Reservoir provides cool-water refuge for adult Chinook salmon in a trap-and-haul reintroduction program

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Reservoir provides cool-water refuge for adult Chinook salmon in a trap-and-haul reintroduction program

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Willamette River basin, OR (~30,000 km$^2$)
Willamette River floods

1948

1996
Willamette Valley Project

- 13 multi-purpose dams
  - Flood control
  - Hydropower
  - Irrigation
  - Water supply
Chinook Salmon

- *Oncorhynchus tshawytscha*
- Native, anadromous, cold-water species
- High ecological, economic, and social value
Chinook salmon

- Spring-run population
- Historically widespread
  - Spawn in tributaries
  - No adult fish passage at dams
- Extirpations / Declines
- ‘Threatened’
  - U.S. Endangered Species Act
Research context

• Large effort to restore Willamette River Chinook
• Historical focus: hatcheries
• Expanded: reintroduction into historic habitats
Research context

Portland: 84 Craft Beer Breweries

Foster Dam
38 m
Research context

Lower Willamette River
Foster Dam, S. Santiam River
SPAWNING

Mean daily temperature (°C)

Chinook salmon body temperatures

Keefer et al. 2015 (J Therm Biol)
Research context

- Long migration (~420 km), long residency time
- Exposure to warm water temperatures...
- Adult prespawn mortality

EGGS

Chinook salmon 450 site years

Bowerman et al. 2016 (Fisheries)
Research context

Prespawn mortality of Chinook salmon above Foster Dam

- Temperature effect on mortality
  - Mean = 28%
  - Hatchery salmon effect

DeWeber et al. 2017 (N Am J Fish Manage)

Bowerman et al. 2018 (Trans Am Fish Soc)
Reservoir release study hypotheses

- Releasing adult Chinook salmon into the reservoir will reduce thermal exposure
  - Prespawn holding in cold, hypolimnetic water
- Lower exposure will reduce prespawn mortality
Methods

• Collection and tagging
• Transport (2-3 h, in total)

<table>
<thead>
<tr>
<th>Year</th>
<th>River release</th>
<th>Reservoir release</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>41</td>
<td>33</td>
</tr>
<tr>
<td>2013</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>2014</td>
<td>8</td>
<td>44</td>
</tr>
<tr>
<td>2015</td>
<td>23</td>
<td>14</td>
</tr>
<tr>
<td>2017</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>102</td>
<td>160</td>
</tr>
</tbody>
</table>

‘Wild’ Chinook salmon collected and radio-tagged

Lotek Wireless transmitters:
- $46 \times 16 \text{ mm, } 16 \text{ g}$
- $61 \times 16 \text{ mm, } 23 \text{ g}$

iButton loggers
Methods

• Release timing

[Diagram showing salmon release dates from 2012 to 2017, with release times marked as 'In-river release' and 'Reservoir release'.]
Methods

- Adult salmon release sites
- Temperature monitoring
- Radiotelemetry antennas
Results

- Water temperatures

![Graph showing water temperatures over time for South Santiam River and Foster Reservoir.](image)
Results

- Salmon residency times in reservoir
  - Annual medians ~ 7, 35, 11, 93, 8 days
Results

- Salmon thermal histories

S Santiam River: warm, shallow
Middle Santiam River: cold!
Green Peter Dam: 100 m
Results

- Thermal benefits
  - 73% of reservoir-released had an estimated thermal benefit
  - Mean benefit ~107 degree days per fish

Mean daily Chinook salmon body temperature
Results

- Final distribution

![Map of Santiam River with distribution percentages]

- Salmon released in river
  - South Santiam River: 98%
  - Middle Santiam River: 2%

- Salmon released in reservoir
  - South Fork Reservoir: 51%
  - Calkins Park: 14%
  - Im Trap: 16%
  - 1% Other
Conclusions: the good

• Salmon released in the reservoir entered tributaries
• At least 70% were last detected in upstream rivers
Conclusions: the good

- Salmon used cool water refuge in reservoir
  - Extended thermoregulatory behavior
  - Presumed selection for preferred temperature range
  - Reduced cumulative and acute thermal exposure
Conclusions: the inconclusive

- Some salmon (~19%) entered the Middle Santiam
  - Historic spawning site, but current spawning unknown
- Some salmon (~14%) fell back past Foster Dam
  - Direct mortality and injury risk
  - Homing behaviors? Natal sites downstream?
Conclusions: the inconclusive

- Effect of release in reservoir on spawning success
- Much larger samples required to estimate prespawn mortality
Some take-homes

- Fish trap-and-haul may be a useful recovery strategy for migratory populations
- Reservoirs may provide thermal refuge for temperature-sensitive species
- Novel strategies + adaptive management experiments are critically needed for progress
Bibliography


https://www.uidaho.edu/cnr/fish-ecology-research-lab