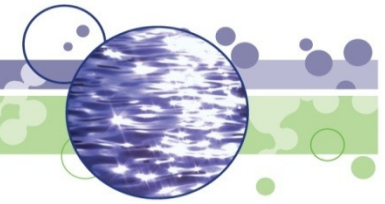




We Protect Hoosiers and Our Environment

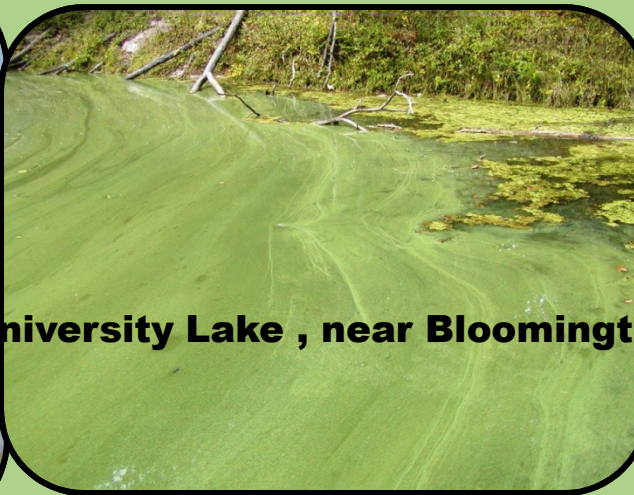
Water



Development of Nutrient Criteria for Indiana's Lakes



Palestine Lake, near Fort Wayne



University Lake , near Bloomington

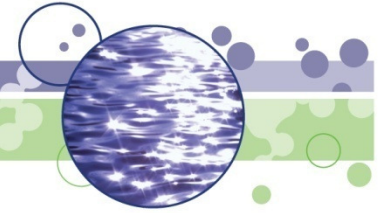
Indiana Clean Lakes Program, 2009

Shivi Selvaratnam, Ph.D.
Indiana Department of Environmental Management
Indiana Water Environment Association
September 21, 2010



Outline

- Why Develop Nutrient Criteria?
- Adverse Impacts of Nutrient Pollution
- Nutrient Sources
- Nutrient Pollution in Indiana's Lakes
- Approaches for Developing Nutrient Criteria
- Multiple Lines of Evidence
- USEPA's National Nutrient Strategy
- Indiana Data
- Data Analysis and Summary of Results
- Next Steps

