Detecting the Contributing Factors of Lotic Algal Blooms

2019 National Water Quality Monitoring Conference
Session: Creative Developments in HAB Monitoring

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Interstate Commission on the Potomac River Basin

Filamentous Algae (attached)


WVDEP


ICPRB Cacapon River WV

Water flows over cells

Planktonic Algae (free-floating)


WVDEP Ohio River


ICPRB

Cells flow with water

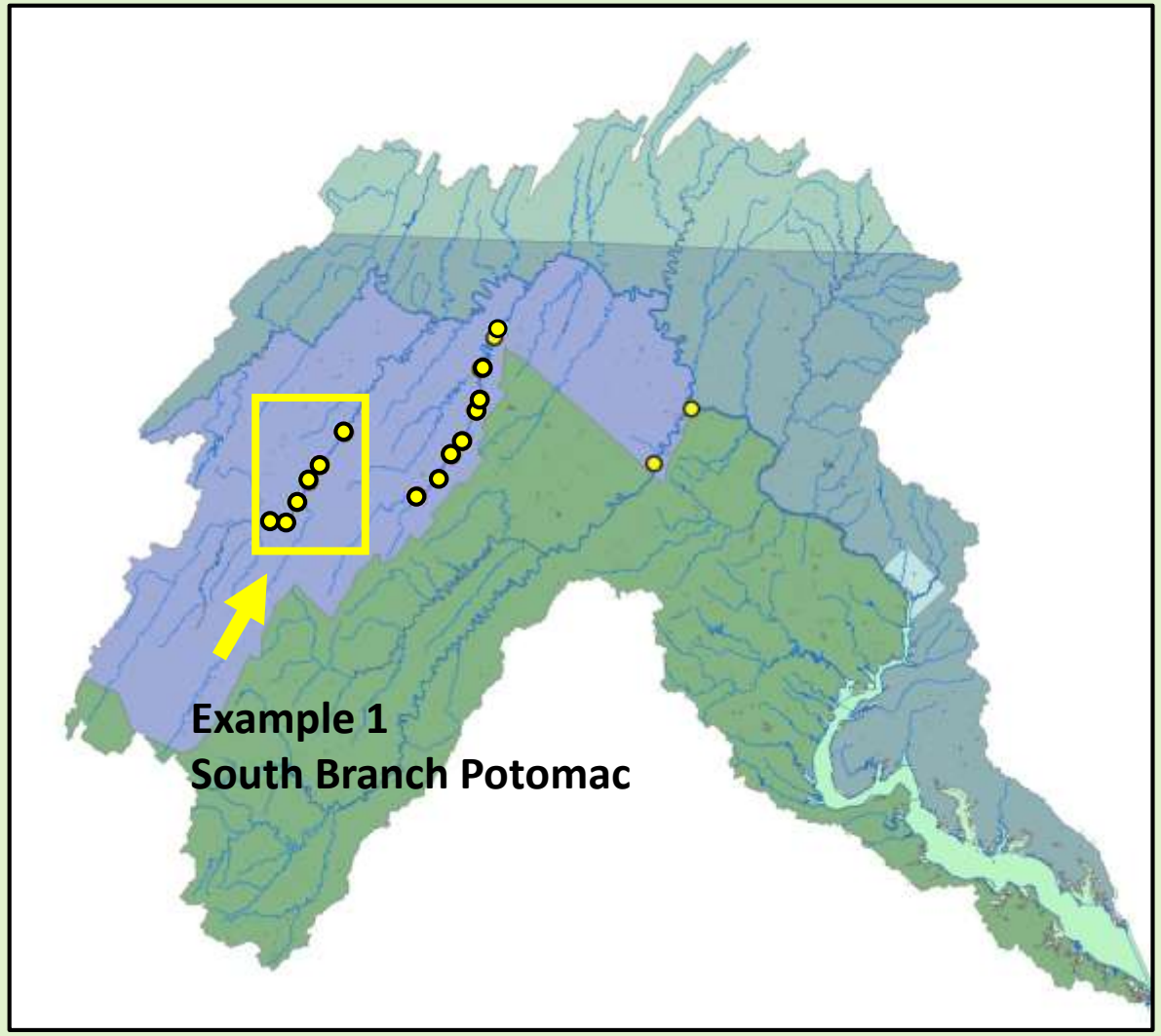
Preface: A Tale of Two Rivers

WVDEP Filamentous Algae Program (2012-2019)

<u>Potomac Basin Locations</u>

1. **South Branch Potomac**
2. Cacapon River

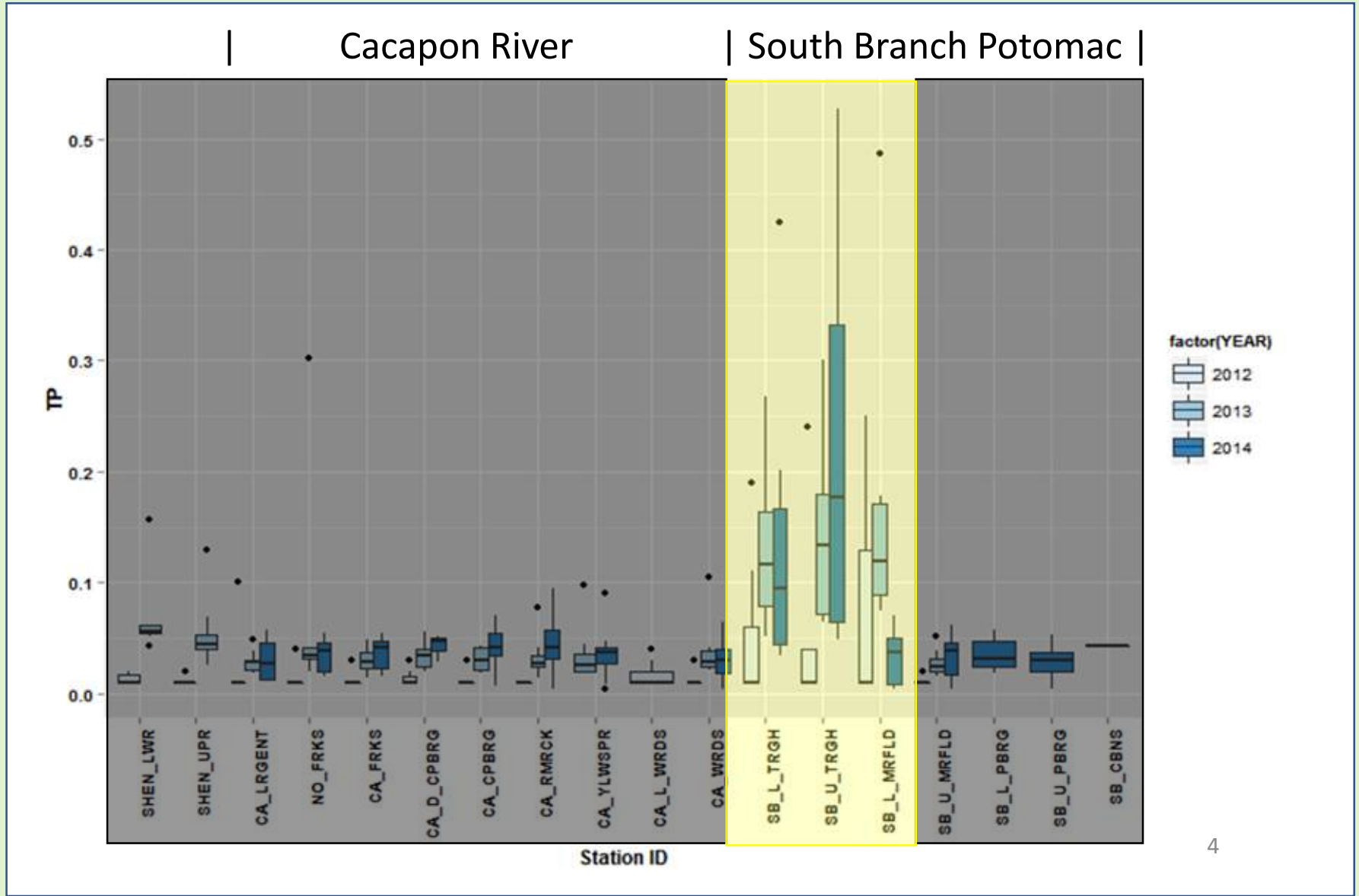
- Routine water chemistry
  - Wet Chemistry
  - YSI
- Physical qualitative habitat assessment
- Visual algae transect assessments



