The Inaugural Upper Midwest Stream Restoration Symposium

Stream Restoration: Why do we do this and is it worth it?

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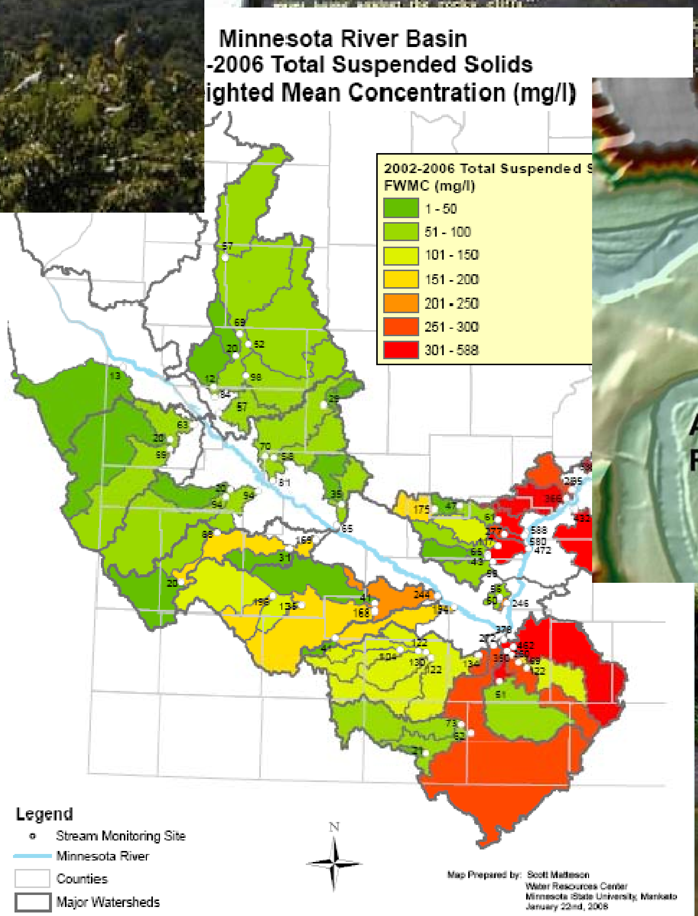
21 February 2010
La Crosse Wisconsin

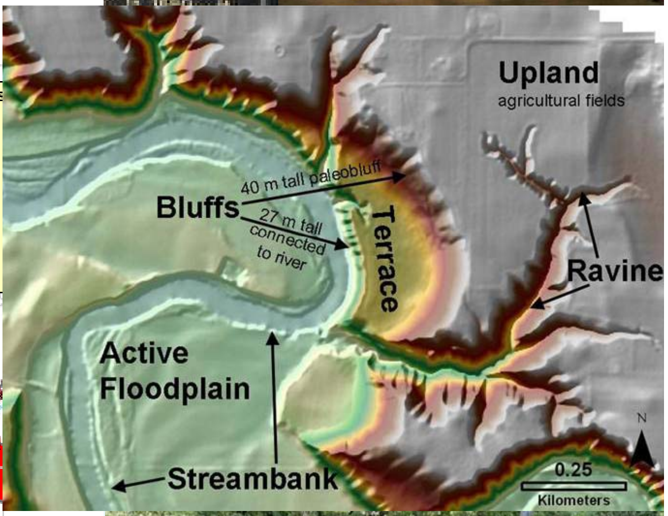
PRRSUM

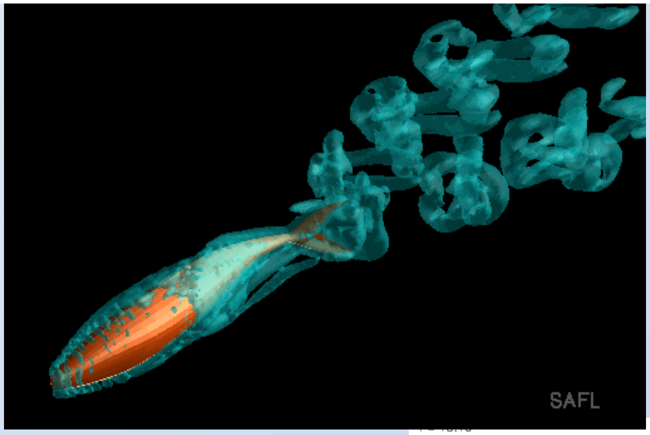
PARTNERSHIP FOR RIVER RESTORATION AND SCIENCE IN THE UPPER MIDWEST

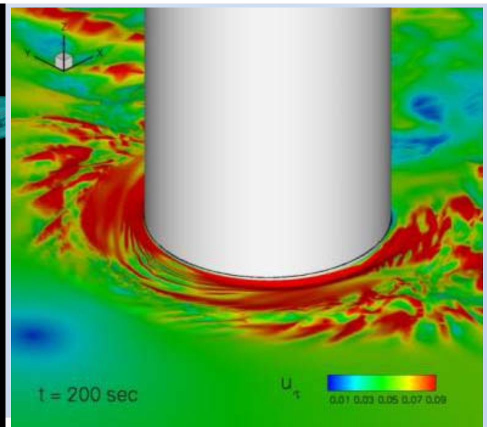
National Center for Earth-surface Dynamics