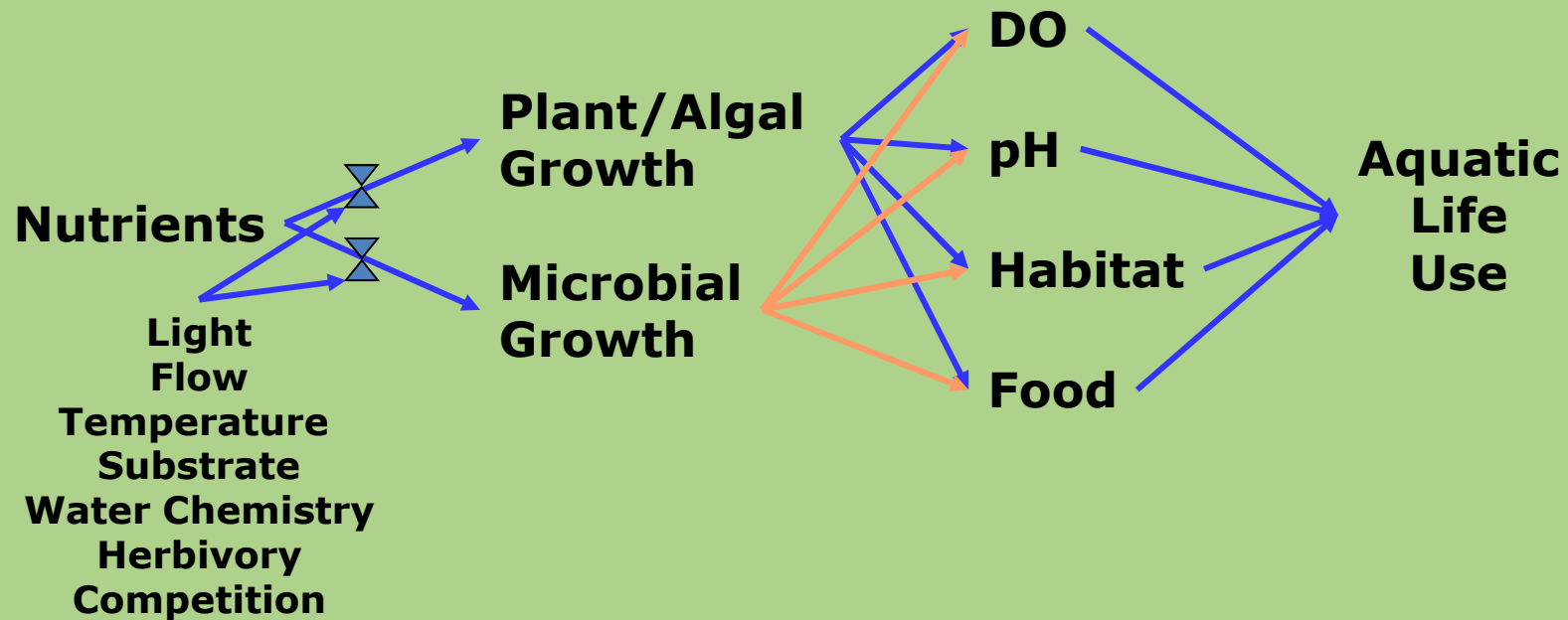


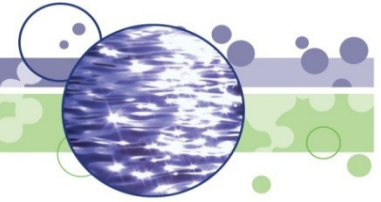
Why Develop Nutrient Criteria?

- Statutory requirements
- USEPA committed to developing nutrient criteria in the Clean Water Action Plan (1998)
- Protect waters from harmful nutrient impacts
- Nutrient criteria are necessary to support 303(d) listing decisions and Total Maximum Daily Loads (TMDLs)



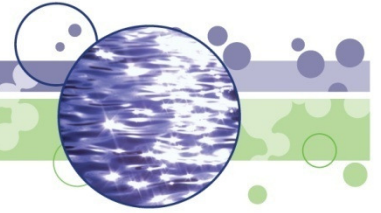
Adverse Impacts of Nutrient Pollution





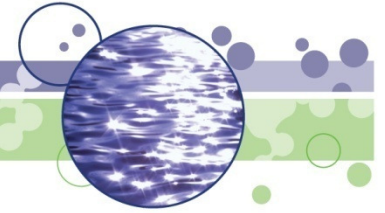
Sources Contributing to Nutrient Pollution

- Waste water treatment plants
- Agricultural run-off
- Animal feed lots
- Lawn fertilizers
- Erosion
- Industry
- Background / natural occurrences



Nutrient Pollution in Indiana's Lakes

- Nutrients fourth cause of impairments in lakes
- Nutrient impairments assessed based on total phosphorous (TP) and chlorophyll *a* (chl *a*) benchmarks
- Currently, 50 lakes on 303(d) list of impaired waters for nutrients

