Linking Stream Restoration Success with Watershed and Design Characteristics

Tess Wynn-Thompson, Biological Systems Engineering, VT

Eric Smith, Statistics, VT

Samuel Withers, RES, formerly graduate student in BSE, VT

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The goal of this project is to improve understanding of the conditions under which stream restoration projects are “successful”

- Provide insight into selecting potential restoration sites with high probability of success
- Improve overall application, design and review of stream projects

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What is project success?

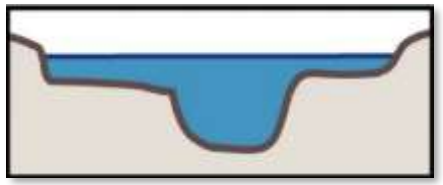
Channel Stabilization

Mitigation

TMDL Credits

Improve habitat

We developed three measures of project “success”



1. Field-based geomorphic function score
   - Floodplain access
   - Stable banks
   - Dense, native riparian vegetation
   - Region-appropriate bed material and bedforms
2. Field-based design score
   - Percentage of the original design still present
   - Are design features still functional
3. Monitoring report score – a mixture of function and design

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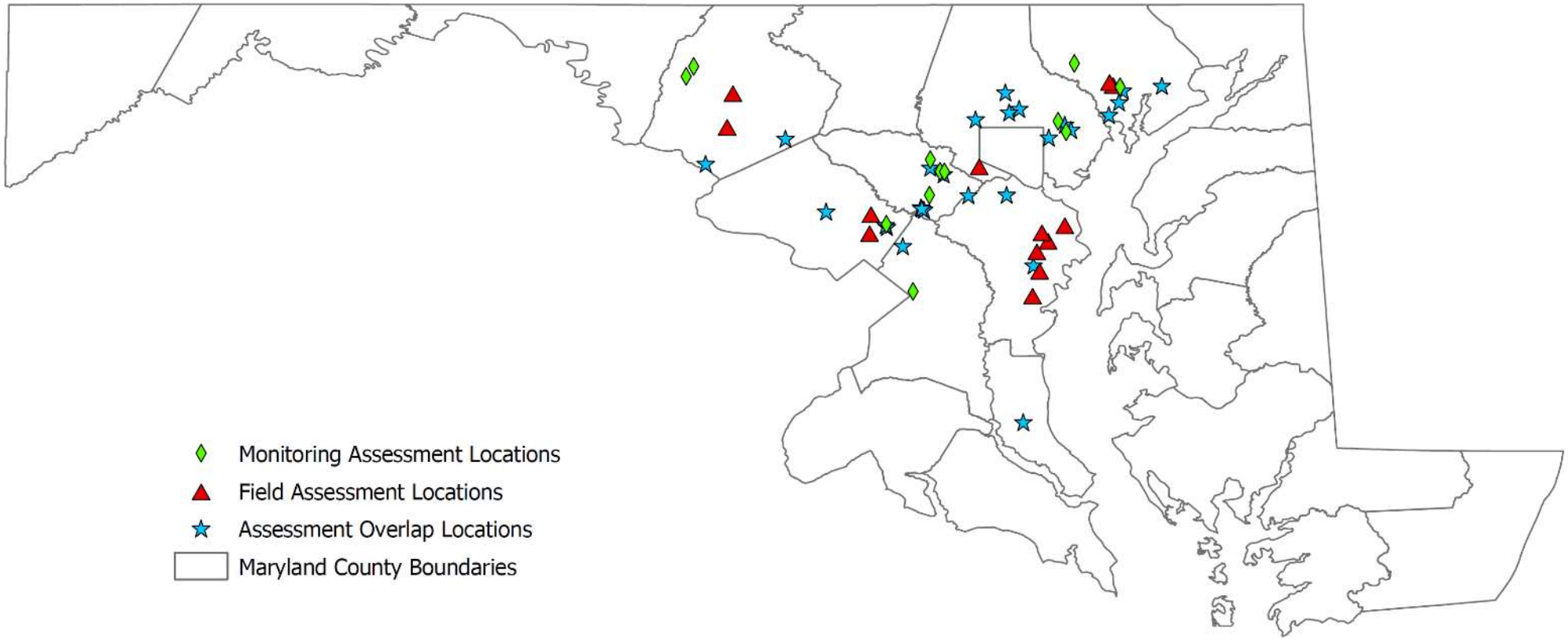
Statistical *Correlation*

