

Proposed Numeric Nutrient Criteria for Streams and lakes

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Streams Overview

- Evaluated Stressor-response relationships
- Benchmark-based criteria
 - Nutrient regions
- Nitrate-nitrate criterion for streams
- Application of stream criteria

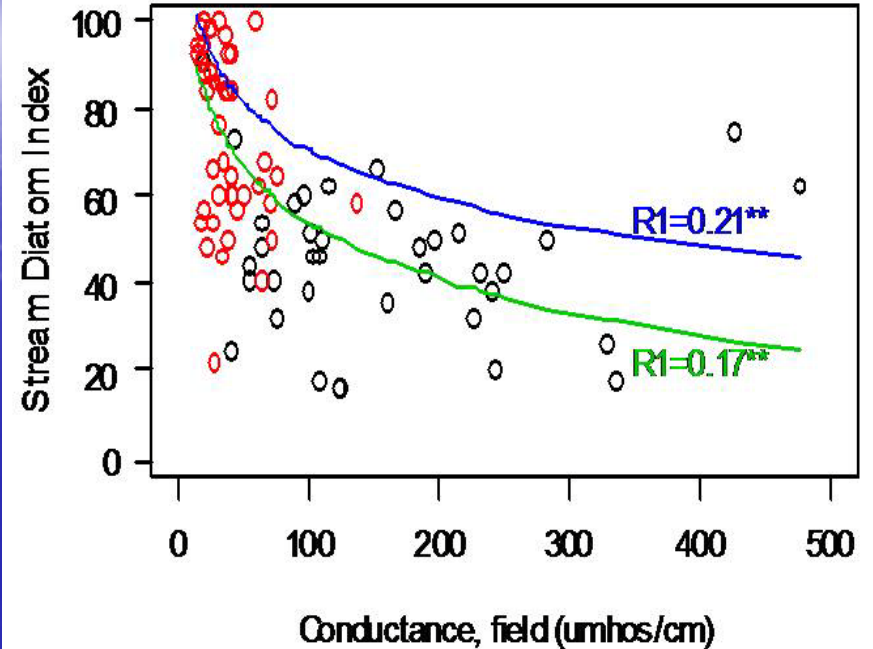
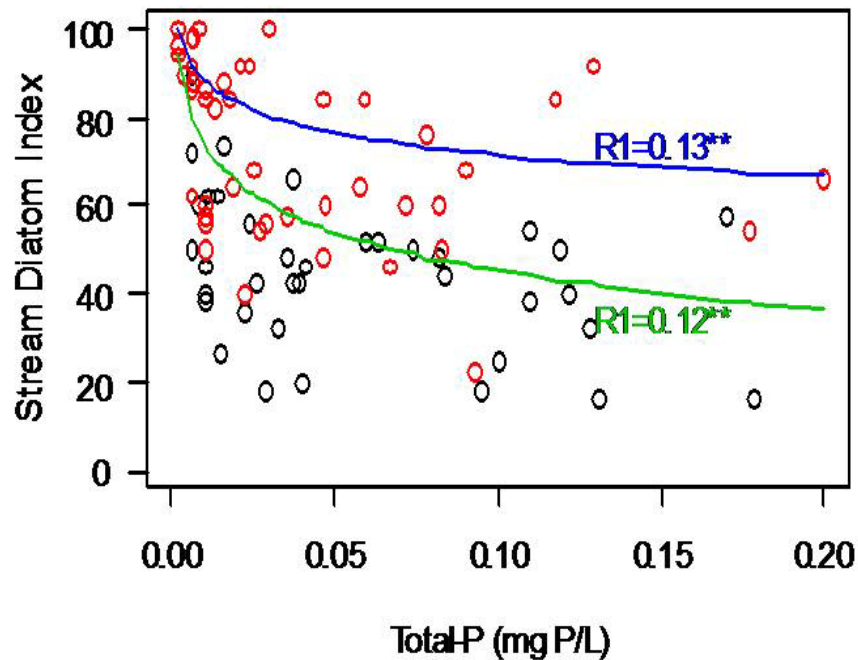
Stressor Response Relationships

- Evaluated responses of chlorophyll *a*, taxonomic composition of macroinvertebrate and algal communities, and frequency of occurrence and abundance of algae (Rapid Periphyton Survey)
- Used linear regression, multiple linear regression, non-linear regression, LOESS regression, change point analysis, CART, correlation analysis, and paired variable plots

Summary of Diatom Response- Multiple Linear Regression

Panhandle Nutrient Region

	Response Variable									
	PollSens	PollTol	%Tol low DO	% Oligosap	VD TSI	TP Sens Dia	TIN Sens Dia	N Metab	pH Optima	SDI
Data Transformation	None	SQRT	arcsin(sqrt(x))	arcsin(sqrt(x))	None	None	None	Recip	Recip	arcsin(sqrt(x))
1	pH	pH	pH	pH	pH	CondL	pH	pH	pH	pH
2	ColorL	ColorL	TNL	TNL	CondL	pH		TNL		
3	TNL	TNL			TINL	TPL				
4	TPL	TPL			TPL	TINL				
5					ColorL					
Adjusted r^2 =	0.25	0.10	0.08	0.10	0.27	0.20	0.18	0.11	0.13	0.12
Yellow shading = Pr < 0.05										



Quantile regression showing highly significant relationships between the Stream Diatom Index and both total phosphorus and conductivity levels.

Stressor-Response

- Many of the biological measures evaluated exhibited a significant adverse response to anthropogenic nutrient enrichment
- Due to confounding factors (e.g., pH, color, conductivity), the relationships between the response variables and nutrient levels were insufficiently robust for establishing **thresholds** needed for criteria
- Nitrate-nitrate was an exception, covered later

Plan B: Reference Site Approach

- Above issues associated with stressor-response analyses required use of Plan B
 - Nutrient benchmark site distributional approach
- Rationale: Nutrient regime associated with minimally disturbed sites, which are characterized healthy biological communities, is inherently protective of the “healthy, well balanced” designated use

FDEP Reference Site Approach

FDEP used extensive, multi-step selection process to demonstrate minimally disturbed conditions (very small amounts human disturbance)

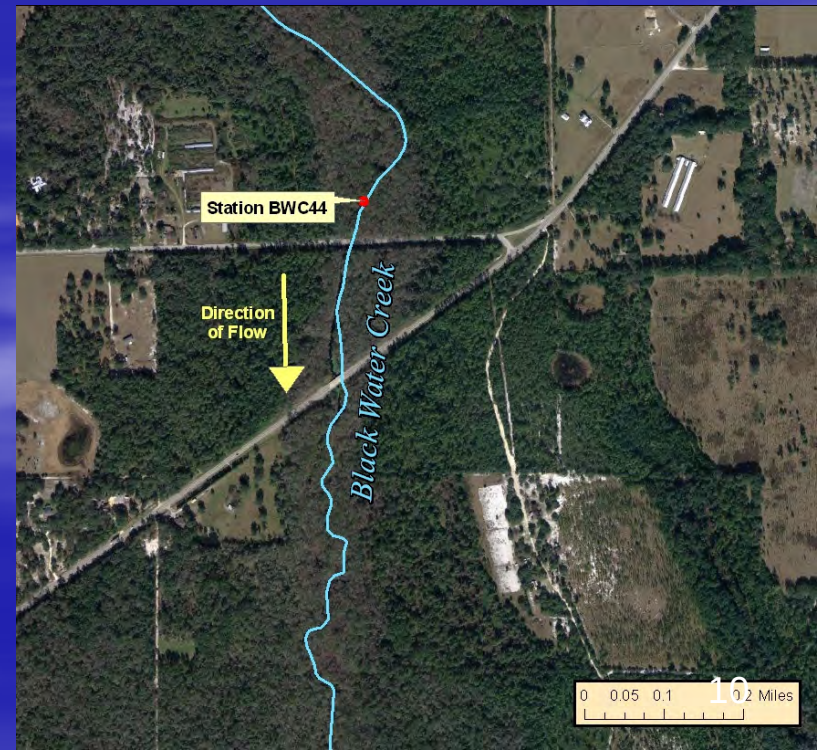
- Landscape Development Intensity Index (LDI) as initial screening
 - Two additional WBIDs excluded as a result of Tetra-tech LDI outlier analysis
- Review of Planning and Verified TMDL Lists
- Screen against springs nitrate threshold (eliminate far field groundwater effects)

