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Central and Arctic Region

DFO Science
Stock Status Report D5-63 (2002)

Firth River Dolly Varden

Background

The northern form of Dolly Varden, Salvelinus malma (Walbaum), inhabits the Firth River. The Inuvialuktun name is iqaluqpiq, however, most local people call them char (Papik et al. 2003).

All spawning and almost all over-wintering habitat for Dolly Varden in this river system occurs in two areas at the Yukon/Alaskan border: the headwaters of the Firth River, and the headwaters of Joe Creek, a major tributary (Baker 1987) (Fig. 1).

An unknown number of Firth River fish are harvested in "mixed stock" subsistence fisheries along the coasts of Yukon and Alaska (Krueger et al. 1999). At present, the only harvests known to occur within the Firth River itself are by sport fishing.

The status of this stock is being reviewed to evaluate the characteristics of a relatively unexploited stock, and information will support co-management needs. The Firth River system flows from Alaska's Arctic National Wildlife Refuge, into the Yukon Territory, within the Inuvialuit Settlement Region (ISR) and Ivvavik National Park. As a result, a number of agencies co-manage the Firth River: Fisheries and Oceans Canada (DFO), Fisheries Joint Management Committee (FJMC), Parks Canada, and the United States Fish and Wildlife Service (USFWS). The West Side Working Group (WSWG) was established in 2001 by DFO, FJMC, the Aklavik Hunters and Trappers Committee (HTC) and Parks Canada to develop an integrated fisheries management plan for this and other stocks of North Slope Dolly Varden.

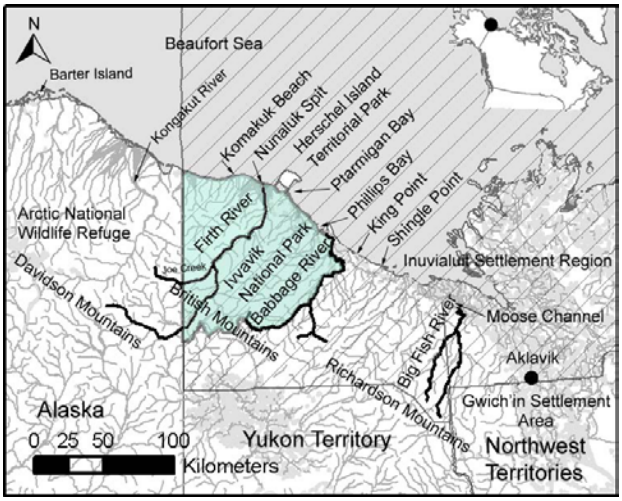

Fig. 1. Map of the North Slope area.

Summary

- Anadromous Dolly Varden spawn and overwinter in headwaters of the Firth River and Joe Creek on the Yukon/Alaska border.
- These Dolly Varden are genetically distinct from other populations in neighbouring systems.
- Although there is some evidence of genetic variation between the Firth River and Joe Creek populations, there is not sufficient divergence to consider them to be distinct stocks.
- The Dolly Varden from the Firth River system are fished in a small sport fishery and mixed stock fisheries along the coast in Canadian and Alaskan waters.
- The contribution of Firth River Dolly Varden to the mixed stock fisheries is unknown.

- Coastal movements of Firth River Dolly Varden are unknown and likely variable.

- Although this stock is considered to be relatively unexploited, the actual harvest and current size of this stock is unknown.

Species Biology

Dolly Varden (*Salvelinus malma*) are closely related to Arctic char (*S. alpinus*), lake trout (*S. namaycush*) and brook trout (*S. fontinalis*). Externally, all chars, including Dolly Varden, can be distinguished from salmon and true trouts by their light spots (yellow, orange or pink) on a darker background, as opposed to black spots or speckles on a lighter background. Dolly Varden can usually be distinguished from Arctic char by their more numerous and smaller spots with blue halos, more laterally compressed bodies and generally less-forked tail fins. The anadromous form of Dolly Varden, when in non-breeding condition, is silvery with an olive-green to brown colour on the dorsal surface. Colours vary between stocks, fish size, and breeding condition (Armstrong and Morrow 1980).

