Towards and Understanding of Water Quality in a Mixed Agricultural and Urban Watershed: Eagle Creek Watershed, Indiana

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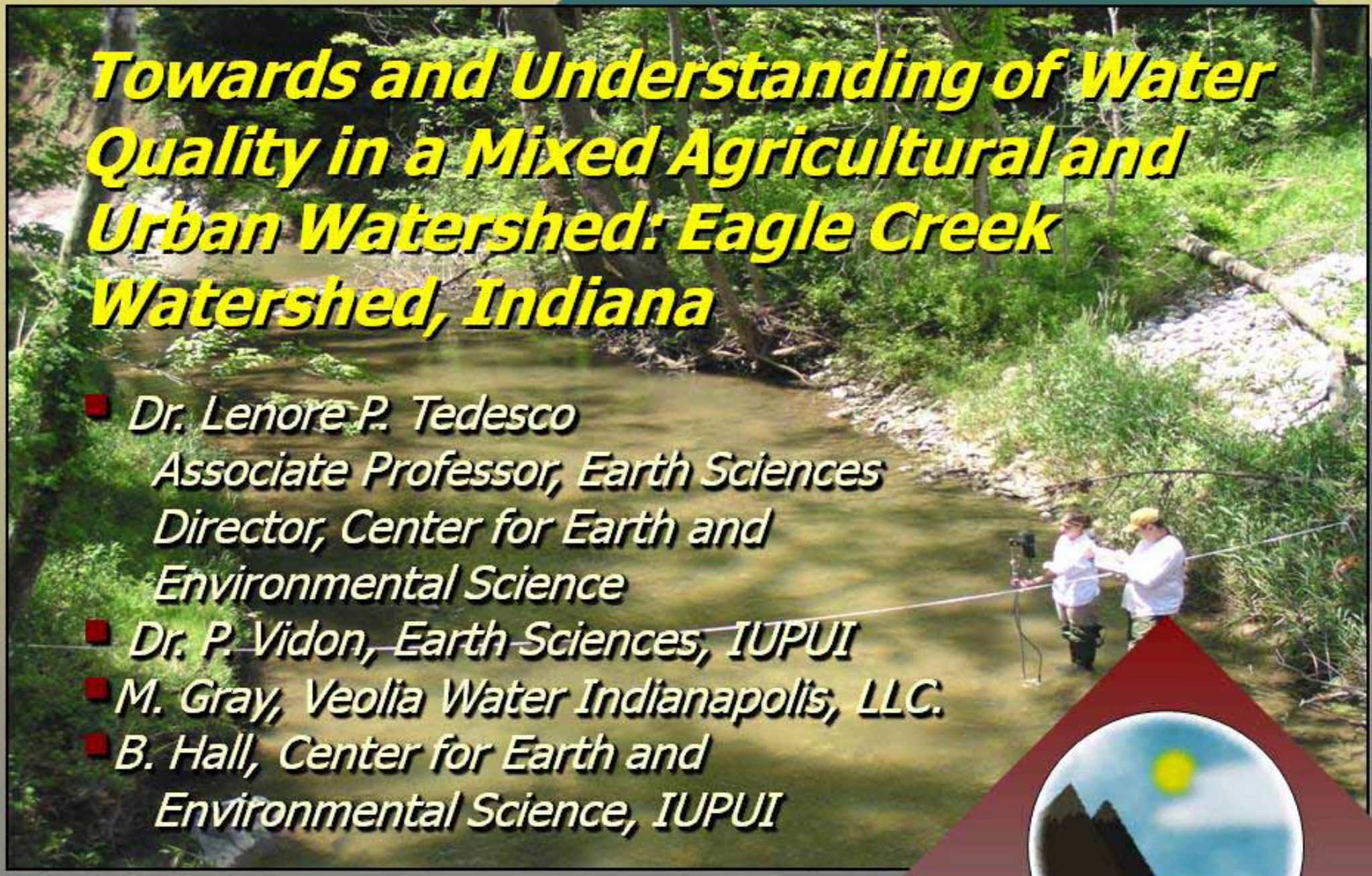

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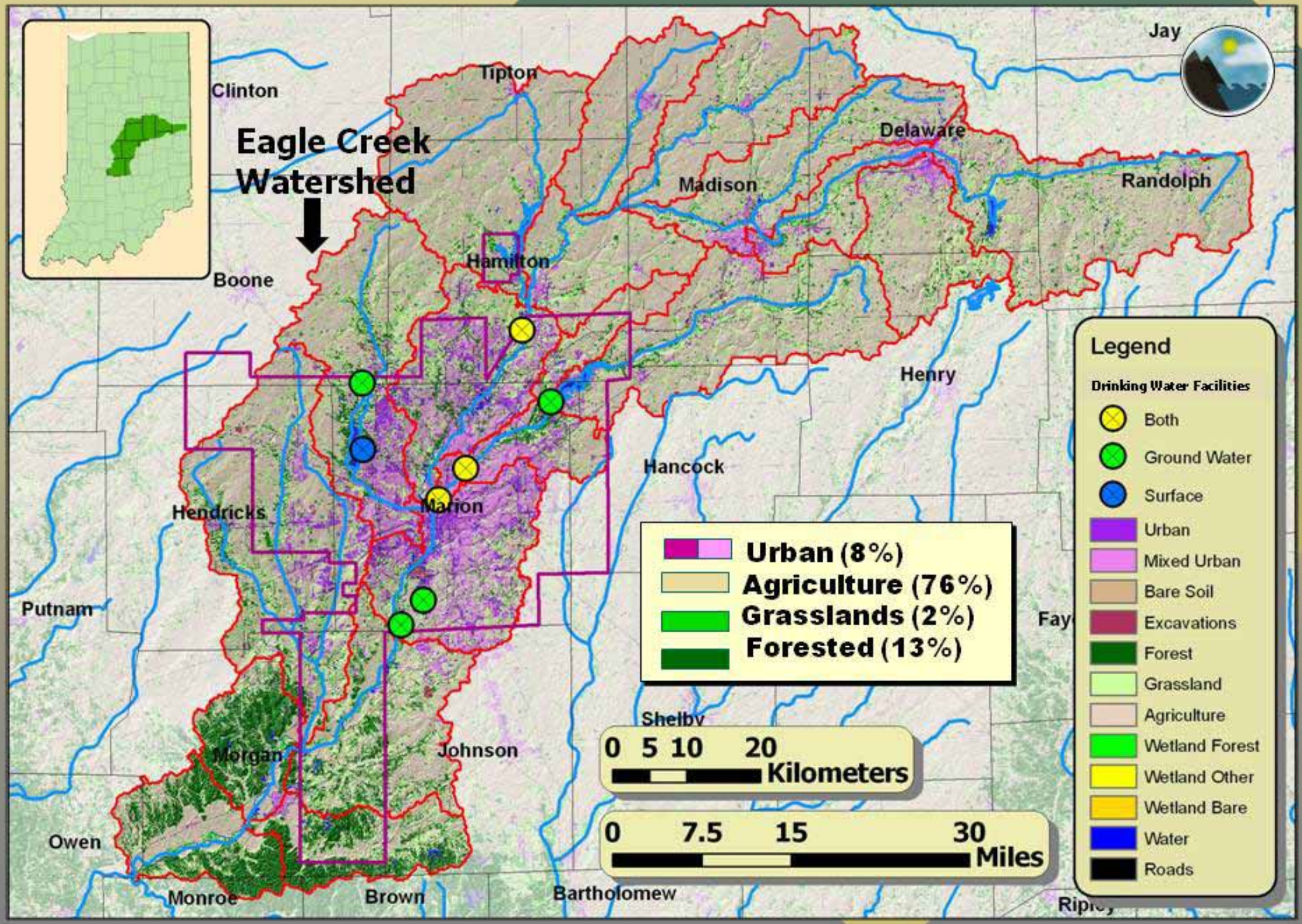
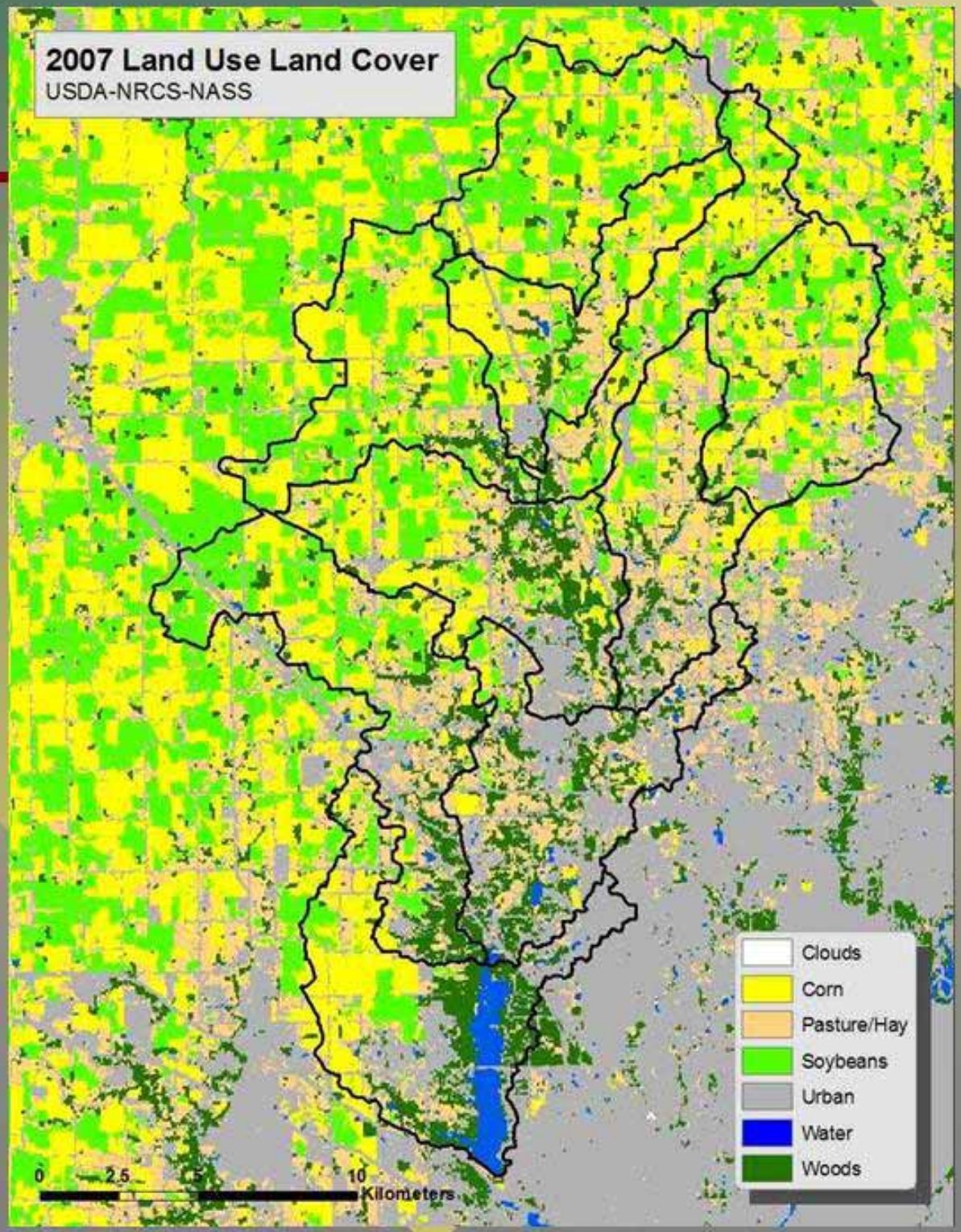

