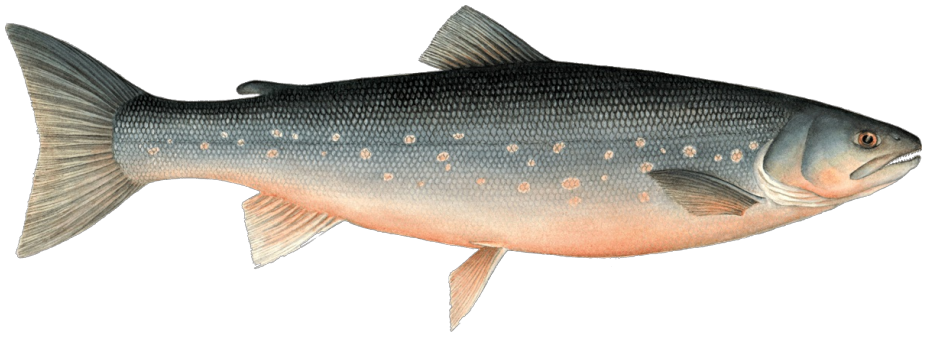
Monterey Bay Aquarium Seafood Watch

Environmental sustainability assessment of wild-caught Arctic char (*Salvelinus alpinus*) from Canada (Nunavut) caught using barriers, fences, weirs, corrals, and set gillnets



Species:	Arctic char (*Salvelinus alpinus*)
Location:	Canada: Nunavut (Cambridge Bay)
Gear:	Barriers, fences, weirs, corrals, etc., Set gillnets
Type:	Wild Caught
Author:	Seafood Watch
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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

Based on this principle, Seafood Watch had developed four sustainability **criteria** for evaluating wildcatch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and **rating**

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught.

Avoid/Red Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report assesses the sustainability of the Arctic char *(Salvelinus alpinus)* weir and gillnet fisheries operating in four waterways (Ekalluktok River, Halokvik River, Paliryuak River, and Jayko River) near Cambridge Bay (Ekaluktutiak) on Victoria Island in Nunavut, Canada. The recommendations in this report cover ~44% of the total Arctic char commercially harvested in this Territory. Fishing for this species occurs throughout the Arctic Ocean region for subsistence purposes, and other commercial fisheries exist off Rankin Island and in the Isuituq River system in Cumberland Sound (but these fisheries are not covered here).

Arctic char is a member of the Salmonidae family, and has the most northern distribution of any freshwater fish (85° N. to 42° N.). In the Arctic Ocean, it occurs in discrete stocks of both anadromous (searun) and non-anadromous (land-locked) forms in coastal waters and alpine lakes. Unlike Pacific salmon (*Oncorhynchus* spp.), Arctic char is iteroparous and can spawn multiple times in the course of its lifetime, but it does not appear to spawn in consecutive years. After spawning, sea-run char remain in freshwater for another winter, migrating to the sea the following spring. It is during the migration to and from the ocean that char in this region are targeted by the fishery.

Comprehensive stock assessments are lacking; however, using data-limited methods, it is believed that the population is healthy and there is a low risk of over-exploitation for the next decade under current fishing pressure. Management currently uses a river-specific quota system combined with annual licensing to limit the amount of char landed, and catch limits are based on a conservative exploitation rate of 5% of the number of char that are vulnerable to the fishing gear in each run. Scientific research into the population and impacts of the fishery is ongoing, and there is a high degree of collaboration from stakeholders at the national, territorial, and community level.

Both gillnets and weirs are used to catch char near Cambridge Bay, with weirs being the preferred method. Both gears have minimal impacts on the surrounding ecosystem in terms of both bycatch and habitat interactions. Weirs are temporary (erected for the season only) and all fish are trapped live. Any non-target fish can be released without harm. Specific measures (including gillnet mesh size and weir positioning) exist to minimize the impacts of both gears, and overall bycatch is believed to be very low. Given that the fishery occurs near the fast-moving river mouth of these oligotrophic northern rivers with rocky bottoms, these gears have negligible impacts on the habitat.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1: Impacts on the Species	CRITERION 2: Impacts on Other Species	CRITERION 3: Management Effectiveness	CRITERION 4: Habitat and Ecosystem	OVERALL RECOMMENDATION
Arctic char Nunavut/Cambridge Bay | Barriers, fences, weirs, corrals, etc. | Canada	Green (3.318)	Green (5.000)	Green (3.464)	Green (3.464)	**(3.756)**
Arctic char Nunavut/Cambridge Bay | Set gillnets | Canada	Green (3.318)	Yellow (3.162)	Green (3.464)	Yellow (3.000)	**(3.231)**

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern[2], and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report assesses the sustainability of the Arctic char *(Salvelinus alpinus)* commercial fishery operating on the waterways near Cambridge Bay (Ekaluktutiak) on Victoria Island in Nunavut, Canada (Fig. 1). It accounts for ~44% of the total Arctic char commercially harvested in this Territory. Char here are caught using two gears: weirs and gillnets, with technique varying across the four waterways where commercial fishing occurs. Fishing for this species occurs throughout the Territory for subsistence purposes and recreational purposes, and other commercial fisheries exist near Rankin Inlet and the surrounding areas of Whale Cove, Fish Bay, Pistol Bay, and Ferguson River, among others in the Kivalliq Region and in the Isuituq River system in Cumberland Sound (but these fisheries are not covered in this assessment).

Species Overview

Arctic char *(S. alpinus)* is a member of the Salmonidae family, and has the most northern distribution of any freshwater fish (85° N. to 42° N.). In the Arctic Ocean, it occurs in discrete stocks of both anadromous (searun) and non-anadromous (land-locked) forms in coastal waters and alpine lakes. Char can be found up to 70 m in depth, but it is most commonly found in very shallow (<1 m) water of temperatures between 4°C and 16°C (Froese and Pauly 2015). Anadramous char feeds in coastal regions during the summer, typically consuming invertebrates and other fish; access to more abundant prey allows this fish to attain a larger body size than land-locked char (DFO 2004). In the fall, the onset of sea ice growth forces all char to migrate to freshwater to overwinter.

