STROUD™

WATER RESEARCH CENTER

ADVANCING KNOWLEDGE AND STEWARDSHIP OF FRESH WATER SYSTEMS THROUGH RESEARCH, EDUCATION, AND RESTORATION

Monitoring Planning & Design

Choices & Decisions

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Monitoring Planning & Design
10 Questions

1. Why is the monitoring taking place?
2. Who will use the monitoring data?
3. How will the data be used?
4. What parameters or conditions will be monitored?
5. How good do the monitoring data need to be?
6. What methods should be used?
7. Where are the monitoring sites?
8. When will monitoring occur?
9. How will monitoring data be managed and presented?
10. How will the program ensure that data are credible?

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Monitoring Planning & Design
10 Questions

1. <u>Why</u>?
2. <u>Who</u>?
3. <u>How</u>?
4. <u>What</u>?
5. How?
6. What?
7. <u>Where</u>?
8. <u>When</u>?
9. How?
10. How?

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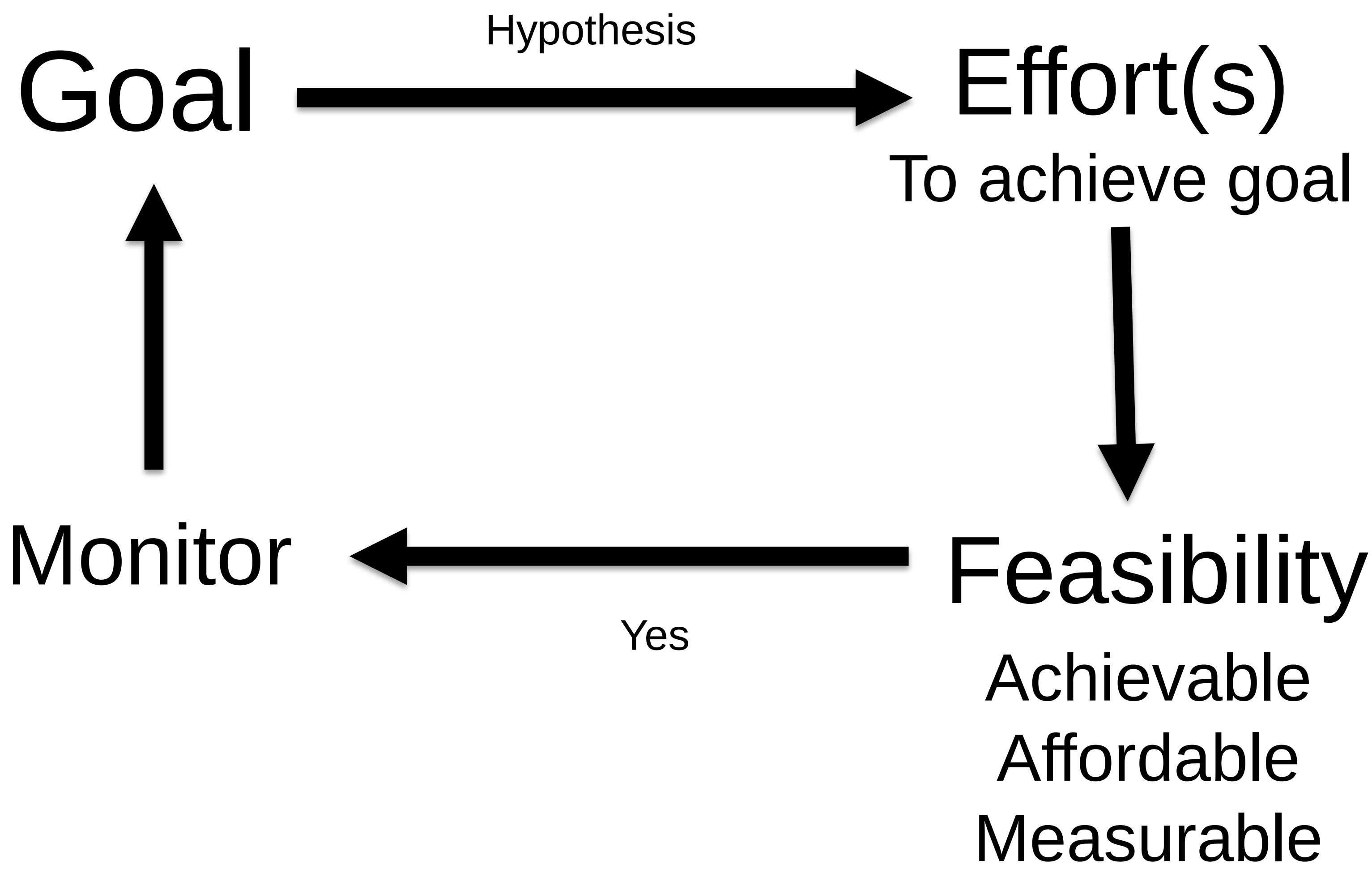
Project Planning & Design



Swimmable

Drinkable

Fishable

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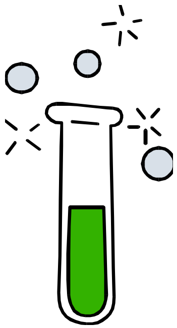
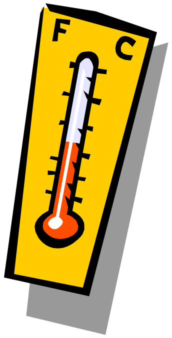
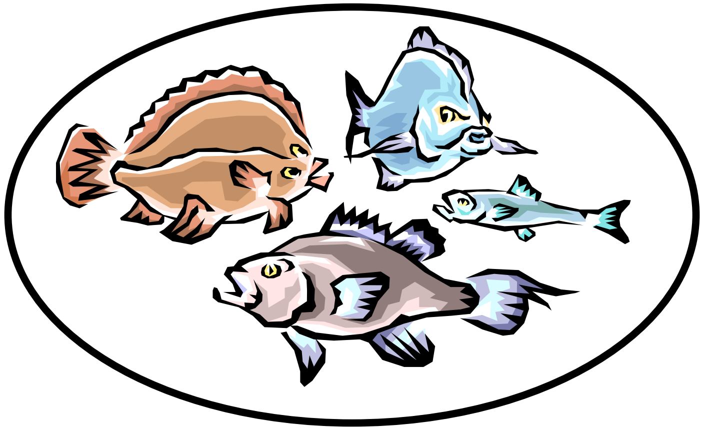
Chemical



Physical



Biological



Sampling water

24 h per day
7 days a week
365 d

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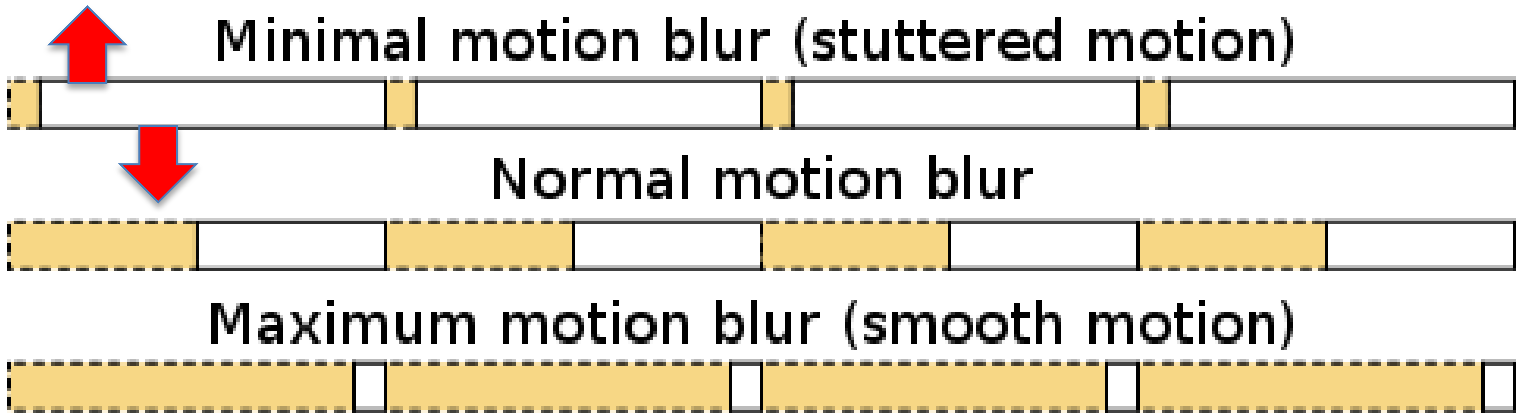
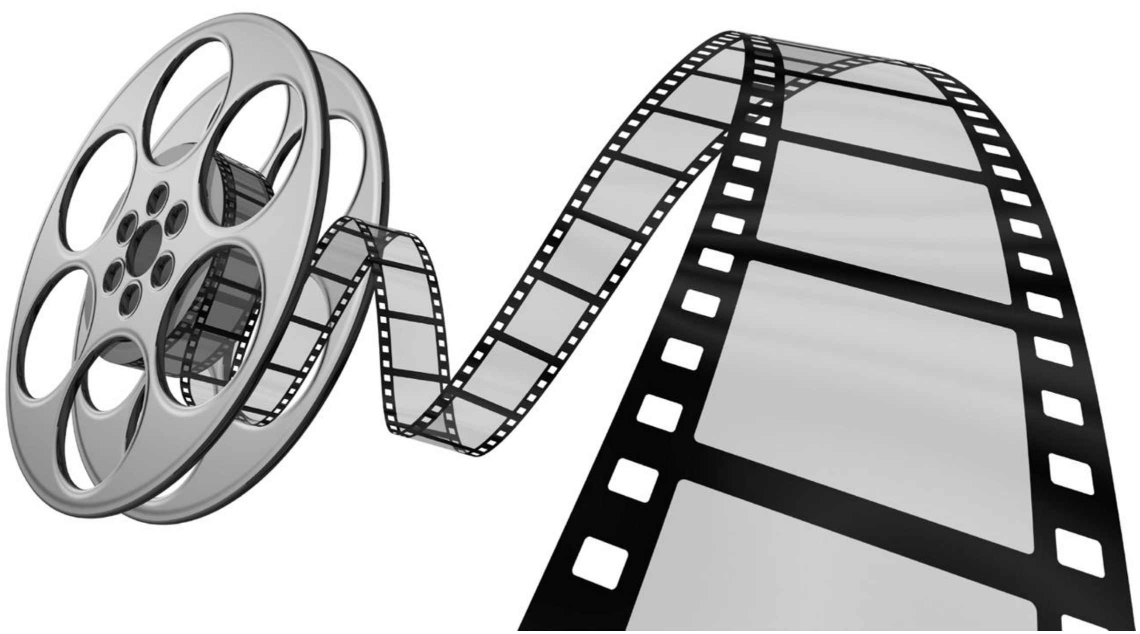
Temporal Perspective – Snapshot versus Movie





Single Frame

vs

Movie

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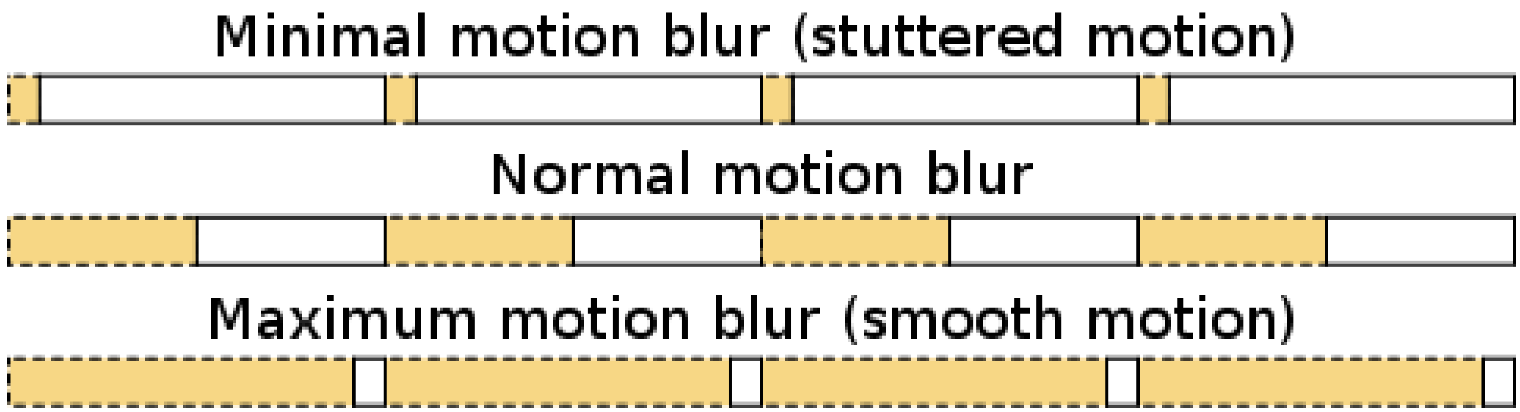
Snapshot versus Movie



Temporal Perspective

water sample ➔ algae ➔ macroinvertebrate ➔ fish

seconds ➔ days ➔ months ➔ years

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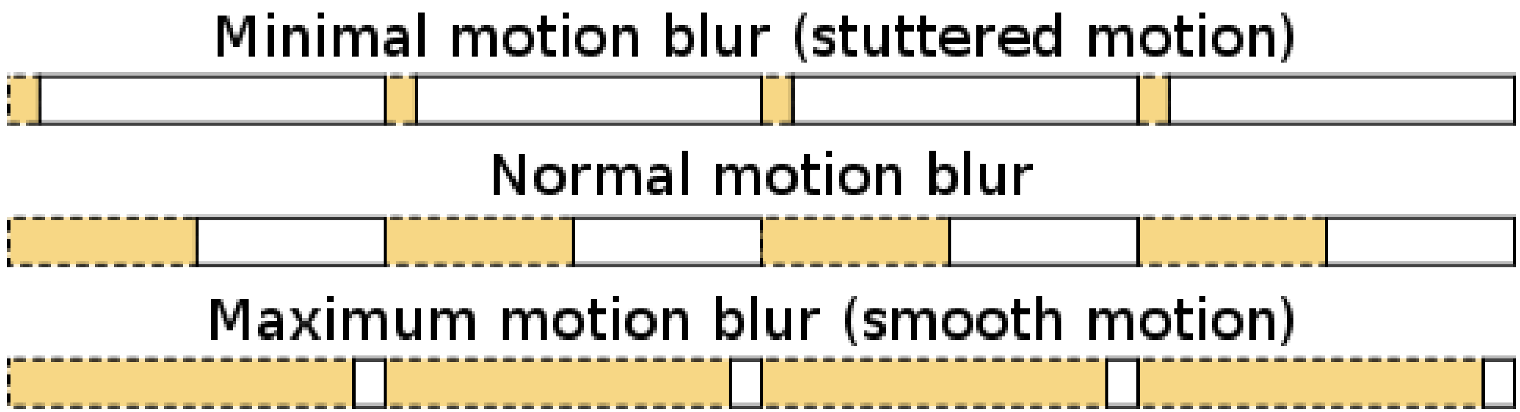
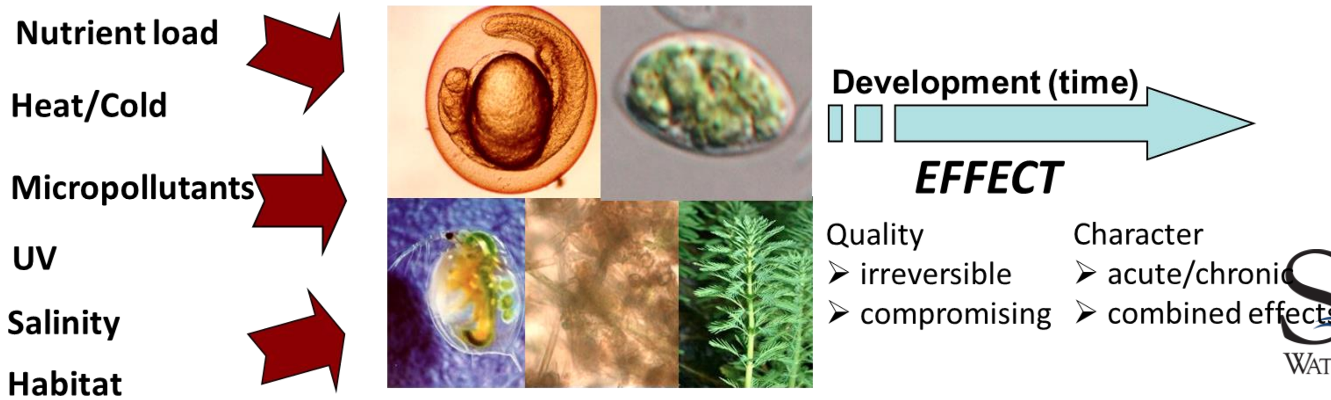
Snapshot versus Movie



Biological Perspective – Integrating Stressors



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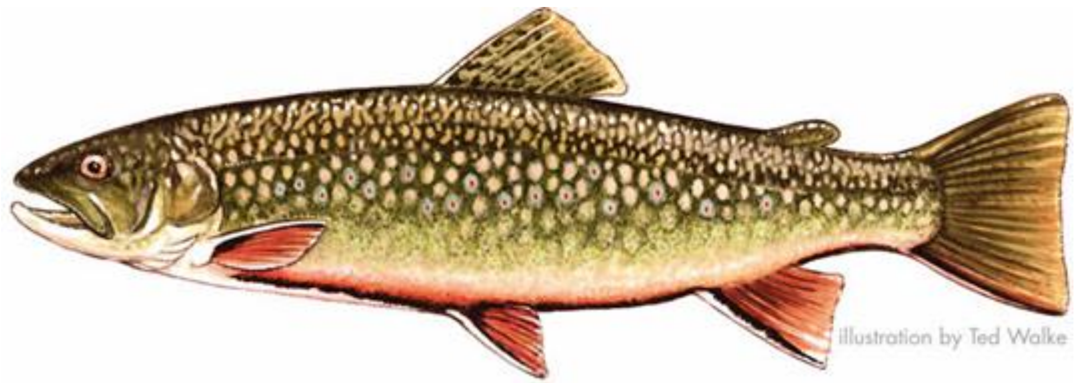
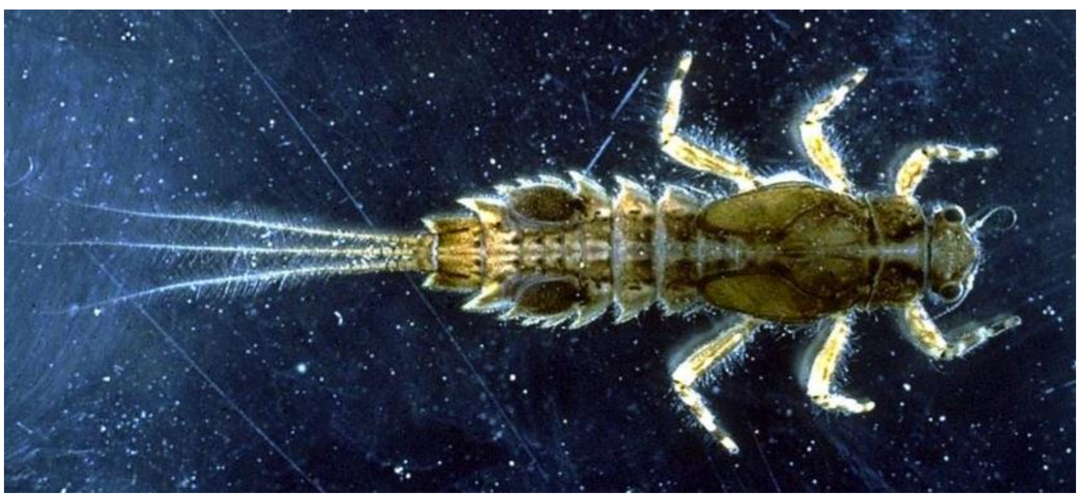
Water quality monitoring tools





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Ephemeroptera
Plecoptera
Trichoptera

Pollution-sensitive

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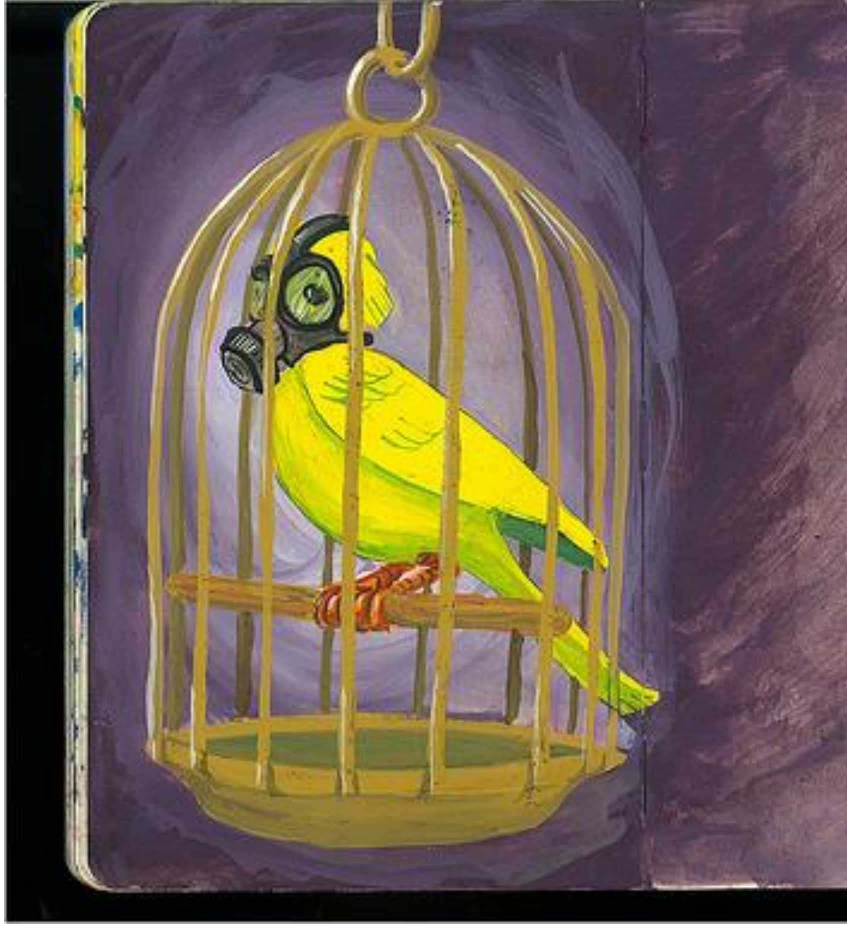
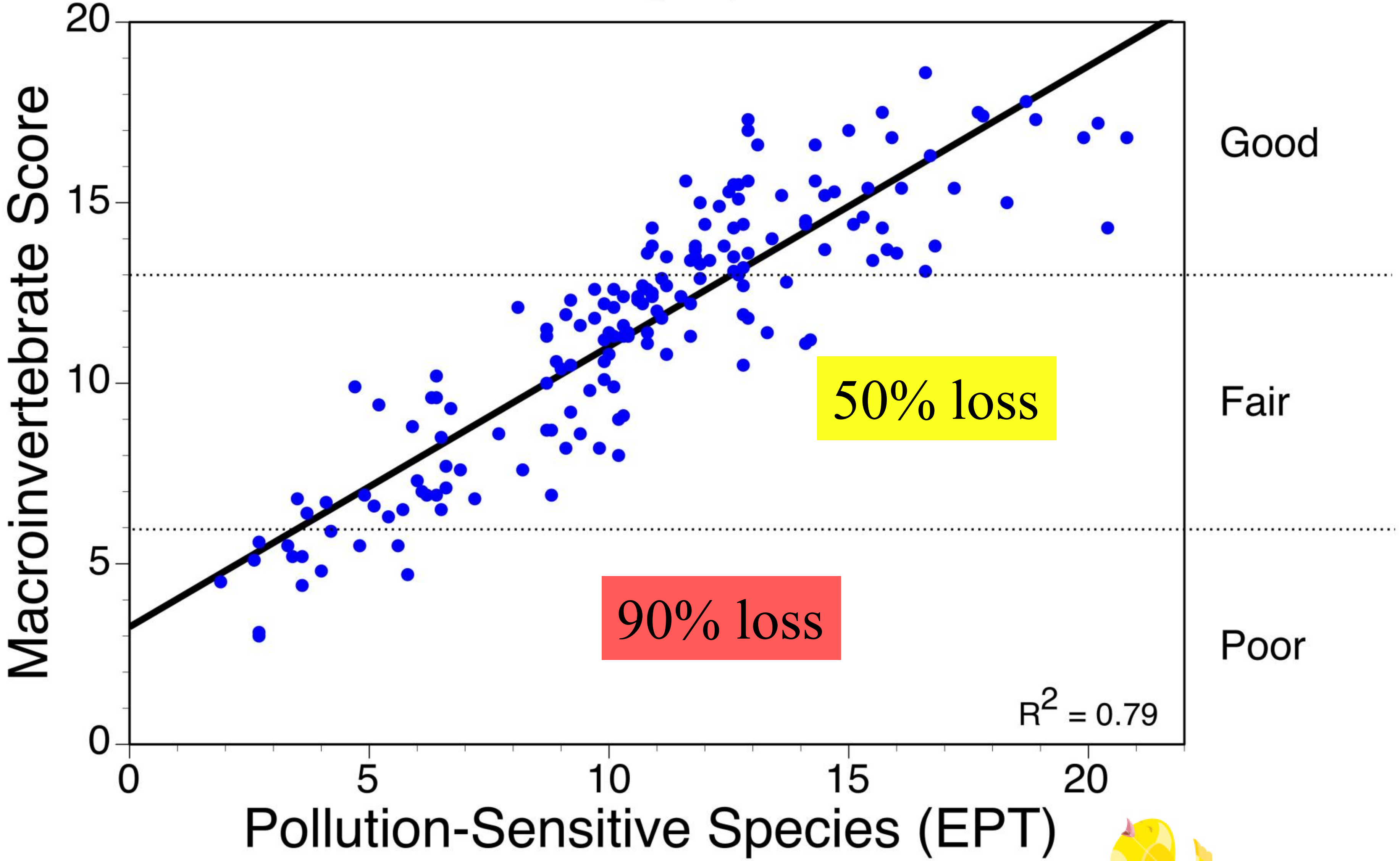
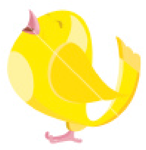


