Delta RMP Nutrient Symposium

Welcome and Introduction

DEBBIE WEBSTER, CENTRAL VALLEY CLEAN WATER ASSOCIATION

MEREDITH HOWARD, CENTRAL VALLEY REGIONAL WATER QUALITY BOARD

Looking Back: A Review of Delta RMP – Funded Nutrient Projects

Looking Back: A Review of Delta RMP – Funded Nutrient Projects

8:30 – 8:40
Opening Remarks
Adam Laputz, Central Valley Regional Water Quality Board

8:40 to 9:10

The Delta Nutrient Research Plan – A Roadmap for Nutrient research in the Sacramento-San Joaquin Delta

Tom Grovhoug, Larry Walker Associates

9:10 to 9:40

Overview of Delta RMP Studies

Tim Mussen, Regional San

Opening Remarks

ADAM LAPUTZ, CENTRAL VALLEY REGIONAL WATER QUALITY BOARD

LOOKING BACK: A REVIEW OF DELTA RMP – FUNDED NUTRIENT PROJECTS, 8:30 TO 8:40 AM

The Delta Nutrient Research Plan – A Roadmap for Nutrient research in the Sacramento-San Joaquin Delta

TOM GROVHOUG, LARRY WALKER ASSOCIATES

LOOKING BACK: A REVIEW OF DELTA RMP – FUNDED NUTRIENT PROJECTS, 8:40 TO 9:10 AM

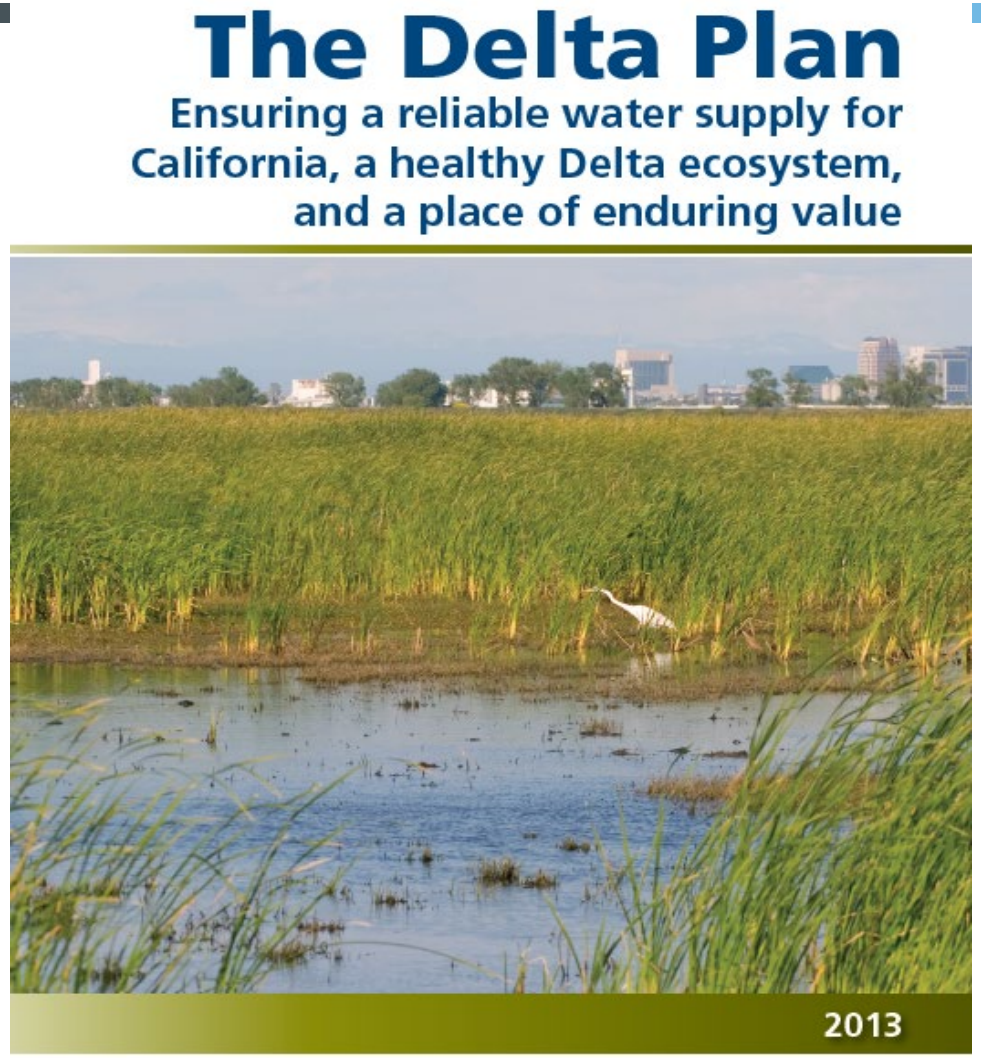
DELTA RMP NUTRIENT SYMPOSIUM

DELTA NUTRIENTS SCIENCE AND RESEARCH PLAN

SEPTEMBER 27, 2022

OUTLINE

- Central Valley Water Board's Delta Nutrient Strategy (DNS)
- Description and Timeline of Actions to Implement DNS
- Elements of Delta Nutrient Science and Research Plan (DNSRP)
- Status of DNSRP implementation



