Oklahoma Scenic Rivers Joint Phosphorus Criteria Study-Proposal

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Outline

- Theory of approach
- Field and lab sampling- data analyses
- Budget

MANDATORY STUDY COMPONENTS

The primary purpose of the Joint Study is to determine the total phosphorous threshold response level at which any statistically significant shift occurs in algal species composition or algal biomass production resulting in undesirable aesthetic or water quality conditions in the Designated Scenic Rivers.

Putting functional relationships and nutrient criteria into context

- What is best possible condition? (reference)
- What response variables are to be considered?
- How do response variables respond to nutrients (functional relationships)

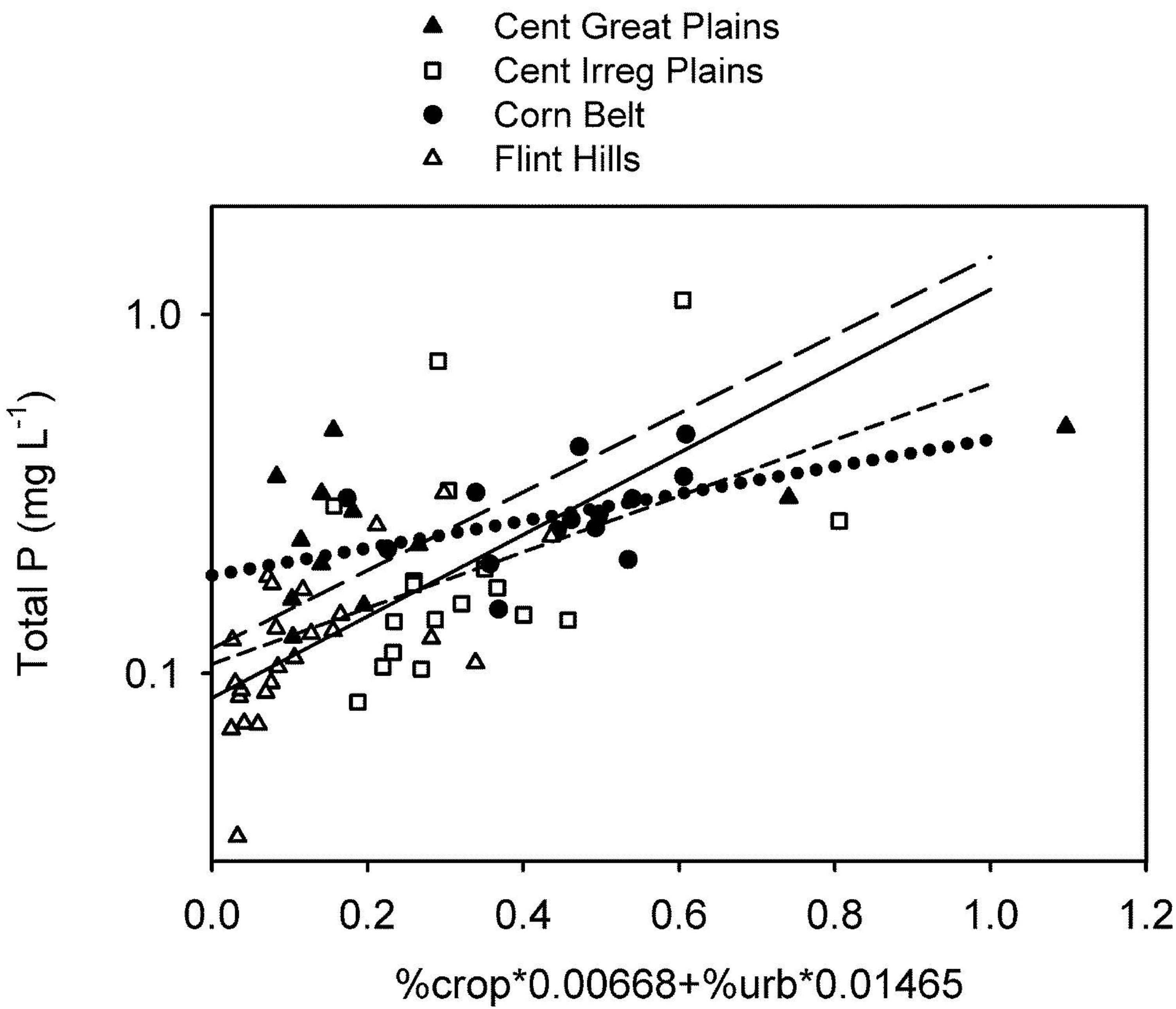
Reference nutrients

- What is the best possible condition?
- Sparrow models (account for downstream accumulation)
- Land use-land cover relationships (account for areas with few reference streams left)
- Reference streams (if they can be found, best indicators of low nutrients as well as local biological indicators)

