# FREQUENCY DISTRIBUTIONS OF SURFACE WATER TOTAL PHOSPHORUS IN THE LOXAHATCHEE REFUGE: SIMILARITY AND IMPLICATIONS FOR DYNAMIC MODELS

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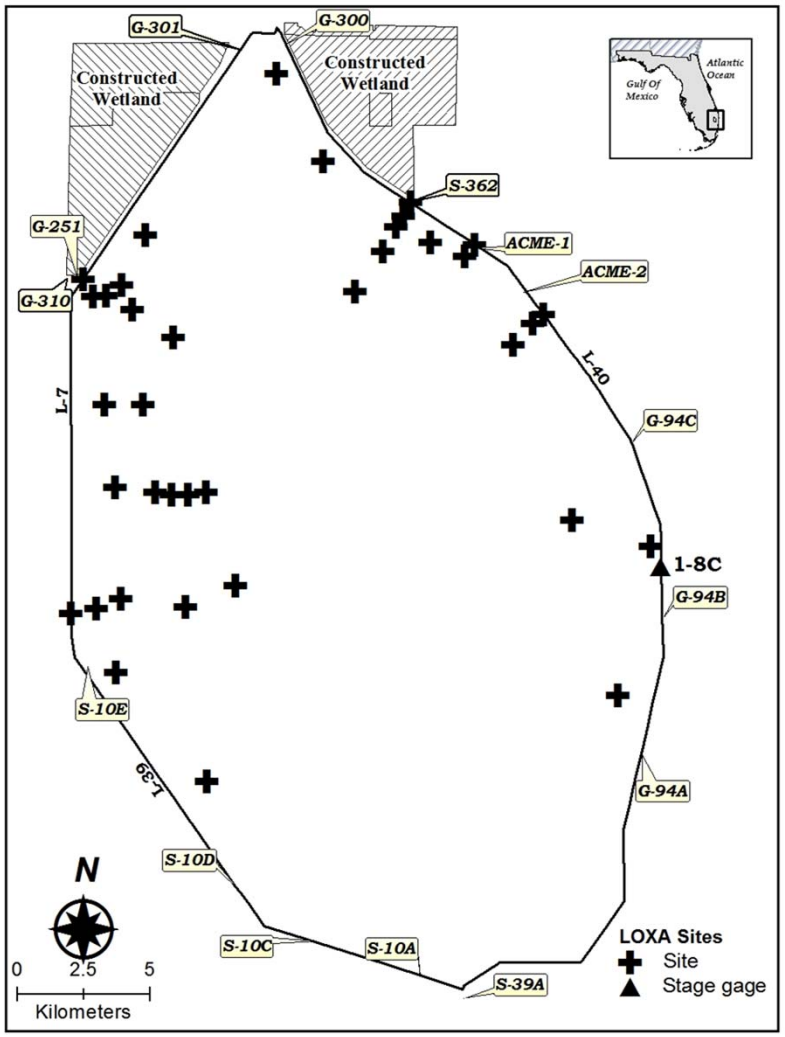
# Acknowledgements

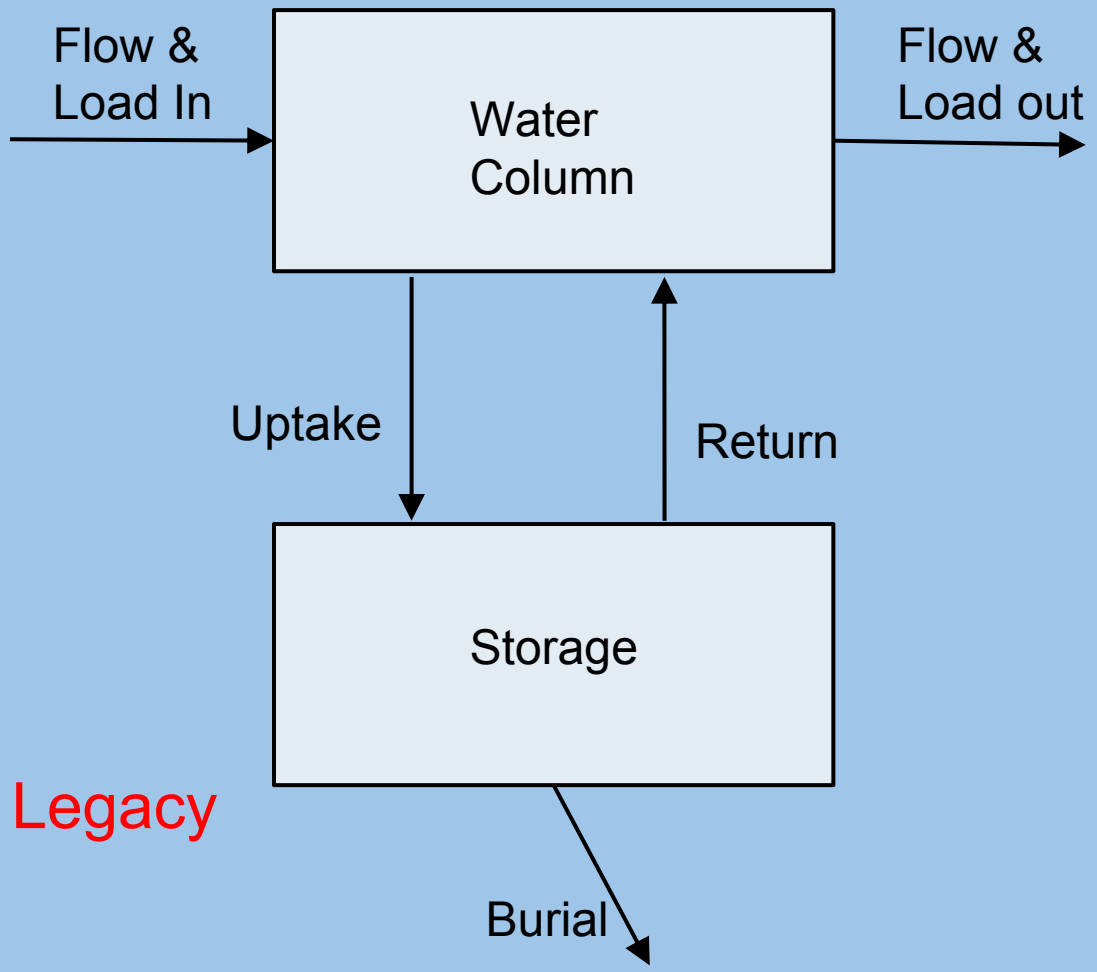
Disclaimer

# Arthur R. Marshall Loxahatchee National Wildlife Refuge LOXA Monitoring Sites



# Phosphorus in the Everglades

# background and models



# Concepts, Processes, Models

- Water column conc *c* (mg/m$^3$ or ug/L)
- Water column mass *m* (mg/m$^2$ or ug/L)
- *m*=*zc* where *z* is water depth (m)
- Available storage *S* (mg/m$^2$ or ug/L)

