

Setting Water Quality Targets for Nitrogen and Phosphorus

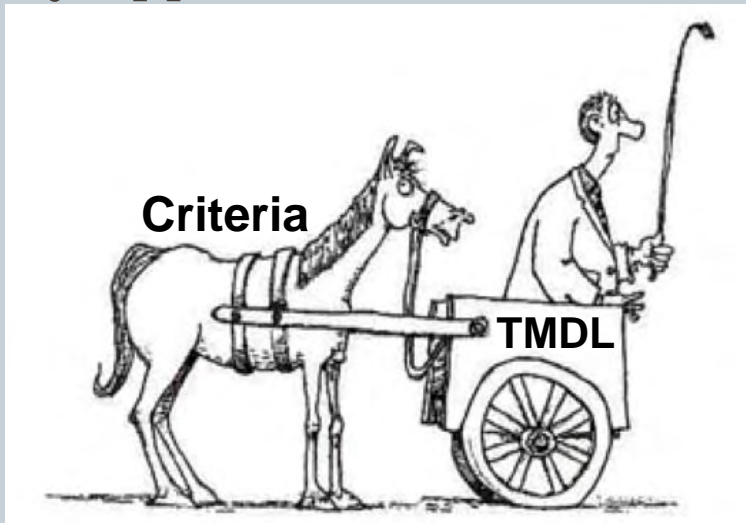


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So you have an impairment...



- **Goal of this talk:**
 - How do you set a numeric target for TMDLs to protect/restore designated use?
 - And how to do so in the context of simultaneous criteria development?
 - Complementary Approaches



Source Material



United States
Environmental Protection
Agency

Office of Water
Office of Science and Technology
Washington, DC 20460

EPA-822-B-00-002
July 2000
www.epa.gov



Nutrient Criteria Technical Guidance Manual

Rivers and Streams



United States
Environmental Protection
Agency

Office of Water
Mail code 4304T

EPA-820-S-10-001
November 2010

Using Stressor-response Relationships to Derive Numeric Nutrient Criteria



United States
Environmental Protection
Agency

Office of Water
4503 F
Washington DC 20460

EPA 841-B-99-007
November 1999

Protocol for Developing Nutrient TMDLs

First Edition

Complementary Approaches

- **TMDL Nutrient Guidance**

- Causal

- P
- N

- Response

- Chl a/Biomass
- Clarity
- DO
- macrophyte coverage/biomass
- biological indicators
- pH
- nutrient ratios

