The State of the Science and Practice of Stream Restoration in the Chesapeake: Lessons Learned to Inform Better Implementation, Assessment and Outcomes

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GMU Potomac Science Center | Woodbridge, VA

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Ben Hayes *Bucknell University*
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Rich Starr *Ecosystem Planning and Restoration*
Scott Stranko *MD DNR*
Tess Thompson *Virginia Tech*

As well as **Meg Cole** (*CRC*), **Sherry Witt** (*General Dynamics*), & **Tou Matthews** (*CRC*), and many other presenters and participants

U.S. Department of the Interior
U.S. Geological Survey

Why this workshop on stream restoration?

Stream restoration is a common management practice used for TMDLs, MS4, mitigation, infrastructure protection, and habitat improvement… success most often defined by getting hydraulics and geomorphology right.

Chesapeake Bay watershed: **266 miles completed as of 2019, 84 miles planned for 2019 to 2025** [CBP WIPs]

Growing interest and controversy about the effects of stream restoration on whole-ecosystem health and services.

The overall purpose of the workshop was to bring together a diverse cross-section of experts and stakeholders in the field of stream restoration …

to distill lessons learned from past stream corridor restoration projects to improve restoration outcomes.

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Workshop goals

Past, Present, and Future

1. Identify the evolution of stream restoration goals, regulations, practices and practice implementation;

2. Present and discuss science and assessment to document holistic impacts and outcomes; and

3. Create a synthesis of the best available science, practices and monitoring to enable adaptive management that improves stream restoration activities.

Why did we get these outcomes?

Causal chain

Stream degradation →

Regulatory/policy drivers →

Goals →

Design approaches/practices →

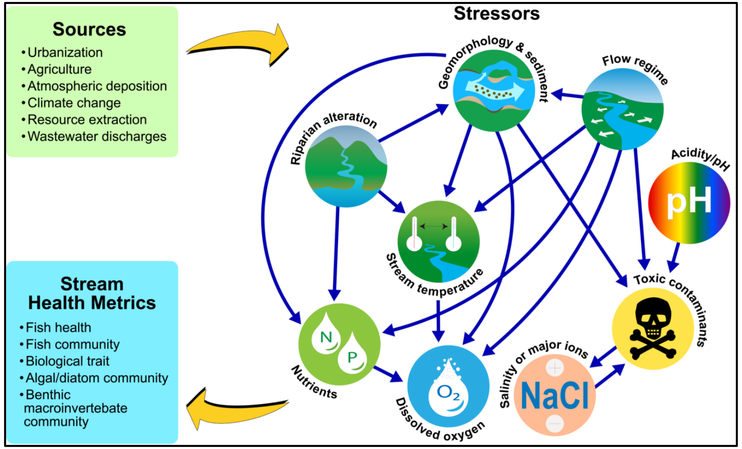
Monitoring →

Outcomes

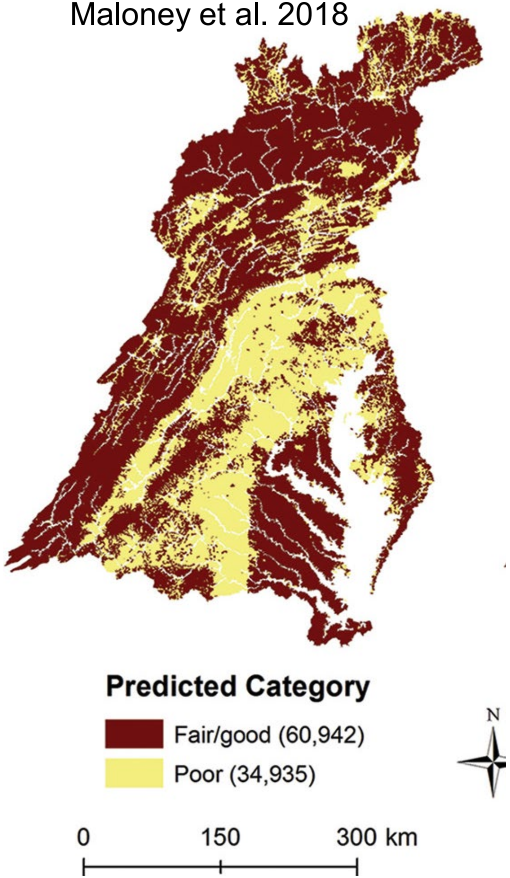
Past:

Streams have been degraded over much of the Chesapeake watershed

Fanelli et al. 2022



Maloney et al. 2018



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Past:

Evolution of stream restoration

<u>*REGs*</u>

1972
Clean Water Act

1990's
mitigation

2010
Ches. Bay Agreement

<u>*GOALs*</u>

stability

water quality

TMDL

………………………………………………….ecological uplift

Restoration approaches:

hydraulics, to channel evolution, to channel stabilization, to Natural Channel Design, to softer structures, to floodplain reconnection.

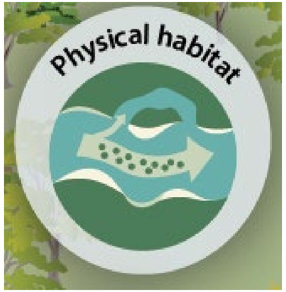

M. Fellows

Present:

Evaluating outcomes

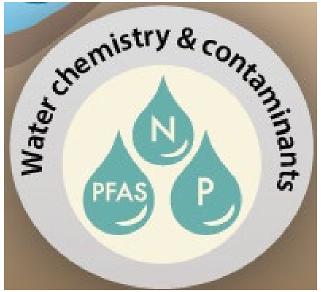
In-channel biotic

‘Stabilization' of channel form over time



Riparian

Water quality



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Present:
Synthesis

In-channel biotic

Biological uplift is rare. Examples of biological uplift include single stressor removal projects, benthic macroinvertebrates where riparian areas have been improved, fish where blockages have been removed, and hyporheic taxa.

'Stabilization' of channel form over time

Natural Channel Design in the Eastern US can stabilize channel form over typical monitoring periods of up to five years. There is little peer reviewed literature on new design techniques that focuses on channel and floodplain geomorphology.

Riparian

Often short-term negative impacts to riparian vegetation. Loss of existing trees in the riparian zone from stream restoration implementation occurs. But deliberate riparian restoration can improve ecosystem health. Amphibians in stream-wetland complexes and soil health can improve.

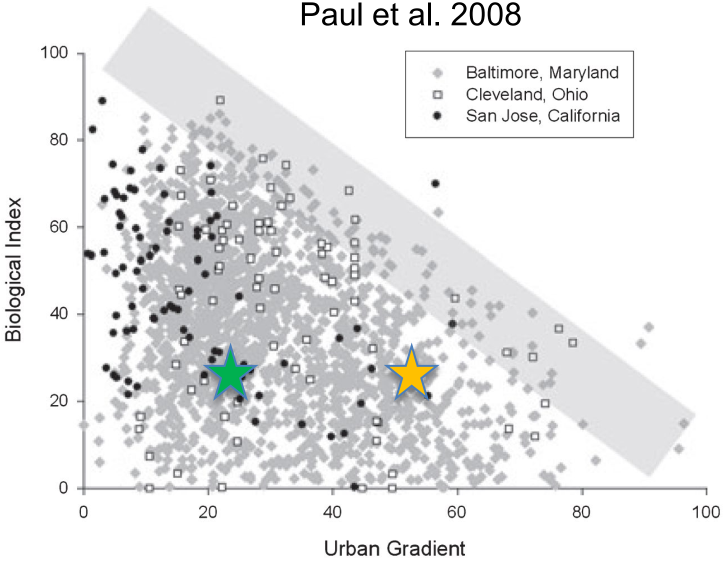
Water quality

Restoration effects are mixed but there are measurable improvements that make restoration a best management practice worth considering for attenuating nutrient pollution and sediment control. Tradeoffs and unintended consequences may occur.