- Uptake, *U* m → S
- Return, *R* S → m
- Burial, *B* S → permanent loss

# Mass Balance Models

$dm/dt = -U + R$ +Load in -Load out

**$K$-$c^*$ model**

$dm/dt = -Kc + Kc^*$ +Load in -Load out

**DMSTA model**

$dm/dt = -k_1Sc + k_2S^2$ +Load in -Load out

$K=k_1S$, and $c^* = (k_2/k_1)S$

## Assumptions & Rationale

- *U* and *R* are fast; *B* is slow
- *S* >> *m*
- Rate of change of *S* and *m* are roughly equal
- Therefore, rate of change for *S* relative to its magnitude is much slower than for *m*
- Roughly assume *S* & thus *K* and *c** constant over 1 to several years or when long-term average loading is unchanged

# No-Load Condition

With the assumption that *S* may be approximated as constant over short periods of weeks to months, when load and flow drop to near zero, *c* will approach the constant equilibrium concentration *c** which is dependent on past long-term net loading.

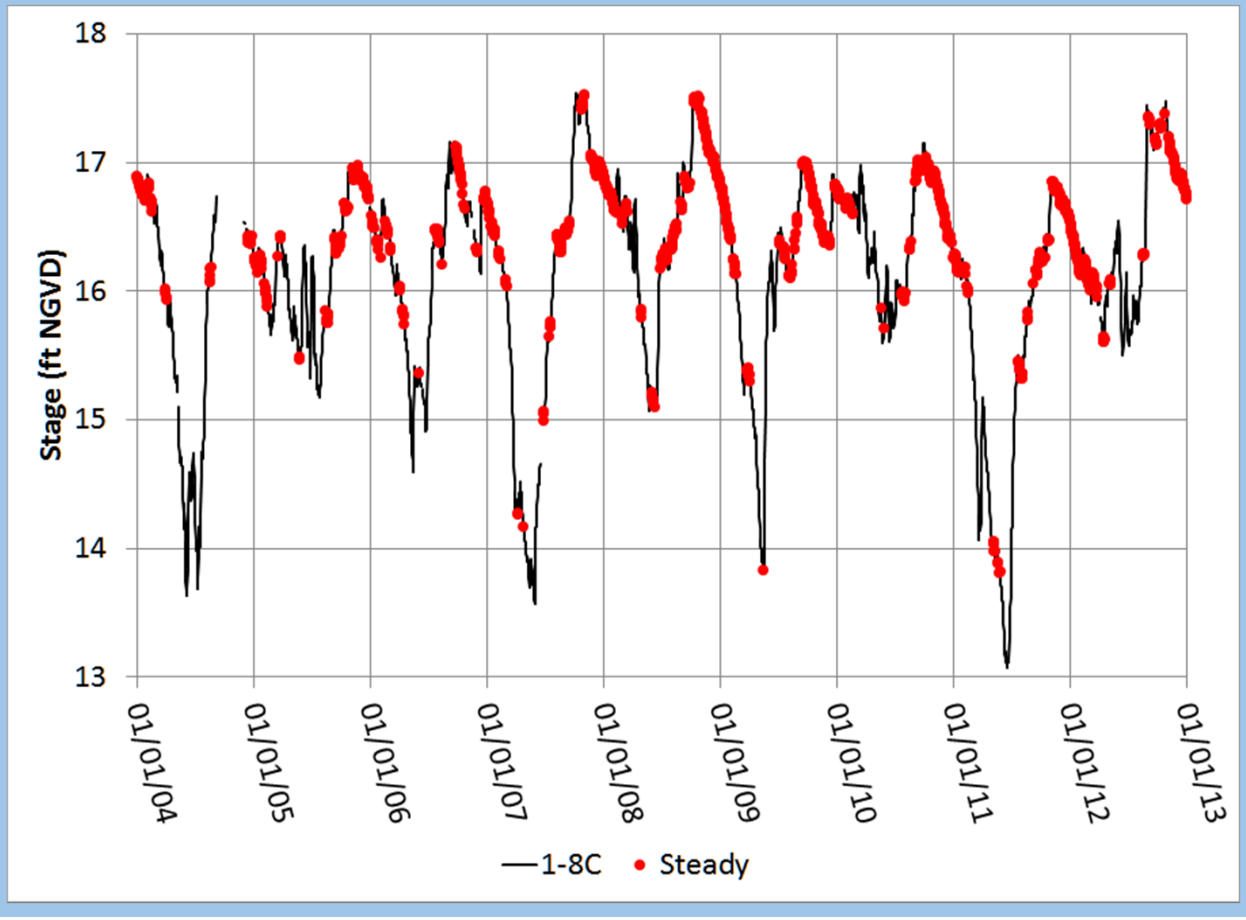
- Use to estimate *c** at monitoring sites.

