Species and Habitat Studies: Behavior and Movement of Adult Spring Chinook Salmon

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Outline

• 2014 and 2015 radiotelemetry studies
  o River conditions
  o Movements and distribution
  o Water temperature exposures

• Caveats

• Data gaps and uncertainties

Note: 2015 report of research just released and available on-line (https://pubs.er.usgs.gov)
River Conditions: Temperature

Water temperature of Chehalis River at Porter, WA

- 2009: fish kill
- 2014: evaluation
- 2015: evaluation

Temperature (°C)

Month

March April May June July August Sept. October
River Conditions: Discharge

Mean daily discharge at Grand Mound, WA 2006-2015

2014 releases

2015 releases

Daily Mean Discharge (cfs)

May

June

July

August

Sept.

October

2006

2007

2008

2009

2010

2011

2012

2013

2014

2015
River Conditions: Summary

• 2009
  o Observed fish kill in late July to early August
    • About 100 dead fish (Chehalis R. and lower Newaukum R.)
    • Temperatures above 21°C where fish were found
      o Peak temperatures (Porter) in July but not exceptional (< 21°C)
      o Typical low summer flows

• 2014
  o Temperatures >21°C from mid-June to early August (~ 6 wks)
  o Typical low summer flows

• 2015
  o Warmest year in record
  o Temperatures >21°C from early June to early August (~ 8 wks)
  o Typical low summer flows
2014–2015 Telemetry Summary

- Temperature-sensitive tag used in both years
- Focusing on Chehalis R. fish (n=11 in 2015)
- **Newaukum R:** fish captured, released, and remained in Newaukum R. (report has a lot of detail on movements, fate)

<table>
<thead>
<tr>
<th>STUDY YEAR</th>
<th># FISH RELEASED</th>
<th>LOCATION</th>
<th>TELEMETRY MONITORING</th>
<th>WATER TEMPERATURE MONITORING</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 Pilot</td>
<td>12</td>
<td>Chehalis R.</td>
<td>Array of fixed-location sites</td>
<td>Limited</td>
</tr>
<tr>
<td>2015</td>
<td>23 (11)</td>
<td>Chehalis R.</td>
<td>Fixed-location sites AND mobile tracking</td>
<td>Extensive (including bathythermograph surveys)</td>
</tr>
</tbody>
</table>
2014–2015 Movements & Fates

• 2014
  o 8 fish (67%) likely did not spawn
    • 3 spit/mort, 2 unknown, 1 harvested, 2 pre-spawn mortality (mouth of Skookumchuck R.)
  o 4 fish (33%) likely spawned
    • 1 in Newaukum R.
    • 2 in South Fork Newaukum R.
    • 1 in Skookumchuck R. (RM 22)

• 2015
  o 8 fish (73%) likely did not spawn
    • 2 spit/mort, 3 unknown, 3 pre-spawn mortality (Cedar Cr, NF New R)
  o 3 fish (27%) very likely spawned
    • 1 in Newaukum R.
    • 1 in North Fork Newaukum R.
    • 1 at mouth of Skookumchuck R.
Limited Summer Movements: 2014

- Mouth of Skookumchuk River
- Mouth of Newaukum River

Chart showing movements along the Chehalis River from June to November, with markers for different months and river mile markers.
Limited Summer Movements: 2015

River mile on Chehalis River

Newaukum River
Skookumchuck River

May June July August September October

FISH 6
FISH 7
FISH 11
FISH 5
FISH 9
FISH 10
2014–2015 Movements & Fates

• Timing of large movements was related to water temperature
  o No substantial movements mid- to late-summer during peak water temperatures
  o Also seen in SF Newaukum R. fish on a smaller scale

• Fish either moved upstream shortly after release or stayed low in the system until late summer and then moved upstream

• Temperature mitigation strategy
Water Temperatures

• Newaukum and Skookumchuck Rivers consistently cooler than main stem Chehalis R.
  o Largest differences in July (max of ~ 5°C)
• Minimal evidence for temperature stratification
  o Series of deep-shallow temperature loggers
  o Deep loggers always ≤ shallow loggers
• Bathythermograph (BT) surveys conducted in 2015
  o At junctions with Skookumchuck R. and Newaukum R.
  o Monthly from May to October
  o Water temperatures and water depths
  o Better understand potential access issues at low water
BT Results: Skookumchuck R

- Tributary influences main stem May to July
- Differences in temperature between Chehalis R. and tributary up to 5°C
- Sufficient water depth to allow access throughout summer (min 0.4m, 16 inches)
BT Results: Newaukum R

- Tributary influences greatest in July to August
- Differences in temperature between Chehalis R. and tributary ~ 3°C
- Sufficient water depth to allow access throughout summer (min 0.6 m, 24.5 inches)
Newaukum R. at low water

September 9, 2016
Skookumchuck R. Influence

- June BT survey, enlarged

Temperature, °C

12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Fish and Water Temperatures

• Tagged fish not frequently detected where water temperatures exceeded 21°C
  o 2015: ~5% in main stem Chehalis R. and ~2% in SF Newaukum R.

• A few examples where fish were in cool-water micro-habitats
  o Tag sensor temperature < ambient water temperature
  o 2014: 2 sites
    • Scheuber (RM 75): 31 July, 1 fish 2°C cooler + 1 fish 0.5°C cooler
    • Mouth of Skookumchuck: 16 July, 1 fish 3°C cooler + 1 fish 3.8°C cooler
  o 2015: Chehalis R near Cloquallum Cr (RM 28)
    • 19 August, fish in water 1°C cooler than ambient (near 20°C)
    • More than 12 other fish (not tagged) observed in the same area
Summary

• No tagged fish very low (Aberdeen) or very high (upstream of Newaukum R.) in the Chehalis R.