Reference nutrients

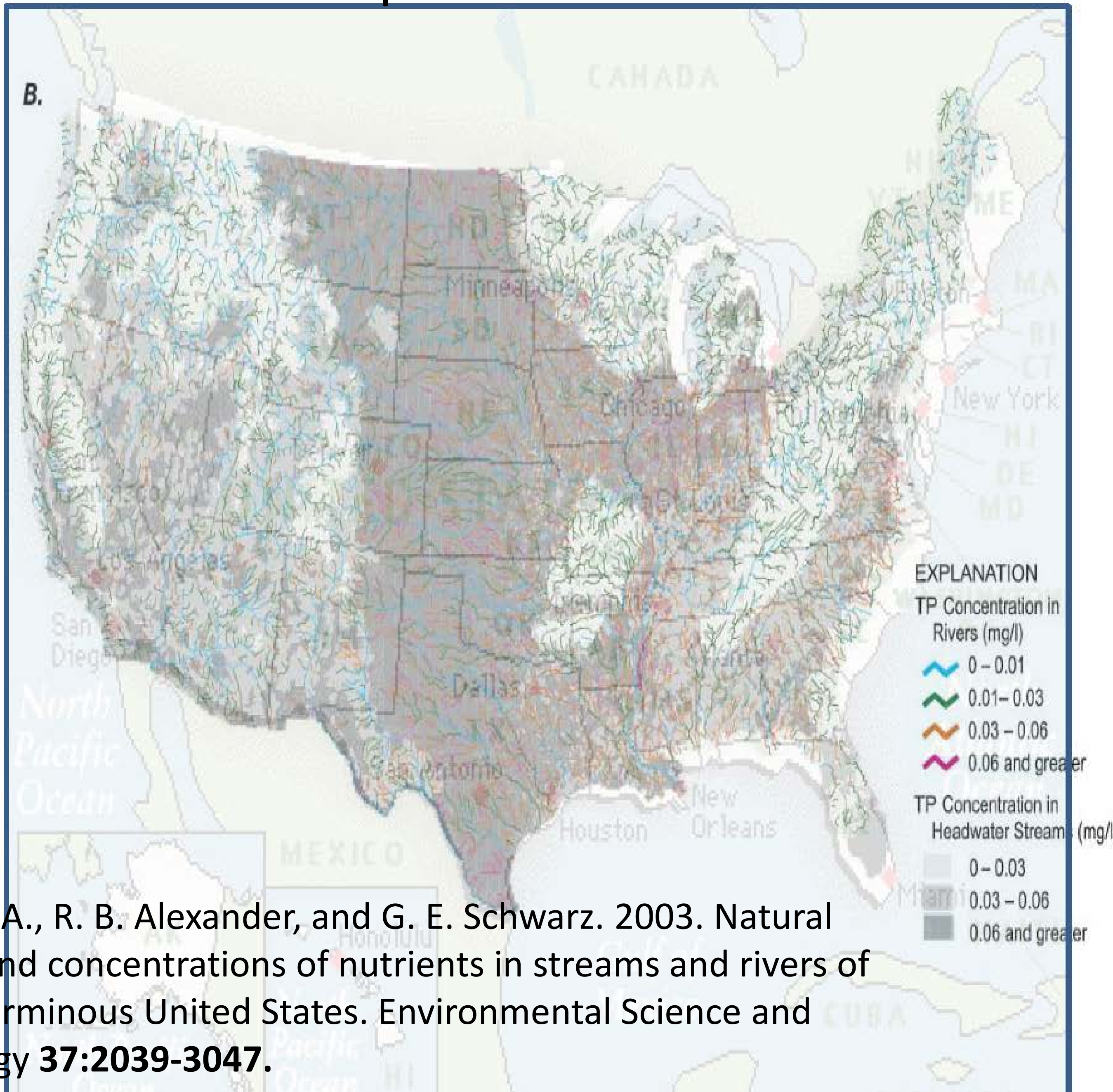
- Get regional results of Sparrow model
- Link land-use land-cover in watershed to nutrients across sub-basins of the scenic rivers
- Identify, cull existing data for, and sample current reference streams that feed into the designated scenic rivers (best of three approaches)

