Showing a Restoration Benefit in the Chesapeake Bay Watershed: The Easy, the Not-So-Easy, and the Very Hard

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May 2, 2012

NWQMC
Water: One Resource – Shared Effort – Common Future
Eighth National Monitoring Conference
April 30 – May 4, 2012 • Portland, Oregon

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Outline

- Need to show a restoration benefit
- Restoration goals
- Monitoring challenges in time and space
- Matching goals to reality
  - The Easy
  - The Not-So-Easy
  - The Very Hard
- Solution for Chesapeake Bay
- Monitoring Advice

Need to Show a Restoration Benefit

- Proof is not yet provided
- Public is not convinced
- Governments need to justify expenditures
- Chesapeake Bay TMDL has a mandate to demonstrate benefits

➢ It's now or never

Restoration Goals

- All assessment (and therefore monitoring) should be goal oriented
  - Assessment objectives (indicators)
  - Measurement (monitoring) objectives
- So what are our goals?
  - Protection of infrastructure or property
  - Restored ecosystem health (designated uses)
    - Reduction in stressors (loading of pollutants, e.g., nutrients (N,P) and sediment)

➢ Results that are fast and over large scale

Monitoring Challenges

- Restoration takes TIME
  - Heal the construction
  - Overcome the legacy
  - Emerge from natural variability
- Ecosystems are BIG
  - Need many small projects to restore
  - Many outside forces confound results

Matching Goals to Reality

- Choosing a restoration goal has implications for monitoring feasibility (and cost)
  - **The Easy**: measuring what you actually did (e.g., changed the stream channel shape)
  - **The No-So-Easy**: measuring the proximal effect of that change (e.g., reduction in sediment load from bank erosion)
  - **The Very Hard**: measuring the ultimate effect on a resource of interest (e.g., improvement in the biota expected from a decrease in sedimentation)

The Easy

- Photodocumentation
- Cross sections
- Plan views
- Habitat features
- RBP physical habitat and BEHI

➢ Is the “as-built” correct?

Cross Sections

Easy

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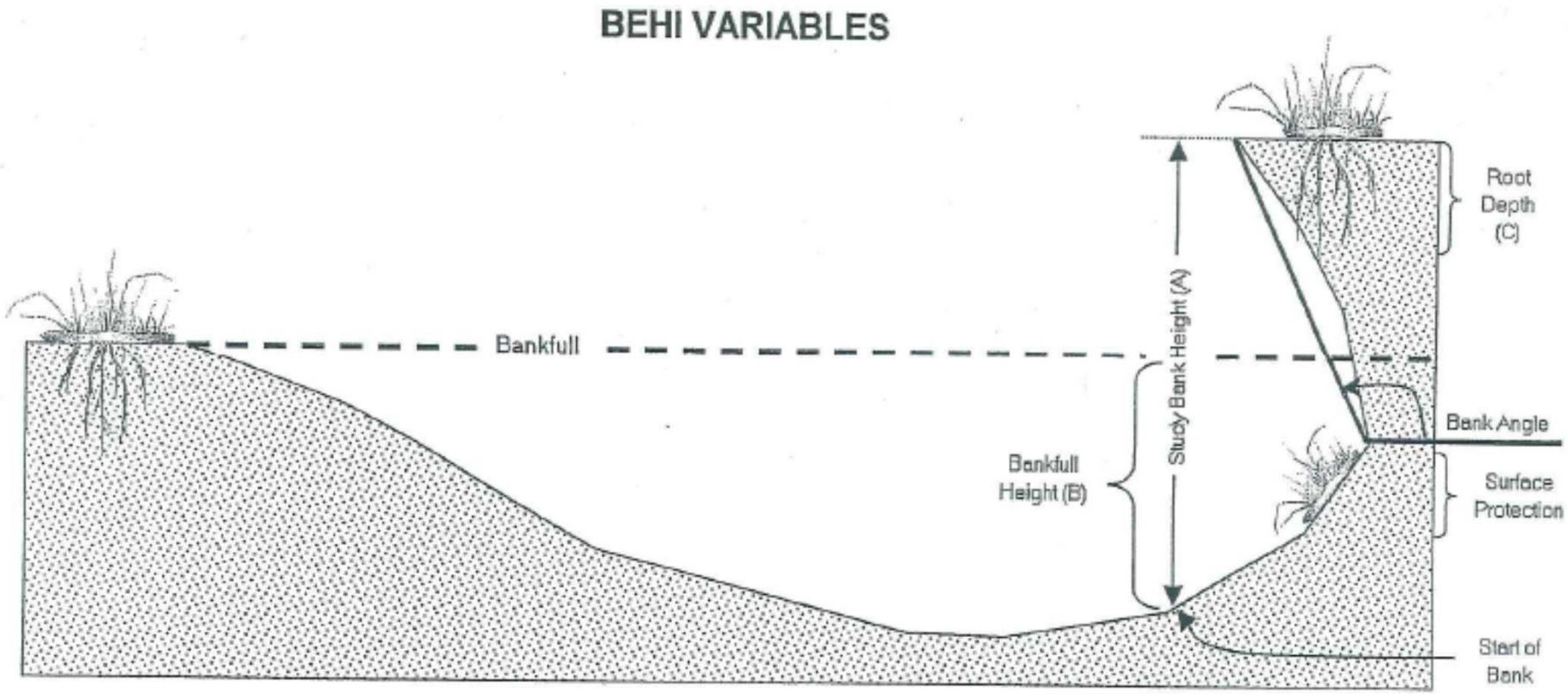
Plan View

RPB Habitat and BEHI



The Not-So-Easy

- Water chemistry
- Hydrology
- Pollutant loadings
- Channel structure
  - Cross sections over time
  - Bank pins and scour chains
- Sediment dynamics
  - Pebble counts
  - Sediment traps
  - Siphon samplers

