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

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

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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

Fork Length (mm)

Frequency (%)
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)
Back-calculate size-at-annuli

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

\[ r^2 = 0.93 \]
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

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Upper Skagit Indian Tribe
Jon-Paul Shannahahan, 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
Larger smolt = Greater marine survival

Between final annulus and smolting...

<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>
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<td>120 ± 1</td>
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<td>120 ± 1</td>
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<td>154 ± 2</td>
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<td>Adult sample</td>
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<tr>
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<td>115 ± 2</td>
<td>165 ± 3</td>
<td>181 ± 3</td>
</tr>
</tbody>
</table>

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