Designing Effective Restoration: Guidance based on three decades of science

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Some Common Problems

- Inadequate habitat assessments
- Ecosystem processes
- Limiting factors
- Design of projects
- Prioritization of projects
- Monitoring and evaluation
- Total amount of restoration
Set Watershed Restoration Goals

Assess & Inventory Watershed Conditions

Identify Problems & Potential Actions

Select Restoration Techniques

Prioritize Restoration Actions

Design Restoration Project & Monitoring

Implement Restoration & Monitoring

Publish Results & Adaptive Management

Roni and Beechie 2013
Assessments – Identifying Problems & Actions

- Historical & Current
- Habitat loss
- Disrupted processes
  - Connectivity
  - Hydrology
  - Riparian
  - Sediment
  - Nutrients
- High Quality Habitat

Beechie et al. 2003
Broad Scale - Land Use Impacts & Processes

A. Sediment supply
   - Impairment:
     - High
     - Moderate
     - Low

B. Hydrology
   - Impairment:
     - High
     - Moderate
     - Low

C. Riparian function
   - Impairment:
     - High
     - Moderate
     - Low

D. Floodplain function
   - Impairment:
     - High
     - Low

Beechie et al. 2013
Reach Scale – local impairments

Bank Erosion

Riparian Cover

Beechie et al. 2013
Limiting Factors Analysis to Identify Restoration

Spawning habitat → Summer rearing → Winter rearing → Smolt
What Habitat is Limiting?

- Spawning
- Summer rearing
- Winter rearing

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Historical</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spawning</td>
<td>40,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Summer rearing</td>
<td>25,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Winter rearing</td>
<td>30,000</td>
<td>10,000</td>
</tr>
</tbody>
</table>
Selecting Restoration Techniques

• Restores processes or improves habitat

• Effectiveness of different techniques

• Restoration and Climate change
### Time and Duration of Restoration

<table>
<thead>
<tr>
<th>Restoration action</th>
<th>Restores Processes</th>
<th>Years till response</th>
<th>Duration of action</th>
<th>Reduce Climate $\Delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect Quality Habitat</td>
<td>Yes/No</td>
<td>0</td>
<td>50+</td>
<td>?</td>
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<tr>
<td>Barrier removal</td>
<td>Yes</td>
<td>&lt;1</td>
<td>50+</td>
<td>Yes</td>
</tr>
<tr>
<td>Floodplain connectivity</td>
<td>Yes</td>
<td>&lt;1</td>
<td>50+</td>
<td>Yes</td>
</tr>
<tr>
<td>Restore in-stream flow</td>
<td>Yes</td>
<td>&lt;1</td>
<td>50+</td>
<td>Yes</td>
</tr>
<tr>
<td>Riparian planting</td>
<td>Yes</td>
<td>25-50</td>
<td>100+</td>
<td>Yes</td>
</tr>
<tr>
<td>Road removal</td>
<td>Yes</td>
<td>10-50</td>
<td>100+</td>
<td>Unlikely</td>
</tr>
<tr>
<td>*In-stream habitat</td>
<td>No</td>
<td>1-5</td>
<td>20-30</td>
<td>Unlikely</td>
</tr>
</tbody>
</table>

Roni et al. 2013
Prioritization or Sequencing Restoration

• A variety of approaches
  – Project type
  – Location
  – Complex models
  – Multi-criteria scoring systems

• Several key steps

Roni et al. 2013
## Prioritization – Common Approaches

<table>
<thead>
<tr>
<th>Technique</th>
<th>Length treated</th>
<th>Smolts /yr</th>
<th>Cost</th>
<th>Cost/Smolt</th>
<th># Species benefiting</th>
<th>Restores process</th>
</tr>
</thead>
<tbody>
<tr>
<td>LWD placement</td>
<td>2 km</td>
<td>500</td>
<td>$100K</td>
<td>$200</td>
<td>2</td>
<td>no</td>
</tr>
<tr>
<td>Floodplain reconnection</td>
<td>1 km</td>
<td>5,000</td>
<td>$500K</td>
<td>$100</td>
<td>5</td>
<td>yes</td>
</tr>
<tr>
<td>Riparian planting</td>
<td>5 km</td>
<td>?</td>
<td>$10K</td>
<td>?</td>
<td>4</td>
<td>yes</td>
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<tr>
<td>Road removal</td>
<td>8 km</td>
<td>?</td>
<td>$750K</td>
<td>?</td>
<td>4</td>
<td>yes</td>
</tr>
</tbody>
</table>

Roni et al. 2002, Beechie et al. 2008
## Prioritization – Scoring System

<table>
<thead>
<tr>
<th>Technique</th>
<th>Length treated</th>
<th>Smolt s/yr</th>
<th>Cost</th>
<th>Cost/s molt</th>
<th># species</th>
<th>Restore process</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>LWD placement</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Floodplain reconnection</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Riparian planting</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>Road removal</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>18</td>
</tr>
</tbody>
</table>

Score of 1 to 5 – five being highest score
Restoration Design Steps

1. Problem Identification
2. Context & assessment
3. Project goals & objectives
4. Alternatives evaluation
5. Project design
6. Implementation
7. Monitoring & Evaluation

RiverRAT – Design Tool

http://www.restorationreview.com/
Steps for Designing a Effectiveness Monitoring Program

- Define project goals and objectives
- Define scale
- Define questions/hypotheses
- Determine monitoring design
- Spatial and temporal replication
- Select parameters
- Selecting sampling scheme/protocol
- Implement monitoring
Key Steps in Restoration

1. Set Watershed Restoration Goals
2. Assess & Inventory Watershed Conditions
3. Identify Problems & Potential Actions
4. Select Restoration Techniques
5. Prioritize Restoration Actions
6. Design Restoration Project & Monitoring
7. Implement Restoration & Monitoring
8. Publish Results & Adaptive Management

Roni and Beechie 2013
Key Points

• **Several Steps to Restoration Process**
  • Successful restoration requires following all of them

• **Assessment of Watershed Conditions Critical**
  • Current, historic and habitat loss
  • Limiting factors
  • High quality/functioning habitats

• **Project selection**
  • Processes, duration, longevity & climate change

• **Prioritization**
  • Multi-metric scoring systems most transparent