Development of a Stream Restoration Practices Database: Initial Progress

Presented by
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Outline

- Motivation
- Literature review of stream restoration as a nutrient management strategy
  - Pollutants of interest
  - Practices considered
- Database structure and results
- Case studies
- Conclusions
Sediment and nutrient pollution
Stream restoration

Before

After

Wohl et al. (2015)
International BMP database

Motivation

Lit Review

Database Intro

Case Studies

Conclusions

Urban Stormwater BMPs (Source Controls, Structural, GI/LID)

Agricultural BMPs

Stream Restoration

Clean Water Act Goals

Fishable & Swimmable
Sediment

- Fine sediment of most concern for water quality
- Sediment supply imbalances impact WQ and channel response
- Linked with nutrient issues
Phosphorus

- Stuck to soil particles
- Floodplain deposition potentially a long-term storage mechanism
- Bioavailability determines magnitude of WQ impacts
Nitrogen

- More often dissolved
- Denitrification is a “permanent” removal mechanism
- Bioavailability also important
Stream restoration strategies

• Bed and bank stabilization
• Riparian buffers
• Floodplain reconnection

• In-stream enhancement
• Channel reconfiguration
• Watershed processes
Bank and bed stabilization

- Limit loading from a potentially large sediment and nutrient source
- Quantifying benefits is complicated

Big Dry Creek, Westminster, CO

NRCS, Schumm et al. (1984)
Riparian buffers

• High plot-scale removal but more uncertain in-stream benefits
Floodplain reconnection

- Settling of sediment and attached phosphorus
- Higher sediment removal than nutrients
In-stream enhancement

- Nutrient retention in backwater areas and hyporheic zone
- Enhance these natural removal areas

Hester and Gooseff (2010)
Channel reconfiguration

- Benefits dependent on specific design
- Focus on functions restored
Watershed processes

- Unmitigated land use change can cause river degradation
- Address causes of impairment
Database approach

- Develop a relational database (multiple tables linked together by common IDs)
- Follow similar approach to Urban and Agricultural BMP Databases (w/future analysis tools)
- Simple data entry spreadsheets in Microsoft Excel
- Data stored in Microsoft Access (publically downloadable)
- Data served [www.bmpdatabase.org](http://www.bmpdatabase.org)
- Future analysis tools
- Platform evolution (e.g., SQL)
Database structure

- Study
  - Watershed
    - Stream
    - Design
  - Monitoring Setup
    - Chemical
    - Hydrologic
  - Monitoring Events
  - Cost
  - Biological
  - Physical
  - Contacts

Motivation | Lit Review | Database Intro | Case Studies | Conclusions
Members in the database

24 studies

- Fish passage
- Flow control
- Passive
- Channel reconfiguration
- Habitat enhancement
- Floodplain reconnection
- Grade control
- Bank stabilization
- Riparian buffer

- Public safety
- Species management
- Flow modification
- Flood conveyance
- Sediment balance
- Infrastructure
- Stormwater
- Habitat enhancement
- Aesthetics/Rec/Ed
- Channel reconfiguration
- Floodplain recon.
- Incision stabilization
- Riparian veg
- Bank stabilization
- Water quality

Number of Projects

Motivation | Lit Review | Database Intro | Case Studies | Conclusions
Types of quantitative analysis

- Compare summary statistics (e.g. mean, median, standard deviation)
- Graphical analysis (e.g. boxplots, quantile plots)
- Hypothesis testing (e.g. Mann-Whitney rank-sum test, Wilcoxon signed-rank test)
Data difficulties

• Lack of:
  • Consistent metrics
  • Standardized monitoring designs
  • Event-scale data
  • Long-term data / sufficient sample size

• Uniqueness of individual restoration projects
Summary Results: TSS

Mean TSS (mg/L) for Stream Restoration Practices

Study and Project Type

- Control
- Treatment

Motivation | Lit Review | Database Intro | Case Studies | Conclusions
Summary Results: Total Phosphorus

Mean Total Phosphorus (ug/L) for Stream Restoration Practices

Study and Practice Description
- Control
- Treatment
Summary Results: Nitrate

Mean Nitrate (mg/L) for Stream Restoration Practices

Stream Restoration Study/Practice
- Control
- Treatment
Summary Results: Load Example

WCRC Stream Stabilization, AR: Total Annual Pollutant Loads
(Study ID # 2016122)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Pre</th>
<th>Post</th>
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</thead>
<tbody>
<tr>
<td>Nitrogen, Total (lbs)</td>
<td>2506</td>
<td>100</td>
</tr>
<tr>
<td>Phosphorus, Total (lbs)</td>
<td>665</td>
<td>27</td>
</tr>
<tr>
<td>TSS (tons)</td>
<td>1958</td>
<td>78</td>
</tr>
</tbody>
</table>

Load/year

Motivation
Lit Review
Database Intro
Case Studies
Conclusions
Case study: Cottonwood Creek

Cottonwood Creek, CO (Cherry Creek Basin Authority)

Before

After
Case study: Cottonwood Creek

Mann-Whitney test / Two-tailed Test for Differences between Pre-Restoration and Post-Restoration Water Quality (following Phase 2)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>p-value (Two-tailed)</th>
<th>Statistically Significant Difference?</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP</td>
<td>&lt; 0.0001</td>
<td>Yes</td>
</tr>
<tr>
<td>TN</td>
<td>&lt; 0.0001</td>
<td>Yes</td>
</tr>
<tr>
<td>TSS</td>
<td>0.003</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Motivation

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Case study: Big Dry Creek

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Sediment

Phosphorus
Conclusions

- Streams can be a source or sink of sediment and nutrients.
- Restoration can prevent loading and encourage retention.
- More research needed to quantify benefits.
- Next steps:
  - Add studies to database
  - Annual report of available data
Questions?

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