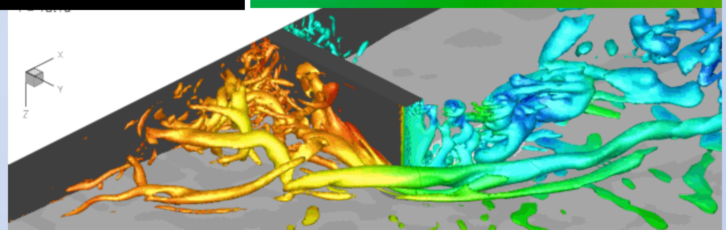
A National Science Foundation Science & Technology Center











streamlabs

NATIONAL CENTER FOR EARTH-SURFACE DYNAMICS
ST. ANTHONY FALLS LABORATORY, UNIVERSITY OF MINNESOTA

collaborative experiments on
physical, chemical, & biological processes,
at field scale,
incorporating advanced technology,
used to develop design guidance

1. indoor
2. outdoor
3. virtual

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Stream Restoration Short Courses

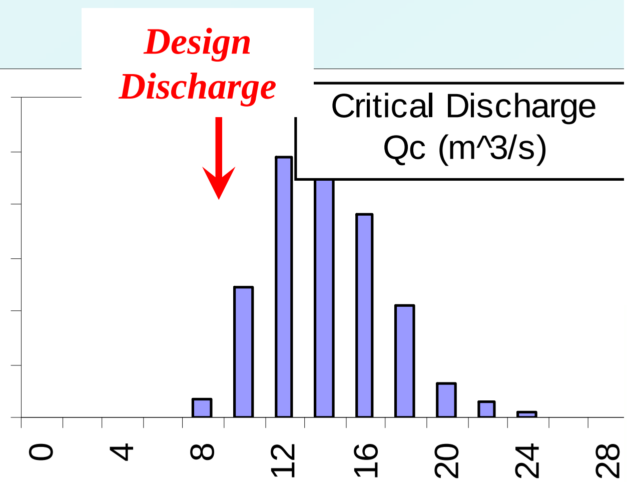
Baltimore MD, Logan UT, Truckee CA, Clinton NJ

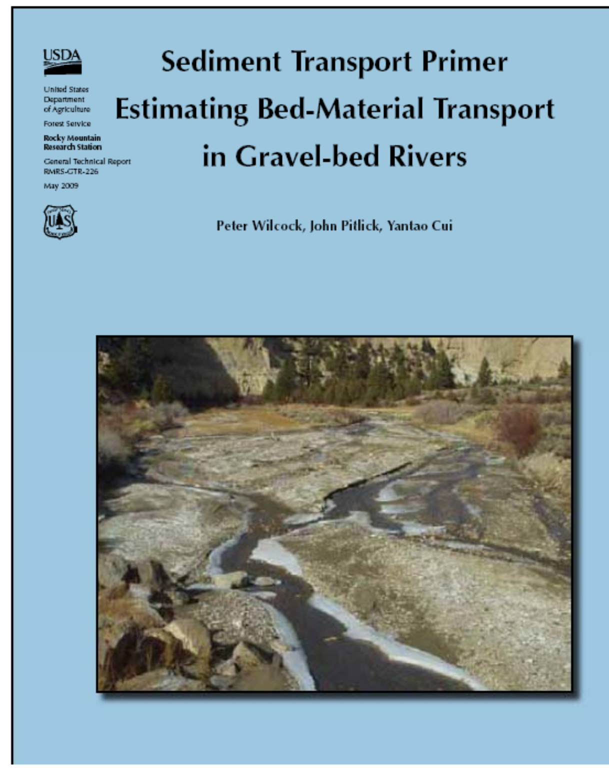
UMN certificate program in Stream Restoration

Regional Stream Restoration Conferences

Stream Restoration Decision Analysis & Design Manual

Working Group on Training & Certification





The Inaugural Upper Midwest Stream Restoration Symposium

River Restoration Northwest

Mid-Atlantic Stream Restoration Conference

North Carolina Stream Restoration Conference

The Stream Restoration Business

Why do we do this?

