

Monitoring Compliance with
Everglades Marsh Phosphorus Criterion

Florida DEP Workshop

October 18, 2001

prepared for

U.S. Department of the Interior

by

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Compliance Methodology for Phosphorus Criterion Problem Dimensions

Numeric Value

- start of transition zone
- midpoint of transition zone
- endpoint of transition zone

Temporal Scale

- daily, monthly
- yearly
- long-term

Spatial Scale

- area-wide average - protect "average marsh"
- each point - protect "entire marsh"
- average within grid cell of dimension ? km

Monitoring Network Design

- station types
 - inflows
 - transect
 - grid
- sampling frequency
- sampling & analytical methodology

Summary Statistic

- geometric mean
- arithmetic mean
- flow-weighted-mean
- percent of samples > threshold

Hydrologic Variability

- factor directly into compliance test
- treat as random factor

Significance Level = α

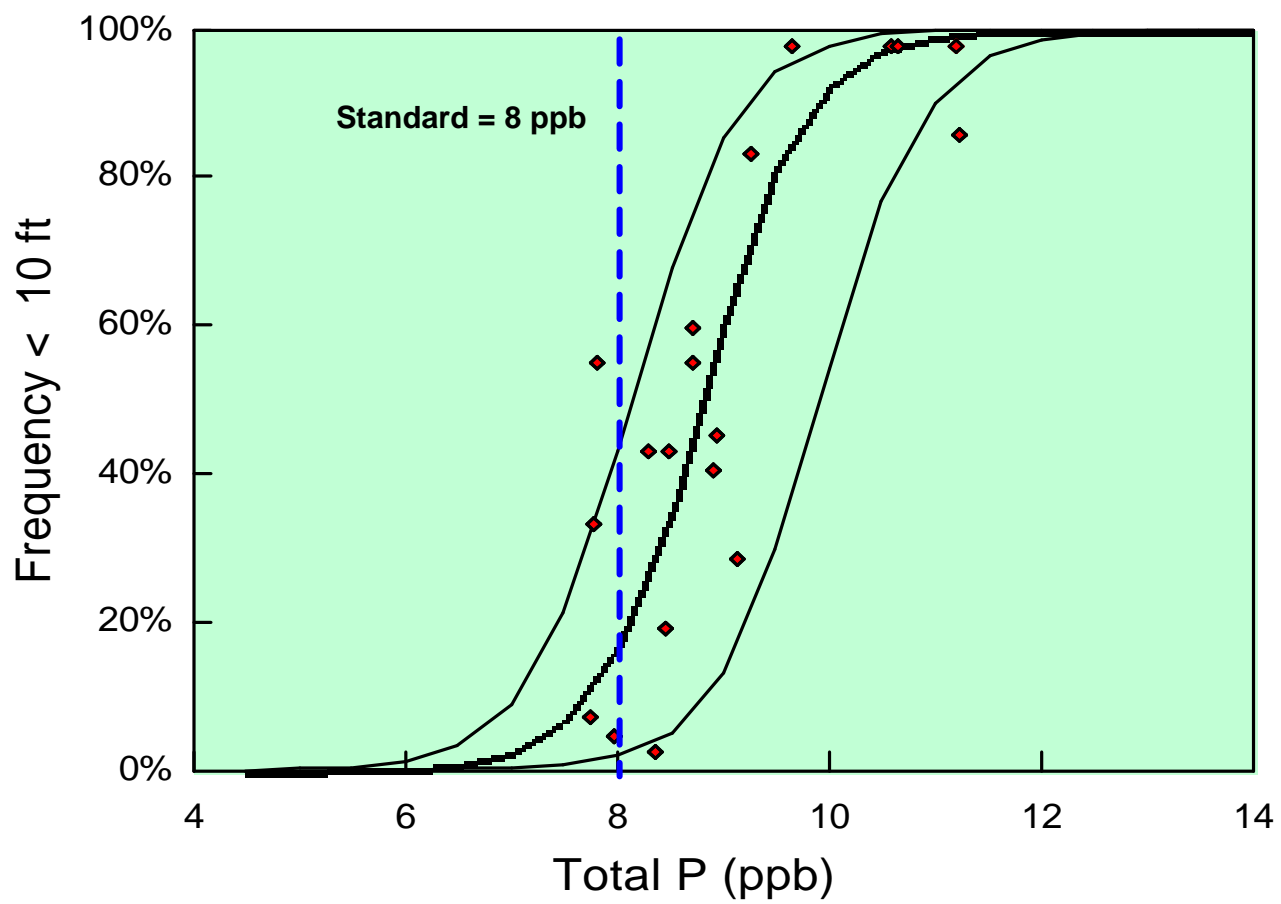
- Type I Error = α = max risk of false violation
- Type 2 Error = $1 - \alpha$ = max risk of not detecting viol.