**Methodology-**classification of stable antecedent conditions to identify approximate no-load monitoring samples

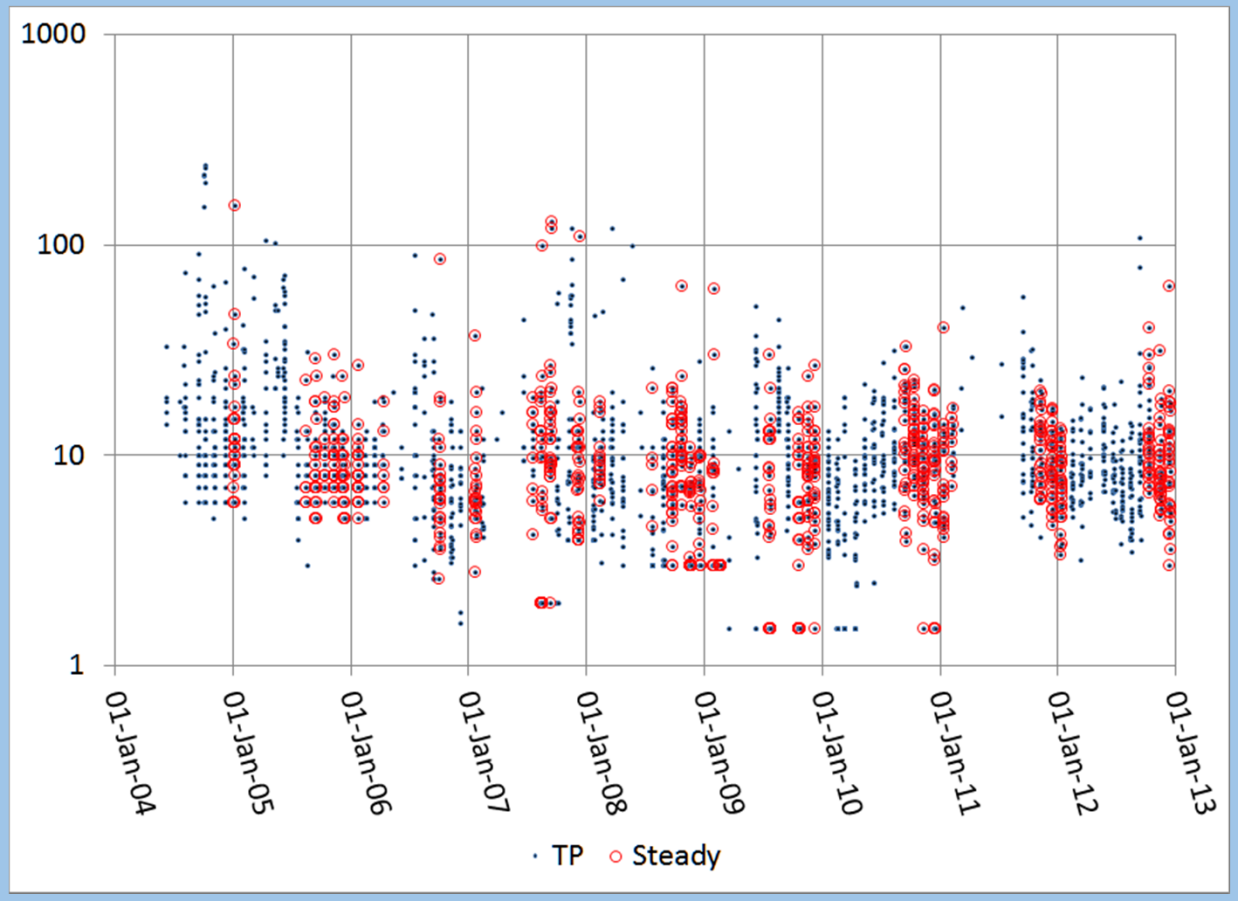
- Assumed flat-pool in Refuge
- Used canal gauge 1-8C
- Classed day as “steady” if

7-day average( $|Stage_i - Stage_{i-1}|$ ) < 0.02 ft/d

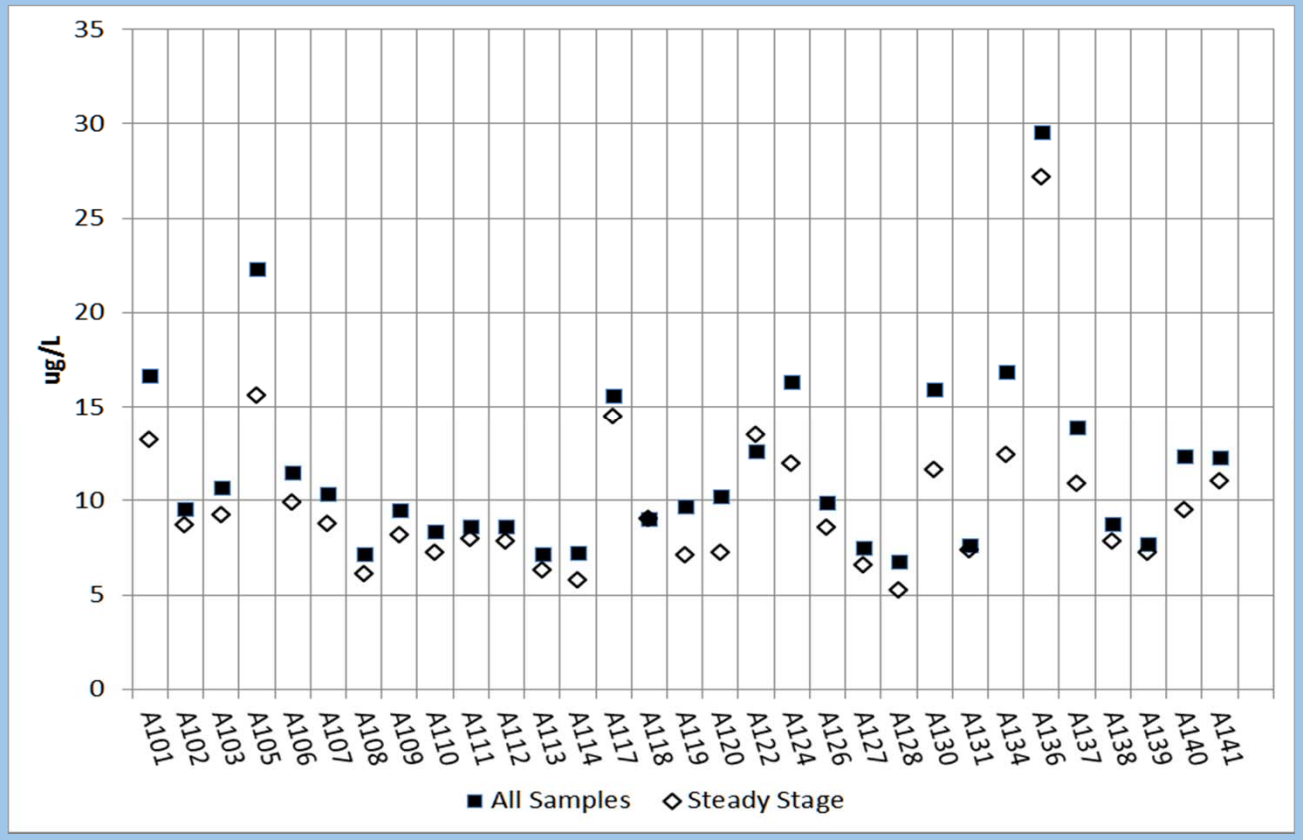
# Water Surface Elevation (Stage) at the 1-8C Canal Gauge



