

## Save Our Char Committee – Arctic Char Otolith Microchemical Analysis

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### *Background Information and Project Objectives*

The Save Our Char Committee (SOCC) is an initiative developed in 2007 to assess, protect, and monitor the health of the Arctic Char stock on the Northern Peninsula of Newfoundland and Labrador in order to preserve the small unique population that exists in this region. The committee works in conjunction with the Community University Research for Recovery Alliance (CURRA) and in partnership with Memorial University of Newfoundland to conduct research, promote awareness, and ultimately recover dwindling stocks. As such, their mandate is “[t]o protect, preserve and enhance the unique local population of Sea Run Arctic Char, Atlantic Salmon and Sea Trout in the Pistolet Bay area through promotion of education, scientific study and public awareness for present and future generations to enjoy.” (<http://www.nedc.nf.ca/SOCC.asp>)

One of the research questions of interest to the SOCC is the frequency of anadromy in the Arctic Char population of Pistolet Bay and the age at first migration for these fish. The following project uses otolith microchemistry to determine how often fish go to sea in their lifetime and at what age they make these trips. This will help to better understand how often char go to sea in a lifetime and to determine whether there is a pattern in migratory behaviour.

Methods:

### *Otolith Collection and Analysis*

The majority of fish heads collected for otolith microchemistry were collected from fisherman in the Pistolet area with nine from Parker's Brook and ten from Stump Hole. Fork length was recorded by fishermen for as many fish as possible, as well as the sex of the fish where possible. Otoliths were removed at the Ocean Sciences Centre in St. John's, Newfoundland and they were polished before being mounted on slides for microchemical analysis.

Laser ablation plasma-mass spectrometry was used to determine the strontium to calcium ratio (Sr/Ca) throughout the life history of each fish using a laser transect starting at the core of the otolith (beginning of fishes life cycle) and travelling outward to the edge of the otolith (end of fishes life cycle). In total, 19 otoliths were analyzed at the MAFIIC lab housed in the INCO Center at Memorial University of Newfoundland (MUN). The analytical system is a Finnigan ELEMENT XR, a high resolution double focusing magnetic sector inductively coupled plasma mass spectrometer (HR-ICPMS) coupled to a GEOLAS 193 nm excimer laser system. A helium flow rate of 0.9 to 1.0 l/min was used to carry ablated material from the ablation cell to the ICP, with an additional 0.75 l/min argon make up gas added after the ablation cell. The laser was rastered across the otoliths at 15  $\mu\text{m}/\text{sec}$  over the otolith to produce profiles across the otolith growth lines. Laser energy was approximately  $3 \text{ J}/\text{cm}^2$  and the laser repetition rate was 10 Hz. Time resolved intensity data were acquired by peak-jumping in a combination of pulse-counting and analog modes, depending on signal strength, with one point measured per peak for masses. The ICP-MS was tuned each day for maximum sensitivity using the NIST 612 glass. Oxides ThO/Th were monitored and were less than 0.5%. Data was calibrated with the NIST 612 glass. Calcium oxide (CaO) was used as an

internal standard to deal with differences in ablation yields and matrix effects between the unknown otoliths and the calibration materials (NIST glasses). The CaO concentrations of the unknowns was assumed to be homogeneous at 55.0%. Approximately 30 seconds of gas background data were collected prior to each laser ablation of both standards and unknowns.

The data acquisition methodology employed an analytical sequence of two analyses of the NIST 612 standard and one of MACS1 reference material with analyses of up to 14 unknown otoliths, closing with a repetition of the same standards in reverse order. The Macs1, a similar matrix to the otoliths, was treated as an unknown and data was acquired to allow the monitoring of accuracy and precision of the dataset and the technique in general. The error for the method when measuring homogeneous materials is estimated to be better than 5% relative based on the reproducibility of results for various reference materials measured from day to day over several months in the MUN laboratory.

