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

2009

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# Acknowledgements – going back, way back


- David Demarest (NPS), Reese Voshell and Steve Hiner (VA Tech)
- SWAS ( Rick Webb, Jack Cosby, Jim Galloway)
- USGS (Karen Rice, John Jastram, Than Hitt)
- Lots, and lots, and lots of field techs


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# 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)

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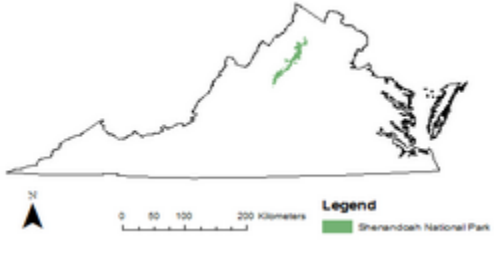
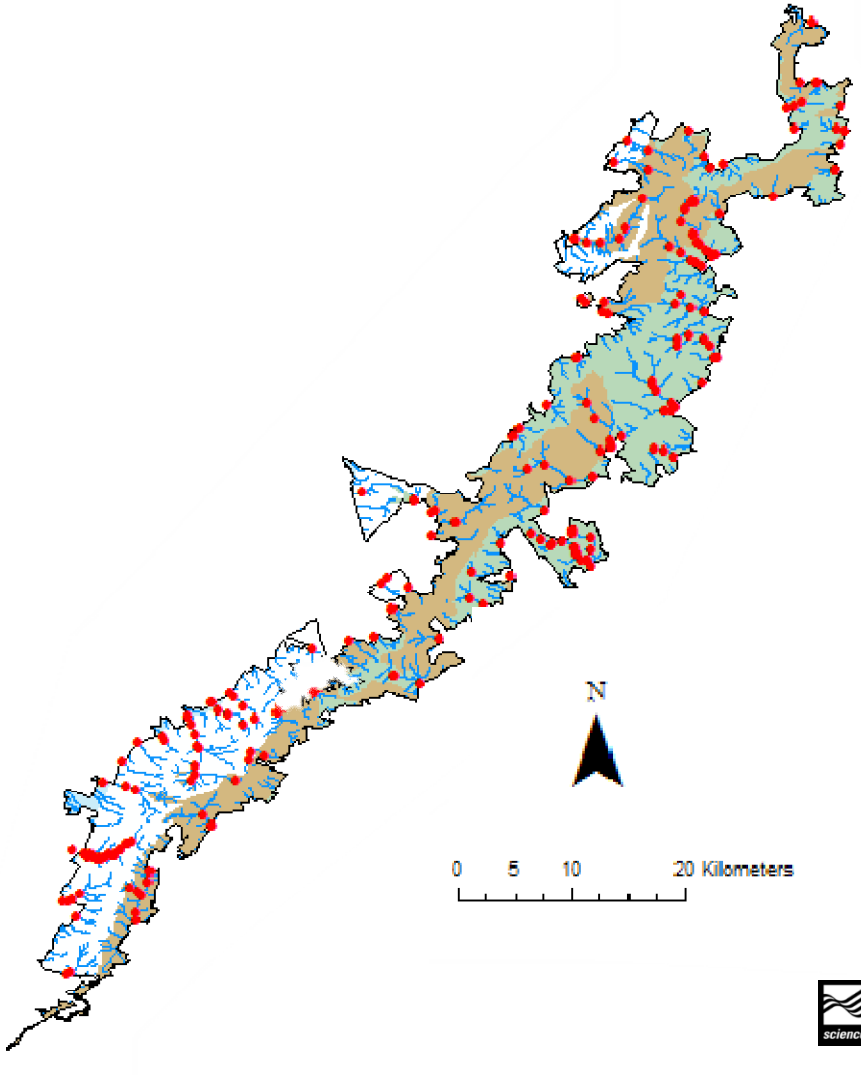
**Explanation**