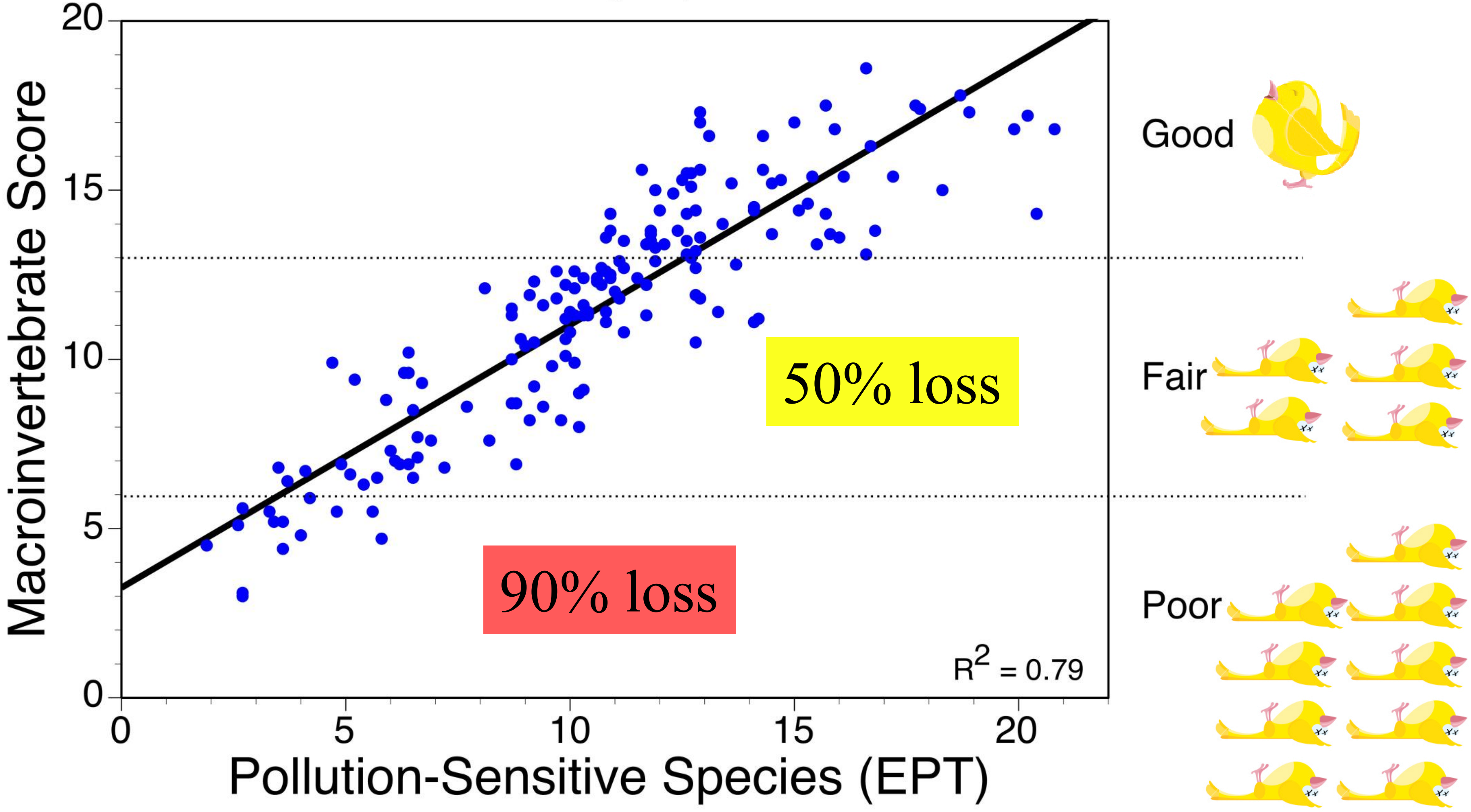
Pollution-sensitive species are our canaries in the coal mine

Biodiversity Loss with Increasing Impairment





Biodiversity Loss with Increasing Impairment



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Monitoring Planning & Design

Choices & Decisions

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Macroinvertebrate sampling in streams

- Where to sample macroinvertebrates
- How to sample macroinvertebrates
- Sample processing
- Data analyses and interpretation

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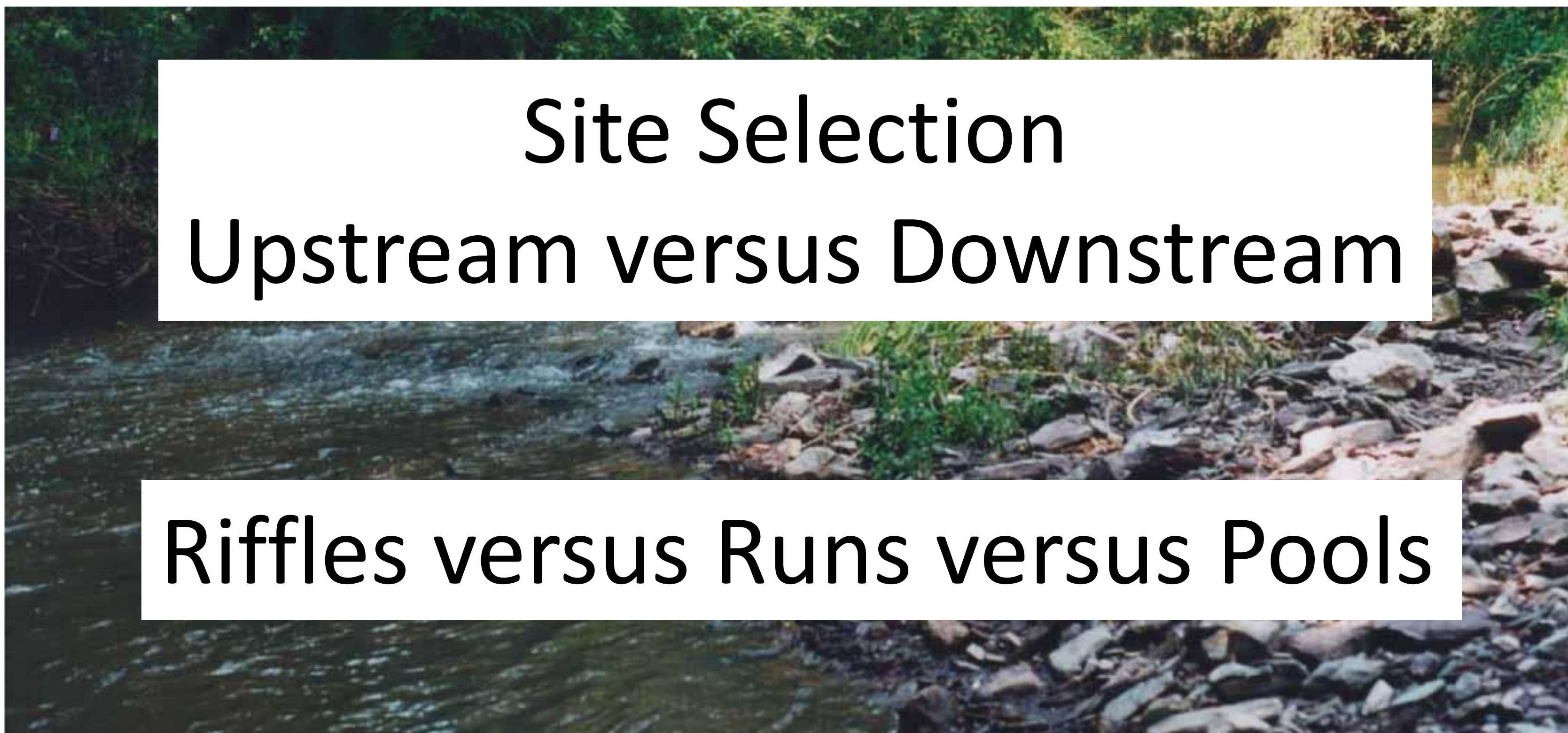
Macroinvertebrate sampling in streams

1. Where to sample macroinvertebrates



Site Selection
Upstream versus Downstream

Riffles versus Runs versus Pools

Macroinvertebrate sampling in streams

2. How to sample macroinvertebrates

a. Surber or Hess

b. Hester Dendy

c. Leaf pack

d. Kick net or D-net

Macroinvertebrate sampling in streams

2. How to sample macroinvertebrates

   a. Quantitative
      - Surber or Hess
      - Hester Dendy
      - Leaf pack

   b. Qualitative (semi-quantitative)
      - Kick net or D-net

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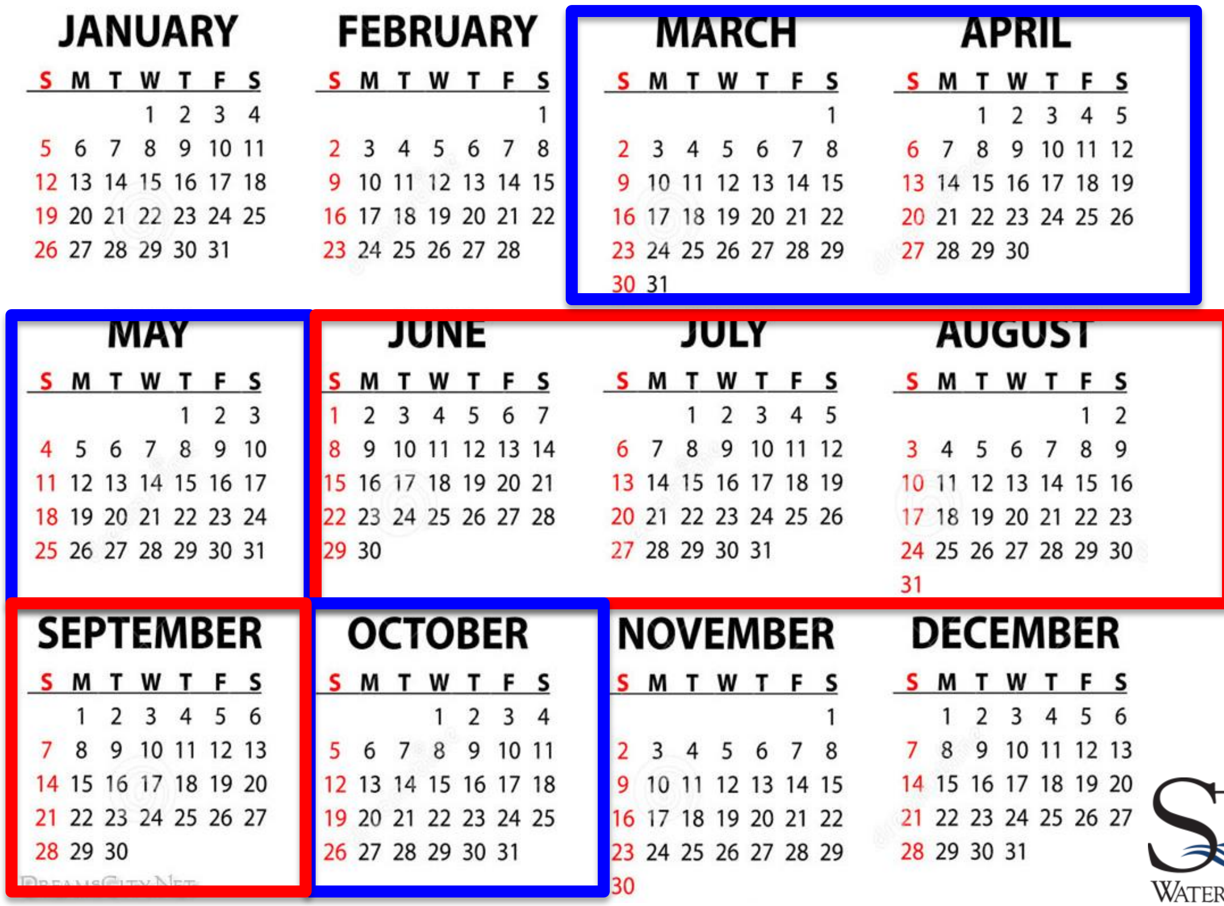
Macroinvertebrate sampling in streams

2. When to sample macroinvertebrates



SWRC
1990s

PADEP
1997

USGS-
CCWRA
1970

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Macroinvertebrate sampling in streams

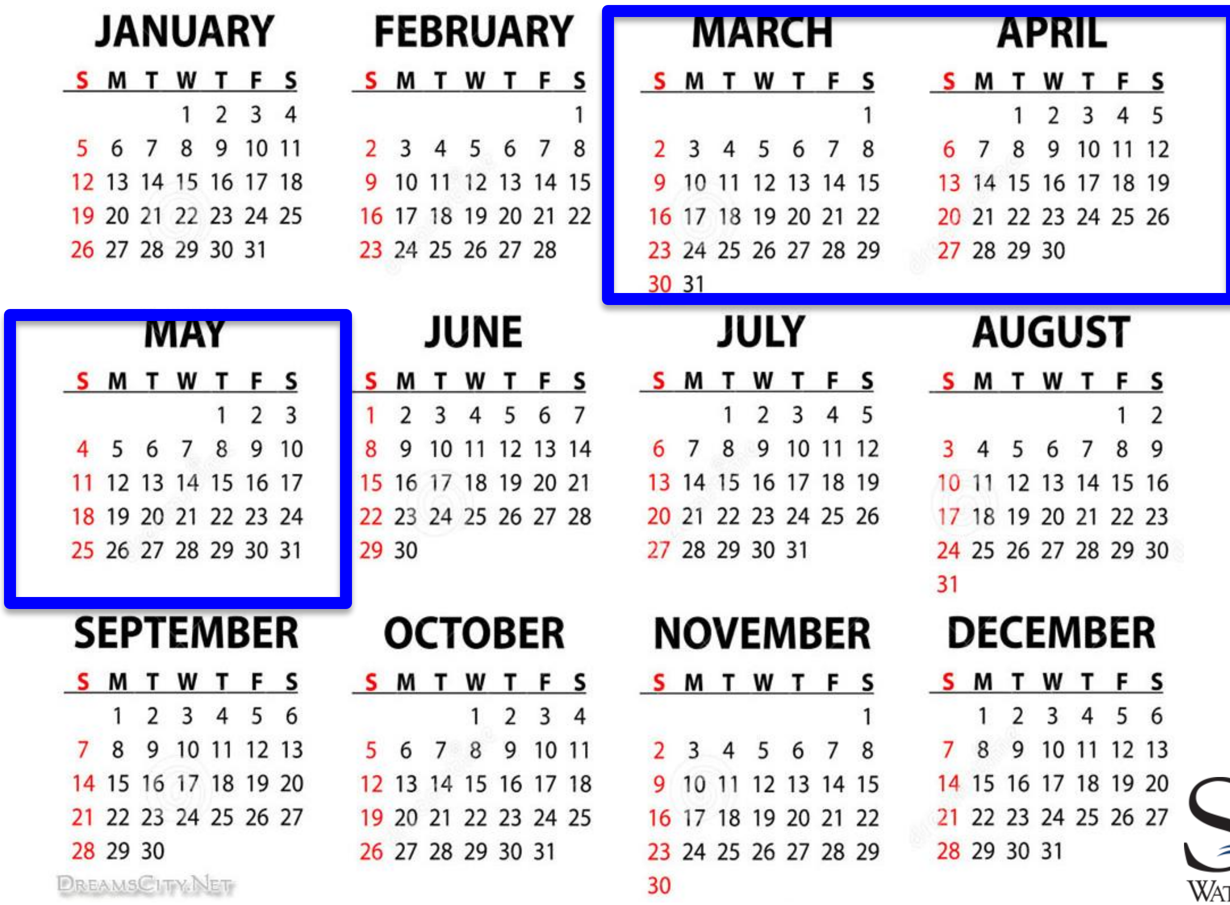
2. When to sample macroinvertebrates

Mar – May

More sensitive species

Bigger

Easier to ID



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Macroinvertebrate sampling in streams

3. Sample processing
   a. Separating/sorting
      - Field or laboratory
      - By eye or with magnification

   b. Taxonomic effort in identifications
      - Order, family, genus, species
      - By eye … with magnification

Macroinvertebrate sampling in streams

4. Data analyses and interpretation
   a. Presence/absence
   b. Relative abundance (%)
   c. Biometrics
      - EPT Richness
      - Biotic Index
   d. Abundance (density)

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What types of data are needed?

Protecting and Restoring Place of Ecological Significance: Delaware River Basin Initiative

WILLIAM PENN FOUNDATION

THE ACADEMY OF NATURAL SCIENCES of DREXEL UNIVERSITY

Open Space Institute

NATIONAL FISH AND WILDLIFE FOUNDATION NFWF

Three tier approach

The three-tier approach to data collection allows the Academy to easily organize the vast DRWI dataset based on method of collection (ex. who, with what).

Tier	Chemistry	Chemistry Lab	Macro-invertebrate Sampling, ID level	Fish Sampling	Habitat Assessment
1	ANS or other designated lab, YSI sonde	Low detection levels	Surber sampler Genus/ species	Quantitative, multiple pass depletion sampling	EPA WSA, Habitat Index, Riparian Index
2	Hach kit or other kit; non-designated lab	Higher detection levels	Kick nets Family	Single-pass, trout presence/ absence	Habitat Index
3	Hach kit or other chemistry kit	No laboratory analysis	Kick nets Family, order	None	Habitat Index, None

Why did we chose Tier 1 methods for macroinvertebrates?

- DRWI goal was to quantify changes in response to preservation and restoration

- Genus/species more sensitive/informative
- Abundance is another response variable

- More rapid assessment methods sacrifice information to reduce cost

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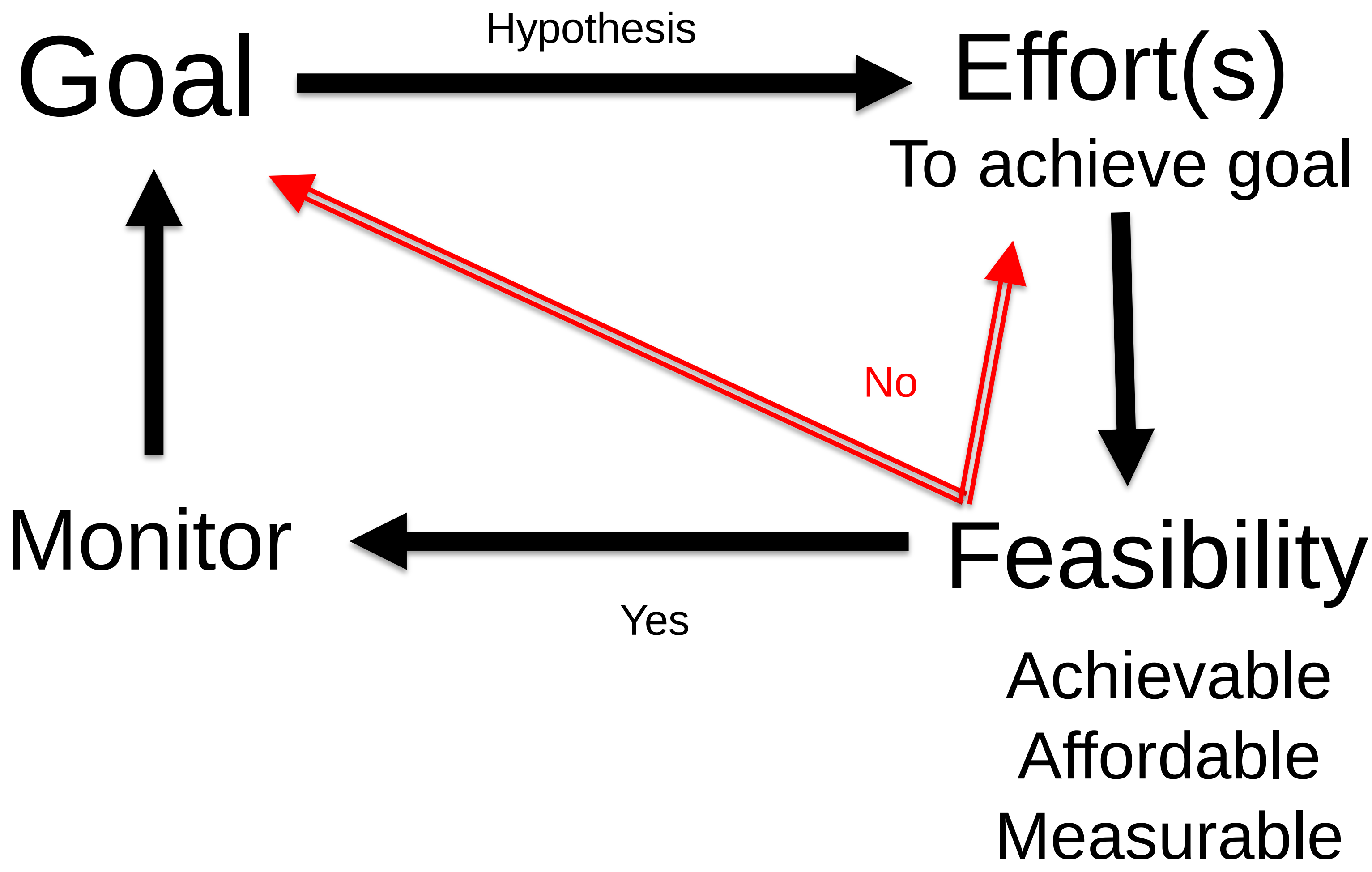