Objectives: multiple, conflicting, ill defined

Who does it?

a diverse blend of engineers, water quality professionals, landscape architects, and short-course trained practitioners

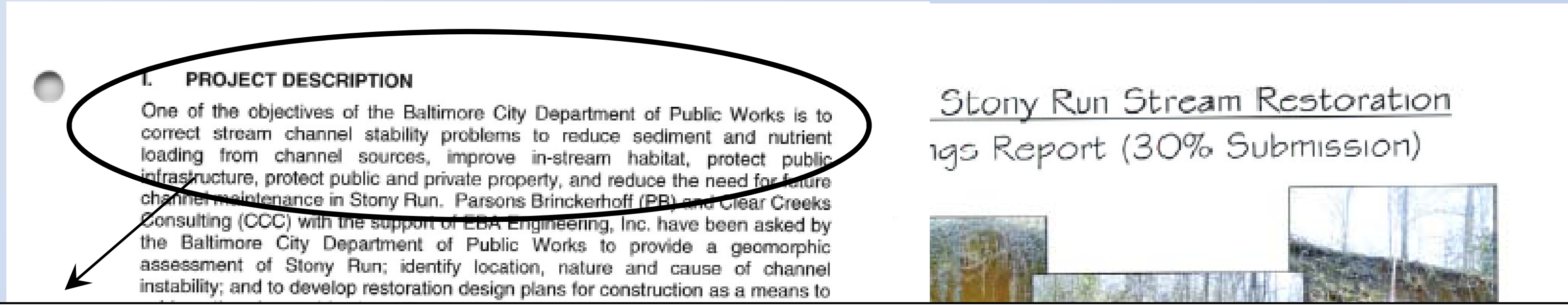
How do we do this?

reference or template approach
difficult to make cause-and-effect connection, explicitly linking objective to actions, incorporating uncertainty

Should we do this?

Can we demonstrate success? Value?

Are we doing good? At what cost?



"One of the objectives of the Baltimore City Department of Public Works is to correct stream channel stability problems *in order* to reduce sediment and nutrient loading from channel sources, improve in-stream habitat, protect public infrastructure, protect public and private property, and reduce the need for future channel maintenance in city streams."

- **Can we demonstrate that we are achieving the objectives?**
- **Can we justify the project cost & disturbance relative to the benefits?**
- **Can we do it for (much) less?**
- **Can we do better?**

There is an emerging standard approach that includes lots of earth-moving and large rocks *and cost and disturbance*

Are we doing good? At what cost?

- Is stream restoration design evolving in a conservative direction,
  making extensive use of stabilizing measures
  that protect contractor liability
  above project objectives, cost, and disturbance?
- Can the objectives be accomplished for a fraction of the cost?
- Can ecological objectives be met with a green pipe?
- If attainment of objectives is not only unverified,
  but assumed, we can't say!
- If objectives, for sediment, channel dynamics,
  habitat, water quality, fish recovery…
  are not directly integrated into a predictive design process
  how do we learn how to do this better? Or cheaper?

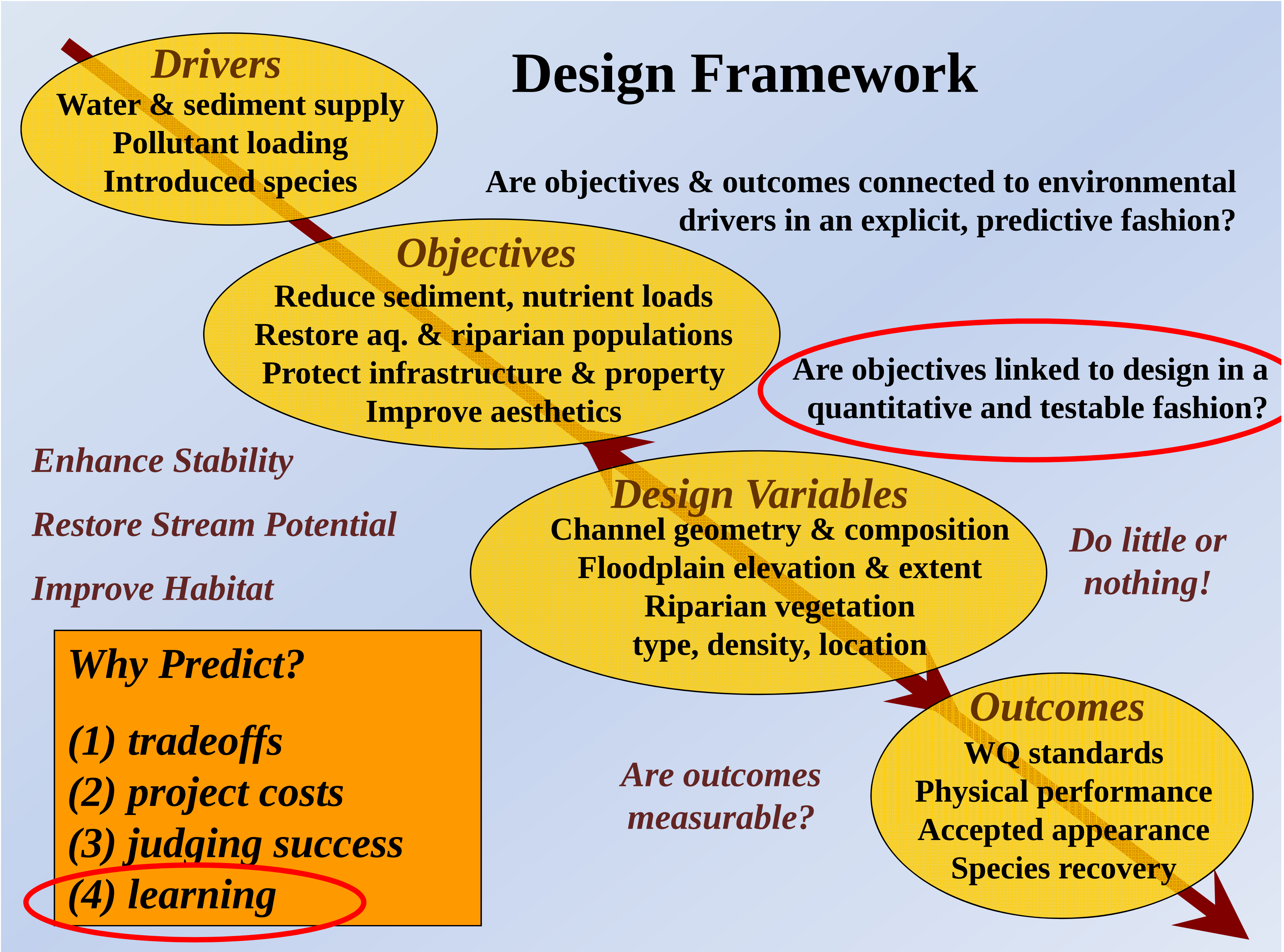
If we provide ‘stability’ with big rocks, do we run the risk of accumulating sediment in the channel (which can trigger instability)?