Shenandoah National Park Bou

SHEN Monitoring Stations

Siliciclastic Bedrock
Granitic Bedrock
Basaltic Bedrock

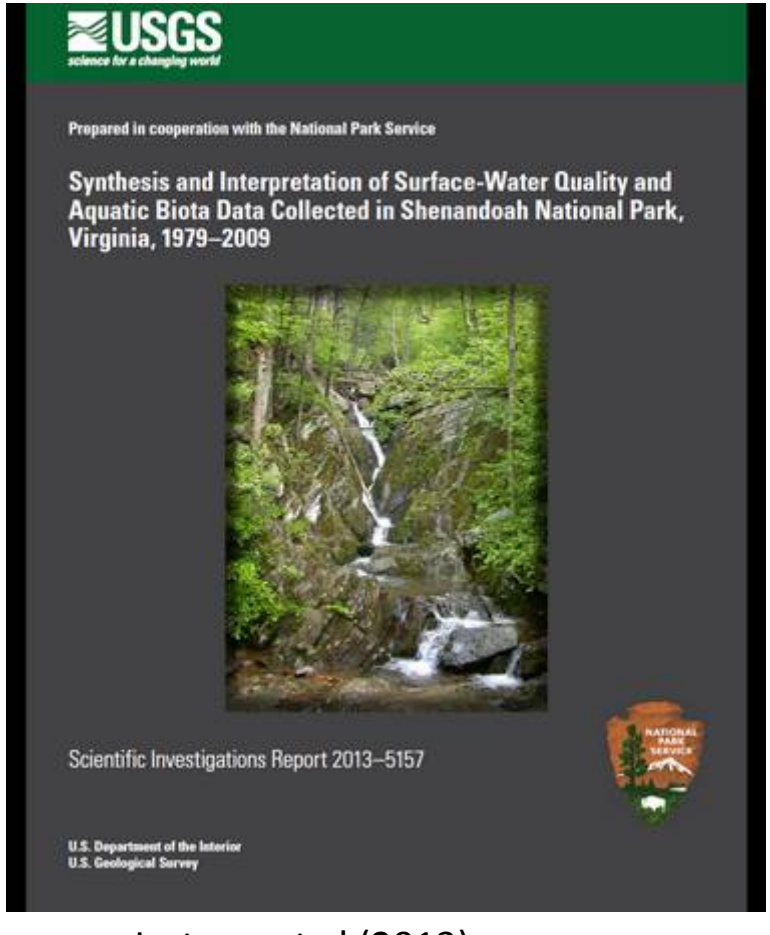



From Jastram et al (2013)