In the Canadian Arctic, Dolly Varden inhabit North Slope rivers (Fig. 1) to the west of the Mackenzie River, including the Vittrekwa (Peel River drainage), Big Fish, Babbage, Firth, and the Rat rivers. Dolly Varden are recognized as a distinct species (Reist *et al*. 1997), although earlier literature for this area either refers to them as the western Arctic form of Arctic char or combines the information for the two species.

Many Dolly Varden stocks, including the Firth River stock, exhibit both an anadromous (sea-run) and a residual, non-migratory (solely freshwater) form (McCart 1980). The residual form is comprised almost exclusively of males, which remain in freshwater for their entire lives and, therefore, do not go through the smoltification process. They mature at a smaller size and younger age than their anadromous counterparts and “sneak” into the redds to spawn with the anadromous females.

The anadromous form, the most commonly observed, reside in their headwater streams for approximately three years as parr before making their first migration to the Beaufort Sea to feed in summer as smolts. Glova and McCart (1974) found that the spring migration occurred in early to mid-June, with larger fish migrating earlier than smaller ones. They return in the fall to the freshwater riverine environment to overwinter. Spawning fish return to the upper areas of the Firth River about a month prior to non-spawners (Glova and McCart 1974). Some spawners may remain in freshwater the year that they spawn (Glova and McCart 1974). In a study of near-shore waters in Alaska, Roguski and Komarek (1971) found some spawners spent time feeding in the Beaufort Sea the same year they spawned. They continue to make summer and fall migrations to and from the sea for the remainder of their lives. The summer feeding movements in coastal waters is a time of intense feeding and growth (Craig 1984). Fechhelm *et al*. (1997), however, found slow growth in early summer along the Alaskan coast, and speculated that this might be explained by migration, dispersal, food availability, water quality, and stock mixing.

Detailed information on aquatic organisms, communities, and habitats,

both freshwater and marine, within Ivvavik National Park, including the Dolly Varden, are summarized in Karasiuk *et al.* (1993). Eddy *et al.* (2001) provide a summary specifically for Firth River Dolly Varden. There is, however, a lack of information about the biology of Canadian Dolly Varden in marine waters during the open-water season.

On average, 40.2% of the anadromous population in the Firth River stock was male (Glova and McCart 1974), and the mean ratio of females to males for all age groups was 1.4:1 (Glova and McCart 1974; Baker 1987).

Estimated mean length of sexually mature anadromous fish was 575 mm (males) and 625 mm (females). Glova and McCart (1974) found that among anadromous fish, the youngest mature individuals, both male and female, from the Firth River, were 4 years old. The youngest of the mature resident males was age three (Glova and McCart 1974). Age of 50% maturity for anadromous fish was age 7 or 8 (Glova and McCart 1974). Glova and McCart (1974) found that males tended to be slightly larger than females for most age classes of seaward migrants, although the discrepancy was small. Females contained an average of 4966 ± 463 eggs (n = 20).

Plots of length-at-age data for Firth River Dolly Varden confirm that males tend to be larger than females, beginning at about four years of age (Fig. 2). Firth River Dolly Varden appear to be the fastest growing of the Beaufort Sea stocks (Armstrong and Morrow 1980). A 1972 sample showed that mature anadromous fish ranged from 350 to 820 mm in length and 4 to 15 years of age. Resident fish sampled at this time were all less than 390 mm in length and younger than 11 years of age (Glova and McCart 1974; Baker 1987).

