Monitoring in Support of Numeric Nutrient Criteria

Robert J. Miltner

Ohio Environmental Protection Agency

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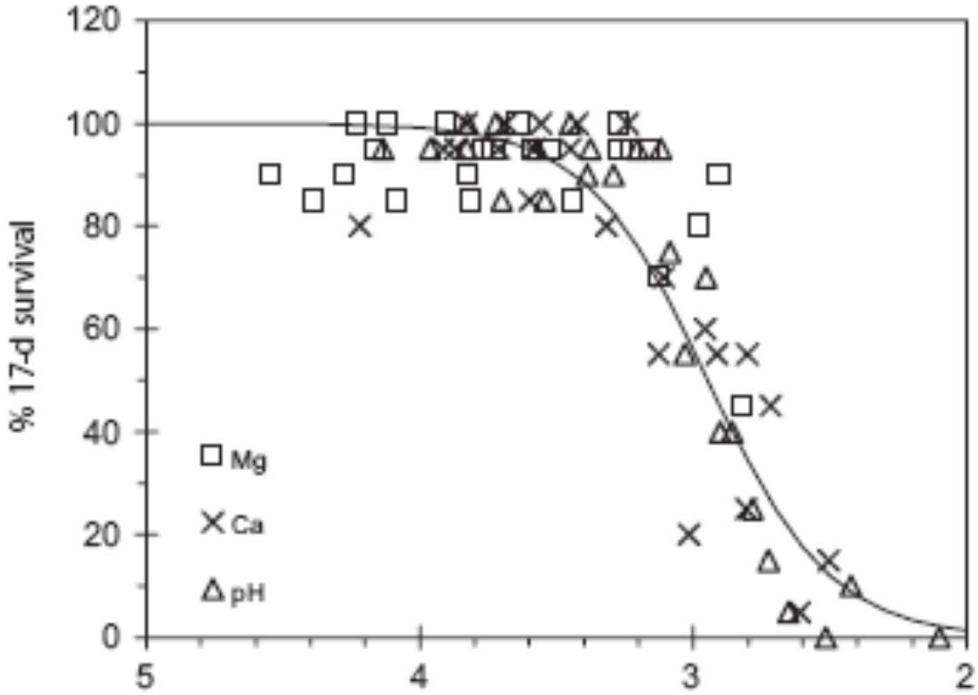
Numeric Nutrient Criteria

Challenges of Implementation

Traditional Paradigm

- Establish protective standard based on well-defined dose-response relationships
- Facilitates implementation
  - Reasonable Potential
  - Independent Application
- Generally amenable to single number or simple algorithmic standard

Survival Curve for Rainbow Trout Exposed to Ni



Deleebeeck et al. (2007) Ecotoxicology and Environmental Safety 67:1-13

- *"To be acceptable to the public and useful in field situations, protection of aquatic organisms and their uses should be defined as prevention of unacceptable ...effects on... fish and benthic invertebrate assemblages in rivers and streams..."* 1985 USEPA Guidelines on Numeric Criteria