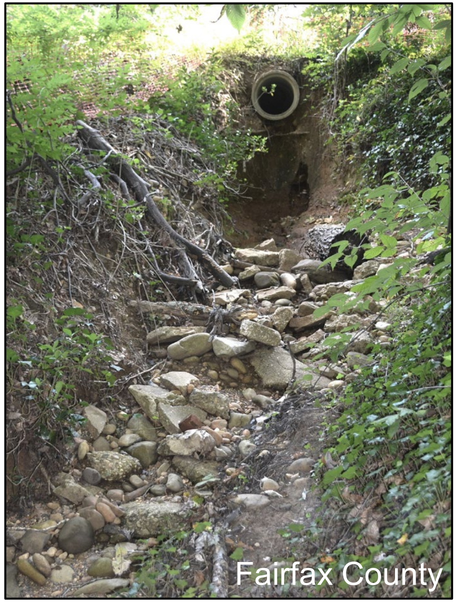
Present: Why did we get these outcomes?
Stressors

Ultimately, watershed condition (including past land uses) determines uplift potential, and should set the expectations for stream restorations

Paul et al. 2008



Or other watershed disturbance gradient



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Future:
What do we do differently to get better outcomes?

Where and why has biotic uplift occurred in response to stream restoration?

- Single known stressor
- Smaller streams
- Whole stream corridor (incl. riparian and floodplain zones)
- Intentional goal and approach to improve ecological uplift

→ Target headcuts, knickpoints, concrete channels, buried streams, headwaters, fish blockages, and disconnected floodplain-stream systems – in less degraded watersheds – for maximum likelihood of ecological uplift. *Give it time*.

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Key Findings

The fundamental finding of the workshop was that often the primary goal of stream restoration projects is not to improve ecological uplift and therefore these projects often do not improve aquatic macroinvertebrate or fish communities

Identify and communicate clear project goals

The outcome of stream restoration monitoring has revealed that while geomorphic and hydrodynamic functions of stream restoration projects may be achieved, ecological stream function improvements remain elusive

It is also likely that current understanding of stressors and drivers of stream ecosystem health is insufficient, and that reach-scale restoration focused on geomorphic restoration may not remove the actual sources of stream health impairment that may arise in the upstream watershed

Monitor more, with multiple ecosystem service metrics

Do No Harm. Projects that may risk resources in higher-quality streams should be avoided

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Summary

If improved ecological functions (**ecological uplift**) are a main goal,
then explicitly identify them and **make them a goal**, and **incentive** that goal,
and use appropriate restoration design approaches to achieve that goal,
and monitor those restoration outcomes.

Improved scientific understanding and predictions of **stressors** to the stream ecosystem are needed at the spatial scale of individual stream reaches.

For this workshop, we followed the *Society for Ecological Restoration*’s definition of restoration as

“the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.”

(Gann et al. 2019).

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Recommendations for improving outcomes of stream restoration

•If improved ecological functions (ecological uplift) are a main goal, then explicitly identify them and **make them a goal**, and use appropriate restoration design approaches to achieve that goal, and monitor those restoration outcomes.

•Most stream restoration projects for the Chesapeake Bay TMDL have the primary goal of nutrient and sediment reduction to the Bay, but do not currently **incentivize** funding or prioritization for local stream biotic uplift.

•FEMA rules discourage changing (increase or decrease) flood levels, restricting the rewetting of the riparian corridor and floodplain and potentially limiting functional uplift.

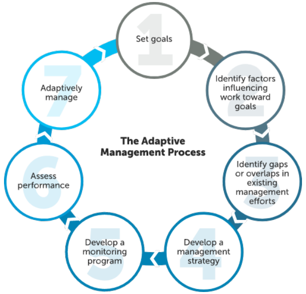
•**Assess** restoration outcomes to project goals using **multiple metrics** of stream ecosystem health

•Improved scientific understanding and predictions of **stressors** to the stream ecosystem are needed at the spatial scale of individual stream reaches.

•Research is needed to identify the **optimal amount of dynamic geomorphic change** for various stream ecosystem attributes.

Recommendations for improving outcomes of stream restoration

Theme 1: Recommendations to achieve better outcomes from stream restoration



•If improved ecological functions (ecological uplift) are a main goal, then explicitly identify them and make them a goal, and use appropriate restoration design approaches to achieve that goal, and monitor those restoration outcomes.