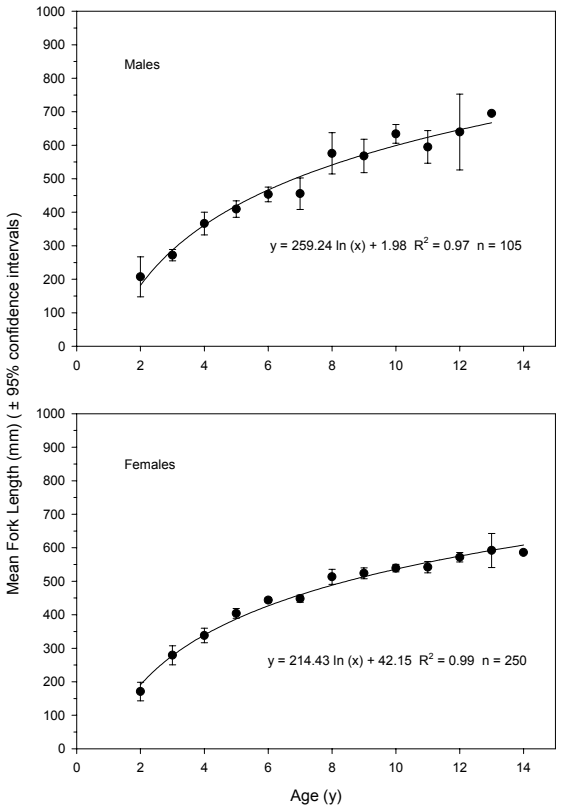

Fig. 2. Length-at-age for male and female Dolly Varden from the Firth River. Data are combined for 1986, 1988 and 1995 (J. Johnson, unpublished data; J. Reist, unpublished data).

Spawning began in mid-August and continued through September and early October in the Upper Firth River while spawners arrived later and spawned later in Joe Creek (Glova and McCart 1974). This may be influenced by the higher water temperature at the thermal upwellings in Joe Creek (4°C) as compared to the Firth River (1.5°C). The frequency of spawning for the stock in the Firth River and Joe Creek is not known (Glova and McCart 1974).

The spawning, nursery, and overwintering areas of the Firth River system are all associated with perennial upwellings that provide flowing water

year-round. Upwelling areas are very restricted, and are used intensively by the population (Glova and McCart 1974). Glova and McCart (1974) observed spawning Dolly Varden in three sites along the upper Firth River and in Joe Creek near the Alaska/Yukon border. There may be additional over-wintering areas in the delta of the lower Firth River (Glova and McCart 1974). The delta of the lower Firth had relatively high densities of fry and juveniles (Glova and McCart 1974). There is evidence that in the Firth River over-wintering areas, Dolly Varden may segregate into size classes (Glova and McCart 1974). In the winter, juvenile fish appear to utilize primarily shallow areas with little flow, such as near stream edges (Glova and McCart 1974). Smolts and mature fish appear to occupy deeper water, such as pools and main channel, as well as under the ice at the edges of open water areas (Glova and McCart 1974). Papik *et al.* (2003) reported one fish hole with "hand length" sized fish in the winter.

Free-swimming young-of-the-year Dolly Varden emerged in areas of winter flow prior to spring break-up (Glova and McCart 1974). They were first observed in Joe Creek on 11 May, and were collected in the gravel at the stream's edge (Glova and McCart 1974).

Description of Habitat

The Firth River system (Figs 1 and 3) originates in the Davidson Mountains in Alaska and flows northeast to the Beaufort Sea. The headwaters of both the Firth River and Joe Creek originate in Alaska within the Arctic National Wildlife Refuge. In Canada, the Firth River and Joe Creek are entirely within the Yukon Territory, within the boundaries of Ivvavik National Park and within the Inuvialuit Settlement Region.

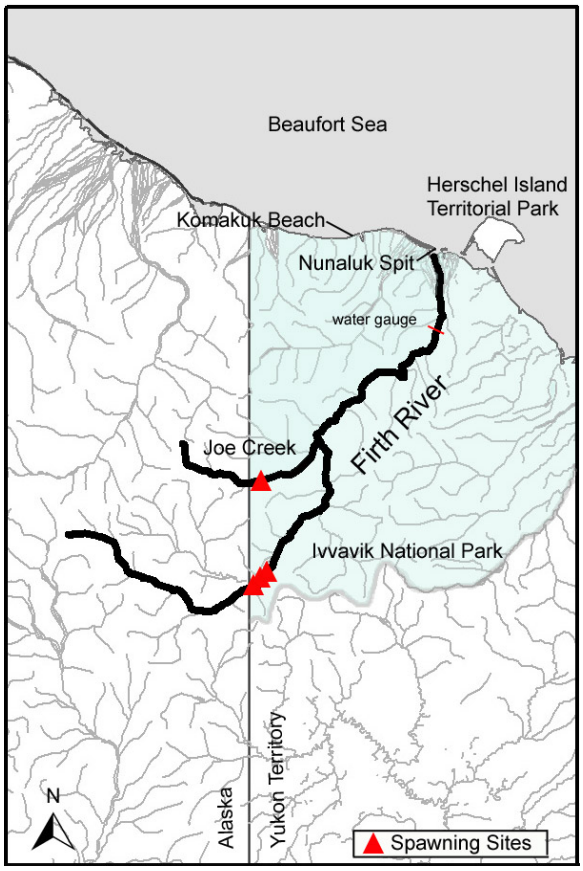

Fig. 3. Map of the Firth River area indicating the spawning sites and water gauge location.

