inupiat from Alaska also used the Firth River for char fishing when travelling to visit Inuvialuit relatives in the Delta. Papik et al. (2003) reported that there are differences of opinion among Inuvialuit as to whether the Inuvialuit Harvest Study (IHS) had enumerated those char caught by Inupiat, but it has recently been pointed out that Inupiat had fished there well before the IHS began (DVTK Verification Workshop 2010). [Two lakes (103 and 104) west of the mainstem Firth River immediately south of the marginal foothills have populations of relictual Arctic Char; as far as is known these lakes are land-locked with no possibilities for migrations of these populations or their inter-mixing with Dolly Varden in the river systems (Reist 1989).]

At the time of the Papik et al. (2003) study, active fishers had never fished on the Firth River in winter. However, elders reported overwintering sites on the Firth tributaries of Sheep and Joe creeks[6]. As Sheep Creek is reportedly drying up (DVTK Verification Workshop 2010), the status of that site is uncertain. Inuvialuit who travel to Alaska also harvest char en route at a spawning/overwintering site on Fish Creek west of Malcolm River situated about 25 km inland (Papik et al. 2003).

[6] Extensive aufeis has been reported by scientists Clark and Lauriol (1997) on both the upper Firth River (20 km long aufeis) and Joe Creek (25 km long). We presume that aufeis areas denote locations of substantive groundwater input and thus are inferred to be indicative of upstream overwintering habitat; however, it is possible that this might not always be the case.

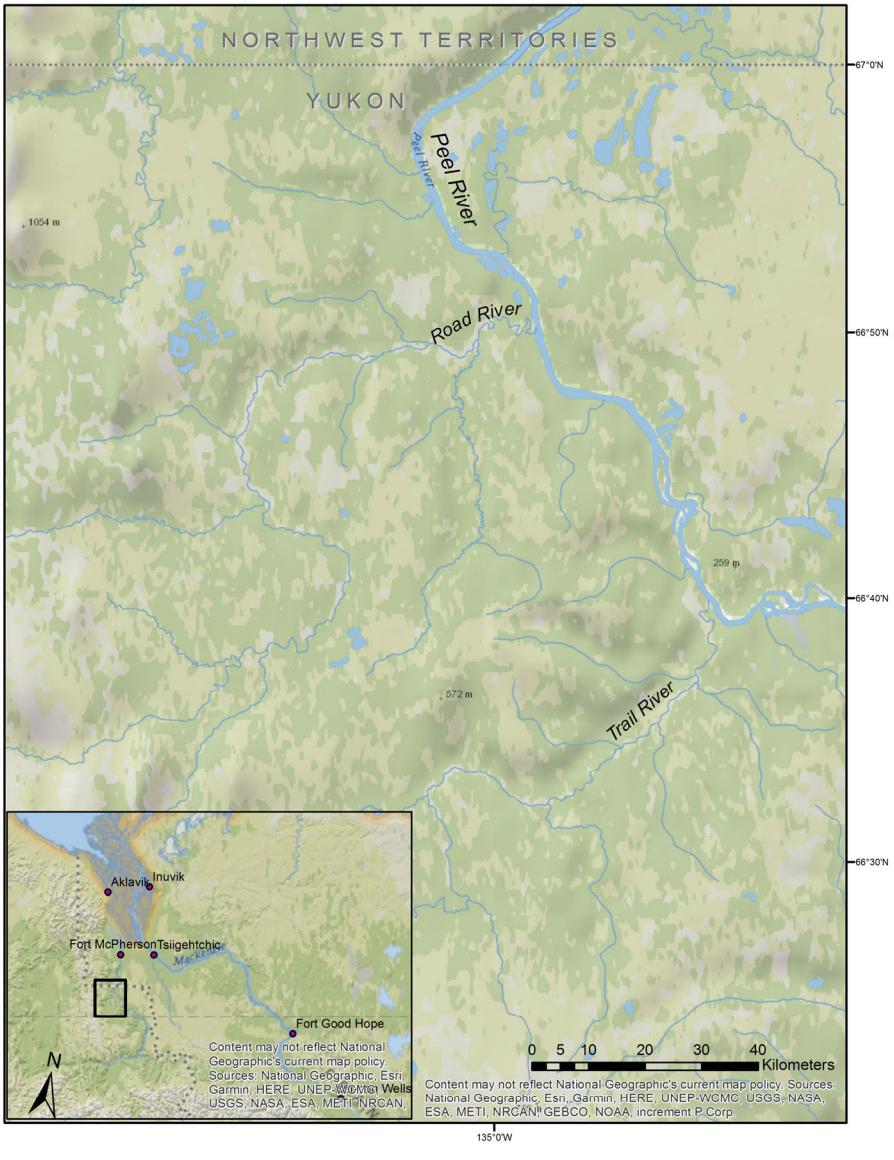

Figure 10. The Road and Trail rivers.

Van Tat Gwich'in from further south in the Yukon — now settled in and around Old Crow as the Vuntut Gwitch'in First Nation — also fished in the Firth and Babbage rivers and Fish Hole Creek (Figure 4). Their harvests occurred in the winter at char overwintering sites (Gray and Alt 2000). This may not be common practice today (Dick Mahoney, pers. comm., 2010; Dolly Varden TK Verification Workshop 2010).

The Malcolm River was fished in winter in the early decades of the 20th century. It was a productive river for fishing, especially at Stickler Lake. There is a suggestion that Dolly Varden overwinter in the river as some locations never freeze but the species reporting was not definite and it could also be grayling. Water levels in the Malcolm River have been lower in recent years, making access difficult. It had not been fished up until at least the early 2000s (Papik et al. 2003). Char caught in North Slope rivers in the 1930s and 1940s were remembered as bigger than those caught in the beginning of the 21st century (Papik et al. 2003), although some are seeing bigger char in recent harvest years at Shingle Point (B. Archie, pers. comm., 2018).

Currently there are community-based Dolly Varden harvest monitoring programs in Ivvavik National Park on Sheep Creek (established 2010), and at Rat River (1999) (C. Gallagher and K. Howland, unpublished [presentation given in 2011]).

The Harvest

Due to concerns about smaller harvests, the Big Fish River was closed to Dolly Varden fishing beginning in 1987. Prior to the mid-1980s, at the mouth of Big Fish River a good fishing year was considered a catch of 50 to 80 Dolly Varden per overnight gill net set (Byers 1993), although the 2010 DVTK Verification Workshop informed Byers those numbers would more accurately have been catches from the **Iqaluk alluaq**, not the Big Fish River mainstem. Elders agree that up to 400 would be caught in one week of fishing on the Big Fish River, the total dependant on whether the nets were in place during the major part of the upstream migration (Byers 1993). Various fishers began experiencing smaller harvests of Dolly Varden in the mid-1970s to early ‘80s in the Big Fish River system as well as coastal fishing sites (Byers 1993; Papik et al. 2003).

Prior to the fishing closure at **Iqaluk alluaq**, fishermen would expect to take between 80 and 700 each on every trip depending on needs and time available to fish (weekend only or week(s) long stay). An instance of low fishing success occurred there in 1968 with only three char caught in one trip. Whether this was due to a later than normal arrival to the spawning grounds or a true stock decline is unknown (Byers 1993). In the two years prior to the voluntary closure of **Iqaluk alluaq** to fishing, Dolly Varden harvests were estimated to total between 400 and 600 by an unknown number of fishermen in 1985 and 1,660 by approximately 20 fishermen in October 1986 (Sparling and Stewart 1986). In 2000, by contrast, only 32 were caught in total in the final year of a limited and regulated subsistence fishery, with two fishermen from Aklavik saying it was the worst fishing they had ever experienced there (Stephenson 2003).

Gwich’in fish for Dolly Varden in approximately 130 km of channels of the Mackenzie River Delta including sections of West Channel, Husky Channel (**Eneekaii han)** and the lower Rat River (Figure 6). The Ehditaat Gwich’in are the only Gwich’in to fish in Big Fish River as it is too far to travel for the Teetł’it Gwich’in and Gwichya Gwich’in of Fort McPherson and Tsiigehtchic, respectively (Usher 1976; GRRB and Gwich’in Elders 1997).

In Husky Channel, the “Big Eddy” (**Ok choo**) is an important fishing site, as is the mouth of Rat River and Destruction City (**Tr’ih zhit Tàgòhdi**) in Rat River. This fishery has been running for well over 100 years. The fishery occurs from early August to mid-September, although Gwich’in reported to Norton (1997) that in the 1990s the Rat River run was beginning earlier than in previous decades. Gwich’in elders remember large Dolly Varden harvests at Big Eddy in the 1920s to 1940s. Net checks had to be done three times a day and one net could get a family enough char to last through the winter. Dolly Varden numbers have gradually decreased since then. Alfred Francis stated:

> "*I remember as far as 50 years ago [1940s], people used to live right at the mouth of Rat River, and I saw [camps on both sides of Husky Channel]. At every camp I saw drying charr, just red outside. Today it's not like that*." (Francis 1995).

Big Eddy has been a popular campsite for generations. It is named such because it is the largest eddy on the Husky Channel. It is east of Jurassic Butte, locally called Black Mountain. John Carmichael, a fish monitor of long-standing for the Rat River Char Fish Plan, has a camp at Big Eddy; his parents used to live in the area year-round. Big Eddy was frequented not only because of its annual bounty of Dolly Varden but also because of its proximity to sheep and caribou hunting in the mountains. An old hunting trail leads into the mountains from there. Elder Mary Kendi said that trail is the shortest overland route from Husky Channel to the mountains. The trail has been used since at least the early 1800s and possibly during the pre-contact period of Gwich'in history (Gwich'in Social and Cultural Institute 2003; Sandstrom et al. 2009; Benson 2010).

