Benthic Taxa Sensitivity Analyses
Response along an urban gradient (2004-2015)

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Department of Public Works and Environmental Services
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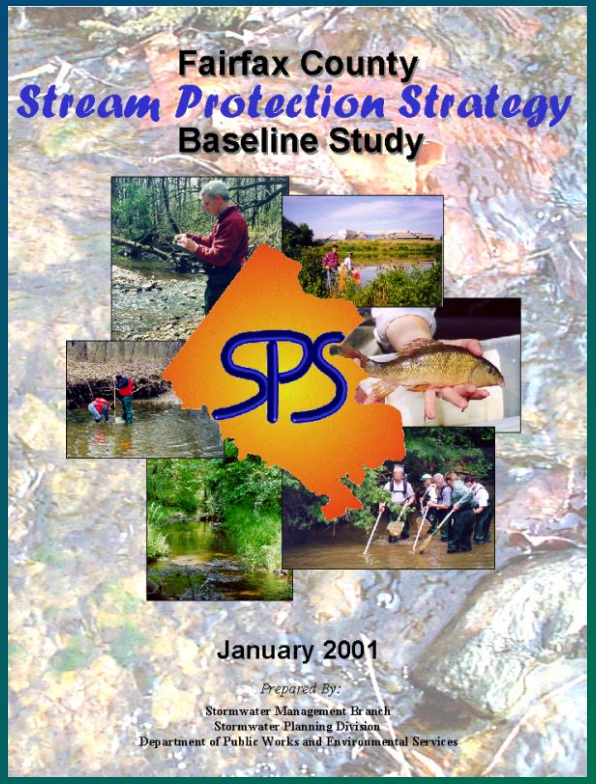
Key Points

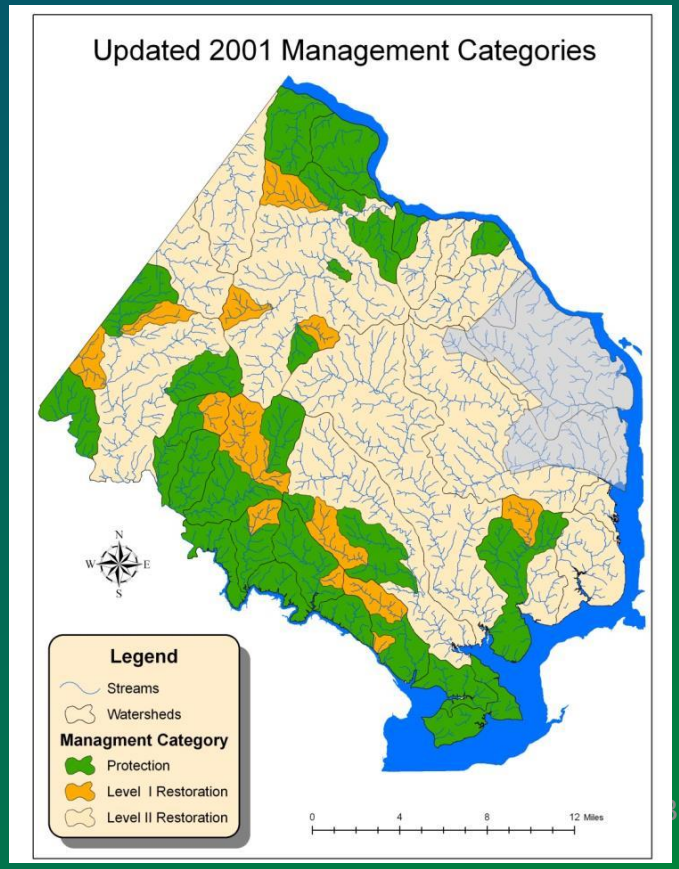
- Fairfax County has a rich monitoring data set, that includes a large number of sites with high levels of watershed imperviousness
- Taxa sensitivity and tolerance values are needed as part of the development and evaluation of:
  - Fairfax County's BIBI
  - Biological Condition Gradient
  - Urban streams standard
- Underlying geology affects stream chemistry, habitat and changes benthic community structure
- Taxa tolerance values can/should be adjusted to local conditions for a local BIBI

Stream Biological Monitoring Program

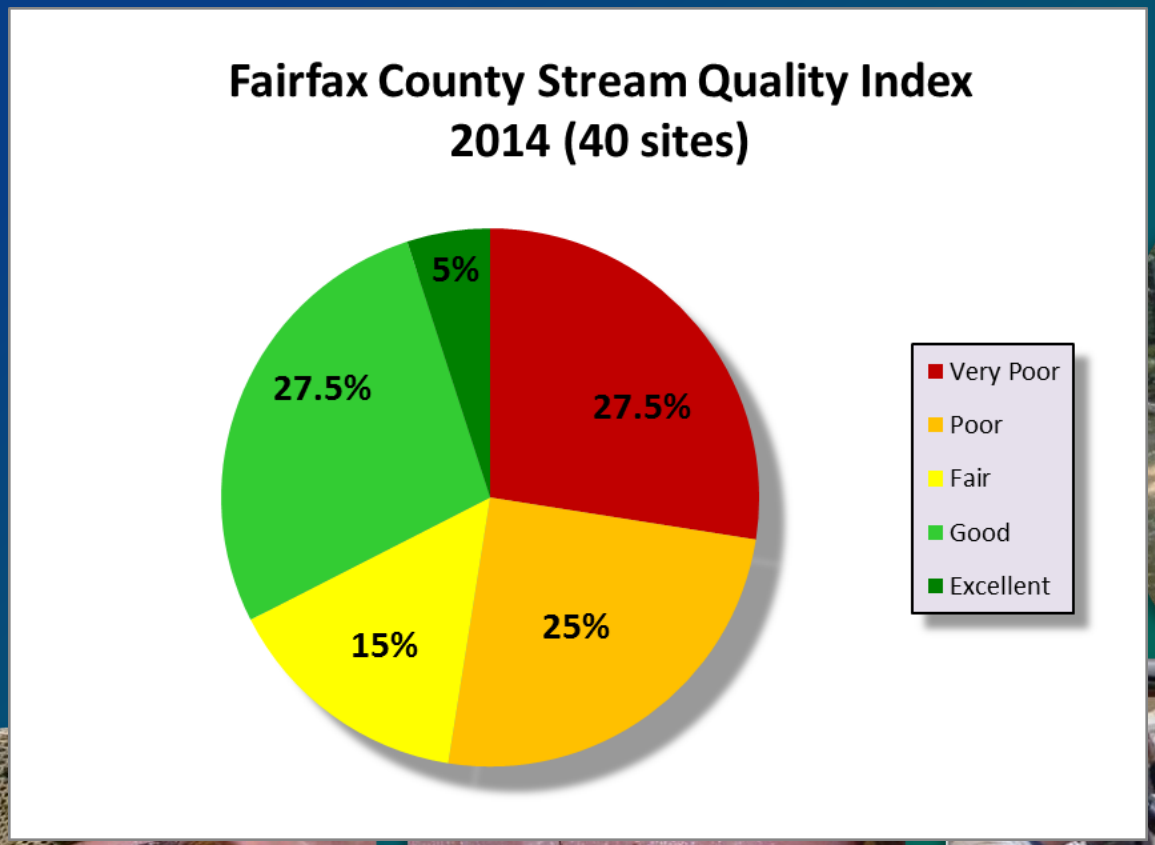
Fairfax County Stream Protection Strategy (SPS)

