Ecological Change and Resilience in Oregon’s Salmon and Columbia River Estuaries

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• What changes have occurred?
• Are these systems (and their salmon populations) resilient to future disturbance?
Salmon Ecosystem

A system of organisms and environments linked to salmon populations or groups of populations

Life History Diversity

- Fry migrants
- Subyearling migrants
- Yearling migrants
- Subyearling migrants (mid summer)
- Subyearling migrants (late summer/fall)
Salmon with subyearling life histories use all wetland types along the tidal gradient.
Estuarine habitat use by juvenile salmon is size-related

Russian Island
Columbia River estuary

Chinook Length Frequency in Wetland Channels

April
n = 155

May
n = 122

June
n = 39

July
n = 19
Tidal wetlands provide food and support growth of juvenile salmon

- Salmon feed in wetland habitats on insects and amphipods produced in these habitats
- Insects from wetlands and other shallow habitats are also a major food source of fish throughout the Col R. estuary

### Composition of Common *Oncorhynchus tshawytscha* Prey by Sampling Site

<table>
<thead>
<tr>
<th>Site</th>
<th>Composition (% Total IRI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>Corophium salmonis, Cladocera, Decapoda larvae, Osteichthys</td>
</tr>
<tr>
<td>WSI</td>
<td>Corophium spinicorne, Cladocera, Decapoda larvae, Diptera adult</td>
</tr>
<tr>
<td>PAB</td>
<td>Corophium salmonis, Cladocera, Decapoda larvae, Osteichthys</td>
</tr>
<tr>
<td>PE</td>
<td>Corophium salmonis, Cladocera, Decapoda larvae, Osteichthys</td>
</tr>
<tr>
<td>LES</td>
<td>Corophium salmonis, Cladocera, Decapoda larvae, Osteichthys</td>
</tr>
<tr>
<td>ETI</td>
<td>Corophium salmonis, Cladocera, Decapoda larvae, Osteichthys</td>
</tr>
<tr>
<td>UCC</td>
<td>Corophium salmonis, Cladocera, Decapoda larvae, Osteichthys</td>
</tr>
</tbody>
</table>

**Legend:**
- Corophium salmonis
- Corophium spinicorne
- Cladocera
- Decapoda larvae
- Diptera adult
- Osteichthys
Habitat Change Lower Columbia River Estuary

Image by: Jennifer Burke, UW
Modern wetlands

Habitat Change Lower Columbia River Estuary

Image by: Jennifer Burke, UW
The tidal river has been disconnected from its floodplain

- Overbank flows now rare and floodplain inaccessible to fish
- Reduced delivery of nutrients, organic matter, salmon prey, and structure (large wood)
- Impact on food webs

Historic: Modern:

Brubaker aerial survey lower Sauvies Island, 4 January 1934
Salmon use wetland-derived food sources in greater proportion than their estuarine abundance.

Juvenile Chinook life histories in the Columbia River been simplified

Estimated proportions of juvenile salmon life histories from historic and contemporary surveys

From Burke, 2005. Data from Rich (1920) & Dawley et al. (1985)
The Salmon River Estuary
Diked in 1960s

1952  1972

Pre-diking  Diked

Hwy 101
Salmon River Estuary Wetland and Tidal Restoration
145 ha marsh restored
Resilience of Salmon River Wetlands
Food webs supporting Salmon River Chinook are closely linked to emergent wetland sources

Juvenile Chinook Diet Composition

CTR site

May 1999
April 1999
June 1998
May 1998
April 1998

0% 20% 40% 60% 80% 100%

78 site

May 1999
April 1999
June 1998
May 1998
April 1998

0% 20% 40% 60% 80% 100%

87 site

May 1999
April 1999
June 1998
May 1998
April 1998

0% 20% 40% 60% 80% 100%

96 site

May 1999
April 1999
June 1998
May 1998
April 1998

0% 20% 40% 60% 80% 100%

- Cerat adult
- Cerat pupae
- Diptera adult
- Trichoptera adult
- Chiro adult
- Insecta adult
- Corophium spp.
- Eogammarus spp.
- Mysidae
- Fish larvae
- Nereidae
- Other

*Food webs supporting Salmon River Chinook are closely linked to emergent wetland sources.*

**Juvenile Chinook Diet Composition**
Can Life History Diversity be Restored?

Chinook Catch Salmon River Estuary

Life history diversity has expanded with increased wetland opportunity.
All juvenile life histories contribute to adult returns at Salmon River

Life histories of juvenile outmigrants (BY 2001 & 02)

<table>
<thead>
<tr>
<th>Season</th>
<th>Size Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent Fry</td>
<td>&lt; 45mm</td>
<td>7%</td>
</tr>
<tr>
<td>Spring (MAM)</td>
<td>47 – 64 mm</td>
<td>10%</td>
</tr>
<tr>
<td>Summer (JJA)</td>
<td>55 – 96 mm</td>
<td>77%</td>
</tr>
<tr>
<td>Fall (SON)</td>
<td>97 – 109 mm</td>
<td>6%</td>
</tr>
</tbody>
</table>

Juvenile life histories of returning adults (2004 RY; n=145)

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</tr>
</thead>
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<tr>
<td>Emergent Fry</td>
<td>&lt;45 mm</td>
<td>17%</td>
</tr>
<tr>
<td>Spring (MAM)</td>
<td>45-60 mm</td>
<td>14%</td>
</tr>
<tr>
<td>Summer (JJA)</td>
<td>61-95 mm</td>
<td>57%</td>
</tr>
<tr>
<td>Fall (SON)</td>
<td>&gt;95 mm</td>
<td>12%</td>
</tr>
</tbody>
</table>
Salmon and Estuary Resilience

- Management controls (dams, hatcheries, dikes) in the Columbia River have reduced the natural range of variability, modified food webs, and eroded estuary and salmon population resilience.

- Dike removal in Salmon River estuary has reinforced population and ecosystem resilience by restoring wetland functions, terrestrial and epibenthic food webs, and diversity of salmon life histories.

- It is unclear whether ecosystem processes in the Columbia River Basin are so altered that it has crossed a threshold to a persistent low-productivity regime that will be resistant to recovery.