Reconnecting floodplains provides opportunities for pollutant removal

Do we want to remove the floodplain & riparian forest?

At what cost?   For what benefit?

Do people like it?


Design Framework
Drivers
Water & sediment supply
Pollutant loading
Introduced species
Are objectives & outcomes connected to environmental drivers in an explicit, predictive fashion?
Objectives
Reduce sediment, nutrient loads
Restore aq. & riparian populations
Protect infrastructure & property
Improve aesthetics
Are objectives linked to design in a quantitative and testable fashion?
Enhance Stability
Restore Stream Potential
Improve Habitat
Design Variables
Channel geometry & composition
Floodplain elevation & extent
Riparian vegetation
type, density, location
Do little or nothing!
Why Predict?
(1) tradeoffs
(2) project costs
(3) judging success
(4) learning
Are outcomes measurable?
Outcomes
WQ standards
Physical performance
Accepted appearance
Species recovery

A short list of predictable, measurable, and relevant objectives:

Protect property and infrastructure

Control flood levels

Alter loading or yield of sediment, nutrients, pollutants

Permit fish passage

Increase population of designated species

Improve aesthetics, access

NB: predictable means capable of prediction – not that we can actually predict all of these in any particular situation, or some of them in any situation

Improve Habitat

Enhance Stability

Restore Potential

Stream restoration projects an awesome set of experiments
if we monitored them, we would learn all sorts of useful things.

The monitoring challenges:

(1) Getting it funded

(2) Defining good experiments

(3) Archiving and using the data

(4) Learning from the data

Judging success

Developing alternatives

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Is stream restoration worth it?
A benefit/cost analysis of urban stream restoration

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Dept. of Geography & Environmental Engineering
Johns Hopkins University

Nicholas Flores
Dept. of Economics
University of Colorado

Better for nutrient removal (?) **Better for walking dogs**

Is either worth >> $1m?

The “worth it?” study

1. effectiveness for *nutrient removal*; costs for alternatives

2. value of *infrastructure* protection

3. preference and willingness to pay for *aesthetics*, *recreation*

Water Quality Benefit: avoided cost of the least expensive, feasible alternative for achieving the same pollution reductions

Annual pollutant reduction:

N: 0.02 lb/ft/yr * 1320 ft = 26.4 lb

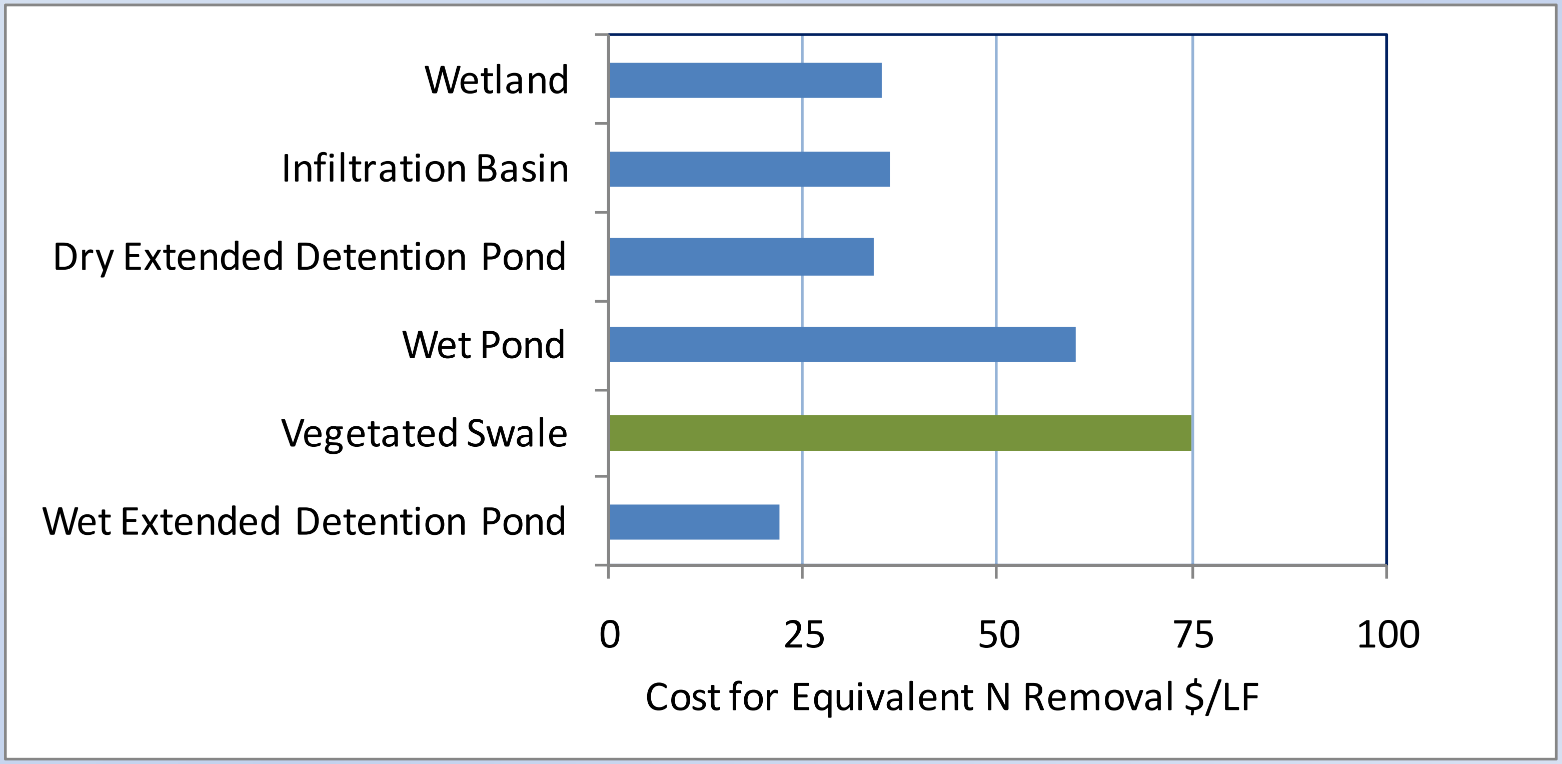
P: 0.0025 lb/ft/yr * 1320 ft = 3.3 lb

Sediment: 2 lb/ft/yr * 1320 ft = 264 lb

Size various BMPs to remove same amount using typical urban N, P, and sediment loads, Determine BMP cost & divide by 1320 ft

Water Quality Benefits

1. **Determine least expensive, feasible BMP alternative**
2. **Calculate the equivalent $/linear foot**



Water quality benefits are optimized and sized for N removal of 26.4 lb/yr.

Infrastructure Benefits

- Avoided expenditure directed at protecting infrastructure : rip rap
- Cost 40-120 $/lf
- Could treat part or all of 1320 ft

Aesthetics and Recreation Benefits

- **Survey of Baltimore residents**
- ***Part I.* Design Preferences**
  - **Stream Bank:**

    high and dry

    vs.

    low and wet
  - **Surrounding Area:**

    tree cover

    vs.

    meadow
- ***Part II.* Willingness to Pay for Aesthetic and Recreation Benefits**

Survey Design

- Random sample of 2000 Baltimore City residents
  total response rate 11.5%;
  adjusted response rate, Stony Run 24.5% , Baltimore City 9.9%

  - Over-sampled residents within 1 mile of Stony Run

  - Administered online and paper surveys

- Scenario: 0.25 mile restoration involving
  - *infrastructure protection*
  - *no water quality benefits*
  - *different appearance*

Part I - Design Preferences

Section 3: Now we want to ask you how you feel about these different design choices. We will ask you to compare different combinations of stream bank design and plant and tree cover and tell us which you like better. Below are the four different combinations that we will ask you to compare.

