



National Atmospheric Deposition Program

2009 Annual Meeting and Scientific Symposium

**Monitoring change in multi-pollutant
deposition and environmental response:
Bridging air and ecosystems**

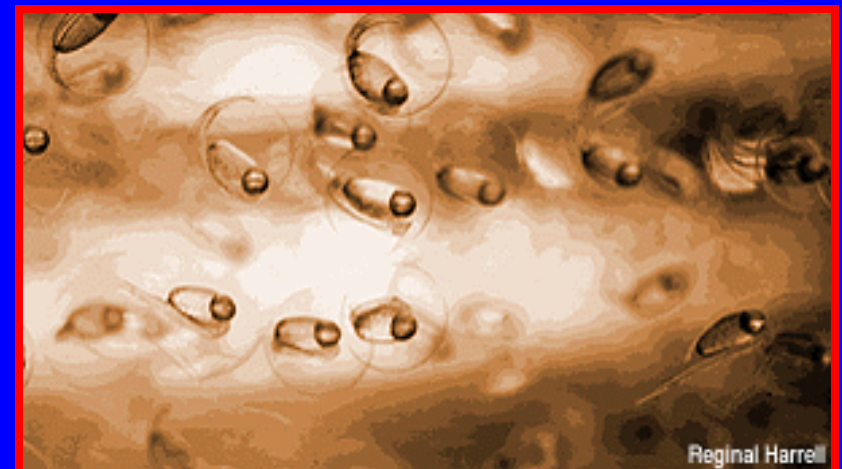
Saratoga Springs, New York

Maryland Critical Loads and the Maryland Biological Stream Survey

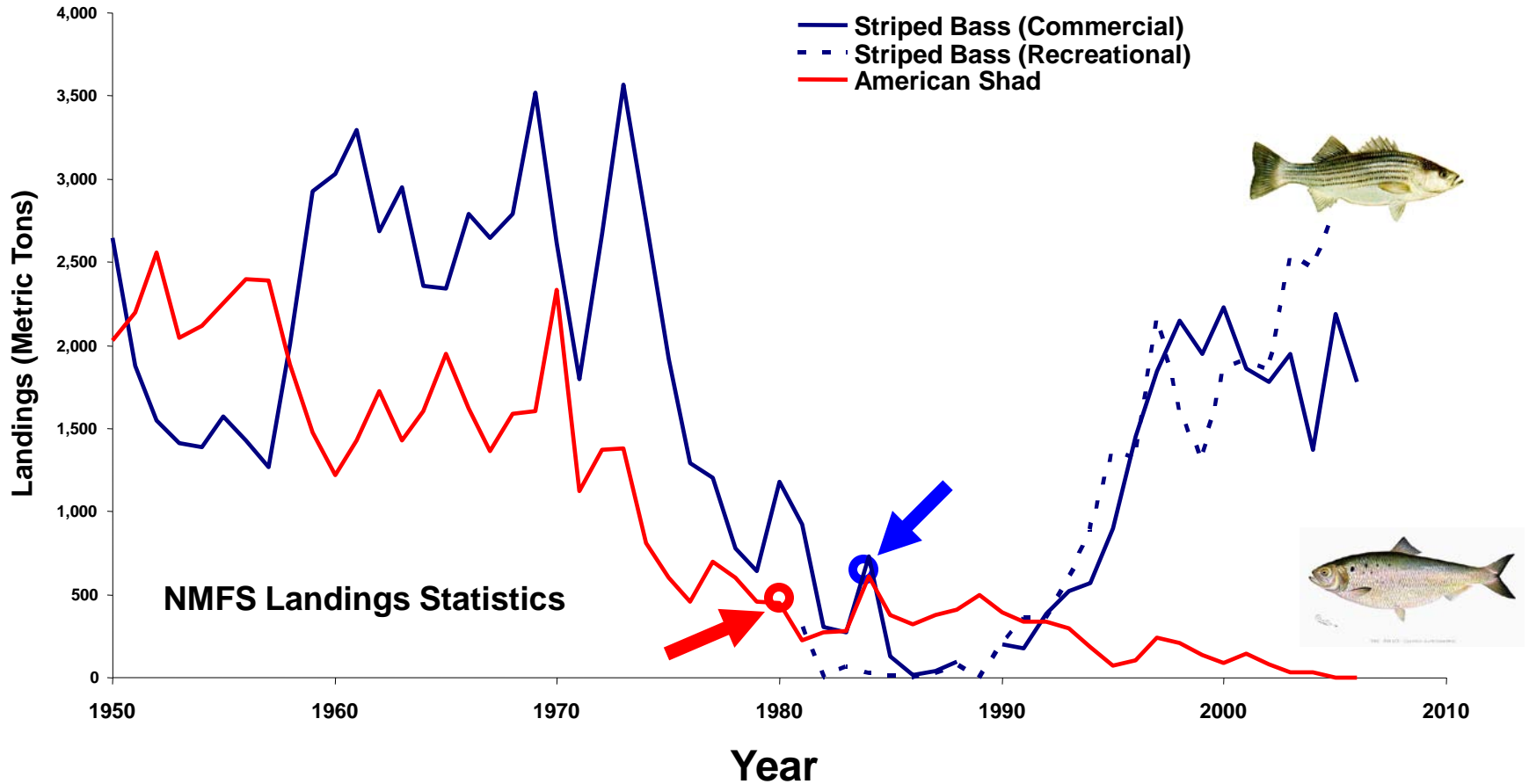




The beginning...



Chesapeake Bay: Striped Bass and American Shad Commercial Landings

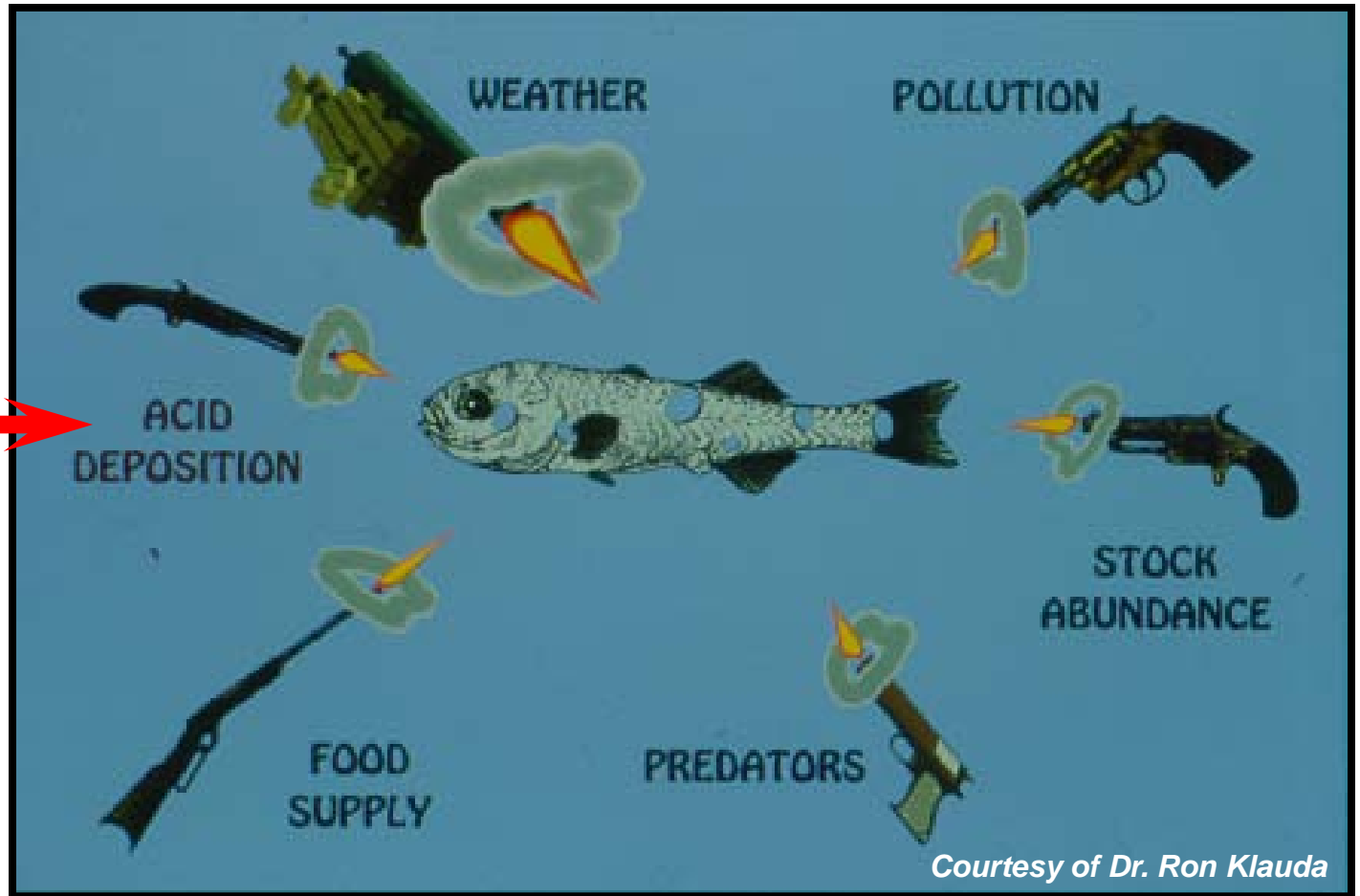


○ Maryland American Shad Moratorium 1980

○ Maryland Striped Bass Moratorium 1984

Courtesy of Dr. Ed Houde

Which Smoking Gun?