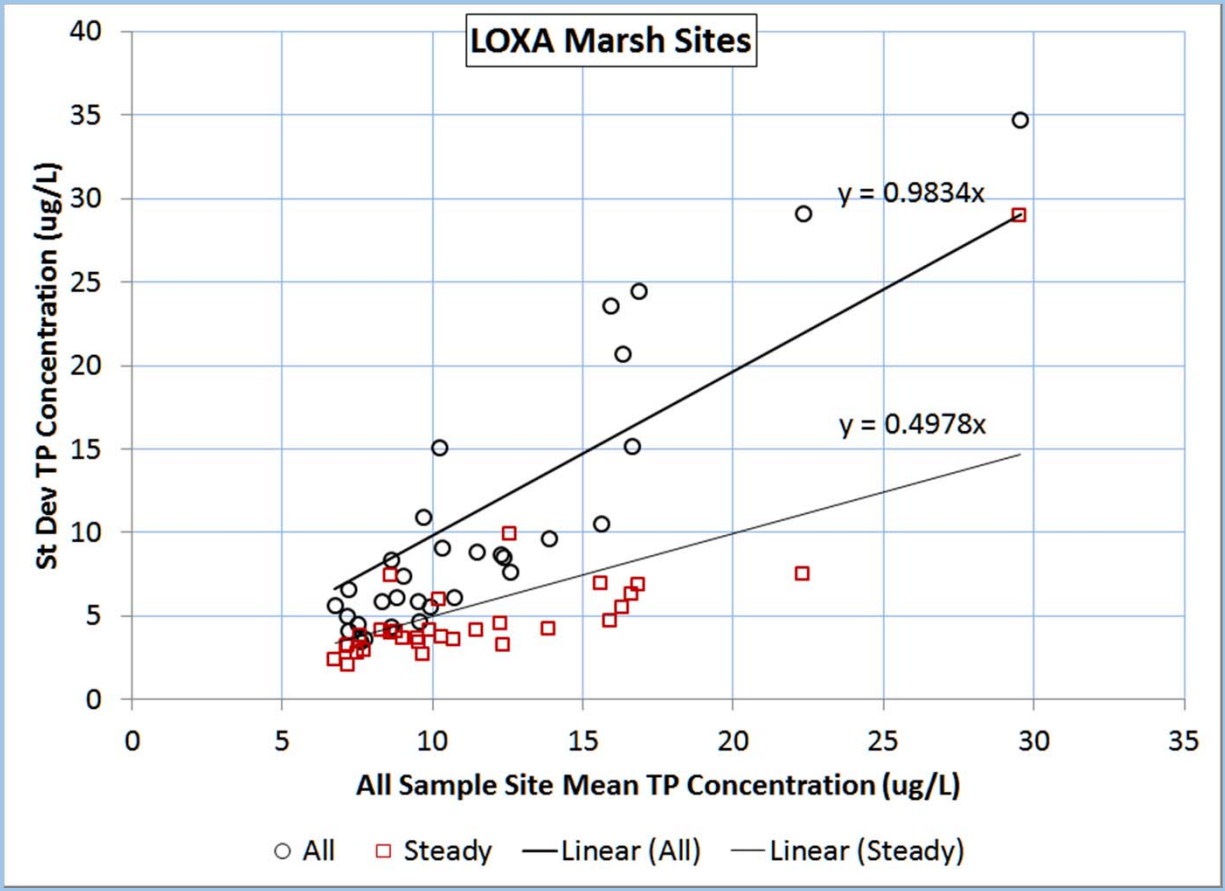
# Total Phosphorus (TP) at Refuge LOXA Marsh Sites