DELTA STEWARDSHIP COUNCIL

CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD

2014 DELTA STRATEGIC WORK PLAN

FEBR[illegible] 2014

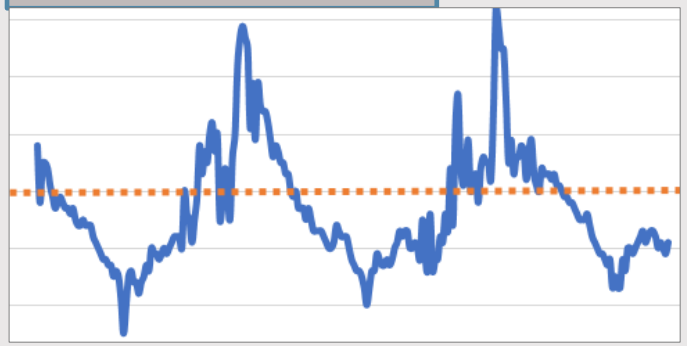
Nutrient-related Water Quality Issues

Eutrophic Conditions

Harmful Algae (Cyanobacteria) Blooms & Toxins, Tastes and Odors

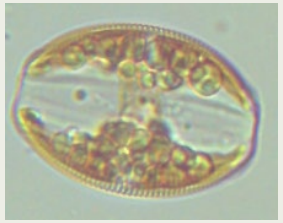
Invasive Aquatic Plants (Macrophytes)

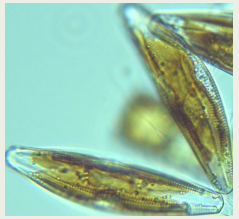
Low Dissolved Oxygen



Ecosystem health

Quantity and Quality of Lower Food Web (Phytoplankton)





CENTRAL VALLEY WATER BOARD'S DELTA NUTRIENTS STRATEGY

- Stakeholder and Technical Advisory Group (STAG)
- Charter
- Science Work Groups
- Delta Nutrient Research Plan
- Decisions regarding Nutrient Water Quality Objectives

Delta Nutrient Research Plan Process

CHARTER – KEY ELEMENTS

- Goals and Objectives
- Guiding Principles
- Roles and Responsibilities
- Nutrient-related Concerns
- Schedule

CHARTER – GOALS AND OBJECTIVES

Overarching Management Question to be addressed:

Should nutrient water quality objectives be established in the Delta?

Underlying question, since WQOs lead to load reductions by some sources through permit and TMDL limitations:

Will nutrient load reductions remedy one or more of the identified nutrient-related concerns?

SCIENCE WORK GROUPS

Subject matter experts – varied by work group

- San Francisco Estuary Institute (SFEI)
- Southern California Coastal Water Research Project (SCCWRP)
- State and federal agencies (DWR, USGS, USBR)
- Water Boards, USEPA
- Academia
- Local agencies (Regional San, Metropolitan Water District)
- Consultants (Applied Marine Sciences)
- NGOs (Clean Water Action)