A Chesapeake-Centric State

Maryland Power Plant Research Program Reports and Papers on Acidic Deposition

1980 - 1985	13
1986 - 1990	34
1991 - 1995	37
1996 - 2000	13
2001 - 2009	3

\$\$\$\$\$\$\$\$



The real beginning...

AD-88-2

PPRP

MARYLAND SYNOPTIC STREAM CHEMISTRY SURVEY

ESTIMATING THE NUMBER AND DISTRIBUTION OF STREAMS
AFFECTED BY OR AT RISK FROM ACIDIFICATION

PREPARED BY

INTERNATIONAL SCIENCE & TECHNOLOGY, INC.
11260 ROGER BACON DRIVE, SUITE 201
RESTON, VIRGINIA 22090

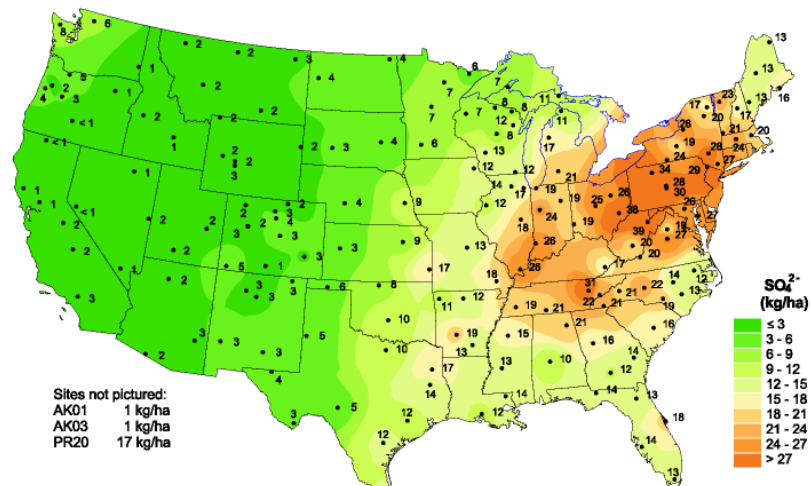
APRIL, 1988

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MARYLAND POWER PLANT
RESEARCH PROGRAM