Glossary

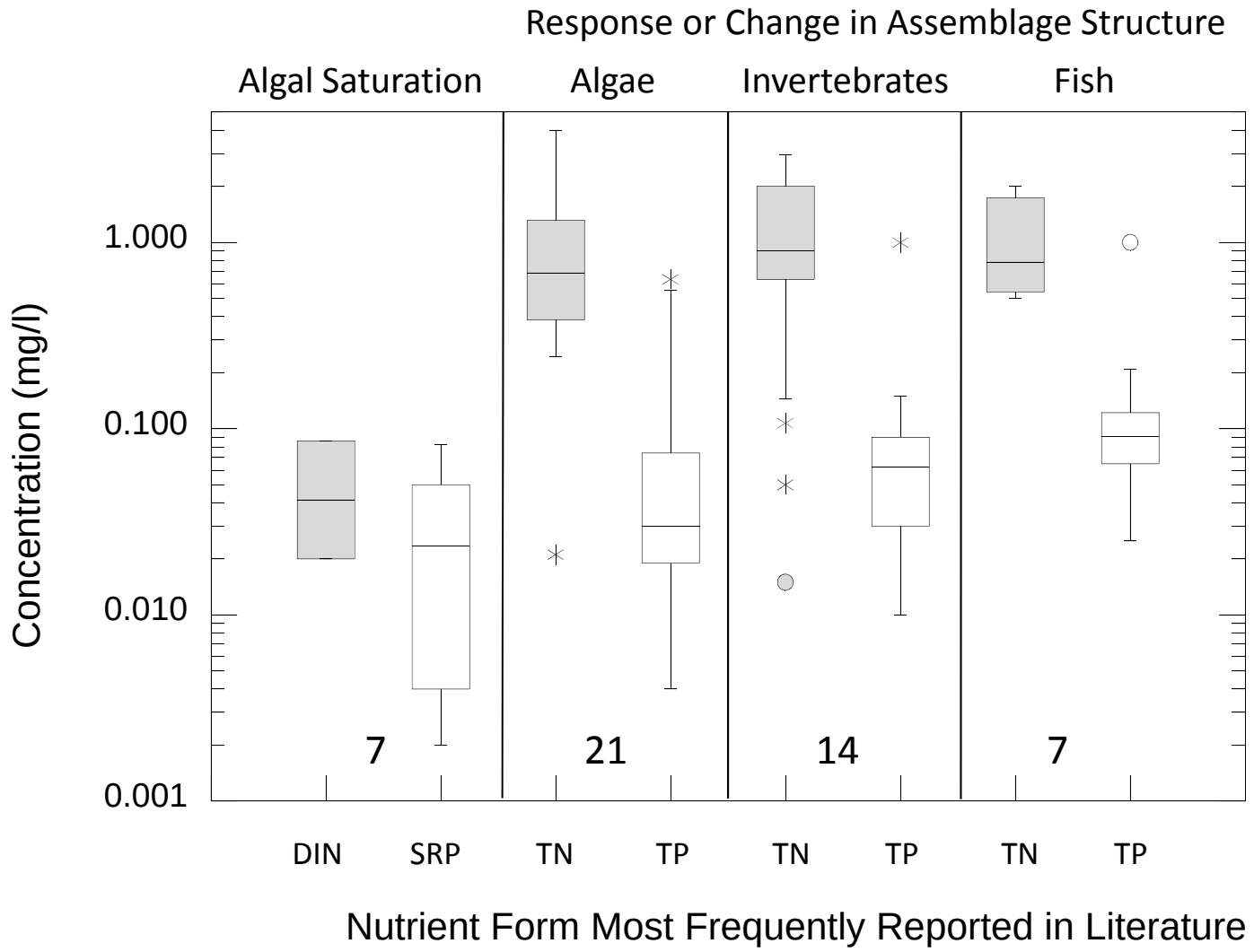
- Independent Application [policy]
  - chemical-specific, whole effluent, or biological measures can demonstrate non-attainment independently of each other
- Reasonable Potential [40 CFR 122.44 (d) (1) (i)]
  - NPDES limits are needed for pollutants discharged at a level with the **reasonable potential** to cause, or contribute to an excursion above a water quality standard (i.e. non-attainment)