Parameters which indicate:

- Flow energy
- Erosion resistance
- Design approach

44 field and 40 desktop assessments completed



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Watershed level data were collected using ArcGIS

Elevation data:

✓ 2-m DEMs from Maryland iMAP

USGS-NLCD land cover data:

✓ 2001, 2006, 2011, 2016

Soils data:

✓ NRCS web soil survey

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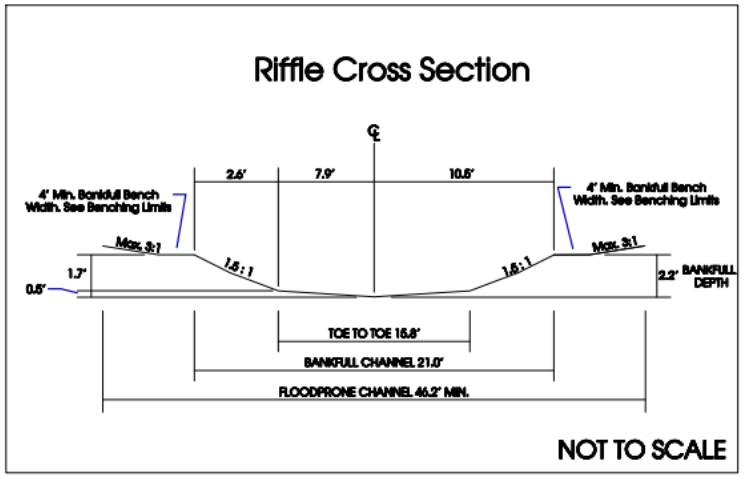
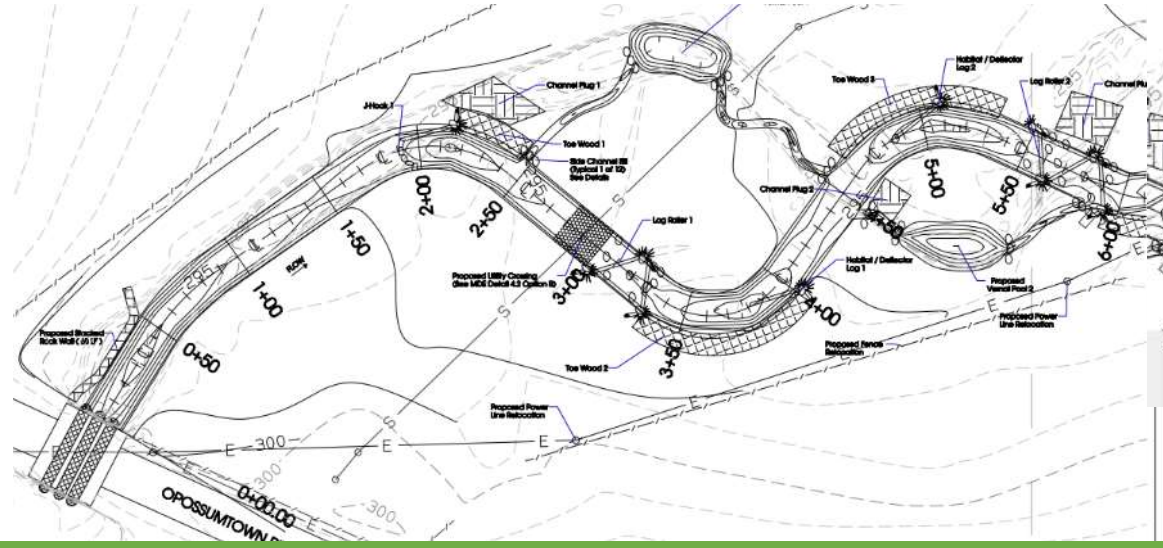
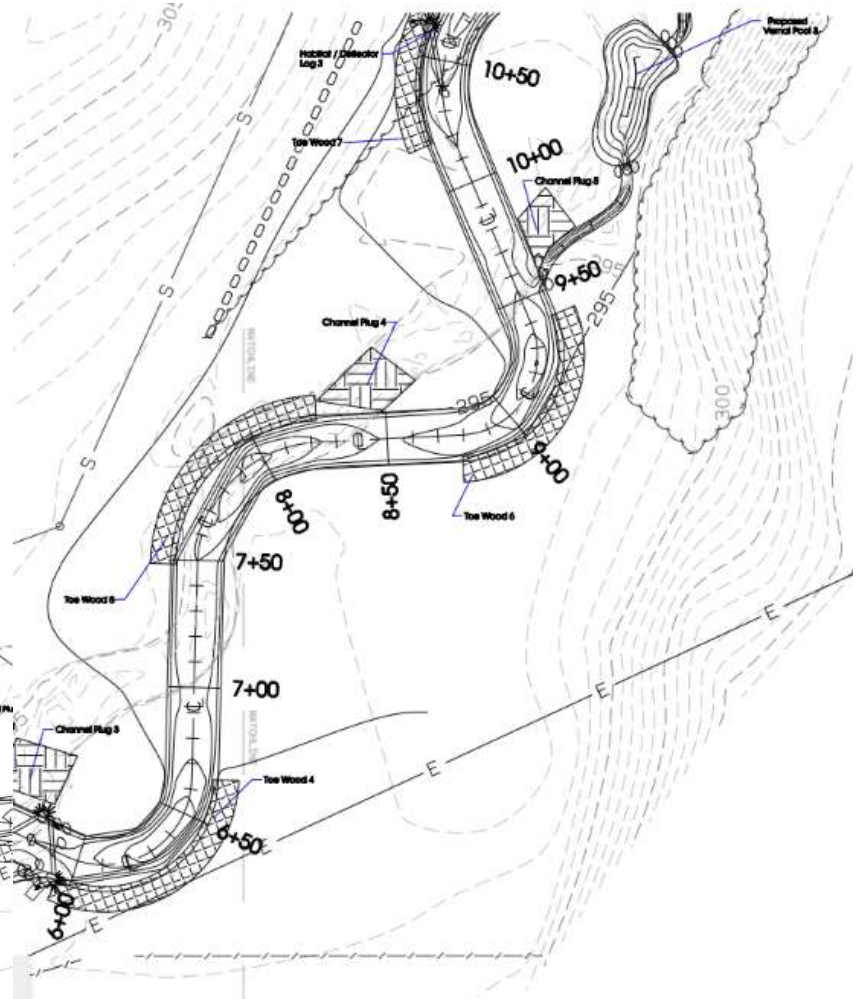
Project-level data were collected from project design plans and reports