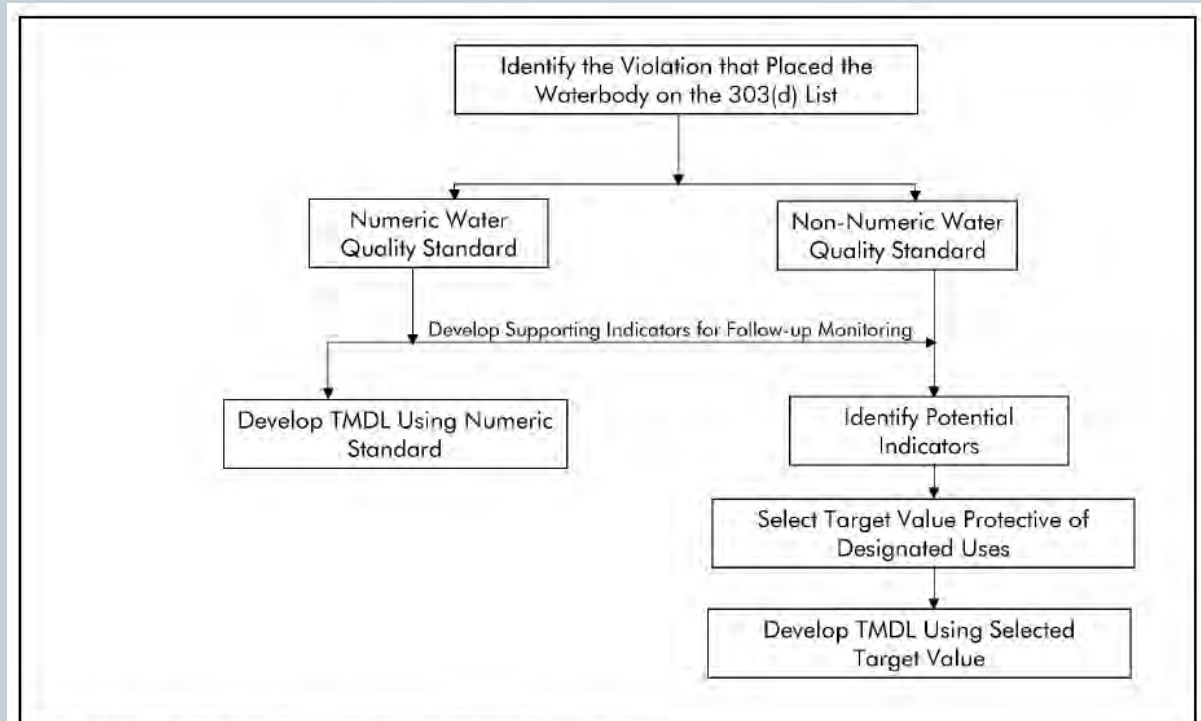


Figure 4-1. Factors for determining indicators and target values

Complementary Approaches

- **Nutrient Criteria Guidance**
- Nutrient
 - P
 - N
- Biological
 - TOC
 - Chl a/Biomass
 - Clarity
 - DO
 - macrophyte coverage/biomass
 - biological indicators
- Could add
 - User perception endpoints
 - Nuisance algal abundances
 - Toxin/other chemical levels (e.g., MIB)

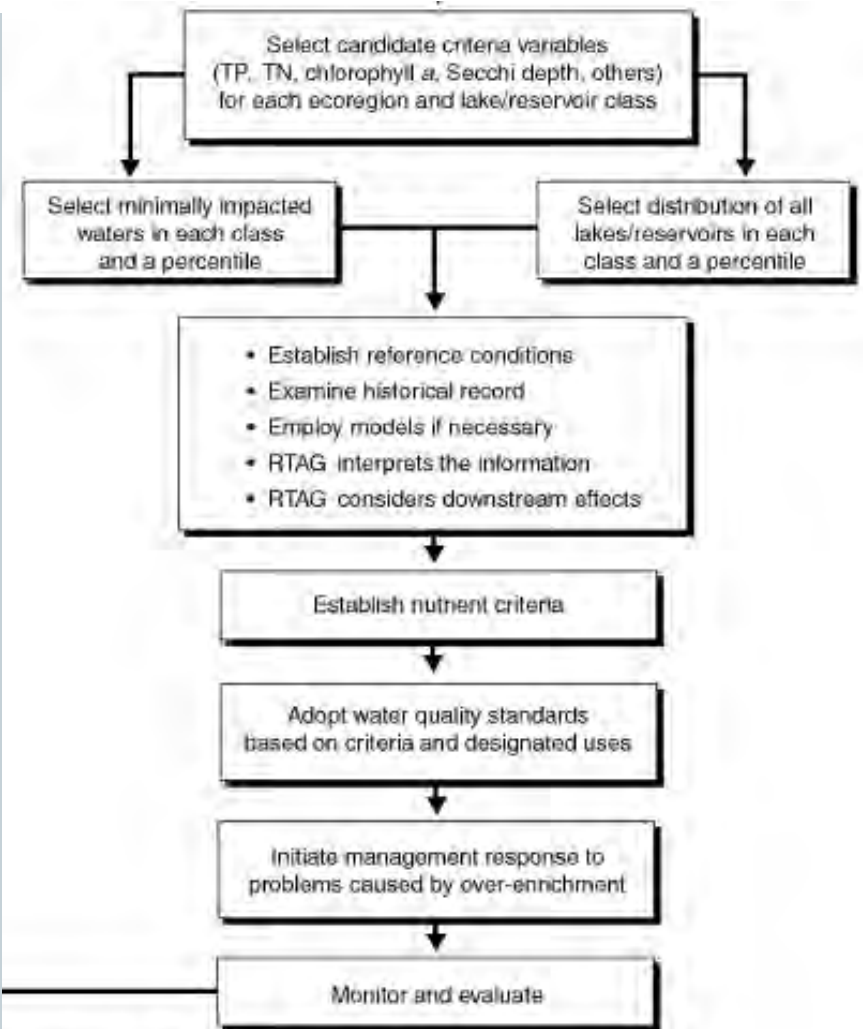


Figure 1.2. Flowchart of the nutrient criteria development process.