Data were reduced using MUN's in-house CONVERT and LAMTRACE spreadsheet programs, which employ procedures described by Longerich *et al.* (1996). LAMTRACE allows selection of representative signal intervals, background subtraction, internal standard correction for ablation yield differences, instrument sensitivity drift during the analytical session, and perform calculations converting count rates into concentrations by reference to the standards.

Raw counts of Sr and Ca were plotted. Transect start and end points and the point of Sr inflection were recorded. These points of interest on the chemical output were then related to actual location on the otolith to determine age at first seaward migration and

age at subsequent migration events using photographs of otolith post-ablation (e.g. Fig. 1). Age was calculated from photographs (Fig. 1)(Brenkman et al., 2007). A high Sr/Ca concentration represents a trip to a saltwater environment. Lower values represent brackish and freshwater environments. Transects usually show an initial freshwater growth signal at the beginning of a fishes life, followed by spikes representing trips to brackish and saltwater environments. These were counted and compared with age to determine the effect of age on number of trips. Data were analyzed to determine frequency of anadromy and effect of age and size on this frequency, as well as to determine age of first seaward migration, using JMP v. 9.0.2., part of the SAS Institute of products.

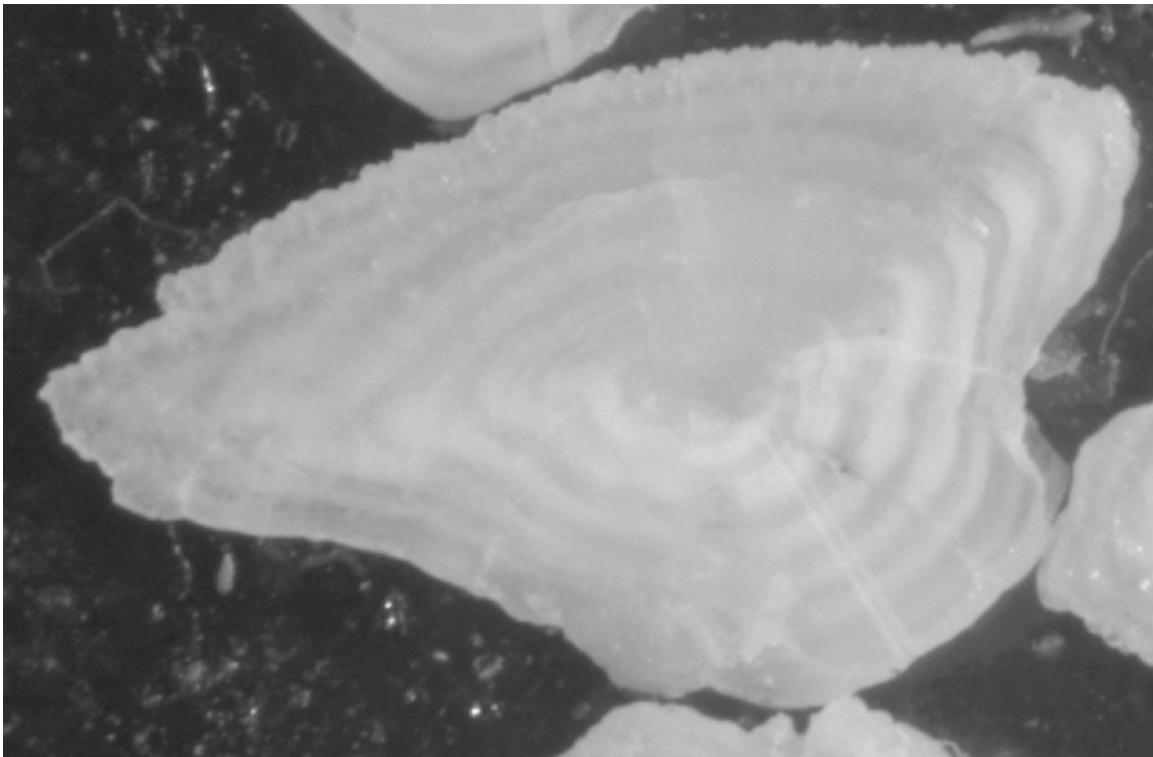


Fig. 1: Otolith transect for Arctic Char specimens

Results and Discussion:

The total number of otolith processed was 17 and the average length reported by fishermen was 359.2mm (+/- 1.39). From counting otolith rings, the average age of char sampled was 4.45 (+/-1.39) with a median age of four. Fishermen gave the sex for 12 of the char collected; seven were female and five were identified as males.