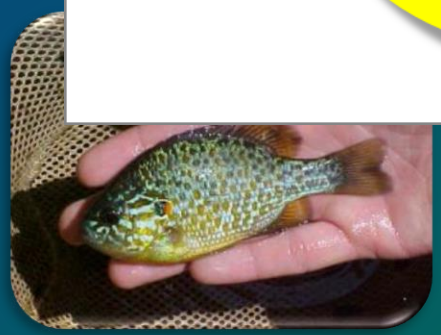
- Established by BOS in 1998 to assess WQ/stream/watershed conditions Countywide
- Evaluated chemical, biological, habitat and geomorphic conditions at 124 sites in 1999





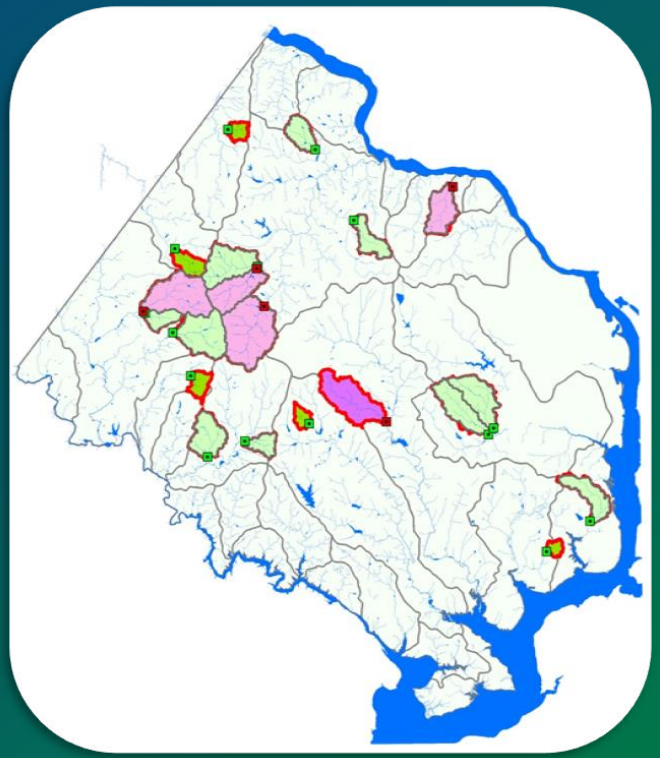
Stream Biological Monitoring Program



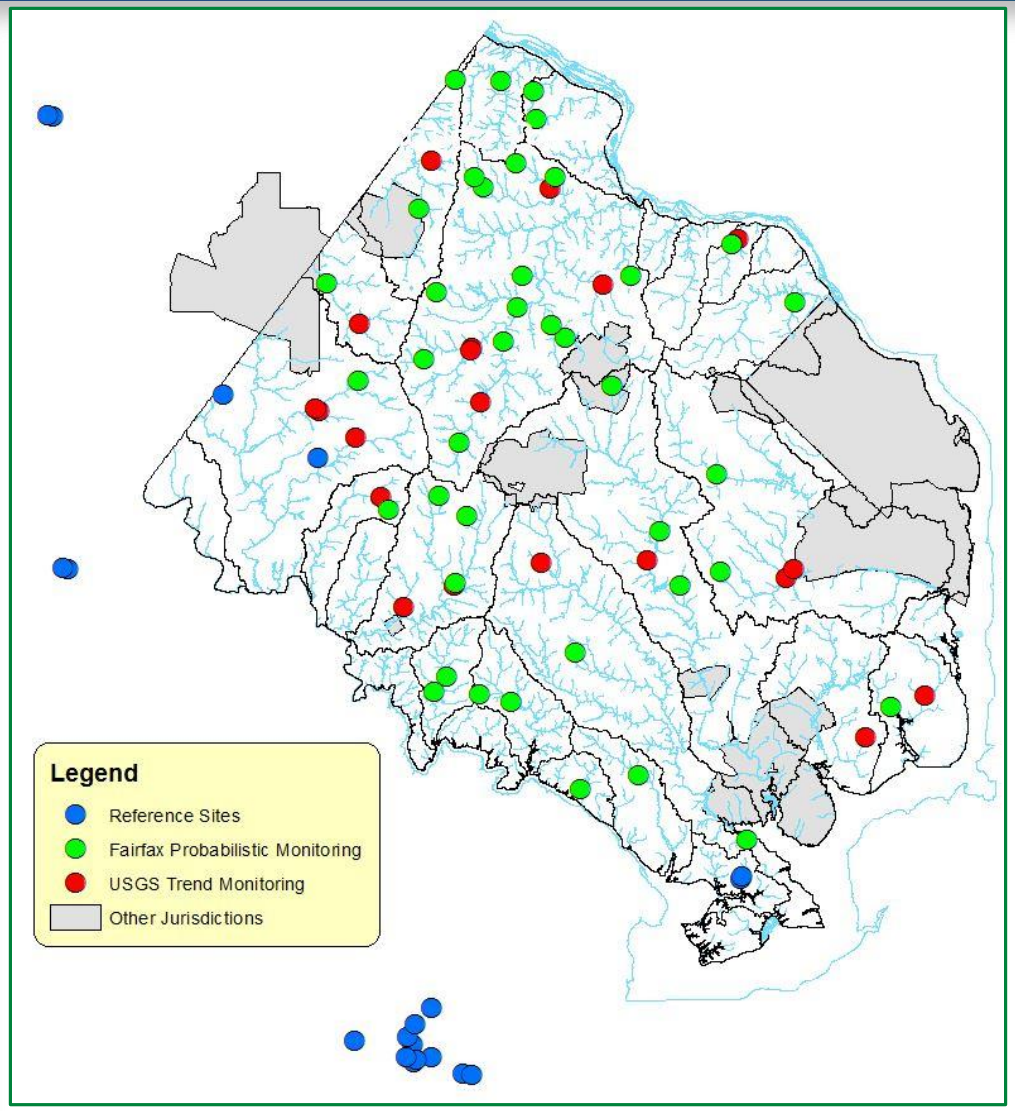


USGS Partnership: Stream Gaging Study

- Initiated in 2007 with the USGS VA Water Science Center (Richmond)
  - Generate long-term monitoring data to describe:
    - Current water-quality conditions
    - Trends in water-quality, nutrient and sediment loads and yields
    - Started with 14 sites, expanded to 20 sites in 2012