Eagle Creek Watershed
Clinton
Tipton
Jay
Delaware
Madison
Randolph
Hamilton
Boone
Henry
Hancock
Hendricks
Marion
Putnam
Shelby
Morgan
Johnson
Owen
Monroe
Brown
Bartholomew
Urban (8%)
Agriculture (76%)
Grasslands (2%)
Forested (13%)
0 5 10 20 Kilometers
0 7.5 15 30 Miles
Legend
Drinking Water Facilities
Both
Ground Water
Surface
Urban
Mixed Urban
Bare Soil
Excavations
Forest
Grassland
Agriculture
Wetland Forest
Wetland Other
Wetland Bare
Water
Roads

Urbanization of Eagle Creek Watershed

- Urbanization is dominating the ECW especially the southern 2/3's
- Research is documenting the effect of land use on water quality in streams and drinking water reservoirs



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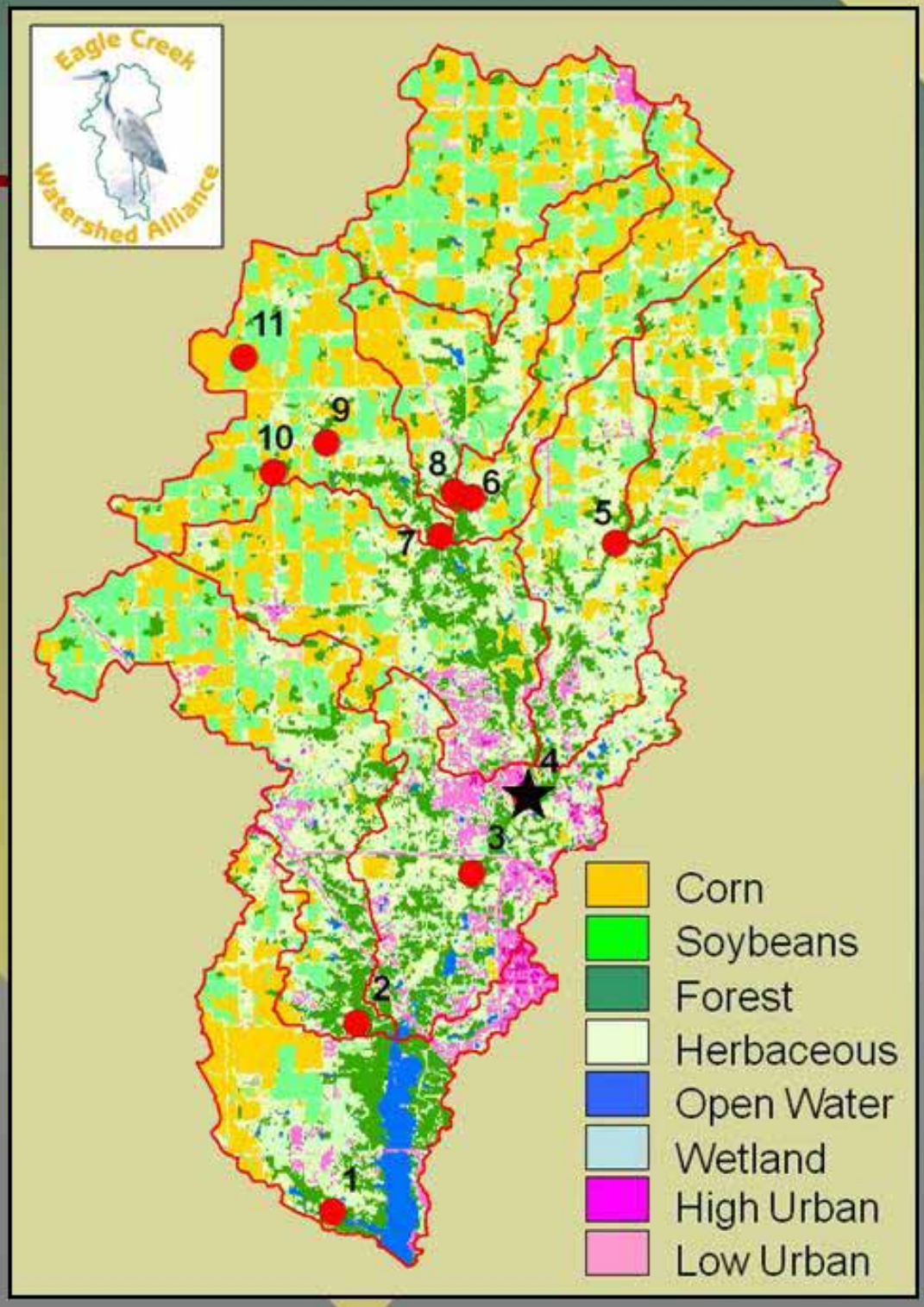
Eagle Creek Watershed

- Glacial Till Landscape
- Area above Dam = 419 km^2 (162mi^2)
- 10 Subwatersheds
- 2007 Land Cover
  - 63% Agriculture
    - 25% Corn
    - 20% Soy
    - 18% Pasture/Hay
  - 19% Urban
  - 13% Forested
  - 2% Open Water
- Eagle Creek Reservoir – Eutrophic Drinking Water Source for Indianapolis



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Areas of Concern - Mixed Urban and Agricultural Watersheds