- Protection of Downstream Uses
  - literal, WQS must protect downstream use

Independent Application, Reasonable Potential & Protection of Downstream Uses

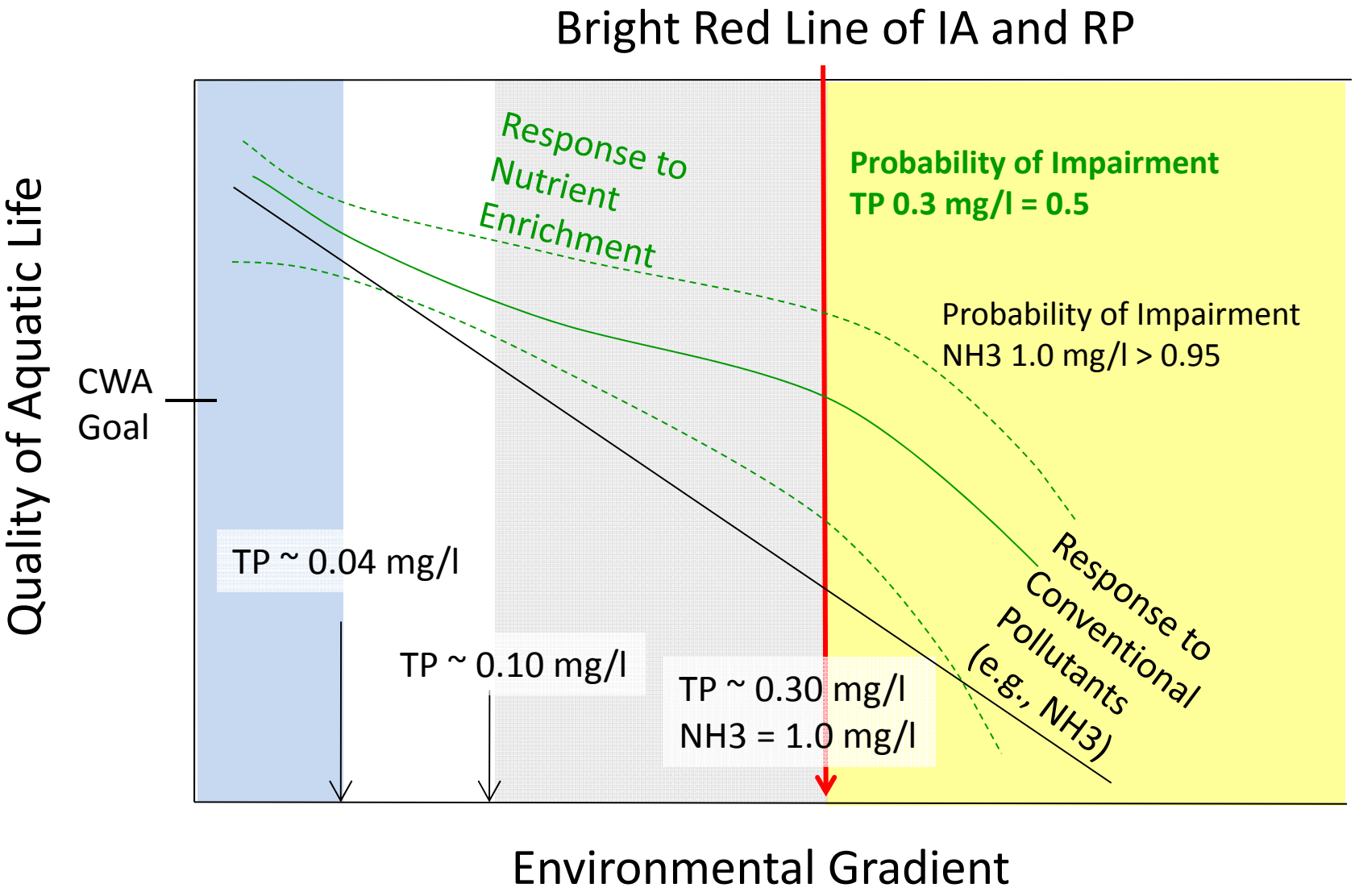
- Basic organizing principal behind administrative and programmatic implementation of the CWA
- 30 year history, generally successful
- Predicated on well-defined dose-response relationships