# Project Initiation (2010)

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

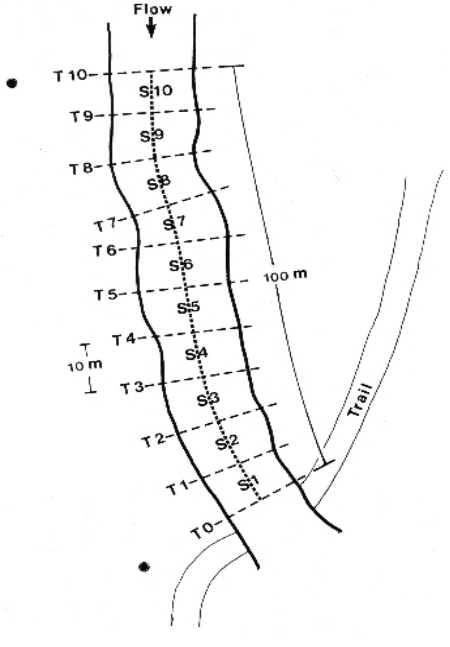


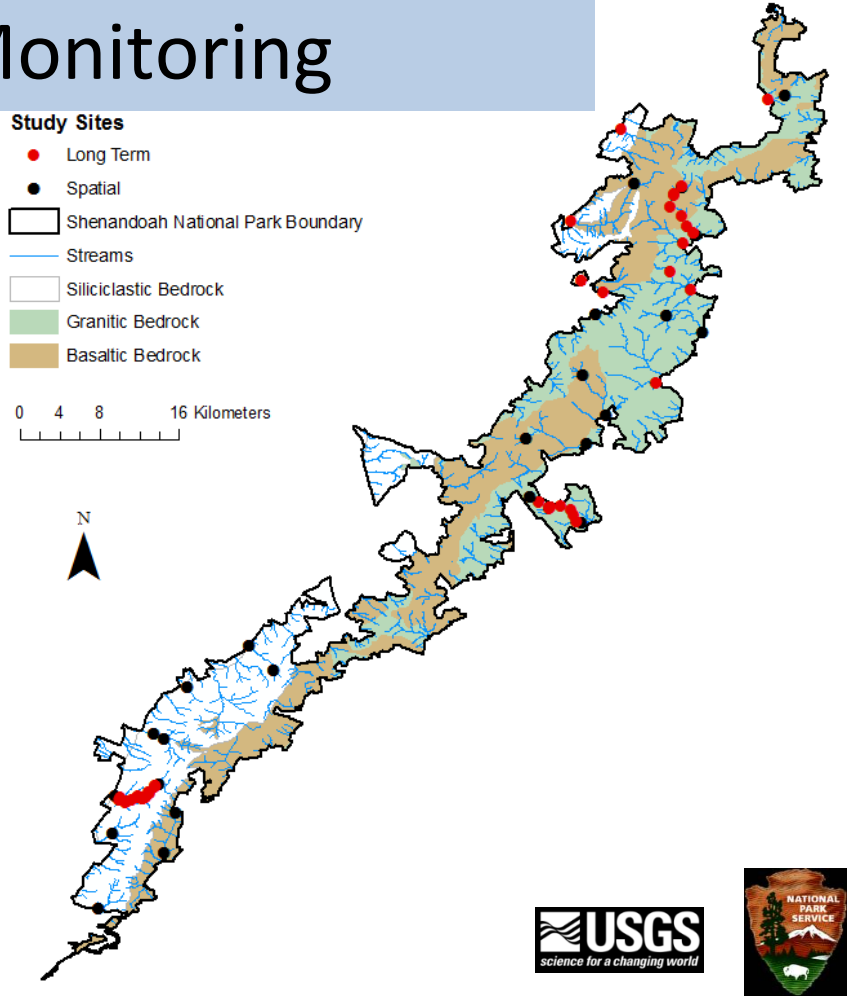

Jastram et al (2013)

# Water Quality Summary

- 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

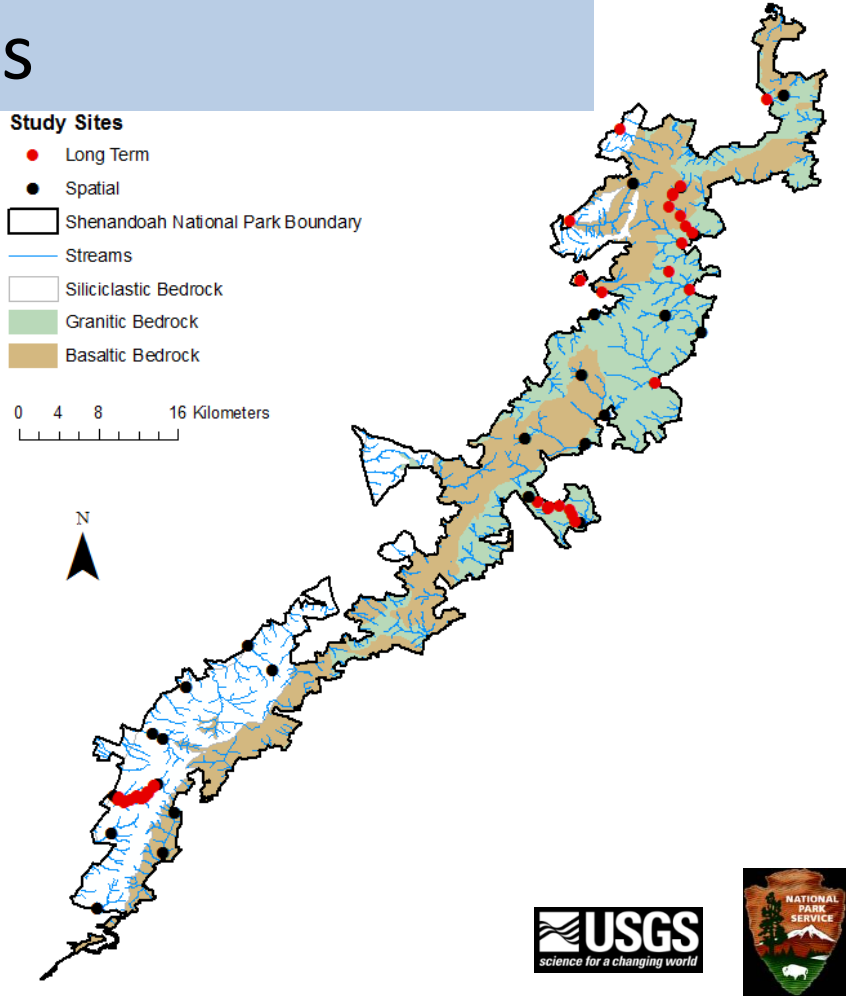
- Principle Component Analysis used to reduce number of environmental variables and general linear modeling used to assess geology and watershed area and interaction on measures