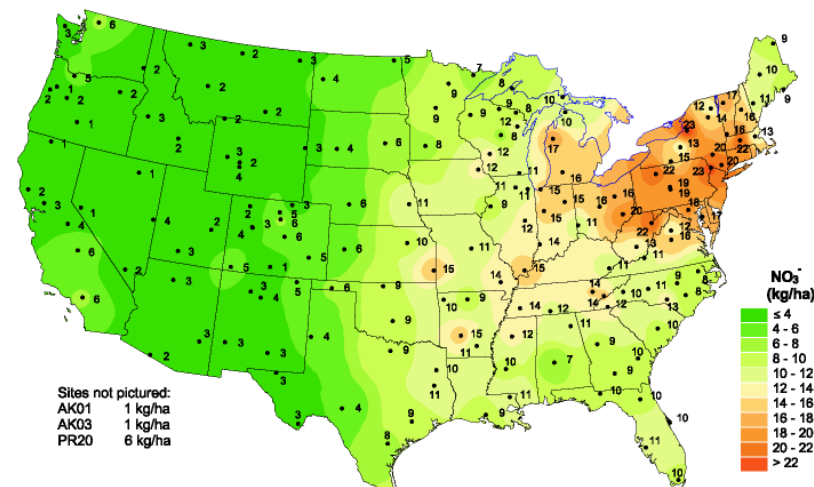


Estimated sulfate ion deposition, 1994

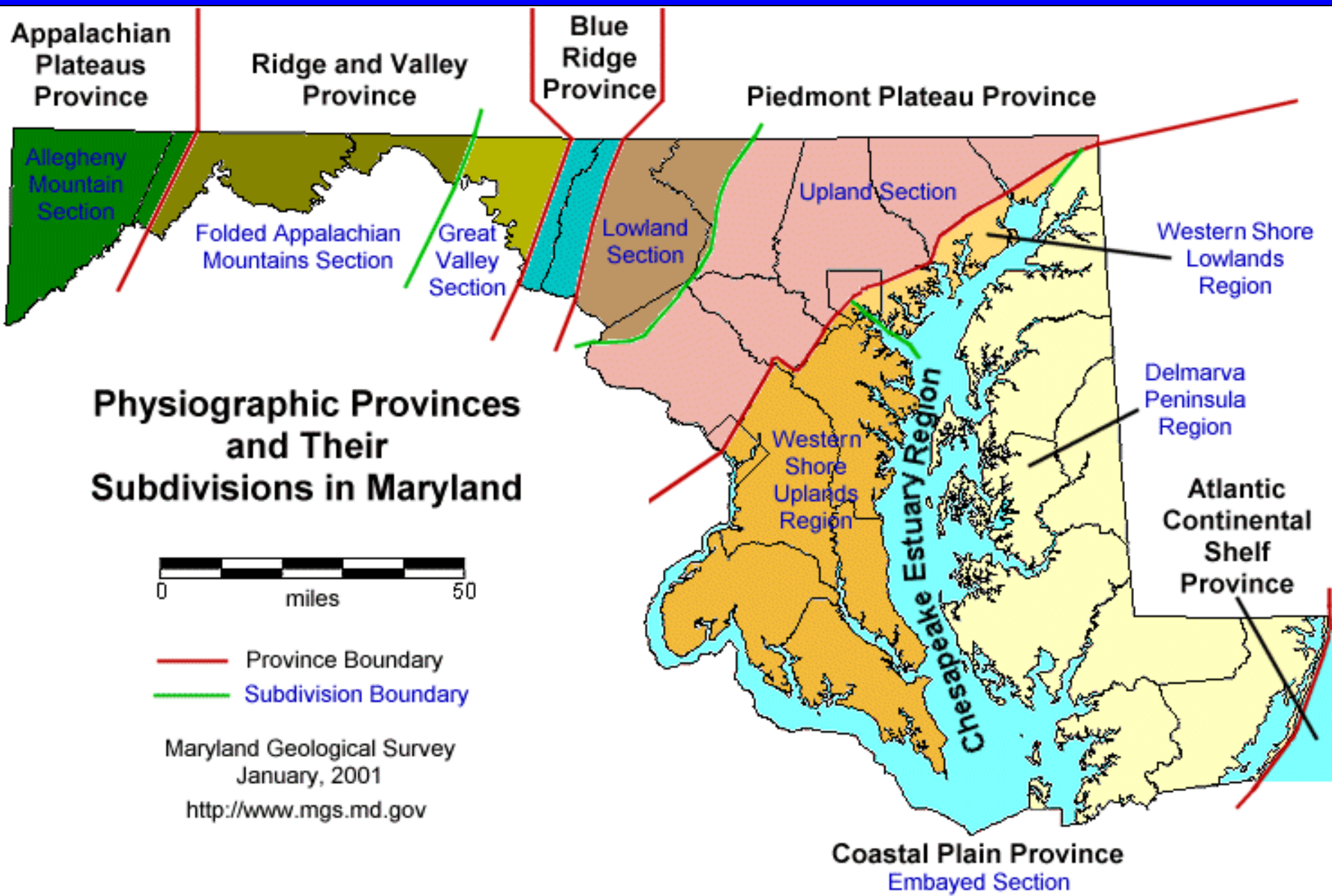


National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

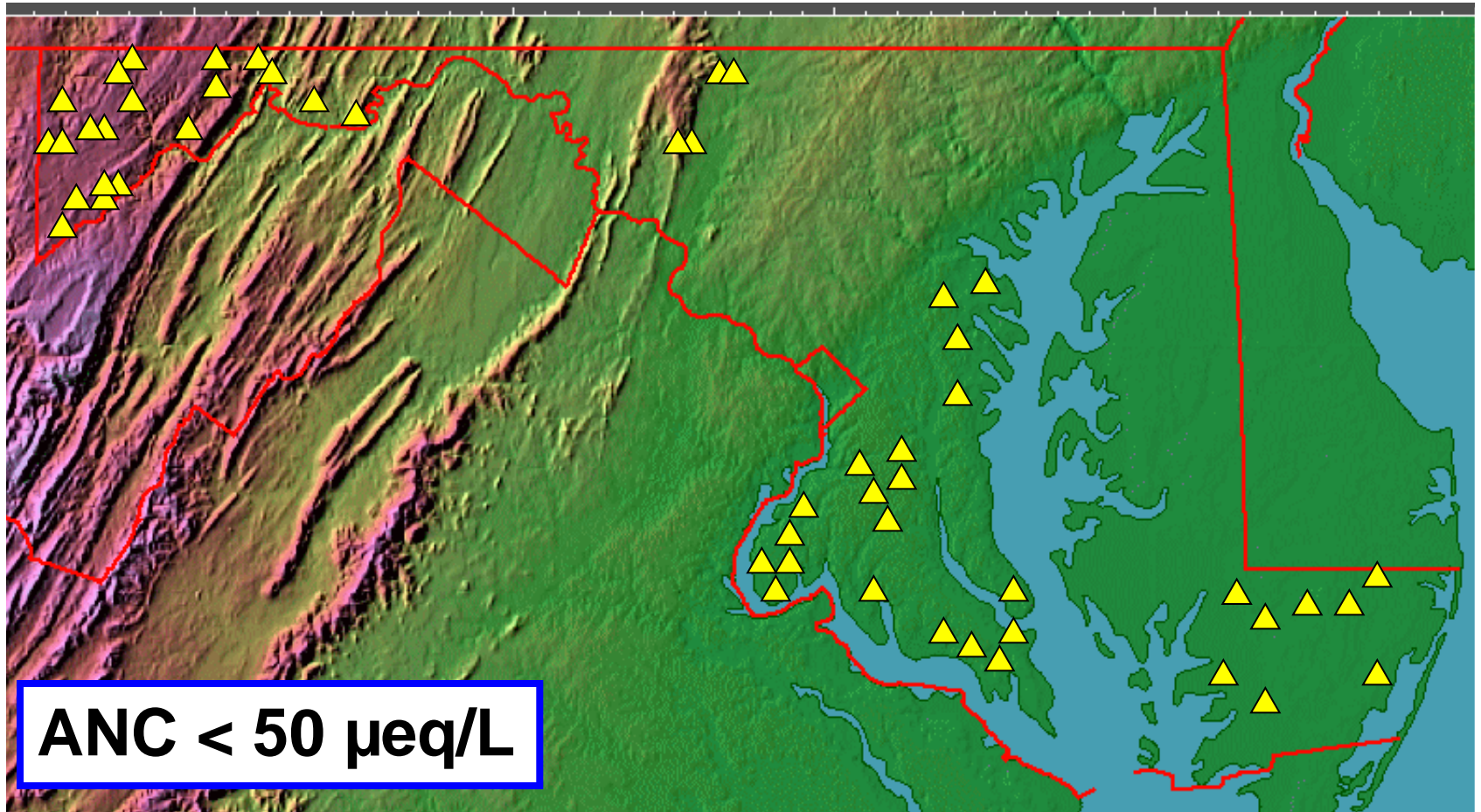
Estimated nitrate ion deposition, 1994



National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

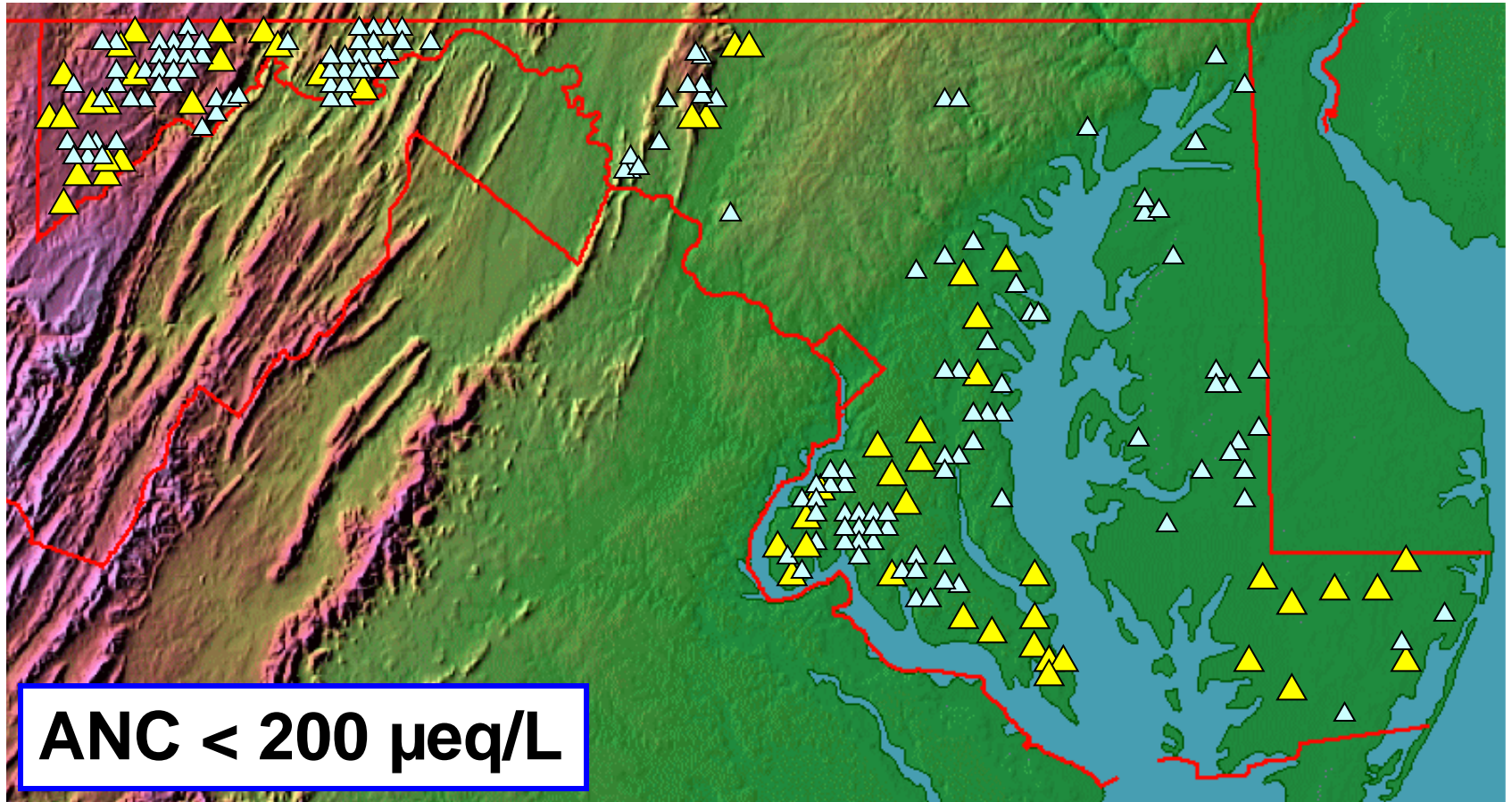


MSSCS (1987)



Stratified Random Design
630 Non-tidal reaches
Sampled East to West from March 7 to May 9

MSSCS (1987)



Western Maryland

Catoctins

Coastal Plain

AD-88-2

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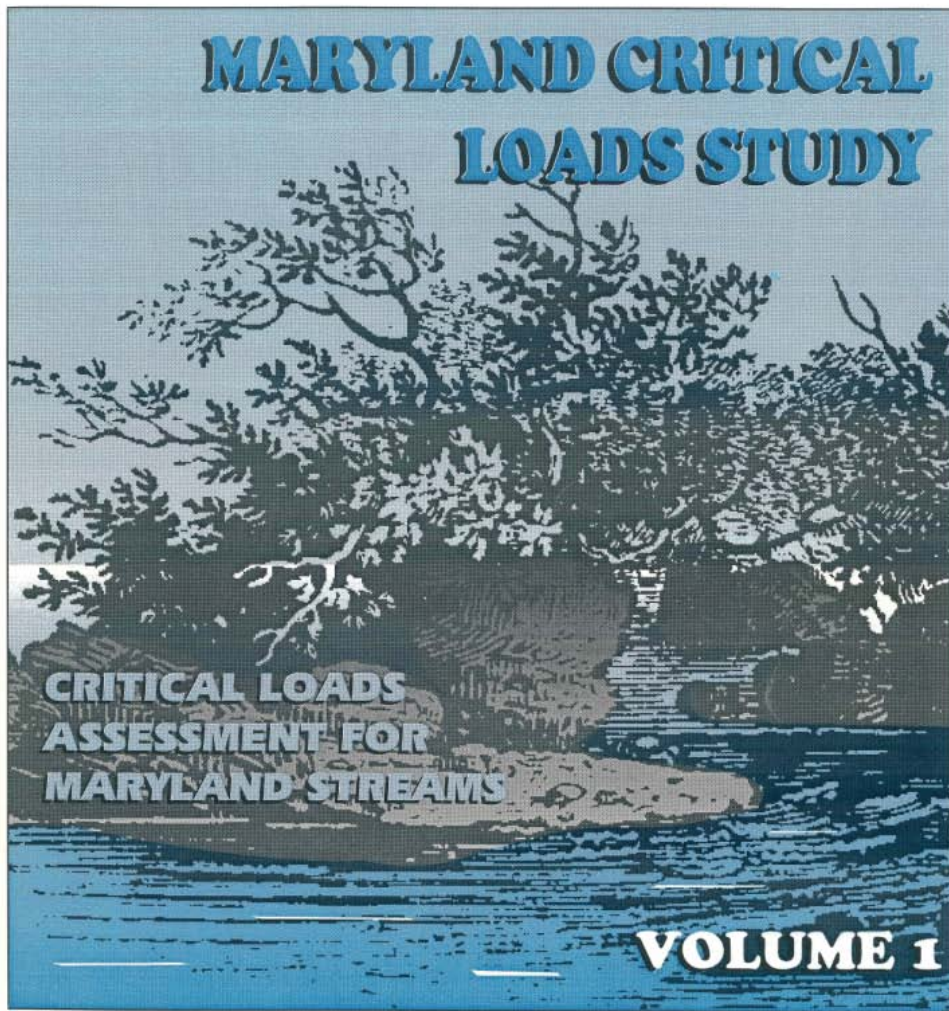
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*The real beginning
again, with the
MSSCS leading
to critical
loads for Maryland..*



