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

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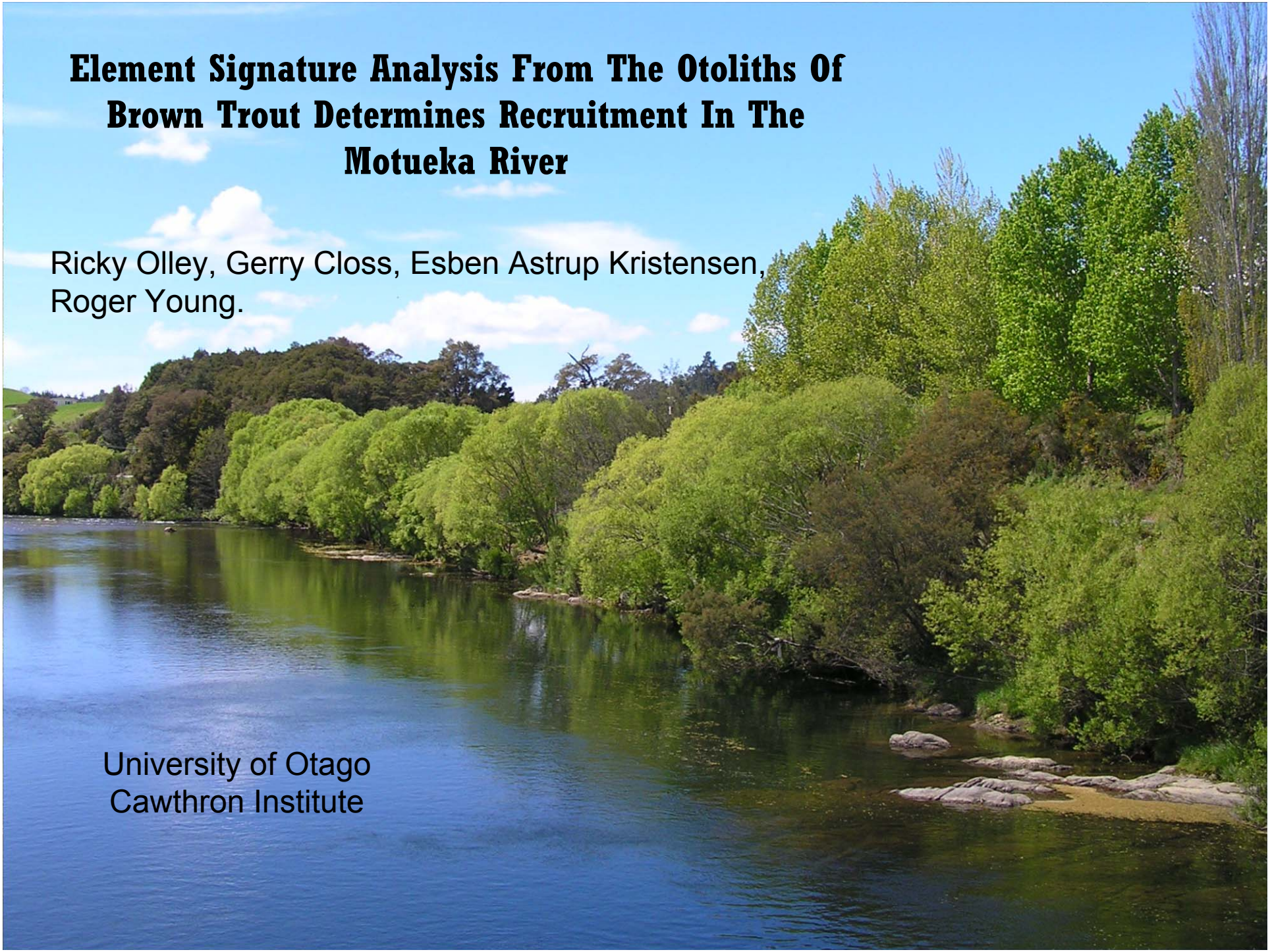
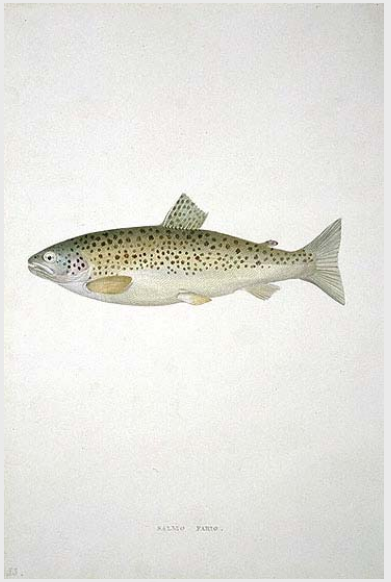


Introduction

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



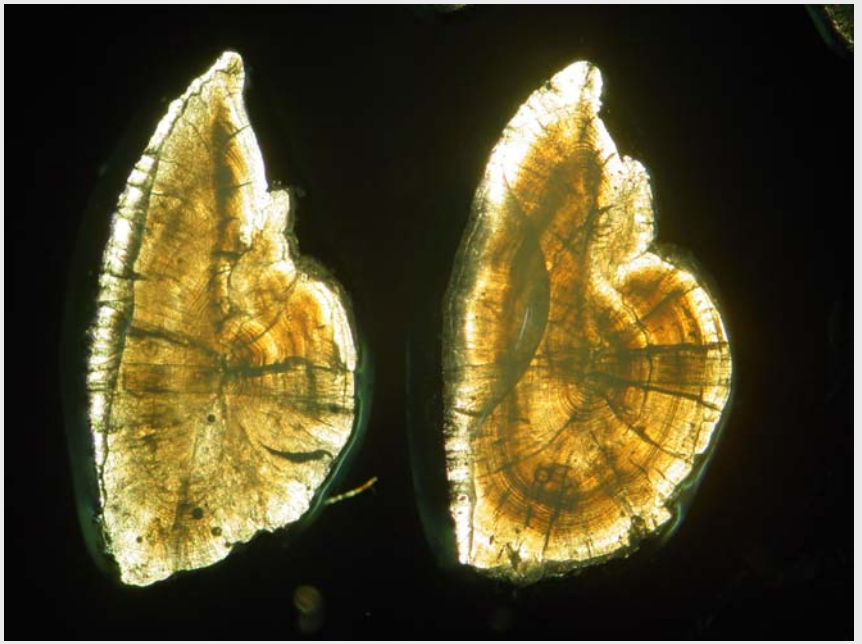
- Of particular Importance is an understanding of which tributaries within a catchment sustain the downstream population