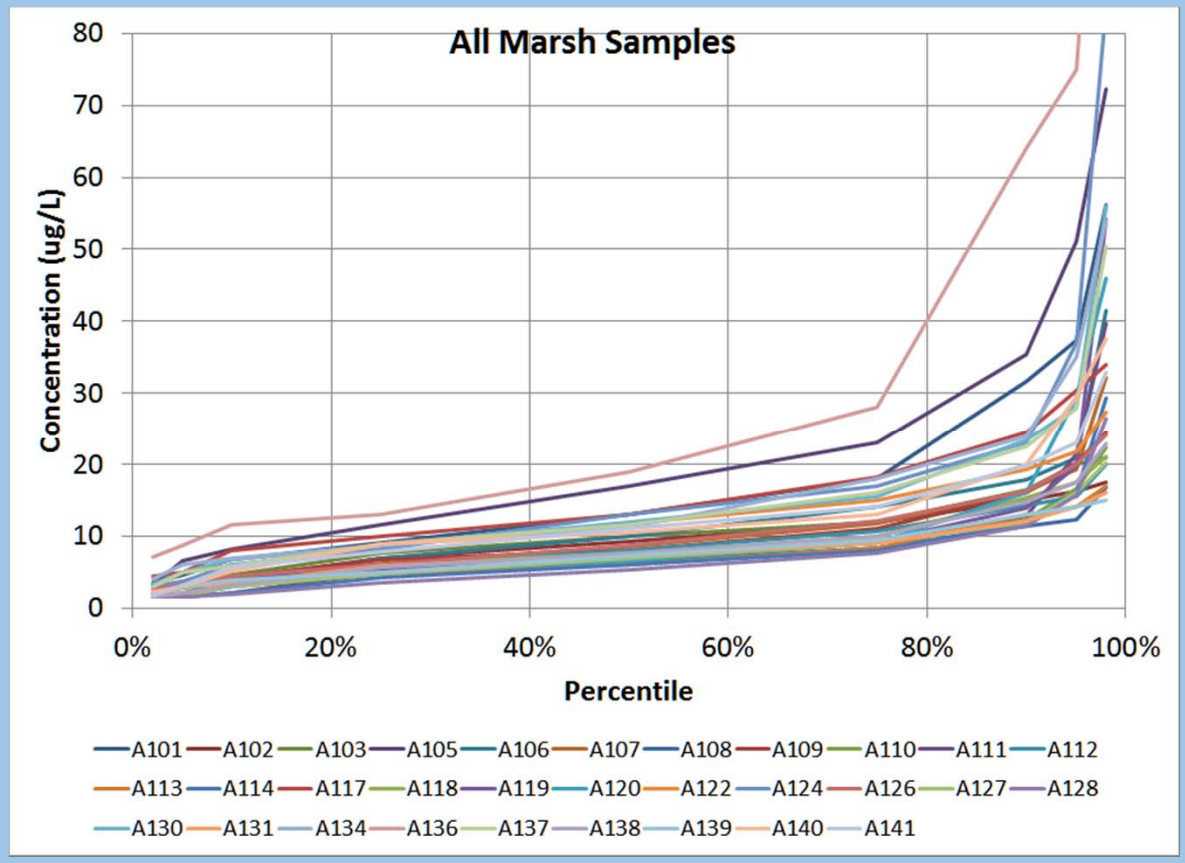
# Mean TP Concentration



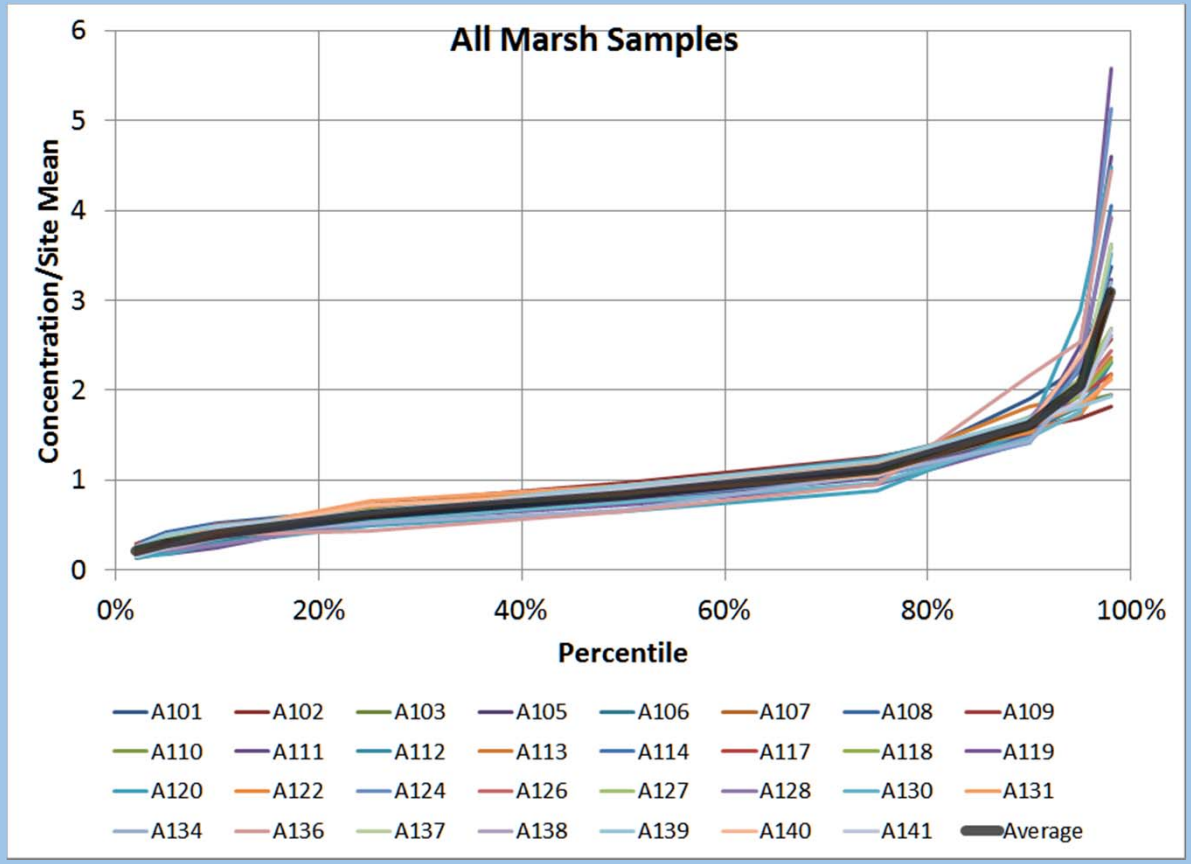
# Variability is reduced at steady stage TP samples