Water Chemistry

Not-So-Easy

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Hydrology and Loadings

Not-So-Easy

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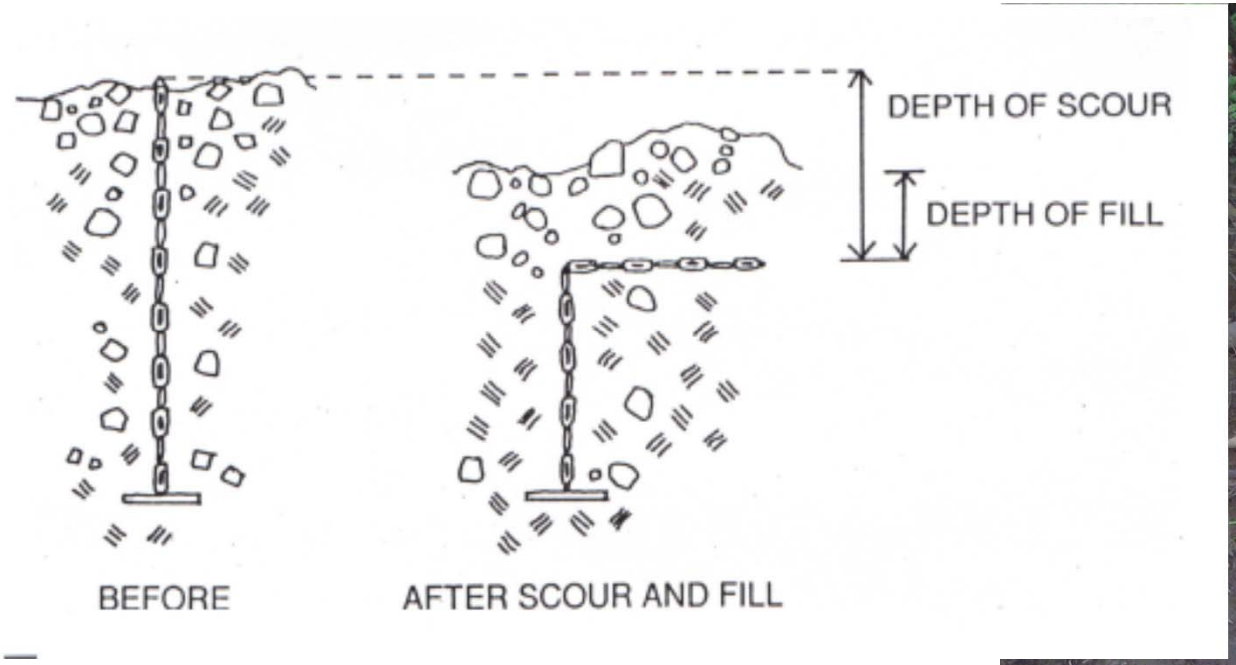
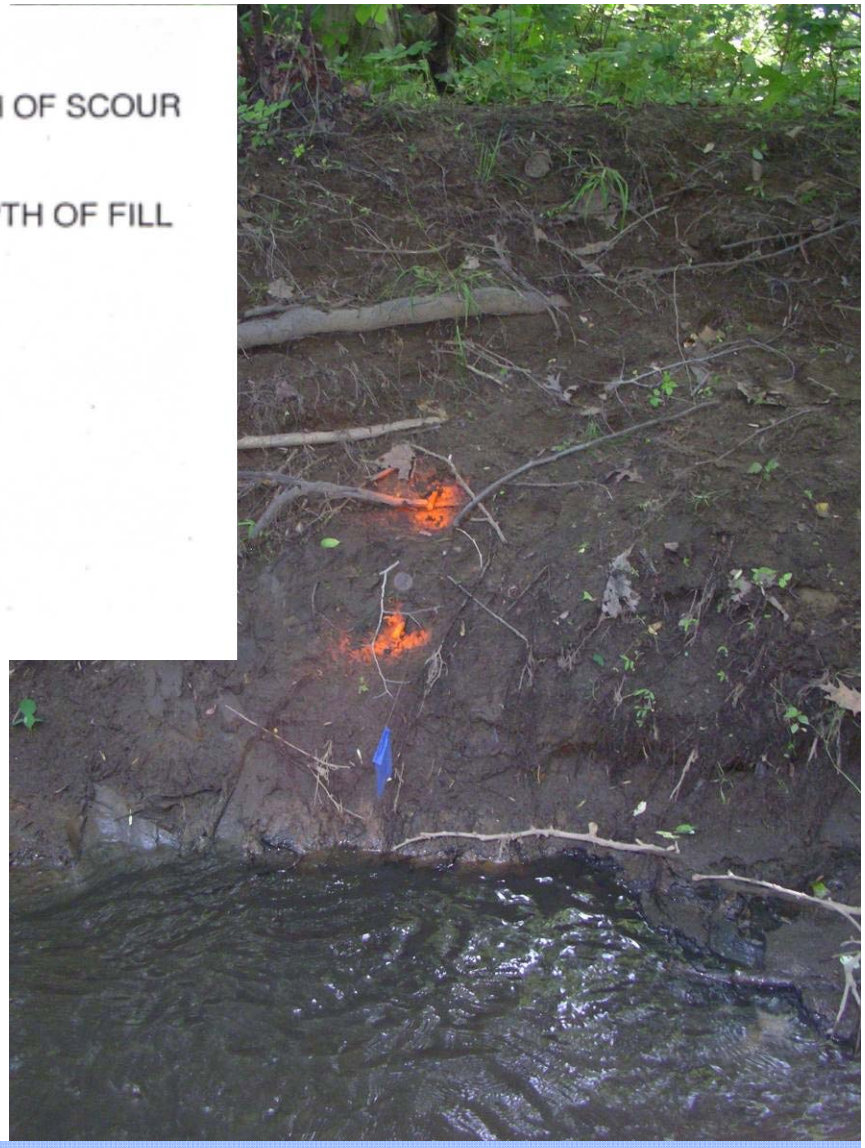
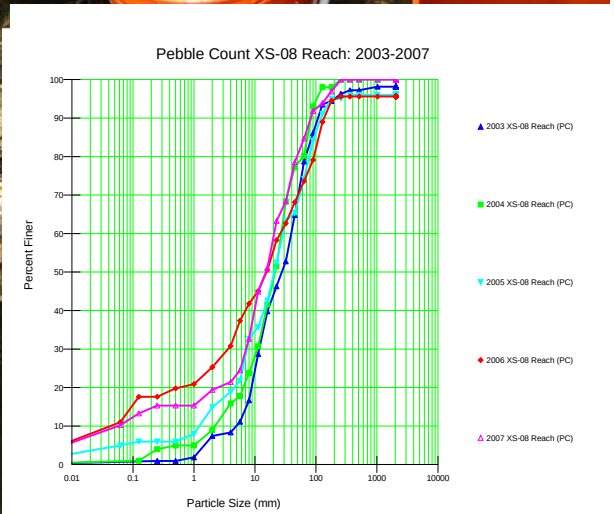
Bank Pins and Scour Chains





