Promoting Successful Restoration through Effective Targeting and Monitoring

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Lots of projects...but are they “working”?

# of stream restoration projects 1994-2004:
- >150
- 50-149
- 25-49
- 5-24
- 1-4
- no data

Lots of projects…but are they “working”?

**Poor ways to assess effectiveness:**
- Tracking # Projects
- Visual assessments
- Physical (one-time) measurements

Freshwater Forested Wetlands

U.S. Fish & Wildlife Service data (includes created wetlands)
(Evidence based) Assessment

What’s coming out right now?

Rigorous studies with pre and post monitoring

What concerns are on the horizon?

Structure vs. Functional measures

What can we say based on peer-reviewed studies?

Site Selection
1. Watershed Priorities
2. Site Screening

Monitoring & Adaptive Management
Non-tidal wetlands
Tidal Wetlands
Streams
Performance metrics

What can we say based on peer-reviewed studies?
Rigorous studies

Quantitative studies
Pre vs. Post and/or vs. ‘Control’, Multi-seasonal, multi-year

Quantitative, Post-restored vs. Forested vs. Degraded

- Urban
- Urban “Restored”
- Non-Urban
- Reference
- Other

Stranko et al. submitted

- Benthic IBI (0.77)
- Intolerant Benthic Genera (0.71)
- Total Benthic Genera (0.82)
- Mayfly Genera (0.67)
- Stonefly Genera (0.66)
- Fish IBI (0.63)
- Fish Species (0.38)
- Intolerant Fish Species (0.45)
- Darters/Sculpins (0.27)
- Trout Density (0.27)
Rigorous studies

Quantitative, Pre vs. Post Restored

26 restoration projects
Mountains & lowlands of Germany
Managers subjective assessment vs. Field data (fish, inverts, morphology)

Jaehnig et al. 2010 Ecol Apps
Reviewed published results of 78 independent restoration projects
32 in U.S., 46 in Europe, Australia, Asia

2 had sig increases in native biodiversity
6 showed some increase

Rigorous studies

Quantitative (statistical), Pre vs. Post OR Post Restored vs. Reference

River restoration, habitat heterogeneity and biodiversity: a failure of theory or practice?

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Moerke et al. 2004 - Indiana; formerly channelized;

Lepori et al. 2005 - Sweden; formerly channelized;
Rigorous studies

Quantitative (statistical), Post Restored vs. Reference over multiple years, functionality directly measured

Anne Arundel coastal plain stream projects
Solange Filoso & Margaret Palmer

Nitrogen and Sediment Flux

Outputs - Inputs = Retention
Mass Balance on N in Baseflow

**Upland Streams**

<table>
<thead>
<tr>
<th>Location</th>
<th>Net Export (g N m⁻¹ d⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRI</td>
<td>-0.25</td>
</tr>
<tr>
<td>MAL</td>
<td>-0.50</td>
</tr>
<tr>
<td>MOR</td>
<td>-0.75</td>
</tr>
<tr>
<td>CONTR-1</td>
<td>*</td>
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</tbody>
</table>

**Lowland Streams**

<table>
<thead>
<tr>
<th>Location</th>
<th>Net Export (g N m⁻¹ d⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBR</td>
<td>-0.25</td>
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<tr>
<td>SPA</td>
<td>*</td>
</tr>
<tr>
<td>WIL</td>
<td>-0.50</td>
</tr>
<tr>
<td>CONTR-2</td>
<td>*</td>
</tr>
</tbody>
</table>

* = Statistically significant; others not statistically significant.
Important findings come from rigorous assessments. Example: The form of nitrogen entering a reach may be quite different than what is going out. So you must measure all forms – particulate nitrogen (PN), dissolved organic nitrate (DOC), ammonium, nitrate – to understand export potential.
What concerns are on the horizon? 
*Ok, it was implemented...but is it working?*

143 wetland projects

80% sub-optimal to poor ecological condition

**Wetland condition success score**

- **Reference wetlands**
- **Mitigation wetlands**

**Compliance vs. Wetland condition**

- Successful compliance
- Failure to comply

*Ambrose, Callaway, Lee (2007)*
What concerns are on the horizon? ..... We’ve been measuring the wrong things

**Structure vs. Functional measures**

<table>
<thead>
<tr>
<th>Static, Point in time</th>
<th>Dynamic, Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>BOD, system respiration, P:R,</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Nutrient uptake, Nutrient flux (budgets)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Thermal regime</td>
</tr>
<tr>
<td>Species presence</td>
<td>Survival, Productivity</td>
</tr>
<tr>
<td>Channel Form</td>
<td>Discharge &amp; Sediment Supply</td>
</tr>
<tr>
<td>Carbon content</td>
<td>Carbon sequestration</td>
</tr>
</tbody>
</table>
What concerns are on the horizon? ..... We need a lot more focus on targeting

Site Selection

1. Watershed Priorities

2. Site Screening

Where are the greatest returns to effort?

Example: Limited but growing evidence (for wetlands) when > 60% cropland, there is a greater decline in in-stream nutrient loads per acre created
Identified metrics used in assessment or restoration monitoring

Keyword search of peer-reviewed literature databases; supplemented with textbooks & reports to fill gaps

Evaluated evidence that
1. Structural metrics represented functional goals
2. Functional metrics were accurate and useful
3. Quantitative metric targets were appropriate

NFWF project ongoing
Early findings

1. Restoring isolated structural components does not necessarily generate the desired functions

2. Instantaneous measurements of dynamic processes (e.g., hydrologic characteristics) are uninformative

3. Isolated measurements of spatially variable processes (e.g., sediment erosion and deposition) are uninformative

4. Integrative assessments (e.g., bioassessments) not typically helpful to use in site selection and monitoring because they do not help to identify particular stressors or suggest adaptive management

5. Species use of restoration sites has not been demonstrated to be correlated with population-level support; evidence of breeding success or fishery recruitment more appropriate to suggest habitat outcomes

6. Metrics can provide misleading *positive* and *negative* outcomes in early assessments