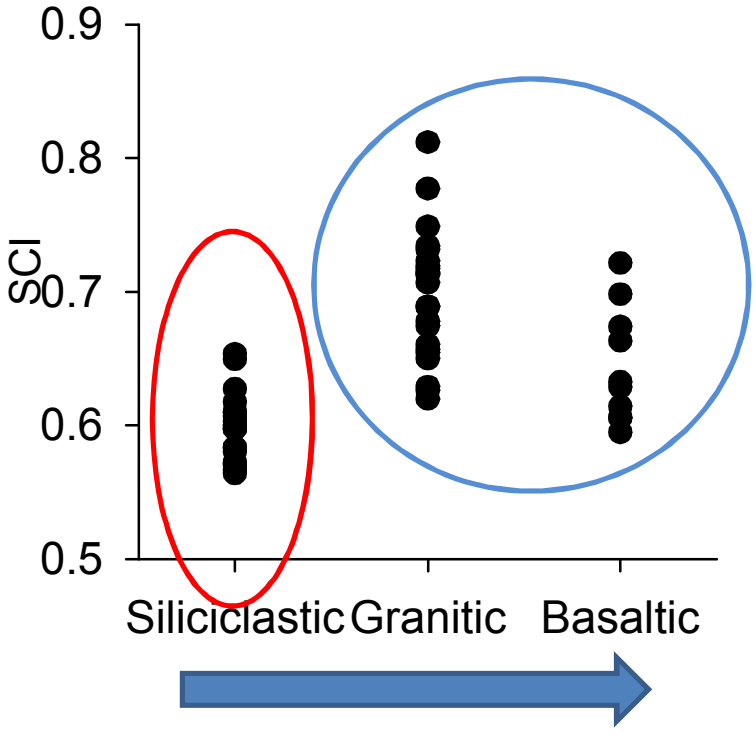
- For temporal trends
  - Simple linear regression