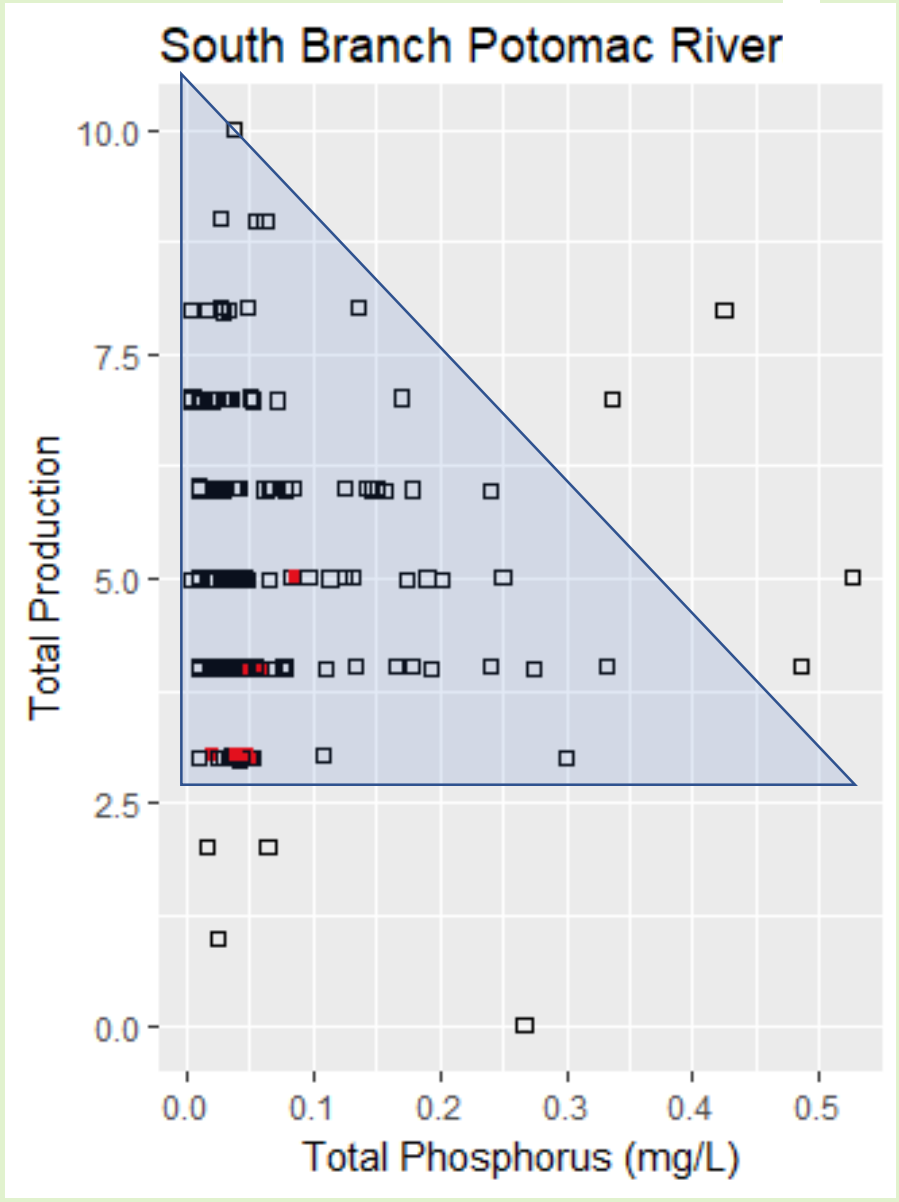
Potomac River Basin

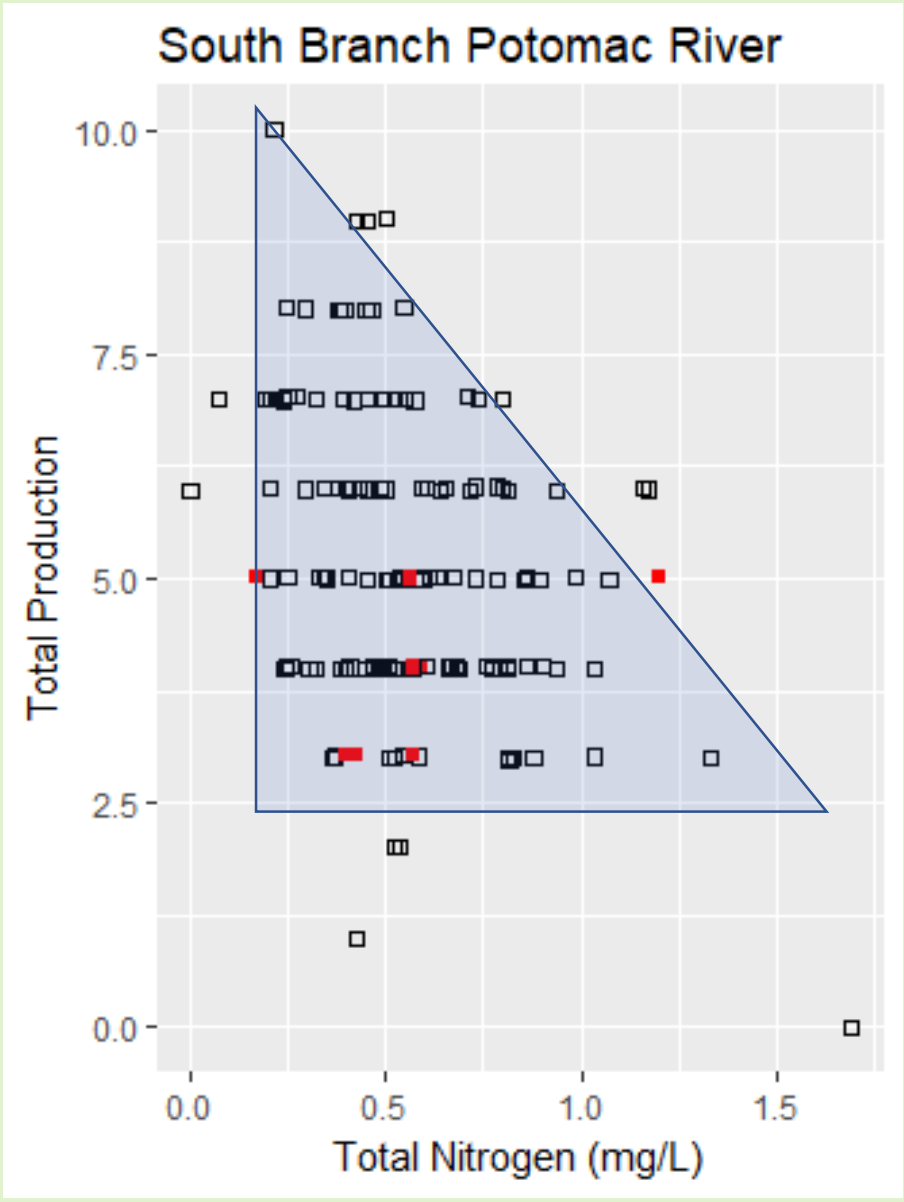
Example #1: South Branch Potomac

- Elevated phosphorus (TP) is from **point source (**Moorefield WWTP), 2012-2013
- Predictable **algal blooms**



An argument for **Nutrient Focused** decisions





Point Source Influenced

Summers 2008 Criteria

> 40 TALK mg/liter

and

< 100 HARD mg/liter)

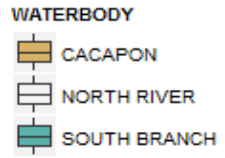
☐ criteria not met (99.5%)

■ criteria met (0.5%)

Example

- WWTP upgrade 2
- No excessive TP s
- FGA blooms disa

*Still infrequent fila
cyanobacterial bloo



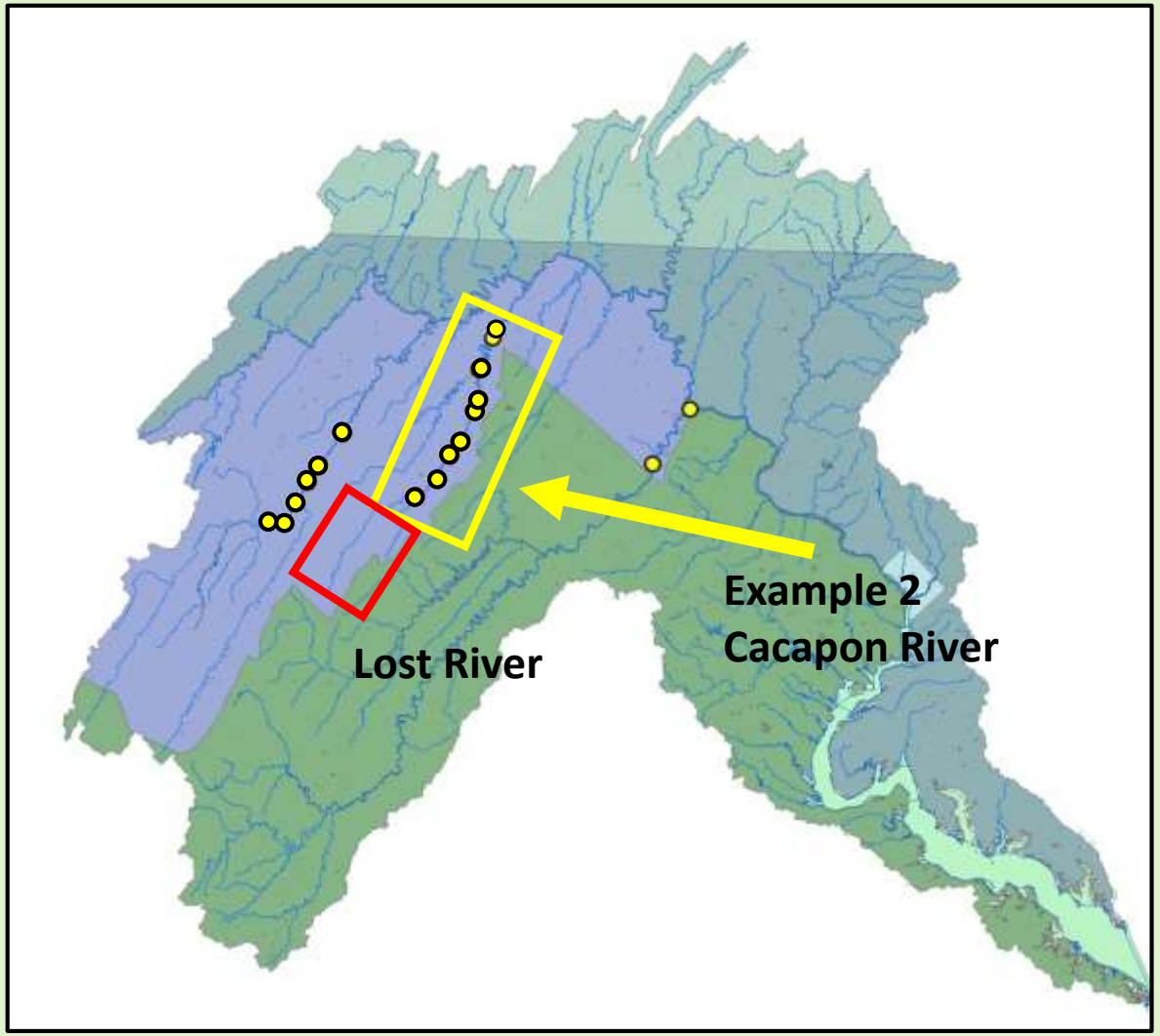
Example #2: Cacapon River

WVDEP Filamentous Algae Program (2012-2019)

