

1. NWSF Project Number: NWSF-2019-008

2. Project Title: Establishing a community-based sampling program for Arctic char stomachs, tissue and biological data in Naujaat

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4. Summary:

For millennia Arctic char have been a traditional, stable food source for the Inuit of Nunavut, including the residents of the communities along the Kivalliq coast. In addition to the important subsistence fisheries that occur throughout the region, commercial harvesting of Arctic char began in various communities throughout the Kivalliq in the early 1960's. Despite its importance in both subsistence and commercial fisheries in the region, there is a lack of samples and there is a scarcity of data on the general biological characteristics of these fish stocks. The purpose of this research program was to establish a community-based monitoring program in the community of Naujaat that will permit the collection of Arctic char samples and biological data. Up to 200 samples (including stomachs, tissue and biological data) will be collected from the waterbodies surrounding the participating communities where Arctic char are typically harvested. Arctic char. The motivation for this research stemmed from the Kivalliq Arctic char Workshop that was held in Rankin Inlet in February 2019. This workshop consisted of representatives from Fisheries and Oceans Canada (DFO), the Government of Nunavut (GN), the Nunavut Wildlife Management Board (NWMB), the Kivalliq Wildlife Board (KWB), and Hunter and Trapper Organization (HTO) representatives from each of the Kivalliq communities. The goal of this meeting was to identify regional interests and research priorities pertaining to Arctic char. A top priority for community representatives that emerged from this meeting was to have a better understanding of Arctic char diet. DFO proposed the idea of a co-managed (between DFO and participating HTOs) Arctic char sampling project for future diet and food web analysis. The premise was to initiate a community-based sampling program within each interested community where local subsistence fishers would be offered payment for providing stomachs, tissue samples and biological data from harvested Arctic char. This NWSF proposal sought funds to cover the payments for fishers and shipping costs associated with transporting samples to DFO for analysis. DFO will cover costs associated with the analyses. Reports summarizing the results will be provided to each community within the Kivalliq region as well as other co-management partners.

