A Review of Current Practice in Restoration Monitoring

Patricia F. McDowell
pmcd@uoregon.edu
UNIVERSITY OF OREGON

Effectiveness monitoring: the hidden crisis in restoration

- NRSSS study (Bernhardt et al., 2007 *Rest. Ecol.*)
  - Most projects have ecological goals, but ecological monitoring is rare (probably less than one-third).
- "Many opportunities to learn from successes and failures, and thus to improve future practice, are being lost."

Outline

- Scales and types of monitoring
- Six key themes in effectiveness monitoring
- Case studies
- Conclusions/recommendations

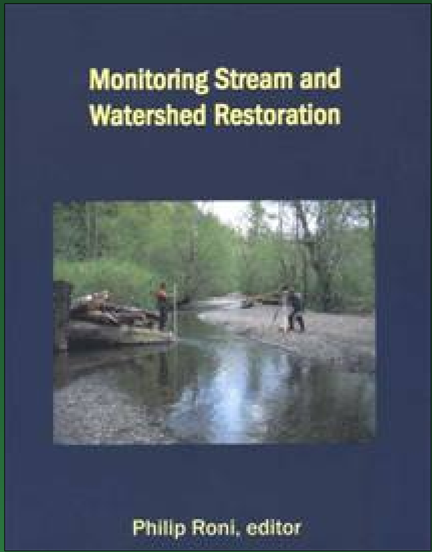

Types of monitoring

- Implementation monitoring
  - Was project built as designed?
- Effectiveness monitoring
  - Did the restoration approach have the expected direct effects?
- Validation (research) monitoring
  - Are the assumptions behind the restoration plan correct? Is the cause-and-effect model linking restoration actions and desired responses correct?

Spatial scales of monitoring

- Reach- or site-level
  - Monitor direct response to restoration design elements.
    - Are specific restoration techniques working?
    - Channel morphology, vegetation cover and structure, limited-range organisms
- Watershed-level
  - Monitor biotic response and other integrative responses to multiple restoration activities.
    - Wide-ranging organisms (salmon populations), water quality, sediment system, wood system

Many critiques and guides



1997, *Restoration Ecology*

Quantitatively Evaluating Restoration Experiments: Research Design, Statistical Analysis, and Data Management Considerations

William K. Michener[1]

Abstract

Conceptual and logistical challenges associated with the design and analysis of ecological restoration experiments are often viewed as being insurmountable, thereby limiting the potential value of restoration experiments as tests of ecological theory. Such research

proaches that support research at broader spatial and temporal scales are critical for enhancing ecological understanding and supporting further development of restoration ecology as a scientific discipline.

Introduction

The potential value of ecological restoration as a test of basic ecological theory has been previously highlighted (Bradshaw 1987; Harper 1987; Jordan et al. 1987). Harper (1987), for example, suggested that ecological science would benefit from attempts by restorationists to design and create new communities and simultaneously test ideas or answer fundamental ecological questions that arose in determining the relationship between species diversity and community stability and resilience, understanding the roles that animals and mutualists play in succession, and documenting the effects of age structure and genetic diversity of component species on community properties. Despite the multitude of resource management and scientific opportunities that are afforded by ecological restoration, only a small fraction of the hundreds to thousands of restoration "experiments" that are performed annually benefit from the combined efforts of practitioners and scientists. Resource managers, funding agencies, policy-makers, and scientists often view ecological restoration as more of an "art" than a "science," often relying upon intuition rather than a well-documented knowledge base for

Evaluating stream restoration projects

Kondolf G.M.; Micheli E.R.

1995
English Journal
Environmental Management, 19, no.1 (1995) p. 1-15

Postproject evaluation must be incorporated into the initial design of each project, ... ct goals against which performance ... cs is emphasized, as these ... uatic ecosystems....