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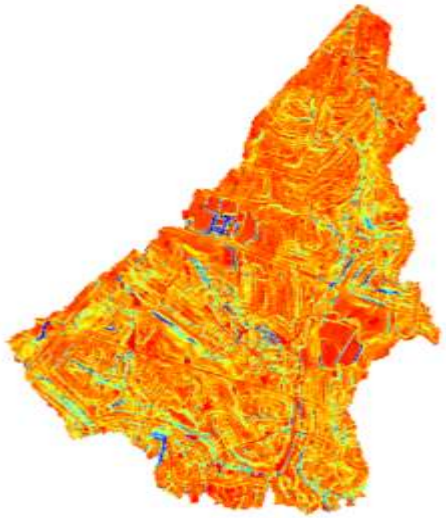
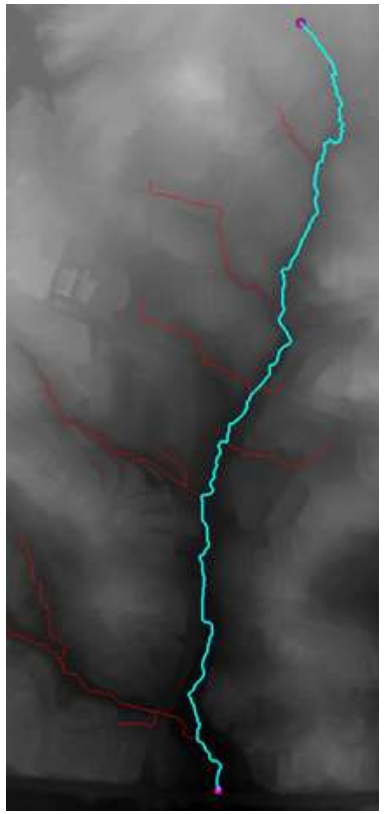
Example explanatory variables:

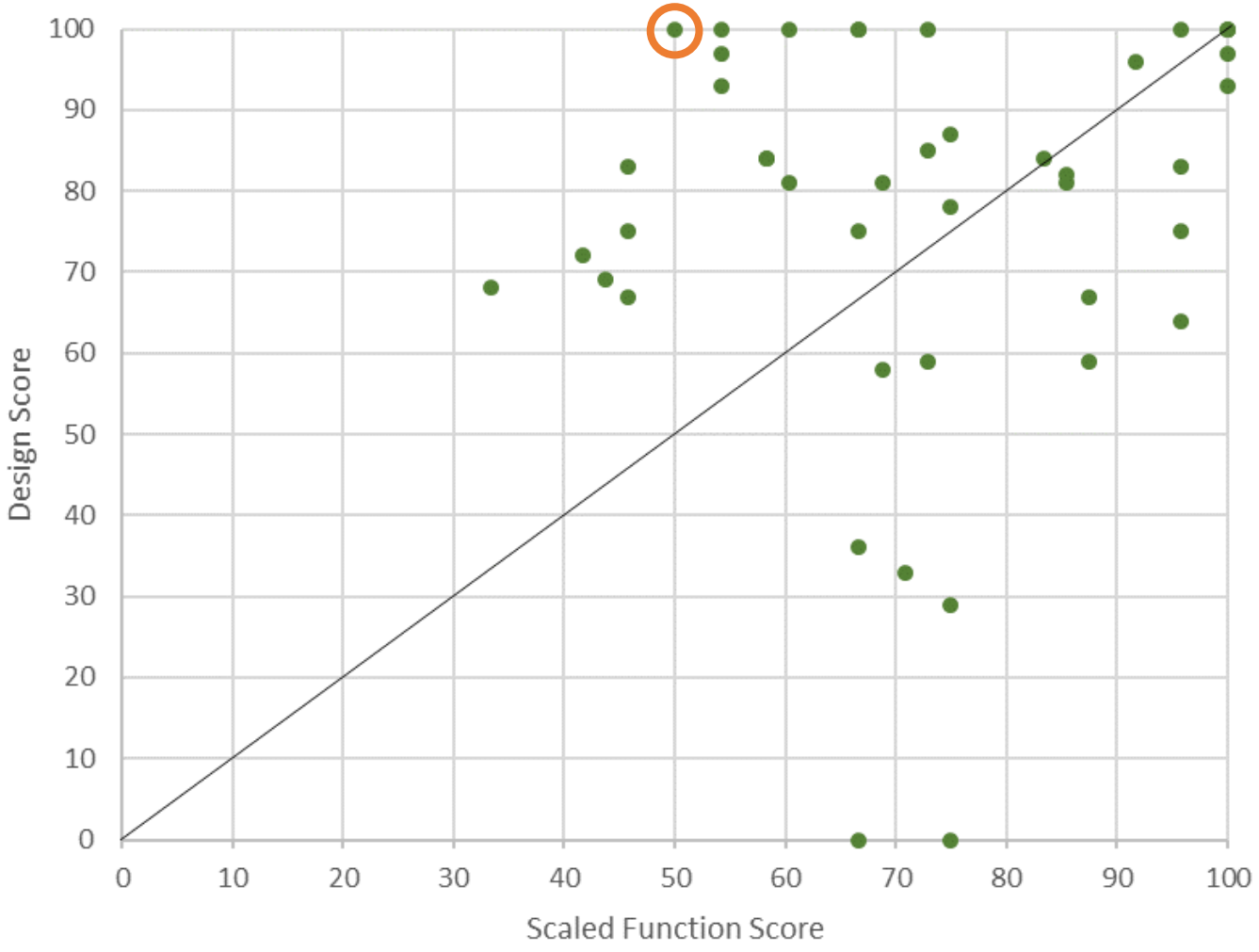
- Flow energy
  - Land cover
  - Discharge/watershed area
  - Unit stream power
- Erosion resistance
  - Soil erodibility
  - D_{50}/bankfull depth
- Design approach
  - Channel width:depth
  - Channel sinuosity





Results…

Projects assessed in the field scored differently in the function and design assessments



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Example: Project 42

- 100% design score
- 50% function score
- Confined - urban subdivision
- Step-pool channel
- Rock-lined

