



Wildlife Conservation and Management Plan 2021

Companion Report 10: Broad Whitefish / Aanaarlirq



Publication Information

Cover photo:	Broad Whitefish, Phillips Bay, © Colin Gallagher
Copyright:	2021 Wildlife Management Advisory Council (North Slope)
Citation:	Wildlife Management Advisory Council (North Slope). (2021). <i>Yukon North Slope Wildlife Conservation and Management Plan – Companion Report</i> . Whitehorse, Yukon: Wildlife Management Advisory Council (North Slope).
Available from:	Wildlife Management Advisory Council (North Slope) P.O. Box 31539 Whitehorse, Yukon, Y1A 6K8, Canada
Download link:	https://wmacns.ca/what-we-do/conservation-plan/companion

Acknowledgements

Many individuals and organizations have contributed to the preparation of the *Yukon North Slope Wildlife Conservation and Management Plan – Companion Report*. Much of the western science and traditional knowledge research that is the evidentiary basis for this plan reaches back several decades.

Critical reviews by Environment Yukon, Parks Canada, the Canadian Wildlife Service, Fisheries and Oceans Canada have been helpful in addressing a wide-range of terrestrial, aquatic and marine conditions that inform the conservation requirements of the Yukon North Slope.

The principal writers of the Companion Report are Kim Heinemeyer and Joan Eamer. Kim is a conservation biologist with Round River Conservation Studies. She was ably supported by Julia O’Keefe, Maggie Triska, and Will Tyson. Joan is a former Council member, science writer, and environmental consultant. They were assisted with strong support from Mike Sutor - Environment Yukon biologist, Dave Tavares – Parks Canada science advisor, Craig Machtans – Environment and Climate Change Canada manager, and Tyler Kuhn – Environment Yukon biologist. Allison Thompson and Kaitlin Wilson – Council biologists, and Lindsay Staples – past chair – participated in all stages of report design, drafting and editing. Kirsten Madsen provided invaluable editing support.

The Aklavik Hunters and Trappers Committee assisted with and contributed to a substantial body of traditional knowledge of the wildlife and habitat, and traditional use mapping, of the Yukon North Slope that informs the report.

Jennifer Smith, Council chair, Council members and alternates, Tyler Kuhn, Matt Clarke, Craig Machtans, Billy Storr, Evelyn Storr, Colleen Arnison, and Michelle Gruben, and Council staff Allison Thompson and Kaitlin Wilson reviewed the final draft of the report.

Companion Report to the Yukon North Slope Wildlife Conservation and Management Plan Number 10: Broad Whitefish / *Aanaarlirq*

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About the Companion Report

This report is a companion document to the *Yukon North Slope Wildlife Conservation and Management Plan* (WMAC (NS), 2022). The *Yukon North Slope Wildlife Conservation and Management Plan* (the Plan) is grounded in traditional knowledge and Western science. It addresses traditional use and wildlife conservation and management issues affecting the Yukon North Slope. Strategies in the Plan align with actions underway or planned by a range of agencies and organizations with jurisdiction on the Yukon North Slope.

This companion report summarizes the information that was used to support the objectives and strategies in the Plan, and provides references for the studies used in its development. The companion report draws from authoritative works, reports that synthesize knowledge and issues, and presentations of recent research findings. Sources include traditional knowledge and traditional use, scientific reports and journal articles, and management and conservation reports.

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Selected Topics

1. Traditional Use
2. Climate Change Effects
3. Contaminants
4. Aullaviat/Aunguniarvik

Featured Species and Species Groups

- | | |
|-----------------|---------------------|
| 5. Caribou | 10. Broad Whitefish |
| 6. Moose | 11. Geese |
| 7. Grizzly Bear | 12. Furbearers |
| 8. Polar Bear | 13. Dall's Sheep |
| 9. Dolly Varden | 14. Muskox |

Each chapter is available for download at: <https://wmacns.ca/what-we-do/conservation-plan/companion>.

There are fourteen companion reports, addressing four selected topics of key interest as well as ten wildlife species featured in the Plan. The featured species were selected by participants at a workshop held in Aklavik. The wildlife species in the companion reports:

- Have high cultural or economic value or are important as food for Inuvialuit;
- Have similar habitat needs to other wildlife species, so that conserving their habitat is key to conserving habitat for other species; and/or
- Are important for healthy ecosystems, including species that are main food items for top predators.

The Plan identifies key conservation requirements on the Yukon North Slope for each featured wildlife species. The Plan's objectives and strategies are designed to meet these conservation requirements. This companion report summarizes the information that guides the objectives, strategies and conservation requirements in the *Yukon North Slope Wildlife Conservation and Management Plan*.

