Restoration Monitoring: A Tool to Address Public Concerns?

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Presentation Outline

- Current politics/realities surrounding restoration
- Study findings investigating potential for detecting responses to restoration
- Monitoring considerations/recommendations for restoration practitioners
- National Riverine Restoration Science Synthesis (NRRSS) Project
Restoration Realities

- Substantial funds are being spent in the Columbia River Basin
  - Over $3 billion from 1985-2000 for salmon research and restoration (Botkin et al. 2000)
  - $1.5 billion from FY97-FY01 for salmon and steelhead recovery (GAO 2002)

- While project efforts are well-intended, lack of accountability and rigorous monitoring is a serious threat to the science of restoration
  - Anybody can claim anything is restoration

- Emerging backlash against restoration

- Monitoring is one component to address these realities

Monitoring Challenges

- Limited funding
  - Some agencies can fund implementation, but not monitoring

- Life cycles of target species are long compared to time frames in which management decisions are expected
  - Management focuses on implementation targets (miles of channel stabilized, # of structures installed), not long-term response

- Uncertainty of what to monitor
  - Identification and quantification of those parameters which demonstrate measurable response to restoration
Uncertainty in Ecological Restoration Monitoring

- Data sets are spatially-sparse and of short-duration.
- Detectable change from restoration is a small percentage of diurnal, seasonal, or inter-annual variability.
- Effects occur at multiple spatial and temporal scales.
- Individual restoration actions may have cumulative responses that are less predictable.

<table>
<thead>
<tr>
<th>Restoration goal</th>
<th>Typical restoration activity</th>
<th>Individual physical responses</th>
<th>Cumulative responses</th>
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<tbody>
<tr>
<td>&quot;Restore channel geometry&quot;</td>
<td>Reduce w/d</td>
<td>+</td>
<td>?</td>
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<tr>
<td>&quot;Restore channel slope and sinuosity&quot;</td>
<td>Increase length</td>
<td>-</td>
<td>?</td>
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Study Goal and Objectives

- Investigate the potential for detecting responses to active stream restoration
- Describe natural variability in physical and biological parameters
- Quantify magnitude and direction of change following restoration
Red River Study Reach

- Located in north-central Idaho; tributary to SF Clearwater River
- Lodgepole and ponderosa pine uplands
- Elevation=1280 m (4200 ft)
- Annual ppt (mostly snowmelt)=76 cm (30 in)
- Drainage area=260 km² (100 mi²)
- Bankfull discharge=16.6 cms (580 cfs)
- Alluvial pool-riffle channel; C and E types

- Channel length=4.1 km (2.5 mi)
- Slope=0.0016; sinuosity=2.7
Physical Forcing Variables Changed by Active Restoration

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<tr>
<td>Length (m)</td>
<td>3750</td>
<td>2594</td>
<td>4115</td>
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<tr>
<td>Sinuosity</td>
<td>2.4</td>
<td>1.7</td>
<td>2.7</td>
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<tr>
<td>Slope</td>
<td>0.0017</td>
<td>0.0025</td>
<td>0.0016</td>
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Study Hypotheses

**Physical parameters**

- $H_1$: $\text{Depth}_A > \text{Depth}_B$
- $H_1$: $W/D_A < W/D_B$
- $H_1$: $A^*_A > A^*_B$
- $H_1$: $D50_A > D50_B$
- $H_0$: $\text{Parameter}_A = \text{Parameter}_B$

**Biological parameters**

- $H_1$: $\text{Resident Salmonid Density}_A > \text{Resident Salmonid Density}_B$
- $H_1$: $\text{Chinook Parr Density}_A > \text{Chinook Parr Density}_B$
Physical Monitoring Variables: Hydraulic, Geomorphic, and Sediment Characteristics

Longitudinal Profile from MIKE11: Post-restoration Conditions at Bankfull Flow
Flood Area Comparison at Bankfull Discharge

|------------------------|-------------------------|

Biological Monitoring Variables: Habitat Types, Parr Snorkels, and Smolt Traps
Physical Results: Changes in Median Particle Size and Percent Fines
Biological Results: Changes in Age 0 Chinook Density

Comparison of Variability in Physical and Biological Parameters at the Project Reach
Quantification of Detectable Difference

\[ s_p^2 = \frac{v_1 s_1^2 + v_2 s_2^2}{v_1 + v_2} \]

Pooled variance: where \( v \) is degrees of freedom \((n-1)\) and \( s^2 \) is the variance of each sample [Zar 1984].

