Coho salmon smolt production from constructed and natural floodplain habitats

Phil Roni¹, Sarah A. Morley¹, Patsy Garcia¹, Chris Detrick², Dave King², and Eric Beamer³

¹Watershed Program NW Fisheries Science Center
²Washington Department of Fish and Wildlife
³Skagit System Cooperative

Floodplain & Off-channel Habitats

• Critical habitats for a variety of species

• Highly threatened by development

• Focus of many restoration activities
Critical Habitat For Coho

**Seasonality of Use**
- fry migrate into off-channel habitats in fall

**Relative Productivity**
- high portion of total basin smolt production

**Growth & Survival**
- enhanced overwinter survival and growth

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**Natural Off-Channel Habitats**

All riverine areas removed from the main channel -

Often formed on floodplains where abandoned channels are reoccupied by runoff, overflow of water from the mainstem, and/or by groundwater (Peterson & Reid 1984)

- Side channels
- Sloughs
- Beaver ponds
Common Types of Rehabilitation

- Reconnected
- Constructed Channels
- Dammed Ponds
- Gravel Pit/Mill Pound

How to design?

- Which projects effective?
  - Size,
  - Shape
  - Depth
  - Complexity
  - Other factors
Objectives

Study 1
• Use existing smolt trapping data to compare production among different types

Study 2
• Examine relationships smolts and physical variables

Study 3
• Compare natural and constructed groundwater channels

Methods – Study 1. Existing Smolt Data
• Hundreds of existing projects
• Many individual evaluations
• 70+ with smolt trapping data
Methods – Existing Smolt Data

• Coho number, density, length

• Only 30 of 70 met criteria
  – No hatchery plants
  – > 3 yrs of data
  – Data from 90s
  – No trap blowouts

Study Site Locations
Physical data

- Physical data collected/available
  - wetted area,
  - distance from saltwater (river kilometer)
  - project type
  - total basin spawner escapement

Smolt Densities

- Channels: NFC, RCT, GWC (n = 6), IMP (n = 8), GP/MP (n = 6)
- Ponds: NFC, RCT, GWC (n = 4)

> 0.05
**Smolt Size**

<table>
<thead>
<tr>
<th>Channel/Pond</th>
<th>Mean Smolt Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFC</td>
<td>n = 6</td>
</tr>
<tr>
<td>RCT</td>
<td>n = 6</td>
</tr>
<tr>
<td>GWC</td>
<td>n = 6, *p &lt; 0.05</td>
</tr>
<tr>
<td>IMP</td>
<td>n = 8</td>
</tr>
<tr>
<td>GP/MP</td>
<td>n = 6</td>
</tr>
</tbody>
</table>

**Length vs. density**

- Plot showing the relationship between average coho length and log (coho density).
- Data points for ponds and channels indicated.
- Trend line showing a negative correlation.
Smolt Length and River Km

![Graph showing average coho length against distance from saltwater (km)].

Density & distance $R^2 = 0.64$

Smolt Production & Escapement

![Graph showing mean smolt production against mean adult escapement)].

$R^2 = 0.28$
Smolt Production and Wetted Area

Multiple regression – Existing Smolt Trapping Data

Density
- Not correlated with habitat type, area, distance from saltwater, escapement

Length
- Differs by project/habitat
- 75% explained by hab. type, distance, density

Total smolt production
- Habitat (pond) area
Study 2 – Intensive surveys

Subsample + Field Survey → Mapping

n = 13

Study parameters: morphology, complexity, depth

Smolt Density and Shoreline Irregularity Index

R² = 0.27

*perimeter length/perimeter of circle of similar area
**Smolt Length and Shoreline Irregularity Index**

![Graph showing the relationship between Smolt Length and Shoreline Irregularity Index. The graph includes a linear regression line with an $R^2$ value of 0.72.](image)

**Summary of Intensive Surveys**

<table>
<thead>
<tr>
<th></th>
<th>Depth</th>
<th>Cover</th>
<th>Shoreline Irregularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0</td>
<td>0</td>
<td>Positive*</td>
</tr>
<tr>
<td>Size</td>
<td>0</td>
<td>0</td>
<td>Negative*</td>
</tr>
<tr>
<td>Smolt production</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
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</table>
Constructed Groundwater Channels?

• High fish densities

• Artificial vs. natural?

Constructed groundwater channel study

Objective: compare differences in constructed and naturally side channels in terms of -

• Morphology and physical habitat complexity

• Temperature regime and nutrient availability

• Fish and invertebrate taxa diversity and density
Methods – Groundwater channels

- **Physical Habitat**
  - morphology
  - LWD density
  - temp. regime

- **Water Chemistry**
  - nutrients
  - N & P
  - DOC

- **Fish Use**
  - taxa diversity
  - density
  - size & condition

- **Invertebrates**
  - taxa diversity
  - density
  - fish gut content
Summer

**Fish/m²**

- **Total salmonids**
  - Constructed
  - Natural/reference
  - * < 0.05
- **Coho**
  - Constructed
  - Natural/reference
  - * < 0.05
- **Trout**

Winter

**Fish/m²**

- **Total salmonids**
  - Constructed
  - Natural/reference
  - * < 0.05
- **Coho**
  - Constructed
  - Natural/reference
  - * < 0.05
- **Trout**
Benthic Invertebrates - Summer

Habitat

* < 0.05
Nutrients

![Nutrient levels graph]

Summer - temperature

![Temperature graph]

Mean Daily Temperature

- **Constructed**
- **Reference**
- **Mainstem**

<table>
<thead>
<tr>
<th>Date</th>
<th>Temperature (°C)</th>
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<tbody>
<tr>
<td>7/24/01</td>
<td>15</td>
</tr>
<tr>
<td>8/24/01</td>
<td>13</td>
</tr>
<tr>
<td>9/24/01</td>
<td>11</td>
</tr>
<tr>
<td>10/25/01</td>
<td>9</td>
</tr>
</tbody>
</table>
Summary – Groundwater Channels

Constructed channels had
– higher coho density
– lower trout density (winter only)
– lower summer temp/higher winter temp.
– deeper
– lower habitat diversity, wood, canopy cover

Overall Summary

Study 1
– Constructed = natural, no difference among types
  – Habitat size <= few hectares most productive

Study 2
– Shoreline irregularity important

Study 3
– Constructed groundwater >= natural
Future Research

• Survival and escapement

• Other factors
  – Temperature
  – location within basin
  – Predation
  – Other species

Design Considerations?

• Morphology
  – Shoreline irregularity
  – Channel shape

• Habitat
  – Complexity/Cover (LWD)
  – Heterogeneity/diversity
Acknowledgements

**WDFW:** B. Barkdull, C. Detrick, D. King, T. Powell

**Skagit System Co-op:** E. Beamer

**UW:** J. Hall, J. Toft, K. Rein

**WDNR:** W. Scarlett

Watershed Program for field assistance