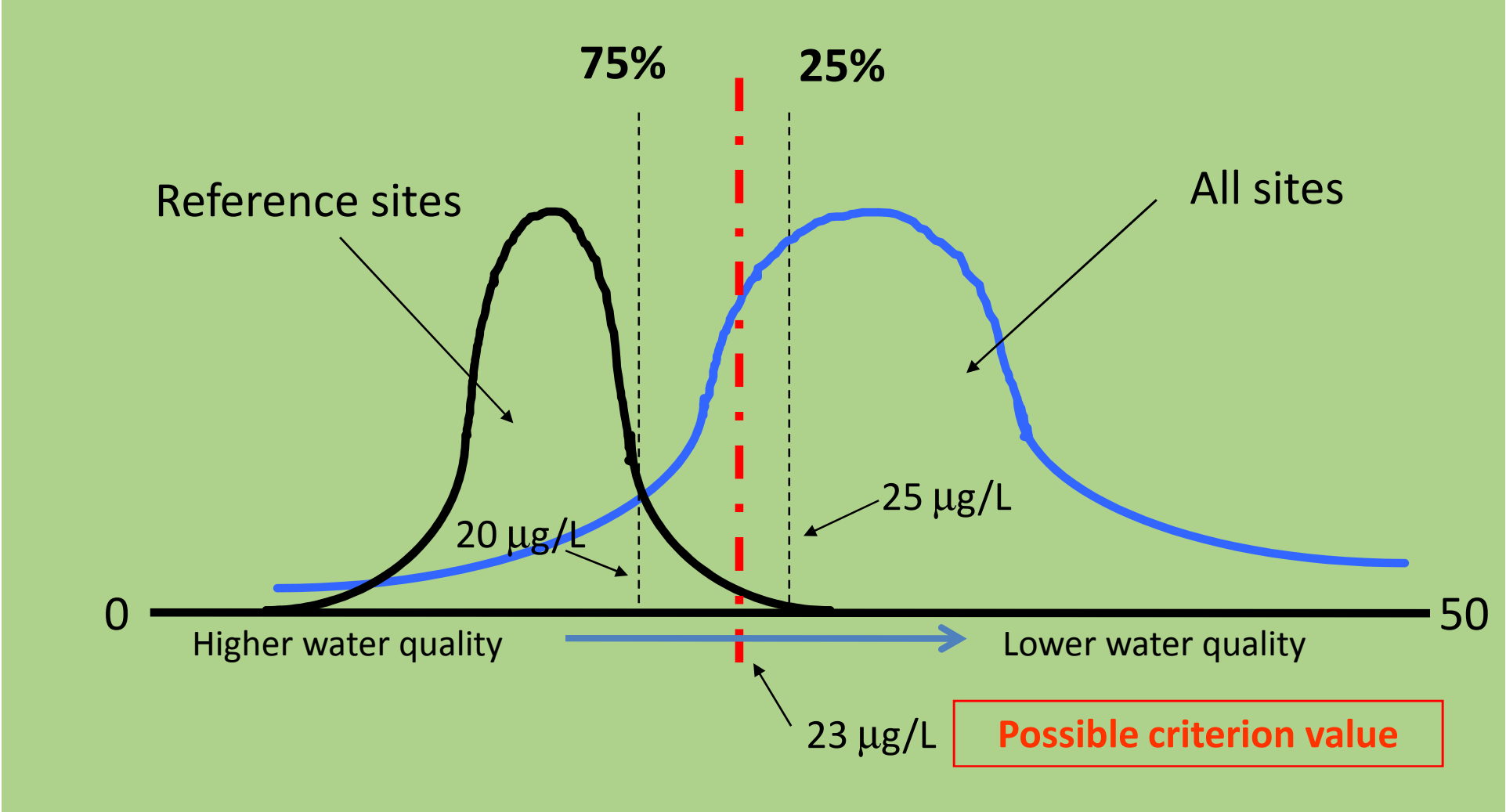


Approaches for Developing Nutrient Criteria

- Distributional/Reference Approach
- Stressor-Response (Effects Based)
- Scientific Literature
- Models
- Experiments



