Native Spring Chinook and Winter Steelhead in the Upper Willamette River Basin

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Upper Willamette Basin

- Spring Chinook and winter steelhead native upstream of Willamette Falls
- Primarily in large, eastside tributaries
- Listed under the ESA as threatened in 1999
- Coho, fall Chinook, summer steelhead introduced
- Large hatchery program for spring Chinook salmon
- Flood control dams on major spawning tributaries
- Most populous basin in Oregon
Willamette Falls Adult Passage

- Spring Chinook
- Winter Steelhead
Current status

Extinction Risk

- Very High
- High
- Moderate
- Low
- Very Low

Upper Willamette River Conservation and Recovery Plan - 2011
Desired status

Upper Willamette River Conservation and Recovery Plan - 2011
Research and Monitoring
Spring Chinook

- Spawning Surveys
  - Redd Counts
  - Carcass sampling
  - Analyze scales and otoliths
- Video Monitoring
  - Willamette Falls, upper and lower Bennett, Leaburg
- Juvenile PIT tagging studies
  - Growth and migration timing
- Seining surveys
  - Abundance
  - Distribution
Research and Monitoring
Winter Steelhead

- Spawning Surveys
  - Redd counts
  - Index reaches

- Video Monitoring
  - Willamette Falls, upper and lower Bennett

- Preliminary Juvenile PIT tagging studies
  - North and South Santiam
Adult Spring Chinook

- Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and Middle Fork
- Adults migrate April – June
- Hold in tributaries through the summer
- Spawning in September
- Most return at age-4 or age-5
McKenzie River

- Most intact tributary (~25% blocked by dams)
- Primarily wild spawners upstream of the SF McKenzie
Many life history pathways
Rearing in many different habitats

Spawning area

Movers

Leaburg/Lower McKenzie

Rearing in the Mainstem Willamette River

Stayers

Fall-winter

28%

72%

<1%

19%

24%

9%

51%

Fry migrant

Subyearling smolt

Summer migrant

Fall-winter migrant

Yearling smolt

Migration past Willamette Falls (150 + km)

Emergence starts

Fry migrant

18%

Subyearling smolt

13%

Summer migrant

Yearling smolt

25%

25%

25%

25%

25%

25%

25%

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25%
Juvenile Chinook
Winter mainstem habitat

- Floodplain within 1,000 m of main channel
- Gentle slope
- Shallow
- Vegetation

Map and images by Dave Hulse et al.
Inside bends on the mainstem

At least 1/3 gravel

Gentle slope

Can support high densities of juvenile Chinook

Map and images by Dave Hulse et al.
Juvenile Chinook
Complex Habitat and Active Channels

- Pools for larger fish
- Productive riffles
- Small side channels
- Cold water pockets
- Shallow edges for fry
- Refuge areas during floods
- Narrow channels with shade
- New gravel bars & islands

Willamette River downstream of McKenzie confluence near Green Island
Life History Variation in McKenzie Wild Spawners

- Adult scales analyzed for total age and migrant type
- Yearling migrants spend their first year rearing in the upper McKenzie River and tributaries
- Subyearling migrants leave soon after emergence, rearing in the mainstem Willamette their first summer

McKenzie Brood Years

This diversity buffers for future changes
### Variable Life History of Wild Spawners

<table>
<thead>
<tr>
<th>Spawning Tributary</th>
<th>Brood Years</th>
<th>Proportion yearlings</th>
<th>Proportion subyearlings</th>
<th>Types</th>
<th>Most Common (Total Age – migrant type)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clackamas</td>
<td>1998 - 2012</td>
<td>90%</td>
<td>10%</td>
<td>5</td>
<td>Age-5 yearling</td>
</tr>
<tr>
<td>McKenzie</td>
<td>1997 - 2012</td>
<td>79%</td>
<td>21%</td>
<td>6</td>
<td>Age-5 yearling</td>
</tr>
<tr>
<td>North Santiam</td>
<td>1998 - 2012</td>
<td>64%</td>
<td>36%</td>
<td>6</td>
<td>Age-5 yearling/Age-4 sub.</td>
</tr>
<tr>
<td>South Santiam</td>
<td>1997 - 2012</td>
<td>34%</td>
<td>66%</td>
<td>7</td>
<td>Age-4 subyearling</td>
</tr>
</tbody>
</table>

- Predominantly yearlings from cold systems
- Spawning and rearing habitat limited by dams in the North and South Santiam
- Higher percentage of subyearlings with earlier emergence
Stability in Adult Returns

- Coefficient of variation calculated for each return year by river
- Compared to total adult run size
- Observed decrease in overall population variability
Winter Steelhead

- Molalla, North Santiam, South Santiam, and Calapooia
- Adults migrate February - May
- Spawning March - May
- Most spawning in smaller tributaries
Steelhead spawning and rearing in smaller tributaries

South Santiam Basin
Juvenile steelhead

- Life history pathways are likely very complex, including a large resident population

- Rearing 1 - 3 years in spawning tributaries (most Age-2)

- Smolts migrate quickly through the mainstem in April and May
Data needs for Winter steelhead

- More consistent monitoring
- Contribution from resident *O. mykiss*
- Age composition
- Juvenile abundance and distribution
- Smolt survival
Habitat Restoration for Spring Chinook