\[ n = \frac{2n_1 n_2}{n_1 + n_2} \]

Harmonic mean of two sample sizes, where \( n \) is the size of each sample [Zar 1984]

\[ \delta \geq \frac{2s_p^2}{n}(t_{\alpha, v} + t_{\beta, v}) \]

Minimum detectable difference where \( \alpha \) is the significance level, \( v \) is the degrees of freedom \( \text{df} = 2(n-1) \), \( \beta \) is the probability of a type II error, \( t_{\alpha, v} \) is the value from a one-tailed \( t \)-table with probability \( \alpha \), and \( \text{df} \), and \( t_{\beta, v} \) is the value from a one-tailed \( t \)-table with probability \( \beta \) and \( \text{df} \) [Zar 1984].

Detectable Impact as a Function of Years of Post-restoration Monitoring

![Graph showing detectable impact as a percent of pre-restoration mean over years of post-restoration monitoring for different indicators such as Age 0 chinook densities and Chinook redds.]
Detectable Impact as a Function of Years of Post-restoration Monitoring

Recommendations for Monitoring to Demonstrate Project Effectiveness

- Monitor at treatment, control, and reference sites
- Monitor as long as possible BEFORE restoration implementation
- Focus on those parameters which have high potential for detecting response and which have biological significance
Useful References


- Roper, B.B., J.L. Kershner, E. Archer, R. Henderson, and N. Bouwes. In review. An evaluation of physical stream habitat attributes used to monitor streams. USDA Forest Service. Fish and Aquatic Ecology Unit. Logan, UT.

Conclusions

- To distinguish between change due to natural variability and response induced by restoration activity, monitoring must be:
  - Initiated prior to implementation
  - Conducted at control sites (and reference sites if possible) as well as at the treatment site

- River restoration curricula and design standards should incorporate topics such as statistics, study design, and monitoring/evaluation.

- By incorporating appropriate monitoring procedures, restoration practitioners may help address some public concerns surrounding stream restoration.
Acknowledgements

- Bonneville Power Administration
- National Science Foundation (Award BES-9874754)
- Dissertation committee members: Peter Goodwin, John Buffington, Peter Bisson, Jan Boll, Piotr Jankowski
- DHI Water and Environment
- Idaho Dept. of Fish and Game
- Idaho Soil and Water Conservation District
- Lower Red River Meadow Restoration Project Technical Advisory Committee
- LRK Communications, Peter Grieve
- NSF Career Grant Summer 1999, 2000, 2001 participants
- Pocket Water, Inc.
- Professional Operator Company
- River Masters Engineering
- TerraGraphics Environmental Engineering, Inc.
- University of Idaho Ecohydraulics Research Group visiting faculty, undergraduate, and graduate students: Dr. Tony Minns, Dr. Nigel Wright, Shawkat Ali, Gloria Beattie, Ken Donley, Dave Fuhrman, Ben Hudson, Aaron Teats, Eric Walton, and Callie Weiss
- USFS Nez Perce National Forest
- Wildlife Habitat Institute

NRRSS
National Riverine Restoration Science Synthesis

M.A. Palmer (co-PI), J.D. Allan (co-PI), E.S. Bernhardt
National Coordinators

The NRRSS Project aims to provide a national level synthesis that can be used to inform policy on river restoration at local, regional, and national levels.

www.americanrivers.org/feature/riverrestoration.htm
The Scientific Team:

Northwest
Pacific NW, Interior Columbia Basin
Northern Rockies
Jenkinson, Clayton, Goodwin, Stanford, Relyea

California - Sacramento-
San Joaquin Basin
White, Boutillier, Kondolf, Merenlander

Southwest
Catchments in Rio Grande
and Colorado River Basins
Shah, Dahm, Gloss

Midwest
Missouri River
Galat

Upper mid-west
Michigan, Indiana, Wisconsin
Alexander, Allan, Gergel

Chesapeake Bay
Hassett, Bernhardt, Hart, Palmer, Paul

Southeast
Georgia, North Carolina, South Carolina, Kentucky
Sudduth, Meyers

Victoria, Australia
Brooks, Lake

What is being done in the name of restoration?
All restoration projects are experiments . . .

What is the role of science in current restoration practice?

- **Evaluate** the state of the practice of stream restoration nationally and identify factors associated with project success.
- **Examine** the links between ecological theory and stream restoration.
- **Identify** the unanswered questions meriting further research.
- **Develop** specific recommendations for implementing and evaluating stream restoration practice.
- **Disseminate** this information broadly and on an on-going basis.
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