- *E. coli* - Septic Leakage, Stormwater Runoff, Livestock, Manure Applications, Wastewater Treatment, Natural Sources
  - Most Streams frequently exceed 235 CFU/100ml
- Atrazine - Agricultural Herbicide
  - EPA Drinking Water Standard 3.0 ppb
  - EPA Aquatic Community Guidelines 17.5 ppb
  - Streams have levels as high as 70 ppb
- Sediment – Soil Erosion, Construction and Stormwater Runoff, Livestock Access to Streams, Stream Downcutting
  - Degrades Aquatic Habitat
  - Carries Attached Pollutants (Nutrients, Herbicide, etc)
- Nutrients (Nitrogen and Phosphorous) – Fertilizer, Septic Systems, Stormwater Runoff, Waste
  - Promote Excessive Growth of Plants
  - Cause Algal Blooms that Result in Taste and Odor of Drinking Water / Potential Production of Algal Toxins
  - Causes Low Oxygen Conditions Stressful or Fatal to Fish

Water Quality Sampling Approaches

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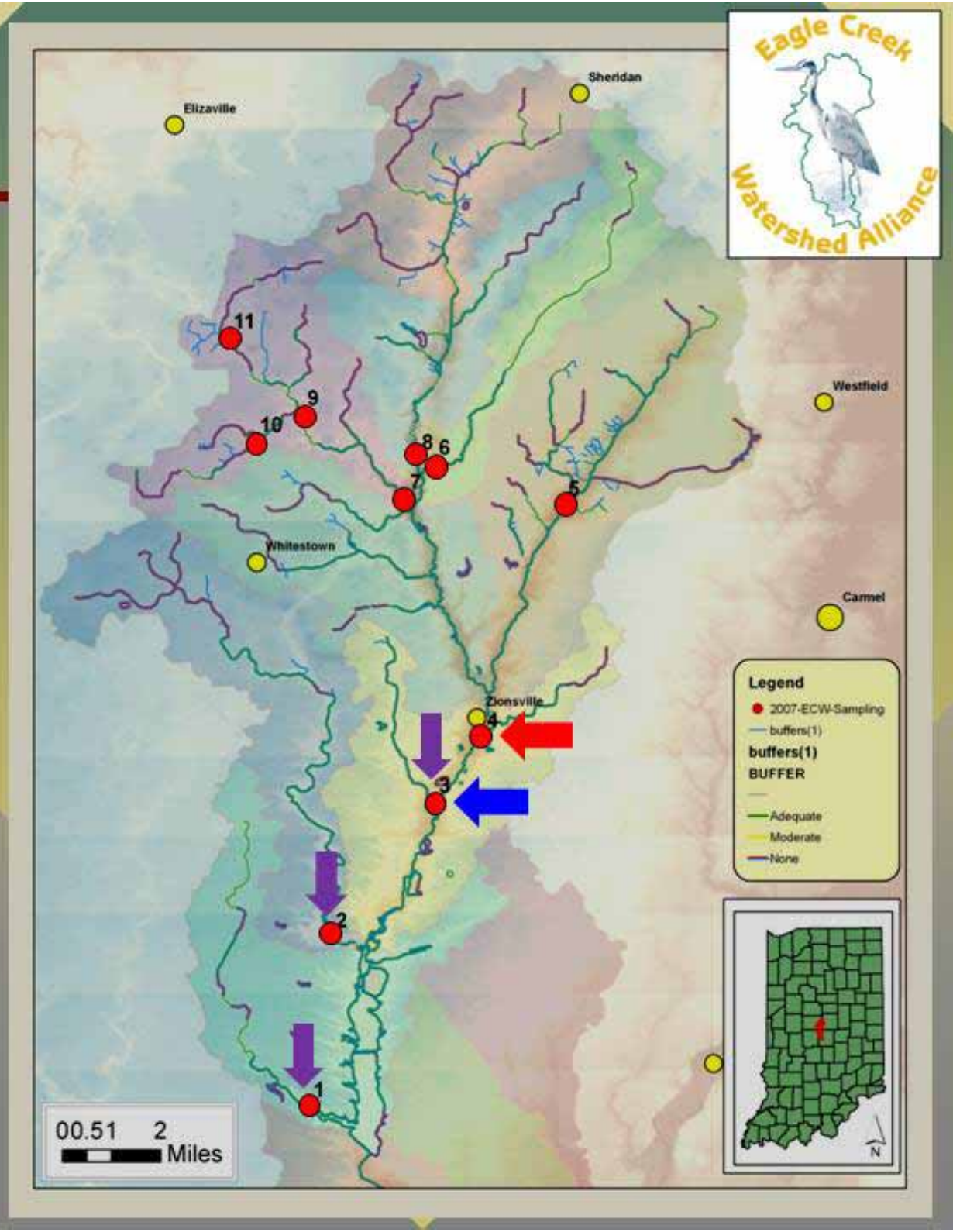
- Spatially Distributed Stations with Monthly Sampling to Determine Contaminant Distribution Relative to:
  - Land Use and Land Use Change
  - Seasonality
  - Discharge (Base vs Event Flows)
- Individual Stations with High Frequency Sampling to Determine Contaminant Transport Timing, Flow Pathways and Loads During Storms
  - Relative to Land Use
  - Relative to Watershed Scale
- Longitudinal Analyses of Reservoir Inflows to Determine Long-term Loads from the Watershed
  - On an Annual Basis
  - Over the Past Decade
- Screening for Contaminants of Emerging Concern and Pesticides
  - Pharmaceuticals (EPA NRI)
  - Pesticides, Personal Care and Domestic Use Products (USGS NWQL)

Eagle Creek Watershed Monitoring

- IDEM 319 Monitoring
  - 11 Stations Monthly (3/07 – 12/08)
  - Event Sampling Seasonally
- Aquisafe Pesticide and Wastewater Screening
- CIWRP High Frequency Sampling
  - Hourly through Events
- Longitudinal Analyses
  - Annual Trend Analyses



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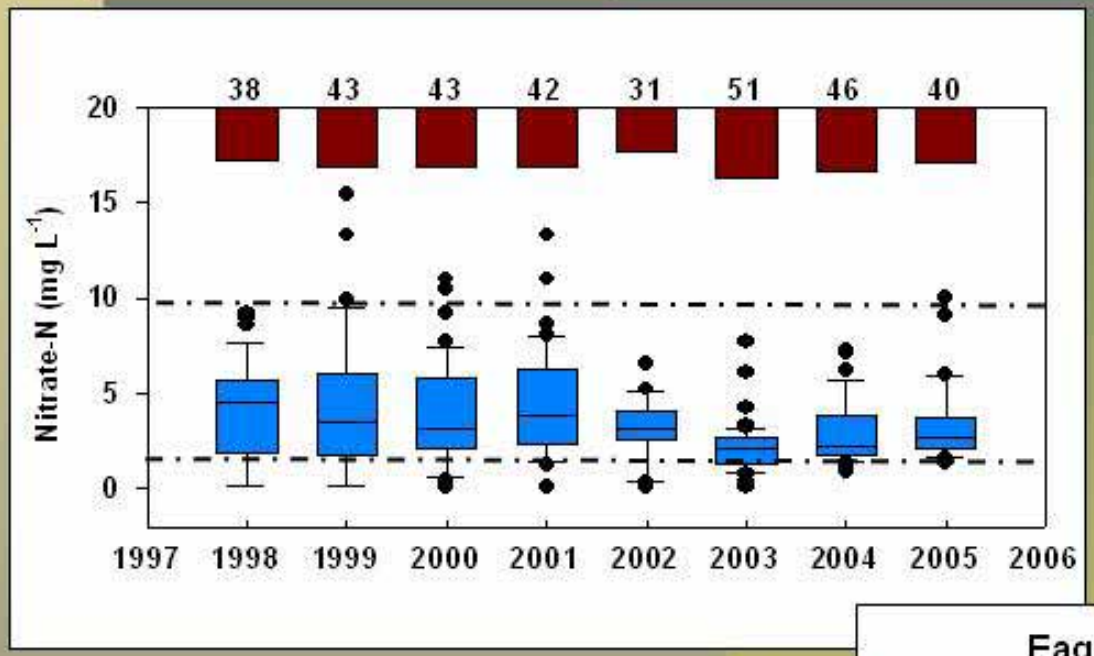
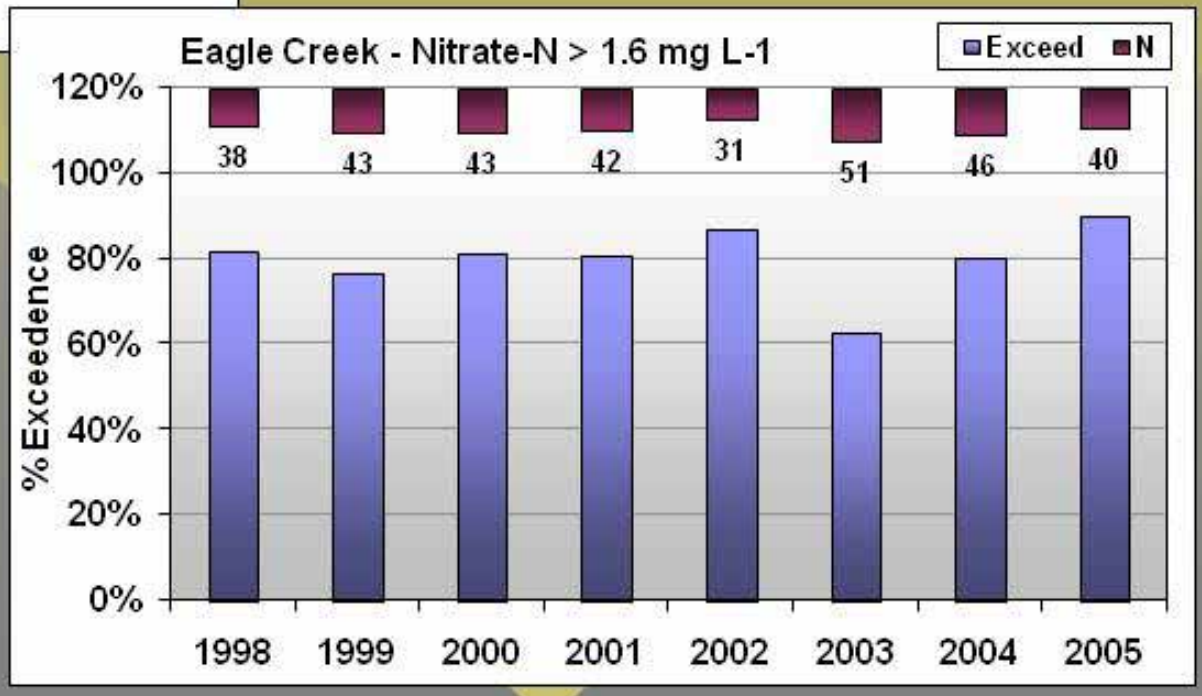
Eagle Creek Watershed Nitrate Trend Analysis (1998-2005)



