

**Integrated Fisheries Management Plan  
for  
Dolly Varden (*Salvelinus malma malma*)  
of the  
Gwich'in Settlement Area  
and  
Inuvialuit Settlement Region  
  
Northwest Territories and Yukon North Slope**

**VOLUME 1: THE PLAN – 2019 UPDATE**



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## FOREWORD

This Integrated Fisheries Management Plan (IFMP) updates the 2011-2015 IFMP for Dolly Varden (*Salvelinus malma malma*) populations and fisheries in the Gwich'in Settlement Area (GSA) and Inuvialuit Settlement Region (ISR) of the Northwest Territories and Yukon North Slope (DFO *et al.* 2010). It incorporates new information, including the listing of Dolly Varden as a species of Special Concern under the *Species at Risk Act* (SARA) in May 2017. It identifies the main objectives and management strategies and measures for the conservation, sustainable use and rebuilding of these Dolly Varden populations and fisheries in the GSA and ISR. It reflects the requirements for a SARA Management Plan for Dolly Varden in the GSA and ISR.

The IFMP also serves to communicate the updated information on the fisheries and their management to Fisheries and Oceans Canada (DFO), the Gwich'in Renewable Resources Board (GRRB), the Fisheries Joint Management Committee (FJMC), Parks Canada Agency (PCA), the Aklavik Hunters and Trappers Committee (HTC), Renewable Resources Councils (RRCs), communities, fishermen and other stakeholders. This IFMP provides a common understanding of the basic guidelines for the conservation, sustainable use and management of the Dolly Varden populations and fisheries. It meets DFO's requirements for an IFMP.

This IFMP is not a legally binding instrument which can form the basis of a legal challenge. The IFMP can be modified at any time, and does not fetter the Minister of Fisheries and Oceans' discretionary powers set out in the *Fisheries Act*. The Minister can, for reasons of conservation or any other valid reasons, modify any provision of this IFMP in accordance with the powers granted pursuant to the *Fisheries Act*, but subject to the requirements of the Gwich'in Comprehensive Land Claim Agreement (GCLCA) and Inuvialuit Final Agreement (IFA).

Where DFO is responsible for implementing obligations under the GCLCA or IFA, the IFMP will be implemented in a manner consistent with these obligations. In the event that the IFMP is inconsistent with obligations under these agreements, the provisions of the agreements will prevail to the extent of the inconsistency.

This IFMP for Dolly Varden in the GSA and ISR will be incorporated in or adopted as part of the required SARA management plan for Western Arctic populations of Dolly Varden.

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## 1. INTRODUCTION

This Integrated Fisheries Management Plan (IFMP) updates the 2011-2015 IFMP (DFO *et al.* 2010). It identifies objectives and management strategies and measures for the conservation, sustainable use and rebuilding of the northern form of Dolly Varden (*Salvelinus malma malma*) populations in the Gwich'in Settlement Area (GSA) and Inuvialuit Settlement Region (ISR) of Canada's Western Arctic (Fig. 1). In the GSA and ISR, Dolly Varden occur in several rivers and along the coast west of the Mackenzie River. The northern form of Dolly Varden also occur in the Sahtu Settlement Area of the Northwest Territories, the Yukon and Alaska. However, this IFMP is restricted to the GSA and ISR.

Dolly Varden is an important food source for the communities of Aklavik and Teetl'it Zheh (Fort McPherson). The major inland subsistence fisheries are focused on the Rat River and Big Fish River populations, given their proximity to the communities. These and other populations are also harvested in the coastal subsistence fisheries. Sport fishing for Dolly Varden also occurs on the Firth River in Ivvavik National Park.

The Big Fish River and Rat River harvests and/or populations have declined in numbers since the 1970s. Targeted harvesting of these populations had been reduced, and in some cases suspended, voluntarily and/or through regulatory changes, while populations recovered, but are now harvested again at levels supported by DFO, the FJMC, the GRRB, the communities and other co-management partners. Important Dolly Varden habitats and water flow may have changed, possibly as a result of earthquakes (see Stephenson 2003), and climate change (see Barber *et al.* 2008) may be affecting or will affect Dolly Varden and its habitats. In 2000 the Minister of Fisheries and Oceans supported community-based management of Big Fish River Dolly Varden if a management plan would be developed and approved by DFO. These factors and the impending assessment of the Dolly Varden stocks under the federal *Species at Risk Act* (SARA) triggered the development of the 2011-2015 IFMP.

In 2010, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) concluded that the northern (Western Arctic) form of Dolly Varden was a species of Special Concern (COSEWIC 2010), and it forwarded its recommendation to the Minister of Fisheries and Oceans. Public consultations in 2012, support from community and co-management partners and consideration of socio-economic and other factors led, in May 2017, to the Minister of Fisheries and Oceans listing the Western Arctic stocks of Dolly Varden as of Special Concern in Part 4 of Schedule 1 of the SARA. Consequently, a SARA Management Plan for Western Arctic Dolly Varden is required within three years of the listing, i.e. by May 2020. The SARA contains provisions for the adoption or incorporation of any existing plan that includes adequate measures for the conservation of the species (SARA Section 69). This IFMP has been prepared in consideration of the requirements of a SARA Management Plan, and it is intended that the IFMP shall provide the species conservation considerations and actions required of a SARA Management Plan for the Western Arctic Dolly Varden found within the GSA and ISR. **This IFMP only applies to Dolly Varden in the GSA and ISR, whereas the SARA Management Plan would apply to the entire range of the Western Arctic Dolly Varden in Canada (Fig. 2).**

The IFMP updated in 2019 incorporates new information on Dolly Varden populations, harvests (up to and including 2016) and their habitats, and the implications of the SARA listing as a species of Special Concern. It identifies objectives, strategies and measures for managing the fisheries and fish habitats, and for sustaining and rebuilding Dolly Varden populations. This IFMP will be used by fishers, communities, Gwich'in, Inuvialuit, Government of Canada and other stakeholders in managing day-to-day and longer-term activities, and is intended to achieve the long-term conservation, sustainable use and rebuilding of Dolly Varden populations in the GSA and ISR.

The IFMP is based on traditional Gwich'in and Inuvialuit knowledge and practices, on scientific knowledge, and on underlying Gwich'in and Inuvialuit beliefs of the importance of showing respect to fish, including no overharvesting, quick and humane killing, clean handling, and no derogatory talk about fish.

The IFMP was developed by and will be implemented by the Government of Canada, Gwich'in and Inuvialuit partners through an adaptive co-management process that advances community-based management. Groups involved in its preparation were Fisheries and Oceans Canada (DFO), the Fisheries Joint Management Committee (FJMC), the Gwich'in Renewable Resources Board (GRRB), Parks Canada Agency (PCA), the Aklavik Hunters and Trappers Committee (HTC), the Ehdiitat Renewable Resources Council (RRC), the Gwichya RRC, the Nihtat RRC, the Tetlit RRC, elders of Aklavik and Teetl'it Zheh, the Rat River Working Group (RRWG), the West Side Working Group (WSWG), and the IFMP Steering Committee (comprising representatives of DFO, FJMC, GRRB and PCA). The RRWG and the WSWG have been instrumental in the development of the IFMP, and continue to be in its implementation.

The 2019 updated IFMP should be read in context with Volumes 1 and 2 of the 2011-2015 IFMP (DFO *et al.* 2010) and with pertinent legislation, including the Gwich'in Comprehensive Land Claim Agreement (GCLCA), Inuvialuit Final Agreement (IFA), *Canada National Parks Act*, *Fisheries Act* and the SARA.

The IFMP is a living document. It can be amended at any time if a request is submitted and agreed to by the signatory parties after meeting with all stakeholders. The IFMP is supported by annual harvest plans that are recommended by the RRWG and WSWG, approved by the IFMP Steering Committee and supported by the communities.

The IFMP outlines the jurisdictional and co-management context, summarizes Dolly Varden biology, and describes the fisheries. It provides the latest information and current state of knowledge on the status of Dolly Varden populations, and outlines the known threats to Dolly Varden. It presents the management plan and the management process to be followed, including objectives, strategies, actions already completed or underway, conservation measures and implementation schedule, measures to track progress on implementation of the IFMP, and outlines the management process. It includes additional references. Appendix 1 summarizes Dolly Varden harvests in the GSA and ISR. Appendix 2 presents the "Traffic Light Process" that the FJMC and WSWG use to evaluate scientific and traditional knowledge indicators of the health of Dolly Varden and other anadromous fish populations within the ISR in order to

recommend changes to allowable harvest levels. Further details can be found in the 2011-2015 IFMP (DFO *et al.* 2010).

The 2011-2015 IFMP (DFO *et al.* 2010) contains several appendices. These have not been updated in this IFMP. However, there is interest and need in updating Appendices F (Management History), G (Harvest Levels), H (Stock Status) and K (Research and Monitoring Plan) as soon as time permits.

## **2. JURISDICTIONAL AND CO-MANAGEMENT CONTEXT OF DOLLY VARDEN MANAGEMENT**

The jurisdictional and legal context provides the framework for the conservation and sustainable use of Dolly Varden in the GSA and ISR. The implementation of the GCLCA and the IFA through the FJMC's and GRRB's co-management processes therefore are vital underpinnings for the conservation, sustainable use and rebuilding of the Dolly Varden stocks.

### **2.1. Jurisdictional and Legal Context**

DFO, the FJMC, the GRRB, PCA, the Aklavik HTC and RRCs all have responsibilities for co-managing Dolly Varden stocks and fisheries in the GSA and ISR. These responsibilities are described in more detail in Appendix C of the 2011-2015 IFMP. All groups coordinate and work closely together to fulfill their specific responsibilities. They fulfil their responsibilities within the context of the legislated GCLCA and IFA land claims agreements, *Canada National Parks Act*, *Fisheries Act*, *Oceans Act* and the *SARA*.

DFO has the ultimate responsibility, derived from the *Constitution Act*, to manage Canada's fisheries, safeguard its waters, and ensure that aquatic ecosystems are protected from negative impacts. DFO exercises this authority through the *Fisheries Act* and its regulations, and through the *Oceans Act* and the *SARA*. The fisheries protection provisions of the *Fisheries Act* replaced the fish habitat protection provisions in 2012/13 and focus on managing threats to the sustainability and on-going productivity of Canada's commercial, recreational and Aboriginal fisheries. In February 2018, the Government of Canada introduced proposed changes to the *Fisheries Act* (Bill C-68) that would restore lost protections and incorporate modern safeguards to protect all fish and fish habitat, and provide for proper management and control of fisheries, establishment of ecologically significant areas and creation of marine refuges. Since key sections of the *Fisheries Act* are under review, the legal requirements for managing Dolly Varden and its habitats may change, and hence the *Fisheries Act* changes should be monitored closely.

DFO incorporates precautionary and ecosystem-based approaches into fishery management decisions through the Sustainable Fisheries Framework. Application of the Framework should ensure the continued health and productivity of fisheries and fish stocks, while protecting biodiversity and fish habitats and meeting the need to maintain sustainable populations as intended under the *SARA*.



The FJMC and GRRB are legislated public institutions. They are the main instruments of fishery management in the ISR and GSA respectively. They must act in the public interest. Their fishery management responsibilities are outlined in the IFA and GCLCA respectively. They have a mix of decision-making, operational and advisory responsibilities. They make recommendations to and advise the Minister of Fisheries and Oceans. Amongst their responsibilities, the FJMC may make recommendations to the Minister of Fisheries and Oceans on subsistence fishing when required, and the GRRB sets Total Allowable Harvests, as well as Minimum Needs Levels and Gwich'in Needs Levels as required.

The Overlap Agreement between the Gwich'in Tribal Council, the Inuvialuit Game Council and the Inuvialuit Regional Corporation states that wildlife (including fish) populations with ranges falling partly or entirely within Aklavik 1400 Land will be managed jointly by the Aklavik HTC and Ehdıitat RRC, and that each group will waive its exclusive and preferential harvesting rights. The Aklavik HTC and RRCs make inter-and intra-community allocation decisions.

The HTCs and RRCs have specific fishery-related responsibilities assigned to them under the IFA and GCLCA respectively. These responsibilities include allocating harvests among communities or participants, advising the FJMC or GRRB respectively on harvesting, participating in harvest data collection and research, and reviewing and approving research proposals.