The Otolith – "Black Box"

Firstly

Continuous growth

- Calcium Carbonate structure
- Varied growth rates, but constant deposition of new material

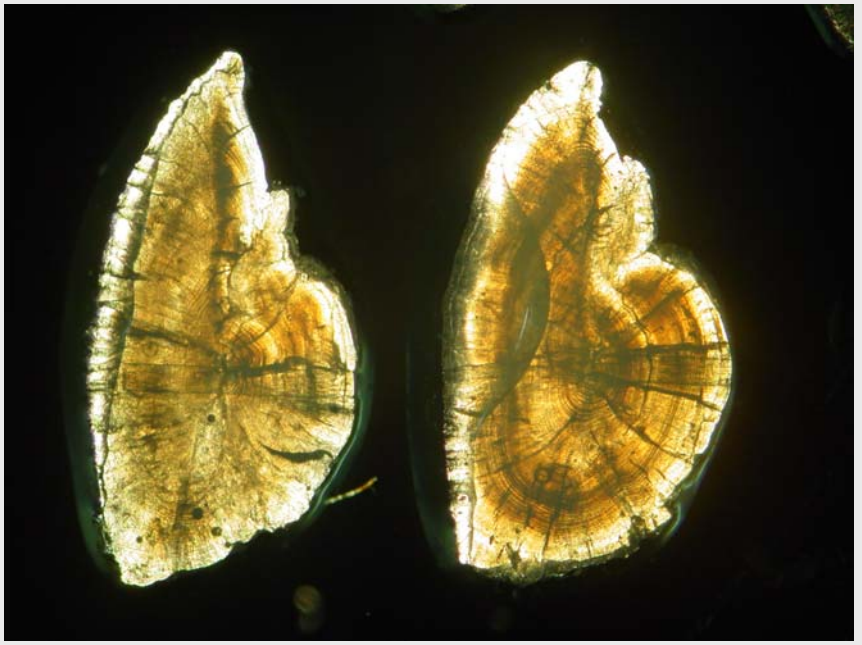


The Otolith – "Black Box"

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"

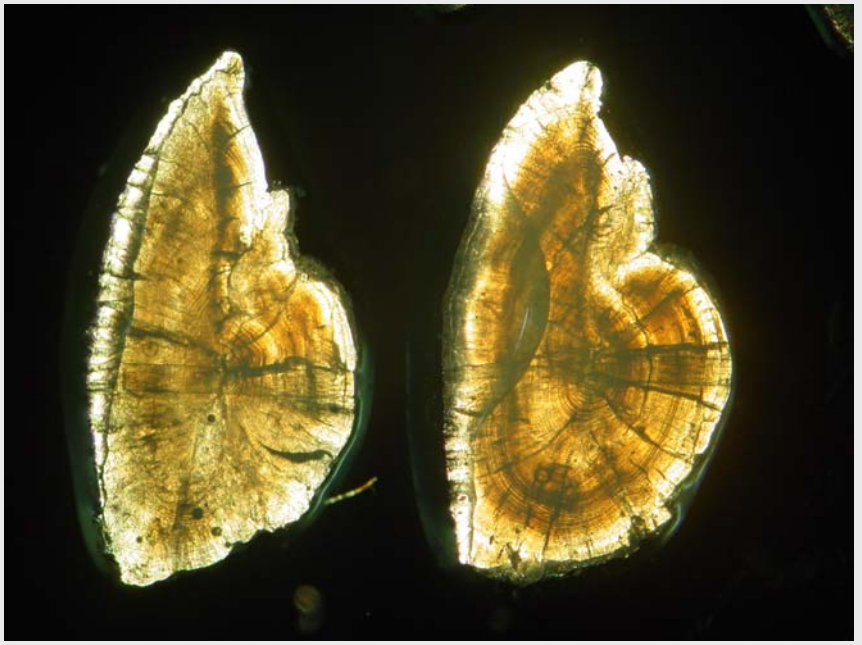
Thirdly

No metabolic re-distribution

- 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

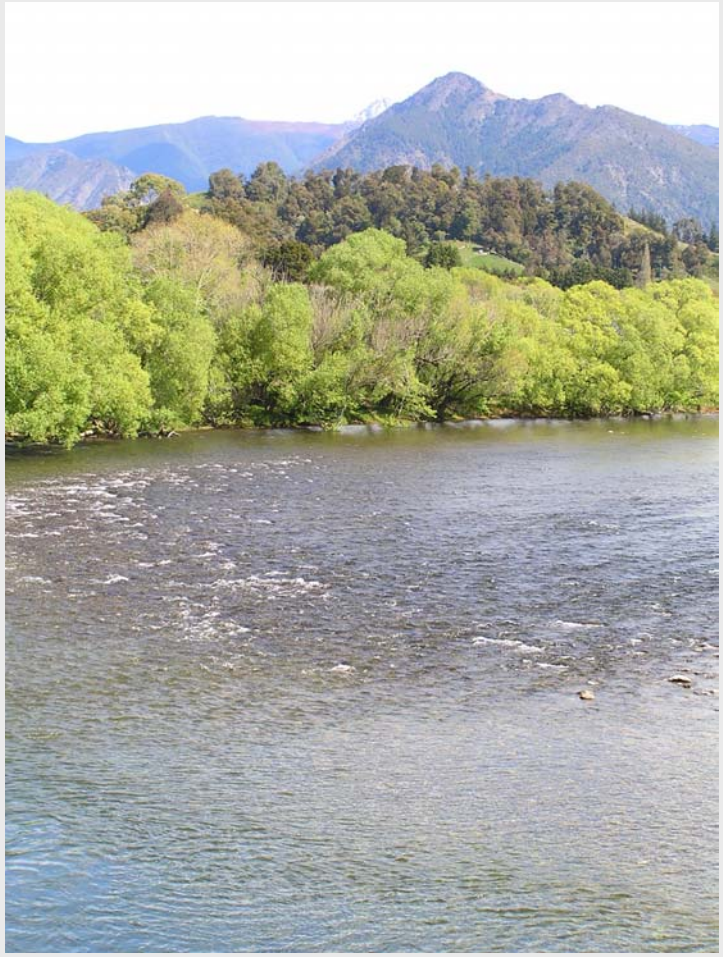
- Create an element map of the catchment by examining the otoliths of juvenile fish from a range of tributaries

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.