Anthony Janicki

David Wade

Harold Wilson

Douglas Heimbuch

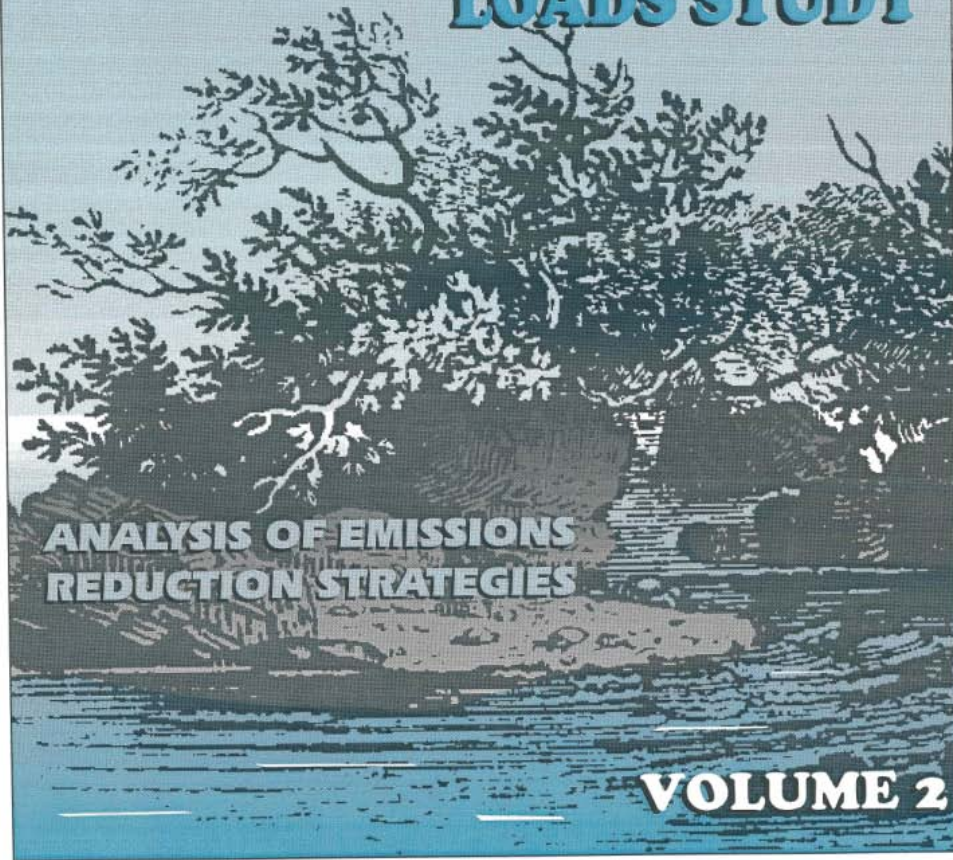
Harald Sverdrup

Per Warfvinge



**CHESAPEAKE BAY RESEARCH
AND MONITORING DIVISION
CBRM-AD-95-9**

MARYLAND CRITICAL LOADS STUDY



**ANALYSIS OF EMISSIONS
REDUCTION STRATEGIES**

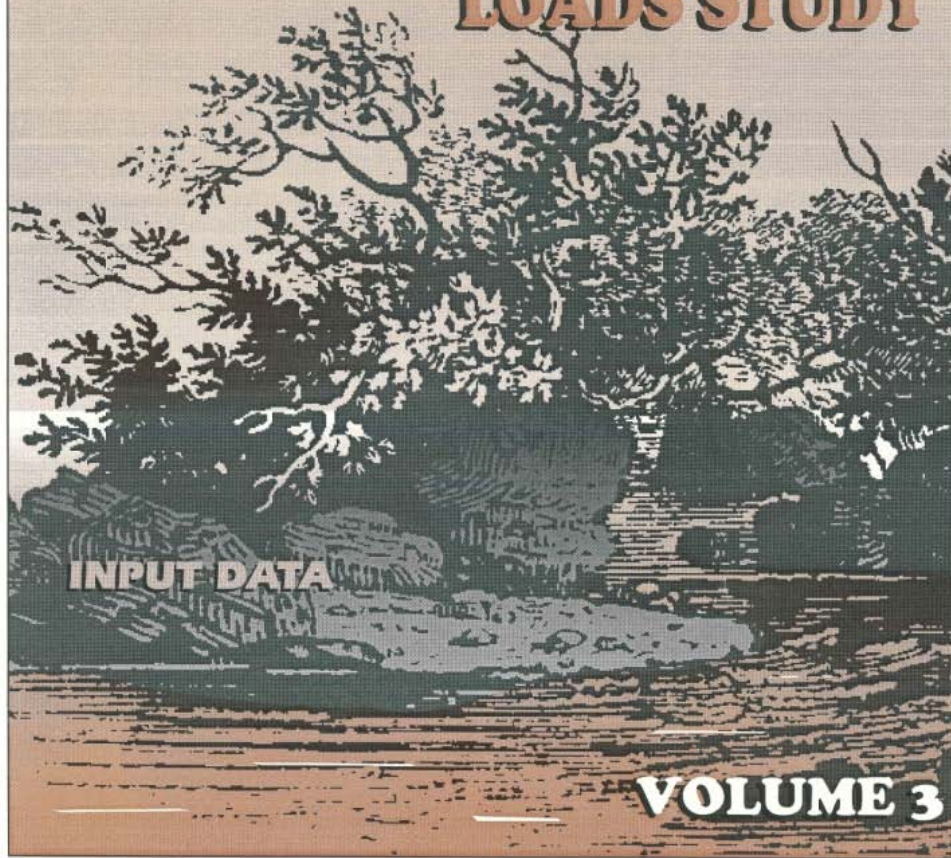
VOLUME 2



**CHESAPEAKE BAY RESEARCH
AND MONITORING DIVISION
CBRM-AD-95-9**

Hugh Ellis

MARYLAND CRITICAL LOADS STUDY



INPUT DATA

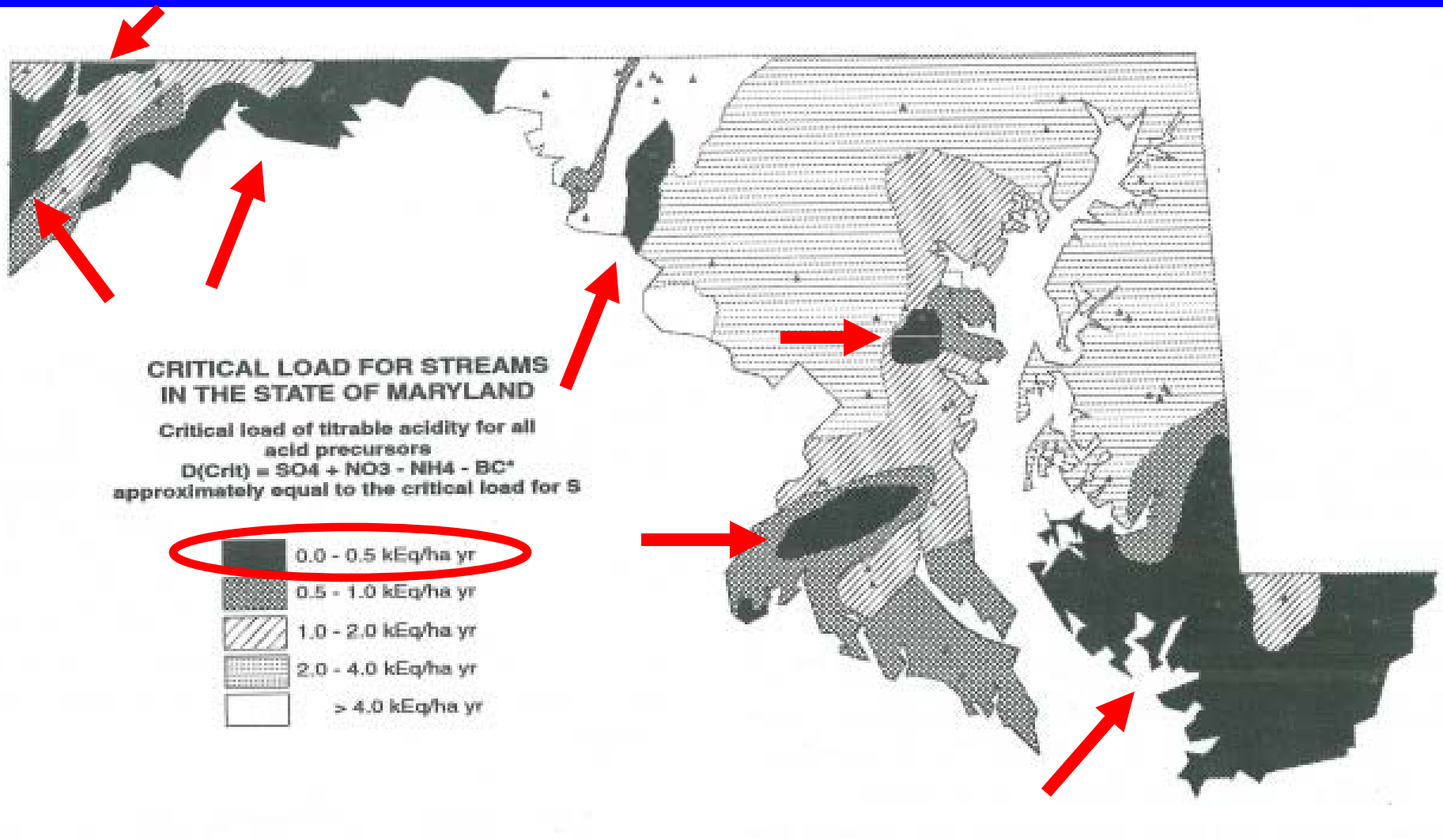
VOLUME 3

Martin Rabenhorst
Christopher Maxwell
Anthony Janicki
Raymond Morgan



CHESAPEAKE BAY RESEARCH
AND MONITORING DIVISION
CBRM-AD-95-9

Identification of Acid Sensitive Areas



*Sverdrup, H, P Warfvinge, M Rabenhorst, A Janicki, R Morgan and M Bowman. 1992.
Critical loads and steady state chemistry for streams in the State of Maryland.
Environmental Pollution 77: 195-203.*

*Critical loads,
now leading to the
Maryland Biological
Stream Survey (MBSS)...*

MBSS GOAL AND OBJECTIVES

Overall Goal:

Provide the best possible information for ensuring the protection and restoration of Maryland's stream ecological resources.