PCA is responsible for protecting and managing the resources within Ivvavik National Park, encompassing 9,750 km<sup>2</sup> on the Yukon North Slope. The Park includes the Fish Creek (Komakuk) watershed, the Firth River watershed, including Joe Creek, and the Babbage River watershed which support Dolly Varden populations, and the Malcolm River which was reported to historically support Dolly Varden. PCA manages Dolly Varden in the Park in accordance with the provisions of the *Canada National Parks Act*, the IFA and the SARA.

Many other organizations play roles in the overall management and protection of Dolly Varden stocks and habitats in the GSA and ISR. These include other organizations created under the GLCLA and IFA, the Yukon Territorial Government, and other federal departments.

## **2.2. Co-Management in the GSA and ISR**

The Dolly Varden fisheries in the GSA and ISR are managed through an adaptive co-management process (see Ayles *et al.* 2007). The processes are similar in both areas, but their details often differ. Adaptive co-management is a process that permits stakeholders to share management responsibility, and to learn from their actions through multi-level feedback. The process focuses on establishing clear decisions and rationales for proposed actions, implementing those decisions, documenting and evaluating the results on fish stocks and fisheries, and responding to the evaluation by confirming, modifying or changing decisions for future years. Decision-making incorporates precautionary and ecosystem-based approaches as defined by DFO.

The adaptive co-management approach enables DFO, the FJMC, the GRRB, PCA, the Aklavik HTC and the RRCs to work closely together in fulfilling their responsibilities for managing the

Dolly Varden fisheries and populations. This is done within the context of the GCLCA, IFA, *Canada Parks Act*, *Fisheries Act*, *Oceans Act* and the *SARA*. The process also involves the communities and fishers, and other stakeholders as required.

Adaptive co-management of Dolly Varden in the GSA and ISR involved establishing the RRWG and the WSWG. These working groups assemble background information, and recommend allowable harvest levels, objectives, strategies and conservation and other fishery management requirements through consensus.

The RRWG was established by the GRRB to oversee the management of the Rat River Dolly Varden. Its membership is from the GRRB, Ehdiiat RRC, Tetlit RRC, Aklavik HTC, DFO and the FJMC; observers and advisors include Gwichya Gwich'in RRC, Nihtat RRC, the WSWG chair, Rat River Char Monitors, and others as required. The WSWG was established by the FJMC to oversee the management of Big Fish River (see Aklavik Hunters and Trappers Committee 2014) and other Dolly Varden populations and fisheries in the ISR west of the Mackenzie Delta to the Canada/Alaska border. Its membership is from the FJMC, Aklavik HTC, Aklavik Elders Committee, DFO, PCA, and Yukon Territorial Parks; observers and advisors include the RRWG chair, GRRB, Ehdiiat RRC, Tetlit RRC, and others as required. Cooperation between the RRWG and WSWG is enhanced by a formal agreement; the chairs of the Working Groups participate as observers in the proceedings of the other Working Group to help ensure a cooperative approach to managing Dolly Varden overlap issues. The working groups also develop operational plans, review the results and new information, and change the plans as necessary. An IFMP Steering Committee, comprising senior representatives of DFO, FJMC, GRRB and PCA, was established from the 2011-2015 IFMP to oversee the implementation of the IFMP. The Steering Committee coordinates Dolly Varden related activities, provides direction to the RRWG and WSWG, and decides on items, such as annual allowable harvest levels, referred to it by the RRWG and WSWG. However, the DFO, FJMC, GRRB and PCA retain ultimate responsibility for items in their mandate.

More details of the adaptive co-management process in the GSA and ISR are provided in the 2011-2015 IFMP, especially in Volume 2 (DFO *et al.* 2010).

### **3. DOLLY VARDEN AND DOLLY VARDEN FISHERIES OF THE GSA AND ISR**

Dolly Varden is related to salmon, trout and Arctic Char (*Salvelinus alpinus*). In the western Canadian Arctic, Dolly Varden populations were considered to be Arctic Char until 1997; now they are considered to be a separate species, *Salvelinus malma* (Walbaum 1792), more closely related to Dolly Varden elsewhere than to Arctic Char (Reist *et al.* 1997).

All Dolly Varden in Arctic Canada belong to the northern subspecies, *S. malma malma*. The northern subspecies occurs north of the Alaskan Peninsula and Aleutian Islands, east to the Mackenzie River in Canada's Western Arctic, and into Asia. In the GSA and ISR, it is found in the Fish Creek (Komakuk), Firth (including Joe Creek, a tributary of the Firth River), Babbage, Big Fish, Rat (Ddah Zhit Han) and Vittrekwa river systems, and along the Beaufort Sea coast

west of the Mackenzie Delta, and historically reported in the Malcolm River (see Fig. 1). Outside of the GSA and ISR, this subspecies occurs in the Upper Peel (but may not be the northern subspecies) and the Blackstone rivers, Yukon, in the Gayna River in the Sahtu Settlement Area (see Fig. 2), and in several Alaska North Slope rivers. The headwaters of the Firth River and its Joe Creek tributary are in Alaska. Research is underway to better understand the occurrence of Dolly Varden east of the Mackenzie River; Dolly Varden have been reported in streams east of the Mackenzie River, possibly in the Hornaday River and as far east as Coronation Gulf; it is not known whether these are migratory 'strays' or small local self-sustaining population(s).

COSEWIC describes the life cycles of Dolly Varden (COSEWIC 2010 and references therein). In the GSA and ISR, Dolly Varden has three life-history strategies: anadromous (sea-run); stream-resident (non-anadromous, residual, riverine); and isolated stream-resident (see McCart 1980). Anadromous Dolly Varden reside in fresh water for about the first three to four years of life, after which they migrate to the sea in May and June to feed, and return to fresh water, usually to their natal stream (Sandstrom and Harwood 2002), in late July and early August to overwinter. They repeat their migration cycle most years. They spawn, beginning at age 4-6 years, in fresh water. At present, anadromous Dolly Varden are known to occur in Fish Creek (Komakuk), Firth (including Joe Creek), Babbage, Big Fish, Rat and Vittrekwa river systems.

Stream-resident, non-anadromous Dolly Varden co-exist with anadromous Dolly Varden in all of these river systems; they are almost exclusively males that reside in headwater streams and sneak spawn with anadromous Dolly Varden. Why some Dolly Varden adopt a residual life history and others an anadromous life-cycle is unclear, but research suggests one possibility is that it might relate to their growth rate in their first three or four years of life.

Isolated forms of Dolly Varden do not migrate to the ocean. Isolated Dolly Varden occur above falls on the Babbage and Big Fish rivers (where anadromous and residual forms occur below the falls), in some rivers in the Peel River watershed, and in the Gayna River. Upstream in the Peel River system, some populations are present in lakes (e.g. Horn Lake) and others in rivers; however, their life-history details (e.g. lacustrine only, or adfluvial stream-resident/lacustrine migratory) are unknown.

Dolly Varden use a variety of habitats (COSEWIC 2010). During winter, they occur in upstream reaches of river systems that do not freeze completely (fish holes) primarily because of discharging groundwater. Most high-gradient rivers in the Western Arctic freeze to the bottom during winter, so these fish hole habitats comprise a small portion of each system, and thus are critical and are spatially limiting in most river systems for Dolly Varden populations. The fish hole habitats are used for spawning, rearing and overwintering. Small streams that do freeze may support young-of-the-year Dolly Varden during the open water season. Larger rivers may be migratory routes of anadromous Dolly Varden. Nearshore marine habitats are crucial feeding areas during summer, and recently Dolly Varden have been found up to 150 km offshore (C. Gallagher, unpublished data). Carrying capacity for Dolly Varden stocks likely is limited, at least to some extent, by spawning and overwintering habitat availability.

In fresh waters, Dolly Varden feed primarily on fishes, fish eggs, insect larvae and snails (COSEWIC 2010), but feeding by adult anadromous Dolly Varden in fresh waters is minimal. At sea, anadromous Dolly Varden feed primarily on fishes and benthic organisms. The information suggests that Dolly Varden are opportunistic feeders.

Dolly Varden occur with other species at various life stages, especially with Arctic Grayling (*Thymallus arcticus*) in spawning and overwintering areas.

Piscivorous fish are predators on Dolly Varden adults, juveniles and eggs. Larger Dolly Varden also eat smaller juvenile Dolly Varden and Dolly Varden eggs. Other opportunistic predators include mammals (e.g. otters, bears and wolves), birds (e.g. eagles, American Dipper (Gallagher and Lea 2019)), larger fish in fresh waters, and beluga (*Delphinapterus leucas*), seals, birds and larger fish in marine waters. Arctic Lamprey (*Lampetra japonica*) are known to parasitize Dolly Varden. The ecological niche of Dolly Varden may overlap with those of Pacific salmon species (*Oncorhynchus* spp.) which are being found more frequently in the western Arctic.

Little information is available on contaminants, diseases and parasites of Dolly Varden in the GSA and ISR. Organochlorines were measured in Rat River Dolly Varden in 1986. Infectious Pancreatic Necrosis Virus was reported in Rat River Dolly Varden in 1980-1984; subsequent tests were inconclusive. All analyses conducted to date have concluded that mean total mercury concentrations among life-history forms, sampling periods and river systems were well below Canadian guidelines for safe consumption (Tran *et al.* 2015). Muscle samples from harvest monitoring programs are archived on an on-going basis and could be analyzed if questions arise about other contaminants.

More information on habitat and ecosystem needs of Dolly Varden in the GSA and ISR is contained in Appendix E of Volume 2 of the 2011-2015 IFMP (DFO *et al.* 2010). The COSEWIC Assessment and Status Report (COSEWIC 2010) provides a comprehensive summary of the biology and habitat requirements of Dolly Varden.

### **3.1. Dolly Varden Fisheries**

Anadromous Dolly Varden are a major target of fisheries in the GSA and ISR. The main traditional fisheries were at spawning and overwintering areas on the Big Fish, Rat and other rivers, along the western Beaufort Sea coast in mixed stock fisheries during the summer, and along the west side of the Mackenzie Delta during their upstream migration in late summer. A sport fishery exists in Ivvavik National Park on the Firth River during the summer visitation season. The Fish Creek (Komakuk), Malcolm and Babbage populations used to be fished directly, but little or no fishing activity has occurred recently on these populations or on the Vittrekwa population except as part of mixed stock fisheries along the western Beaufort Sea and Alaska coasts and in the Mackenzie Delta. No socio-economic analysis of the Dolly Varden fisheries has been conducted.

Appendix F of Volume 2 of the 2011-2015 IFMP (DFO *et al.* 2010) contains a summary of the management history of Dolly Varden stocks in the GSA and ISR up to 2010.

### Traditional Fisheries

Anadromous Dolly Varden have been harvested ever since people first inhabited the Western Arctic about 8,000 years ago. The Dolly Varden fisheries have been and remain an essential part of Gwich'in and Inuvialuit cultures for subsistence, cultural, nutritional and medicinal purposes. Traditionally the Gwich'in and Inuvialuit used as much of the fish as possible, and shared a good harvest within the community (Papik *et al.* 2003; Gwich'in Social & Cultural Institute 2010; Byers *et al.* 2019). Today, the fish often is smoked, dried or frozen to preserve it. In emergencies, Dolly Varden used to be fed to dog teams which were vital for Mackenzie Delta residents' participation in the fur trade economy. Under the GCLCA and IFA, Gwich'in and Inuvialuit participants have the right to fish without acquiring a licence, except in areas that are closed to fishing in the *Northwest Territories Fishery Regulations* due to conservation concerns.

Before 1930 there were many traditional fishing locations (Papik *et al.* 2003; Byers *et al.* 2019). Inuvialuit fishing was concentrated along the western Beaufort Sea coast between the Alaska border and the Mackenzie Delta, and at the Big Fish River overwintering area (the fish holes). Inuvialuit began fishing the lower reaches of the Big Fish River in the 1960s. Gwich'in fished primarily in the Mackenzie Delta and Peel River drainage, and Vuntut Gwich'in from the Yukon fished Yukon North Slope rivers, especially the Firth and Babbage. After people moved from their traditional camps and RCMP posts into communities, several more remote locations were fished less frequently.

Traditional fishing methods included baleen, sinew and willow gill and sweep nets used in deeper waters, and rock, driftwood and willow traps and spears used in shallow streams and river beds. Now, more efficient cotton and nylon gill nets are used, and the mesh size has changed from 76-127 mm (3.0-5.5 inches) to 102-114 mm (4.0-4.5 inches), and to 89 mm (3.5 inch) at Shingle Point. An 89 mm (3.5 inch) mesh had been popular as it caught smaller, tastier fish. Voluntary gear restrictions and rotational use of rivers were traditional management practices.