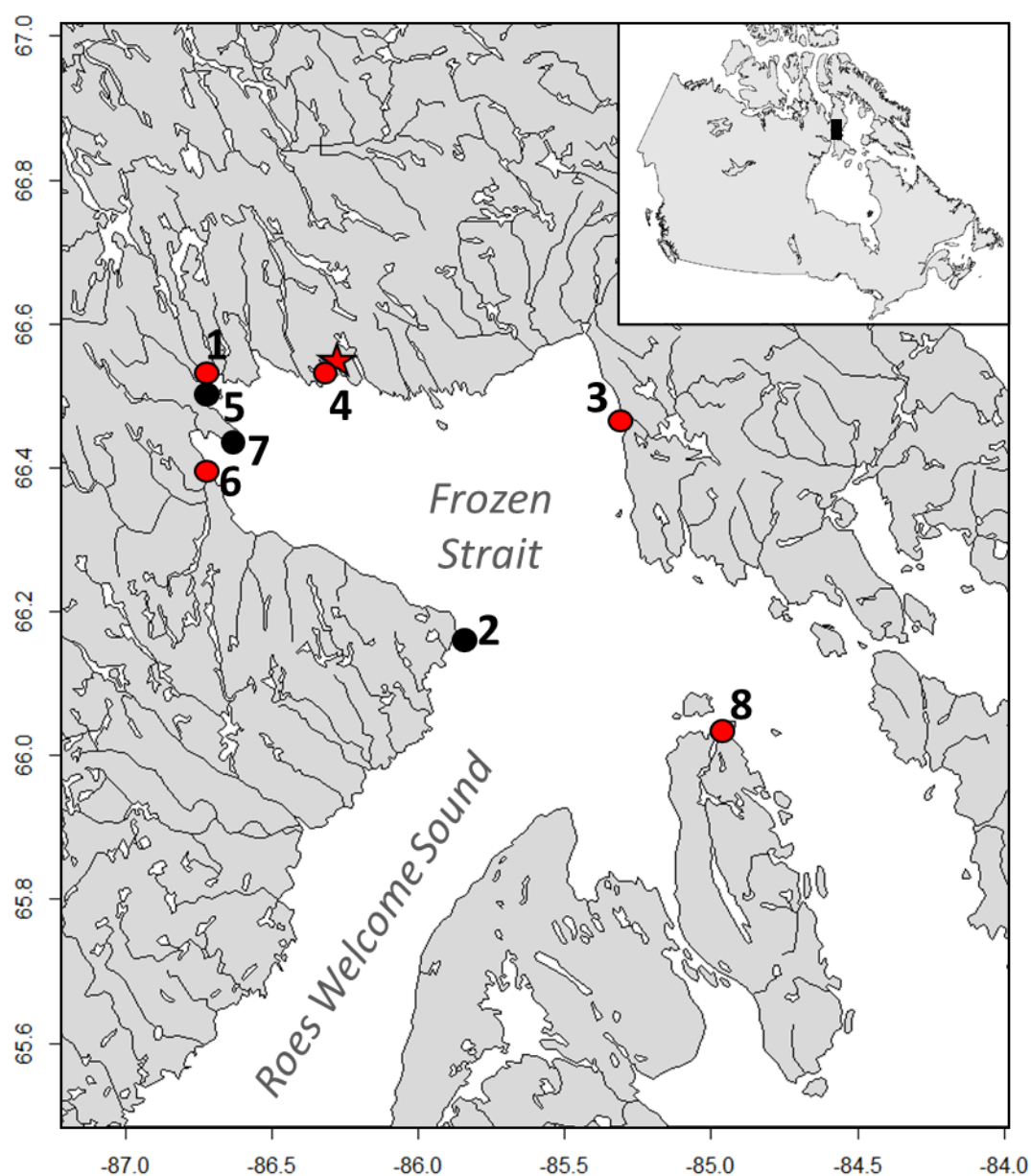


Figure 1. Community-based sampling locations in 2019 for the collection of Arctic char stomachs and tissues near the community of Naujaat (red star). Red circles indicate locations where stomachs were subsequently assessed for diet. Map codes are shown in Table 1.

5. Project Objectives:

Based on discussions at the 2019 Kivalliq Arctic char workshop, the specific objectives of this project aimed to:

- Establish a community based sampling program in Naujaat with the intent that local fishers would collect stomachs and tissues from subsistence harvested Arctic char in the region.
- Assess stomach contents in Arctic char for diet analysis.
- Report the results back to the community (via community reports and posters).

6. Materials and Methods:

DFO supplied sampling kits to the Arviq HTO and the HTO distributed sampling kits to local Arctic char fishers from the community. Local fishers sampled their subsistence catch of Arctic char for stomachs and a piece of tissue. When possible, biological data (length, weight, sex and maturity) were recorded as well as the date and location of harvest. Rewards were offered for sample kits that were returned to the HTO that contained Arctic char stomachs and a piece of tissue. At the end of the summer fishing season, the sample kits were returned to DFO for processing.

Location-English	Location-Inuktitut	Lat.	Lon.	Sample Size	Map #
-	Aviluasu	66.527	-86.689	8	1
Beach Point	-	66.153	-85.837	2	2
-	Kuugarjuk	66.470	-85.310	91	3
Naujaat	Naujaat	66.507	-86.224	40	4
North Pole River	Niaqunnguu	66.530	-86.731	13	5
-	Sipujatuu	66.388	-86.719	24	6
-	Tikiraq	66.432	-86.617	9	7
White Island	-	66.025	-84.985	20	8

Table 1. Community-based sampling locations (provided in English and/or Inuktitut) in 2019 for the collection of Arctic char stomachs and tissues near the community of Naujaat (red star). Also shown is the latitude and longitude for each location, the sample size and corresponding map code associated with Figure 1.

Stomach content analyses were performed on a subset of Arctic char samples. The stomach sample was briefly thawed and sample ID and, if available, location and date of capture were recorded. The degree of stomach fullness (F = Full (distended); PF = partially full (obvious contents, not completely distended); NE = near empty (few contents); or E = empty) and State of Digestion (I = Intact; PD = partially digested; D = digested (individual stomachs may include some intact and some digested prey items)) was also recorded. Total stomach weight and stomach lining weight were recorded. Diet items in each stomach were identified to the lowest practical taxonomic level (preferably to species) and all individual diet items per stomach were enumerated (counted) and total wet weight of unique items per stomach was determined. Photographs of all stomach contents for each sample were taken. If gonads were present in the sample, sex, maturity and gonad weight ($\pm 0.01g$) were all recorded. Weights of any other potential organs (if available) were also recorded. For this report, the top 10 most consumed prey items by number and weight are described