Informants say their yearly **dhik'ii** catch from Rat River was generally in the low hundreds per man, although one fisherman took 2,200 in his best year (around 1990) (Benson 2010). One elder reported that in the 1940s he was able to fill a fish tub with **dhik'ii** from one net set (4-inch mesh). The same net set in 1995 caught only 30, although it is not clear from the report if this was from one set or over the entire fishing season (A. Semple as reported in Benson 2010).

Use of the Rat River for **dhik'ii** fishing was in decline prior to the RRWG's voluntary closure in 2006. This was likely due to the time constraints of wage employment (DVTK Verification Workshop 2010). In the years prior to the closure of the Rat River Dolly Varden fishery, there were 18 harvesters in 1997 (28% were DFO-trained fish monitors); this was down to a maximum of seven (57–100% were monitors) in 2001–2005 (Harwood et al. 2009).

As mentioned earlier, spawners and non-spawning "silvers" are both found at **Ne'eedilee**. It has been observed that prior to fishing closures a trend had developed towards an increasing proportion of spawners to "silvers" in both the Big Fish (DVTK Verification Workshop 2010) and Rat (mentioned by an informant to Benson in 2008) rivers. This trend would be noticed by fishers because both Inuvialuit and Gwich'in prefer eating "silvers". Gravid and spent spawners have less meat and fat and the meat is not as firm as that of "silvers" (Papik et al. 2003; Benson 2010). It is not clear if Inuvialuit and Gwich'in differentiate between immature or spent females and resting males. Benson (2010) reports that some Gwich'in use the word "spawners" only for gravid females, not males. Juveniles are considered the tastiest by some Gwich'in, but these are not usually caught anymore since people no longer use 3-inch mesh gill nets.

Gwich'in elders believe many more **dhik'ii** were consistently harvested in the past (i.e., 1960–70s) than in the 1980s to present. However, due to greater employment levels limiting time available for fishing, and less optimal river conditions, contemporary Gwich'in fish less than previous generations, and those that still do catch substantially fewer fish than in the past. Only five families and a few individuals from Fort McPherson fished at Rat River and Husky Channel in the mid-1990s, whereas prior to the 1960s there were at least that many families fishing at the Rat River mouth alone and eight families by the 1960s (GRRB and Gwich'in Elders 1997; J. Charlie Sr. as reported in Sandstrom et al. 2009; Benson 2010). A Teetl'it Gwich'in fisherman informed Gill (2013) that quicker growing shrubs, attributed to a warming climate, invade temporarily unused trails, impeding access to fishing camps:

> *"...you don't travel one year, and [willows are] already growing too fast. Some people just leave it, they can't even see their portage trails. So it kind of discourages people from basically going back to their camp, lot of deserted camps up here. People don't go out anymore."*

According to John Carmichael, one of the longest serving char monitors, the steady decline in Rat River **dhik'ii** may be reversing as he has seen gradually increasing catches at **Ok Choo** from 2006–2008 (Benson 2010). Recent DFO and RRWG results have confirmed this.

FISHING TECHNOLOGY

INUVIALUIT

Gill nets have been used by the Siglit/Inuvialuit at least since the 18th century, and possibly as long as 600 years ago. In fact, the Siglit and Alaskans were the only Inuit ever to have used fish nets prior to European contact (Snyder 1986). In pre-contact times nets were made of whale baleen or willow roots, but by the 1940s, Inuvialuit as well as Gwich'in used cotton nets (A. Semple, as reported in Benson 2010), followed by nylon nets decades later.

Baleen, made of keratin, is thick and pliable. As reported in Snyder (1986:69):

> "*Robert F. Spencer (1984:336) recorded the [Alaskan Inuit] process for preparing baleen into sections for basket making, which is the only example of treatment discovered in the literature. The baleen was first soaked in water, then split longitudinally [baleen is difficult to cut across the grain] into sections and scraped clean. A supple, long flexible line resulted which could easily be used for a variety of purposes, including net-making*".

This type of fish net was called a **kupyaq** (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006). An Inuvialuit elder born in 1948 also mentions gill nets made of seal sinew used at Herschel Island. However, baleen was probably considered a superior net-making material than sinew or rawhide, as it does not ice up in freezing water, tends not to kink and is more durable, especially when wet. Some sinew nets could be used only for one season before being discarded. Baleen also could provide more material for net-making than the multi-use hides and sinew of marine mammals and caribou. Baleen nets were 7 m long by 3 m deep and had a 7 cm mesh size (Snyder 1986). On the coast, nets were set from shore using a long pole (**kaimutaq**), 20 to 30 m in length. Some Inuvialuit still use this technique while others prefer a pulley system anchored out to the length of rope available to the fisher. The net would be set from shore by pulling on the rope.

In the early 20th century, Stefansson (1922) found Inuvialuit to be using 9 m long nets of 1 m depth. Norton (1997) reports nets are set perpendicular to shore in wind-created eddies and, in the case of King Point, within nearshore currents.

People used to fish for char with gill nets with mesh sizes ranging from 2.5–5.5 inches. Today, elders indicated that 3-inch mesh nets are only used for "herring" (Arctic Cisco and Least Cisco [*Coregonus sardinella]* and Pacific Herring [*Clupea harengus*]), 4 to 4.5-inch nets are used for char, and 5 to 5.5-inch nets are used for whitefish (i.e., Broad Whitefish) and Inconnu (*Stenodus leucichthys*). Those used

on the coast are shorter (3 to 9 m long) than in main channels and rivers inland (between 22 and 92 m), although the Gordon family use 20 to 30 m net lengths of 4.5-inch mesh set on either side of Ptarmigan Bay spit (Harwood et al. 2012).

GWICH'IN

Prior to the development of trading posts at Fort McPherson in 1840 and Tsiigehtchic in 1902 (Heine et al. 2007), which introduced manufactured cotton gill nets, Gwich'in made gill nets out of tightly twisted strands of willow bark or roots. The inner bark was soaked and thin strips pulled apart to make the net twine. Babiche – moose sinew – was also tried but it was not as good because it would rot in water (Osgood 1936; Benson 2010). Cotton nets eventually gave way to the stronger, more durable nylon monofilament gill nets used today.

Gwich'in also used fish traps made of willow sticks in 2.5–3 ft (0.7–0.9 m) depths of water on tributaries into the Peel River (Isbister 1845; Osgood 1936; Benson 2010). This trap, with wings spread across the entire width of the stream, was used starting from about Sept. 1 to freeze-up for "*graylings of 2 varieties which come down streams in fall*." (Osgood 1936:69). The last time a fish trap was built and used (although presumably not for **dhik'ii**) was in the 1980s, set from an island upstream of the Peel River crossing (R. Charlie reported at DVTK Verification Workshop 2010). Dipnets with wooden poles and baskets at the end made of willow bark twine were used in the river "fish holes" but these were probably not used for Dolly Varden. Rather, Dolly Varden were pulled out of the trap either by hand or using a trident (3-pronged lance). Upstream of Destruction City, people also caught grayling and likely Dolly Varden by spearing them directly from the water using spears made of caribou antlers. As observed by Osgood (1936:24) in describing fishing for grayling, the "*grey and spotted river trout is …caught with a fish spear or a long drag hook*". Gwich'in today also use rod and reel with lures in the mountain creeks but these are useless in the Delta channels as the water is too murky to allow visual contact with the lure (DVTK Verification Workshop 2010).

Dolly Varden at **Ne'eedilee** were caught by seining with gill nets, much like the Inuvialuit do at the Big Fish River "Fish Hole". Fine-mesh seine nets were never used (Osgood 1936).

In explaining the relative efficiency of various net mesh sizes in catching **dhik'ii**, a Gwich'in elder (Semple 1996) said that 1.5 pound Dolly Varden swim through mesh larger than 3-inches; 4-inch mesh catches Dolly Varden of 5–6 pounds, 4.5-inch gets 12–15 pounds, and most if not all Dolly Varden swim through 5-inch. This knowledge was gained before the implementation of net restrictions recommended by the Rat River Working Group.

Inland nets are 24–48 meshes (1–2 m) deep, and are often placed near the bottom of creeks, as Dolly Varden seem to stay close to the bottom. Prior to regulated net sizes, Gwich'in used up to 60-mesh deep (about 2.5 m) nets in the main channels (J. Carmichael as reported in Benson 2010). DFO-hired community Rat River Dolly Varden monitors use nets of 24–30 mesh depth and sets about 0.5 m below the water surface so that a portion of the migrating fish can swim over or under it (GRRB and Gwich'in Elders 1997; Sherry and Vuntut Gwitchin First Nation 1999; Harwood et al. 2009; DVTK Verification Workshop 2010).

Gwich'in used a "lobstick" (**njoh)** to mark a good fishing spot. A lobstick is a tree, usually a spruce, standing apart from nearby trees whose branches are cut off in such a way as to visually stand out (Figure 11) (Heine et al. 2007:34).

