JUVENILE LIFE-HISTORY
OF FALL CHINOOK SALMON
UNDERSTANDING LIFE HISTORY EVOLUTION
IN A SPATIALLY STRUCTURED POPULATION

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NOAA
Northwest Fisheries Science Center
• What are the drivers of life history variation in salmonids?
• How does spatial heterogeneity and environment impact survival/reproduction trade-offs throughout the life-cycle?
OBJECTIVES

Snake River Fall Chinook

- Representation of juvenile yearlings within major spawning areas
- Reconstruct detailed juvenile migratory behavior using otolith microchemistry
- Model life-history decisions using otolith data in concert with other data sources.
- Understand long term changes and year-to-year variation in juvenile life history strategy.
Microchemical Signatures in Otoliths Come From Underlying Rock
LA-ICP-MS

- **Natal Signature** (100-250 microns)
- **Rearing Signature** (250-800 microns)
- **Overwinterting signature** (>800 microns)
- **Ocean Entry** (increase in strontium intensity)
Migration Reconstruction

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WATER CHEMISTRY

From Hegg et al. 2013, Oecologia
### Determining Yearling Representation

<table>
<thead>
<tr>
<th>Natal Stream</th>
<th>Subyearling</th>
<th>Yearling</th>
<th>% Yearling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Snake</td>
<td>12</td>
<td>2</td>
<td>13% *</td>
</tr>
<tr>
<td>Clearwater/Salmon</td>
<td>10</td>
<td>34</td>
<td>77% *</td>
</tr>
<tr>
<td>Lower Snake</td>
<td>22</td>
<td>36</td>
<td>62%</td>
</tr>
<tr>
<td>Grande Ronde/Tucannon/Imnaha</td>
<td>1</td>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>71</td>
<td></td>
</tr>
</tbody>
</table>

Percentage: 39% 61%

N = 120

From Hegg et al. 2013, *Oecologia*
Snake River Fall Chinook

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- **Reconstruct detailed juvenile migratory behavior using otolith microchemistry**
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From Hegg et al.

Rearing Location

From Hegg et al. 2013, Oecologia
OVER-WINTERING LOCATION

From Hegg et al. 2013, Oecologia
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Can we model migration timing in terms of fitness?

Stage Dependent Modeling of Steelhead out-migration

Juvenile Migration Strategies

<table>
<thead>
<tr>
<th></th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>Hatching</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>River Rearing</td>
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<tr>
<td>Reservoir Rearing</td>
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<tr>
<td>Out-migration</td>
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<td></td>
</tr>
<tr>
<td>Ocean</td>
<td></td>
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</tr>
</tbody>
</table>

Estuary?
Important Inputs

- Life Stage Survival
- Lifetime Fecundity
- Habitat Specific Bioenergetics
  - Growth
  - Food Availability
  - Temperature
What data can we get from otoliths?

- Location (trace chemical signature)
- Yearling vs. Subyearling
- Growth
  - Juvenile otoliths
  - Adult Otoliths
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✓ Understand long term changes and year-to-year variation in juvenile life history strategy.
LONG-TERM TRENDS

• Collections at Lyons Ferry
  • Otolith collections 2006-2012
  • 700-800 otoliths per season collected.

• Juvenile Otolith Collections
  • 6 – Upper Snake
  • 6 – Lower Snake
  • 6 – Grande Ronde
  • 12 – Clearwater
  • Sort-by-code juveniles (variable numbers)

• Modeling will allow us to understand year-to-year variation.
Determining hatchery origin has been difficult using otolith microchemistry.

- We have used scale analysis and presence/absence of tags to determine hatchery vs. wild origin in the past.
HATCHERY/WILD ORIGINS

- We are now able to determine hatchery origin using a suite of chemical tracers.
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HATCHERY/WILD ORIGINS

- We are now able to determine hatchery origin using a suite of chemical tracers (83%, $\hat{K} = 80.1$)

<table>
<thead>
<tr>
<th>Actual Classification</th>
<th>Tucannon</th>
<th>Clearwater</th>
<th>Lyons Ferry</th>
<th>Lower Snake</th>
<th>NPTH Early</th>
<th>NPTH Late</th>
<th>Upper Snake</th>
<th>Users Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tucannon G. Ronde Imnaha</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Clearwater</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>80%</td>
</tr>
<tr>
<td>Lyons Ferry</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>85%</td>
</tr>
<tr>
<td>Lower Snake</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>90%</td>
</tr>
<tr>
<td>NPTH Early</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>88%</td>
</tr>
<tr>
<td>NPTH Late</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>Upper Snake</td>
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<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>43%</td>
</tr>
<tr>
<td>Producers Error</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>75%</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
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ACKNOWLEDGEMENTS

• Collaborators
  • Brian Kennedy – U. of Idaho Dept. Fish & Wildlife
  • Rich Zabel – NOAA - NWFSC
  • Paul Chittaro – NOAA – NWFS
  • Debbie Milks – Lyons Ferry Hatchery Staff
  • Bill Arnsberg – Nez Perce Tribe
  • Billy Connor – USFW

• Funding
  • NOAA
  • Army Corps of Engineers