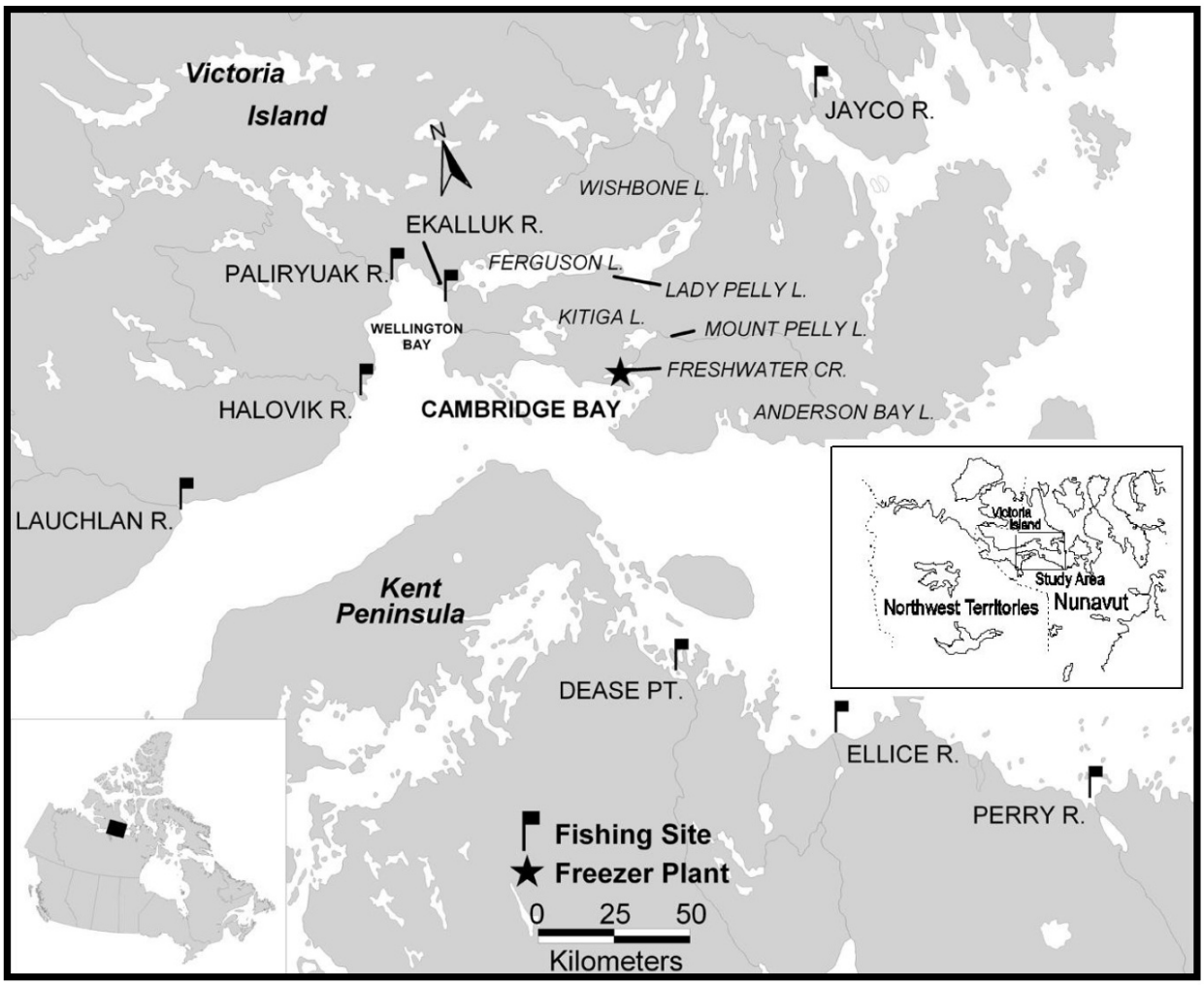

Figure 1 Past and present commercially harvested rivers on Victoria Island, Nunavut. Currently, char are landed at four rivers: Ekalluktok (Ekalluk), Halovik, Paliryuak, and Jayko (Jayco), and all fish are processed in the town of Cambridge Bay. (Image from Day and Harris, 2013).

Despite differences in life history and appearance, there is evidence for spawning between the land-locked and migratory forms in some river systems (Johnson 1980). Spawning in the Cambridge Bay area takes place on gravel beds in cool lakes in September or October (Johnson 1980). As with other salmonid species, male char compete for mating territory and, once spawning occurs, the female lays her eggs in a redd, typically of 2-3 m in diameter and at a depth of 3-6 m. Juvenile char hatch after ~6 months, and spend the next 4-5 years living in freshwater systems and brackish estuaries, where they acclimate to salt water. Most searun char are ready to take their first migration at a size of 15-25 cm (Johnson 1980), but maturity is not reached until 9-10 years of age, with most spawners being 15-21 years of age. It is believed that the maximum age for this species is 40 years (Froese and Pauly 2015).

Unlike Pacific salmon (*Oncorhynchus* spp.), Arctic char is iteroparous and can spawn multiple times in its lifetime. But it does not appear to spawn in consecutive years. After spawning, char remain in freshwater for another winter, and migrate to the sea the following spring. This behavior is physically demanding and can result in a decrease in weight up to 40%. Given the physiological toll that such behavior takes, some anadromous char may only spawn a couple of times in their lives (Johnson 1980).

Production Statistics

Although commercial fishing for Arctic char dates to 1960 (Fig. 2), subsistence fishing by local Inuit communities in Nunavut has likely existed for centuries, and these fish serve as a key source of protein for communities living in the Territory. Today, both subsistence and recreational fishing continue and, although subsistence landings are largely inferred, it is estimated that this sector accounts for about 23 t annually (about half the size of the commercial harvest) (Priest and Usher 2004) (DFO 2013). The commercial fishery and subsistence fishery do not overlap spatially because char caught for local consumption are typically landed closer to the town of Cambridge Bay (DFO 2014a).

The commercial fishery has been managed under different strategies over the last 50 years but has always been based on annual quotas and license controls. At the start of the fishery in 1960, the entire watershed was under one large regional quota. The decline in the fishery (as evidenced by a decrease in mean weight) at Ekalluktok (Ekalluk) River, where most of the fishing took place, necessitated the establishment of "river-specific" quotas to distribute fishing effort among these systems. Eventually, commercial fishing was extended to the Jayko (Jayco) River to the northeast of Cambridge Bay and the Ellice and Perry Rivers on the nearby mainland. Today, fishing occurs in four main freshwater systems in the area surrounding the community of Cambridge Bay, NU (common Inuit and English names given): 1) Ekalluktok/Ekalluk/Wellington River; 2) Halokvik/Halovik/Thirty-Mile River; 3) Paliryuak/Surrey River; and 4) Jayko/Jayco River and Albert Edward Bay. The Palik/Lauchlan River was commercially fished up to 2011, but no fishing has occurred there in recent years (Fig. 1). Since 1960, annual landings have averaged about 42 t, but have exhibited considerable variation over time (Fig. 2). In addition to changes in quota, these fluctuations in catch are also largely related to the prevailing environmental conditions of the region (i.e., ice coverage and inclement weather) and challenges associated with transport.