Draft Aggregations of Level III Ecoregions for the National Nutrient Strategy



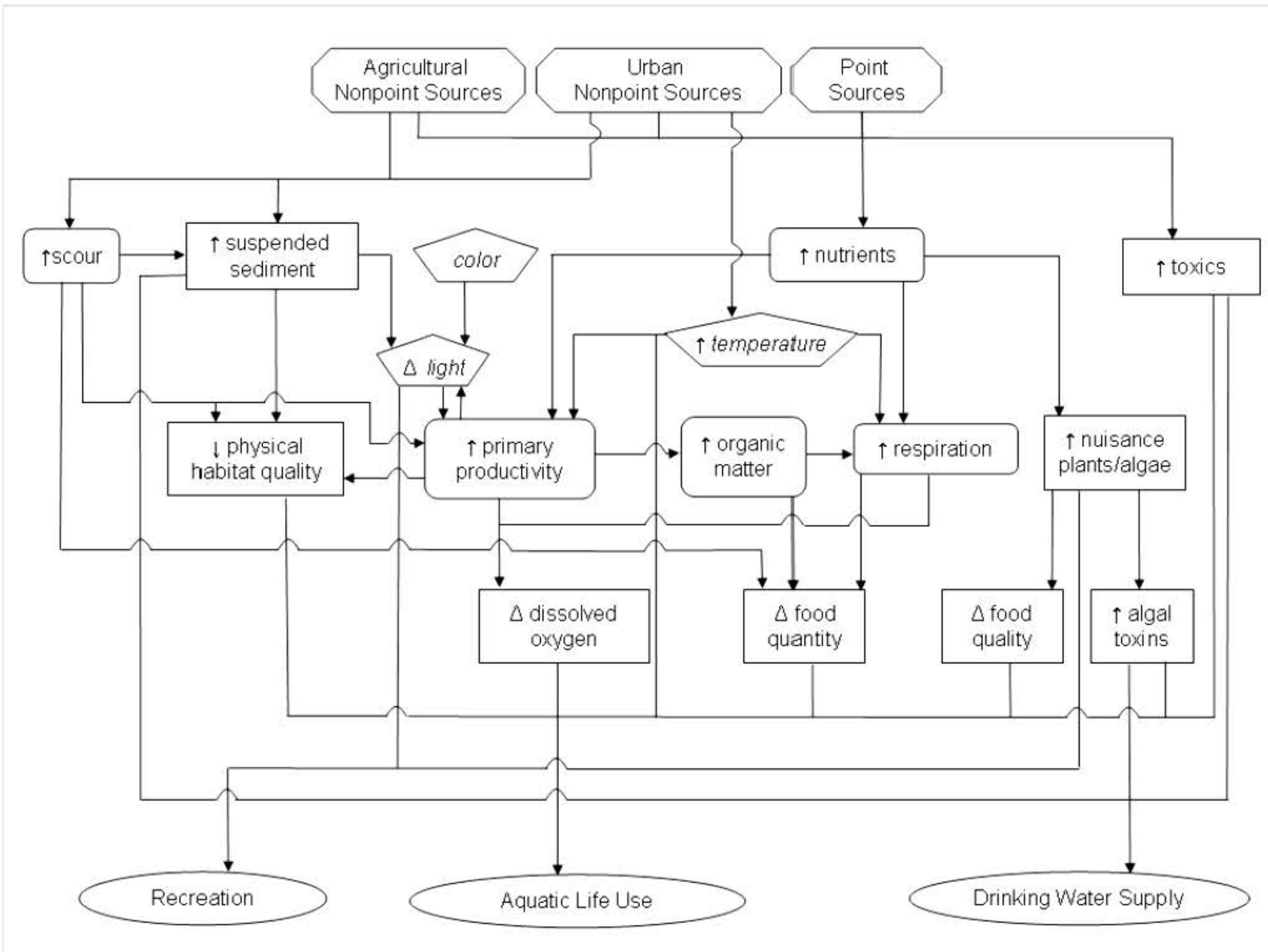
Dodds, W.K. and R.M. Oakes. 2004. A technique for establishing reference nutrient concentrations across watersheds impacted by humans. *Limnology and Oceanography Methods* 2:333-341.

Sparrow Model



Smith, R. A., R. B. Alexander, and G. E. Schwarz. 2003. Natural background concentrations of nutrients in streams and rivers of the conterminous United States. Environmental Science and Technology **37:2039-3047.**

Determining response variables: EPA stressor response model for Rivers and streams



Proposed response variables

- Algal biomass (aesthetics, potential water quality problems)
- Biological integrity
  - Algal (primary)
  - Invertebrate and vertebrate diversity (secondary)
- Water quality (extreme oxygen excursion, pH swings)
- System productivity (whole stream metabolism, primary production and respiration)

Temporal and spatial grain of sampling

- Assemble existing data- determine temporal autocorrelation scale
- Increased sampling intensity in critical times of year (e.g. summer low flow period vs spring high flow)
- Longitudinal sampling to reveal patterns downstream of point sources or high load confluences
- Take advantage of existing sampling sites/ prior data for context
  - USGS
  - Oklahoma and Arkansas DEQs
  - Stevenson et al. (Hydrobiologia (2012) 695:25–42)