FDEP Reference Site Approach

- BPJ Input from District Biologists
- Examination of recent aerial photos
- Field Verification, including watershed assessment and application of BPJ
- Demonstration that sites support valued ecologic attributes (healthy SCI and minimal algae growth)

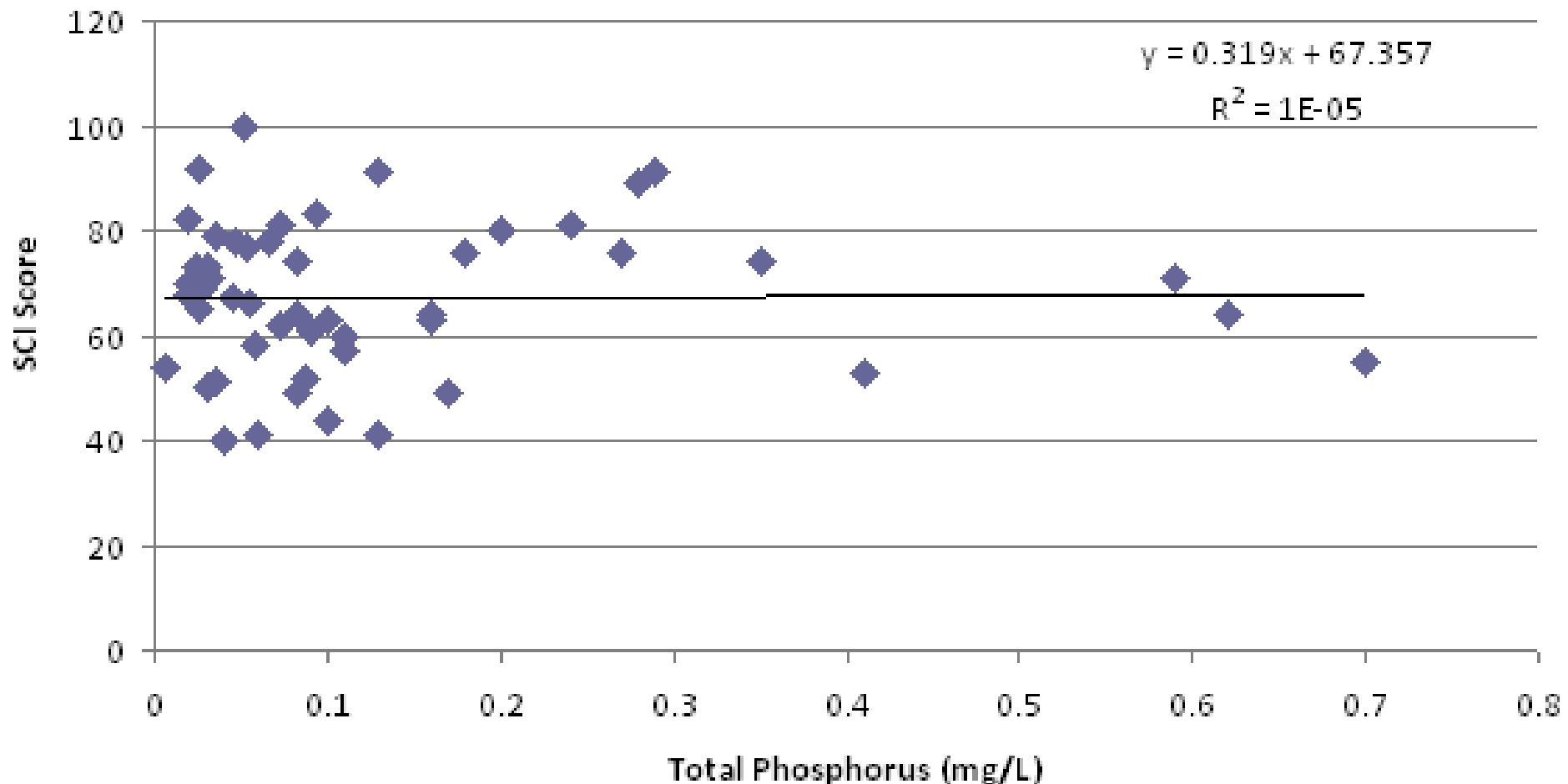
Documenting Results of Reference Site Evaluation Study

- DEP has documented that reference sites selected truly represented minimally disturbed conditions. Eco-summary including site photos, aerial photos, and key biological and water quality data prepared for each study site.



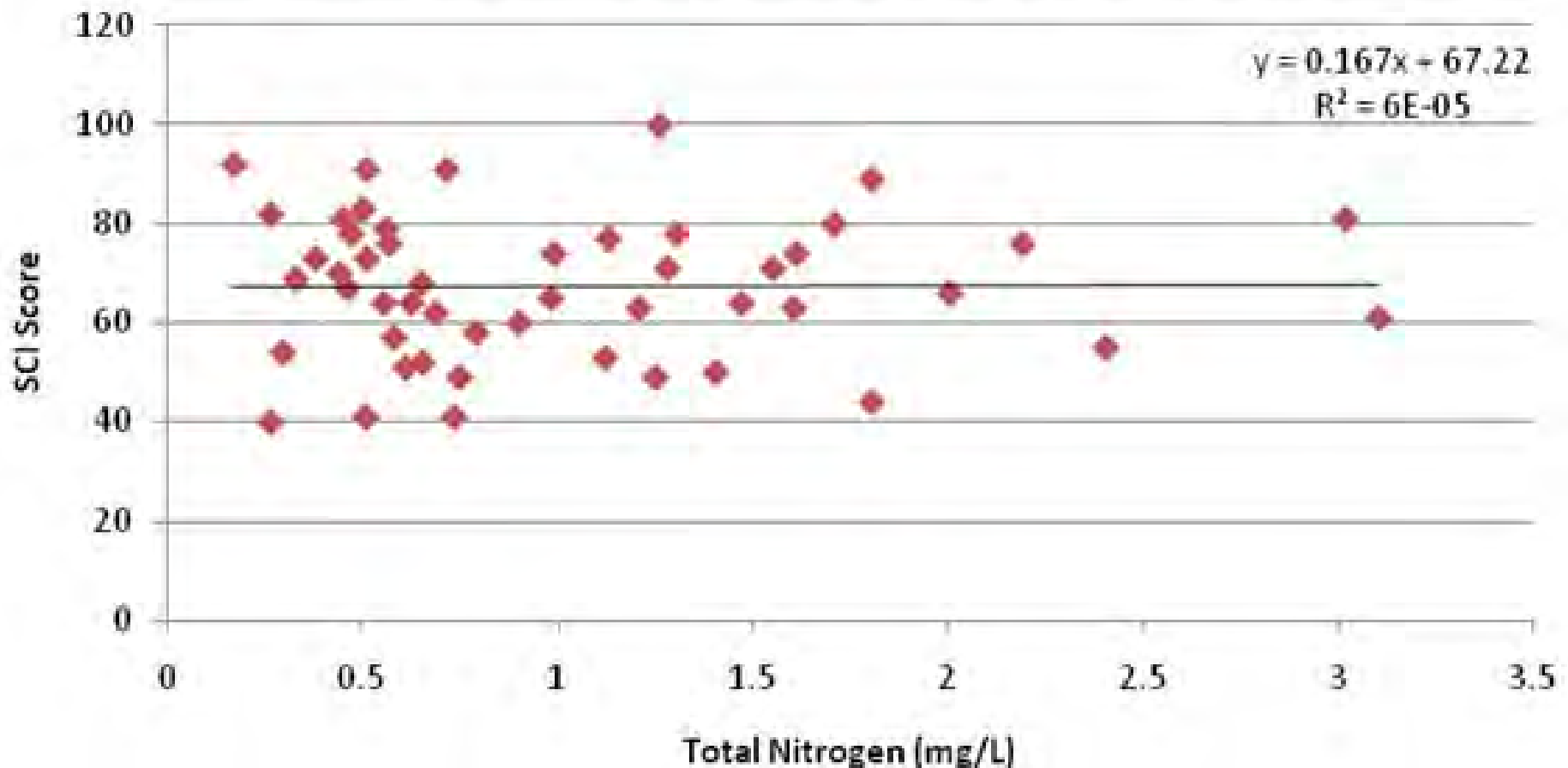
No Evidence of Biological (SCI) Impairment Across the Range of Reference TP Conditions