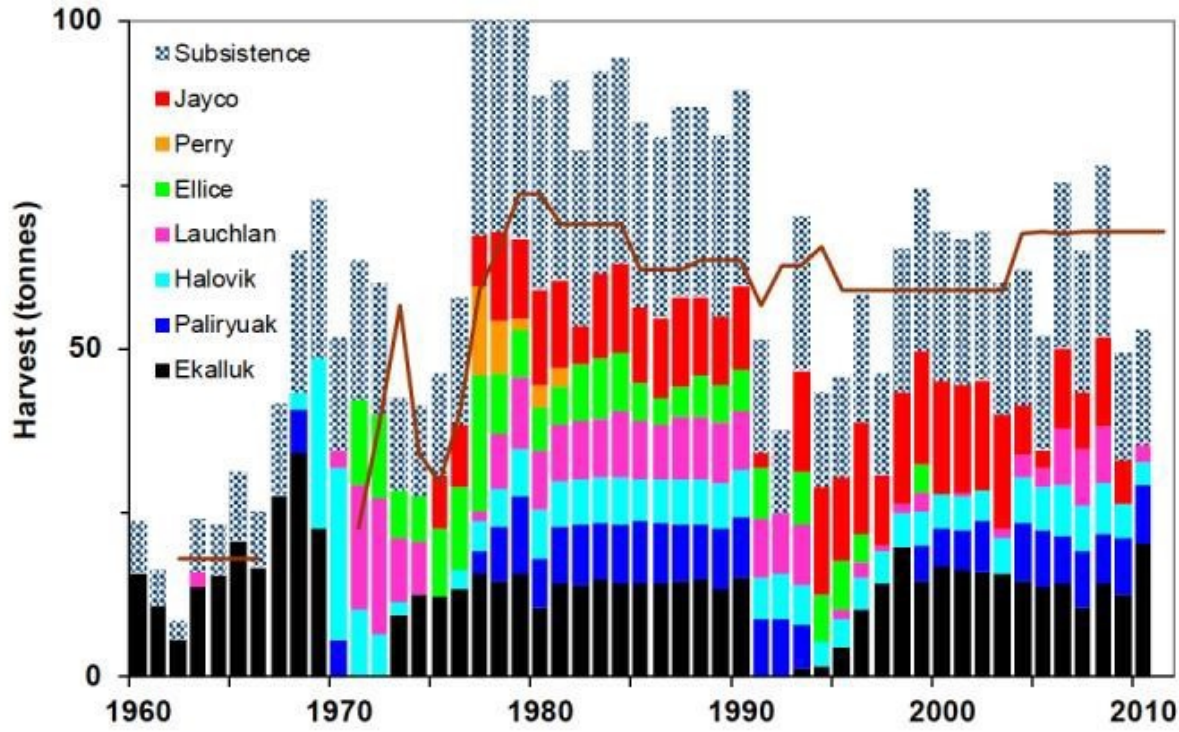

Figure 2 Landings of Arctic char (all major river systems) from 1960-2010. Colored bars indicate commercial fisheries in individual rivers and hatched bars show estimated subsistence fisheries; the brown line indicates the total allowable commercial catch for all rivers combined. Presently, only four rivers are fished commercially: Ekalluktok (Ekalluk), Halokvik, Paliryuak, and Jayko (Jayco). (Image from Zhu et al. 2014).

In 1993, Canada settled The Nunavut Land Claims Agreement (NLCA) with the Inuit of Nunavut, which endowed priority access and wildlife harvesting rights to Inuit and other Aboriginal groups in the region. Today, all participants in the fishery are from the local Inuit communities, and an estimated 28 residents are involved in production either as fishers or as processors and managers at the associated processing plant operated by Kitikmeot Foods Ltd. in Cambridge Bay (DFO 2014a).

At the beginning of the season, fishers (3-6 per site) obtain a fishing license from local Conservation Officers (Department of Environment, Government of Nunavut) on behalf of the Department of Fisheries and Oceans Canada (DFO). Fishers live together and camp at each of the waterbodies throughout the harvest period (~3 weeks). During both the spring and fall fisheries, char are caught using weirs or gillnets, usually near the mouth of the river as they migrate downstream (July) or upstream (August/September). In places where it is possible to use a weir, this is the preferred fishing method because this gear is better at targeting mature fish and does not leave any marks on the fish (as gillnets do), which results in a more valuable product. Once the char are caught, the removal of viscera and gills occurs on site, and the char are cleaned before being packed in ice tubs. Roughly a dozen tubs are transported at a time by float plane to the town of Cambridge Bay, where they are offloaded at the dock and transported directly to the Kitikmeot Foods Ltd. plant for immediate processing (DFO 2014a).

Importance to the US/North American market.

Given the isolated and remote nature of the fishery, factors such as weather conditions, transportation costs, and fluctuating market demand have a significant influence on the harvest potential and distribution of Arctic char from Cambridge Bay. Thus, the revenue generated by this fishery in the Territory has high inter-annual variability. In 2009, this commercial fishery contributed $652,749 to the Nunavut economy; Cambridge Bay Arctic char currently sells for ~$24/kg (DFO 2014a).

The majority of the Arctic char caught in Cambridge Bay and distributed by Kitikmeot Foods Ltd. remains in Canada. Retailers and restaurants in Ottawa, Toronto, Montreal, and western Canada (including fresh fish sold to Vancouver) are the main recipients of its products (Anonymous 2015).

Common and market names.

Several subspecies of Arctic char have been identified in different parts of the world (see "Overview of the Species" above). Kitikmeot Foods Ltd., which is the lone processor and distributer of *S. alpinus* from Cambridge Bay, markets its product under the larger brand *Truly Wild Arctic Char* (although this brand also includes char from the fisheries of Rankin Inlet and Pangnirtung). More generally, *S. alpinus* may also go by the names char, charr, common char, alpine char, alpine trout, and sea trout (Fish Choice 2015); this species is known as *iqaluk* in Inuktitut and *iqalukpik* in Inuinnaqtun (the local language in Cambridge Bay).

Primary product forms

Arctic char can be bought fresh or frozen, and also as value-added product. *Truly Wild Arctic Char* sells frozen whole fish, fillets, and steaks, as well as hot- and cold-smoked cured fillets, and jerky and candied pieces. Given the similarities in texture and taste of char and salmon, restaurants will often prepare Arctic char in a style similar to how they would prepare Pacific or Atlantic salmon, commonly serving char as a baked or pan-fried fillet.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown.

The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical

Criterion 1 Summary

ARCTIC CHAR				
Region | Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Nunavut/Cambridge Bay | Barriers, fences, weirs, corrals, etc. Canada	1.00: High	3.00: Moderate Concern	3.67: Low Concern	Green (3.32)
Nunavut/Cambridge Bay | Set gillnets Canada	1.00: High	3.00: Moderate Concern	3.67: Low Concern	Green (3.32)

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Inherent Vulnerability

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator). Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.*

Factor 1.2 - Abundance

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*
- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

Factor 1.3 - Fishing Mortality

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).*
- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

ARCTIC CHAR

Factor 1.1 - Inherent Vulnerability

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

High

According to FishBase, Arctic char has a high to very high vulnerability (74 out of 100) to fishing (Froese and Pauly 2015).

Factor 1.2 - Abundance

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderate Concern

The most recent (and only) region-wide abundance estimate for Arctic char in Cambridge Bay was derived from reconstructed CPUE data. The current biomass predicted from associated Hierarchical Bayesian State Space (HBSS) models suggests that the population is healthy. There is significant uncertainty because the model relies on limited fishery-dependent data through only 2008, and the model output gives a biomass estimate for the entire char population rather than by river system. Thus, this criterion was scored as "moderate" concern.

Justification:

Current assessments of stock status rely on reconstructed catch-per-unit effort (CPUE) as an index of abundance. Because data for this fishery are very limited (i.e., 12 independent CPUE estimates from 1972-2006), (Zhu et al. 2014b) used pair-wise correlation between these CPUE values and large-scale climate change variables, and found that the wintertime Arctic Oscillation Index (AOI) with a 5-year lag was the best explanatory variable. Thus, (Zhu et al. 2014a) reconstructed a more complete time series of CPUE for this fishery using multiple Hierarchical Bayesian State Space (HBSS) models. From these, the authors were also able to construct relative biomass (B/B_{MSY}), which is currently estimated as >1 in all models (Fig. 3). Given that the interim limit reference point for the population as a whole is 0.40 B_{MSY} (i.e., 207 t), and the upper stock reference point is 0.80 B_{MSY} (i.e., 414 t), the biomass of char in the Cambridge Bay system as of 2008 (~610 t) was in a healthy zone (Fig. 4). Although these estimates suggest that the stock is not overfished, this criterion was scored "moderate" concern due to the data-poor nature of the fisheries (including uncertainty pertaining to stock-river dynamics), and the lack of an independent biomass estimate for 2015.