At present the main subsistence fisheries occur on the Big Fish and Rat rivers, along the west side of the Mackenzie Delta, and along the western Beaufort Sea coast. Little or no fishing activity has occurred directly on other stocks in recent years, but they are harvested in mixed-stock fisheries along the coast and in the Mackenzie Delta.

Significant decreases were observed in harvests and the abundance of the harvested populations in the Big Fish River and Rat River in the early 1970s. Community-supported management measures were introduced to reduce harvests of these populations, and temporary closures were introduced. The waters of the Big Fish River (68°39'48" N, 135°52'35" W) and Fish Creek (67°43'42" N, 136°15'44" W) and all of their tributaries are closed to fishing under the *Northwest Territories Fishery Regulations*, except for educational or scientific purposes under the authority of a licence. Since 2012 allowable harvest levels have been recommended by the WSWG (see Aklavik Hunters and Trappers Committee 2014) and approved by the IFMP Steering Committee for harvesting at the mouth of the Big Fish River (Mackenzie River Delta Area VI) by Variation Order. Similarly, a community harvest at the Big Fish River fish holes has been supported by the WSWG and the IFMP Steering Committee, and is achieved through

the issuance of an Aboriginal Communal Fishing Licence (issued under the *Aboriginal Communal Fishing Licence Regulations*) beginning in 2014.

The Rat River was under a voluntary closure in 2006-2008. It was reopened in 2009 with an allowable harvest level established by the RRWG and approved by the GRRB. The allowable harvests levels are reviewed annually, recommended by the RRWG and approved by the IFMP Steering Committee.

Total Dolly Varden Harvests. Some general and stock-specific harvesting estimates exist from DFO, the Gwich'in Harvest Study (1995-2004) and the Inuvialuit Harvest Study (1988-1997), and for the Big Fish and Rat rivers and the coastal fisheries from 1971 (Appendix 1). Comprehensive annual harvest monitoring programs, including the collection of biological data, began in 1995 for the Rat River, in 2011 for the coastal fisheries, and in 2012 for the Big Fish River. Voluntary surveys and sampling are conducted in Ivvavik National Park.

Annual harvest levels and fishing effort have varied considerably. Total Dolly Varden harvests were consistently higher in the 1960s and 1970s than in the 1990s and later years. For instance, the estimates of harvests in 1972 and 1973 ranged from 6,650 fish to 19,500 fish, in the 1980s and 1990s up to 4,128 fish. The change may have resulted from fewer harvesters, less effort or fewer fish, or may reflect higher gas prices. More recently, total harvests from 2000 to 2010 ranged from 95 fish to 1,806 fish, and from 2011 to 2016 ranged from 813 to 1,320 fish (Table 1). The harvest numbers for the Big Fish and Rat rivers in Table 1 are not total population-specific harvest numbers since the coastal fisheries harvests also include Dolly Varden from these rivers. The Coastal Fisheries also may include all other Canadian and Alaskan Dolly Varden populations. Harvests by beneficiaries on the Firth River are included in the reported harvests for Ivvavik National Park. There has not been a directed subsistence fishery on the Babbage River in recent years.

Big Fish River. Harvests ranged from 8,000-12,000 in 1972, to 94 in 1980, and increased to 1,875 in 1986. The decline in the abundance and size of Big Fish River Dolly Varden resulted in Aklavik residents requesting its legislated closure under the *Northwest Territories Fishery Regulations*, which began in 1987. Annual safe harvest levels are recommended by the WSWG and approved by the IFMP Steering Committee. In 2012 and 2013 a safe harvest levels of 150 Dolly Varden were regulated through Variation Orders for the mouth of the Big Fish River (Mackenzie River Delta Area VI). The mouth of the Big Fish River and further downstream are outside of this closure area; however, the *Northwest Territories Fishery Regulations* has a restriction for gill-net fishing at the mouth within this area (Mackenzie Delta Area VI) during the month of August. The lifting of the gill-netting restriction has continued to be enacted by Variation Order since 2012 since the community continues to be interested in fishing at some traditional sites in the area. However, beginning in 2014 Dolly Varden also have been harvested from the fish holes under Aboriginal Communal Fishing Licences (also see Aklavik HTC 2014). The safe harvest level of 150 was based on the assumption that an additional 25 Dolly Varden from the Big Fish River are taken in the coastal fisheries derived from recent average harvest numbers and estimated contributions based on genetic mixed-fishery stock analysis. Recent harvests at the fish holes have ranged from 150 fish in 2014 and 2015 to 187 in 2016 harvest

(Table 1). Big Fish River Dolly Varden also are caught in the coastal fisheries; the total Big Fish River Dolly Varden harvested in the fish hole and coastal fisheries from 2014 to 2016 has ranged from an estimated 190 fish to 282 fish.

Rat River. Concern about the health of the Rat River Dolly Varden led to the development of the Rat River Char Fishing Plan in 1996 that included recommended harvest levels. The Plan has undergone regular updates. Harvests in the 1970s ranged from 2,100 to 6,500 fish, and in the 1980s from 1,100 to 3,125 fish. From 1990 to 2003 harvests ranged from 376 to 3,331 fish, with population estimates ranging from 7,953 to 11,191 fish. A significant but temporary decline was noted in 2004 when the harvest was 363 fish, and the population estimate was 2,912 fish. A 2005 mark-recapture study confirmed the decline of Rat River Dolly Varden. A voluntary closure of the fishery occurred in 2006 for three years, except for an allowed harvest of 120 Dolly Varden per year by harvest monitors to continue collecting biological data. In 2007, an estimated 14,887 Dolly Varden occurred at the overwintering site, composed mainly of a single age-class. In 2009 the harvest was only 95 fish, so the allowable harvest level was reduced to 600 fish (from 1,225 fish) for 2010 as studies suggested a potential decline in the number of fish entering the fishery. Since 2011, the annual inland harvest has ranged from 293 to 573 Dolly Varden (Table 1). Ne'edilee (Rat River Fishing Hole) has been closed to fishing since 1978. Rat River Dolly Varden also are caught in the coastal fisheries; the total Rat River Dolly Varden harvested in the Rat River and the coastal fisheries from 2011 to 2016 has ranged from 326 fish to 771 fish. Allowable harvest levels are recommended by the RRWG and approved by the IFMP Steering Committee.

Coastal Fisheries. The coastal fisheries are conducted mainly at Herschel Island (Thetis Bay) and Shingle Point, but also at Ptarmigan Bay, King Point/Sabine Point and other traditional fishing locations (Papik *et al.* 2003). Coastal fishery harvests ranged from 37 fish in 1991 to 1,365 in 1996, and more recently from 335 fish to 597 fish from 2009-2016 (see Table 1). A genetic mixed-stock analysis in recent years has shed light on the contributions of the various stocks to coastal harvesting areas (see Gallagher *et al.* 2018, Gallagher *et al.* 2020a). The population composition of the coastal fishery at Shingle Point varied annually from 2011-2015 with Dolly Varden from the Firth, Babbage, Big Fish, Rat and Vittrekwa rivers, and from Alaska harvested (R. Banjo, unpublished data). Dolly Varden from the Babbage River comprised the majority of harvests at Shingle Point over this time period (Gallagher *et al.* 2018). Dolly Varden harvested further west at Herschel Island were predominantly from the Babbage River, Firth River, Joe Creek, and the Kongakut River in Alaska (R. Banjo, unpublished data).

Other Fisheries. Traditional fisheries for Dolly Varden also have occurred in adjacent Peel River drainages in the Yukon, and a few Dolly Varden have been taken incidentally in the Sahtu Settlement Area.

### Commercial Fisheries

In 1960, the Department of Northern Affairs and Natural Resources started a Dolly Varden (then considered to be Arctic Char) fishery at Shingle Point (Corkum and McCart 1981). The fishery

closed after two years. The harvest over two years was 13,626 kg of Dolly Varden (at 4 kg/fish = 3,407 fish).

In 1965 and 1966, Menzies Fisheries of Edmonton operated a commercial fishery for Dolly Varden out of Pauline Cove and Ptarmigan Bay (Corkum and McCart 1981). The harvest was 7,675 kg of Dolly Varden (= 1,919 fish). Due to the high cost of shipping the catch by air from the Yukon coast to Inuvik, the fishery operated with very high losses. There have been no further attempts to establish commercial coastal Dolly Varden fisheries.

In the 1970s, a small commercial fishery on the Big Fish River had a quota of 900 kg. It was unsuccessful and was not continued. Yaremchuk et al. (1989) record commercial “Arctic Char” harvests in the Mackenzie Delta region of 357-4,713 kg (= 89-1,178 fish) from 1978-1982; these, in all or in part, might be from the Big Fish River and/or Rat River.

At present no commercial quota exists for any Dolly Varden stock in the GSA or ISR. The Firth and Babbage rivers within Ivvavik National Park are closed to commercial fisheries under the *Canada National Parks Act*.

### Sport Fisheries

Sport fishing for Dolly Varden by DEW Line personnel occurred around the stations at Komakuk Beach and Stokes Point when the sites were active. The sites closed in 1993 and 1963 respectively. A small number of visitors have fished recreationally for Dolly Varden, primarily in Ivvavik National Park and Herschel Island Territorial Park. Firth River Dolly Varden are a main target for anglers in Ivvavik National Park.

Depending on location, a Northwest Territories Sport Fishing Licence, a Yukon Territorial Sport Fishing Licence, or a National Parks Canada Fishing Permit may be required. In the GSA and ISR, the daily catch and the possession limits for Dolly Varden are zero, i.e. catch and release only as established by variation orders, and the Big Fish River is closed to all fishing. The *Yukon Territory Fishing Regulations* specify a daily catch limit of five Dolly Varden, and a possession limit of ten Dolly Varden. Pursuant to the *National Parks of Canada Fishing Regulations*, the sport fishing daily catch and possession limit in Ivvavik National Park is one Dolly Varden, and the fish holes on the Firth River and Joe Creek are closed to sport fishing. A National Parks Fishing Permit is required to sport fish within Ivvavik National Park, except by Inuvialuit beneficiaries. Sport fishing in the ISR requires validation through the licence vendor, and registration with HTC's or the FJMC for fishing from private lands.

Between 21 and 63 fishing permits have been issued annually for Ivvavik National Park from 2003 to 2017, averaging about 40 permits per year.

### Scientific Collection

Dolly Varden have been collected for scientific purposes from various stocks, including the Fish Creek (Komakuk), Firth, Babbage, Big Fish, Rat and Vittrekwa systems, and harvesting locations along the coast. All recent scientific collections of Dolly Varden have been supported by the RSWG and WSWG. The majority of the scientific collections have been from Dolly



Varden harvested by Gwich'in and Inuvialuit harvesters and collected by Gwich'in and Inuvialuit monitors. Since 2000, fish from subsistence fisheries and specific biological investigations have been sampled. Otoliths, adipose fins and other samples have been collected by visitors and staff in Ivvavik National Park and are provided to DFO for analysis.

In most cases scientific sampling requires a Licence to Fish for Scientific Purposes from DFO. Issuing such a Licence requires the support of the HTC or RRC and of the GRRB or FJMC. A research permit from the Northwest Territories Government or Yukon Territory Government also may be required for non-DFO researchers.

## **4. STOCK ASSESSMENT AND STATUS**

### **4.1. Stock Status**

Stock assessments, beginning in 1972, have been conducted on the anadromous Dolly Varden populations of the Firth (DFO 2003c), Babbage (DFO 2003b, 2017a), Big Fish (DFO 2003a, 2013) and Rat (DFO 2001, 2014, 2017b) rivers. No stock assessments have been conducted for the Vittrekwa River although population studies have been attempted. Population studies on Fish Creek (Komakuk) began in 2016. The results until 2010 are summarized in the 2011-2015 IFMP, especially Table 2 in Volume 1 and Appendix H of Volume 2.

Population estimates for anadromous Dolly Varden in the GSA and ISR are provided in Table 2. Insufficient data are available from the Firth and Babbage rivers to show any trends in abundance over time. The stock assessments suggest a decline in abundance of Dolly Varden in the Big Fish River, with estimates of 13,500-20,700 fish in 1972, 9,300 fish in 1984, and 2,232-4,447 fish since the 1990s. Estimates for the Rat River show a decline in 2004 and an increase in 2007, peer-reviewed estimates in 2010 and 2013 being 5,820 and 11,919 fish respectively, and non-peer-reviewed estimates in 2015 and 2016 ranging from 14,492 to 30,832 fish.