Objectives:

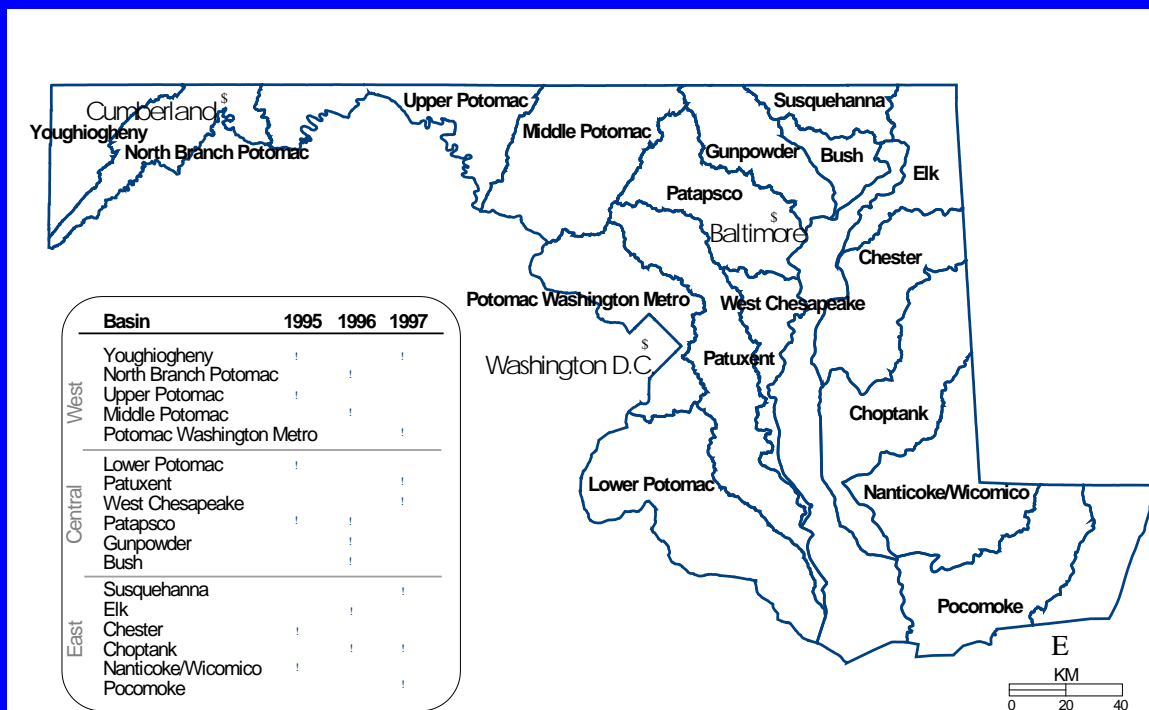
- Assess the condition of ecological resources in streams and rivers
- Quantify the effect of acidic deposition on biological resources
- Identify causes of adverse effects (stressors)
- Compile a biodiversity inventory
- Prioritize areas for protection and restoration
- Document changes in biological resources (temporal component)

Estimates of Maryland Stream Length

Order	Length (km)	%
1	11,230	50%
2	5,789	26%
3	3,000	13%
4	1,580	7%
5	837	4%

MBSS BACKGROUND

- Initiated by and patterned after the Maryland Synoptic Stream Chemistry Survey done in 1987
- Probability-based design: 17 x 3 (ws x yr) lattice sampling
- Non-tidal 1st-3rd order streams (some 4th later)
- Equal basin allocation
- 75 meter segment
- Meetings: 90-93?
- Pilot: 93
- Demonstration: 94
- First Round: 95-97
- Second Round: 00-05
- Third Round: 07-09



MBSS ATTRIBUTES

- Precise definition of target waters
- Probability-based sample site selection
- Measurement of many biological variables
- Standardized sampling methods
- Standardized index periods
- Measurement of water chemistry
- Ongoing and rigorous QA/QC (training)

MBSS Design and Statistics

<http://www.dnr.state.md.us/streams/mbss>

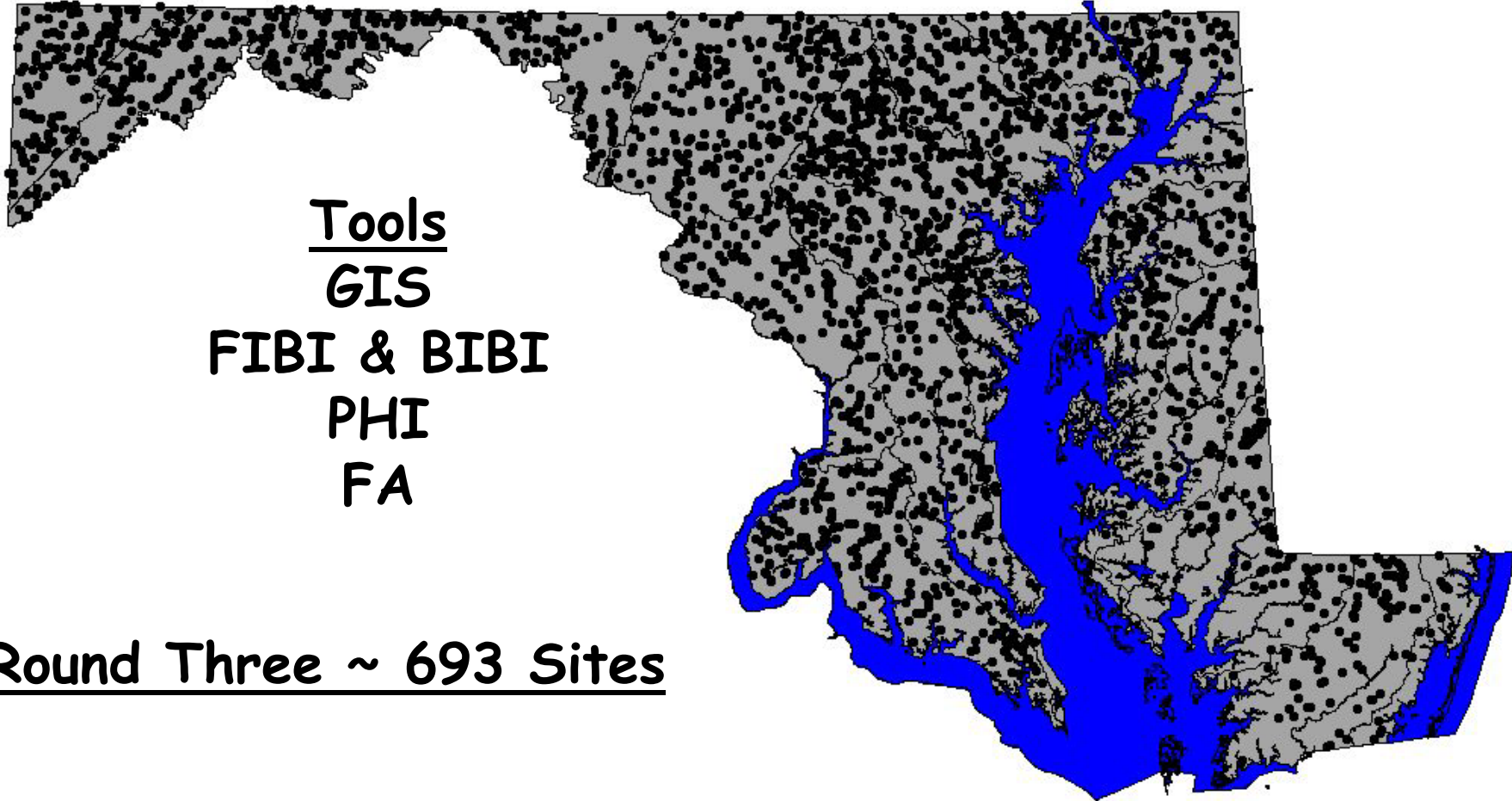
or type "mbss" in your favorite search engine

MBSS and PPRP Publications

<http://www.dnr.state.md.us/bay/pprp/>

or type "mbss" or "PPRP" in your favorite search engine

MBSS Sites ~ 2,500 Non-tidal Streams Rounds One and Two (1st - 3rd Order)



Tools

GIS

FIBI & BIBI

PHI

FA

Round Three ~ 693 Sites

MBSS Good News/Bad News

Sampling at each 75 m site consists of..