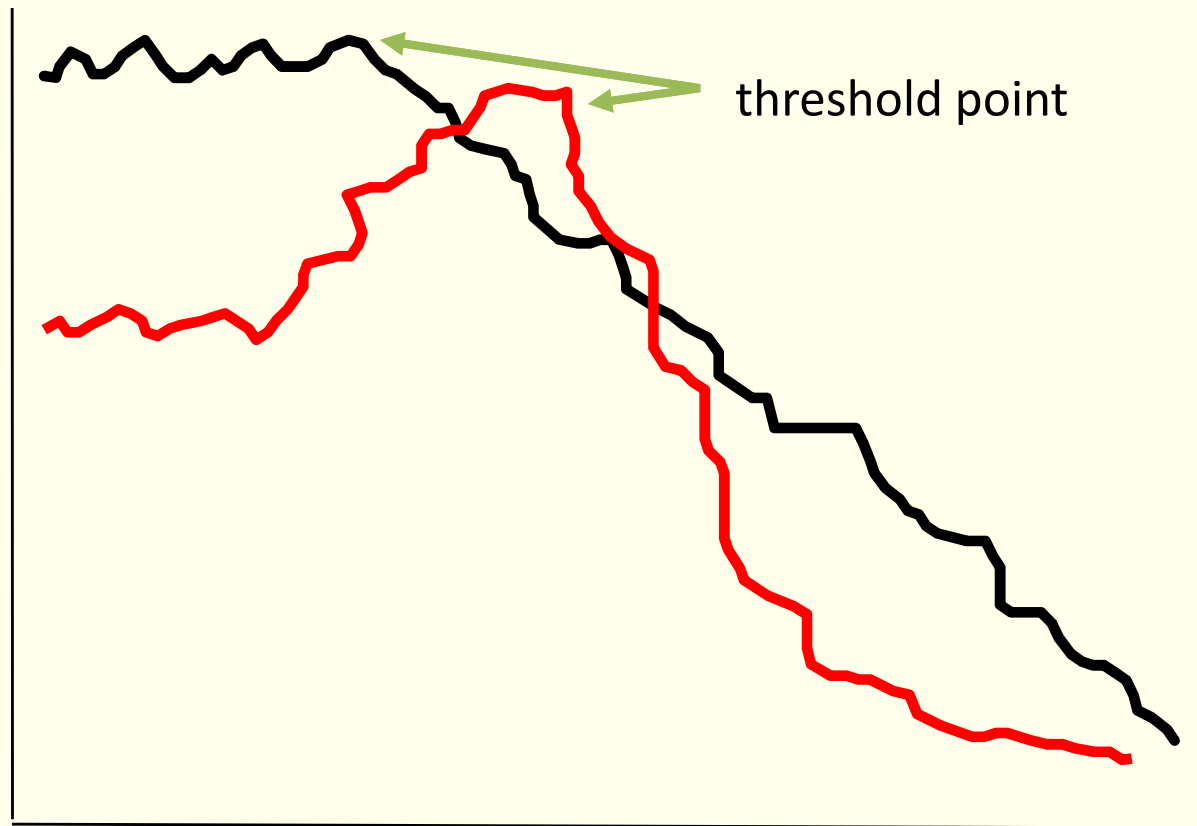
Distribution Based Approach (USEPA Approach)





Stressor-Response Approach

↑
Ecological attribute



→
Increasing nutrient concentration



Scientific Literature

- Established thresholds
- Known effects levels

Comparing effects of nutrients on algal biomass in streams in two regions with different disturbance regimes and with applications for developing nutrient criteria

R. Jan Stevenson^{1,*}, Steven T. Rier², Catherine M. Riseng³, Richard E. Schultz⁴
& Michael J. Wiley³

¹Department of Zoology, Michigan State University, East Lansing, MI, 48824, USA

²Department of Biological & Allied Health Sciences, Bloomsburg University, Bloomsburg, PA, 17815, USA

³School of Natural Resources and the Environment, The University of Michigan, Ann Arbor, MI, 48109, USA

⁴Department of Biological Sciences, University of Louisville, Louisville, KY, 40292, USA

(*Author for correspondence: E-mail: rjstev@msu.edu)

SUGGESTED CLASSIFICATION OF STREAM TROPHIC STATE: DISTRIBUTIONS OF TEMPERATE STREAM TYPES BY CHLOROPHYLL, TOTAL NITROGEN, AND PHOSPHORUS

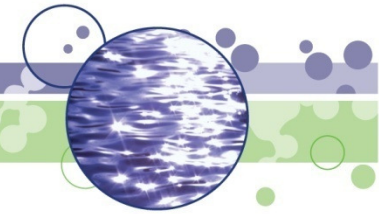
WALTER K. DODDS^{1,*}, JOHN R. JONES² and EUGENE B. WELCH¹

¹Division of Biology, Kansas State University, Manhattan, KS 66506, U.S.A., ²School of Natural Resources, 112 Stephens Hall, University of Missouri, Columbia, MO 65211, U.S.A. and ³Department of Civil Engineering, P.O. Box 352700, University of Washington, Seattle, WA 98195, U.S.A.