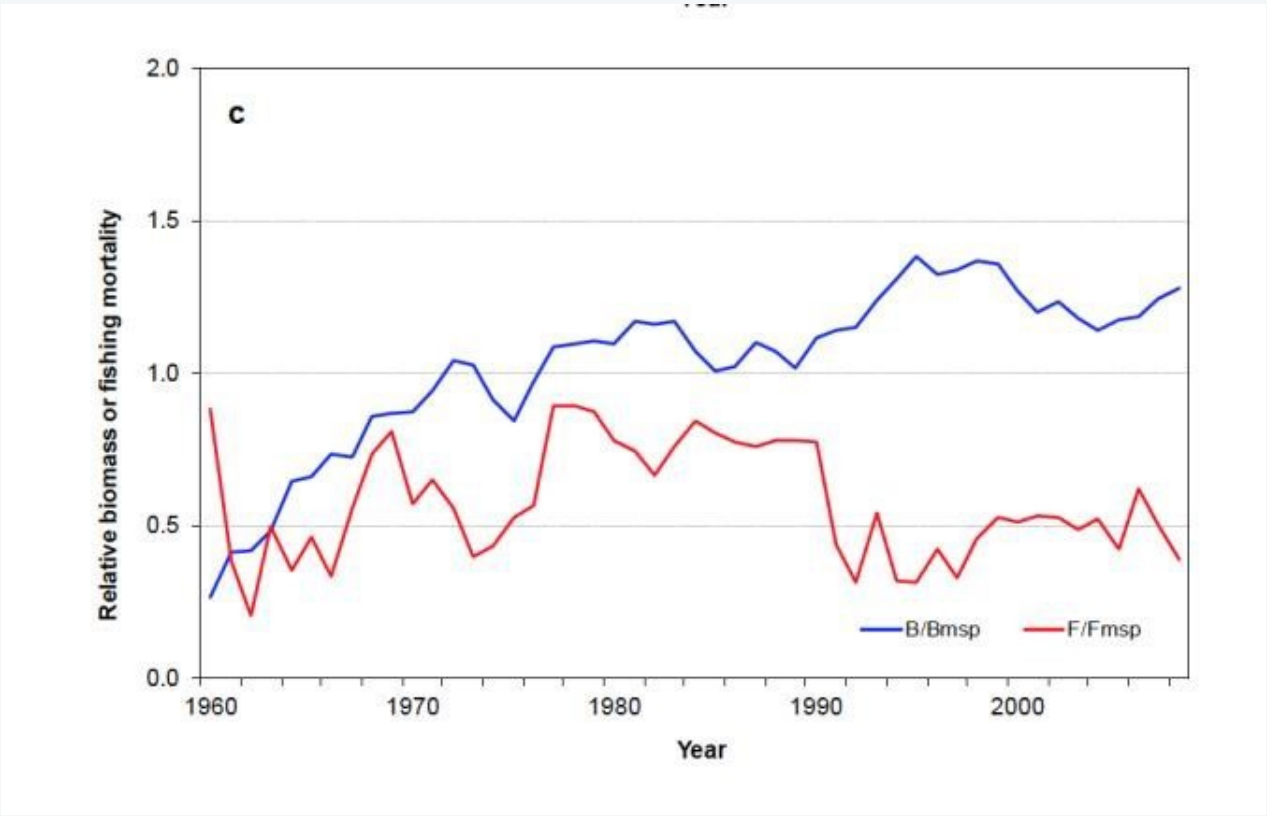

Figure 3 Relative biomass (B/BMSP) and fishing mortality (F/FMSP) for the Arctic char population in Cambridge Bay derived from HBSS. (Image from DFO, 2014a.)

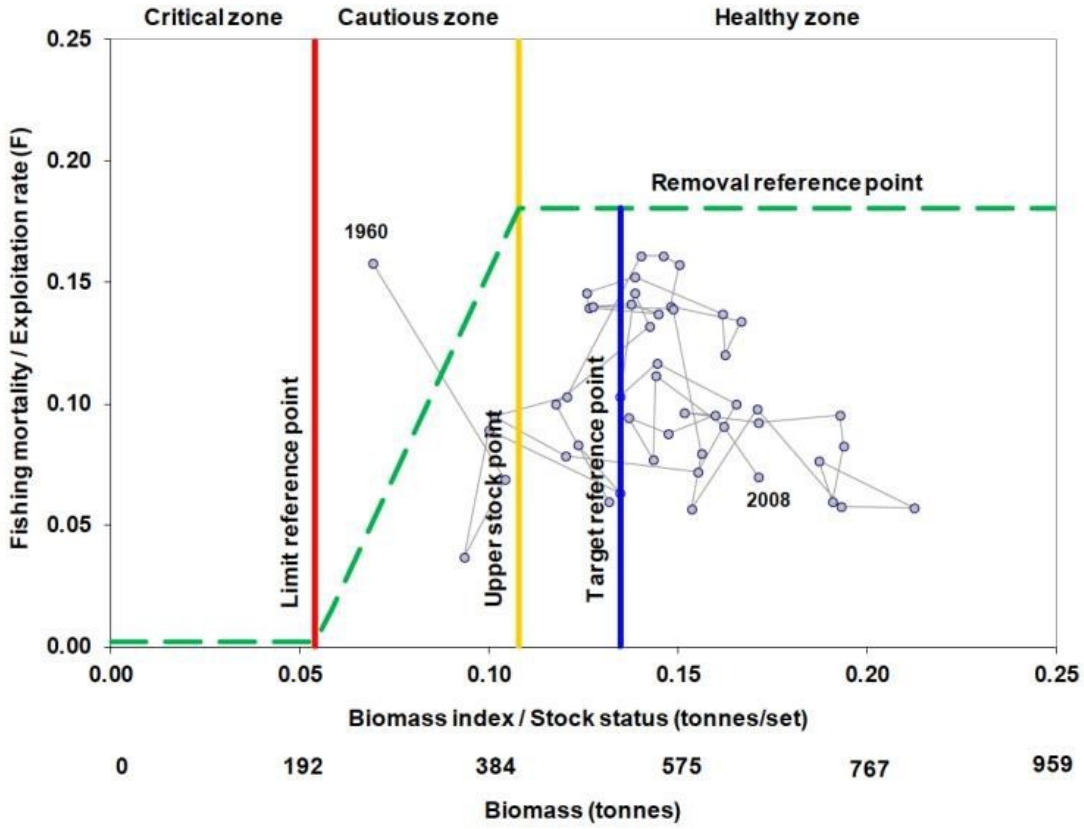

Figure 4 Population status of Arctic char in 2008 with limit reference points removal reference zones. Both biomass index and fishing mortality were computed using the HBSS model; as of 2008, the population as a whole was not overfished and no overfishing was occurring. (Figure originally from DFO, 2014a.)

Factor 1.3 - Fishing Mortality

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Low Concern

The most recent (and only) region-wide fishing mortality estimate for Arctic char in Cambridge Bay was derived from reconstructed CPUE data (Zhu et al. 2014a). Although the exploitation rate derived from associated Hierarchical Bayesian State Space (HBSS) models suggests that the population was not overfished as of 2008, the model relies on limited fishery-dependent data through only 2008, and the model output gives a biomass estimate for the entire char population rather than by river system.

