Beyond Nutrients:

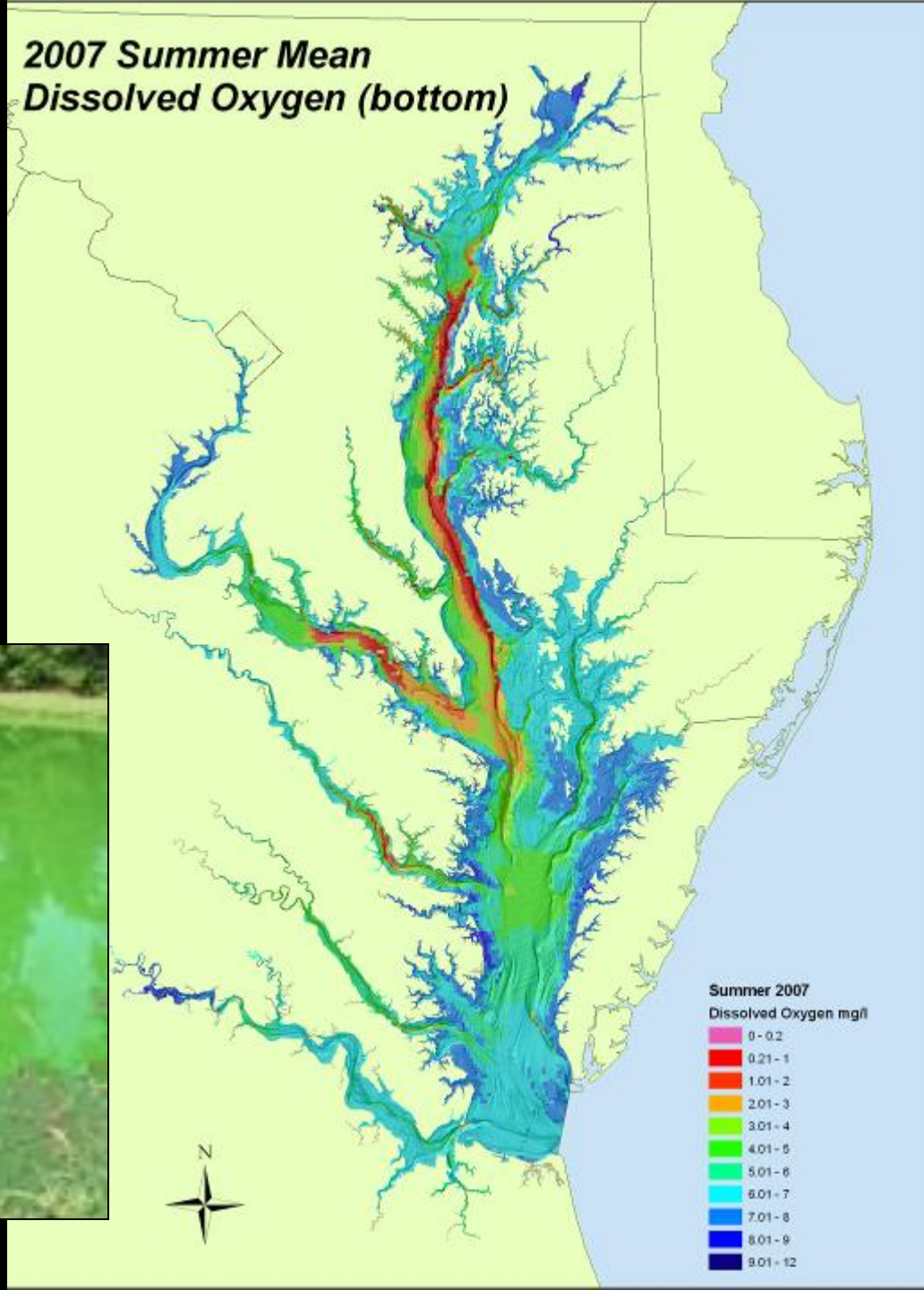
Factors Important for Understanding, Measuring, and Tracking Non-Tidal Stream Biological Condition

Scott Stranko

April 12th, 2016

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Nutrients are Important Stressors to Chesapeake Bay Health



Nutrients may influence leaf decomposition and cause subtle changes to stream biota

Science
www.sciencemag.org
Science 6 March 2015:
Vol. 347 no. 6226 pp. 1142-1145
DOI: 10.1126/science.aaa1958

- REPORT

Experimental nutrient additions accelerate terrestrial carbon loss from stream ecosystems

Amy D. Rosemond[1,*], Jonathan P. Benstead[2], Phillip M. Bumpers[1], Vladislav Gulis[3], John S. Kominoski[1,†], David W. P. Manning[1], Keller Suberkropp[2], J. Bruce Wallace[1]

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± Author Notes

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ABSTRACT | EDITOR'S SUMMARY

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Nutrient pollution of freshwater ecosystems results in predictable increases in carbon (C) sequestration by algae. Tests of nutrient enrichment on the fates of terrestrial organic C, which supports riverine food webs and is a source of CO_2, are lacking. Using whole-stream nitrogen (N) and phosphorus (P) additions spanning the equivalent of 27 years, we found that average terrestrial organic C residence time was reduced by ~50% as compared to reference conditions as a result of nutrient pollution. Annual inputs of terrestrial organic C were rapidly depleted via release of detrital food webs from N and P co-limitation. This magnitude of terrestrial

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But, nutrients are not primary stressors to streams

stream ecosystems

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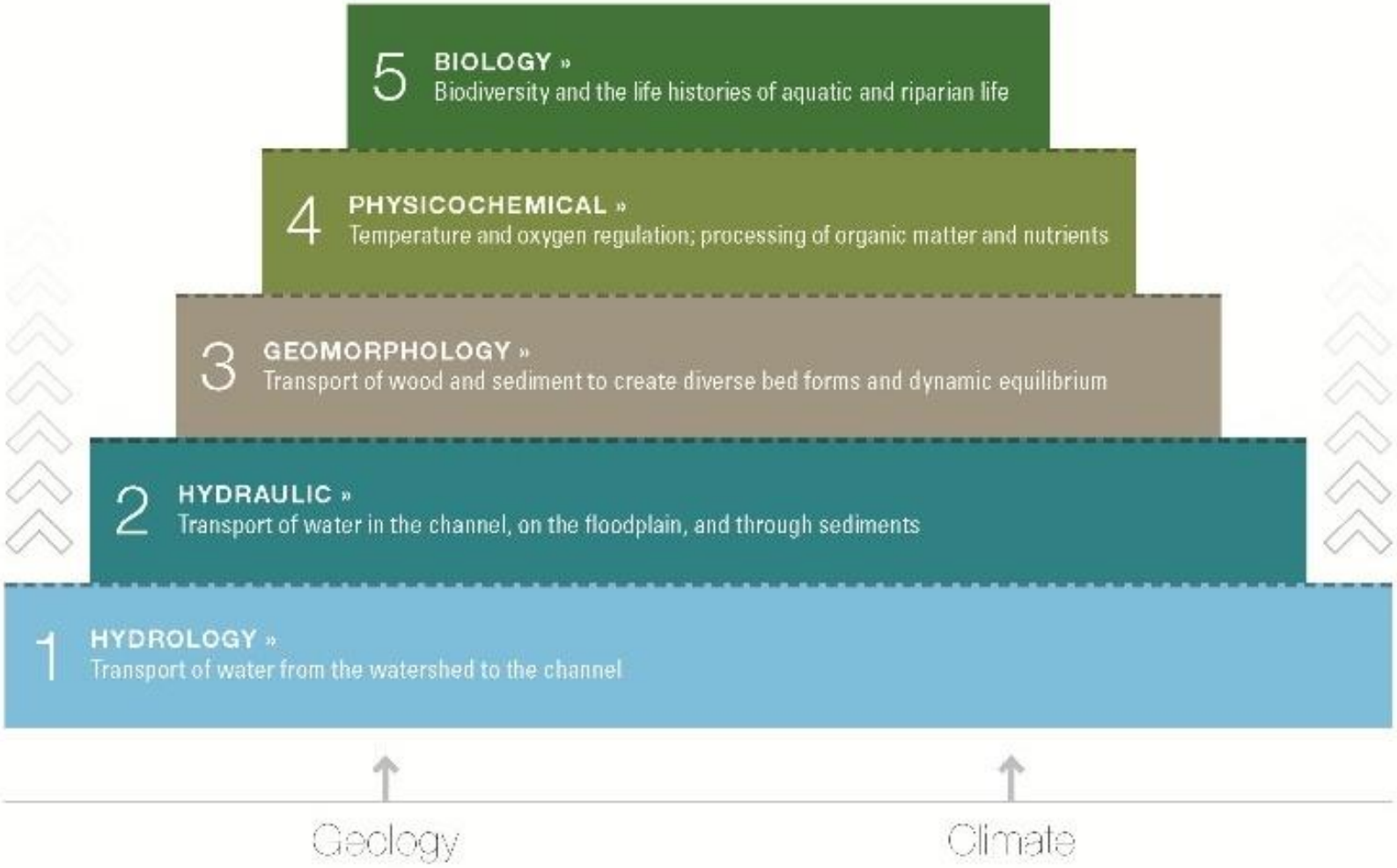
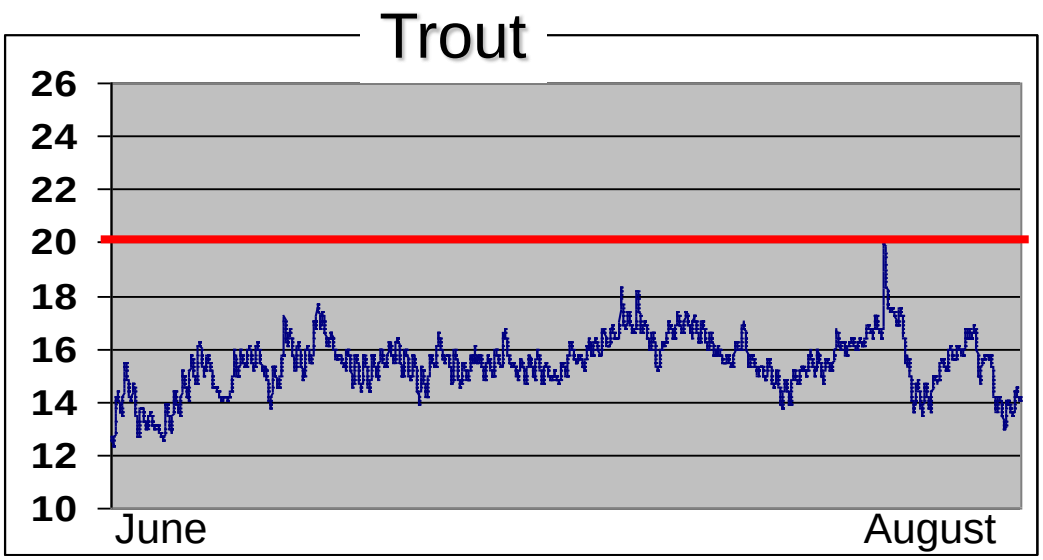
Stream Biota are affected by many other <u>stressors</u>