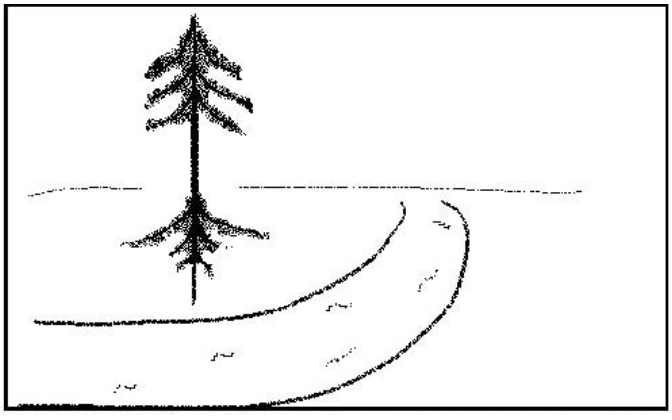

Figure 11. A lobstick, used to mark a good fishing spot on a river or lakeshore.

Ehditaat Gwich'in and Inuvialuit from Aklavik often set their gill nets on inland rivers with a nearshore stationary end and the other end allowed to drift in the current, while for eddy sets the nearshore and middle would be stationary and the stream end allowed to drift (Norton 1997). How a fisher sets a net is dictated by properties of the current and water conditions. If the water is clear, nets are set from shore. If the water is silty, then nets are set further out into the current (DVTK Verification Workshop 2010). Nets are checked at least once per day; three times daily during the middle of the migratory runs. Nets are pulled if they cannot be checked within 24 hours to avoid the possibility of the flesh of caught fish becoming too soft and ultimately spoiling.

DOLLY VARDEN HARVEST – FOOD PREPARATION

Traditionally, Dolly Varden could be live-stored temporarily in water-filled pits on river banks in preparation for processing. Dolly Varden was processed the same as whitefish. Both were prepared either as "stick fish" or "pit fish". Stick fish had a stick pushed through the head and were hung in a cache or smoke house to dry. Pit fish were buried in pits dug into the permafrost to keep them cool and away from bears (Benson 2010). These processing methods are uncommon today.

Contemporary Gwich'in and Inuvialuit who do not have time to stay at fish camps will pack their catch in coolers and bring them home to be placed in freezers. But those who spend prolonged time at fish camps will dry their Dolly Varden catch (Figure 12). This is done by splitting and hanging each one from wooden poles over a smoky fire, either in the open air or in smokehouses, with the hanging fish turned occasionally to assure even drying. An Inuvialuit elder also mentioned the following:

> "*You just can't start cutting for dry fish. You have to learn to clean the fish, and you've got to learn how to drain the blood out of the dried fish*" (WMAC[NS] and Aklavik HTC 2018b: 100).

Most Dolly Varden are smoke-dried but the first few caught every season are fried over an open fire or boiled (GRRB and Gwich'in Elders 1997). August is considered by Gwich'in to be the best time for drying fish, with July being too hot. Gwich'in often use driftwood for the firewood used to dry fish. Poplar is the preferred driftwood for this purpose. It is gathered by hand along beaches and riverbanks during summer and transported by boat to fish camps. A few boatloads of driftwood will last throughout the months spent drying fish (Greenland and Walker-Larsen 2002). The Gwich'in method to prepare the fish for drying is the same as for whitefish, as follows:

> "...[the fish] *is cut lengthwise on both sides of the backbone from head to tail, not along the belly as you would to cook it. The cut is then made down the ribs, but without cutting through them. The meat is cut away from the ribs, so that it stays in one piece. The belly is not cut. This forms a large flat slice of meat, with both sides attached at the belly. The guts are removed ...and the head is cut off. The backbone may be left attached to the meat at the tail, or cut off."* (GRRB and Gwich'in Elders 1997:148).

Dry fish of all harvestable species has been an important staple of the Gwich'in diet at least since the 1930s. Dolly Varden eggs were also used, usually dried and eaten in winter. Some elders used them in bannock, and others boiled them and put them into fish "pipes" (stomachs) for eating (DVTK Verification Workshop 2010). Osgood (1936) reported that these "river trout" eggs were the least preferred fish eggs by Gwich'in of that time as they are hard and take longer to boil. Since Dolly Varden flesh is delicate and spoils quickly if left too long after harvest, char were smoked and dried right away. In the past, some of the dried catch was put into 'ice-houses' (caches dug into the permafrost).

> "*In those days there were no freezers — so people would dig a hole in the ground, about five to seven feet (1.5–2.1 m) deep, and use it or an ice-house That was where they kept their fish. Some people still use ice-houses*." (Francis 1995).

In modern times, Dolly Varden dryfish is frozen since it has a higher fat content than other dryfish such as whitefish (Benson 2010) and Alaskan salmon (Stewart 1979). The boiled then mashed Dolly Varden liver, mixed with berries, was a highly prized delicacy of the Gwich'in in past decades but it is not eaten much at present if at all (Benson 2010; DVTK Verification Workshop 2010). If intended to eat, the livers are always checked to ensure they are healthy, just as is now done for all fish and animal species' livers.

Interestingly, some people say that Dolly Varden caught in different locations can have slightly different tastes. At Herschel Island they are found to be more oily than elsewhere, which is thought to be due to their diet of marine crustaceans. At the start of the run at high water on Running River, big Dolly Varden have a "mossy" taste which was considered to be a new phenomenon (Papik et al. 2003). An Aklavik elder states that she can detect a taste difference between coastal-caught and Delta-caught anadromous fish. She prefers the taste of fish from the coast:

> "*The coastal areas is where I like to get my meats and fish because even with the fish you really could taste the difference in the fish meat. Fish and the caribou [in the Delta taste] really willowy*." (WMAC[NS] and Aklavik HTC 2018b: 82).

Figure 12. Dolly Varden being dried at Shingle Point, YNS (photo credit: Kristin Hynes).

HARVESTING ETHICS AND TRADITIONAL MANAGEMENT

Gwich'in, according to Osgood (1936), are animistic, meaning they believe that all biotic and abiotic objects have life or a life force. The Inuvialuit hold the same belief system. As in the past, it is considered important to show respect to fish, or else they would avoid your nets in future. This cosmology is similar to that of other northern Indigenous peoples. Minc (1986) explains this in discussion of the animistic beliefs of Inuit of northwest Alaska. An animal's "breath-spirit" (*ilitqusiq*) is the "spiritual counterpart of the individual animal". When death releases the *ilitqusiq* from the body, the *ilitqusiq* lives on, eventually reincarnating into another individual of its species. The *ilitqusiq* ultimately determines an Inuit hunter/fisherman's success. Consequently, a positive relationship between hunter and prey species has to be nurtured through respectful treatment of the animal in the entire process from killing through final disposal of remains after eating.

This belief system holds that some misfortune will await a person or his family if he overharvests. If no respect is shown, fish will avoid the greedy fisherman's nets in future harvests. Thus, in the interests of ensuring good relations between fisherman and fish, harvesting protocols must be maintained (Sherry and Vuntut Gwitchin First Nation 1999), including:

- do not overharvest (leads to waste of fish meat);
- kill quickly and humanely;

- handle fish cleanly; and
- no derogatory jokes or negative talk about fish.

People have observed a strict taboo about the Little Fish Creek “Fish Hole” [Cache Creek, Big Fish River] which demonstrates the reverence Inuvialuit and Gwich’in have for it. It is considered disrespectful and a harbinger of future ill fortune in harvesting if a person washes himself or animal meat in the water there. This important habitat of the Dolly Varden must be kept unspoiled at all times (Byers 1993).

The Siglit told Rasmussen (1942) in the 1920s of other taboos specific to salmonids. Drying char could never be laid out in the same direction in which they were swimming when caught. If there was sea mammal blubber in a house, char could not be brought in through the front entrance but only through a hole in a wall. Women were discouraged from eating a char whose head had been shot with a firearm. Char were never to be placed together with red meat for drying or at meal times. Sewing of animal hides such as moose or caribou was not to be done inside tents at char-fishing sites. If essential, sewing could only be done in an open place set apart from the fish camp. Only the latter two customs are still followed today, at least among the elders of Aklavik. Also, an elder reported that during the times of dog team transport, the youth were taught never to catch Dolly Varden in the shallow waters of “fish holes” by shooting them as the dogs would bark and howl all night long (DVTK Verification Workshop 2010).

Traditional fish management practices involve gear restrictions (mesh sizes for fish nets), rotational use of different lakes and rivers in alternating years and halting the use of an intensively harvested area for a number of years to, as one Inuvialuk elder told Byers (1993), "*allow the land to rest*". Byers (1993) reviews a number of factors first postulated by Berkes (1981) that have the potential to disrupt traditional management of the subsistence Dolly Varden fishery.

Among Aklavik elders polled in 1992, a quota system was the least supported (and incompatible with local management traditions and culture) means of managing Big Fish River Dolly Varden stock, compared to closure of the fishery and net restrictions. Quotas would be no more useful to fishing families than outright closure if the allotted numbers did not meet families’ needs.

> “*The 1992 BFR* [Big Fish River] *charr quota (13 charr per fisherman per week) established by the HTC was felt to be ill-conceived. It was explained that any future quota of this sort ought to be set at no fewer than 40 to 50 charr per fisherman since this amount could easily be gotten in just one net set during the height of the run. Fewer fish would not make it economically feasible to travel there from town considering the cost of gasoline*.” (Byers 1993:19).