High and Dry Stream Bank with *Meadow*

High and Dry Stream Bank with *Tree Cover*

Low and Wet Stream Bank with *Meadow*

Low and Wet Stream Bank with *Tree Cover*

Comparison 1

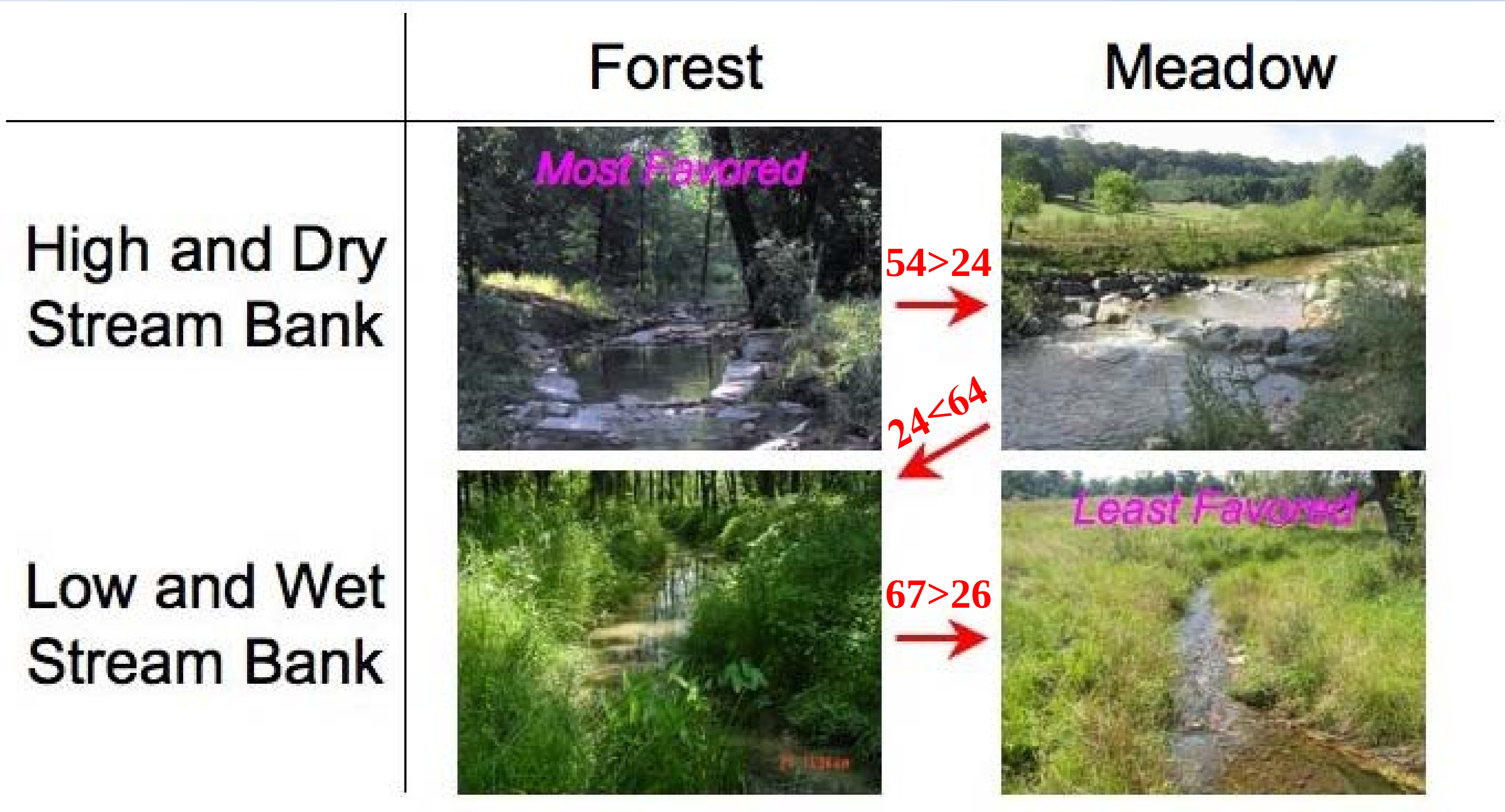
Alternative A: Low and Wet Stream Bank with *Tree Cover*

Alternative B: High and Dry Stream Bank with *Tree Cover*

1. Of the two designs above, which design would you prefer to:

	Alternative A	Alternative B	I like both about the same
look at?			
walk along?			
have in the city?			

Results - Design Preferences



- **Residents preferred a forest with high and dry stream bank (54% preferred) to a meadow and high and dry stream bank (24% preferred)**
- **a meadow and high and dry stream bank (64%) to a forest with low and wet stream bank (24%), and**
- **a forest with low and wet stream bank (67% preferred) to a meadow and low and wet stream bank (26%).**

Part II - Willingness to Pay for Restoration

Section 5: Now we want you to consider how much you would be willing to pay for two different stream projects that could be built at the same place. *Please note that this is a made-up example. It is not related to any ballot issue that you will vote for in this election or any future election.*

Suppose that Baltimore City wanted to build a stream project at a particular place. This project would be located approximately 5 miles from your home. The city is considering two different alternative stream bank and tree cover designs. Several features would be the same for both options regardless of the design. The same features are:

Walking Paths – Paths covered in wood chips allow easy access along the stream bank.

Length of Project – This project is a quarter mile long or about the length of 2 city blocks.

Sewer lines and Roadways – This project will protect existing sewer lines and a nearby road.

Water Quality Improvements – This project is unlikely to improve water quality.

Consider the two alternatives (Project A and Project B) on the following page and tell us how you would vote for a one-time tax to pay for the project.

Location of the stream project.

