

**ASSESSING THE ANADROMY OF SALMONIDS
USING ANALYSIS OF SCALE MICROCHEMISTRY
AND GROWTH PATTERNS**

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Introduction

Documentation of periods of anadromy often relies on expensive and difficult tracking or marking studies. An alternative non-lethal technique, the analysis of strontium (Sr) content in the scales of these fish, allowed us to successfully determine the age at first movement to sea, timing of migration between fresh- and saltwater environments and the presence of facultative anadromy in some wild and stocked populations of Atlantic salmon (*Salmo salar*) and brook charr (*Salvelinus fontinalis*), at a fraction of the costs involved with other methods.

As the scale develops in concentric ridges, trace elements (eg. Strontium) are incorporated in its calcified matrix in proportion to their ambient level (Bagenal, 1973; Yamada, 1982). Since water strontium (Sr) concentration is directly proportional to salinity, a high Sr/Ca ratio in some circuli would indicate periods of life spent in saltwater. The analysis of Sr was done in this study using a wavelength dispersive X-ray electron microprobe (WD-EM).

We focused on landlocked Atlantic salmon from the Magaguadavic River (New Brunswick, Canada), stocked prior to 1995. Some of these individuals moved below a 20m waterfall and were recaptured between 1996 and 1999 after considerable growth, in a fish ladder at the head of tide, between 1996 and 1999. They were suspected to have moved into saltwater, but it is also possible that they moved downstream but remained in the lower river.

Methods

We analyzed 34 salmon scales (13 from 1996, 2 from 1997, 12 from 1998, and 7 from 1999). The scales were embedded in an epoxy (Epofix) and a transverse cut was made along the long axis of the scale, through the focus, using a steel blade microtome. The smooth surface necessary with the use of WD-EM was attained with a finishing cut using a glass-knife ultramicrotome and the finished blocks were carbon coated.

Analysis was conducted using the electron microprobe on a X-ray Wavelength Dispersive Scanning Electron Microscope (JEOL733). Each sampling point was determined optically and centered on the circuli (ridges). Since calcium (Ca) composes most of the matrix and is less affected than trace elements by the exact position and angle of the beam, we used the Sr/Ca ratio as our measure.

We analyzed the first 5 contiguous circuli and 15 additional points were sampled at every other circulus, when possible, covering a region corresponding to approximately the 35 last-laid circuli. Since between eight and twelve circuli are formed each year in the case of the Atlantic salmon (Summerfelt and Hall 1987), we then investigated the past 3 or 4 years of these fish, at a one or two months time resolution.

Results

Five different patterns were distinguished: true landlocked (n=3), frequent contact with saltwater (n=12), one summer spent in seawater (n=3 early, n=8 late), and multiple migrations to the sea (n=8 - Fig. 1, next page). Fast growth was associated with high Sr contents. Only one fish seems to have spent the majority of its life in saltwater.

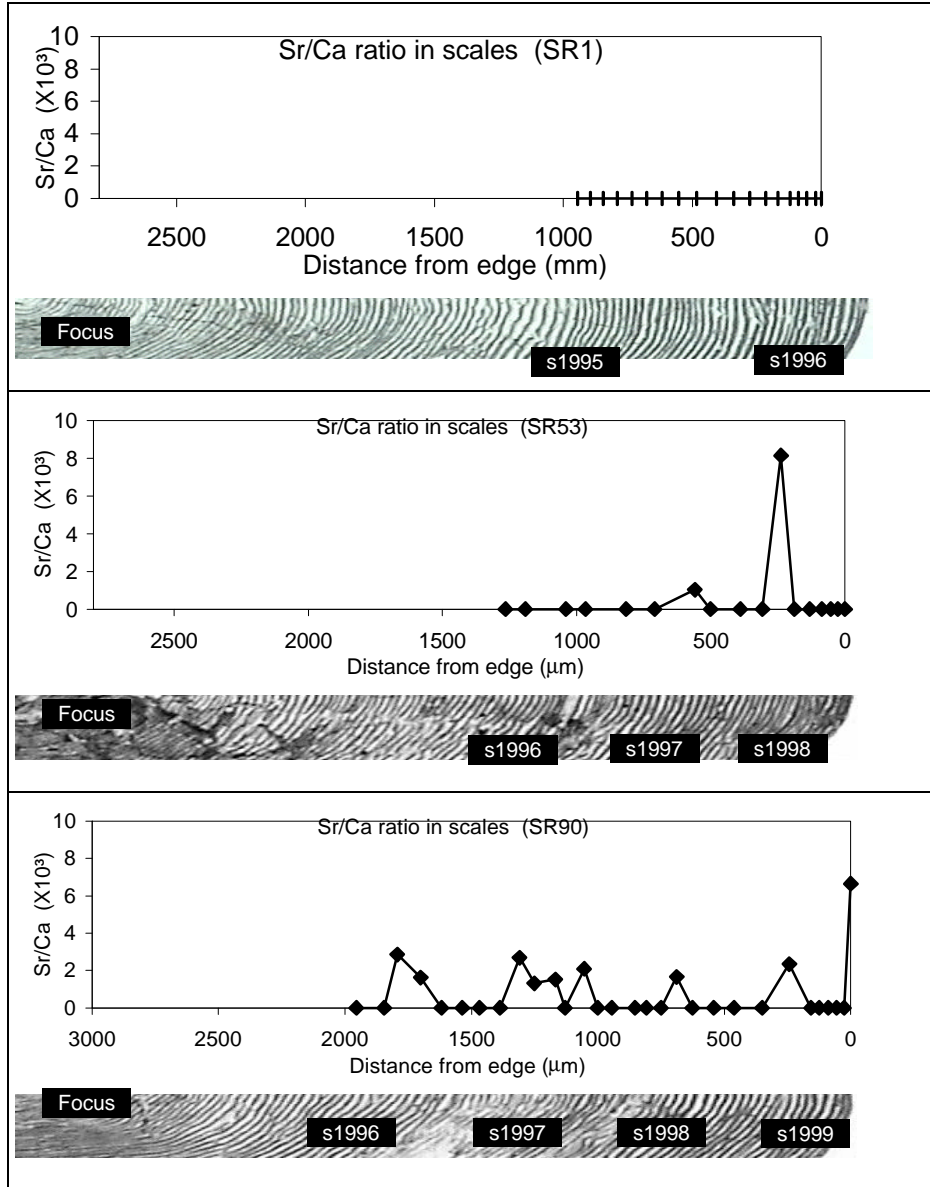


Fig. 1. Sr/Ca analysis showing true landlocked (SR1), saltwater residency in the past summer only (SR53), and frequent use of the saltwater (SR90).

Discussion

These preliminary results may have major management implications. It appears possible that some “landlocked” Atlantic salmon use the saltwater environment. Thus rivers that have lost their wild anadromous runs, but still have landlocked salmon in the system, could regenerate sea-run populations.

Also, in this particular case, individuals that moved into the Bay of Fundy could contact diseases like ISA (Infectious Salmon Anemia), and then move back into the rivers.

The analysis of scale microchemistry coupled with the analysis of growth patterns seems to be an efficient method to assess saltwater residency over many years of a large number of fish, and can be useful for management purposes.

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