Benchmark Site Total Phosphorus vs. SCI Score

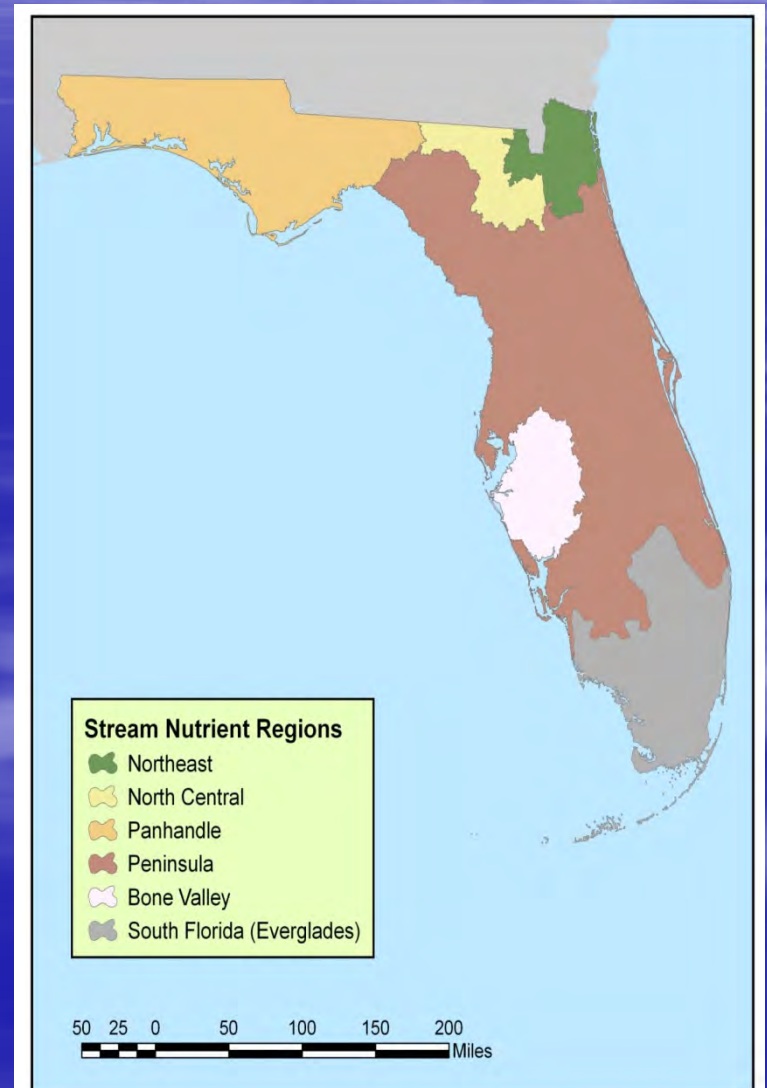
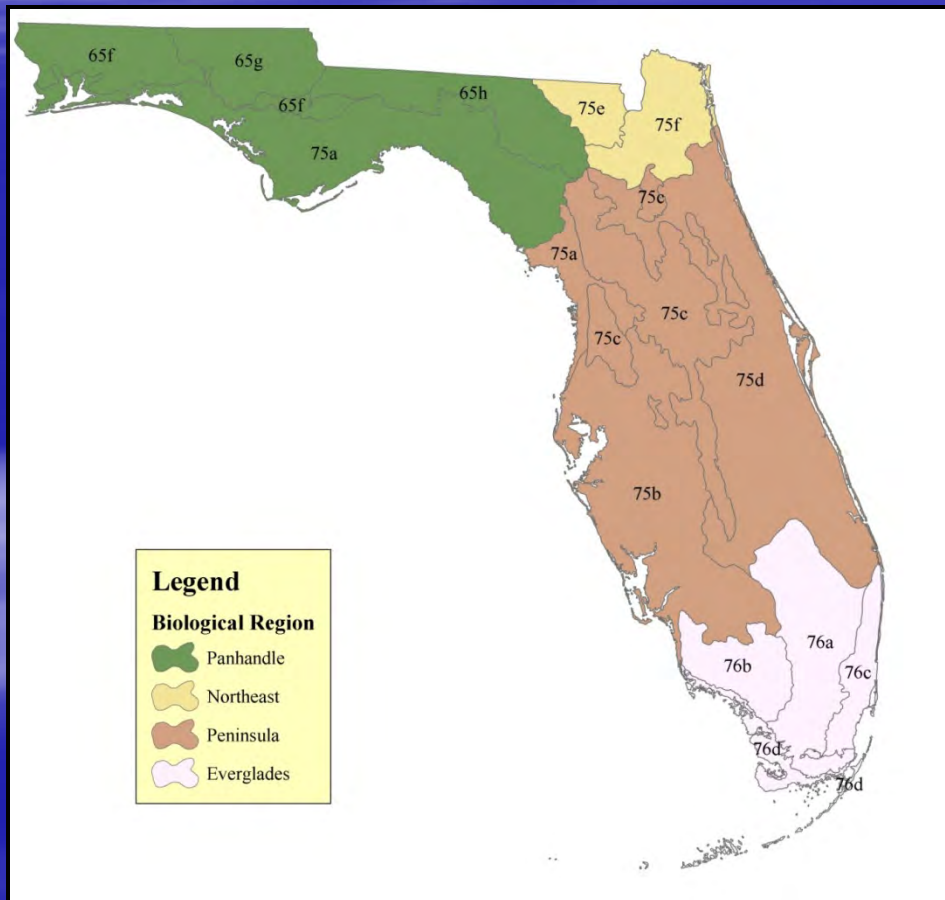