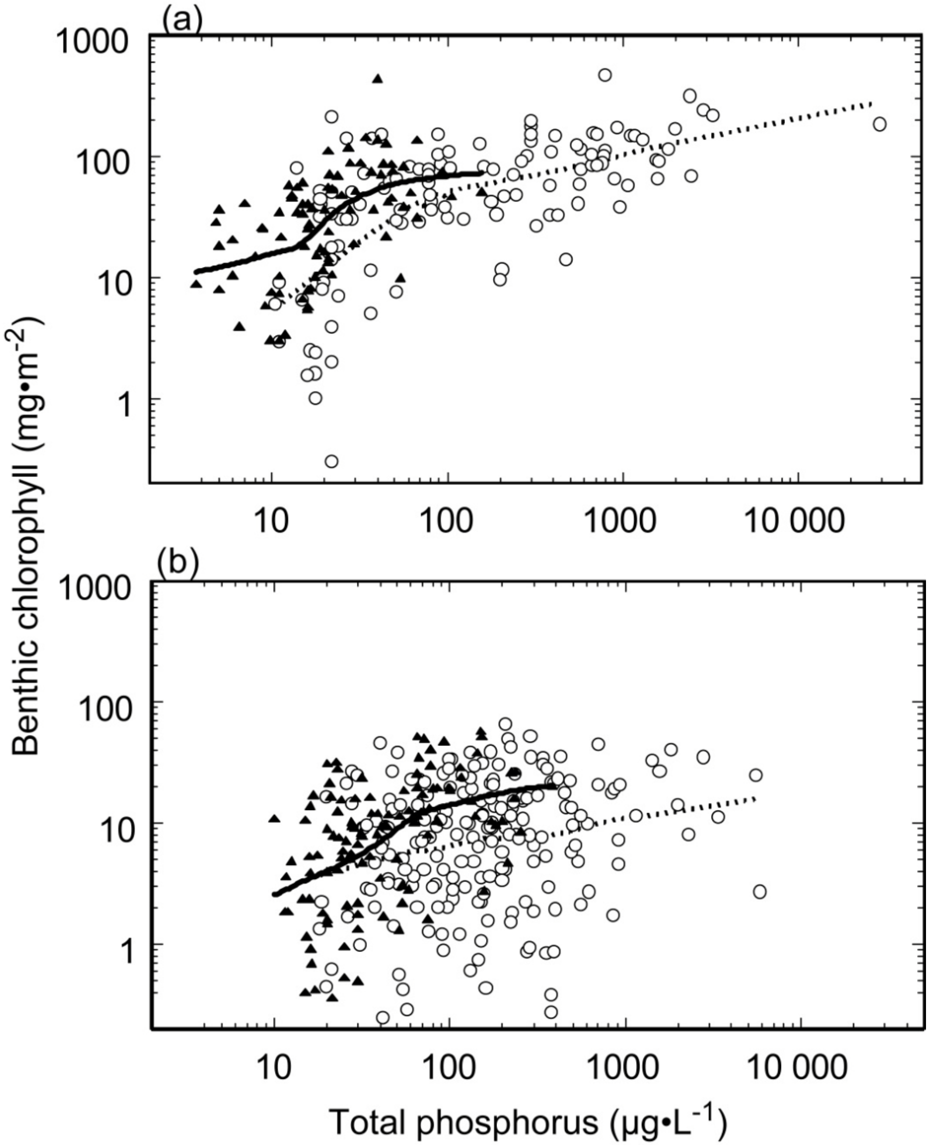
Lots of good USGS Stream Gages

07194760 Illinois River Site 5 Near Viney Grove, ArK	07195500 Illinois River Near Watts, OK
07194800 Illinois River At Savoy, AR	07195800 Flint Creek At Springtown, AR
07194880 Osage Creek Near Cave Springs, AR	07195855 Flint Cr Nr W Siloam Sprgs OK
07195000 Osage Creek Near Elm Springs, AR	07196000 Flint Creek Near Kansas, OK
07195400 Illinois River At Hwy. 16 Near Siloam Springs AR	07196090 Illinois River At Chewey, OK
07195430 Illinois River South Of Siloam Springs, AR	07196500 Illinois River Near Tahlequah, OK

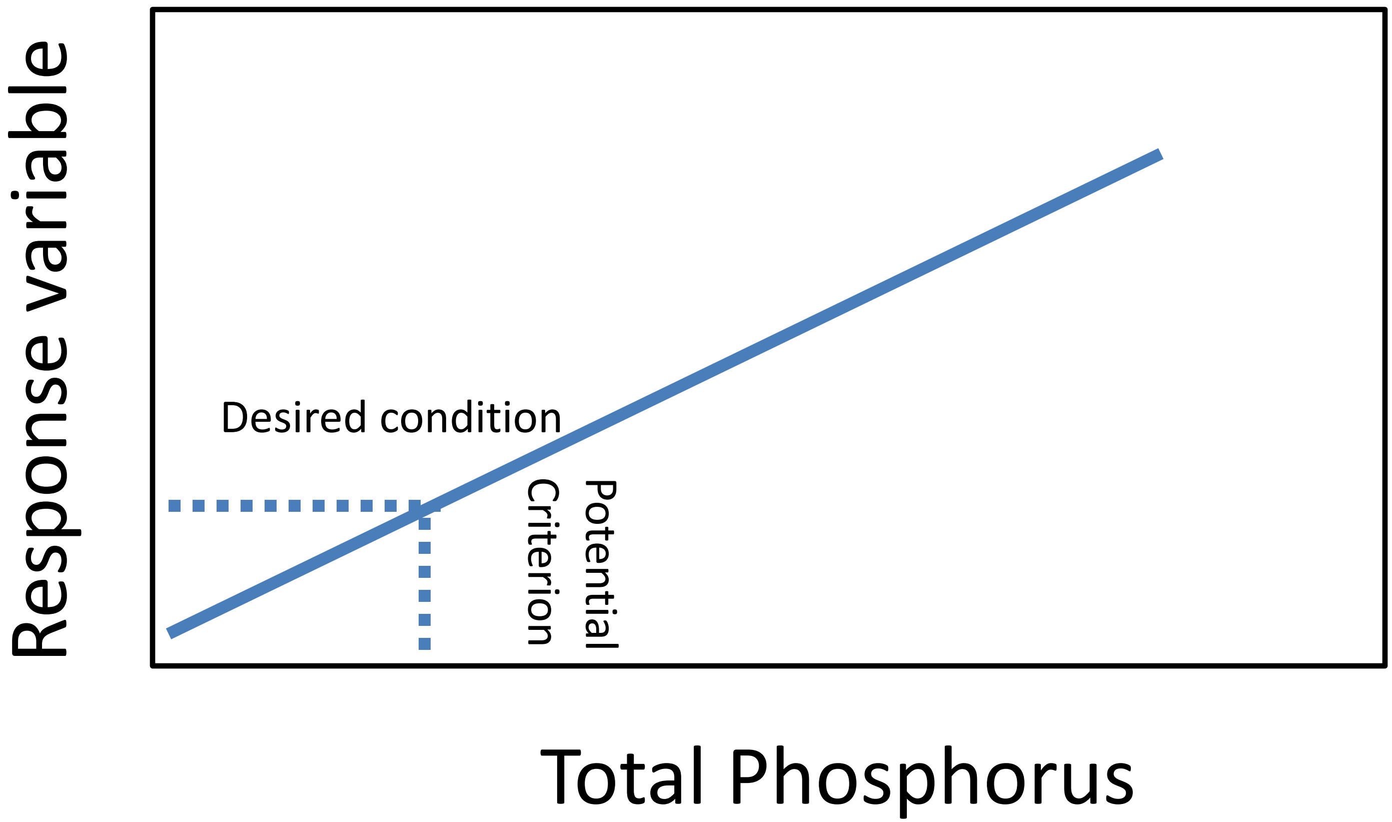
How do response variables respond to nutrients (functional relationships)