Pebble Counts and Sieves



Not-So-Easy

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The Very Hard

- Benthic macroinvertebrate community
- Fish community
- Other biota
- Rare species
- Stream metabolism
- Other stream functions
- Connection to larger ecosystems

Benthic Sampling

Very Hard

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Electrofishing

Very Hard

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Other Biota and Rare Species

Very Hard

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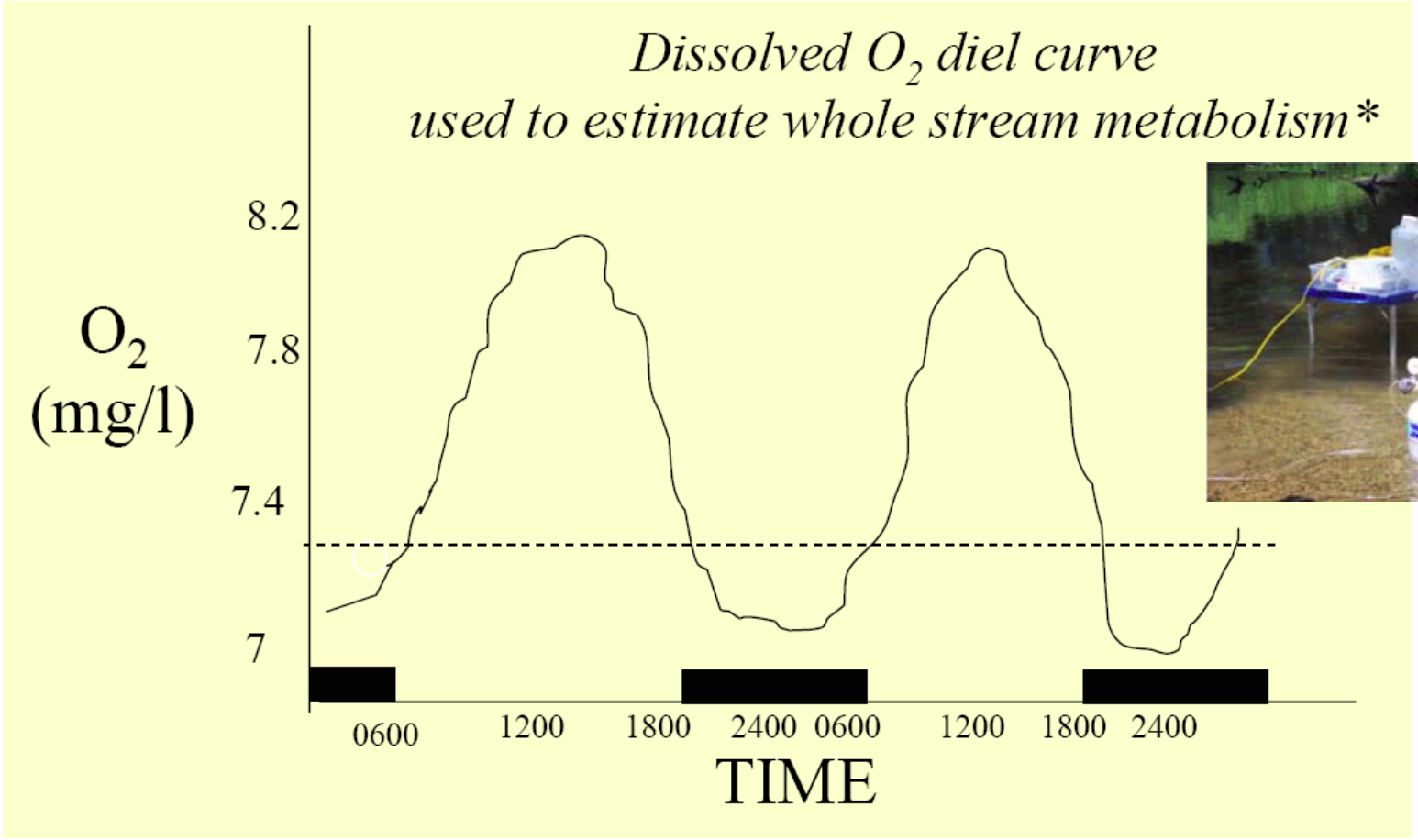
Stream Metabolism



NDM* = **GPP** – **community respiration**

Average daytime O_2 production (includes losses due to heterotrophic respiration)

Average night-time O_2 use

Very Hard

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The Very Hard

- **Good**: We have indicators
  - MBSS IBIs for benthos and fish
  - References for biotic integrity and biodiversity
  - Not-so-hard to sample
- **Bad**: Indicators are subject to confounding
  - Variability in IBIs
  - Annual variability
  - Land use and other stressor changes
  - Legacy effects
  - Delays in response
  - ➢ Monitoring to date has shown little or no response of biotic communities