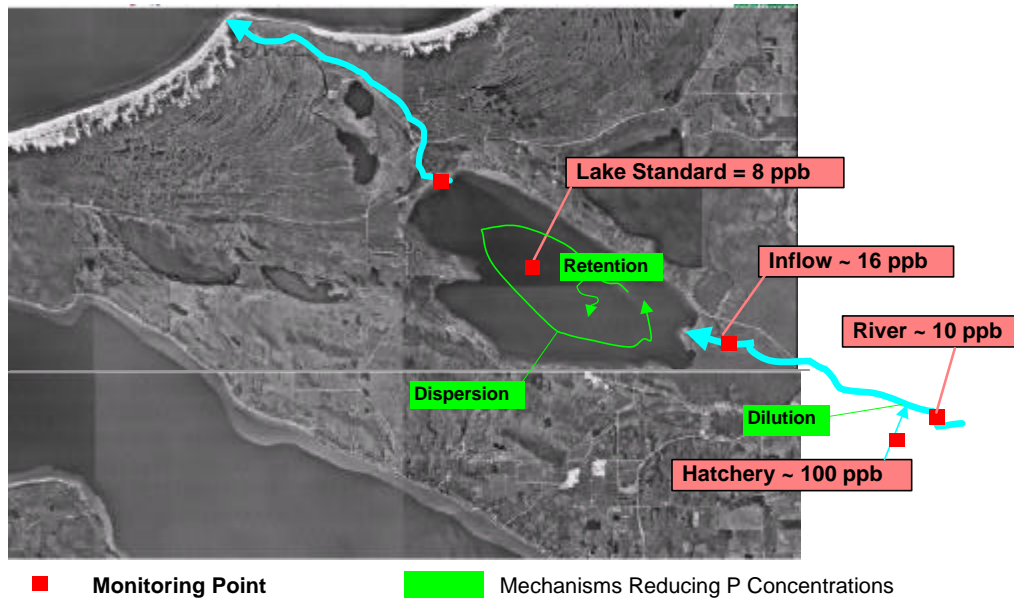
Lake Standard = 8 ppb

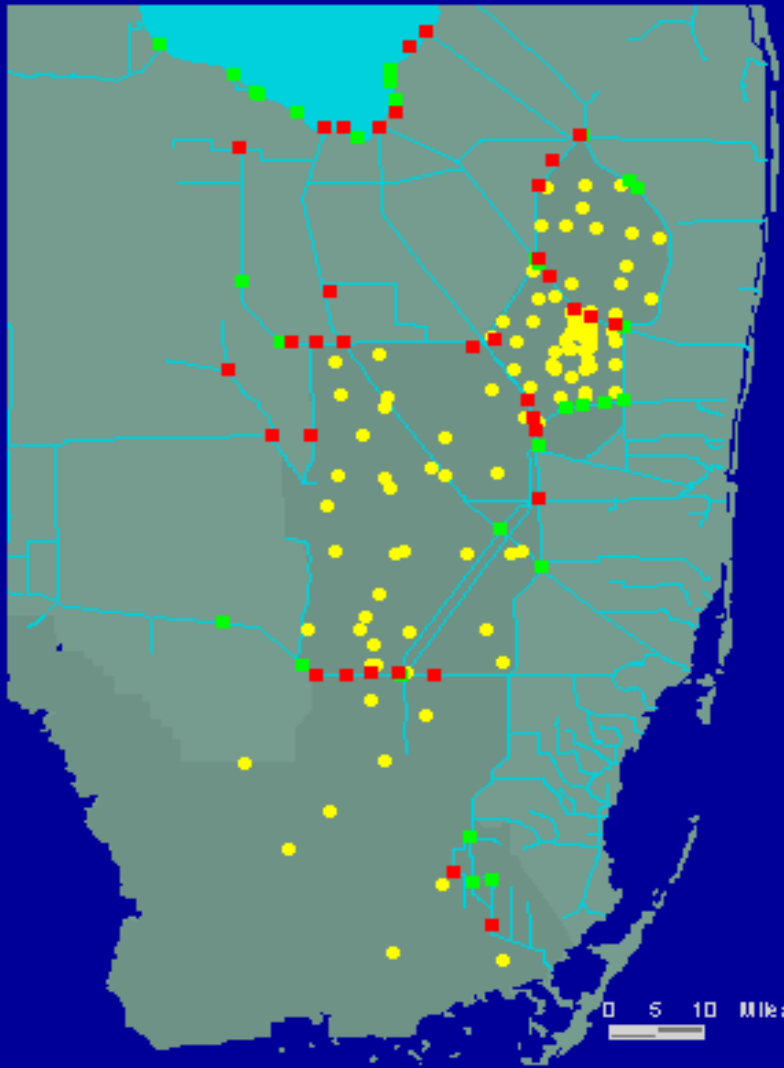


Transparency Reponse to Total Phosphorus - Platte Lake



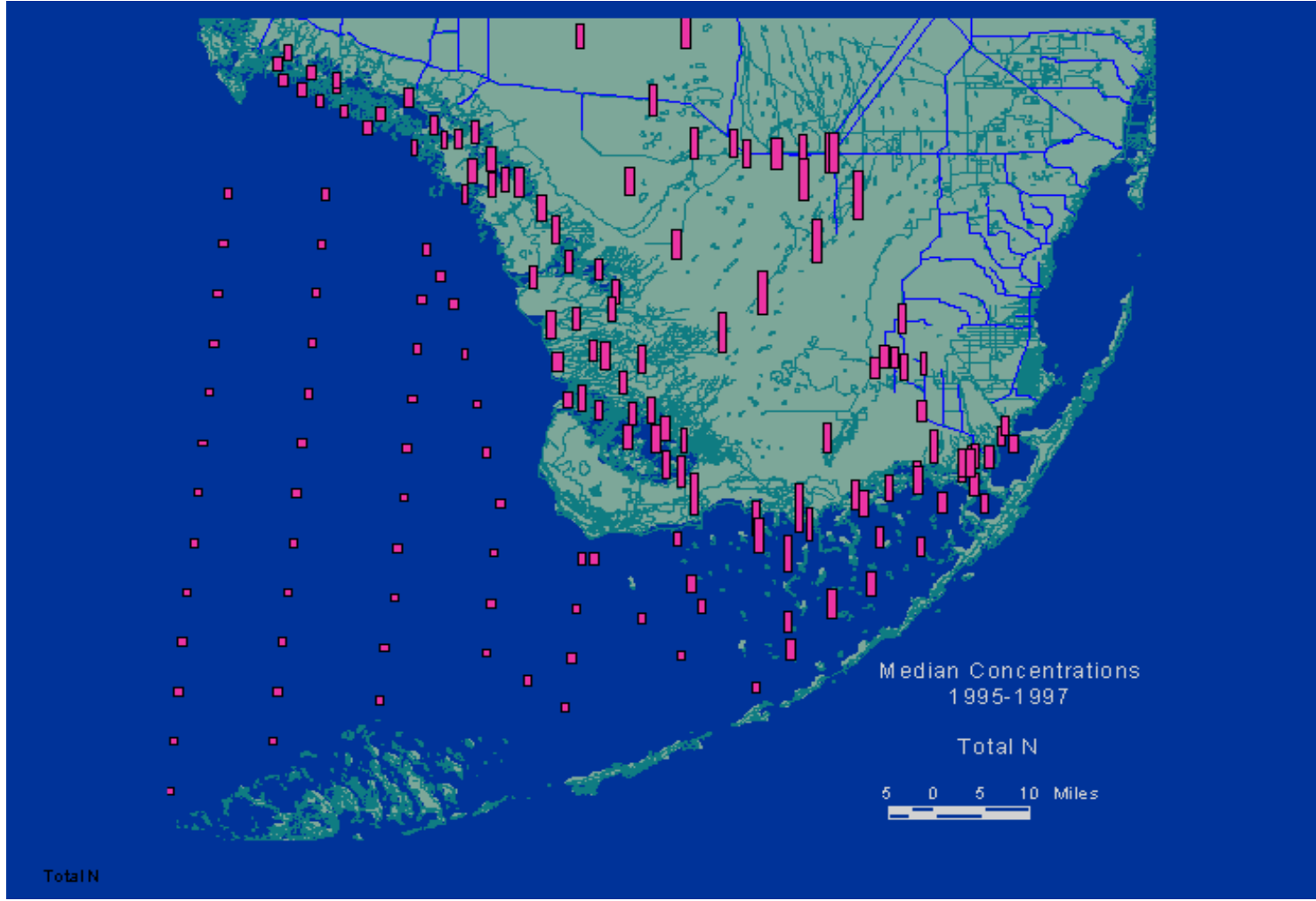
Monitoring Compliance with Phosphorus Standard in Platte Lake, Michigan