No Evidence of Biological (SCI) Impairment Across the Range of Reference TN Conditions

Benchmark Site Total Nitrogen vs. SCI score

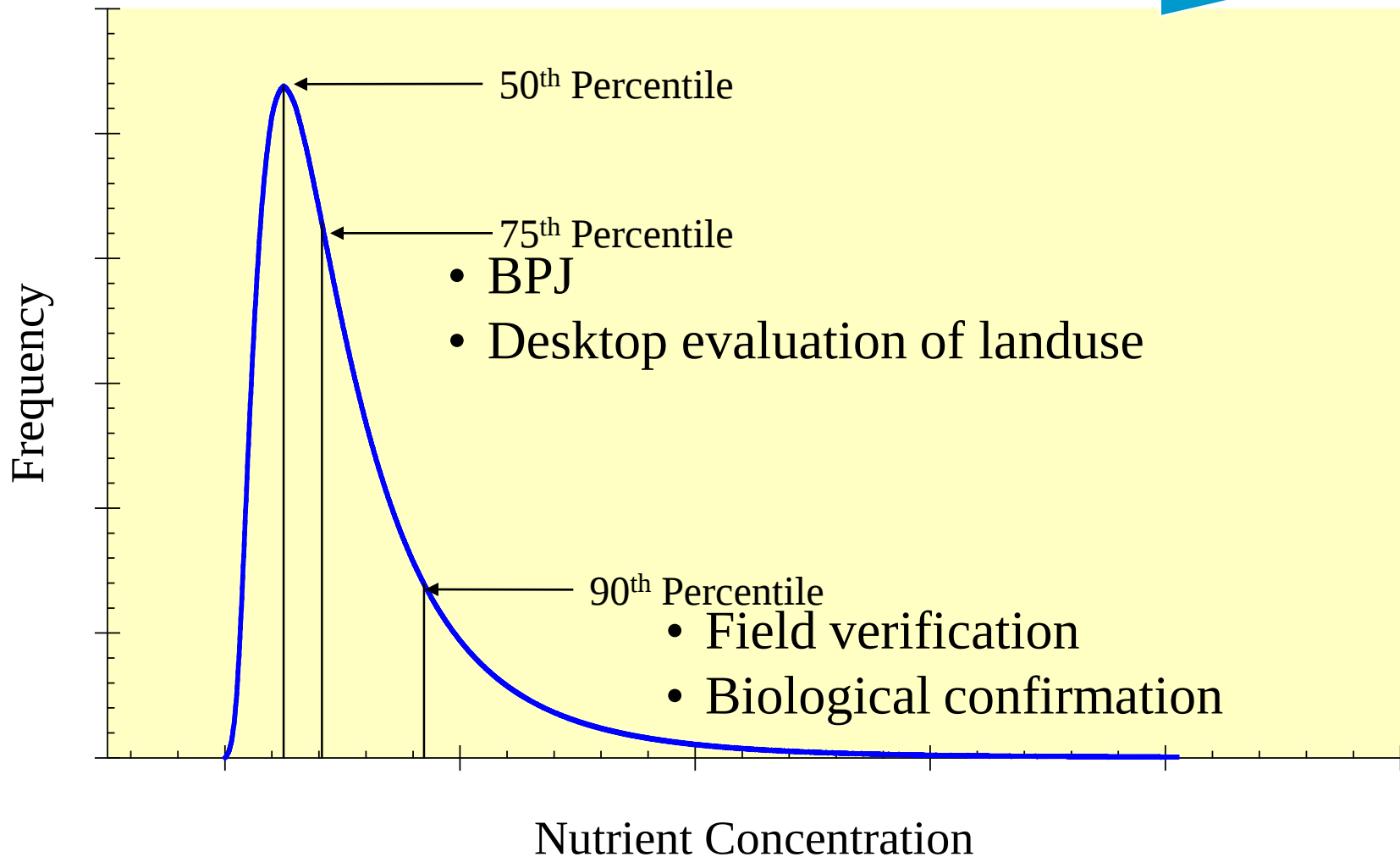


Bioregions were Starting Point, Comprehensive Geographic Analyses Resulted in Nutrient Regions