Longitudinal Analyses at Eagle Creek

Percent Exceedence

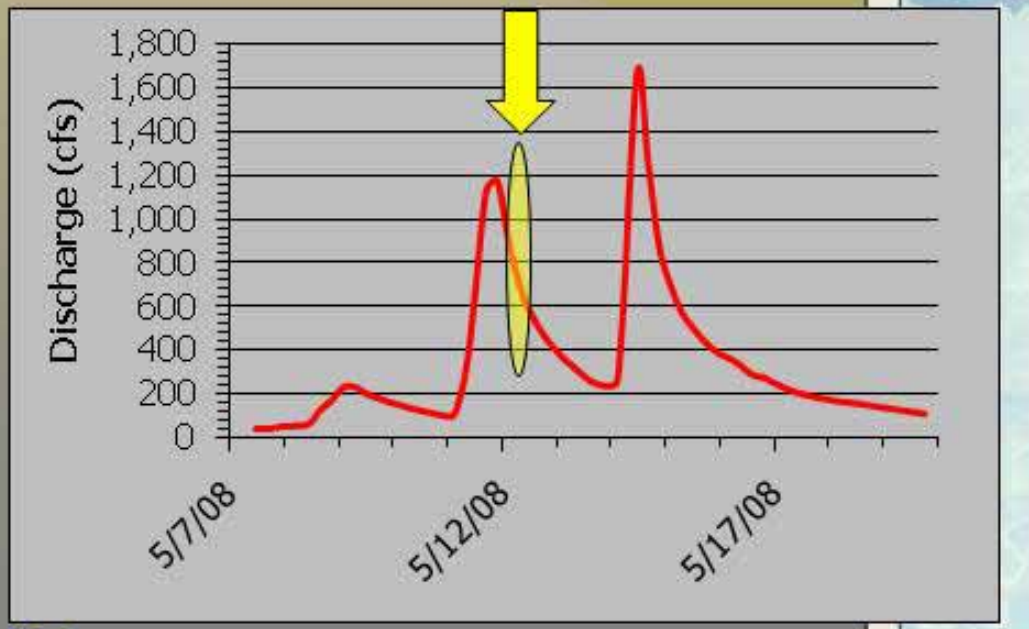


USEPA Region VI: 55
Reference:
Nitrate = 1.6 mg N L^{-1}

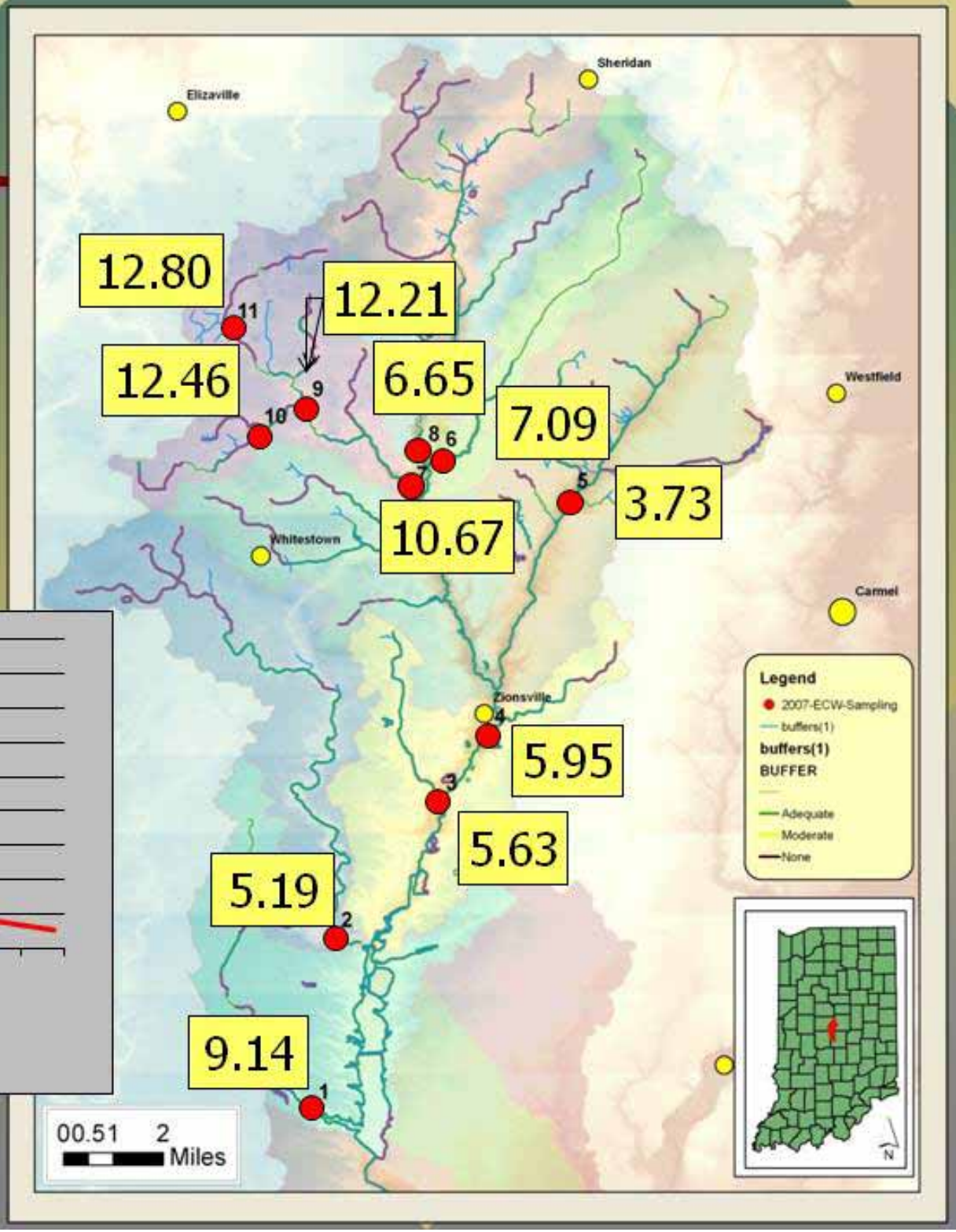
Nitrate MCL = 10 mg L^{-1}

Nitrate vs Watershed Location (May Storm)