•Identify the stressors to stream ecosystem health prior to restoration so that management approaches are likely to alleviate those stressors.

•Consider the appropriate historical and contemporary conditions and processes that define the restoration potential of the stream in order to identify project goals, design approach, and assessment of sustainable outcomes.

•Focus on holistic ecosystem condition and resilience, not only geomorphic stabilization, and allow sufficient dynamic change to promote stream evolution that optimizes ecological functional uplift and dynamic habitats at a rate that doesn't adversely impact biological and water quality resources.

•Avoid harm. Target stream restoration for locations with more strongly disturbed stream reaches, use approaches that are more likely to address stream ecosystem stressors and generate improved functional uplift, and avoid harming higher quality streams.

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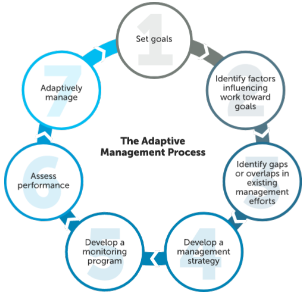
Recommendations for improving outcomes of stream restoration

Theme 2: Policy issues that impact outcomes of stream restoration



•Most stream restoration projects for the Chesapeake Bay TMDL have the primary goal of nutrient and sediment reduction to the Bay, but do not currently incentivize funding or prioritization for local stream biotic uplift.

•FEMA rules discourage changing (increase or decrease) flood levels, restricting the rewetting of the riparian corridor and floodplain and potentially limiting functional uplift.

•Long-term monitoring of holistic ecosystem outcomes from restoration, with clear linkage to project goals and objectives, could be incentivized in order to support adaptive management.

•Current performance standards for stream restorations encourage relatively static channels. For improved biotic uplift, success criteria could be allowed to evolve over time, as appropriate for project goals, to allow for dynamic stream ecosystems.

•Conflicting policies, funding availability, and funding source requirements can lead to divergence in restoration goals and objectives across jurisdictions.

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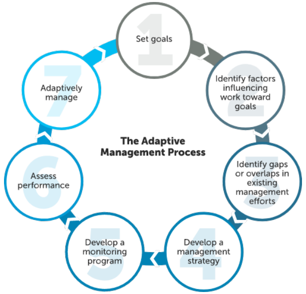
Recommendations for improving outcomes of stream restoration

Theme 3: Recommendations to improve assessments of stream restoration outcomes



•Choose metrics of stream response to restoration that evaluate the project's goals and objectives.

•Assess restoration outcomes to project goals using multiple metrics of stream ecosystem health (such as multiple taxonomic groups, ecological processes, human use and engagement, socio-economics, the riparian zone, and functional processes) and a study design to test hypotheses and assess project goals and objectives.

•Additional long-term focused monitoring is needed to understand and adaptively manage restoration outcomes.

•Assessment of restoration outcomes should consider the possibility of differing time lags of the response times of different stream ecosystem health metrics to project implementation.

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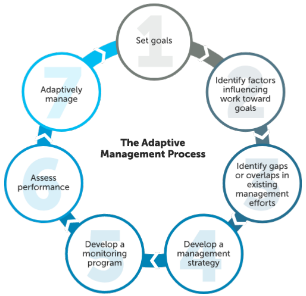
Recommendations for improving outcomes of stream restoration

Theme 4: High priority science gaps



•Improved scientific understanding and predictions of stressors to the stream ecosystem are needed at the spatial scale of individual stream reaches.

•Research is needed to identify the optimal amount of dynamic geomorphic change for various stream ecosystem attributes.

•The terminology of "stream restoration" could be refined to be more specific of actual management goals, objectives, and practices of each project in order to better communicate project intentions.

•Additional long-term monitoring of ecosystem responses to restoration is needed beyond regulatory and permit requirements, including the pre-restoration period.

•Publicly available databases of stream restoration project goals, objectives, implementation information, and assessed outcomes are needed that are comprehensive and follow data usability guidelines.

•Review and development of suggested best approaches and methods for assessing restoration outcomes in order to facilitate consistent, standardized, and effective evaluation techniques.