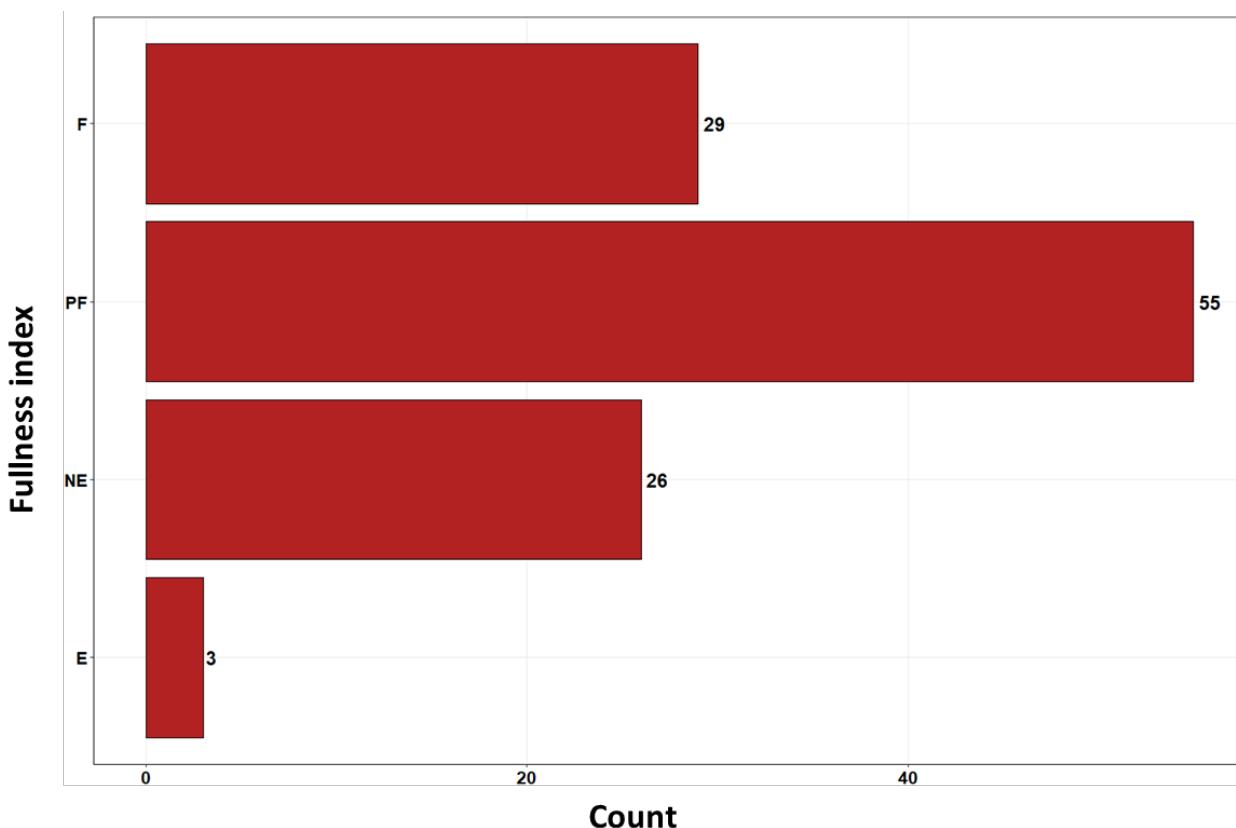


Figure 2. Breakdown of the fullness index showing the number of stomachs assessed that were empty (E), near empty (NE), partially full (PF) and full (F).

7. Results:

From the Naujaat area, a total of 207 samples were collected from local subsistence fishers from a total of nine different locations (Table 1, Figure 1). Of the 207 samples collected, 114 were assessed for stomach contents which represented five different locations (Figure 1). Of the 114 samples that were assessed for diet, 77 samples had associated sex information and in this data set there were 49 females and 28 males. Across all samples, fork length ranged from 406.4 mm to 762.0 mm (mean = 602.7 mm) and weight ranged from 454.0 g to 6804.0 g (mean = 2727.0 g). There were no statistical differences in fork length and weight between males and females (both $P > 0.05$). Of all stomachs assessed, the majority were considered partially full ($N = 55$) or full ($N = 29$, Figure 2). Only three stomachs were found not to contain any prey.