The most recent conclusions of the reviews are:

- *Firth River Watershed*: the harvest and current size of the population is unknown (DFO 2003)
  - The 1989 population estimate was 8,250-10,700 fish (not peer-reviewed).
  - Population studies have occurred annually since 2014 and visual examination of these stocks during the spawning season suggests abundance is relatively high in both the Firth River and Joe Creek.
- *Babbage River*: the population is currently stable and is sustainably harvested (peer-reviewed – DFO 2017a, Gallagher *et al.* 2018)).
  - The 2010-2014 population estimates were 5,861-6,553 fish.
- *Big Fish River*: the population appears stable although the impact of an increase in fishing mortality is uncertain (peer-reviewed – DFO 2013, Gallagher *et al.* 2013).
  - Population estimates were 3,853 in 2009 and 4,338 in 2010, lower than in the 1970s but comparable to those in the 1990s.

- *Rat River*: the population is currently stable and is sustainably harvested (peer-reviewed – DFO 2017b, Gallagher *et al.* 2020b).
  - Population estimates increased from 5,820 in 2010 to 11,919 in 2011.

The status of residual Dolly Varden and isolated Dolly Varden populations has not been studied or assessed.

The 2011-2015 IFMP (DFO *et al.* 2010) classified Dolly Varden populations as Healthy, Cautious, Critical, or Undetermined. That classification now is unnecessary as sufficient stock assessments and peer reviews have been completed (see above), scientific knowledge and traditional knowledge have increased, and the working group processes are effective.

Overall, the western Arctic populations of Dolly Varden are listed as of Special Concern under SARA.

#### **4.2. Precautionary Approach**

Due to the relatively low numbers of Dolly Varden and the limited information on each population, a precautionary approach is required for their management. A precautionary approach in fishery management (DFO 2009) is about being cautious when scientific and traditional knowledge is uncertain, and not using the absence of adequate scientific information to postpone or fail to take actions to avoid serious harm to fish populations or their ecosystems when decisions are required.

An explicit harvest strategy is part of a precautionary approach (DFO 2009). A harvest strategy should be incorporated into fishery management plans to keep the removal rate moderate when the population status is healthy, to promote rebuilding when population status is low, and to ensure a low risk of serious or irreversible harm to the population.

DFO (2009) advocates, if sufficient information exists, a precautionary approach with a harvest strategy that: identifies three stock status zones (healthy, cautious, critical) according to Upper Stock and Limit reference points; sets the removal rate at which each stock may be harvested within each stock status zones; and adjusts the removal rate, based on pre-agreed decision rules, according to stock status variations (e.g. spawning stock biomass or other index relevant to population productivity).

Although insufficient information exists at this time to establish reference points, stock status zones and removal rates for Dolly Varden populations in the GSA and ISR, sufficient information now exists to set allowable harvest levels based on scientific and traditional knowledge rather than using a harvest rate guideline of 5% of population size as a precautionary low risk option. The precautionary application of this information will ensure that no major changes will be made to harvest levels until trends in population size and/or indicators are clear.

A lack of knowledge also often results in the use of indicators of population health to help establish or change harvest levels (e.g. see DFO 2013, 2017a, 2017b). Fisheries indicators are simple measures (e.g. changes in age, length, weight, age, catch-per-unit-effort) that show what is happening to a fish stock. The FJMC and WSWG are developing a “Traffic Light Process”

with explicit decision-making rules (Appendix 2) for fisheries within the ISR to help make changes to allowable harvest levels during annual adaptive co-management reviews. The GRRB and RSWG use and document similar information but not in such a structured approach as proposed in the “Traffic Light Process”.

## **5. THREATS AND LIMITING FACTORS**

The COSEWIC Assessment and Status Report (COSEWIC 2010) identifies 14 potential threats for Western Arctic Dolly Varden throughout its range. The threats in Table 3 are those in Table 20 in the COSEWIC Assessment and Status Report that identifies actual or potential threats that may affect the conservation, sustainable use and effective management of Dolly Varden stocks in the Western Arctic; all these COSEWIC threats for the GSA and ISR are covered in Table 3 although their nomenclature may be slightly different. The organization of Table 3 is based on the Threat Assessment Table for the fin whale SARA Management Plan (DFO 2017c) with an additional column summarizing the status of each threat in the GSA and ISR. The Level of Concern in Table 3 represents the concern before the application of mitigation measures.

### **Dolly Varden Stock Depletion**

Some Dolly Varden populations in the GSA and ISR are at lower population levels now than historically, and it is thought that either the Malcolm River no longer supports a Dolly Varden population or if Dolly Varden are present that they have not been observed during several reconnaissance flights in recent years. Over-fishing of Dolly Varden had been a concern for the Big Fish and Rat rivers. The recovery and rebuilding of the populations following the decline is due, at least in part, to the implementation of appropriate management measures. Recent assessments for the Babbage, Big Fish and Rat rivers conclude that the populations are stable, sustainably harvested, and with no immediate conservation concerns, but specific issues and needs vary among populations. Further studies are required on Fish Creek (Komakuk), Firth River and Vittrekwa River to assess population size and status.

“Fish holes” are critical spawning, rearing and overwintering sites, essential for the survival of Dolly Varden stocks. Fish holes also were major traditional sites for fisheries as Dolly Varden congregate there, and hence Dolly Varden are especially vulnerable to over-fishing at these locations. Over-fishing at fish holes may have contributed to the decline in the abundance of some populations, as could the alteration of habitats at fish holes caused by changed water flow, erosion, climate change and/or earthquakes. Fish holes on the Big Fish and Rat rivers currently are closed to harvesting (although community harvests have occurred in recent years at the Big Fish River fish holes under an Aboriginal Communal Fishing Licence), and the Firth River and Joe Creek fish holes are closed to sport fishing.

In addition to population-specific fisheries on individual rivers, populations are harvested in the mixed-stock coastal fisheries which includes fish from all anadromous populations including those from Alaska to some extent. Mixed-stock fisheries also occur in some areas of the

Mackenzie Delta. Knowledge of the stock composition of these fisheries is essential in ensuring that specific populations are not overharvested.

Predation on Dolly Varden by other species, such as bears, otters, birds and seals, is a natural occurrence. However, many community members are concerned that increased predation, in particular by increasing numbers of otters, may have contributed to the decline of some Dolly Varden populations especially by feeding at fish holes and other overwintering areas. Examples of these observations and concerns are: an increase in the otter population since the 1970s, otters eat fish and travel up rivers, and could wipe out Dolly Varden populations if they reach fish holes; black and grizzly bears have been observed feeding on Dolly Varden runs in the Rat River; eagles and hawks eat Dolly Varden, and high concentrations of eagles have been reported around fish holes; Ringed Seals eat Dolly Varden along the coast and their numbers may be increasing, and they have been reported congregating at river mouths. Understanding the impacts of the reported increased predation on populations is required.

Sound management of the Dolly Varden populations and fisheries is necessary to ensure their conservation and sustainable use for future generations. Management of Dolly Varden fisheries should follow a precautionary approach, with emphases on sustainable use and rebuilding stocks if possible. Sufficient information exists to use scientific and traditional knowledge to establish allowable harvest levels for Dolly Varden populations. The current harvest management measures appear to be working well, as the harvests appear to be sustainable. However, continued harvest monitoring and stock assessments are required to ensure the conservation, sustainable use and rebuilding of the Dolly Varden populations, and to optimize harvest levels. Great care should be taken in managing any harvesting at fish holes, including incorporating more comprehensive monitoring and assessment programs. Harvests from the mixed-population coastal fisheries should continue to be incorporated into the establishment of allowable harvest levels for each population. Better understanding of the origin of fish caught in the mixed-population fisheries in Canada and Alaska is required to ensure that no population is overharvested.

Changes to harvest levels should use indicators of population health, such as changes in length, weight, age, CPUE etc. to help establish and change harvest levels, and could follow “The Traffic Light Process” (Appendix 2) to help make the decision-making process explicit.

### Habitat Changes

Changes to or loss of critical habitats (e.g. spawning, overwintering and nursery habitats) would severely affect Dolly Varden populations, and may have contributed to declines of populations in the Big Fish River and the Rat River in the past. Habitat changes along migratory routes and in coastal feeding areas also could have negative effects on Dolly Varden populations. The importance of the river systems and the nearshore Beaufort Sea to Dolly Varden is reflected in the Aklavik Inuvialuit Community Conservation Plan (Aklavik Hunters and Trappers Committee *et al.* 2016), the Gwich'in Land Use Plan (Gwich'in Land Use Planning Board 2003), and in the identification of ecologically and biologically significant areas in the Beaufort Sea (Cobb *et al.* 2014). Ivvavik National Park protects Dolly Varden and its habitats in the Fish, Firth, Malcolm

and Babbage rivers. The upper reaches of the Firth River and Joe Creek that are in Alaska are protected by being within the U.S.A.'s Arctic National Wildlife Refuge, the purpose of which is to conserve fish and wildlife populations and their habitats in their natural diversity.

Habitat changes could result from natural changes and anthropogenic stresses, and from climate change (see next section). Natural changes are occurring and include: changes in groundwater levels; reduced water flow in rivers, e.g. the Big Fish River; less saline water in the Big Fish River fish hole; and slumping and erosion of river banks. Lower water levels and reduced groundwater flow might have significant impacts on Dolly Varden spawning and overwintering habitats. Earthquake activity, slumping and erosion (see Stephenson 2003) might have similar impacts on spawning, overwintering and nursery areas, and might block migration routes. Habitat changes that have occurred appear to have resulted in lower carrying capacity. Potential anthropogenic stresses on Dolly Varden and their habitats include on-land developments (such as pipelines, roads and gravel extraction) and marine developments in the western Beaufort Sea (such as hydrocarbon developments and shipping). At present, no developments are planned that might adversely affect Dolly Varden freshwater or marine habitats in the GSA and ISR.

Past projects or proposals might have affected Dolly Varden and their habitats. DEW Line sites were built at Komakuk Beach, Stokes Point and Shingle Point and have been decommissioned (but are still maintained); a major concern was the disposal of PCBs and other chemicals. The Yukon North Slope was a proposed route for a pipeline to carry oil from Alaska which would have crossed river systems that support Dolly Varden stocks. The western Beaufort Sea has been the site of hydrocarbon exploration and development that has involved seismic testing and exploration, the construction of artificial islands, drilling, shipping activities and the use of Herschel Island as a harbor for drill ships; all of these might interfere with Dolly Varden migration and feeding. In addition, a contaminant release, such as an oil spill or a chemical spill, might have significant effects on Dolly Varden and their habitats. Port construction has historically been proposed along the Yukon North Slope, e.g. at King Point and Stokes Point. A future increase in hydrocarbon exploration and development is possible but is unlikely in the near future as a moratorium on offshore drilling currently is in place. The discovery of satellite-tagged Dolly Varden occupying waters up to 150 km offshore increases the concern that marine developments might affect Dolly Varden populations (C. Gallagher, unpublished data).

Other possible activities include cruise ships, increased tourism, gravel extraction, and construction of roads, trails and stream crossings with associated culvert installations and clearing rights-of-way. All these activities have the potential to have adverse effects on Dolly Varden and their habitats, but currently they are not issues in the GSA and ISR.

Population growth in local communities is expected and could increase demand for subsistence fishing. However, the IFMP provides the approach necessary for managing increased interest in fishing for Dolly Varden.

The COSEWIC Assessment and Status Report (COSEWIC 2010) identifies water removal, logging, dam construction and population growth as additional potential threats. They are not

considered to be likely or significant threats to Dolly Varden in the GSA and ISR in the near future.

All these potential activities might affect Dolly Varden and their habitats. Therefore, important Dolly Varden habitats should continue to be identified, monitored and protected. All projects that may affect Dolly Varden and their habitats should be carefully reviewed, appropriate decisions made on whether they should proceed, and appropriate planning decisions and protection measures incorporated into their construction and operation. The GCLCA and the IFA contain strong frameworks for the co-management of environmental assessments and habitat protection that involve the DFO, FJMC, GRRB and PCA and that have been implemented successfully. The Beaufort Sea Beluga Management Plan (FJMC 2013), the Beaufort Sea Integrated Ocean Management Plan (Beaufort Sea Partnership 2009) and the Beaufort Sea Integrated Fisheries Management Framework (DFO *et al.* 2014) also contain provisions relevant to the protection of the marine Dolly Varden habitats.

