

Factors Contributing to Exceedances of Interim Phosphorus Levels in the Refuge

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Continuing Analysis of Refuge Compliance

- Walker & Kadlec report for DOI is an excellent preliminary analysis; parts of presentation are repeated here with thanks
- Study Objective: Examine issues from June TOC and summarized in W&K report
 - Role of external loading in exceedances of Interim Levels
 - Correlates to TP dynamics and compliance (e.g., stage, loading)
 - Role of error or extraordinary natural phenomena
- Study Assumptions based on the Settlement Agreement
 - Refuge TP loading is capped, not eliminated
 - TP marsh penetration is expected and unregulated
 - Information limited to 14 stations across marsh; quality data set
 - Data are purely observational and correlative

Issues Considered by the State

- **P response pattern across Refuge**
- Conservative substances as tracers
- Signs of enrichment in compliance data
- Marsh penetration by canal water
- Integrative conclusion on exceedances
- Recommendations for Principals

Refuge Monitoring Stations

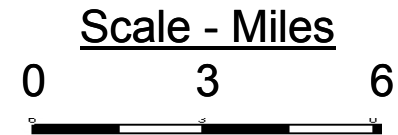
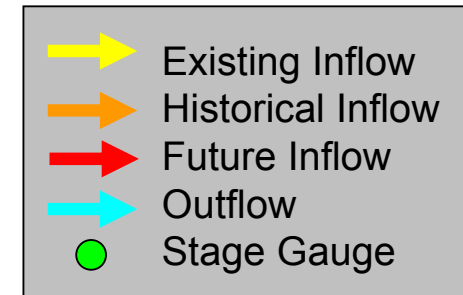
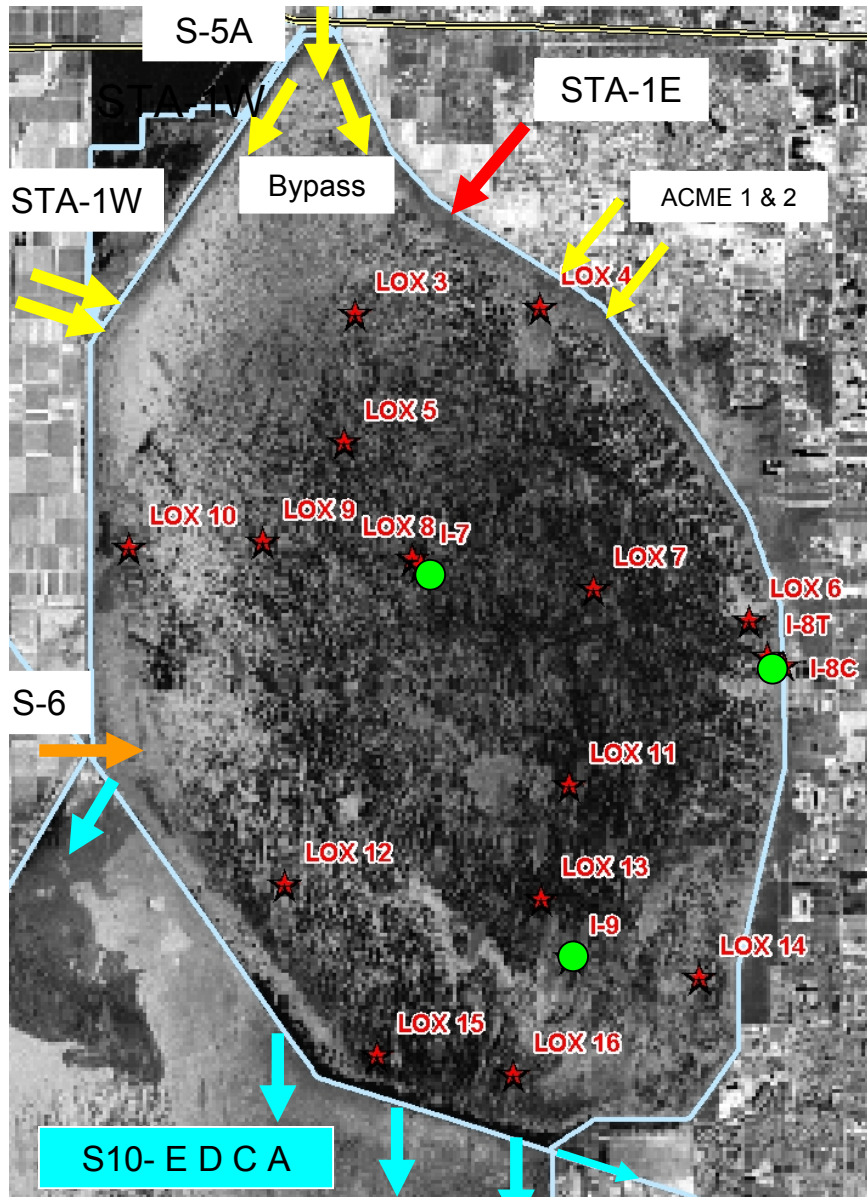
- Divide into two groups -

Peripheral Stations:

LOX 4, 6, 10, 12, 14, 15, 16

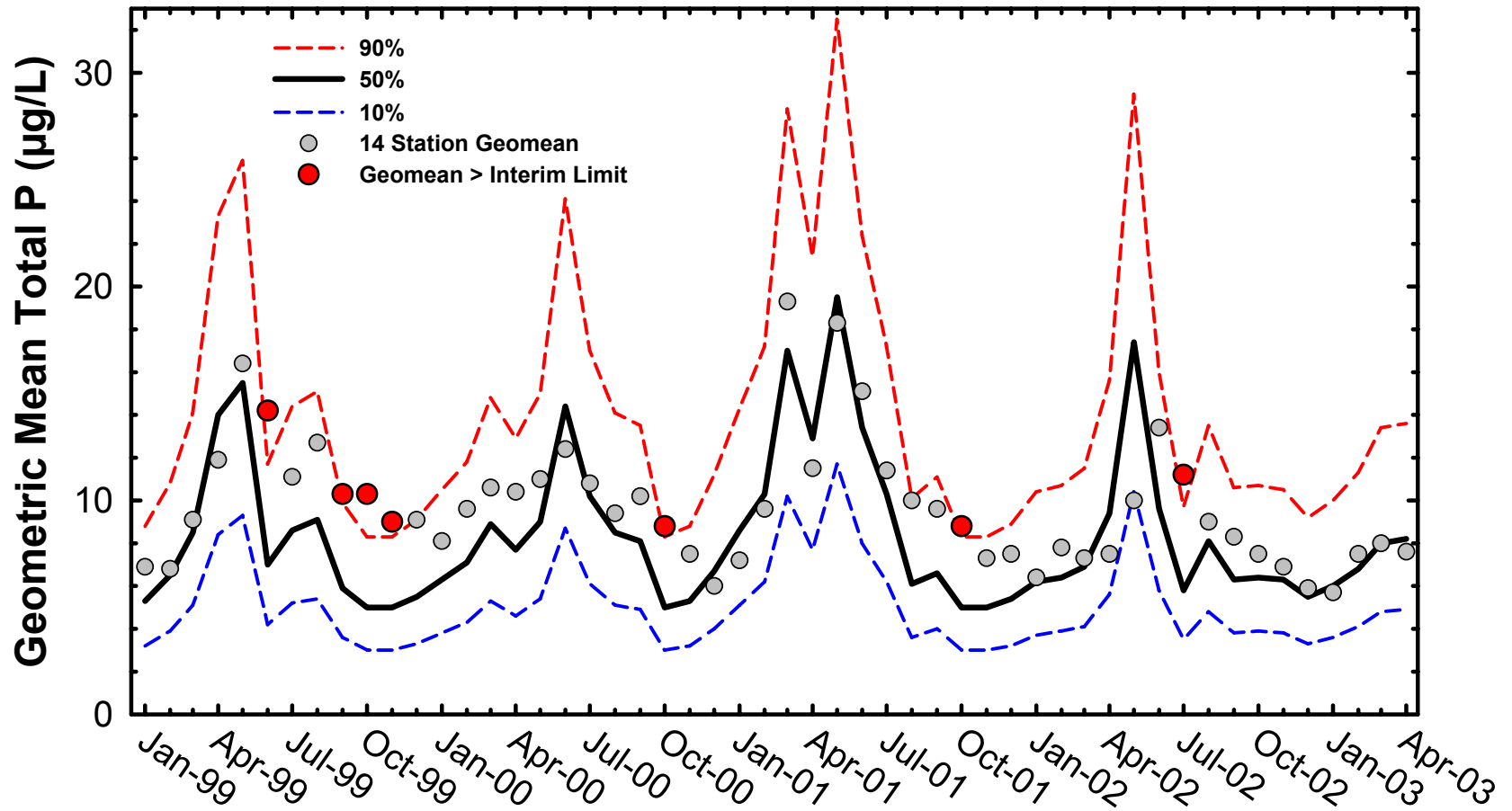
Interior Stations:

LOX 3, 5, 7, 8, 9, 11, 13



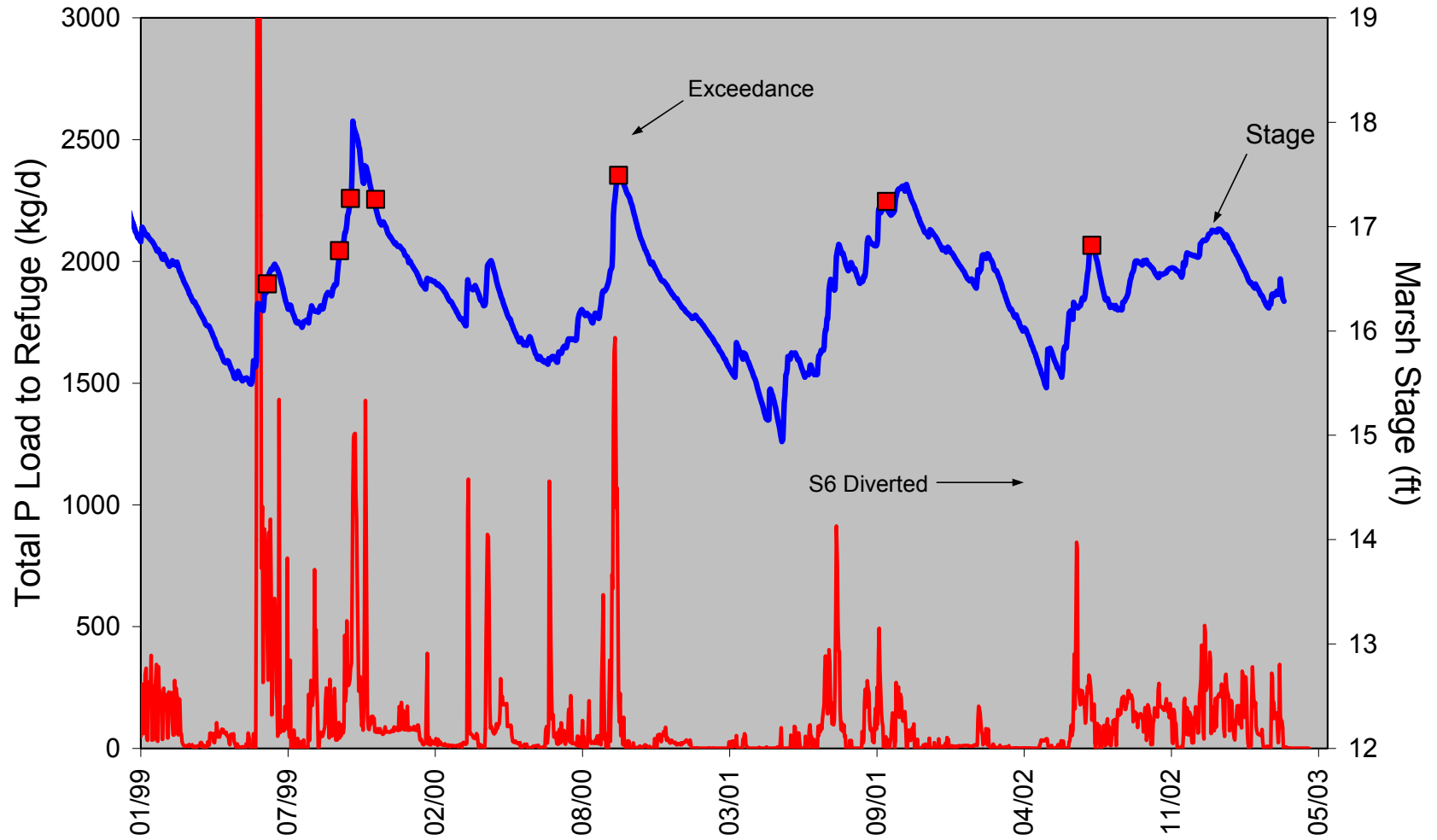
Refuge Geomean TP with Confidence Interval