DEVELOPING NUTRIENT TARGETS TO CONTROL BENTHIC CHLOROPHYLL LEVELS IN STREAMS: A CASE STUDY OF THE CLARK FORK RIVER

W. K. DODDS^{1,*}, V. H. SMITH² and B. ZANDER³

¹Division of Biology, Kansas State University, Manhattan, KS 66506, U.S.A., ²Environmental Studies Program and Department of Systematics and Ecology, University of Kansas, Lawrence, KS 66045, U.S.A., ³United States Environmental Protection Agency Region 8, Suite 500, 999 18th St. Denver, CO 80202, U.S.A.



Models

- Mechanistic
- Empirical

Stream Water Quality Model (QUAL2K)



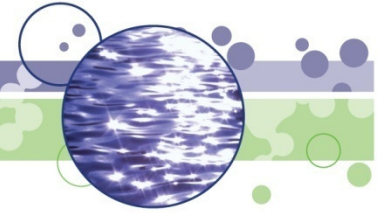
QUAL2K (or Q2K) is a river and stream water quality model that is intended to represent a modernized version of the QUAL2E (or Q2E) model (Brown and Barnwell 1987).

- Sediment-water dissolved oxygen rather than being nutrient fluxes and particulate organic and the concentration waters.
- Bottom algae, bottom algae.

Regional interpretation of water-quality monitoring data

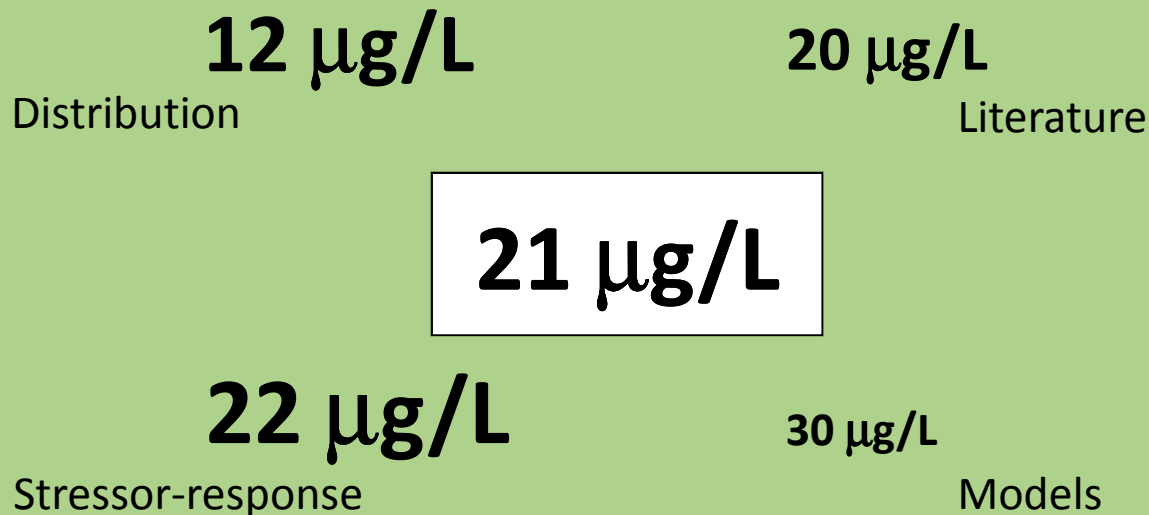
Richard A. Smith, Gregory E. Schwarz, and Richard B. Alexander
 U.S. Geological Survey, Reston, Virginia

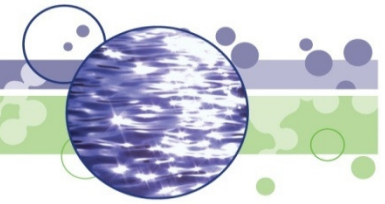
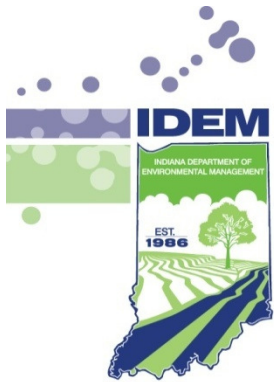
Abstract. We describe a method for using spatially referenced regressions of contaminant transport on watershed attributes (SPARROW) in regional water-quality assessment. The method is designed to reduce the problems of data interpretation caused by sparse sampling, network bias, and basin heterogeneity. The regression equation relates measured transport rates in streams to spatially referenced descriptors of pollution sources and land-surface and stream-channel characteristics. Regression models of total phosphorus (TP) and total nitrogen (TN) transport are constructed for a region defined as