### Climate Change

Climate change is a major concern in the GSA and ISR. Climate change, as indicated by rising temperatures, is occurring more rapidly in the Arctic than elsewhere (see Barber *et al.* 2008). For instance, in Aklavik, days colder than -30°C are predicted to decrease from 68.5 a year in 1976-2005 to 13.6 a year by 2051-2080, and the frost-free season to increase from 89.5 days a year to 126.0 days a year (Univ. Winnipeg 2018). Climate change is projected to affect the physical environment (e.g. air and water temperatures, ice, etc.) which then may have subsequent direct or indirect effects on Dolly Varden and on the freshwater and marine ecosystems that support them.

The following are some projections and concerns. The distribution of Dolly Varden could contract or shift northwards in response to temperature changes. Other species may become more numerous in the area and compete with Dolly Varden for food or spawning habitats. Already, Pacific Salmon (*Oncorhynchus* spp.) have been harvested in increasing numbers and may compete with Dolly Varden for spawning habitats in fresh waters and for food in coastal waters; Chum (*O. keta*) and Sockeye (*O. nerka*) have been found in the Little Fish Creek, a tributary to the Big Fish River, a Chum has been captured in Fish Hole Creek, tributary to the Babbage River, and Sockeye have been found in Fish Creek (Komakuk) (C. Gallagher, pers. comm.).

Climate change may render Dolly Varden habitats less suitable. Bank and shoreline erosion and silting might change substrate composition, affecting freshwater habitats and nearshore migration routes and feeding areas. Changes to the amount of groundwater at spawning and overwintering might affect survival of eggs, fry and overwintering fish. Changes in water levels also might affect Dolly Varden spawning grounds, nursery areas and migration corridors. Several significant slumps and changes in water levels in the fish holes have been noted, and reduced water flow and decreased salinity has been observed in the Big Fish River. Increased mercury levels in Dolly Varden from the Firth River and Rat River from 1986-88 to 2011-13

(Tran *et al.* 2019) may be related to climate change; the mercury levels were well below safe consumption guidelines.

Climate change is projected to increase the ice-free period and to enhance productivity in offshore pelagic environments which might provide Dolly Varden with longer access to and/or increased quantity and quality of food during their coastal feeding phase; increased growth of Dolly Varden from 1995 to 2007 suggests this may be happening. Other changes in the distribution of marine food organisms might result in a less nutritious diet and less growth and lower condition, as was found in Arctic Char. However, at present the direct and indirect effects of climate change on Dolly Varden and its ecosystem components are complex and hard to predict.

Climate change also might increase the likelihood of other human activities. Increased shipping, hydrocarbon development and human activity might occur, and they potentially might have adverse effects on Dolly Varden and their habitats.

To the extent possible, the effects and implications of climate change on Dolly Varden in the GSA and ISA should be monitored, monitoring results and predictions incorporated into management decisions, and appropriate indicators of climate change developed and monitored. This also requires improved understanding of Dolly Varden diet and ecosystem linkages.

#### Sahtu, Yukon and Alaska Overlaps

Dolly Varden populations occur in the Sahtu Settlement Area, the Yukon south of the North Slope and Alaska, and Alaskan Dolly Varden stocks occur along the Western Canadian Beaufort Sea coast. No formal agreement exists between these jurisdictions on the management of Dolly Varden and no community-to-community mechanism exists for addressing conflicts such as harvesting of overlapping stocks, but informal information exchange does occur. As more knowledge accrues, and if interjurisdictional issues arise, their more formal participation in the management of GSA and ISR Dolly Varden populations may be beneficial.

## **6. THE MANAGEMENT PLAN**

### **6.1. Management Objectives**

The overarching goal for Dolly Varden management in the GSA and ISR is to ensure the long-term conservation, rebuilding and sustainable use of the Dolly Varden stocks for the benefit of present and future generations.

The following conservation, ecosystem, stewardship and socio-economic objectives are broad in scope.

1. To maintain healthy stocks of Dolly Varden throughout the GSA and ISR.
2. To preserve and protect Dolly Varden habitats in all rivers in the GSA and ISR and along the Beaufort Sea coast to ensure that Dolly Varden stocks continue to thrive.

3. To manage the Dolly Varden fisheries using adaptive management processes with full community participation.
4. To ensure the maintenance of Dolly Varden in the GSA and ISR to provide subsistence food and to support traditional Gwich'in and Inuvialuit culture.
5. To manage, to the extent possible, the Dolly Varden fisheries in a manner consistent with Gwich'in and Inuvialuit cultural practices.

The objectives are essentially the same as in the 2011-2015 IFMP (DFO *et al.* 2010). They are consistent with the general objectives of the GCLCA, IFA, *Fisheries Act*, the *SARA* and *Canada National Parks Act*, and of the Big Fish River Fishing Plan (Aklavik Hunters and Trappers Committee 2014).

## **6.2. Actions Already Completed or Currently Underway**

Many actions have been completed or are being undertaken to improve the conservation, sustainable use and rebuilding of Dolly Varden populations in the GSA and ISR. The following actions were triggered by the decline of Dolly Varden populations and harvests in the Big Fish and Rat rivers between the 1980s and early 2000s.

- Developed and implemented the 2011-2015 Dolly Varden IFMP.
- Developed and updated annual fishing plans for the Big Fish River and Rat River.
- Developing and implementing “The Traffic Light Process” in the ISR to use indicators and explicit rules to increase or decrease harvest levels for the Big Fish River population.
- Established allowable harvest levels using a precautionary interpretation of population estimates and trends, indicator trends and other scientific and traditional knowledge, and accounting for harvests in the coastal fisheries.
- Developed and successfully carried out harvest communication plans.
- Implemented clear legal and co-management frameworks for the management of Dolly Varden in the GSA and ISR.
- The establishment of Ivvavik National Park protected Dolly Varden and its habitats in the Fish Creek (Komakuk), Firth, Malcolm and Babbage rivers.
- Closed the Big Fish River to harvesting from 1987, with regulated community harvesting since 2012 under variation orders and Aboriginal Fishing Communal Licences.
- Voluntarily closed the Rat River to harvesting from 2006-2008.
- Closed the “fish holes” to harvesting in the Big Fish River from 1987, and in the Rat River from 1978, and to sport fishing in the Firth River and Joe Creek.
- Decreased sport fishing limits in the *Northwest Territories Fishery Regulations* to a catch limit and possession limit of zero (i.e. catch-and-release only) in the Northwest Territories, and pursuant to the *National Parks of Canada Fishing Regulations* to a catch limit and a possession limit of one Dolly Varden in Ivvavik National Park.
- Conducted population studies and scientific assessments.
  - Firth River, including Joe Creek, annually since 2014, and Fish Creek (Komakuk) annually since 2016;



- Babbage River: population studies from 2010, formal peer-reviewed assessment in 2015;
  - Big Fish River: population studies from 2009, formal peer-reviewed assessment in 2012;
- Rat River: annual population studies from 2009, formal peer-reviewed assessment in 2015. Conducted annual harvest and biological monitoring of the Big Fish River, Rat River and coastal subsistence fisheries, and subsistence and sport harvest surveys in Ivvavik National Park.
- Undertook genetic mixed-stock fishery analyses of coastal and Mackenzie Delta fisheries.
- Surveyed and characterized Dolly Varden habitats in the Fish Creek (Komakuk), Firth, Babbage, Big Fish and Rat rivers.
- Monitored freshwater and marine Dolly Varden habitats in the GSA and ISR.

### **6.3. Broad Strategies**

The following strategies will help achieve the objectives of the Dolly Varden IFMP. The strategies, in general, are a continuation of the actions undertaken to date (see above), and should help ensure the conservation, sustainable use and rebuilding of Dolly Varden stocks. The relationships of the strategies to the objectives is shown in brackets.

#### **General Strategies**

- Apply the precautionary and ecosystem-based approaches when making decisions on the management of Dolly Varden populations, fisheries and habitats (all Objectives).
- Manage the Dolly Varden fisheries and their habitats in the GSA and ISR through the RRWG and WSWG (all Objectives).
  - Involve harvesters and communities in decision-making and information exchanges.
  - Promote traditional practices in implementing Dolly Varden management decisions.
- Promote cooperation and resolve, as necessary, any interjurisdictional issues with the Sahtu, Yukon and Alaska (Objectives 1, 2 and 4).

#### **Management of Fisheries**

- Do not permit commercial fisheries for Dolly Varden (Objectives 1 and 4).
- Do not permit any fishing, including recreational fishing, in fish holes except if supported by the IFMP Steering Committee (Objectives 1 and 4).
- Continue to ensure the long-term sustainability of Big Fish River fishery through the fishing plan (Aklavik Hunters and Trappers Committee 2014) and WSWG's process of determining recommended annual allowable harvest levels through consensus, using the best available scientific and traditional knowledge (Objectives 1 and 4).
  - Have a target population abundance that is not less than one standard deviation below the mean of the most recent population estimates.
  - Ensure an allowable harvest of at least 150 adult Dolly Varden for cultural and subsistence purposes.

- Base changes to allowable harvest levels on changes in the population size as determined by the agreed upon “Traffic Light Process” that use the best available scientific and traditional knowledge of populations and indicators.
  - Support harvesting at the mouth of the Big Fish River and at Shingle Point.
- Develop management regimes for sustainable fisheries on the Babbage and Firth rivers, similar to the approach for the Big Fish River (Objectives 1 and 4).
- Continue to ensure the long-term sustainability of the Rat River fishery through the RRWG’s process of determining a voluntary recommended annual harvest levels through consensus, using the best available scientific and traditional knowledge (Objectives 1 and 4).
- Ensure that any Vittrekwa River fishery is sustainable (Objectives 1 and 4).
- Manage Coastal Fisheries to ensure that no stocks are over-harvested (Objectives 1 and 4).
- Review allowable harvest levels, fisheries and populations annually (Objectives 1 and 4).
  - Make changes to allowable harvest levels based on the best available scientific and traditional knowledge and biological indicators, e.g. through “The Traffic Light Process”.
  - Follow the adaptive co-management process.
  - Complete “The Traffic Light Process” for Dolly Varden in the ISR.
- Ensure effective allocation of harvested fish (Objective 4).

#### Habitat Protection

- Protect Dolly Varden and its habitats from adverse effects of developments through environmental assessment and protection processes established under the GCLCA and IFA (Objective 2).

#### Research and Monitoring

- Monitor harvests, effort and biological indicators in coastal and inland fisheries (Objective 1).
  - Undertake both fishery dependent and independent sampling.
- Conduct periodic stock assessments to provide estimates of stock sizes (Objective 1).
  - Conduct assessments of all harvested anadromous Dolly Varden stocks.
  - Characterize residual and isolated Dolly Varden populations.
- Collect samples from Dolly Varden caught in the coastal and Mackenzie Delta fisheries for genetic analyses to understand the annual variability of stock contributions to these fisheries (Objectives 1 and 4).
- Undertake studies to better understand the life-cycles of anadromous and residual Dolly Varden (Objectives 1 and 4).
- Identify, assess and monitor critical, sensitive and limiting habitats (Objective 2).
  - Study water temperature and level monitoring related to spawning and overwintering habitats.
  - Study marine habitat use.
- Gain better understanding of Dolly Varden and ecosystem interactions (Objectives 1 and 2).
  - Establish baselines, and monitor changes.

- Gather local knowledge/observations in association with river and coastal harvest data to better understand how environmental conditions affect catches and effort in the fisheries (Objectives 1,2 and 3).
  - Monitor impacts of climate change.

#### Communication, Education and Compliance

- Undertake communication and education activities to ensure that fishers, communities and stakeholders implement their responsibilities to conserve and protect Dolly Varden populations and their habitats (all Objectives).
- Manage fisheries and fish habitats through self-compliance whenever possible (all Objectives).
- Undertake compliance activities as required (Objectives 1 and 2).

Appendix J of Volume 2 of the 2011-2015 IFMP (DFO *et al.* 2010) includes more details on how these strategies should be implemented.

#### **6.4. Conservation Measures and Implementation Schedule**

Implementation of the strategies identified above should achieve the objectives of the IFMP and address the threats to Dolly Varden in the GSA and ISR. This information and their implementation schedule is identified in Table 4.

The High Priority strategies are those that relate to the conservation and sustainable use of Dolly Varden populations and the protection of their habitats.

