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*

David A. Beauchamp  
*Washington Cooperative Fish and Wildlife Research Unit*

Follow this and additional works at: [https://cedar.wwu.edu/ssec](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 → Freshwater → Smolts → Marine → Adults

Juveniles
Size-selective mortality

Juvenile population size-at-annuli distribution

Survived to Smolt stage
Survived to Adult stage

Fork Length (mm)
Frequency (%)

Annulus-1
Annulus-2
Annulus-3
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

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

\[ r^2 = 0.93 \]

- Fork Length (mm)
- Scale Radius (mm)

Data points:
- Juveniles (643)
- Smolts (229)
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

Between final annulus and smolting...

Larger smolt = Greater marine survival

<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>Smolted at age-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smolt sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<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></td>
<td></td>
<td>120 ± 1</td>
<td></td>
<td>154 ± 2</td>
</tr>
</tbody>
</table>

| Adult sample       |     |                     |                     |                 |
| Snow               | 33  | 130 ± 2             | -                   | 159 ± 4         |
| Mixed              | 75  | 130 ± 2             | -                   | 154 ± 2         |
|                    |     | 130 ± 2             |                     | 156 ± 2         |

Smolt sample grew 11% in FL

Adult sample ONLY grew 9% in FL

| Smolted at age-3   |     |                     |                     |                 |
| Smolt sample       |     |                     |                     |                 |
| Snow               | 11  | 114 ± 3             | 151 ± 4             | 169 ± 5         |
| Mixed              | 50  | 112 ± 2             | 155 ± 3             | 174 ± 2         |
|                    |     | 113 ± 2             | 154 ± 2             | 173 ± 2         |

Adult sample ONLY grew 16% in FL

| Adult sample       |     |                     |                     |                 |
| Snow               | 6   | 118 ± 8             | 163 ± 8             | 177 ± 8         |
| Mixed              | 55  | 115 ± 2             | 165 ± 3             | 181 ± 4         |
|                    |     | 115 ± 2             | 165 ± 3             | 181 ± 3         |