Complementary Approaches: Setting Targets

- **TMDL Guidance**
 - Reference
 - User surveys
 - Trophic classification
 - Literature
 - BPJ
- **All of these are elements of Criteria Guidance**
- **Nutrient Criteria Guidance**
 - Classification
 - Reference Condition Approaches
 - Stressor-Response Approaches
 - Scientific Literature and Expert Judgment
 - Mechanistic Models
 - Multiple Lines of Evidence
- **Some of these under TMDL Guidance**
- **Multiple uses**

General Approach: Classification

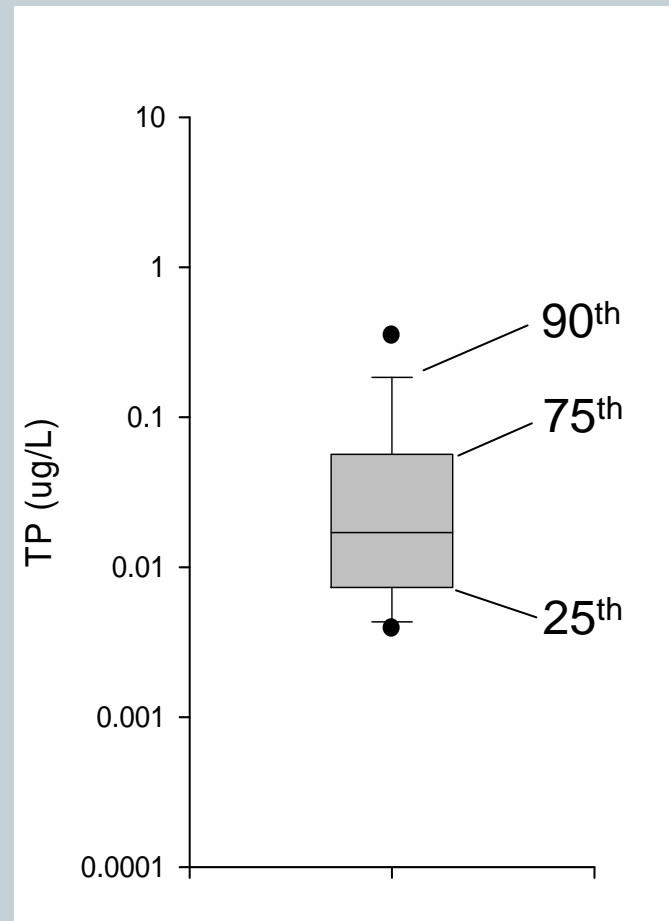


- **Classification**
 - Apples and Oranges
 - Separate waterbodies into ones expected to exhibit similar nutrient dynamics and biological responses in the absence of human impacts
 - ✦ *A priori*
 - Flow, climate, geology, hydrology
 - Ecoregions, physiographic provinces
 - ✦ *A posteriori*
 - Analyze nutrient/response dynamics in reference sites across landscape
 - For TMDLs, important to know that this is factored into target development, may not be necessary for a single waterbody

General Approach: Reference

- **Reference**

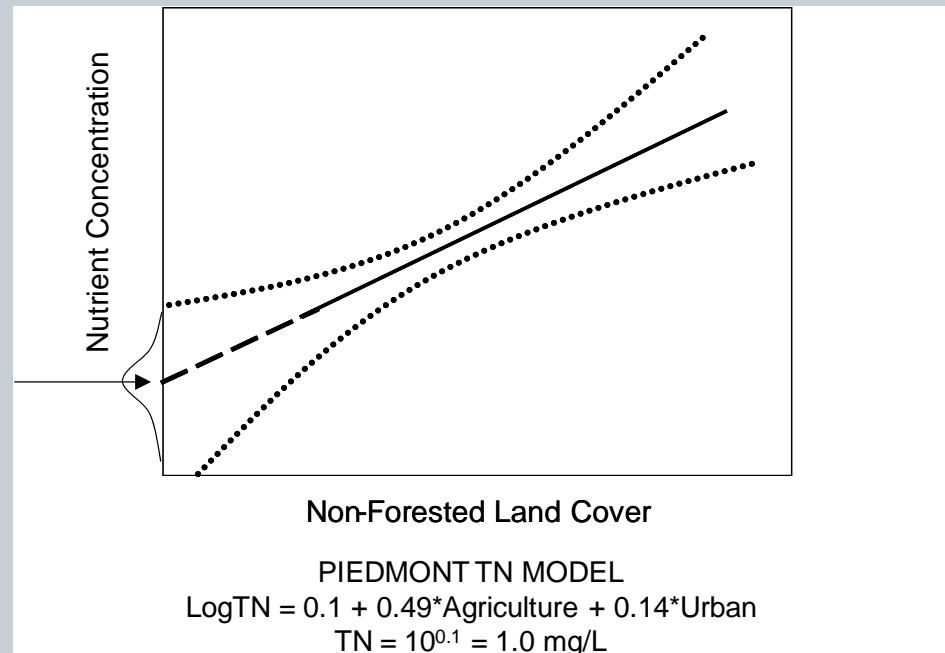
- Ideally natural or near-natural
 - ✦ Integrity
- Often “least disturbed”
- May need to use all sites
- Select a percentile
 - ✦ Management decision that involves risk/acceptability of reference
 - ✦ Will depend on quality of reference, sampling, and risk acceptability