Companion Report: Broad Whitefish / Aanaarlirq

This companion report provides information on the conservation requirements for broad whitefish as identified in the *Yukon North Slope Wildlife Conservation and Management Plan*. It summarizes the information that guides the objectives, strategies and conservation requirements in the Plan. It includes information on traditional use, population status and trends, important habitat types and locations, threats to broad whitefish, programs and measures for conservation and management, and selected studies and research relevant to the Yukon North Slope.

Conservation requirements for broad whitefish on the Yukon North Slope

1. Conservation of the nearshore band of brackish water along the Yukon North Slope coastline and in bays with a freshwater surface layer.
2. Conservation of lakes and creeks along the coastal plain.

From the *Yukon North Slope Wildlife Conservation and Management Plan* (WMAAC (NS), 2022)

Broad Whitefish on the Yukon North Slope

The common English name for broad whitefish for Inuvialuit on the Yukon North Slope is whitefish. Lake whitefish (*Coregonus clupeaformis*) are called crooked backs, and round whitefish (*Prosopium cylindraceum*) are called lake fish (Brewster, Neumann, Ostertag, & Loseto, 2016).

Broad whitefish (*Coregonus nasus*, **Aanaarlirq**) are widely distributed in the Arctic, from Nunavut through to the Bering Sea. There are three lifeforms: lake-dwelling, river-dwelling, and searun (anadromous). Searun broad whitefish are the most common. Broad whitefish are abundant in the Mackenzie Delta area, where they overwinter in tributaries and side channels. They are present in relatively small numbers along the Yukon North Slope coast.

Broad whitefish of the lower Mackenzie River system are semi-anadromous, as their time in the ocean is spent only in the brackish waters of the Delta and nearshore Beaufort Sea. They avoid marine waters with high salinity. While in their nearshore coastal habitat, young broad whitefish feed on zooplankton in the open water, while adults feed on shellfish on the ocean floor. Broad whitefish are a food source for beluga and seals (DFO, 2000; USGS, 2016). Grizzly bears also feed on broad whitefish in the Mackenzie Delta (Barker & Derocher, 2009).

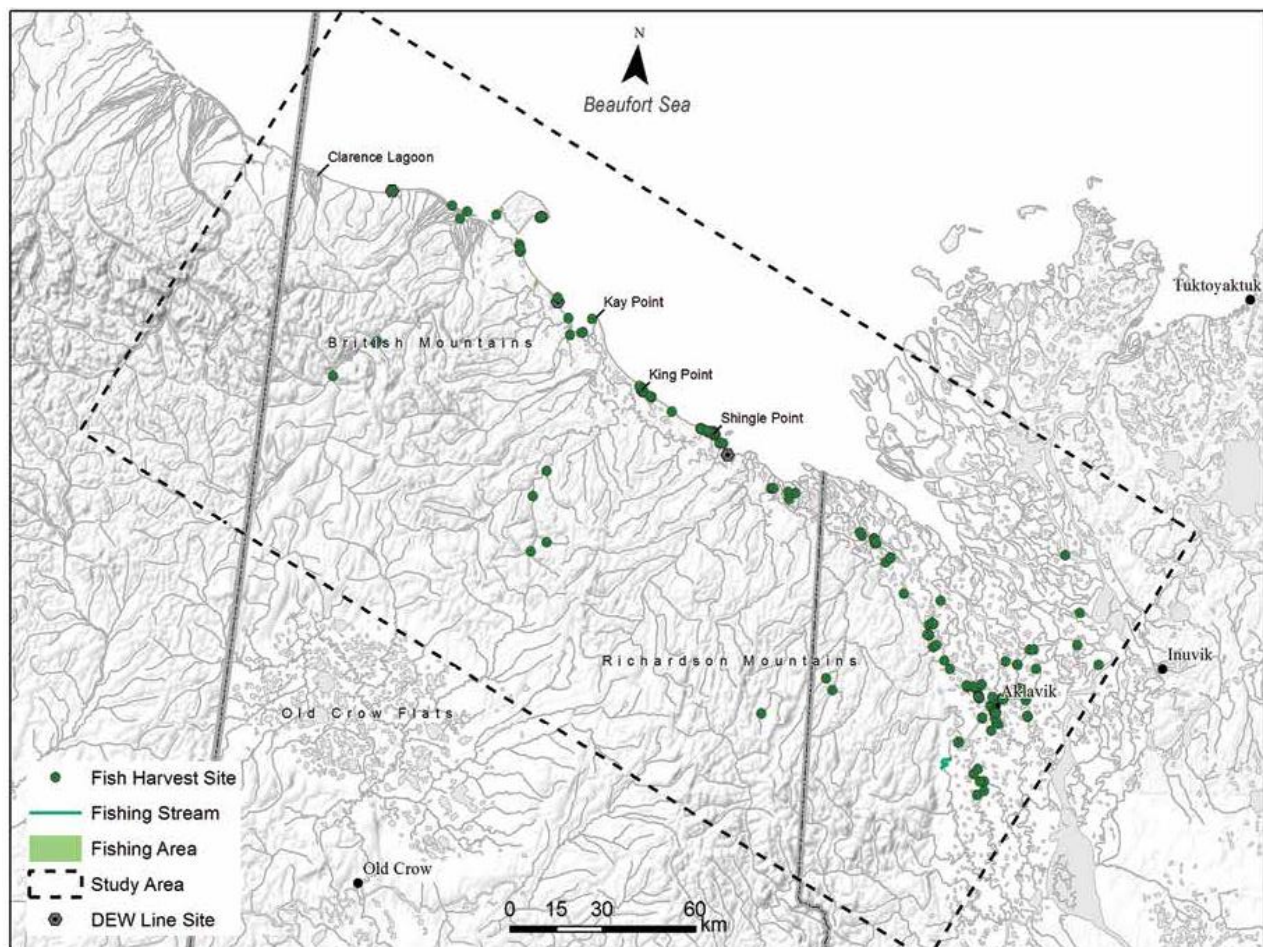
Broad whitefish do not spawn until they are about seven to nine years old (Eddy, 2001; Martin, 2010). Mature adults return to rivers to spawn every two or more years. Spawning adults aggregate in the Delta in mid-summer and migrate upstream from October to November, when