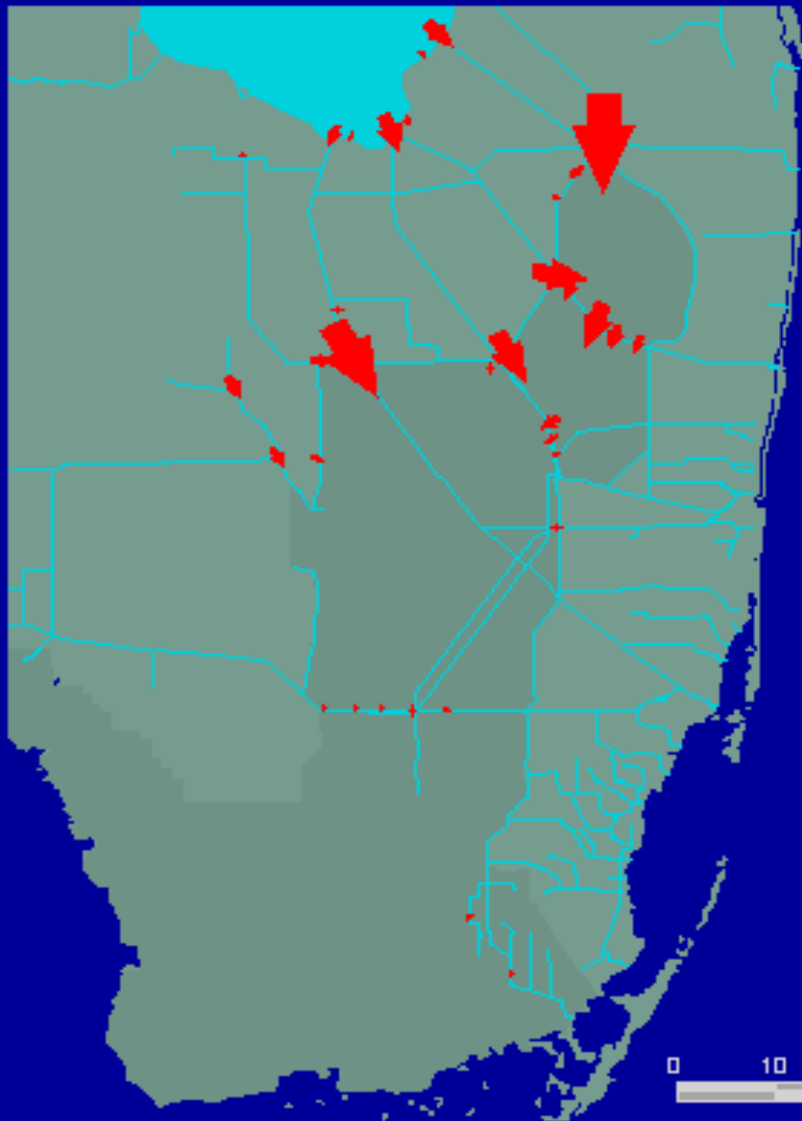




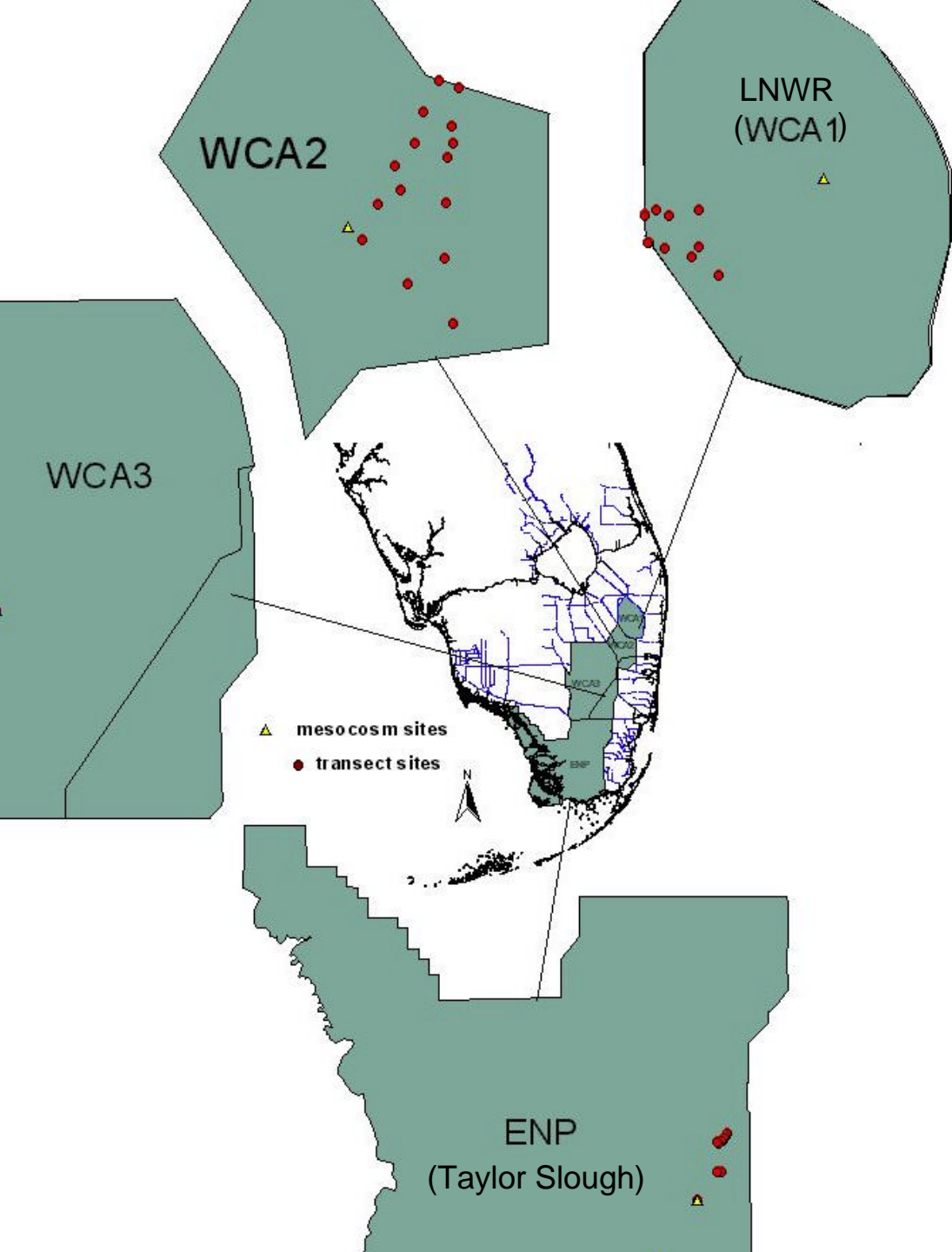
Monitoring Stations 1978 - 1996

- Flux Stations
- Structure Stations
- Marsh Stations



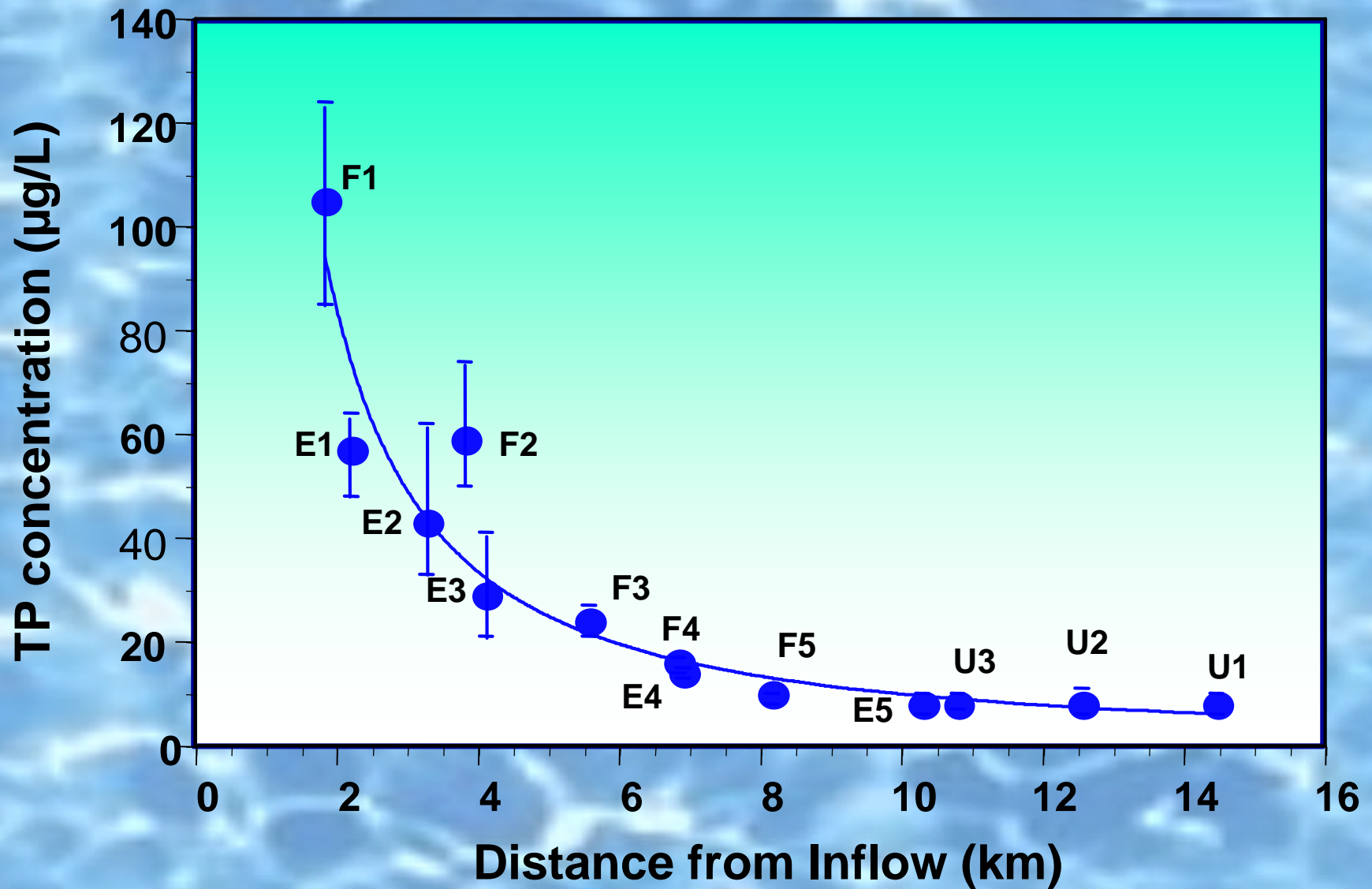


Structure TP Loads WY 1992 - 1996



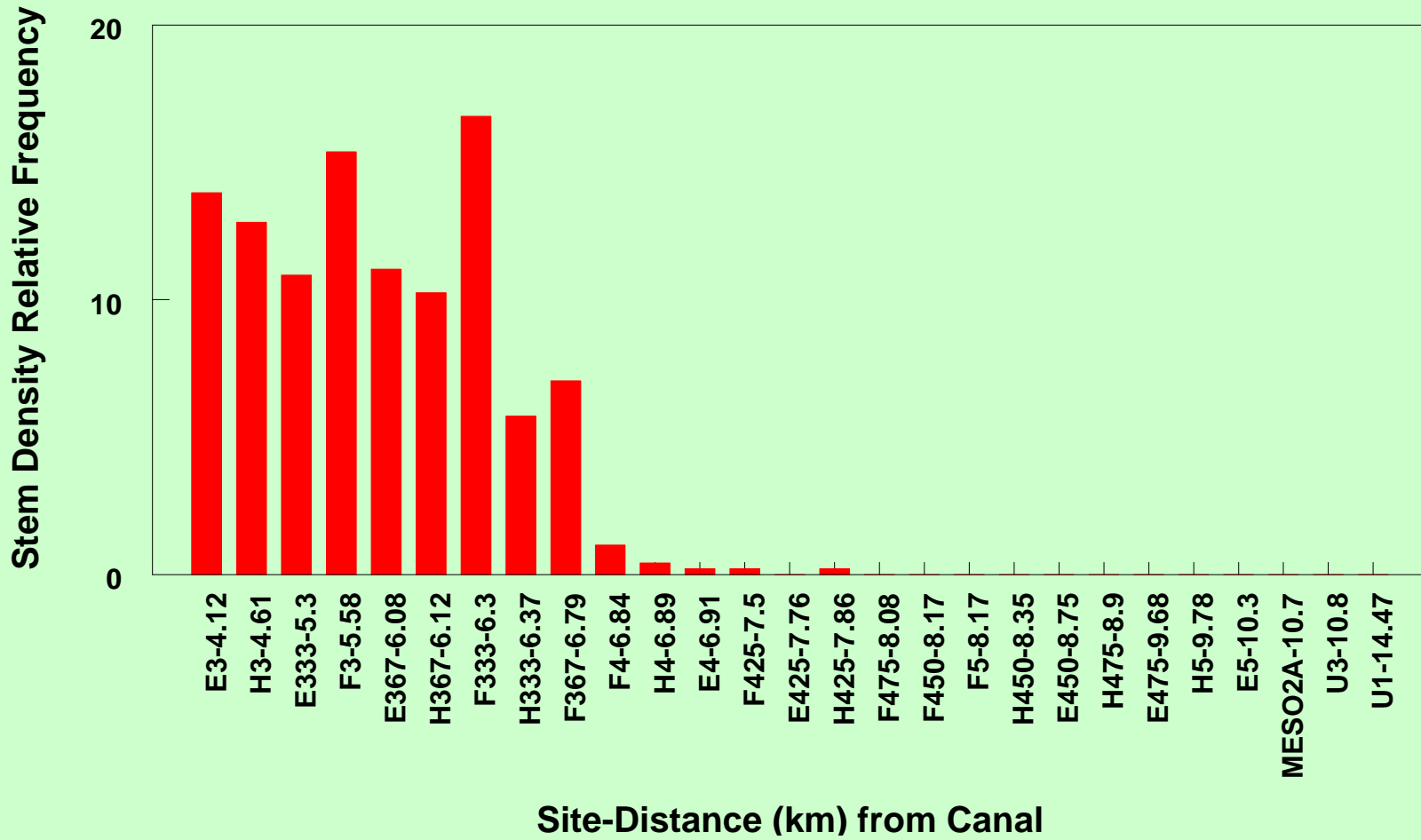
Spatial Variability

Regression

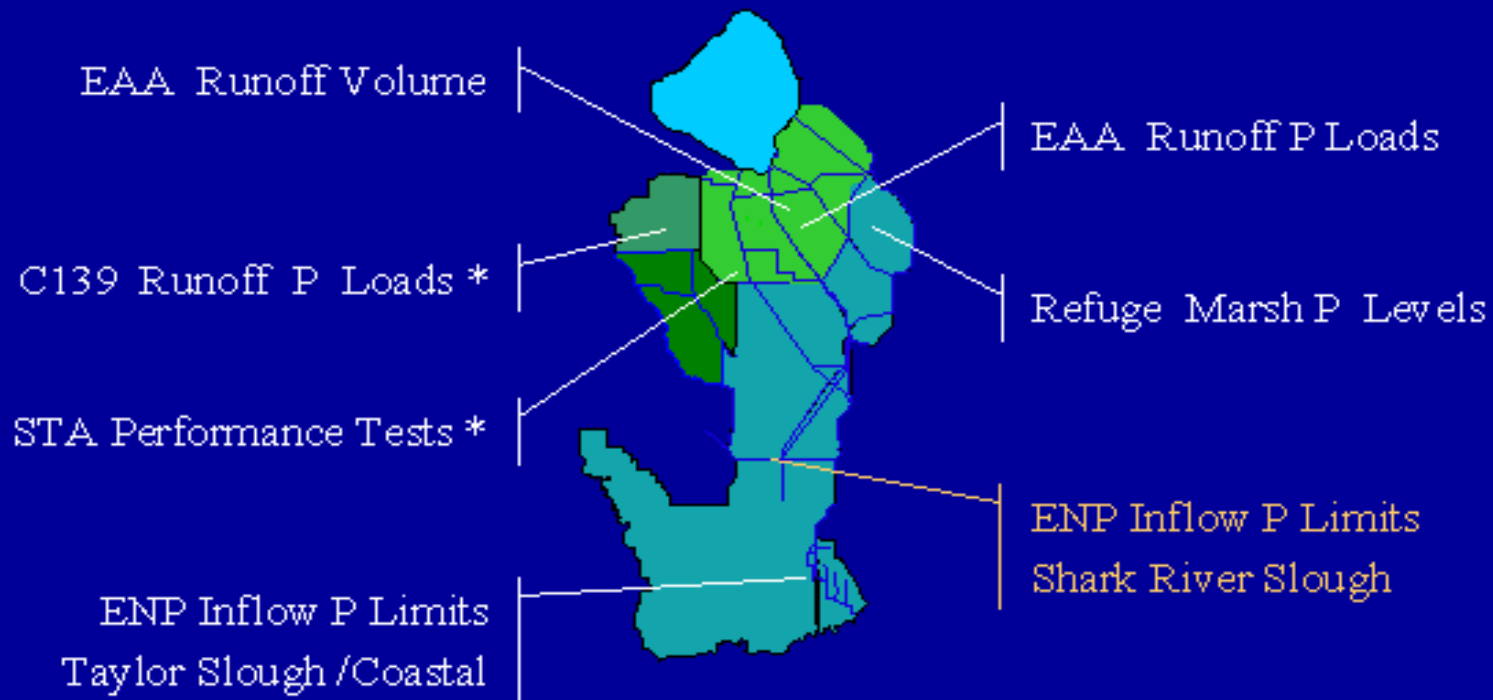


Geometric Mean (bars = annual range, 1994-1998)

Cattail Stem Densities in WCA-2A



Tracking Model Applications to Everglades



*Application Under Development

Compliance Model Structure

$$\begin{array}{ccccccc} \text{Measured} & = & \text{Long-Term} & + & \text{Trend?} & + & \text{Hydrologic} & + & \text{Random} \\ \text{Value} & & \text{Mean} & & & & \text{Variation} & & \text{Variation} \\ & & \text{Management} & & \text{Management} & & \text{Rainfall} & & \text{Natural} \\ & & \text{Concern} & & \text{Concern} & & \text{Depth} & & \text{Sampling} \\ & & & & & & \text{Flow} & & \text{Analytical} \end{array}$$