General Approach: Reference

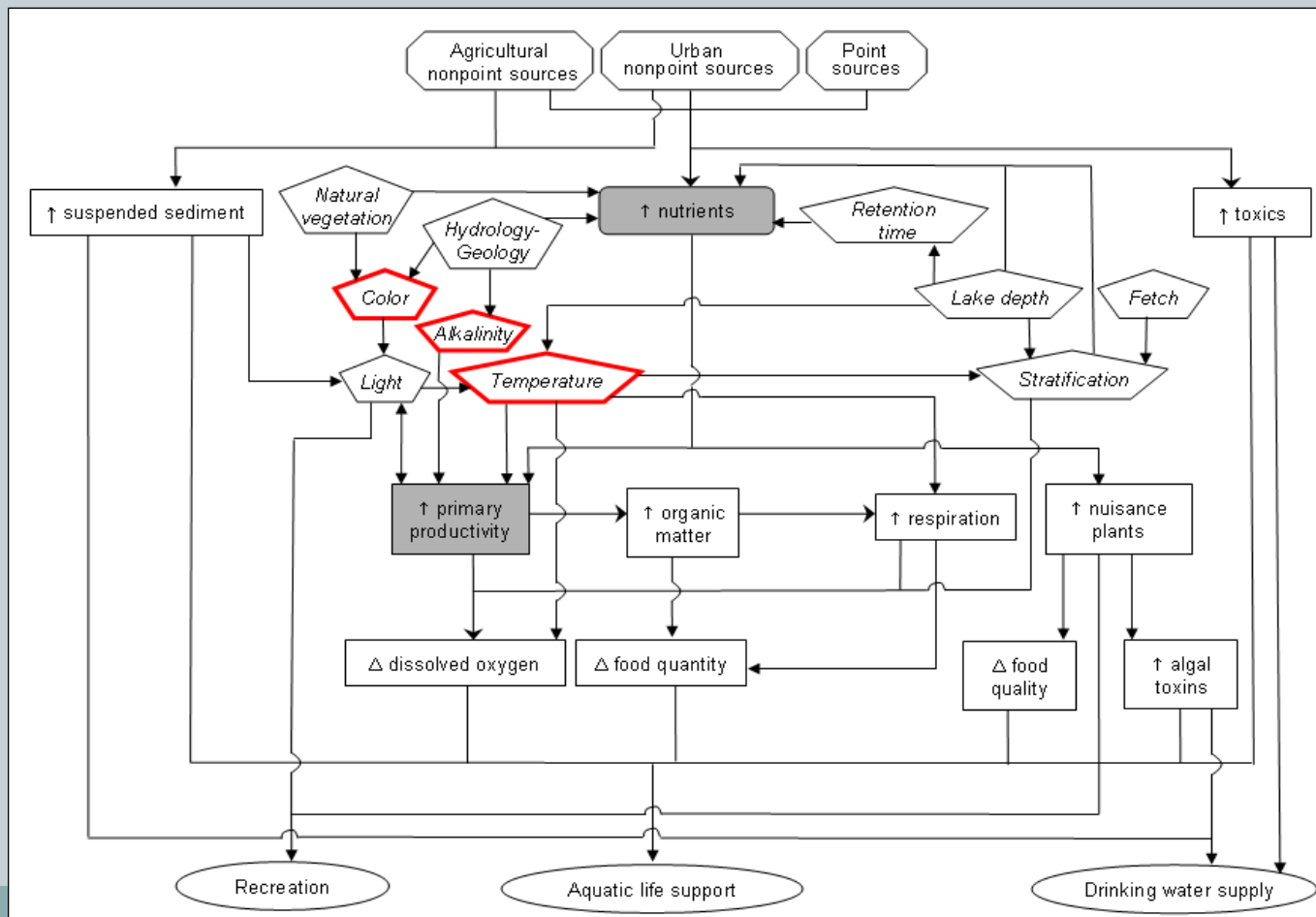
- **Modeling Reference**

- Model the reference condition based on disturbance
- Also can incorporate classification into this
 - Add factors for ecological setting, size, date, etc.