the rivers are slow flowing. Spawning takes place upstream of the ISR in the Mackenzie River mainstem and tributaries, especially in the Peel River. Broad whitefish spawn in late fall, returning to nearshore coastal habitat gradually in small groups over the winter. Juveniles are distributed throughout the Mackenzie River and Delta and in the lakes of the Tuktoyaktuk Peninsula.

Traditional Use

Broad whitefish are harvested by net on the Yukon North Slope Coast and in the Mackenzie Delta (Map 10- 1).

Map 10- 1. Fish harvest locations identified in Inuvialuit traditional use interviews



The fishing locations are for all species of fish. The interviewers asked Inuvialuit land users to identify fishing areas and harvest sites used within living memory. Data from this map were used to develop the composite traditional use map in the Plan. Source: (WMAC (NS) and Aklavik HTC, 2018b) Map 11.

On average, about 6000 broad whitefish were harvested annually by Aklavik Inuvialuit over the ten-year period from 1988 to 1997, as reported through the Inuvialuit Harvest Study (Inuvialuit

Harvest Study, 2003, Table 21). Broad whitefish was harvested in larger numbers than any other fish species over the 10-year period.

A 1991 dietary survey showed the importance of whitefish in the diet of Aklavik Inuvialuit (Wein & Freeman, 1992). Of the 36 households surveyed, 28 reported eating whitefish at least once over the previous year. The survey did not distinguish among whitefish species. This was a similar level of use as for the other main fish species: Dolly Varden char, herring (cisco), loche (burbot), and coney (inconnu). Whitefish was eaten on average 31 times over the year in the households surveyed.

Fish harvest was documented through the Inuvialuit Harvest Study's (2016-2019) monthly interviews with active harvesters. Aklavik Inuvialuit participants reported an average annual harvest of 465 broad whitefish over the three-year period from 2016 to 2018 (IRC, 2019), a steep decline from the harvests of the 1980s and 1990s.

Broad whitefish traditional uses

"The broad whitefish is used all year round as a basic food, not like any other fish. Loche is mostly taken in the fall time, same with coney. You use it [broad whitefish] all through the early spring and summer. Whitefish is used all the time."

However, despite its importance as food, its total importance in the domestic economy has declined now that fewer people maintain dog teams and less trapping is carried out. Also, at the present time some earlier uses no longer occur. Among the earlier practices mentioned were the use of fish oil and fish liver oil as medicine, and fish broth used to treat colds and diarrhea. The oil was formerly used as a condiment (for dipping) or for greasing bread pans, and to waterproof or preserve wood. Many people remember these uses from their childhood.

The above excerpts are from a broad whitefish Inuvialuit traditional knowledge study based on interviews in Inuvik and Aklavik (Freeman, 1997, p. 32).