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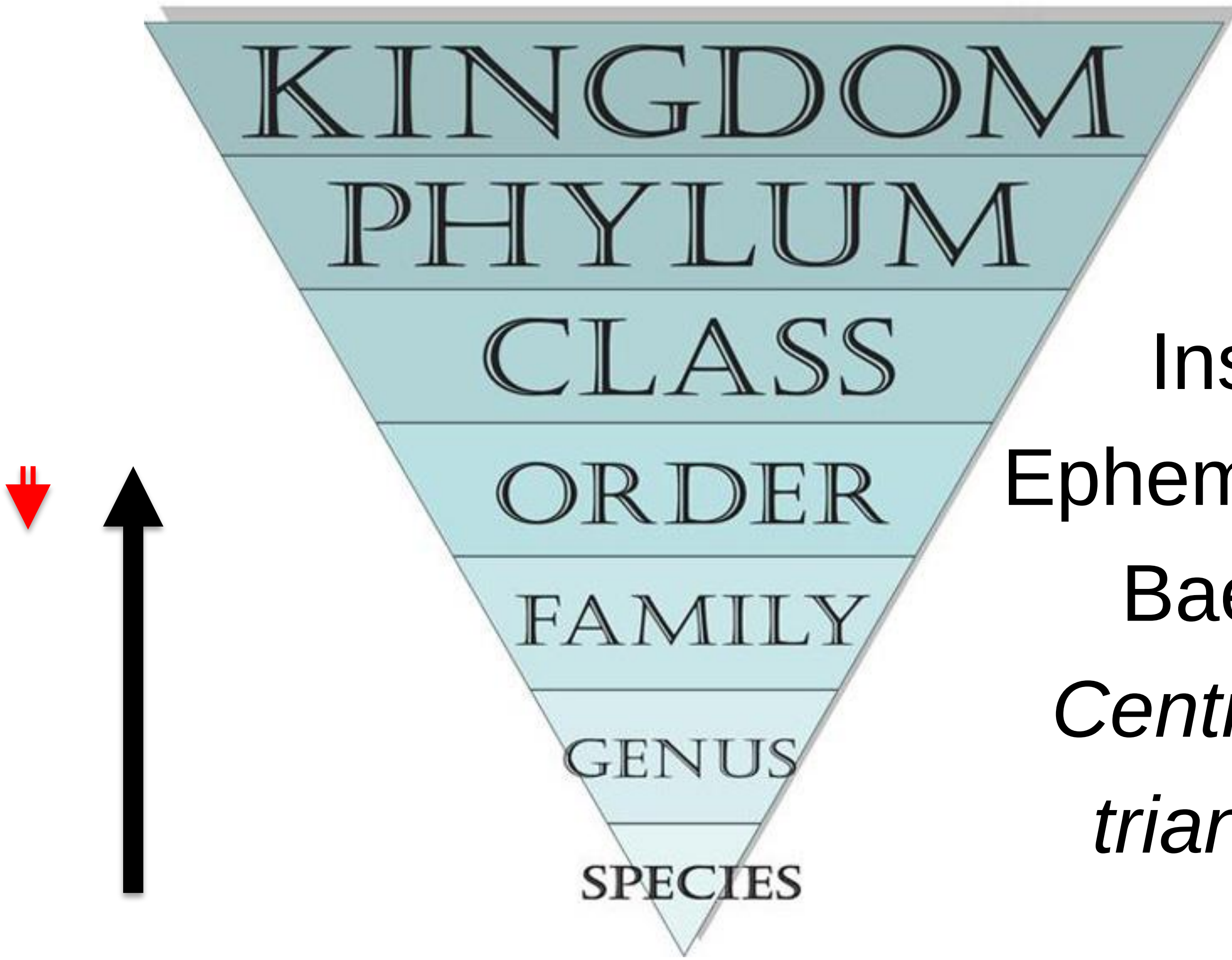
Why did we chose Tier 1 methods for macroinvertebrates?

- Taxonomic data are hierarchical, density is flexible

Taxonomic Hierarchy



Insecta

Ephemeroptera

Baetidae

Centroptilum

triangulifer

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Why did we chose Tier 1 methods for macroinvertebrates?

- Taxonomic data are hierarchical, density is flexible

- Genus/Species data could be converted to family or order data, but … <u>Family or Order data cannot be converted to Genus/Species</u>

- Abundance can become relative abundance (%) or Presence/Absence

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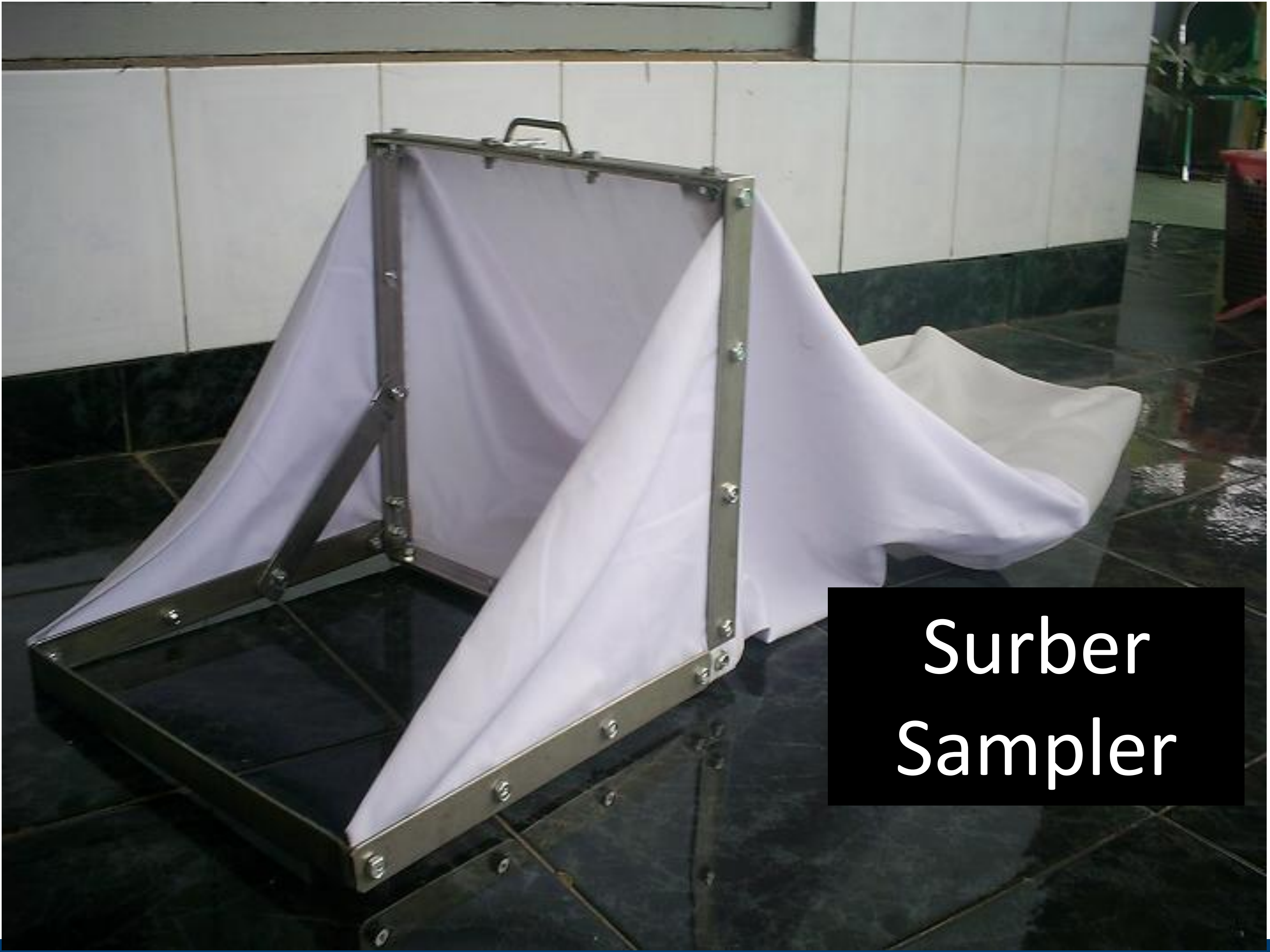
Surber
Sampler


Riffles

White Clay Creek
March 2009
Number of species in riffles versus pools

	Total Richness-Riffle	Total Richness-Pool	EPT Richness-Riffle	EPT Richness-Pool
WCC Woods	18	10	9	4

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Macroinvertebrate sampling in streams

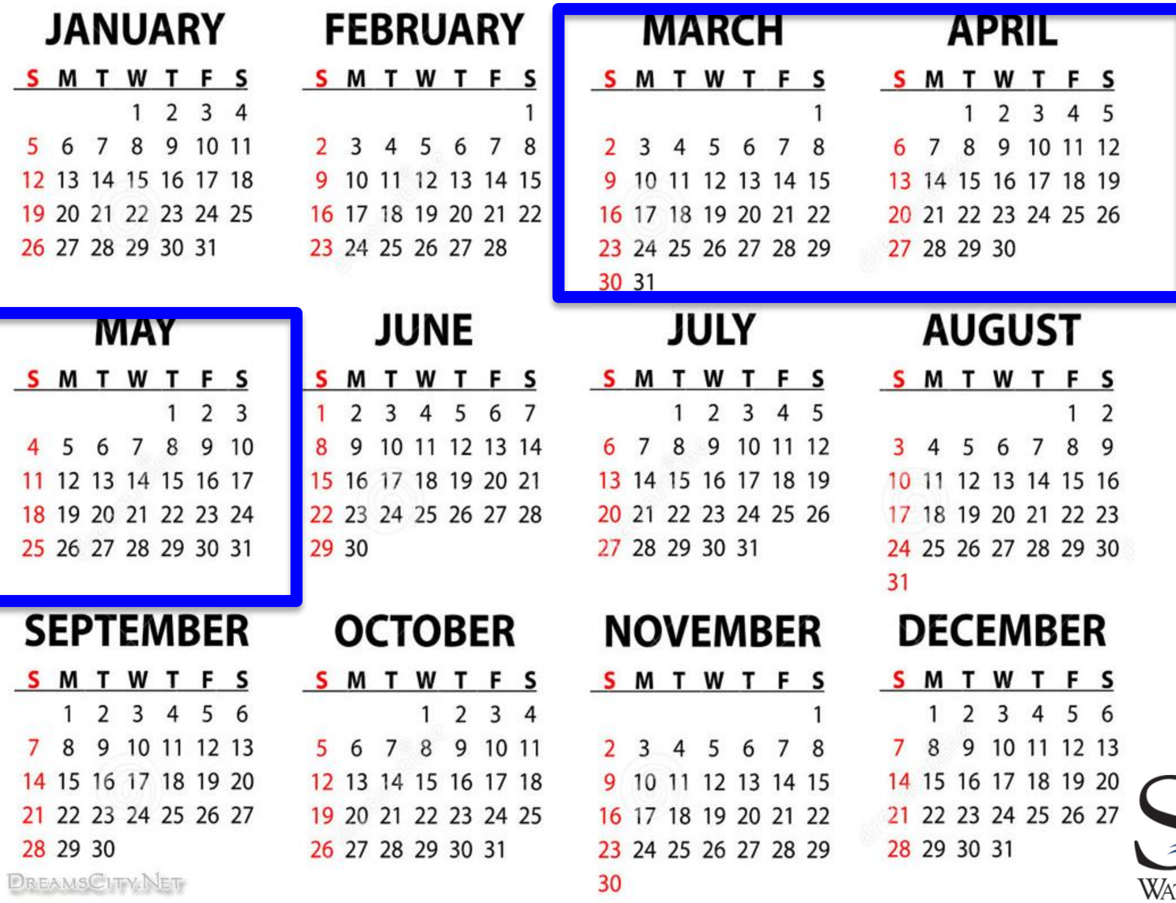
2. When to sample macroinvertebrates

Mar – May

More sensitive species

Bigger

Easier to ID



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Fly Fisherman's Hatch Chart

West Virginia North Fork River - Hatch Chart																																	
Mayfly Name	**Mar**				**Apr**				**May**				**Jun**				**Jul**				**Aug**				**Sept**				**Oct**				**Remarks**
Little Blue Winged Olive			■	■	■	■	■																										s18, early PM
Quill Gordon						■	■	■	■	■																							s12, 14 early/mid PM
Little Blue Quill						■	■	■	■																								s16, 18 late AM/early PM
Henderickson							■	■	■	■																							s12,14 early/mid PM
Gray Fox											■	■	■	■	■																		s12,14 early/mid PM
March Brown											■	■	■	■																			a10,12 sporadic PM
Green Drake												■	■	■	■																		s8,10 early/late PM
Little Maryatt											■	■	■																				s14 late AM/late PM
Sulfur Dun											■	■	■																				s12 late AM/late PM
Little Sulfur Dun											■	■	■	■	■																		s18 mid/late PM
Blue Winged Olive													■	■	■	■	■	■															s12,14 AM sporadic
Light Blue Winged Olive													■	■	■	■	■	■															s16 AM sporadic
Tiny White Winged Black													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			s22,28 early AM/PM
Dun Var Mahogany Dun														■	■	■	■	■	■	■	■	■	■	■									s10,12 mid/late PM
Light Cahill														■	■	■	■	■	■														s12,14 PM sporadic
Cream Varient															■	■	■	■	■														s10 dusk late PM
Pale Evening Dun															■	■	■	■	■														s14,16 evening
Yellow May														■	■	■	■	■															a10,12 mid/latePM
Dark Blue Quill															■	■	■	■	■	■													s16,18 mid/late PM
Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	

*** Note: Hatch Chart based upon data from "Charlie Charmers

*** Start and End Dates may vary depending on weather

S - Hook Size & Time of Day

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Spring

West Virginia North Fork River - Hatch Chart																																	
Mayfly Name	**Mar**				**Apr**				**May**				**Jun**				**Jul**				**Aug**				**Sept**				**Oct**				**Remarks**
Little Blue Winged Olive			■	■	■	■	■																										s18, early PM
Quill Gordon						■	■	■	■	■																							s12, 14 early/mid PM
Little Blue Quill						■	■	■	■																								s16, 18 late AM/early PM
Henderickson							■	■	■	■																							s12,14 early/mid PM
Gray Fox											■	■	■	■	■																		s12,14 early/mid PM
March Brown											■	■	■	■																			a10,12 sporadic PM
Green Drake												■	■	■	■																		s8,10 early/late PM
Little Maryatt											■	■	■																				s14 late AM/late PM
Sulfur Dun											■	■	■																				s12 late AM/late PM
Little Sulfur Dun											■	■	■	■	■																		s18 mid/late PM
Blue Winged Olive													■	■	■	■	■	■															s12,14 AM sporadic
Light Blue Winged Olive													■	■	■	■	■	■															s16 AM sporadic
Tiny White Winged Black													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			s22,28 early AM/PM
Dun Var Mahogany Dun														■	■	■	■	■	■	■	■	■	■	■									s10,12 mid/late PM
Light Cahill														■	■	■	■	■	■														s12,14 PM sporadic
Cream Varient															■	■	■	■	■														s10 dusk late PM
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Dark Blue Quill															■	■	■	■	■	■													s16,18 mid/late PM
Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
*** Note: Hatch Chart based upon data from "Charlie Charmers																																	S - Hook Size &
*** Start and End Dates may vary depending on weather																																	Time of Day

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Spring

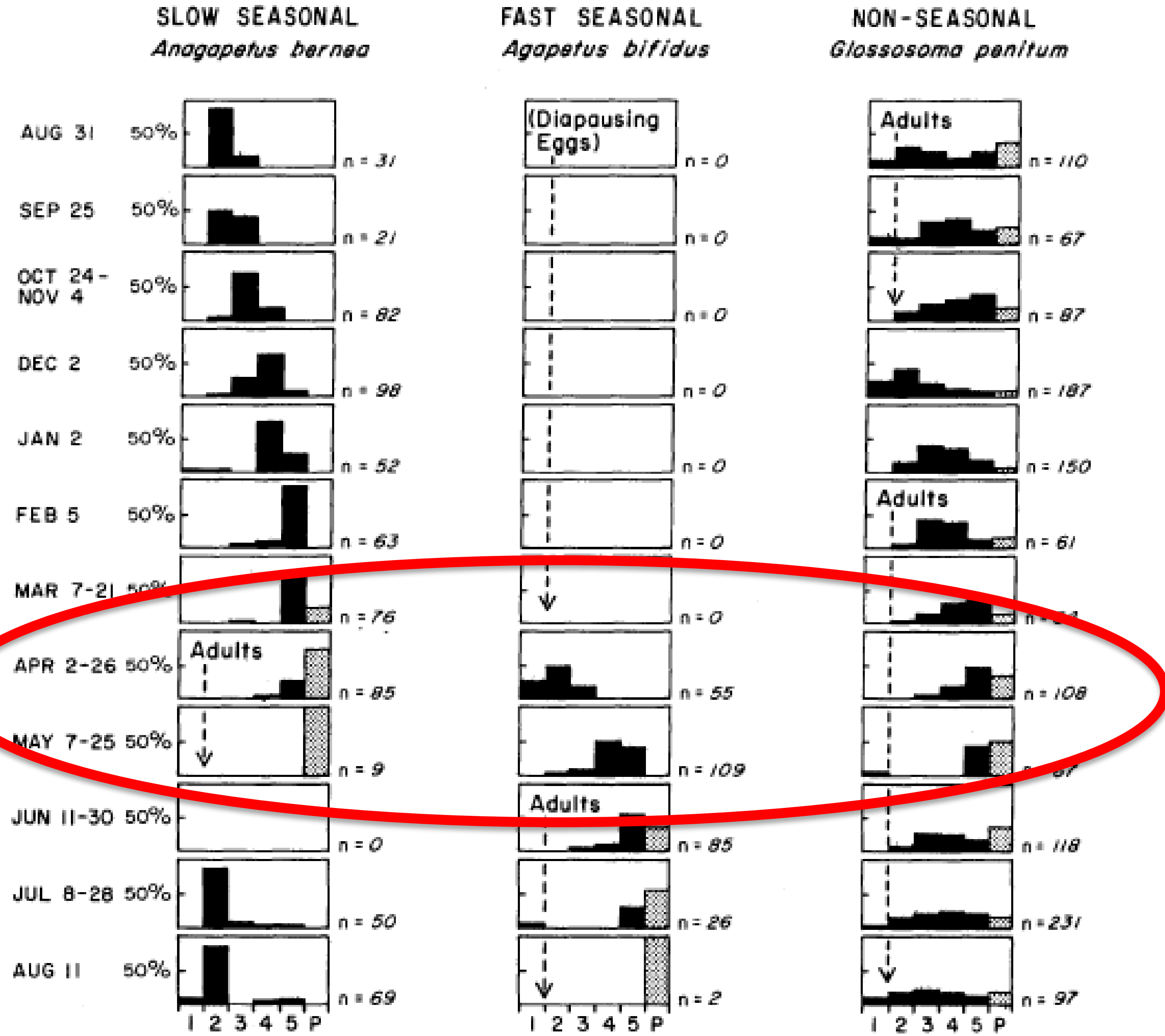

Figure 5.2. Age distribution of three glossosomatid caddisflies, illustrating life cycles. Field data are expressed as percentage composition per month for each instar. There are five larval instars; *P* = prepupa + pupa; *n* = number per sample. Flight period of adults is also indicated. (Data from Anderson and Bourne [1974].)

Genus/Species

White Clay Creek, Chester Co, PA

Amateurs (interns)	26
Expert – genus	67
Expert – species	88
Genetics	150

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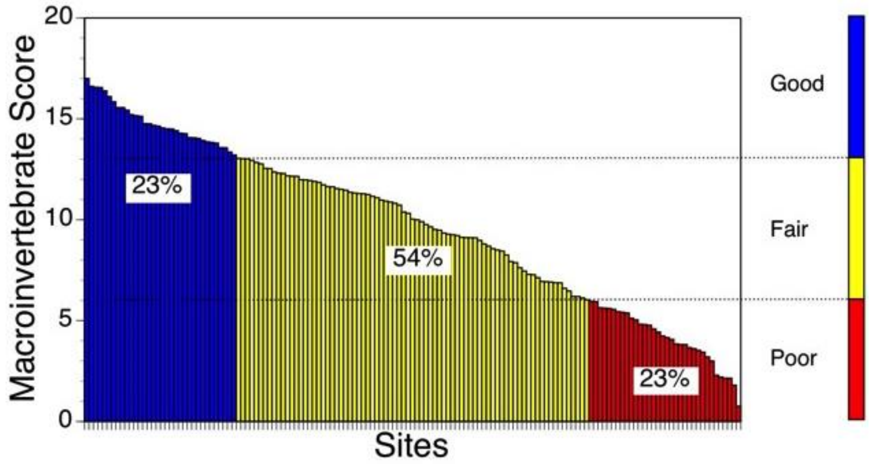

Good & Poor
easy to see

Small
improvements
difficult to see

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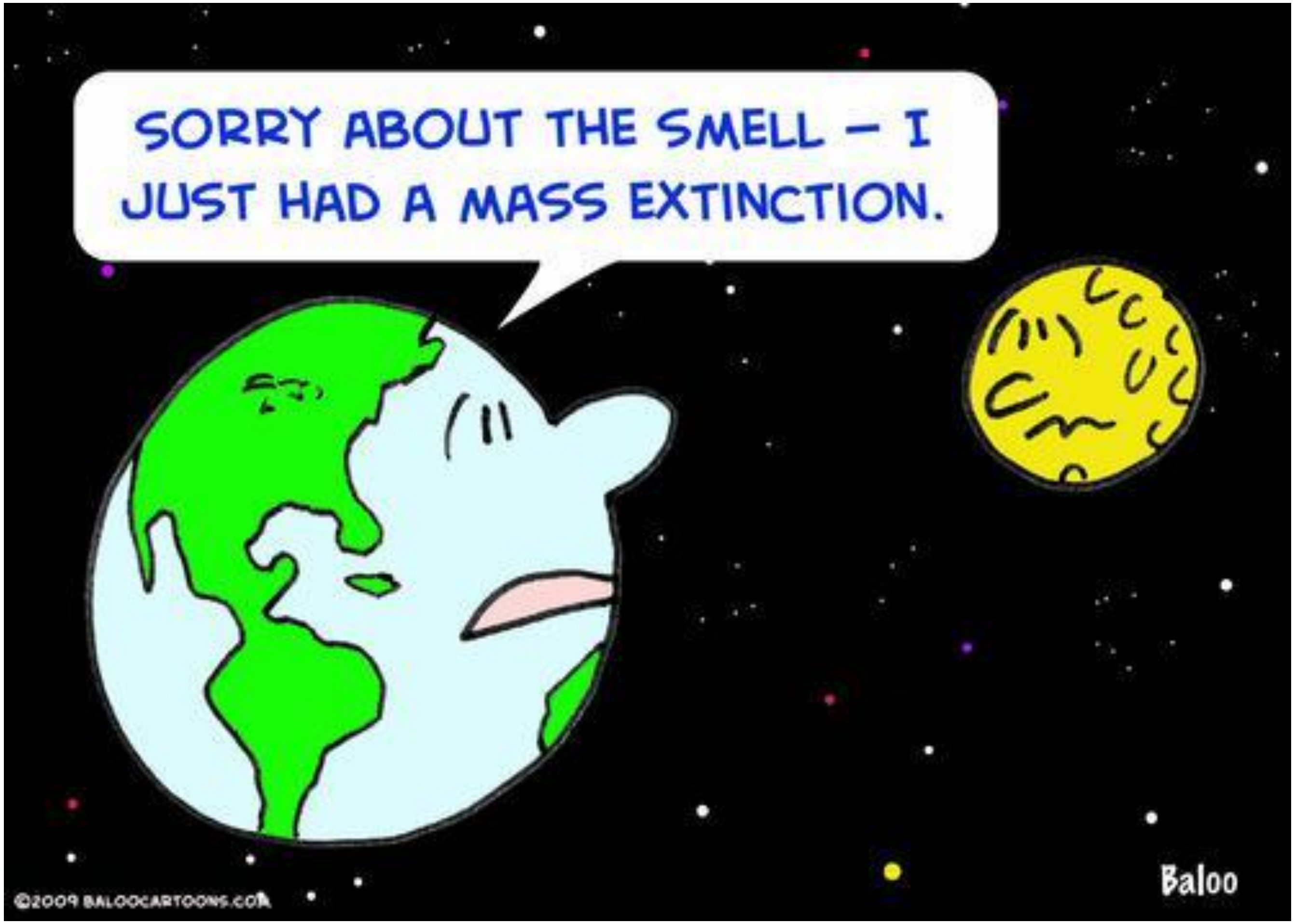
Impairment = Biodiversity Loss
16 families versus 44 species



