Element Signature Analysis From The Otoliths Of Brown Trout Determines Recruitment In The Motueka River

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Introduction

- Understanding the life-history and migration of brown trout is both
  - A Biological Question
    - Salmonid ecology
  - A Management Question
    - Protection of the fishery

- Of particular Importance is an understanding of which tributaries within a catchment sustain the downstream population
The Otolith – “Black Box”

Firstly

Continuous growth

- Calcium Carbonate structure
- Varied growth rates, but constant deposition of new material
The Otolith – “Black Box”

Secondly
Trace element incorporation

- Elements substituted into the crystal lattice in place of calcium
- Elements vary between different environments
  - Geology
  - Land use
The Otolith – “Black Box”

Thirdly

No metabolic redistribution

- Elements remain trapped for the life of the fish.

So...

- Environmental fingerprint can be predicted over the entire life of the fish.
Aims

Part 1

• Create an element map of the catchment by examining the otoliths of juvenile fish from a range of tributaries

Part 2

• Trace adult fish back to the tributaries to gain an understanding of recruitment importance
Motueka River

- Diverse Geology and land use.
  - Creates diverse element fingerprints

- Nationally renowned brown trout fishery.
Part 1

Creation of the Element Map
Methods Overview

- Juvenile Fish collected from a range of tributaries

- Elemental signatures of otoliths analysed by ICPMS

- Signatures entered into a discriminant function analysis to classify the element signature of each stream.
LA-ICPMS

(Laser Ablation Inductively Coupled Plasma Mass Spectrometry)

- Otolith is cleaned and placed in a sealed chamber.

- Laser beam is fired at the otolith.

- Otolith material is ablated and transferred into a mass spectrometer.

- Amount of each element determined by atomic mass.
Greenwich Azimuth Map

Mg
Mn
Sr
Ba

Metal/Ca millimol/mol

Edge Zone = Most recent otolith material = Tributary signature
Multi element fingerprint for each tributary

Elements used: Strontium, Barium, Manganese.
Overall 94.7% of the juvenile fish correctly classified to the stream they were caught.

<table>
<thead>
<tr>
<th>Tributary</th>
<th>% Classification</th>
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</thead>
<tbody>
<tr>
<td>Overall</td>
<td>94.7</td>
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<tr>
<td>Baton</td>
<td>93</td>
</tr>
<tr>
<td>Blue Glen</td>
<td>100</td>
</tr>
<tr>
<td>Dart</td>
<td>100</td>
</tr>
<tr>
<td>Graham</td>
<td>100</td>
</tr>
<tr>
<td>Motupiko</td>
<td>100</td>
</tr>
<tr>
<td>Rainy</td>
<td>100</td>
</tr>
<tr>
<td>U. Motueka</td>
<td>100</td>
</tr>
<tr>
<td>U. Wangapeka</td>
<td>60</td>
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</tbody>
</table>
Part 2

Tracing back the adult fish
Methods Overview

• Adult fish collected from the main stem of the Motueka River

• Elemental signatures of otoliths analysed by ICPMS

• Adults entered into the juvenile analysis as unknowns to estimate for each a likely rearing tributary.
Adult Preparation

- Removed, cleaned and ground to a thin section
- Laser used to scan a transect from edge to edge through the core
Adult Profile

Manganese Spike = Core

Rearing Zone = 200 microns from the core
Adults entered into the analysis as unknowns

- The tributary each adult fish was most likely to have come from
- And a probability defining how well it matched

To quantify recruitment adults matching a specific tributary with 95% confidence were examined
Motueka River Catchment

North Island

South Island

NEW ZEALAND

0 10 20 kilometres

Total n=48

80km+

Baton

Dart

Rainy

Blue Glen

Total n=48
Conclusions – Motueka River

• Recruitment processes occurring at the catchment scale.

• Beginning to get an idea of important parts of the catchment sustaining the downstream fishery.

• Further investigation should clarify the pattern further.
Conclusions – Potential in the Method

• Differentiation within a completely freshwater catchment.
  – Classification of 94.7%

• Element map enhancement.
  ➢ Strontium isotopes
  ➢ Smaller streams
    ➢ (Baton, Wangapeka)
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