Peak discharge levels generally occur during spring flooding in late May and early June, when there is also high turbidity, substantial undercutting of banks, shifting substrates, and dislodging of shoreline vegetation (Glova and McCart 1974).

The numerous spring-fed areas in an approximately 12 km long stretch in the headwaters of Firth River and the spring-fed area in the headwaters of Joe Creek are the only known spawning, nursery, and primary over-wintering areas for anadromous Dolly Varden in the river system (Baker 1987). Large fields of ice (*aufeis*) form on the braided areas of the river or its tributaries that

are downstream from these spring-fed areas, and usually persist throughout the summer months (Baker 1987).

The delta area of the Firth River may also contain important habitat for Dolly Varden, particularly feeding and nursery areas for young fish during the ice-free period (Glova and McCart 1974). While no direct evidence for spawning in this area is available, eggs and embryos have been recorded in the stomachs of fish captured in the springs between the Malcolm and Firth river deltas. Fry and juveniles are present in the delta during the ice-free season, and fry, presmolts, and immature anadromous fish have been found in high densities in these springs in late winter (Glova and McCart 1974). This area also provides an important transitional zone between the freshwater and marine environments that Dolly Varden use during smoltification.

The Fishery

Historical harvest

In the past, the Firth River stock has been harvested directly from the river and along the Beaufort coast as part of a mixed stock fishery (Papik *et al.* 2003). The fishing pressure directly on fish in this river has been low, likely due to its inaccessibility (Kristofferson and Baker 1988; Baker 1987). A small domestic/ commercial fishery was operated by the residents of Herschel Island until the town and Island were abandoned in the mid-1960s (Papik *et al.* 2003). The Menzies Fish Co. Ltd. conducted commercial fishing from Pauline Cove and Ptarmigan Bay off Herschel Island in the mid-1960s. Approximately 7296 kg of Dolly Varden were harvested in 1965, and 363 kg were harvested in 1966, before lack of profit closed the fishery (Baker 1987). Fish harvested by this fishery may have come from the Malcolm, Firth, and other rivers to the west, and from the rivers eastward as far as the Mackenzie (Currie 1964). Dolly Varden arrive at Herschel Island in early July, and remain in the area until late August (Currie 1964). Currie reports that, in 1963, the Royal Canadian Mounted Police living on Herschel Island used 10 nets inside Pauline Cove to catch 5000 char in 10 days. In addition to harvests in this area, some Firth River Dolly Varden may be taken in mixed stock harvests in Alaska or the Mackenzie Delta (Kristofferson and Baker 1988; Baker 1987).

Current harvest

Within the past decade, levels of harvest from the Firth River and Joe Creek stocks are thought to be low. Small numbers of these stocks are harvested in subsistence fisheries at Shingle and King Points (Sandstrom *et al*. 1997). Some harvesting at Herschel Island also occurs, and some Canadian Dolly Varden are harvested in Alaska (Krueger *et al.* 1999). The numbers harvested in the mixed stock fisheries can be variable and may not be reported (D.C. Gordon, pers. comm.). Alaskan Inupiat travel between Aklavik and Kaktovik, and may harvest Canadian Dolly Varden. In 2002, for example, seven boats were stranded at Herschel Island by bad weather, and it was estimated that as many as 300 fish may have been caught (D.C. Gordon, pers. comm.) in addition to over 200 taken by young fishers. There is a commitment by the Yukon Government to monitor the harvest from Herschel Island Territorial Park, which will provide

additional information relevant to the management of the Firth River stock. A small summer sport fishery on the Firth River in Ivvavik National Park took an estimated 38 Dolly Varden in 2001 (McLean, in prep.). An additional 28 Dolly Varden were caught and released on the Firth that season. No recreational harvest of Dolly Varden was reported along the North Slope coast during spring and summer months of 2001. Sport fishing is regulated by Parks Canada within Ivvavik National Park.