- Are there thresholds below which there is no significant response?
- Are there thresholds above which nutrient control is pointless?
- Do conditions in these scenic rivers line up with other areas?
  - how well will models generated over larger geographic areas transfer?
  - are there unusual controlling mechanisms in these watersheds?

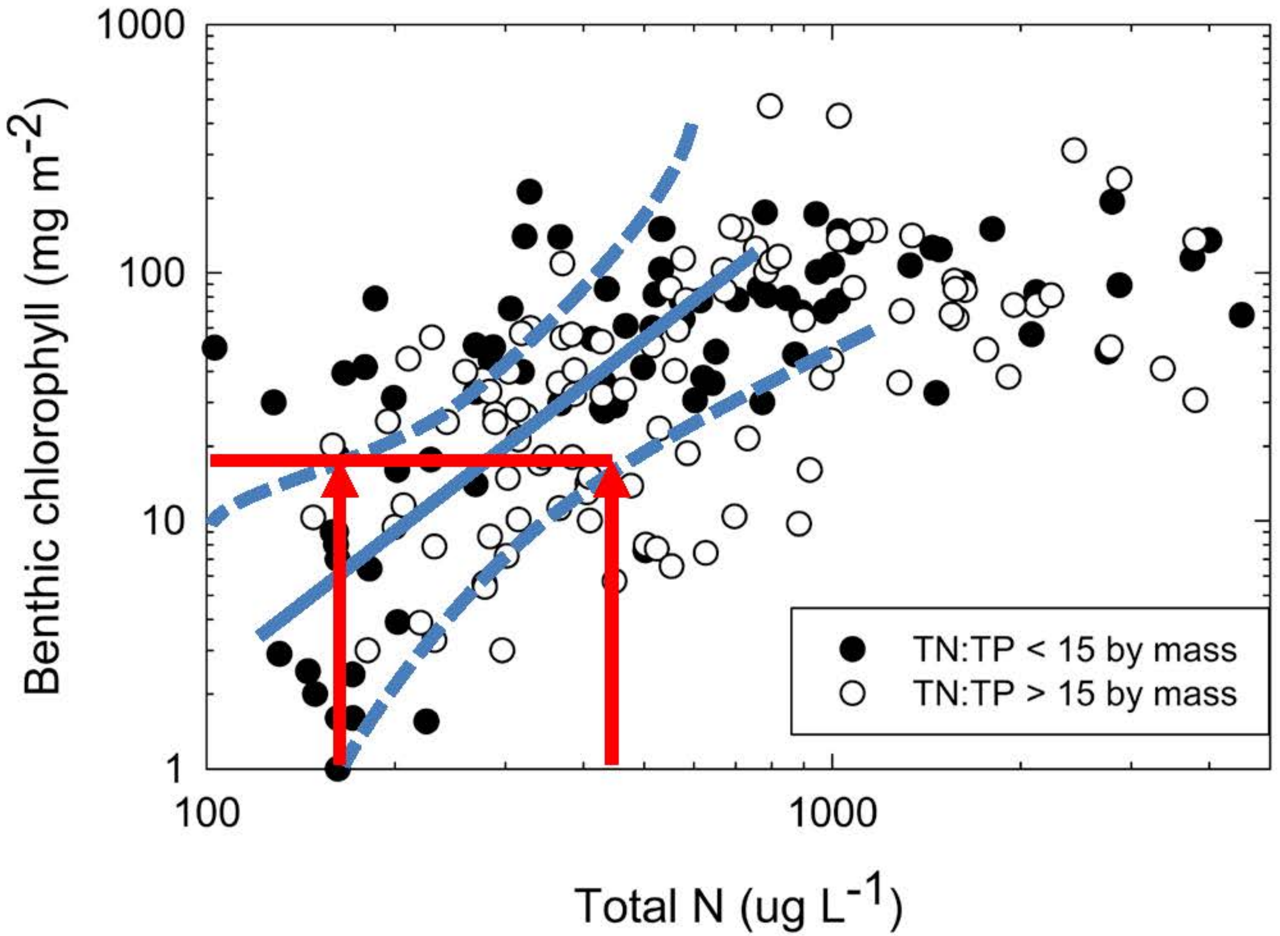
Relationship Between Algal Biomass and Nutrients in Streams- Interaction between N and P



