Out of sight, out of mind: what can otolith microstructure reveal about the New Zealand whitebait *Galaxias maculatus*?

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Galaxias maculatus (Inanga) ecology

- One of five migratory galaxiids
- Lowland coastal rivers
- Widespread distribution
- Environmental & biophysical gradients
  - Phenotypic variability

[Image of Galaxias maculatus]
[Image of lowland coastal river]
[Map of New Zealand showing rivers]
Gregarious Spawning

Spawning Fish
Amphidromy

Eggs

Marine larval development

Juveniles = “whitebait”
The Fishery

- Cultural
- Recreational
- Commercial

1kg = €50
Fishery management

“The whitebait fishery has always been a hit and miss *ad-hoc* affair” McDowall 1991

- >90% of whitebait catch is *G. maculatus*
- Multispecies fishery >10% others

Bucket jumpers!

(Galaxias brevipinnis)

(Galaxias fasciatus)
Management or mis-management?

- Multi-gear fishing pressure
- No licences
- No quotas
- Data poor
- 8000 fish in 2 minutes!!
- Sustainable?
Out of sight out of mind?

- Larval “black box”
- Legacy effects
- Anecdotal evidence of population decline
- Impedes conservation and management

Key Question

Are the larval traits of *Galaxias maculatus* populations homogenous throughout New Zealand?
Methods

- Sampling
- 3 regions
  - 3 rivers in each region
  - Fortnightly (Sept-Nov)
Otolith microstructure

Counts → Pelagic larval duration
Increment width → Growth per day (µmd⁻¹)

• Daily deposition validated
• Positive linear relationship fish length vs otolith length

Image Pro Premier

400µm

R² = .76
Size at recruitment

- **Spatial**
  - *Bay of Plenty* fish smaller at recruitment
  - Similarities between *Buller* and *Canterbury*
  - *Buller* fish 7mm larger at recruitment than *Bay of Plenty*

- **Temporal**
  - Significant differences between regions in later months
Pelagic Larval Duration

- Latitudinal
- Generally longer PLD = larger size at recruitment

Bay of Plenty 93 days
Buller 136 days
Canterbury 167 days

\[ R^2 = 0.52 \]
Hatch dates are different

- Latitudinal variation in hatch dates
- Results consistent with gonad histological studies (Hill et al 2013)
Population specific growth differs

- **Spatial variation**
  - **Bay of Plenty** highest growth rates (max 2.7µm)
  - **Buller** and **Canterbury** similar growth rates up to day 71
  - **Canterbury** lowest growth rates
Population specific growth differs

- Temporal variation
- Offset in timing of maximum growth
  - Bay of Plenty = 71-80 days
  - Buller = 111-120 days
  - Canterbury = 41-50 days
Summary

- Larval characteristics not homogenous
- Latitudinal variation
  1. Hatch dates
  2. PLD
- Spatial and temporal variation
  3. Growth rates
  4. Size at recruitment
Conclusions

• Dispersal history?
• Growth characteristics are different
  - What does this mean?
• Otolith microchemistry
  Buller and Canterbury
  - Local retention
  - Mostly dispersal
• Genetics
  - Larval durations, mixing?
  - Panmixia highly likely
Conclusions

- Environmental history
  - Growth rates
  - Metabolism
  - Larval duration
  - Legacy effects?

- Stable isotopes
- Otolith shape
- Integrated and holistic approach required
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Growth relationship

- Slope of growth is different for Bay of Plenty and Buller populations
- Buller fish achieving better condition

- But not for Buller and Canterbury