Continue on next page

Stream Project: Alternative A

Stream and Stream Bank – High and dry design with large boulders in the stream and along the bank. The stream banks are dry and accessible except during large floods.

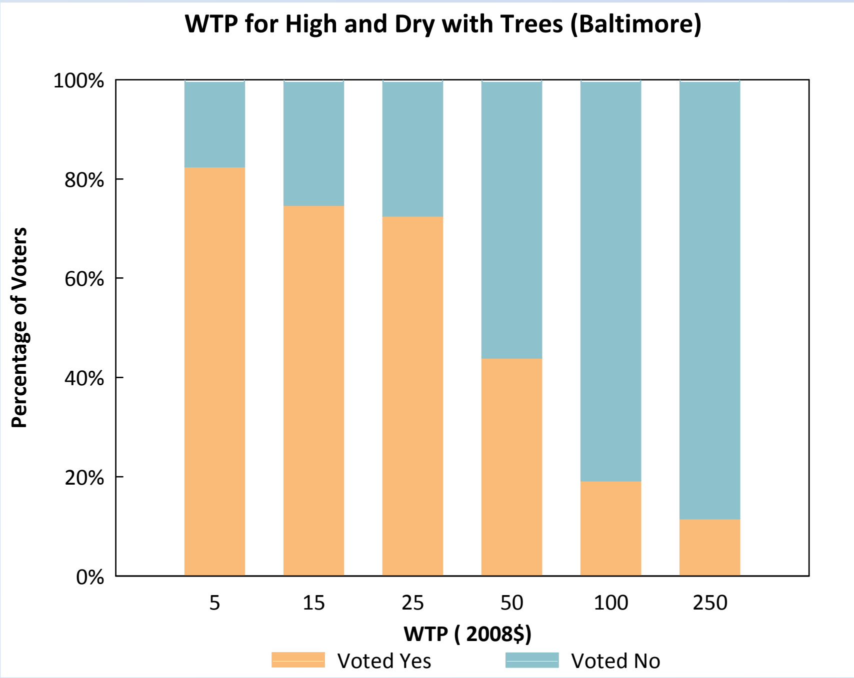
Trees – Trees will only be cut down only as necessary to get equipment into the stream area for construction. Most of the trees will remain, providing a canopy that shades the stream area.

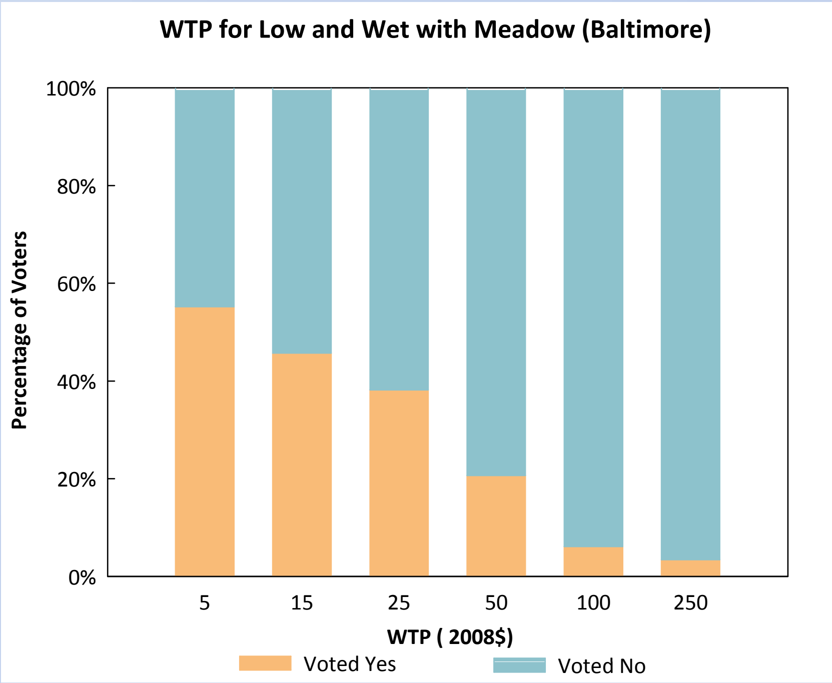
1. Suppose that you will vote on a ballot question that asks City of Baltimore residents to approve a one-time tax to pay for this project. How would you vote? Please answer each of the following questions. *(PLEASE ANSWER EACH ROW BY CHECKING THE APPROPRIATE BOX)*

One-time Tax to Pay for Alternative A	How would you vote for a one-time tax to pay for this project?		
	I would vote yes.	I would vote no.	I would not vote.
$5			
$15			
$25			
$50			
$100			
$250			

Turn to back of page

Fraction Willing to Spend $X or More on Restoration





- **Both options include infrastructure protection**
- **Difference in WTP ($58) provides lower bound on aesthetic/recreation value**
- **Equivalent to $620/lf (conservative with assumption that non-respondents have zero WTP)**

