

Application: What comes next: phase 2 of Char and Cod research near Kugluktuk NU.

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Nunavut Wildlife Research Trust (2024-2025)

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Project Title: What comes next: phase 2 of Char and Cod research near Kugluktuk NU.

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Summary: The Kugluktuk Angoniatit Association Hunters and Trappers Organization (HTO) has annually identified priority concerns around declines in fish numbers and climate change impacts on subsistence fisheries within the Coronation Gulf (i.e., waters where the community of Kugluktuk spend time assessing country foods). From 2019 to 2023, a team-based approach was formed between the HTO, University of Waterloo and Fisheries and Oceans Canada to start examining issues on two targeted subsistence fisheries: 1. Chars (Arctic Char and Dolly Varden Char) and 2. Cods (Greenland Cod and Arctic Cod). Original research undertaken by graduate students to address questions on char movements and species identification via telemetry, morphometrics and meristics, Inuit Qaujimajatuqangit, and genomics, have been interpreted by all partners and have led to development of the next phase of research questions. We have recently confirmed that there are two species of chars were identified in the Coppermine River with Dolly Varden being the predominate species found within subsistence harvesters catches. While acoustic telemetry results have allowed us to understand fish movements in the marine environment and identified that some fish overwinter below Kugluktuk Falls in the Coppermine River, new telemetry approaches are needed to identify more specific spawning and overwintering habitats, and if the two species of char (newly confirmed) differ in the habitats used for spawning and overwintering. Inuit Qaujimajatuqangit interviews in addition to morphometry and meristics have also demonstrated two types of char and specific physical characteristics to distinguish visually. Further, research to date on cod declines using community monitoring samples is demonstrating a reduction of larval hatch size for Greenland Cod and connection to environmental variables.

During the 2023-24 HTO/Science board meetings (February and October), HTO board members requested that we continue science research in the region. HTO board members specifically wanted research gaps to be addressed such as 1.) where do char spawn and overwinter in the Coppermine, and does it differ between Dolly Varden and Arctic Char; 2.) do marine movements differ between Arctic Char and Dolly Varden; 3.) what can we further learn from community based fish collections specifically focused on marine fishes? Moving forward in 2024, research will be focused on addressing research gaps using 1.) radio-telemetry and radiotracking of fish in freshwater environments, 2. continued monitoring of marine acoustic telemetry arrays, with addition of genetics on as many tagged fish as possible and 3. continued community fish collections.

Project Objectives: The main purpose of the overall study, which this community sampling program supports, is to increase our understanding of chars and cods in the Coronation Gulf region. Results will be used to support the management of the subsistence harvested fish by the community of Kugluktuk, NU.

Research Questions Addressed Since 2018:

- 1.) Where do chars overwinter and spawn within the Coppermine River?
- 2.) Do chars congregate in feeding areas in the marine environment or do they disperse randomly?

3.) What species of char exists in the Coppermine River and how does this relate to migration timing in the run? 4.) What do we know about marine species (focused on cods) in Coronation Gulf?

5.) Which species have seen an increase in occurrence in recent years and what do we know about these fish (i.e., wolffish)?

Research questions and objectives pursued in 2024:

- 1.) Do Arctic Char and Dolly Varden differ in their overwintering and spawning habitat use in the Coppermine River, and where are these habitats?
- 2.) Do Arctic Char and Dolly Varden differ in their marine movements?
- 3.) Use community-based fish collections to increase knowledge on marine fishes, including "unusual" fishes, such as Bering Wolf fish, and new species of fish in the area, including Pacific salmon species.

Materials and Methods: Objective 1(Char spawning areas): To examine freshwater char movement, fish are being implanted with a radiotag (best suited for freshwater tracking) then tracked in the fall spawning period via fixed wing or helicopter areal surveys of the Coppermine River. A pilot project was initialized in 2023 to assess feasibility and success, and the HTO is very keen for this technique to be continued and expanded. Fish were captured (gillnets, angling, dipnets), assessed for health, anesthetized, surgically implanted with tags, held for a period time to recover (15 minutes), and then released back into the natural environment. Tagging locations were determined by the Inuit researchers on our team. In 2023, 17 fish were radiotagged. Nine of these fish were detected in two primary locations in the Coppermine River in October 2023. In 2024, we will increase the number of radio tags to 30, and collect data on water and habitat features of systems/locations where radio tagged fish are detected. We are also initializing winter patrols for radio tags (undertaken entirely by the Inuit researchers), as we have recently confirmed that the radio tags can be heard through the ice. Presently, work on the radio tagging program is completed and data synthesis is ongoing.