Solution for Chesapeake Bay

- Chesapeake Bay TMDL requires
  - Watershed Implementation Plans (WIPs)
  - 2025 deadline for restoration
  - 2017 interim deadline for adaptive management
  - 2-year milestones to measure progress
- Maryland Trust Fund requires
  - Monitoring of shovel-ready projects
- MS4 stormwater permits require
  - Monitoring of watershed restoration

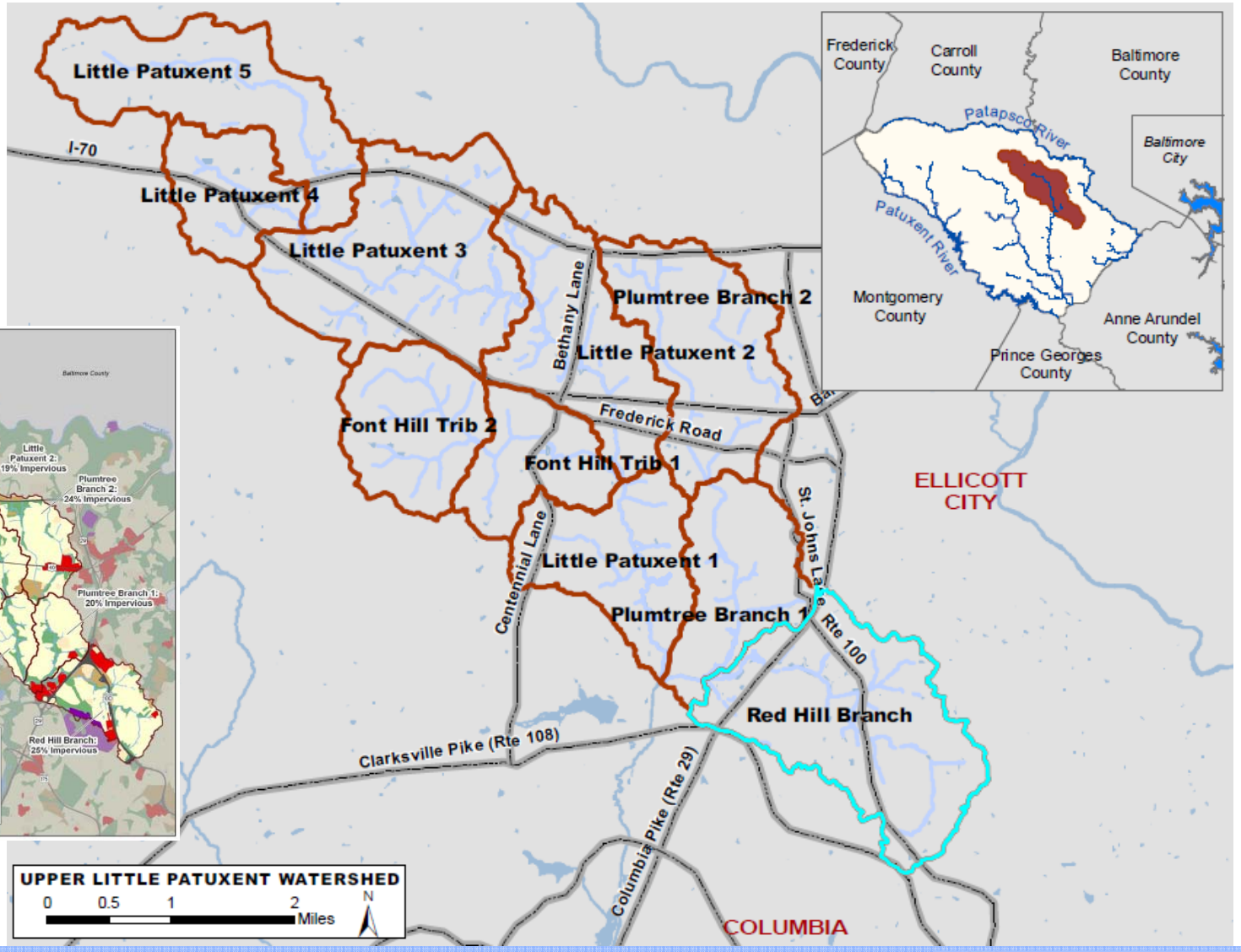
Monitoring Solution

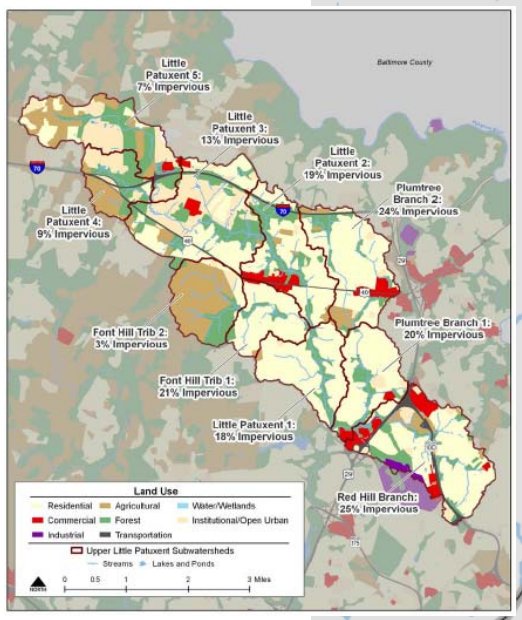
- Goals are to "reduce downstream loadings of nutrients and sediment" and restore watersheds
- Proximal solution
  - Throw the kitchen sink at demo projects
- Ultimate solution
  - Minimal set of indicators with strongest signal
- Scale is tiered
  - Monitor clustered projects in subwatersheds to show early benefit
  - Use representative sites to extrapolate results