Water Chemistry (SPIP)
Benthic Macroinvertebrates (SPIP)
Fish (SUIP)
Physical Habitat (SUIP)
Temperature Monitoring (SUIP)
Land Use (GIS)



Physical Habitat Variables

Instream Habitat

Epifaunal Substrate

Velocity/Depth Diversity

Pool/Glide/Eddy Quality

Riffle/Run Quality

Embeddedness

Shading

Woody Debris/Rootwads

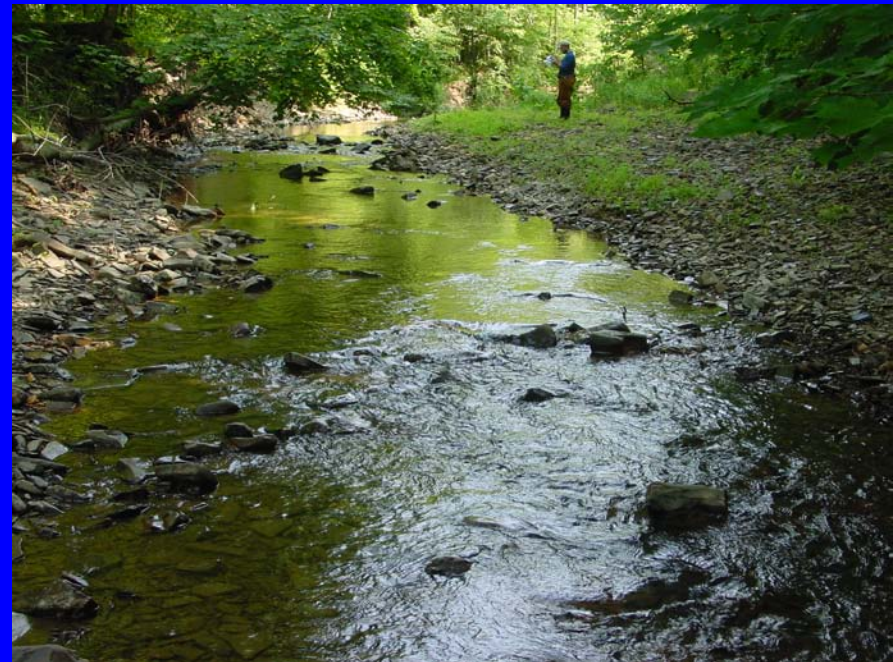
Bank Stability

Erosion Potential

Stream Gradient

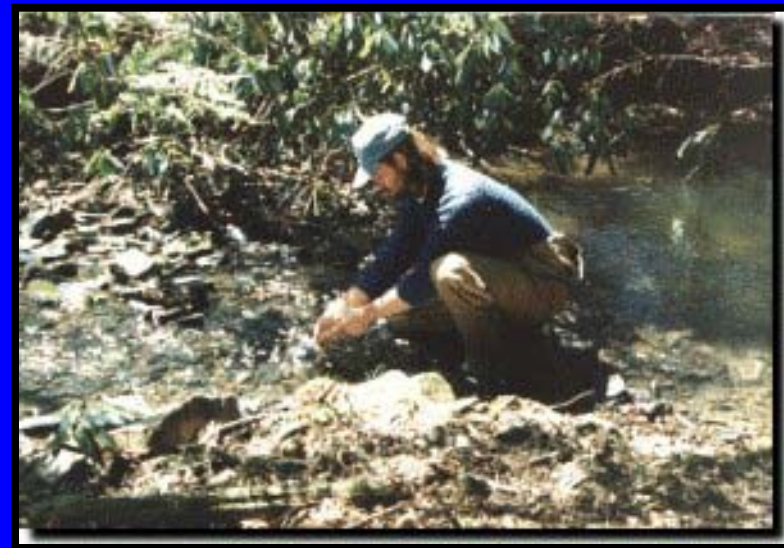
Sinuosity

Stream Discharge



Water Chemistry Variables

DO, Temperature, pH, Turbidity, ANC, Sulfate, Nitrate, Nitrite, Ammonia, Total Nitrogen (dissolved and particulate), Orthophosphate, Total Phosphorous (dissolved and particulate), Chloride, Conductivity, and DOC



Design of core MBSS allows for assessment of average stream conditions over a multi-year period for:

1. The entire state;
2. ecoregions;
3. Maryland counties;
4. Tributary Strategy Basins;
5. Maryland 6-digit drainage basins;
6. Maryland 8-digit watersheds (303d); and
7. other permutations and combinations of interest.

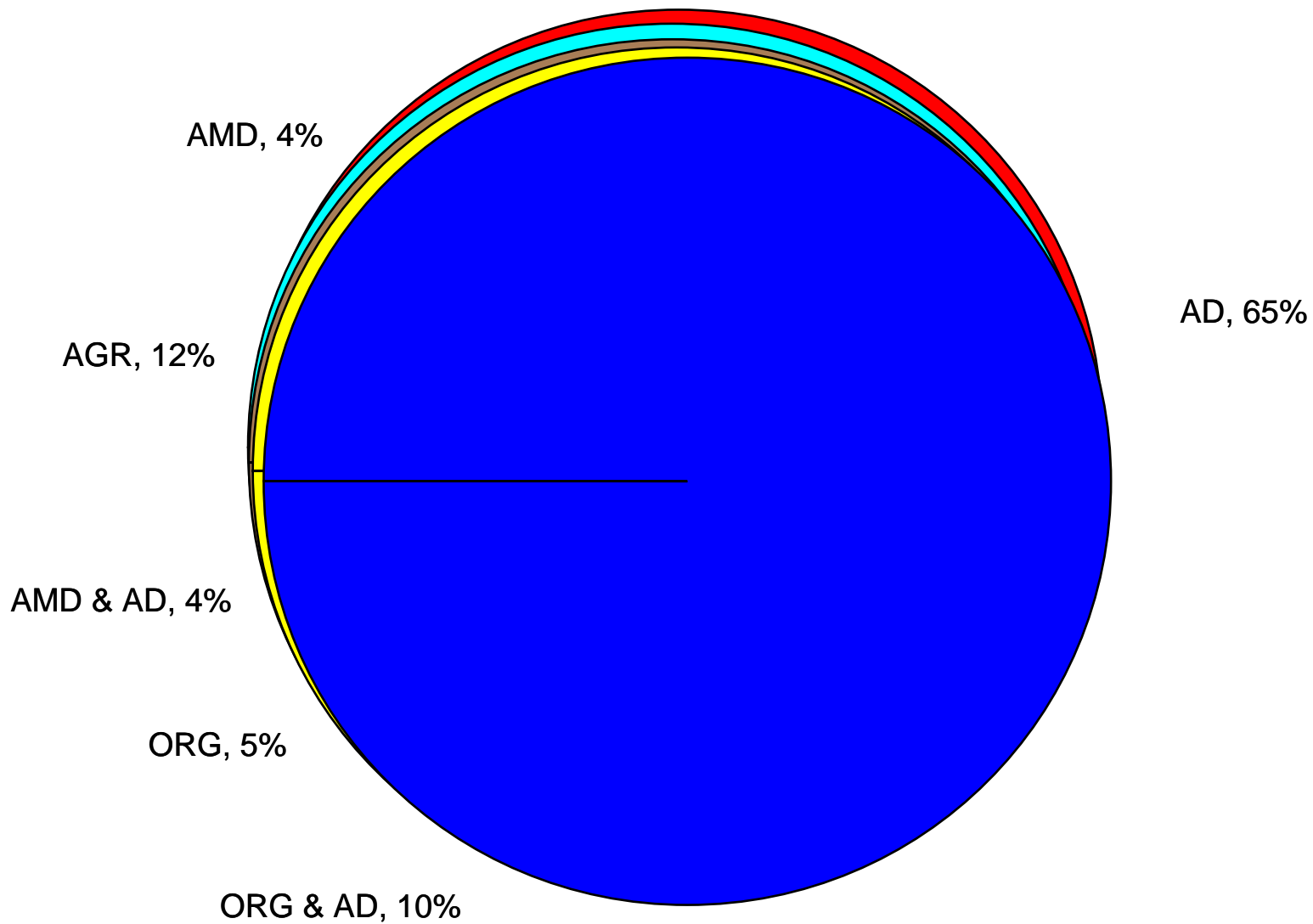


ANC Comparison Across Four MD Stream Studies

ANC Level ($\mu\text{eq/L}$)	MSSCS (1987)	MBSS RD 1 (95 – 97)	<u>MBSS RD 2</u> (00 - 04)	<u>MBSS RD 3</u> (07 - 09)
< 0	7.1%	1.5%	2.8%	3.3%
0 - 50	5.8%	4.8%	8.1%	9.8%
50 - 200	39.0%	24.2%	32.9%	32.6%
> 200	48.1%	69.5%	56.2%	54.3%