In the Naujaat area, more than 50 unique prey categories were identified ranging from invertebrates to fish and even plant material, sand and stones. The top 10 prey items by count for all locations combined is shown in Table 1 and Figure 3. The top 5 prey items made up 89.7% of all prey counted and the top 10 prey items totaled 96.7% of all prey counted across all samples. By count, invertebrates dominated the diet of Arctic char harvested near the community of Naujaat. The amphipod *Onisimus litoralis* was especially important in the diet of Arctic char from the Naujaat area making up 55.61% of all prey counted.

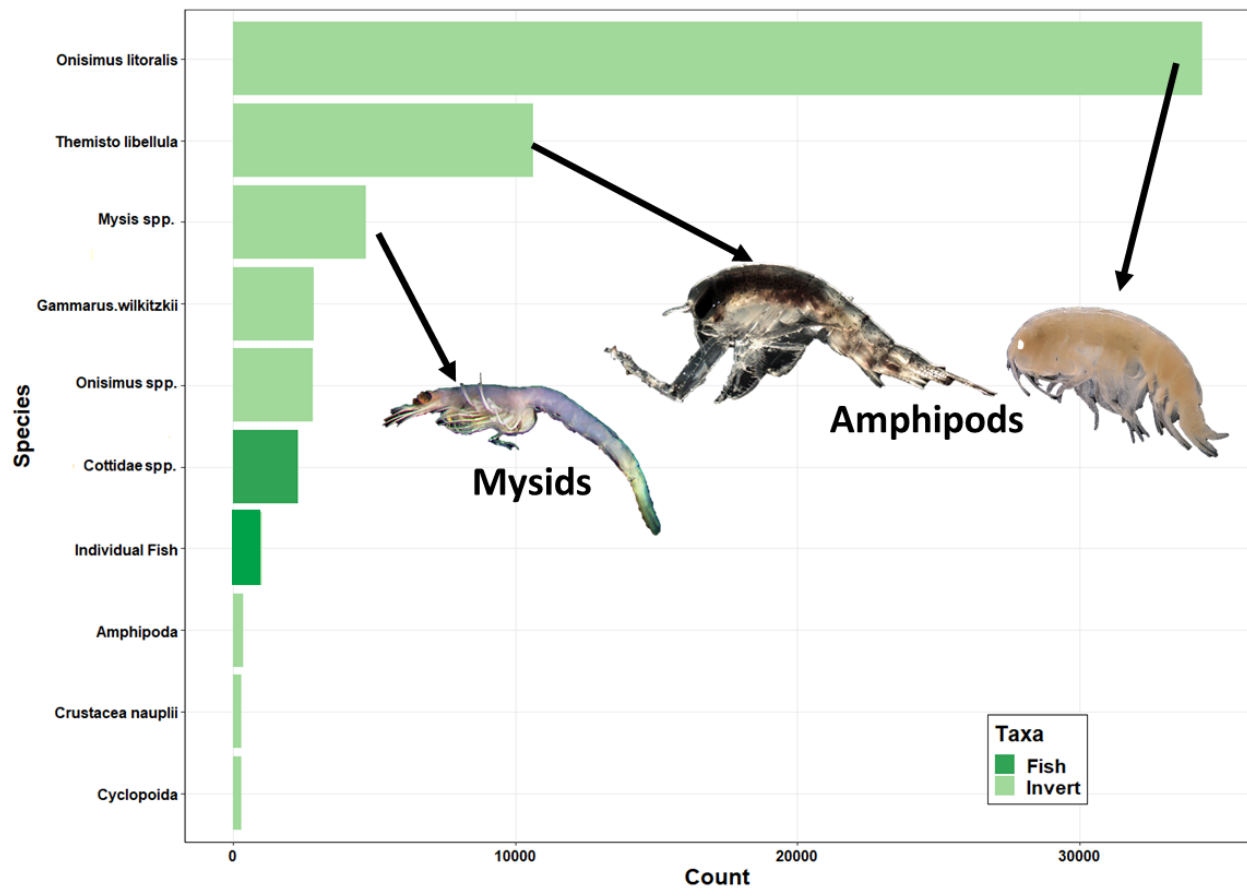


Figure 3. Shown are the top 10 species found in the stomachs of Arctic char across all samples collected in the Naujaat area in 2019.

