Sprague River Basin Restoration Post Project Evaluations: Lessons Learned and Future Applications

Mark R. Tompkins, P.E., Ph.D.

River Restoration Northwest, 2015
ACKNOWLEDGEMENTS

• The Klamath Tribes
  — Larry Dunsmoor, Kris Fischer, Tony LaGreca
• U.S. Fish and Wildlife Service
  — Ruth Olsen, Sue Mattenberger, Matt Barry, Damion Ciotti, Hoda Sondossi, and Jared McKee
• Oregon Watershed Enhancement Board (OWEB)
• Oregon Department of Fish and Wildlife
  — Roger Smith
• The Nature Conservancy
  — Craig Beinz and Mark Stern
• UC Berkeley
  — Carolyn Doehring, Zan Rubin, and Rashmi Sahai
• Oregon Institute of Technology
  — Michael Hughes
• Klamath Watershed Partnership
  — Ginnie Monroe, Dannette Watson, Katharine Jackson, and Nathan Jackson
• Klamath Basin Rangeland Trust
  — Shannon Peterson
• All of the private landowners who provided access to their property...
**WHAT IS A PPE?**

Success Criteria Available?

- **NO**
  - Do X, Y, Z
  - ET ASSISTANCE GROUP (ETAG)
  - EVALUATION TEAM (ET)

- **YES**
  - Pre-Project Surveys Exist?

Pre-Project Surveys Exist?

- **NO**
  - Do X, Y, Z

- **YES**
  - Design Rationale Stated?

Design Rationale Stated?

- **NO**
  - As-Built Drawings Available?

As-Built Drawings Available?

- **NO**
  - Do X, Y, Z

- **YES**
  - Monitoring Program Ongoing
ORGANIZED AROUND RESTORATION CLASS

CONCEPTUAL MODELS FOR THE SPRAGUE
<table>
<thead>
<tr>
<th>Class</th>
<th>Definition</th>
<th>Goal</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instream</td>
<td>The instream class includes project types and actions implemented in the active channel area bounded laterally by the extents of the riparian class of projects and defined by fluvial processes such as erosion, deposition, and sediment transport.</td>
<td>Maintain, create, improve, and restore more normative hydrologic, geomorphic, and sediment transport processes that create <em>instream</em> conditions and variability that better supports target and/or native aquatic plant communities and biota.</td>
<td>Channel Manipulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Habitat Creation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flow Augmentation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fish Passage Improvement</td>
</tr>
<tr>
<td>Riparian</td>
<td>The riparian class includes project types and actions implemented in the area bounded laterally by the extents of the instream and floodplain classes of projects and characterized by a gradient of hydrologic conditions from permanent inundation at the instream margin to seasonal inundation at the floodplain margin.</td>
<td>Maintain, create, improve, and restore more normative hydrologic, geomorphic, sediment transport, and biological processes that create <em>riparian</em> conditions and variability that better supports target and/or native riparian plant communities and biota.</td>
<td>Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Expansion</td>
</tr>
<tr>
<td>Floodplain</td>
<td>The floodplain class includes project types and actions implemented in the area bounded laterally by the extent of the riparian class of projects and the valley walls (or other geologic features that prevent lateral movement of floodwaters) and characterized by seasonal inundation.</td>
<td>Maintain, create, improve, and restore more normative hydrologic, geomorphic, sediment transport, and biological processes that create <em>floodplain</em> conditions and variability that better supports target and/or native riparian plant communities and biota.</td>
<td>Reconnection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Modification</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Management</td>
</tr>
<tr>
<td>Spring</td>
<td>The spring class includes project types and actions implemented directly in springs and in channels and other features that connect springs to wetlands, river channels, and other features of the landscape where local hydrology is dominated by spring flows.</td>
<td>Maintain, create, improve, and restore more normative hydrologic, geomorphic, sediment transport, and biological processes that create <em>spring</em> conditions and variability that better supports target and/or native riparian plant communities and biota.</td>
<td>Reconnection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Enhancement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Management</td>
</tr>
</tbody>
</table>
**Why PPEs in the Sprague Basin?**

- Active restoration for 25+ years
- Unclear performance

*A step towards more rigorous, data-driven restoration project development and monitoring for the Klamath Basin.*

- KBRA + KHSA + Upper Klamath Basin Comprehensive Agreement (SB 133) = more restoration to come

- *Future restoration must demonstrate success!*
WHERE?
Lost River and Shortnose Sucker

- Adults migrate upstream from Upper Klamath Lake (Lost River Suckers also spawn on the east side of Upper Klamath Lake).
- Winter/Spring storms.
- Adult spawn.
- Fry emerge and outmigrate.
- Spring snowmelt peak.
- Fry emerge downstream to Upper Klamath Lake.
- Base flow.