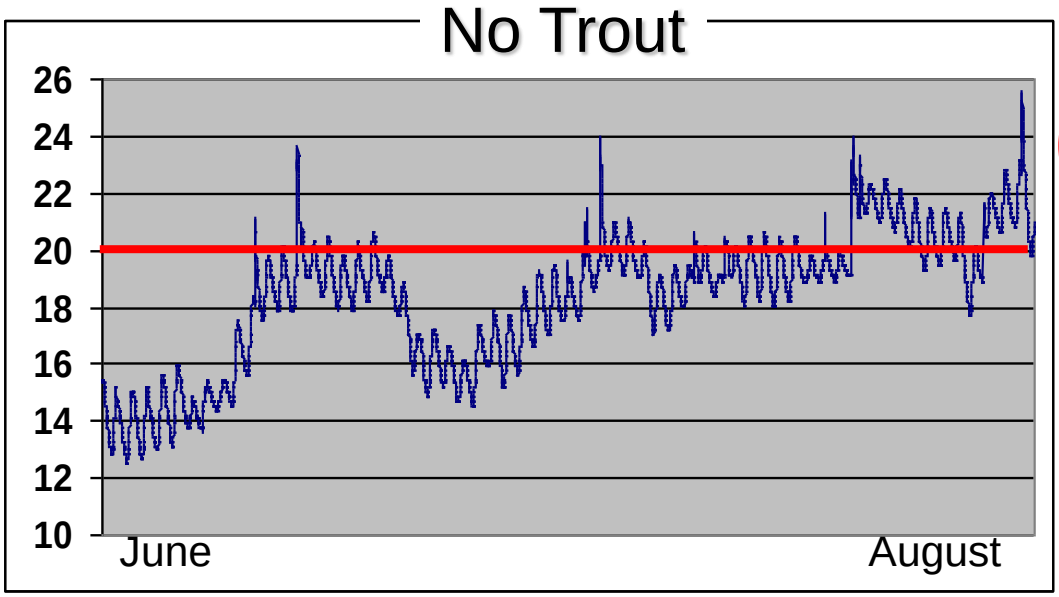


Hutchinson 1957
Harman et al 2012

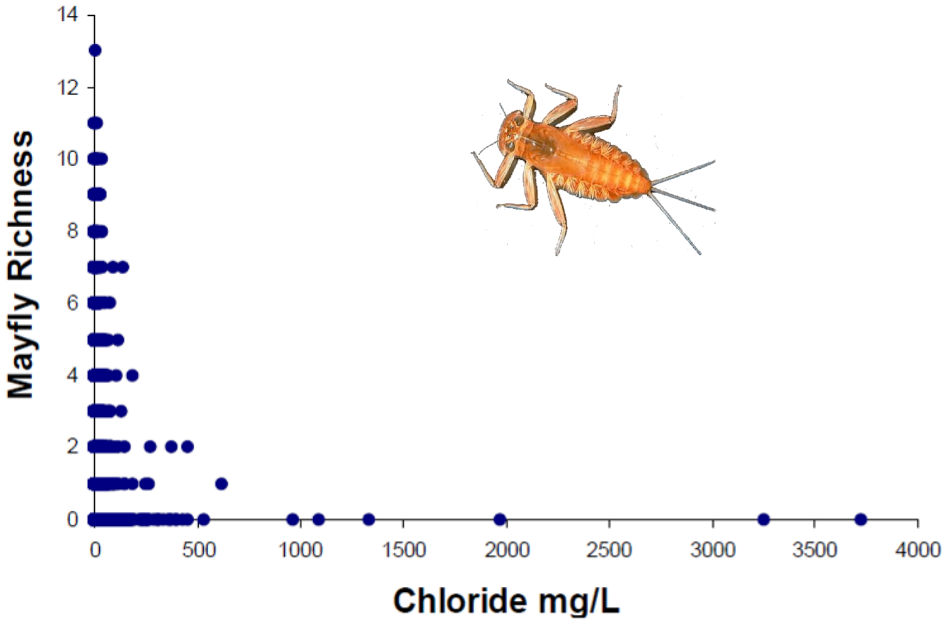
Physical Habitat Alteration

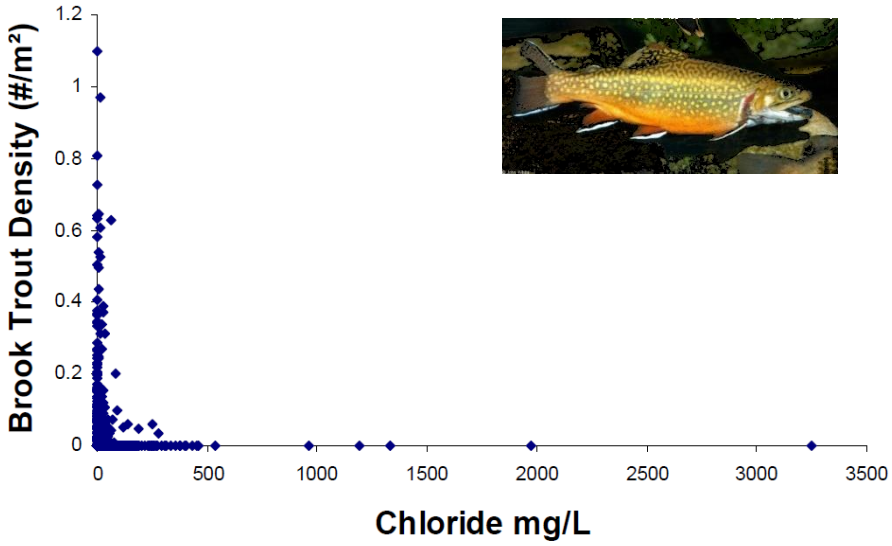
Temperature

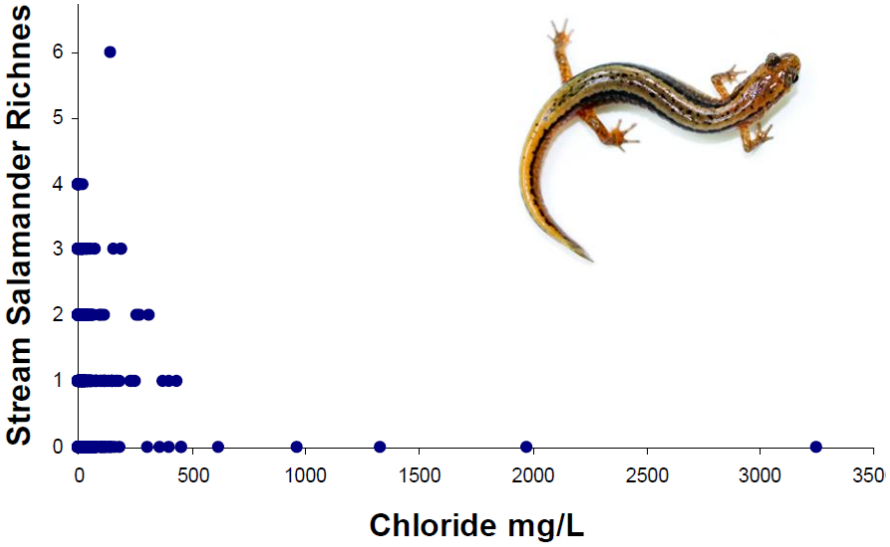


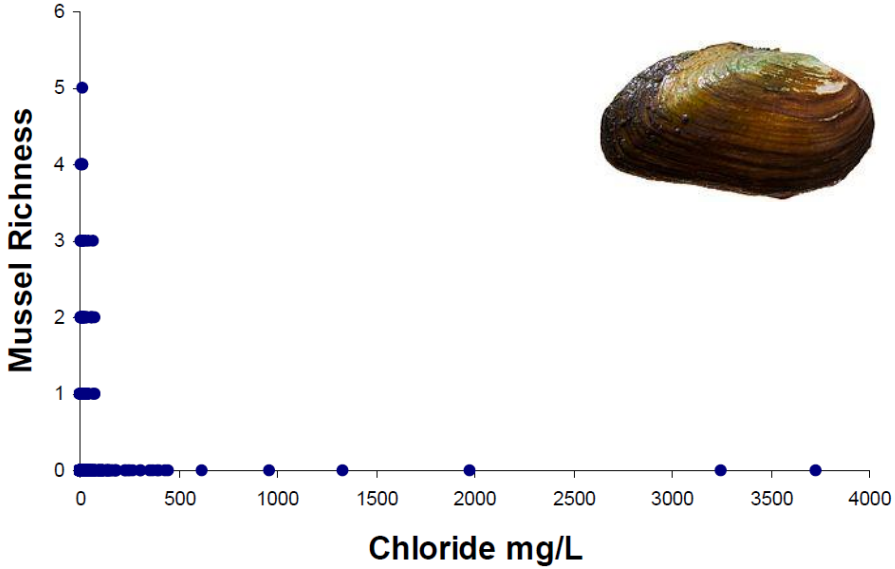


Freshwater Animals Don't Like Salt Water



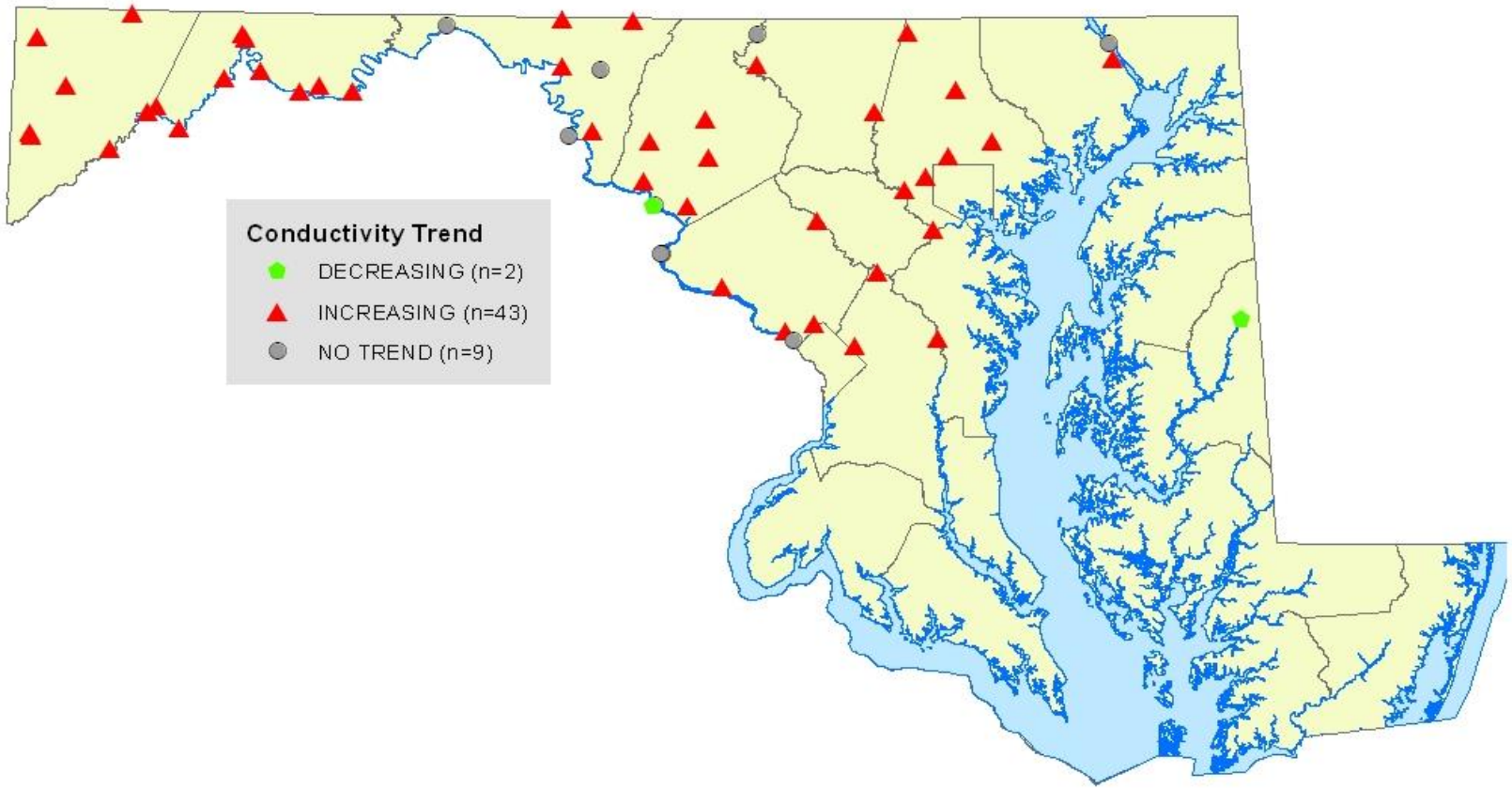