General Approach: Stressor-response

- Response can depend on other factors



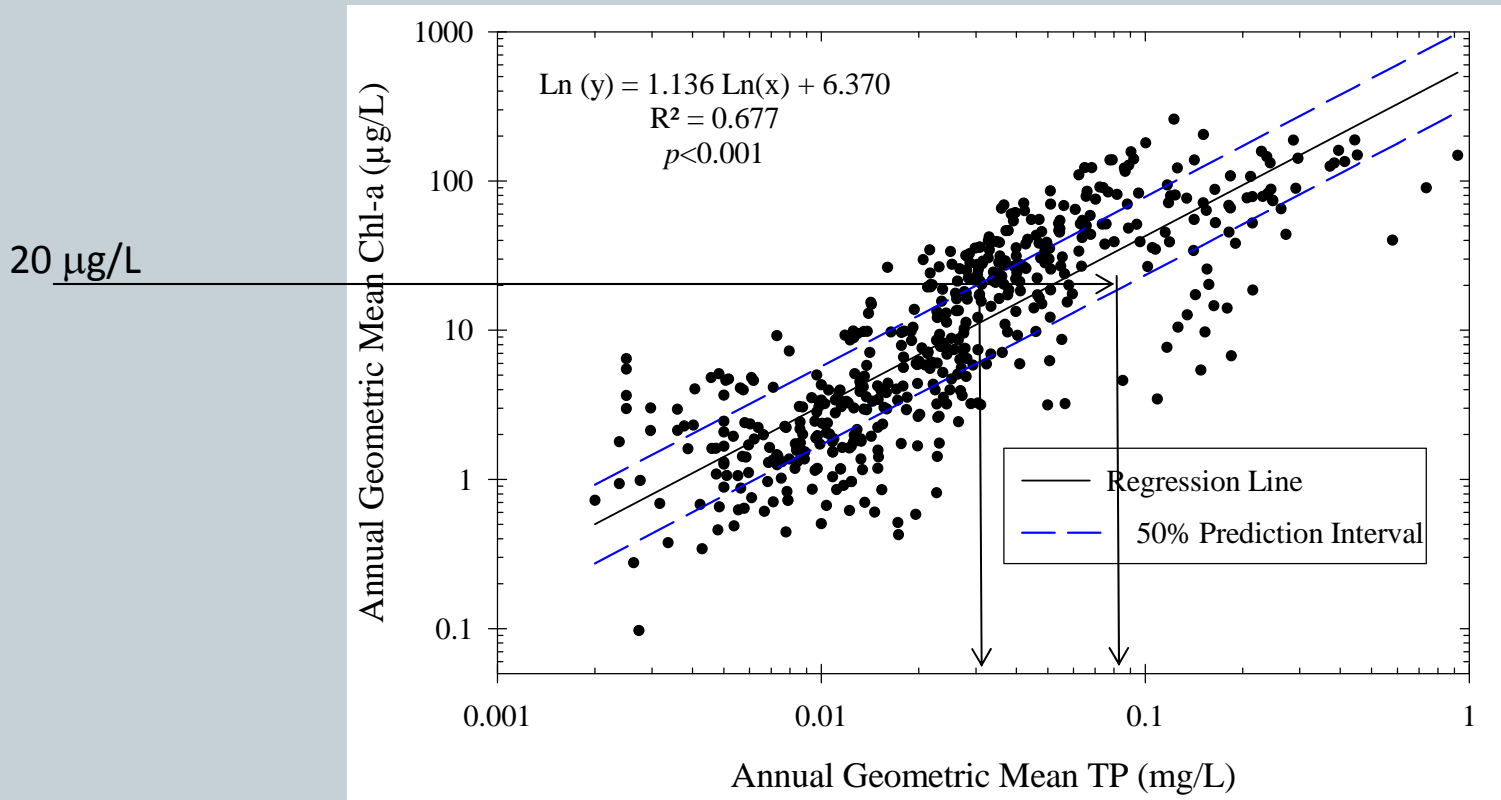
General Approach: Stressor-response



- **Identify that concentration associated with an adverse response condition**
 - Is this just kicking the can? What is an “adverse condition”?
 - ✦ Can be an existing criterion (DO, pH)
 - ✦ Could be an existing translator (biocriteria)
 - ✦ Can be BPJ (seagrass coverage)
 - ✦ Can be estimated from reference
 - ✦ Can be identified from S-R relationship
 - ✦ Can use a series of S-R models to get from something with an existing value to nutrient criteria?