Implementing these strategies is part of the on-going responsibilities of DFO, the FJMC, the GRRB and PCA. They have annual processes in place to plan projects that implement the strategies and to review the results of the projects.

DFO, the FJMC, GRRB, PCA, the RRWG and the WSWG meet regularly with their HTC's, RRCs and communities. This enables them to hear first-hand about issues and local observations on Dolly Varden, fisheries, habitat and climate change. This information is then fed back through the adaptive co-management process to address issues and to improve the management of Dolly Varden.

The FJMC and the GRRB have annual processes to solicit, receive, review and approve project proposals from DFO and universities that address their research and study needs for the upcoming year. These processes are meshed with DFO's project planning cycle. These processes will be followed to develop projects to further several strategies, such as "conduct stock assessments", "identify, assess and monitor critical habitats", and "undertake life-cycle studies".

A major part of managing Dolly Varden populations in the GSA and ISR is the annual review process led by the RRWG and the WSWG. It is described in the next section. It enables management measures, especially harvest levels, to be adjusted to reflect new information

obtained from stock assessments, traditional knowledge, harvest monitoring and biological indicators.

The RRWG and WSWG also have annual cycles of meetings, reviews and evaluations to ensure that allowable harvest levels and management measures are reviewed annually and altered as necessary, new information is gathered and considered, project needs identified, and monitoring programs conducted.

These processes enable DFO, the FJMC, the GRRB and PCA to work closely together and with the HTC's, RRCs and communities in implementing this IFMP and to make timely adjustments, as required, to its implementation.

## **7. THE MANAGEMENT PROCESS**

### **7.1. Measuring Progress**

#### *Annual Reviews*

Implementation of this Dolly Varden IFMP requires annual reviews and updates. Each year, the RRWG and the WSWG review results from the year's fisheries. They evaluate the success of management measures, harvest levels, monitoring programs, communications, research results, local observations and community concerns to help ensure that the objectives and desired results of the IFMP are being achieved. The RRWG and WSWG consult with affected communities on any proposed adjustments to allowable harvest levels, strategies, conservation measures and specific projects to reflect these results and new information on Dolly Varden and their habitats. The reviews follow the adaptive co-management process.

In the annual reviews, the Working Groups will:

- use the information from the harvest monitoring and stock assessment programs and other sources to determine
  - whether changes in allowable harvest levels should be recommended,
  - whether changes to the strategies, conservation measure and other management activities are required,
  - when new stock assessments are required,
  - whether additional research initiatives (e.g. on habitat) should be undertaken,
  - whether the harvest monitoring program should be changed;
- determine whether any changes are required to improve habitat protection;
- determine whether any new educational initiatives are required;
- determine whether any other new initiatives should be undertaken; and
- consider whether implementation is achieving the IFMP's objectives and desired results.

The RRWG and the WSWG provide their reviews formally to the IFMP Steering Committee (see below). The IFMP Steering Committee reviews recommendations from the RRWG and WSWG and provides its approval on changes and advice.

### *Performance Reviews and Modification*

Every five years, the IFMP will undergo an in-depth evaluation. The evaluation will include information on the implementation of each strategy. The evaluation will determine whether the IFMP's objectives are being met, whether the strategies and conservation measures are being implemented effectively, and whether they are achieving the desired results. The evaluation will make recommendations and suggestions for improvements. Evaluation criteria and measurable indicators will be developed to help guide the process. The evaluation will build on the formal annual reviews of the RRWG and the WSWG.

The SARA Dolly Varden Management Plan has to be reviewed every five years. The SARA review process and the IFMP review process should be linked closely.

### **7.2. Management of the Process**

The implementation of this Dolly Varden IFMP needs to be well-managed, therefore:

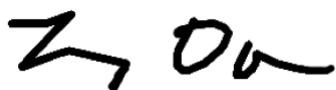
- The IFMP Steering Committee of senior representatives of DFO, the FJMC, the GRRB and PCA will continue to oversee the implementation of the IFMP, annual reviews and in-depth evaluations.
- The RRWG and the WSWG will continue to play key roles in implementing the IFMP and in conducting the annual reviews.
- The RRWG and the WSWG will continue to work closely together, and will continue to ensure the involvement of the Aklavik HTC, the RRCs, the communities and fishers.
- The IFMP Steering Committee will receive the RRWG's and the WSWG's annual reviews of the fisheries, and will approve any significant changes.
- The IFMP Steering Committee will review and update its Terms of Reference and those of the RRWG and the WSWG.
- The parties of the IFMP Steering Committee will work together to ensure that funds are available to the extent possible to support the effective implementation of their responsibilities in this Dolly Varden IFMP and for any revisions.

## SIGNATURE PAGE

The Department of Fisheries and Oceans, the Fisheries Joint Management Committee, the Gwich'in Renewable Resources Board and Parks Canada Agency support this Dolly Varden Integrated Fisheries Management Plan for the Gwich'in Settlement Area and the Inuvialuit Settlement Region and are committed to its effective implementation.

The signatories wish to acknowledge the Aklavik HTC, the Ehdiitat RRC, the Tetlit RRC, the Rat River Working Group and the West Side Working Group for their help in the development of the IFMP, and for their roles and responsibilities for its implementation.

The signatories undertake to conduct an in-depth review and evaluation of the Dolly Varden IFMP every five years.



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L. Dow, Director Northern Operations, Central and Arctic Region, Department of Fisheries and Oceans Canada



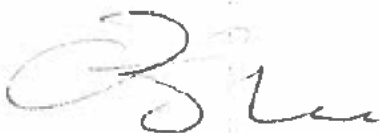
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A. Kennedy, Chair, Fisheries Joint Management Committee



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J. Carnogursky, Chair, Gwich'in Renewable Resources Board



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L.E.K. Binder, Field Unit Superintendent, Western Arctic Field Unit, Parks Canada Agency

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Figure 1. The general area covered by the Dolly Varden Integrated Fisheries Management Plan.



Fig. 2. The distribution of the Western Arctic Form of Dolly Varden in Canada.



Table 1. Dolly Varden Harvests from the Big Fish River, Rat River and Coastal Fisheries from 2011 to 2016 (E. Lea, unpublished data).

<b>Fishery</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Big Fish River <sup>a</sup>	-	29 <sup>b</sup>	61 <sup>b</sup>	150 <sup>c</sup>	150 <sup>c</sup>	187 <sup>c</sup>
Rat River <sup>a,d</sup>	355	345	293	347	573	541
Coastal Fisheries	458	597	335	571	597	512
<b>Total</b>	<b>813</b>	<b>971</b>	<b>689</b>	<b>1,068</b>	<b>1,320</b>	<b>1,240</b>

<sup>a</sup> harvests reported for the Big Fish River fishery and the Rat River fishery do not account for their stock contributions to the mixed-stock coastal fisheries.

<sup>b</sup> Big Fish River fish hole closed; harvest in Mackenzie Delta at mouth of Big Fish River.

<sup>c</sup> harvest at Big Fish River fish hole under an Aboriginal Communal Fishing Licence.

<sup>d</sup> harvests for the Rat River fishery includes harvests from the Rat River Monitoring Program.

Table 2. Population estimates for anadromous Dolly Varden among populations in the GSA and ISR. Please do not cite population estimates after 2010 that have not been peer-reviewed without permission (C. Gallagher, DFO Winnipeg).

Population	Year	Population Estimate	Comments	Peer-reviewed?
Firth River	1972	32,000	Visual assessment (may have included Arctic Grayling)	No
	1989	8,250–10,700		No
Babbage River <sup>a</sup>	1991	13,369	Mark Recapture DIDSON sonar	No
	2010	8,427		Yes <sup>c</sup>
	2011	2,839–3,119		Yes <sup>c</sup>
	2011	7,407		Yes <sup>c</sup>
	2012	7,950		Yes <sup>c</sup>
	2013	10,365		Yes <sup>c</sup>
	2014	16,182		No
	2015	18,860		No
	2016	15,882		No
Big Fish River <sup>b</sup>	1972a	20,700	Mark Recapture	No
	1972b	13,500	Mark Recapture	No
	1984	9,300	Mark Recapture	No
	1991a	2,840	Mark Recapture	No
	1991b	2,232	Mark Recapture	No
	1993	4,477	Mark Recapture	No
	1998	4,026	Mark Recapture	No
	2009	3,853	Mark Recapture	Yes <sup>c</sup>
	2010	4,338	Mark Recapture	Yes <sup>c</sup>
	2011	3,342	Mark Recapture	No
	2012	4,241	Mark Recapture	No
	2013	4,639	Mark Recapture	No
	2014	5,195	Mark Recapture	No
	2015	8,809	Mark Recapture	No
	2016	9,169	Mark Recapture	No
Rat River <sup>a</sup>	1989	11,191	Mark Recapture* Mark Recapture <sup>+</sup>	Yes
	1995	9,036		
	1997	10,411		
	2001	7,953		
	2004	2,912		Yes
	2007	14,887		No
	2007	9,120		No
	2010	9,310		Yes <sup>c</sup>
	2010	5,820		Yes <sup>c</sup>
	2013	14,891		Yes <sup>c</sup>
	2013	11,919		Yes <sup>c</sup>
	2015	30,831		No
	2015	15,959		No
	2016	14,492		No
	2016	23,421		No

<sup>a</sup> Population estimates presented for minimum sized fish ( $\geq 310$  mm).

<sup>b</sup> Population estimates presented for fish  $\geq 365$  mm to be consistent with how Big Fish River indicators process was established (Appendix 2).

<sup>c</sup> References for most-recent peer-reviewed populations estimates are as follows: Babbage R. (Gallagher *et al.* 2018); Big Fish River (Gallagher *et al.* 2013), and Rat River (Gallagher *et al.* 2020b).

\*Recapture of tags from Rat River Monitoring Program.

<sup>+</sup> Recapture of tags in fall seining program.

Table 3. Threat Assessments for Dolly Varden in the GSA and ISR (see below for an explanation of the column titles).

Threat	Extent	Occurrence	Frequency	Causal Certainty	Severity	Mitigation Potential	Level of Concern	GSA and ISR Status
<b>Stock Depletion</b>								
General Over-Fishing	Widespread: all populations	Historical Current: unlikely	Continuous	High	High	High	High	A past concern for the Big Fish River and Rat River. Safe harvesting regimes now in place.
Over-Fishing at Fish Holes	All Fish Holes	Historical Current: unlikely	Continuous	High	High	High	High	Fishing not permitted in most fish holes. Now permitted in the Big fish river in carefully monitored fisheries.
Mixed Stock Fisheries	Coastal and Delta: all populations	Historical Current	Continuous	High	Moderate	High	Medium	An area of uncertainty. Timely genetic monitoring is required.
Predation	Widespread	Historical Current	Continuous	High	Low	Low	Medium	Local knowledge suggests periodic problems, but issues not addressed.
<b>Habitat Changes - Natural</b>								
Groundwater Levels	Widespread	Historical Current	Continuous	High	High	Low	High	The Big Fish River is major area of concern.
Water Flow	Widespread	Historical Current	Continuous	High	High	Low	High	Natural variability is high and may increase with climate change.
River Salinity	Widespread	Historical Current	Continuous	High	High	Low	High	Changes noted in the Big Fish River only.
Slumping and Erosion	Widespread	Historical Current	Continuous	High	High	Low	High	Reported in watersheds and may increase with climate change.
<b>Habitat Changes - Anthropogenic</b>								
Stream Crossings and Culvert Installations	Widespread	Unlikely	Infrequent	High	High	High	Medium	Not currently an issue in streams covered by the IFMP.
Road Construction	Widespread	Unlikely	Infrequent	High	High	High	Medium	Not currently an issue in streams covered by the IFMP.
Pipeline Construction	Widespread	Unlikely	Infrequent	High	High	High	Medium	Not currently an issue in streams covered by the IFMP and unlikely to be so in the future.
Stream Crossings and Culverts	Widespread	Unlikely	Infrequent	High	High	High	Medium	Not currently an issue in streams covered by the IFMP.

