Beyond ‘do no harm’: Restoration Needs of Freshwater Mussels

River Restoration Northwest Symposium- Stevenson, WA- February 8, 2024

Presented by Laura McMullen
Additional Authors: Zee Searles Mazzacano¹, Travis Williams², Kevin MacKay¹

¹ICF, Portland, Oregon  ²Willamette Riverkeeper, Oregon City, Oregon

Contact Laura.McMullen@icf.com
Freshwater Mussels of PNW

- Floater mussels
  *Anodonta* clade

- Western pearlshell mussel
  (*Margaritifera falcata*)

- Western ridged mussel
  (*Gonidea angulata*)
“Given the integrative role of mussels in food webs and ecosystem structure, the restoration of mussels has a greater potential to generate ecosystem-scale benefits through providing beneficial interactions and enhancing ecosystem functioning.” – Eveleens & Febria (2022)
“Given the integrative role of mussels in food webs and ecosystem structure, the restoration of mussels has a greater potential to generate ecosystem-scale benefits through providing beneficial interactions and enhancing ecosystem functioning.” – Eveleens & Febria (2022)
Freshwater Mussels and Native Fish

Mussel & native host fish (primarily salmonids) life cycles intertwined

**Conservation of either can benefit both**
Decline of Pacific Northwest Freshwater Mussels

All native PNW FW mussel species have experienced some combination of range withdrawals, decline in abundance, or lack of recruitment.

Reasons for decline:
Water quality
Flow changes
Host fish declines
Restoration itself
Restoration of Freshwater Mussels

- Mussel population augmentation
- Host fish re-introduction
- Habitat restoration

Types of restoration from Eveleens and Febria (2022)
Habitat Restoration for Freshwater Mussels

▪ We do have some information on habitat preferences for mussels, but more information on habitat associations and requirements is needed.

▪ More distribution and population status information on freshwater mussels is also needed.
## Mussel Habitat Requirements

### Western Pearlshell

<table>
<thead>
<tr>
<th>Substrate &amp; flows</th>
<th>Water quality</th>
<th>Fish hosts</th>
<th>Reproductive period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobble/gravel interspersed with boulders in slow to moderate flows; in faster flows at stable bank edges and in flow refuge microhabitats; also at sand/gravel bank edges; unpredictable flow regimes can increase burying in substrate; water depths up to 3 m</td>
<td>Colder, better oxygenated water; intolerant of eutrophication, turbidity (but can be abundant in some urban streams); wide range of elevations</td>
<td>Chinook, steelhead/rainbow trout, Coho, cutthroat trout</td>
<td>Intrinsically low recruitment rate; glochidia release generally spring/summer; can vary with watershed and water temperature; can be hermaphroditic and self-fertilizing</td>
</tr>
</tbody>
</table>

Photo Cred: C.A. Searles
# Mussel Habitat Requirements

## Western Ridged Mussel

<table>
<thead>
<tr>
<th>Substrate &amp; flows</th>
<th>Water quality</th>
<th>Fish hosts</th>
<th>Reproductive period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabilized sand &amp; gravel bars, bank edges in waters 45 cm–3 m deep; may also be in coarse sand or between cobbles; lower to moderate velocity, flow refuge microhabitats</td>
<td>Cold clean water; more tolerant of softer substrates than <em>M. falcata</em>; generally low- to mid-elevation; may co-occur with <em>M. falcata</em> or <em>Anodonta</em></td>
<td>Not entirely known, include margined and shorthead sculpin, dace, northern pikeminnow</td>
<td>Gravid females found April-July</td>
</tr>
</tbody>
</table>