Phosphorus Compliance Tests Currently Applied in Everglades

<u>Location</u>	<u>Compliance Point</u>	<u>Hydrologic</u>			<u>Long-Term Limit</u>	<u>Annual Limit</u>	<u>3 -Yr Test</u>
		<u>Variable</u>	<u>Factor</u>	<u>Objective</u>			
STA Discharge Permits	Each STA Outflow	Qw Conc	-	Meet Design Objective	50	75	
EAA Regulatory Rule	Comb. Basin Outflows	Load	Rain	25% Reduc vs. 1979-88	167	100 - 550	yes
C139 Regulatory Rule	Comb. Basin Outflows	Load	Rain	No Increase vs 1978-88	36	8 - 230	yes
Lox. Refuge - Interim	Interior Marsh Avg	Gm Conc	Stage	No Increase vs. 1978-79	8	8 - 25	
"" - Longterm	Interior Marsh Avg	Gm Conc	Stage	"" Least Impacted Sites	8	7 - 18	
ENP Shark Sl. - Interim	Comb. Basin Inflows	Qw Conc	Flow	No Increase vs. 1978-79	8	9 - 14	
"" - Longterm	Comb. Basin Inflows	Qw Conc	Flow	"" Least Impacted Sites	8	7 - 13	
ENP Coastal - Longterm	Comb. Basin Inflows	Qw Conc	-	No Increase vs. 1978-79	6	11	

3 - Year Test: Out of Compliance if Yearly Value > Long-Term Limit (Hydro.-Adjusted) in 3 or More Consecutive Years

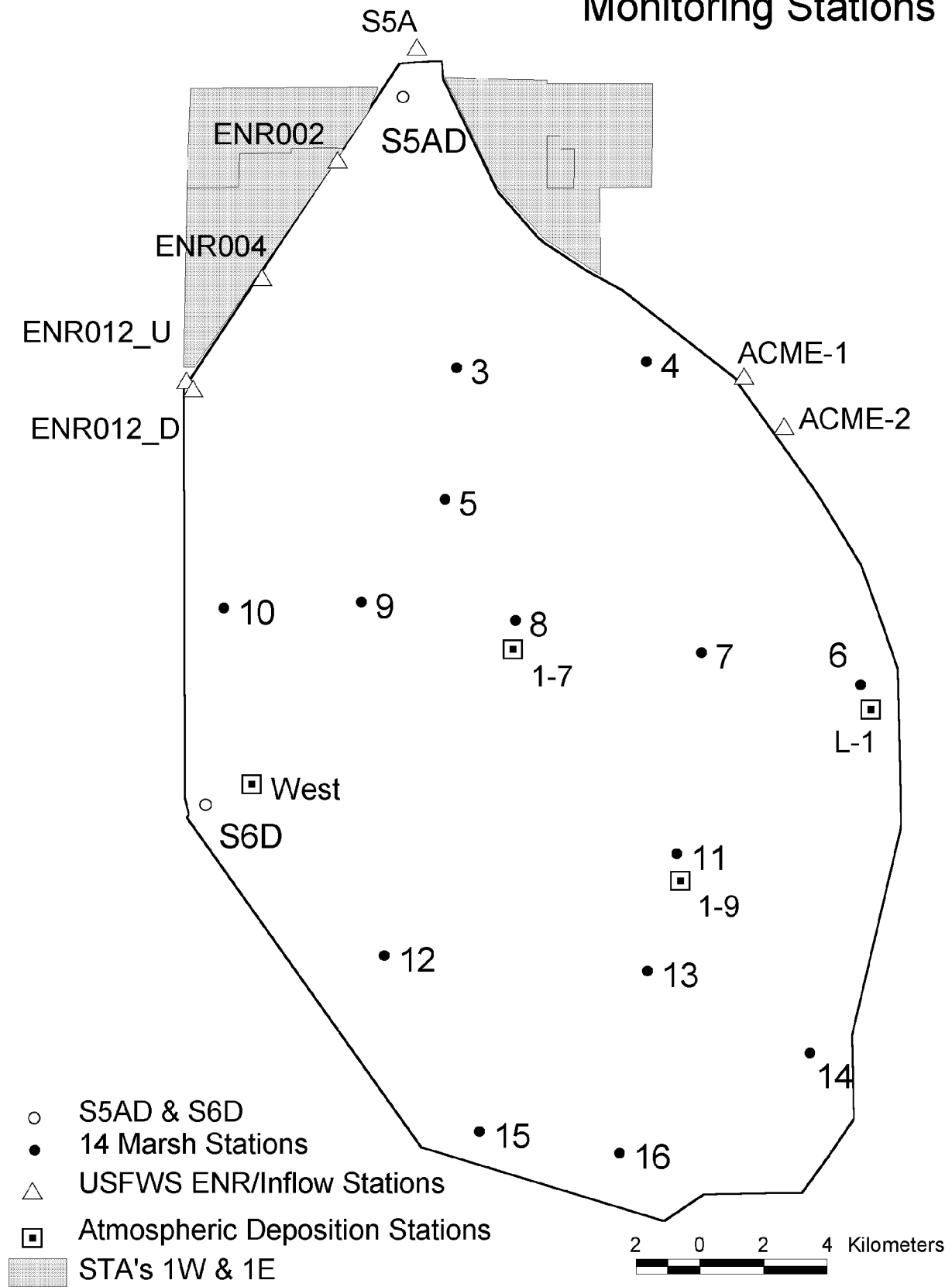
Attributes of Each Test:

Allows for Random Variations, Calibrated to Historical Monitoring Data

Implemented Yearly (Monthly in Refuge)