Nutrient Enrichment in Rivers and Streams

Benchmarks, Thresholds & Change Points

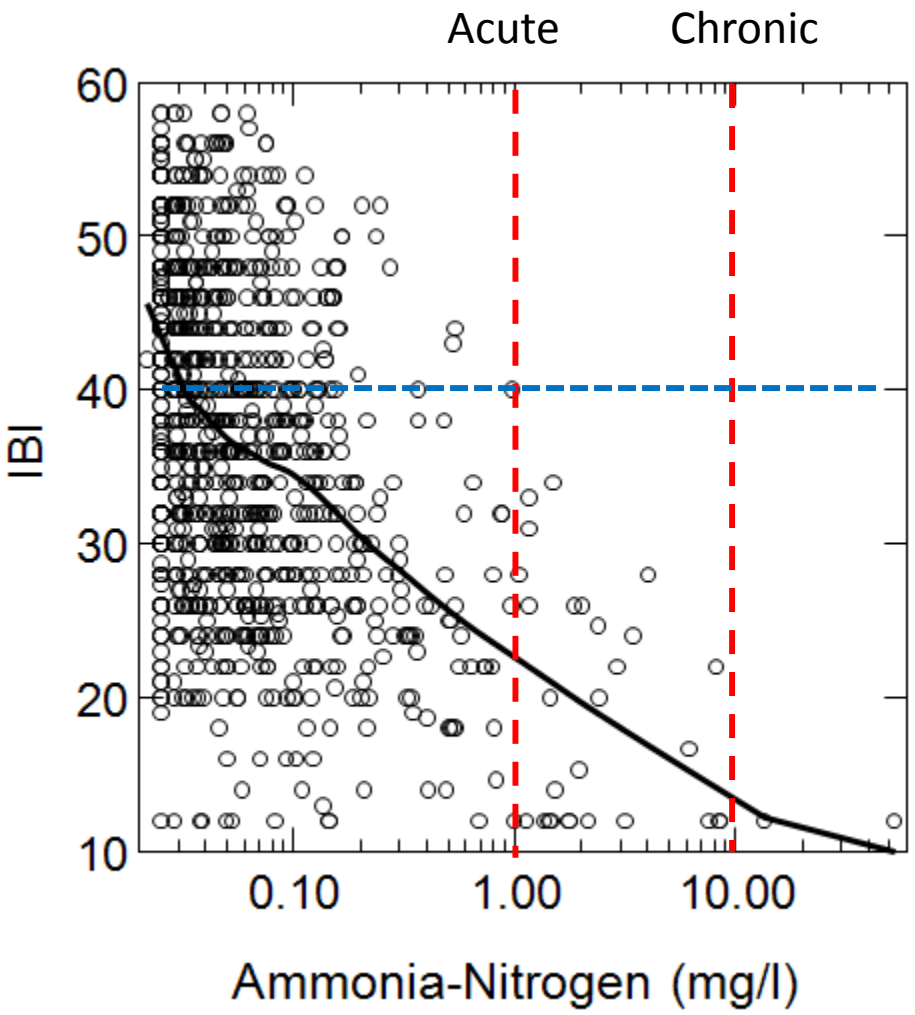


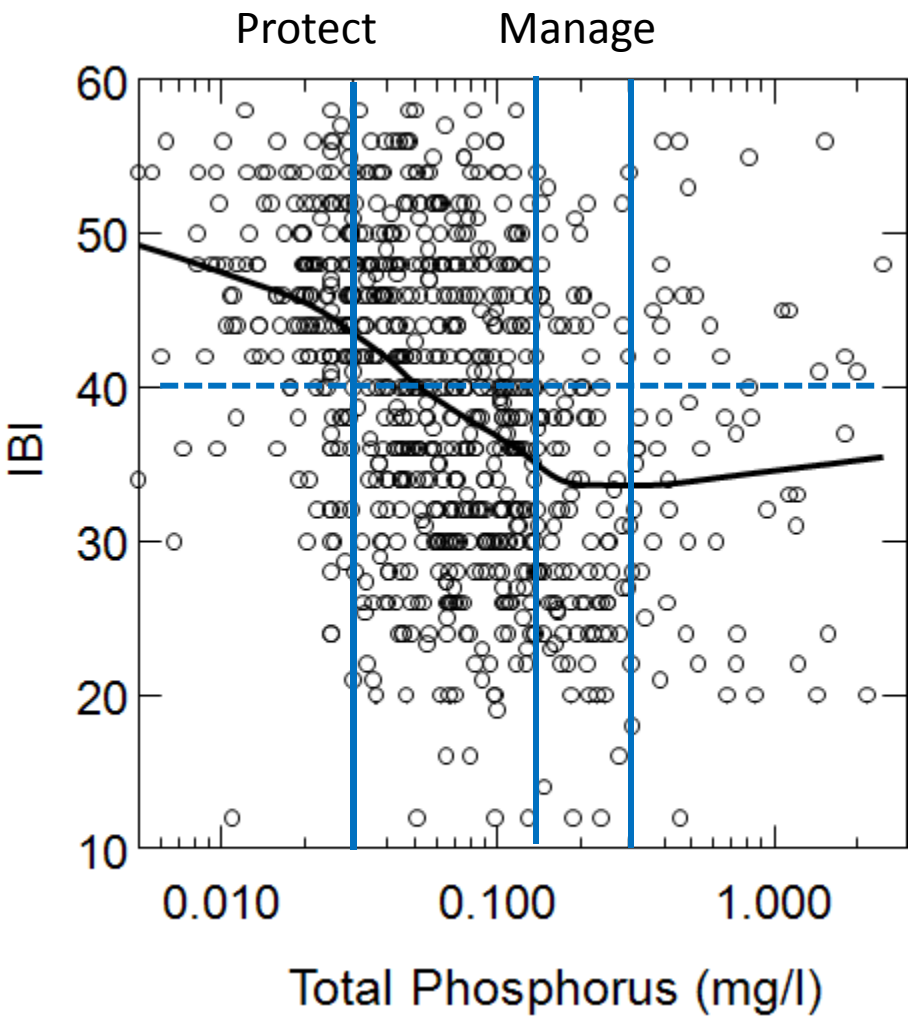
Conceptual Framework



Conceptual Framework with Real Data

Headwater Stream in the ECBP of Ohio





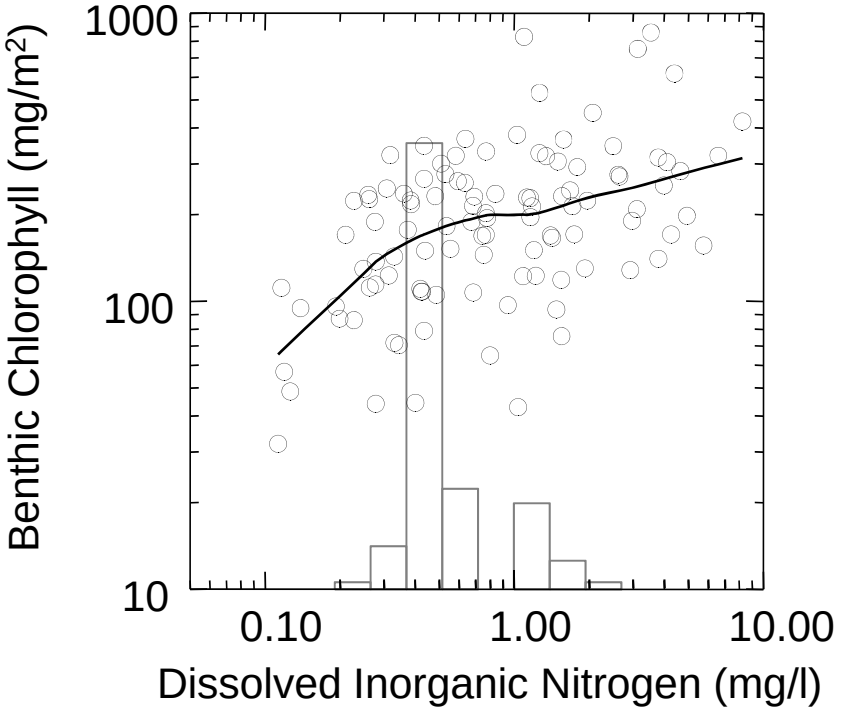
Reasonable Potential, Independent Application, and Protection of Downstream Uses