Concentrations of Sr/Ca for each fish in each of three environments (freshwater, estuarine, and saltwater) were calculated and the means of these groups were compared (Fig. 2). The three categories were significantly different (all three  $p < 0.001$ ,  $N=17$ ) indicating that the groups represented three distinct signals. Based on these levels, number of saltwater and estuarine events was calculated and number of total trips to saline environment was calculated (Total trips = S + E). The average number of trips to sea for char was one (+/- 0.24) and a median of zero ( $N=17$ ); however, there were two fish that made two trips to sea, and two fish that made three trips to sea. The average number of trips to brackish environments was 1.55 (+/- 0.17) with a median number of trips of two. Age at first, second, and third migration was calculated and average age at first migration was 3.36 (+/-0.24) ( $N=12$ ). Average age for second migratory event was 4.75 (+/- 0.48) ( $N=4$ ), and average age for third migratory event was 6.00 (+/- 1)( $N=2$ ).

The effect of age on migration was calculated using regression analysis and there was no significant effect of age on number of trips to saltwater ( $p=0.0525$ ,  $N=17$ ), on number of trips to brackish environments ( $p=0.2791$ ,  $N=17$ ), or on the total number of trips ( $p=0.3064$ ,  $N=17$ ) (Fig. 3 and Fig. 4). Additionally, the difference between the sexes for trips to sea was calculated by comparing the mean values using a t-test and no significant difference was found between the number of trips to sea ( $p=0.1546$ ,  $N=11$ ) and for total trips ( $p=0.5148$ ,  $N=11$ ).