Multiple Lines of Evidence

- Generate candidate endpoints
- Weight qualitatively using best professional judgment
- Final is a result of multiple lines





USEPA's National Nutrient Strategy

- Should reflect ecoregional differences
- Should be specific for waterbody type:
 - Rivers & Streams
 - Lakes & Reservoirs
 - Estuaries & Coastal
 - Wetlands
- Should include:
 - Total Nitrogen
 - Chlorophyll *a*
 - Total Phosphorus
 - Turbidity

(causal variables) **(early response variables)**

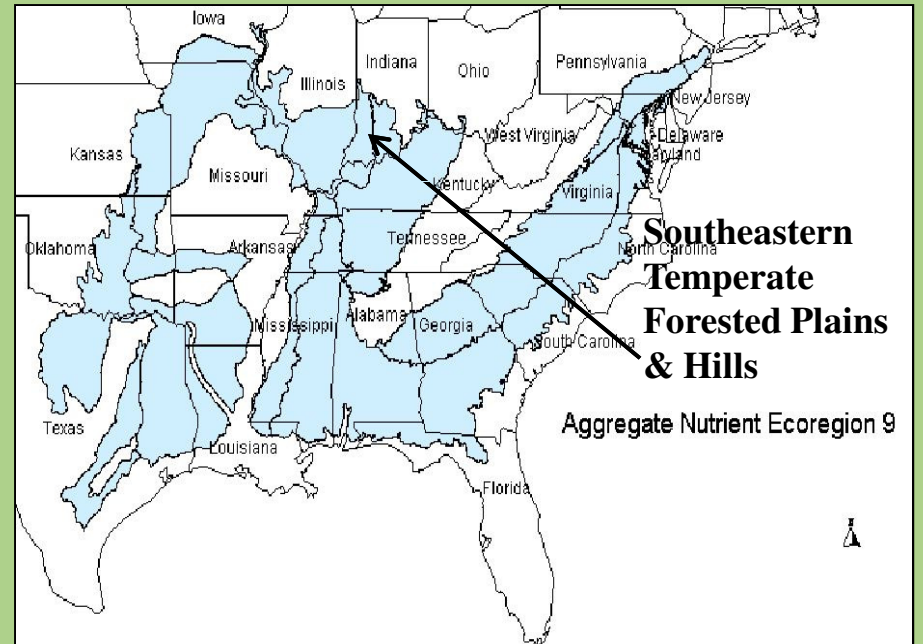
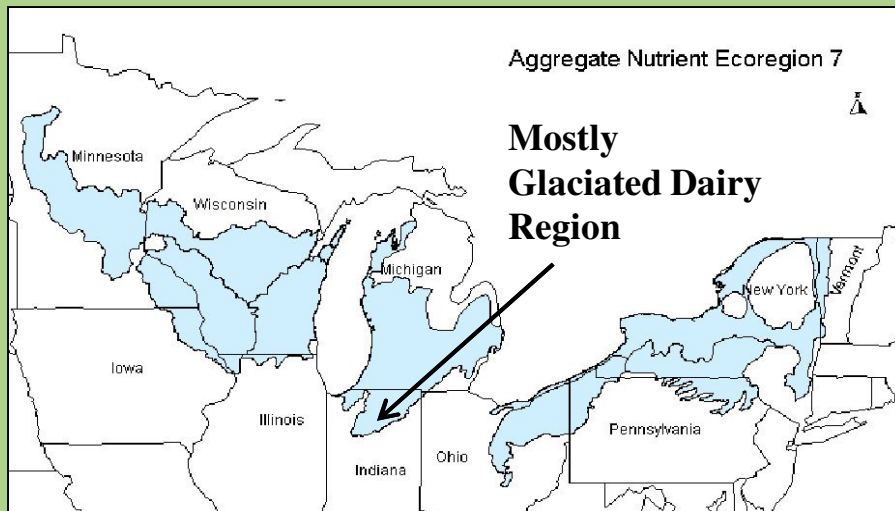
*Draft Aggregations of Level III Ecoregions
for the National Nutrient Strategy*