All 14 Stations: LOX3 – LOX16

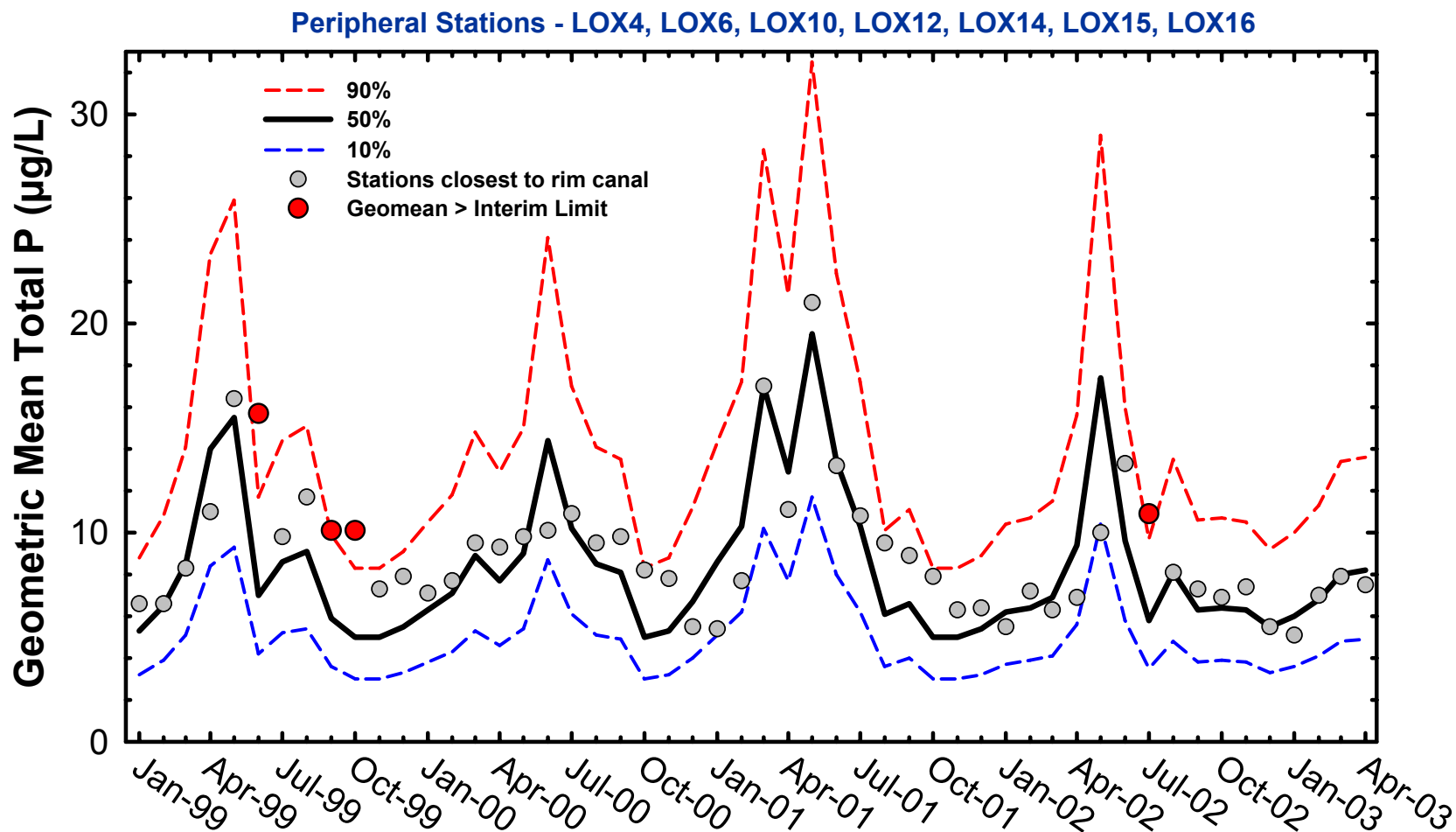


- Geomean exceeds Interim Level 7 times in 52 months
- Exceedances tend to occur in periods of rising stage