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Macroinvertebrate sampling in streams

4. Data analyses and interpretation
   a. Presence/absence
   b. Relative abundance (%)
   c. Biometrics
      - EPT Richness
      - Biotic Index
   d. Abundance (density)

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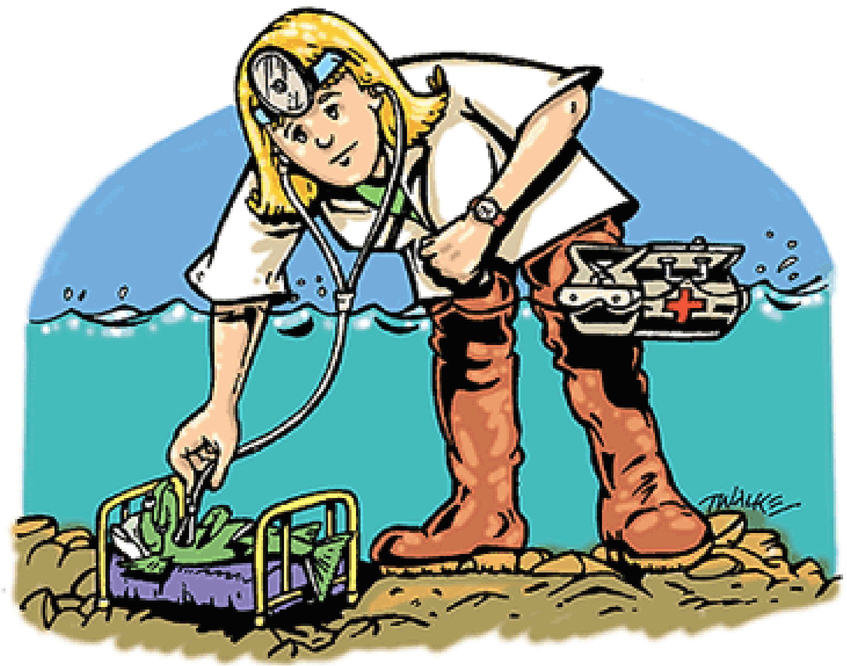
In pollution monitoring,

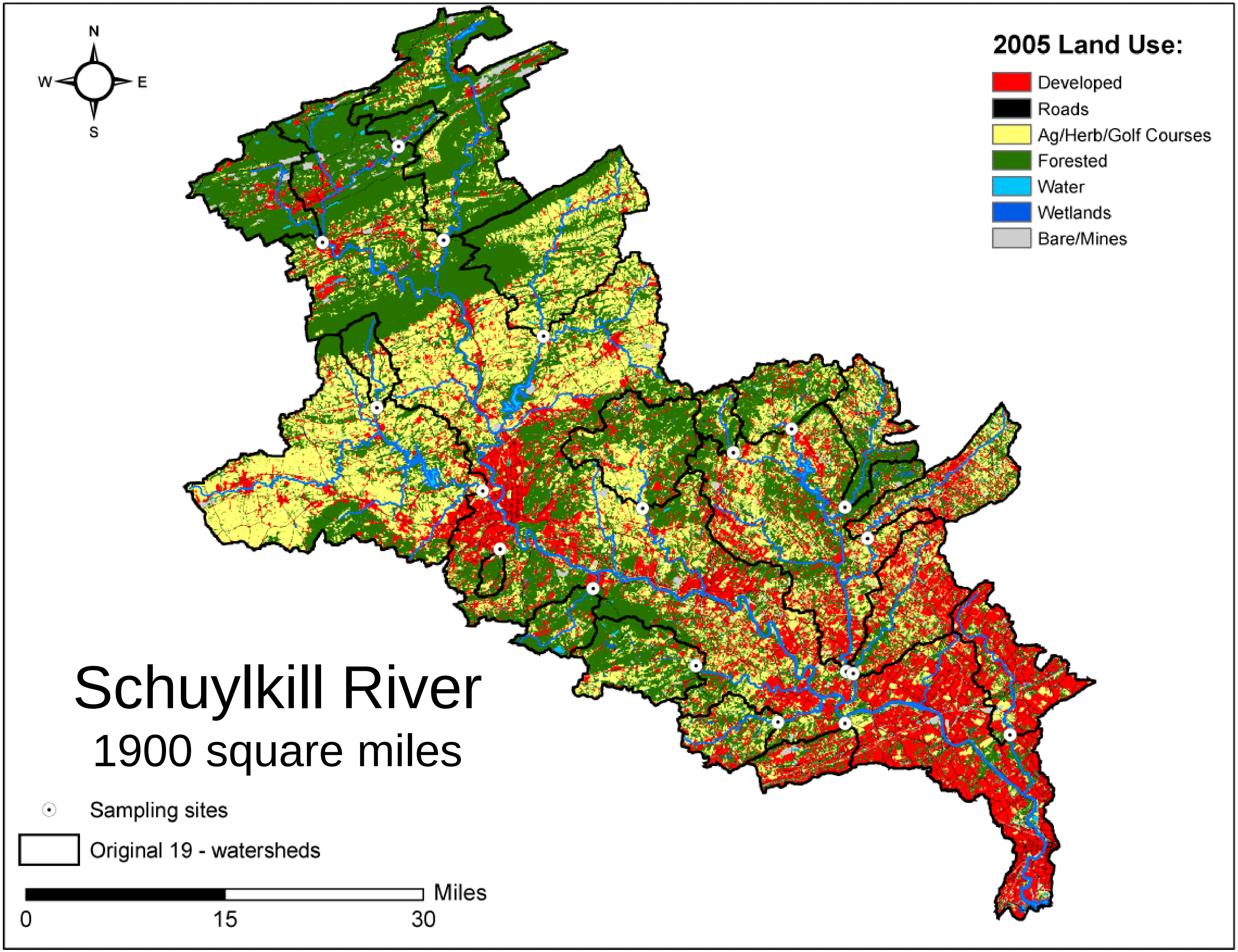
Presence tells you something

Conspicuous absence also tells you something

Use caution –
absence could reflect natural phenomena such as season, location, or microhabitat



What has monitoring told us about stream condition over time?


N
W
E
S
2005 Land Use:
Developed
Roads
Ag/Herb/Golf Courses
Forested
Water
Wetlands
Bare/Mines
Schuylkill River
1900 square miles
Sampling sites
Original 19 - watersheds
Miles
0
15
30

Development

Agriculture

Mining

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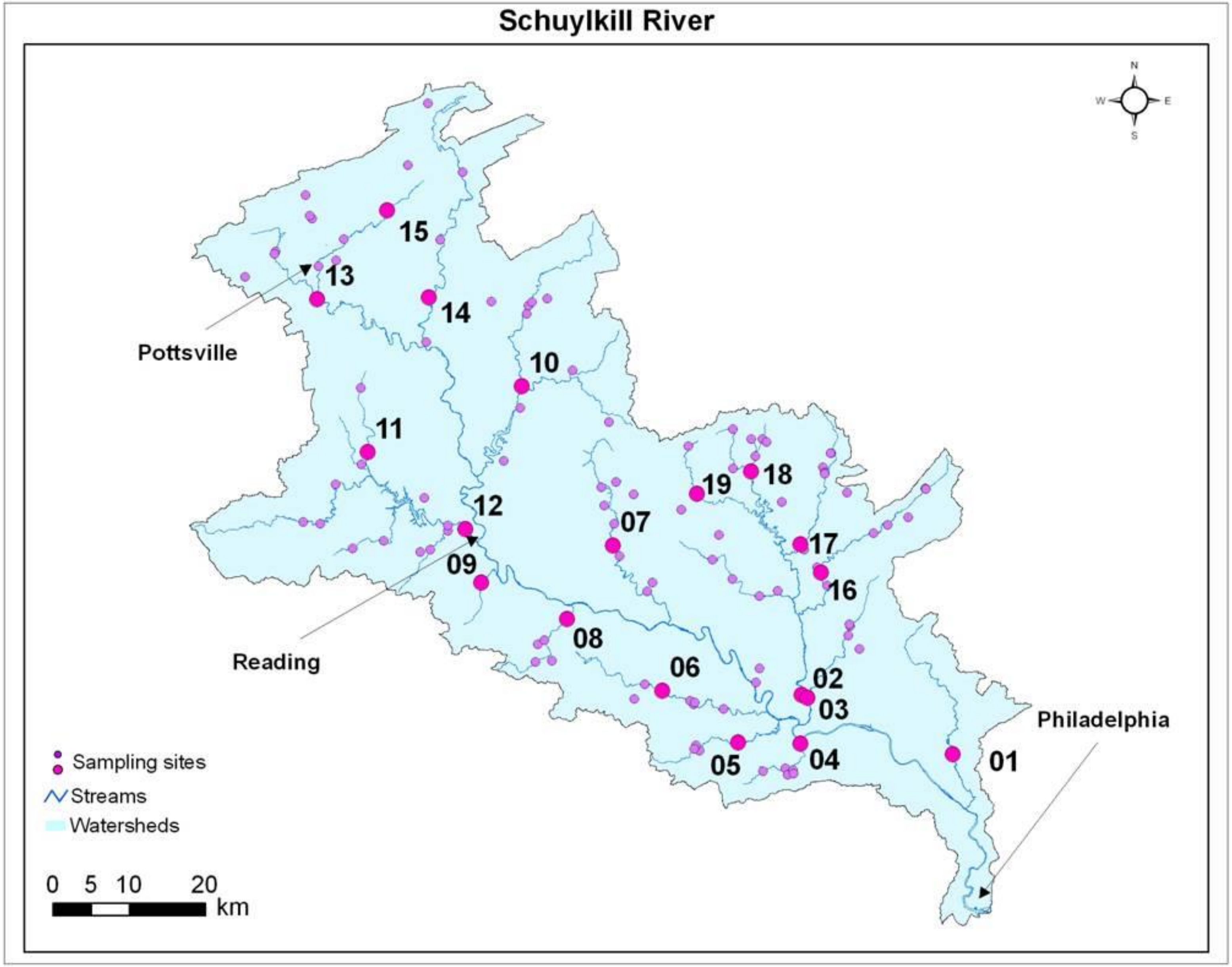
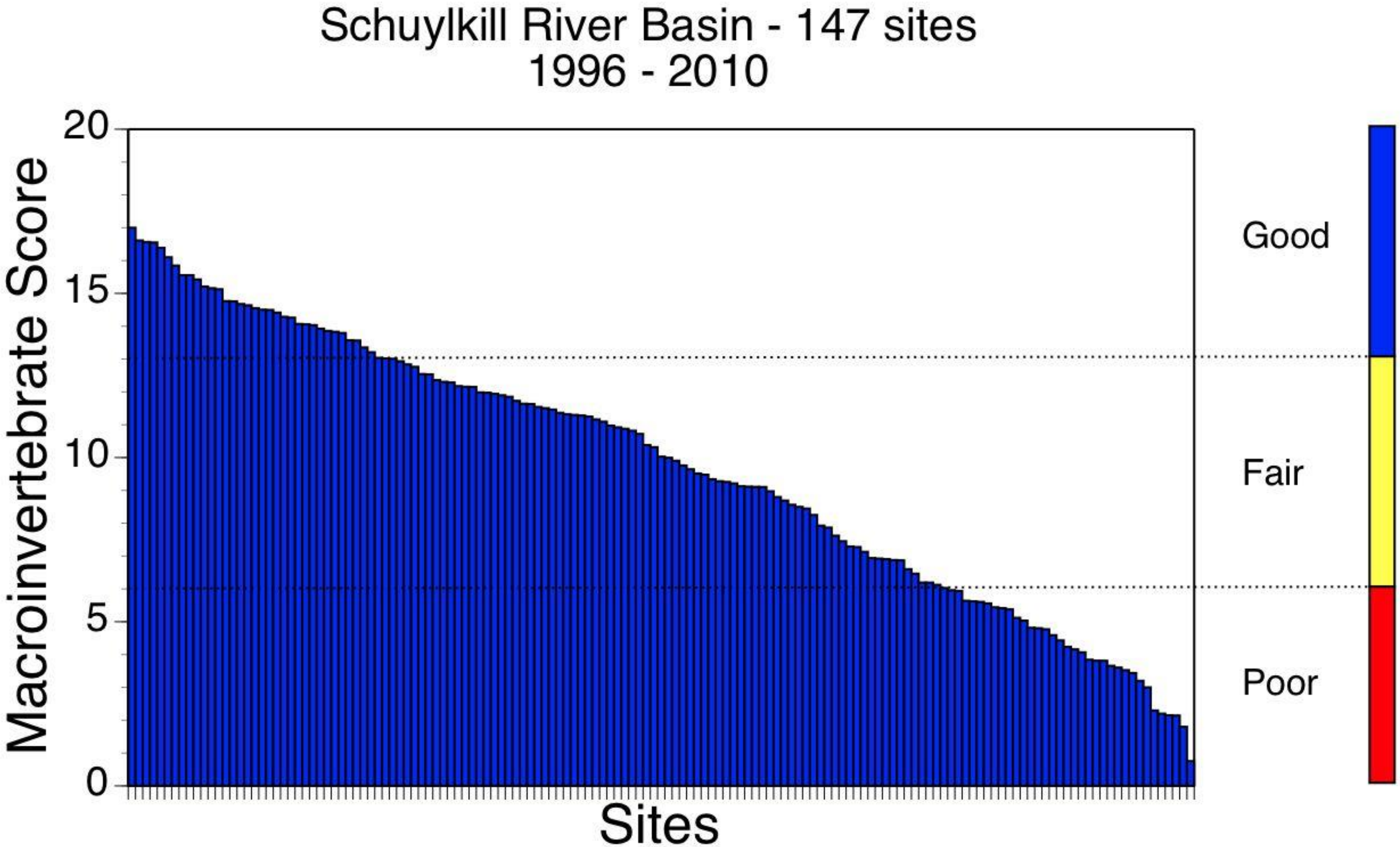
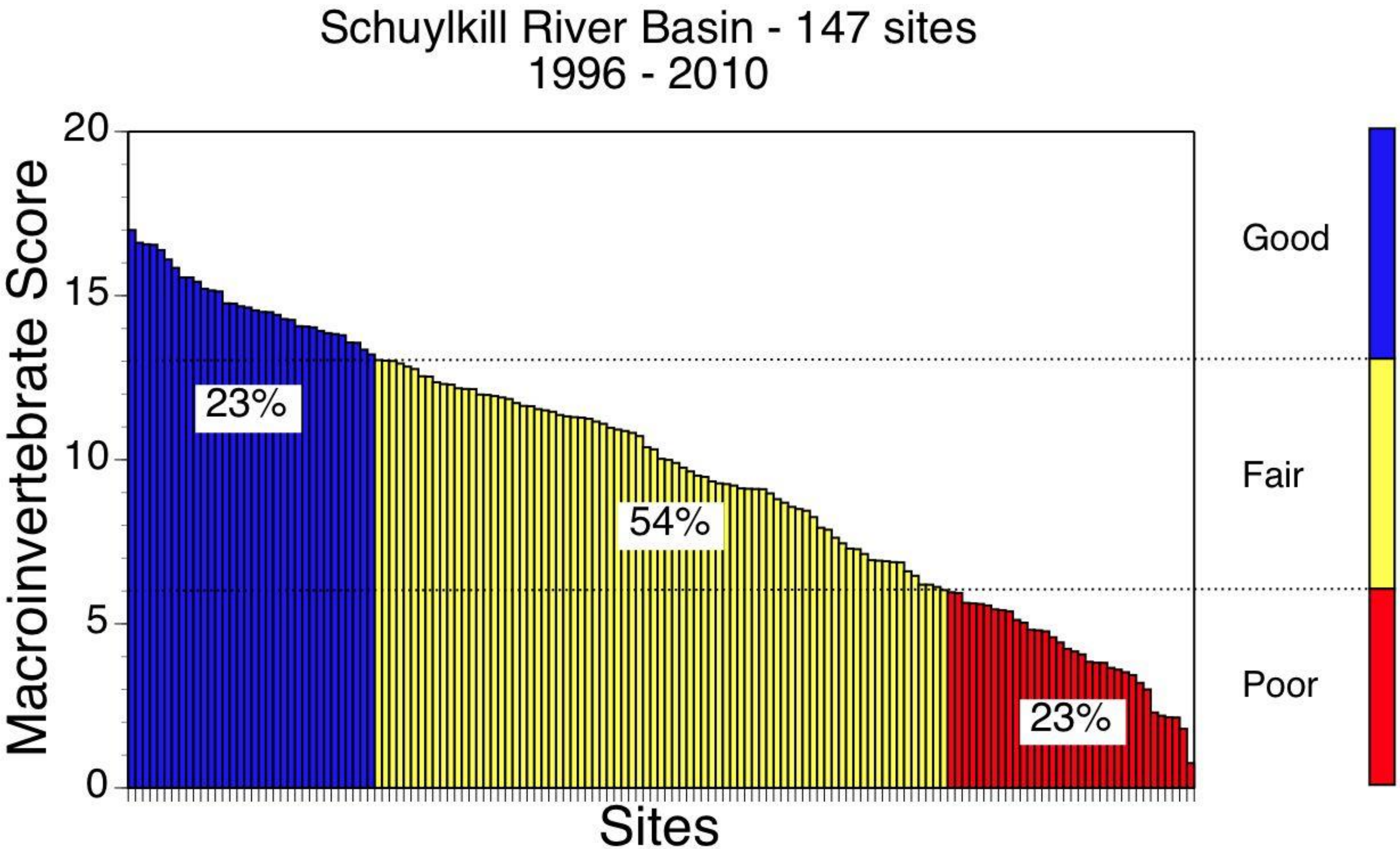


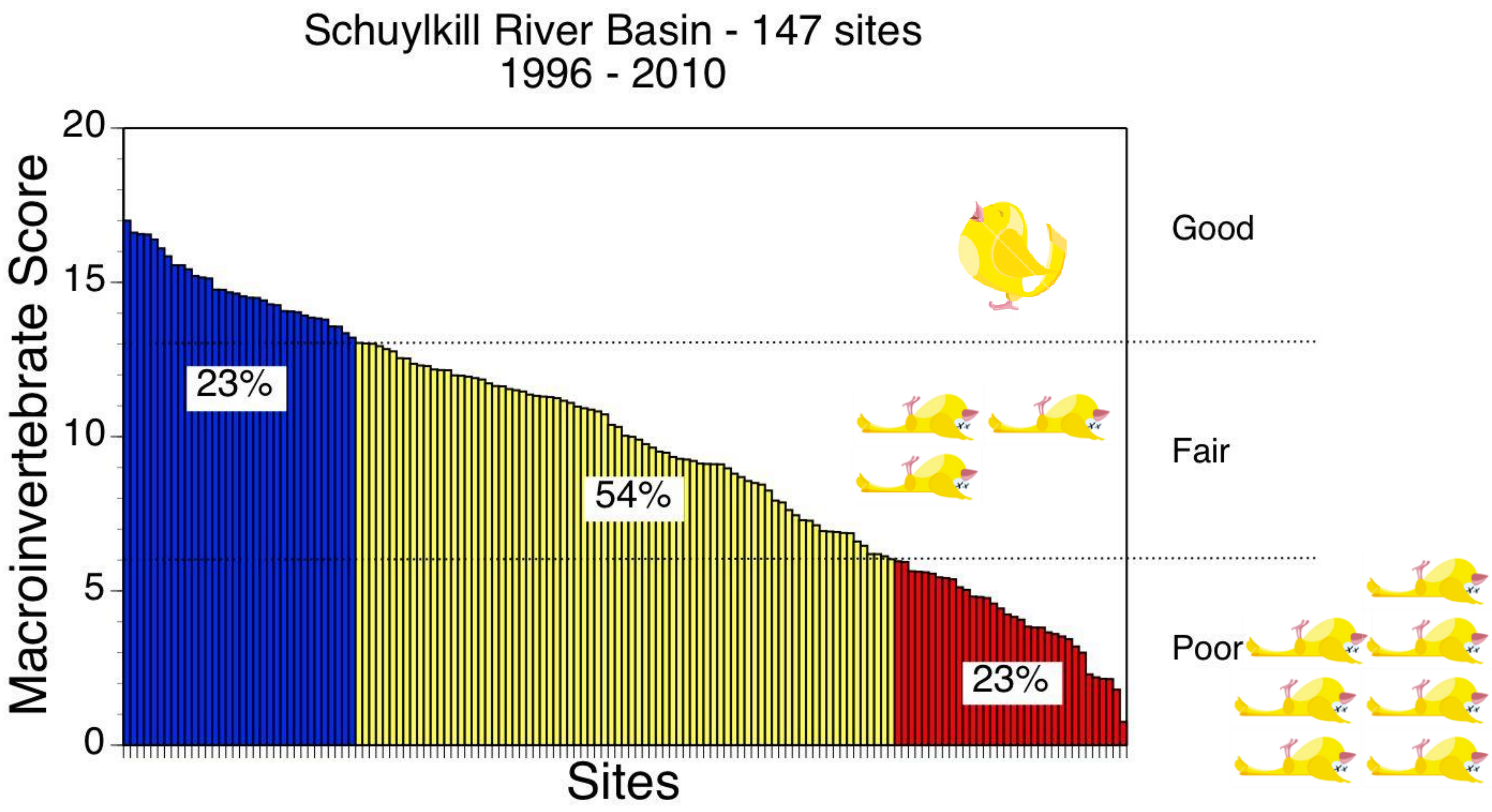
1996 – 2010
147 sites



Degradation is gradual



50% are clearly degraded



Changes are not minor

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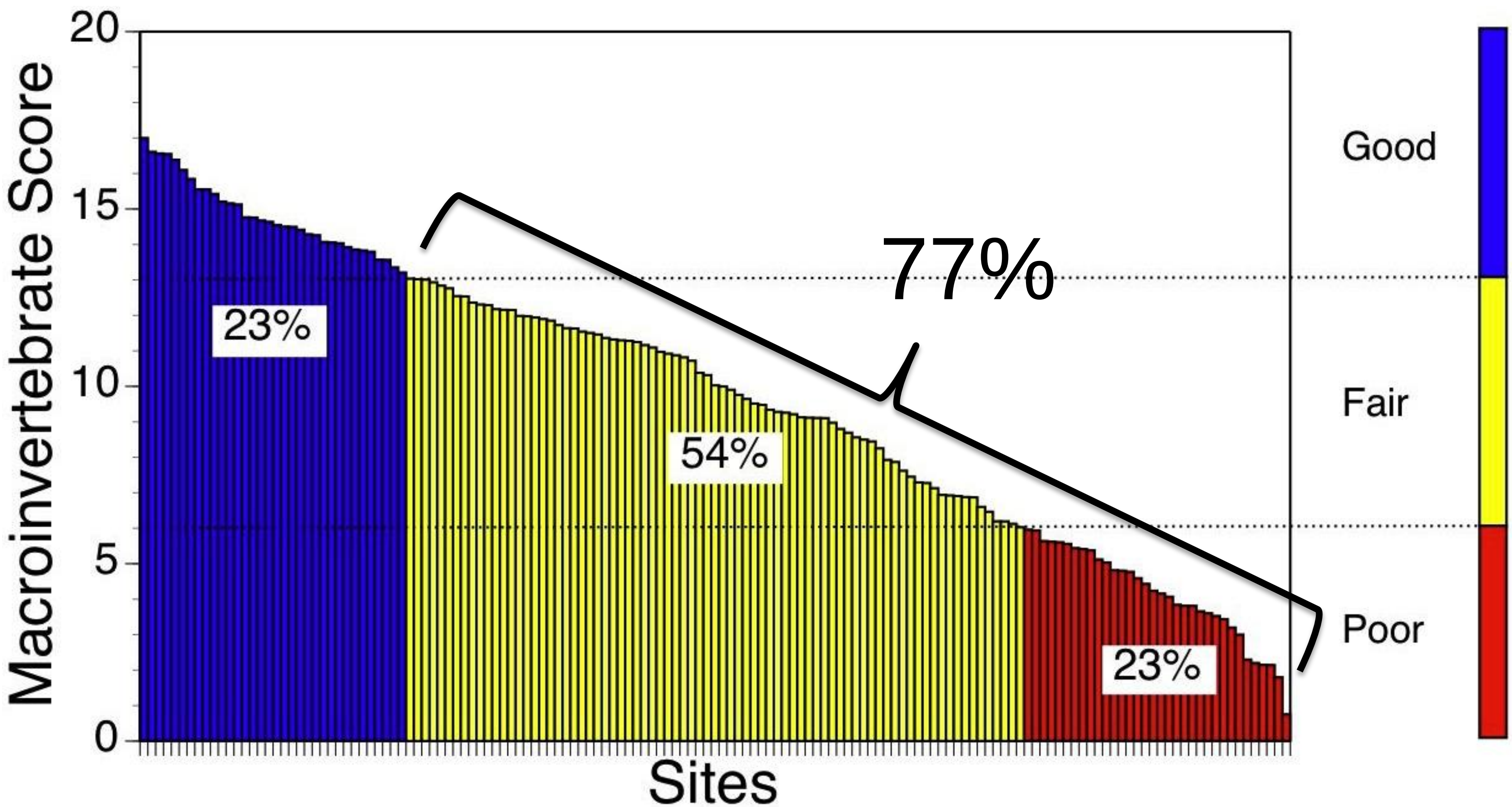
The Schuylkill basin is on average - Fair
> 50% of the streams show evidence of degradation.



