River Restoration

A 2005 Review

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https://www.iowadnr.gov/environmental-protection/water-quality/river-restoration

General Introduction

Problem Statement:

- Rivers continue to deteriorate
- Restoration projects lack:
  - Solid conceptual models
  - Clear understanding of ecosystem processes
  - Recognition of temporal and spatial scales
  - Long-term monitoring

Definition:

- River restoration aims to improve hydrologic, geomorphic, and ecological processes.

Goal Setting in River Restoration

2005

2010

Wohl *et al.* 2015

Common goals:

- Water quality
- Riparian zones
- Habitats
- Fish passage
- Bank stability

Limitations:

- Knowledge gaps in ecosystem processes
- (Un)Feasibility of restorative actions
- Social and economic costs

Scientific and Social Challenges

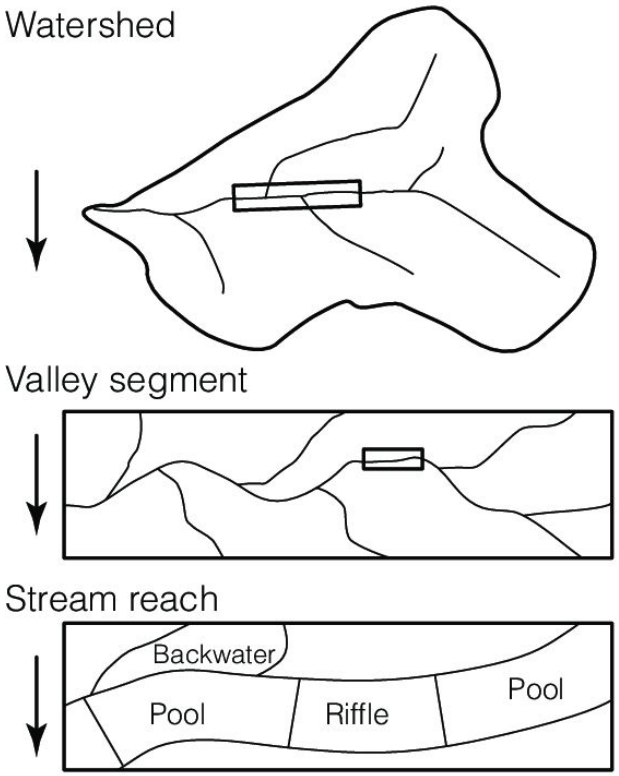
Scientific:

- Transferring knowledge across projects
- Limited experiments at appropriate scale
- Need interdisciplinary approaches
- Tools: Bayesian networks, Fuzzy Mapping, decision-oriented models

Social:

- Rivers enhance quality of life
- Educational role of river scientists
- Working with nonscientists

The Need for Scientific Advances I



https://www.researchgate.net/figure/The-hierarchy-and-spatial-scales-of-stream-habitat-after-Frissell-et-al-1986_fig4_259311227

- Focus on restoring variability and adopt watershed-scale approaches
- Small-scale restoration projects lead to (Brettschneider *et al.* 2023):
  - Large scale impacts
  - Need of coordination
  - Limited ecological efficacy
- Critical Questions:
  - Essential ecosystem processes?
  - Interaction between hydrologic and ecological functions?
  - Most cost-effective tools?

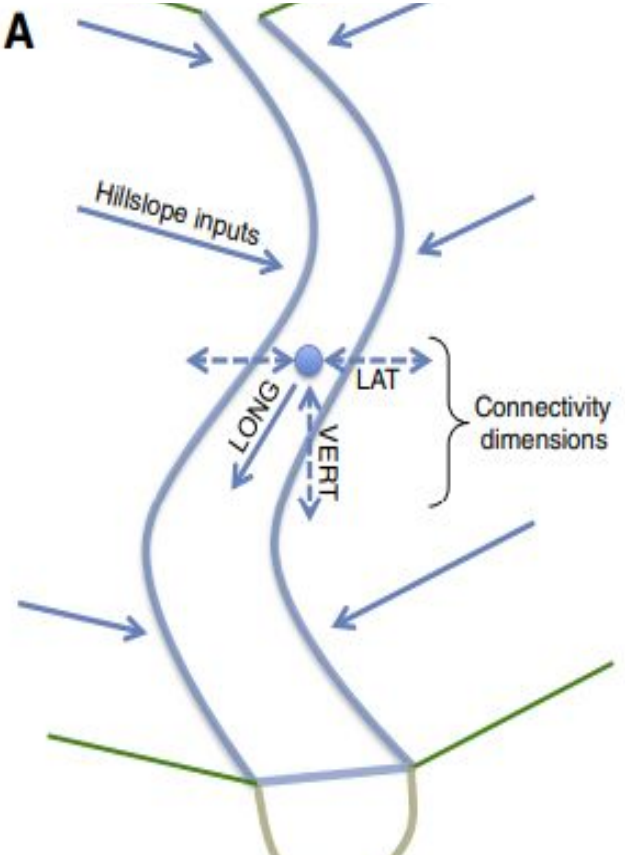
The Need for Scientific Advances II

Biogeochemical connectivity (Covino 2017):