Habitat for Broad Whitefish

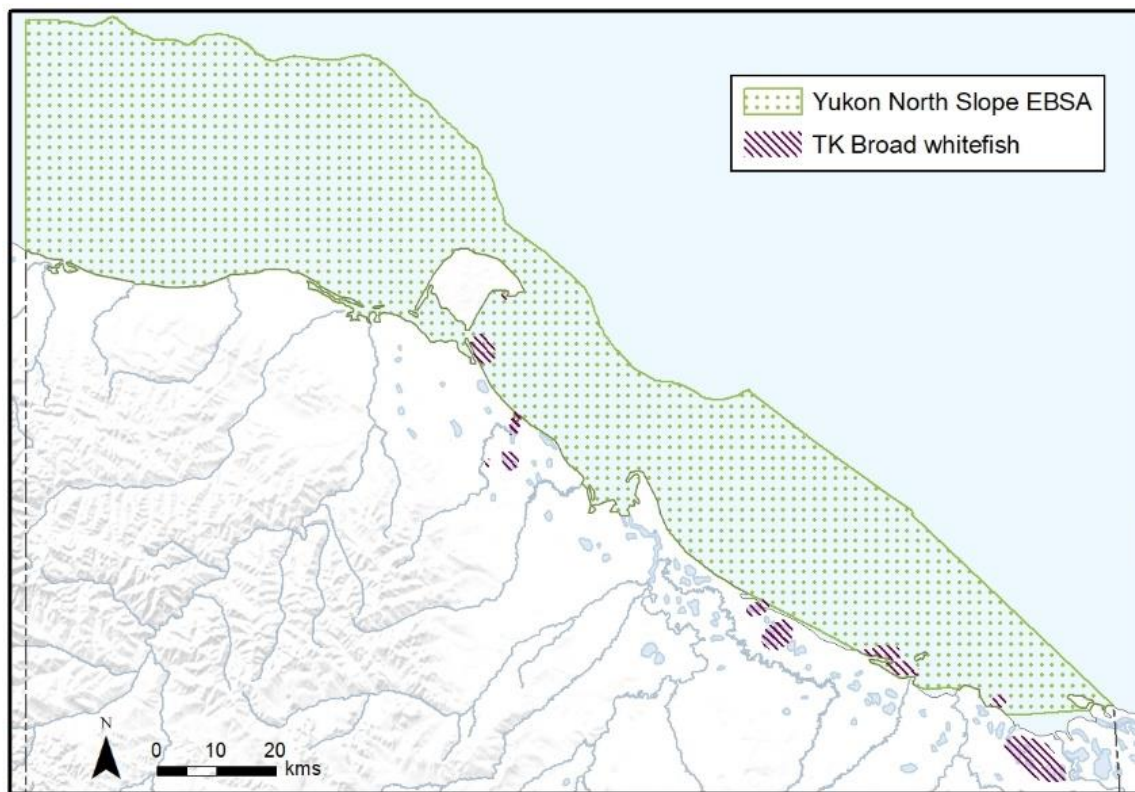
Overview of Habitat

Yukon North Slope broad whitefish habitat is in the nearshore coastal zone and lakes close to the seashore (Map 10- 2). Broad whitefish feed in coastal areas with a strong Mackenzie River influence. They feed on small crustaceans and shellfish on the ocean bottom, so they are exposed to coastal sediments (Brewster, Giraldo, et al., 2016). Broad whitefish habitat extends to estuaries and lower reaches of rivers along the coast (Steigenberger, Robertson, Johansen, & Elson, 1975). The fast-flowing rivers upstream of the coastal plain are generally not suitable

habitat for whitefish (Reist & Chang-Kue, 1997). Inuvialuit have observed changes in broad whitefish habitat use in recent years – see *Observations, Concerns, and Threats*.

The broad whitefish conservation requirements in the *Wildlife Conservation and Management Plan for the Yukon North Slope (WMAC NS, 2021)* relate to habitat protection, including the nearshore band of brackish water along the coastline, bays with a freshwater surface layer, and lakes along the coastal plain. Streams and other waterways that connect these lakes with the Mackenzie Delta and the Yukon coast are also important habitat for conservation of broad whitefish.

Map 10- 2. Marine and coastal lake habitats of broad whitefish, based on surveys in marine waters and Inuvialuit traditional knowledge of whitefish locations



This map is from the Plan (WMAC (NS), 2022, Appendix 1). The Yukon North Slope EBSA (Ecologically and Biologically Significant Area) is shown to represent coastal habitat. Data sources: (WMAC NS and Aklavik HTC, 2018a); (DFO, 2014)

Inuvialuit participants in the *Yukon North Slope Inuvialuit Traditional Use Study* (WMAC (NS) & Aklavik HTC, 2018a) shared observations on broad whitefish habitat. Broad whitefish is considered to be primarily a delta and freshwater fish. It is not traditionally considered an ocean species. Broad whitefish habitat types identified on the Yukon North Slope were lakes and nearshore coastal waters, including:

- Lakes close to shore;
- Roland Bay;

- Nearshore coastal waters near Shingle Point, where broad whitefish are caught with Dolly Varden in the summer months.