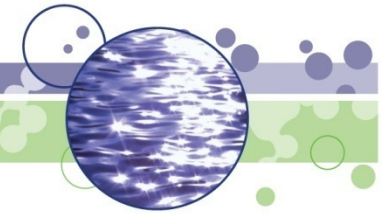


- I. Willamette and Central Valleys
- II. Western Forested Mountains
- III. Xeric West
- IV. Great Plains Grass and Shrublands
- V. South Central Cultivated Great Plains
- VI. Corn Belt and Northern Great Plains
- VII. Mostly Glaciated Dairy Region
- VIII. Nutrient Poor Largely Glaciated Upper Midwest and Northeast
- IX. Southeastern Temperate Forested Plains and Hills
- X. Texas-Louisiana Coastal and Mississippi Alluvial Plains
- XI. Central and Eastern Forested Uplands
- XII. Southern Coastal Plain
- XIII. Southern Florida Coastal Plain
- XIV. Eastern Coastal Plain



Indiana is Composed of Aggregate Nutrient Ecoregions VI, VII, IX





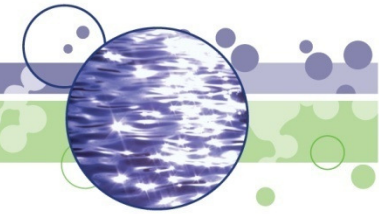
US EPA's Recommended Values Compared to Values Generated Using Indiana Ecoregional Data

Ecoregion	TP ($\mu\text{g/L}$)	Chl <i>a</i> ($\mu\text{g/L}$)	SD (m)
VI – IN	33	2	2
VI – EPA	38	9	1.3
VII – IN	23	2	2.7
VII – EPA	15	3	3.3
IX - IN	18	1	3.9
IX - EPA	20	5	1.5

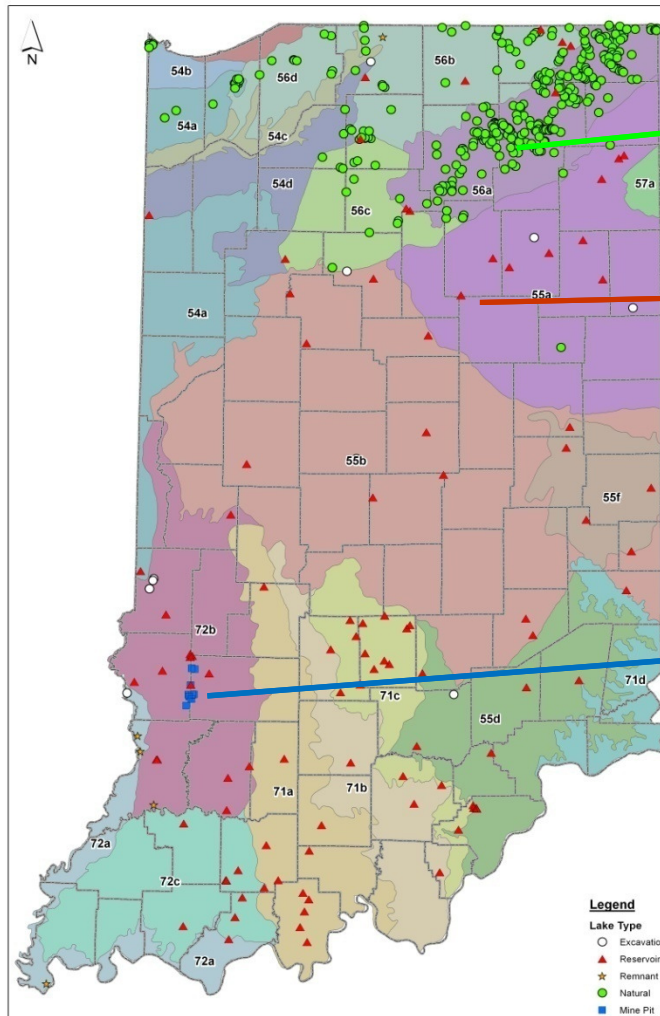


Indiana Data

- 1989 -2005 data
- Huge effort involved –
 - Compilation, QA/QC, and reduction
- Spatial Data - 3,629 different lentic waterbodies
 - Delineations, land cover (buffer) and watershed area
 - Geology
 - Geomorphology: max and mean depth, area
- Water Quality Data
 - TP, Chl α , SD, cyanobacteria cell counts, surface and bottom temp, % oxic
 - Summer medians calculated and medians across years then used
 - “Complete” data for ~520 lentic waters