View of Fishers

The Inuvialuit have long depended on the Dolly Varden (*iqaluqpiq*) of the Yukon North Slope for food. Along the Firth River, at a place called Iggitchiarq, there is an old fishing location for the Inuvialuit. Archaeologists have carbon-dated artifacts from this site back to 8000 years ago (Papik *et al.* 2003). Inuvialuit fishers have changed their fishing locations and practices over the decades, because a number of circum-stances have changed. In the early 1900s, Herschel Island (a thriving community of about 1500 people), at the mouth of Firth River, was used as a main port for whalers in the Beaufort Sea (Papik *et al.* 2003). People lived there year round, hunting, trapping, and fishing. Elders recall several good fishing locations, such as Sheep Creek, Joe Creek, Iggitchiarq, at the start of the Firth Delta, Ptarmigan Bay, and Komakuk Beach on the coast. People began to leave Herschel Island as whaling declined and the muskrat boom in the Mackenzie Delta began in the 1930s and 1940s. The store and school closed and, in the 1950s, the RCMP post closed.

A small commercial Dolly Varden fishery was initiated in the 1960s at Herschel Island and Phillips Bay, and fish were flown to Shingle Point for processing and freezing. The operation lasted for only two years, and since then only subsistence and recreational fishing has taken place.

People frequently stop at Herschel Island on their way to visit family and friends in Alaska, and Alaskans stop on their way to visit in Canada. At times, significant numbers of Dolly Varden may be taken during these visits. People fish mostly in the late summer and early fall, when the char start migrating to their spawning areas.

Even though Firth River Dolly Varden are not harvested extensively, the fishers still consider it to be an important system, especially given the present condition of the Big Fish River stock (DFO 2003). Elders and fishers consider that a holistic approach is essential to ensure the future survival of Dolly Varden in the ISR. They have supported the establishment of the WSWG by the FJMC, DFO, the Aklavik HTC, and Parks Canada to develop a long-term objective-based Fisheries Management Plan for all fish stocks west of the Mackenzie River to the Canada/Alaska border, including the Firth River Dolly Varden.

Resource Status

Stock Delineation

There is some evidence of genetic variation between the Firth River (main stem) and Joe Creek populations, but there is insufficient divergence to declare them to be distinct stocks. They are, however, distinct from other North

Slope river populations of Dolly Varden (Reist 1989; Everett *et al.* 1997; Krueger *et al.* 1999; Rhydderch 2001; Bajno and Reist, in prep). There are significant differences in otolith core strontium levels between Firth River and Joe Creek Dolly Varden in both anadromous and residual fish (Babaluk and Reist, in prep.). Morphometric data also suggest that these two spawning populations differ from one another (Johnson 2002).

Discrete stocks appear to be maintained by high fidelity to natal streams by spawning fish. While some wandering into other river systems is evident from tagging studies, these fish are thought to be non-spawners (McCart 1980), and may be overwintering in a non-natal system. Recaptures of tagged Dolly Varden (Glova and McCart 1974) indicate the extent of movement in coastal waters. Two Dolly Varden tagged in the upper Firth River and Joe Creek during spring migration were recaptured during upstream migrations in the Canning and Kongakut rivers in Alaska. The Canning River is approximately 250 km west of the Firth River. Fourteen were recaptured in the Upper Firth River later the same year. Four more were captured at Herschel Island the same year, and three more were caught at Barter Island one summer later. Krueger *et al.* (1999) also found mixing of stocks between Canadian and Alaskan waters.

Stock Size

There are no reliable estimates for Dolly Varden abundance from the Firth River.

Stock Trends

There is no information to assess stock trends for this population.

Sustainable Harvesting Rate

It has been recommended that until sustainable exploitation rates for Dolly Varden stocks located west of the Mackenzie River have been determined, annual exploitation rates should not exceed 5% of the anadromous population of harvestable sized fish (Cosens *et al.* 1998).

Sources of Uncertainty

There is no current estimate of stock size and little information on the harvest of Firth River Dolly Varden, particularly along the coast. As a result, the sustainable harvest levels can not be determined. The present day contribution of the Firth River stock to any of the coastal harvests is unknown. The composition of mixed stocks at specific harvest locations and times needs to be determined (Reist 1989). There is no information on possible habitat changes that may be occurring in the Firth River. Very few trend data are available, and there are no catch effort data available for this system.

Outlook

There seems to be a potential for increased recreational and subsistence fishing pressure because of increased interest in Ivvavik National Park, Herschel Island Territorial Park, and Inupiat and Inuvialuit travelling along the coast. Increased harvest of Dolly Varden from Alaskan waters may also impact the Firth River system stocks.