Nearshore Coastal Waters

Broad whitefish are associated with estuaries, lagoons, and the narrow strip of brackish water along the Yukon North Slope coast (WMAC (NS), 2012). This corridor of fresh to brackish water extends from the shore to water depths of about 10 metres and runs from the Mackenzie Delta to Alaska. Further offshore, the ocean bottom drops off quite steeply. This topography, combined with wind events, results in upwelling (movement of deep, cold, nutrient-rich waters to the surface). Upwelling replenishes nutrients and provides a productive nearshore coastal area that is used for feeding and migration by anadromous fishes, including broad whitefish (Cobb, Roy, Link, & Archambault, 2014). The freshwater corridor and upwelling are attributes recognized in the designation of the Yukon North Slope Ecologically and Biologically Significant Area (EBSA) and the Tarium Niryutait Marine Protected Area (MPA).

Broad Whitefish and Tarium Niryutait MPA

Assessment of broad whitefish habitat, including documentation of Inuvialuit traditional knowledge (Freeman, 1997), was undertaken as part of the groundwork for designation of Tarium Niryutait MPA. The three marine areas that became the MPA were all identified as providing feeding and coastal migratory habitat for young-of-the-year and juvenile broad whitefish. Bays with fresh water on top of or instead of salty water provide overwintering habitat. These bays are important for all fishes that do not tolerate high salinities, including broad whitefish and coney.

Source: (BSIMPI, 2003)

The coastal nearshore waters of the Yukon North Slope are not good habitat for young-of-the-year broad whitefish. Fry migrate or are washed downstream in the Mackenzie River in spring floods in May and June (Reist & Chang-Kue, 1997). Although most of the fry are carried eastward from the Delta with prevailing water currents, some are carried westward along the Yukon North Slope at least as far as Phillips Bay (Cobb et al., 2008; Reist & Chang-Kue, 1997). The fate of these fish is uncertain, as this is not favourable habitat for fry because salinity varies (they need brackish water) and the corridor is often disrupted by storms (Reist & Chang-Kue, 1997).

Lakes

Along the western part of the Yukon coastal plain (in Ivavik National Park), lakes and ponds that are deep enough not to freeze to the bottom may support populations of broad whitefish (Kavik-AXYS Inc., 2002), and there may be seasonal use of other ponds and lakes. Participants in a traditional knowledge study of fish west of the Mackenzie River commented that big whitefish are found in shallow lakes between Kay Point and King Point year-round (Papik, Marschke, & Ayles, 2003). Surveys undertaken in the early 1970s of 11 tundra lakes along the Yukon North Slope showed that 2 of the lakes were habitat for broad whitefish in the summer (Du Bruyn &

McCart, 1974). Broad whitefish were caught in fish surveys of 2 of 4 lakes in 1973 to 1974. In one of these lakes, traditional knowledge and sampling during the winter provided evidence of an overwintering population of broad whitefish (Steigenberger et al., 1975). Proceedings of the 1997 workshop on broad whitefish indicated that it was not known if coastal lakes support isolated lake-dwelling populations or if fry migrating along the coast could enter the lakes (Reist & Chang-Kue, 1997).

Studies indicate that broad whitefish occur in most Alaskan North Slope rivers and estuaries, and that in summer the fish frequent shallow lakes. The fish may overwinter in deeper lakes that have stream connections, or in lakes that are separated from the sea by land that floods occasionally, providing access to marine waters (George, Moulton, & Johnson, 2009).

Broad Whitefish Populations

Species Conservation Status

Table 10–1. Broad whitefish conservation status

Status assigned by	Applies to	Status	References
Species at Risk Act (SARA)	Canada	Not listed	(Canada, n.d.)
Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Canada	Not assessed	(Canada, n.d.; COSEWIC, n.d.)
Canadian Endangered Species Conservation Council (General Status of Species in Canada)	Canada	N5: Secure*; 2015 status	(Canadian Endangered Species Conservation Council, 2016)
Yukon	Yukon	S4: Apparently Secure*	(Yukon, 2020)
NatureServe	Global	G4G5: Apparently Secure to Secure*; last reviewed 2016	(NatureServe, n.d.-b)

*Following the ranking system developed by NatureServe, an international network of conservation data centres (NatureServe, n.d.-a). G=Global; N=National; S=Subnational

Harvest and Management

Broad whitefish are caught by Inuvialuit fishers along the Yukon North Slope coast in the summer in relatively small numbers. In 2011, broad whitefish made up 6% of fish harvested at Shingle Point (Gallagher & Howland, 2011). They are caught from mid-July to mid-August along with Dolly Varden char (WMAAC (NS) & Aklavik HTC, 2018a).