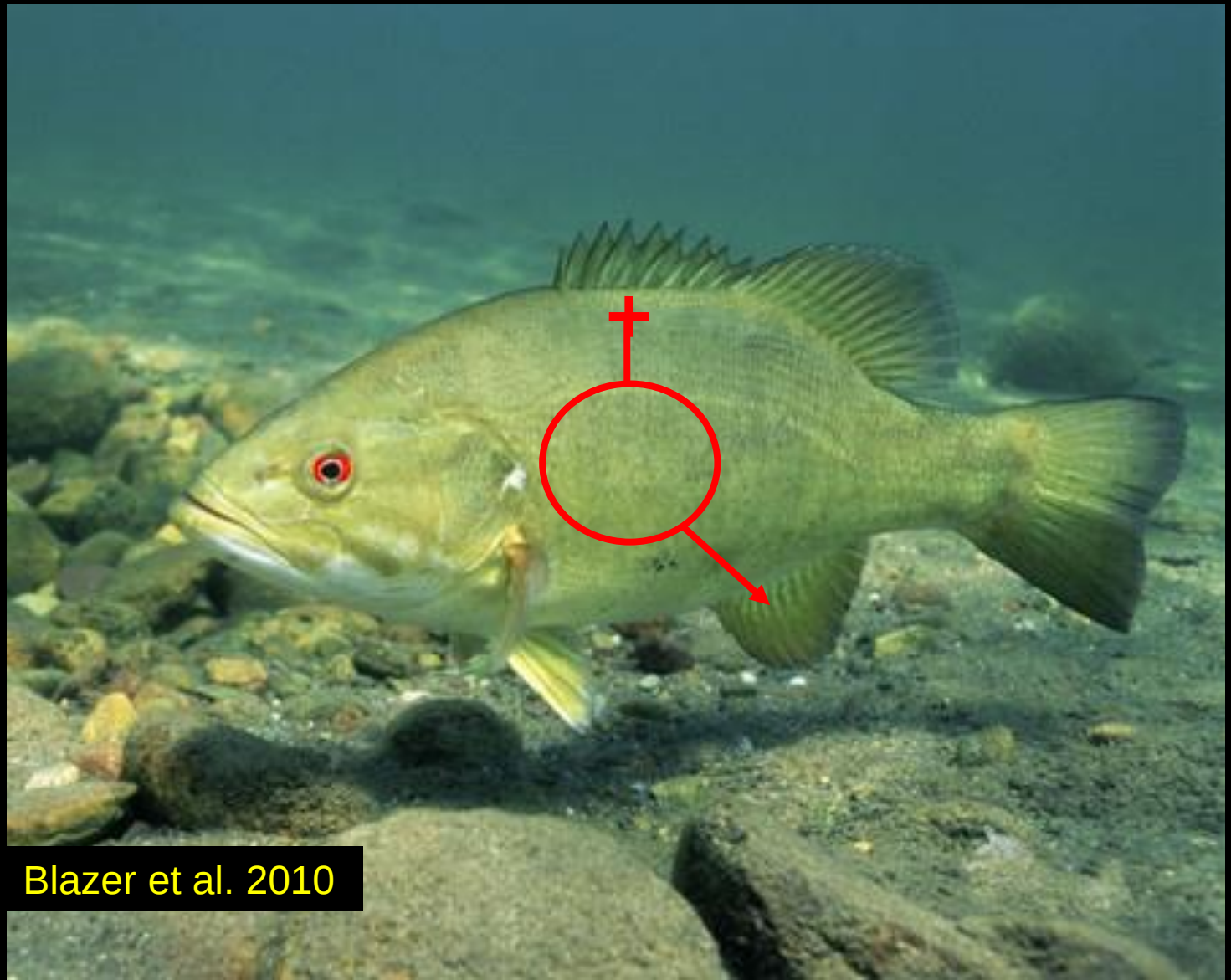


www.dnr.state.md.us/streams/pdfs/RoadSalt2013.pdf

Long Term Conductivity Trends in Maryland Streams and Rivers



Other Contaminants Affect Stream Biology



Blazer et al. 2010

Acidity

“We may say that of the Monongahela drainage by far the greatest part is utterly polluted, chiefly by mine water.”