<u>Potomac Basin Locations</u>

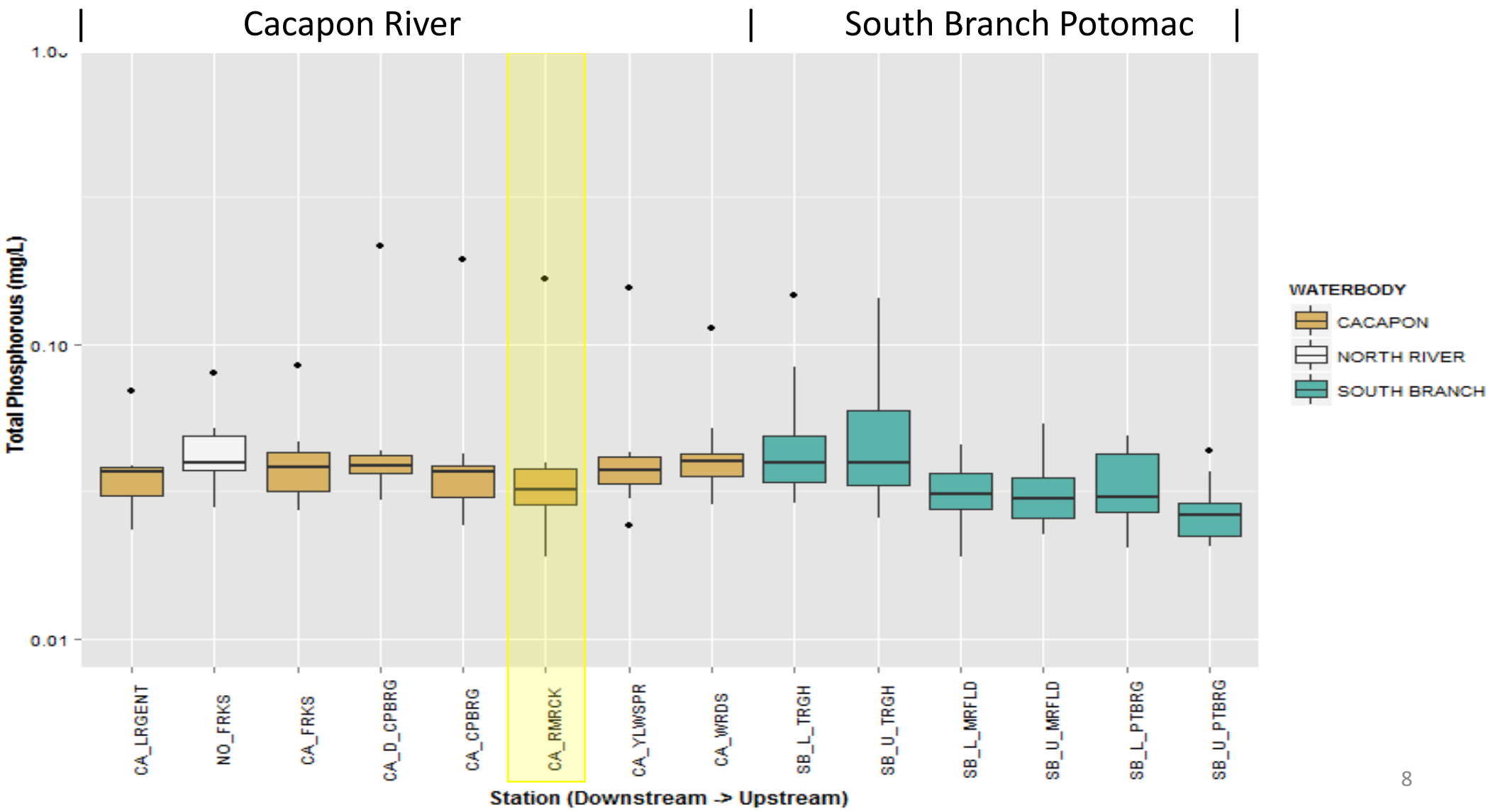
1. South Branch Potomac, WV
2. **Cacapon River, WV**

- Routine water chemistry
  - Wet Chemistry
  - YSI
- Physical qualitative habitat assessment
- Visual algae transect assessments