<b>Threat</b>	<b>Extent</b>	<b>Occurrence</b>	<b>Frequency</b>	<b>Causal Certainty</b>	<b>Severity</b>	<b>Mitigation Potential</b>	<b>Level of Concern</b>	<b>GSA and ISR Status</b>
Gravel Extraction	Widespread	Unlikely	Infrequent	High	High	High	Medium	Not currently an issue in stream covered by the IFMP.
Hydrocarbon Exploration and Development including Seismic Testing	Widespread	Anticipated: coastal	Recurrent	High	High	High	High	Not currently an issue in streams covered by the IFMP and unlikely to be so in the future. A possible concern for coastal locations
Contaminants Releases	Sea and Shores	Historical Anticipated	Recurrent	High	High	Moderate	High	Possible from old sumps in the Mackenzie Delta.
Tourism	Widespread	Anticipated	Recurrent	High	Moderate	Medium	Medium	Primarily in the Firth River but could be an issue elsewhere in the future.
Water Removal	Widespread	Unlikely	Rare	High	High	High	Low	Not currently an issue in streams covered by the IFMP.
Logging	Widespread	Unlikely	Rare	High	Moderate	Medium	Low	Not currently an issue in streams covered by the IFMP.
Dam Construction	Widespread	Unlikely	Rare	High	High	Medium	Low	Not currently an issue in streams covered by the IFMP.
Population Growth	Widespread	Possible	Recurrent	High	Moderate	Low	Medium	Local population growth may increase demand for subsistence fishing. Implementation of the IFMP will address such demands.
<b>Climate Change</b>								
Climate Change	Widespread	Current	Continuous	High	High	Low	High	A major concern in the GSA and ISR from water quantity and salinity problems in spawning, rearing and overwintering areas to permafrost melting to changes in access to the fishery resources because of river-flow changes.
<b>Interjurisdictional Overlaps</b>								
Interjurisdictional Overlaps	Widespread: all populations	Anticipated	Occasional	Low	Moderate	High	Medium	There are potential overlaps/conflicts with Alaska. Currently there is no community-to-community mechanism to address conflicts such as harvesting of overlapping stocks.



### Explanation of Column Titles

A **Threat** is any human activity or process that has caused, is causing, or may cause harm, death or behavioural changes to a wildlife species at risk (e.g. Dolly Varden), or the destruction, degradation and/or impairment of its habitat, to the extent that population-level effects occur. A human activity may exacerbate a natural process.

**Extent** refers to the proportion of the population (Dolly Varden) affected by a given **Threat**, i.e. how widespread the **Threat** is across the species' (Dolly Varden) range.

**Occurrence** refers to the probability of a specific **Threat** occurring for a given population (Dolly Varden) over ten years or three generations, whichever is the shorter. In simple terms: how often does the impact from an activity related to a **Threat** occur over a given period of time.

**Frequency** refers to how often the population (Dolly Varden) would experience the **Threat** over the next ten years or three generations, whichever is shorter. In the case of Dolly Varden, which has an age of maturity of approximately 5 years, three generations would equate to roughly 15 years, so ten years has been used. **Frequency** is characterized as: Single (occurring once), Recurrent (occurring periodically or repeatedly) or Continuous (occurring without interruption).

**Causal Certainty** reflects the strength of evidence linking the **Threat** to the survival and recovery of the population (Dolly Varden). Evidence can be scientific, traditional ecological knowledge or local knowledge.

**Severity** (also known as Level of Impact) refers to the magnitude of the impact to the species (Dolly Varden) caused by a given **Threat**, and to the level to which it affects the survival or recovery of the population.

**Mitigation Potential** is the feasibility, logistically and financially, of implementing efficient measures or actions to reduce or eliminate the impact of a **Threat**.

**Level of Concern** is an indication of whether **Threat** management is, on the whole, of high, medium or low concern. This may take into account the capacity to mitigate or eliminate the threat.

Table 4. Conservation Measures and Implementation Schedule.

Conservation Measure	Priority	Threats or Concerns Addressed	Timeline and Lead Responsibilities <sup>a</sup>
<b>General Strategies</b>			
Apply the precautionary and ecosystem-based approaches	High	Stock Depletion Habitat Changes – Natural Habitat Changes - Anthropogenic	On-going: RRWG, WSWG, FJMC, GRRB, DFO
Manage fisheries through RRWG and WSWG	High	Stock Depletion Habitat Changes - Natural Habitat Changes - Anthropogenic	On-going: RRWG, WSWG, DFO, FJMC, GRRB, PCA
Promote cooperation and resolve any interjurisdictional issues	Low	Interjurisdictional Overlaps	As required: DFO, FJMC, GRRB, PCA
<b>Management of Fisheries</b>			
Do not permit commercial fisheries	High	Stock Depletion	As required: DFO, FJMC, GRRB
Do not permit fishing in fish holes without IFMP Steering Committee approval	High	Stock Depletion	On-going: DFO, FJMC, GRRB, PCA
Ensure the long-term sustainability of the Big Fish River fishery through specific goals	High	Stock Depletion	On-going: DFO, FJMC
Develop management regimes for the Firth and Babbage rivers	Medium	Stock Depletion	By 2023: DFO, FJMC
Ensure the long-term sustainability of the Rat River fishery through specific goals	High	Stock Depletion	On-going: DFO, GRRB
Ensure that any Vittrekwa River fishery is sustainable.	Medium	Stock Depletion	On-going: DFO, GRRB
Manage Coastal Fisheries to ensure no stock is over-harvested	High	Stock Depletion	On-going: DFO, FJMC, GRRB, PCA
Review allowable harvest levels and fisheries annually	High	Stock Depletion	Review annually: RRWG, WSWG, FJMC, GRRB, DFO, PCA
Ensure effective allocation of harvests	Medium	Stock Depletion	On-going: RRWG, WSWG, HTC, RRCs
<b>Habitat Protection</b>			
Protect habitats	High	Habitat Changes - Anthropogenic Stock Depletion	On-going: DFO, FJMC, GRRB, PCA

Conservation Measure	Priority	Threats or Concerns Addressed	Timeline and Lead Responsibilities <sup>a</sup>
<b>Research and Monitoring</b>			
Monitor harvests	High	Over-Harvesting	Monitor annually: RRWG, WSWG, DFO, PCA, HTC, RRCs, Harvesters
Conduct periodic stock assessments	High	Over-Harvesting	Plan annually: DFO, FJMC, GRRB, PCA Conduct cyclically: DFO
Collect coastal and Mackenzie Delta samples for genetic analyses	High	Mixed-stock Fisheries	Collect annually: RRWG, WSWG, DFO, HTC, RRCs, Harvesters Annual analysis: DFO
Undertake life-cycle studies	High	Stock Depletion	Plan annually: DFO, FJMC, GRRB Conduct as required: DFO
Identify, assess and monitor critical, sensitive and limiting habitats	High	Habitat Changes – Natural Habitat Changes - Anthropogenic	Plan annually: DFO, FJMC, GRRB, PCA Conduct as required: DFO, PCA Monitor annually: RRWG, WSWG, HTC, RRCs, Harvesters
Gain better understanding of Dolly Varden and ecosystem interactions	High	Habitat Changes – Natural Habitat Changes – Anthropogenic Stock Depletion Climate Change	Plan annually: DFO, FJMC, GRRB, PCA Conduct as required: DFO
Gather local observations on environmental conditions and climate change	High	Stock Depletion Habitat Changes – Natural Habitat Changes - Anthropogenic Climate Change	On-going: Harvesters, HTC, RRCs, RRWG, WSWG, PCA
<b>Communication, Education and Compliance</b>			
Undertake communication and education activities	High	Stock Depletion Habitat Changes – Natural Habitat Changes - Anthropogenic	On-going: RRWG, WSWG, DFO, PCA, GRRB School Outreach Program
Manage fisheries and fish habitats through self-compliance whenever possible	High	Stock Depletion Habitat Changes – Natural Habitat Changes – Anthropogenic	On-going: RRWG, WSWG, DFO, PCA, FJMC, GRRB
Undertake compliance activities	Medium	Over-Harvesting Habitat Changes - Anthropogenic	As required: DFO, PCA

<sup>a</sup>: the RRWG, WSWG, HTC, RRCs and the communities also have significant roles in developing and implementing these conservation measures.

## **APPENDIX 1: DOLLY VARDEN HARVESTS IN THE GSA AND ISR**

The following tables summarize available information on annual harvests from the traditional Dolly Varden fisheries in the GSA and ISR. The information comes from DFO, the Gwich'in Harvest Study (GRRB 2009) and the Inuvialuit Harvest Study (Joint Secretariat 2003). The tables are based on those in Appendix G of the 2011-2015 IFMP (DFO et al. 2010) and the more recent information in Table 1 of this IFMP.

Harvest information is presented for the Gwich'in and Inuvialuit in Table A1-1, and for the Big Fish River, Rat River and coastal subsistence fisheries in Table A1-2.

### **Gwich'in and Inuvialuit Harvests**

Table A1-1 (from Table G-1 in DFO et al. 2010) summarizes available information for overall Gwich'in and Inuvialuit harvests of Dolly Varden. The information comes from the DFO harvest monitoring programs, the Gwich'in Harvest Study conducted from 1995 to 2004 (GRRB 2009) and the Inuvialuit Harvest Study conducted from 1988 to 1997 (Joint Secretariat 2003). Information from some fisheries is not available for all years. Information after 2009 is only presented in Table A1-2

The Gwich'in Harvest Study recorded the estimated total Dolly Varden harvest from the Rat River for all Gwich'in communities and accounts for over and under harvest reporting. Gwich'in harvest numbers from DFO incorporate 50% of the harvest from Shingle Point. The Inuvialuit Harvest Study recorded the estimated Dolly Varden harvest for Aklavik, plus 50% of the harvest from Shingle Point.

### **Big Fish River, Rat River and Coastal Fisheries**

Table A1-2 presents harvest information for the Big Fish River, Rat River and coastal subsistence Dolly Varden fisheries. Information on harvest guidelines for the Big Fish River and Rat River also is presented. Table A1-2 is based on Table G-2 in the 2011-2015 IFMP (DFO *et al.* 2010). However, the Herschel Island, Shingle Point and Other Coastal Fisheries harvests in Table G-2 are presented just as Coastal Fisheries information in Table A1-2. Also harvest information in Table 1 of this IFMP is added in Table A1-2.

The harvests in Table A1-2 for the Big Fish River and the Rat River do not include fish caught in the Coastal Fisheries.

The Guideline columns include information on any established safe harvest levels, fishery closures (V. Closure = Voluntary Closure) and whether the fish hole was closed (F. H. Closed)

Table A1-1. Gwich'in and Inuvialuit Dolly Varden harvests.

<b>Year</b>	<b>Gwich'in Harvest</b>	<b>Inuvialuit Harvest</b>
1972	6,500	9,000-13,000
1973	2,600	4,050
1975	2,100	
1980	1,545	94
1984		343
1985		989
1986	1,100	1,875
1987	3,125	203
1988	1,681	735*
1989	1,999	1,164*
1990	1,051	768*
1991	376	352*
1992	1,034	759*
1993	1,409	1,301*
1994	2,155	2,759*
1995	1,524*	548*
1996	2,920*	2,457*
1997	3,393*	1,079*
1998	3,760*	386
1999	1,911*	321
2000	1,453*	39
2001	1,781*	1-25
2002	635*	1-25
2003	1,492*	
2004	772*	
2005	658	
2006	124	64
2007	120	166
2008	119	56
2009	95	

\*Harvest levels being reviewed to ensure no double counting of DFO information, the Gwich'in Harvest Study and the Inuvialuit Harvest Study.

Table A1-2. Dolly Varden harvests from the Big Fish River, Rat River and Coastal Fisheries (harvest data for 2009-2016 provided by E. Lea, DFO Inuvik).

Year	Big Fish River Fishery		Rat River Fishery		Coastal Fisheries
	Harvest	Guideline	Harvest	Guideline	
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	V. Closure	3,125		332
1988	0	V. Closure	1,681		197
1989	0	V. Closure	1,999		130
1990	0	V. Closure	1,051		219
1991	0	V. Closure	376		37
1992	24	700	1,034		61
1993	40	200	1,409		138
1994	36-74	200	2,155		215
1995	40-93	200	1,492		111
1996	18	200	2,517		1,365
1997	99	150	3,331	1,500	253
1998	77	150	3,319	2,000	809
1999	96	200	1,761	2,000	250
2000	39	400	1,485	2,000	15
2001	1-25	Closure	1,781	2,000	
2002	1-25	Closure	1,180	2,000	
2003	0	Closure	1,083	2,000	
2004	0	Closure	363	600	
2005	0	Closure	554	600	
2006	0	Closure	132	V. Closure	127
2007	0	Closure	146	V. Closure	219
2008	0	Closure	120	V. Closure	70
2009	0	Closure	261	1,225	
2010	0	Closure	279	600	
2011	0	Closure	355	300	458
2012	29	150 F.H. Closed	345	375	597

Year	Big Fish River Fishery <sup>a</sup>		Rat River Fishery <sup>a,b</sup>		Coastal Fisheries
	Harvest	Guideline	Harvest	Guideline	
2013	61	150 F.H. Closed	293	420	335
2014	150	150	347	420	571
2015	150	150	573	450	597
2016	187	150	540	450	512

<sup>a</sup> harvests reported for the Big Fish River Fishery and the Rat River Fishery do not account for their stock contributions to the mixed-stock coastal fisheries.