Indiana Lakes Selected for Analysis

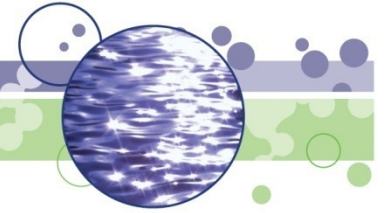


Natural Lakes (320)

Reservoirs (110)

Mine Pits (70)

Others (15)



Data Analysis

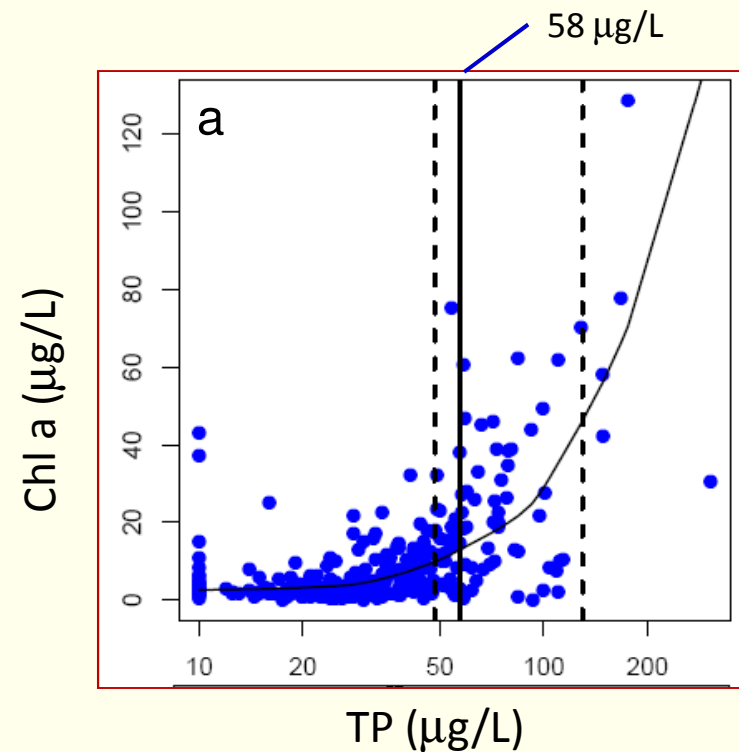
- Classification
 - Lake classes: natural, reservoirs, mine pits
- Distribution Based
- Examination of Stressor-Response relationship

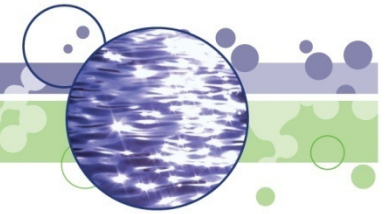


Stressor-Response Analysis

- Change-point analysis of raw data
 - Used to ID thresholds in response

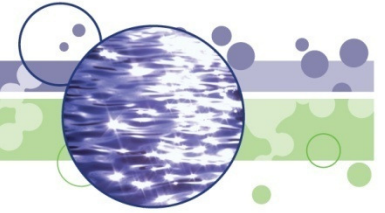
Summer Median Chl *a* vs. TP in Natural Lakes





Summary of Analyses

	<u>TP (µg/L)</u>	<u>Chl a (µg/L)</u>	<u>SD (m)</u>
Distribution Based			
Natural	23	2.4	2.7
Reservoir	28	1.7	2.5
Mine Pit	12	0.6	4.5
Other	31	4.2	2.0
Stressor-Response			
Natural	47		
Reservoir	56		
Mine Pit	35		



Next Steps

- (1) Development of final criteria
 - Recently completed regression analysis
- (2) Consultation with EPA
- (3) Stakeholder workgroup meetings
 - Implementation issues



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Water



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