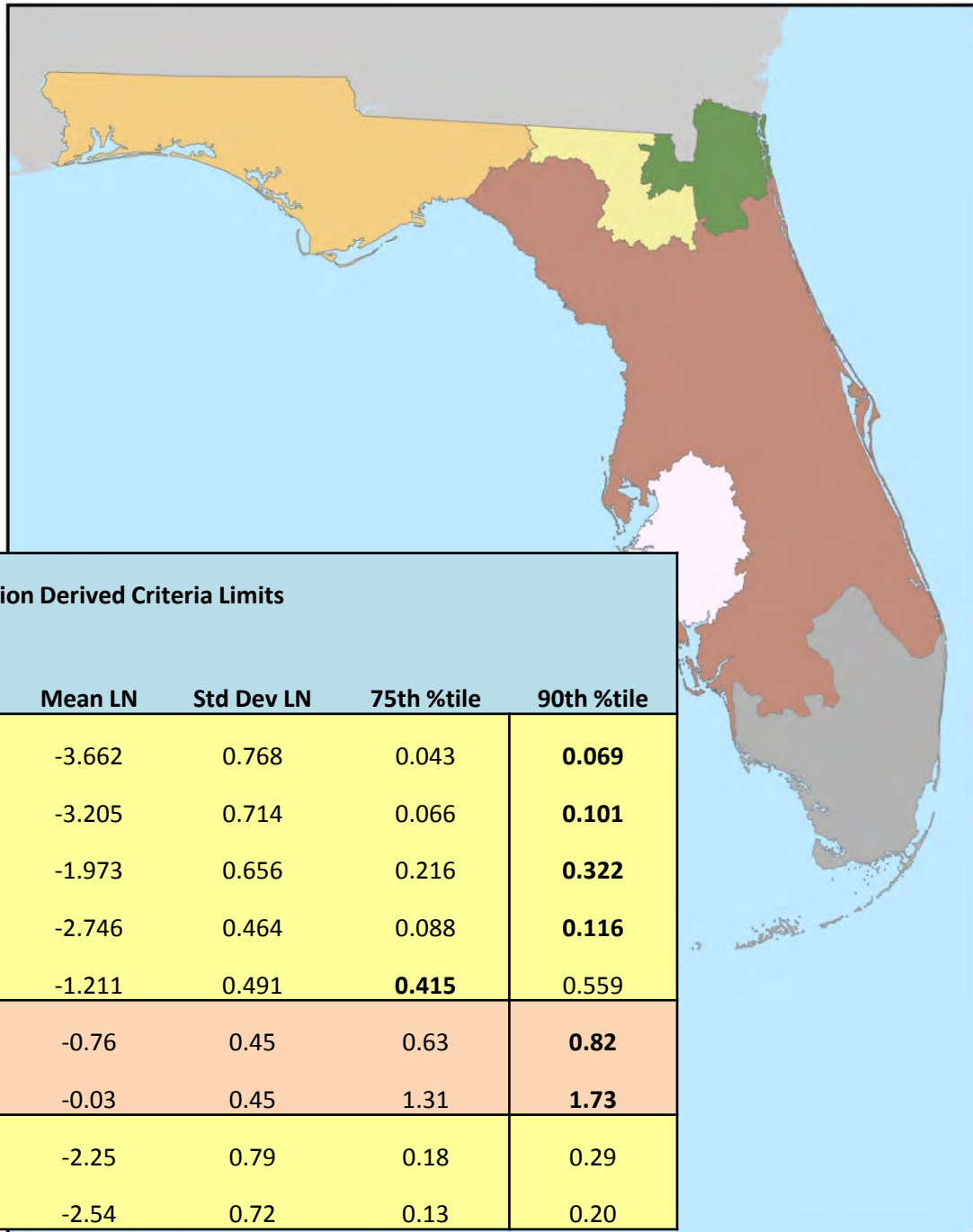


Percentile Depends on Documentation

Certainty in minimally disturbed condition and biological health



Draft Benchmark - Based Criteria

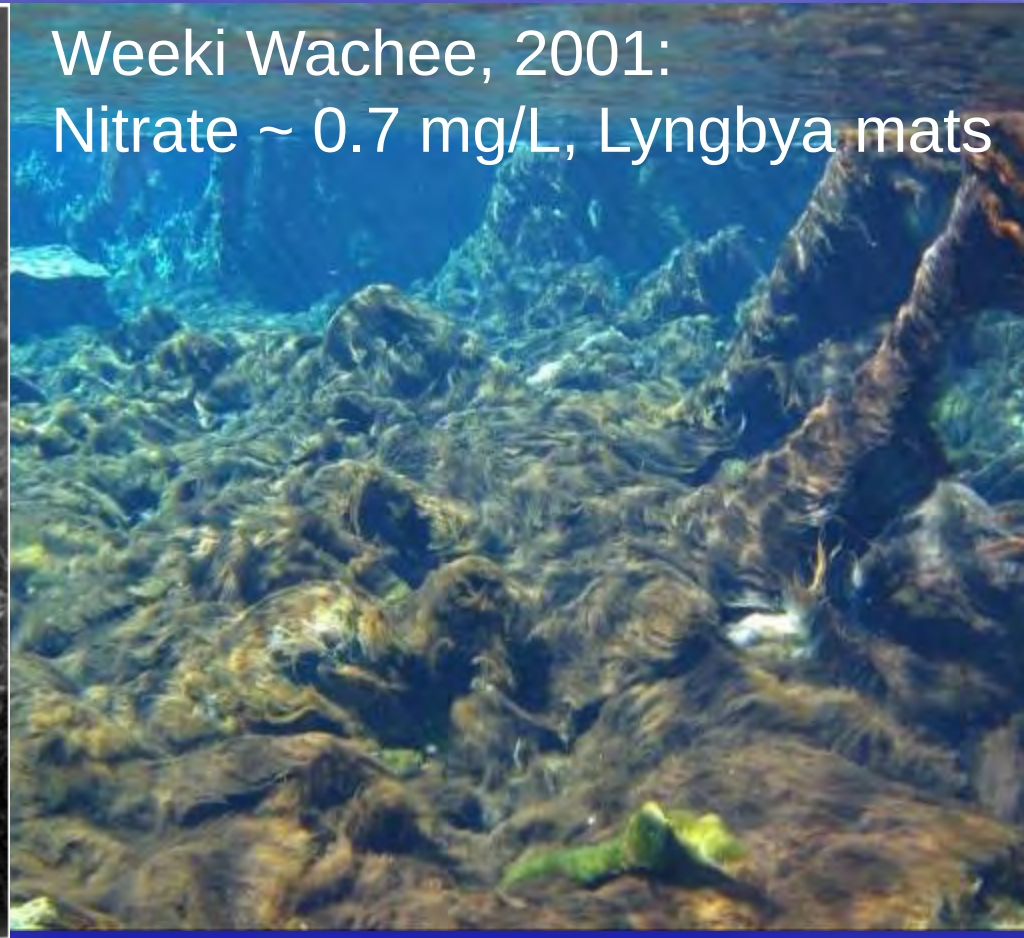


Stream Benchmark Distribution Derived Criteria Limits							
Parameter	Region	WBID Years	WBIDS	Mean LN	Std Dev LN	75th %tile	90th %tile
TP (mg/L)	Panhandle	125	44	-3.662	0.768	0.043	0.069
	Northeast	54	20	-3.205	0.714	0.066	0.101
	North Central	180	18	-1.973	0.656	0.216	0.322
	Peninsula	193	42	-2.746	0.464	0.088	0.116
	Bone Valley	13	3	-1.211	0.491	0.415	0.559
TN (mg/L)	Panhandle	123	42	-0.76	0.45	0.63	0.82
	NE-NC-Pen-BV	400	85	-0.03	0.45	1.31	1.73
TIN (mg/L)	Panhandle	120	44	-2.25	0.79	0.18	0.29
	NE-NC-Pen-BV	379	84	-2.54	0.72	0.13	0.20

Benchmark Conclusions

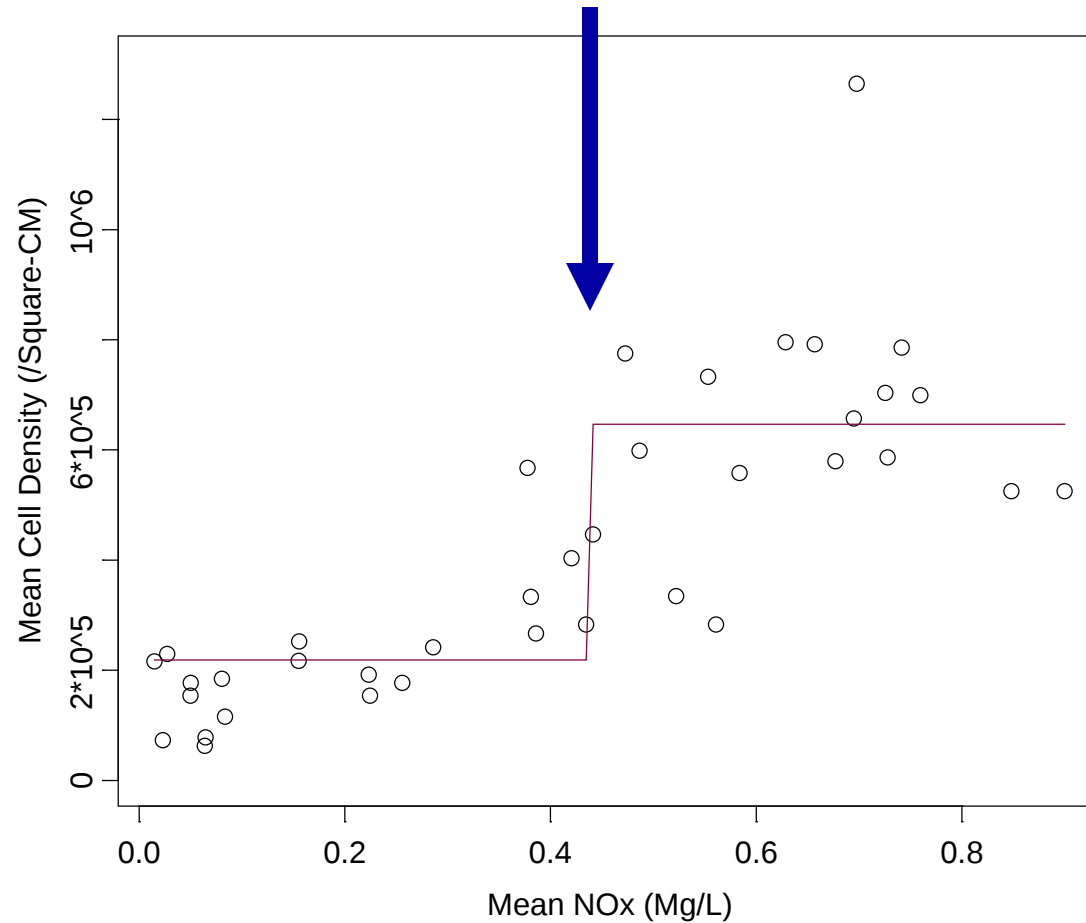
- High confidence in 90th percentile due to data sufficiency, inclusive of the distribution of minimally disturbed sites.
- 95th and 99th were considered, but we have less certainty in the inclusiveness of these levels given the sparseness of data at the extreme end of the distribution.
- Because sites that exceed the 90th percentile may indeed be healthy, TAC recommended biological confirmation of adverse response to establish non-attainment of designated use