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FORUM

Standards for ecologically successful river restoration

M.A. PALMER,* E.S. BERNHARDT,* J. D. ALLAN,† P.S. LAKE,‡
G. ALEXANDER,† S. BROOKS,‡ J. CARR,§ S. CLAYTON,¶ C. N. DAHM,**
J. FOLLSTAD SHAH,** D. L. GALAT,†† S. G. LOSS,‡‡ P. GOODWIN,¶
D.D. HART,§ B. HASSETT,* R. JENKINSON,§§ G.M. KONDOLF,¶¶
R. LAVE,¶¶ J.L. MEYER,*** T.K. O'DONNELL,†† L. ...
E. SUDDUTH***

**Department of Entomology, University of Maryland, USA and Department of ... †School of Natural Resources, University of Michigan, USA; ‡Department of ... University, Australia; §Patrick Center for Environmental Research, Academy of ... ¶Ecohydraulics Research Group, University of Idaho, USA; **Department of ... USA; ††US Geological Survey, Cooperative Research Units, Department of Fishe... of Missouri, USA; ‡‡Grand Canyon Monitoring and Research Center, USA; §§... Resources, University of Idaho, USA; ¶¶Department of Landscape Architecture ... University California, USA; and ***Institute of Ecology, University of Georgia,*

Summary

1. Increasingly, river managers are turning from hard engineeri... cally based restoration activities in order to improve degraded ... ration projects aim to maintain or increase ecosystem goo... protecting downstream and coastal ecosystems. There is growi...

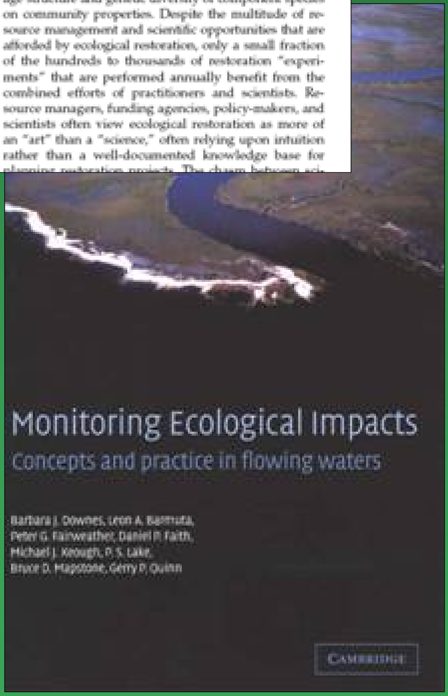
Montgomery, 2003, *Restoring Puget Sound Rivers*

9. Putting Monitoring First: Designing Accountable Ecosystem Restoration and Management Plans

Stephen C. Ralph and Geoffrey C. Poole

Abstract

Recovery of Puget Sound rivers and their native fish fauna will depend upon carefully documenting the ultimate effectiveness of restoration actions. Yet, as currently designed and implemented, monitoring programs are predestined to fail in this task. Consequently, our attempts to implement iterative, adaptive



And others….

The vicious cycle of inadequate monitoring

- Most projects are not monitored.
- Much monitoring is not disseminated.
- Bias is toward success -- failures usually not reported.
- No common standards exist for how to monitor.
- We are not learning from errors and are doomed to repeat them.

Lack of funding for monitoring

- Funders won’t pay for monitoring.
  - Keeps us from “doing it right”.
- Restoration scientists and managers often leave monitoring plan (and funding) to the end of planning process.
- Need to change the mindset of both the restoration profession and the funders of restoration.

Lack of funding for monitoring

- Need to make monitoring plans as efficient as possible while still getting the job done.

1. Use holistic approach in restoration design and monitoring

- “The design of an ecological river restoration project should be based on a specified guiding image of a more dynamic, healthy, sustainable river that could exist at the site.” (Palmer et al. 2005)
- Design to restore ecosystem processes and functions, as far as possible.
- Monitor ecosystem processes and functions.