MEDICINAL AND OTHER USES

Fish guts (intestines) were cleaned then fried. Fish oil rendered from it was saved and stored while the organ was given to dogs to eat. One tablespoon/day “*prevents illness, especially colds*” (Dene Cultural Institute 1989). If the oil was too old to use for medicine, it was mixed with bait for trapping and was especially effective for marten (A. Peterson reported at DVTK Verification Workshop 2010). Long ago, Gwich’in used the fish oil from Dolly Varden as ear drops for hearing problems (loosens ear wax) and soothing ear pain (Simon 1996; GRRB 2009a). It was also used in winter dog feed and as a commodity of trade with other First Nations as long ago as the early 1800s (Stewart 1979).

For burns and cuts, a poultice of Dolly Varden skin with oil/fat on it was placed directly on the affected area. Smoked and dried vertebrae were also used as bait in trapping furbearers (Benson 2010).

CHAR HEALTH AND FEEDING

Indicators of the health of Dolly Varden include: external colour and shape, fattiness, flesh colour and firmness, liver spottiness and presence of parasites. It is mentioned by harvesters that livers in fish are always checked for health (DVTK Verification Workshop 2010). Rat River Dolly Varden that migrate earlier than most, in late July to early August, may be pale but otherwise show no signs of ill health. This is significant as other fish species in the Mackenzie Delta have been caught with stunted livers, lesions, "watery" texture of flesh, unhealthy eggs and unpalatable flavour. In 1988, about 38% of people in Fort McPherson, Tsiigehtchic and Fort Good Hope had observed these conditions in whitefish and Burbot (*Lota lota*) in spring, summer and fall (DIAND 1990). There is no mention in the TEK literature about external scarring on Dolly Varden, but the WSWG does report on this as a science indicator of Dolly Varden health — less than 10% of sampled fish showed scars with a decreasing trend from 2012 to 2016. The WSWG is attempting to develop a similar TLK (Traditional and Local Knowledge) health indicator using scarring (WSWG 2018).

Current harvesters of coastal fish at Shingle Point report that Dolly Varden appear fatter than those caught in the earlier decade of this century (B. Archie, pers. comm., 2018). IHS data for 2016 and 2017 show all 1,138 Dolly Varden caught were categorized as being in "average" to "very healthy" condition (ISR-CBMP 2018); at Shingle Point in 2015-2017 and at the Big Fish "Fish Hole" in 2014-2016, they were categorized as healthy (WSWG 2018). A 2015 survey of 18 Inuvialuit by Brewster et al. (2016) showed that one third (33%) had noticed changes in coastal fish health generally. In that survey, Dolly Varden was the second most reported species in terms of health behind only Arctic Cisco. Most of the discussion centred around parasites rather than overall body condition, and concerns about this were not its effects on fish health but rather on edibility of these fish (J. Brewster, pers. comm. 2018).

It used to be uncommon to find Dolly Varden infested with worms or other parasites. The proportion of Inuvialuit fishers reporting parasite presence in char increased significantly in 2007 and 2008 (ABEKS 2011). It was not indicated whether these were internal or external. Abe Peterson, a Gwich'in elder, reported that only in the last few years of the first decade of the 2000s in the Rat River did he occasionally catch a Dolly Varden externally infected by long worms of roughly the diameter of a pin. [Fisheries biologists would recognize these as parasitic copepods from the sea that Dolly Varden may carry with them in their upriver migration, likely of the genus *Salmonicola* or *Coregonicola* (Stewart and Bernier 1999)]. He said that they do not appear to affect the health of the fish as the body always looks in good condition. These ectoparasites were a new occurrence in char in his experience. It has also been noted that healthy gills are bright red and even healthy ones sometimes have parasites. Rates of parasitism seem to be increasing as noticed in Dolly Varden caught at Destruction City. But it is the general consensus that parasitism in Dolly Varden is not a big issue for Dolly Varden health (Benson 2010; DVTK Verification Workshop 2010).

One elder reported that long ago, he had caught some Dolly Varden descending the Rat River in spring, "*but they were pale and skinny, as if they were starving.*" (GRRB and Gwich'in Elders 1997:162). This may be an observation of post-spawning fish that survive over winter returning to sea to replenish energy stores used for spawning and overwintering.

People believe the fish do not eat when travelling to the Rat River spawning grounds, as their stomachs are usually empty when caught during the upstream run. An Inuvialuk elder said that Dolly Varden in rivers eat things off rocks and stones (Peter Thrasher, pers. comm., 1992). He did not know if they were after invertebrates or periphyton, but he saw the fish feeding directly off the rocks as well as taking stones into their mouths and then spitting them out. Most knowledgeable fishers mention insects and fish are found in Dolly Varden stomachs in the Big Fish River in both autumn and summer (Byers 1993). In the Beaufort Sea, Abe Peterson observed Dolly Varden to eat “ice worms” [amphipods?] from the sea-ice edge when he was hunting seals (DVTK Verification Workshop 2010). Amphipods as well as small fish are eaten by char off the coast of Herschel Island in Workboat Passage and Ptarmigan Bay, where these prey species are thought to be attracted to the calm waters (Harwood et al. 2012).

NATURAL MORTALITY

GRRB and Gwich’in Elders (1997:162) reported that “*On their way upstream, some Dolly Varden die from accidents, disease and predators*.” The same can happen on the downstream migration in some rivers. Inuvialuit reported to Papik et al. (2003) that in some years on the Firth River, char swimming downstream at breakup can end up on top of river ice as the water flow is pushed up over unmelted ice [*aufeis*?]. They are stranded and can be easily picked up by hand or be caught by birds and animals if they do not die on their own before being discovered. On rivers to the west of the Delta, winter overflow conditions are especially common when there is a lot of northwest wind. Dead fish have also occasionally been seen on the Babbage River after spawning (DVTK Verification Workshop 2010). Similar events have been reported in the Big Fish River near Fish Hole (Byers 1993); particularly noteworthy was the spring of 1999 when hundreds of dead fish were found (Stephenson 2003).

Five Aklavik people reported Dolly Varden found dead of presumably natural causes at the Little Fish Creek "Fish Hole" at four different times (Byers 1993). Two elders found five “silvers” and unidentified fingerlings (probably YOY or 1+) dead at "Fish Hole" in the spring of 1986. Another found fewer than 10 spawning males dead in "Fish Hole", but did not remember the year. It is not known whether these were resident or anadromous fish. A fourth man reported finding "3 or 4 silvers" in March of an unknown year. They were in a pool empty of other adult char, although fingerlings were present. Finally, an elder told of finding dead "sardines" on top of the ice at "Fish Hole". These were likely juveniles of either Dolly Varden or Arctic Grayling.

TERRESTRIAL PREDATORS

Both black and grizzly bears, as well as river otters will eat Dolly Varden. Bears have been observed to fatten up on Dolly Varden in October in the Richardson Mountains prior to hibernating (GRRB and Gwich’in Elders 1997; Benson 2010; Benson 2014). A Gwich’in elder believes bears get nutrients from fish that aren’t present in other prey (Benson 2014). Inuvialuit and Gwich’in informants report seeing bears actively fishing at Dolly Varden spawning/overwintering sites. Grizzlies have also been seen to follow Dolly Varden runs upriver as the bears move into the mountains from the coast to den.

> “*Most times… they are moving into [the mountains]. I’ve seen myself, in the fall, I’m working [the] lower Firth …counting the Arctic char … in one day there were 14 grizzly bears walk by us, going upstream… I never, ever seen a bear come down river, they were all moving upriver*.” (WMAC[NS] and Aklavik HTC 2018a).

The lower water levels of the last several years have made the catching of fish by predators such as bears and eagles much easier and eagles have been seen in greater numbers around **Ne'eedilee** (Benson 2010). It is unclear whether people believe that bears and/or eagles were a contributing factor to the decline in the population of Dolly Varden, with some of the opinion that sea mammals on the coast were a more important source of predation pressure. Inuvialuit have observed seals congregating around the mouths of North Slope rivers (L. Harwood pers. comm. 2009). However, Gwich'in generally agreed that otters may be a factor in the decline of Dolly Varden stocks, and are concerned about otters since fish comprise the bulk of the otters' diet. In the mid-1990s, it was reported that otter activity on both the Big Fish and Rat rivers, including the spawning grounds, had increased (Norton 1997). In 2009, some fishermen still thought otter numbers were increasing, while another said this was not the case along the Husky Channel (RRWG meeting 2009; Benson 2010). The belief that otter numbers in the Mackenzie Delta are increasing continues, at least as late as 2016 (IRC 2016). It is unclear from the TEK literature whether an increasing otter population in the Delta would result in greater otter activity in the mountains. There is no biological information on the status of otter populations and no density or population estimates in the GSA. From 1995–2002 a total of only two otters were harvested within the GSA, both taken by Aklavik trappers in 1995. (GRRB 1996, 2005a). Total harvests were between 5 and 10 in each of 2016 and 2017 for Inuvialuit trappers in Aklavik, according to the harvest program director for the Joint Secretariat (C. Brogan, pers. comm., 2018). Gwich'in concerned about otters have recommended they be trapped to reduce their numbers, although it is said they are a difficult animal to trap (Benson 2010). The availability of dens and resting areas are important limiting habitat factors for otters (GRRB 1996). Other mammalian predators of Dolly Varden are said to be mink and foxes (GRRB and Gwich'in Elders 1997). Wolverine tracks have also been seen following spawning creeks (DVTK Verification Workshop 2010).