Broad whitefish are also harvested in the Mackenzie Delta, where they are abundant (Martin, 2010). The availability of broad whitefish for harvest in the Delta varies over the year and from year to year, influenced by the timing of spring break-up and the flow characteristics of the river (Reist & Chang-Kue, 1997). There is a small commercial fishery for broad whitefish and other fish species in the Mackenzie Delta (east of the Yukon North Slope); harvested fish are sold locally within the NWT (E. Lea, personal communication, 2020).

Broad whitefish are not a favoured species for sport fishing. There is no fisheries management plan that includes broad whitefish that frequent the Yukon North Slope.

Population Status and Trends

Although previous studies have focused on life history, movement patterns, and habitat-use, there are not enough data available to provide a robust quantitative assessment of population status for broad whitefish.

Genetic studies show that the broad whitefish that spawn in the lower Mackenzie basin, including those in the waters of the Yukon North Slope, are distinct from the broad whitefish from other river systems to the west (Alaska) and to the east (Reist & Chang-Kue, 1997).

Inuvialuit have observed an increase in abundance of broad whitefish in the coastal zone, based on their knowledge of fishing at Taqpaq (Shingle Point) (Papik et al., 2003; WMAC (NS) & Aklavik HTC, 2018a). Fisheries and Oceans Canada (DFO) conducted surveys of fish in nearshore Yukon coastal waters in 1986, 2007, and 2008 (Niemi et al., 2012). These coastal surveys likely include multiple migratory populations, with movements driven by complex environmental and biological factors, so they are not directly comparable. Additional surveys have been replicated on the Yukon coast to provide information on the fish community over time.

Transboundary Conservation and Management

The range and the annual movements of anadromous Mackenzie River broad whitefish cross territorial and land claim boundaries. Spawning is upstream of the ISR in the Mackenzie River and tributaries, including the Peel and Arctic Red rivers. Significant habitat for rearing, adult feeding, migrating, and overwintering is within the ISR, in the Mackenzie Delta, lakes, and in Beaufort Sea bays and other nearshore areas. Genetic analyses show that lower Mackenzie River/coastal fisheries are dominated by broad whitefish originating in the Peel River (Harris & Taylor, 2010).

This species is not associated with international conservation issues. Broad whitefish are an important subsistence fish for people in the Alaskan coastal plain, but most harvest is west of Prudhoe Bay. Most broad whitefish in Alaska remain within one river system (ADF&G, n.d.) and are genetically distinct from the broad whitefish that spawn in the Mackenzie River system (Reist & Chang-Kue, 1997).

Observations, Concerns, and Threats

Participants in the traditional knowledge study conducted by WMAC(NS) and the Aklavik HTC (2018a) shared observations on broad whitefish habitat change (p.43). These interview excerpts are about broad whitefish at Shingle Point:

Well, whitefish never used to be at Shingle Point long ago, when I was a little girl... Now the fish from the Delta are starting to come into that area... Because our water is not as salty as before.

...there's also a lake that breaks out, lets out the big lake whitefish from that area.

We noticed that...[there are] more and more... freshwater fish in the sea.

Only time they [broad whitefish] come out [to the ocean] is when there's a big wind and the tide comes up... And this [water] overflows and they come out.

The majority of interviewees observed a recent trend of more broad whitefish in coastal waters. Observations on habitat change included an increase in flooding and storm surges, allowing whitefish to move into the ocean from lakes that are near the coast. They also described coastal waters becoming less salty, perhaps due to more freshwater runoff due to climate change.

In a study documenting Inuvialuit knowledge of fisheries west of the Mackenzie (Papik et al., 2003), interviewees observed that, while fewer char were running at Taqpaq-Shingle Point, people were catching more broad whitefish in their nets. Some participants in the study commented that whitefish spawn earlier, and many people commented that whitefish flesh was more watery than in the past.

Inuvialuit observations on fish in the Mackenzie Delta were documented through community-based monitoring (Hynes, Wesche, & Aklavik HTC, 2017). Observations of changes relevant to broad whitefish in the Delta area include:

- Whitefish have softer meat; this is observed more regularly in the last 5 years.
- Some harvesters have lower harvest rates for broad whitefish in the Delta.
- Reduced ice thickness makes it less safe to travel to some areas (in the last 5 to 10 years). This and other climate-related changes are leading to changes in access of community members to traditional fishing areas.

Broad whitefish abundance on the Yukon North Slope could increase or decrease if there are changes to temperature-salinity regimes. Such changes would affect whitefish migratory patterns, as the fish do not tolerate high salinity. While changes in climate factors are the most obvious potential source of these changes to coastal waters, development activities can locally alter temperature-salinity regimes. A study of impacts from construction of a causeway into the Beaufort Sea at Prudhoe Bay, Alaska, found that broad whitefish use of the surrounding area decreased (Griffiths, Gallaway, Gazey, & Dillinger, 1992). The authors related this change to the fact that construction led to larger masses of high salinity water, which is avoided by broad whitefish.