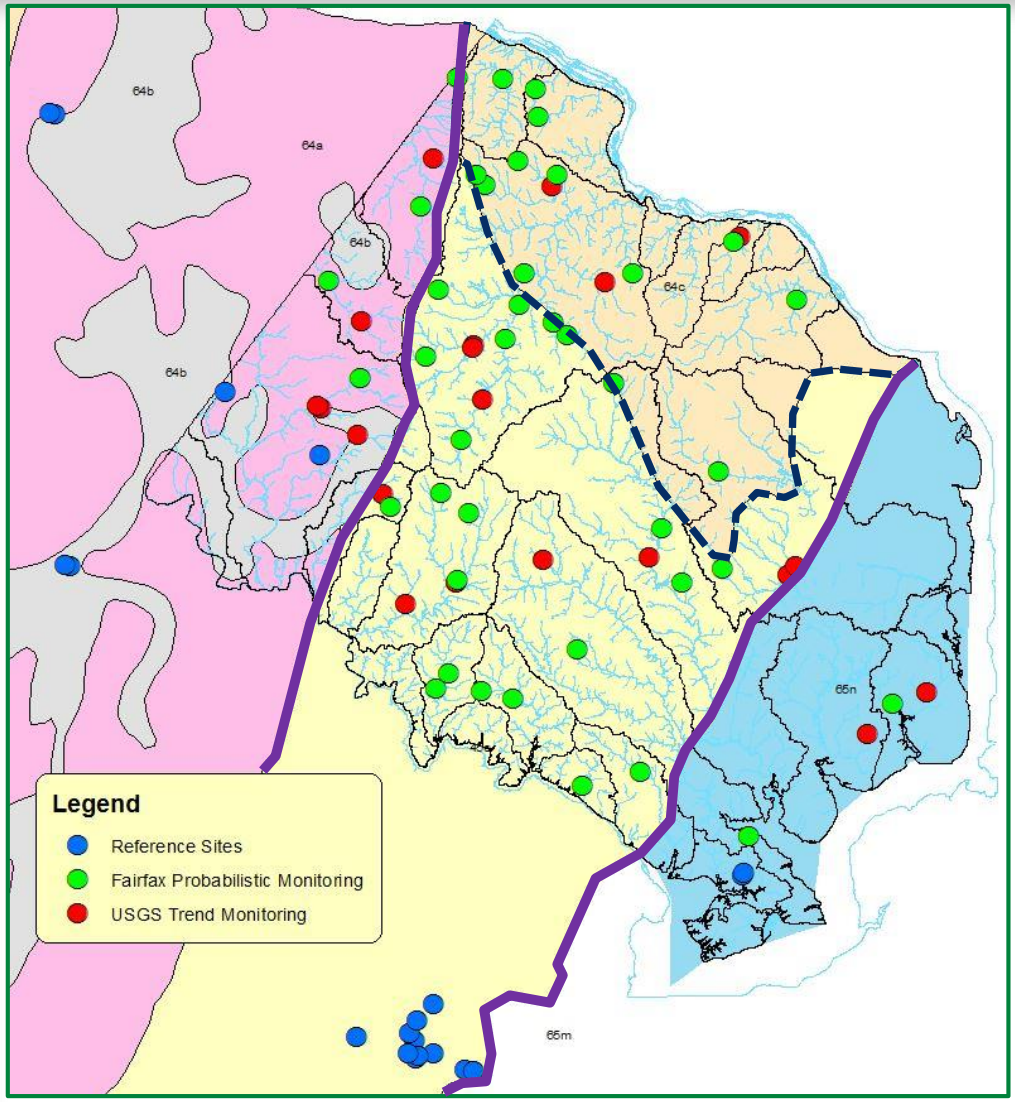
Typical Year of Fairfax Co. Benthic Monitoring (2015)



- Probabilistic [40]
- USGS (trend) [20]
- Reference (trend) [18]
- Restorations and special projects [8]
- QA/QC [4]

- ~ 90 sites annually

Level IV Ecoregions – Benthic Monitoring 2015



- Northern Piedmont (64)
  - 64a Triassic Lowlands
  - 64b Diabase and Conglomerate Uplands
  - 64c Piedmont Uplands
- Piedmont (45)
  - 45e Northern Inner Piedmont
- Southeastern Plains (65)
  - 65e Chesapeake Rolling Coastal Plain

Fairfax Co. Data for this Study

- 644 benthic samples (2004-2015)
  - Evaluated unique taxa occurring 20+ times (n=80)
- Drainage areas
  - 2ft elevation DTM, created a DEM in 2009
  - Storm Sewer network & outfalls burned to DEM in 2010
  - Each monitoring reach was delineated using a tool developed for Ffx Co.
  - Additional data from adjoining jurisdictions were appended
- 2009 Planimetric layer (fly-over) for impervious areas
  - Resolution is <1m instead of 30m with NLCD
  - Went live in 2013 (4 years for QA/QC)
- Median annual specific conductance – 620 samples (491 sites)
  - Mean number of measurements/year ~5

Sensitivity Analyses

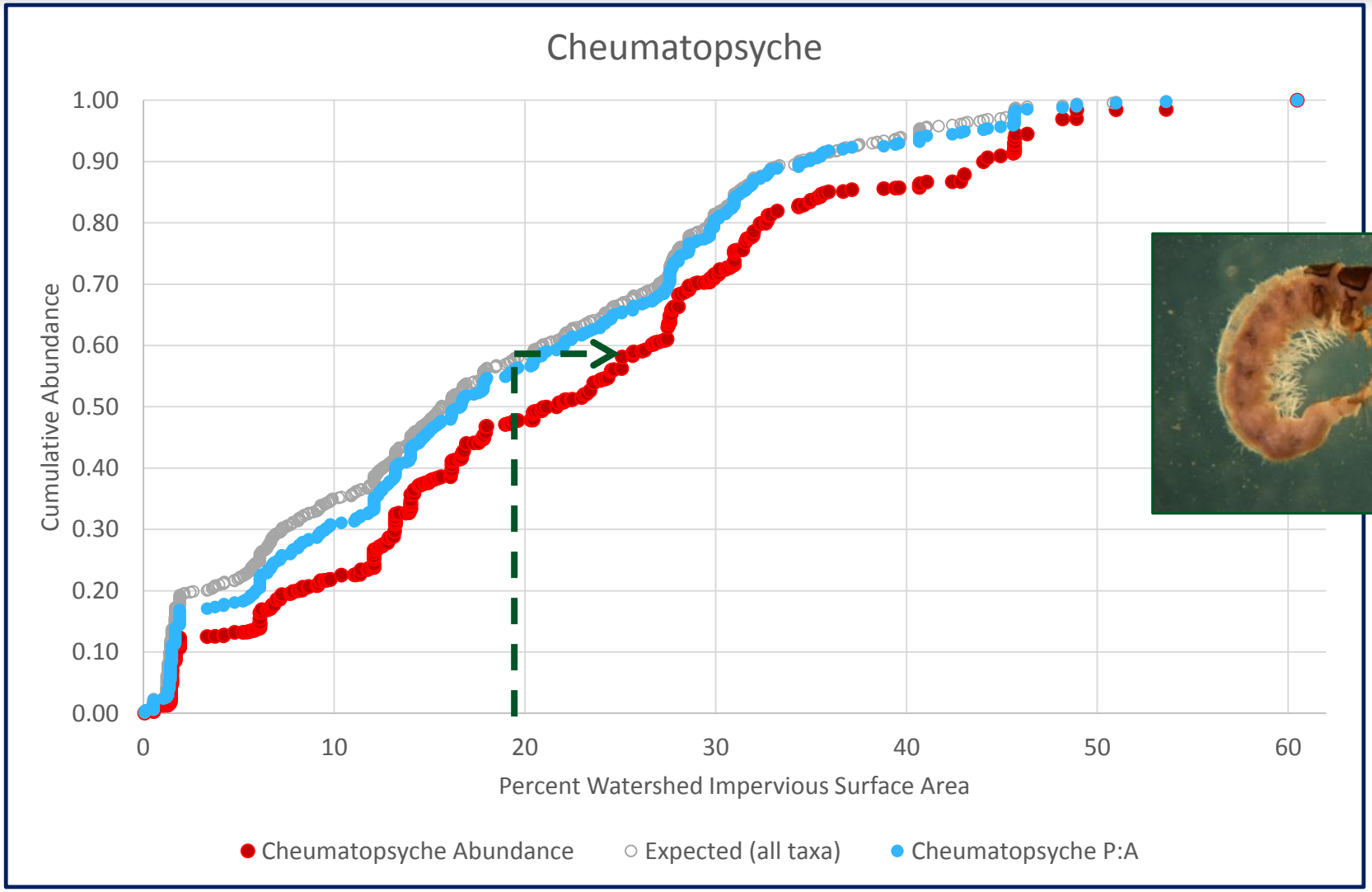
- How to evaluate taxa sensitivity and tolerance values as part of the evaluation and re-development of a new BIBI?