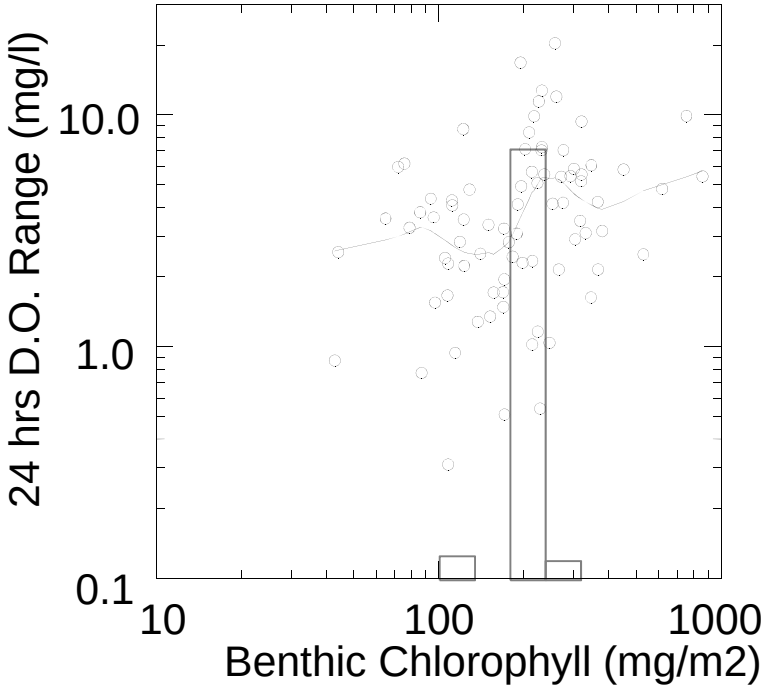
A New Paradigm

- Waterbody needs to be positioned on the enrichment gradient
  - requires information from response variables
- Evaluation within the context of the watershed
  - robust monitoring design that includes biological measures
  - lakes have their own criteria; TMDL WLA for impaired lake may supersede stream NNC; *DPVs ruled arbitrary for unimpaired lakes (Florida)*
- Complexity precludes independent application of concentration-based criteria
  - complexity not an excuse for inaction

Develop Enrichment Indicators

- Step 1, Examine relationships between causal and response variables
- Step 2, Make sense of noisy, tenuous relationships
  - no silver bullet, at the end of the day, some BPJ is involved
- Step 3, Use resulting information to set benchmarks, thresholds, criteria





Change Points and Thresholds Identified in Nutrient Study of Ohio Rivers and Streams