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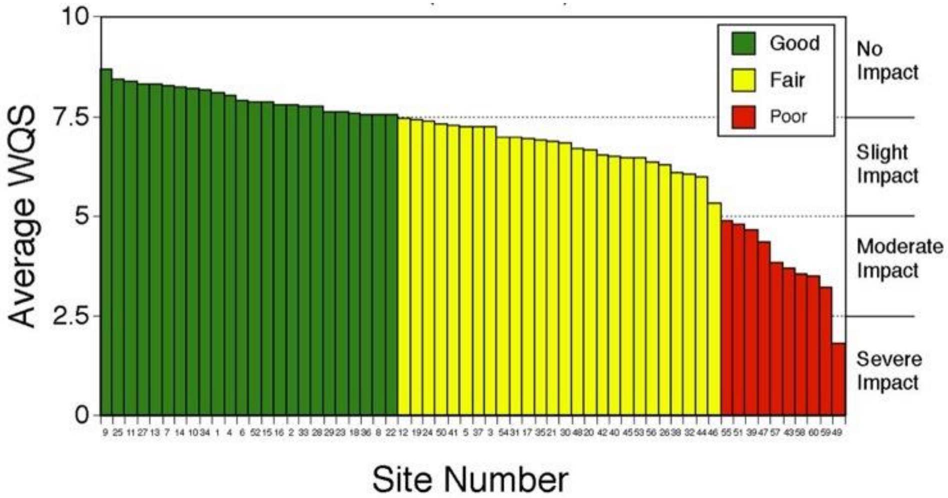
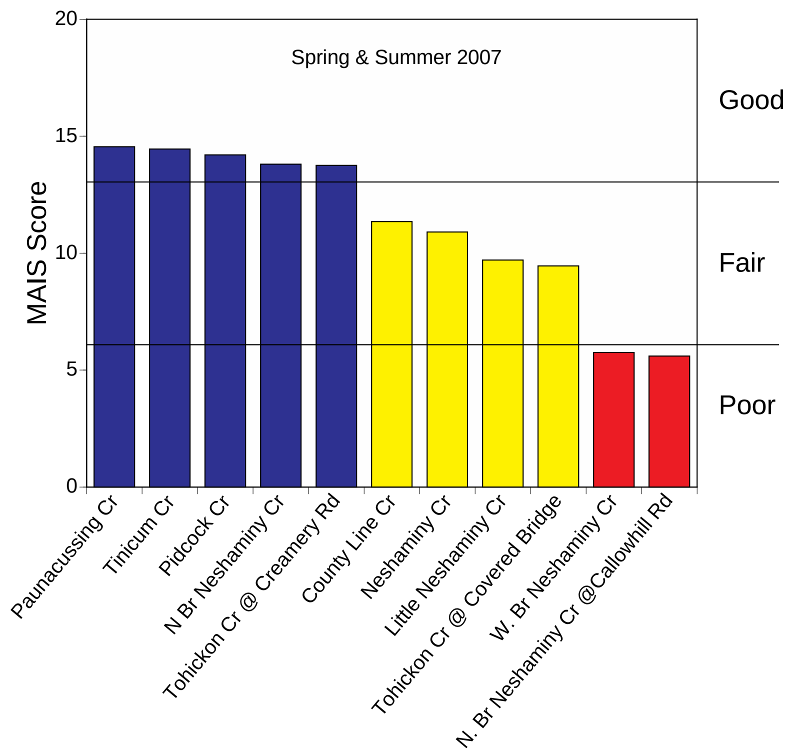
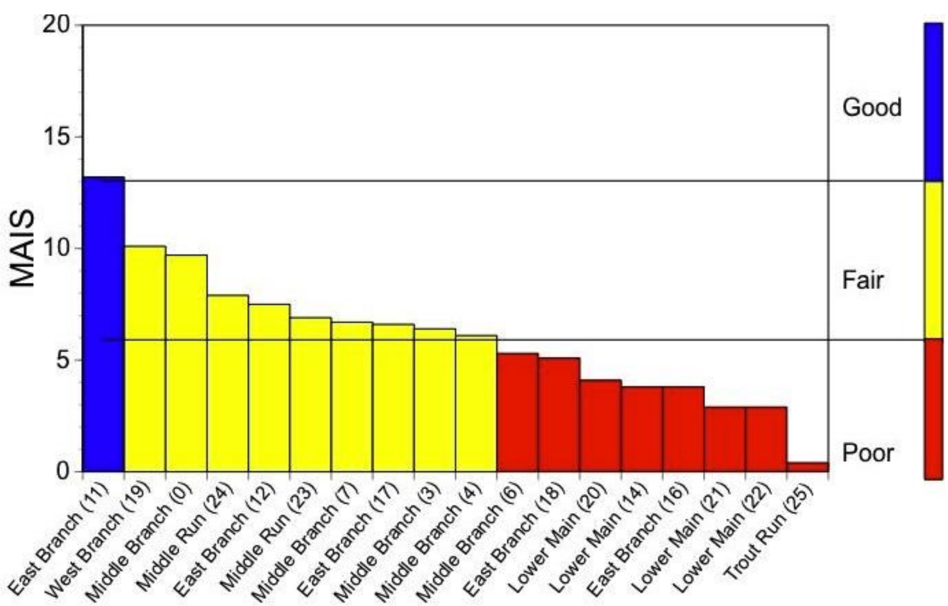
NYC Watersheds – 2000-2002



Bucks County - 2007



White Clay Creek – 1994 - 2008



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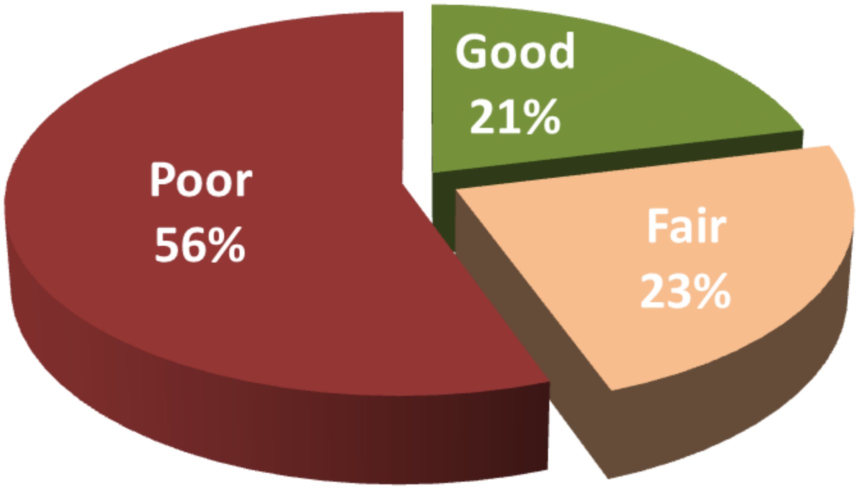
www.epa.gov/aquaticsurveys

- 56% of the nation's river and stream miles do not support healthy populations of aquatic life



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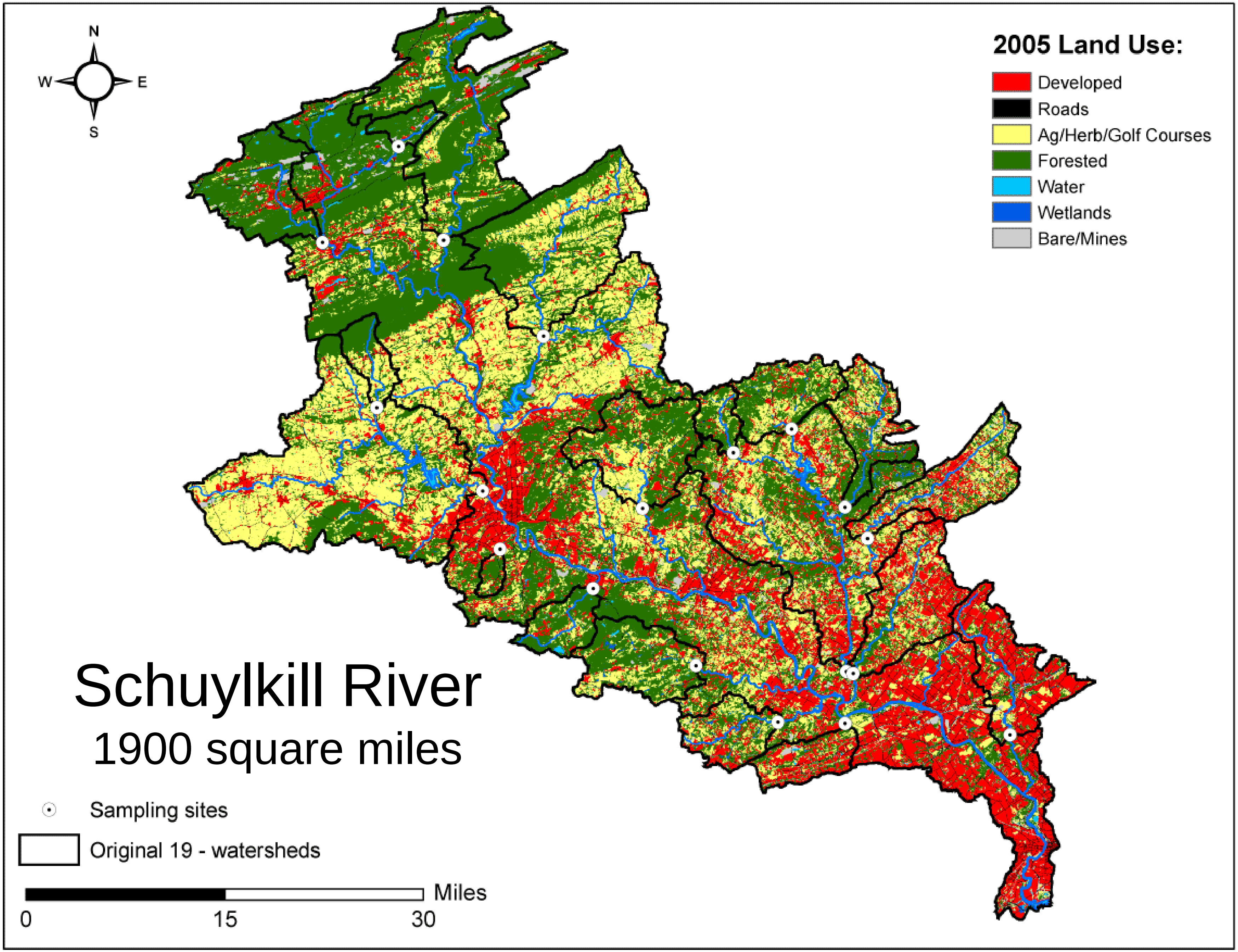
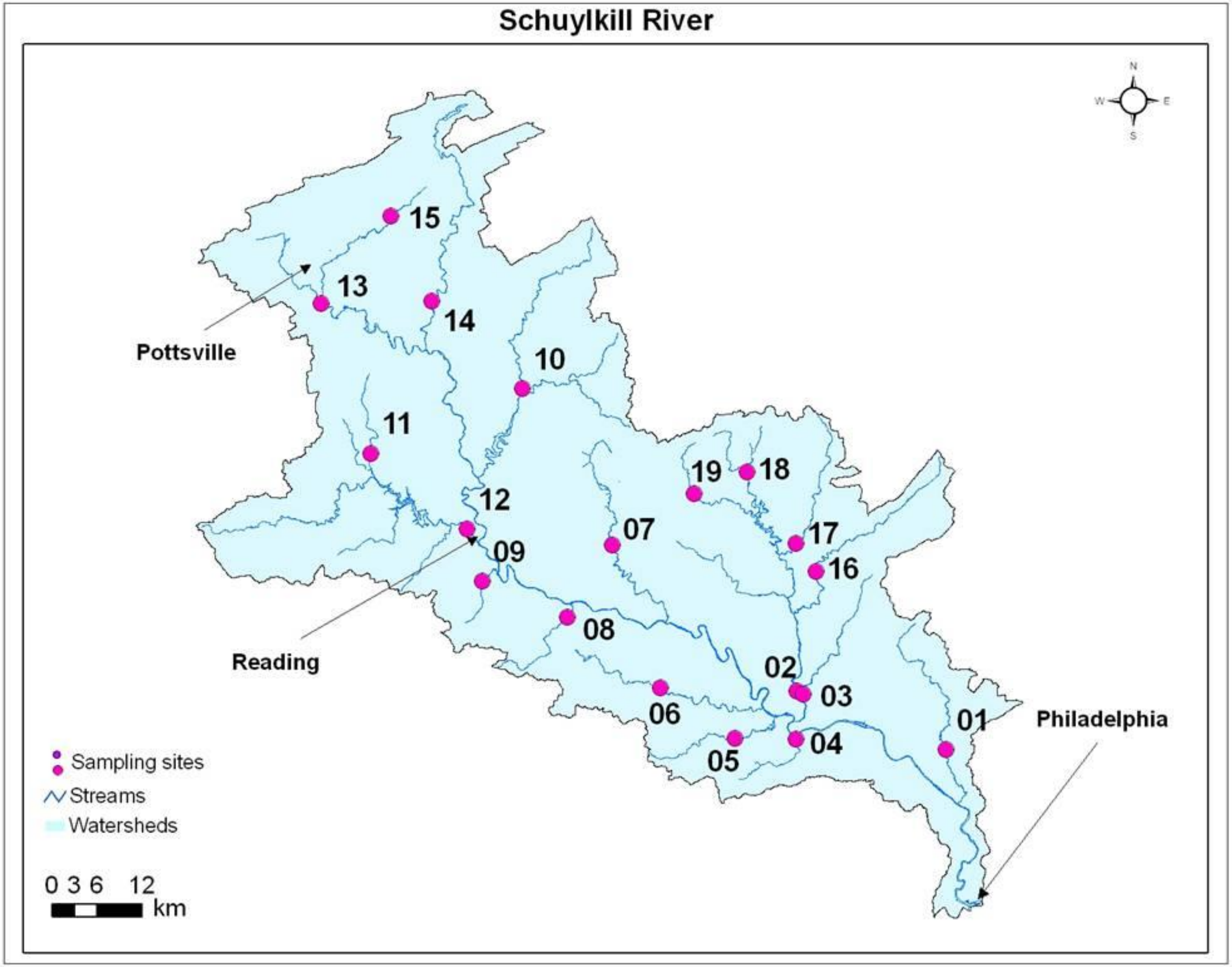
US EPA – Draft Report: National Rivers & Streams Assessment 2008-2009


N
W
E
S
2005 Land Use:
Developed
Roads
Ag/Herb/Golf Courses
Forested
Water
Wetlands
Bare/Mines
Schuylkill River
1900 square miles
Sampling sites
Original 19 - watersheds
Miles
0
15
30



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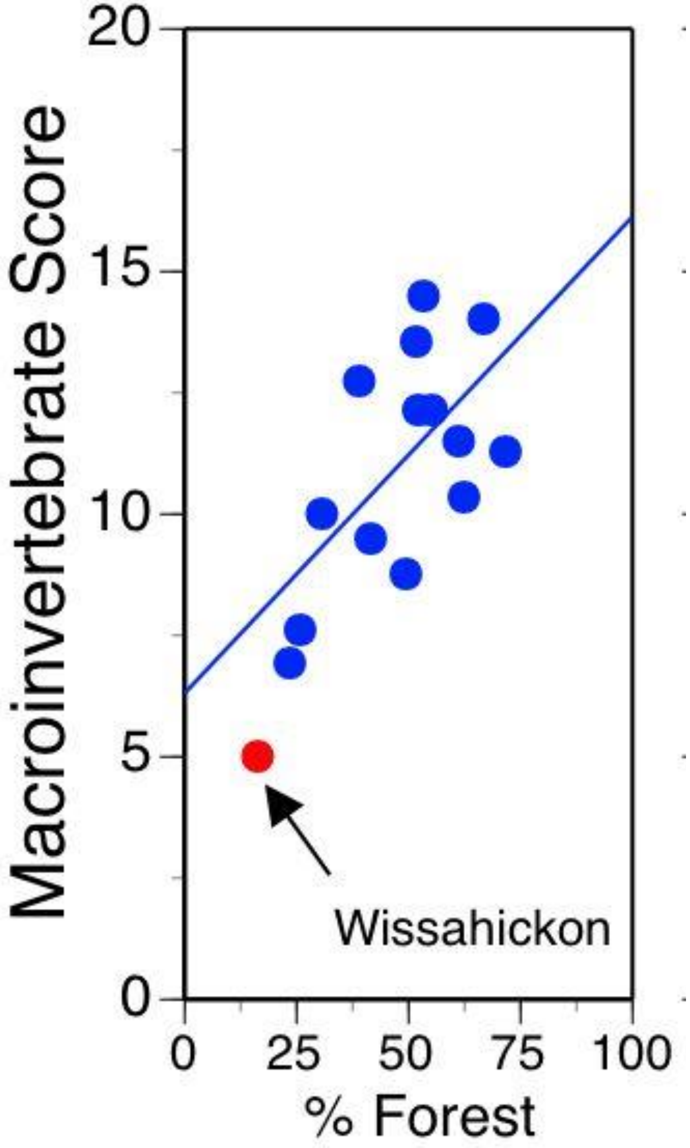
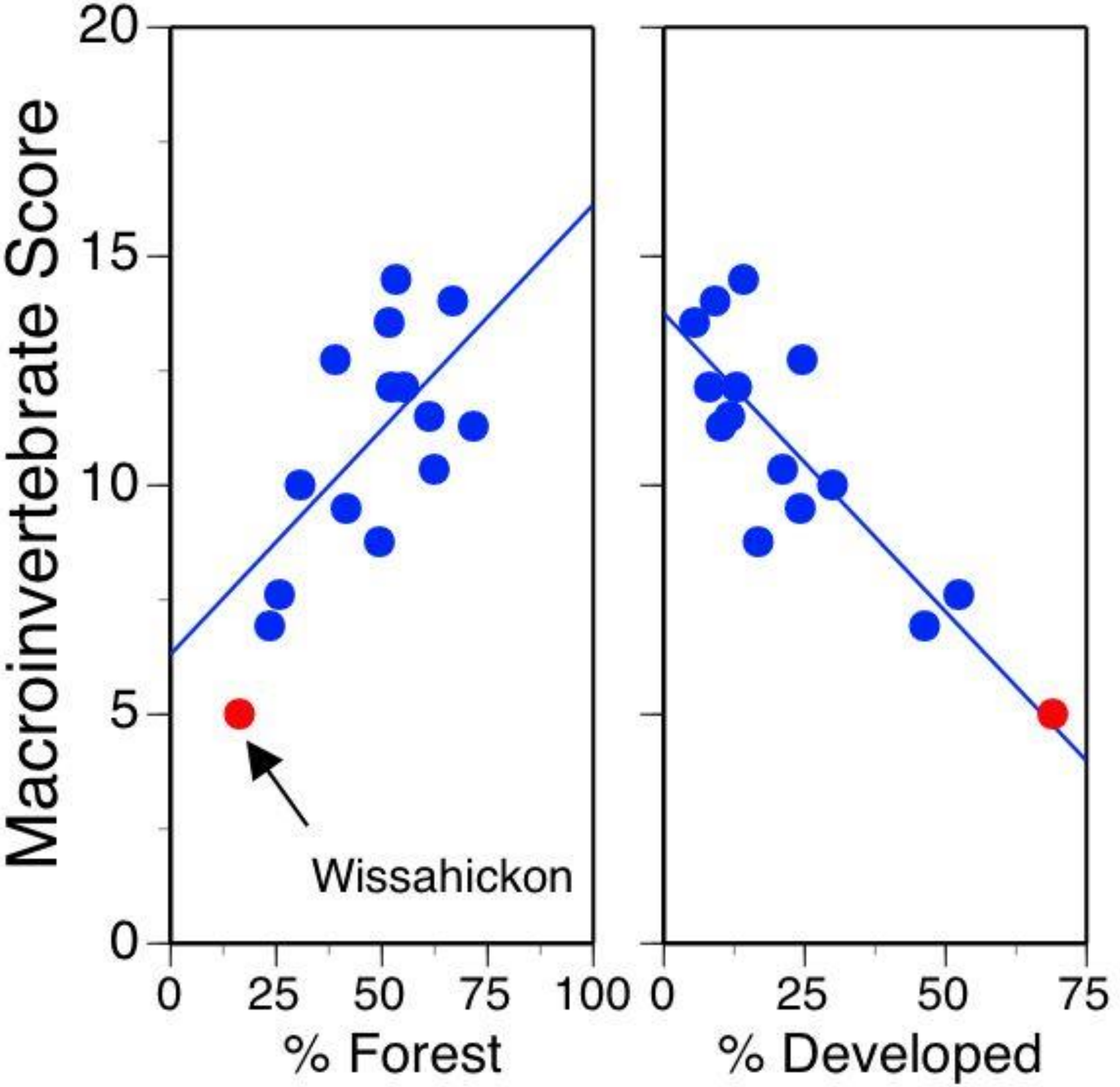
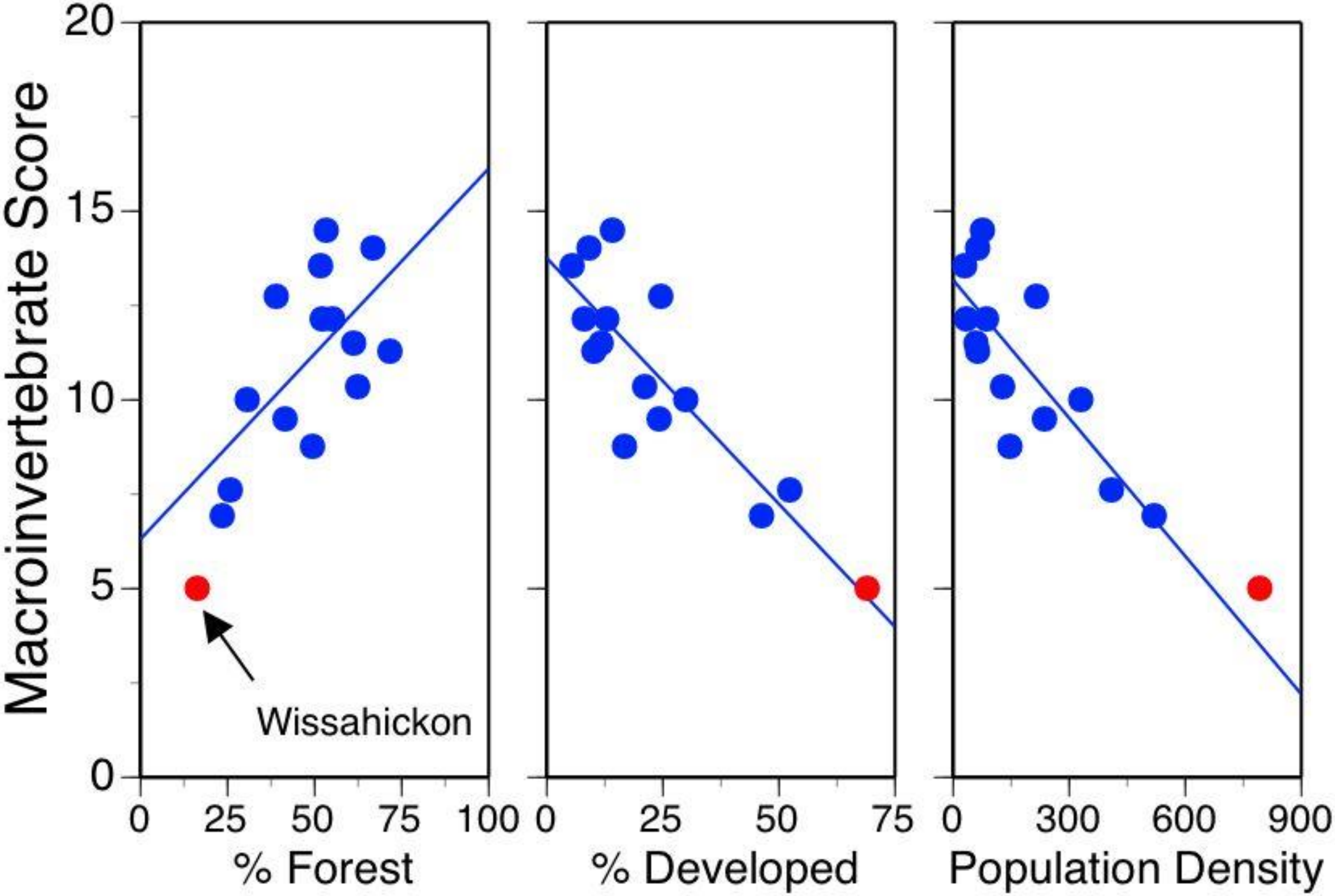