“in many cases …..life had entirely disappeared from many streams”

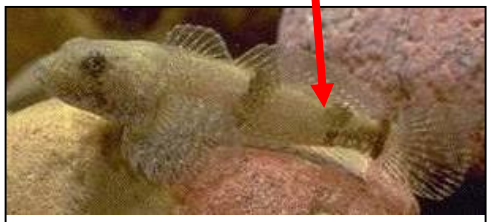
Ortmann 1909

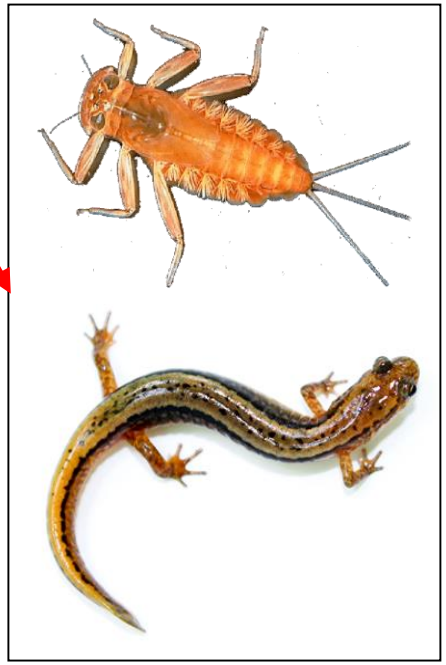
Invasive Species

Connectivity is important to migratory and resident species

•Free movement is important for re-colonization and population sustainability

•Excluding migratory species can have cascading influences





Stream Biological Condition Indicators

-Fish

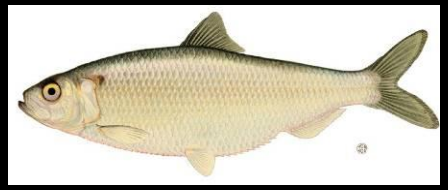
-Insects

-Salamanders

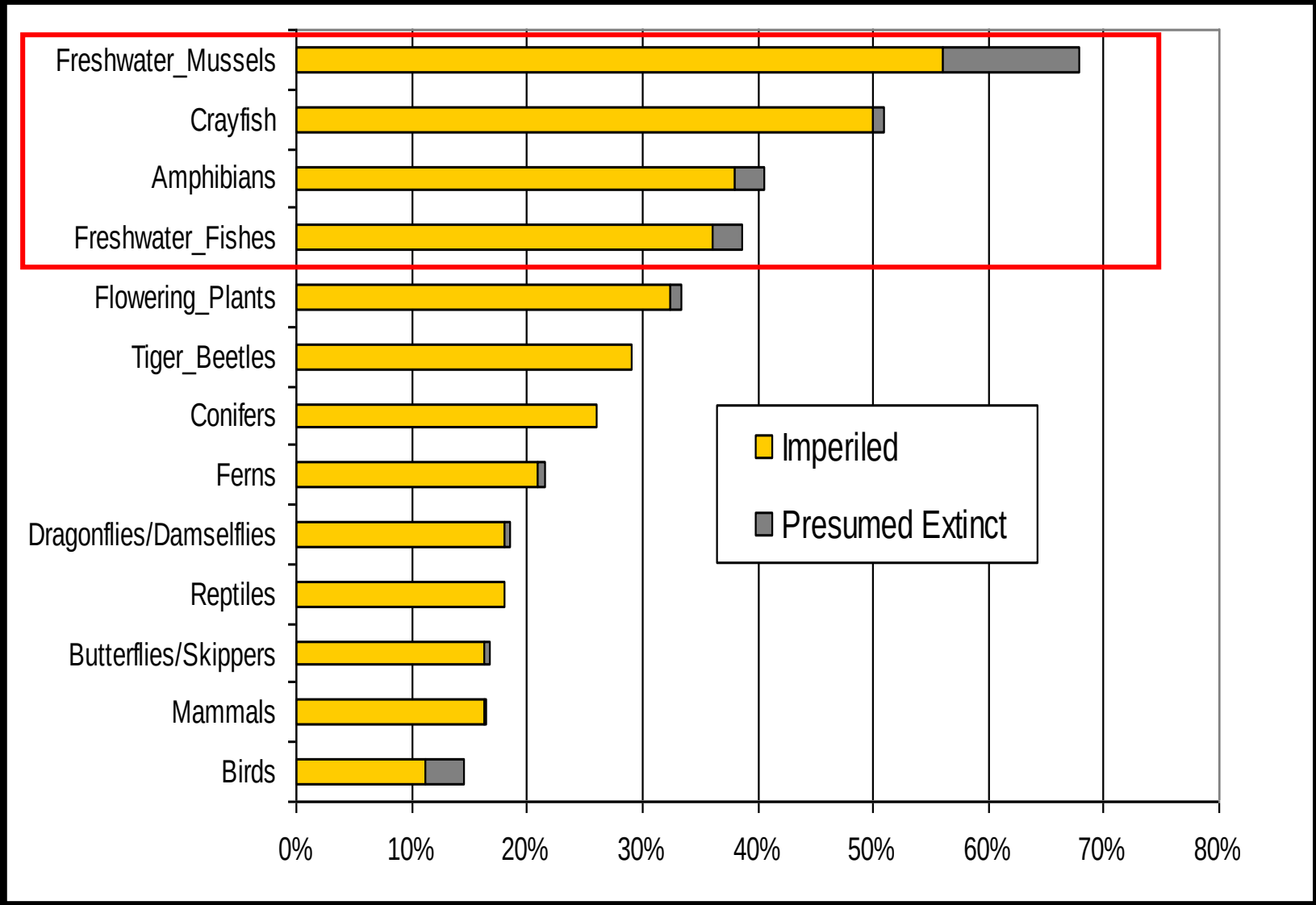
-Freshwater mussels

-Crayfish

- Migratory Species



Imperiled Biota - United States



TNC 1997

Maryland Regulations Focused on Stream Biological Condition

Stream Designated Use/existing use
- All streams should have sufficient water quality to support fishing and aquatic life
- Use Class IV streams should support stocked trout
- Use Class III streams should support trout reproduction
- Use Class II waters should support migratory fish spawning
- Streams that feed drinking water supplies should have extra protection from pollution

Anti-degradation
- High Quality (Tier II) streams should maintain biologically diversity comparable to reference

Impaired Waters
- Streams with "impaired" (303d) water quality or biology should be improved

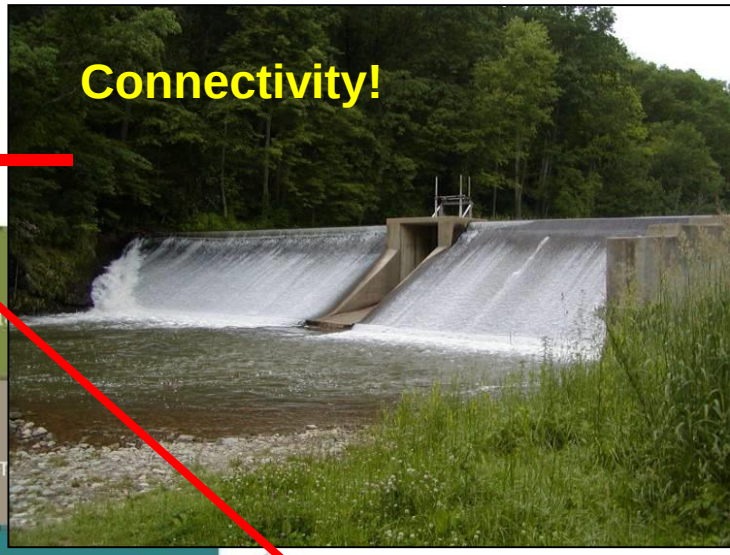
Nuisance and Prohibited Species
- Invasive species should not be in our streams

Federal and State Endangered Species
- Rare species should be protected from extirpation/extinction

Executive Order 13508 Chesapeake Bay Protection and Restoration

Among other things ….there should be….
- Less pollution from streams to Chesapeake Bay
- Fewer blockages to fish passage
- More forested buffers
- More brook trout
- Improved stream health

Difficult to Choose Important Variables
-All Requirements Must Be Met To Support Biology



5 **BIOLOGY »**
Biodiversity and the life histories of aquatic and riparian life

4 **PHYSICOCHEMICAL »**
Temperature and oxygen regulation; processing of organic matter and nutrient

3 **GEOMORPHOLOGY »**
Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

2 **HYDRAULIC »**
Transport of water in the channel, on the floodplain, and through sediments