# Spatial Results

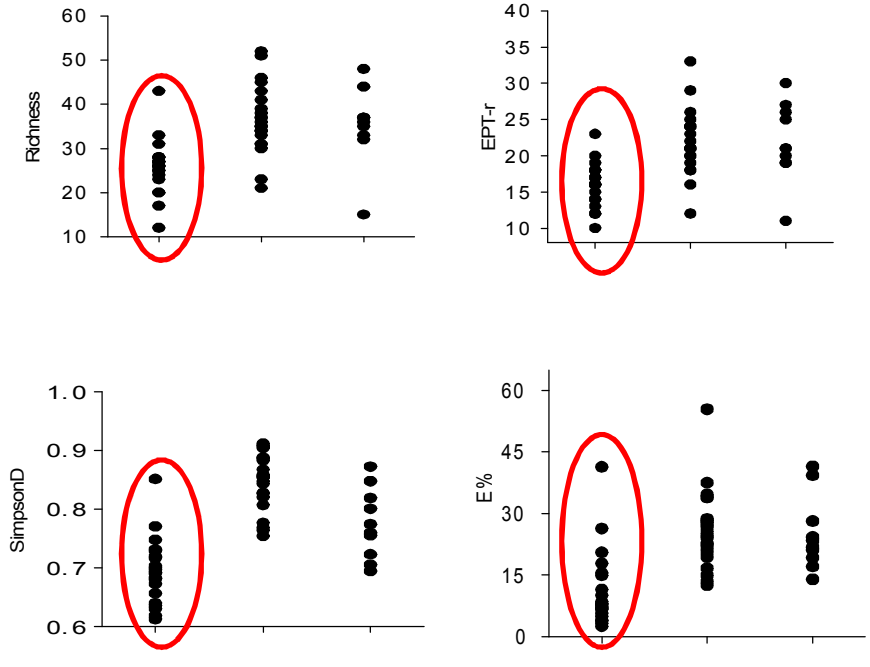
## Geology

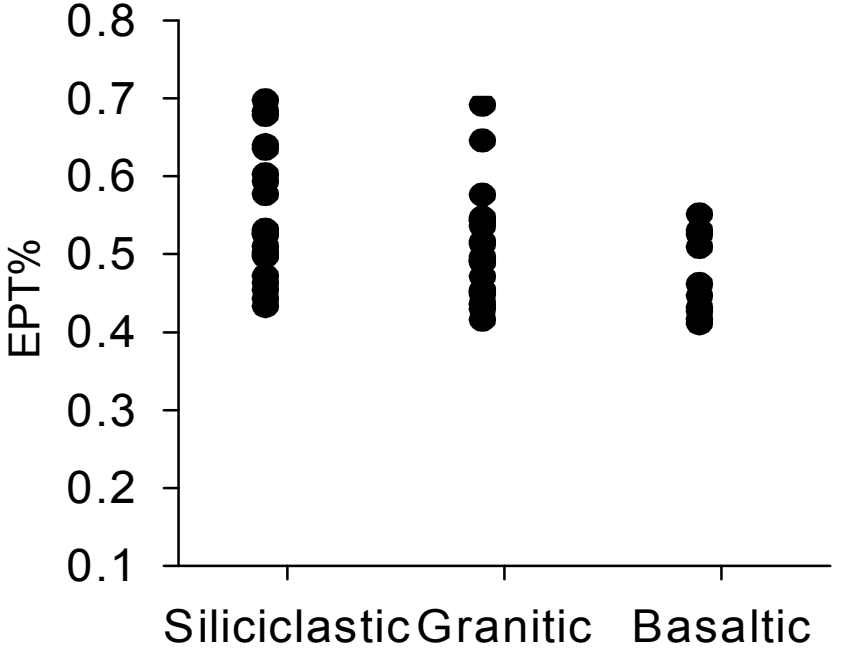
-was a very strong predictor, significant with 12 metrics and explaining up to 64% of variation in some metrics






Buffering capacity






Buffering capacity

Leuctra stoneflies



Acidification –
highly tolerant

Temperature increase–
highly sensitive

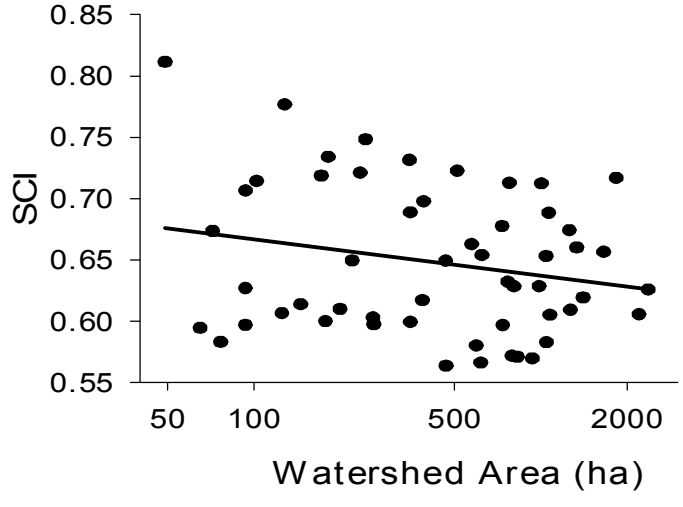
Most pollution—
highly sensitive

# Spatial Results

Watershed Area

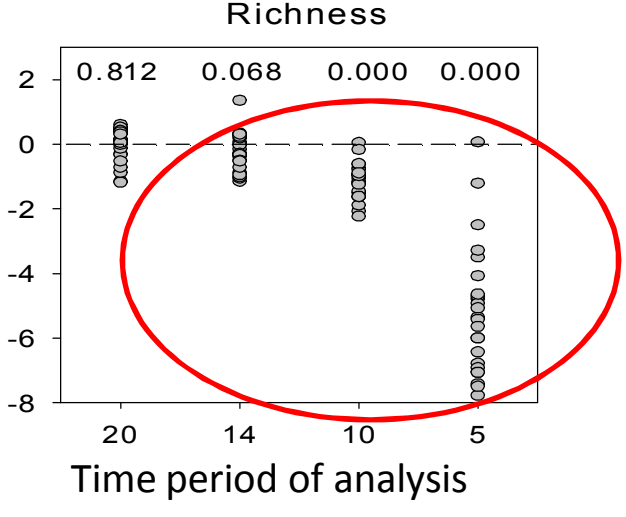
7 metrics were significantly influenced by watershed size