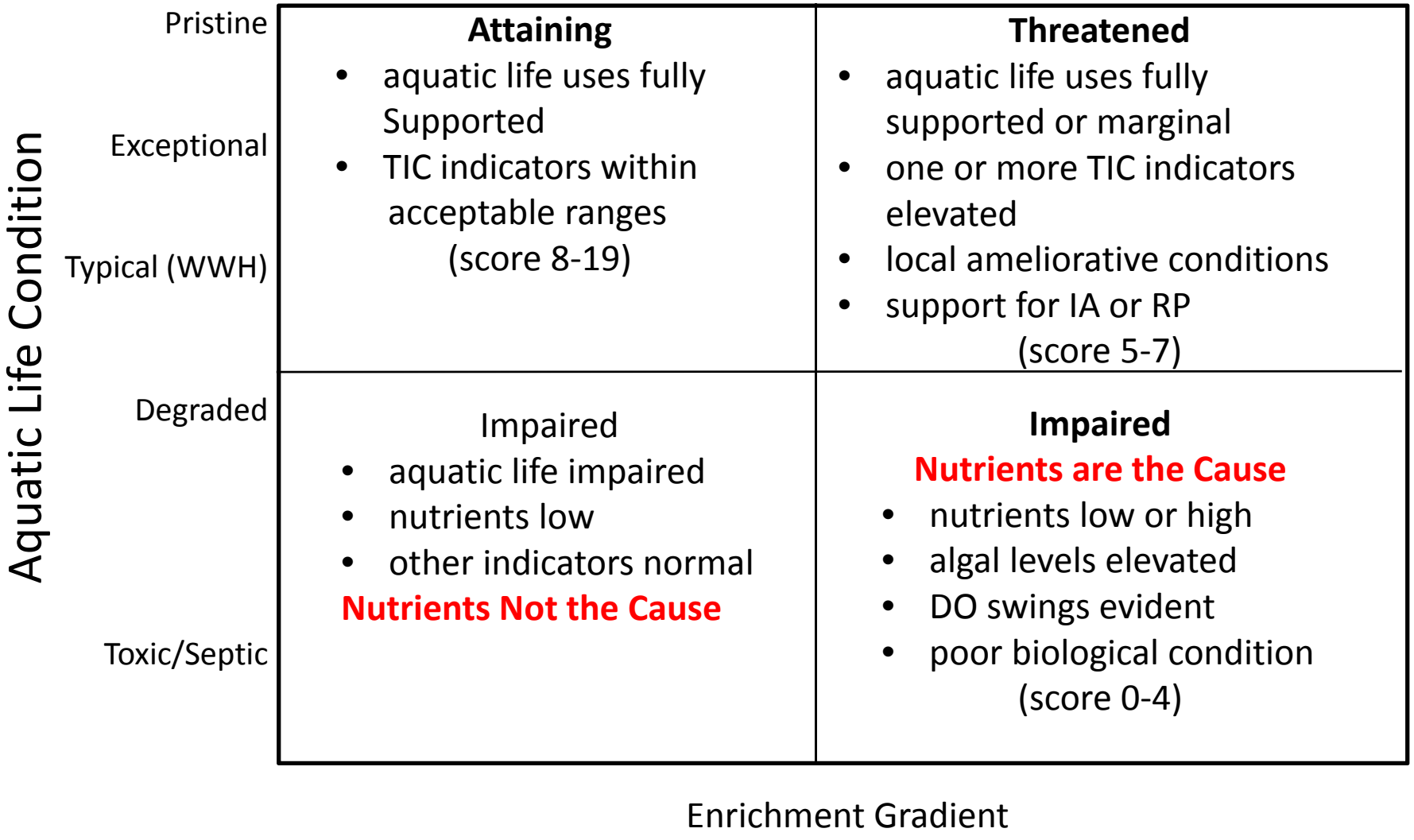
Drainage Areas < 1000 mi^2

DIN (mg/l)	TP (mg/l)	Benthic Chl a (mg/m2)	24 hour DO Range (mg/l)	DO Min (mg/l)	Canopy (degree open)
0.44	0.04	120	6	6	<45
1.0	0.10	183	9	5	<45

- Collective assessment of these measures plus information from biological communities can be used to position a water body along an enrichment gradient
- Rarefied as Trophic Index Criterion (TIC)

The Trophic Index as a Box Model

Positions Waterbody on an Enrichment Gradient



Draft Numeric Nutrient Criteria

Ohio Wadeable Streams and Small Rivers

Aquatic Life Use and QHEI	**TP (mg/l)**	**DIN (mg/l)**
Exceptional warmwater habitat and all QHEI scores	0.060	3.0
Warmwater habitat and QHEI score = 12 to 64	0.13	3.0
All other aquatic life uses and QHEI scores	0.30	3.0