1 **HYDROLOGY »**
Transport of water from the watershed to the channel

Geology

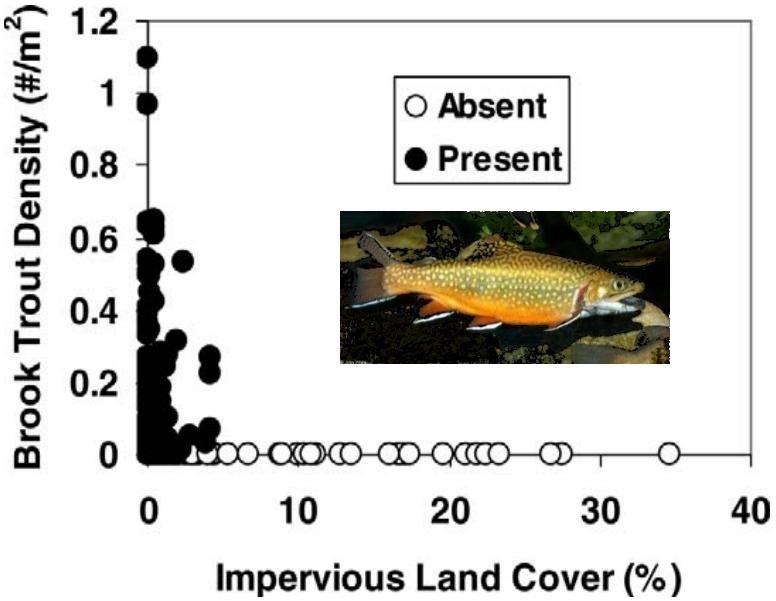
Climate

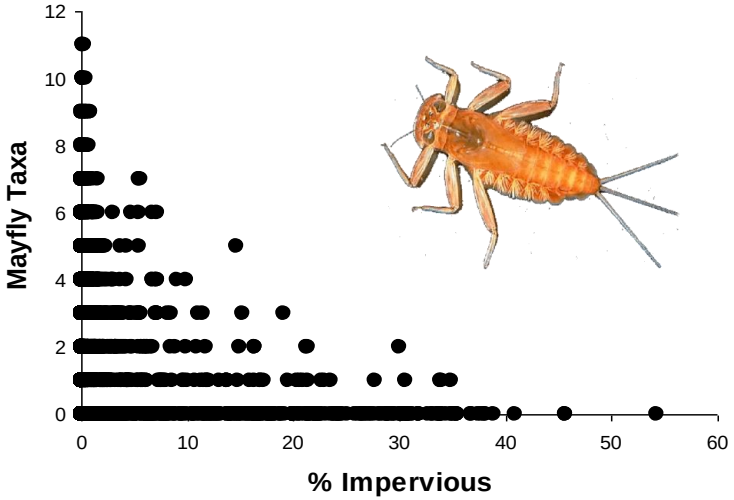
Many other…

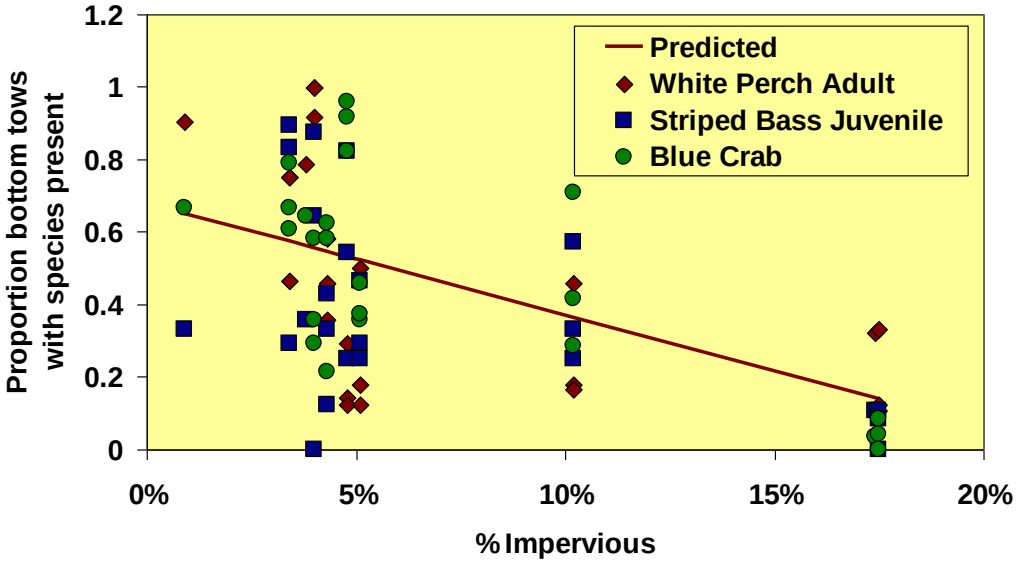
Hutchinson 1957
Harman et al 2012

Land use/cover may be an indicator of many other stressors

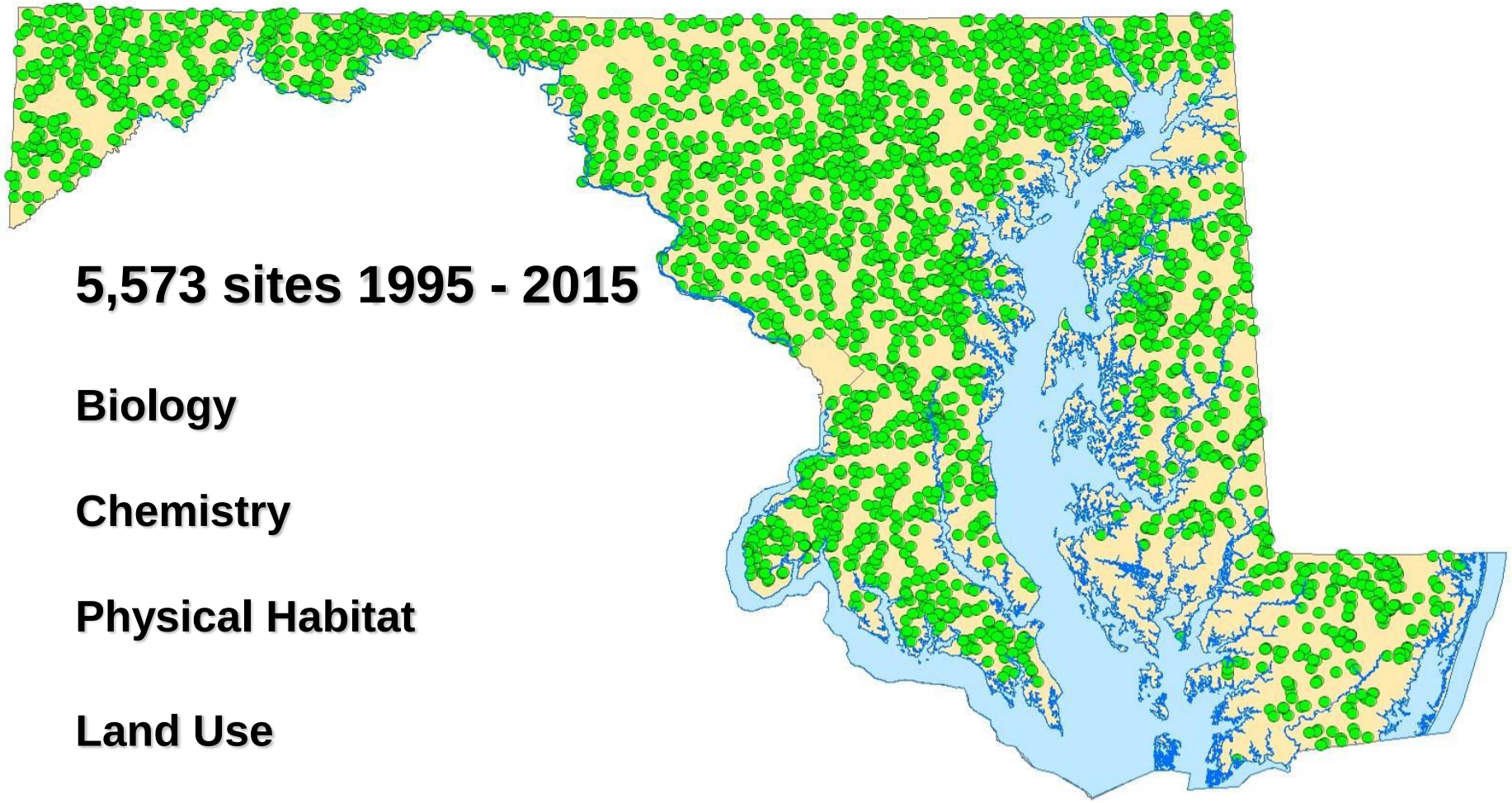
Land Use is Correlated with Impacts to Biota at Many Levels and Habitats







Maryland Biological Stream Survey Used to Focus Restoration and Protection Priorities



5,573 sites 1995 - 2015

Biology

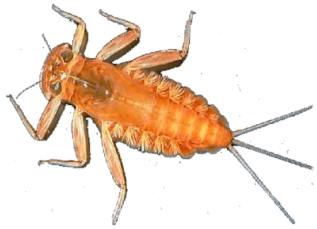
Chemistry

Physical Habitat

Land Use

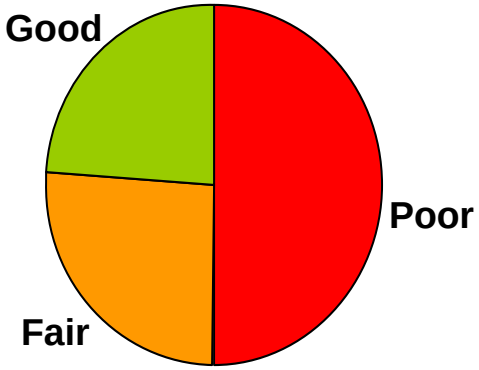
Using Data to Develop Ranges of Conditions Needed for Species Restoration/Protection

Temperature	**<24°C**
Chloride	**<40 mg/L**
Stream Size	**<3,000 acre d/a**
Instream Habitat	**>Poor**
pH	**>6.0**
Brown Trout	**Few - None**