Monitoring Solution

- Methods are
  - Easy: Physical habitat assessment scores
  - Not-So-Easy:
    - Cross sections over time
    - Bank pins erosion rates
  - Very Hard: Benthic IBI
- Scales are
  - Red Hill Branch “kitchen sink”
  - Little Patuxent “clustered projects”
  - Montgomery County “representative network”

Upper Little Patuxent Watershed





Solution

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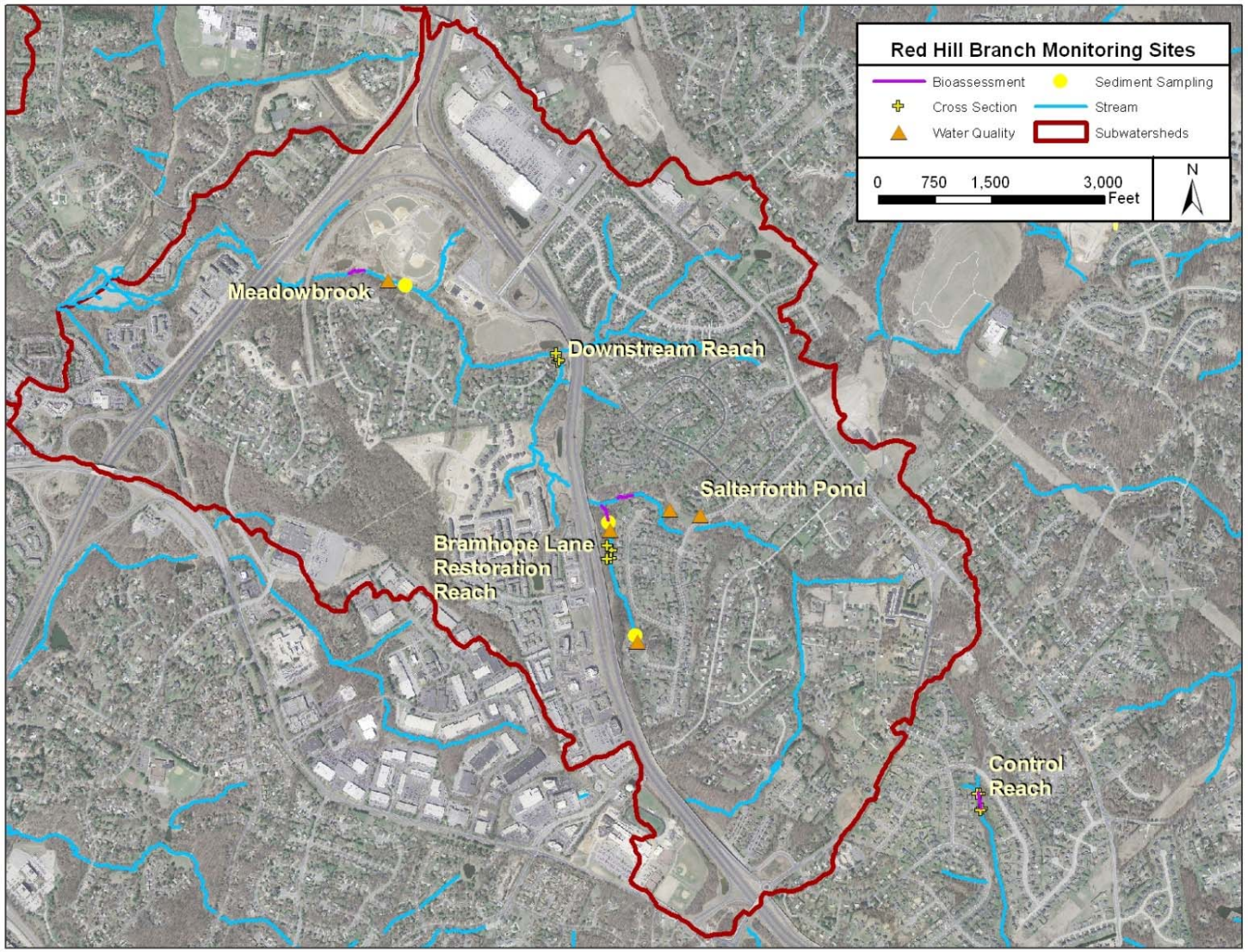
Red Hill Monitoring Locations



Red Hill Monitoring Design

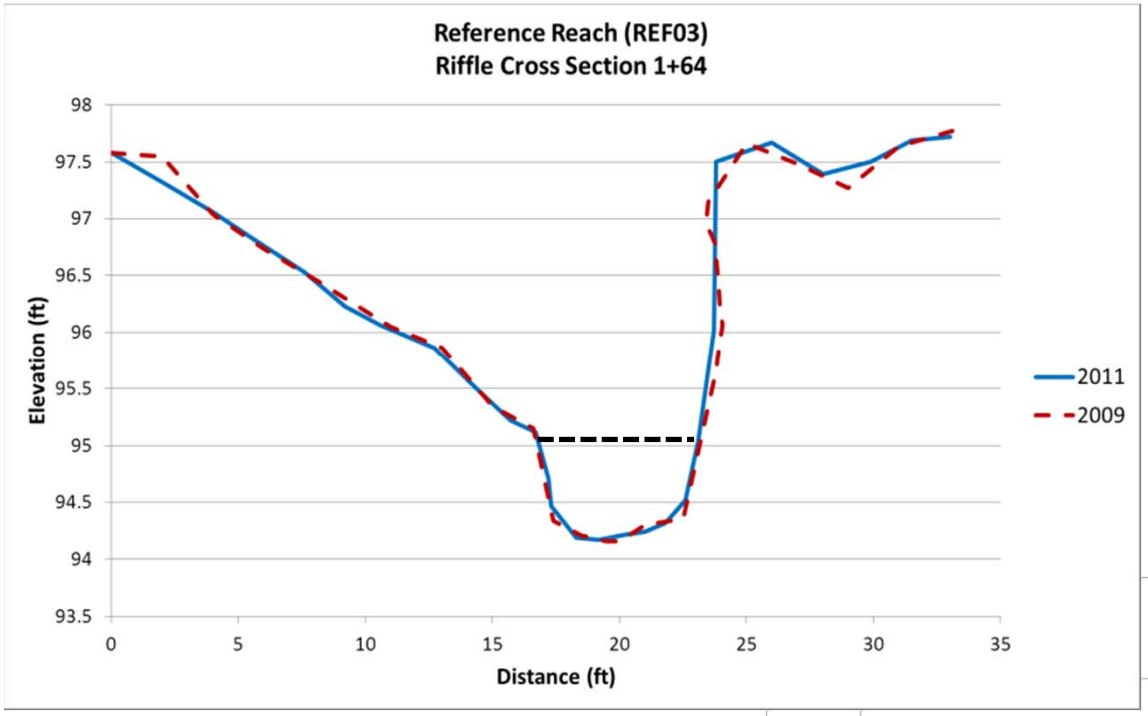
- Project Specific Goals
  - Downstream loadings of nutrients and sediment
  - Watershed condition
- BACI Design
  - Compare pre- and post-restoration conditions
  - Compare to unimproved control reach
- Monitoring Constraints and Confounding Factors
  - Numerous stormwater outfalls
  - State Highway ditch from Route 100
- Three Monitoring Reaches
  - Within restoration reach
  - Downstream of restoration
  - Adjacent subwatershed (control)