• Monitored 2 warm-water years compared to historic trends
  o Rich datasets for other applications

• Fish not commonly found in water over 21°C

• Fish used 2 temperature mitigation strategies
  o Limited large movements during peak temperatures
  o Selected sites where cool water was available
    • Large spatial scale: a reach or relatively large area (high in a tributary)
    • Micro-habitat scale: limited examples
Summary (continued)

• Tagged fish spawned in Newaukum R. (both SF and NF), and in Skookumchuck R. (and at mouth)
• Cedar Creek commonly used in 2015
• Skookumchuck R. not used in 2015 despite cool water and documented access
• Fates of tagged fish suggest that pre-spawn mortality may be an important factor
  o Assignment requires evidence of tag being removed from water (harvest, predation)
  o 27% of Chehalis R. fish
  o 42% of SF Newaukum R. fish (shallow reaches = vulnerability?)
• Tag sensor performance compromised in some cases
Caveats

• Low sample sizes of tagged fish
  o Further restricted by fish with short/incomplete detection histories
  o Limited power for inference

• 2014 was a pilot effort

• Limited inference to “typical” years based on unusual water temperature conditions

• Short residence times near fixed-site monitoring stations (esp. in 2015) restricted tag temperature sensor data collection
  o Powerful approach, but need more/different sites
Data Gaps and Uncertainties

• Cool water refugia micro-habitat availability
  o Identify sites where springs/seeps/other may be introducing cooler water
  o Special protection and restoration efforts

• What were the drivers of the 2009 fish kill?
  2015 was especially warm, but few dead fish observed

• Do our tagged fish represent typical spring Chinook salmon?
  o Difficult to assess the study fish in relation to the total run
  o Potential concerns in findings
    • Fish observed in the Newaukum R. before any released in Chehalis R.
    • No tagged fish used Skookumchuck R. in 2015 (but largest spawning population is from this sub-basin)
Questions?
2015 Study
### 2014 Fixed Sites

<table>
<thead>
<tr>
<th>Location (rm)</th>
<th>Description/Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>In the town of Cosmopolis, WA, midway between the mouths of Elliott and Mox Chuck Sloughs</td>
</tr>
<tr>
<td>33.6</td>
<td>East of the town of Rony, WA, 1 rm downriver of the mouth of the Mox Chehalis River</td>
</tr>
<tr>
<td>62.8</td>
<td>South of the town of Grand Mound, WA, 1.5 rm upriver of the mouth of Prairie Creek</td>
</tr>
<tr>
<td>69.8</td>
<td>0.15 rm downriver of the confluence of the Skookumchuck and Chehalis rivers</td>
</tr>
<tr>
<td>78.1</td>
<td>0.1 rm downriver of the confluence of the Newaukum and Chehalis rivers</td>
</tr>
<tr>
<td>91.6</td>
<td>East of the town of Ceres, WA, 0.75 rm upriver of the mouth of the South Fork Chehalis River</td>
</tr>
<tr>
<td>100.4</td>
<td>East of the town of Dryad, WA, 0.1 rm upriver of the Marcuson Creek</td>
</tr>
<tr>
<td>111</td>
<td>South of the town of Pe Ell, WA, 0.1 rm downriver of the mouth of Mahaffey Creek</td>
</tr>
</tbody>
</table>
## 2015 Fixed Sites

<table>
<thead>
<tr>
<th>River</th>
<th>Location (river mile)</th>
<th>Description/Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chehalis</td>
<td>31.4</td>
<td>Midway between the towns of Porter and Saginaw, WA, near Eaton Creek.</td>
</tr>
<tr>
<td>Chehalis</td>
<td>41.1</td>
<td>Downstream of the town of Oakville, WA, at the mouth of Cedar Creek.</td>
</tr>
<tr>
<td>Chehalis</td>
<td>58.7</td>
<td>South of the town of Rochester, WA, upstream of the mouth of Scatter Creek.</td>
</tr>
<tr>
<td>Chehalis</td>
<td>65.1</td>
<td>Downstream of the town of Galvin, WA, near Lincoln Creek.</td>
</tr>
<tr>
<td>Chehalis</td>
<td>69.8</td>
<td>0.2 river miles downstream of the confluence of the Skookumchuck and Chehalis rivers.</td>
</tr>
<tr>
<td>Skookumchuck</td>
<td>70.4</td>
<td>0.4 river miles upstream of the mouth of the Skookumchuck River.</td>
</tr>
<tr>
<td>Chehalis</td>
<td>74.8</td>
<td>Midway between the mouths of the Newaukum and Skookumchuck Rivers.</td>
</tr>
<tr>
<td>Chehalis</td>
<td>78.7</td>
<td>Newaukum River mouth.</td>
</tr>
<tr>
<td>Newaukum</td>
<td>80.3</td>
<td>1.5 river miles upstream of the mouth of the Newaukum River.</td>
</tr>
<tr>
<td>Chehalis</td>
<td>91.0</td>
<td>Upstream of the town of Millburn, WA.</td>
</tr>
</tbody>
</table>
Skookumchuck R. September
Skookumchuck R. September