Management Considerations

Jurisdiction

The Firth River Dolly Varden fisheries within Canada are co-managed by DFO, FJMC, and Parks Canada, as established under the Inuvialuit Final Agreement (IFA 1984).

Important overwintering and spawning sites, located within Ivvavik National Park boundaries, are protected by Parks Canada. The Ivvavik National Park of Canada Management Plan describes the management and protection of the ecological resources of Ivvavik National Park, including Dolly Varden and their habitat. The plan was developed by Parks Canada in partnership with Inuvialuit resource management organizations and co-management boards established through the Inuvialuit Final Agreement.

The FJMC, DFO, Aklavik HTC, and Parks Canada have established the WSWG to develop a long-term, objective-based Fisheries Management Plan for the rivers between the Mackenzie River and the Canada/Alaska border. The WSWG is currently made up of fishers from Aklavik, community elders, biologists, and managers.

The WSWG has initiated a process to:
- assemble scientific and traditional knowledge and information on fish stocks and habitats, implemented through the DFO Science Regional Advisory Process (RAP),
- establish conservation limits for the stock,
- set fisheries management objectives and strategies for the stock, and
- develop the fisheries management operational plan.

The Aklavik Inuvialuit Community Conservation Plan (Community of Aklavik *et al.* 2000) was prepared by the community of Aklavik, the Wildlife Management Advisory Council (NWT), and the Joint Secretariat. This plan has designated the Firth River watershed in Ivvavik National Park as Management Category D, which indicates lands and waters where renewable resources are of particular significance and sensitivity throughout the year. Management should eliminate, where possible, potential damage and disruption.

Part of the Firth River and Joe Creek watersheds are located in Alaska. The Alaska Department of Fish and Game (ADFandG) manages all subsistence, commercial, and sport fishing that occurs within Alaska. Land use activities in streams containing anadromous fish are also regulated by the ADFandG under the Anadromous Fish Act. Additionally, USFWS is responsible for habitat management within the Arctic National Wildlife Refuge. Being within the boundaries of the Arctic National Wildlife Refuge should ensure that the Alaskan portion of the Firth River watershed is protected.

Management of this stock is complicated by the fact that it is vulnerable to a mixed stock fishery along the Beaufort Coast likely on both sides of the Canada/U.S. border. Dolly Varden from the Firth River are vulnerable to any habitat disturbance that occurs in their summer feeding areas along the coast. Impacts from oil and gas exploration and development could occur in these areas.

Fishing pressure may increase on the Firth River because of the decline of the Big Fish River stock as fishers look for alternate sources of Dolly Varden. In the event of increased harvest, there would be an opportunity to study the transition from a relatively unexploited to a harvested stock.

Mixed Stock Harvesting

Fish captured in summer coastal fisheries can be from one of several different river systems (Reist 1989; Kristofferson *et al.* 1991). The composition of mixed stocks is generally unknown and highly variable.

Timing of Harvests

Fish that are aggregated in over-wintering sites are highly vulnerable to capture, and large numbers can often be harvested in a short period of time. Harvest in these areas following spawning also has the potential to increase egg mortality. This can occur if seining activities disturb or destroy redds (Stephenson 1999).

Other Considerations

The Firth River is unique as it has never been glaciated, and, therefore, may be one of the oldest continuously flowing rivers in Canada (Welch 1993). It is a tourist destination for whitewater rafting adventures, and is an area of spectacular scenery.

Habitat alteration and/or degradation of the spawning and over-wintering sites are the major threats faced by Dolly Varden stocks on the North Slope. Any development activity (e.g., roads, right-of-way) that would diminish the integrity or physical characteristics (water level, oxygen level, silt loads, temperature, pH) of the spawning and over-wintering areas, could pose a threat to developing embryos, rearing juveniles and/or spawning, and over-wintering adults found there. The integrity of the watershed must be maintained. More pervasive threats, such as climate change or increased incident ultraviolet radiation resulting from ozone depletion, may affect the fish and their habitat but details are not understood at the present time. Water quality/chemistry has been monitored on the Firth River by Parks Canada on an ongoing basis, along with measurements of water flow at the water gauge site (69°19’37”N, 139°34’8”W). This will provide baseline historical data to compare with current conditions.

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