Exceedances vs. Stage & Phosphorus Load



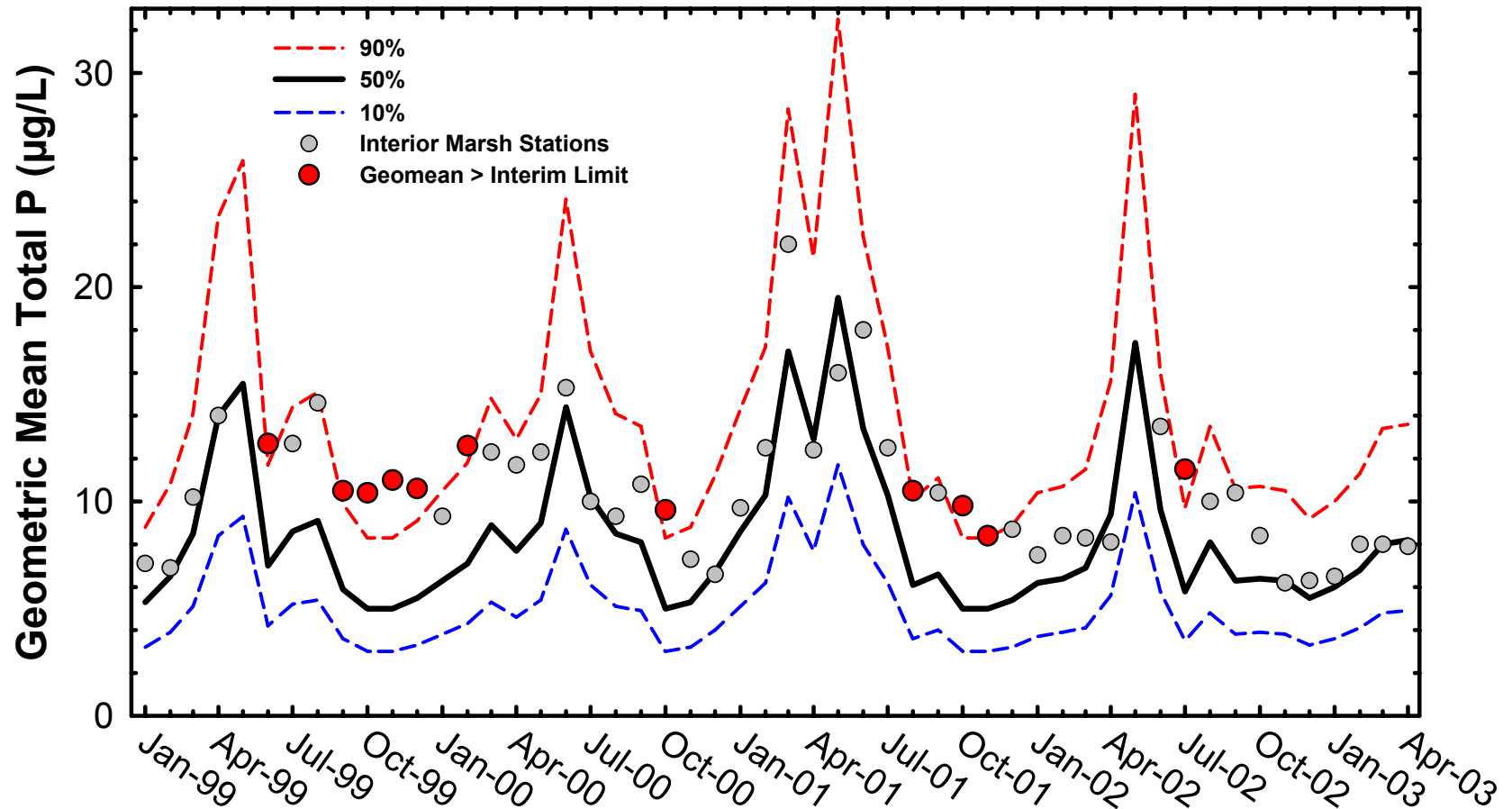
Rim Canal Stations Geomean TP and Confidence Interval



- Geomean exceeds Interim Level 4 times in 52 months
- Exceedances tend to occur in periods of rising stage
- Geomeans are generally lower, closer to median

Interior Stations Geomean TP and Confidence Interval

Interior Stations: LOX3, LOX5, LOX7, LOX8, LOX9, LOX11, LOX13



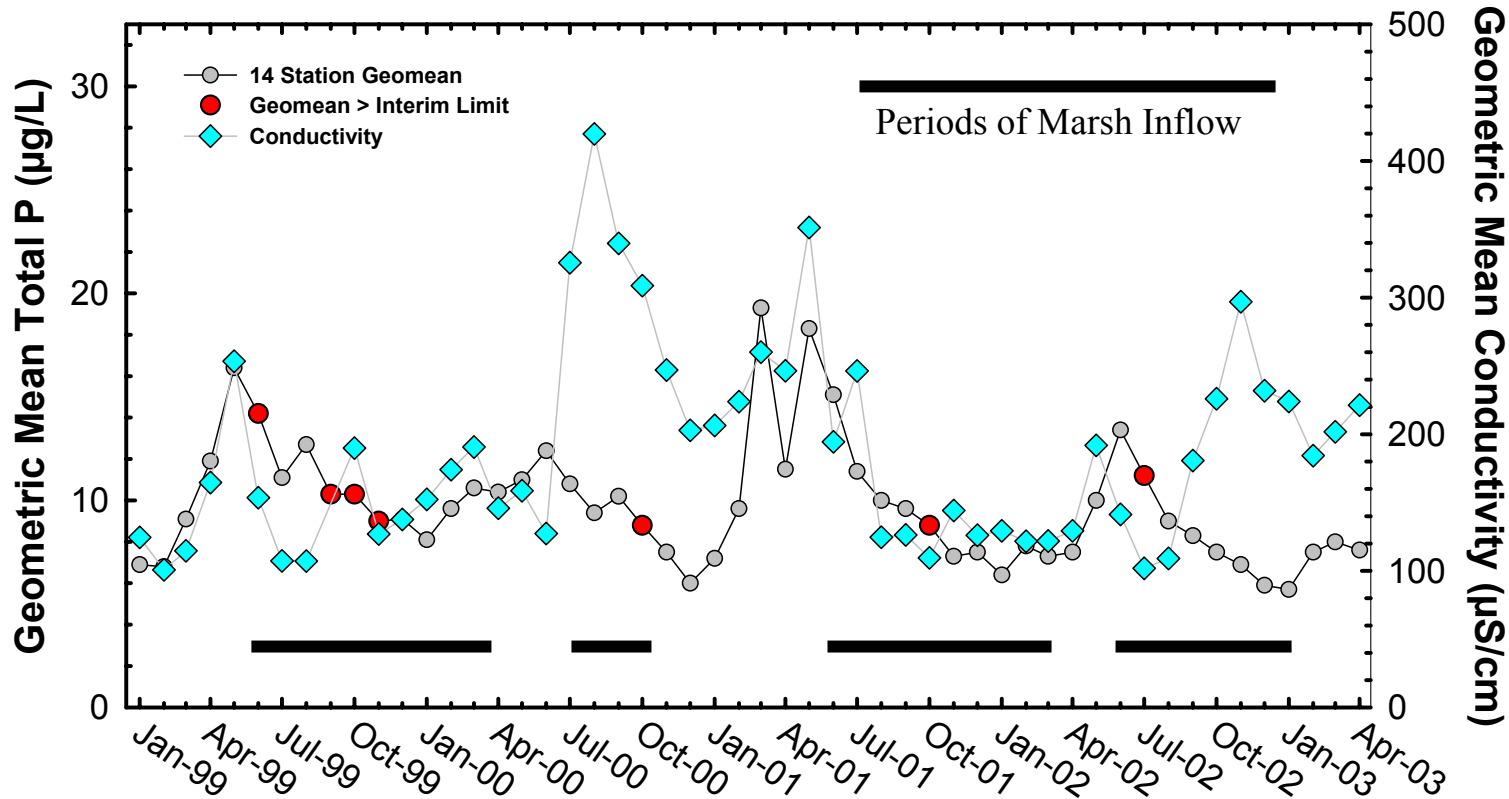
- Geomean exceeds Interim Level 11 times in 52 months
- Exceedances tend to occur in periods of rising stage
- Geomeans are generally higher and above the median