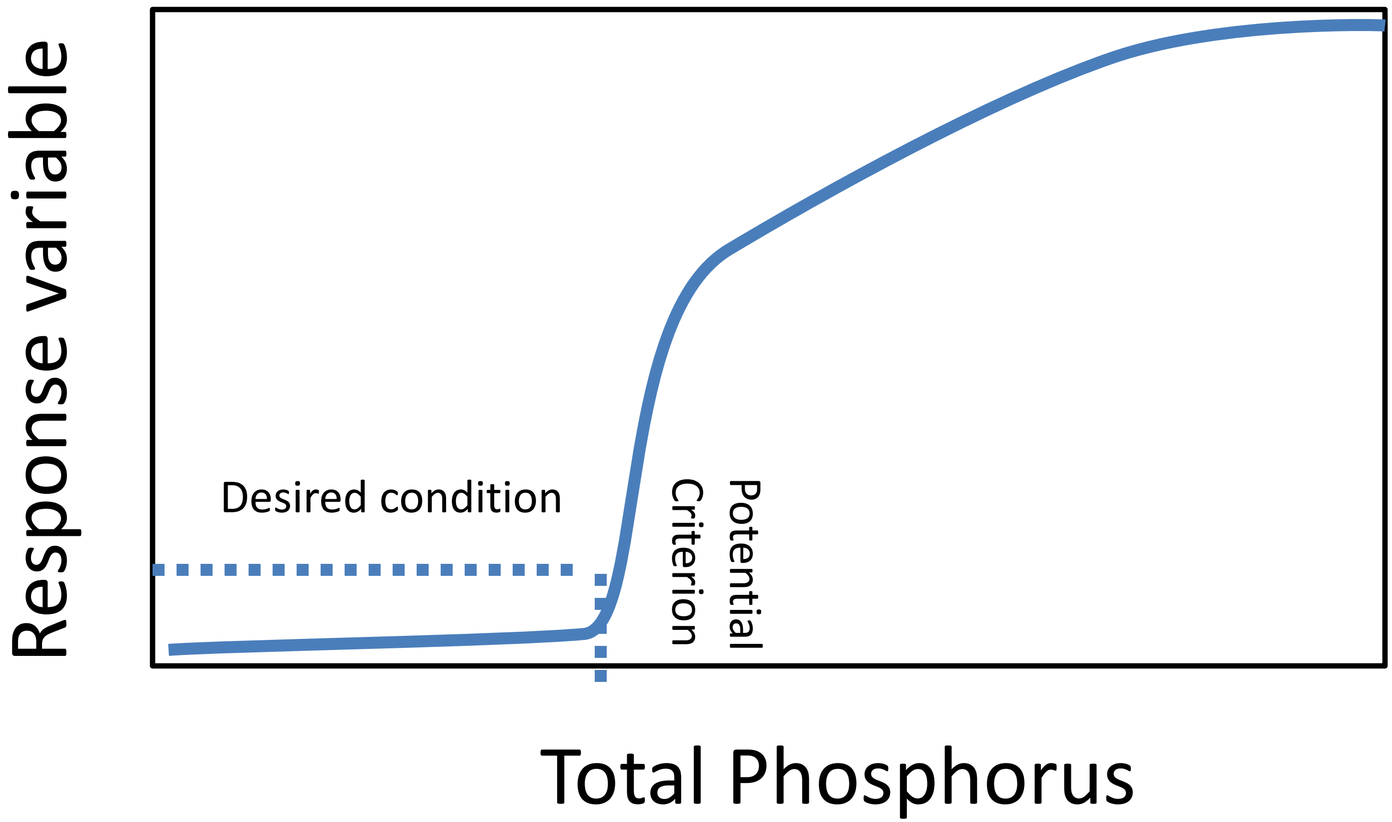
Dodds, W.K., V.H. Smith, and K. Lohman. 2002 Nitrogen and phosphorus relationships to benthic algal biomass in temperate streams. *Canadian Journal of Fisheries and Aquatic Science* 59: 865–874.


Response variable
Desired condition
Potential Criterion
Total Phosphorus

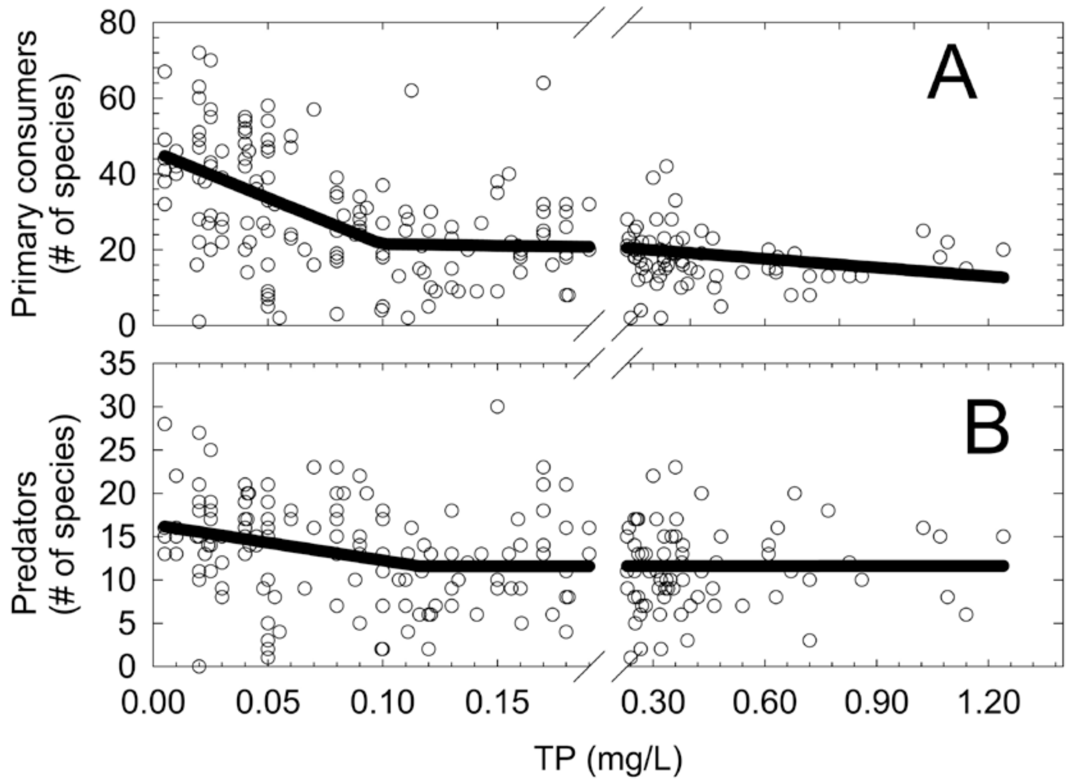
Relationship Between Algal Biomass and Nutrients in Streams