- Richness + EPT richness
- PTV
- %Intolerant
- SCI
- %Haptobenthos
- % Shredder



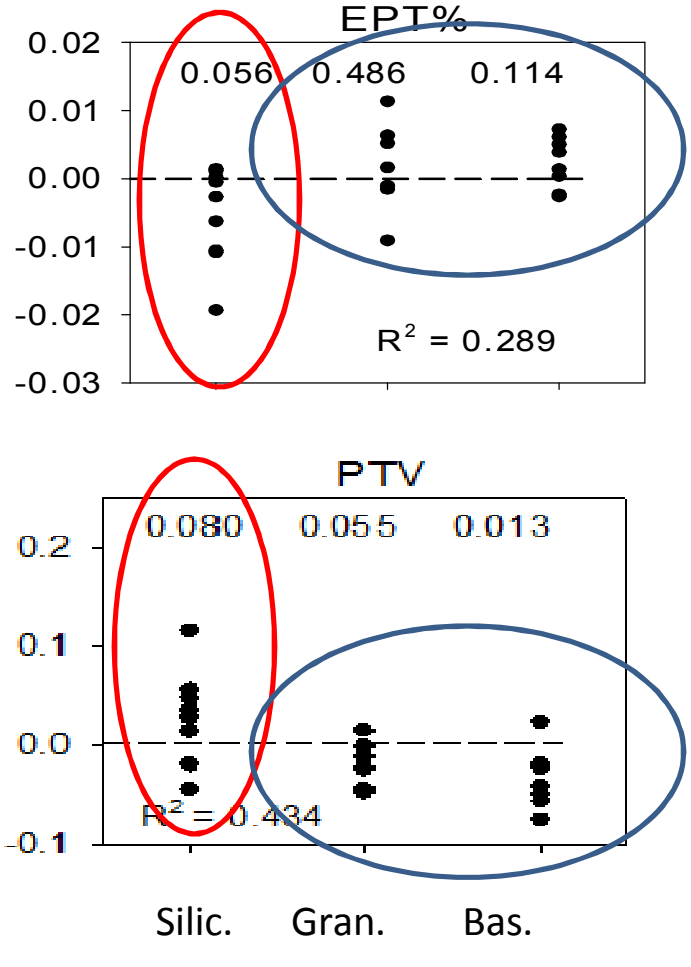

# Benthic Macroinvertebrate Trends

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




| Metric | Stream Health |
|---|---|
| • Richness | ➢ Declining |
| • EPT richness | ➢ Declining |
| • Simpson D | ➢ Declining/Neutral |
| • Dominant 2 | ➢ Declining/Neutral |
| • % Leuctra | ➢ Indeterminate |
| • %Ephemeroptera | ➢ Indeterminate |
| • %Haptobenthos | ➢ Indeterminate |