20
15
10
5
0
Macroinvertebrate Score
0
25
50
75
100
% Forest
Wissahickon



Macroinvertebrate Score
20
15
10
5
0
0
25
50
75
100
% Forest
Wissahickon
0
25
50
75
% Developed



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Development

Agriculture

Mining

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Pollution
is about people

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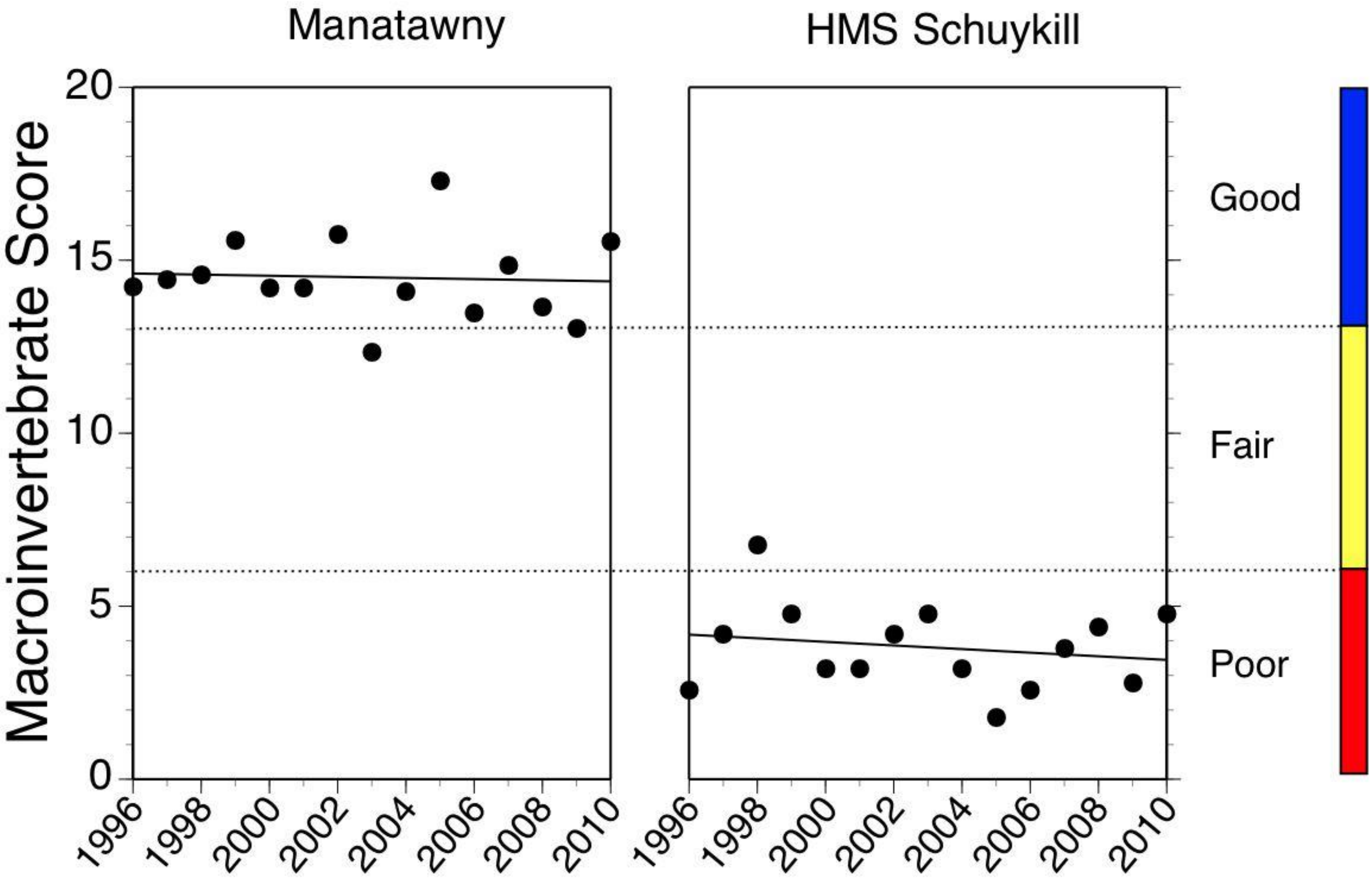
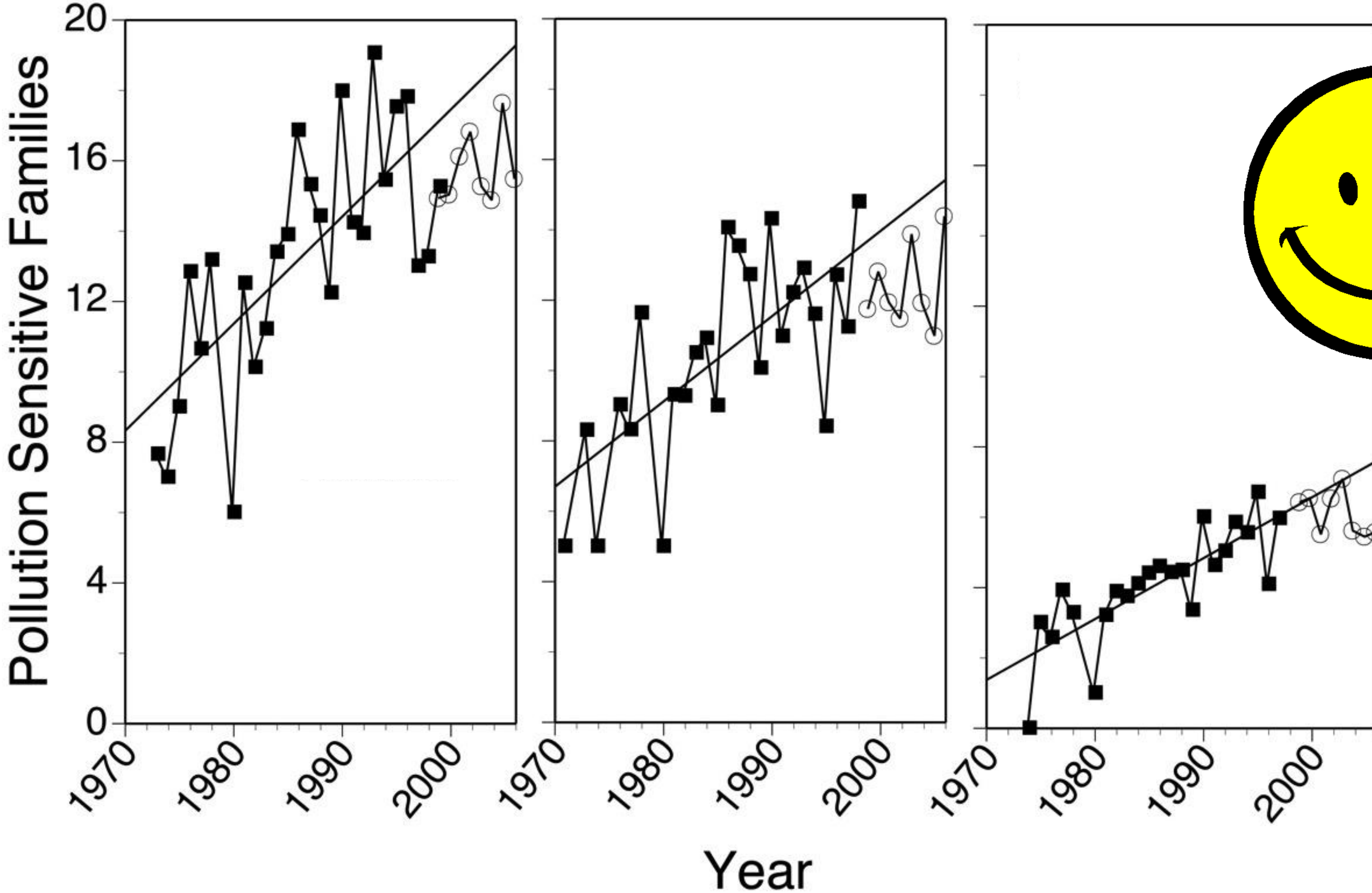
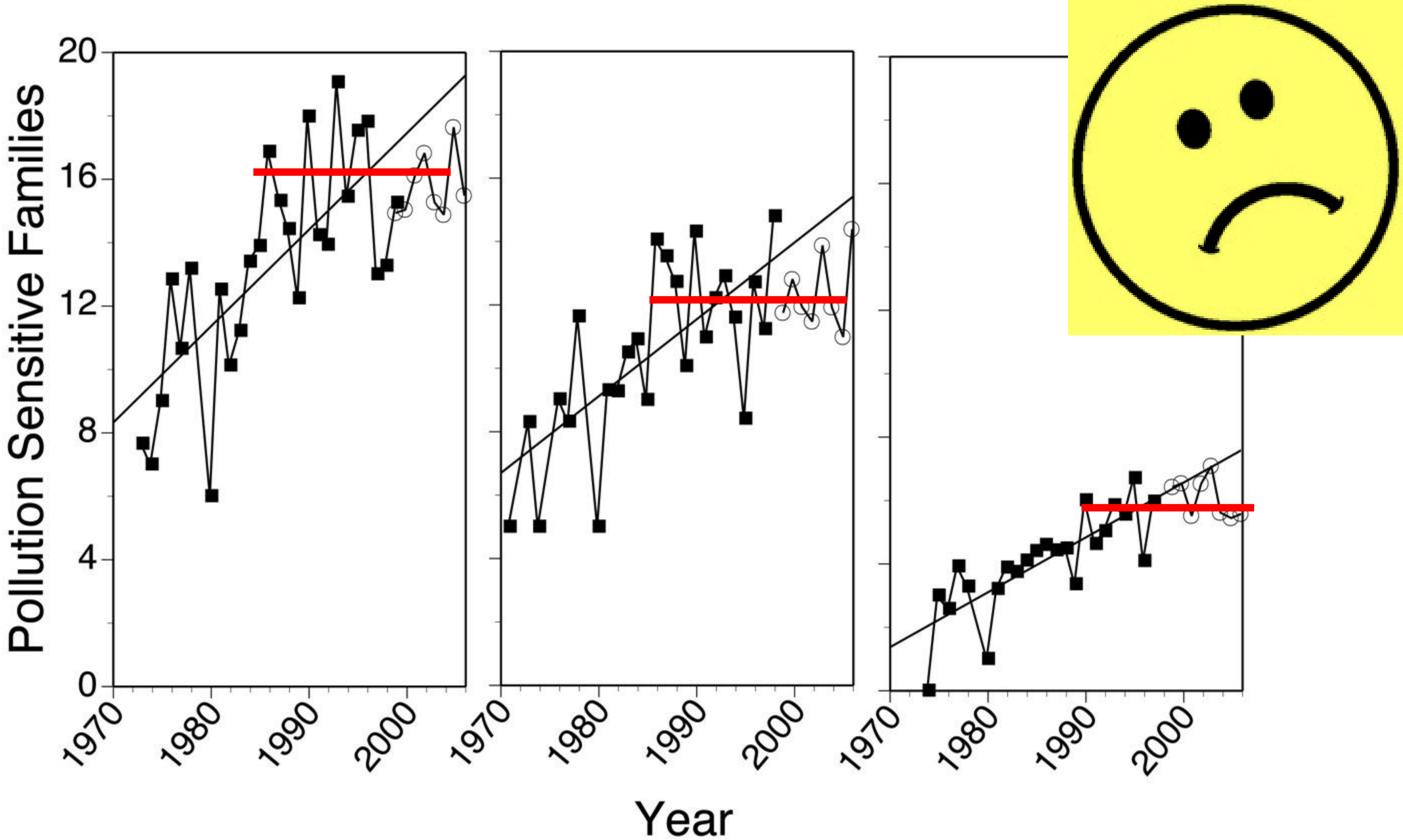
Stream conditions did not improve from 1996 - 2010!



Stream Conditions Have Improved!



But not a lot recently



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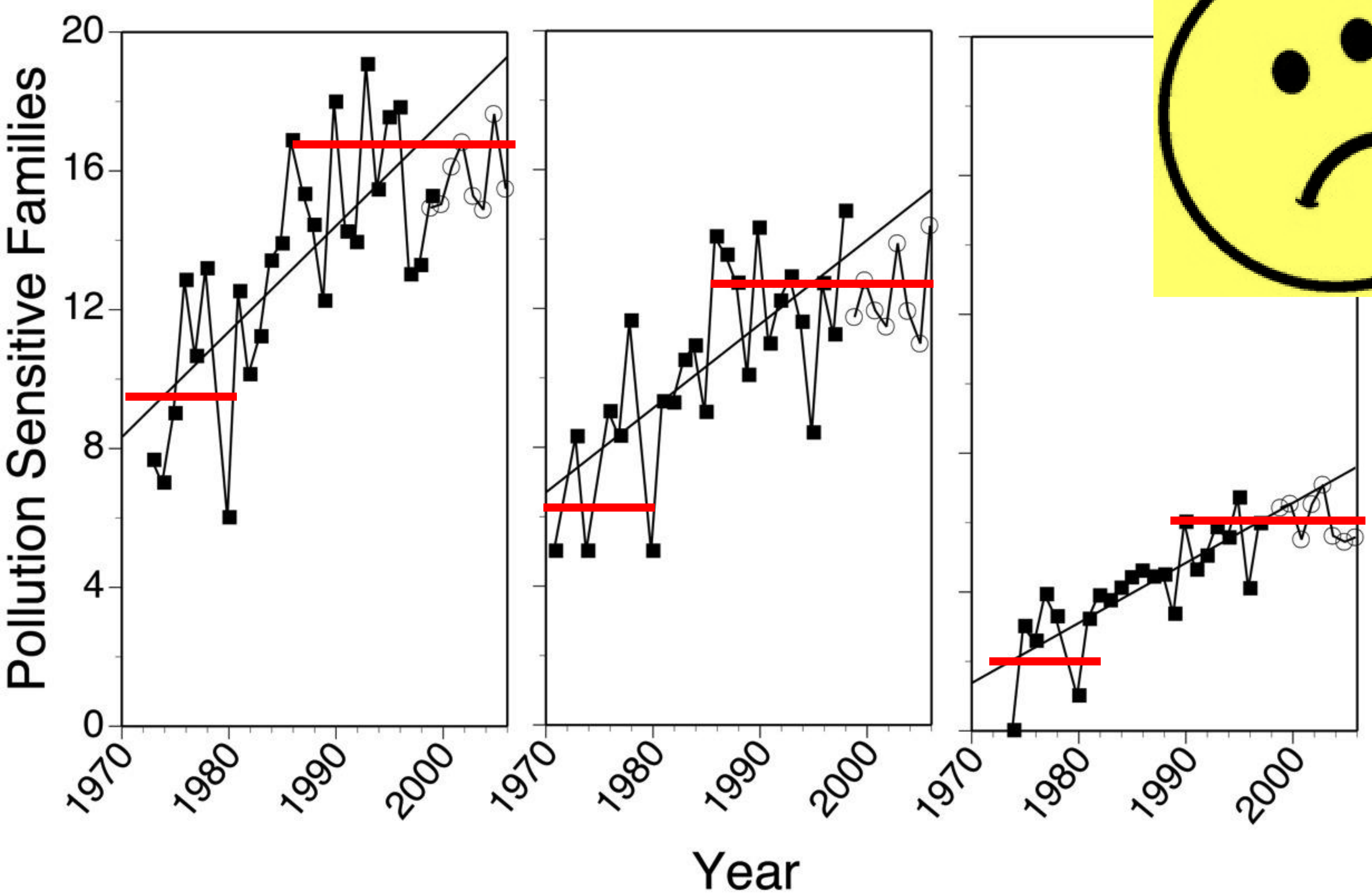
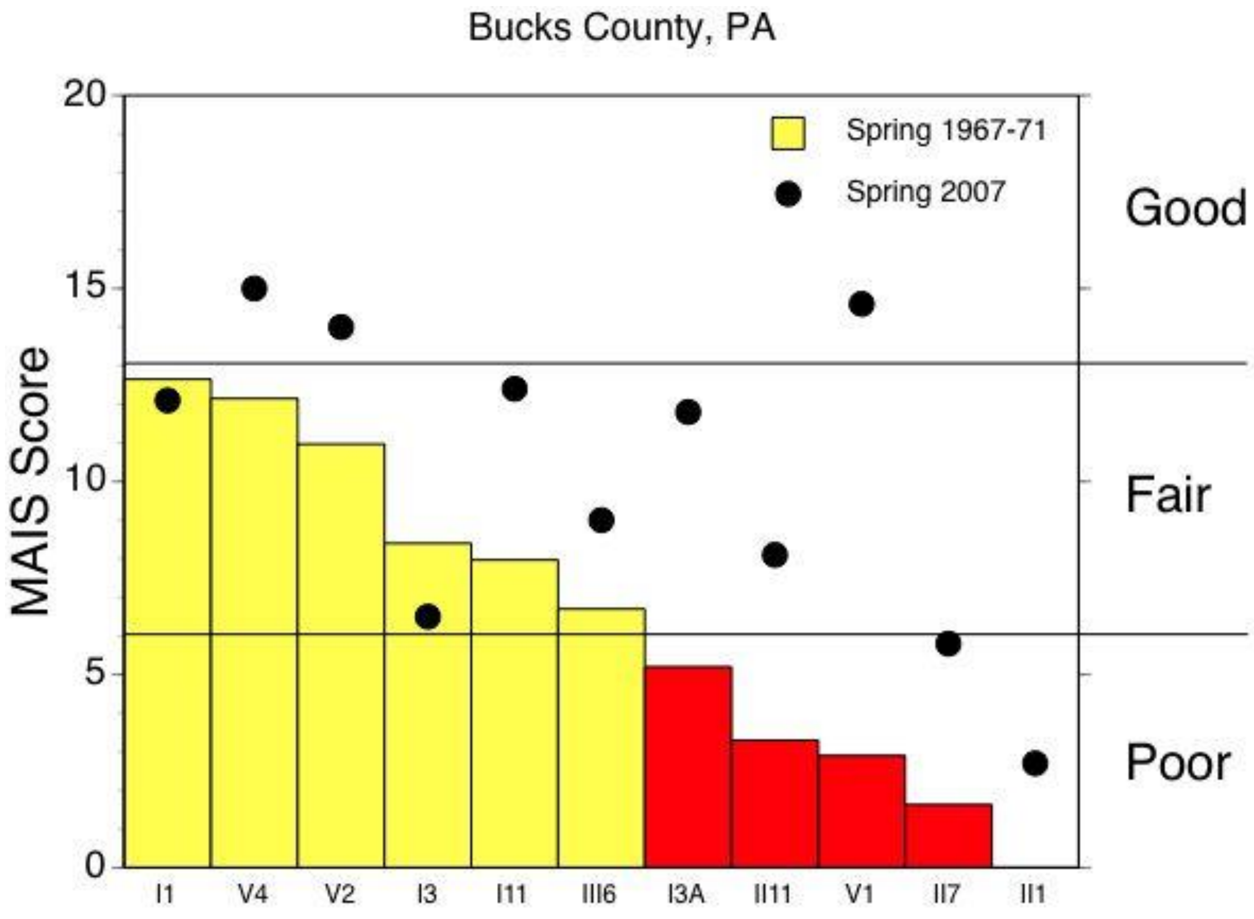
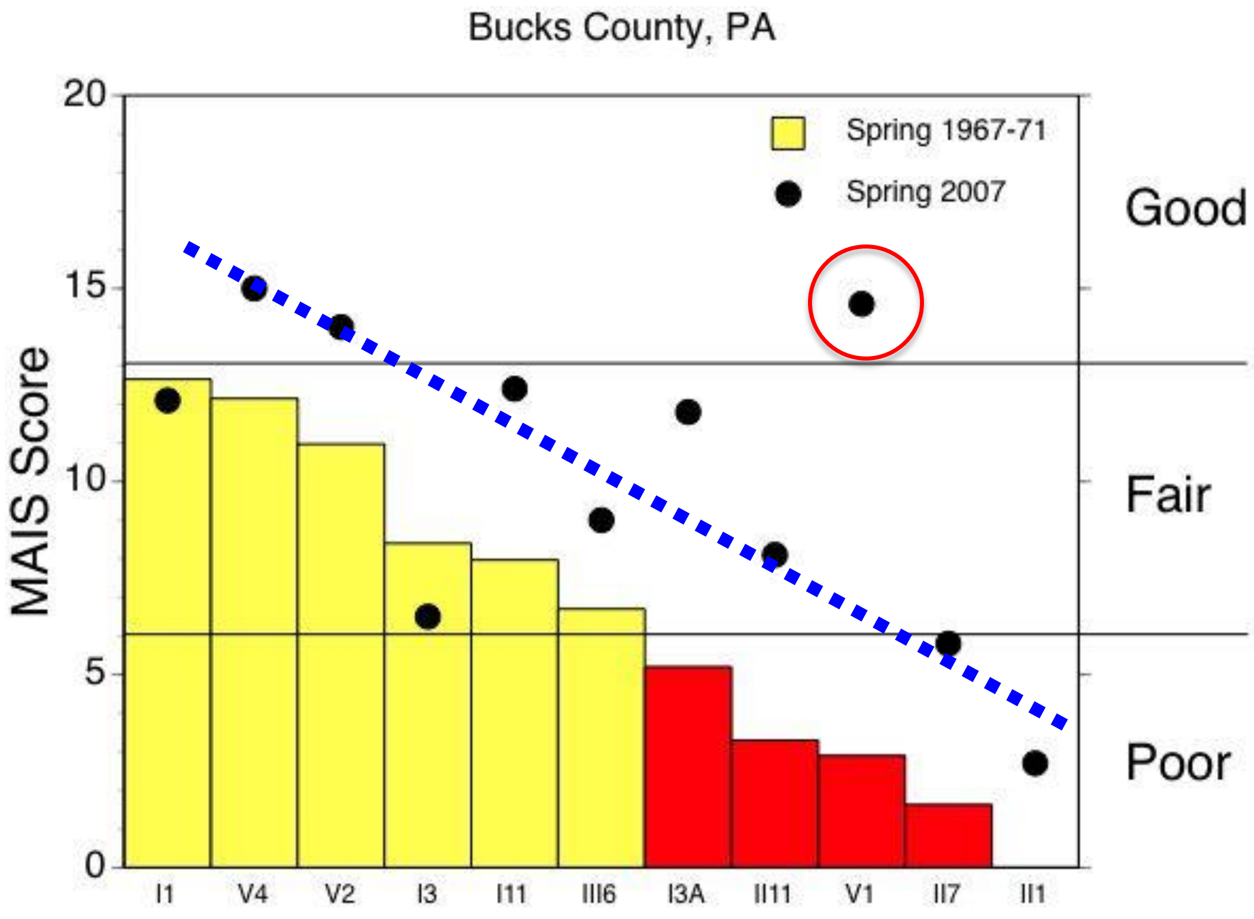
Poor streams rarely become great streams.