Physical Habitat Scores

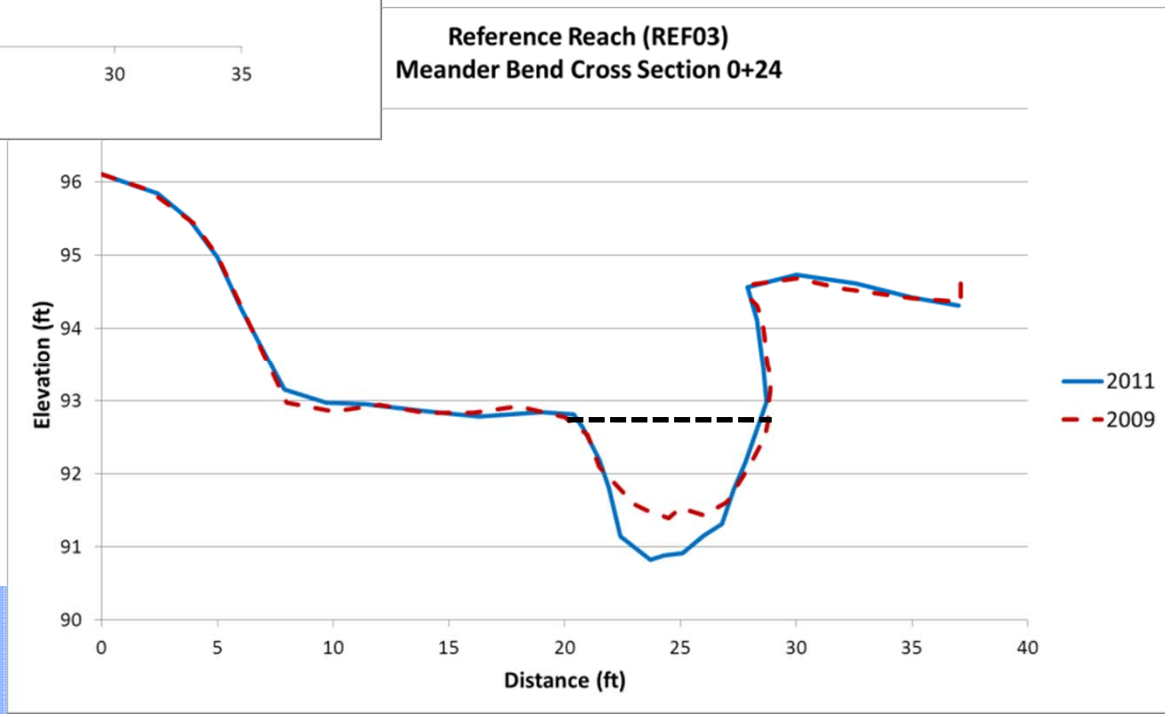
- **Physical Habitat Assessment scores are consistent across all sites and years**

Site	2010 RBP		2011 RBP	
BIO-1	58.5	Non-Supporting	58.6	Non-Supporting
BIO-2	60	Partially Supporting	59.7	Non-Supporting
BIO-3	60	Partially Supporting	72.4	Partially Supporting
BIO-4	60.5	Partially Supporting	65.8	Partially Supporting