AVIAN PREDATORS

Eagles and gulls will eat char. There is no agreement on whether eagles are a contributing factor to the decline in the population of Dolly Varden, but one informant noted eagles are present at the Rat River spawning grounds in greater numbers than elsewhere (Benson 2010). It is possible that, as for bears, the shallower water in mountain streams over the past two decades has made catching Dolly Varden much easier for these birds.

AQUATIC PREDATORS

On the coast, seals and beluga whales eat Dolly Varden. The presence of beluga can have a positive or negative influence on harvesting success as they frighten char towards or away from gill nets (Norton 1997). Some Inuvialuit and Gwich'in thought that seals may be a factor in the declining stocks. Aquatic predators in Delta rivers include the piscivorous fishes Northern Pike and Burbot. One informant has seen Dolly Varden in a Northern Pike stomach. Nets set in rivers are positioned to avoid sites known to be frequented by pike (DVTK Verification Workshop 2010). Northern Pike were found at the Big Fish River fish hole in approximately 1975 (Byers 1993) and Burbot were reported at Fish Creek spawning grounds (**Ne'eedilee**) for the first time in 2001 (RRWG 2003). A number of observations of salmon in the Babbage and Firth watersheds is generating a new concern that salmon "intruders" may directly impact Dolly Varden (Aklavik HTC et al. 2016). In Alaska, the concern seems to be reversed as one Inuvialuit informant said there was a "bounty" on char in Alaska because the char eat salmon eggs (Benson 2010).

CANNIBALISM

Aklavik elders told Stephenson (2003) that large Dolly Varden will eat small ones at **Iqaluk alluaq**. It was not explained how they knew this (direct observation or checking stomach contents). However, Inuvialuit have caught them with lures on rod and reel after spawning at Fish Holes, inferring that they will eat smaller fish at the spawning grounds (DVTK Verification Workshop 2010).

INTERSPECIFIC INTERACTIONS

In the Big Fish River watershed, Arctic Grayling (known as “blue fish” or **srii jaa** in Teetł’it Gwich’in and **hulukpaugaq** in Inuvialuktun) are the only fish species other than Dolly Varden that annually use Little Fish Creek, although Round Whitefish (*Prosopium cylindraceum*), are also found there. There are conflicting reports of Round Whitefish being either always rare (Byers 1993) or common in decades past but rarer in the years preceding the fishery closure (Stephenson 2003). Like Dolly Varden, Arctic Grayling have been observed to be declining in Little Fish Creek in both number and size (Chiperzak and Cockney 2000; Stephenson 2003; Community of Aklavik et al. 2016). This trend has been observed since an unspecified time period prior to 1998. This observation may be a function of shifting locations of grayling habitat use rather than fewer grayling. In the abnormally warm October of 2002, Stephenson (2003) and four Aklavik HTC members found abundant grayling at an open-water downstream site that would have normally been ice-covered and thus inaccessible to fishers during the fall harvest.

Most Gwich’in see whitefish in the rivers during the **dhik’ii** run. However, some observe that whitefish are no longer caught when **dhik’ii** move through. Benson (2010) quotes one as saying:

> “*there is a lot of whitefish in the river; when the char come they all disappear basically. It is just like the char would have right of way*.”
> (Anonymous informant, as reported by Benson 2010:32).

LIMITING FACTORS AND THREATS TO DOLLY VARDEN POPULATIONS

Climate change is seen as threatening fish habitat. Related to climate change, coastal erosion and upland slumping and landslides are often mentioned occurrences in the ISR TEK literature. Climate change and land erosion seem to be top-of-mind for Inuvialuit. In Aklavik there is an initiative to use elders' knowledge of their language and of the land to develop a trilingual (Inuvialuit-Gwich'in-English) dictionary of words and terms related to climate change (IRC 2016). As reported by Trisha Greenland, an Inuvialuit ABEKS community monitor in Aklavik, harvesters:

> "*like to share their knowledge about the land, like to talk about mudslides and climate change*." (ABEKS 2017).

Permafrost melt and the resulting land erosion are observed to be intensifying and accelerating. Inuvialuit in Aklavik, Inuvik and Tuktoyaktuk are seeing increased coastal shoreline erosion along the entire coastline from the Mackenzie Delta all the way to Herschel Island (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006; Brewster et al. 2016). Burial sites, noted particularly at Ptarmigan Bay (**Qargialuk**) and Shingle Point (**Tapqaq**), are even starting to fall into the sea (WMAC[NS] and Aklavik HTC 2018a). On the stretch of coastline between Shingle Point and Kay Point there is one elder report of roughly between 300 and 400 mudslides. This is attributable to both wind-

driven sea waves on the newly ice-free sea, and melting permafrost on land (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006; DVTK Verification Workshop 2010). As stated by Emmanuel Adam of Tuktoyaktuk:

> "*Even from my own observations, from my own travels, things have really changed. And it's getting faster and faster because of the warming, because of the melt. Things are changing pretty fast now*." (Bennett 2012).

One landform is significant to Aklavik Inuvialuit in regard to coastal erosion impacts. Seagull Island, also known as Escape Reef, due west of Shingle Point, was used as an emergency shelter from strong west winds in boating between Shingle Point and Herschel Island. Most of it has been washed away.

These observations have been corroborated by scientists who also use TEK information sources. In fact, geomorphologists state that Inuvialuit travelling along the Beaufort coast "*provide most of our information about wave and storm patterns*." (Pollard et al. 2012:75). Storm surges have been observed to cause water levels at coastal shorelines to rise by 1.2 m, washing over sand and gravel spits and small barrier islands. The frequency and intensity of storms battering the Herschel Island coast increase from August through October. In most years this area experiences at least four major storms (defined as waves of 1.5 to 2.0 meters to a maximum of 3.0 meters) (Pollard et al. 2012).

An interesting observation that may signal changes in seawater currents and/or water quality is that jellyfish are no longer observed off Shingle Point (Brewster et al. 2016).

Geologists have reported significant coastal erosion occurring as early as the mid 20th century (McKay 1963; Pollard et al. 2012). Some coastal study sites between Blow River and the southern end of Shallow Bay experienced a loss of 3–5 m of land per year over a 50-year period and even individual storms have been known to cut back the shoreline by that amount. Within a 20-year period an island over 6 m high and well over 100 m wide was reduced to a sand spit connected to land (McKay 1963). Thaw slumps are reported to have increased in number by 73% and in areal extent by 14% along the entire Yukon coast between 1952 and 2011 (Ramage et al. 2018). On Herschel Island alone, thaw slumps are reported to have increased in number by 125% and in areal extent by 160% between 1952 and 2000. Herschel Island's ice-rich, fine-grained soils are highly erodible by sea waves. Almost the entire coastline around the island is eroding away, and has been since at least the 1950s, at an average rate of coastline retreat of 1.5 m per year (Pollard et al. 2012) with a recently measured maximum of 21 m in one year at Avadlek Spit (Obu et al. 2017). Scientists say that the coastal thaw slumps they and Inuvialuit are seeing on the island are larger and more spatially concentrated than most places in the Canadian Arctic. Inuvialuit question whether coastal soil erosion into the sea is impacting the Dolly Varden's nearshore migration corridor.

Permafrost thaw is by no means restricted to the coast. Teetl'it Gwich'in report the most commonly seen change in the landscape is slumping and erosion attributed to permafrost thaw. They see this most prominently in the Peel Plateau southwest of Ft. McPherson and in the lower Peel River watershed (Gill 2013). This is also reported by geologists in this region (Kokelj et al. 2017).

Mountain streams are drying up, and channels in the Mackenzie Delta that used to be travelled by schooner decades ago would not be passable by them if used today. Noticeably lower water levels are seen at several places including Esau Channel, Big Fish River, Moose Channel and lakes beside Moose Channel, Husky Channel and Peel Channel (Chiperzak and Cockney 2000; DVTK Verification Workshop 2010). This sometimes makes returning to Aklavik from fish camps difficult and new travel

routes need to be taken. In general, more open water, stream overflows, and shallow waters make travel more difficult for Aklavik harvesters (IRC 2016). Phillips Bay and the Firth River delta are also shallower now than decades ago. In the early to mid-20th century, when large schooners were in use, Inuvialuit were able to dock their schooners at the shore of both of these locations but now, even with the much shallower-draught boats used today, people have to pole their way in (Papik et al. 2003).

Eddy pools are gradually filling in, resulting in eddies disappearing or becoming too shallow to set nets (Benson 2010). Fewer drift logs are seen in rivers than in the 1970s, indicating that spring high-water levels are not as high as they once were. Gwich'in harvest drift logs for a variety of uses such as home-building, tent poles, pilings, skids, smoking and caching food and as firewood, therefore the absence of driftwood does not escape their notice (Greenland and Walker-Larsen 2002). Besides climate change, stream obstruction by beaver dams and otter houses are blamed for lower water levels. Populations of these mammals are believed to be increasing (IRC 2016).

Inuvialuit believe water levels are also being impacted, at least partially, by developments further south. As far back as the early 1990s, no one in Aklavik attributed the trend of shallower water in the Big Fish River to normal river bank erosion or sediment deposition. Decreasing water levels were considered as a separate, unrelated process. In addition to climate change, water manipulations further south, such as hydroelectric dams on the Peace River in northern BC and draining of lakes (caused by Delta rivers gradually changing their course, cutting into lakeshores thereby draining lake water into the river channel), are considered to be the culprits (Chiperzak and Cockney 2000; DVTK Verification Workshop 2010).