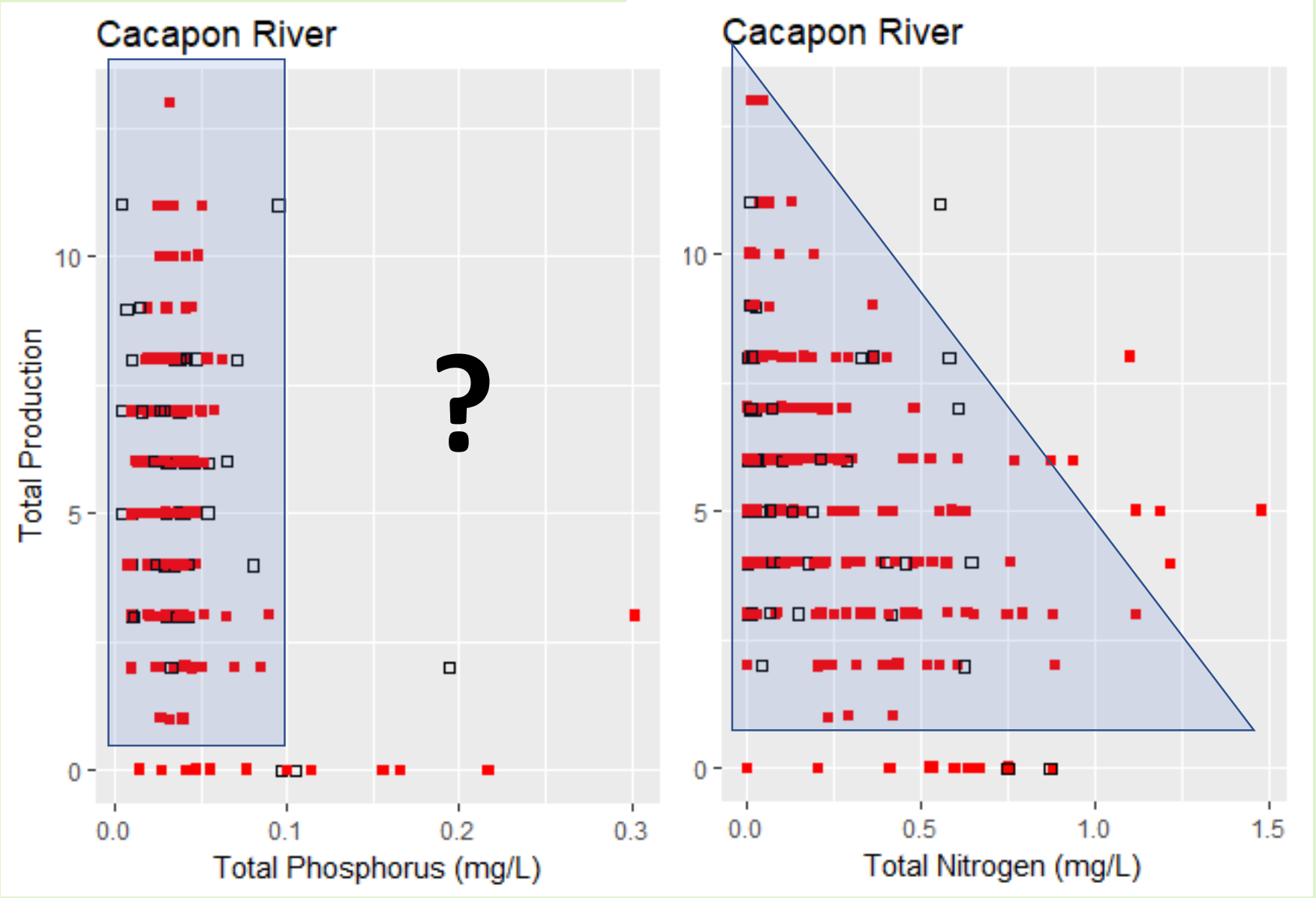


Potomac River Basin

Example #2: Cacapon River



An argument for **Non-Nutrient** based decisions



Non-Point Source Influenced

Summers 2008 Criteria

> 40 TALK mg/liter

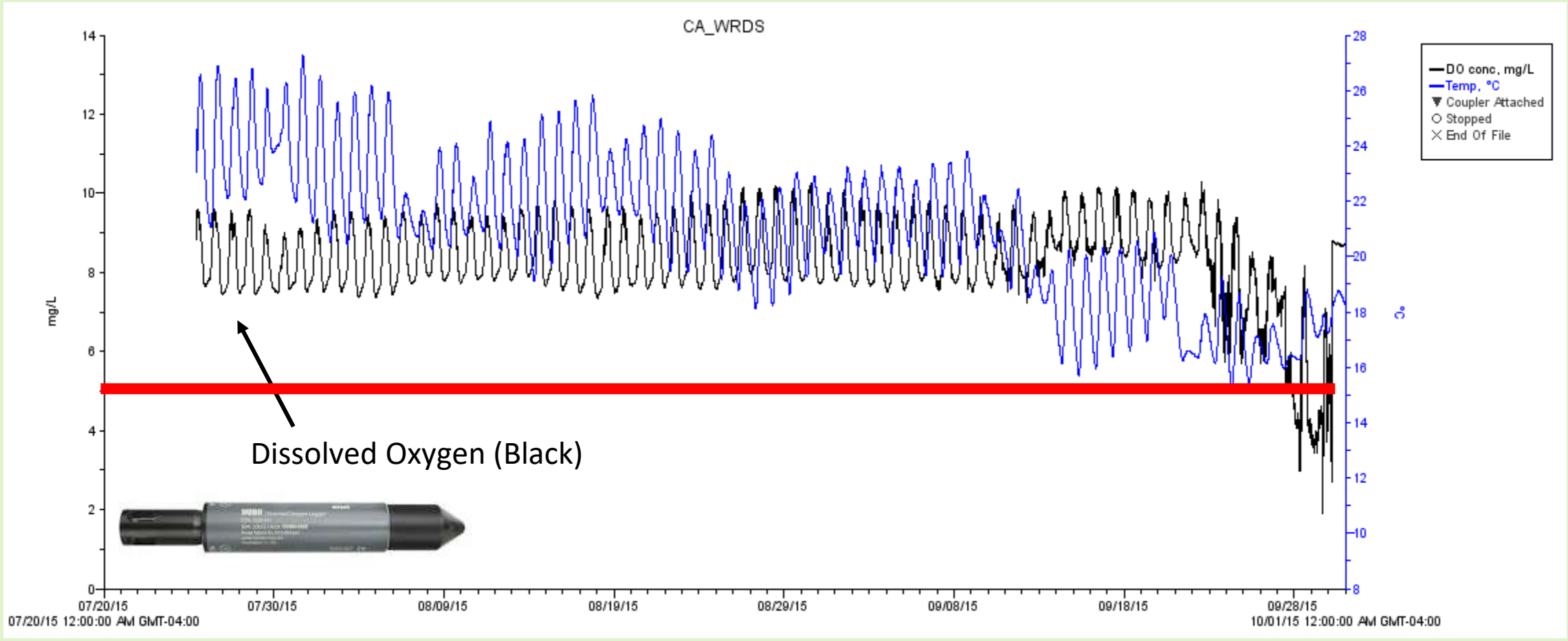
and

< 100 HARD mg/liter)

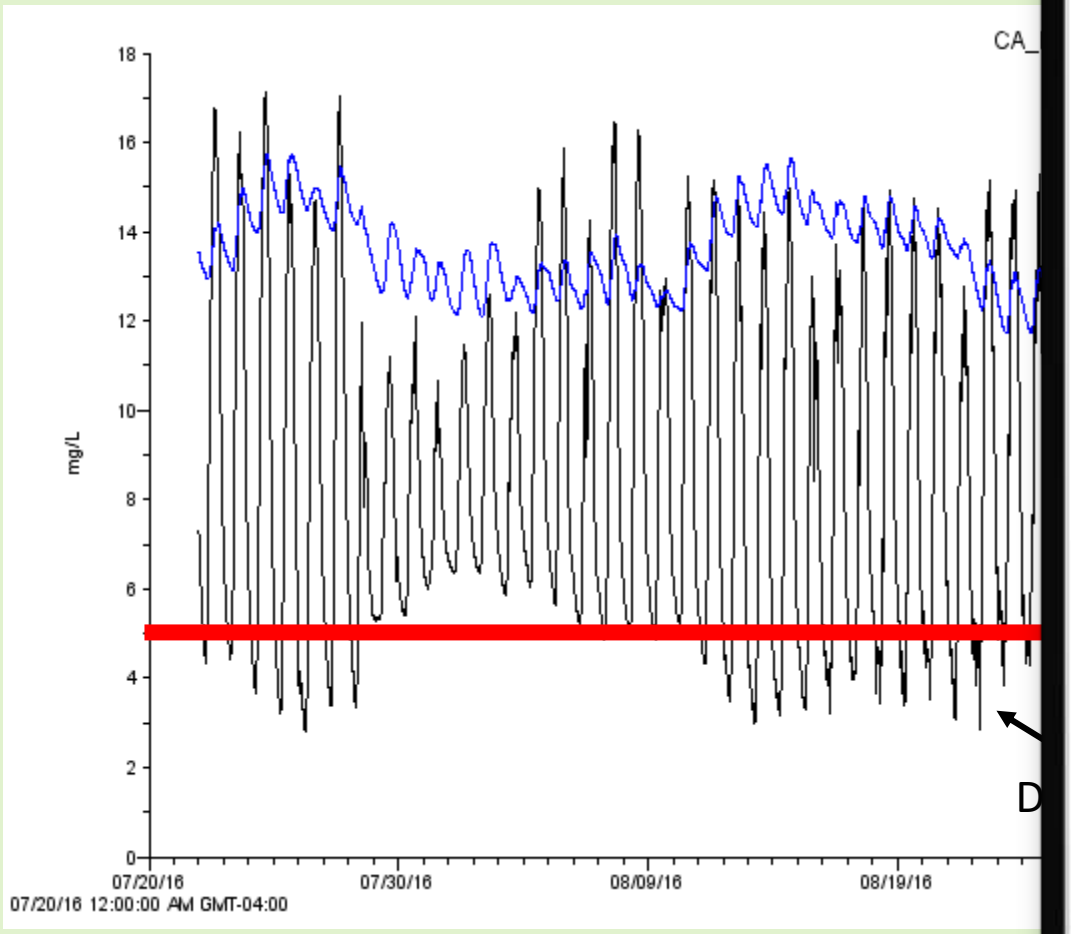
□ criteria not met (22%)

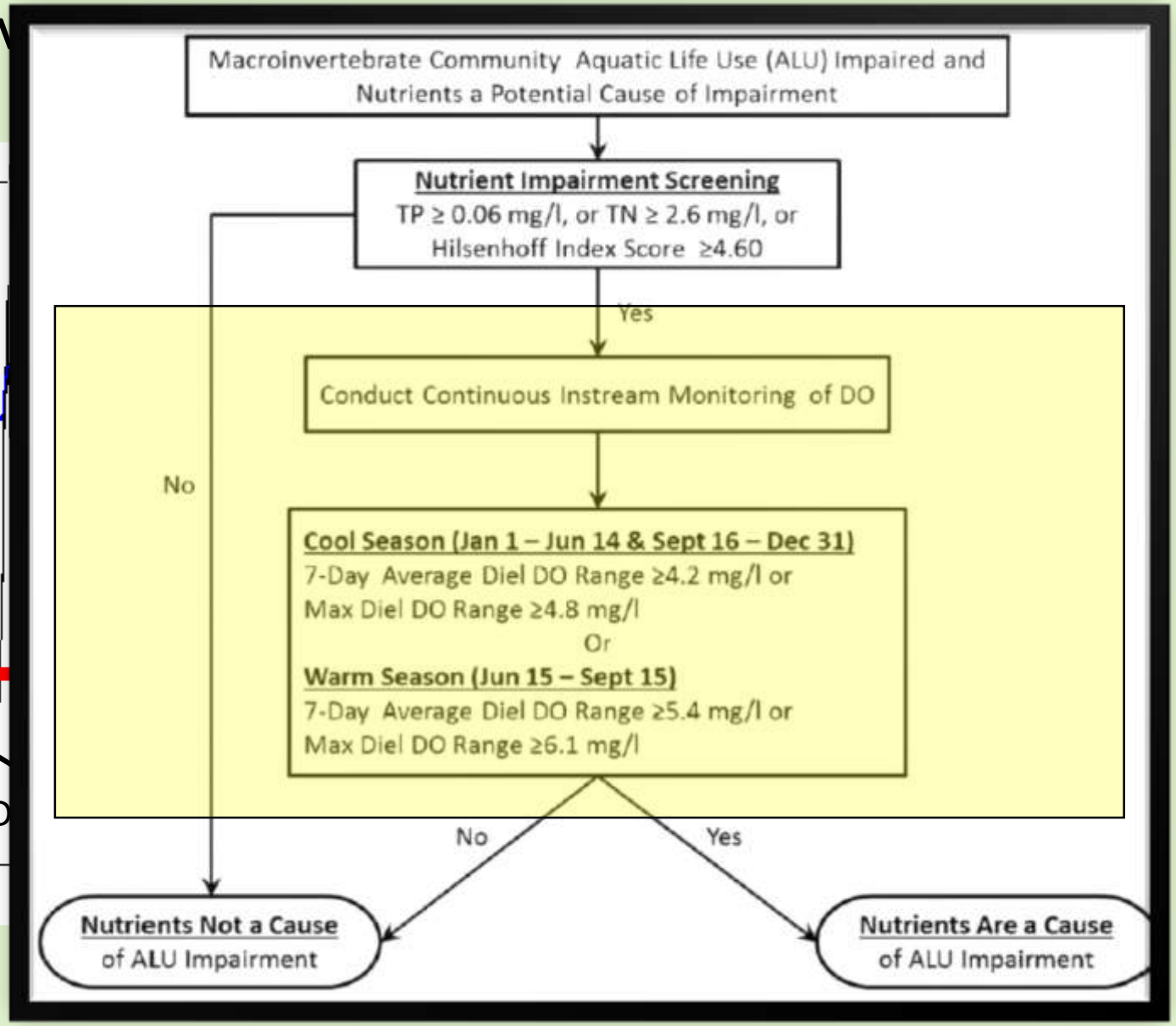
■ criteria met (78%)

