Aquatic Ecosystem Health in Shenandoah National Park
- Benthic Macroinvertebrate Monitoring Results
  (1990-present)

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- Lots, and lots, and lots of field techs
Monitoring History

• National Park Service Vital Signs Program

• Water quality (1979 – present)
• Fish (1982-present for brook trout, 1996 – present for all fish species)
• Macroinvertebrates (1984 – present)
Explaination

- Shenandoah National Park Boundary
- SHEN Monitoring Stations
- Siliciclastic Bedrock
- Granitic Bedrock
- Basaltic Bedrock

From Jastram et al (2013)
Project Initiation (2010)

• Long term trends in biota had not been formally assessed and a holistic review of water resource data was needed.

Jastram et al (2013)
• Geology is a major spatial driver of water quality problems (i.e. acidification) with smaller, high elevation siliciclastic basins most impacted.

• Temporal trends indicate continued degradation and lack of recovery in poorly buffered systems, some improvement in other watersheds

• Almost all water temperature measures show increasing trend (over last decade median +0.3° C/year)
Benthic Macroinvertebrate Monitoring
Benthic Macroinvertebrate Metrics

- Richness
- EPT richness
- % EPT
- % Ephemeroptera
- Hydropsychidae:T%
- Leuctra:P%
- %2 Dominant Taxa

- Simpson D
- Pollution tolerance value (PTV)
- % Intolerant
- % Scrapers
- % Shredders
- % Haptobenthos
- VA Stream Condition Index (SCI)

Some go up...and some go down... and some go all around...
Spatial and Temporal Analysis

• Principle Component Analysis used to reduce number of environmental variables and general linear modeling used to assess geology and watershed area and interaction on measures

• For temporal trends
  • Simple linear regression
Geology

-was a very strong predictor, significant with 12 metrics and explaining up to 64% of variation in some metrics
Leuctra stoneflies

Acidification — highly tolerant

Temperature increase — highly sensitive

Most pollution — highly sensitive

Buffering capacity

EPT%

Siliciclastic  Granitic  Basaltic
Spatial Results

Watershed Area

7 metrics were significantly influenced by watershed size

- Richness + EPT richness
- PTV
- %Intolerant
- SCI
- %Haptobenthos
- % Shredder
Benthic Macroinvertebrate Trends

7 metric trends showed significant **parkwide** trends at some time scale

<table>
<thead>
<tr>
<th>Metric</th>
<th>Stream Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richness</td>
<td>Declining</td>
</tr>
<tr>
<td>EPT richness</td>
<td>Declining</td>
</tr>
<tr>
<td>Simpson D</td>
<td>Declining/Neutral</td>
</tr>
<tr>
<td>Dominant 2</td>
<td>Declining/Neutral</td>
</tr>
<tr>
<td>% Leuctra</td>
<td>Indeterminate</td>
</tr>
<tr>
<td>%Ephemeroptera</td>
<td>Indeterminate</td>
</tr>
<tr>
<td>%Haptobenthos</td>
<td>Indeterminate</td>
</tr>
</tbody>
</table>

[Image of a graph showing trend lines and data points with Richness on the y-axis and Time period of analysis on the x-axis.]
7 metric trends were dependent upon geologic class.

In general, showed stream health stream health declines in poorly buffered systems and improvements or no trend in well buffered watersheds.
Mean annual temperature and *Leuctra* abundance (Z scores)

- Mean temp
- Mean Leuctra
Mean annual temperature and *Leuctra* abundance (Z scores)
Mean annual temperature and *Leuctra* abundance

(Z scores)

Mean temp

Mean *Leuctra*
Benthic macroinvertebrate summary

- Geology is major driver of spatial patterns in macroinvertebrate metrics, largely result of water quality (i.e. acidification).

- Temporal trends indicate small declines in ecosystem health parkwide with larger declines in condition in more acidified (i.e. siliciclastic geology) watersheds

- Increase in water temperature may be driving declining stream conditions parkwide
Moving Forward

• Use data to support air quality improvements/mitigation/regulatory environment

• Restructure monitoring plans?
  • Difficult to formally assess current data holistically
  • Develop park standards

• Stream liming (?)
Synthesis and Interpretation of Surface-Water Quality and Aquatic Biota Data Collected in Shenandoah National Park, Virginia, 1979–2009

By John D. Jastram, Craig D. Snyder, Nathaniel P. Hitt, and Karen C. Rice

Questions?

http://pubs.usgs.gov/sir/2013/5157/