By weight, across all samples assessed, Arctic cod made up most of the diet of Arctic char from the Naujaat area (Figure 4, Table 3). Indeed, Arctic cod made up 31.95% of all prey that was weighed. The amphipod *Onisimus littoralis* was also very important by weight making up 23.25% of all prey weighed.

There were also clear differences in the diet of Arctic char depending on the sampling location (Figures 5 and 6). For example, by count, the amphipod *Onisimus littoralis*, dominated the diet of Arctic char harvested at Kuugarjuk, Sipujatuu and the North Pole River (Figure 5). Another amphipod *Themisto libellula* was the most important prey item by count for Arctic char harvested near the community of Naujaat and at White Island (Figure 6). By weight, the amphipod *Onisimus littoralis* was the most important prey item in the diet of Arctic char harvested at Kuugarjuk, Sipujatuu and the North Pole River (Figure 6). Arctic cod (*Boreogadus saida*) dominated the diet by weight at White Island and the amphipod *Themisto libellula* dominated near the community of Naujaat (Figure 6).

Prey Item	Count	Percent
Onisimus litoralis	34334	55.61
Themisto libellula	10653	17.25
Mysis spp.	4716	7.64
Gammarus wilkitzkii	2861	4.63
Onisimus spp.	2832	4.59
Cottidae	2302	3.73
Individual Fish	1029	1.67
Amphipoda	383	0.62
Crustacea nauplii	291	0.47
Cyclopoida	289	0.47

Table 2. Shown are the top 10 species found in the stomachs of Arctic char across all samples collected in the Naujaat area in 2019. Also shown is the percent that each prey item constituted across all prey items combined.

Prey Item	Total Weight (g)	Percent
Boreogadus saida	938.47	31.95412
Onisimus litoralis	682.867	23.25105
Themisto libellula	294.287	10.02023
Mysis spp.	247.267	8.419234
Mallotus villosus	175.318	5.969431
Cottidae spp.	113.901	3.878233
Amphipoda	107.907	3.674143
Gammarus wilkitzkii	74.724	2.544289
Digested Remains	56.94	1.938759
Onisimus spp.	43.072	1.466565

Table 3. Shown are the top 10 species by weight found in the stomachs of Arctic char across all samples collected in the Naujaat area in 2019. Also shown is the percent weight that each prey item constituted across all prey items combined.