Nitrate-nitrite Criterion



Suwannee Periphytometer Change Point Analysis: Cell Density

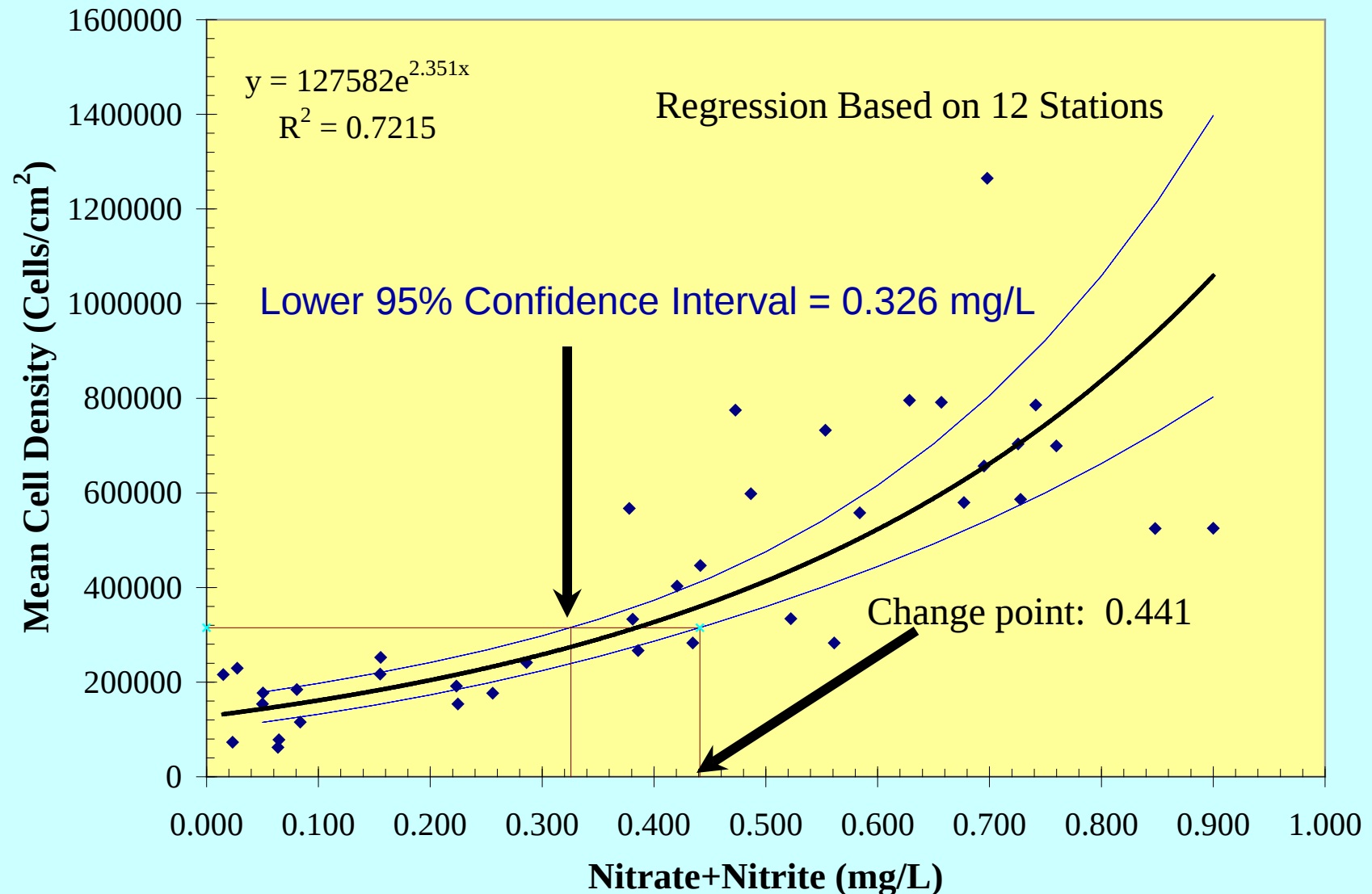
Change Point at **0.441 mg/L Nitrate-nitrite**, $R^2 = 0.62$



Nitrate-nitrite Conclusions

- Lab studies demonstrated nitrate-nitrite was primary factor causing elevated growth at levels above 0.230 to 0.263 mg/L
 - But don't know growth level resulting in impairment
- Independent field studies showed imbalances occur at 0.441 to 0.454 mg/L nitrate-nitrate
 - But need to set criterion below these levels to prevent imbalance from occurring

Lower 95% Confidence Interval below Change Point = 0.326 mg/L



Nitrate-nitrite Conclusions

- Proposed criterion (0.35 mg/L) combines both lines of evidence and provides a margin of safety below levels demonstrating imbalance
 - Monthly median will be used for compliance purposes
- Originally derived from spring-dominated streams, but additional analyses (Tetra-tech) indicate it would be appropriate to apply to all streams below 40 PCU color

Application of Stream Criteria

- Benchmark-based Criteria (TP and TN)
 - Annual Geometric Mean Concentration
 - Based on presumed protection of in-stream biology and minimal disturbance, not threshold of impairment.
 - Applicability for control of sources
 - Need evidence of adverse response to nutrients prior to TMDL development

Application of Stream Criteria

- Response-based Criteria (nitrate-nitrite)
 - Monthly median not to be exceeded more than 10% of the time.
 - Based on biological response in the streams
- All streams eligible for site specific criteria based on protection of aquatic life use using biological health assessments
- Protection of Downstream Waters from excess loading still required

Lakes Nutrient Criteria Development Overview

- Adopt Chlorophyll *a* as response variable
- DEP has demonstrated significant and strong nutrient relationships with chlorophyll *a*
- DEP proposes using chl-*a* relationships as primary line of evidence to develop nitrogen and phosphorus numeric criteria
- LVI response provides additional support for criteria development in clear lakes
 - Significant relationships support need for nutrient criteria

Chlorophyll a Thresholds

- IWR TAC recommended TSI threshold of 60 for most Florida Lakes
- However, TAC realized that this may not be protective of oligotrophic lakes
 - PCA analysis classified TSI and related parameters by color
 - Lakes with Color ≤ 40 PCU had significantly lower TSI (oligotrophic lakes)
 - DEP recommended and TAC agreed to a TSI threshold of 40 for clear lakes (≤ 40 PCU)
- These TSIs equate to chlorophyll a of 20 and 5 $\mu\text{g/L}$ for colored and clear lakes, respectively