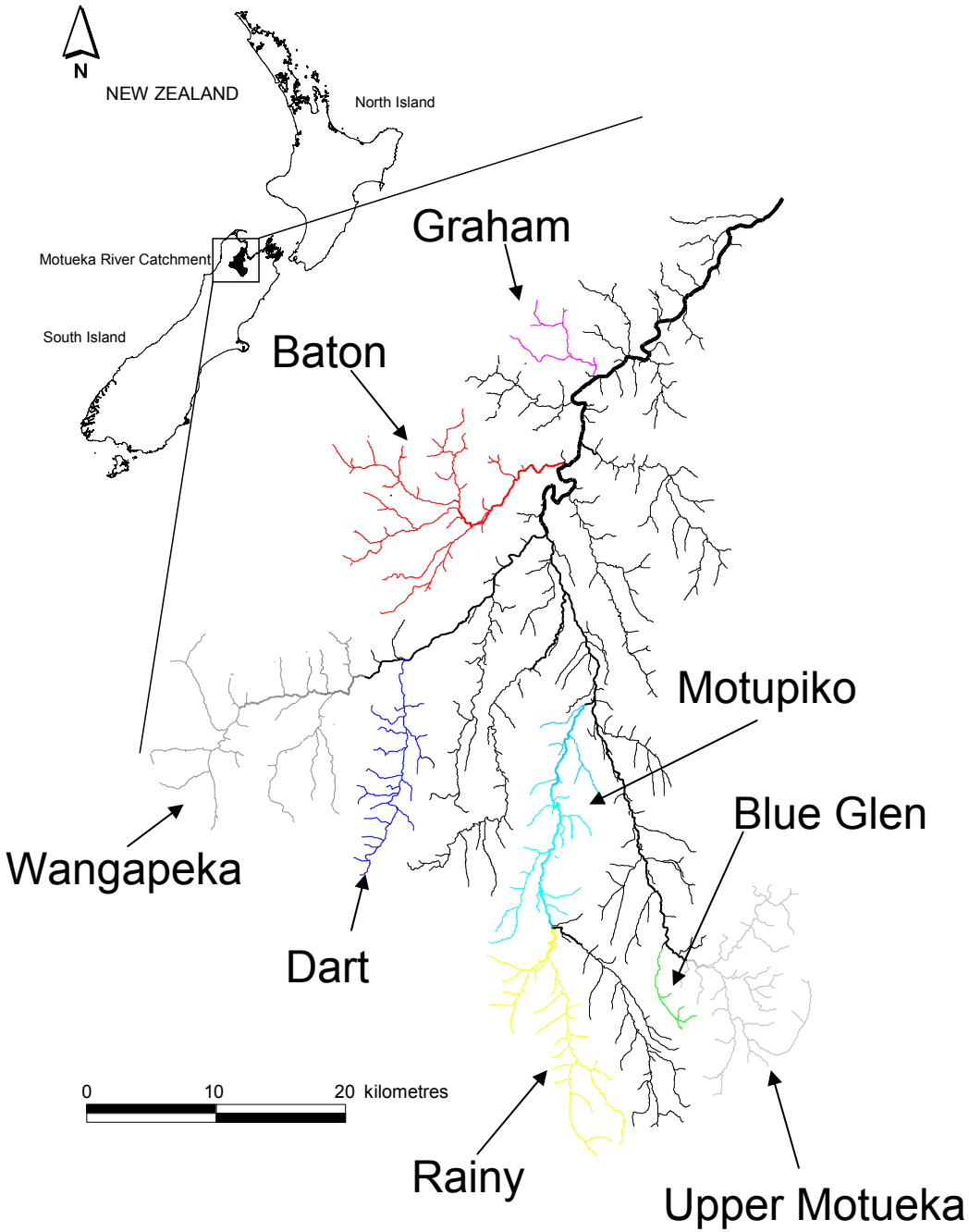


Part 1

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.