2. Monitor to address specific project objectives

- Monitoring should answer specific questions related to the objectives of the project.
  - Leads to focus, efficiency, transparency, accountability
- Implication: Objectives should be <u>monitorable.</u>
  - And usually quantifiable.
  - Performance standards or desired future conditions for evaluating success may be used to evaluate success.

Conflict between holistic approach and specific objectives?

- An apparent conflict.
- Specific objectives should reflect holistic processes and functions.
  - May result in a long list of objectives and monitored variables – how to make the monitoring plan efficient?
  - Be transparent about which variables are selected for monitoring and which ones are not selected, and why.

3. Incorporate time scales of response into monitoring plan

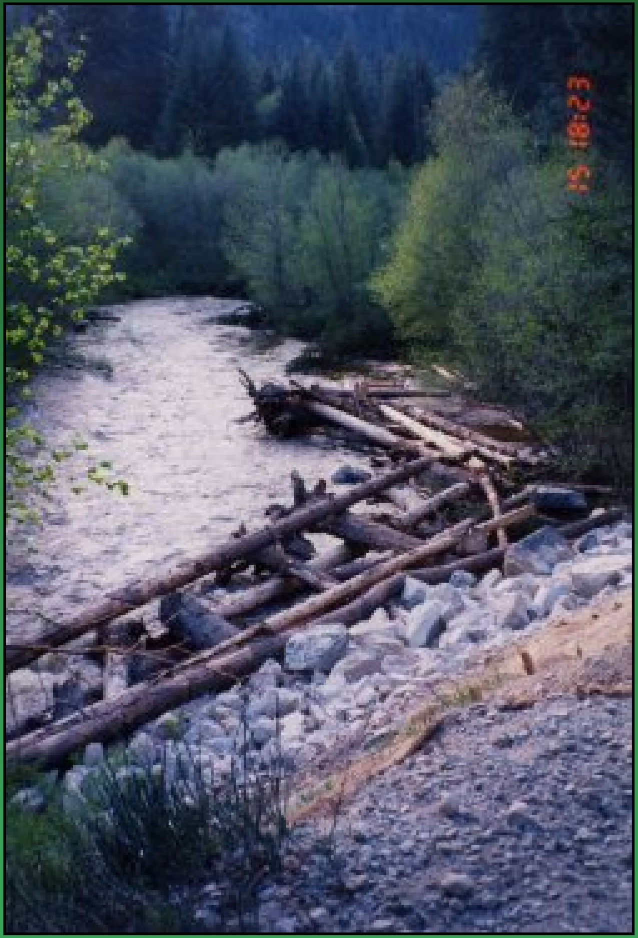
- Identify rates of habitat-forming processes and response times of monitored variables.
- Consider the role of stochastic events – floods, droughts – in controlling response.
- Rates determine the monitoring schedule.
  - For example, don’t monitor every year if response depends on mature bank vegetation community.
  - Rate indicates endpoint for monitoring – decades?

4. Use experimental design and statistical analysis to answer questions

- Response to confounding factors may be mistaken for response to the restoration treatment
  - BACI (before-after-control-impact)
- Use multiple replicate measuring sites to account for spatial variability, confounding variables, and for statistical power
  - Multiple BACI (Downes, 2002, *Monitoring Ecological Impacts*)
  - Project design may impede finding control sites
- Alternatives to MBACI (Michener 1997, Roni 2005)

5. Address the why questions

- Was the treatment effective? yes-no
- <u>Why</u> was the treatment ineffective, partially effective or effective?
- Understanding why is key for adaptive management, and for generalization or transfer of knowledge.