Flow (cfs)

Oct Nov Dec Jan Feb Mar Apr May June July Aug Sept Oct

Normal water year 2000.
THE PPE TEMPLATE

• Select Conceptual Model
• Assemble PPE Data
  – Success Criteria, Pre-Project, Design Rationale, As-Built, Post Project
• Quantify Magnitude and Certainty of Benefit
• Extract Lessons Learned
<table>
<thead>
<tr>
<th>Conceptual Model Name</th>
<th>Disturbance</th>
<th>Restoration or Enhancement Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meander Bend Cutoff</td>
<td>Meander bend cutoff initiation and progression</td>
<td>Meander bend cutoff plug</td>
</tr>
<tr>
<td>Corridor Confinement</td>
<td>Channel, riparian, and floodplain constriction</td>
<td>Levee removal, setback, and/or notching</td>
</tr>
<tr>
<td>Channel Simplification</td>
<td>Channel straightening</td>
<td>Channel relocation and/or recreation</td>
</tr>
<tr>
<td>Grazing</td>
<td>Riparian and floodplain grazing</td>
<td>Livestock management and/or vegetation planting</td>
</tr>
<tr>
<td>Diversions</td>
<td>Flow reduction and fish entrainment</td>
<td>Fish screening and diversion reduction</td>
</tr>
<tr>
<td>Springs</td>
<td>Disconnection and degradation of springs</td>
<td>Spring reconnection, enhancement, and protection</td>
</tr>
<tr>
<td>Wetlands</td>
<td>Degradation of wetlands, wet meadows, and floodplains</td>
<td>Restoration and reconnection of seasonally-inundated habitats</td>
</tr>
</tbody>
</table>
MEANDER BEND CUTOFF
The abandonment of a river channel and the formation of a new river channel, as a result of naturally-occurring geomorphic processes in meandering channels.

Localized changes in sediment erosion and deposition, and localized rearrangement of landforms in the channel, floodplain, and riparian ecosystems.

MEANDER CUTOFF PLUG
“Plugs” the channel avulsion / cutoff, and forces water and sediment through the original channel meander.

Provides off-channel aquatic and fish habitat in the downstream (unfilled) extent of the avulsion / cut-off, prevents natural geomorphic evolution of the channel form in this area.

Figure 3.2-3: Meander bend cutoff plug conceptual model
**CUTOFF BEND**

- Connected Side Channel → Oxbow Slough → Oxbow Lake → Terrestrialized Oxbow Lake

**Meander Cutoff**

- Main channel shortens, straightens, steepens
  - Reduced habitat → Incision

**Assumed Human Impact**

- Bank protection + levees prevent bank erosion and channel migration
  - Channel fixed in shorter, straighter course
  - No sediment and wood recruitment

**Natural Sequence**

- Channel migration:
  - Increase length, sinuosity reduce slope
  - Recruit sediment and wood via bank erosion
  - Meanders redevelop
  - Habitat values restored

**Permanent loss of mainstem habitat**

**New meanders**

**Channel migration**
Downs and Kondolf PPA Scale Rating

MORE

LEVEL OF INVESTMENT

FULL-TERM

MEDIUM-TERM

SHORT-TERM

ONE-SHOT

REMAINS

Project Class, Type(s), and Action(s)

Class: Instream
Type: Channel Manipulation
Action: Reverse Meander Cutoffs
Action: Levee Removal

Class: Riparian
Type: Management
Action: Grazing Management
LESSONS LEARNED

• **SITE SCALE:** Plugging meander cutoffs can lower the invert of the original meander channel.

• **BASIN SCALE:** Meander cut off projects should consider all processes contributing to meander cut offs prior to design and implementation.
CHANNEL STRAIGHTENING

Straightening a channel to reclaim land that was historically occupied by meander bend(s). Often, this was conducted to convert land into pasture, or to protect properties from actively adjusting channel meanders.

Localized changes in channel sinuosity and slope, often a catalyst for channel instability (incision / downcutting and bank erosion). Changes to channel morphology may result in a localized decrease in channel complexity, degrading aquatic habitats.

CHANNEL RECREATION AND/OR RELOCATION

“Plugs” the straightened channel, and routes water and sediment through the historical channel.

Restores the channel to its historical configuration, increasing sinuosity and decreasing slope. Restores channel complexity, and arrests localized erosion that occurred from channel straightening.
BAILEY FLAT — CHANNEL RECONSTRUCTION
Bailey Flat

Downs and Kondolf PPA Scale Rating

MORE

Full-term

Medium-term

Short-term

One-shot

Remains

LEVEL OF INVESTMENT

LESS

Project Class, Type(s), and Action(s)

Class: Instream

Type: Channel Manipulation

Action: Reconnect Old Channel

Type: Habitat Creation

Action: Construct Structures

Class: Riparian

Type: Management

Action: Planting
Figure 6.9-5: Comparison of the 2010 as-built channel cross section and our 2011 cross sections G through L. The locations of the cross sections are identified in Figure 6.9-2.
LESSONS LEARNED

• **SITE SCALE:** Channel realignment can increase complexity and improve habitat, with dynamic channel adjustment early.

• **BASIN SCALE:** Hydrologic / hydraulic connectivity of abandoned channel critical to success.
<table>
<thead>
<tr>
<th>Project Type</th>
<th>Magnitude</th>
<th>Certainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel manipulation</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Habitat creation</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Fish passage</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Riparian management</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Riparian expansion</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Floodplain reconnection</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Floodplain modification</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Floodplain management</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Spring reconnection</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Spring enhancement</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

↑ = high
| = moderate
| = low
• Systematic, data driven guide for practitioners in any phase of restoration life cycle.
• Framework for conceptual model-centered implementation of future restoration projects.
Floodplain conceptual model showing the normative condition including key processes (arrows), components (boxes), and drivers (ellipses), modified from Miller et al 2010 and Opperman 2012.