<sup>b</sup> the Rat River Fishery includes harvests from the Rat River Monitoring Program.

## **APPENDIX 2: A “TRAFFIC LIGHT PROCESS” FOR THE ASSESSMENT OF SCIENTIFIC AND TRADITIONAL KNOWLEDGE INDICATORS OF THE HEALTH OF DOLLY VARDEN IN THE ISR**

The purpose of this Appendix is to briefly outline the procedures currently in place and being developed for sustainable management and use of Dolly Varden in the ISR west of the Mackenzie River to the Yukon/Alaska border. It summarizes the goals for the Dolly Varden of the Big Fish River, which is the major source of harvested Dolly Varden at this time, and the “Traffic Light Process” which is the mechanism being developed to integrate scientific and traditional knowledge indicators of the health status of the Dolly Varden population into a decision tool for a Recommended Allowable Harvest (RAH) of Dolly Varden in the subsistence fishery.

The primary responsibility of fishers and managers of a fish population is to ensure that the population remains healthy and productive for the use of future generations. Critical is agreement on common goals for the stock. These goals should be biological or environmental and social or cultural and should also consider economics or costs. If a consensus is reached on the goals, then the path to achieve them should be clearer. The WSWG has established a set of four specific goals for the Big Fish River. Consistent with the IFA the first goal is the priority goal in that long-term protection and preservation of the Dolly Varden populations must remain paramount. The other three goals are considered of equal importance.

*Goal 1. To ensure the long-term sustainability of northern Dolly Varden, with a target population abundance that is not less than 1 standard deviation below the mean of the most recent population estimates (3-5 years) in the Big Fish River.*

*Goal 2. To ensure at least an allowable harvest of 150 adult Dolly Varden in the Big Fish River for cultural and traditional purposes.*

*Goal 3. Future changes in Recommended Allowable Harvests (RAH) for the Big Fish River (up or down) will be based on changes in the population size in the Big Fish River as determined by an agreed upon “Traffic Light Process”. This Process will include scientific and traditional knowledge indicators from the mixed stock coastal fishery and the Big Fish River in an adaptive co-management regime. Thresholds for change will be transparent and agreed to by all parties in the development of the Process.*

*Goal 4. Fishing in the fish holes in the Big Fish River will be permitted following approval from the Minister of Fisheries and Oceans and following agreement on harvest method.*





Each of the goals is supported by a specific rationale and the goals and rationale are to be reviewed annually and, following the process of adaptive co-management, modified as appropriate.

There are many ways of determining whether a fish population is remaining stable or is in a period of increase or decline. The use of “indicators” of population health has become important around the world as a means for making sound management decisions. Fisheries indicators are



simple measures that tell what is happening to fish populations. They should be measures that are credible to scientists and fishers and that can help track trends in the state of a fish population. Examples of indicators that have been considered for other fisheries include: mark-recapture population estimates; raw catch or catch-per-unit-effort; mean age/length/weight of population samples; age structure of population samples; area distribution; and interview information and other subjective sources amongst many others. Traditional knowledge can also inform our understanding of stock health. Observations on the health of individuals such as scarring levels, plumpness or condition of harvested fish, external and internal parasites, harvest levels and environmental conditions during the harvest all can be useful observations.

Across the ISR the FJMC is developing a “Traffic Light Approach” within each Community Working Group’s annual adaptive co-management process. This Approach will bring scientific and traditional knowledge indicators together, indicators that are credible to scientists and fishers, and that can help track trends in the state of a fish population. In the ISR the indicators of the health of major populations of Arctic Char and Dolly Varden, will be assessed regularly using the following categories: healthy (green); cautious (yellow); critical (red); and undetermined (grey) using general criteria in the table below:

Category of Rating	Description of the Assessment of the Indicator Status
	The indicator is above a threshold and is increasing over time showing that the population health is normal and may be getting better.
	The indicator is above a threshold but does not show either a decreasing or increasing trend over time.
	The indicator is declining or below a threshold showing that the population health is decreasing or not good.
	There is insufficient data or understanding of this indicator. This could be because of a failure to collect certain data for a year or because insufficient years of data exist to make an interpretation.

This tool should lead to more transparent and better evidence-based management decision-making, increase fishers’ participation in the monitoring and management of fisheries, identify areas for future research and foster closer cooperation between fishers, the HTC, the FJMC and the DFO. The approach has three principle features.

1. It is a visual tool that summarizes the trends in a series of indicators of the health of a fish population(s) for use in management decision making.
2. It incorporates both traditional knowledge and scientific knowledge of trends in harvests, population abundance, fish and population health and the environment upon which the fish populations depend.
3. It is an annual cyclical process of decision making, harvesting, monitoring, data collection, research, assessment and re-evaluation.

The choice of indicators to use depends on factors, such as data availability, cost of data collection and variability of the indicator. Working together fishers, scientists and managers will agree together about the kinds of indicators that are to be used. Together they will decide what changes in the observed indicators mean with respect to opportunities to harvest more or fewer

fish, and to change fishing locations or fishing times. The following table identifies the 14 scientific and traditional knowledge indicators currently in use or under consideration by the WSWG for decision-making for the Big Fish River Dolly Varden population. For each indicator the Table includes the strength or sensitivity of the indicator and the decision thresholds. The annual assessment of indicators is the basis for any WSWG recommendations on changes to harvest levels.

#	Indicator	Sensitivity / Strength	Decision Thresholds			
			Superior or Normal	Fair or Caution	Critical	Unknown
1	<b>TOTAL HARVEST</b>	Low	Increasing over 3-year period	No consistent trend / change	Declining over 3-year period	Insufficient data or rationale
	Data Source(s):					
	<ul style="list-style-type: none"> <li>Subsistence harvest levels: coast, mouth of the Big Fish River</li> <li>Scientific Harvests, Abundance Estimate</li> </ul>					
2	<b>GENETIC MIXED-STOCK ANALYSIS</b>	High	Stable	Moderate change	Significant change	Insufficient data or rationale
	Data Source(s):					
	<ul style="list-style-type: none"> <li>Shingle Point Monitoring</li> <li>Abundance and stock health</li> </ul>					
2a	<b>SHINGLE POINT HARVEST</b>	Low / Moderate	TBD	TBD	TBD	Insufficient data or rationale
	Data Source(s): Shingle Point Monitoring					
	Notes: This indicator has not yet been considered by the WSWG. It is determined by multiplying the total Shingle Point harvest by the proportion that are from the Big Fish River, as determined by the genetics analysis. It is a critical statistic for the harvest plan, but is it an indicator of stock health? Further evaluate if increase in contribution is correlated with increase in population abundance. (highly interrelated indicators, redundancy?)					
3	<b>ADULT POPULATION POINT ESTIMATE</b>	High	>4,400	3,500 to 4,400	<3,500	Insufficient data or rationale
	Data Source(s):					
4	<b>ADULT POPULATION TREND ESTIMATE</b>	High	Increasing over 3-year period	No consistent trend/ change	Declining over 3-year period; Dramatic decline from one year to next (?)	Insufficient data or rationale
	Data Source(s):					
	<ul style="list-style-type: none"> <li>Big Fish River mark-recapture program (for fish <math>\geq 365</math> mm)</li> <li>Abundance estimate</li> </ul>					

#	Indicator	Sensitivity / Strength	Decision Thresholds			
			Superior or Normal	Fair or Caution	Critical	Unknown
5	<b>ESTIMATED NATURAL AND HARVEST MORTALITY RATES</b>	High / Moderate	Mortality: <50%	TBD	TBD	Insufficient data or rationale
	Data Source(s):					
	Notes: The mortality rates have not yet been calculated. Several years of data are required. Evaluate methods / robustness (confidence) of metric based on tag returns.					
6	<b>LENGTH DISTRIBUTION OF ADULTS IN FISH HOLE</b>	High	Bimodal btw sexes; not skewed; proportion of male spawners $\geq 550$ mm is >7%	Intermediate	Unimodal; overlapping M & F; skewed to younger sizes; consecutive years of $\leq 5\%$	Insufficient data or rationale
	Data Source(s):					
	Notes: The interpretation of this indicator needs to be explained further by the WSWG.					
7	<b>LENGTH AT 50% MATURITY (FEMALE &amp; MALE)</b>	Moderate	>421/479 mm	Intermediate	<421/479 mm	Insufficient data or rationale
	Data Source(s):					
	Notes: The interpretation of this indicator needs to be explained further by the WSWG.					
8	<b>PROPORTION OF SPAWNING MALES</b>	High	$\geq 20\%$	~15-19	Consecutive years of $\leq 15\%$	Insufficient data or rationale
	Data Source(s):					
	Notes: The interpretation of this indicator needs to be explained further by the WSWG.					
9	<b>PROPORTION OF SPAWNING FEMALES</b>	Low	$\geq 40\%$	Intermediate	Consecutive years of <40%	Insufficient data or rationale
	Data Source(s):					
	Notes: The interpretation of this indicator needs to be explained further by the WSWG.					
10	<b>SCARRING LEVELS</b>	Moderate	Stable/ decreasing (~10%)	Intermediate	Increasing ( $\geq 15\%$ )	Insufficient data or rationale
	Data Source(s):					
	Notes: Scarring levels have been consistently less than 10% and have decreased for past 3 years.					

#	Indicator	Sensitivity / Strength	Decision thresholds			
			Superior or Normal	Fair or Caution	Critical	Unknown
11	<b>CHAR CONDITION - HEALTH</b>	TBD	Very healthy / healthy	Average / fair	Unhealthy	Insufficient data or rationale
Data Source(s): - Inuvialuit participants in the Big Fish River Fish Hole harvest monitoring program - Inuvialuit monitors from the Big Fish River mark-recapture program - Inuvialuit monitors from the Shingle Point monitoring program						
Notes: "Healthy" = fat, plump, round, head looks relatively small, firm meat. "Unhealthy" = skinny, head looks relatively large, soft meat.						
12	<b>CHAR CONDITION – SCARRING, WOUNDS, SIGNS OF PREDATORS</b>	TBD	None to very few injuries	Average	Many injuries	Insufficient data or rationale
Data Source(s): - Inuvialuit participants in the Big Fish River Fish Hole harvest monitoring program - Inuvialuit monitors from the Big Fish River mark-recapture program - Inuvialuit monitors from the Shingle Point monitoring program						
Notes: Redundancy with Science Indicator # 10. Signs of predation (observed animals, tracks, etc.) are recorded; however, they have not yet been categorized into threshold levels, as very few have been observed since 2014.						
13	<b>CHAR CONDITION – PARASITES (EXTERNAL &amp; INTERNAL)</b>	TBD	None to very few	Average	Many	Insufficient data or rationale
Data Source(s): - Inuvialuit participants in the Big Fish River Fish Hole harvest monitoring program - Inuvialuit monitors from the Big Fish River mark-recapture program - Inuvialuit monitors from the Shingle Point monitoring program						
Notes: Internal parasites are not observable to monitors unless in their own fish that they consume. Aklavik HTC members have provided comments that they have received from the membership regarding distributed Big Fish River Dolly Varden. Would likely need to develop annual surveys for community members from Aklavik to improve information collection on internal char parasites.						
14	<b>NUMBER OF CHAR IN EACH SEINE HAUL / NUMBER OF SEINE HAULS</b>	TBD	TBD	TBD	TBD	Insufficient data or rationale
Data Source(s): - Inuvialuit participants in the Big Fish River Fish Hole harvest monitoring program - Inuvialuit monitors from the Big Fish River mark-recapture program						
Notes: The Big Fish River Fish Hole harvest monitoring program has been the focus of the development of this indicator; however, monitor observations from the mark-recapture program also have been recorded. The Fish Hole program has only run 3 years (2014-2016) with the number of Dolly Varden in pools and captured being quite variable each year. Will require more years of this program to establish rankings for what is considered good, average and poor.						