- Continue to improve and connect habitat along the mainstem Willamette and floodplain
  - Fry, subyearlings, fall migrants, smolts
- Protect flows and cold water in the spawning tributaries
  - Adult holding and spawning, yearling life history
- Restore spawning habitat and side channels
  - Adults and yearlings (recent examples in McKenzie)
Habitat Restoration for Winter Steelhead

- Restoration projects in smaller tributaries
- Large wood and gravel
  - Spawning habitat
- Side channels and connectivity
  - Juvenile rearing, seasonal movement
- Maintain spring flows in the mainstem
  - Smolt migration
Need for Improved Dam Passage

- Much of the habitat in the large tributaries is still blocked by flood control dams
- Can greatly increase spawning habitat
- Will allow adult Chinook to hold in colder water upstream before spawning
- Can connect habitat for both juvenile and adults
Habitat Above Dams
• 66% for spring Chinook
• 63% for winter steelhead
Potential of the Willamette

- Pieces in place for success
- Unique part of the Columbia Basin
- Lots of habitat still intact, if passage can be improved
- Great local support and interest

“The Willamette River from a Mountain” Paul Kane, 1847
Acknowledgments

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- Tom Friesen
- Cam Sharpe

http://odfw.forestry.oregonstate.edu/willamettesalmonidrme/spring-chinook
Habitat – adult winter steelhead
Recovery – habitat improvements

- Conserve current habitats for winter steelhead
- Maintain river levels to allow for migration (juvenile and adult)
- Recent examples of big restoration projects in the McKenzie creating new spawning habitat
- Maintain coldwater habitats in the tributaries for spawning and rearing
Recovery – Improved Dam Passage

Spawning Habitat Upstream of Dams*
• 72% of habitat for spring Chinook
• 39% of habitat for winter steelhead

*Upper Willamette River Conservation and Recovery Plan
Fry Dispersal

- Wide range of emergence timing
- Fry first caught in McKenzie January
- Fry dispersed throughout the Willamette by late February
- Peak catch:
  - Lower McKenzie – February
  - Leaburg – March
  - Upper McKenzie and Horse Creek – April
Spawning Surveys

- Complete census of all available habitat
- Surveys on a 7-10 day rotation, July-Oct.
- Carcasses recovered and sampled
  - Scales
  - Otoliths
  - Length
  - Sex
  - Spawning success
Adult Scale Analysis

- Scales read for freshwater and total age
- First annulus after saltwater entry = subyearling (FW age 0)
- First annulus before saltwater entry = yearling (FW age 1)
- If FW age can’t be determined = pattern X (possible reservoir rearing)
- Summarized for each brood year after all adults returned (total age 2 through age 6)
- 50-300 scales read per return year
Length of spring Chinook salmon captured as fry (●) or juveniles (■)
Willamette and upper McKenzie rivers
Steelhead - Adult Spawners

- Adult migration conditions are favorable during the winter and spring
- Spawning takes place in upper reaches of Santiams and smaller tributaries (Thomas and Crabtree)
Migration Timing

Leaburg Dam

past Willamette Falls
River Flow During Emergence

- The proportion of subyearlings positively correlated with winter flows
- Weaker relationships with other variables (Columbia, mainstem Willamette, etc.)

![Graph showing the relationship between average winter flow and ArcSine proportion of subyearlings with an R² of 0.4342.](image-url)
### Spawning Habitat and Incubation temperatures

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<th>Spawning Tributary</th>
<th>Average Peak Emergence</th>
<th>Proportion subyearlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clackamas</td>
<td>March 23</td>
<td>10%</td>
</tr>
<tr>
<td>McKenzie</td>
<td>March 5</td>
<td>21%</td>
</tr>
<tr>
<td>North Santiam</td>
<td>February 15</td>
<td>36%</td>
</tr>
<tr>
<td>South Santiam</td>
<td>January 13</td>
<td>66%</td>
</tr>
</tbody>
</table>

- Warmer water downstream of dams leads to earlier emergence
- Spawning and rearing habitat limited by dams
- Higher percentage of subyearlings with earlier emergence
• Adult spawners age-5 that migrated as yearlings the most common type
Summary

- Some fry begin moving soon after emergence, to lower tributaries, the Willamette, and the estuary
- Smolts begin to migrate around 100 mm FL
- 82% of PIT tagged juveniles migrate as yearlings; 18% as subyearlings
- The floodplain in the lower Willamette provides additional rearing habitat
- Many life history types spend some time rearing in the Columbia River estuary
Summary (continued)

- Proportions of life history types varies by spawning population and by year

- Freshwater conditions can affect life history expression from year to year

- Incubation temperatures and available freshwater habitat affect life history expression

- Portfolio effect with multiple life histories that stabilize adult returns
Future Research and Challenges

- Increase sampling the lower Willamette River

- Smolt to Adult Return (SAR) survival estimates
  - By life history?
  - By brood year?

- Survival in different mainstem reaches

- Abundance of wild Chinook in the McKenzie
Spawning area

Movers

Willamette River rearing

Subyearling smolt

Fry migrant

Migration past Willamette Falls

Fry migrant

Subyearling smolt

Summer migrant

Fall-winter migrant

Yearling smolt

Stayers

Fall-winter

Spring

Precocial

2-year smolt

Other Scale patterns ---- ?