Remote Sensing – Moderate levels Productive Site

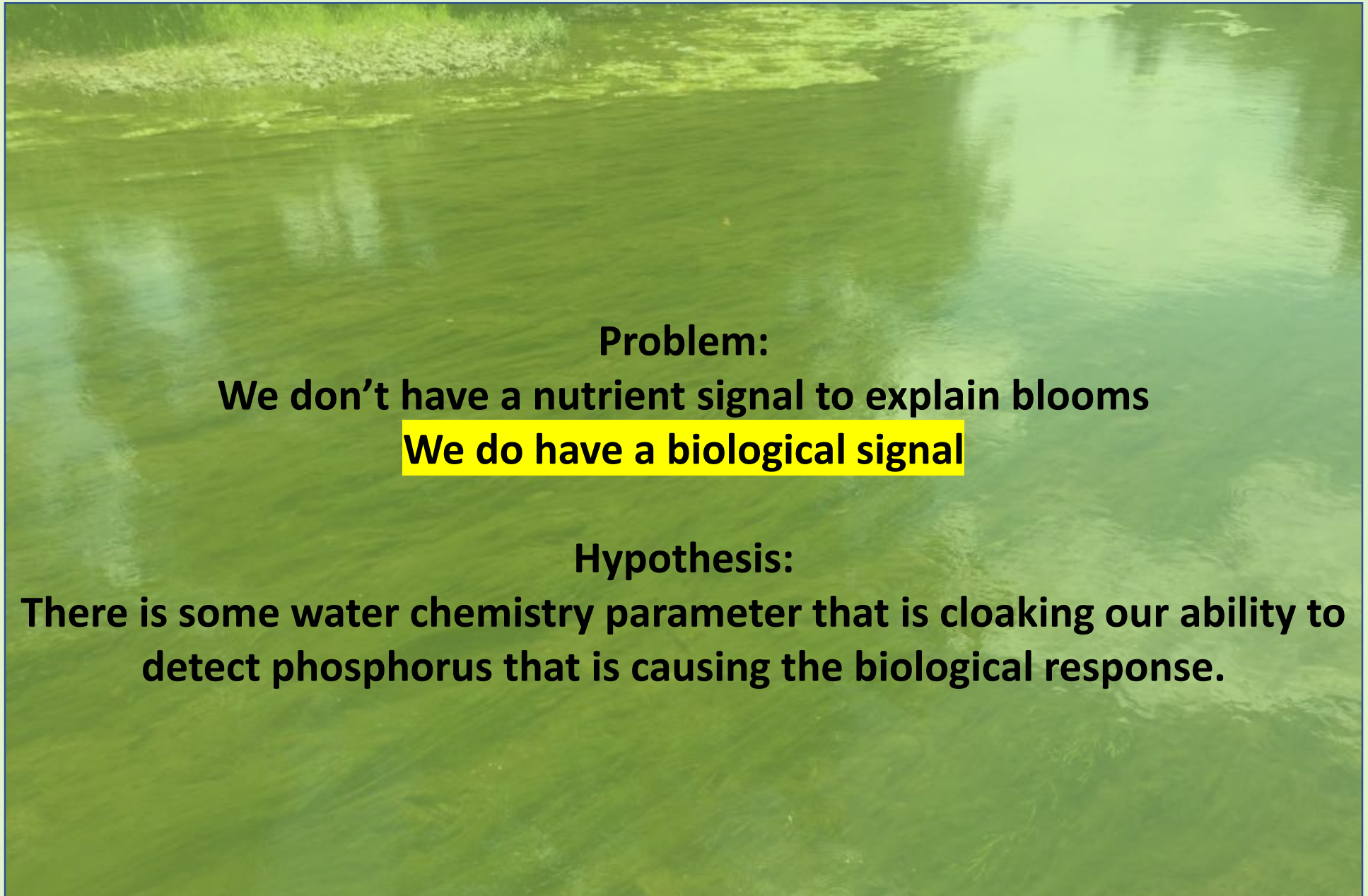


Remote Sensing– Highly Productiv





Remote Sensing– Highly Productive Sites



Problem:

We don't have a nutrient signal to explain blooms

We do have a biological signal

Hypothesis:

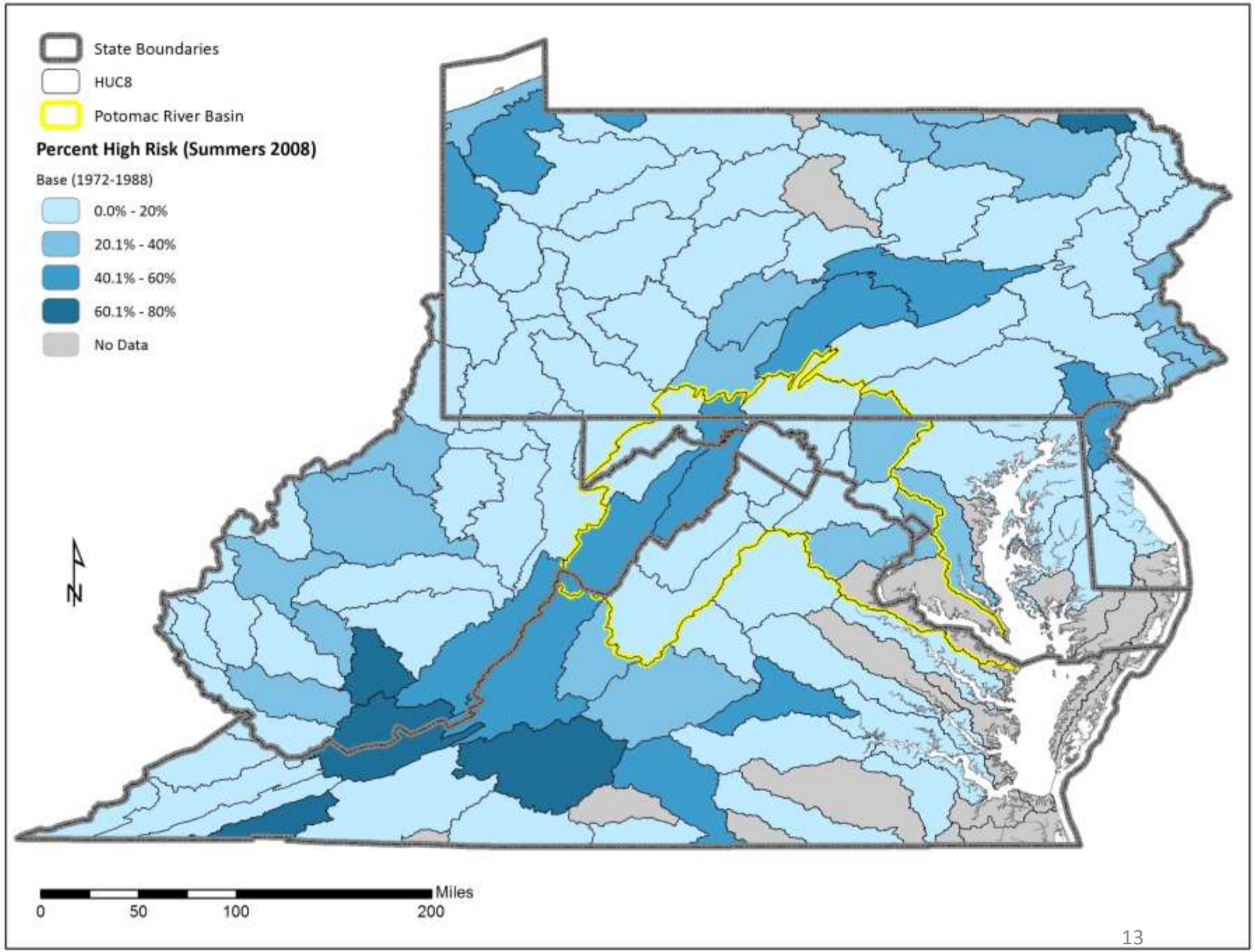
There is some water chemistry parameter that is cloaking our ability to detect phosphorus that is causing the biological response.

Risk

Frequency of samples that meet criteria:

- Alkalinity > 40
- Hardness <100

1972-1988

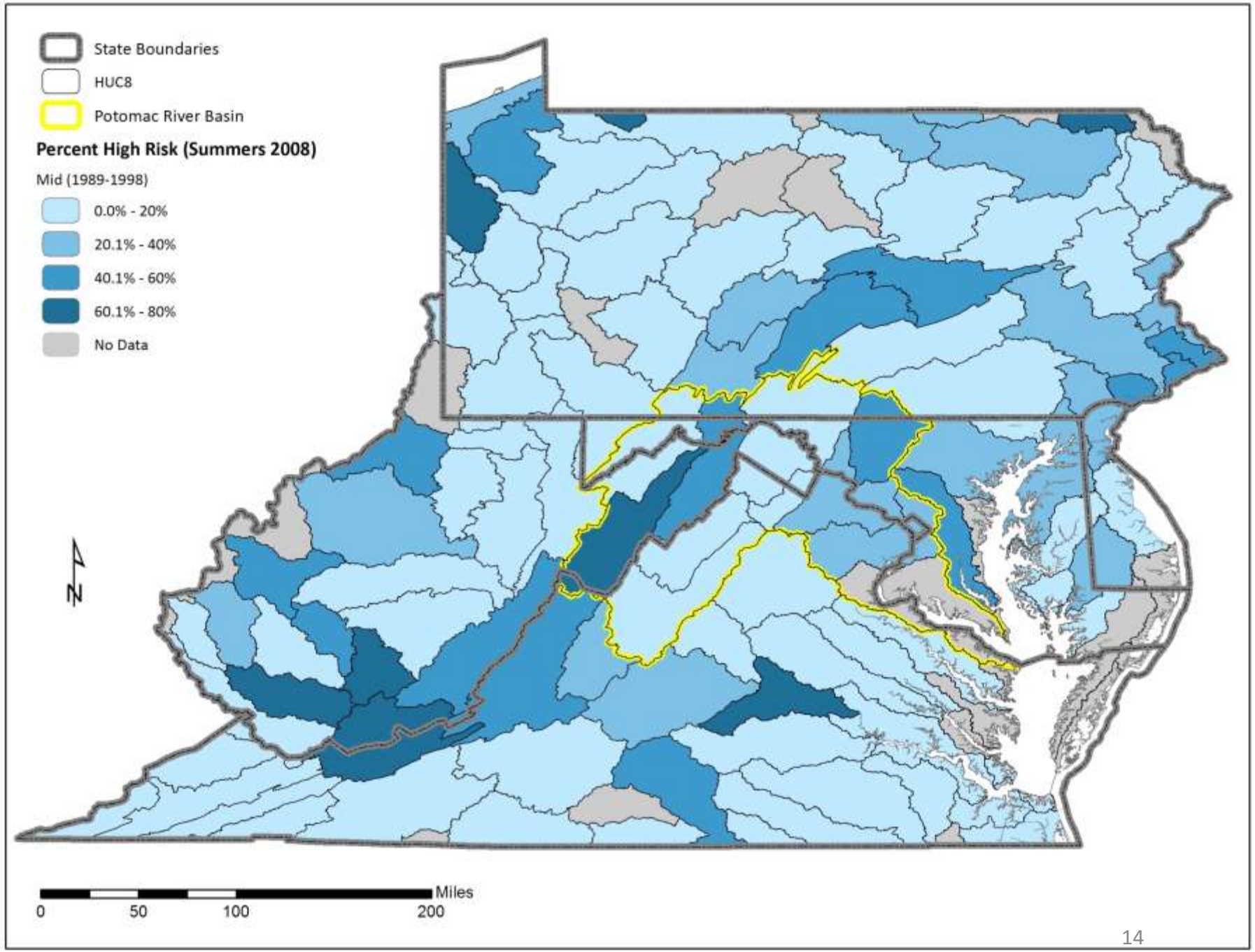


Risk

Frequency of samples that meet criteria:

- Alkalinity > 40
- Hardness <100

1989-1998

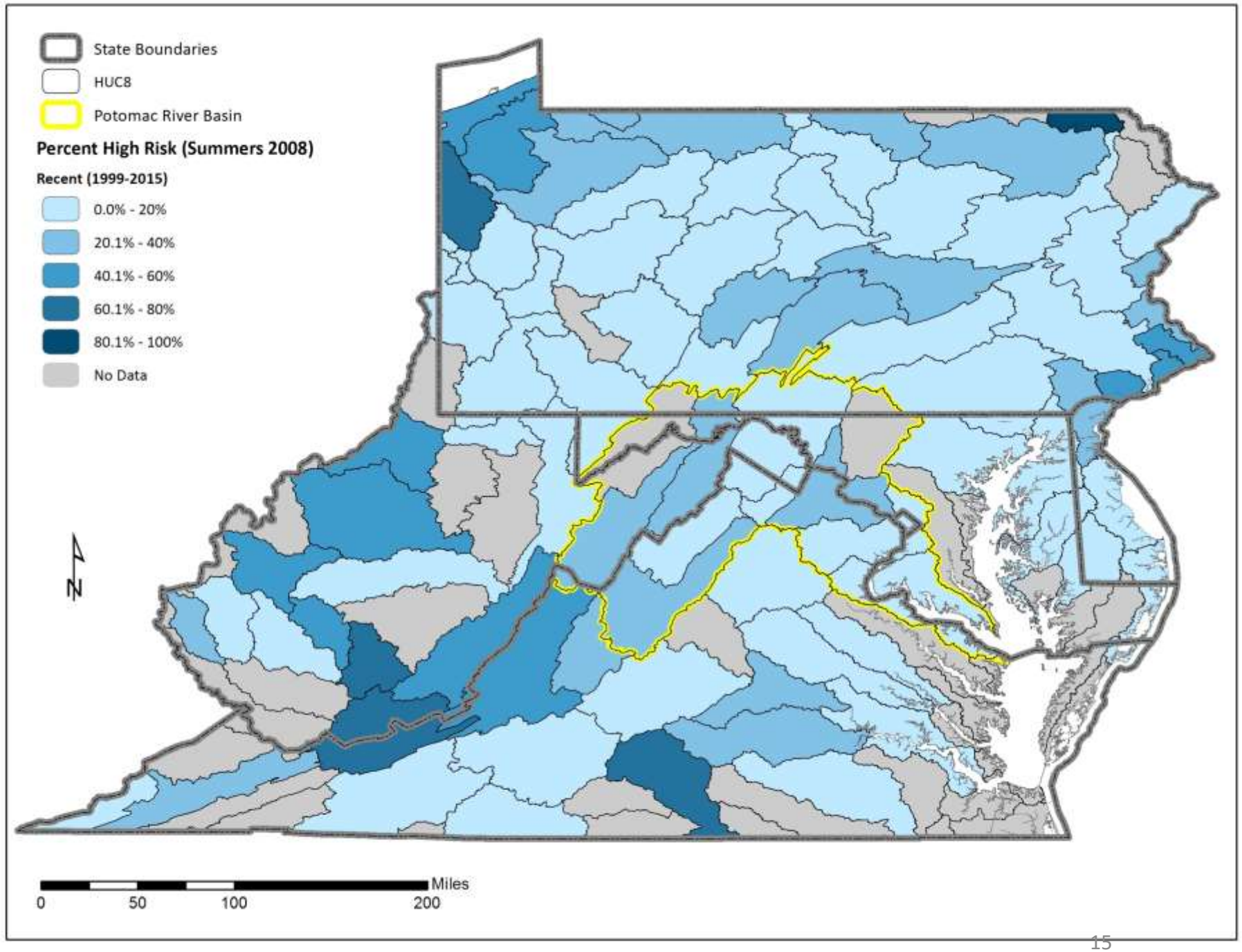


Risk

Frequency of samples that meet criteria:

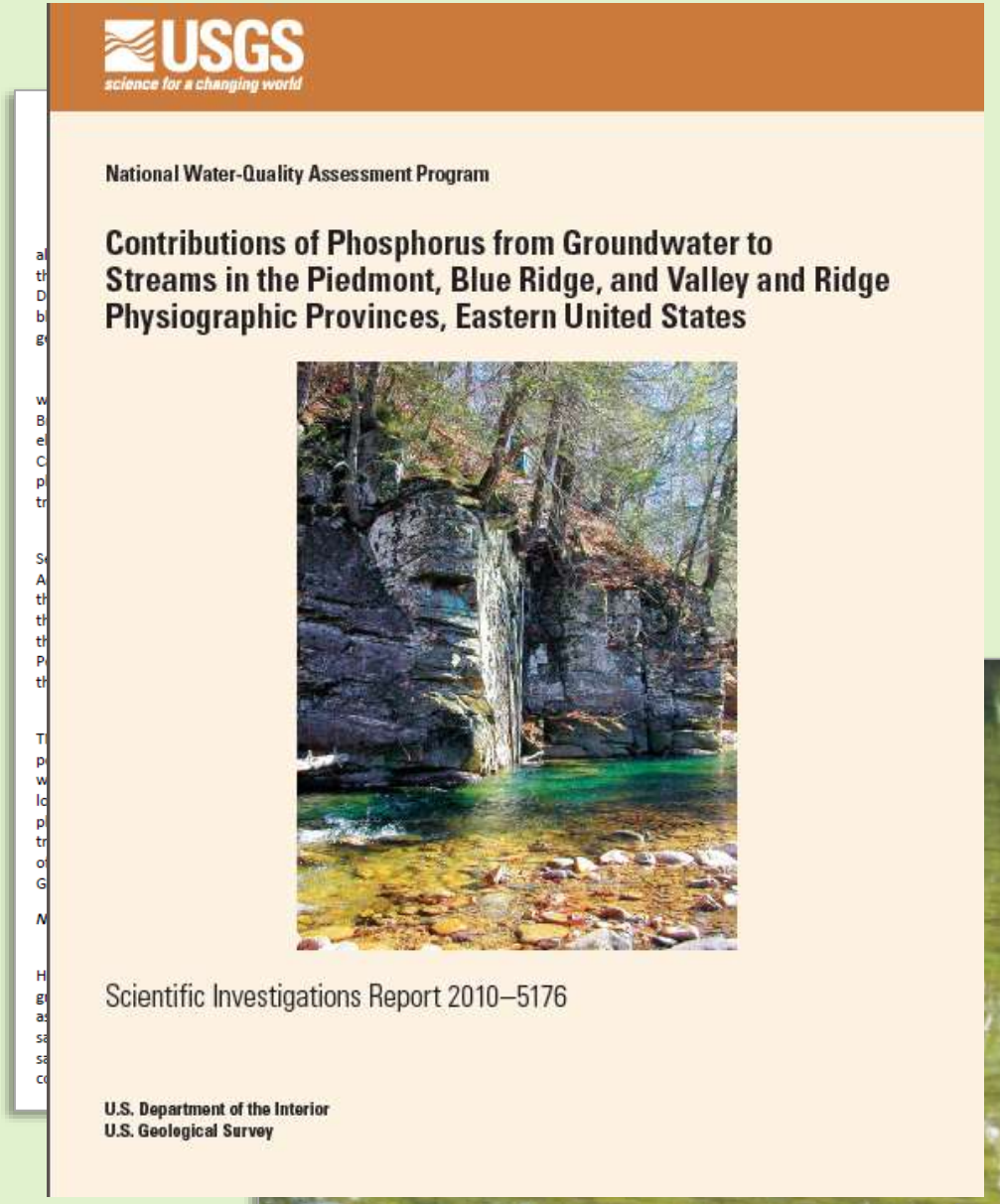
- Alkalinity > 40
- Hardness <100

1999-2015



- ***Alkalinity & Hardness***
  - High Alkalinity (>40 mg/L) primarily CO_3^{2-} and HCO_3^-
  - Low Hardness (<100 mg/L) primarily Ca^{2+}, Mg^{2+}

- ***USGS 2010***
  - **pH x (Alkalinity + Hardness) = Δ P availability**
  - Carbonate geology = ↑ P (baseflow)
  - Mineral Dissolution = Dominant source P