- Cumulative Distribution Function (CDF) [from Utz et al. 2009]
  - Process for linking sensitivity of benthic taxa to a particular stressor
  - Requires much data (20-25 occurrences of a taxa)

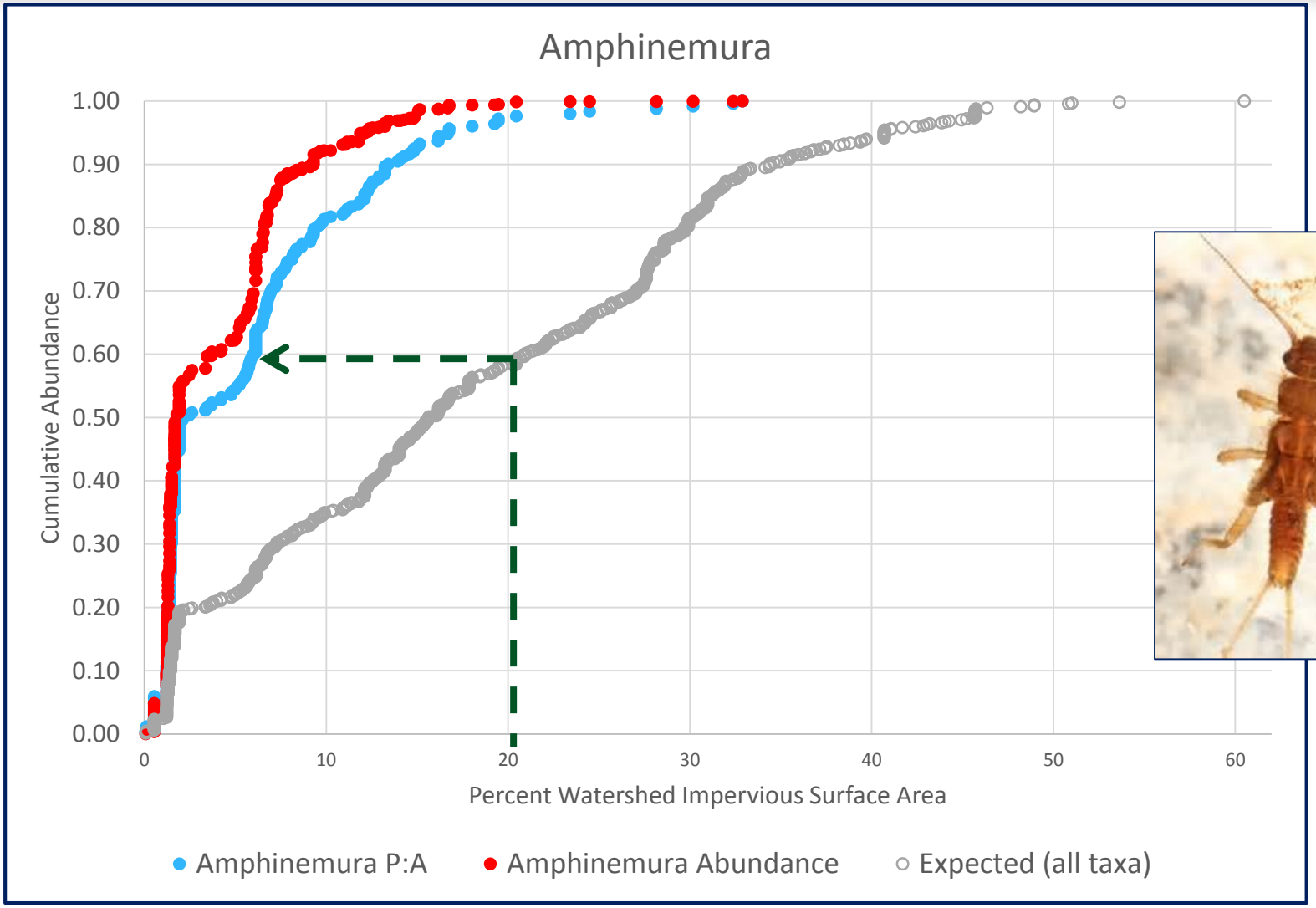
- Can create other metrics, based upon a CDF stressor gradient
  - T_{95} = the point at which 95% probability you will no longer find the taxa
    - Essentially a measure of extirpation

- Taxa sensitivity comparable to other CDFs & Tolerance Values (TVs)

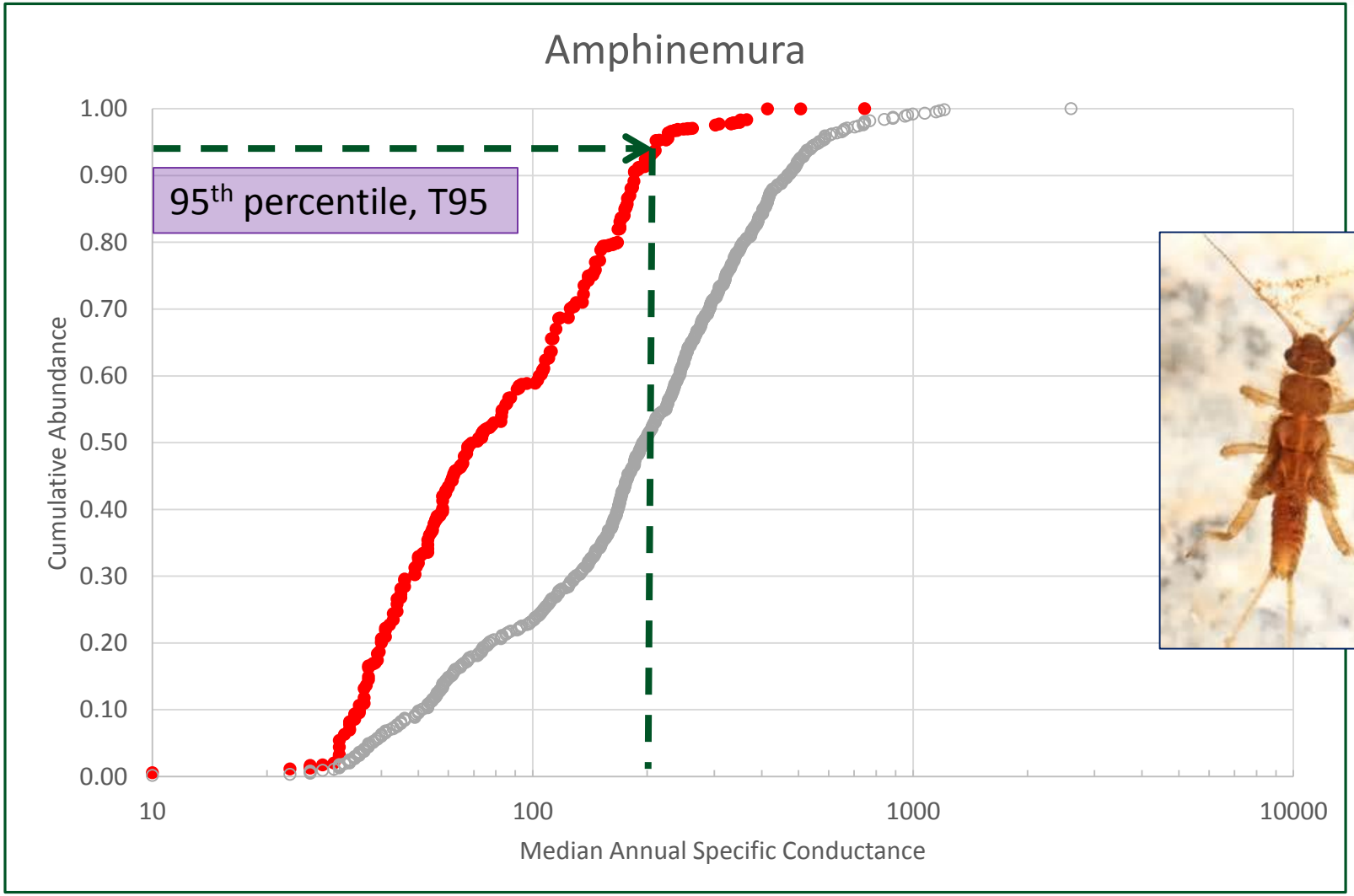
Positive Response to Stressor (% Imp. Area)