General Approach: Stressor-response

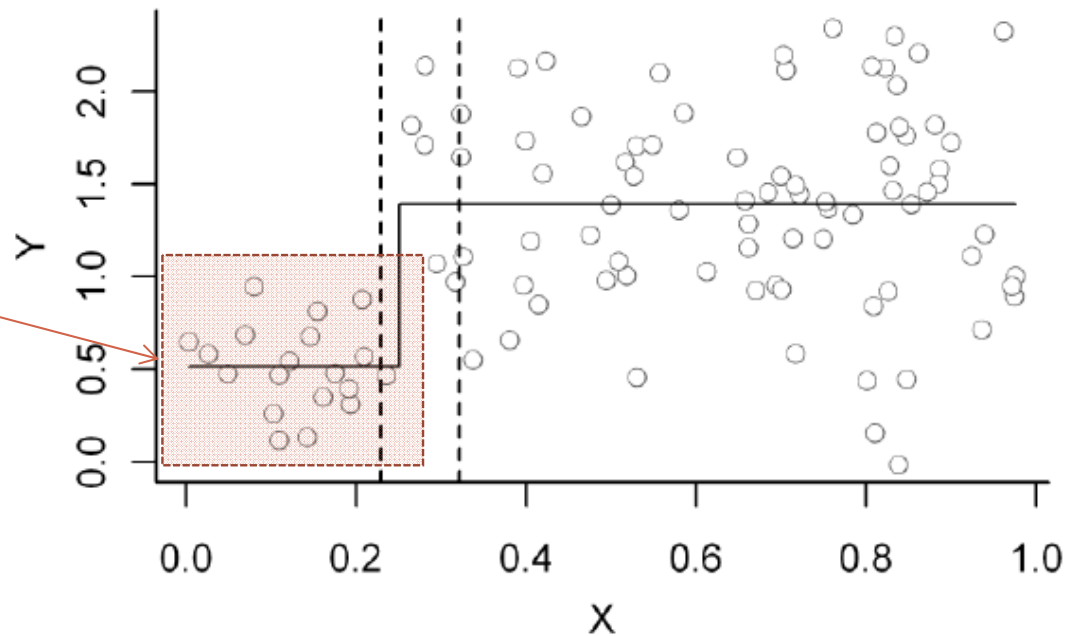
- Empirical Modeling



General Approach: Stressor-response

- Empirical Modeling
 - Change points may be informative

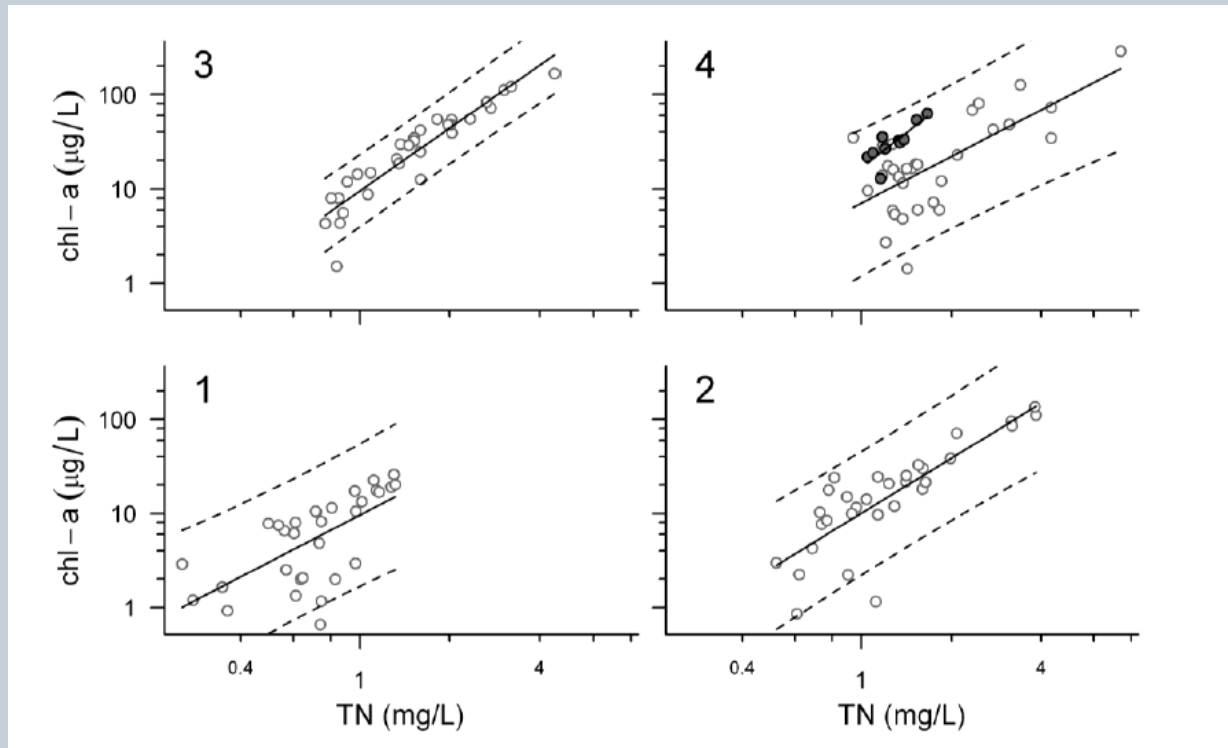
All reference sites



General Approach: Stressor-response



- **Controlling for covariation/other variables**
 - Classification (e.g., splitting, clustering, propensity classes)



General Approach: Scientific Literature/Expert Judgment



- **Voluminous literature on nutrient effects on aquatic systems**
 - For example, 9,300 citations in NSTEPS bibliography alone
 - Some of this may help identify management endpoints, surely
- **Scientific expertise**