Photo Cred: Z. Searles Mazzacano
**Mussel Habitat Requirements**

- **Floaters (Anodonta clades)**

<table>
<thead>
<tr>
<th>Substrate &amp; flows</th>
<th>Water quality</th>
<th>Fish hosts</th>
<th>Reproductive period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft sediments; coarse sand; silt/sand/cobble; slow velocity, little shear stress; depths up to 3 m</td>
<td>Warmer, slower flows; more tolerant of sediment and/or eutrophication; seen in pools 1.7-2.2 m deep at temps up to 31°C, DO from 5-15 mg/L</td>
<td>Not entirely known, include threespine stickleback prickly sculpin, Dolly Varden, cutthroat, speckled dace, torrent sculpin, redside shiner</td>
<td>Females gravid late summer through following spring, glochidia released late fall to spring</td>
</tr>
</tbody>
</table>

**Photo Cred:** Z. Searles Mazzacano
### Habitat Overlap - Freshwater Mussels and Salmon

<table>
<thead>
<tr>
<th>Habitat Access</th>
<th>Edge Habitat</th>
<th>Substrate Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Salmonids</strong></td>
<td>Needs to be able to migrate upstream to spawning habitat</td>
<td>Benefit from shallow edge habitat for spawning and rearing</td>
</tr>
<tr>
<td><strong>Freshwater Mussels</strong></td>
<td>Host fish access improves mussel access</td>
<td>Flow refuge and ideal depths</td>
</tr>
<tr>
<td></td>
<td>Bank Stability</td>
<td>Flows</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Salmonids</strong></td>
<td>Decreases erosion that leads to fine sediment and improves channel integrity</td>
<td>Variety in flows and timing through year is important. Faster flows needed for outmigration. Also need for refuges and slower areas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Freshwater Mussels</strong></td>
<td>Provides consistent habitat, decreases fine sediment</td>
<td>Prefer slow to moderate flows; in faster flows need refuge</td>
</tr>
</tbody>
</table>
FW Mussel Restoration Treatments
Barrier Removals

Passage improvement for steelhead
Solstice Creek, CA
Photo Cred: K. MacKay
FW Mussel Restoration Treatments
Increase Bank Stability and Reduce Sedimentation

Crib wall for bank stability
Guadalupe Creek, CA
Photo Cred: K. MacKay
FW Mussel Restoration Treatments
Increase Shading/ Improve Water Temperatures

Riparian area, Johnson Creek, OR
Photo Cred: L. McMullen

Riparian area, Salmon River, OR
Photo Cred: L. McMullen
FW Mussel Restoration Treatments
Increase Coarse Substrate/Substrate Diversity
Modeling Restoration/ Protection Priorities- Mussels
Conceptual Framework

STEP 1

Host fish presence  +  Host fish abundance estimates  +  Habitat attributes important to mussels  →  Spatially-explicit habitat model for mussels
Modeling Restoration/Protection Priorities - Mussels

**Conceptual Framework**

**STEP 1**

- Host fish presence
- Host fish abundance estimates
- Habitat attributes important to mussels

→ Spatially-explicit habitat model for mussels

**STEP 2**

Iterative comparison of restoration of different areas of watershed

→ Model changes in predicted host fish abundance with restoration of each area

→ Model changes in habitat attributes important to mussels with restoration of each area

Which leads to most improvement in mussel habitat throughout the basin?
Modeling Restoration/ Protection Priorities- Mussels

Conceptual Framework

Could build from framework of Ecosystem Diagnosis & Treatment (EDT) or a similar spatial model.

STEP 1

Host fish presence + Host fish abundance estimates + Habitat attributes important to mussels → Spatially-explicit habitat suitability for mussels

STEP 2

Iterative comparison of restoration of different areas of watershed → Model changes in predicted host fish abundance with restoration of each area

Model changes in habitat attributes important to mussels with restoration of each area → Which leads to most improvement in mussel habitat throughout the basin?
Modeling Restoration/Protection Priorities - Mussels

Conceptual Framework

+ Habitat Features important to Mussels → Weighted Spatial Mussel Model
Literature Cited and Acknowledgements


Acknowledgements for Funding and Partnerships:

Oregon Watershed Enhancement Board (OWEB)
Oregon Conservation and Research Fund (OCRF)
Alice Tyler Trust
Grand Ronde Tribe
Freshwater mussels are worth our time and effort in restoration.

Contact: Laura McMullen
Laura.McMullen@icf.com