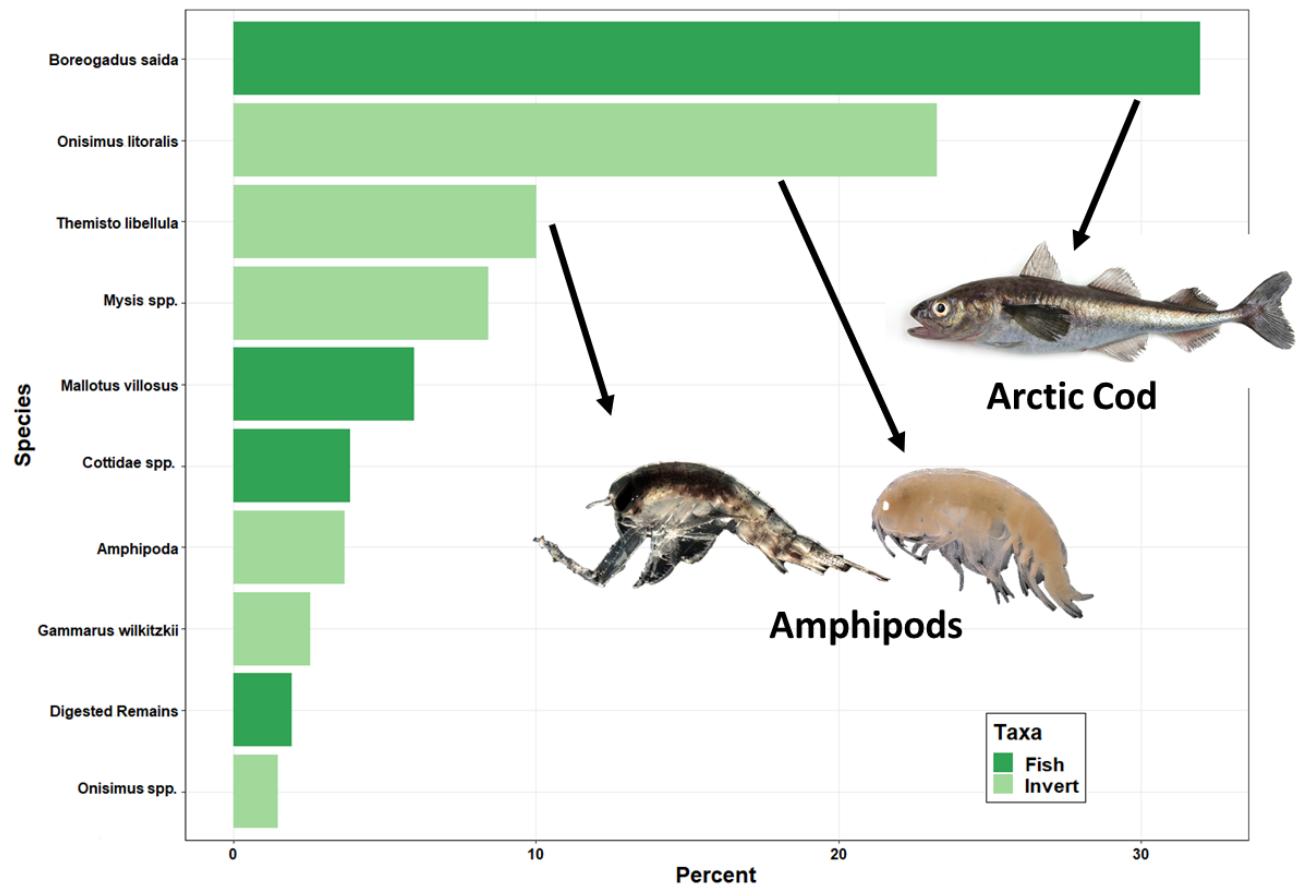


Figure 4. Shown are the top 10 species by weight found in the stomachs of Arctic char across all samples collected in the Naujaat area in 2019.

8. Discussion/Management Implications

Having a clear understanding of Arctic char diet is important when managing this species in changing Arctic ecosystems. Here, to our knowledge, we provide the first description of diet of Arctic char from the Kivalliq region of Nunavut. Our results suggest that Arctic char are highly opportunistic feeding on a variety of different taxa. All told, amphipods, namely *Onisimus litoralis* and *Themisto libellula*, were by far the most important prey item in the region making up over 70% of all prey consumed by number. Arctic cod were also important, making up 32% of all prey consumed by weight. Finally, there were clear differences in diet among sampling locations which further highlights the opportunistic foraging strategy in this species.