Objective 2 (Marine Movements): Char Movement Studies (Acoustic telemetry and otolith isotope and element analysis, community fish harvest collection program): To examine marine char movement an array of listening devices (n=75; see Smith 2020 for a list of specific equipment) was installed both within the Coppermine River and marine/coastal waters adjacent to Kugluktuk, NU. The array design was developed from local knowledge of char behavior, scientific observations from other Arctic Char tagging studies (i.e., Spares et al. 2015; Moore et al. 2016, 2017; Harris et al. 2020), costing of array equipment (i.e., number of listening devices that could be purchased), and safety of installing the listening devices. Subsequent to installing the listening array, char were tagged in the summer fishing season over a 2-year period. Fish were captured (gillnets, angling, dipnets), assessed for health, anesthetized, surgically implanted with acoustic tags, held for a period time to recover (15 minutes), and then released back into the natural environment (see Smith 2020 for a detailed discussion of tagging methods). Tagging locations were determined through consultation with local community members and consent from the HTO. In total 197 chars have been tagged. In addition, the listening array was set up to parallel and function similarly with 2 other telemetry studies in the region (potentially detect any straying fish from other locations such as Cambridge Bay and Uluhaktok). The listening array was maintained at the beginning and end of each field season to download data, replace batteries, and complete any other maintenance required for them to function. When possible the array was left in the water throughout all seasons. Statistical methods for acoustic telemetry involves the detection data being imported into VUE software (VEMCO) where the file editor can be used to account for receiver clock drift and to correct recorded times (see Smith 2020 for detailed methodologies). VUE False detection Analysis Tool

will be used to identify errors in signal detection (Smith 2020). Network analysis, general linear models and mixed effects models, maximum likelihood estimation were used to model the date of fall freshwater entry and will also be used when examining marine fish movements (Smith 2020). QGIS will be used to map acoustic data detections. Otoliths (i.e., ear bones in fish) are also collected each year as part of a community fish harvest collection program (i.e., sharing of fish heads) for a \$25 monetary reward. Due to concerns of fish declines in numbers and regular subsistence harvesting for chars, no scientific gillnetting surveys for dead sampling fish were considered for the program. Otoliths are extracted from fish heads, cleaned, embedded into epoxy resin, sectioned in half with an isomet slow speed saw to expose the nucleus center, embedded into circular rings, polished (30 micron, 9 micron, 0.5 micron), and ultrasonically cleaned before being analyzed for strontium isotopes and trace elements. We are using a split stream Laser-Ablation-Induced-Coupled Mass Spectrometer (LA-ICPMS) that allows for simultaneous analysis isotope ratios (Thermo Neptune multicollector) and trace elements (Thermo XSeries 2 quadrupole) in the same transect line on the otolith (see Loewen 2016 for general/similar otolith analytical methodologies and applications; <https://uwaterloo.ca/groundwatergeochemistryremediation/laboratories/clean-room-analytical-laboratory>). Otoliths, in conjunction with acoustic tags, will provide information on migration timing (i.e., age at first migration and frequency of migration; total strontium element) and juvenile rearing location (strontium isotopes). Additionally the use of otolith elements and isotopes allows for an understanding of historical stocks of origin and migration timing from archived samples (periodic collections from 1980's to present). Statistical methods for otolith isotope and element analysis will include multivariate analyses such as Principle Component Analysis, Random Forest Analysis (Loewen et al. 2015) and descriptive statistics on binned trace element data for each annuli (Loewen 2016). Binning data involved digitizing and marking otolith annuli across the elemental scan line, developing R statistical code create element bins for each annuli and to run descriptive statistics. Environmental data (trace elements and strontium isotopes in freshwater) were collected in association to otolith studies (since elements and isotopes from the environment are incorporated into otolith structures, Loewen et al. 2016). Helicopter surveys of the Copeprmine, Rae, Richardson, Napaaktoktok, Asiak, Kugaryuak, and Tree rivers allowed for the collection of water trace element and strontium isotope analysis to accompany otolith studies. Water samples were collected (30 sites) from the surface water of the river in acid washed bottles then preserved with hydrochloric acid (strontium isotopes) or nitric acid (trace elements) (see Loewen et al. 2015 for methodologies) over a period of 3 years during the summer season.

Objective 3 (Marine Fish/Community Monitoring program): A community fish collection program for whole marine fish (5 focused species : Greenland Cod, Saffron Cod, Arctic Cod, Freshwater Cod, and Wolffish) with financial reward of \$25 per fish has been established in Kugluktuk. All fish collected are assessed for species identification, photographed, and sampled for biological parameters (i.e., length, weight, sex, maturity stage). Tissues are collected for stable isotope analysis, and stomach contents are recorded. Fish carcasses are returned to community members (or HTO) when biological sampling can occur within the community. Life history characteristics are examined for marine fish species through descriptive statistical analysis of biological data and age determination (otoliths) (see Loewen et al. 2010 for fish biological collection and age determination methodologies). Stomach content analysis and tissue stable isotope analysis (Carbon and Nitrogen) will address feeding ecology for marine fish species (see Brewster et al. 2016 for methodologies on stable isotope analysis and Chambers 2009 for stomach content analysis). Stable isotope ratios will be analysed using general linear models, and overlap/discrimination in isotopic niches will be explored through nicheROVER (Swanson et al. 2015). Otolith trace element analysis preparation, data collection, and statistical analysis is

the same as described above for chars. Marine biodiversity is assessed and compared to existing science and Inuit knowledge.