The current trend to growth of larger and more numerous stands of willows[7] close to riverways in the Delta is thought by some Inuvialuit elders to possibly be "drinking" that much more water from the banks (DVTK Verification Workshop 2010). More beaver dams have also been seen in back channels.

At **Iqaluk alluaq,** elders say that at places in the creek that you could only cross with hip waders over 40 years ago you now need only rubber boots. Also, much less water is flowing out of the falls above the pools. One regular user of the **Iqaluk alluaq** reported noticing the start of lower water levels there in 1988 (Byers 1993). Aklavik fishermen have also reported episodes of a mysterious rapid fluctuation in water levels at overwintering grounds in the Big Fish River. Waters rapidly increased and subsequently rapidly declined, leaving Dolly Varden stranded in pools on higher ground (Norton 1997). A rock slide about 20 km upstream of the Big Fish River mouth was also mentioned. Additionally, elders say that a large section of limestone cliff, just above the main waterfall on Little Fish Creek, collapsed into the stream during the late 1970s or early 1980s. These significant natural events may have been triggered by earthquakes that reduced the flow of a primary tributary into the Big Fish River mainstem and may have resulted in lower water levels at **Iqaluk alluaq** (Byers 1993; Sandstrom and Harwood 2002; DVTK Verification Workshop 2010). These local observations correlate reasonably well with records of the Geological Survey of Canada which measured an earthquake in the Richardson Mountains in the "Fish Hole" area in 1976, as well as two earth tremors in the late '70s and seven between 1981 and 1985. While all of these seismic events could have affected water quality and groundwater discharge volume, the ones in the early '80s were nearest the surface and consequently could also have affected stream flow (Stephenson 2003). A younger harvester in his late 20s gave an intriguing account of the aftermath of a more recent (2013) earthquake in the area of the upper reaches of Big Fish River:

[7] Willow is often used in English by Inuvialuit as a catch-all word to refer to willow (*Salix* spp.), alder (*Alnus* spp.) and birch (*Betula* spp.) shrubs (Bandringa and Inuvialuit Elders 2010).

> "*Up Fish River there's a mountain at the forks. There was an earthquake… two years ago in the forks of that mountain. It cracked. It must have been a foot wide and hot air was coming out. Then, two months ago, three months ago, when we went to go check it out again, all that crack that formed, it was pushing out gravel, hot gravel….It must have been as high as the big building here. We walked up onto it, and it was like minus 30* [air temperature, degrees C]*, and we were picking up rocks that are warm…. Those boys too, when we walked up to the top, they smelt that smoke when they went back down, when I was waiting for them at the bottom. When they came back down they had a wicked headache just like a migraine.*" (WMAC[NS] and Aklavik HTC 2018b: 102).

The most recent observations of seismic activity on the Big Fish River are being investigated by the WSWG. A site of gas emissions, dead spruce trees on the bank and orange and greenish coloured water) was located in 2014 on a tributary about 100 m upstream from its confluence with the Big Fish River and extends 200 m upstream. Later water sample analysis revealed low pH and high metals. It is speculated that earth movement due to a landslide may have exposed sulfur-rich shale or coal to the air. A chemical reaction with oxygen could cause combustion, a phenomenon similar to the Smoking Hills on the east coast of Cape Bathurst. Similar to the 2013 account above, three Inuvialuit suffered headaches when they were at the site and mentioned a foul taste from the air. Inuvialuit are questioning how this water quality change may affect Dolly Varden migration in the river (WSWG 2014).

Aklavik residents have observed a significant decrease in salinity at the "Fish Hole"; the high salt content made the water undrinkable 40 years ago, but you could drink it beginning in 1991 and 1992 continuing to the early years of this century (Byers 1993; Papik et al. 2003). In more recent years the water has returned to being salty (B. Archie, pers. comm., 2010). The Big Fish River is also siltier than in previous decades and break-up has been occurring earlier in the year (Papik et al. 2003). It has been pointed out, though, that this latter point may be influenced by where the observations were made along the river as meltwater flows and ice breakup occur earlier in the mountains than in the Delta (DVTK Verification Workshop 2010).

People have no doubt that something is changing the rivers and lakes that they have known throughout their lives. Landslides and riverbank washouts are more frequent in the Rat River watershed over the last two decades. As Tsiigehtchic elder Billy Cardinal is quoted as saying:

> "*It is hard to explain unless they're raised up in the bush like we do, thus we know the changes right away we can tell the [river]banks is going fast, we can tell there's slides, more slides along Mackenzie than before, and the ice on the lakes is not like it used to [be]. You might have about three feet ice, maybe a one foot and a half of main ice, blue ice, the rest is frozen slush, it's not like long ago, maybe slush on top…the rest is blue ice all the way, real main ice so that lakes and rivers can stay good for a long time in the spring, but now it goes really fast. It even melting from the bottom, I noticed that 'cause I trap rats. Ice is melting from the bottom.*" (Mustonenen [Pulli] and Elders of Tsiighetchic 2004:155).

Almost half of 15 Inuvialuit respondents (46%) recently surveyed by Brewster et al. (2016) have noticed an increase in air temperature. This is borne out by the historical record for Herschel Island. A missionary who established the first mission on the island recorded detailed meteorological

measurements from 1897 to 1903. His annual mean temperatures were 3°C lower than mean annual temperatures between 1995–2010 (Burn 2012). A similar historical warming trend for summer air temperatures has been reported in the Mackenzie Delta over an 80 year period (Lantz and Kokelj 2008). Symptomatic of the increased air temperatures, freeze-up on the east side of Herschel Island has been later over 110 years. Burn (2012) reported that freeze-up at Pauline Cove was almost one month later during the 10-year period 2000–2010 when compared to the 1890–1900 period.

There are a number of observable effects of this warming that can adversely impact Dolly Varden habitat, according to Inuvialuit. There is less snow in the hills along the coast as noticed in the lifetimes of Inuvialuit. This is attributed to drier fall and winter seasons every year from at least 2002 to 2008 (ABEKS 2011). This can directly affect Dolly Varden habitat in that less runoff results in shallower streams important to Dolly Varden migration, spawning and overwintering (WMAC[NS] and Aklavik HTC 2018a). Warm west and northwest winds are indicative of impending storms such that Aklavik people will avoid travel to Shingle Point. In general, these storms as well as thunderstorms are more frequent and precipitation has increased (Brewster et al. 2016), while calm weather periods have decreased (Kokelj et al. 2012). Greater storm frequency and less nearshore sea ice result in storm surges that drive waves into the shoreline. Greater intensity and frequency of storm surges combined with melting permafrost create greater opportunity for coastal erosion which can muddy the nearshore migratory routes of anadromous fish.

Coastal storm surge impacts are not restricted to coastal areas. Inuvialuit reported to Kokelj et al. (2012) that extreme storm surges like the one identified in 1999 have been known to drive brackish seawater far upstream into the Blow River delta and channels of the Mackenzie River. Storm surges more often than not occur in fall when the Mackenzie is at low water levels and its freshwater outflow is reduced. This allows storm-driven Beaufort Sea water to push well upriver, raising water levels in the channels temporarily (up to 1.5 m rise in the East Channel at Inuvik in the early 2000s) and forcing salt water upriver. Inuvialuit report taking river water for tea after a storm surge that tasted salty all the way upriver to 20 km below Aklavik.

Inuvialuit fish monitor Annie B. Gordon noted the unpredictable weather patterns leave people to wonder if the late freeze-up, deep snow and overflow are caused by climate change. Her indicator of change was tied to fish processing. The dampness of the humid, rainy weather of 2003 made it very difficult to dry enough fish to meet the people's needs (ABEKS 2004).

Inuvialuit and Gwich'in are also concerned that industrial development, especially hydrocarbon exploration/production and shipping, and barging operations will have a major impact on the fish resources. Seismic exploration for oil and gas in Tuktoyaktuk peninsula and Mackenzie Delta south to 68°N latitude occurred in the late 1960s through the 1990s, resulting in 156 onshore wells in this region by 1995 (INAC 1995). Offshore exploration occurred most prominently in the late 1970s through the 1980s. Thetis Bay on the east coast of Herschel Island served as an exploration base in the early 1980s, with oil tankers, ice breakers, supply ships, tug boats and two mobile drilling platforms overwintering there (Lane et al. 2012). Smith (2015) maps an array of seismic lines within Mackenzie Bay that both parallel and bisect the Dolly Varden migration route. As long ago as the Berger Commission inquiry of the mid-1970s, Gwich'in related how, although still plentiful, char were not as healthy directly after seismic explosions in Delta rivers in the 1960s and 70s (Berger 1977). Inuvialuit living at Herschel Island experienced reduced harvesting success (Mackenzie Valley Pipeline Inquiry 1975a). Seismic work by developers is cause for concern for a couple of reasons. Firstly, a potential

direct impact on fish is considered to be bursting of fish bladders by the high-intensity pressure waves of air guns, as Frank Elanik of Aklavik told the Berger Inquiry in 1975:

> "*when I was a kid I used to walk on the lake and on the river along the shore and you can see little fishes swimming under the ice, and if you bang the ice, they will roll over, and the same with the muskrat in the lake. If you are following up on a muskrat in a lake and you bang the ice, they roll over dead.*" (Mackenzie Valley Pipeline Inquiry 1975a: 25).