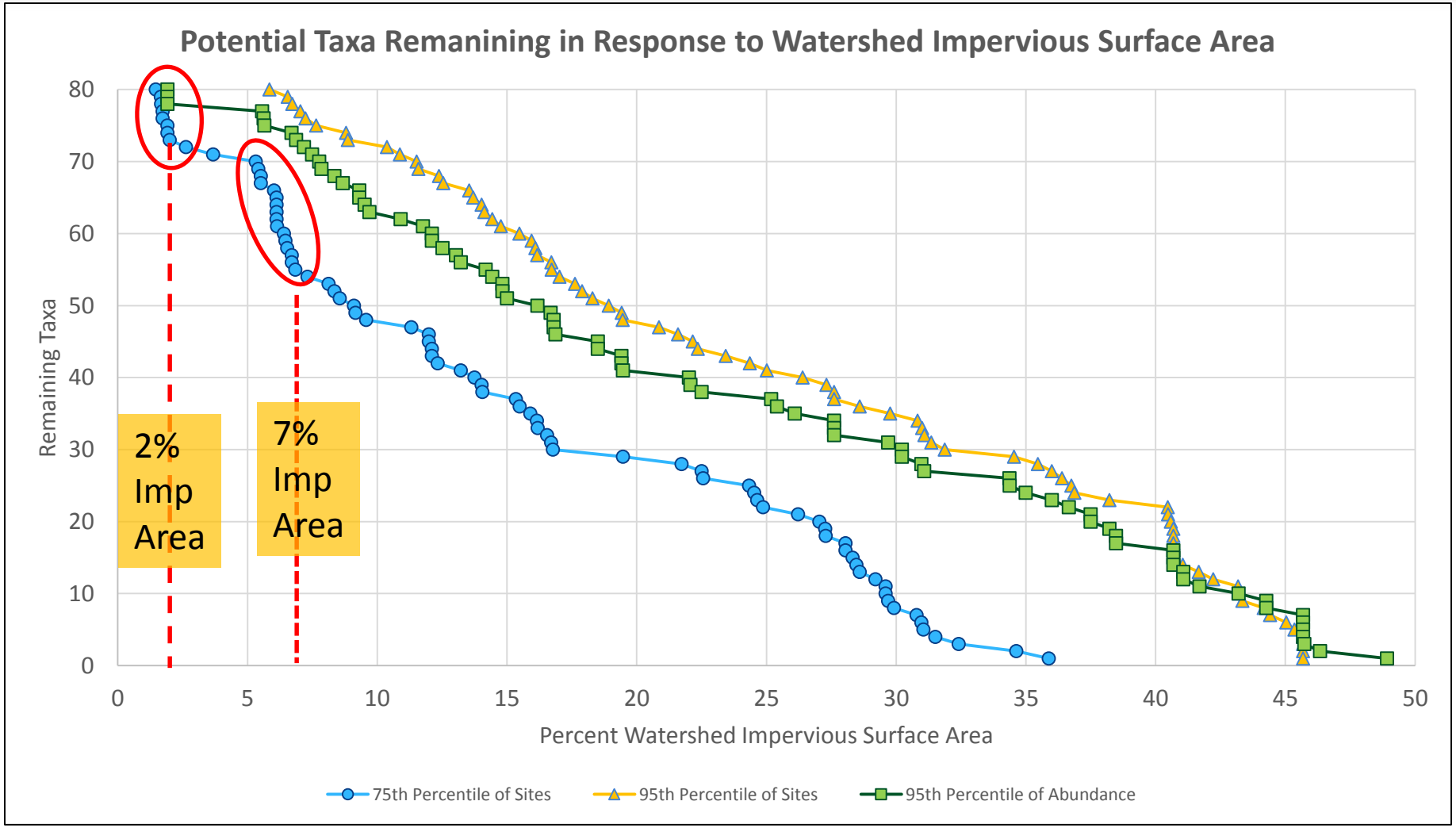
Negative Response to Stressor (% Imp. Area)



Negative Response to Stressor (Specific Conductance)



Taxa Richness vs Stressor (% Imp Area), 80 taxa



Taxa lost as Impervious Area Increases (75th percentile)

34% of common taxa (20+) effectively lost by 7% watershed imperviousness

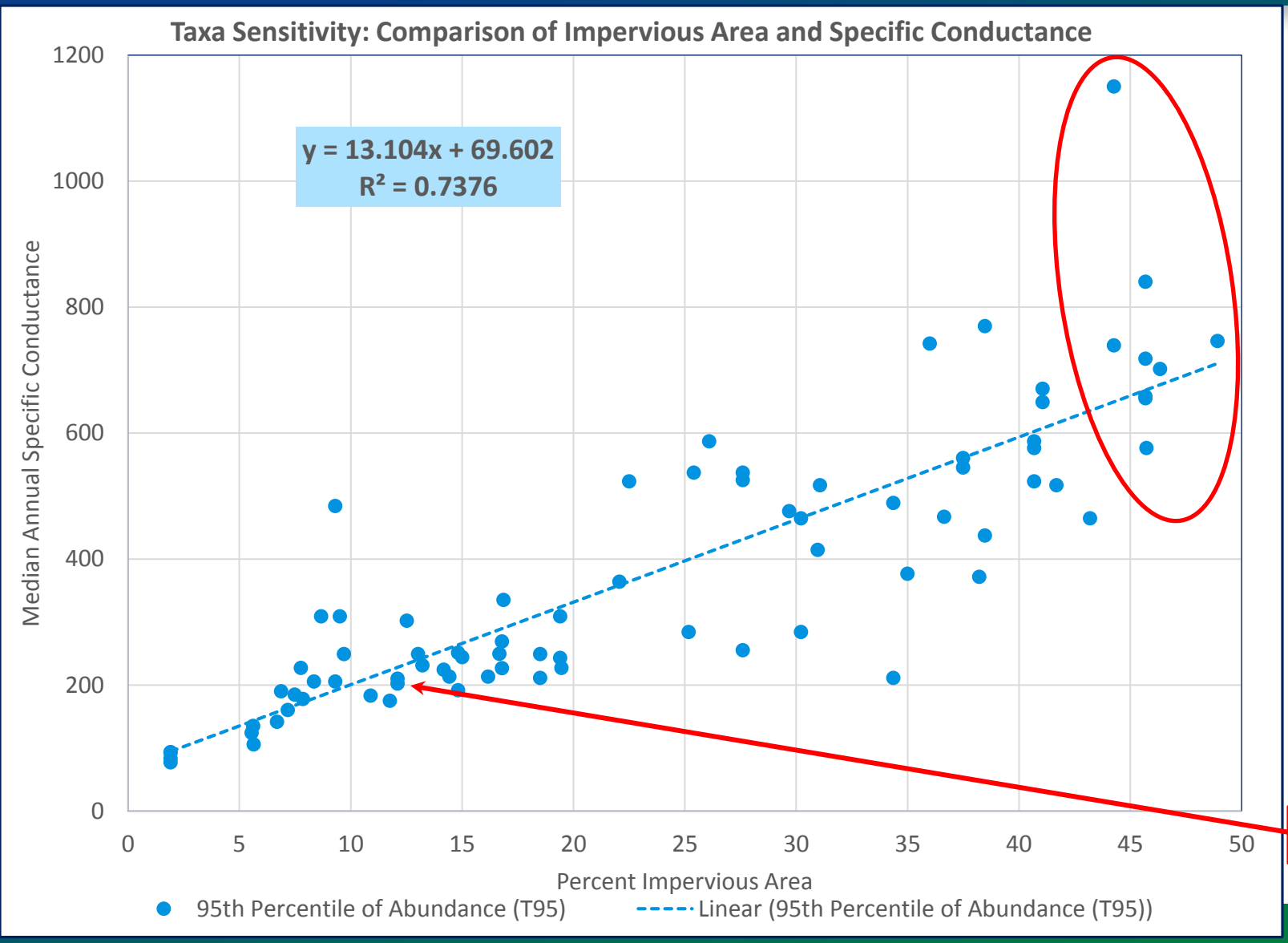
Impervious Area 0→2%
Mean TV = 1.9

Taxon	IA75th Sites	TV
Hexatoma	1.37	1.5
Haploperla	1.46	1.6
Lepidostoma	1.66	0.0
Ephemerella	1.67	2.3
Serratella	1.73	2.8
Acroneuria	1.73	2.5
Heterocloeon	1.91	TBD
Isonychia	1.91	2.5
Wormaldia	2.00	1.8