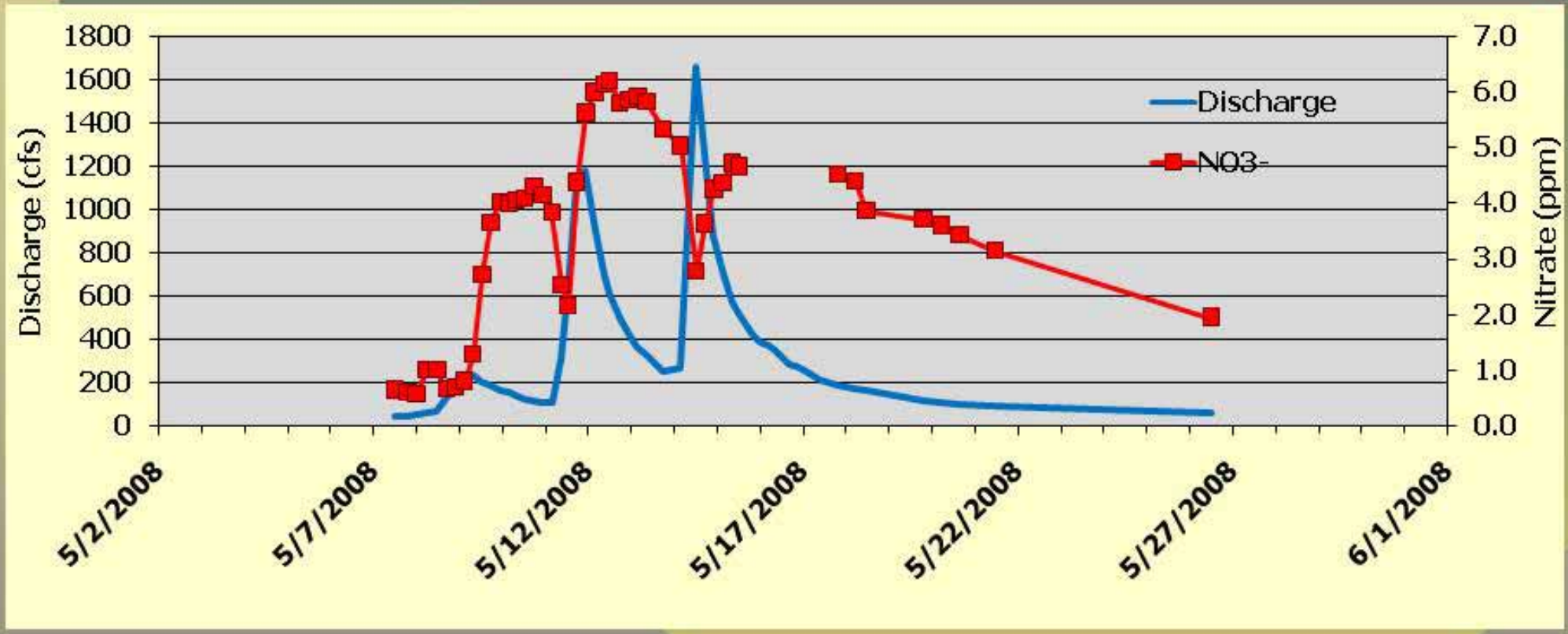
- Nitrate Concentration (5/12/08)
  - Drinking Water MCL 10 mg/L
  - EPA Nutrient Criterion 1.6 mg/L



Sampling Time Frame



Nitrate Export: Eagle Creek Watershed

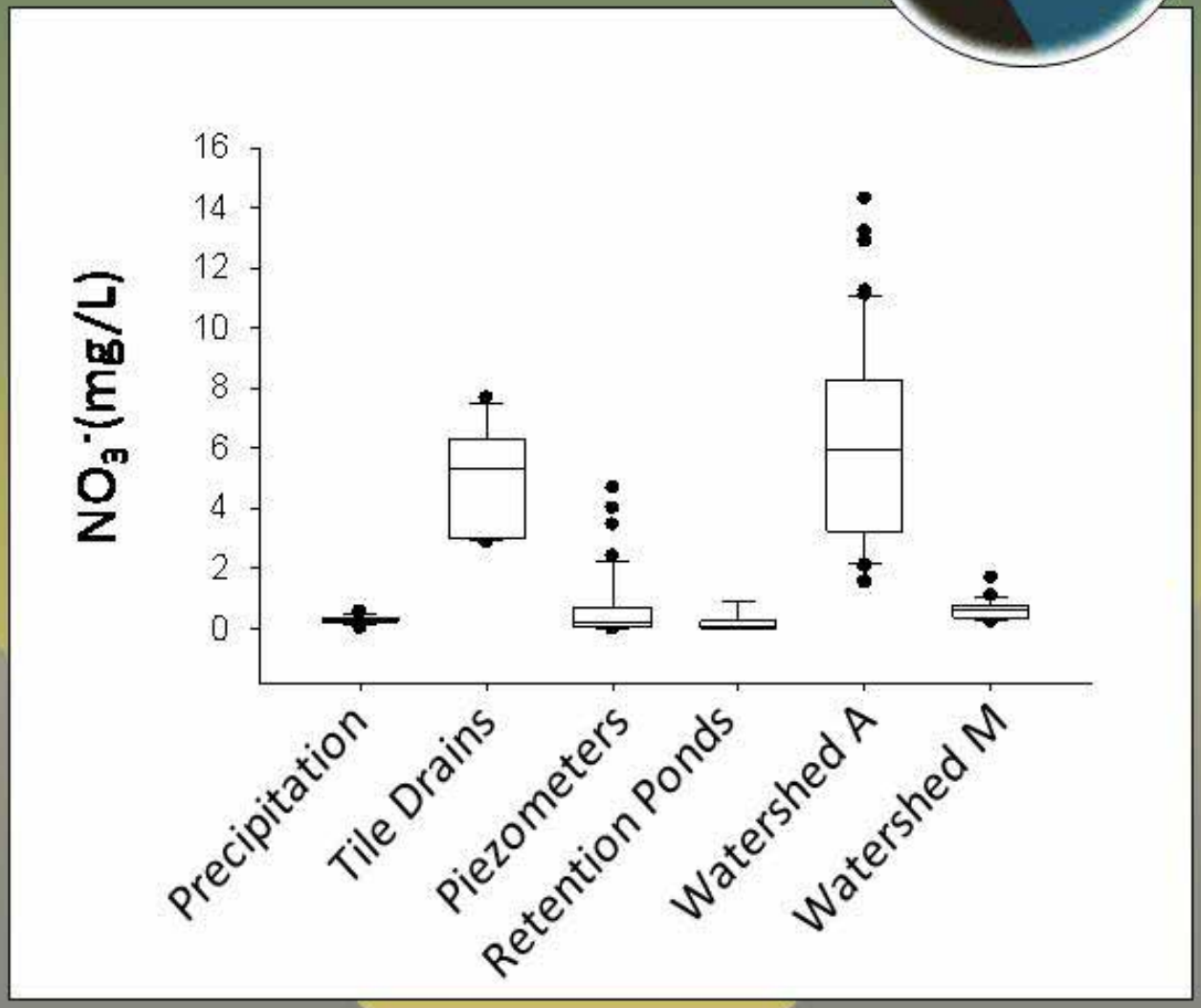


- Nitrate concentration (and load) increases with discharge following a short period of dilution
- Peak nitrate concentrations frequently lag behind peak discharge in agricultural settings (tiles)