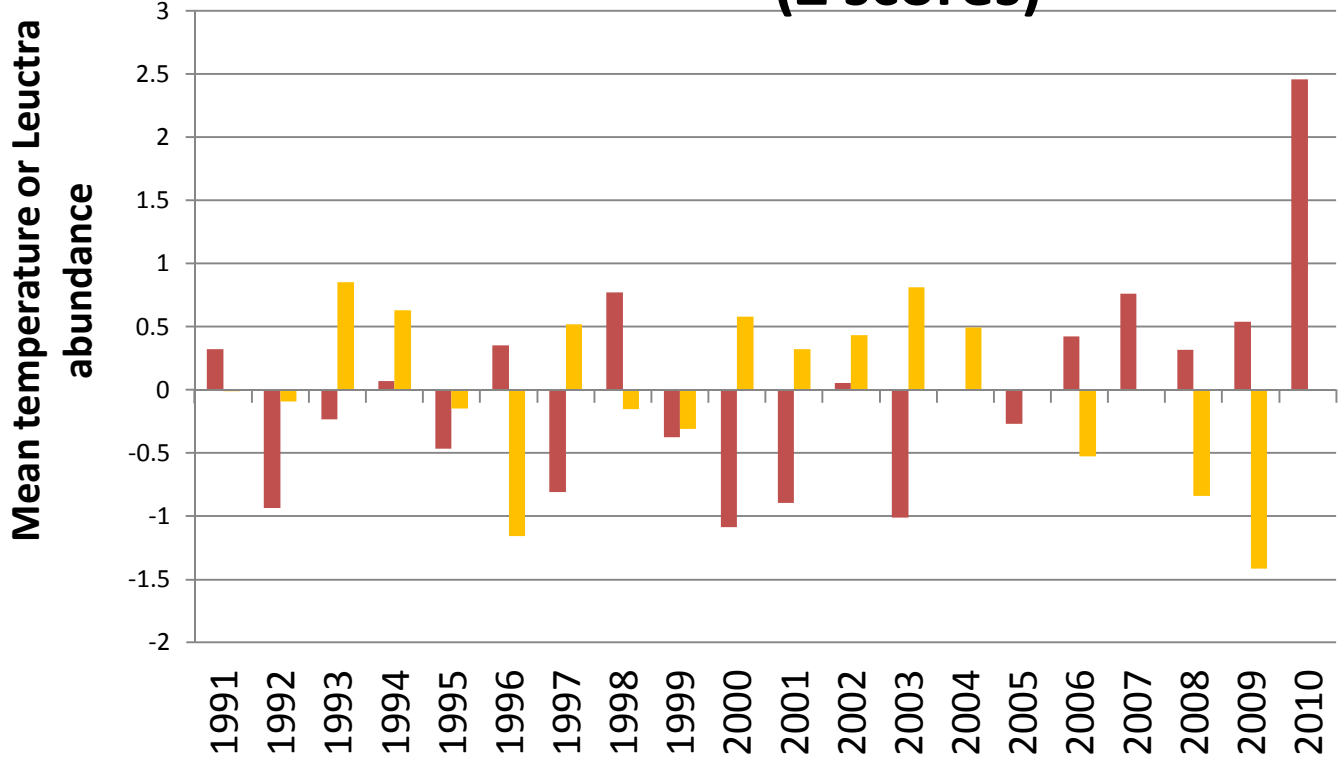
# 20 Year Trends




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)



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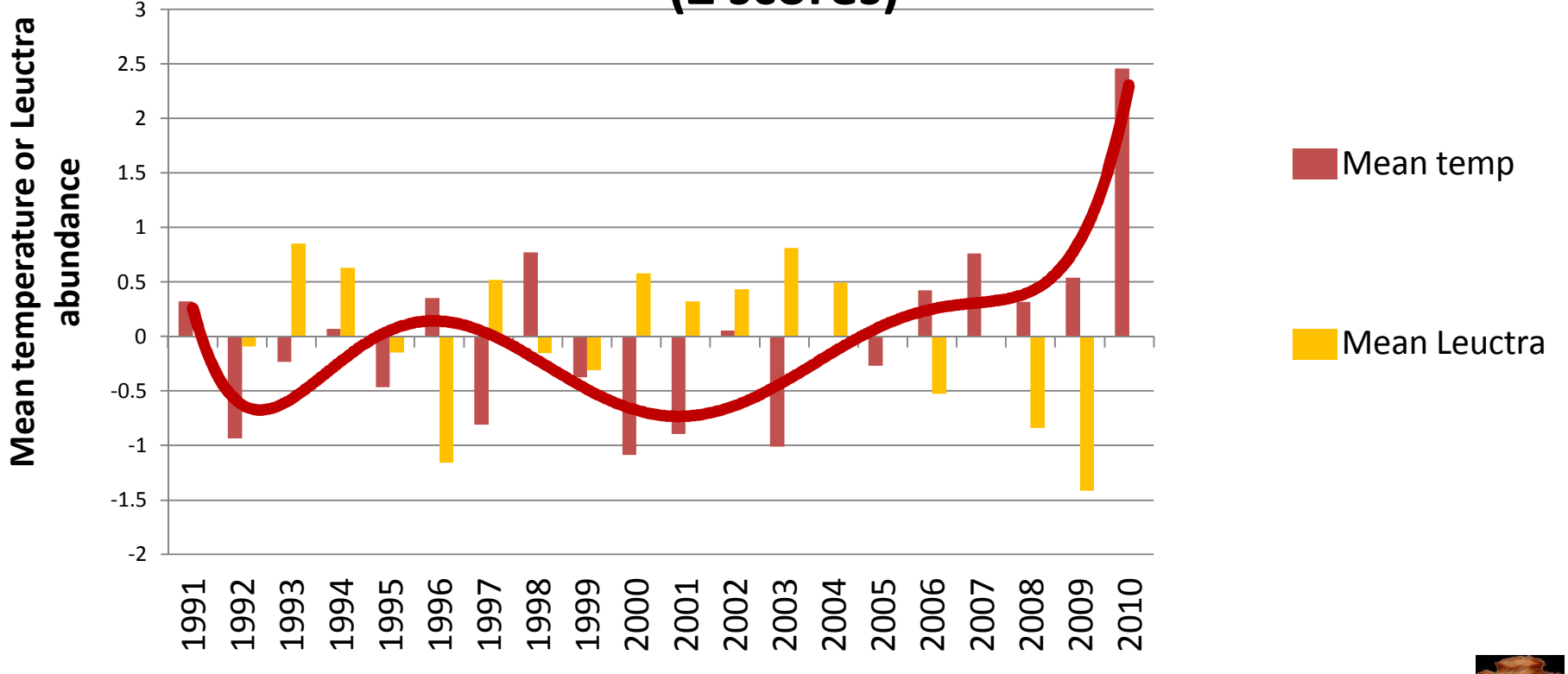