 - Criteria development guidance encourages development of technical advisory groups
 - Accumulated knowledge is useful

General Approach: Mechanistic Models

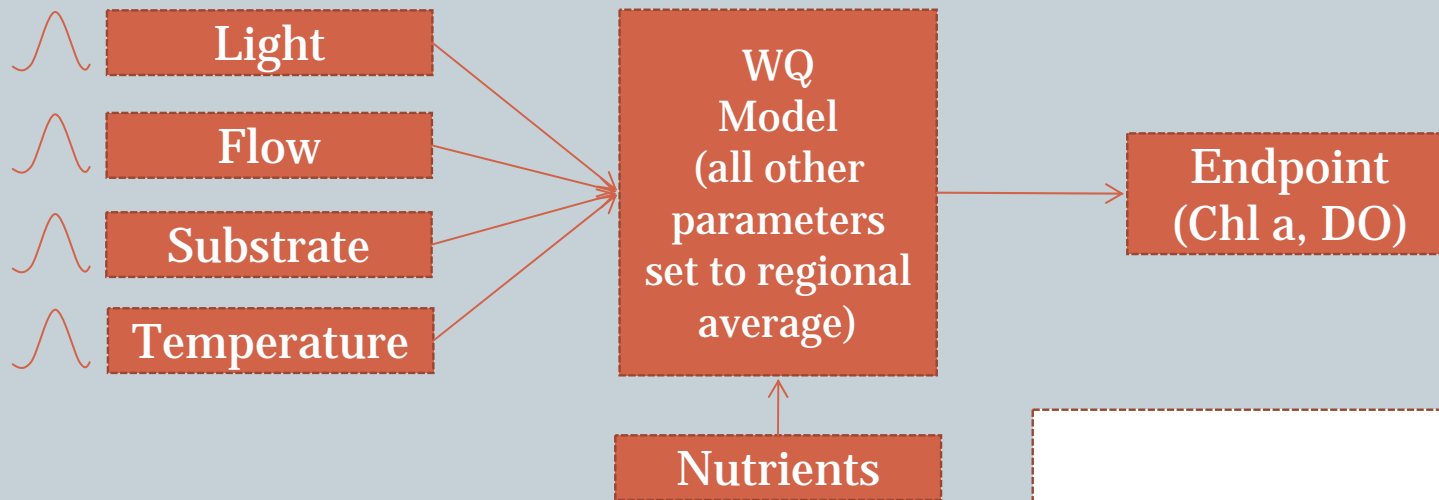


- **Mechanistic and/or Process Models**
 - E.g., WASP, QUAL-2k, EFDC, CE-QUAL, HSPF, MIKE...
 - Model specific endpoints to generate nutrient goals
 - Still need a desired endpoint for something...kicking the can, again
 - ✦ Primarily chemical endpoints (DO, clarity, pH), some biological endpoints (Chl a, some species)
 - ✦ AQUATOX can do ecological endpoints
 - ✦ Run these to back out nutrient concentrations/loads to meet response endpoint
 - Site specific application has limited the utility for regional criteria