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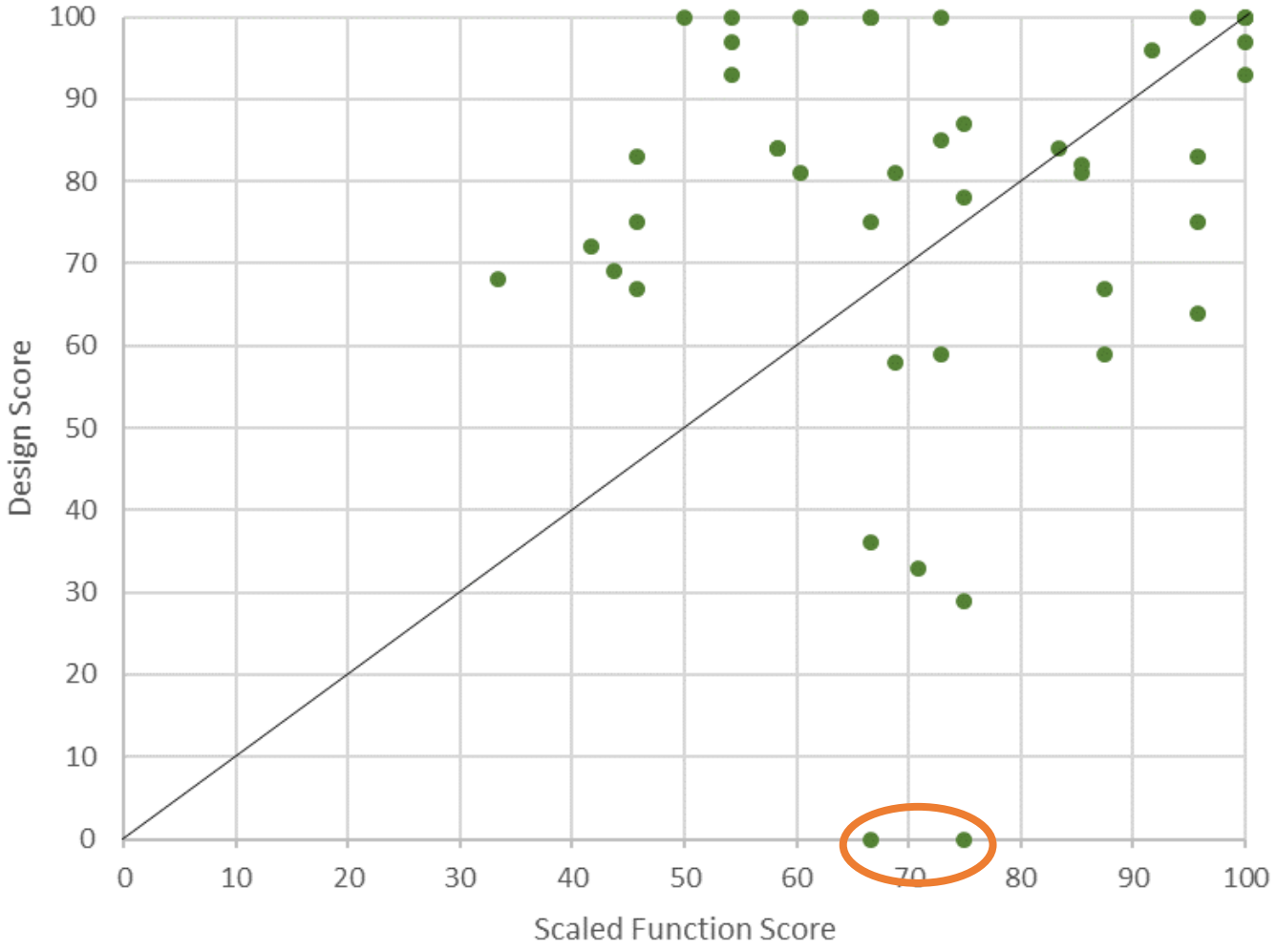
Projects assessed in the field scored differently in the function and design assessments