Best case scenario



Potential feedbacks with diversity of animals- additional information on biotic integrity



Variation in diversity of stream invertebrate primary consumers (A) and predators (B) from rivers and streams in Kansas, Missouri, and Nebraska in spring and autumn samples as a function of water phosphorus concentration. There were significant breaks in the relationships as denoted by the two lines, with the predator break occurring at greater total phosphorus than the primary consumers. *(Data from Evans-White* et al.*, 2009).*

Breakpoints or thresholds determined using various methods . Take home message: need multiple methods and will not get one single answer

Method	breakpoint on x axis (mg/L TP)	significance of breakpoint	Confidence interval of breakpoint (95%)
Non-parametric change point analysis	0.041	<0.001	0.040-0.075
Quantile regression tree (10%, 50% and 90% quantiles, respectively)	0.041, 0.049, and 0.75	<0.001	-
Two dimensional Kolomgorov Smirnonv	0.090	0.002	-
Breakpoint regression	0.100	0.001	0.0679 - 0.131
Cumulative frequency, point where half sites with more than 25 species had been reached	0.05	-	-
Regime shift detection, total P substituted for time	0.05	<0.001	-
SiZer (threshold estimated based on locally weighted polynomial regression using a bandwidth of h = 0.06)	0.15	-	-

Dodds, W.K., W.H. Clements, K. Gido, R.H. Hilderbrand, and R.S. King. 2010. Thresholds, breakpoints, and nonlinearity in freshwaters as related to management. *Journal of the North American Benthological Society* 29:988-997.

Factors that may de-couple response to phosphorus in streams

- Heavy shading (light limitation)
- Extensive grazing (snails common in high densities in limestone watersheds, herbivorous fishes might be locally abundant)
- Flooding/ high flow high turbidity
- Luxury P consumption- delayed response to increased P in water column

Luxury P consumption- need time-lagged analysis and sampling

- Most P runoff will occur in spring (90% in 20% of the events)
  - Banner, E., A. Stahl, and W.K. Dodds. 2009. Stream discharge and riparian land use influence in-stream concentrations and loads of phosphorus from Central Plains watersheds. *Environmental Management* 44:552–565.
- Algae can retain P in spring and grow through summer, particularly filamentous algae
  - Lohman, K. and J. C. Priscu. 1992. Physiological indicators of nutrient deficiency in Cladophora (chlorophyta) in the Clark Fork of the Columbia River, Montana. Journal of Phycology **28:443-448.**
- P deposition in calcareous areas can store P as calcite for slow release later
  - Dodds, W.K. 2003. The role of periphyton in phosphorus retention in shallow freshwater aquatic systems. *Journal of Phycology* 39:830-849.

Sampling for Nutrients/ Algae

- 30 sites from a wide range of background concentrations in Illinois River basin, 8 sites in Upper Mountain Fork
  - TP, TN, chlorophyll, algal chemical composition and community assemblage
  - Habitat assessment, visual assessment of filamentous algal cover , macrophyte cover (if any)
- Samples in winter, summer low flow (2x), fall low flow and spring high flow (to catch luxury consumption of P)
- Note - 30 extra sites samples taken but not analyzed for summer unless needed
  - will not be able to tell how many samples will be needed to be counted for diatoms until preliminary data analysis

Diatom community as response variable

- Samples can be taken quickly from erosional habitats.
- Easy to preserve
- Substantial literature on relationship of stream diatoms to phosphorus
- Voucher specimens last indefinitely
- Rex Lowe world expert on their taxonomy will train in identifications, help with sampling protocol and check identifications

Creating diatom-based index

- Will start with published index approach from US rivers
  - Potapova, M. and D. F. Charles. 2007. Diatom metrics for monitoring eutrophication in rivers of the United States. Ecological Indicators **7:48-70.**
- Will check that indicator species follow general US trends (e.g., are there ecoregion-specific differences)

Sampling for dissolved oxygen-metabolism

- Run DO and light loggers at 15 sites for 2 days
- Pick range of sites from lowest to highest nutrients
- Use USGS gaging stations when possible or state monitoring sites to put in historical perspective and provide physical data for models of metabolism
- Pick three times when low oxygen or high oxygen most likely (summer, spring and fall low-flow periods)

Sampling invertebrates

- Invertebrate sampling and sample processing methods standardized
- Predictable community responses to nutrient enrichment
- Assess potential confounding grazer effects
- Auxiliary biotic integrity data
- Collections at same time as nutrients, but two times per year (spring high flow, summer low flow)

Field and lab work

- Conform to field and lab EPA bioassessment protocols
- QA/ QC conform to EPA guidance
  - Digital records of diatom communities
  - Subset of diatom samples re-identified
  - Subset of invertebrate samples checked for picking accuracy and proper identifications
  - Nutrients based on standards at national level (USGS round-robin)
  - Light probes NIST traceable, oxygen probes regularly calibrated
- Best data handling procedures (backup, quality check etc.)

