Using PHABSIM to Investigate Effects of Altered Streamflow on Fish in the Chehalis River, Washington

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Overview

• Brief background
• Summary of results and discussion
• Key gaps and next steps
• Implications for restoration efforts
Background

• PHABSIM predicts stream depth and current velocity distributions in relation to streambed characteristics (not temperature)
• Compares distribution of these characteristics within a reach to calculate an index of habitat quality and quantity
• Produces an estimate of weighted usable area (WUA) for each species
Background

- Habitat Suitability Indices (HSIs) used with PHABSIM to identify different WUA for different species and life stages.
- HSIs describe each species and life stage habitat preferences.

Pacific lamprey rearing (Stone & Barndt 2005)
Background
Background
Background

HSIs

PHABSIM

WUA
Background

HSIs

PHABSIM

WUA

Used HEC RAS modeled flows to select/compare WUA
Species Assessed

(K. Brady, WDFW)

(J. Tyson, WDFW)
Species Assessed

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Species Assessed

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(J. Tyson, WDFW)
Research objectives

• The goal of this study is to employ PHABSIM to compare WUAs for select species present in the Chehalis River Basin under two stream flow conditions:

1) An average water year (WY)
2) An average WY with stream flows altered by a multi-purpose dam (MPD)
Three analyses

1. Flows that maximize WUA compared to median monthly flows for an average WY
2. Monthly baseline flow WUAs for spawning and rearing compared to MPD flows
3. Spawning and rearing WUA were combined to give overall WUA changes
Three analyses

1. Flows that maximize WUA compared to median monthly flows for an average WY
2. Monthly baseline flow WUAs for spawning and rearing compared to MPD flows
3. Spawning and rearing WUA were combined to give overall WUA changes
WUA under modeled baseline flows

<table>
<thead>
<tr>
<th>Species</th>
<th>Elk Creek to SF Chehalis</th>
<th>SF Chehalis to Newaukum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific (S)</td>
<td>- - - - - -</td>
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</tr>
<tr>
<td>Lamprey (R)</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Largemouth (S)</td>
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<td>- - - - - -</td>
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<tr>
<td>Bass (R)</td>
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<td></td>
</tr>
<tr>
<td>Smallmouth (S)</td>
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<td>- - - - - -</td>
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<tr>
<td>Bass (R)</td>
<td></td>
<td></td>
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<tr>
<td>Speckled dace (R)</td>
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</tr>
<tr>
<td>Largescale (S)</td>
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<td>- - - - - -</td>
</tr>
<tr>
<td>Sucker (R)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Western toad (R)</td>
<td>- - - - - -</td>
<td>- - - - - -</td>
</tr>
<tr>
<td>Mountain (S)</td>
<td>- - - - - -</td>
<td>- - - - - -</td>
</tr>
<tr>
<td>Whitefish (R)</td>
<td>- - - - - -</td>
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</tr>
</tbody>
</table>

Legend:
- Median monthly flows are higher than flows that maximize WUA
- Median monthly flows are lower than flows that maximize WUA
- Median monthly flows are within 5 cfs of flows that maximize WUA
- Species not present in reach at any life stage
- Species not present in reach during this time
WUA varies by streamflow

- Pacific lamprey (s)
- Pacific lamprey (r)
- Largescale sucker (s)
- Largescale sucker (r)

Flow (cfs)
Three analyses

1. Flows that maximize WUA compared to median monthly flows for an average WY
2. Monthly baseline flow WUAs for spawning and rearing compared to MPD flows
3. Spawning and rearing WUA were combined to give overall WUA changes
Modeled median monthly flows at baseline conditions vs. with MPD

- **Elk Cr to SF Chehalis reach at baseline**
- **Elk Cr to SF Chehalis reach with dam**

**Monthly median flows (cfs)**

**X-axis**:
- Nov-07
- Jan-08
- Feb-08
- Apr-08
- Jun-08
- Jul-08
- Sep-08
### Percent changes in WUA with a MPD

| Species          | Oct | Nov | Dec | Jan | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Pacific lamprey  | (S) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Largemouth bass  | (S) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Smallmouth bass  | (S) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Speckled dace    | (R) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Largesscale sucker | (S) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Western toad     | (R) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Mountain whitefish | (S) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                  | (R) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

### Legend
- If < -20
- If 1 to 5
- If 6 to 10
- If 11 to 15
- If 16 to 20
- If >20

*Species not present in reach at life stage*
Three analyses

1. Flows that maximize WUA compared to median monthly flows for an average WY
2. Monthly baseline flow WUAs for spawning and rearing compared to MPD flows
3. Spawning and rearing WUA were combined to give overall yearly WUA changes
Estimated % change in WUA from baseline to MPD

-20  -15  -10  -5  0  5  10  15

Pe Ell to Elk Creek  Elk Creek to South Fork  South Fork to Newaukum  Newaukum to Skookumchuck  Skookumchuck to Porter

Pacific lamprey  LM Bass  SM Bass  Speckled dace*  Largescale Sucker  Mtn Whitefish  Chum  Western toad
Estimated % Change in WUA with MPD and Climate Change
Summer months only

<table>
<thead>
<tr>
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<td>Western toad</td>
</tr>
<tr>
<td>WUA (% Change from Baseline)</td>
<td>Summer months only</td>
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<td></td>
</tr>
</tbody>
</table>

- Pacific lamprey: [-10, 5]
- Largemouth bass: [5, 15]
- Smallmouth bass: [-5, 10]
- Largescale sucker: [0, 10]
- Speckled dace*: [-5, 5]
- Western toad: [-10, 0]
- Mountain whitefish: [5, -10]
What was interesting or surprising about the results?
What was interesting or surprising about the results?

• Variety of flows is favorable for the breadth of species present
• WUA increases for some species and diminishes for others
  • (i.e., spawning Pacific lamprey and mountain whitefish vs rearing Pacific lamprey)
• Dependent on the species, life stage, location, time of year
• Increased summer flows exceed flows that maximize WUA, subsequently decreasing WUA
  • Limiting aquatic habitat by increasing flow
Key gaps

- Incorporate temperature
  - Task for 2015-2017
- Validate habitat suitability for Chehalis River
  - Task for 2015-2017
- Climate change is only considered with MPD in summer months
- Substrate changes
- Reservoir impacts
Restoration of non-salmonids

• Diversity of streamflow and depths is required for diversity of species
• To better answer restoration requirements, we need to understand more about these species – i.e., habitat preferences
Acknowledgements

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