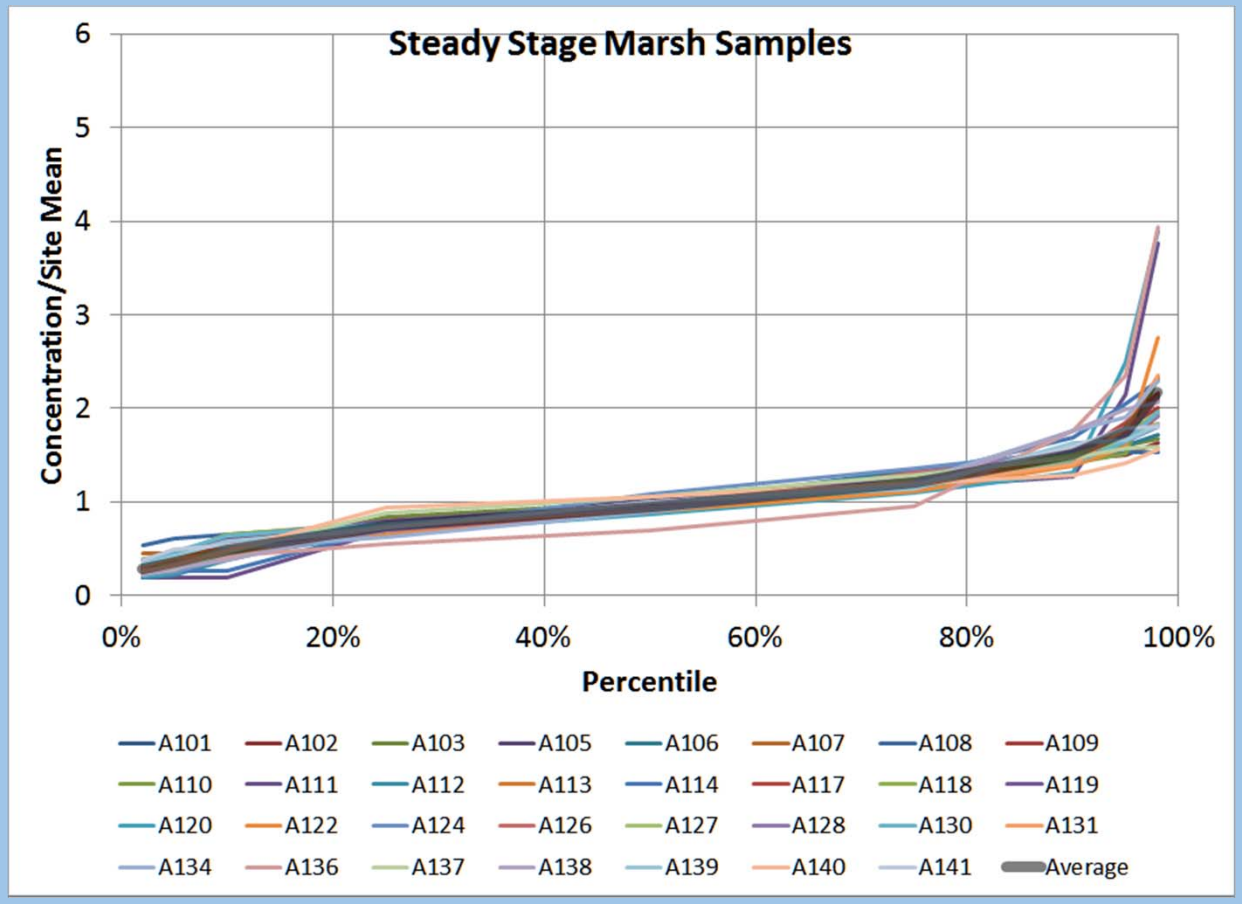
# Frequency Distributions



# Scaled Concentration Frequency Distribution



# Scaled Concentration Frequency Distribution



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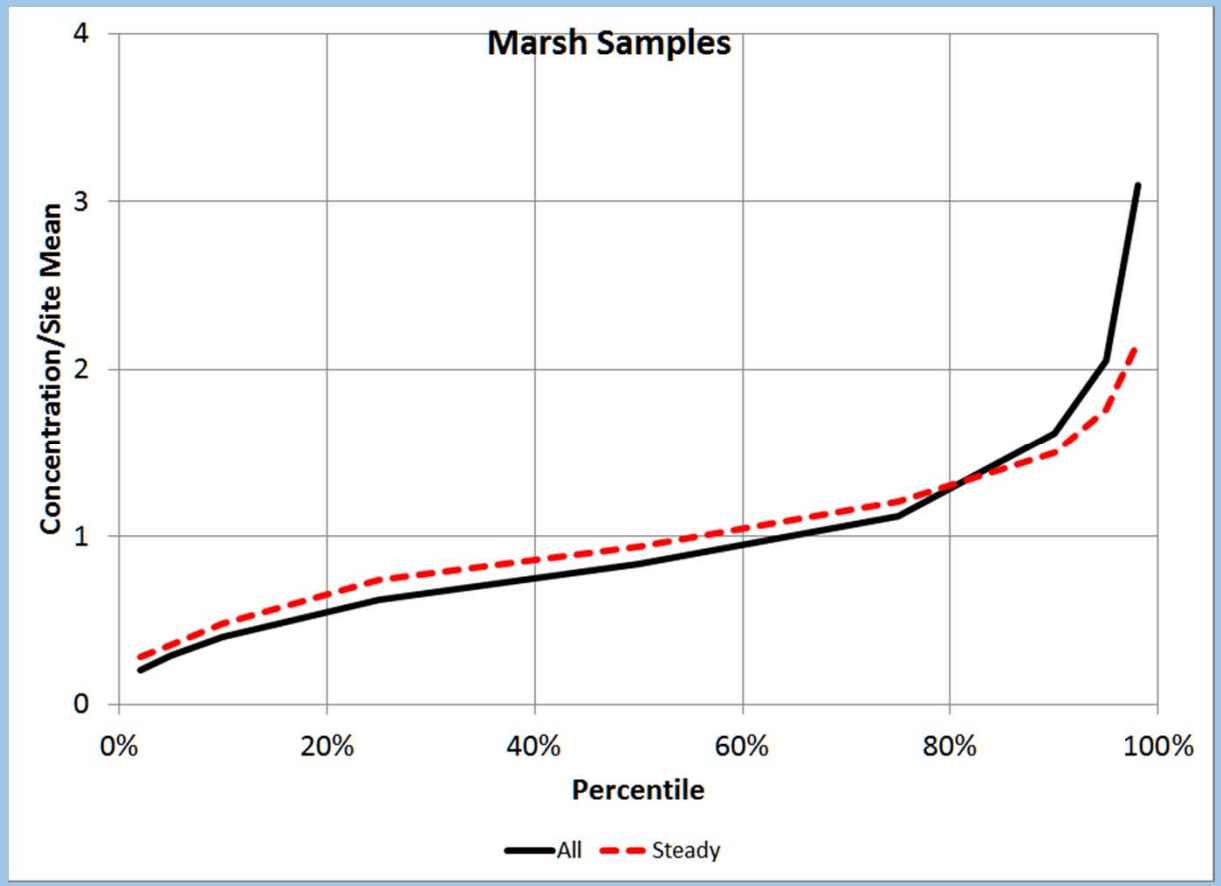
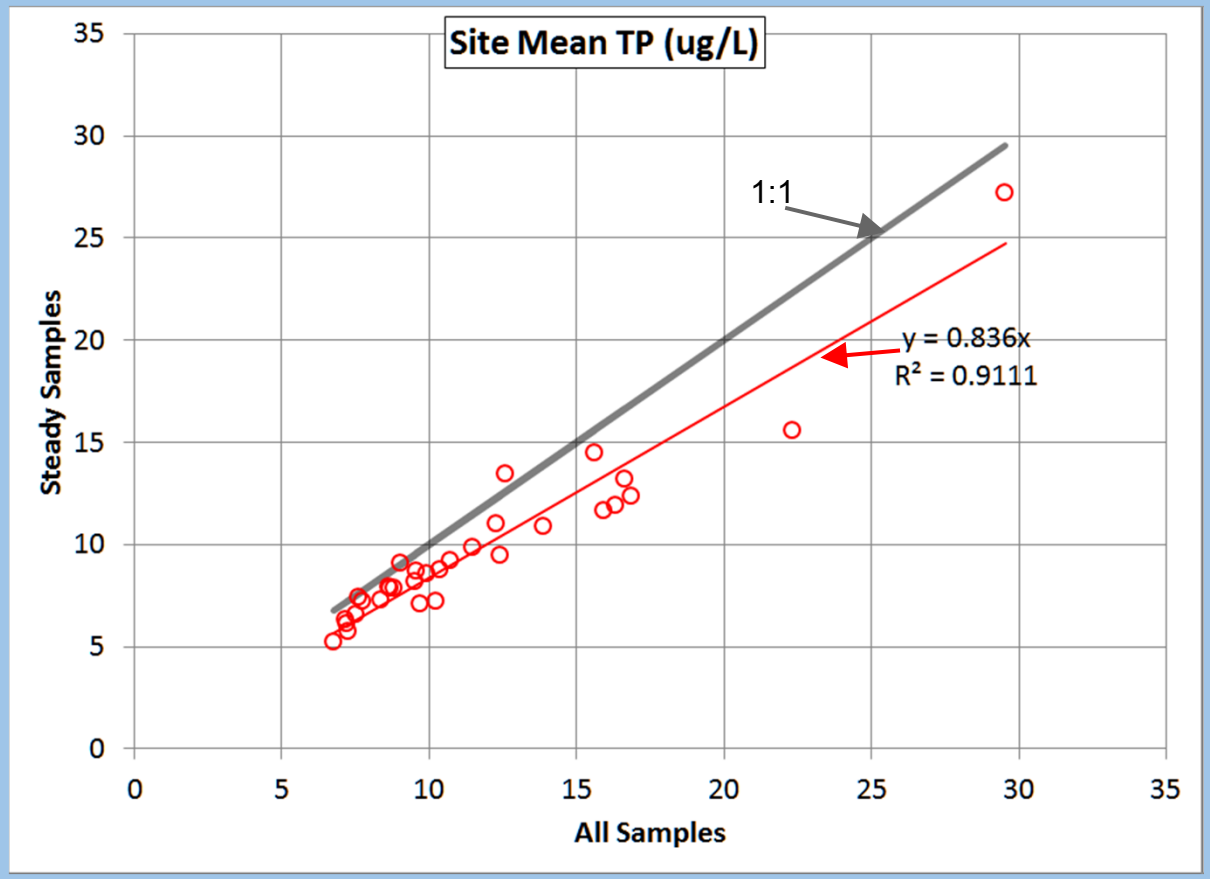
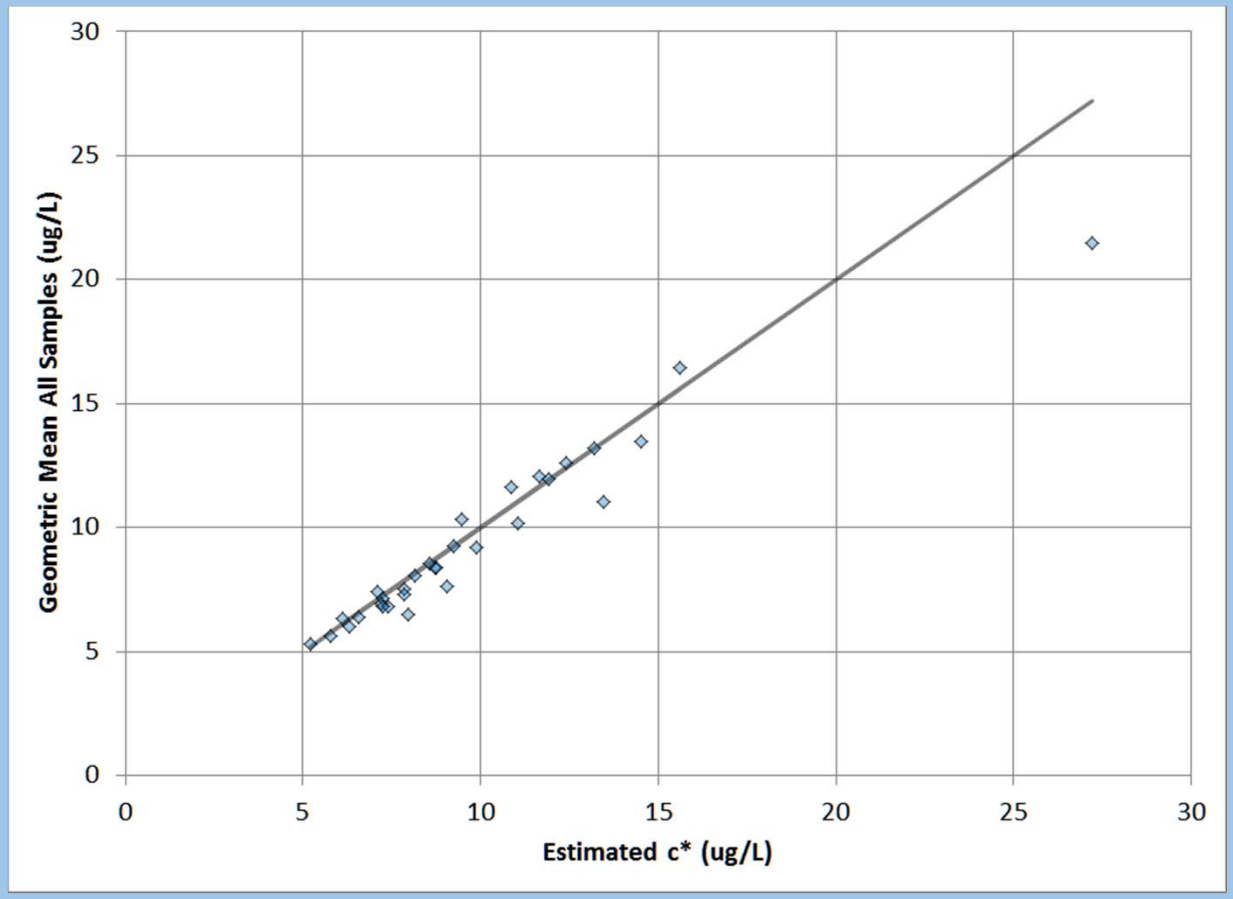