Mechanism of Phosphorus Availability

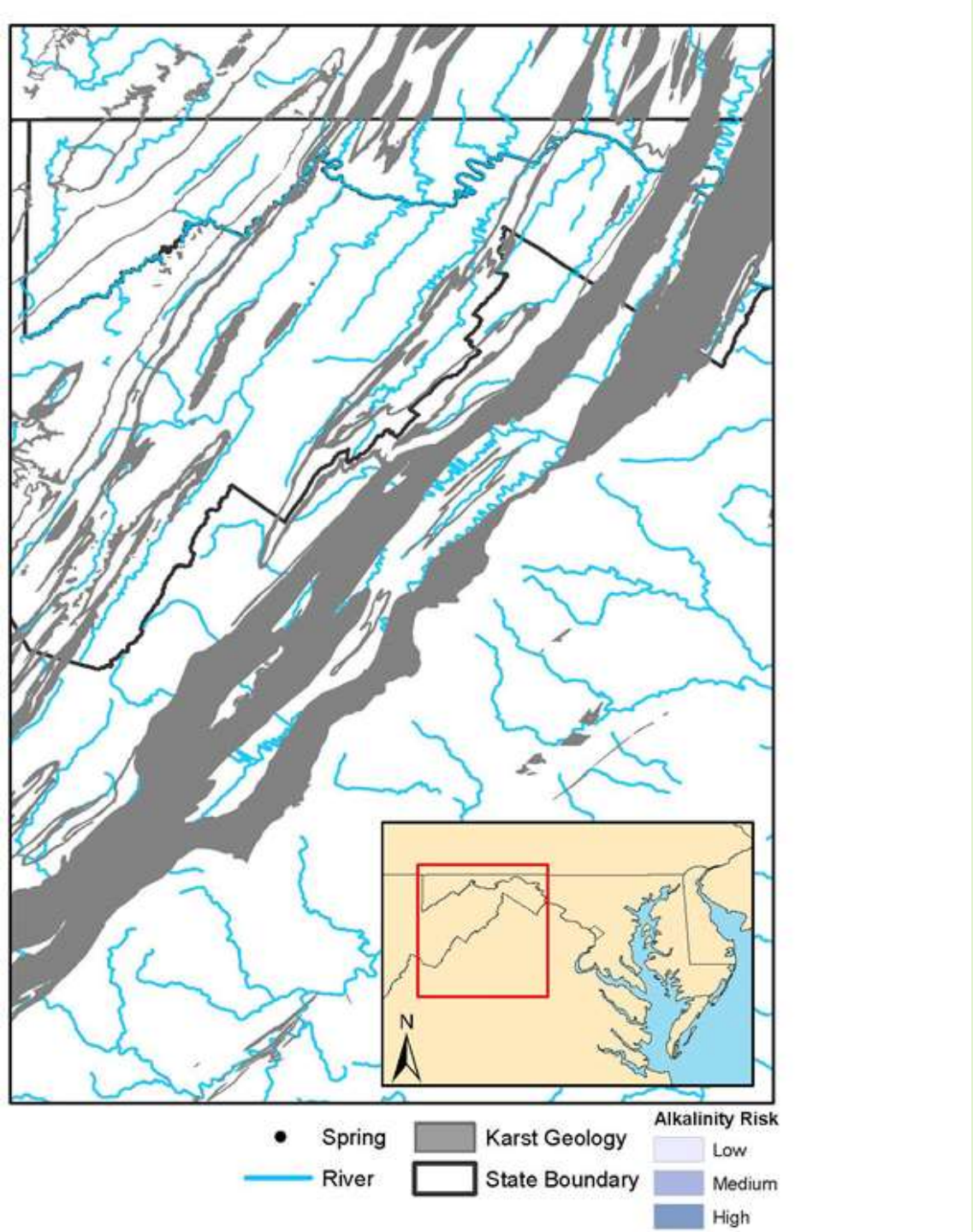
Release of bound Phosphorus from

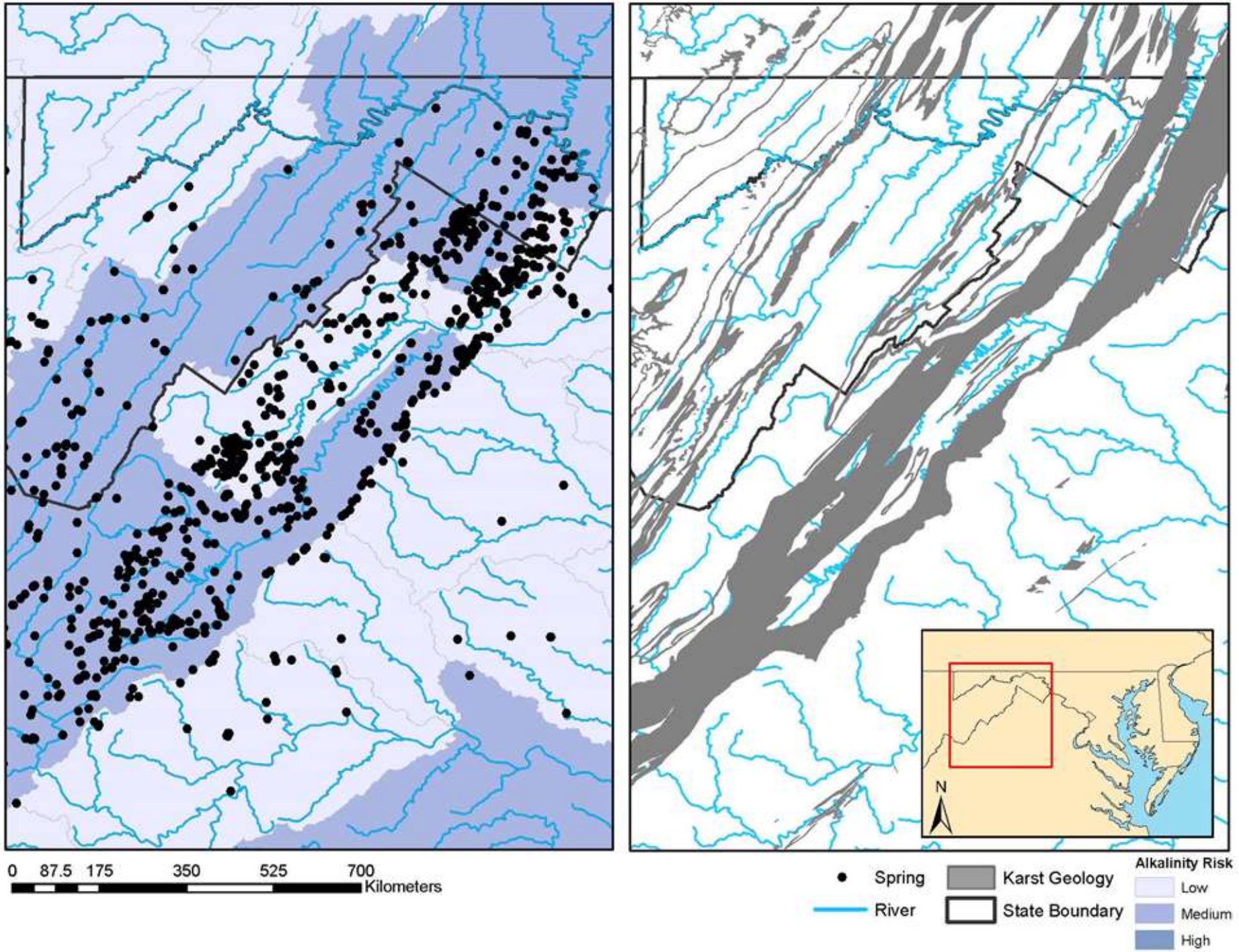
Ca, Mg, Fe, and others

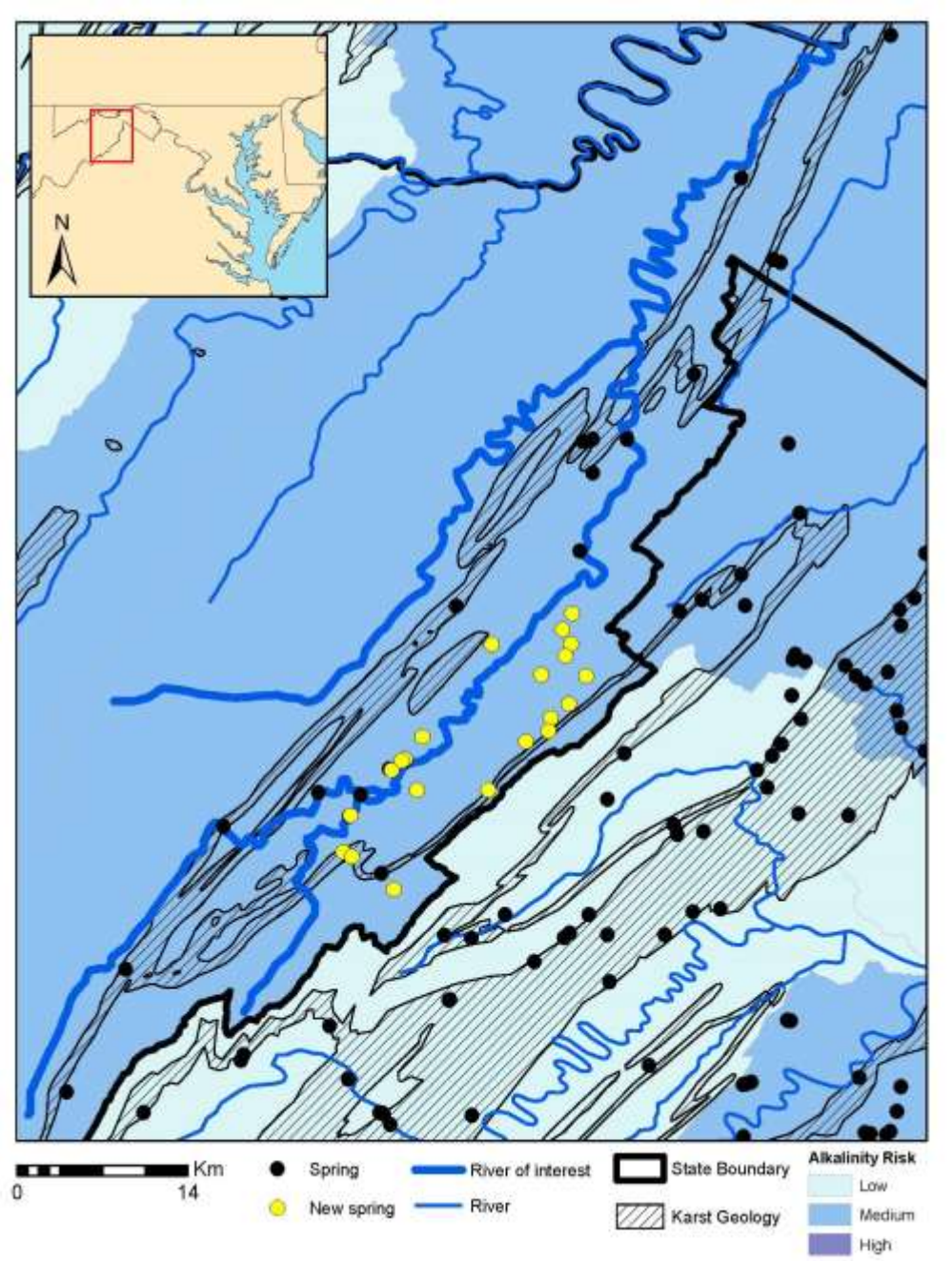
- Diel pH
  (Moore and Reddy 1994, Penn et al 2000)
- Diel DO
  (Gomez et al. 1999)
- *Redox Potential, Silicate concentration, sulfate reduction, organic matter decomposition, disturbance event, climate change*
  (Huang et al. 2005)