- Lateral
- Longitudinal
- Vertical

Central concept:

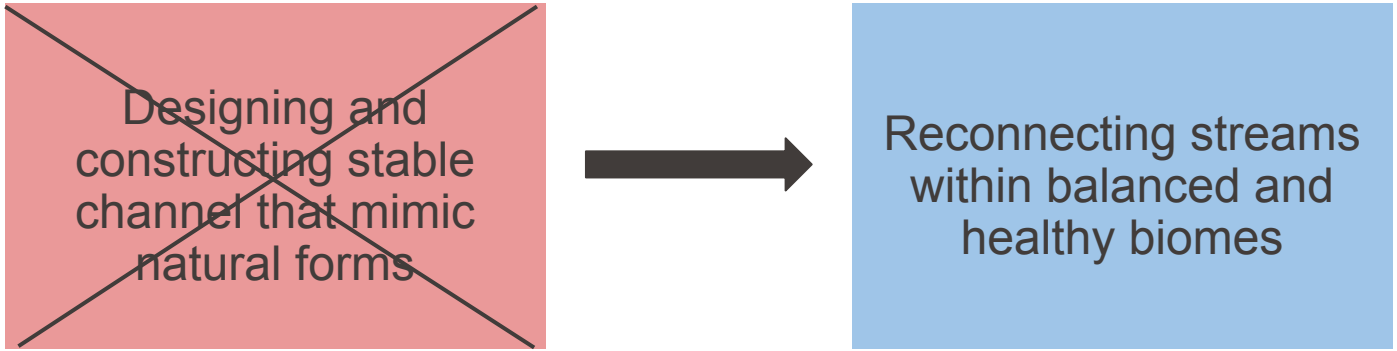
- Need for a natural timing, frequency, magnitude and rate of change in river flows
- River needs to be self sustainable after restoration



Covino 2017

Biomic River Restoration

“if river restoration is to reverse long-standing declines in river functions, it is necessary to recognize the influence of biology on river forms and processes and re-envisage what it means to restore a river” (Johnson *et al.* 2020)



Criteria for Successful Restoration I

Palmer *et al.* 2005

1. A guiding image of a more dynamic and healthy river
2. Measurable ecological improvement of the river
3. River providing self-sustainability and resilience
4. No lasting harm during the restoration process
5. Transparent pre- and post-assessments

Wohl *et al.* 2005

1. Develop theoretical frameworks
2. Recognize complexities and uncertainties
3. Enhance science and monitoring of restoration
4. Link science, practitioners, and stakeholders
5. Develop effective methods within existing constraints

Criteria for Successful Restoration II

Wohl *et al.* 2005

1. Develop theoretical frameworks
2. Recognize complexities and uncertainties
3. Enhance science and monitoring of restoration
4. Link science, practitioners, and stakeholders
5. Develop effective methods within existing constraints

Wohl *et al.* 2015

1. Restore flow regimes
2. Physically reconnect main channels with floodplains or secondary channels
3. Reintroduce natural ecosystem engineers
4. Remove barriers
5. Restore physical connectivity
6. Restore natural range of variability

Conclusion

https://www.wwf.eu/?14185866/Rivers2Restore-identifies-key-river-restoration-projects-that-could-lessen-the-impact-of-floods--droughts

- Restoration is critical for ecological and societal well-being
- Success requires science-driven, adaptive, and inclusive approaches
- Collaboration and innovation are key

References

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[1] Brettschneider, H., *et al.* (2023). Much effort, little success: causes for the low ecological efficacy of hydromorphological restoration measures. *Environmental Sciences Europe*, 35(31), 1–22.

[2] Covino, T. (2017). Hydrologic connectivity as a framework for understanding biogeochemical flux through watersheds and along fluvial networks. *Geomorphology*, 277, 133-144.

[3] Johnson, M. F., *et al.* (2020). Biomic river restoration: A new focus for river management. *River Research and Applications*, 36(1), 3-12.

[4] Palmer, M. A., *et al.* (2005). Standards for ecologically successful river restoration. *Journal of Applied Ecology*, 42, 208–217.

[5] Wohl, E., *et al.* (2015). The science and practice of river restoration. *Water Resources Research*, 51(8), 5974–5997.