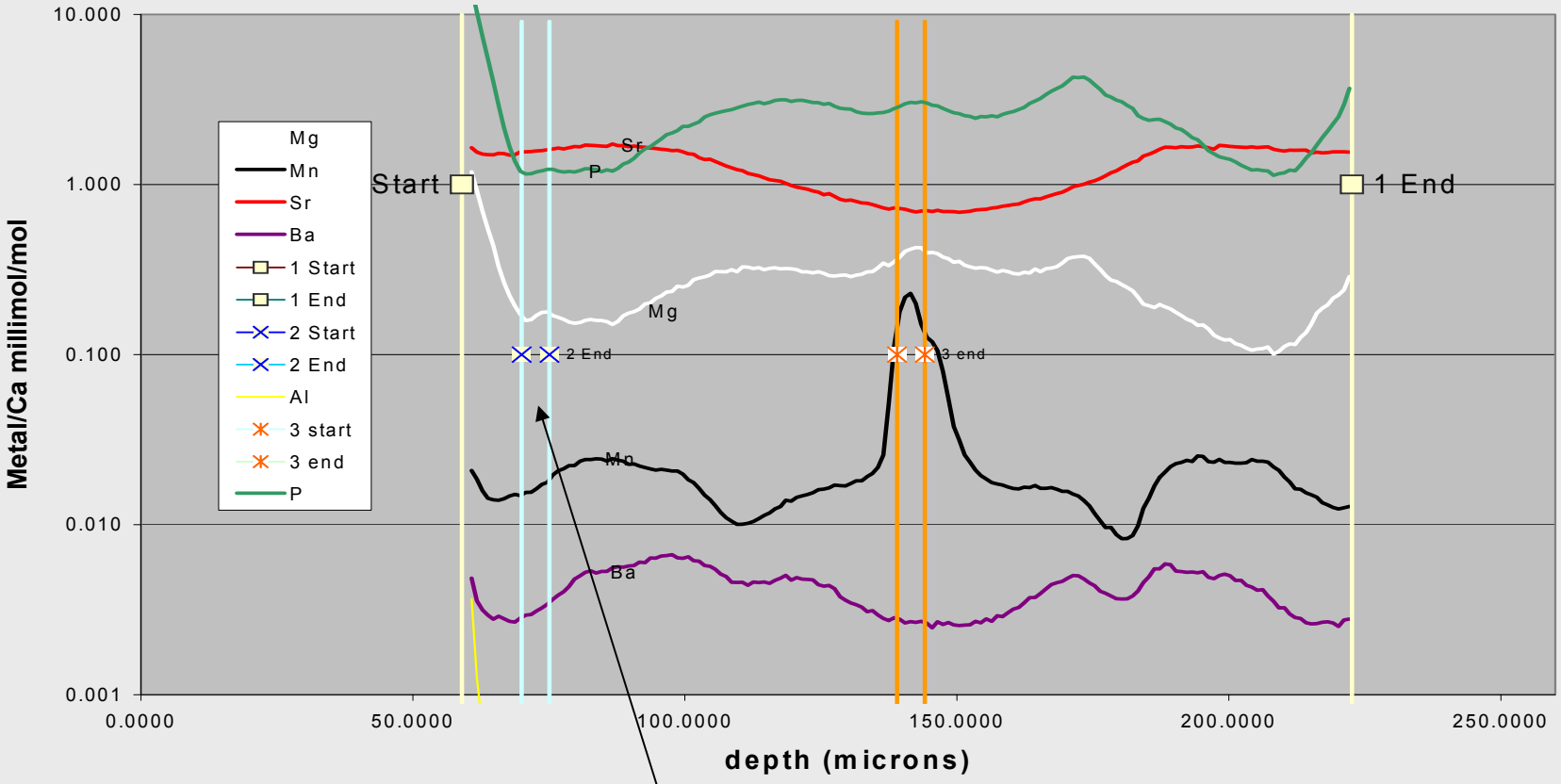

N
NEW ZEALAND
North Island
Motueka River Catchment
South Island
Graham
Baton
Motupiko
Blue Glen
Wangapeka
Dart
Rainy
Upper Motueka
0
10
20 kilometres

LA-ICPMS

(Laser Ablation Inductively Coupled Plasma Mass Spectrometry)

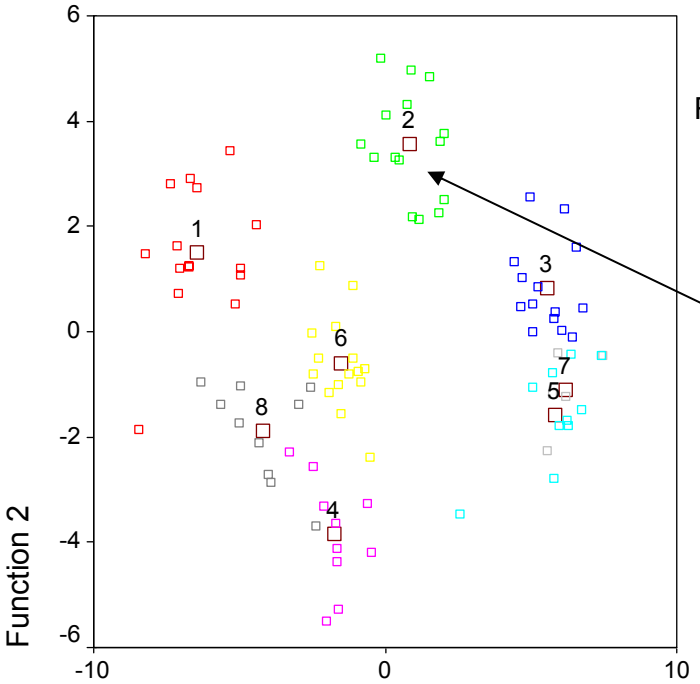
- Otolith is cleaned and placed in a sealed chamber.
- Laser beam is fired at the otolith .
- Otolith material is ablated and transferred into a mass spectrometer.
- Amount of each element determined by atomic mass .

Juvenile Profile



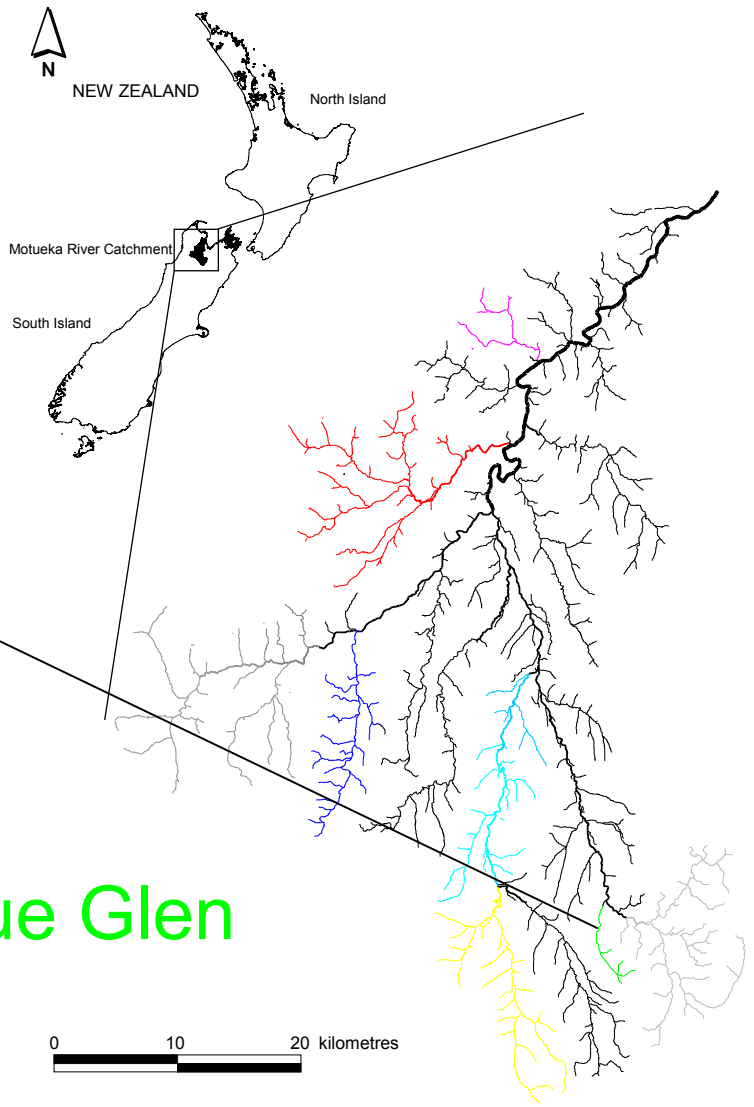
Edge Zone = Most recent otolith material = Tributary signature