Compare Meander Cross Sections



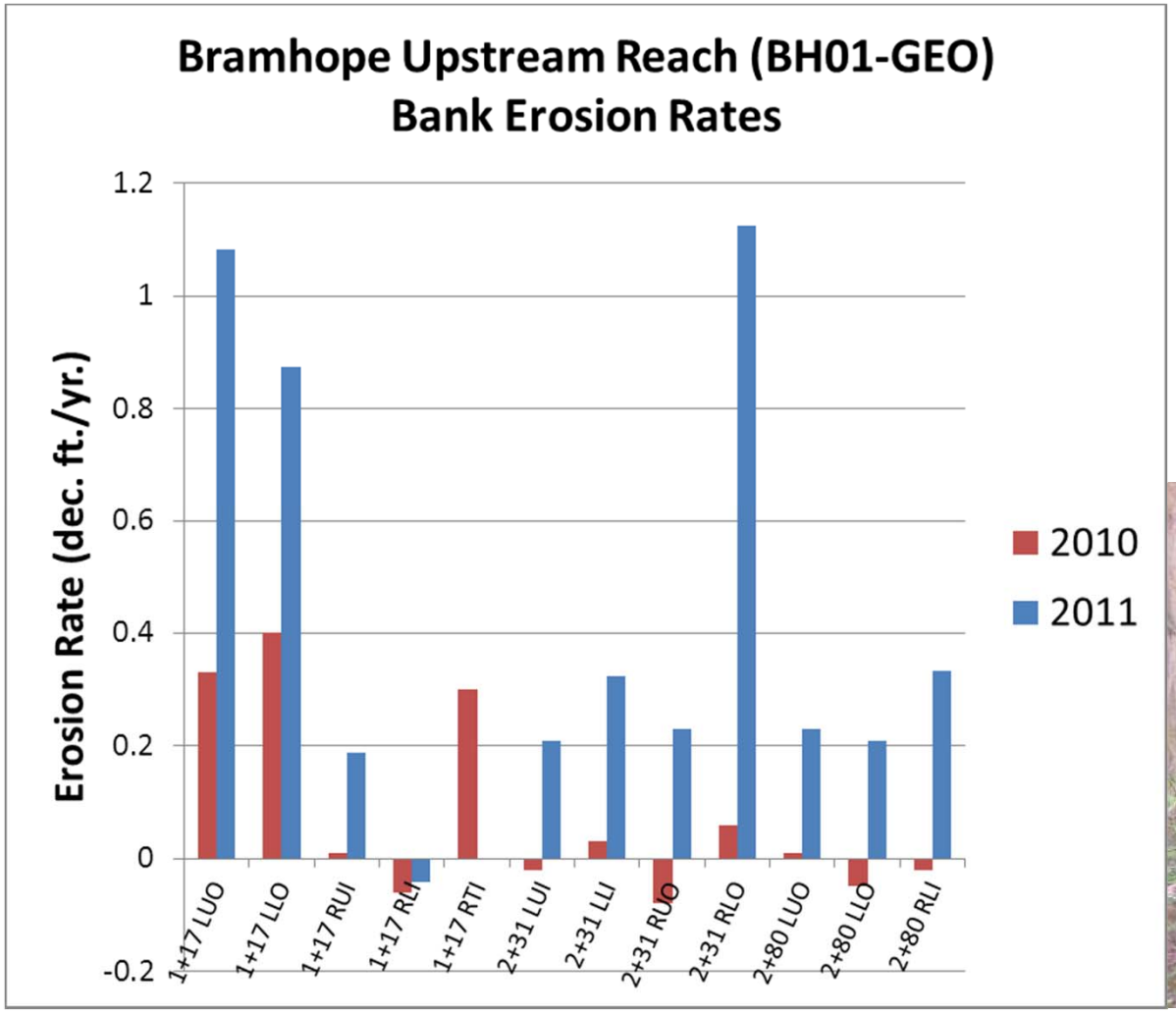
- Riffle CSs remain relatively unchanged



- Meander bend CSs are more sensitive to erosion changes

Solution (No-So-Easy)

Bank Pin Erosion Rates



- Bank pins are another sensitive measure of erosion and sediment loss

Solution (Not-So-Easy)

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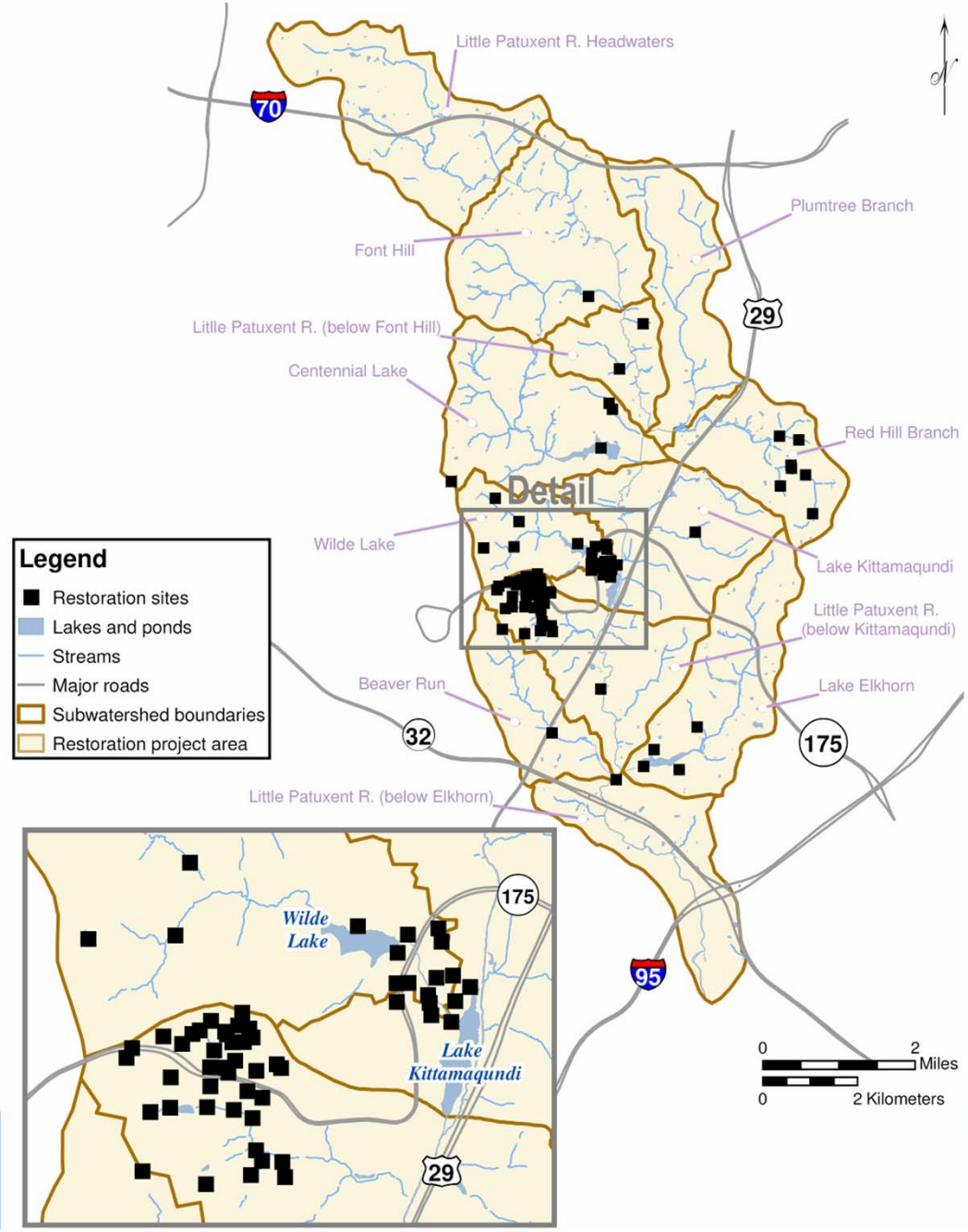
Biological Monitoring