Significance Level - 10% = Max. Risk of Failing Test if Objective is Achieved

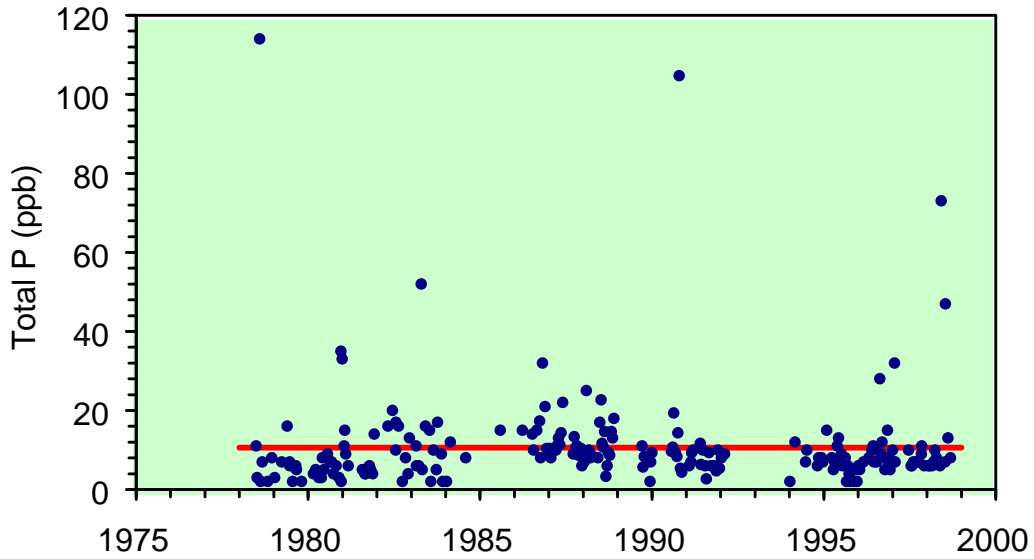
Monitoring Stations



Phosphorus Concentrations at WCA-2A Reference Site U3

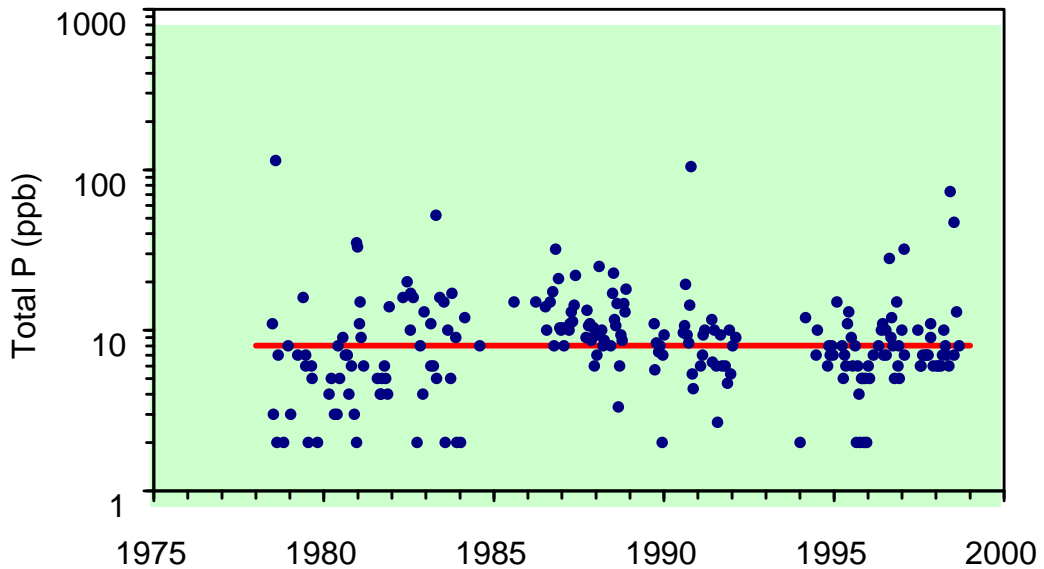
Arithmetic Mean = 10.6 ppb Coef of Variation = 117%

Linear Scale

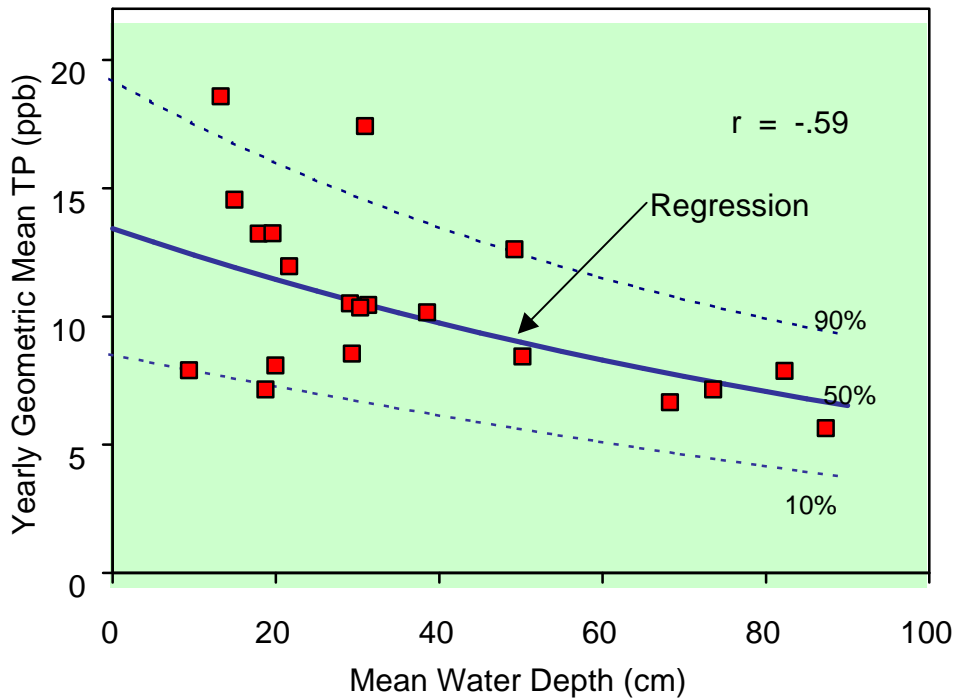
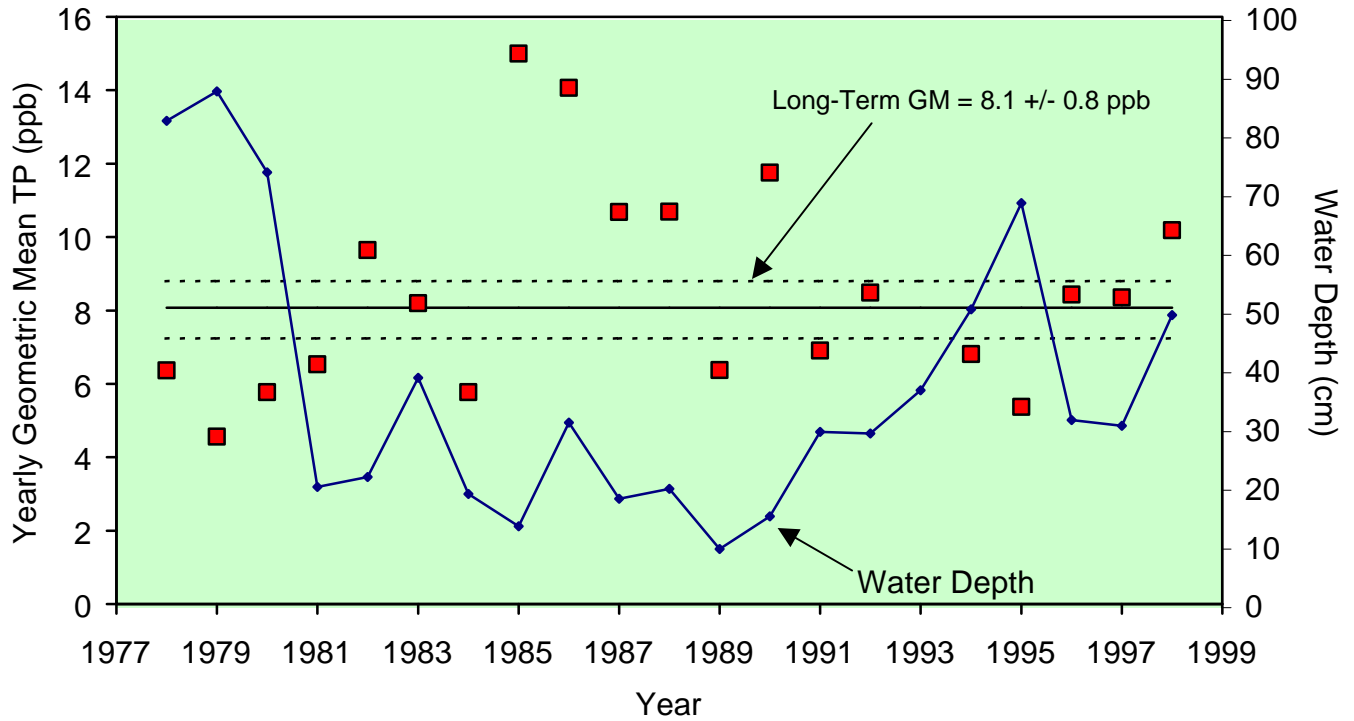