Inuvialuit surmise that some fish killed by this would not float to the surface to be visible to community fish monitors, rather they would sink to the bottom. But if they did float people would likely be alerted to this by congregations of gulls at kill sites (EIRB 2003). Secondly, although not yet seen in Dolly Varden waterways, Inuvialuit and Gwich'in have observed that winter seismic work done in the Mackenzie delta and lower Peel River watershed often destroys or blocks creeks due to broken willows, the damage only noticeable when spring arrives (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006). In fact, there is a Gwich'in legend about the damming of a Dolly Varden stream that has been told for generations. The legend tells of a powerful, malevolent medicine man who caused a rock slide to dam Fish Creek near the "Fish Hole", thus preventing Dolly Varden from swimming down to where the people could catch them. The worried people could only break the dam through appealing to the medicine man's son, who used his own magical powers to create a huge fish to break through the dam. This story provided a lesson to generations of Gwich'in as to how human activities can impact a Dolly Varden fish migration and the attendant essential harvesting (GRRB and Gwich'in Elders 1997).

Petroleum reserves have been identified along faults within the watershed near the mouth of the Rat River. Sand, gravel and rock material along the Dempster Highway through the James Creek area (a tributary of the Vittrekwa River) is valued by the Government of Northwest Territories Department of Transportation (Gwich'in Land Use Planning Board 2003).

Inuvialuit are aware that mercury levels in beluga on the Beaufort Sea coast have been increasing over the last 20 years. Thus, there is concern among Inuvialuit and Gwich'in that the same thing could be happening to anadromous fish such as Dolly Varden (RRWG 2009).

Inuvialuit do not want to see dredging at or near spawning sites (Inuvik, Aklavik and Tuktoyaktuk Community Corporations 2006). Construction of port facilities and structures to stabilize shorelines on the Beaufort Sea coast may alter fish habitat or prevent fish from following their normal migration routes, and this construction could put contaminated sediments into the sea (Chiperzak and Cockney 2000). An industry-proposed option when closing down an oil rig platform after production is completed is to store the platform at Herschel Island. This option has been identified as a small but long-term risk to Dolly Varden and/or its habitat (Devon Canada Corporation 2004).

Gwich'in are also concerned with upstream and downstream effects on water and fish habitat from road and pipeline water crossings (Joint Review Panel 2008). Erosion of the banks during and after construction, as well as possible rupture of the pipeline in the vicinity of rivers and streams, leading to damming or polluting the waterway, are the greatest fears.

In a general sense, when nature acts in unpredictable ways, this can be cause for concern in people who make a living from the land. Unexpected or unpredictable conditions or occurrences in nature are usually attributed to an anthropogenic cause by the Inuvialuit and Gwich'in. Gwich'in use the word

"wild" to describe wildlife that do not offer themselves to harvesters. As reported by Wishart et al. (2000:23-24):

> "*People have noticed that the weather is considerably warmer than it used to be and they attribute to this a variety of problems… Having spent the spring of 1999 on the land with several members of the community I was able to record several instances of people talking about how their 'country' is going wild. The weather during this spring was characterized as being poor. The ice did not let out until late, the latest anybody had seen, and the geese were acting wild which kept people from having successful hunts. The anxiety caused by such strange fluctuations in weather and animal behaviour have people very concerned that something is going drastically wrong due to improper behaviour of people somewhere. The fact that the water was several feet below its normal level has people looking southwards – upriver – to seek a cause for these 'wild' events.*"

Ultimately, any adverse changes to fish, their habitat and/or access to fishing sites that are induced by climate change negatively affect Inuvialuit and Gwich'in directly both in terms of health and culture. Fewer fish or access to them has food security implications through increased reliance on less affordable, often less nutritious store-bought food. Lack of access to fishing sites over prolonged time also risks the loss of TEK itself. When Inuvialuit and Gwich'in no longer have that connection to harvesting sites, this negates the need to be there and travel to them. Thus, the direct contact with the land is broken, reducing the relevant TEK in the future to treasured stories from ancestors without the ability to use the transmitted TEK to inform contemporary harvesting lifestyles and the inability to build on the TEK with additional contemporary observations (IRC 2016).

THE SAHTU

The Sahtu Settlement Harvest Study Data Report for 1998 through 2003 has recorded no more than 21 Dolly Varden harvested in any one year, with none recorded in 2003. The only communities reporting a Dolly Varden harvest are Norman Wells (10 in August 1999, 1 in 2000 and 2001) and Tulita (11 in July 1999, 6 in May and September 2002). However, people in those communities may not distinguish between Dolly Varden and Bull Trout, so those numbers may either represent all, or include an unknown number of, Bull Trout (Sahtu Renewable Resources Board 2002).

One Dolly Varden was caught in September of 2008 at Fort Good Hope, reportedly the first time in memory of Fort Good Hope residents. Its identification was confirmed by a biologist and was described as having a "flatter" profile, and a red ventral surface. It was caught at the mouth of Jackfish Creek outside of town in an eddy where whitefish and Inconnu are harvested (Roger Boniface, pers. comm., 2009).

It is noteworthy that a traditional trail (**Shuht'a got'ine eht'ene)** used for centuries by the Mountain Dene people (**Shita Got'ine**) to get into the Mackenzie Mountains in the fall, passed through the Keele River and on to Drum Lake (Sahtu Heritage Places and Sites Joint Working Group 2000). These water bodies are known to contain Bull Trout (Mochnacz 2002; Reist et al. 2002). Interestingly, although people in Deline have a unique Slavey word for char (**łuewa**) that is different from the other Sahtu communities (McLean 1998; Sahtu Renewable Resources Board 2002), none was reported in the Sahtu Harvest Study for Deline. However, Bull Trout do occur in the Great Bear River (Reist et al.

2002). Given the question from the documents at hand concerning local identification of the Dolly Varden/Bull Trout complex in the Sahtu, this issue may require a separate TEK study to properly document. Perhaps a local Slavey taxonomy has its own words for the two distinct species or types of fish equivalent to those biologists delineate as Dolly Varden and Bull Trout.

In 1971, Environment Canada's Fisheries Service (the precursor to the Department of Fisheries and Oceans) collected a few charr they classified as Dolly Varden in the Mackenzie River at the inflow of Stewart Creek, just outside Norman Wells, and Bluefish Creek just west of Tulita (Hatfield et al. 1972). O'Grady Lakes, in the mountains west of Tulita, is described by the Sahtu Land Use Planning Board (2001) as a "wetland complex" containing "Dolly Varten (sic)". However, a recent consultant's report (EBA Engineering Consultants Ltd. 2009) displays a map of fish locations showing only Bull Trout at that site. These conclusions likely reflect the taxonomic realignment documented in Reist et al. (2002).

After discussions with the former director of the Sahtu Renewable Resources Board (Jody Snortland Pellissey), staff of Renewable Resources councils of Norman Wells and Fort Good Hope, and a university researcher of Fort Good Hope TK (Deborah Simmons, University of Manitoba), it was determined that there were likely no TEK studies dedicated specifically to Dolly Varden, Bull Trout, or fishing ever done in this area. However, industry environmental assessment reports for projects in the mountains were not examined; these may hold some TEK on the subject of Dolly Varden/Bull Trout or their stream habitat.

As in the ISR and GSA, Indigenous people of the Sahtu are concerned about dropping water levels. Water levels in mountain streams are observed to be decreasing (Roger Boniface, pers. comm., 2009). Furthermore, the Sahtu Renewable Resources Board has observed changes to water levels that it associates with winter road construction: "*Water drawn from rivers and lakes to construct the ice road is both depleting water in fish-bearing and beaver-inhabited waters, and at the same time creating a stream from the runoff extending the full course of the road, effectively creating an artificial river during spring melt*." (Gartner Lee Ltd. 2005:21).

There was concern for the preservation of fish habitat in waterways that were to be crossed by the proposed Mackenzie Valley Pipeline. Another concern, relating to harvesting rights, was expressed as: "*Workers that are brought in from outside of the Sahtu to live and work compete for harvesting resources. This was seen in Norman Wells and resulted in large increases in fishing and hunting of large game in the Mackenzie Mountains*." (Gartner Lee Ltd. 2005:22).

The SRRB advised the Joint Review Panel for the Proposed Mackenzie Gas Project that ice roads should be sited away from steep embankments of rivers and streams (Joint Review Panel 2007).

SUMMARY AND CONCLUSIONS

Subsistence harvesting of northern form Dolly Varden has been conducted by Inuvialuit and Gwich'in since at least the 19th century in rivers on the west side of the Mackenzie River and Yukon North Slope (rivers and coast). Rivers on the North Slope of the Yukon Territory that are utilized by Dolly Varden include the Fish, Malcolm, Firth and Babbage rivers as well as coastal nearshore areas. Major river systems for this anadromous fish species in the NWT are the Big Fish and Rat rivers, both of which are formed from headwaters in the Richardson Mountains. The Vittrekwa, Road and Trail rivers further south in the Peel River drainage are also used by Dolly Varden. At least one isolated population of Dolly Varden occurs in the Sahtu Settlement Area (Mochnacz and Reist 2007), but the documented

TEK on this species is primarily associated with fishing on the Rat and Big Fish rivers as well as along the Beaufort Sea coast.