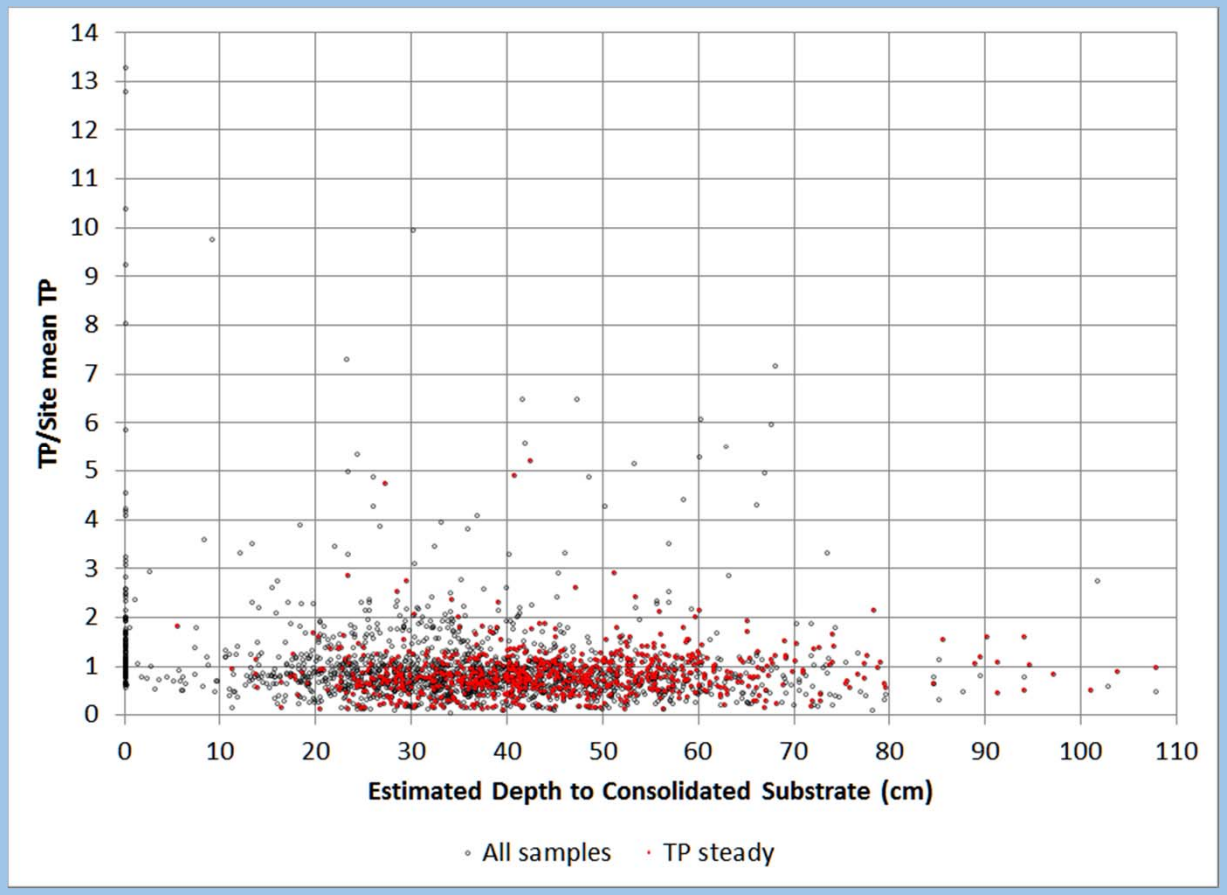
# Estimate of c* as a function of mean c