Oil spills affecting the nearshore coastal zone, bays, and estuaries would pose a threat to broad whitefish. The Beaufort Regional Environmental Assessment (BREA, 2016) included broad whitefish in the list of species most sensitive to damage from oil spills.

Links to Plans and Programs

This section lists plans and programs that link to the objectives and strategies of the *Yukon North Slope Wildlife Conservation and Management Plan*. These plans and programs informed the development of the Yukon North Slope Plan and are an integral part of its implementation.

Fisheries Management

- [Co-management in the Inuvialuit Settlement Region](#)
All fish in the Inuvialuit Settlement Region are co-managed as described in the Inuvialuit Final Agreement. This involves cooperation between the community Hunters and Trappers Committees, the Inuvialuit Game Council, the Fisheries Joint Management Committee, Government of Canada's Department of Fisheries and Oceans, Parks Canada (within National Park boundaries) and Government of Yukon (for Qikiqtaruk Herschel Island and other Yukon coastal and freshwater areas).

Habitat Conservation

- [Aklavik Inuvialuit Community Conservation Plan \(Aklavik HTC, Aklavik Community Corporation, WMAC \(NWT\), FJMC, & Joint Secretariat, 2016\)](#)
Identifies Mackenzie Bay and Shallow Bay as important for whitefish overwintering.
- [Peel Watershed Regional Land Use Plan \(Peel Watershed Planning Commission, 2019\)](#)
Management plans and habitat conservation measures in major broad whitefish spawning grounds are relevant to maintaining abundance of this fish species in the Mackenzie Delta and Yukon North Slope. The most important spawning areas for lower Mackenzie River system broad whitefish are in the Peel River and its tributaries (Harris & Taylor, 2010). The Peel Regional Land Use Plan addresses conservation of whitefish habitat, while identifying the lack of knowledge about broad whitefish spawning locations in the Peel watershed as a limitation on sustainable wildlife management.
- [Beaufort Sea Conservation and Management](#)
Beaufort Sea nearshore ecosystems are important habitat for broad whitefish. Plans and programs for integrated management of Beaufort Sea ecosystems include:
[Beaufort Sea Partnership \(BSP, 2020\)](#)

This partnership provides a forum for information sharing and discussion of mutual interests, goals, and responsibilities for Beaufort Sea conservation and management, guided by an integrated ocean management plan (BSP, 2009).

Tarium Niryutait Marine Protected Areas Management Plan (DFO, 2013) and *Monitoring Plan* (DFO & FJMC, 2013)

The plan recognizes the importance of these protected areas for fish, including broad whitefish. The monitoring plan includes fish surveys and fish sampling to assess status and trends of fish populations, fish health, and marine food webs.

Research and Monitoring Programs

➤ Yukon North Slope monitoring and research programs

Objective (BSP, 2017 p. 3):

Arctic Coastal Ecosystem Program (ACES): To characterize the habitat and diet of coastal fish populations to develop baseline information and monitor any shifts using key monitoring species, including broad whitefish.

➤ Lower Mackenzie Whitefish Project (“Lower Mackenzie Whitefish Project,” n.d.)

A community-based monitoring program focused on broad whitefish harvested in the Gwich'in Settlement Area near Aklavik, Fort McPherson, and Tsiigetichic, NWT. This project was established in 2017 and it brings together community organizations, harvesters and researchers. The project collects data on harvested fish, which provides insight about whitefish body condition, population dynamics, habitat use and migration. The results of the project will contribute to the understanding of how Whitefish use the waterways of the Gwich'in Settlement Area and Inuvialuit Settlement Region.

➤ Inuvialuit Harvest Study (IHS) (IRC, 2017, 2018, 2019)

Annual harvest monitoring in the ISR from 2016-2019 was led by the Inuvialuit Game Council and the Inuvialuit Regional Corporation. This program included broad whitefish harvest monitoring. Aklavik Inuvialuit Community Resource Technicians (CRTs) collected harvest information through monthly interviews with active harvesters. Results were summarized for each community in annual newsletters. This program built on previous harvest monitoring (Inuvialuit Harvest Study, 2003).

Selected Studies and Research Relevant to the Yukon North Slope

This section is an annotated listing of selected reports, scientific papers, and other resources that provide support to the *Yukon North Slope Wildlife Conservation and Management Plan* and

highlight issues and research directions that will be important to consider during its implementation.