Issues Considered by the State

- P response pattern across Refuge
- **Conservative substances as tracers**
- Signs of enrichment in data
- Marsh penetration by canal water
- Integrative conclusion on exceedances
- Recommendations for Principals

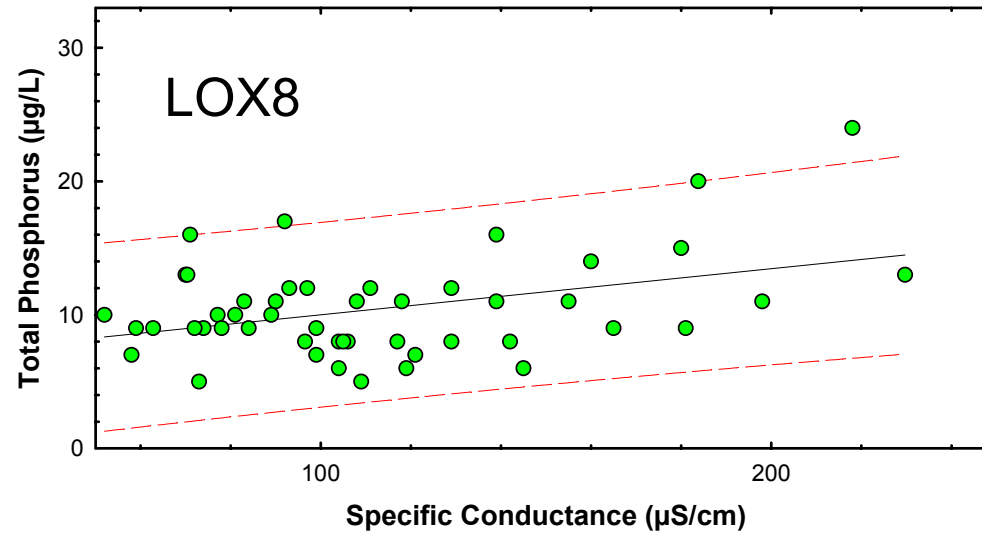
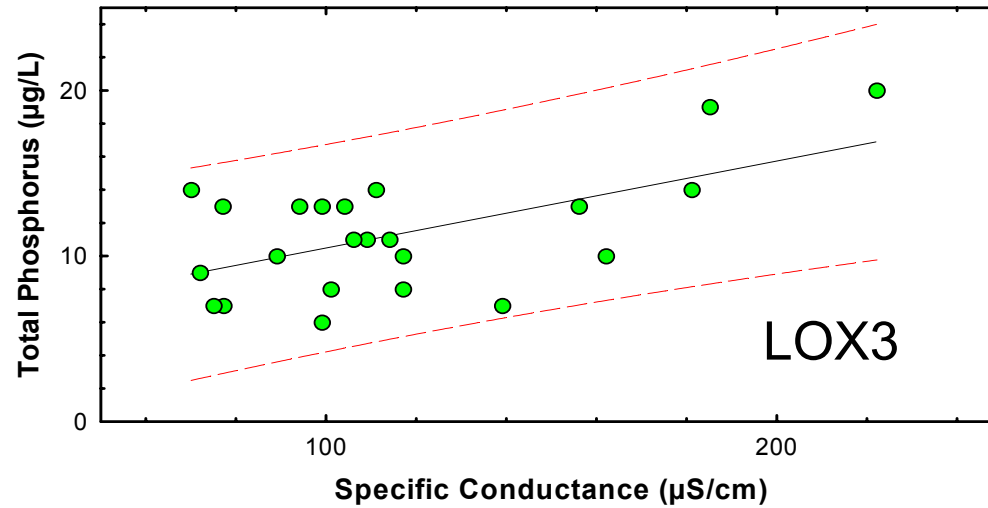
Refuge Geomean TP and Conductivity