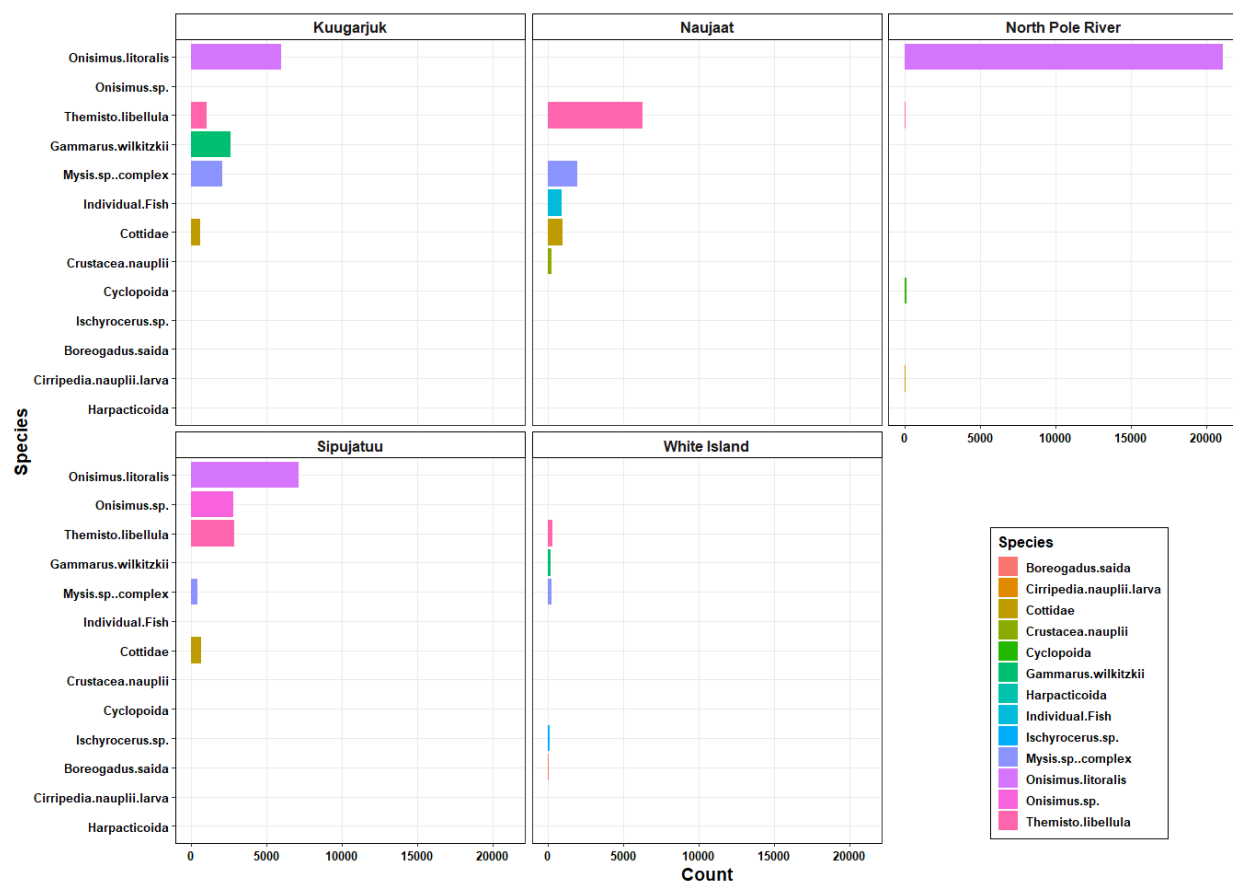


Figure 5. Differences in diet among Arctic char harvested at five locations near the community of Naujaat. Shown for each location are the top five prey items by count.

Management of Arctic char fisheries in the Kivalliq region should focus on promoting char health and sustainability, but it should also consider potential impacts to the entire food web by examining short and long-term diet patterns and trophic structuring as a way to identify potential shifts in foraging as a result of changing conditions or perturbations the ecosystem. Ecosystem-based approaches to management are now becoming an increasingly popular framework for conservation efforts, especially within the marine environment. Indeed, a primary objective of the DFO Sustainable Fisheries Framework (SSF) is to establish ecosystem-based approaches to fisheries management and this management approach is increasingly being used across Canada. Ecosystem-based management also allows for comparisons between historical baseline information and contemporary findings, which in turn have supported the conservation of species and critical biological integrity within this ecosystem. Indeed, observing changes within the marine food web through methods of diet analysis for culturally and economically important species, such as the Arctic char, will be crucial for informing future management decisions. Using the results from this study will provide important baseline information for future research and assist in the successful implementation of ecosystem-based management across Arctic environments.

The SSF also aims to manage fisheries through the implementation of Integrated Fisheries Management Plans (IFMPs). The long-term objective for this fishery involves the eventual development of an IFMP which includes, among other things, information on the biology and ecology of Arctic char that will help make informed management decisions. Thus, the results of this work will be relevant for inclusion in an eventual IFMP for Arctic char in the region that will include the most recent biological and stock status information on this species. Additionally, the data collected as part of this project will increase our understanding of food-web dynamics in the region which will be directly relevant for developing ecosystem-based approaches to fisheries management.

All told, the results of this study provide important baseline information on the foraging of anadromous Arctic char in the marine environment, particularly in the Naujaat region of Nunavut. Exploring the diet of anadromous char in different areas along the Kivalliq coast and across Nunavut will provide a clearer picture of char diet across this species' range and if the results observed here for the Naujaat area are common in other areas of the territory. With the continuing impacts of climate change and the poleward migration of temperate species, additional diet studies on Arctic char will be crucial for examining potential shifts in the food web structure. This study now provides important baseline data that could be used to test for such shifts in diet and/or trophic positioning, the results of which should prove to be valuable in future ecosystem-based management initiatives. Given the historic data poor conditions of Arctic char in the Kivalliq region, future research studies should build off of this project, incorporating methods of stable isotope and fatty acid analysis to examine diet shifts over longer periods of time. Results from this research will be a key component of ensuring the long-term sustainability of species and the integrity of changing Arctic ecosystems through the holistic approach of ecosystem-based management.