As presented in (DFO 2014b), the model designed by (Zhu et al. 2014a) also provided estimates of relative fishing mortality (F/F_{MSP}) over time (Fig. 3). (Here, MSP denotes "Maximum Surplus Production," which is a term synonymous with MSY, "Maximum Sustainable Yield.") This model was able to incorporate estimates of subsistence catch as well as commercial landings, and since 1990, $F/F_{MSP} < 0.50$, which suggests that the Arctic char stock (as a whole, not by river) is currently within the Healthy Zone (Fig. 4). Moreover, an assessment of population age structure over the last four decades suggests that the population has remained stable over time (Table 2 (Day and Harris 2013)). This evidence suggests that overfishing is not occurring and

supports the assertion that, "current levels of harvest are likely sustainable with a low risk of overexploitation predicted over the next decade for the five rivers currently harvested commercially" (DFO 2013).

Justification:

Location	Period	Strong Modal Age Classes	Risk Level (over 10 years)
Ekalluk	1971-1980	12-16	Low to Moderate
	1981-1990	12-14	
	1991-2000	11-14	
	2001-2009	11-14	
Ellice	1971-1980	8-13	Moderate
	1981-1990	7-12	
	1991-2000	8-11	
	2001-2009	Not fished	
Halovik	1971-1980	11-15	Low
	1981-1990	13-17	
	1991-2000	11-15	
	2001-2009	11-14	
Jayco	1971-1980	15-16	Low
	1981-1990	13-16	
	1991-2000	10-15	
	2001-2009	11-14	
Lauchlan	1971-1980	8-14	Low
	1981-1990	11-16	
	1991-2000	12-13	
	2001-2009	11-15	
Paliryuak	1971-1980	Not fished	Low
	1981-1990	12-15	
	1991-2000	13	
	2001-2009	12-14	

[1] fished five of ten years during this period.

Figure 5 Strong model age classes by river and fishing period and associated risk of overfishing if current landings remain stable. (Image from DFO 2013).

Criterion 2: Impacts on other species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing.

To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

ARCTIC CHAR Nunavut/Cambridge Bay | Barriers, Fences, Weirs, Corrals, Etc. | Canada					
Subscore:	**5.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**5.000**
Species | Stock	**Inherent Vulnerability**	**Abundance**		**Fishing Mortality**	**Subscore**
No other main species caught					

ARCTIC CHAR Nunavut/Cambridge Bay | Set Gillnets | Canada					
Subscore:	**3.162**	**Discard Rate:**	**1.00**	**C2 Rate:**	**3.162**
Species | Stock	**Inherent Vulnerability**	**Abundance**		**Fishing Mortality**	**Subscore**
Lake trout	1.00:High	2.00:High Concern		5.00:Very Low Concern	Yellow (3.162)
Arctic cod	2.00:Medium	3.00:Moderate Concern		5.00:Very Low Concern	Green (3.873)
Arctic sculpin	2.00:Medium	3.00:Moderate Concern		5.00:Very Low Concern	Green (3.873)
Lake whitefish	2.00:Medium	3.00:Moderate Concern		5.00:Very Low Concern	Green (3.873)

Given the passive and selective nature of the weir fishery, as well as the location and timing of the fishery, almost no bycatch occurs with this gear; any incidentally caught fish (typically under-sized char) are released back into the environment unharmed (DFO 2014). The gillnet fishery is more prone to landing non-target species, including lake whitefish *(Coregonus clupeaformis)* and lake trout *(Salvelinus namaycush)*; other species may include marine sculpins (*Myoxocephalus* spp.) and Arctic cod *(Boreogadus saida)* (DFO 2014). Although a comprehensive bycatch study is in progress, preliminary observations suggest that this fishery does not have a substantial impact on these species through this incidental catch.

Commercial and subsistence gillnet fisheries can pose a threat to some species of waterfowl in various parts of the world and, in many places, the impacts remain unquantified (Zydelis et al. 2013). The red-throated loon *(Gavia stellata)* is one species known to become entangled in gillnet fisheries in parts of the Atlantic Ocean (Hedd et al. 2015), and there have been anecdotal reports of isolated interactions between the Cambridge Bay char fishery and this species (Wheeland 2016). Although localized declines of red-throated loons have been observed in other parts of the world (Groves et al. 1996), these declines do not appear to be rapid, and this species exhibits a large, stable population trend in North America over the last four decades (data from Breeding Bird Survey and/or Christmas Bird Count: Butcher and Niven 2007, from (BirdLife International 2012)). Thus, the red-throated loon is currently classified as a species of "Least Concern" by the IUCN; fishing net entanglement is one of many (unranked) threats to this species (BirdLife International 2012). Given the very small size of the Arctic char fishery, the red-throated loon is not considered a main species in this assessment.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Inherent Vulnerability
(same as Factor 1.1 above)

Factor 2.2 - Abundance
(same as Factor 1.2 above)

Factor 2.3 - Fishing Mortality
(same as Factor 1.3 above)

LAKE TROUT

Factor 2.1 - Inherent Vulnerability

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

High

The FishBase vulnerability score is 72 out of 100 (Froese and Pauly 2015), which suggests high inherent vulnerability.

Factor 2.2 - Abundance

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

High Concern

Because there are no current stock assessments for this species, current biomass estimates do not exist and

abundance is unknown. Given that there is no evidence to suggest that the stock is either above or below reference points, and because this species has a high inherent vulnerability to fishing, this criterion is scored as "high" concern.

Factor 2.3 - Fishing Mortality

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Very Low Concern

Overall, the Arctic char gillnet fishery generates very little bycatch (DFO 2014a). But there is no data currently available to support this assertion, or a stock assessment for this species, so this criterion was scored "low" concern based on a precautionary basis for the species known to be caught incidentally with Arctic char.

Justification:

(DFO 2014a) suggests that the ecological impacts of bycatch from the Arctic char are “negligible,” and fishing mortality is believed to be very low. Furthermore, since no commercial fishery exists in this part of Nunavut for any of these species, the only other catch of some of these fish comes from local subsistence fishing. Thus, it is unlikely that the char fishery poses any threat to the health of these populations.

Factor 2.4 - Discard Rate

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

< 20%

Although a small amount of bycatch is generated by the gillnet fishery, discarding is rare because many fish (typically lake whitefish, Arctic trout, and Arctic cod) that have been incidentally caught are kept for consumption by the fishers (pers. comm., Tyler Jivan 2015). No bait is used in this fishery.

Criterion 3: Management Effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region | Method	Harvest Strategy	Bycatch Strategy	Score
Nunavut/Cambridge Bay | Barriers, fences, weirs, corrals, etc. Canada	3.000	4.000	Green (3.464)
Nunavut/Cambridge Bay | Set gillnets Canada	3.000	4.000	Green (3.464)

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Harvest Strategy

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*
- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.*

Factor 3.1 Summary

FACTOR 3.1 - MANAGEMENT OF FISHING IMPACTS ON RETAINED SPECIES							
Region | Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Nunavut/Cambridge Bay | Barriers, fences, weirs, corrals, etc. Canada	Moderately Effective	N/A	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective
Nunavut/Cambridge Bay | Set gillnets Canada	Moderately Effective	N/A	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderately Effective

Management measures for the Cambridge Bay Arctic Char commercial fishery include controls related to quota, openings, and notice for the closure of fisheries; licensing; and reporting requirements, including bycatch and discards and the use of logbooks. Although reference points have recently been devised for the fishery as a whole, these have not yet been applied to each river system, and the current TAC is based on estimates of gear susceptibility instead.

Justification:

A comprehensive Integrated Fisheries Management Plan (IFMP) was published for the Cambridge Bay Arctic char fishery in 2014. Within this plan, the current state of knowledge of the fishery is presented, along with the harvest strategy and procedures aimed at addressing current knowledge gaps. The IFMP further establishes both short- and long-term goals for ensuring both the ecological and socio-economic sustainability of the fishery into the future.