All 14 Stations: LOX3 – LOX16

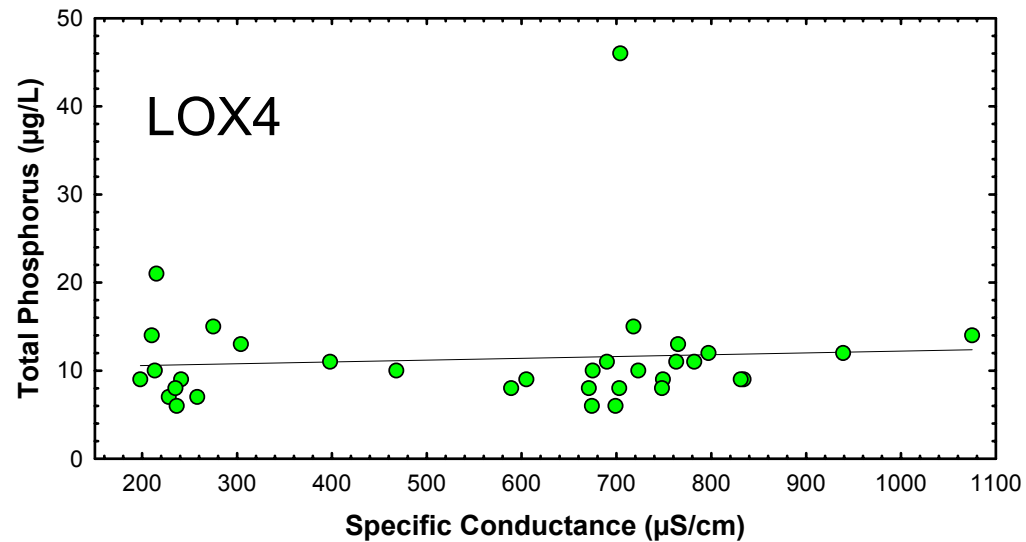
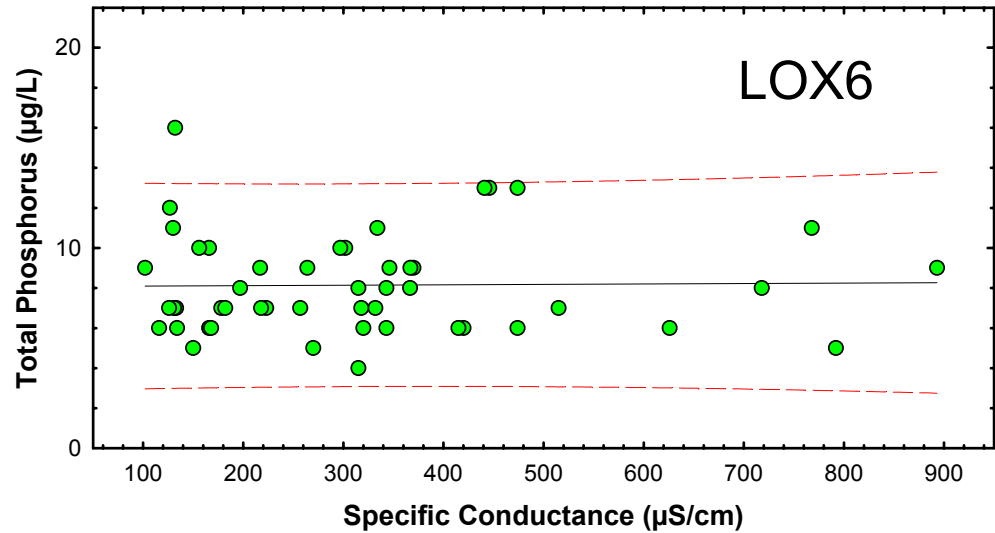


- Geomean conductivities range from 100 to 400
- No consistent correspondence between conductivity or stage-corrected P levels
- Marsh inflows do not correspond with conductivities

- TP increases slightly with conductivity at interior sites



- TP does not increase with conductivity at peripheral sites



Issues Considered by the State

- P response pattern across Refuge
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- **Signs of enrichment in compliance data**
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- Integrative conclusion on exceedances
- Recommendations for Principals