9. Reporting to communities/resource users

The results of this work were presented at the 2020 Kivalliq Arctic char Workshop held in Rankin Inlet that consisted of representatives from Fisheries and Oceans Canada (DFO), the Government of Nunavut (GN), the Nunavut Wildlife Management Board (NWMB), the Kivalliq Wildlife Board (KWB), and Hunter and Trapper Organization (HTO) representatives from each of the Kivalliq communities. The results of this work were also presented at KWB annual general meeting in 2020 and at a Naujaat HTO board meeting 2022. Community reports that will be translated to Inuktitut are currently being finalized and will be provided to the HTO for subsequent distribution within the community.

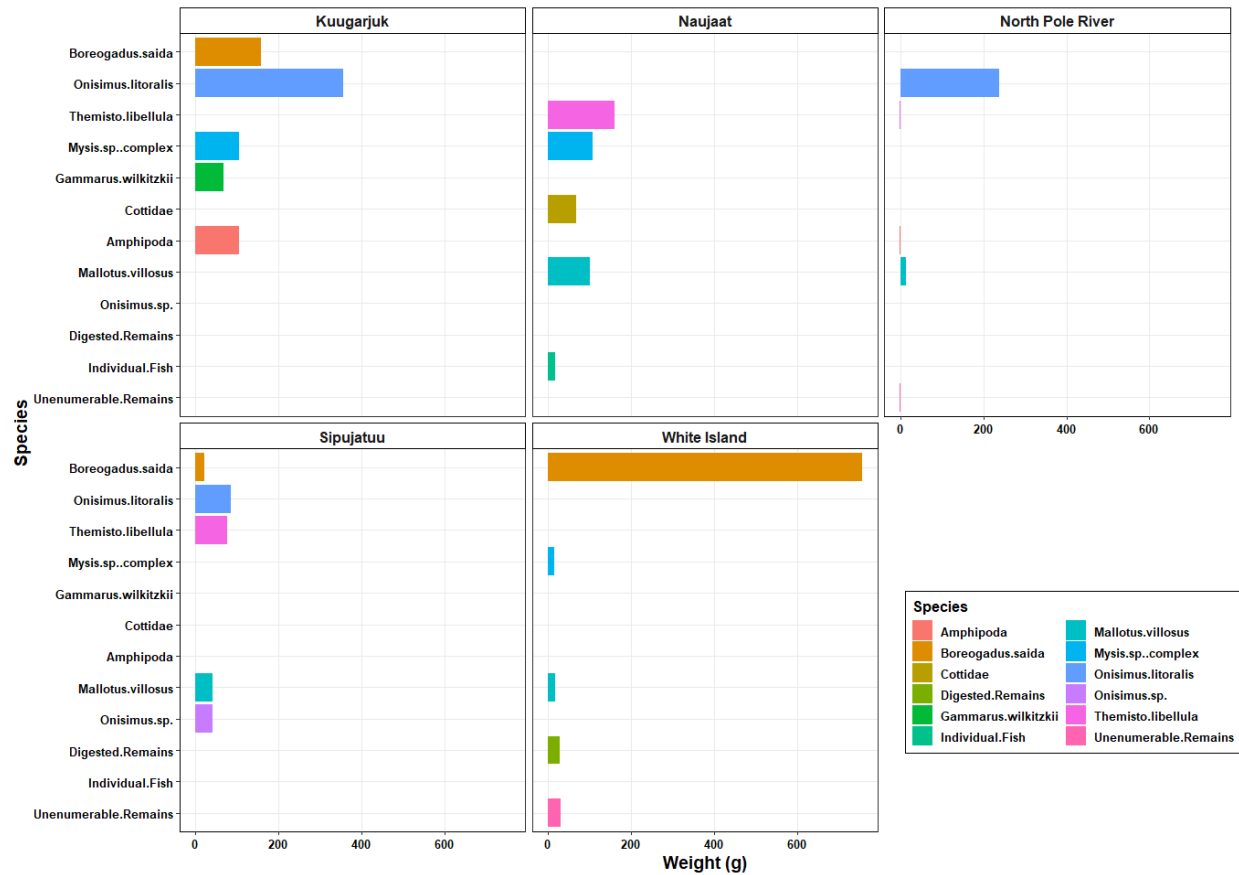


Figure 6. Differences in diet among Arctic char harvested at five locations near the community of Naujaat. Shown for each location are the top five prey items by weight.