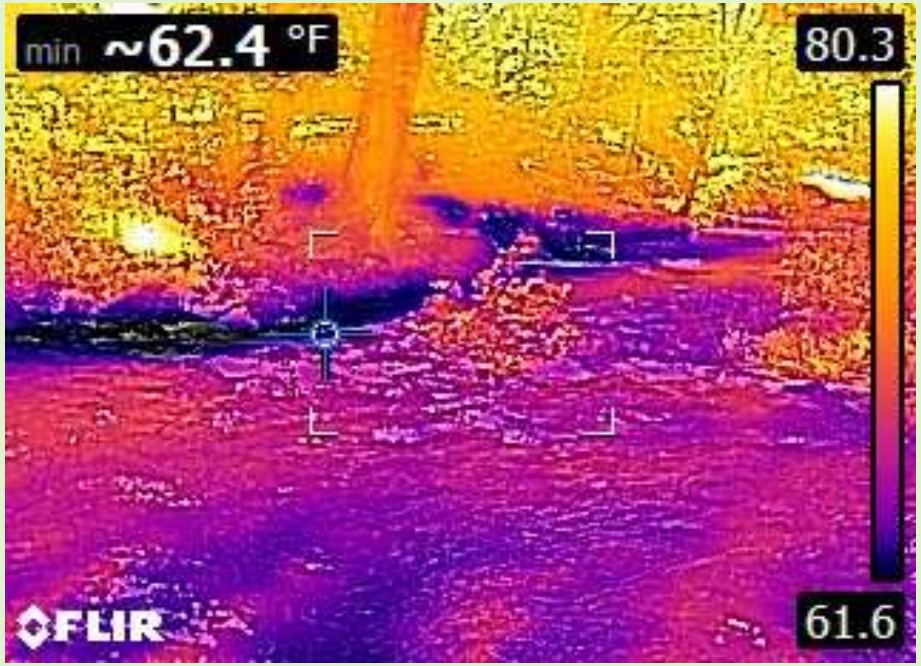
Mid-Atlantic Non-Nutrient Algae Bloom "Hotspots" overlap very well with the Karst geology of the region.

Karst groundwater flow paths provide a nutrient transport corridor




0 87.5 175 350 525 700
Kilometers
N
Spring
River
Karst Geology
State Boundary
Alkalinity Risk
Low
Medium
High

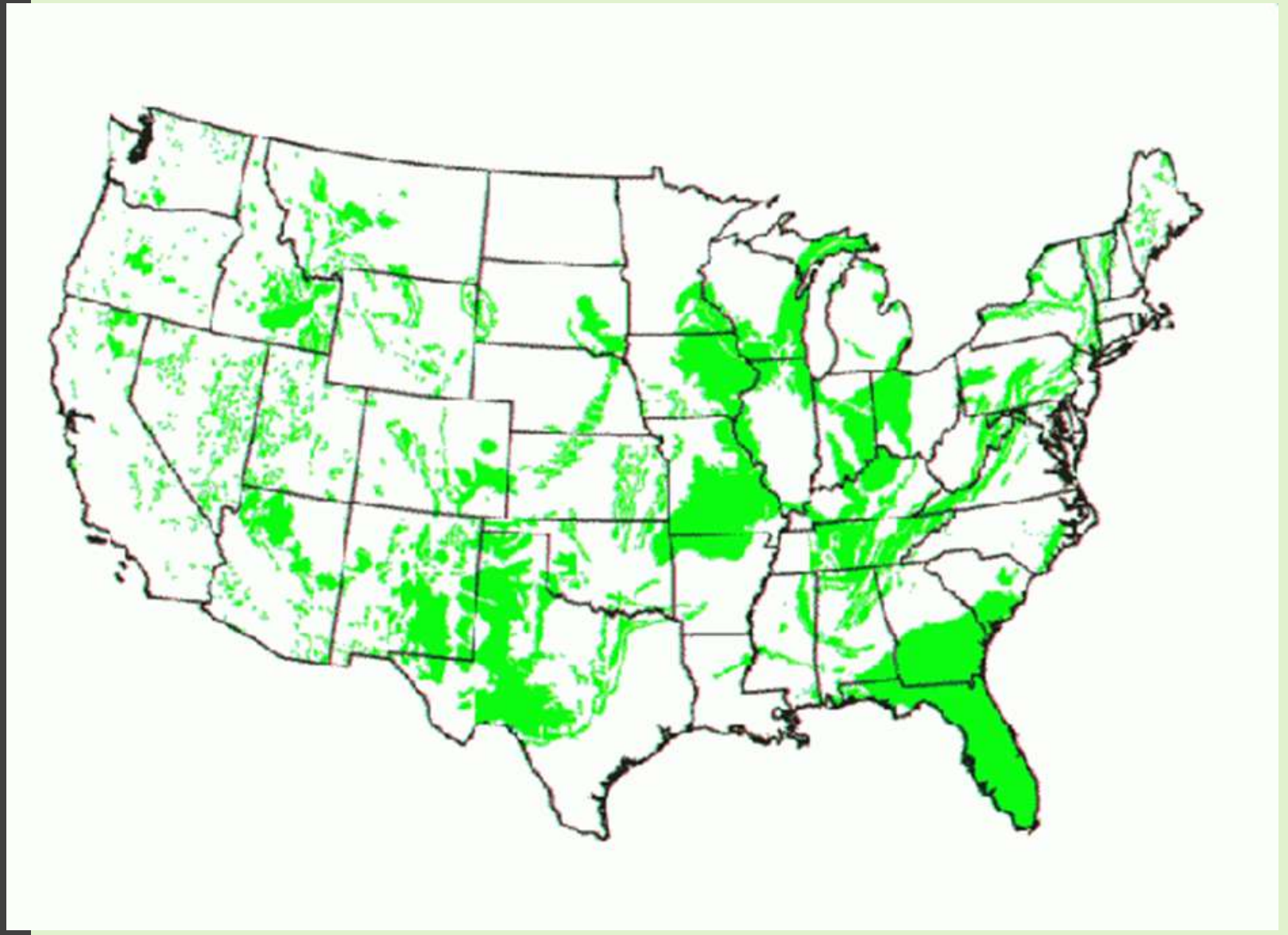

N
Km
0
14
Spring
New spring
River of interest
River
State Boundary
Karst Geology
Alkalinity Risk
Low
Medium
High


min ~62.4 °F
80.3
61.6
FLIR


max 50.5 °F
47.0
32.0
FLIR

Conclusions…

- Chemistry
  - Nutrients normally attributed to algal blooms are not always detectable (monitor for ionic constituents)
- Biology
  - Production at bloom sites not only cloaks nutrient signals but may be driving (feedback loop) their own proliferation
- Geology
  - Underlying geology may create environments more conducive to nutrient availability due to environmental and biological factors
- Landuse
  - Groundwater flow paths through high nutrient regions act as nutrient travel corridors




Cladophora glomerata

Questions?

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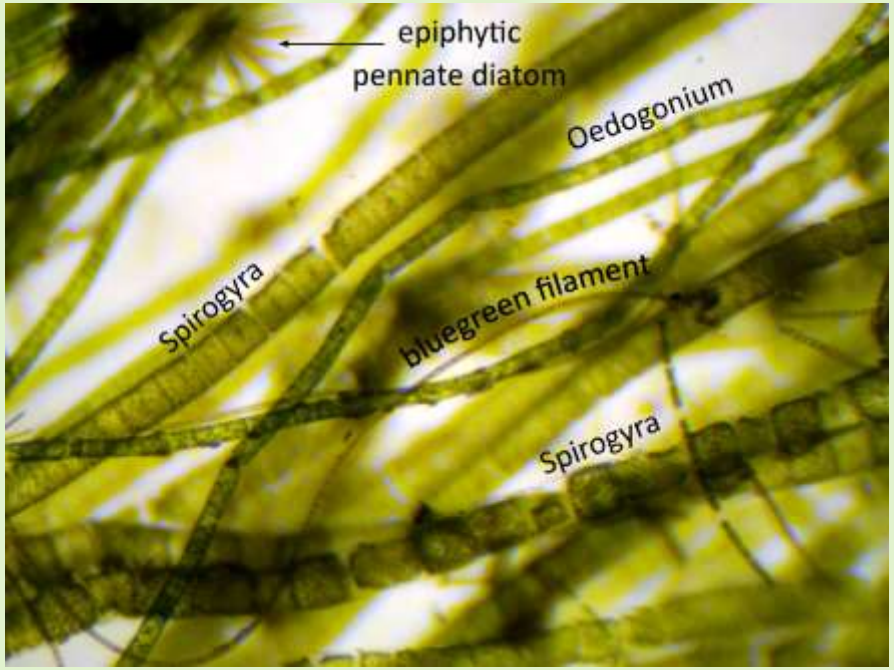


Hydrodictyon sp.