Chlorophyll *a* Thresholds

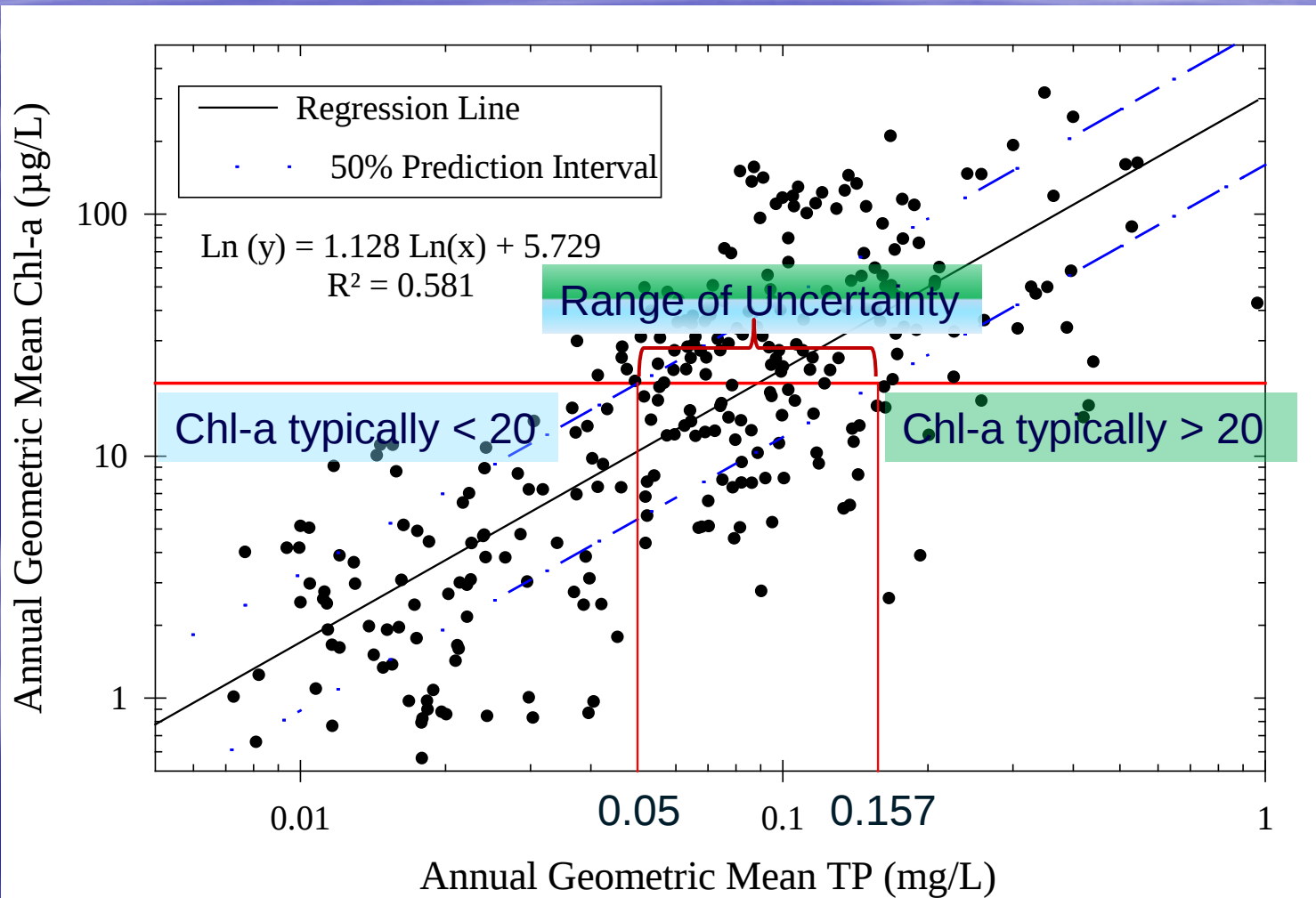
(continued)

- 5-10 $\mu\text{g/L}$ in clear lakes
 - IWR clear lake threshold primarily targeted at a specific geographic region of Florida (the panhandle)
 - Coldwater fishery: 3-5 $\mu\text{g/L}$
 - TetraTech reference lake: 8 $\mu\text{g/L}$
 - Salas and Martino TSI 50 (mesotrophic): 10 $\mu\text{g/L}$