Although interim Limit, Upper, and Target reference points have recently been devised for the fishery as a whole (DFO 2014b), these reference points have not been incorporated into the current management plan. The main reason for this situation is that quotas are currently assigned to each river independently. Stock assessments will be completed for two river-specific fisheries in 2017 (including abundance estimates and reference point recommendations); thereafter, this new information will be compared with the information in (DFO 2014b) and, along with fisheries management and stakeholder engagements, adjustments to existing quotas will be considered (pers. comm., Tyler Jivan 2015).

The current IFMP states that each river quota has been determined based on a conservative exploitation rate of 5% of the number of char that are vulnerable to the fishing gear in each run (for gillnets, this equates to a fork length ≥400 mm) (DFO 2014a). This exploitation rate was originally proposed by the DFO Scientific advisory team at the time, the Arctic Fisheries Science Advisory Committee (AFSAC), and was based on

tagging and weir enumeration data from the 1980s (pers. comm., Les Harris 2016). At the time, the AFSAC believed that 5% was a conservative exploitation rate because previous research found that an exploitation rate of 11% was not sustainable (Johnson 1980). Abundance estimates have not been regularly updated since those initial quotas were established, and sustainability assessments have primarily been based on trend analyses (long-term trends in biological characteristics; for example, age, length, weight, and condition). These analyses suggest that the fishery remains sustainable, so quotas have remained the same in recent years (Day and Harris 2013) (pers. comm., Les Harris 2016).

Each of the five river systems has a different Total Allowable Catch (TAC), and teams of 3-8 local Inuit fishers from the Cambridge Bay area (all of whom need an annual license to participate) fish the migrating char competitively. Once the quota is reached for a given waterbody, no further commercial harvesting of Arctic char on that river is allowed, and it is closed through regulation (Notice of Closure). All landings are to be recorded on site, and these are re-checked once fish have been transported and off-loaded at the processing plant in Cambridge Bay. In order to track landings in real time so quotas are properly adhered to, records are kept by Kitikmeot Foods Ltd. and are reported daily to DFO (DFO 2014a).

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

N/A

There are currently no overfished, depleted, or endangered species targeted or retained by this fishery.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Highly Effective

There are several ongoing studies to improve the current understanding of the char fishery. Specifically, a revised stock assessment is anticipated for 2017, and research projects on the population in terms of habitat usage, migration dynamics, and ecosystem interactions are all in progress.

Justification:

Research into the Arctic char populations in Nunavut has been ongoing since the 1970s and traditional

ecological knowledge (TEK) from Inuit fishers and community members is used in conjunction with scientific research to help develop and implement effective management strategies for this fishery. Specifically, information provided by the community includes char spawning locations (Kristofferson 2002) and TEK has further contributed to understanding the behavior of subsistence fishers, which has been included in past stock status updates (Day and Harris 2013). TEK continues to be collected regularly through community consultations.

DFO continues to amalgamate fishery-dependent morphometric data and bycatch data and, as of 2012, CPUE and harvest information have been collected through river-based monitoring programs at all sites. Although currently led by the Ekaluktutiak Hunters and Trappers Association (EHTO), it is hoped that this program will transition into a fisher-led program in 2017, because it is designed to estimate annual CPUE through the use of logbooks (DFO 2014a).

As (DFO 2014a) further discusses, a multi-year tagging program for Halokvik began in 2013, and an enumeration and mark-recapture study has also recently been completed at this site (pers. comm., Les Harris 2016). An acoustic telemetry project for the Cambridge Bay area (funded by the Ocean Tracking Network) is ongoing, with some results already published (Moore et al. 2016). This project aims to better understand the overarching population dynamics of char in the region, specifically in the context of spatial distribution among rivers and ocean migration patterns. To address the impacts of parasites on Arctic char, assessments on fish in all river systems are currently being undertaken through collaboration between DFO and Lakehead University (Thunder Bay, ON). Other work is currently underway to better understand stock structure and gene flow, and current projects include micro-satellite assessments and next-generation genetic sequencing, otolith assessments, and a stable isotope study that seeks to improve understanding of the overall marine trophic structure in this region (pers. comm., Les Harris 2016).

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Highly Effective

Prior to the release of the new IFMP in 2013, several amendments to annual quotas for individual fishing sites were made over the years. These catch limits were set based on the prevailing information, and observations of the time and landings were largely consistent with these recommended catch limits (especially in recent years).

Justification:

DFO scientific advice was regularly provided by Arctic Fisheries Science Advisory Committee (AFSAC) throughout the 1980s and into the 1990s, resulting in adjusted annual quotas for several rivers. In addition to the four rivers included in this assessment, additional rivers in the Cambridge Bay region have been fished periodically since the 1960s, and three sites (Ellice, Perry, and Palik) have not been actively fished in recent years due to difficulties primarily with transport costs and fish quality (DFO 2014a). At present, the most recent stock assessment suggests that "current levels of harvest remain sustainable, however, in the absence of information on stock size, it is extremely difficult to predict the sustainability of quotas" (DFO 2013). Current

quotas have remained static since 2006 and additional research regarding stock structure (as proposed by the stock assessment authors) is ongoing.

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Highly Effective

Enforcement measures include daily reporting at time of processing (to ensure real-time catch reporting), site visits, and logbook verification during post-season reviews.

Justification:

All fishers are required to record all landings (i.e., commercially caught char as well any bycatch) in logbooks. At the end of the season, these logbooks are submitted to the Ekaluktutiak Hunters and Trappers Association (EHTO) or Kitikmeot Foods Ltd. and returned to DFO for review and data collection. Throughout the season, Kitikmeot Foods Ltd. keeps a daily record of landings at each commercial waterbody, and this information is verified regularly to allow real-time harvest reporting and quota monitoring. Validation of plant logbook information occurs at the end of the season (DFO 2014a). Because all char are gutted in the field prior to shipment to Cambridge Bay, a conversion is required to determine char round weight from dressed weight (the quota is given in round weight).

Despite the remote sites of the fishery, DFO Fishery officers monitor harvesting activities to ensure compliance with the *Fisheries Act* and regulations applicable to this fishery (e.g., correct gear usage). Enforcement officers conduct visits to fishing sites when possible; however, due to limited resources, not all sites will be visited in a given season. Compliance issues and concerns are addressed as much as possible during the season, with additional concerns reviewed during stakeholder meetings before or after the season. Given the small number of fishers involved in this fishery, there do not appear to be any concerns regarding the level of monitoring available to this fishery.

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderately Effective

For the most part, management measures seem to have been effective at ensuring the long-term maintenance of the ecosystem and the Arctic char population. But a lack of defined stock reference points makes it impossible to determine current levels of abundance relative to previous years.

Justification:

The current IFMP maintains that quotas are fished competitively until this quota is reached, at which time the river in question is closed for the season (DFO 2014a). Although management measures are in place to ensure real-time reporting of landings between the fishing site and processing plant in Cambridge Bay, landings exceeded the TAC for the Halokvik River on occasion between 2007 and 2011 and the reason is unclear. Daily reporting measures were implemented in 2012 to address this issue and, since implementation, no sites have been over-harvested. There is no evidence to suggest that the population of char in the Cambridge Bay area has been negatively affected by fishing, but the overall lack of data regarding stock dynamics and health over time (and a lack of measurable management targets) and the relatively new IFMP for this fishery result in a precautionary score of "moderately effective" for this criterion.