Impervious Area 2→7%
Mean TV = 2.9

Taxon	IA75th Sites	TV
Hydatophylax	2.63	3.4
Leuctra	3.67	0.4
Cordulegaster	5.32	2.4
Stegopterna	5.42	TBD
Eccoptura	5.51	0.6
Paraleptophlebia	5.51	2.0
Isoperla	6.02	2.4
Psephenus	6.12	4.4
Anchytarsus	6.12	3.1
Bezzia	6.12	3.3
Nigronia	6.12	1.4
Paranemoura	6.14	2.9
Rhyacophila	6.40	2.1
Limnophila	6.46	4.8
Ameletus	6.52	2.6
Hydroptila	6.70	6.0
Prosimulium	6.70	2.4
Pycnopsyche	6.84	3.1

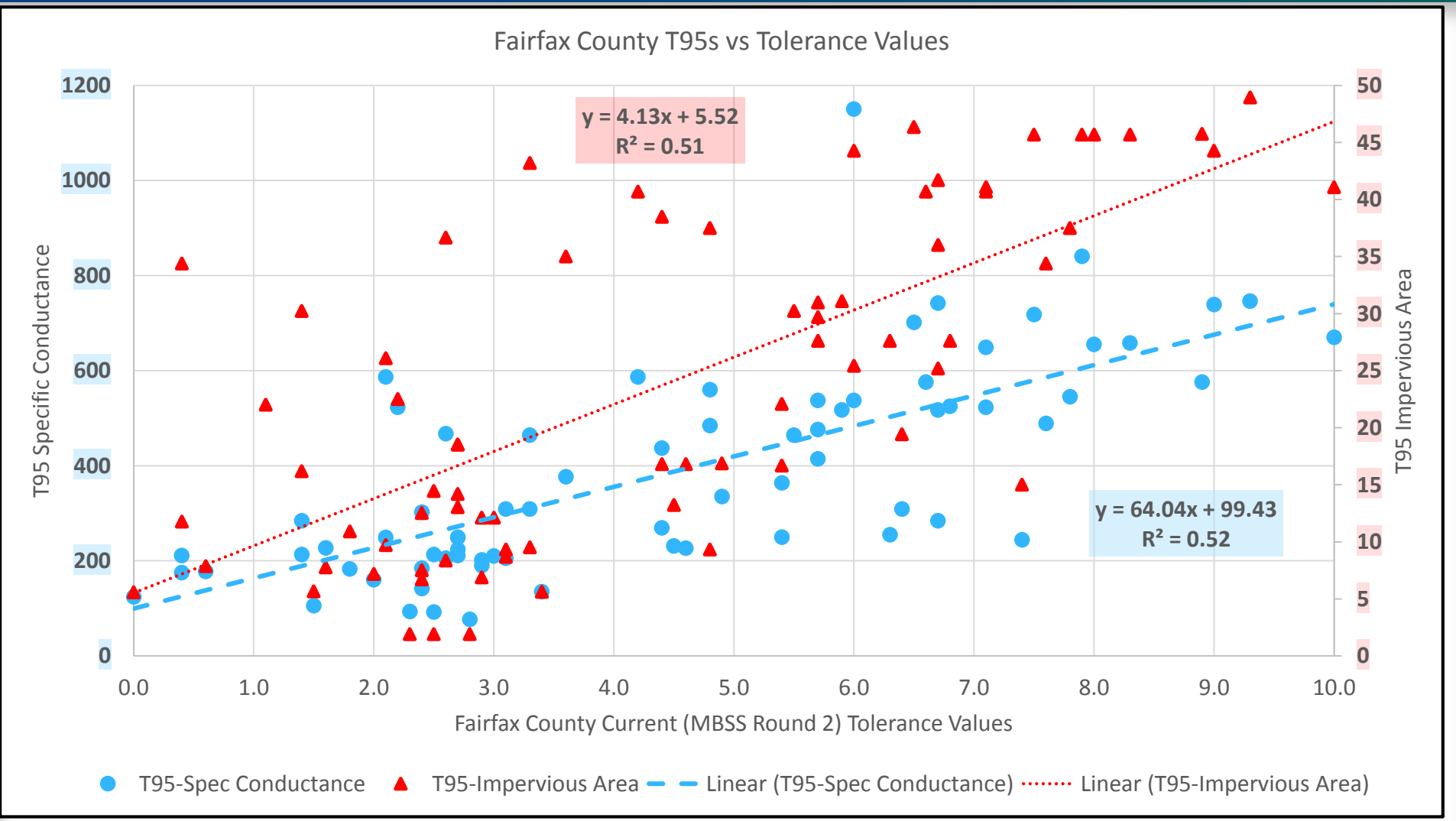
Sensitivity: Specific Conductance & % Imp Area



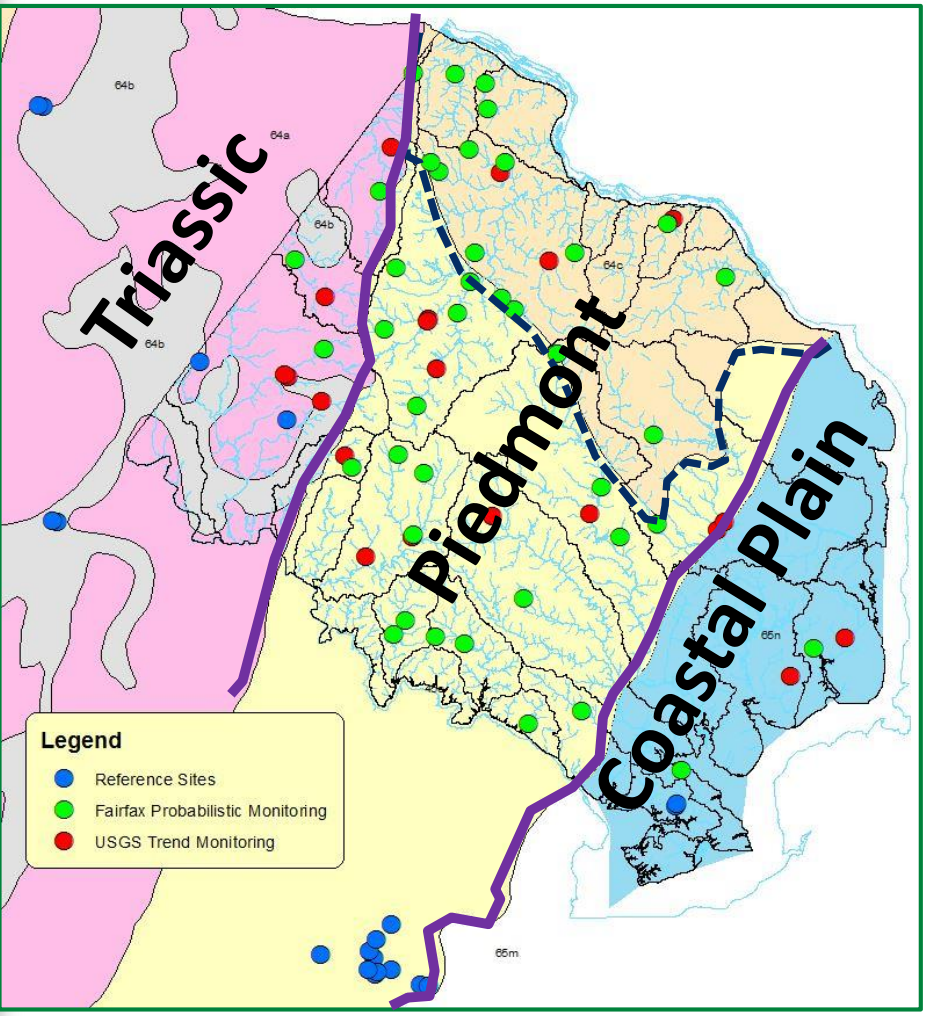
Antocha
Argia
Calopteryx
Cheumatopsyche
Corbicula
Enallagma
Hemerdromia
Hydropsyche
Peltodytes