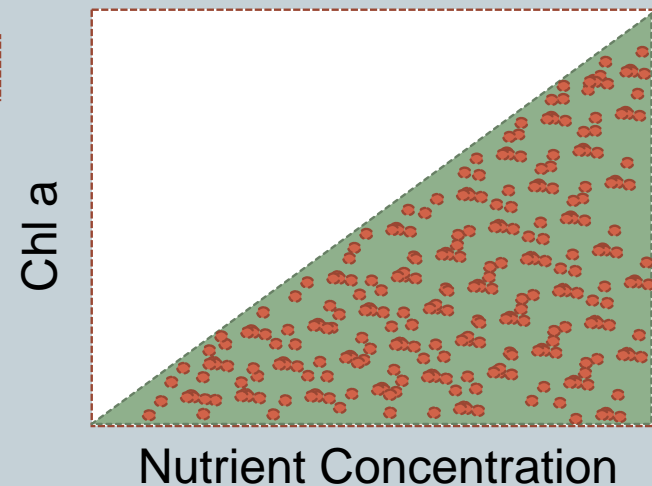
General Approach: Mechanistic Models



- **Mike's Fantasy World – Generic Waterbody Models**



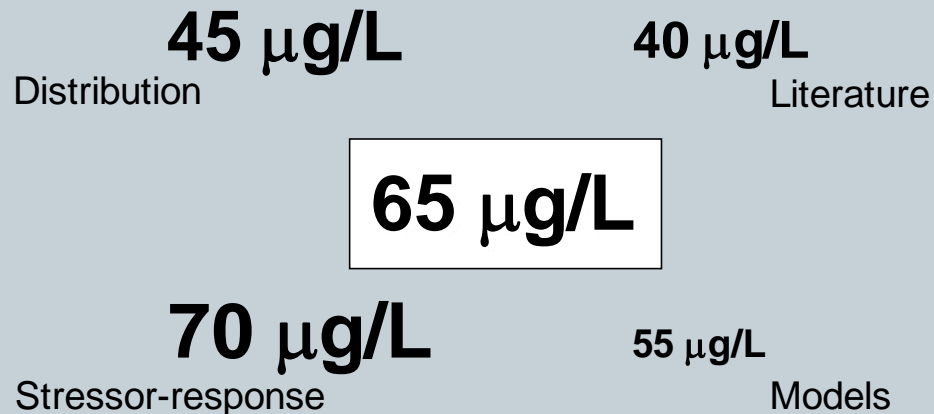
- Making process models “regional”
- Complement empirical models



Multiple Lines of Evidence



- Generate candidate endpoints
- Weight qualitatively/quantitatively
- Final target is a result of multiple lines



- “A weight of evidence approach that combines one or more of the three approaches described below will produce criteria of greater scientific validity.” – USEPA Streams and Rivers Guidance

So you have an impairment...



- **Goal of this talk:**

- How do you set a numeric target for TMDLs to protect/restore designated use?

- ✦ **Complementary approaches**

- Especially if you know criteria are coming (or riding alongside...)

- ✦ **Site specific models have the potential to be more precise for a specific site**

- Well calibrated/validated

- Still need a response endpoint if not using an existing criterion (DO, pH)



Some Very Good Examples



- 9:30** **Pennsylvania Nutrient TMDLs – Using a Weight of Evidence Approach**
Elizabeth Gaige, US EPA Region 3
- 10:00** **Michigan Approach to Setting Nutrient Targets Based on Biological Impairments**
Sylvia Heaton, Michigan Department of Environmental Quality
- 10:30** *Break*
- 10:45** **Identification of Nutrient Concentrations and Enrichment Indicators for Application in a Weight- of-Evidence Based Nutrient Water Quality Standard for Ohio**
Bob Miltner, Ohio Environmental Protection Agency
- 11:15** **Development of Biologically Based Total Maximum Daily Loads for Nutrients in the Upper Midwest**
Shivi Selvaratnam, Indiana Department of Environmental Management and **Jeff Frey**, USGS