Assemble and explore data- and accuracy of models

- Look for stressor-response functional relationships with various statistical and graphical approaches
- Remove outliers
- Cumulative frequency plots- characterize distributions
- Regression confidence intervals for response variation
- Identify thresholds (e.g., non-parametric change point analyses, other methods)
- Evaluate precision

Deliverables
Raw data for TN, TP, chlorophyll, dissolved oxygen, habitat mapping, and invertebrates
Analysis of expected background nutrient level from existing data and added samples
Functional relationships between response variables (algal biomass, algal communities, invertebrate communities, oxygen dynamics, system production) and phosphorus
Corrections in functional relationships related to temporal patterns (luxury P effects), and interactions with nitrogen and invertebrate grazing communities
Verification that QA/ QC procedures followed EPA guidance
Threshold analyses of functional relationships, multiple comparative approaches
Peer-reviewed publication (will eventually follow, though will take longer than final report). Final report will be in form of peer reviewed papers.
Presentations of results at local and national meetings
Participation as technical expert in future meetings
Final report and required updates

		Mos			
A. Faculty	**Base**	**or %**	**Year 1**	**Year 2**	**Total**
PI - Matt Whiles		**Summer 1.00**	**0**	**0**	**0**
Total Faculty			**0**	**0**	**0**
B. Other Personnel					
Grad Students			**19,800**	**17,500**	**37,300**
Post Doctoral			**0**	**0**	**0**
Pat Staff			**0**	**0**	
OS Staff			**0**	**0**	
Labor (incl student)		**undergrad (2)**	**9,000**	**9,000**	**18,000**
Total Salaries & Wages (A+B)			**28,800**	**26,500**	**55,300**
C. Fringe Benefits					
grad	**0.0%**		**0**	**0**	**0**
faculty	**34.0%**		**0**	**0**	**0**
student	**0.0%**		**0**	**0**	**0**
Subtotal Fringe			**0**	**0**	**0**
Total Salaries, Wages & FB (A+B+C)			**28,800**	**26,500**	**55,300**

F. Travel - Domestic			7,000	7,000	14,000
F. Travel - Foreign			0	0	
G. Other Direct Costs					
Materials & Supplies		routine supplies	3,000	2,000	5,000
Publications Cost			0	2,000	2,000
Other		consult	0	0	0
Other (F&A Exempt)			0	0	0
		Subtotal Other Direct Costs	3,000	4,000	7,000
	Total Direct Costs		38,800	37,500	76,300
					0
H. Facilities & Administrative			10,088	9,750	19,838
					0
Total Direct + F&A			48,888	47,250	96,138
total less equip			38,800	37,500	76,300
					0
					0
	Total Project Costs		48,888	47,250	96,138
		MTDC Base	38,800	37,500	76,300
	F&A Rate (off campus)		26.00%	26.00%	

				Mos or			
A. Faculty		Base		%	Year 1	Year 2	Total
PI - W.Dodds			Summer	1.00	13,000	14,000	27,000
Total Faculty					13,000	14,000	27,000
B. Other Personnel							
	Grad Students				25,000	20,000	45,000
	Post Doctoral Assoc		50,000		50,000	30,000	80,000
	Labor (incl student)		undergrad (2)		15,000	10,000	25,000
	Total Salaries & Wages (A+B)				103,000	74,000	177,000
C. Fringe Benefits			5.9%		1,475	1,180	2,655
			34.0%		21,420	14,960	36,380
			1.0%		150	100	250
		Subtotal Fringe			23,045	16,240	39,285
	Total Salaries, Wages & FB (A+B+C)				126,045	90,240	216,285

E. Equipment	microscope camera, vehicle	35,000	0	35,000
F. Travel - Domestic		20,000	14,000	34,000
F. Travel - Foreign		0	0	
G. Other Direct Costs				
Materials & Supplies	routine supplies, computer, backup, 15 oxygen probes	27,000	7,000	34,000
Publications Cost		0	2,000	2,000
Other	consult	12,000	8,000	20,000
Other (F&A Exempt)		0	0	0
	Subtotal Other Direct Costs	39,000	17,000	56,000
Total Direct Costs		220,045	121,240	341,285
				0
H. Facilities & Administrative		92,523	60,620	153,143
				0
Total Direct + F&A		312,568	181,860	494,428
total less equip		185,045	121,240	306,285
				0
				0
Total Project Costs		312,568	181,860	494,428
	MTDC Base	185,045	121,240	306,285
F&A Rate		50.00%	50.00%	

Summary of all costs	
Kansas State University	494,428
Southern Illinois State University	96,138
Total	590,566