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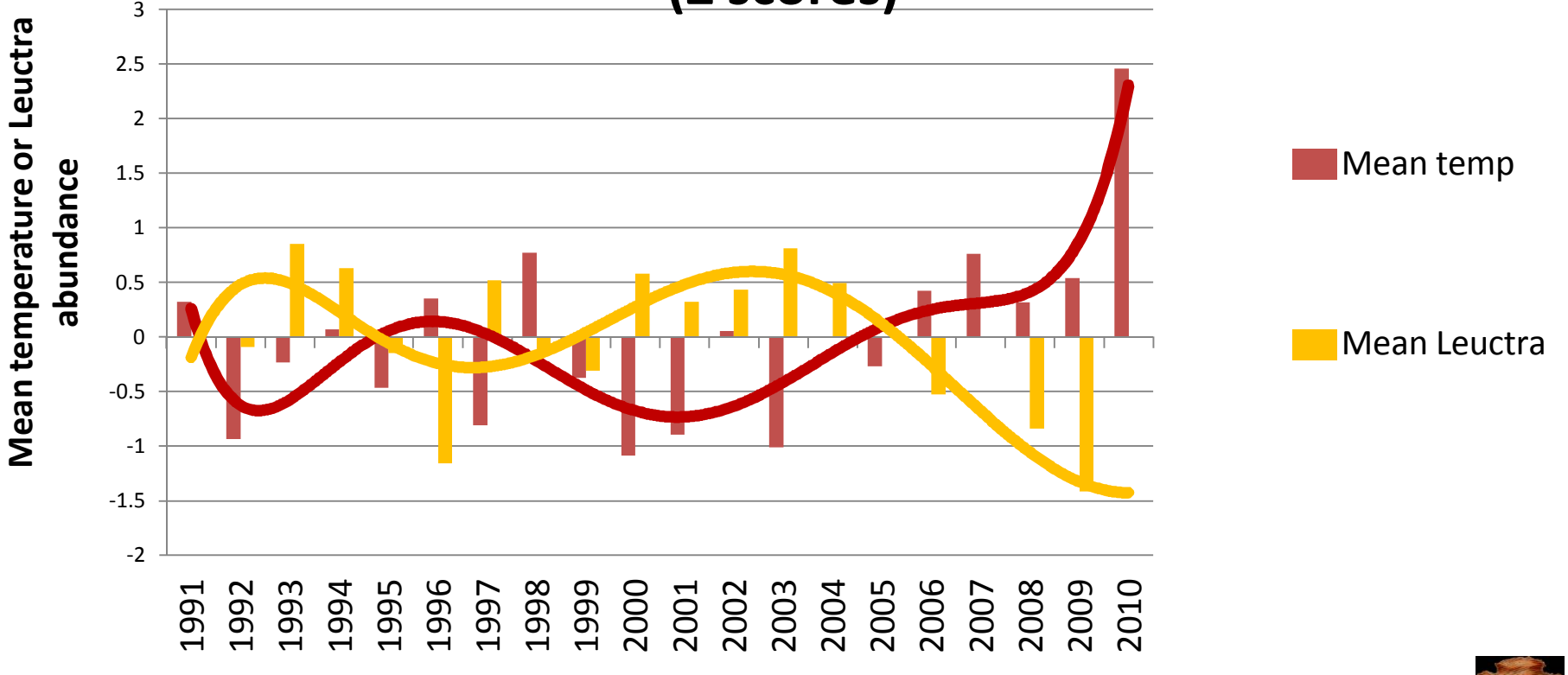


# Benthic macroinvertebrate summary

- 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

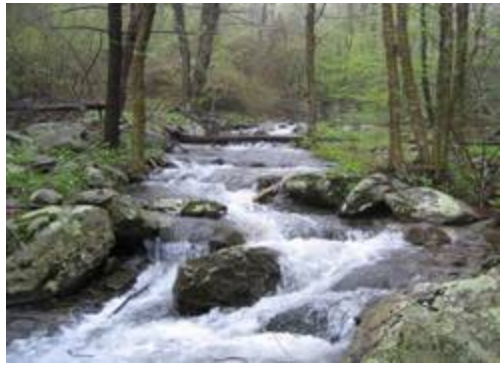
- Increase in water temperature may be driving declining stream conditions parkwide

# 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 (?)



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# 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

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

Questions?