Monitoring and Assessing Change in Urban Waters

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Virginia & West Virginia Water Science Center
Our questions....

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>What are the <strong>hydrologic conditions</strong> in urbanized watersheds?</td>
<td>How are they <strong>changing over time</strong>?</td>
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<tr>
<td>What are the <strong>nutrient and sediment loads</strong> from urbanized watersheds</td>
<td>How are they <strong>changing over time</strong>?</td>
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<td>across different <strong>physiographic provinces</strong>?</td>
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<tr>
<td>What is the <strong>benthic macroinvertebrate</strong> community structure?</td>
<td>How is it <strong>changing over time</strong>?</td>
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<td>How do these conditions <strong>compare to urbanized watersheds</strong> in other</td>
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<td>areas?</td>
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<td>How do monitored conditions (ie. Loads) <strong>compare to modeled conditions</strong></td>
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<td>What are the <strong>drivers of the changes</strong> observed?</td>
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<td>What effect are <strong>management actions</strong> having on small urban/suburban</td>
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<td>watersheds?</td>
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Urban Stream & Stormwater Monitoring Approaches

**Intensive Monitoring**

Monitoring Scale $\propto$ Watershed Scale

(Temporal) (Spatial)

Monitoring smaller-scale watersheds requires finer-scale data

- Scaling of hydrographic response time with watershed scale
- Desire to understand processes and detect/describe changes
Urban Stream & Stormwater Monitoring
Approaches

**Intensive Monitoring**

**Continuous Monitoring**
- 5-minute interval data
  - Streamflow
  - Water Quality (temperature, turbidity, SC, pH, DO, NOx)

**High Frequency Sampling**
- Autosamplers
- Nutrient and Sediment Analyses

**Surrogate Methods for Load Computation**
- Using continuous WQ data to compute

**Benthic Macroinvertebrate Sampling**
Fairfax County Virginia
20 stations since 2007

Hampton Roads Virginia
12 stations since 2014

City of Roanoke Virginia
1 station since 2016
City of Roanoke Virginia
City of Roanoke Virginia

Objectives:
1. Compute suspended sediment loads for Lick Run using methods which permit rapid computation of accurate and precise loads.
2. Assess relations between monitored loads and implementation of management practices.
3. Operate a 9-station precipitation monitoring network to inform stormwater management.

Approach: Intensive Monitoring

13” difference across City (43 mi²)
Hampton Roads Virginia
Hampton Roads Virginia

Problem:
Data describing sediment and nutrient loading rates within the urbanized Coastal Plain are lacking.

Limitations on the calibration of the Chesapeake Bay Watershed Model in these areas

Objectives:
1. Collect high quality nutrient and sediment data representative of the Coastal Plain
2. Compute loads that can be compared to those developed for the Chesapeake Bay TMDL

Approach:
Intensive Monitoring
- IN Stormwater System

https://va.water.usgs.gov/HRstormwater
Fairfax County Virginia
20 stations since 2007
Fairfax County

Water-Resources Monitoring:

Assessing Watershed Scale Responses to BMP Implementation in Urban Watersheds
Fairfax County, VA

Northern Virginia – Washington, DC Suburbs
Highly urbanized
Population 1+ million

Potomac River Watershed
Piedmont and Coastal Plain Provinces
>1,600 miles of streams
>75% rated Fair, Poor, or Very Poor

2nd highest median household income in nation
County Budget ≈ $8.4 billion
$83 million for stormwater
Study Objectives

Phase 1

*Ongoing since 2007*

1. Generate long-term monitoring data to describe:
   - Current water-quality conditions,
   - Trends in water-quality,
   - Nutrient and Sediment Loads and Yields.

Phase 2

2. Transfer the understanding gained to other less-intensively monitored watersheds.

3. Evaluate relations between observed conditions/trends and BMP implementation.
Approach: Intensive Monitoring

5 intensive monitoring stations

10+ years of data collection

- Continuous Streamgage
- Continuous water-quality monitor
  (turbidity, pH, SC, water temp, DO)
- Nutrient & Sediment Sampling
  - Automated sampler (storm samples)
  - Scheduled monthly sampling

Annual benthic macroinvertebrate monitoring
Approach: Knowledge Transfer – Trend Monitoring

15 trend monitoring stations

- Partial-record stream gage
- Nutrient & sediment sampling
  - Scheduled monthly sampling
- Annual benthic macroinvertebrate monitoring

Evaluate long-term trends with greater spatial density

Evaluate spatial patterns with greater resolution
Approach: BMP Evaluation

Assembling datasets to describe landscape change

- BMP Implementation
- Development
- Other Factors

Evaluate relations between stream responses and implementation

Stream restoration is the primary management strategy in Fairfax Co.

http://fairfaxcountygis.maps.arcgis.com
Network Design

Goal: Represent the range of land use conditions across the County

Structured Approach to Site Selection
- GIS Analysis
- Statistical Analysis
- Local Knowledge

All watersheds <5 mi²

- Trend Monitoring Station
- Intensive Monitoring Station
- Site Added in WY 2013
Where are we now?

≈11 years of monitoring
  • >50 site-years of continuous WQ & Flow
    • Tens of millions of individual measurements
  • ≈ 100,000 records from discrete WQ samples
  • >50 site-years of benthic macroinvertebrates

  • Study design
  • Characterizations from 1st 5 years of monitoring
  • Nutrient & Sediment Loads

Extensive implementation County-wide

Comprehensive analysis and reporting effort underway
Publications and Websites

Fairfax County Monitoring
Program Website: https://va.water.usgs.gov/fairfax/

- Describes study design
- Summarizes initial 5-years of monitoring
- Nutrient and Sediment Loads

Hampton Roads Monitoring
Program Website: https://va.water.usgs.gov/HRstormwater

2016 Fact Sheet: https://doi.org/10.3133/fs20163095

City of Roanoke Monitoring
Program Website: http://www.usgs.gov/projects/CityofRoanoke

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