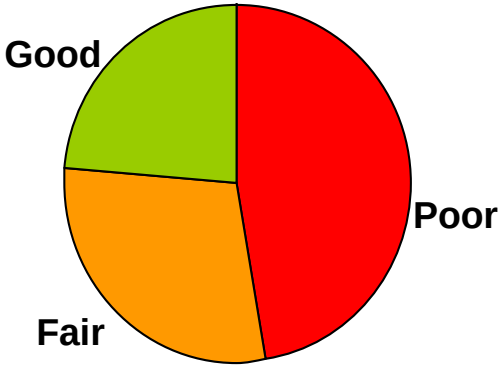


Temperature	**<30°C**
Chloride	**<56 mg/L**
Stream Size	**<45,000 acre d/a**
Instream Habitat	**>Poor**
pH	**>6.7**
Conductivity	**<360 ueq/L**

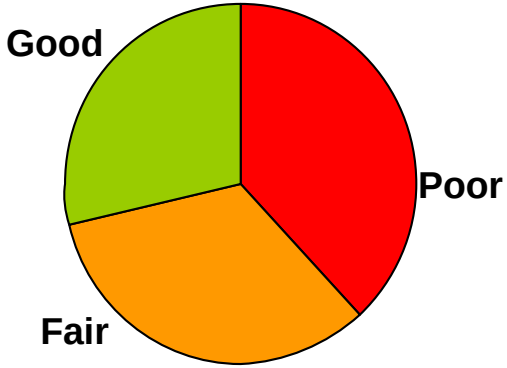
Tracking Maryland's Stream Health Over Time



Round 1
1995 - 1997



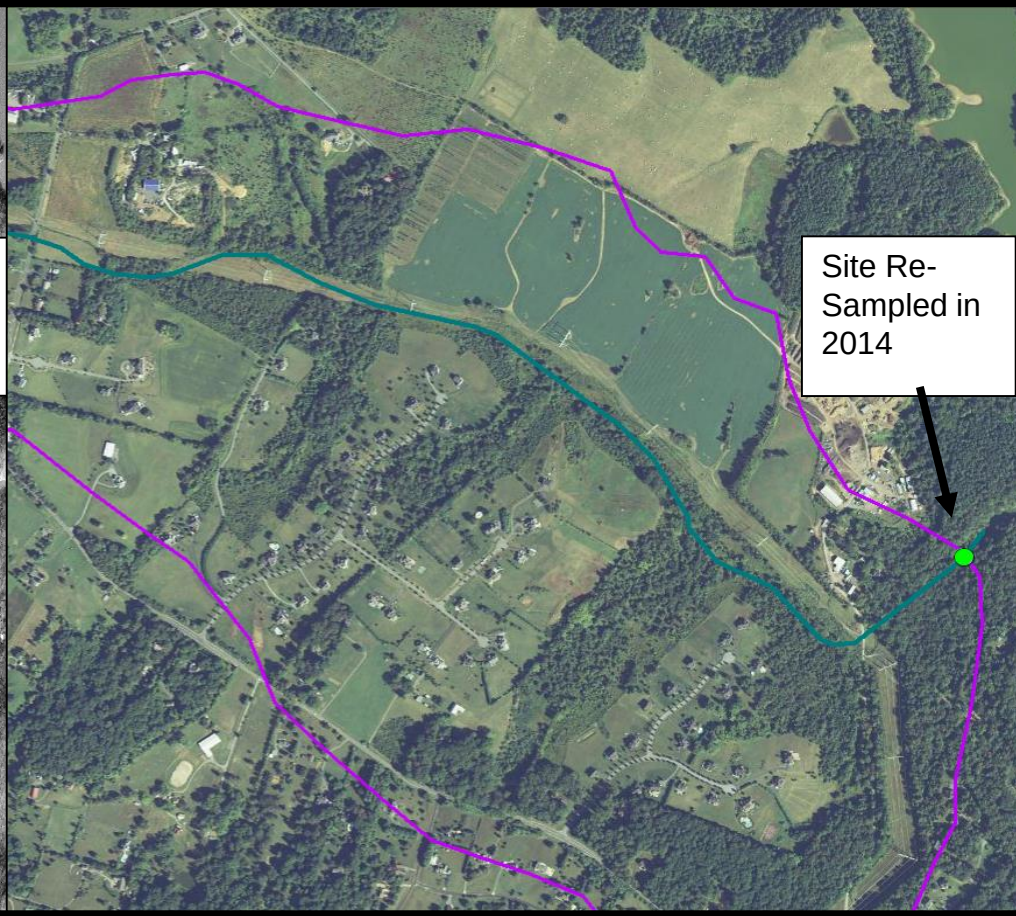
Round 2
2000-2004



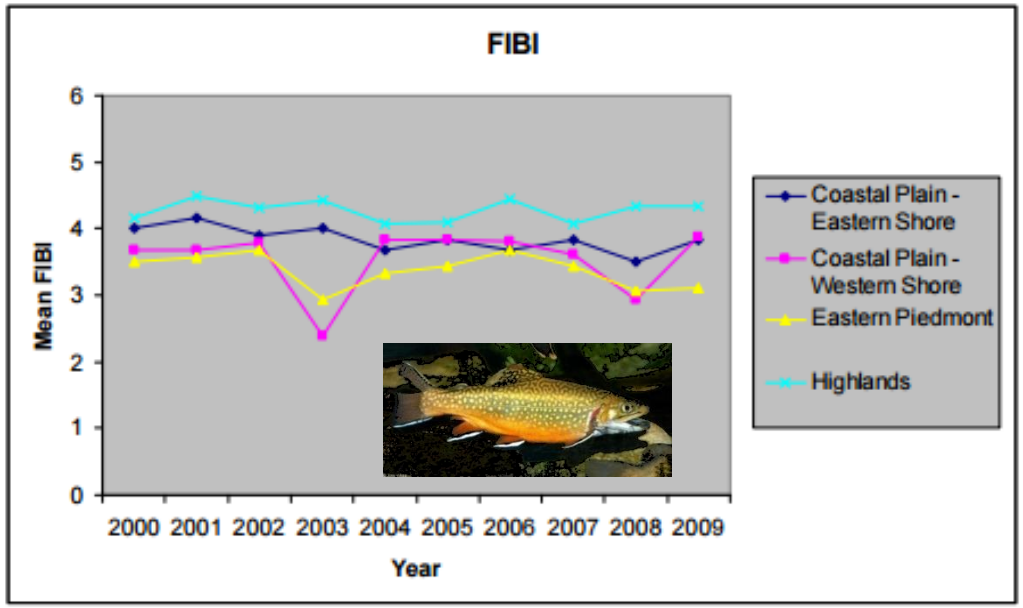
Round 3
2007 - 2009

Round 4 = Resample Round 1 and 2

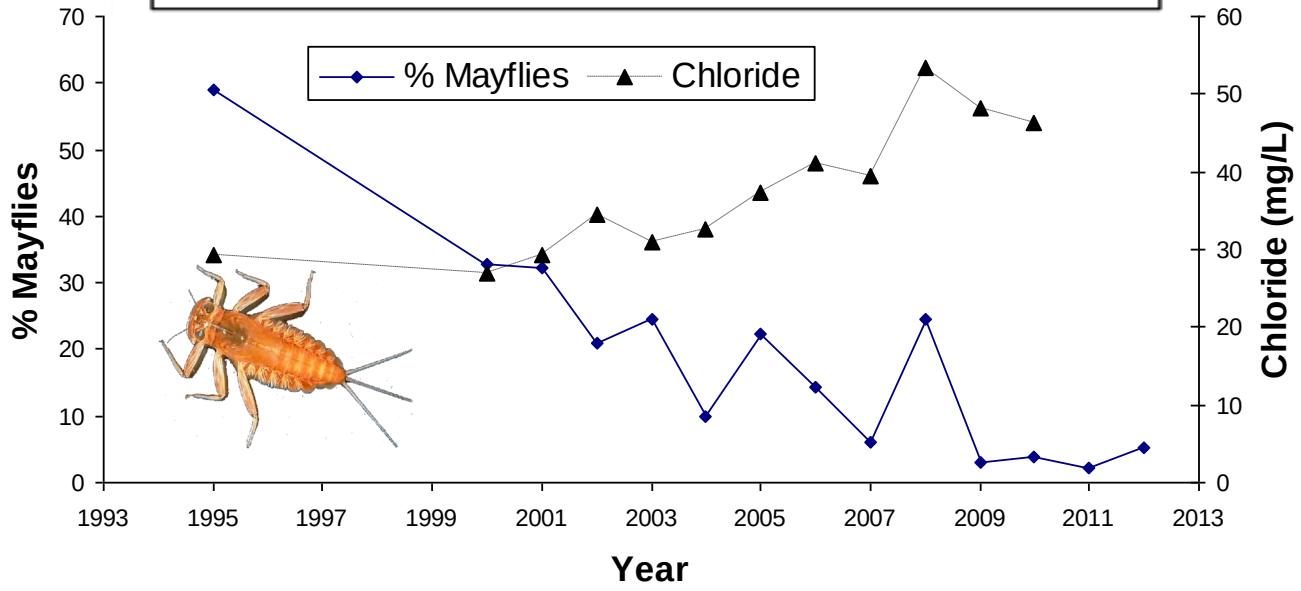
Land Cover Change at MBSS Sites (Round 4)



