Passive Restoration Trajectory
Small, Perennial Mountain Stream after Implementation of Livestock Management and Water Conservation

Anthonie M. Holthuijzen
Sarah J. Funk
Gary L. Holmstead
IPC purchased Daly Creek in 2005 as proposed, partial mitigation for ongoing operations of the Hells Canyon Hydroelectric Project.
Daly Creek Habitat Management Area

- Located in southeastern Oregon
- Settled, ranched and farmed since the 1880s
- About 11,400 acres
  - 865 acres riparian habitat (7.6%)
- Daly Creek, a perennial stream, runs through property
Riparian Management Direction

Passive Restoration

• Passive restoration implemented in 2007
  – Passive restoration is defined as the cessation of those anthropogenic activities that cause degradation or prevent recovery
  – Identified Legacy Activities:
    • Unrestricted livestock grazing
    • Water diversion for irrigation purposes
Controlled Livestock Grazing

- Unrestricted livestock grazing ceased in 2007
- Controlled livestock grazing started in 2014
- Continued limited trespass grazing
Irrigation Water Conservation

• Discontinued irrigation of marginal uplands
  – Reduced irrigated acres from 580 to 120 acres

• Optimized irrigation water delivery
  – Changed from flood irrigation to sprinkler
  – Open ditch to pressurized system
Objective

- Assess Passive Restoration of Daly Creek over 10 years (2007-2017)
Timeline and Metrics
Riparian Vegetation And Stream Morphology After Livestock Exclusion

Literature Review General Conclusions
- Initial conditions vary considerably
- Different metrics and success criteria
- Large varied, geographic area
  - Riparian Recovery: 1-30 years
  - Stream Morphology: 30-60 years
Predictions Passive Restoration Daly Creek

- **Ground vegetation:**
  - Decrease in percent bare ground and litter
  - Increase in grass cover
- **Woody vegetation:**
  - Increase in woody cover and stem density
- Increase in stream shading
- Decrease in stream temperature
Methods – Integrated Sampling Lay-Out

• Co-Locating:
  – Stage Flow Gages (N=2; Blue)
  – Temperature probes (hobos) (N=7; Red)
  – Vegetation Monitoring Sites (N=26)
    • Stream shading (N=26; Citron)
    • Woody vegetation cover, and density (N=14; Green)

• Beaver Dams (entire reach)
Methods: Daly Creek Reaches

- **Lower Daly Creek**: straight, channelized incised channel (1.2 mi)
- **Middle Daly Creek**: moderately incised (5.8 mi)
- **Upper Daly Creek**: trespass livestock grazing, moderately incised (2 mi)
- Contrast impacts of management activities among reaches
Methods: Stream Flows

- Data collected at 30 min intervals since 2009
Methods: Instream Temperature

- Stream temperature collected at 30 min interval since 2007
- Used longest, continuous record at mouth of Daly Creek
Methods: Stream Shading

• Aerial imagery collected in 2005 (NAIP), 2009 (Low-level flight), 2013 and 2017 (Drones)

• Estimate percent stream shaded at each sample site (N=26)
Methods: Woody Cover, Stem Density, and Ground Cover

• Data collected in 2007, 2011, 2014, and 2017 at 14 sites
• Standard sampling methods to measure cover and density of woody riparian and ground cover
Results: Ground Cover

Daly Creek Entire Reach

Percent Grass Cover by Reach

Percent Litter Cover by Reach

Percent Bare Ground by Reach
Results: Woody Cover

Woody Cover Daly Creek 2007-2017

Woody Cover by Reach Daly Creek 2007-2017
Results: Woody Stem Density

Woody Stem Density Daly Creek 2007-2017

Woody Stem Density by Reach Daly Creek 2007-2017
Results: Stream Shading

- Stream shading increased more than 4-fold over 10 years
- High variability in stream shading among sites
Results: Beaver Colonization

- Beaver activity concentrated in Middle Reach
- Beaver dams quadrupled between 2013 and 2017
- 64% turnover rate

Number of Beaver Dams

Yearly Turnover Dams (%)

[Charts showing data]
Results: Average Daily Flows and Maximum Daily Temperature

Daly Creek 2007-2017
Results: Maximum Daily Water Temperature

- Maximum daily temperature (late July-early August) declined 2 °C between 2007 and 2017
- Summer (August) base flows increased from 2-4 cfs between 2012 and 2017
- During past 6 years, 4 summers in top 10 hottest years and 2 in top 20 hottest years since 1865
- Ongoing monitoring is required to determine significance of temperature trend
Results: Summary

<table>
<thead>
<tr>
<th>PREDICTION</th>
<th>Lower Reach</th>
<th>Middle Reach</th>
<th>Upper Reach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Herbaceous Vegetation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease Bare Ground</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Increase Grass Cover</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Decrease Litter</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Woody Vegetation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase Woody Cover</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Increase Woody Stem Density</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td><strong>Stream</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase Stream Shade</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Decrease Summer Max Stream Temperature</td>
<td>✓: At Mouth</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

• Integrated monitoring of biotic- and abiotic factors provides understanding of changes to riparian systems over time.

• Reach Differences:
  – Middle Reach: responded vigorously and according to expectations. Declining vigor in 2017 may be due to:
    • Incised channel
    • Cottonwoods shading willow understory
    • Heat stress during hot summers 2012-2017
    • Controlled livestock grazing starting in 2014
  – Lower Reach: initially responded favorably to passive restoration then stalled
  – Upper Reach: ongoing trespass livestock grazing stalled riparian recovery

• Water temperature decreased with increasing shade, beaver activity and summer base flows in spite of increasingly high air summer temperatures

• Riparian recovery in Middle Reach not reached full potential. This may take another 10-20 years, depending how rapidly incised streambeds fill in and reconnect to the former floodplain
Questions?
Results: Woody Species Composition

Strongest response by willows *Salix exigua* and *S. lucida* (Pacific willow) followed by *Populus trichocarpa* (black cottonwood)