Multi element fingerprint for each tributary



RIVER

- Group Centroids
- Upper Wangapek
- Upper Motueka
- Rainy
- Motupiko
- Graham
- Dart
- Blue Glen
- Baton

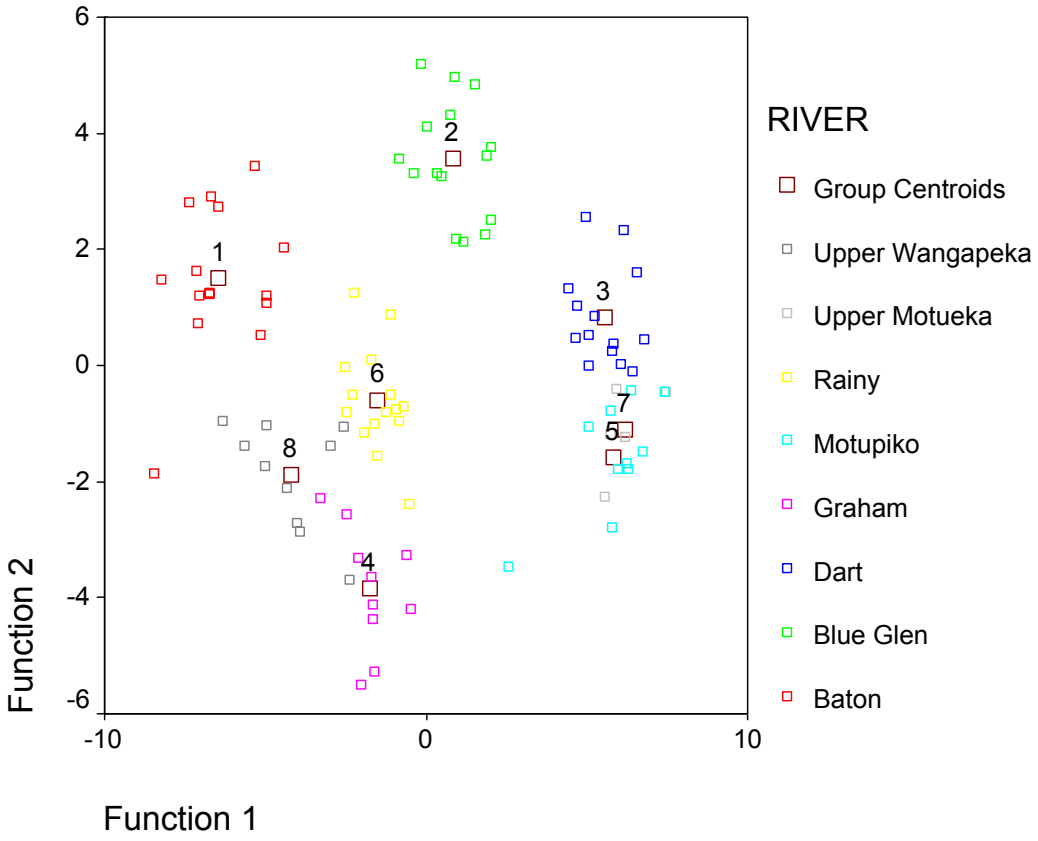


Blue Glen

Elements used: Strontium, Barium, Manganese.

Classification

Overall 94.7% of the juvenile fish correctly classified to the stream they were caught



Tributary	% Classification
Overall	94.7
Baton	93
Blue Glen	100
Dart	100
Graham	100
Motupiko	100
Rainy	100
U. Motueka	100
U. Wangapeka	60