Methow Conservancy

How to address the why questions

- A broader geomorphological, hydrological and ecological view
- Look outside the project boundaries
- Use history, understand equilibrium status
- Qualitative/quantitative diagnosis approach (Montgomery and MacDonald 2002)
- Development of a conceptual model in advance (Richter and Richter 2000)

6. Disseminate results

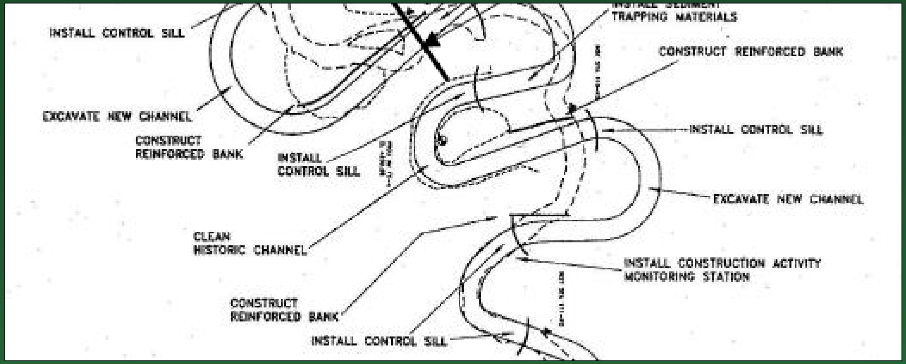
- "Both pre- and post-assessment must be completed and data made publicly available." (Palmer et al 2005)
- Data dissemination through publications, reports and presentations.

Case studies

- Three projects from Pacific Northwest
- Identities obscured to protect the innocent

- Selected based on literature searches and recommendations from restoration experts
  - Not a scientific sample
- Selected strong projects
  - Prominent, well-funded lead agencies
  - Multi-agency input

Case study #1



- Channel relocation into historical meandering channel, 1.5 miles
  - Present channel is incised, straight, riffle-dominated
  - Goals: Improve main channel habitat, increase side channel habitat, increase wetland area, lower temperature
- Custom-made monitoring plan
- Not implemented yet; I reviewed project plans and monitoring plan.

Case study #2

- Large wood placement
  - Unanchored, 8 miles of stream, completed in 2002
  - Improve channel function, floodplain connectivity, fish response
- Used existing monitoring programs and protocols
  - Before-After; no other experimental design
- Analysis based on specific questions on habitat response and fish response
- Results mainly showed no response or negative response – confounding conditions?

Case study #2 Recommendations & lessons learned

- Evaluate specific treatment sites (sub-reach).
  - Don't integrate to a higher spatial level (reach) because effects are lost.
- Improve and refine protocols.

Case study #3

- Channel relocation into historical meandering channel, 2.5 miles long
  - Restore natural channel form, fish habitat, wet meadow ecosystem
- Custom-made monitoring plan
  - BA (4 years post-treatment)
  - Substantial monitoring budget (for limited years)
- I reviewed plans, completion reports, monitoring reports I reviewed plans, completion reports, monitoring reports

Case study #3: Results

- BA design with statistical hypothesis testing
- No controls or reference site
  - Evaluated success using performance criteria
- Positive response on majority of variables

Case study #3
Recommendations & lessons learned

- Year-to-year variability limited the interpretation of data
  - Use controls, and extended monitoring period
- Need to develop clear process models of expected responses
  - Identify potential confounding factors
- Performance criteria approach is useful

Case study summary

	#1	#2	#3
Holistic?	**Y**	**Y**	**Y**
Variables tied to objectives?	Y	Y	**Y**
Timescales of response?	Y	N	Y
Experimental design?	N	Y	Y
Explanation of response?	N	Y	N
Dissemination plan?	N	Y	**Y**

Conclusions/Recommendations

- Each theme was achieved by at least one project, but no project hit all of them.
  - It is feasible to do it right.
- Experimental design is a challenge, but at least <u>some</u> projects should be monitored with an experimental design.
- We need to develop models and standards for monitoring that achieve an appropriate balance between efficiency ($) and information gain.
  - Collaborative development

Conclusions/Recommendations

- Second-party or third-party monitoring for transparency, objectivity
- Form coalitions for project-level effectiveness monitoring