Over 40 years, stream condition generally improved or maintained



Again, poor streams rarely become great streams.

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Why are we not seeing more clean streams, or larger improvements?

1. Not Enough Time?

2. Not Enough Intensity?

3. Wrong Prescription?

4. Missed Something?

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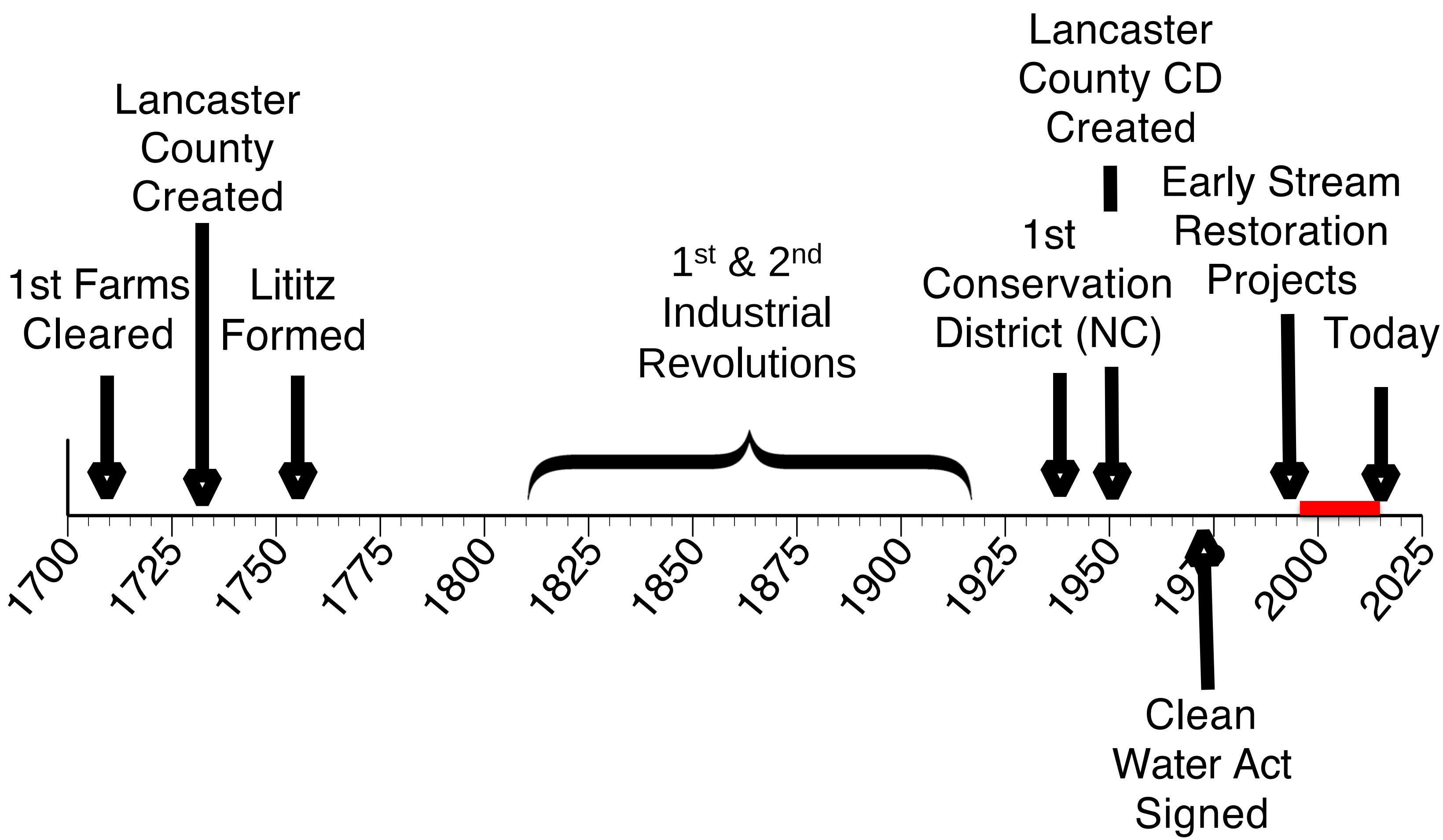
Lancaster County Created
1st Farms Cleared
Lititz Formed
1st & 2nd Industrial Revolutions
Lancaster County CD Created
1st Conservation District (NC)
Early Stream Restoration Projects
Today
Clean Water Act Signed
1700
1725
1750
1775
1800
1825
1850
1875
1900
1925
1950
2000
2025

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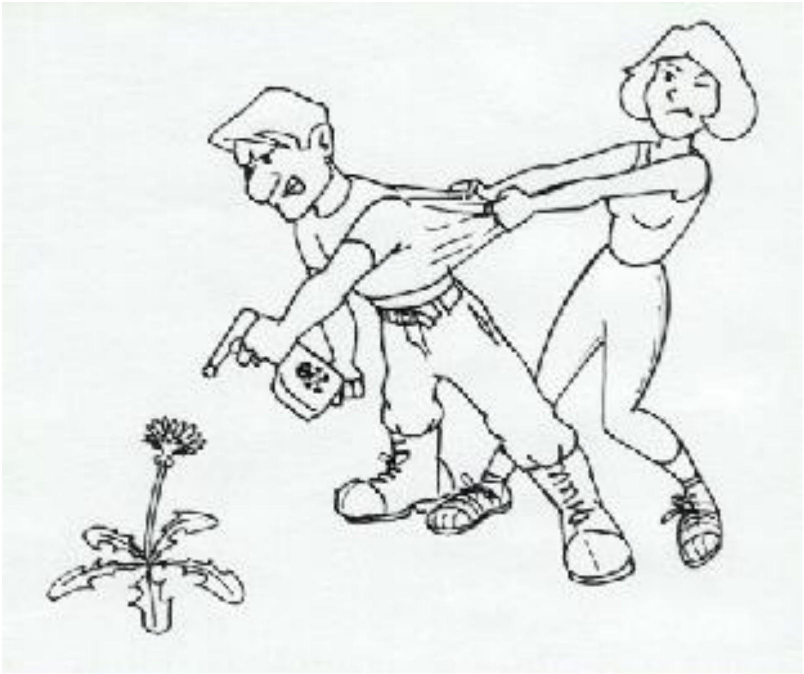
Restoration & Prevention



Are Generally Local Concerns And Efforts

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Addressing 100 ft here and 1000 ft there, leaves us much more to do!

Lancaster County, PA

824 miles impaired

4,350,720 feet impaired

Comparison

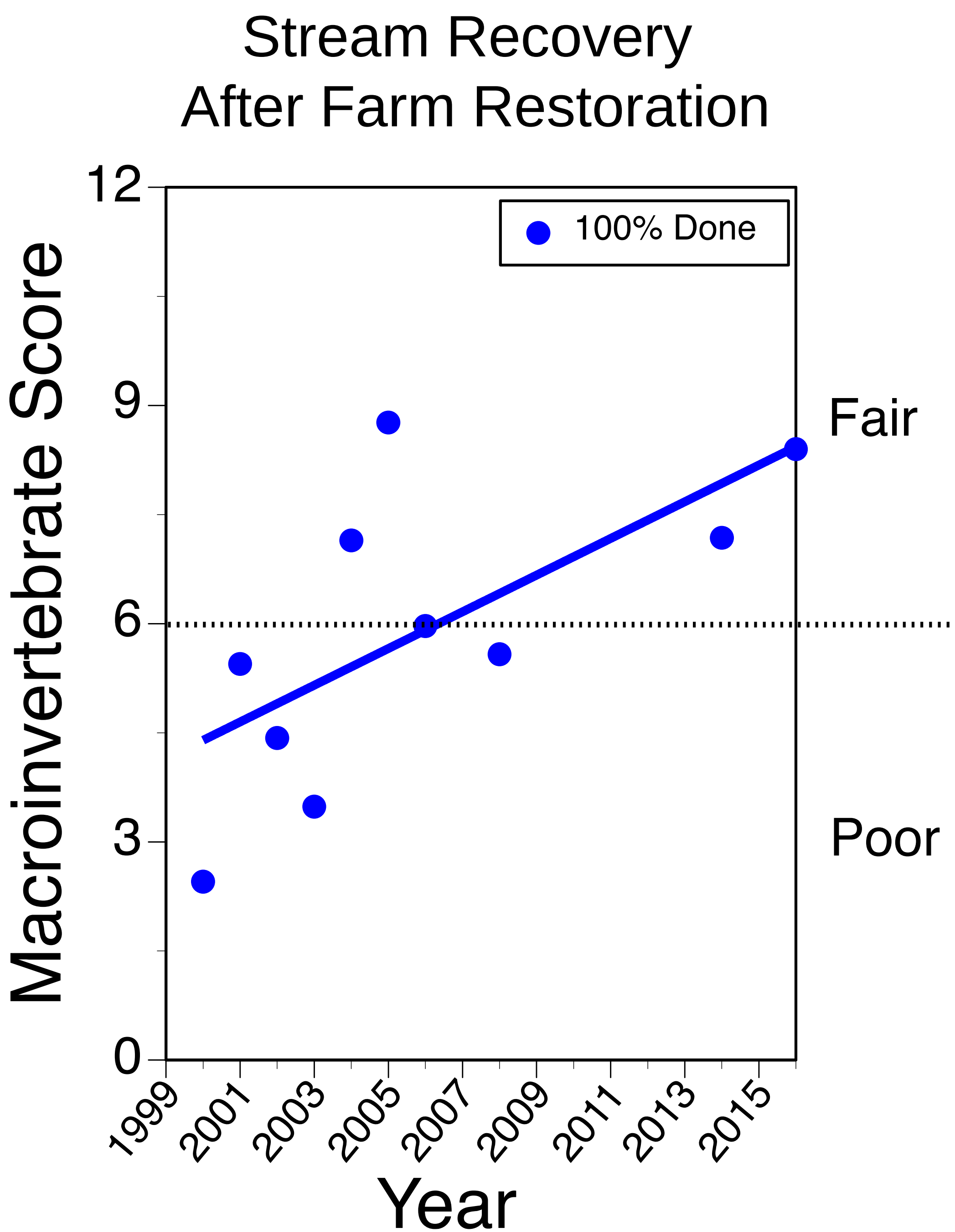
of stream

condition

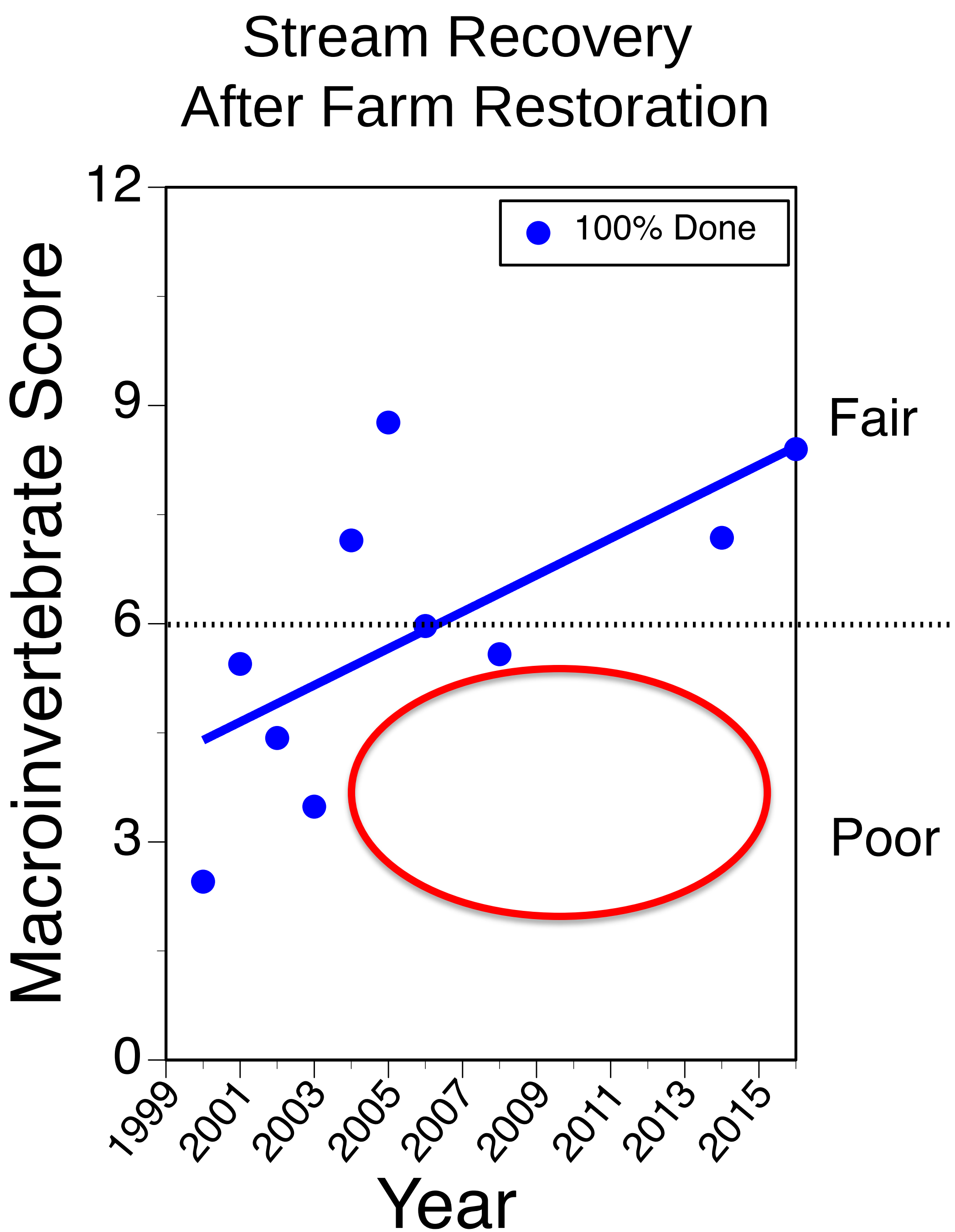
2000

versus

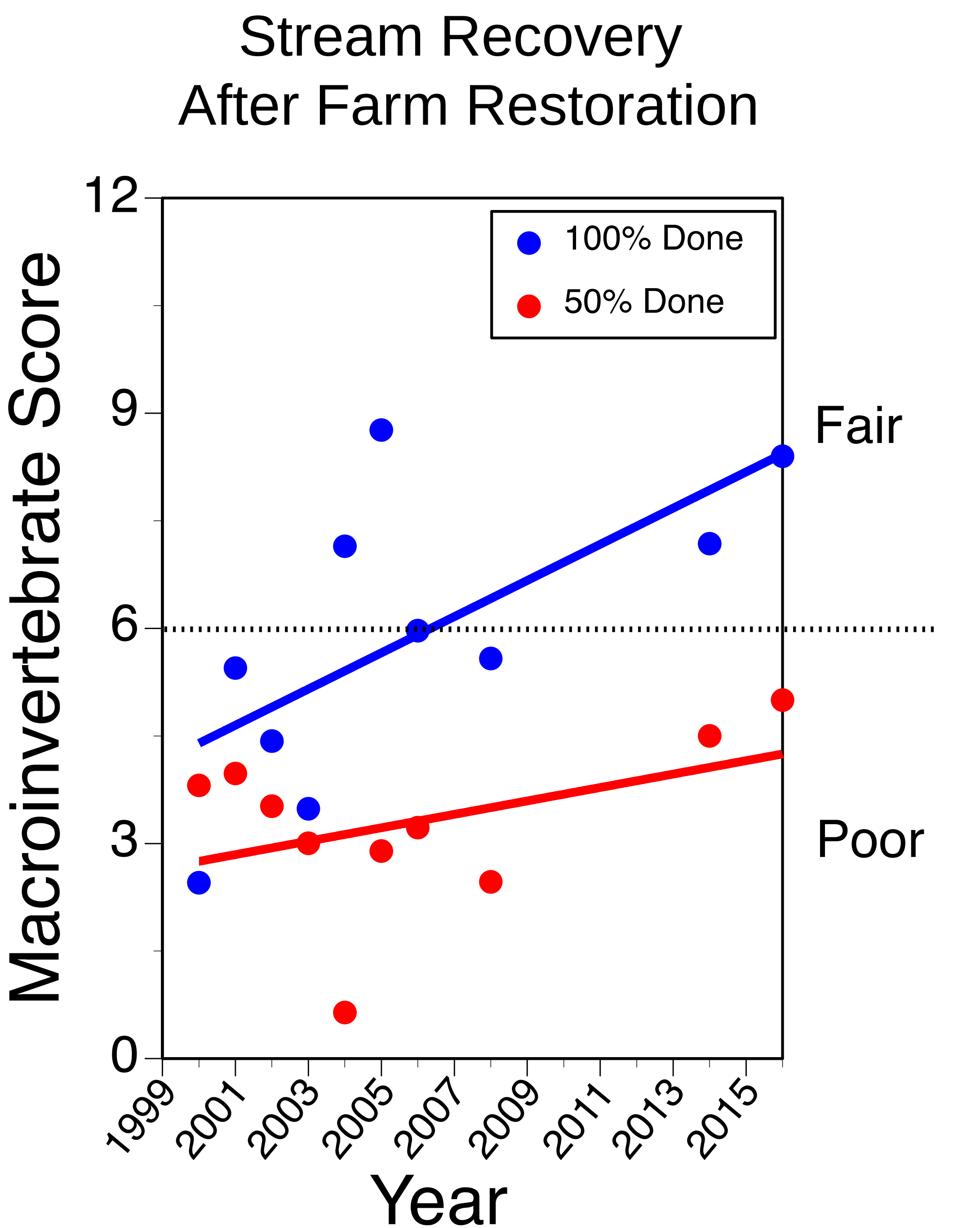
2016



Comparison of stream condition 2000 versus 2016



Comparison of stream condition 2000 versus 2016



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QUALITY
QUANTITY

Channel Modifications

Field Challenges Unaddressed

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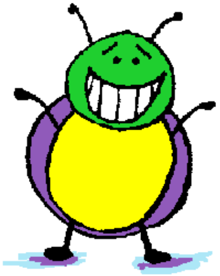
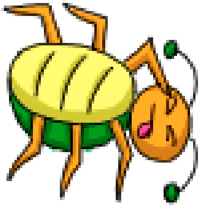
Revisit Regulatory Limits?