CIWRP High Frequency Sampling Stations

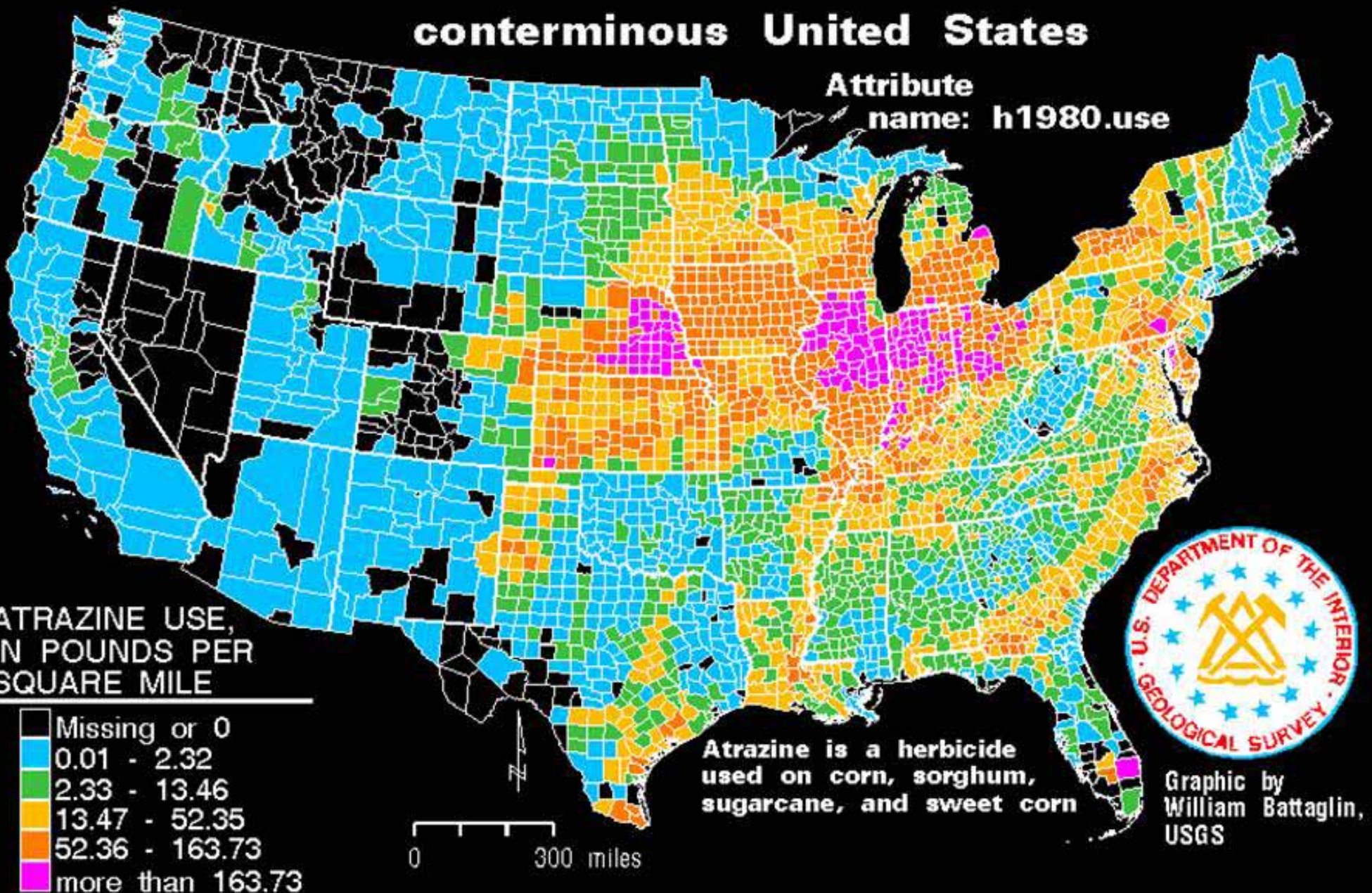
Nitrate Export

- Streams in agricultural watersheds (A) have higher nitrate than streams in mixed land use watersheds (M)
- Tile drains are an important nitrate transport conduit



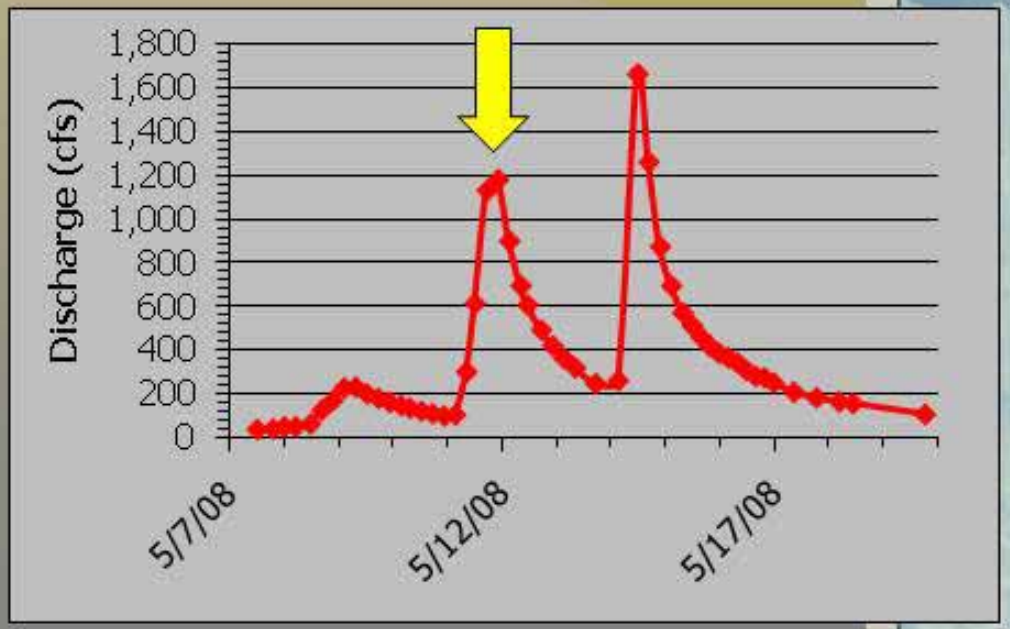
Wagner, Vidon, Tedesco and Gray 2008

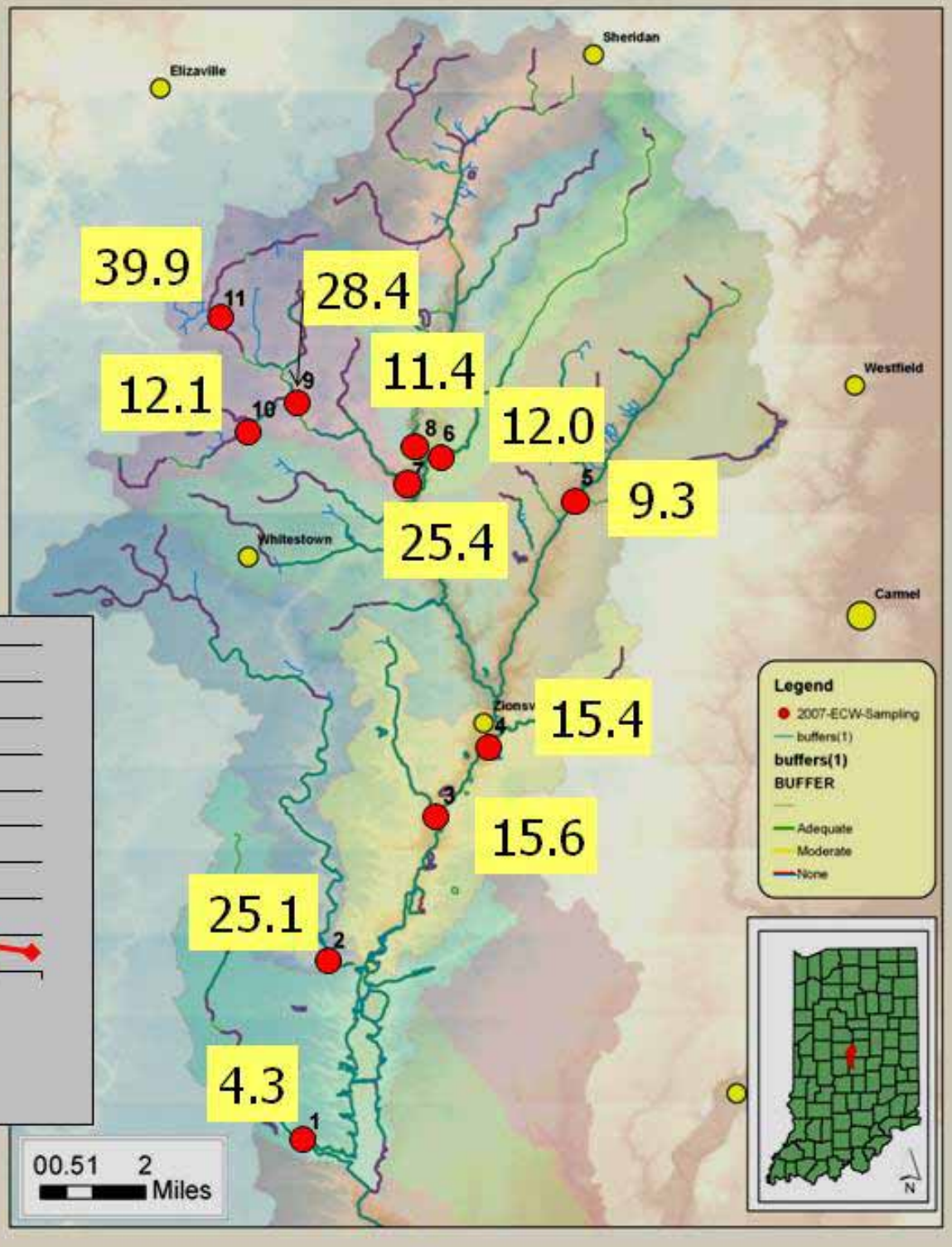
HERBICIDE1--Coverage of use estimates for the 20 most-used herbicides in the conterminous United States