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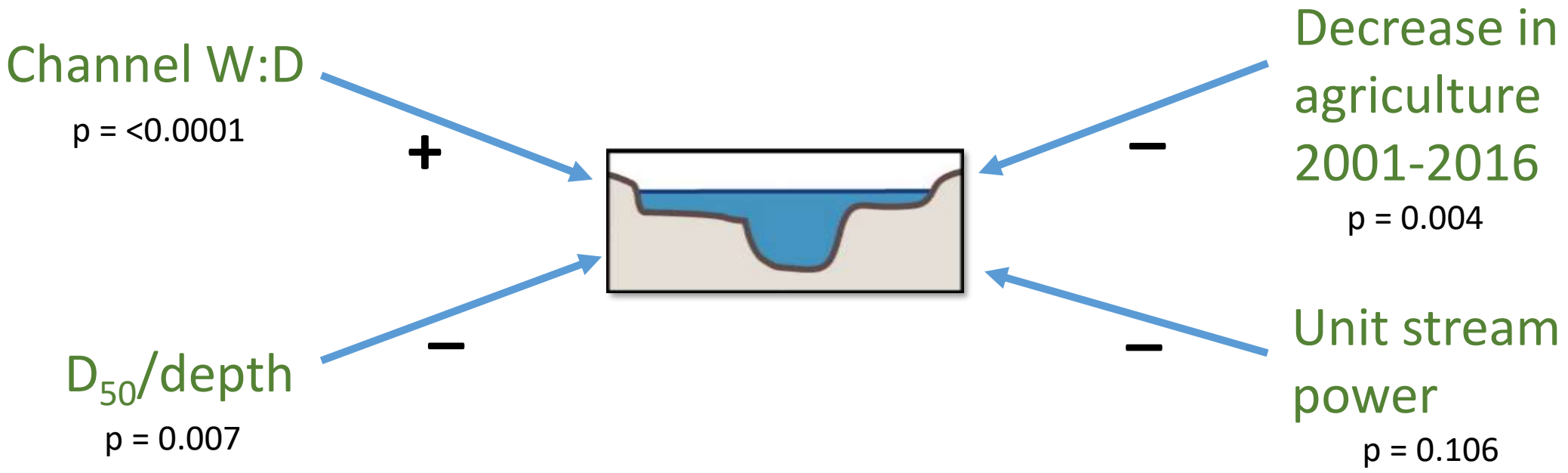
Projects 7 and 39 scored 0% on the design assessment but maintained high scores in the bedforms, substrate and cover categories.

Project 7
(1995)

Project 39
(1999)

Multiple linear regression analysis resulted in statistically significant ($p < 0.05$) relationships between project success and up to 4 explanatory variables

Geomorphic function was correlated with land cover change, channel width:depth, bed sediment size, and stream power.



Design success was correlated with project age, urban land cover, bed sediment size, and stormwater BMPs in watershed.

Year constructed

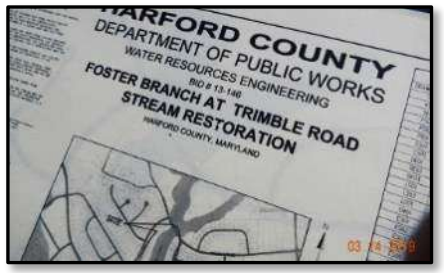
p = 0.036

+

2016 urban land cover

p = <0.0001

−



Stormwater BMPs

p = 0.002

−

D_{50}/depth

p = 0.008

+

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Design success was also correlated with:

– Distance to downstream grade control

\+ Entrenchment ratio (floodplain width/ bankfull width)

– Channel slope at project

Project scores based on monitoring reports were correlated with project age and length, stream discharge, and 2016 high density development.

Year constructed

p = 0.003

+

Project length

p = 0.006

−

Regression Equation

p = 0.003

Adj. r^2 = 0.28

Discharge/ watershed area

p = 0.024

−

2016 High density development

p = 0.099

−

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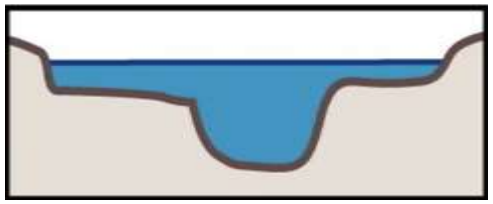
Research take-aways…



- Site selection is critical to restoring geomorphic function.
- Choose sites with…
  - Rural watersheds or watersheds without recent development
  - No constraints to decreasing bank height (increasing floodplain access)

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Research take-aways…

- Expect stream restoration design features to fail over time (~ 20 yrs.)
- Design in urban watersheds is challenging
- Design failure ≠ stream function loss
- If failure is not an option (e.g. infrastructure protection):
  1. Design with large bed particle size relative to channel depth
  2. Create as much floodplain access as possible
  3. Install grade control at the downstream end of the project

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Research take-aways…

Suggestions for monitoring reports

- Project goals should be clearly stated and measurable
- Post-project monitoring requirements should assess project goals
- Do not measure what will not assess project goals

Channel Stabilization

Mitigation

Improve habitat

TMDL Credits

Questions?

Final CBT Report