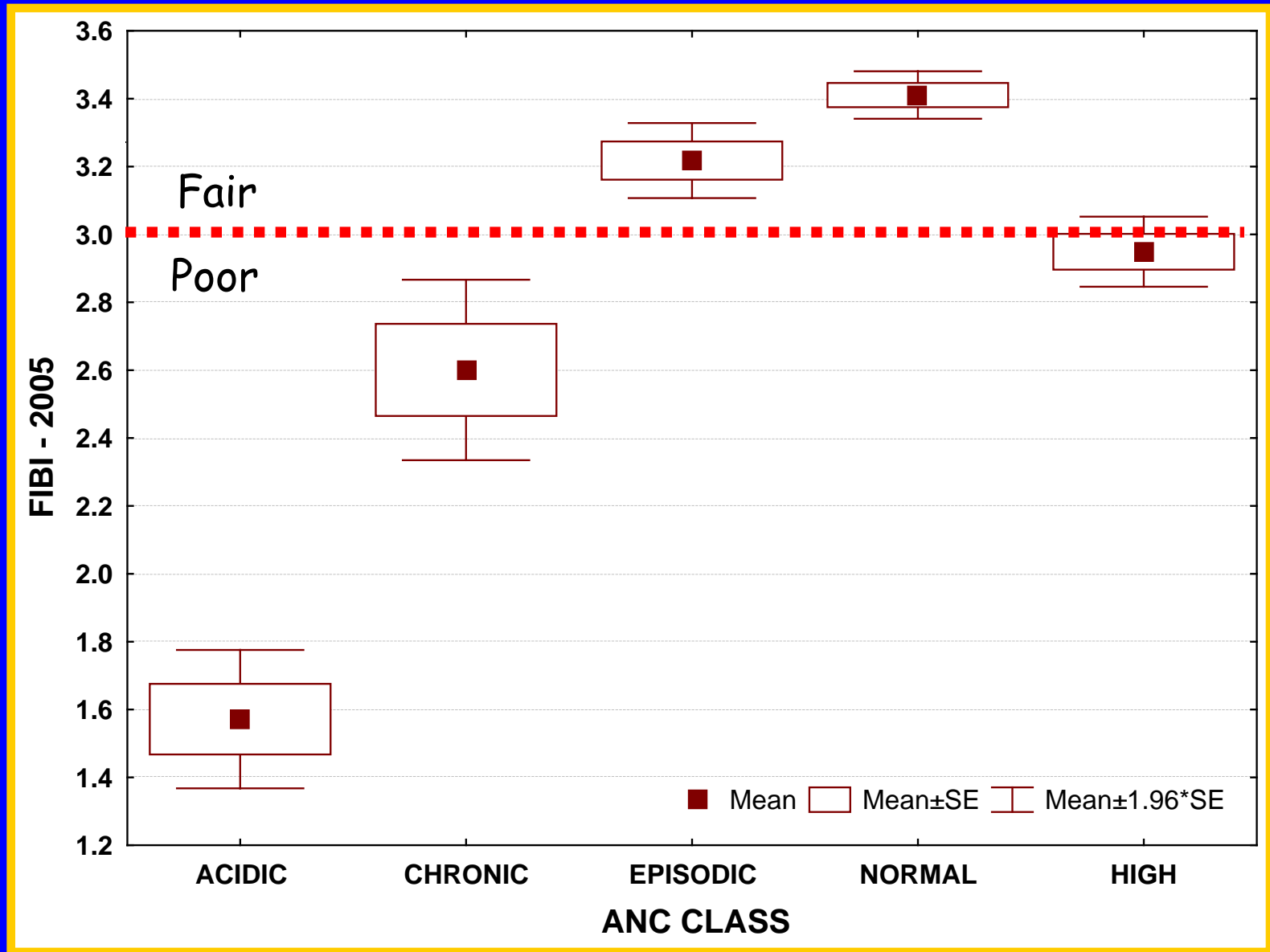


In western Maryland, gaining about 1-2 $\mu\text{eq/L}$ ANC per year.



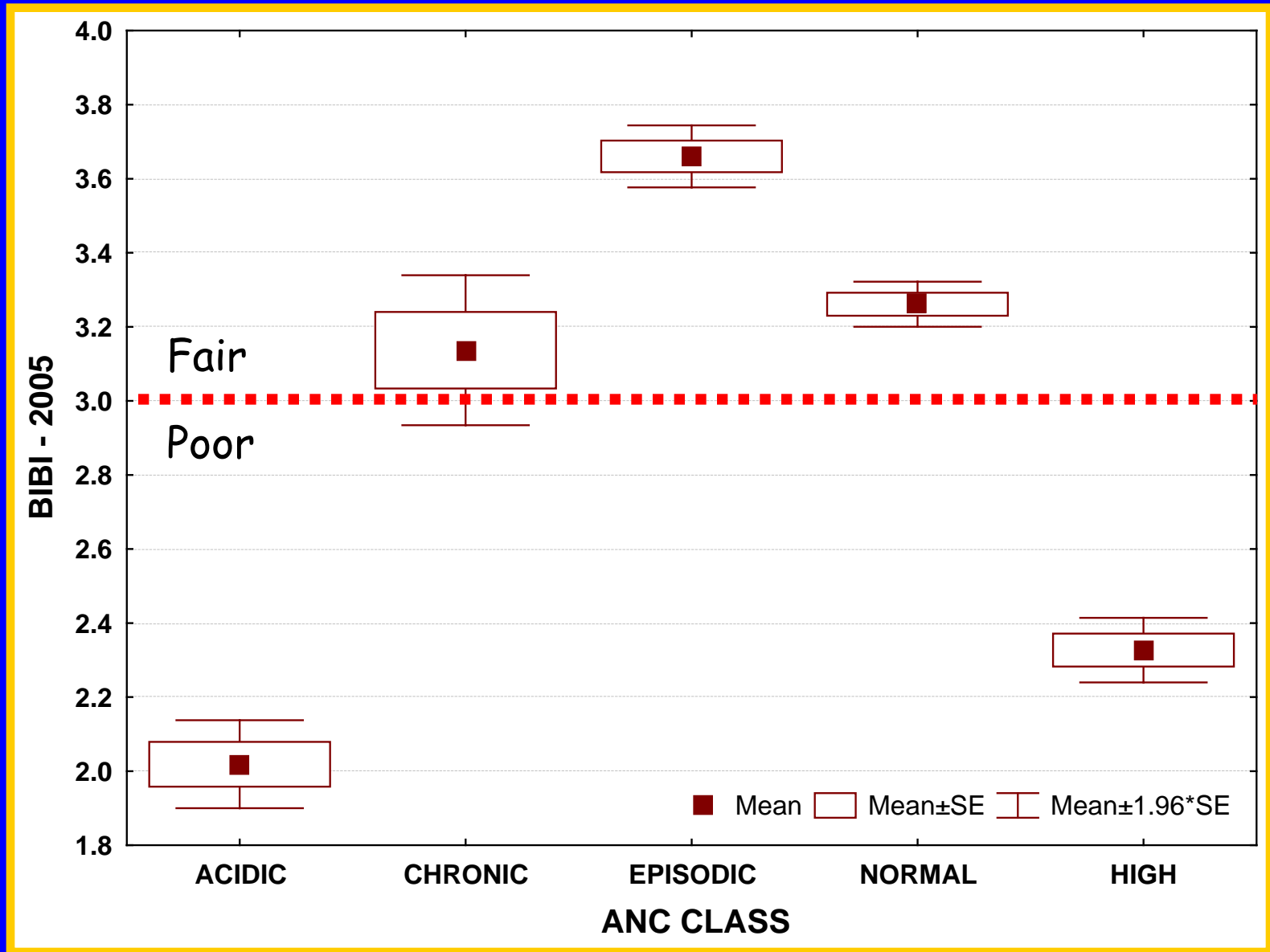
Acidic Sources in Maryland

Biotic data I...



Acidic < 0, Chronic 0 -50, Episodic 50 -200, Normal 200 - 750, High > 750 $\mu\text{eq/L}$

Biotic data II...



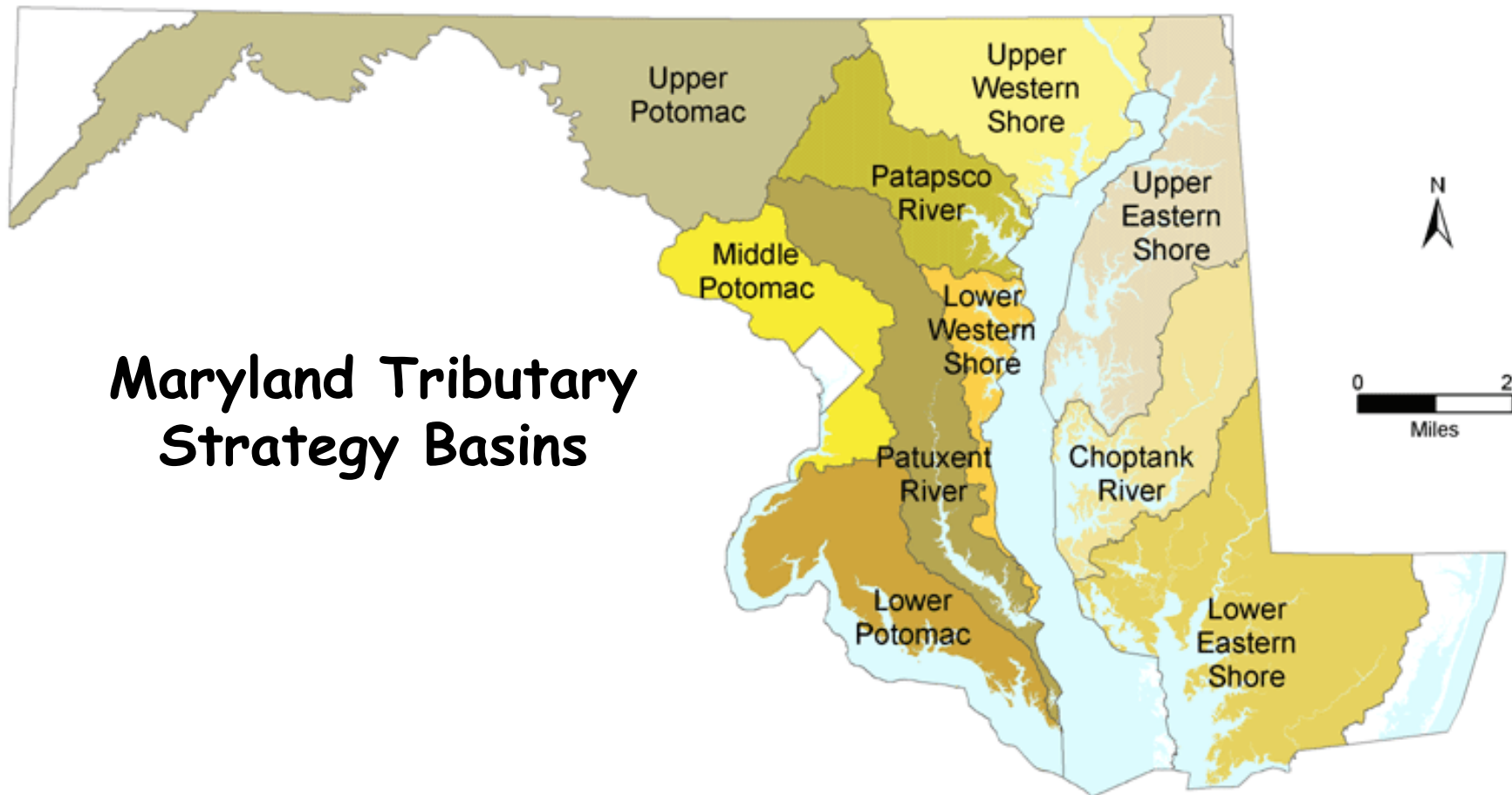
Acidic < 0, Chronic 0 -50, Episodic 50 -200, Normal 200 - 750, High > 750 $\mu\text{eq/L}$