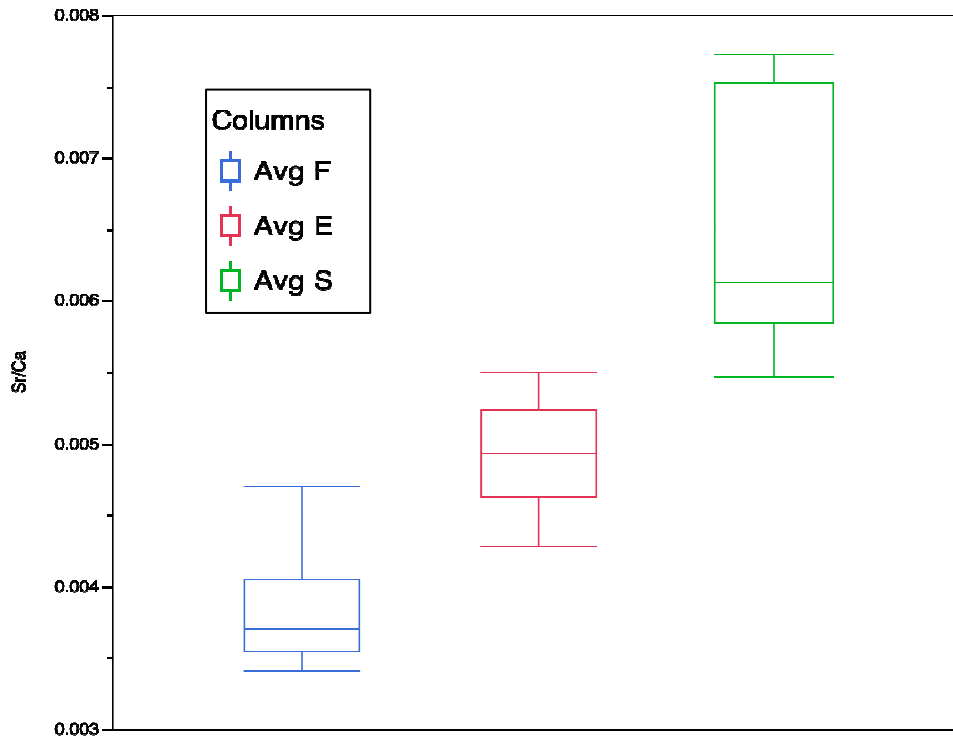


Fig. 2: The average Sr/Ca concentration for three different environments: freshwater (Avg. F), brackish or estuarine (Avg. E), and saltwater (Avg. S) (N=17).

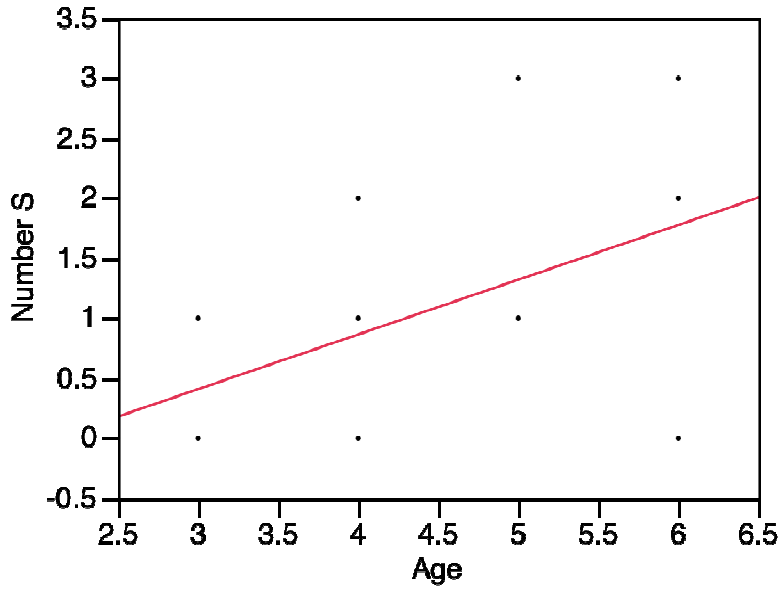


Fig. 3: The effect of age on number of trips to sea (N=17) ( $p=0.0525$ ).

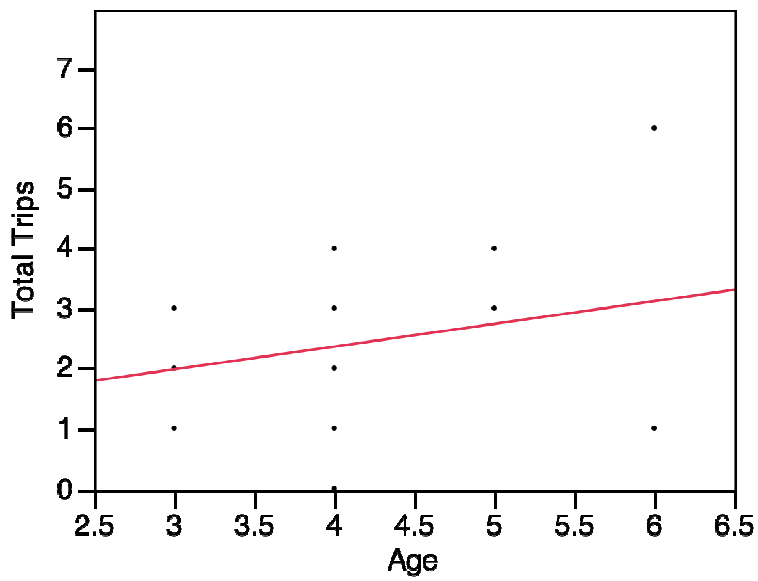


Fig. 3: The effect of age on number of total trips to saltwater environment (both S and E) (N=17) ( $p=0.3064$ ).