Geometric Mean = 8.0 ppb Coef of Variation = 68%

Log Scale



Historical Phosphorus Data from WCA-2A Reference Site U3

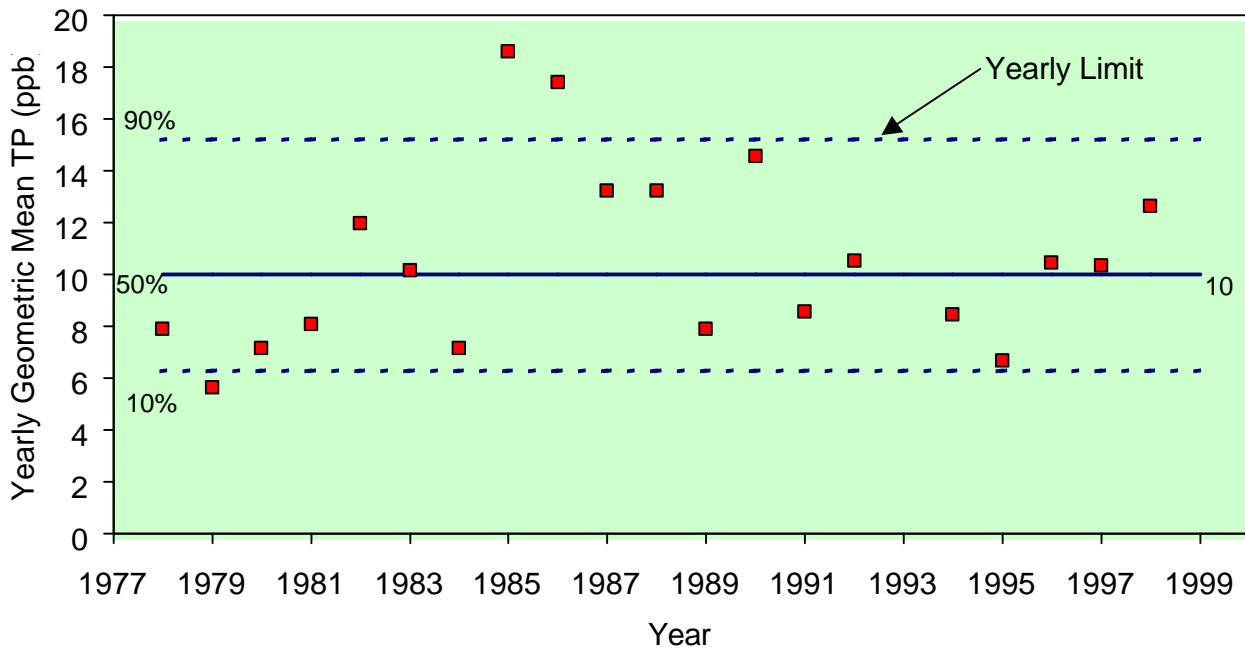


Derivation of 1-Year Limit for Marsh Threshold Compliance Test Applied to Data from a Single Station

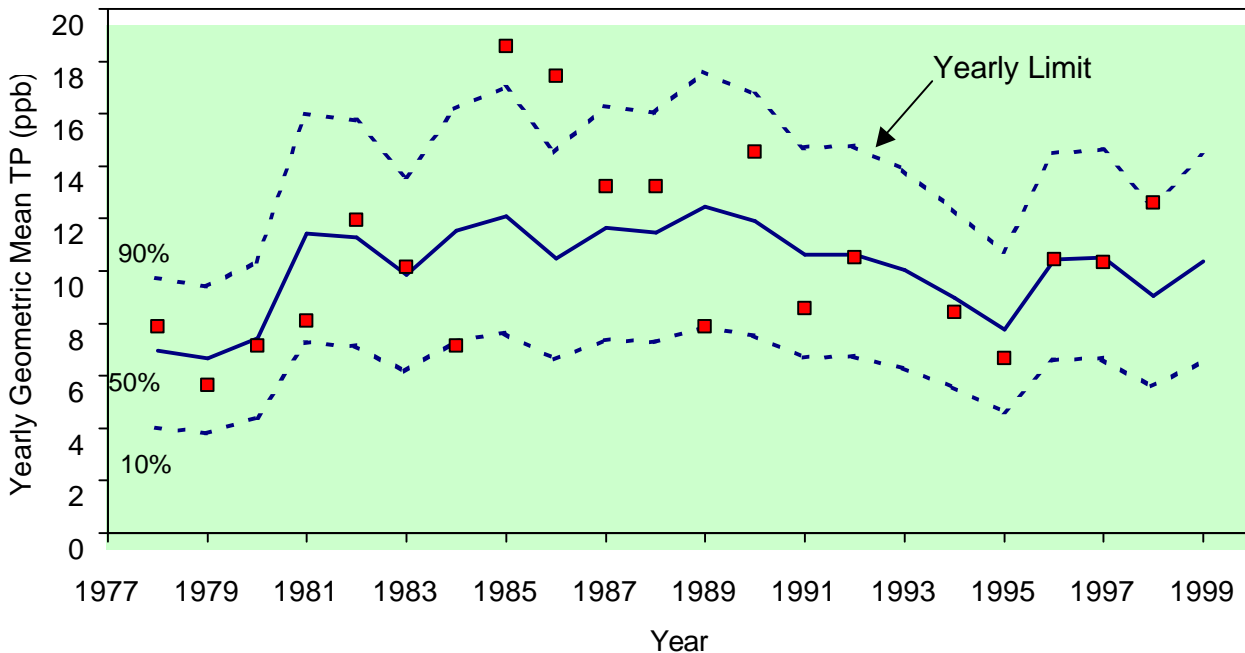
Objective: Long-Term Geometric Mean < 10 ppb

WCA-2A Reference Site Data Rescaled to Long-Term GM = 10 ppb

Option 1 - Fixed Yearly Limits:



Option 2 - Depth-Dependent Yearly Limits Developed from Conc vs. Depth Regression



The Compliance Game

D R A F T - for Illustration Purposes Only

Demonstrates Basic Principles for Designing Monitoring Networks to Test Compliance with Phosphorus Criterion

W. Walker for U.S. Dept of the Interior

October 18, 2001

Decision Variables:





Discharge TP Conc	50	ppb
Monitoring Grid Scale	1	km
Threshold	10	ppb

Results for Grid Scale = .06 km

Grid Length	11.0	km
Grid Geometric Mean	11.7	ppb
Distance > Threshold	5.5	km
New Impacted Area / STA Area	2.5	

Model Parameters:

STA Flow / Width	25	hm ³ /yr/km
STA Area / Width	2.2	km
C*	4	ppb
Net Setting Rate	10.2	m/yr
Hydroperiod	90%	
Rainfall	1.17	m/yr
Evapotrans. Rate	1.37	m/yr

	Previously Impacted Cell
	Previously Unimpacted Cell > Threshold
	Previously Unimpacted Cell < Threshold
	No Data

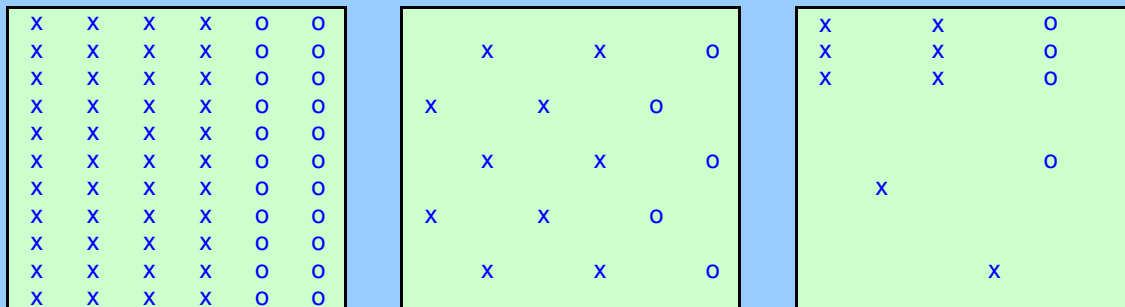
Network	Fine Grid	Coarse Grid	Transect + Coarse Grid
Sites in Impacted Zone	22	5	4
Sites in Unimpacted Zone	44	10	8
Sites > Threshold	24	10	8
Grid Geo. Mean (ppb)	11.7	11.4	21.0
Max Conc (ppb)	42	31	42
Grid Compliance	Failed	Failed	Failed
Site Compliance	Failed	Failed	Failed
Discharge < Threshold	Failed	Failed	Failed

STA's Not to Scale:

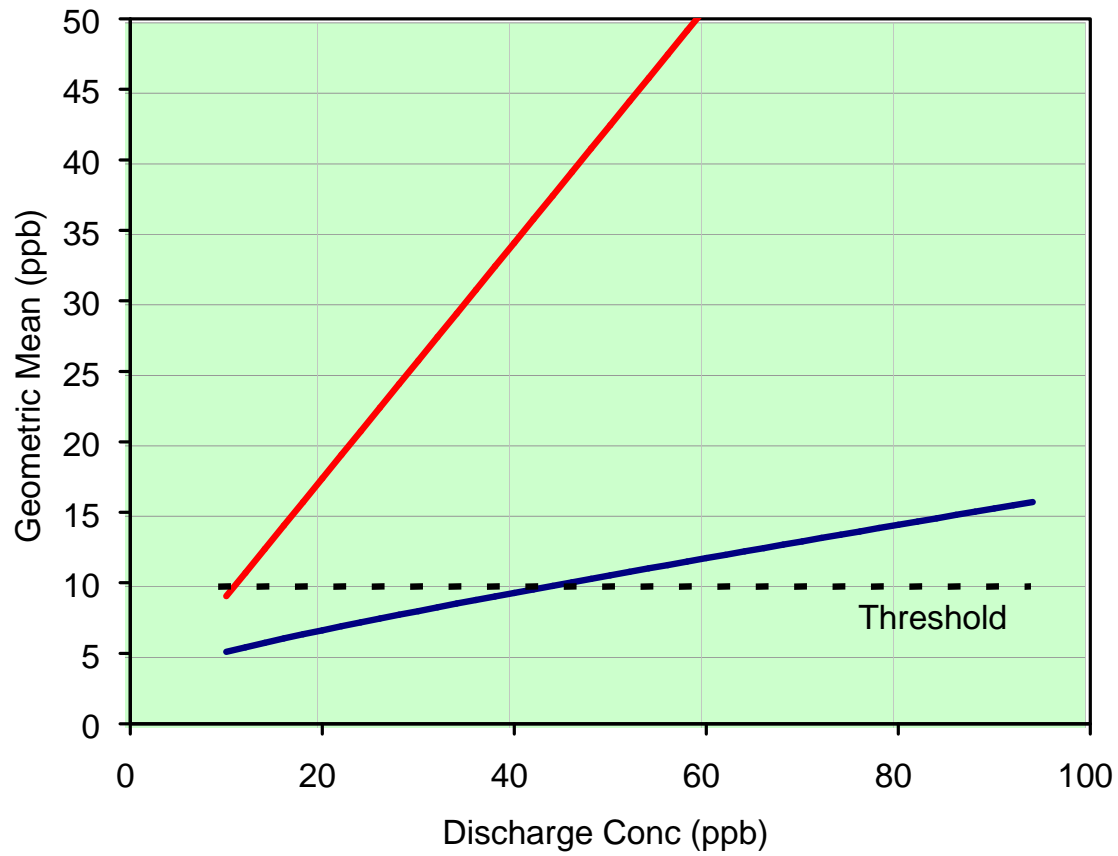
Simulated
Concs (ppb):



User-Defined Station Network:

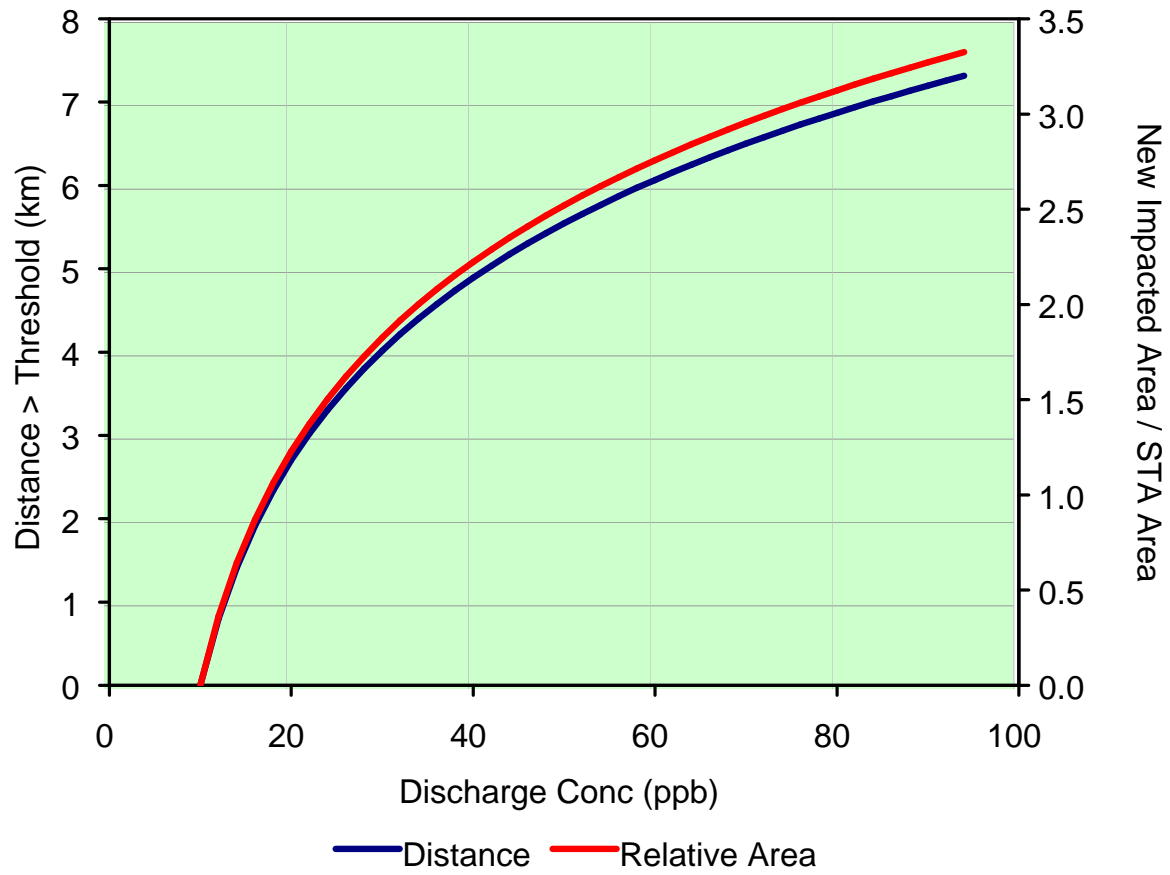


- o Previously Impacted Site Monitored for "Net Improvement"
- x Previously Unimpacted Site Tested for Compliance with Threshold Criterion



— Grid Geo Mean — Maximum Conc - - - Threshold

Grid Scale = 1 km Sampling Grid 1



Discharge / Width = 25 hm³/km
 STA Area / Width = 2.2 km

Phosphorus Compliance Tests Currently Applied in Everglades

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Attributes of Each Test:

Allows for Random Variations, Calibrated to Historical Monitoring Data

Implemented Yearly (Monthly in Refuge)

Significance Level - 10% = Max. Risk of Failing Test if Objective is Achieved

Compliance Tests That Would Protect Entire Marsh

<u>Option</u>	<u>Compliance Point</u>	<u>Distance from</u>		<u>Hydrologic Factor</u>	<u>Long-Term Limit</u>	<u>Annual Limit</u>
		<u>Inflows</u>	<u>Variable</u>			
1 - "End of Pipe"	Each STA Outflow	0 km	Qwtd Conc		10 ?	15 ?
2 - "End of Pipe"	Each STA Outflow	0 km	Gm Conc		10 ?	15 ?
3 - "Edge of Marsh"	Perimeter Marsh Each Station	X km	Gm Conc		10 ?	15 ?
4 - "Edge of Marsh"	Perimeter Marsh Each Station	X km	Gm Conc	Stage	10 ?	10 - 18 ?
5 - "Edge of Marsh"	Perimeter Marsh Averaged by STA	X km	Gm Conc		10 ?	14 ?
6 - "Edge of Marsh"	Perimeter Marsh Averaged by STA	X km	Gm Conc	Stage	10 ?	9 - 17 ?

Attributes of Each Test:

Objectives:

No Imbalance in Previously Unimpacted Areas

Maximum Rate of Recovery in Previously Impacted Areas

Marsh Protected on a Spatial Scale of X kilometers (X = Legal/Policy Decision ?)

Allows for Random & Hydrologic Variations, Calibrated to Historical Monitoring Data

Test Statistic: Yearly Geometric Mean of Samples Collected Biweekly (Monthly?)

Out of Compliance if:

Yearly GM > Limit in Any Year or

Yearly GM > 10? ppb in 3 or More Consecutive Years

Limit Value (10 ? ppb) Depends on Interpretation of Research

Significance Level - 10% = Max. Risk of Failing Test if Objective is Achieved

Patterned After Other Compliance Methodologies Being Used in Everglades

Supplemented with Additional Grid-Based Monitoring to Track Long-term Trends

in Unimpacted & Previously Impacted Areas