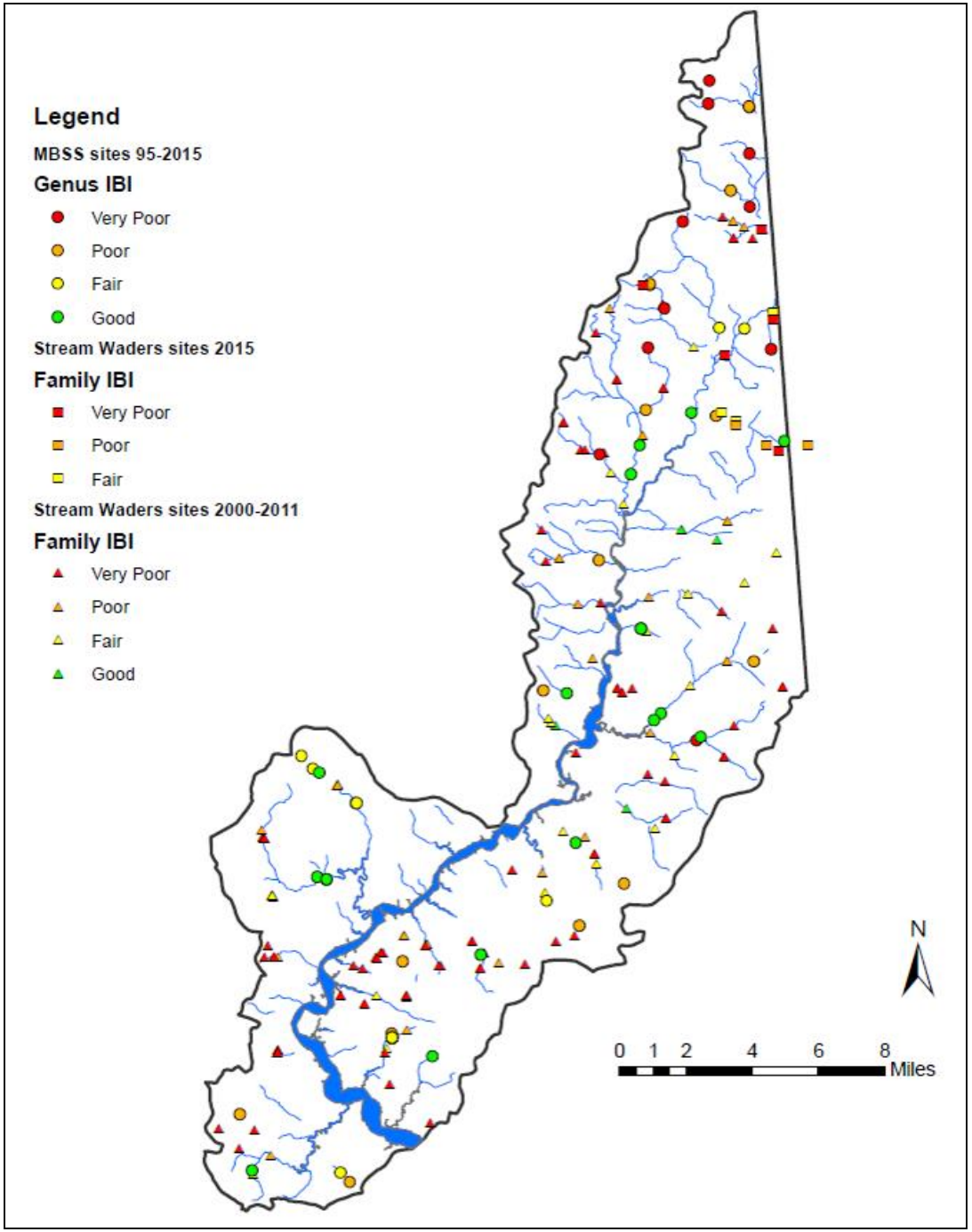
Sentinel Site Network to Investigate Climate Change and Natural Variability



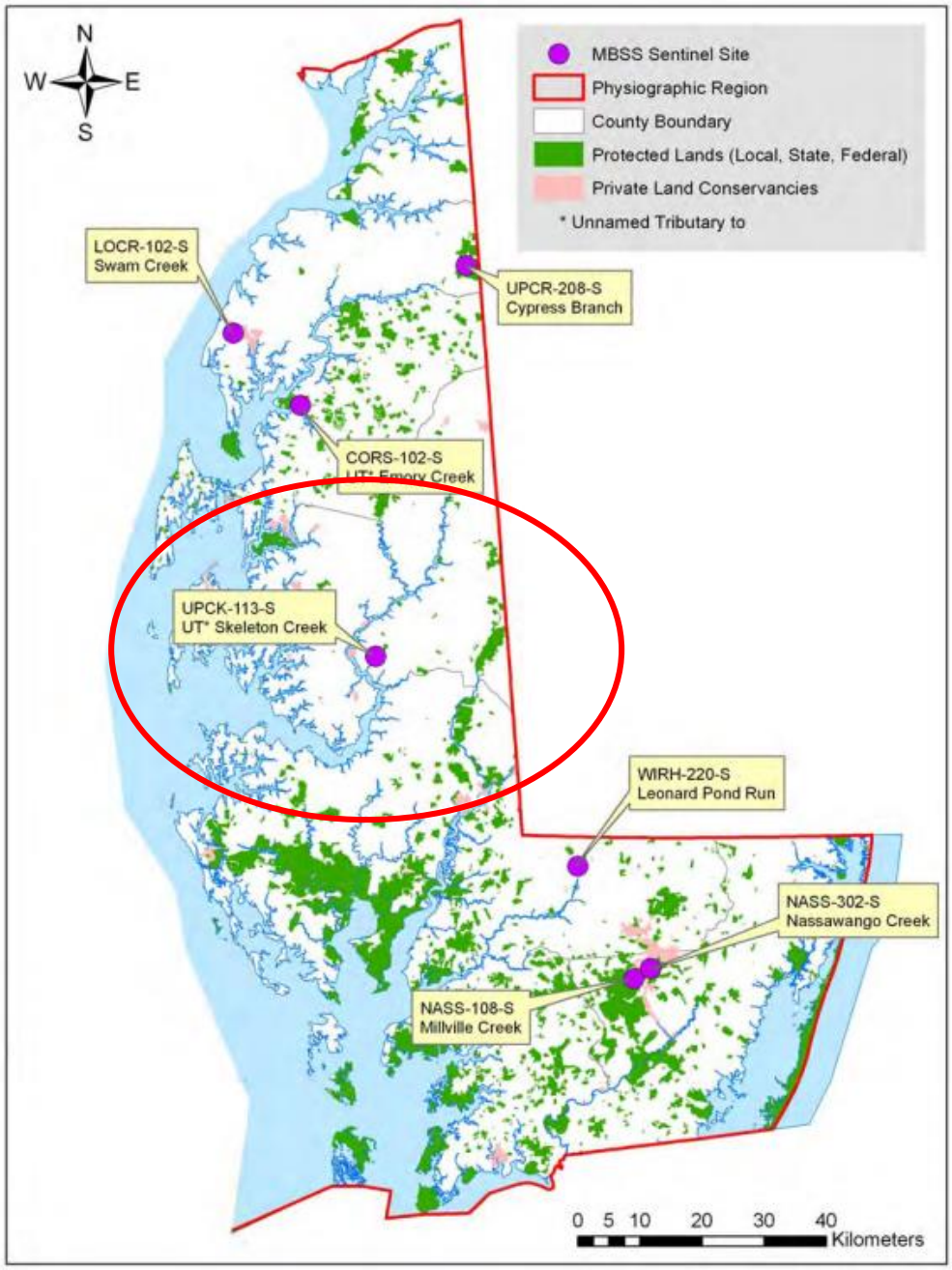
What about the cumulative effects of climate change and urbanization?