Refuge Compliance Data

February 1999 - April 2003

Peripheral Stations

All 7 show declining P trend

Four are significant @ $P < 0.1$

Interior Stations

All 7 show declining P trend

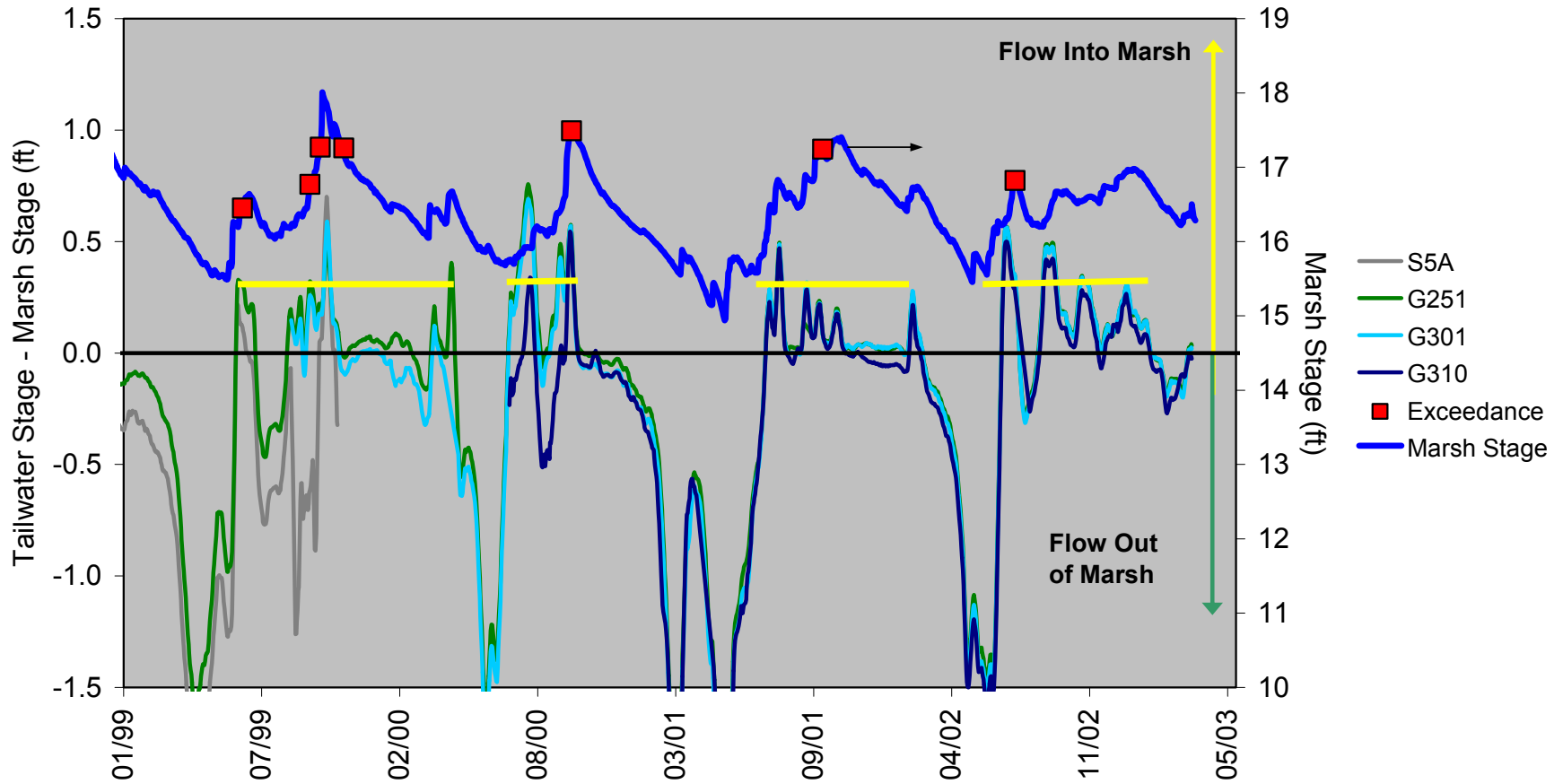
Four are significant @ $P < 0.1$

- Conservative interpretation appropriate
- Both peripheral and interior stations behaving similarly
- No sign of marsh enrichment

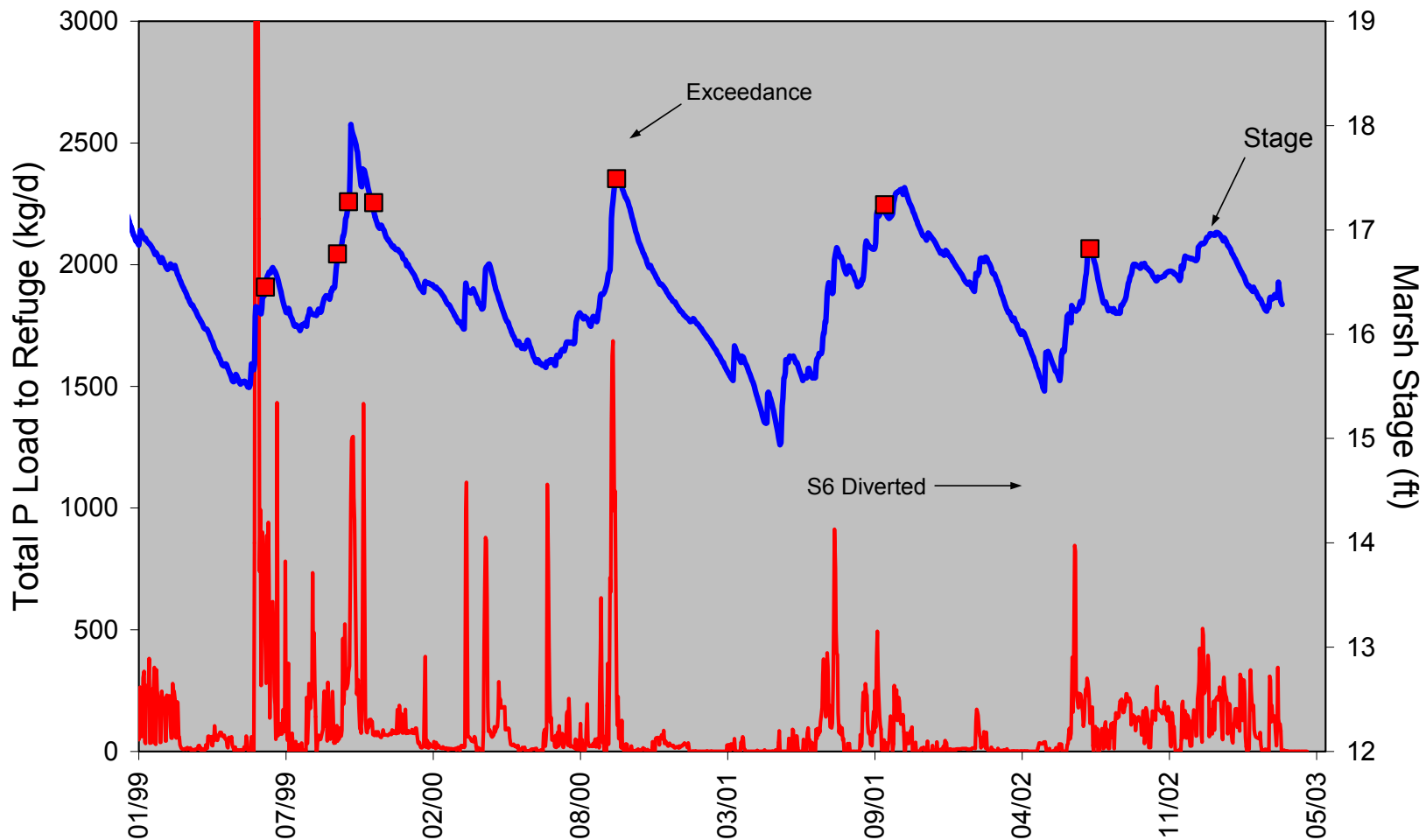
Issues Considered by the State

- P response pattern across Refuge
- Conservative substances as tracers
- Signs of enrichment in compliance data
- **Marsh penetration by canal water**
- Integrative conclusion on exceedances
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Exceedences vs. Stage Differential – West Side

