Assessing reasons for changes in the condition of Deception Bay Arctic charr (Salvelinus alpinus L.)

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Background

• The Raglan Mine has collected biological data on Deception Bay Arctic charr (Salvelinus alpinus) through an employee sport fishing program, which since 2004, has documented a decline in fish condition.

• Concerns expressed by the local Hunting, Fishing, and Trapping Coordinating Committee (HTFCC) regarding the importance of Arctic charr to the surrounding communities, as well as the effect of growth and condition on population dynamics and survival1,2, have triggered additional scientific studies to determine the possible causes of the observed decline.

• Anadromous Arctic charr were captured in Deception Bay, Nunavik, Québec, Canada. Sampling sites (outlined in red).

Methods

• The Hg analysis was performed with a direct mercury analyzer (DMA) (DMA-80, Milestone Inc., Shelton, USA).

• Tissue was evaluated in triplicate with certified reference materials from the National Research Council of Canada (TORT-3 and DOLT-4), as well as blanks, to establish accuracy and recovery rates.

• Stable isotope analysis was performed with a Delta Plus Continuous Flow Stable Isotope Ratio Mass Spectrometer (Thermo Finnigan, Bremen, Germany) coupled to a Carlo Erba Elemental Analyzer (CHNS-O EA1108, Carlo Erba, Milan, Italy).

• Duplicates were run every 12 samples and measurement precision was determined using laboratory working standards (IAEA-CH₃ and CH₄) cross calibrated to International Atomic Energy Agency (IAEA) standards: CH₄ for δ²⁰⁶⁰C.

Methods Continued And Preliminary Results

Hg Analysis

Figure 1. A Deception Bay Arctic charr.

Figure 2. Map of the Nunavik region of Québec. Sampling sites (outlined in red).

Figure 3. Gillnetting sites in the Deception Bay and River during August 2016.

Figure 4. The decline in somatic condition of Deception Bay Arctic charr.

Objective

• To examine whether physiological processes associated with the period of marine residency may be negatively affected by anthropogenic stressors related to mining activity in Deception Bay. Specifically, whether the observed declines in the somatic condition of Deception Bay Arctic charr are the result of significant differences in total mercury THg concentrations between sites, while also investigating the relationship between (THg) concentrations and feeding patterns (δ¹³C) during the marine residency.

Figure 5. Dissecting an Arctic charr.

Preliminary Results

Figure 6. Performing a plantarflexion.

Figure 7. Measuring the somatic condition of Deception Bay Arctic charr.

Figure 8. Measured length-standardized logTHg (mg/kg) did not vary significantly among the 4 sampling sites and the additional Néphée River data set (n= 1,895; p=0.1159).

Figure 9. Length-standardized logTHg (mg/kg) significantly increased (p=0.0134) with rising δ¹³C values in Arctic charr muscle tissue collected from Deception Bay during August 2016.

Figure 10. Length-standardized logTHg (mg/kg) significantly increased (p=0.2096) with rising δ¹³C values in Arctic charr muscle tissue collected from Lake François-Malherbe during the Spring 2017 fishery.

Figure 11. The negative relationship between standardized logTHg (mg/kg) and δ¹³C was not significant (r²=0.035) in muscle tissue from Lake Duquet captured Arctic charr during the Spring 2017 fishery.

Figure 12. There was a significant (p=0.0022) negative relationship between length-standardized logTHg (mg/kg) and δ¹³C in the muscle tissue collected from the reference site near Aupaluit.

Figure 13. The negative relationship between length-standardized logTHg (mg/kg) and δ¹³C in the muscle tissue collected from Lake François-Malherbe during the Spring 2017 fishery.

Discussion

• Differences in mean THg values between sites were not significant (F=1.177; p=0.8950) suggesting that anthropogenic activity may not be a singular cause of condition declines. However, positive THg-δ¹³C relationships are not consistently observed in the literature1,2, or elsewhere in Ungava Bay, which may point to an ecological cause of poor condition.

• The positive THg-δ¹³C relationship may be influenced by: (1) the role of δ¹³C in estuarine environments3 and (2) size related prey use, supported by initial diet observations.

• In Deception Bay, a dietary shift to amphipods farther from the freshwater influences of the River by larger fish may be causing the positive THg-δ¹³C relationship, given known δ¹³C interactions and the relationship between growth and offshore feeding in Arctic charr8. In Aupaluit, the negative relationship appears to be associated with a prey shift from amphipods to fish as Arctic charr size increases.

• These statements are supported by the positive THg-δ¹³C relationship in Lake François-Malherbe, but not in Lake Duquet. Lake François-Malherbe is dominated by larger (p<0.0001), predominantly anadromous fish, while Lake Duquet is populated by a greater number of smaller and landlocked Arctic charr.

Next Steps

• Continued stomach content analysis. Examine sea ice clearance and temperature data to determine whether declines in somatic condition may be related to large scale ecological changes. Warming temperatures may have altered historic feeding in Arctic charr. Additional archival THg data collected from Néphée River Arctic charr near Kuujjuaq, Québec was included as a second reference site.

• Tissue samples (liver and muscle tissue, gonads, stomach contents, and otoliths) and biological data (fork length (cm), weight (g), gonad weight (g), and reproductive maturity) were collected.

• To establish the somatic condition of post-winter fish prior to their marine migration and feeding, samples were collected in Deception River headwater lakes Duquet and François-Malherbe in May 2017.

• These samples were acquired via a collaborative fishing program using local Inuit fishermen and the Nunavik Research Centre, and provided tissue and data for several different analyses.

References