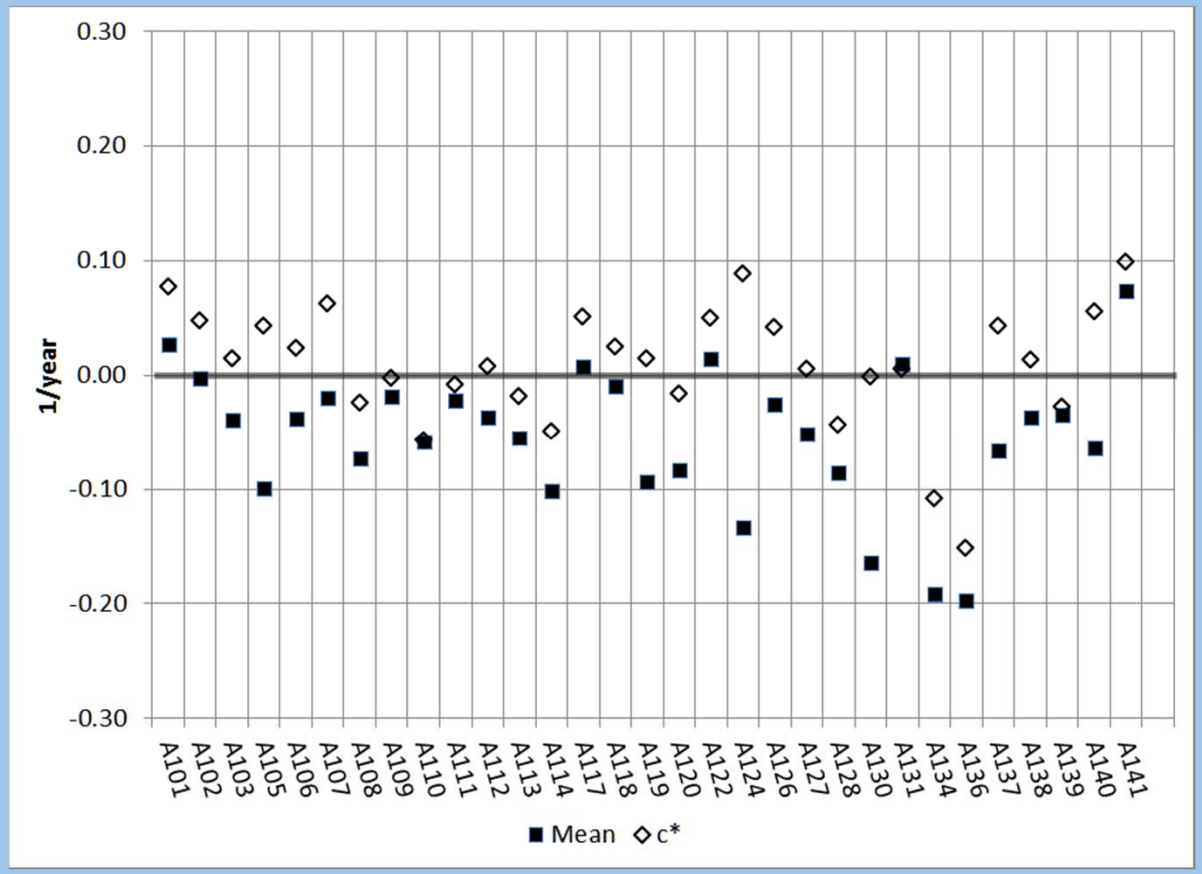
# Relationship to Geometric Mean



# Relationship to Depth



# Temporal trends



## Values of This Approach Estimating c*

- Gain a better physical/scientific understanding
- Quantifies a hydrologic source of TP variability
- Provides a basis for further study
- Reduced uncertainty in statistical TP models
- Constrain dynamic model parameters
- Improved credibility of dynamic TP models

## Conclusions

- The wide range of mean TP at LOXA sites provides a resource for testing concepts/models of marsh TP concentration response to loading
- Frequency distributions among sites are similar
- Some statistical analyses may utilize this property to pool site data and thus reduce uncertainty
- Variability is reduced in steady stage TP samples
- $c^*$ is roughly 84% of mean $c$ at LOXA sites
- This proportionality informs model structure design, and the value constrains model parameter estimation

## Recommendations

- Investigate residual variability in the *c** estimates
  - Determine if there are temporal trends - temporal trend in *c** relates to similar trend in *S*, and estimates legacy impairment recovery
- Use EDEN stage estimates to improve the steady stage antecedent condition classification at marsh sites
- Extend steady stage/no-load analyses
  - to other Everglades marsh monitoring
  - to STA monitoring data analysis and modeling

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