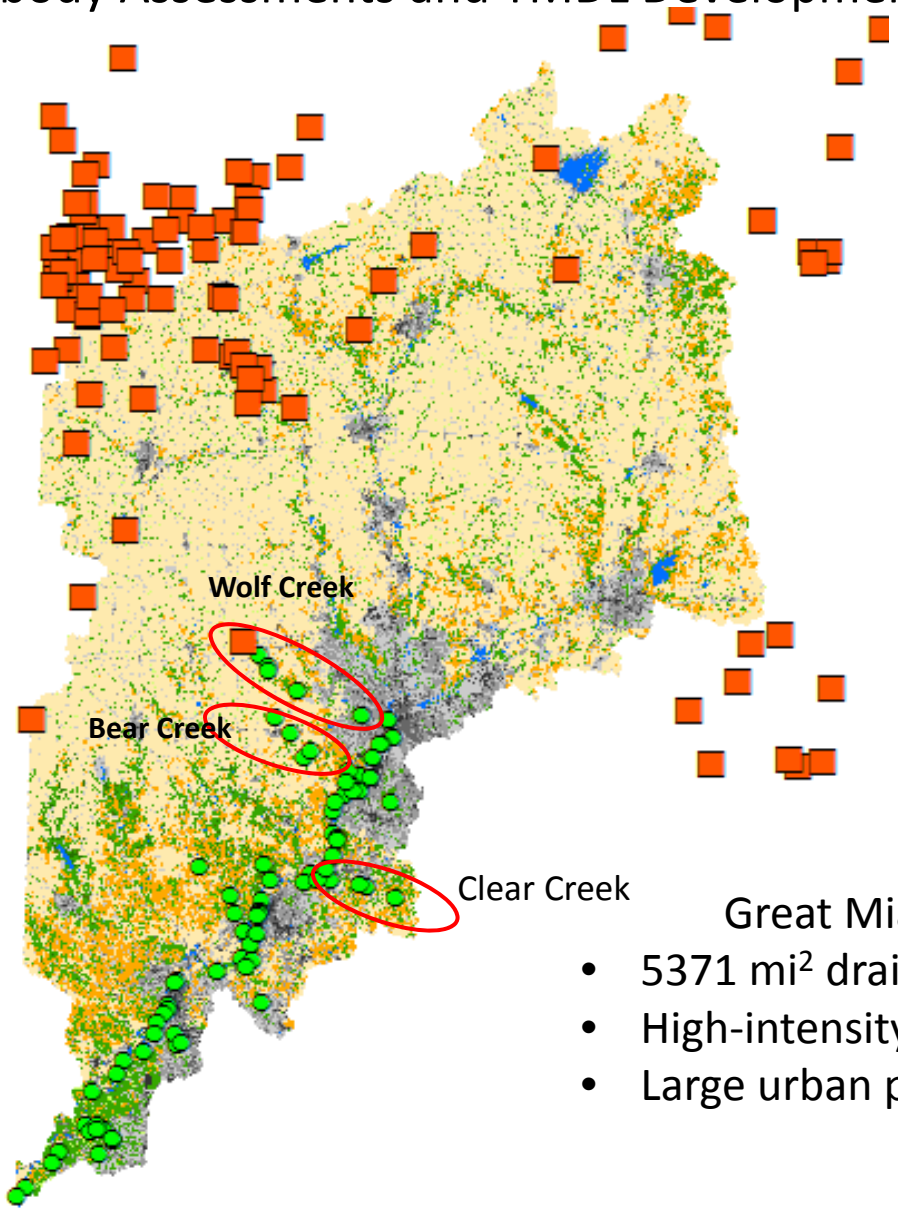
Application of Trophic Index Criterion

Waterbody Assessments and TMDL Development

AFO

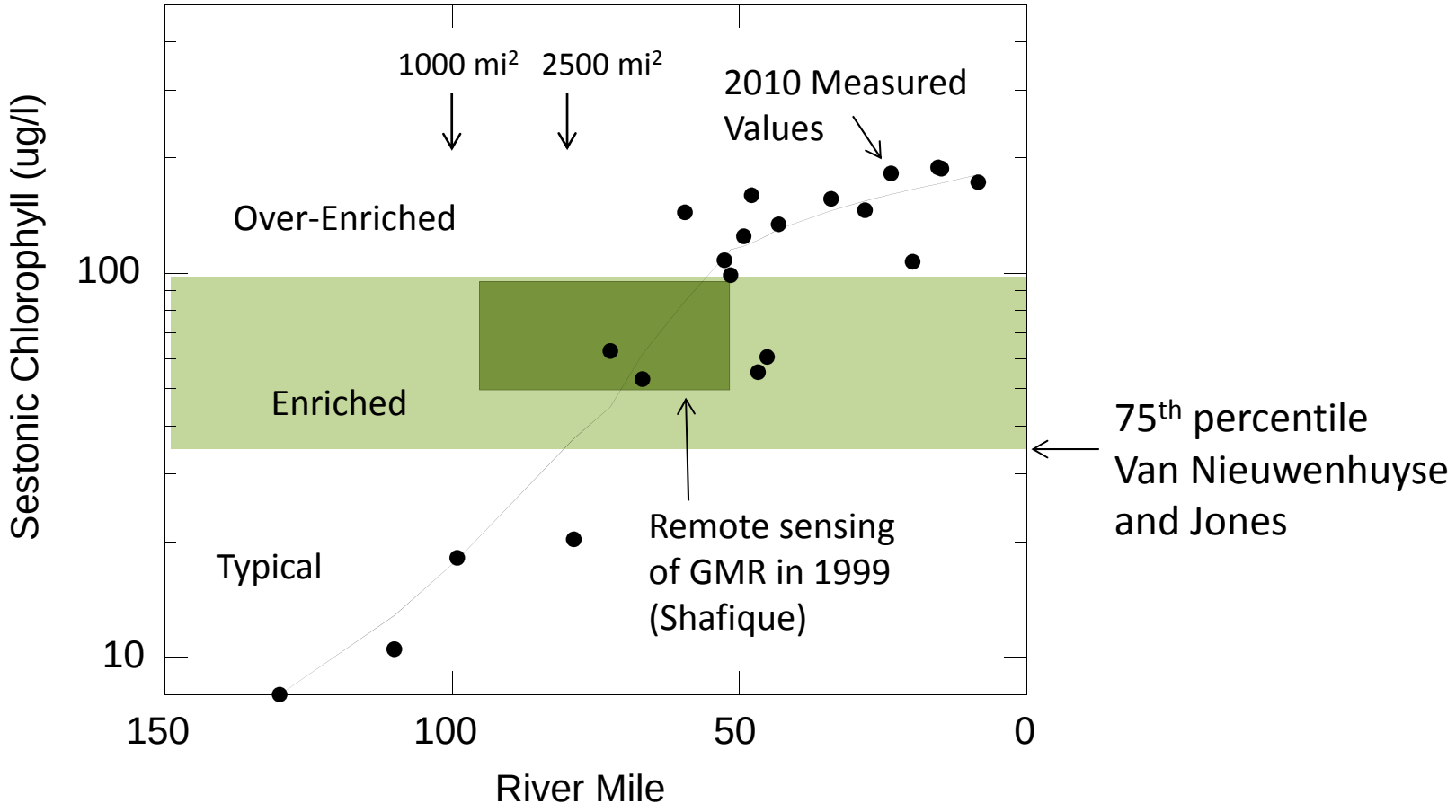
Row Crop
Pasture
Urban
Forest

2010 Monitoring
- fish
- macroinvertebrates
- water quality
- sestonic chlorophyll
- benthic chlorophyll
- continuous D.O.
- habitat quality