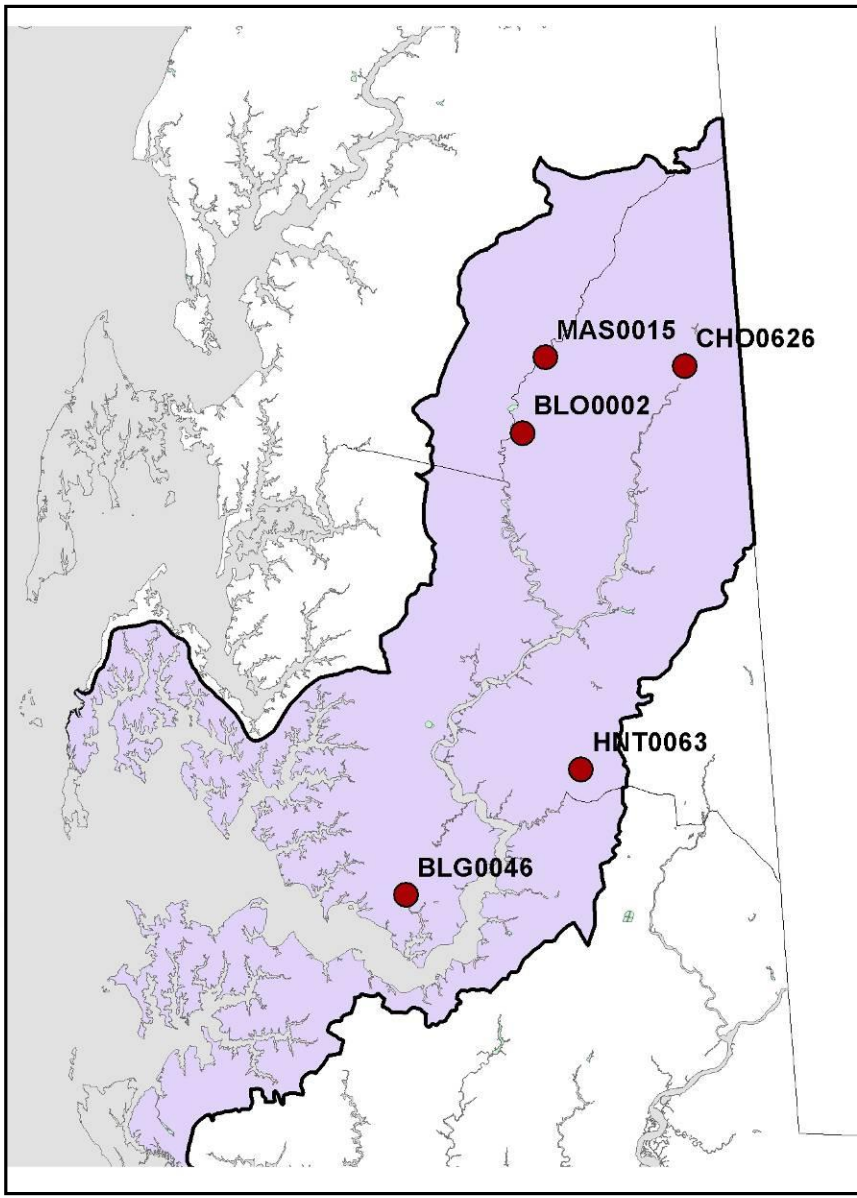


MBSS and Volunteer Samples in the Choptank Watershed

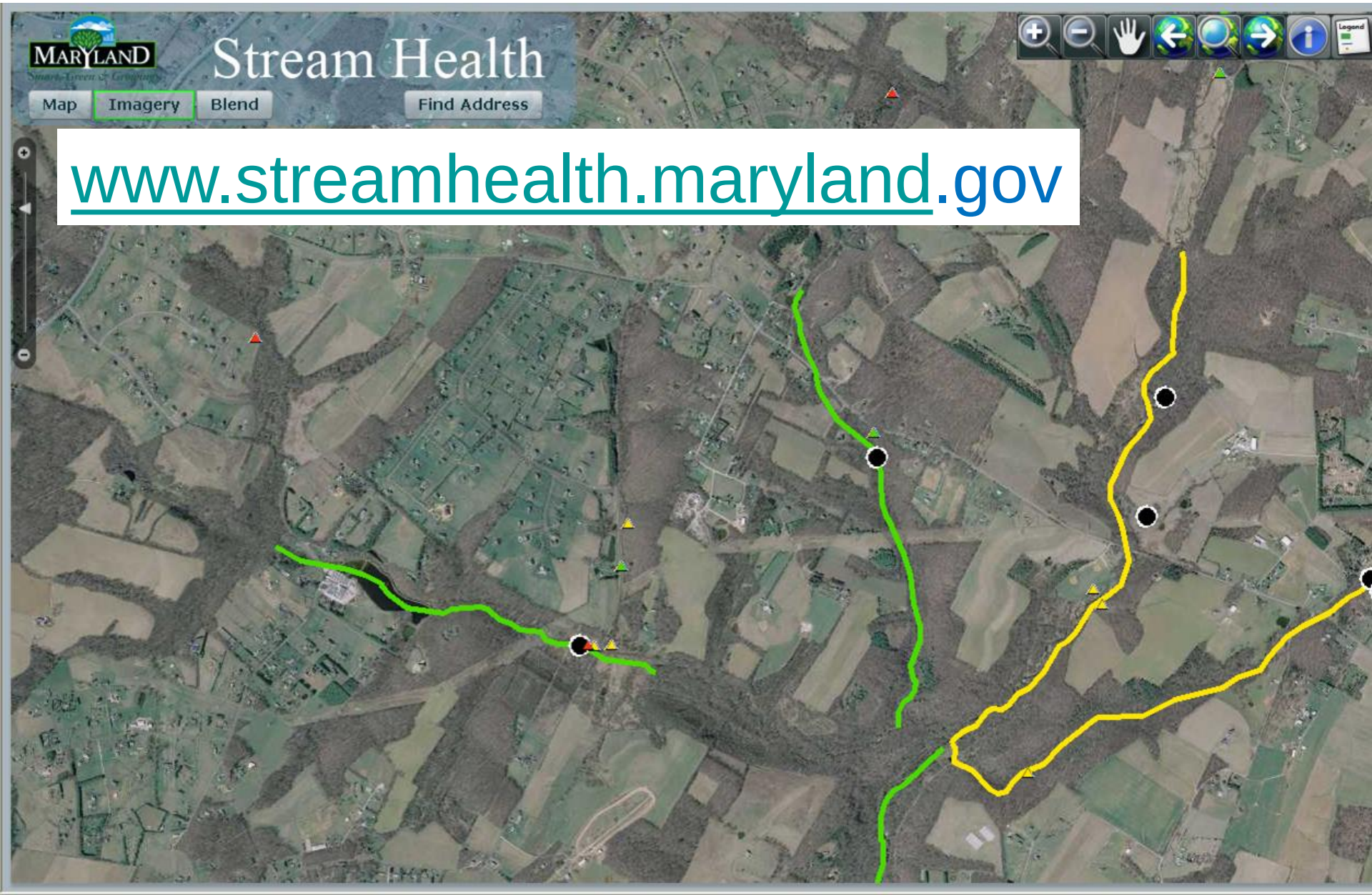


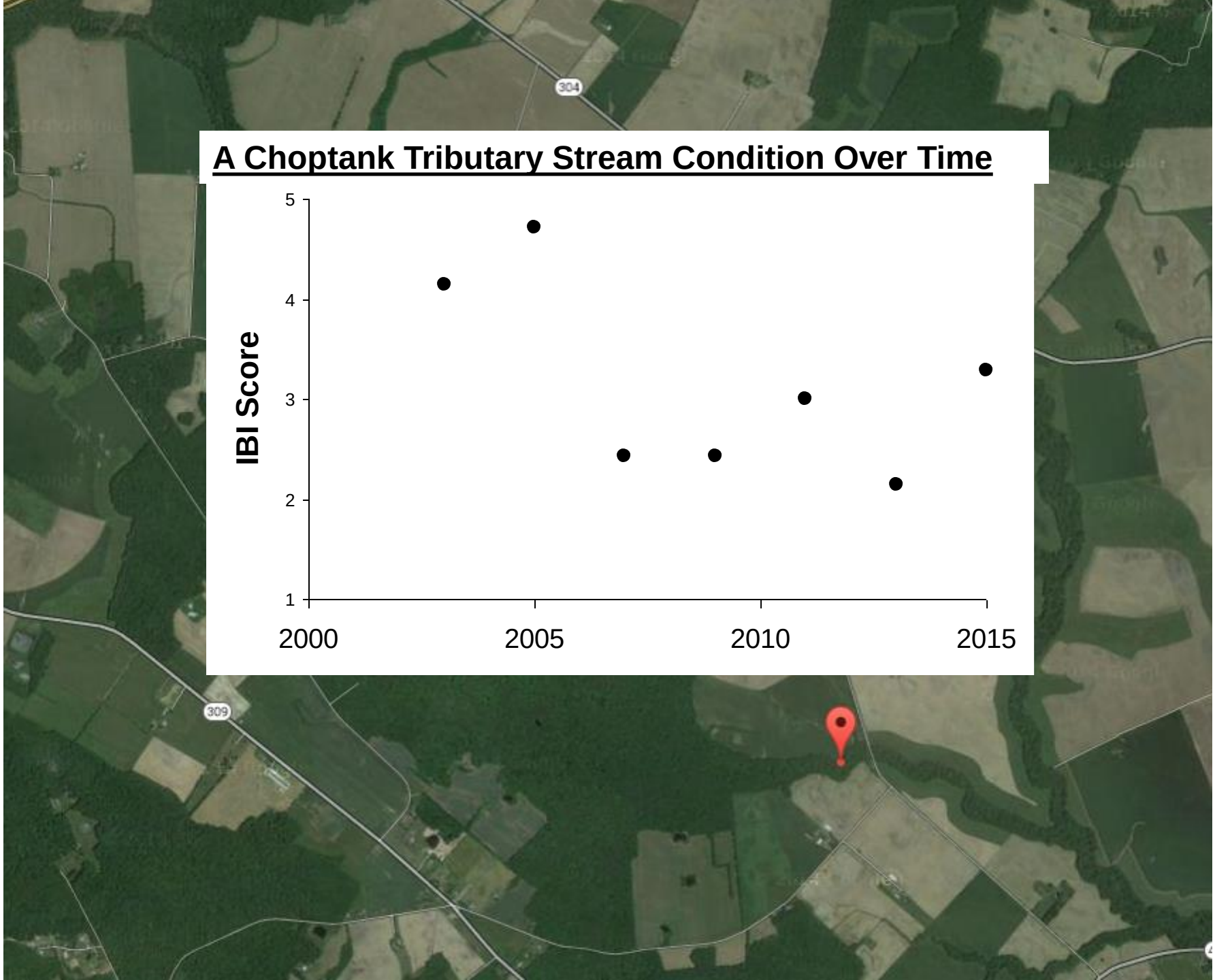
Long Term Regular Monitoring for Stream Biological Condition - Choptank





Maryland's Stream Health Web Site





A Choptank Tributary Stream Condition Over Time