Part 2

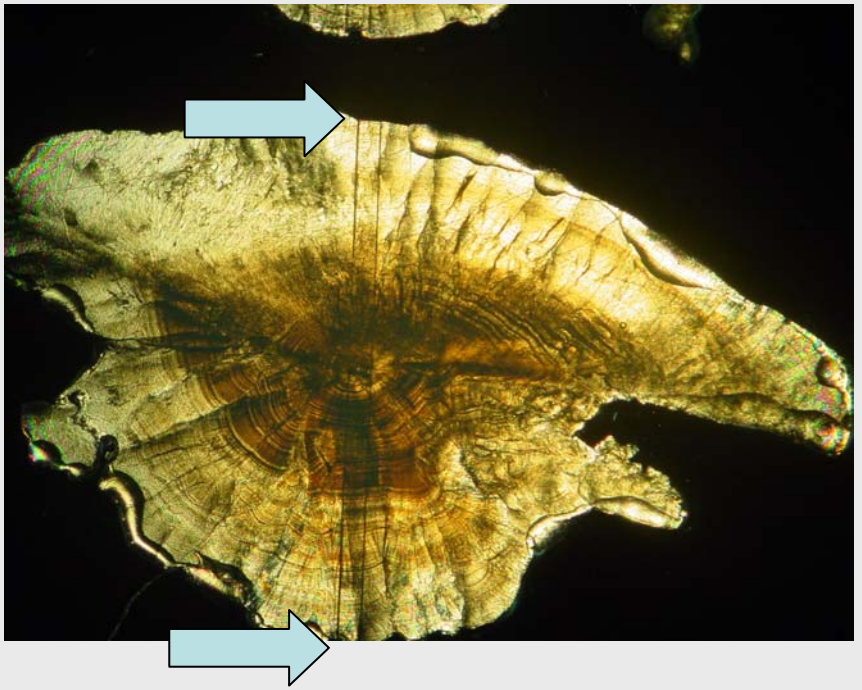
Tracing back the adult fish

Methods Overview

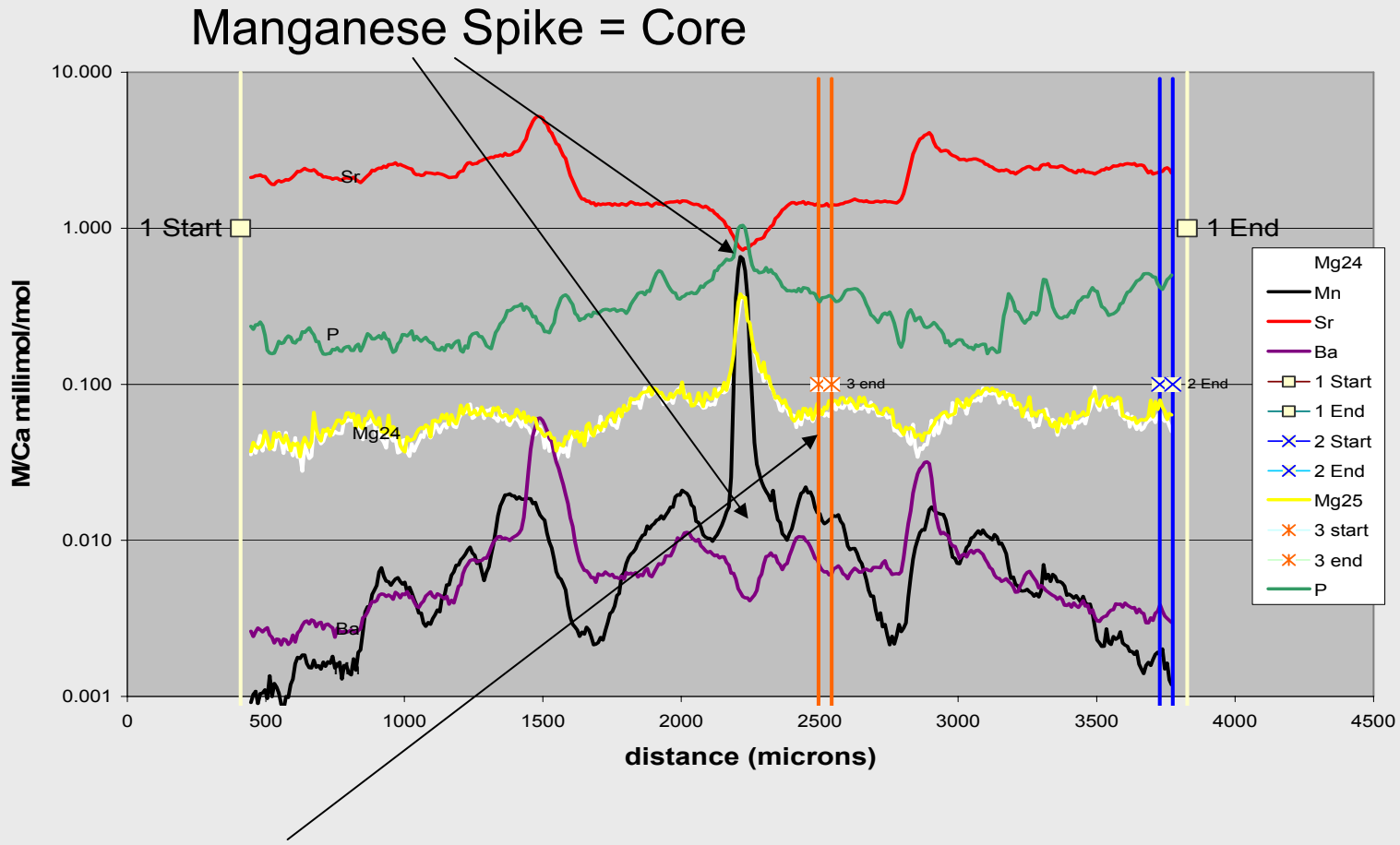
- Adult fish collected from the main stem of the Motueka River
- Elemental signatures of otoliths analysed by ICPMS
- Adults entered into the juvenile analysis as unknowns to estimate for each a likely rearing tributary.

Adult Preparation

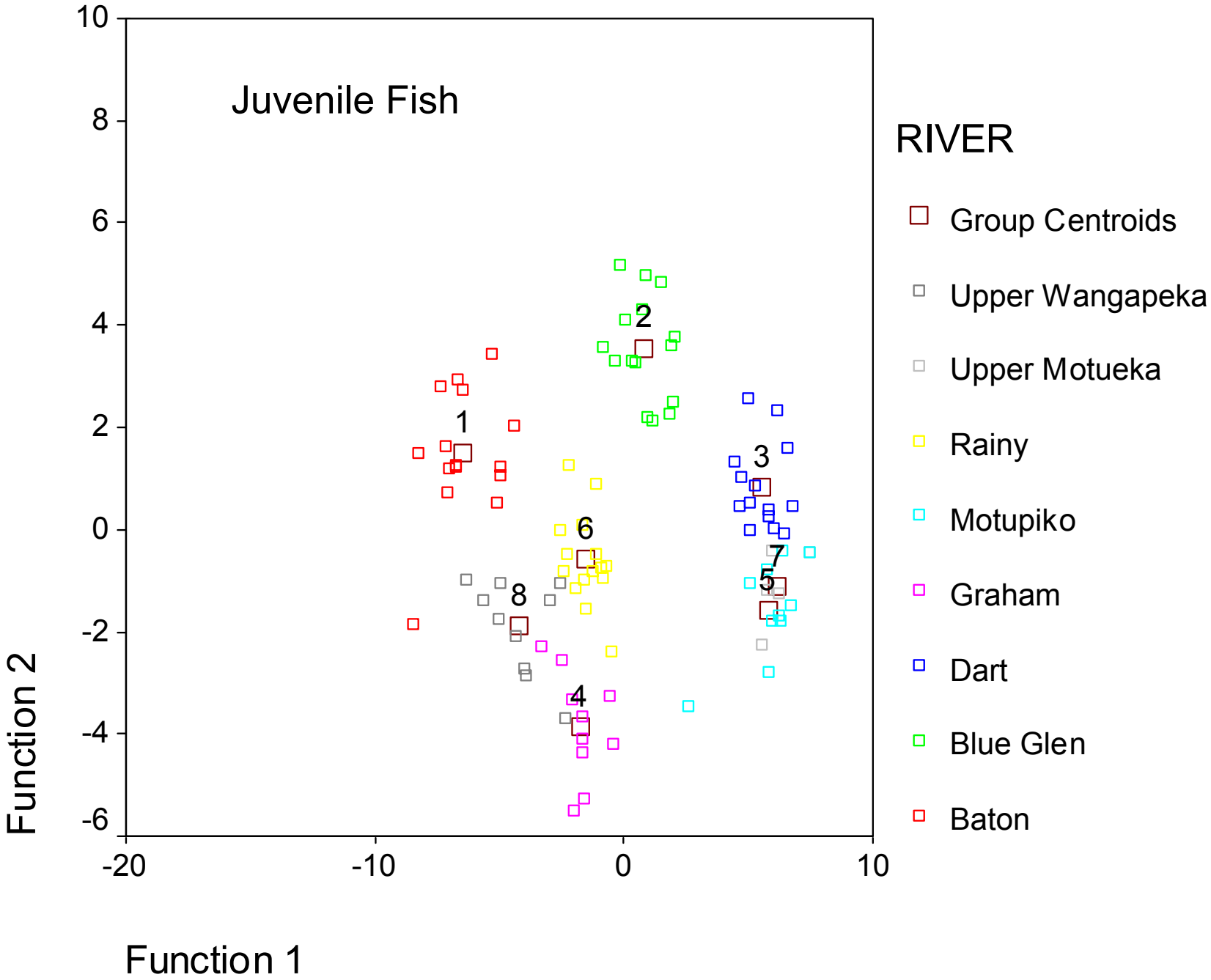
- Removed, cleaned and ground to a thin section
- Laser used to scan a transect from edge to edge through the core