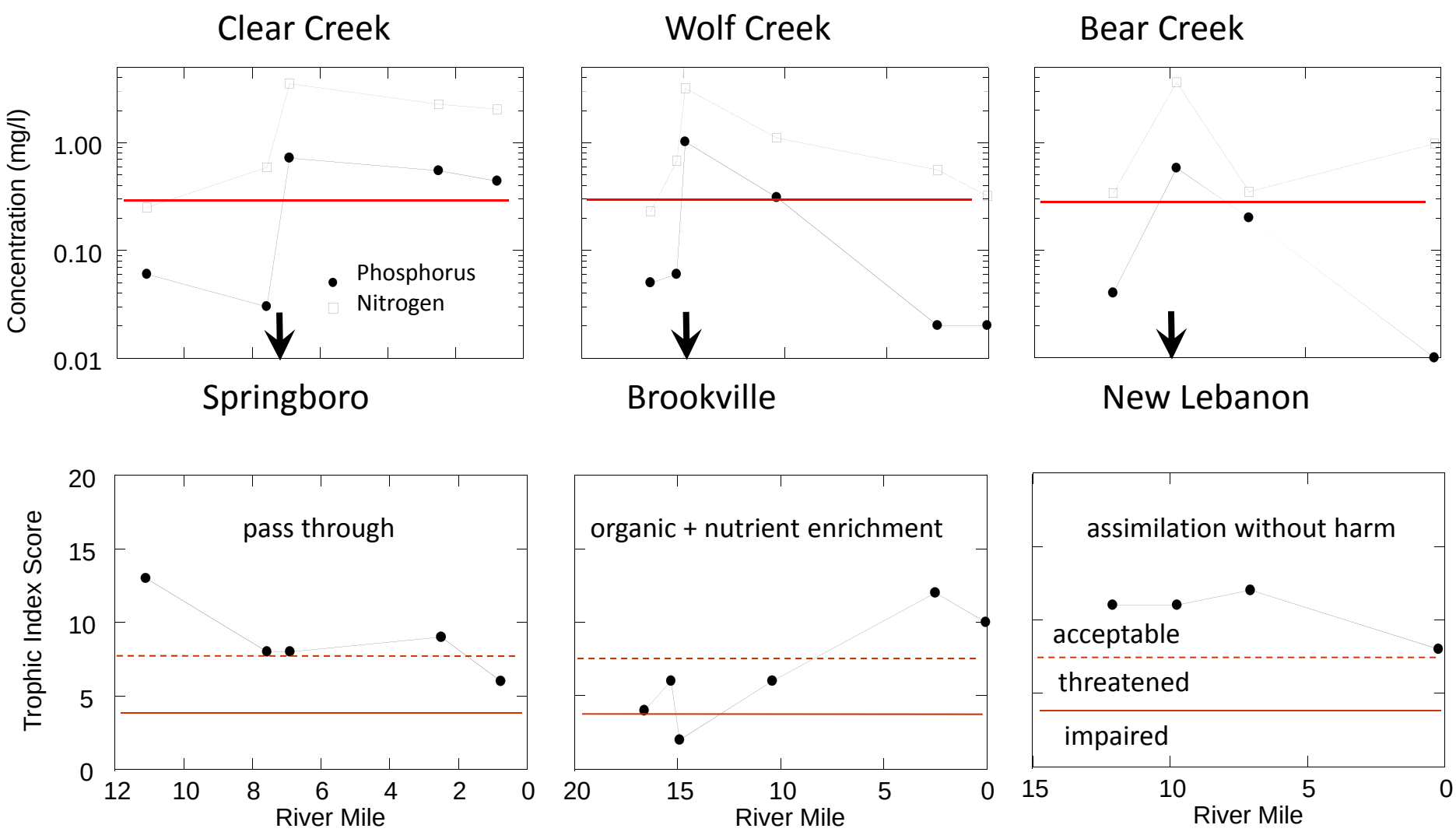


Great Miami River
- 5371 mi^2 drainage area
- High-intensity agriculture
- Large urban population

Great Miami River
Sestonic Chlorophyll *a* Concentrations



TIC Applied to Tributary Streams in the GMR



Summary and Conclusions

- Measurable changes to stream systems occur along a nutrient gradient
  - Implies system will respond to management
  - Monitor causal and response variables to determine waterbody position on enrichment gradient
    - phosphorus, nitrogen
    - chlorophyll, algae cover (e.g., Biggs)
    - dissolved oxygen, pH
    - assemblages (diatoms, macroinvertebrates or fish)
  - Complexity precludes independent application of chemical indicators
  - TIC encapsulates indicators, reduces to algorithm
    - Application is 2 parts heuristic, 1 part algorithmic