Atrazine vs Watershed Location (May Storm)

- Atrazine Concentration (5/12/08) in ppb
  - Drinking Water MCL 3 ppb
  - EPA Chronic Aquatic Community Guideline 17.5 ppb





Atrazine Transport During Storm Flow: Eagle Creek Stream

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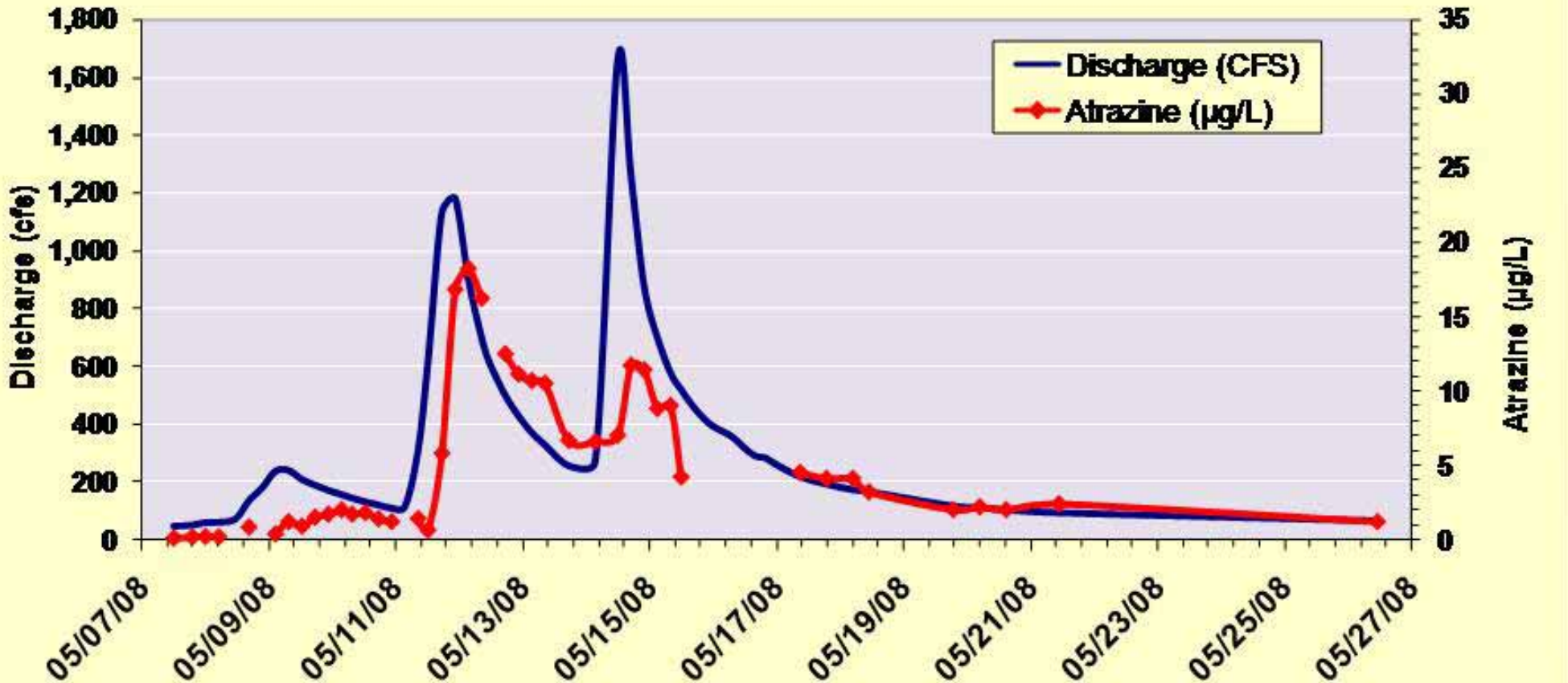

CIWRP High Frequency Sampling Stations

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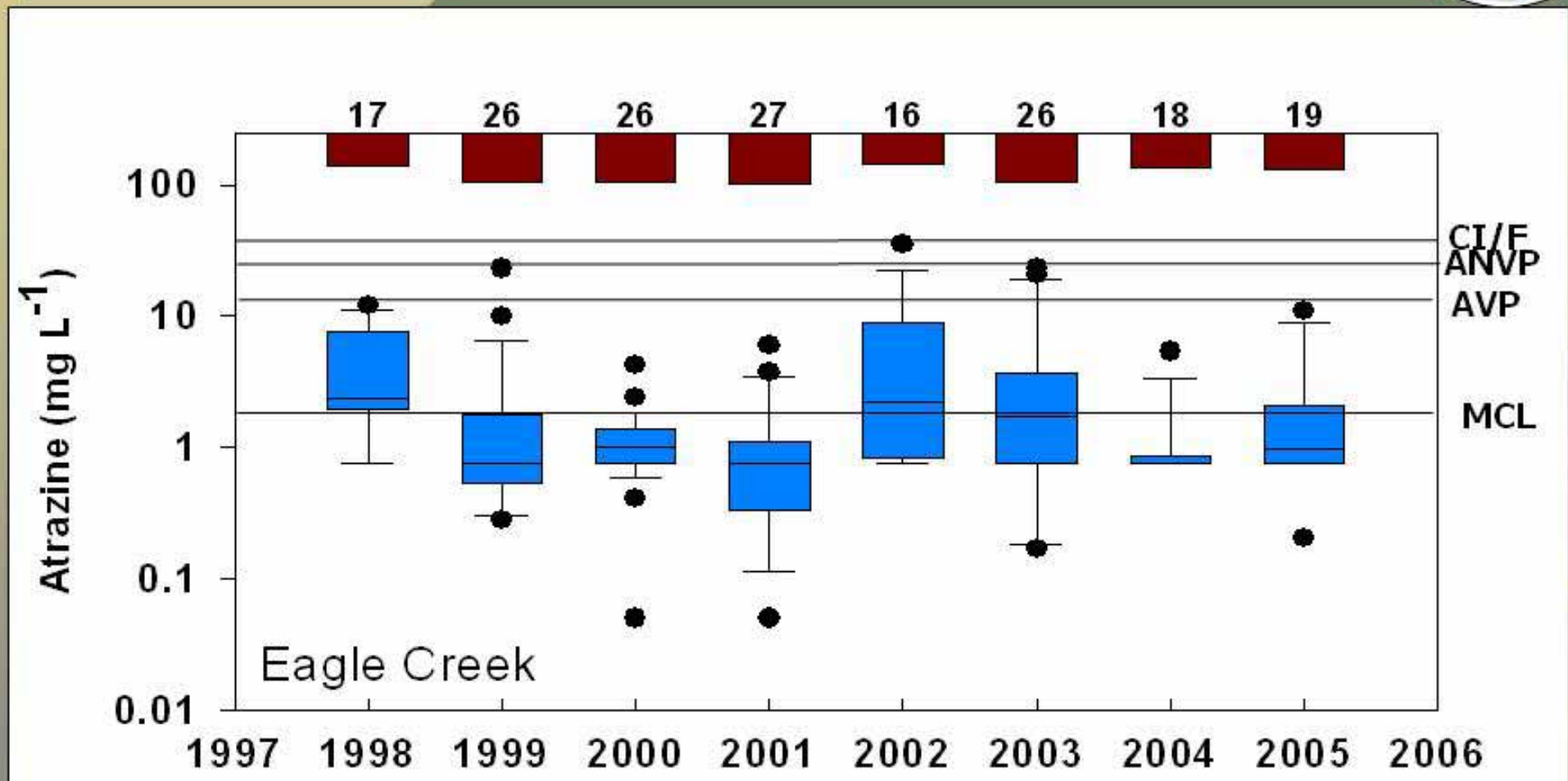
Eagle Creek Stream
Atrazine Concentration Trends



Chronic Toxicity Invertebrate/Fish – 62 mg/L (CI/F)
Acute Toxicity Nonvascular Plant Benchmark – 32 mg/L (ANVP)
Acute Toxicity Vascular Plant Benchmark – 18 mg/L (AVP)
MCL – 3 mg/L