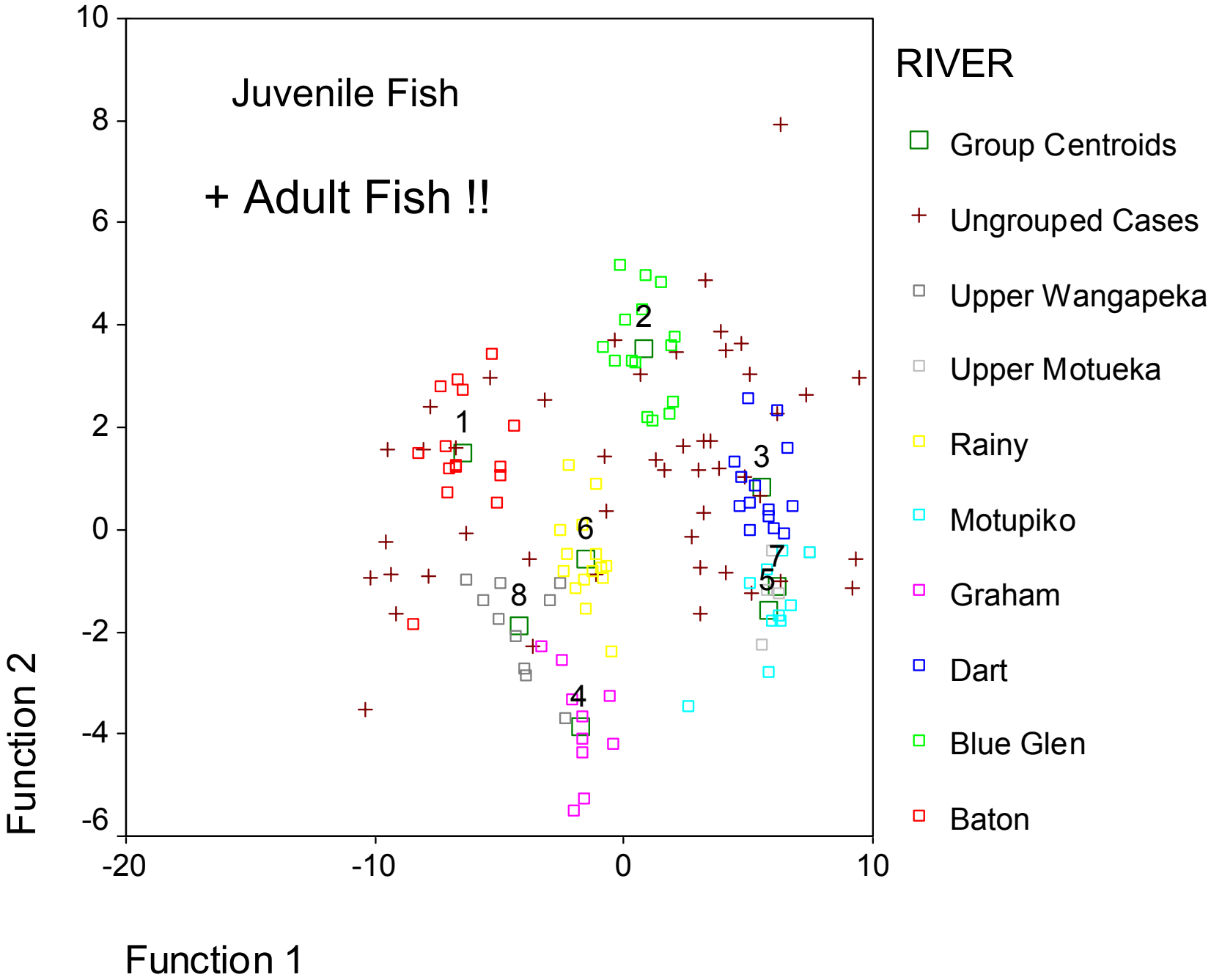


Adult Profile



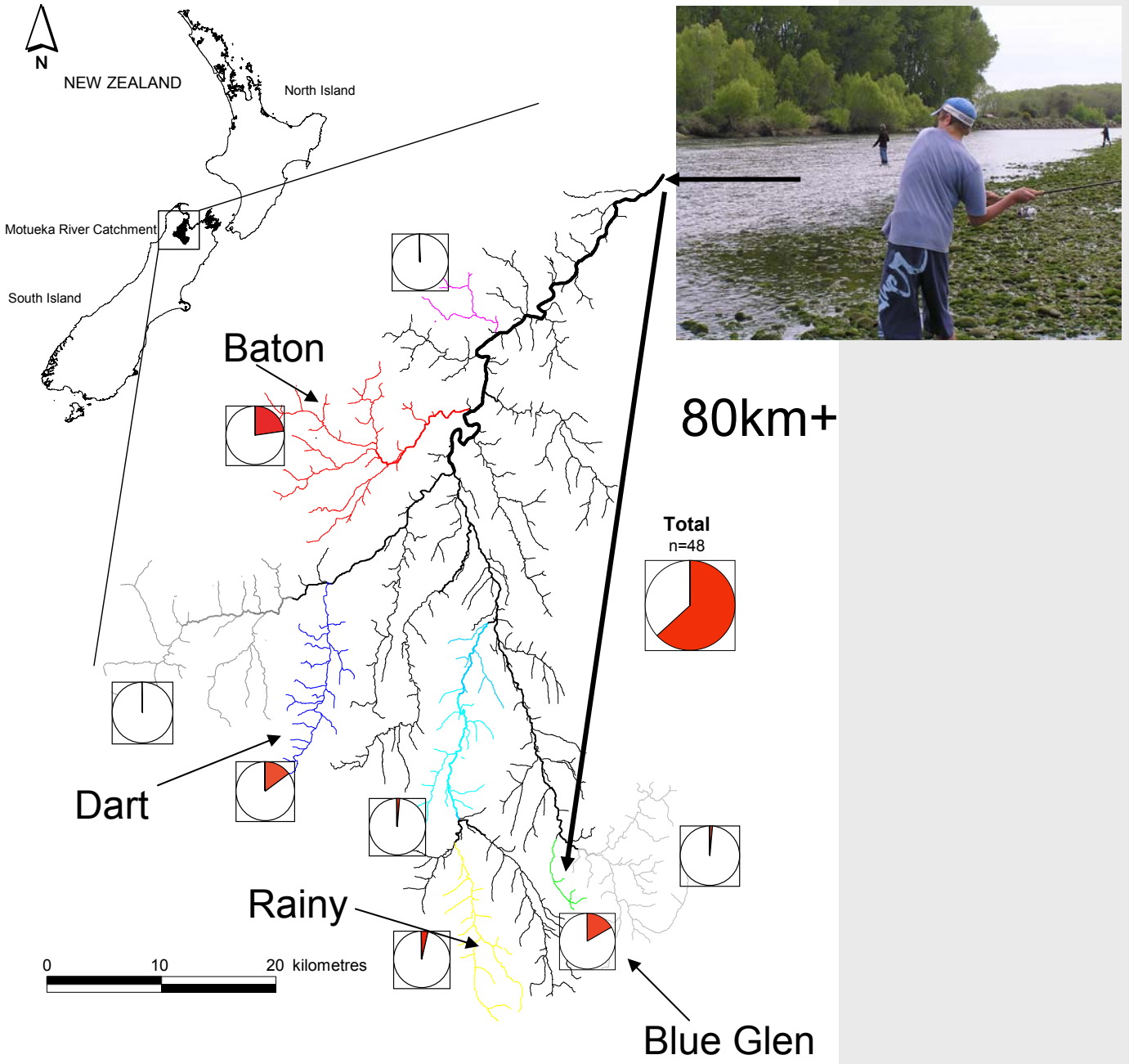
Rearing Zone = 200microns from the core


Juvenile Fish
RIVER
Group Centroids
Upper Wangapeka
Upper Motueka
Rainy
Motupiko
Graham
Dart
Blue Glen
Baton
Function 1
Function 2
10
8
6
4
2
0
-2
-4
-6
-20
-10
0
10
1
2
3
4
5
6
7
8


Juvenile Fish
+ Adult Fish !!
Function 2
Function 1
10
8
6
4
2
0
-2
-4
-6
-20
-10
0
10
1
2
3
4
5
6
7
8
RIVER
Group Centroids
Ungrouped Cases
Upper Wangapeka
Upper Motueka
Rainy
Motupiko
Graham
Dart
Blue Glen
Baton