Traditional Knowledge and Traditional Use Studies

- *Yukon North Slope Inuvialuit Traditional Use Study* (WMAC (NS) & Aklavik HTC, 2018b) and *Inuvialuit Traditional Knowledge of Wildlife Habitat, Yukon North Slope* (WMAC (NS) & Aklavik HTC, 2018a)

These two studies were undertaken by the WMAC (NS) and the Aklavik HTC to document traditional use patterns and knowledge about wildlife habitat on the Yukon North Slope. Both studies were based on interviews with Aklavik Inuvialuit land users. Maps were used in the interviews and all geographically referenced data were digitized and displayed on maps. The results were used in developing the Plan and are described and referenced throughout this chapter.

- *Broad Whitefish Traditional Knowledge Study* (Freeman, 1997)

This report is a summary of findings from interviews with elders living in Aklavik and Inuvik in 1992. The scope of the interviews was broad whitefish biology and the fishery in the lower Mackenzie River. The report is part of the proceedings of a workshop on broad whitefish in the lower Mackenzie River (Tallman & Reist, 1997).

- *Ecological Knowledge of Fisheries in Rivers West of the Mackenzie River* (Papik et al., 2003)

This study was conducted at the recommendation of the West Side Working Group. It covers all fish species and includes observations on whitefish ecology and harvest.

- *Traditional Ecological Knowledge (TEK) at Shingle Point, YT: Observations on changes in the environment and fish populations* (Brewster, Neumann, et al., 2016)

In 2015 a traditional ecological knowledge survey was conducted at Shingle Point at the request of the FJMC and Aklavik HTC. This study complemented the fish and marine monitoring program in place since 2010. The 15 participants included elders and younger participants. The report summarizes information on observations of conditions and changes affecting fisheries but does not provide information specific to broad whitefish.

Assessments and Syntheses of Survey Results

- *Fishes of the Yukon Coast* (Kendel, Johnston, Lobsiger, & Kozak, 1975)

This report's purpose was to collect baseline information on nearshore fish resources along the Yukon coast and to identify areas that would be critically affected by oil spills. Surveys, conducted in 1974 and 1975, included the coastal sea out to 7 km offshore and lagoons and estuaries from Blow River to Herschel Island. The baseline surveys showed that upstream migration of broad whitefish into the Mackenzie River peaks during September and October and downstream migration to the Beaufort Sea occurs in late fall and early winter. Broad whitefish were not abundant but were widespread along the coast from Shingle Point to

Herschel Island. Broad whitefish made up only 0.2% to the total catch in surveys over both years. Lakes were not surveyed, but the report notes that broad whitefish are known to occur in some of the tundra lakes.

- *Proceedings of a workshop on broad whitefish in the lower Mackenzie River (Tallman & Reist, 1997)*

This volume is a series of papers presenting information on broad whitefish biology, traditional knowledge, and management. Field studies and traditional knowledge documentation focus on the Mackenzie River and Delta, and lake and marine habitat east of the Mackenzie. The Inuvialuit traditional knowledge documentation is based on interviews conducted in Aklavik and Inuvik.

- *Beaufort Regional Environmental Assessment (BREA, 2016)*

BREA was a four-year research program (2012-2015) focused on research to inform decision-makers on offshore oil and gas development in the Beaufort Sea. The assessment included a project to develop vulnerability profiles for key marine species, including broad whitefish.

- *Summer studies of the nearshore fish community at Phillips Bay, Beaufort Sea coast, Yukon (Bond & Erickson, 1989)*

This report synthesizes information about abundance, biology and summer movement patterns of multiple fish species (including broad whitefish) at Phillips Bay, Yukon.

Research

- *Characterizing the diet and habitat niches of coastal fish populations in the Beaufort Sea Tarium Niryutait Marine Protected Area (Brewster, Giraldo, et al., 2016)*

This study is based on analyses of carbon isotopes (different forms of carbon that can be related to the sources of food) in fish caught at Shingle Point from 2011 to 2013. The study indicates that broad whitefish caught in the sea feed on a wide range of prey items in a variety of habitats—they are generalists and may adapt well to changing marine feeding conditions.

- *Migratory variation in Mackenzie River system broad whitefish (Harris et al., 2012) and genetic population structure studies (Harris & Taylor, 2010)*

Research based on analysis of otoliths (bones in the inner ears) showed that there are anadromous, river-dwelling, and lake-dwelling populations of broad whitefish in the lower Mackenzie River system, and that there is a great deal of variability in how much time fish spend in marine and estuarine habitats. The researchers also found that some broad whitefish in lakes moved between lake and marine and estuarine environments. Genetic analyses showed that there are two main genetic groups of broad whitefish: anadromous and lake-dwelling. Fish caught in the lower Mackenzie system (which would also be caught

in the Beaufort Sea) were of both types, with whitefish originating in the Peel River dominating.

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