Reproductive success of Chinook and coho salmon colonizing newly accessible habitat

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Dam removal and fish passage

What is the biological response by salmon following reconnection of previously isolated habitats?

Elwha River, WA

Cedar River, WA

White Salmon River, WA

Sandy River, OR

Deschutes River, OR

Calapooia River, OR

Rogue River, OR

Map: G. Pess
Cedar River, WA
Research objectives

1. What is the productivity of the colonizing Chinook and coho salmon populations?
   Self-sustaining?

2. What is the fitness of hatchery salmon relative to naturally spawned salmon?
   Demographic benefit vs. genetic risk tradeoff
Abundance of colonizing population

Chinook salmon

Number of salmon

0 100 200 300 400

Coho salmon

Number of salmon

0 250 500 750 1000 1250 1500

*
Molecular genetics methods

Collect tissue samples
Chinook = 99 %; coho = 94 %

Genotype salmon at 10 microsatellite DNA markers

Assign parentage using likelihood based algorithm
“Recruit” – assigned two parents from previous generation
“Stray” – no matching parents
**Coho salmon productivity**

<table>
<thead>
<tr>
<th>Year</th>
<th>Recruits per spawner</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>2.20 – 2.40</td>
</tr>
<tr>
<td>2004</td>
<td>1.09 – 1.32</td>
</tr>
<tr>
<td>2005</td>
<td>1.94 – 2.20</td>
</tr>
<tr>
<td>2006</td>
<td>2.31 – 2.54</td>
</tr>
</tbody>
</table>

*Note: females only*

The diagram shows the number of coho salmon returning to the hatchery origin, categorized by recruits and hatchery origin strays. The data is presented for the years 2003 to 2009.
Chinook salmon productivity

<table>
<thead>
<tr>
<th>Year</th>
<th>Recruits per spawner</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>0.56 – 1.13</td>
</tr>
<tr>
<td>2004</td>
<td>1.18 – 1.50</td>
</tr>
<tr>
<td>2005</td>
<td>0.75 – 1.06</td>
</tr>
</tbody>
</table>

*Note: females only*
Fitness of hatchery salmon

Relative RS = \frac{Hatchery RS}{Wild RS}

Araki et al. 2007 Science
Hatchery Chinook salmon

Demographic benefit vs. genetic risk

- Hatchery males
- Naturally spawned males
- Hatchery females
- Naturally spawned females

Number of Chinook salmon

2003 2004 2005 2006 2007 2008 2009
Demographic benefit?

Second generation recruitment

Overall, allowing the hatchery females to spawn in 2003 - 2005 more than doubled (2.7x) the total number of second generation recruits.
## Genetic risk?

<table>
<thead>
<tr>
<th>Sex</th>
<th>Year</th>
<th>Hatchery</th>
<th>Naturally spawned</th>
<th>Rel RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>2003</td>
<td>0.74</td>
<td>1.06</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>2.84</td>
<td>4.00</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>0.74</td>
<td>0.82</td>
<td>0.90</td>
</tr>
<tr>
<td>Females</td>
<td>2003</td>
<td>1.80</td>
<td>2.50</td>
<td>0.720</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>5.47</td>
<td>3.71</td>
<td>1.47</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>5.00</td>
<td>2.42</td>
<td>2.07</td>
</tr>
</tbody>
</table>

**Generalized linear model**

RS ~ year + origin + year X origin

<table>
<thead>
<tr>
<th>Sex</th>
<th>Origin p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>&gt; 0.10</td>
</tr>
<tr>
<td>Females</td>
<td>&gt; 0.10</td>
</tr>
</tbody>
</table>

Anderson et al. 2013 *Evolutionary Applications*
Conclusions

-Chinook and coho salmon immediately colonized newly accessible habitat through natural dispersal

-Colonizing coho salmon exceeded replacement in all four cohorts, rapidly increased in abundance

-Colonizing Chinook salmon less productive than coho but still growing in abundance

-For Chinook salmon, hatchery males and females exhibited asymmetric risk-benefit trade-off
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- Heidy Barnett

**Chinook Spawning Male**
Parentage assignments

**Recruit:** salmon assigned both a mother and a father

**Stray:** salmon that did not match any single parent

**Uncertain:** salmon assigned one but not two parents

How many true recruits were mis-classified as strays?

N = 1719 juvenile coho from 5 cohorts

- 87.6 % recruits
- 9.8 % uncertain
- 2.6 % strays

How many true strays were mis-classified as recruits?

N = 267 hatchery Chinook salmon adults

- 0.4 % recruits
- 3.0 % uncertain
- 96.6 % strays