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | CanadaY
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | CanadaY

Highly Effective

This fishery is co-managed by the Department of Fisheries and Oceans Canada (DFO), the Nunavut Wildlife Management Board (NWMB), and the Ekaluktutiak Hunters and Trappers Association (EHTO), under both the Nunavut Land Claims Agreement and the *Fisheries Act* (including the Fishery [General] Regulations and the Northwest), and there was a high degree of cooperation and transparency in the development of the current management plan and in its execution.

Justification:

The Arctic char Integrated Fisheries Management Plan, which was the first of its kind for this species in Canada, was developed with significant collaboration in the form of a multi-stakeholder Working Group. This Working Group began holding meetings in March 2010 and was co-chaired by DFO and EHTO, and also included representatives from Kitikmeot Foods Ltd., community elders, Nunavut Department of Environment (Fisheries and Sealing Division), and commercial fishers. The discussions of these regular Working Group meetings "focused on stock conservation of Arctic Char populations, monitoring of fishing activities, license conditions, compliance and harvest reporting" (Anonymous 2014). To ensure transparency and communication with the Cambridge Bay community during the development of the IFMP, all Working Group meetings were accompanied by public meetings and the minutes of each Working Group meeting were made available to the public. Furthermore, high school students from the local community were provided with an opportunity to attend meetings. A letter of support was provided to the Working Group from NWMB in 2011, and all work conducted and the associated progress made by the Working Group is reported to the NWMB, Kitikmeot Regional Wildlife Board, and Nunavut Tunngavik Incorporated.

Factor 3.2 - Bycatch Strategy

SCORING GUIDELINES

Four subfactors are evaluated: Management Strategy and Implementation, Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.' Unless reason exists to rate Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations differently, these rating are the same as in 3.1.

- *5 (Very Low Concern)—Rated as 'highly effective' for all four subfactors considered*
- *4 (Low Concern)—Management Strategy rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy but some other factors rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy rated 'ineffective.'*
- *0 (Critical)—No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substatntially impacted by the fishery*

FACTOR 3.2 - BYCATCH STRATEGY

Region | Method	All Kept	Critical	Strategy	Research	Advice	Enforce
Nunavut/Cambridge Bay | Barriers, fences, weirs, corrals, etc. Canada	No	No	Highly Effective	Moderately Effective	Highly Effective	Highly Effective
Nunavut/Cambridge Bay | Set gillnets Canada	No	No	Highly Effective	Moderately Effective	Highly Effective	Highly Effective

Subfactor 3.2.2 – Management Strategy and Implementation

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada

Highly Effective

Although non-target fish do occasionally get caught in the weirs, the passive nature of this gear enables all incidentally caught fish to be released into the waterway unharmed. Although there are currently no estimates available, weirs are a non-lethal form of fish capture, and the post-release survival of these fish is likely very high.

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Highly Effective

Bycatch is mitigated primarily through fishing behavior (e.g., short net-soak times) and gear modification (e.g., gillnet mesh size > 139 mm), which results in minimal incidental landings of non-target species.

Justification:

At present, the retention of bycatch is currently not permitted in the weir fishery (because most incidentally caught fish are still alive and unharmed at the time of capture and can safely be returned to the river) (DFO 2014a). Retention of bycatch associated with the gillnet fishery is permitted, and most fishers retain it for personal consumption. Because bycatch is believed to be very low, there are no bycatch limits or quotas for either fishery. The main form of bycatch management occurs in the form of mitigation of this problem through gear modifications; all gillnets must have a mesh size of 139 mm. Furthermore, fishers actively seek to retrieve their nets within 4-12 hours so some non-target fish can still be released alive (pers. comm., Tyler Jivan 2015). Given the low amount of incidental catch, it is likely that these measures are proving effective for this fishery; however, an absence of data and no comparison to similar fisheries make it impossible to confirm this assumption. Regardless of size, all spawning char are to be released into the river unharmed, although there are virtually no spawners in fall runs (DFO 2014a).

Subfactor 3.2.3 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery's impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderately Effective

To date, there is little information published on bycatch associated with the char fishery. But a multi-year study to evaluate the fishing effort of both gears and the impacts on non-target species is currently underway, with the goal of publishing this report in 2017 (pers. comm., Tyler Jivan 2015). In the past, research into optimum weir design and positioning was carried out to ensure that interactions with non-target species could be mitigated as much as possible (see (Kristofferson et al. 1986)). It is likely that this work led to the low levels of bycatch observed in the weir fishery, although there is no scientific evidence to support that assertion.

Subfactor 3.2.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Highly Effective

As discussed in Factor 3.2.2, the gear restrictions employed by management to reduce bycatch are based on scientific research and publications, and there is no reason to believe that management will disregard the findings of future studies.

Subfactor 3.2.5 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen's compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Highly Effective

There is no reason or evidence to suggest that fishers are violating any of the measures imposed to reduce bycatch or that recorded data pertaining to bycatch are inaccurate.

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region | Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
Nunavut/Cambridge Bay | Barriers, fences, weirs, corrals, etc. Canada	3.00: Low Concern	1.00: Strong Mitigation	3.00: Moderate Concern	Green (3.464)
Nunavut/Cambridge Bay | Set gillnets Canada	3.00: Low Concern	0.00: Not Applicable	3.00: Moderate Concern	Yellow (3.000)

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

- *5 (None) - Fishing gear does not contact the bottom*
- *4 (Very Low) - Vertical line gear*
- *3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (*
- *2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand*
- *1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 (Very High)—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl) Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.*

Factor 4.2 - Mitigation of Gear Impacts

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.*
- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced*
- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats*

Factor 4.3 - Ecosystem-Based Fisheries Management

- *5 (Very Low Concern)—Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators)*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts*
- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada

Low Concern

The weirs used in this fishery affect a small portion of the habitat because they are a passive, stationary fishing gear. Weirs are not used at each site; only where they are viable. Where they are utilized (a maximum of one per river system), weirs are usually installed near to the mouth of the river, where the riverbed is made of rocky sediment. Currently, weirs are only used in the fall run, and all weirs are temporarily installed until the season is finished.

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Low Concern

Rivers in the Arctic are highly oligotrophic and contain virtually no marine benthic flora or fauna (thus, no sensitive bottom habitat). Gillnet anchors do not risk damaging these environments because they are only in contact with substrate that comprises rocks and gravel. Although char migrate up these rivers, spawning occurs in lakes farther inland, so these gears pose no risk to chars' redds.

Factor 4.2 - Mitigation of Gear Impacts

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada

Strong Mitigation

Weirs have a very low spatial footprint because only one temporary weir is erected on a river at a given time. Char are primarily targeted in the spring and fall as they migrate to and from the ocean, so these structures are set up at the mouth of the river during these times; they are removed immediately after the runs (pers. comm., Tyler Jivan 2015).

Justification:

Traditional stone/rock weirs were used for millenia and appear to have not had an impact on riverine habitats (pers. comm., Les Harris 2016). Today, when using a weir, 1/3 of the width of the river is always left open (DFO 2014a). Past research was used to determine the optimal design for weirs targeting char (Kristofferson et al. 1986) and, given the short time that a weir occupies a site, there is no evidence to suggest that it poses a significant threat to the structure of the surrounding habitat (both the riverbank and riverbed). Furthermore, traditional ecological knowledge (TEK) surveys suggest that weir sites are not located near any of the identified spawning grounds in the surrounding Cambridge Bay area (Kristofferson 2002). Although these are likely not the only spawning grounds for these species, the fact that weirs are set up near the stream mouth suggests that they are likely not near nursery or overwintering habitats, which are located farther inland.