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Atrazine Levels – Eagle Creek Reservoir (2001-2008)

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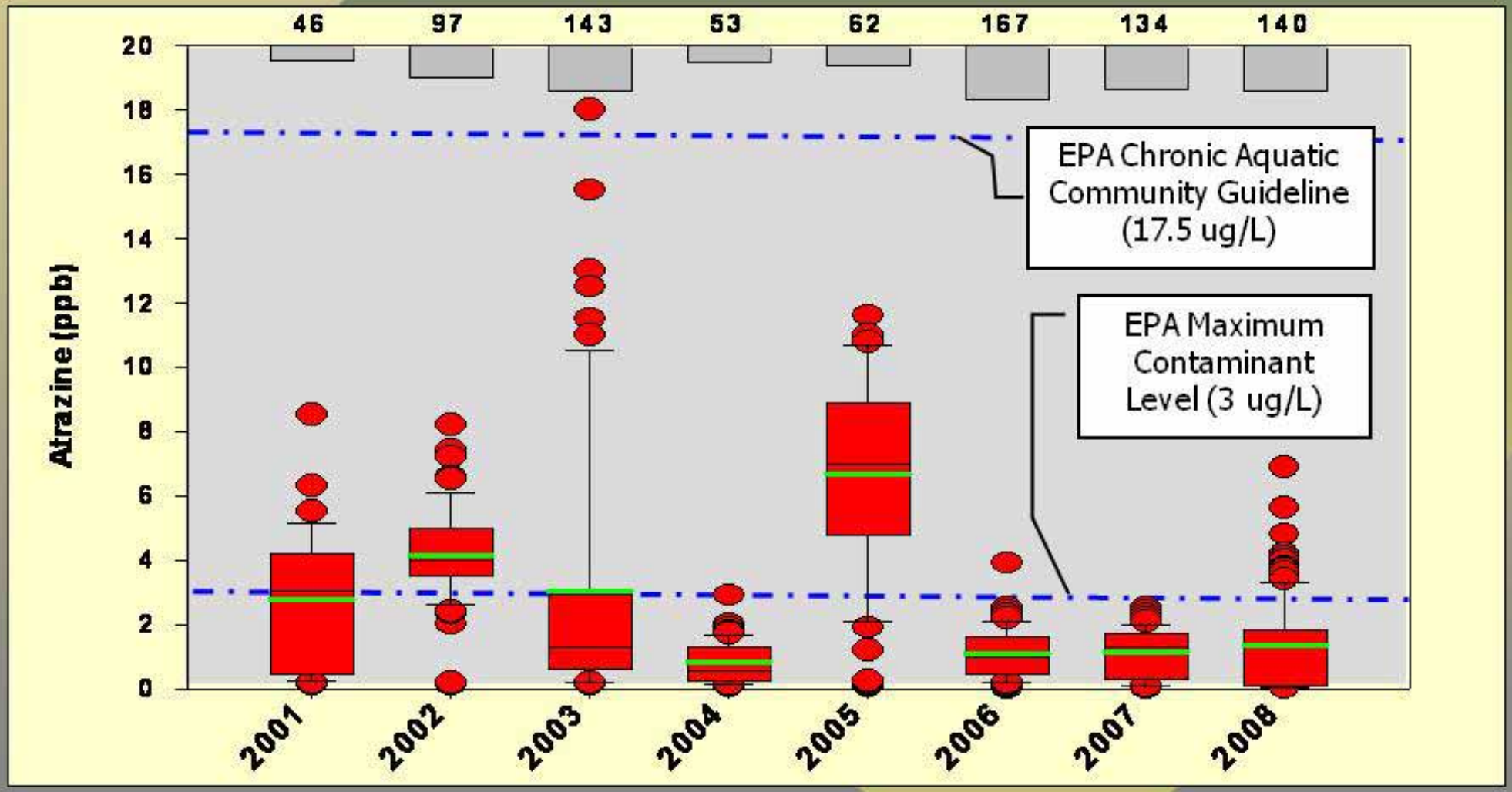

Reported as Total Triazine
Measured at Intake to Drinking Water Treatment Plant

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Atrazine Levels – Eagle Creek Reservoir (2001-2008)

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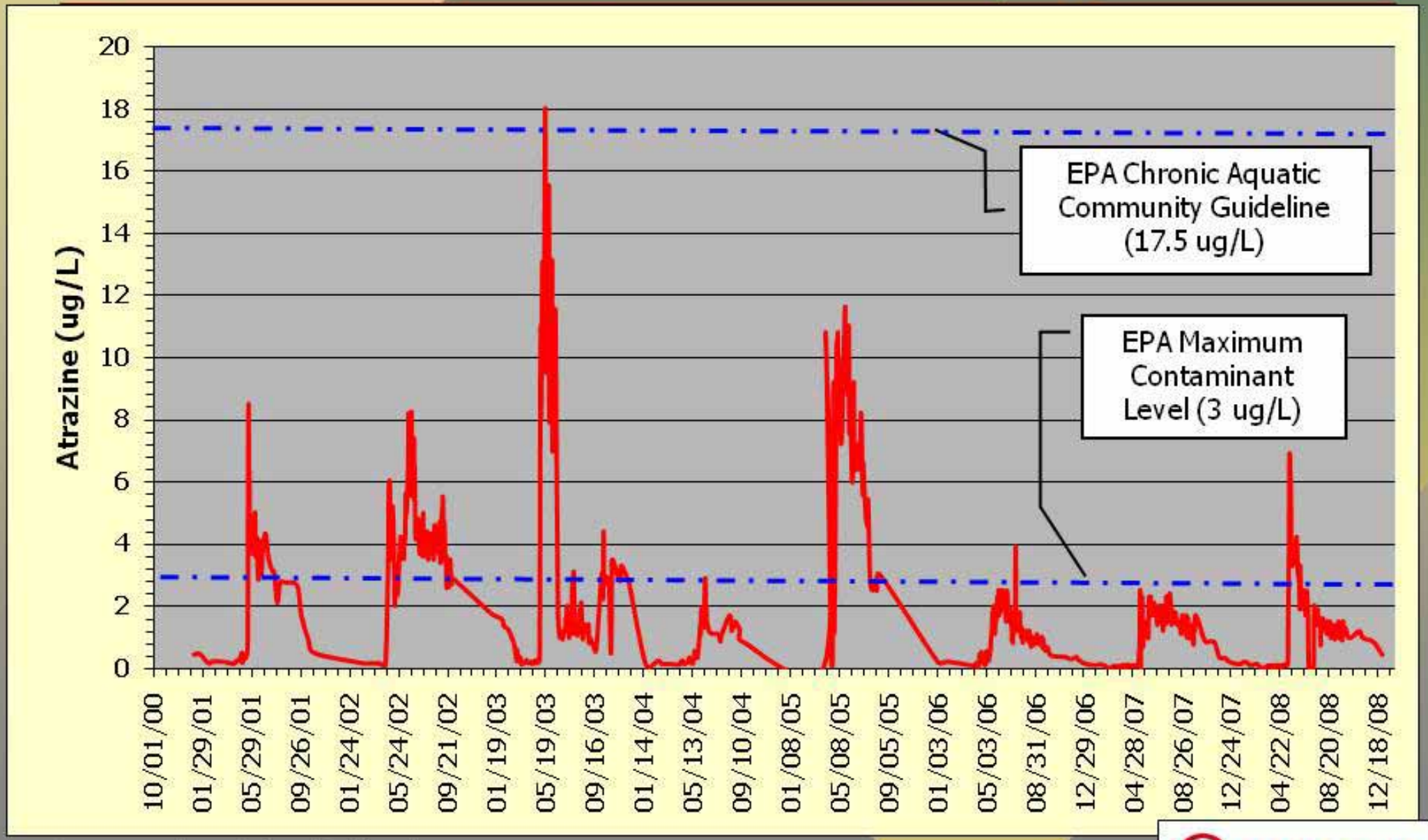

Reported as Total Triazine
Measured at Intake to Drinking Water Treatment Plant

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Summary

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- Agricultural chemicals are a significant contaminant in Eagle Creek Watershed streams
  - Herbicides and Insecticides dominate the detections in a pesticide and wastewater compound screening done in Eagle Creek
  - Atrazine frequently exceeds the drinking water MCL and exceeds some aquatic life benchmarks
- Nitrate concentrations frequently exceed the drinking water MCL during runoff events
- Tile drainage of agricultural areas enhances the transport of chemicals that readily dissolve explaining the high concentrations of nitrate, atrazine (and acetochlor) in Eagle Creek streams


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