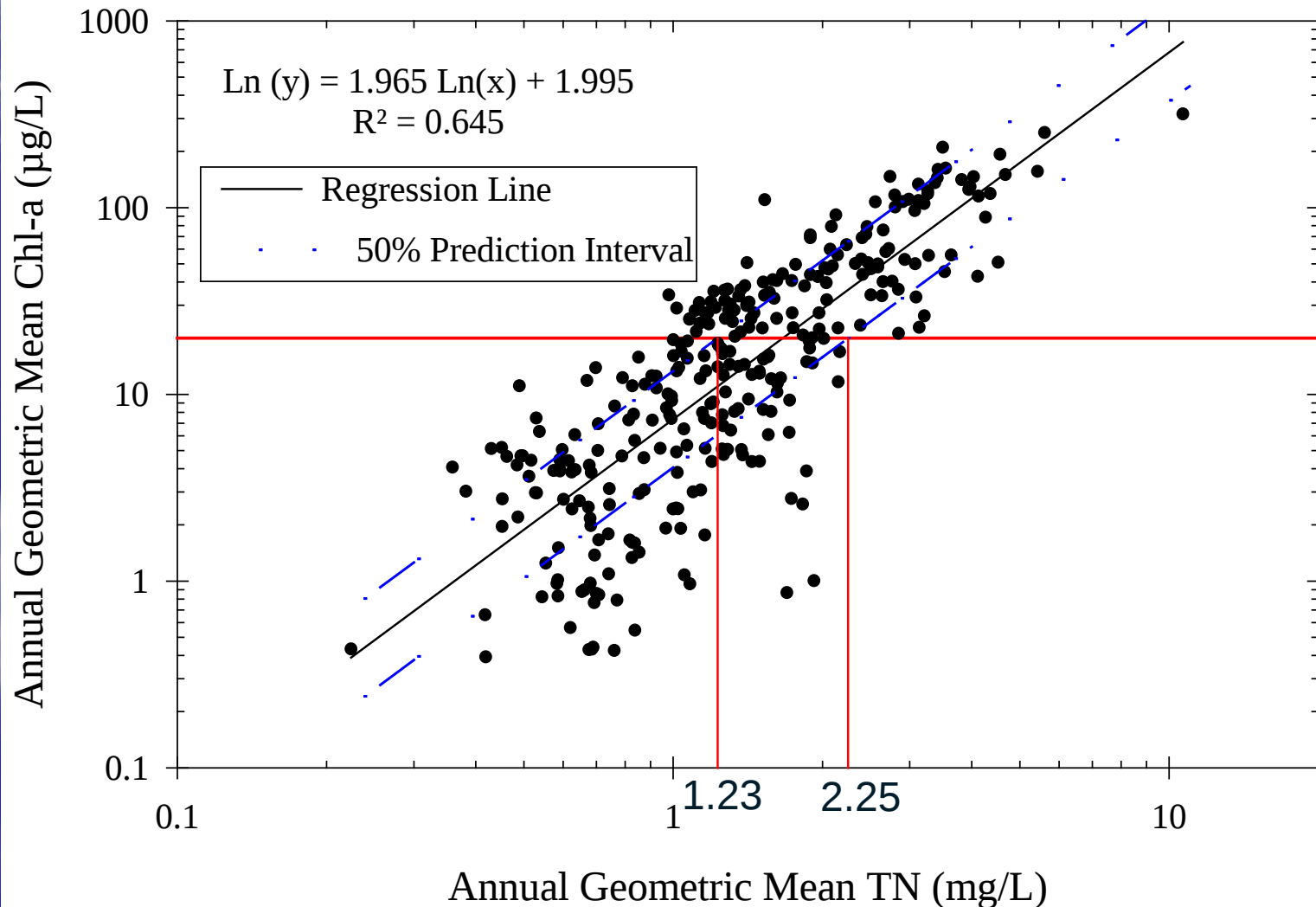
Chlorophyll a Thresholds

- Based on multiple lines of evidence, an annual average chlorophyll a of **20** µg/L in colored lakes (>40 PCU) or clear lakes with high alkalinity (>50 mg/L) is protective of designated uses
 - Protect against shift from mesotrophic to eutrophic conditions
 - Low probability of harmful algal blooms
 - Literature review
 - TAC agreement
- TAC seemed to support an annual average chlorophyll a of **9** µg/L in clear (≤40 PCU) lakes with low alkalinity (≤50 mg/L)
 - Protect against shift from oligotrophic to mesotrophic conditions-TAC recommendation
 - Salas and Martino TSI 50 (mesotrophic): 10 µg/L
 - TetraTech reference lake: 8 µg/L

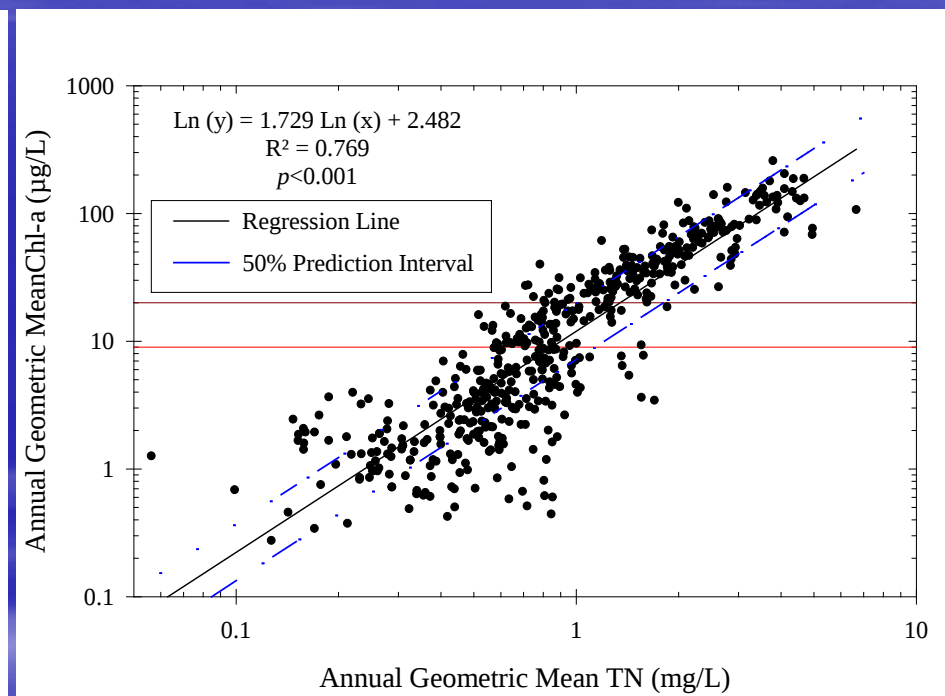
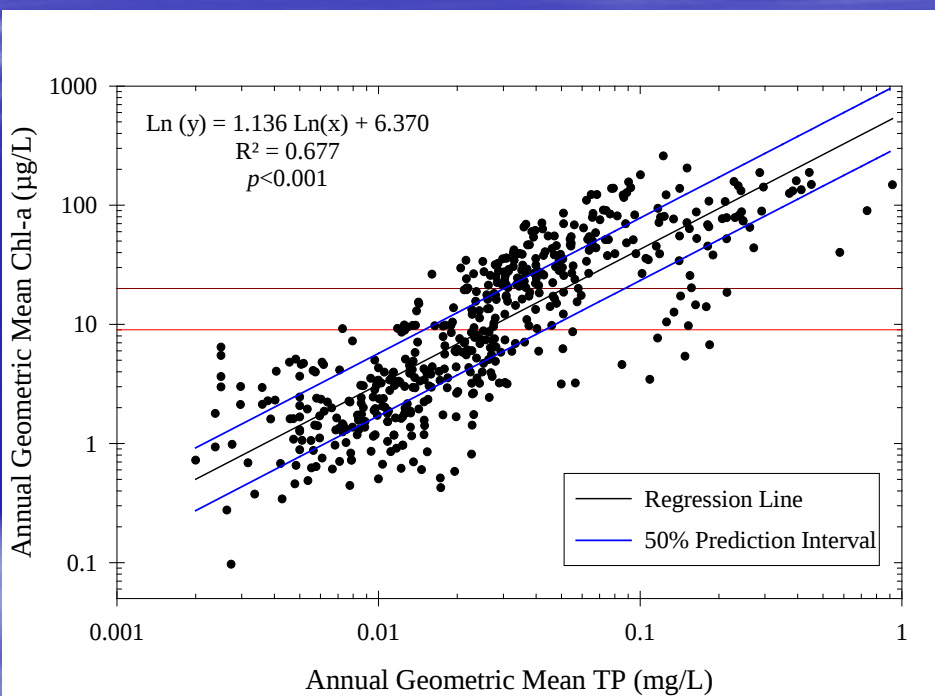
Colored Lake Chl-a Response to Total Phosphorus



Colored Lake Chl-a Response to Total Nitrogen



Clear Lake TP and TN Thresholds



Proposed Lake Nutrient Criteria

Annual Geometric Mean Thresholds

Long Term Average Lake Color and Specific Conductance	Lower Threshold		Upper Threshold	
	TP (mg/L)	TN (mg/L)	TP (mg/L)	TN (mg/L)
>40 Platinum Cobalt Units	0.05	1.23	0.157	2.25
≤ 40 Platinum Cobalt Units and > 50 mg CaCO ₃ /L	0.030	1.00	0.087	1.81
≤ 40 Platinum Cobalt Units and ≤ 50 mg CaCO ₃ /L	0.015	0.85	0.043	1.14

- Color and alkalinity based on 7 year rolling average
- If alkalinity data are unavailable, specific conductance data shall be used, with a value of 250 μ mhos/cm used to estimate the 50 mg/L CaCO₃ alkalinity threshold until such time that alkalinity data are available.

Application of Lake Criteria

- Criteria established based on an analysis of annual geometric mean Chlorophyll *a* and TN/TP
 - Applicable TN/TP Criteria for a given year is based on Chlorophyll *a* levels, subject to boundaries
 - Permitting and Assessment decisions based on Criteria applicable for each year
 - Criteria are not to be exceeded more than once in any three-year period
- All lakes eligible for site specific criteria based on protection of aquatic life use using biological assessments
- Protection of Downstream Waters from excess loading still required.
- Example: Lake with long term Color > 40
 - Chlorophyll *a* standard is geometric mean of 20µg/L
 - TP criterion automatically adjusted based on Chlorophyll *a*,
 - cannot be lower than a 0.05 mg/L
 - cannot be greater than 0.157 mg/L (or what's necessary to protect immediate downstream waters)