Incorporation of Inuit Qaujimajatuqangit has occurred at all steps of our research program. The project has been developed based on the HTO's concern of fish decline within the community and subsequent research has been co-developed to address these concerns. All field research is led by Inuit researchers. Inuit researchers also participate in laboratory analyses both in the community and during visits to southern labs.

Project Schedule:

Output or step	Start date (dd/mm/yyyy)	End date (dd/mm/yyyy)	Completed as of December 14, 2021
Initiate Program: advertisement, contract set up with HTO, science licensing	01/03/2024	31/05/2024	Yes
Community team member: hire, training, work outputs	1/06/2024	31/03/2025	Yes
Mid-season fish shipment & summary of sample collections	15/10/2024	15/11/2024	Yes
Community monitoring mid- year reporting	1/12/2024	15/12/2024	Yes
End-season fish shipment, and summary of sample collection for the season	31/03/2025	15/04/2025	Yes
Contracting invoice payments, Financial year end reporting & Science Licensing reports	31/03/2025	15/04/2025	Yes
Community monitoring year- end reporting	01/06/2025	01/09/2025	Yes
Laboratory analyses for sampling fish and preliminary report	01/12/2024	01/09/2025	In progress (age estimation)

The project is on-schedule presently with no changes to the project schedule needed to date.

Preliminary Results/discussion:

Fish Tagging & Oceanographic Moorings: The mooring array of approximately 75 listing receivers was successfully set up and data was downloaded at the end of the season. This was completed by R. Smith and E. Hitkolok. Presently, Rosie Smith (PhD student) and Simon DePascale are completing the data analyses on fish movements. These research manuscripts are presently being submitted for publication. A publication is expected to occur within the next 12 months on freshwater movements of chars within the Coppermine River system.

Community Monitoring: A total of 350 Char heads, and numerous other whole fish were collected as part of the community monitoring program including Saffron Cods, Greenland Cods, whitefish, flatfish, and any other fish that the HTO deemed of interest to the community for collection. We are awaiting final shipments of fish from the community to complete biological sampling for the program.

Bering Wolffish is one species we are collecting as part of community programming. Presently, we are examining biological characteristics, age, sex, maturity, stomach contents/isotopes/ecology, and parasitology. To date (all years of collection) we have fully sampled 12 fish and data were presented to the Kugluktuk HTO in February 2024. To date, the lifespan of wolffish is known to be 6-7 years of age, with a sex ratio of 5 males: 2 females that have been in a non-reproductive condition with round weights ranging from 652-1930 g and a length of 446-660 mm. It is unknown presently how many wolffish were collected in the 2024 summer season. Presently, we are finishing the biological sampling and age estimation work for the community based program. A few fish were shipped later than anticipated as they were lost in the freezer and were shipped later than anticipated. A report will be developed to summarize all the information for the community members over the next 12 months. This report will include all data collected in the community program to date. There is interest in the HTA continuing the community monitoring program independently and I have offered to assist with this as requested to support any collections moving forward. In addition, a primary publication on Greenland Cod age and growth will be completed within the next 3 months and submitted for publication.

Char morphometry, genomics and IK work is presently coming to an end. Preliminary results (all years of collection) suggest a high presence of Dolly Varden within the char populations (morphometry and genomics) in the region but more work is being done to verify and quantify this finding. To date genomics for 227 fish have been examined from the Coppermine River. In addition, 44 Tree River and 86 reference Arctic Char and Dolly Varden samples have been analyzed. For morphometrics a total of 735 char have been examined to date (Kugluktuk and other regions of Canada). A total of >150 char were examined for meristics. A primary publication is in the process of review for publication (morphometrics). IK interviews have not been fully verified and this should be completed in 2025.

Reporting to the communities/resource users: T. Loewen and H. Swanson met with the Kugluktuk HTO board in Feb. 2024 and March 2025 to provide research updates and discuss the future of the program. A letter of support for the NWRT 2024-25 application was provided.

The HTO is generally positive about the progress made and were particularly interested in: the high proportion of fish that are genotyping out to be Dolly Varden Char, the otolith microchemistry work (both the approach, and temperature reconstruct), and the wolffish. The HTO is interested in taking a broad approach to the community collection program with some focus on char, whitefish, cod, and wolffish.

There has been a decision at DFO to step back the funding for work in Kugluktuk. T. Loewen has discussed ways to support and assist the Kugluktuk HTA in continuing the research from their organization. T. Loewen will help assist the HTA in writing funding applications and can complete sample analyses on community collected samples through DFO resources. T. Loewen will also provide any inkind report that the HTA requests to ensure the program continues as directed by the HTA.