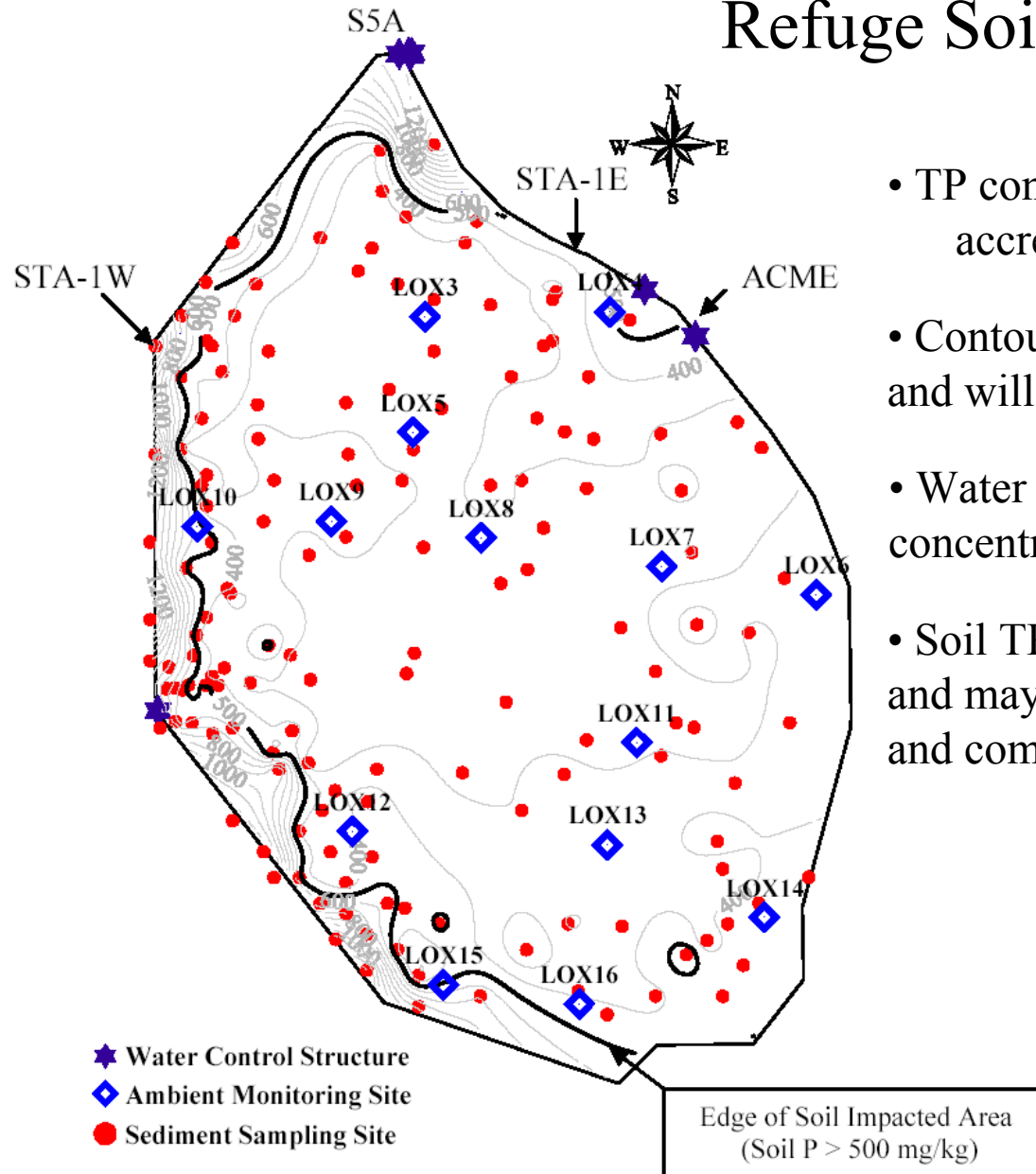


Exceedances vs. Stage & Phosphorus Load



- Exceedances are associated with loading and rising stage
- Pattern of exceedances is partially inconsistent with loading hypothesis

Refuge Soil Phosphorus Levels



- TP contours reflect P movement and accretion in Refuge periphery
- Contours are a pre-existing condition and will exist into foreseeable future
- Water penetration evidenced in soil concentrations is normal and unregulated
- Soil TP cycling can redistribute P and may influence P concentrations and compliance at remote locations

Issues Considered by the State

- P response pattern across Refuge
- Conservative substances as tracers
- Signs of enrichment in compliance data
- Marsh penetration by canal water
- **Conclusions on exceedances**
- Recommendations for Principals

Summary of Findings

- Exceedances of Refuge Interim Levels are associated with periods of external loading and rising stage.
- Analysis of Refuge data indicates that exceedances are not due solely to external loading:
 - **Peripheral stations had lower TP levels and a lower exceedance frequency than interior sites; the opposite is predicted**
 - **Conductivity patterns were not consistent with external loading for all stations together or at individual stations**
 - **No signal of enrichment is evident in TP data for the whole marsh, at peripheral and interior groups, or in data from individual stations**
 - **Pattern of exceedances is not fully consistent with loading effects, more exceedances should occur with extended periods of loading**
- Together, these findings and those of W&K suggest that many factors are involved in exceedances of the Interim Level in the Refuge

Conclusions from the State Perspective

- Exceedances of Interim Levels occur during periods of external loading and increasing stage
- Analysis of data from across Refuge stations suggests many factors, such as internal P loading, external P loading, and uncertainty in the compliance equation contribute to Refuge exceedances
- It is not feasible or constructive for TOC to attempt to establish causation using existing information from the Refuge
- A better use of time and resources is to complete and enhance P control programs and improve water management for the Refuge.

Draft Consensus Recommendations

- Request Federal government to expedite completion of STA 1E
- Request that District and DEP fund STA enhancements at high priority
- Continue to implement strategies to operate STA 1W within its design range
- Request that USACE review water management guidelines under WSE for Lake Okeechobee
- Request IMC and RECOVER to conduct WQ modeling for the Refuge
- Develop the capability to make water quality predictions and conduct P mass balance modeling to evaluate causative factors in P compliance.