Size-selective mortality during freshwater and marine life stages of steelhead related to freshwater growth in the Skagit River, Washington

Jamie Thompson
R2 Resource Consultants, jamostomos@hotmail.com

Dave Beauchamp
Washington Cooperative Fish and Wildlife Research Unit

Follow this and additional works at: https://cedar.wwu.edu/ssec
Part of the Terrestrial and Aquatic Ecology Commons


This Event is brought to you for free and open access by the Conferences and Events at Western CEDAR. It has been accepted for inclusion in Salish Sea Ecosystem Conference by an authorized administrator of Western CEDAR. For more information, please contact westerncedar@wwu.edu.
Size-selective mortality of steelhead during freshwater and marine life stages related to freshwater growth in the Skagit River, Washington

Jamie N. Thompson  
*R2 Resource Consultants, Inc.*  
Redmond, WA

David A. Beauchamp  
*U.S. Geological Survey, Washington Cooperative Fish and Wildlife Research Unit*  
*School of Aquatic and Fishery Sciences*  
*University of Washington*
Life stages and survival of steelhead

- Embryo/alevin
- Juveniles
- Smolts
- Adults

Freshwater

Marine
Size-selective mortality

Juvenile population size-at-annuli distribution

Survived to Smolt stage
Survived to Adult stage
Questions:

- Are faster-growing juveniles more likely to survive to later stages?

- Does size matter more in certain habitats?
Steelhead were sampled as:

- **Juveniles (2011-2012; age 0-3)**
- **Smolts (2012; age 1-5)**
- **Adults (2008-2012; various ages)**
Data collection

Juveniles

Smolts

Adults

Fork length (mm)
Back-calculate size-at-annuli

\[ \text{FL} = 176.7 \times (\text{SR}) + 12.0 \]

\[ r^2 = 0.93 \]
Occurrence of size-selective mortality: 2-way ANOVA

**Annulus-1:**
- Snow > Mixed (no interaction)
- Juveniles < Smolts & Adults
- = Freshwater SSM

**Annulus-2:**
- Juveniles < Smolts < Adults
- = Freshwater & Marine SSM

**Annulus-3:**
- Juveniles & Smolts < Adults
- = Freshwater & Marine SSM
Magnitude of size-selective mortality: K-S 2 Sample Test

**Annulus-1:**
Juveniles ≠ Smolts & Adults
Low-to-moderate Freshwater SSM

**Annulus-2:**
Juveniles ≠ Smolts ≠ Adults
High Freshwater & Marine SSM

**Annulus-3:**
Juveniles ≠ Smolts ≠ Adults
High Freshwater & Marine SSM
Conclusions

1) Size at annuli-2 and -3 strongly influences survival

1) Growth in natal habitats important, but we need more detailed evaluation of habitat effects on growth and survival

1) **Usefulness:** If SSM is significant, evaluating and improving growth in freshwater habitats could be useful tool for recovery
Acknowledgements

Funding: Fidalgo Chapter of Puget Sound Anglers, Seattle City Light, Upper Skagit Indian Tribe, and Wild Steelhead Coalition

Seattle City Light
Ed Connor and Dave Pflug

University of Washington
Christian Torgersen, Mark Sorel, Bryan Donahue, Adam Hansen, Verna Blackhurst, Erin Lowery, Allison McCoy, Iris Kemp, Megsie Siple, Casey Clark

Upper Skagit Indian Tribe
Jon-Paul Shannahan, Tim Shelton, Josh Adams

Washington Department of Fish and Wildlife
Lance Campbell, Clayton Kinsel, Mara Zimmerman, Brett Barkdull, Lucinda Morrow
Measure of size-selective mortality: K-S 2 Sample Test

**Annulus-1:**
Juveniles ≠ Smolts & Adults

**Annulus-2:**
Juveniles ≠ Smolts ≠ Adults

**Annulus-3:**
Juveniles ≠ Smolts ≠ Adults
**Smolt sample** grew 22% in FL

**Adult sample** ONLY grew 16% in FL

**Smolt sample** grew 11% in FL

**Adult sample** ONLY grew 9% in FL

---

**Larger smolt = Greater marine survival**

Between final annulus and smolting...

**Smolt sample** grew 22% in FL

**Adult sample** ONLY grew 16% in FL

**Smolt sample** grew 11% in FL

**Adult sample** ONLY grew 9% in FL

---

<table>
<thead>
<tr>
<th>Precipitation Zone</th>
<th>n</th>
<th>FL at annulus-2 (mm)</th>
<th>FL at annulus-3 (mm)</th>
<th>Smolt Size (mm)</th>
<th>Adult sample</th>
<th>Smolt sample</th>
<th>Smolt sample</th>
<th>Adult sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow</td>
<td>16</td>
<td>119 ± 3</td>
<td>-</td>
<td>146 ± 2</td>
<td>130 ± 2</td>
<td>169 ± 4</td>
<td>169 ± 5</td>
<td>177 ± 8</td>
</tr>
<tr>
<td>Mixed</td>
<td>84</td>
<td>120 ± 1</td>
<td>-</td>
<td>155 ± 2</td>
<td>130 ± 2</td>
<td>174 ± 2</td>
<td>174 ± 2</td>
<td>181 ± 4</td>
</tr>
<tr>
<td>Snow</td>
<td>33</td>
<td>130 ± 2</td>
<td>-</td>
<td>159 ± 4</td>
<td>130 ± 2</td>
<td>159 ± 4</td>
<td>159 ± 4</td>
<td>181 ± 4</td>
</tr>
<tr>
<td>Mixed</td>
<td>75</td>
<td>130 ± 2</td>
<td>-</td>
<td>154 ± 2</td>
<td>130 ± 2</td>
<td>154 ± 2</td>
<td>154 ± 2</td>
<td>181 ± 4</td>
</tr>
</tbody>
</table>

---

**Smelted at age-2**

**Smolt sample**

<table>
<thead>
<tr>
<th>Precipitation Zone</th>
<th>n</th>
<th>FL at annulus-2 (mm)</th>
<th>FL at annulus-3 (mm)</th>
<th>Smolt Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow</td>
<td>16</td>
<td>119 ± 3</td>
<td>-</td>
<td>146 ± 2</td>
</tr>
<tr>
<td>Mixed</td>
<td>84</td>
<td>120 ± 1</td>
<td>-</td>
<td>155 ± 2</td>
</tr>
<tr>
<td>Snow</td>
<td>33</td>
<td>130 ± 2</td>
<td>-</td>
<td>159 ± 4</td>
</tr>
<tr>
<td>Mixed</td>
<td>75</td>
<td>130 ± 2</td>
<td>-</td>
<td>154 ± 2</td>
</tr>
</tbody>
</table>

---

**Smelted at age-3**

**Smolt sample**

<table>
<thead>
<tr>
<th>Precipitation Zone</th>
<th>n</th>
<th>FL at annulus-2 (mm)</th>
<th>FL at annulus-3 (mm)</th>
<th>Smolt Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow</td>
<td>11</td>
<td>114 ± 3</td>
<td>151 ± 4</td>
<td>169 ± 5</td>
</tr>
<tr>
<td>Mixed</td>
<td>50</td>
<td>112 ± 2</td>
<td>155 ± 3</td>
<td>174 ± 2</td>
</tr>
<tr>
<td>Snow</td>
<td>6</td>
<td>118 ± 8</td>
<td>163 ± 8</td>
<td>177 ± 8</td>
</tr>
<tr>
<td>Mixed</td>
<td>55</td>
<td>115 ± 2</td>
<td>165 ± 3</td>
<td>181 ± 4</td>
</tr>
</tbody>
</table>