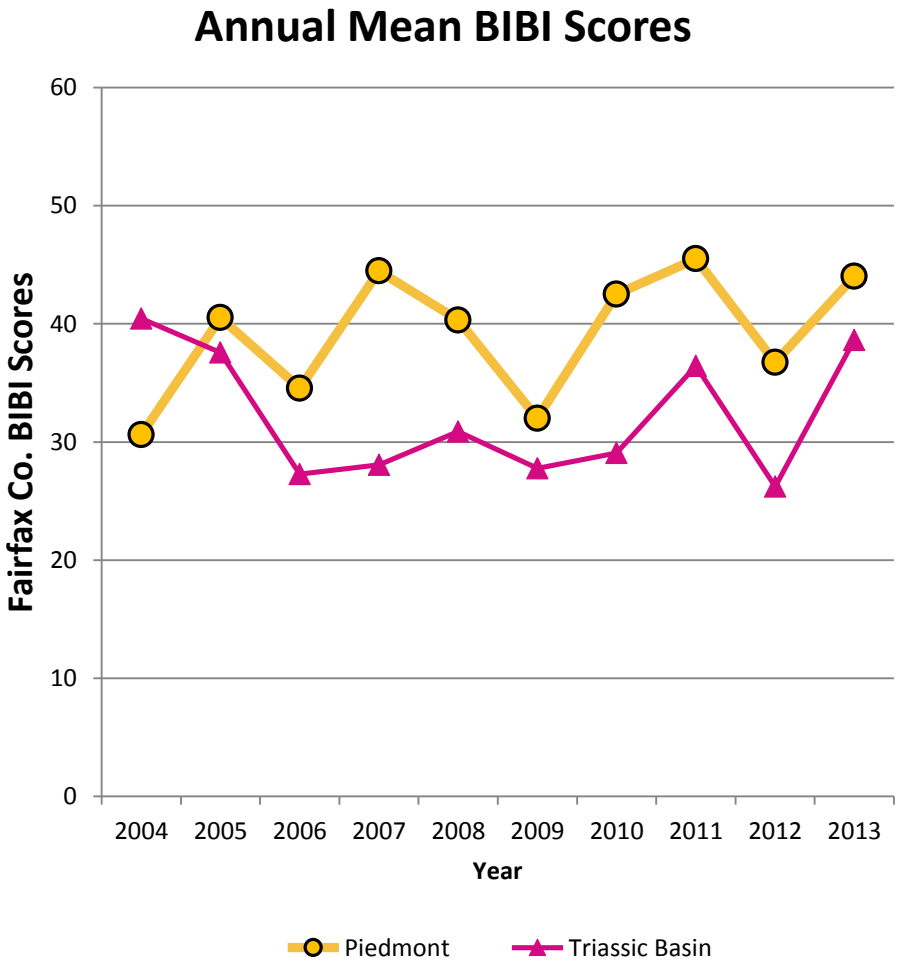
Amphinemura

Extirpation Thresholds (T_{95}) vs. Tolerance Values (TVs)