Inuvialuit and Gwich'in TEK provides a wealth of information regarding the biology and traditional use of Dolly Varden, unsurprising considering these Indigenous land users have harvested the same fish species in the same locations for many generations. Fishers are always keenly interested in the relative abundance of Dolly Varden stocks as well as the physical condition of individual fish. As well, changes in fish habitat do not escape their notice and this is a subject of much concern and discussion in communities.

A common theme in discussions of causes of habitat changes is the seemingly drier and warming climate as seen in lowering of water levels in rivers and upland streams, reduced snowpack on the Yukon North Slope, and greater frequency and areal extent of permafrost thaw resulting in land erosion into the sea coast and inland waterways. A drier climate seems to be noticed further south in the NWT as well. As in the ISR and GSA, declining water levels in the Sahtu area are observed in the mountain waterways. Climate change and winter road construction are the likely culprits according to Indigenous people there.

Mammal predation on Dolly Varden in rivers and in the sea is a significant concern expressed by both Inuvialuit and Gwich'in. Although it is feared that predation may play a role in reductions in Dolly Varden stocks, habitat changes appear to be of greater concern. In addition to climate change impacts, industrial development in the Beaufort Sea associated with hydrocarbon exploration and extraction (i.e., drilling and shipping activity) as well as seismic work in the Delta are ongoing concerns for the future of the Dolly Varden population and its harvest. The primary concerns associated with these activities are physical disruption of the migration by stream blockages and chemical contamination of habitat.

As stated by Howland et al. (2012), after decades of Dolly Varden research and stock assessments it remains an open question as to how the mechanisms of interaction between changing harvest rates and changing environmental conditions in the face of climate change influence shifts in stock abundance over time. Hopefully the knowledge base of Dolly Varden harvesters as synthesized in this report will serve to help answer this question. It should be apparent from this report that the ongoing study of habitat change and Dolly Varden reactions to it that inform effective management of the species will require the contribution of ongoing field observation by Inuvialuit and Gwich'in land users.

The development of indicators of stock health for the Big Fish River calls for both Science and TEK information inputs (WSWG 2018). The synthesis of TEK on Dolly Varden in this report should provide such information relevant to stock management decision-making for not only the Big Fish River but for all stocks. In a larger sense, it is the authors' expectation that this report will also provide positive support to those advocating for incorporating TEK into fisheries management decision-making.

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APPENDIX A

Appendix Table A1. Inuvialuit, Gwich'in and North Slavey word translations**.**

English	Inuvialuktun (Uummarmiutun dialect)
Dolly Varden "charr"	*iqalukpik/ iqalukpiit* (plural)
(land-locked)	*iqaluaqpak*
spawning charr	*ivitaarut*
juvenile charr	*iqaluyak*
egg(s)	*suvak(it)*
the land	*nuna*
sea; salty water; table salt	*tariuq*
grayling	*hulukpaugaq*
Broad Whitefish	*anaakliq*
Predators	
river otter	*pamiuquuq*
eagle	*tingmiakput*
ringed seal	*natchiq*
grizzly bear	*aklaq*
Burbot	*tittaalik*
Northern Pike "jackfish"	*hiullik*
Fishing Equipment	
fish hook (for small fish)	*nikhik*
fish hook (home-made for rod & reel)	*iqaluksiun*
long pole used to set nets from shore	*qaimutaq*
sweep net	*qaaqtuun*
chisel (bone or steel)	*tuuq/ turrun*
fish scoop	*qalutaq*
ice scoop (made of wood or caribou scapula)	*ilaun*
gill net (for coastal fishing)	*kiimun*
baleen gill net	*qupyaq*
willow fish trap	*taluyaq/qaluyaq*
spear	*Qaggiaq/kakivak*
forked spear	*kakivait/kappun*
sinkers (for nets of rod & reel)	*qiviyaouat*
whale bag (for storing fish and other foods)	*qilalukkam aqirua*
dryfish	*bipsi*
frozen fish	*quaq*
	Teetł'it Gwich'in
Dolly Varden "mountain trout" or "river trout"	*dhik'ii*
Dolly Varden male	*dhik'ii dinjii*
Dolly Varden female	*dhik'ii tri'k*
large Dolly Varden	*dhik'ii choo*
small Dolly Varden	*dhik'ii tsal*
the land	*nan* or *nan kak*
fish eggs	*k'in*
place where fish spawn	*Ne'eedilee*
lobstick tree (marker)	*njoh*
Cisco "herring"	*treeluk*
Broad Whitefish	*łuk zheii*
Inconnu "coney"	*sruh*

English	Teetł'it Gwich'in
grayling	*srii jaa*
Predators	
grizzly bear	*shih / sheh*
black bear	*shoh*
Burbot	*chehluk*
	North Slavey
Dolly Varden/Bull Trout	*dehgá sahba* (not used in Fort Good Hope)
Arctic Char "red fish" "silver trout"	*Åuededele* or *luge dedélé* or *łuewa* (Deline)
Lake Trout "trout"	*sahba*

APPENDIX B

Appendix Table B1. Inuvialuit Harvest Study – estimated total number of Dolly Varden harvested for Aklavik from 1988–1997 (Joint Secretariat 2003).

1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
661 ± 59	1,111 ± 64	661 ± 98	349 ± 117	750 ± 64	1,241 ± 158	2,742 ± 1212	516 ± 111	2,054 ± 356	1,017 ± 165

Appendix Table B2. Estimated total annual Dolly Varden harvest by Inuvialuit and Gwich'in, and percent harvested by all Gwich'in (DFO 2010), and estimated percent harvests from Gwich'in residents of Aklavik, Fort McPherson and Inuvik (GRRB 2005b, 2009b).

Year	Total Number Dolly Varden Harvested	% Harvest by all Gwich'in	% Harvest by Aklavik	% Harvest by Fort MacPherson	% Harvest by Inuvik
1972	15,500 – 19,500	33.3 - 41.9			
1973	6,650	39.1			
1975	>2,100	Unknown			
1980	1,639	94.3			
1984	>343	Unknown			
1985	>989	Unknown			
1986	2,975	37.0			
1987	3,328	93.9			
1988	2,416 [a]	69.6			
1989	3,163 [a]	63.2			
1990	1,819 [a]	57.8			
1991	728 [a]	51.6			
1992	1,793 [a]	57.7			
1993	2,710 [a]	51.9			
1994	4,914 [a]	43.8			
1995	2,072 [a]	73.5	99.7	0	0.3
1996	5,377 [a]	54.3	37.9	61.3	0.7
1997	4,472 [a]	75.9	57.8	39.8	2.3
1998	4,146 [a]	90.7	49.0	48.1	2.8
1999	2,232 [a]	85.6	46.2	52.7	1.0
2000	1,492 [a]	97.4	15.2	84.7	0
2001	1,782-1,806 [a]	98.6-99.9	0	100	0
2002	636-660[a]	96.2-99.8	72.2	25.6	
2003	1,492[a]	-	59.7	40.3	
2004	772[a]	-	58.6	40.3	
2005	658	-			
2006	188	66.0			
2007	186	64.5			
2008	175	68.0			
2009	95				

[a] Original total number pending to ensure no double counting of DFO information between the Gwich'in Harvest Study and the Inuvialuit Harvest Study (DFO 2010).

Appendix Table B3. Harvest totals from Dolly Varden fishing areas (DFO 2010: Table G2). 2014 data from Nov 2014 WSWG meeting minutes. Data from 2016 and 2017 was provided by the Joint Secretariat's ISR-Community Based Monitoring Program, 2018. No data found for 2012, 2013, and 2015.

Year	Inland Fisheries				Coastal Fisheries		
	Big Fish River	Rat River	Husky River	Peel Channel	Herschel Island	Shingle Point	Others
1971					200		
1972	8,000–12,000	6,500			1,000		
1973	3,850	2,600			200		
1975		2,100					
1980	94	1,545					
1984	343						
1985	989						
1986	1,875	1,100					
1987	0[b]	3,125			73	259	
1988	0[b]	1,681				147	50 (King Point)
1989	0[b]	1,999			25	30	75[a]
1990	0[b]	1,051				214	5 (Phillips Bay)
1991	0[b]	376			30	7	
1992	24	1,034			20	17	24 (King Point)
1993	40	1,409			19	119	
1994	36–74	2,155			130	33-110	36 (King Point)
1995	40–93	1,492			48	63-171	16 (PhillipsBay)
1996	18	2,517			560	805	
1997	99	3,331			130	124	
1998	77	3,319			233	521	35[a]
1999	96	1,761				250	
2000	39	1,485				15	15 (King Point)
2001	1–25	1,781				<50	
2002	1–25	1,180				<50	
2003	0[b]	1,083					
2004	0[b]	363					
2005	0[b]	554					
2006	0[b]	132[b]				127	
2007	0[b]	146[b]			113	106	
2008	0[b]	120[b]			51	29	
2009		95			80	307	2 (PhillipsBay) 6 (Ptarmigan Bay)
2010					256	252	
2011*					129	193	43 (King Point) 93 (Ptarmigan Bay)
2012*							
2013*							
2014*	140	216	56	15	157		
2016*[c]			201	10		306	
2017[c,d]	7	10	58		154	338	

[a] Includes an unknown number from Shingle Point.

[b] Fishery closure; 120 allocated to community-based Rat River fishery monitors.

[c] Inuvialuit Harvest Study only

[d] An additional 9 caught at “Fish Point” on a tributary of Beaver House Creek.

[*] A 2019 IFMP report containing updated harvest numbers for these years is not yet finalized as we go to press.