Guidelines for evaluation of stream and watershed rehabilitation

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Why Monitor?

- Millions spent on rehabilitation of aquatic habitats
- Assure techniques are effective
- Guide future restoration efforts
- Understand aquatic ecosystems and biota
- Best chance for field experiments
- Continued public support
Types of Monitoring

- **Status and trend**
  Annual measures of abundance, condition, etc.

- **Implementation**
  Was project implemented as planned

- **Effectiveness and validation**
  Did projects have desired physical/biological effect
  Experiments/hypothesis driven

Effectiveness Monitoring  Guidance

- Define project goals and objectives
- Define questions/hypotheses
- Define scale
- Determine monitoring design
- Select parameters
- Spatial and temporal replication
- Selecting sampling scheme/protocol
Questions/Hypotheses

Reach Scale
- What is effect of project x on local conditions or fish abundance?
- What is effect of projects like x on local conditions or fish abundance?

Watershed Scale
- What is effect of project x on watershed conditions or a salmon population?
- What is effect of a suite of projects on watershed conditions or a salmon population?

Monitoring/Study Designs

- Before After or BACI
  - Intensive
  - Extensive

- Post-treatment
  - Extensive
Example of data from Alsea Basin
(from Solazzi et al. 2000)

Years of Monitoring

Number of coho smolts

- Control Watershed
- Treatment Watershed

Before
After

Number of projects (n = 20)

BA and BACI designs
**Extensive Posttreatment Design**

Roni and Quinn 2001

- LWD placement projects
- 30 small streams
- Paired treat. & ref. Reaches
- Space for time substitution

**What is effect of projects like X on local fish abundance?**

<table>
<thead>
<tr>
<th>Species</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coho salmon</td>
<td>80%*</td>
<td>220%*</td>
</tr>
<tr>
<td>Cutthroat trout</td>
<td>30%</td>
<td>70%*</td>
</tr>
<tr>
<td>Steelhead trout</td>
<td>20%</td>
<td>70%*</td>
</tr>
<tr>
<td>Larval lamprey</td>
<td>50%</td>
<td>--</td>
</tr>
</tbody>
</table>

*< 0.05
Regression Analysis: Relationship between coho response and pool-forming LWD

![Graph showing the relationship between coho density and pool-forming LWD with an r^2 value of 0.25.]

Strengths of Monitoring Designs

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Before-after</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Int.</td>
<td>Ext.</td>
</tr>
<tr>
<td>Interannual variation</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Correlate to physical</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Results broadly applicable</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Length of monitoring</td>
<td>10+</td>
<td>1-4</td>
</tr>
</tbody>
</table>
Spatial and Temporal Replication

- How many sites?

- How many years?

Depends on - Type of Rehabilitation

Riparian planting – long term

Instream - immediate

restoration

year

smolts
Rehabilitation schedule

Gradual

All at once

Restoration

Year

BACI Design

Site 1

Site 2

Site 3

Years
Temporal variability (within site)

Among site variability (in rehabilitation response)
Power analysis to estimate sample size

- Estimate of variability
- Desired effect size
- \( \alpha = 0.05 \) (level of significance)
- \( B = 0.80 \) (1 - B = Power or ability to detect change)

Power Analysis
(among site variability)
When Selecting Parameters -

- Linked to key question/hypothesis
- Change in measurable way linked to treatment
- Have limited/manageable variability

What to monitor for various actions?

<table>
<thead>
<tr>
<th>Restoration Technique</th>
<th>habitat</th>
<th>primary</th>
<th>Inverts</th>
<th>fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culvert/Passage</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>In-stream</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Riparian</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>?</td>
</tr>
<tr>
<td>Sediment</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>?</td>
</tr>
<tr>
<td>Easements</td>
<td>X</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>All projects</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
**Common Sampling Schemes**

- Census
- Simple random
- Systematic
- Stratified random
- Line transect

**Example Large Wood Placement**

- H0 What is the average of effect of LWD placement on habitat and fish?
- Design Extensive post-treatment design
- Scale - Reach scale (paired treat. and cont.)
- Replication – spatial  n = 30
- Parameter – fish, habitat
- Sampling - census
Analysis and Reporting

- Analyze and write up data
- Publish results!!!

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