New
Toxicity
Tests



ppl

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Delaware River Basin Commission

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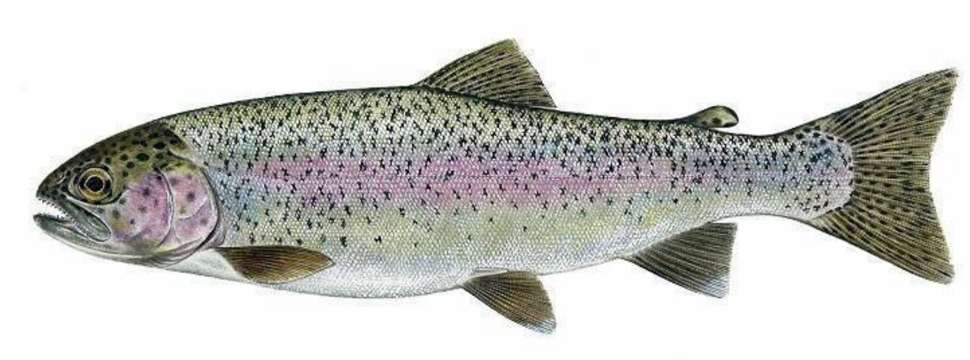
Standard Laboratory Test Species



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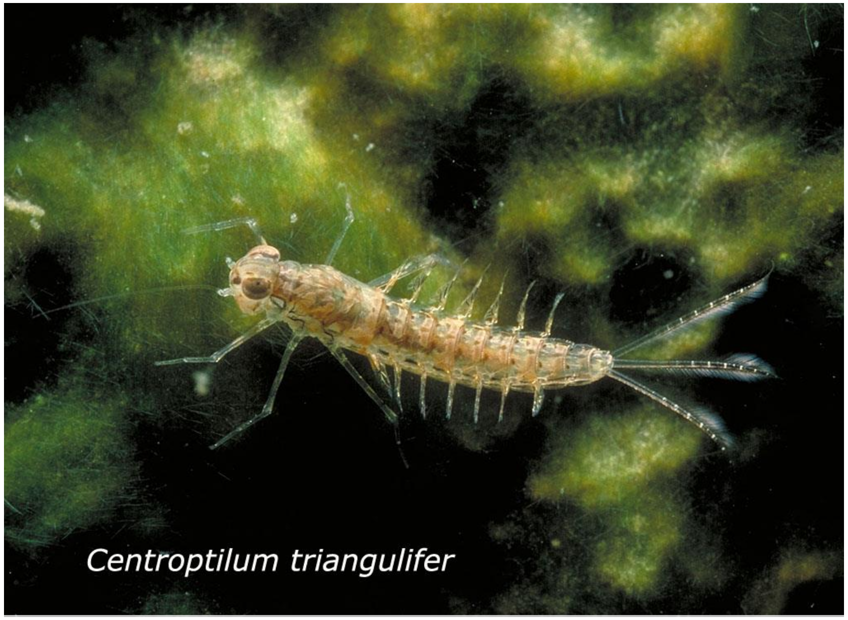

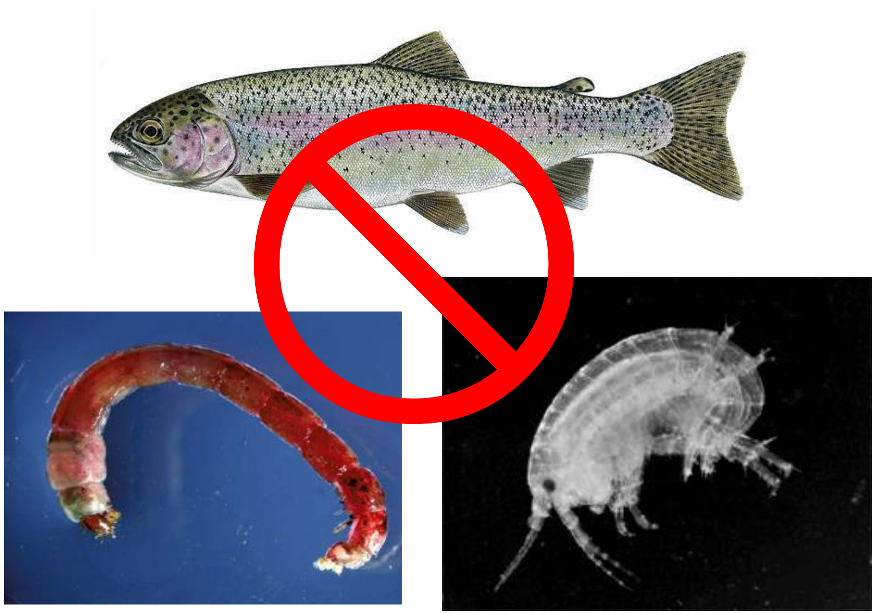

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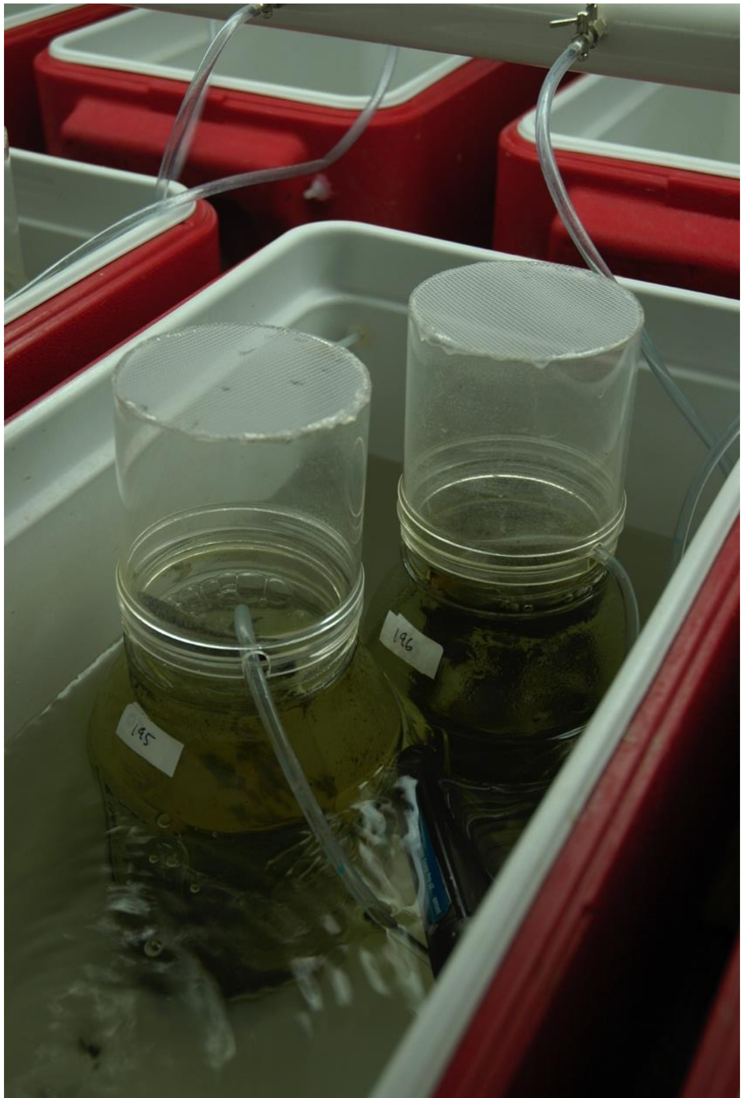
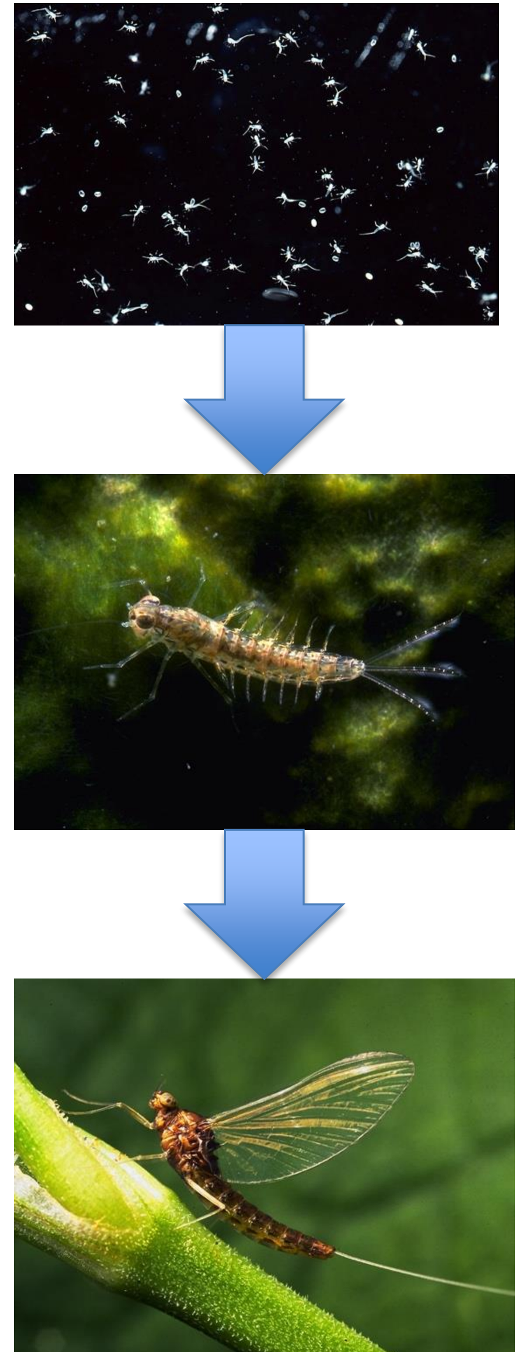
Whole lifecycle in laboratory

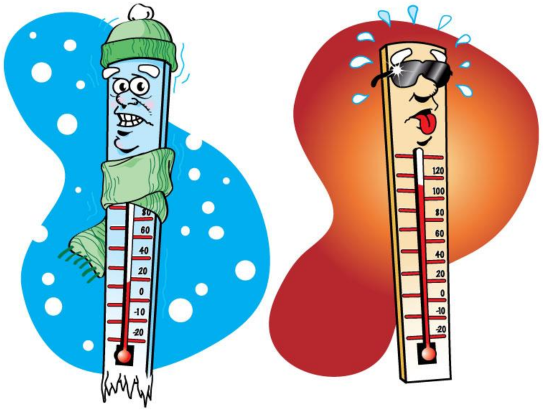




Toxicity Testing

Chloride

Sulfate



Temperature

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Urban Pollutants?

- Solids
- Oxygen-demanding substances
- Nitrogen and phosphorus
- Pathogens
- Petroleum hydrocarbons
- Metals (Cu, Pb, Zn)
- Synthetic organics

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Emerging Contaminants?

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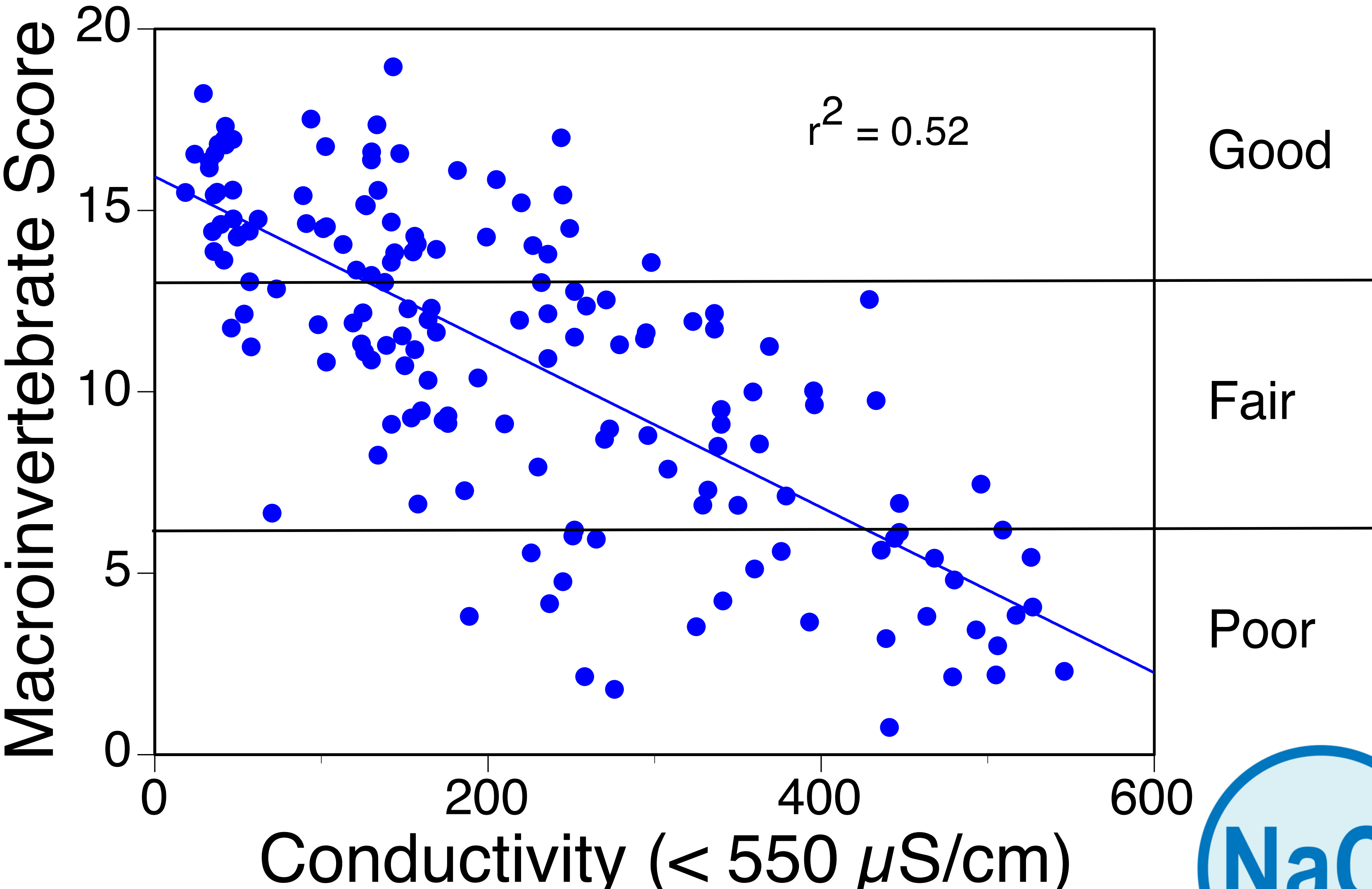
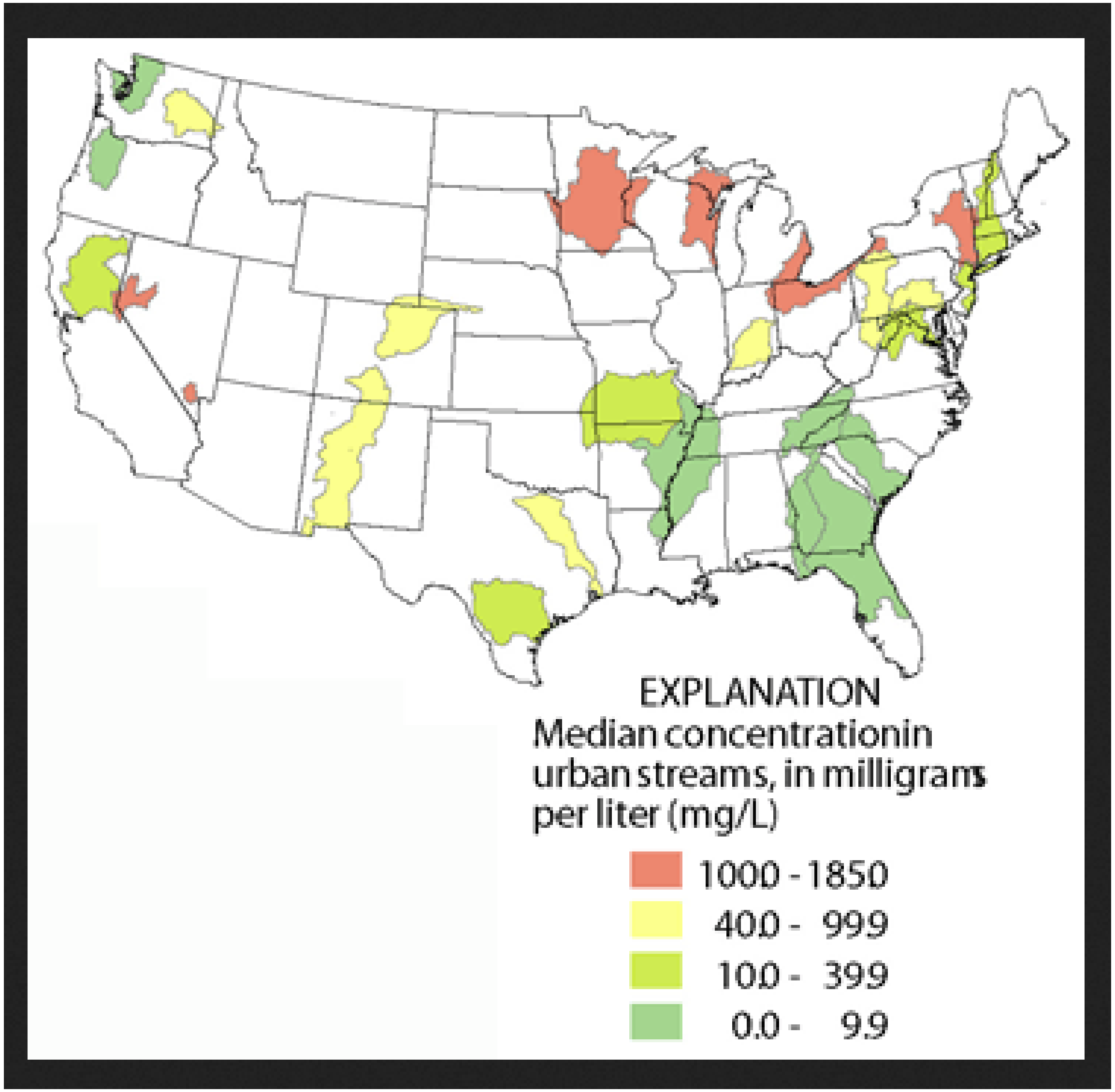
CHLORIDE Toxicity

157 sites, primarily in Schuylkill River basin



NaCl

Emerging Contaminants?

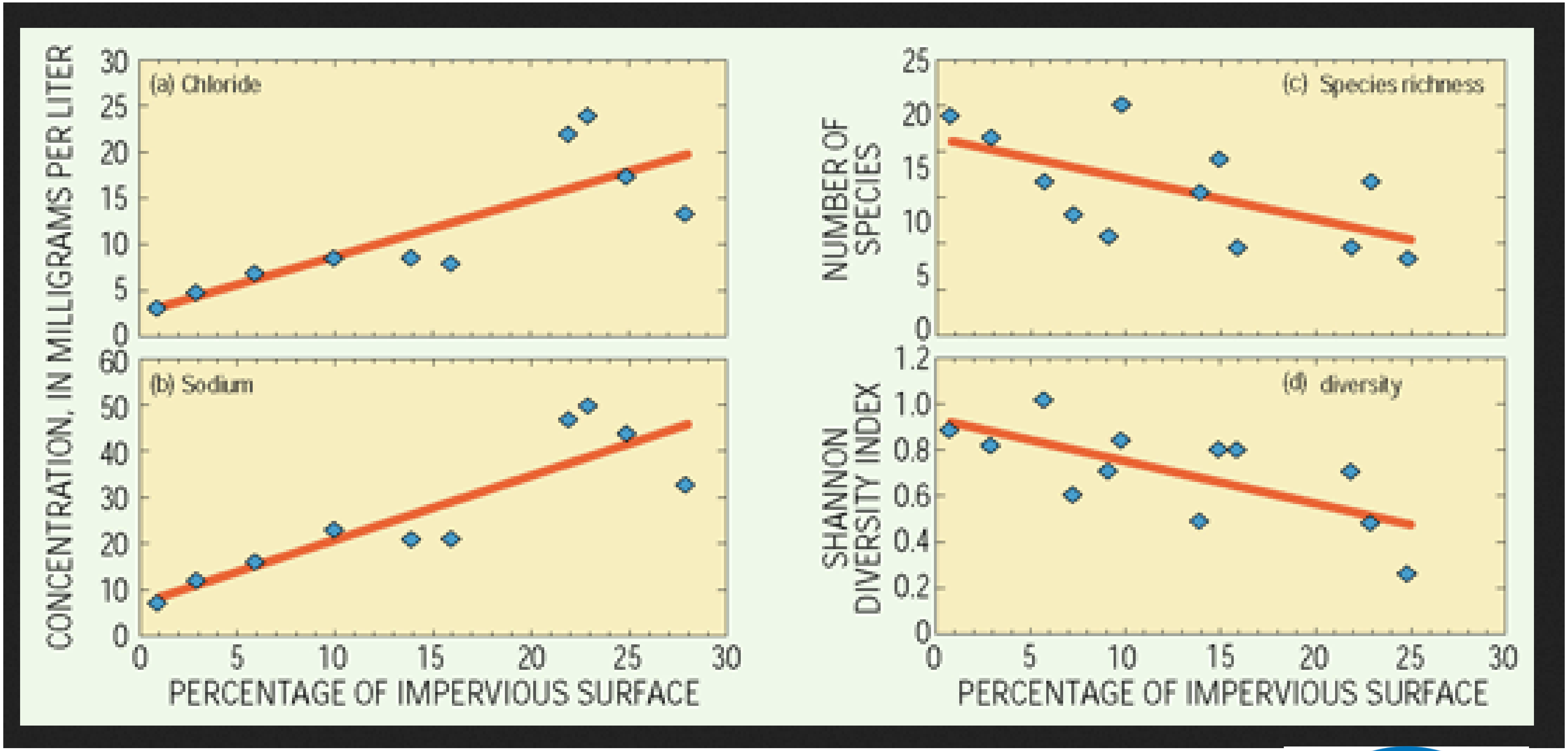


Chloride

NaCl

https://www.macalester.edu/academics/environmentalstudies/threerivers/studentprojects/LakesStreamsRiversFall09/UrbanizationWeb/Pollutants1.html

Emerging Contaminants?



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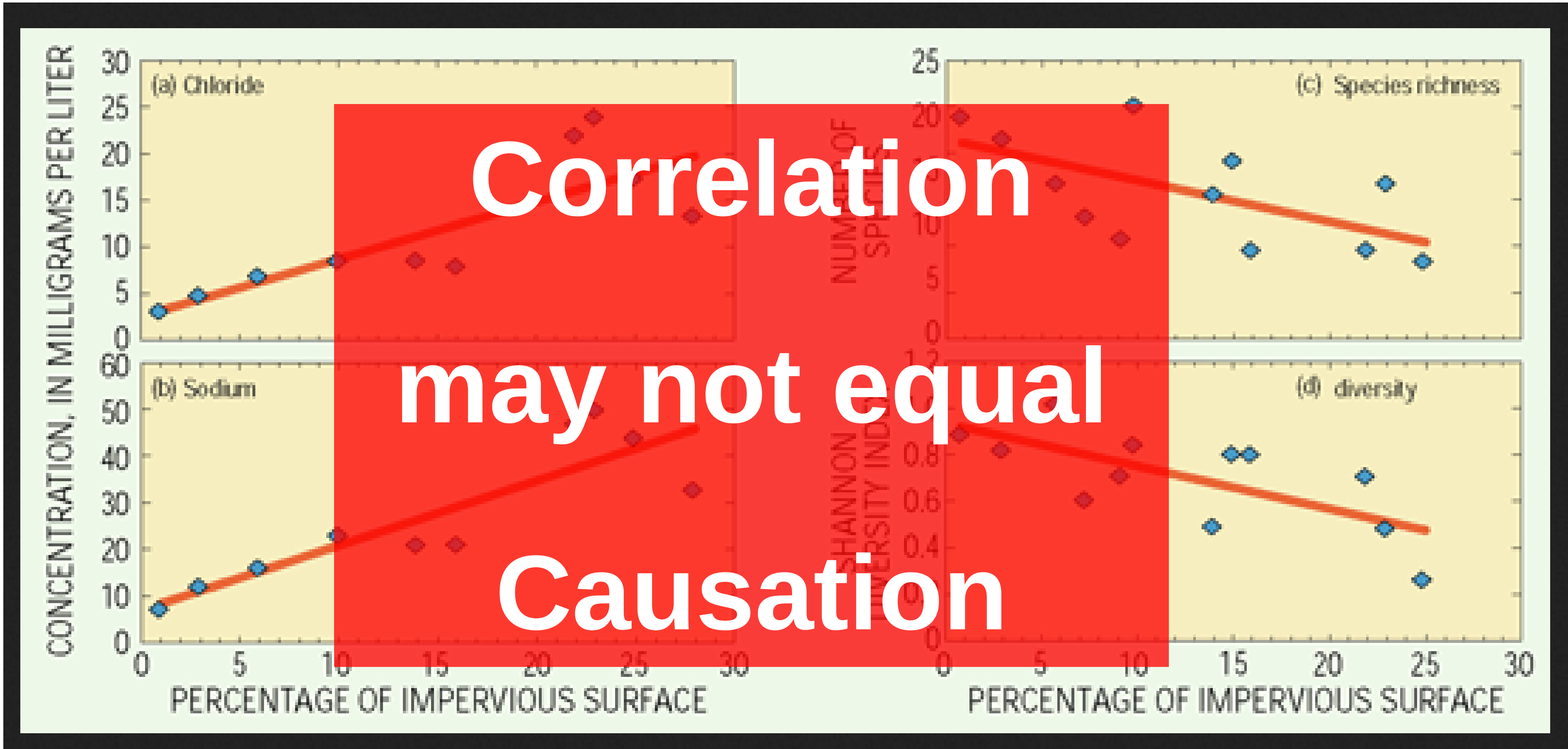
Emerging Contaminants?



Correlation may not equal Causation

https://www.macalester.edu/academics/environmentalstudies/threerivers/studentprojects/LakesStreamsRiversFall09/UrbanizationWeb/Pollutants1.html

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How do we see more improvement?

1) Do more, try new things.

- Research

2) Be vigilant.

- Monitor

1) Change regulations.

- Demand will increase

John K. Jackson, Ph.D.
Senior Research Scientist
Stroud Water Research Center

jkjackson@stroudcenter.org
610.268.2153 x226