- Benthic macroinvertebrate IBI is most robust and widely comparable
- BIBIs stable across two years at site

SITE	2010 BIBI		2011 BIBI	
BIO-1	1.67	Very Poor	1.67	Very Poor
BIO-2	2.67	Poor	1.67	Very Poor
BIO-3	2.33	Poor	2.33	Poor
BIO-4	1	Very Poor	1.67	Very Poor

Little Patuxent Trust Fund



- Projects are **clustered** for quicker cumulative response

Solution

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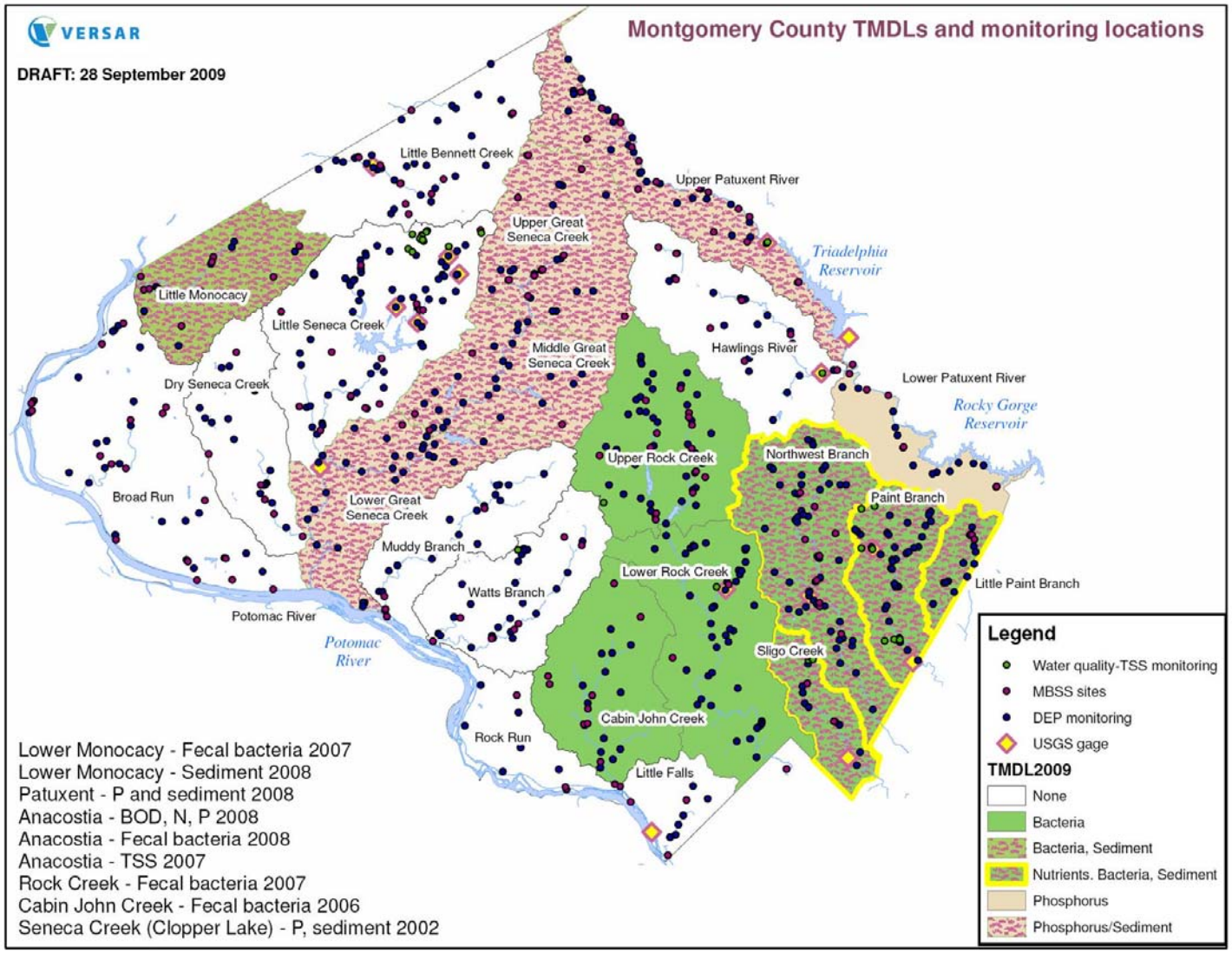
Montgomery Co MS4

Extrapolation of Representative Sites



Monitoring Advice

- Choose appropriate goals:
  - Be clean (safe for human contact and consumption)
  - Be good neighbor (no adverse loadings downstream)
  - Be good steward (ecological health and biodiversity)
- Choose methods to show a restoration benefit quickly to establish political will and to allow for adaptive management
- Choose representative sites so you can extrapolate

➢ **Always choose an Easy method** (to go with your Not-So-Easy and Very Hard)

➢ **Use a tiered monitoring approach across multiple scales** to show early restoration benefit