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Not Applicable

This gear does not pose any threat to the bottom habitat of the Cambridge Bay rivers, so no modifications are required.

Factor 4.3 - Ecosystem-Based Fisheries Management

NUNAVUT/CAMBRIDGE BAY
Barriers, Fences, Weirs, Corrals, Etc. | Canada
NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderate Concern

The remote, small-scale nature of this fishery suggests that it poses little risk to the health and function of the greater ecosystem, and the release of an IFMP in 2014 shows an eagerness by managers and local stakeholders to ensure that this is the case. But presently there is insufficient information regarding the genetic composition of char runs and if/how this composition is affected by the commercial fishery.

Justification:

In 2009, DFO released its Sustainable Fisheries Framework, a series of documents with the goal of providing a foundation for ecosystem-based management and a precautionary approach to fisheries management in Canada (DFO 2009). As part of this initiative, the application of sustainable-use policies will be implemented into the fisheries management process through various planning and monitoring tools, including comprehensive integrated fisheries management plans (IFMPs), which take into account not only the health of the target species but also the impacts of the fishery on the surrounding environment and species. The size

and scope of these plans is still varied, because they are highly dependent on the magnitude of the fishery under assessment.

On Victoria Island in Nunavut, commercial fishing for Arctic char currently occurs in four of the dozens of waterways in the Cambridge Bay area. Although no specific marine protected areas have been formally designated, the necessity of having fishing sites that are accessible (i.e., close to communities) and the costs associated with transporting landed fish to the processing facility in Cambridge Bay currently limits the economic viability (and thus, spatial footprint) of this fishery. At 217,300 km^2, Victoria Island is the second-largest island in Canada and the eighth-largest in the world (Hund 2014). But with fewer than 2,000 inhabitants (of which ~80% live in Cambridge Bay), the overall direct human impacts on the marine ecosystem and environment in this area are low and likely do not inhibit ecosystem function.

Although there are few areas in which char fishing occurs commercially in Cambridge Bay, until there is a better understanding of genetic mixing and the genetic structure of the char in Nunavut, it is unknown if this fishery is having a greater impact on the larger ecosystem function of this population and what (if any) consequences the localized depletion of certain runs may have in the long term.

As with most marine species in the Arctic, the greatest uncertainty pertaining to the long-term health and viability of Arctic char (both in the Canadian north and more broadly speaking) is likely the indirect anthropogenic influence of climate change. Although ongoing research and independent studies have looked at the susceptibility and vulnerability of this species—and several others—to changing environmental conditions and contaminants, no holistic ecosystem study for the region currently exists.

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Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Appendix A: Extra By Catch Species

ARCTIC COD

Factor 2.1 - Inherent Vulnerability

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Medium

According to FishBase, Actic cod has a moderate vulnerability (45 out of 100) to fishing (Froese and Pauly 2015).

Factor 2.2 - Abundance

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderate Concern

Because there are no current stock assessments for this species, current biomass estimates do not exist and abundance is unknown. This factor was scored "moderate" concern on a precautionary approach that took into account this absence of data and the species' inherent vulnerability to fishing.

Factor 2.3 - Fishing Mortality

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Very Low Concern

Overall, the Arctic char gillnet fishery generates very little bycatch (DFO 2014a). But there is no data currently available to support this assertion, or a stock assessment for this species, so this criterion was scored "low" concern based on a precautionary basis for the species known to be caught incidentally with Arctic char.

Justification:

(DFO 2014a) suggests that the ecological impacts of bycatch from the Arctic char are "negligible," and fishing mortality is believed to be very low. Furthermore, since no commercial fishery exists in this part of Nunavut for any of these species, the only other catch of some of these fish comes from local subsistence fishing. Thus, it is unlikely that the char fishery poses any threat to the health of these populations.

Factor 2.4 - Discard Rate

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

< 20%

Although a small amount of bycatch is generated by the gillnet fishery, discarding is rare because many fish (typically lake whitefish, Arctic trout, and Arctic cod) that have been incidentally caught are kept for consumption by the fishers (pers. comm., Tyler Jivan 2015). No bait is used in this fishery.

ARCTIC SCULPIN

Factor 2.1 - Inherent Vulnerability

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Medium

According to FishBase, marine sculpin has a moderate inherent vulnerability (40 out of 100) (Froese and Pauly 2015).

Factor 2.2 - Abundance

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderate Concern

Because there are no current stock assessments for this species, current biomass estimates do not exist and abundance is unknown. This factor was scored "moderate" concern on a precautionary approach that took into account this absence of data and the species' inherent vulnerability to fishing.

Factor 2.3 - Fishing Mortality

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Very Low Concern

Overall, the Arctic char gillnet fishery generates very little bycatch (DFO 2014a). But there is no data currently available to support this assertion, or a stock assessment for this species, so this criterion was scored "low" concern based on a precautionary basis for the species known to be caught incidentally with Arctic char.

Justification:

(DFO 2014a) suggests that the ecological impacts of bycatch from the Arctic char are "negligible," and fishing mortality is believed to be very low. Furthermore, since no commercial fishery exists in this part of Nunavut for any of these species, the only other catch of some of these fish comes from local subsistence fishing. Thus, it is unlikely that the char fishery poses any threat to the health of these populations.

Factor 2.4 - Discard Rate

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

< 20%

Although a small amount of bycatch is generated by the gillnet fishery, discarding is rare because many fish (typically lake whitefish, Arctic trout, and Arctic cod) that have been incidentally caught are kept for consumption by the fishers (pers. comm., Tyler Jivan 2015). No bait is used in this fishery.

LAKE WHITEFISH

Factor 2.1 - Inherent Vulnerability

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Medium

Lake whitefish has a moderate to high vulnerability (48 out of 100) according to FishBase (Froese and Pauly 2015).

Factor 2.2 - Abundance

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Moderate Concern

Because there are no current stock assessments for this species, current biomass estimates do not exist and abundance is unknown. Thus, it was scored as "moderate" concern on a precautionary approach that took into account this absence of data and the species' inherent vulnerability to fishing.

Factor 2.3 - Fishing Mortality

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

Very Low Concern

Overall, the Arctic char gillnet fishery generates very little bycatch (DFO 2014a). But there is no data currently available to support this assertion, or a stock assessment for this species, so this criterion was scored "low" concern based on a precautionary basis for the species known to be caught incidentally with Arctic char.

Justification:

(DFO 2014a) suggests that the ecological impacts of bycatch from the Arctic char are "negligible," and fishing mortality is believed to be very low. Furthermore, since no commercial fishery exists in this part of Nunavut for any of these species, the only other catch of some of these fish comes from local subsistence fishing. Thus, it is unlikely that the char fishery poses any threat to the health of these populations.

Factor 2.4 - Discard Rate

NUNAVUT/CAMBRIDGE BAY
Set Gillnets | Canada

< 20%

Although a small amount of bycatch is generated by the gillnet fishery, discarding is rare because many fish (typically lake whitefish, Arctic trout, and Arctic cod) that have been incidentally caught are kept for consumption by the fishers (pers. comm., Tyler Jivan 2015). No bait is used in this fishery.

Appendix B: Updates to Arctic Char Report

This report was reviewed for any significant stock status and management updates to the fishery on December 10, 2019. None were found that would indicate the final ratings are no longer accurate.