Some Costs

Recent Baltimore projects: $500-$1,200/LF

On the street:
design $50-$200/LF
construction $200-$500/LF.
Total: $250 - $700

TABLE 3.1
TYPICAL STREAM CHANNEL PROJECT CHARACTERISTICS AND CONSTRUCTION COSTS PER LINEAR FOOT
(assuming a second –third order stream)

Typical Projects	Per Linear Foot Construction Costs	Comments
Rural watershed requiring fencing and riparian buffers, and cattle watering	$25-75	Cost can be lower if implemented by volunteers or agency staff
Rural watershed requiring a priority one or two relocation (construct new floodplain and channel)	$50-100	No constraints to constructing new channel, readily available materials nearby
Suburban/Urban stream requiring bank stabilization, grade structures with some utility and similar constraints	$90-250	Stabilization in-place, and limited ability to salvage local materials increases costs
Urban watershed, highly confined channel stabilized in-place, requiring utility relocations, outfall repairs, with many constraints	$250-400	Urban constraints, utilities and outfalls result in high costs

Source: Costs were derived from a review of a range of projects, but individual project costs can be highly variable.
Construction costs include labor, material, equipment and installation, but excludes design costs.

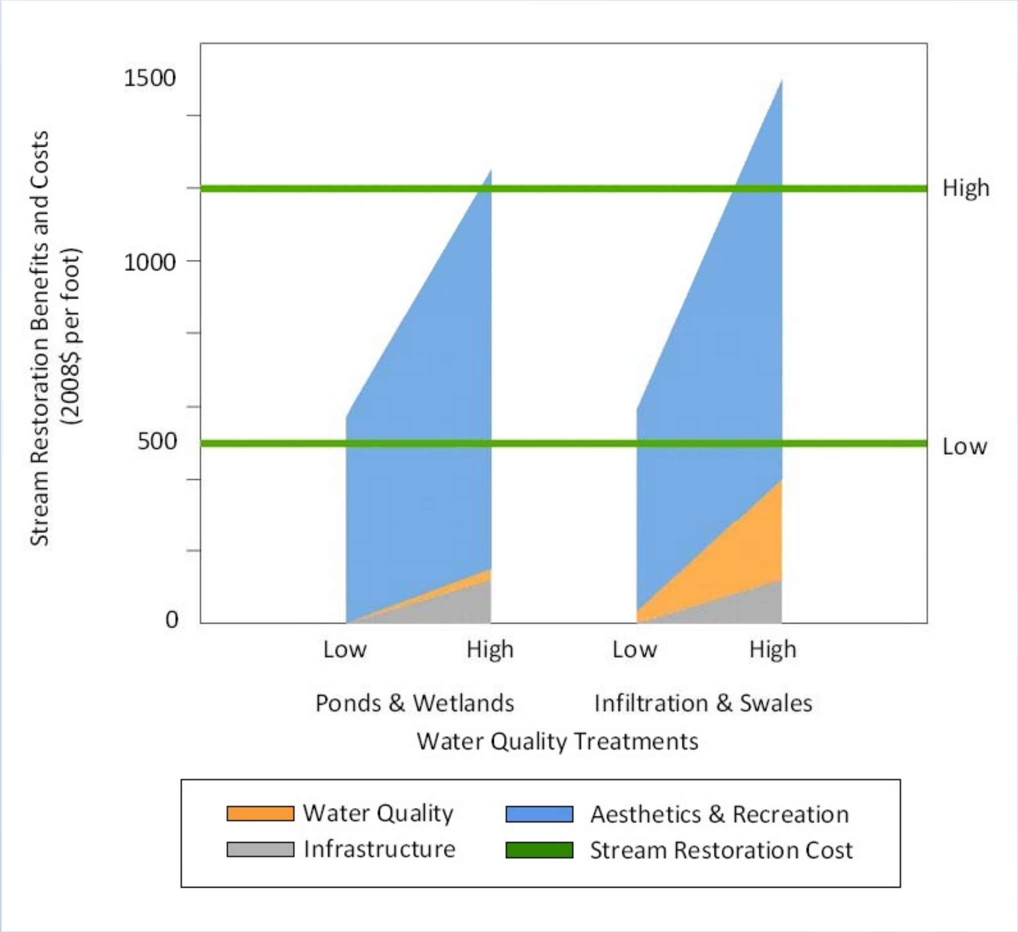
The Virginia Stream Restoration & Stabilization Best Management Practices Guide
2004

COST PER FOOT RANGE

- **Rural**
  - **2002: $94.40 - $146.85**
  - **2004: $80.16 - $234.39**
- **Urban**
  - **2002: $130.96 - $232.11**
  - **2004: $106.01 - $315.14**

Jurek 2004
Analysis of Stream Restoration Costs in NC EEP

So, is urban stream restoration worth it?



Based on water quality and infrastructure alone – ***probably NOT***, unless compelled to reduce loadings with only expensive alternatives available

If Aesthetic/Recreation value added in – ***could be***
& then there can be education, community, ethical value
& maybe ecosystem value too

Speaker has exceeded all bounds of taste and duration