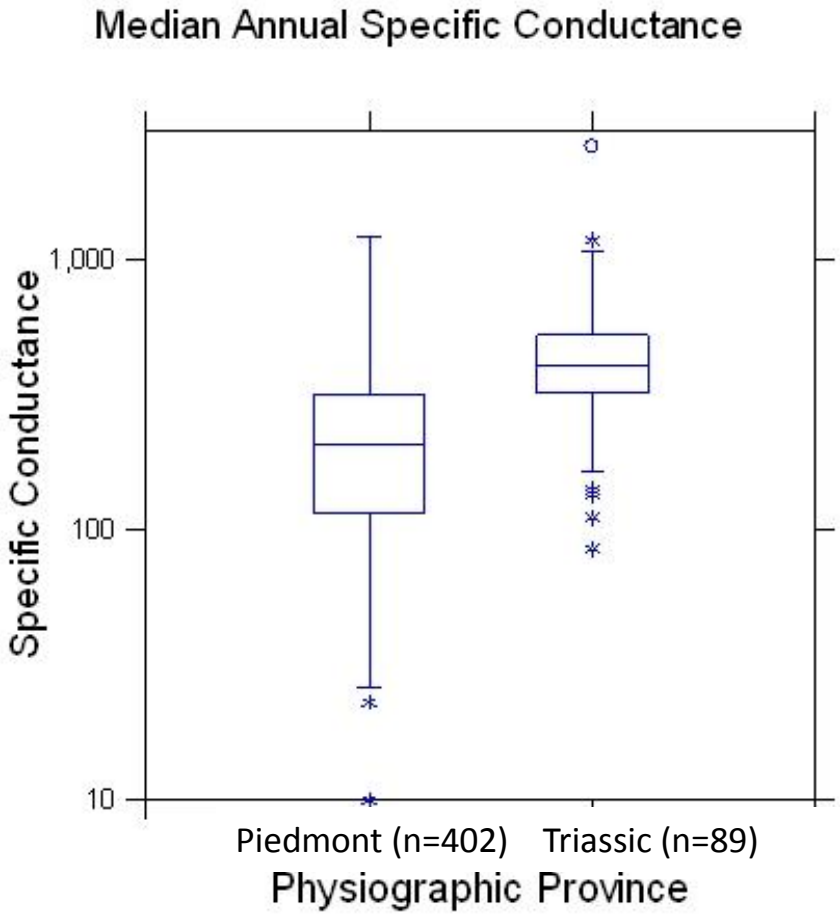


Ecoregion variation





Specific Conductance – Ecoregion Signal

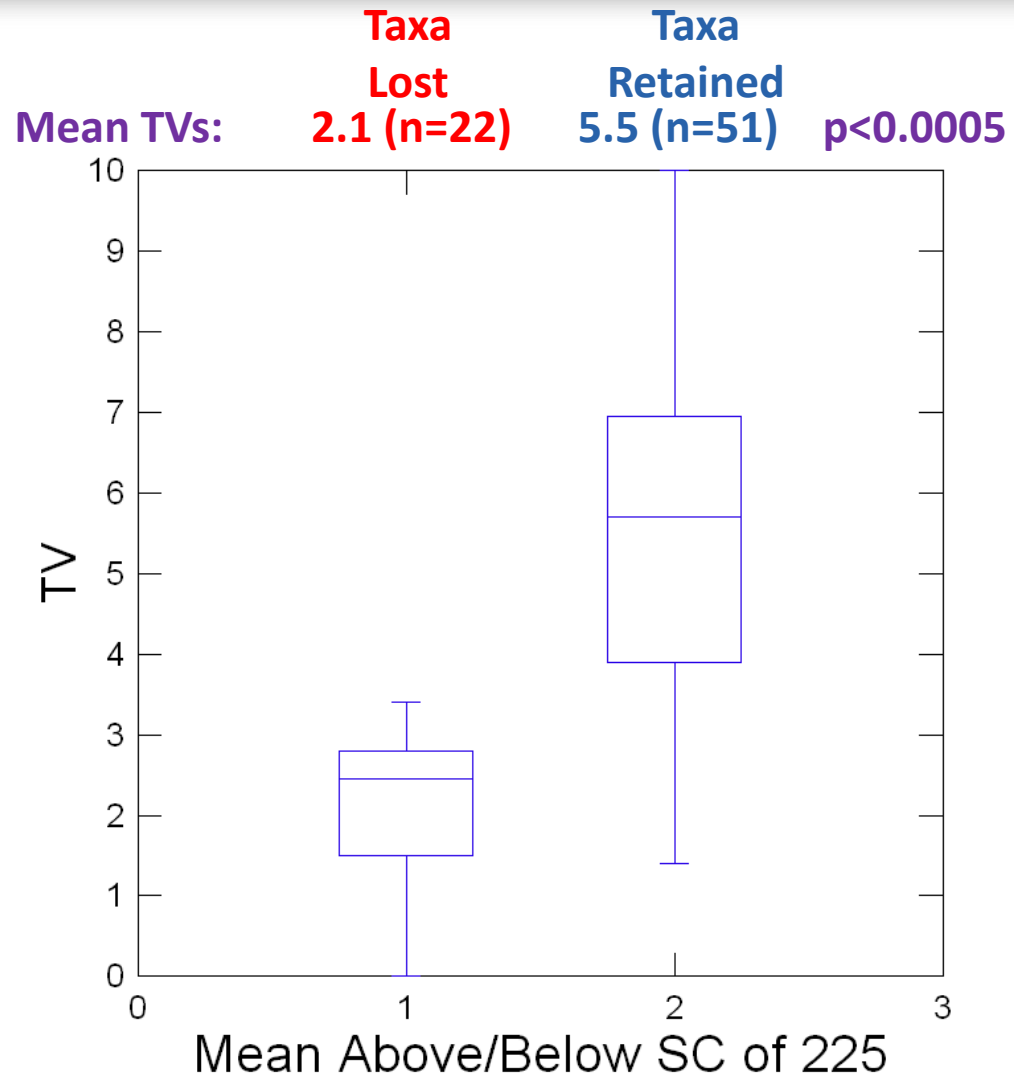


Triassic Basin (64a & b) mean specific conductance is **225.5** µS/cm^3@25°C **higher** than Piedmont (64c & 45e).

(159 to 292, 95%CI, $p < 0.0005$)

Tolerance of taxa at Spec Cond 225

Taxa lost (Genus)	TV
Lepidostoma	0.0
Cambarus	0.4
Leuctra	0.4
Eccoptura	0.6
Nigronia	1.4
Hexatoma	1.5
Wormaldia	1.8
Paraleptophlebia	2.0
Ephemerella	2.3
Isoperla	2.4
Prosimulium	2.4
Acroneuria	2.5
Isonychia	2.5
Ameletus	2.6
Ceratopogon	2.7
Oulimnius	2.7
Serratella	2.8
Paranemoura	2.9
Shipsa	2.9
Amphinemura	3.0
Pycnopsyche	3.1
Hydatophylax	3.4
Heterocloeon	TBD
Stegopterna	TBD



Conclusions & Next Steps

- CDFs are an effective approach at evaluating taxa sensitivity
  - Supports indicator species analyses
  - Supports IBI re-development
- The Triassic Basin has a much higher base level of dissolved ions (Specific Conductance)
  - There are thresholds at which sensitive taxa are unexpectedly absent

<u>Next Steps</u>

- Explore difference among Ecoregions (Triassic)
- Test other possible stressors (Habitat, land use, or other factors?)
- Use ordination or regression to determine likely taxa TVs
- Apply new TVs to evaluate/re-redevelop BIBI, BCG, or USS

Additional Information

For additional information, please contact

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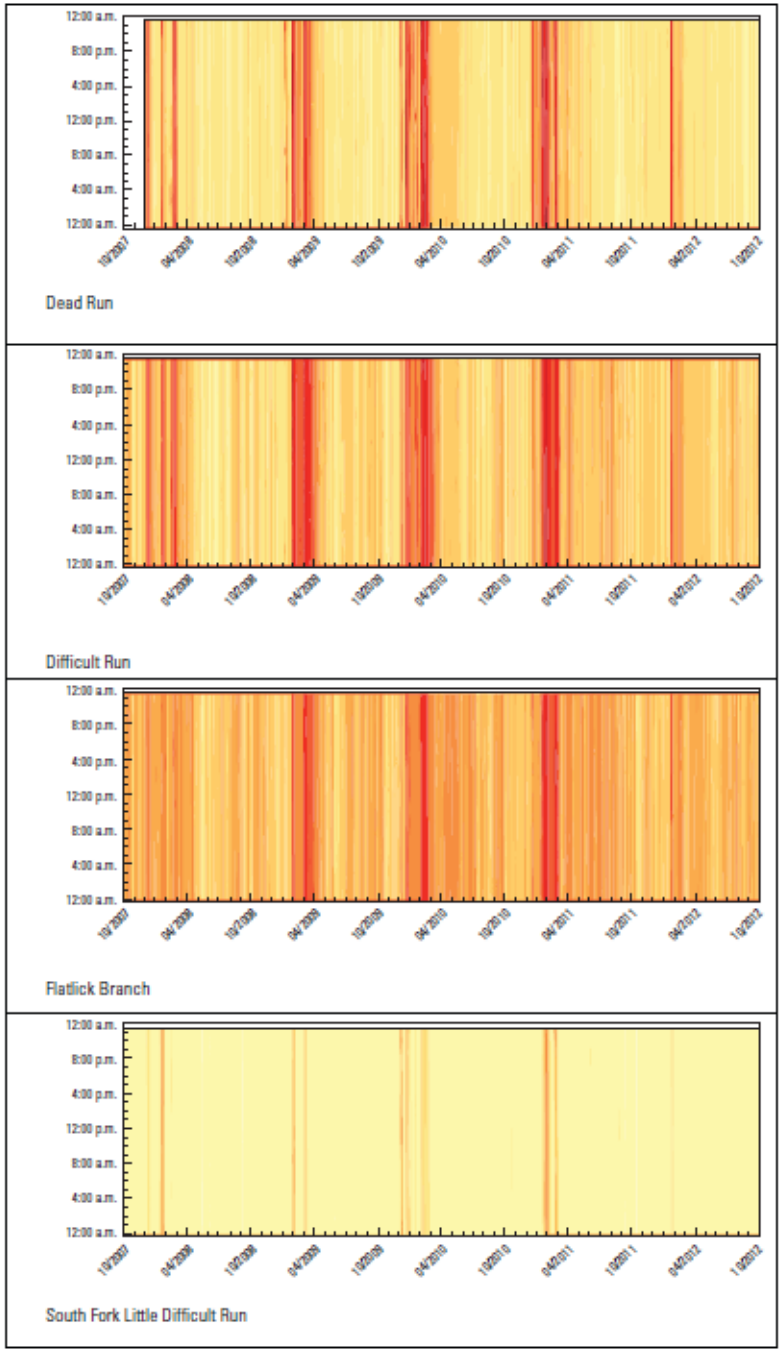

Extirpation Thresholds (T_{95}) vs. Tolerance Values (TVs)