Drawing inferences...

Estimated percentage of stream km within each threshold category for selected tributary strategy basins.

Analyte	Threshold	Lower Eastern Shore	Upper Eastern Shore	Lower Western Shore	Upper Western Shore	Upper Potomac	<u>Youghiogheny</u>
pH (SU)	< 5.5	26.2	1.3	10.0	0.8	3.4	16.1
	5.5 – 6.5	40.0	20.9	43.5	4.2	4.1	11.9
	> 6.5	33.7	77.8	46.5	95.0	92.4	72.0
ANC (µeq/L)	< 0	12.2	1.3	3.0	0	2.1	10.2
	0 - 50	11.8	0	7.0	0.8	3.9	9.2
	50 - 200	37.5	16.6	39.9	8.1	15.5	59.5
	> 200	38.6	82.1	50.1	91.1	78.5	21.1

Maryland Tributary Strategy Basins



Data Source:
Maryland DNR

Landscape & Watershed Analysis Division
Watershed Services Unit
Maryland Department of Natural Resources

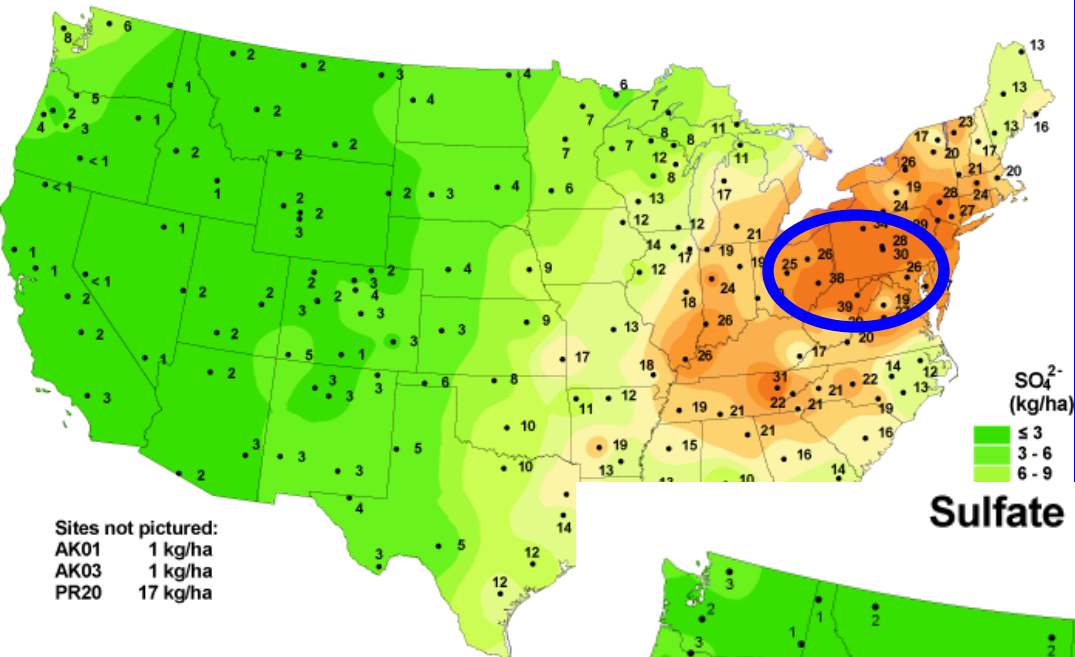


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Sulfate ion wet deposition, 1994

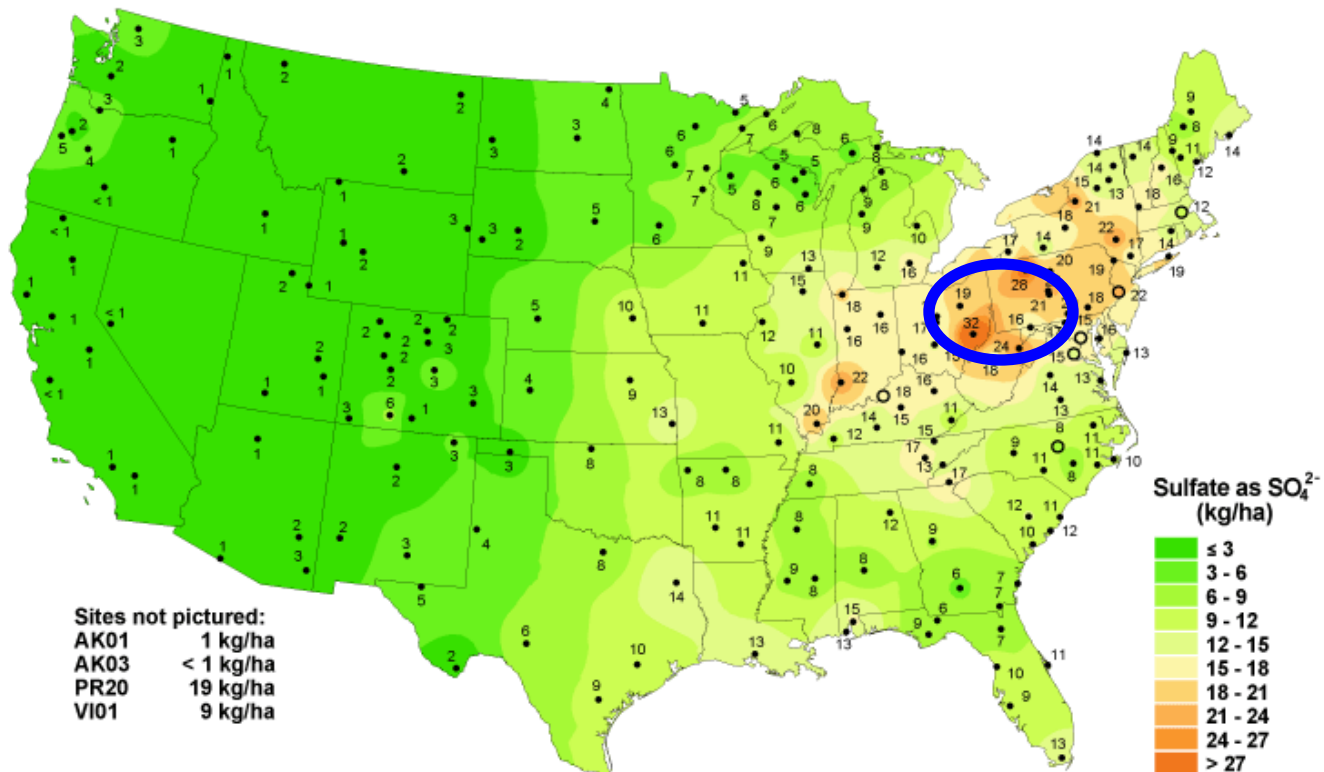


Sites not pictured:
 AK01 1 kg/ha
 AK03 1 kg/ha
 PR20 17 kg/ha

National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

A big change...

Sulfate ion wet deposition, 2007



Sites not pictured:
 AK01 1 kg/ha
 AK03 < 1 kg/ha
 PR20 19 kg/ha
 VI01 9 kg/ha

National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

AD-13-66

PPRP

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Twenty-Five Year Anniversary Study

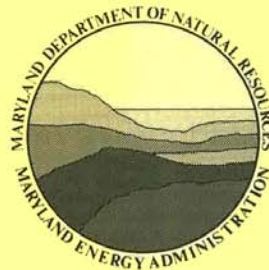
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*Twenty-five
years later,
the next step...*