Adults entered into the analysis as unknowns

- This gave…
  - 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


N
NEW ZEALAND
North Island
Motueka River Catchment
South Island
Baton
Dart
Rainy
Blue Glen
Total
n=48
0
10
20 kilometres
80km+

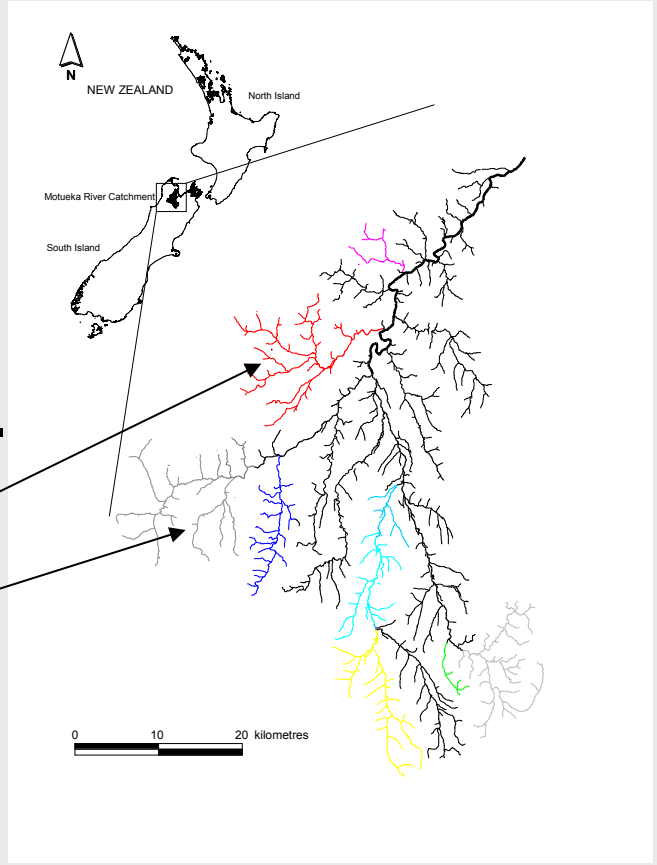
Conclusions – Motueka River

- 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)



Acknowledgements

University of Otago
Cawthron Institute, ICM Program
Lawson Davey, Nelson/Marlborough Fish and Game
Brian Weatherhead
ICPMS Lab, Australian National University
Nelson Trout Fishing Club