SCIENCE WORK GROUPS – WHITE PAPERS

State of Delta Science, data gaps, future work

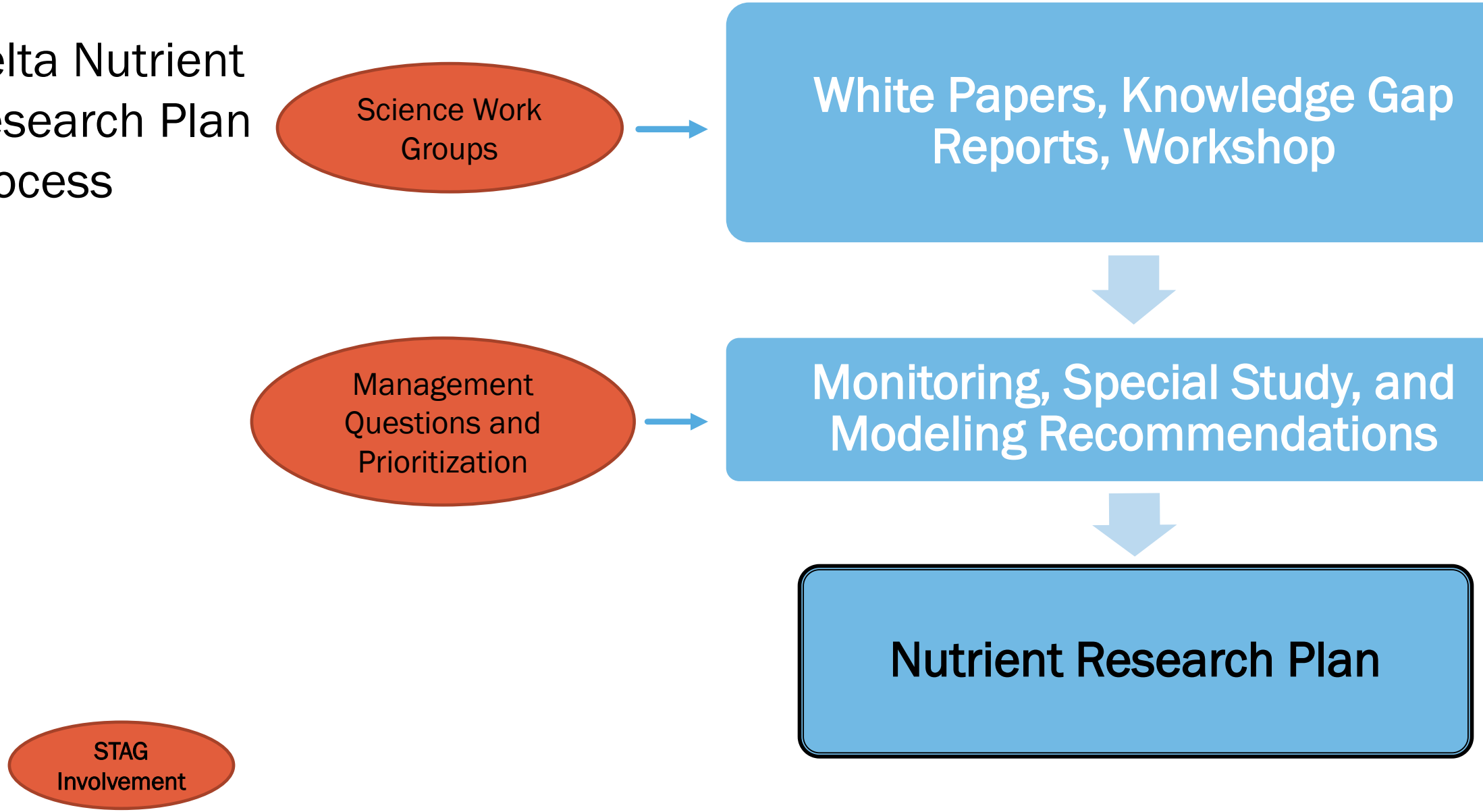
- Cyanobacteria (aka HABs)
- Macrophytes (aka Aquatic Vegetation)
- Modeling
- Drinking Water issues
- Delta Ecosystem issues – phytoplankton, food web – November 2016 workshop

SCIENCE WORK GROUPS – WHITE PAPERS

Key Conclusions from White Papers

- Cyanobacteria and Macrophytes – nutrients not limiting, don't drive bloom initiation, may impact duration and intensity
- Modeling – essential tool per all WGs, needed to test various future scenarios to address management questions
- Drinking Water – different cyanobacteria cause taste and odors, impacts outside Delta, controls uncertain
- Delta Ecosystem, food web issues – needs holistic approach considering multiple factors, must consider P

Delta Nutrient Research Plan Process



TIMELINE OF ACTIONS TO IMPLEMENT CVWB NUTRIENTS STRATEGY

DELTA NUTRIENTS SCIENCE AND RESEARCH PLAN

- Goal
- Problems to be Addressed, Management Questions
- Research to Fill Data Gaps or Develop Tools identified in White Papers
  - Monitoring
  - Special Studies
  - Modeling
- Prioritization of Research
- Next Steps – Implementation/Coordination

GOAL OF THE DELTA NUTRIENT RESEARCH PLAN

Conduct research and modeling to determine whether numeric water quality objectives for nutrients are needed to protect beneficial uses.

Address Nutrient-Related Water Quality Problems:

- Harmful algal blooms (HABs)
- Invasive aquatic plants
- Low phytoplankton production
- Low dissolved oxygen
- Drinking Water Issues

DNSRP – THEMES

Two Primary Themes

- **Deeper understanding is required** of multiple factors influencing the Delta ecosystem's response to nutrients
- **Numeric process-based models are needed** to understand the Delta system and to test management scenarios

DNSRP – MANAGEMENT QUESTIONS

Table 1

- Is there a WQ problem? - *where, when, trends?*
- Are nutrients contributing? - *role of nutrients and other factors?*
- Can nutrient management help? – *scenario outcomes?*
- Are particular conditions necessary for nutrient management to be successful? – *influence of other factors?*
- How will future conditions affect the problem(s)? – *climate change, water management, etc.?*
- What nutrient management measures are needed? –*effectiveness of management?*

DNSRP – PRIORITIZATION CRITERIA

- Addresses Management Question
- Fills early info need, Important first step in multi-step process.
- Provides important input to models
- Has broad application in Delta
- Addresses multiple WQ issues
- Provides opportunity for collaboration, leveraging
- Can be completed in 3 to 5 years

DNSRP – HIGHEST PRIORITIES

Table 2 – DNRP

- HABs and toxins – monitoring and special field studies
- Model development and utilization
- Phytoplankton abundance and growth – monitoring and special field studies
- Macrophytes – special field and laboratory studies

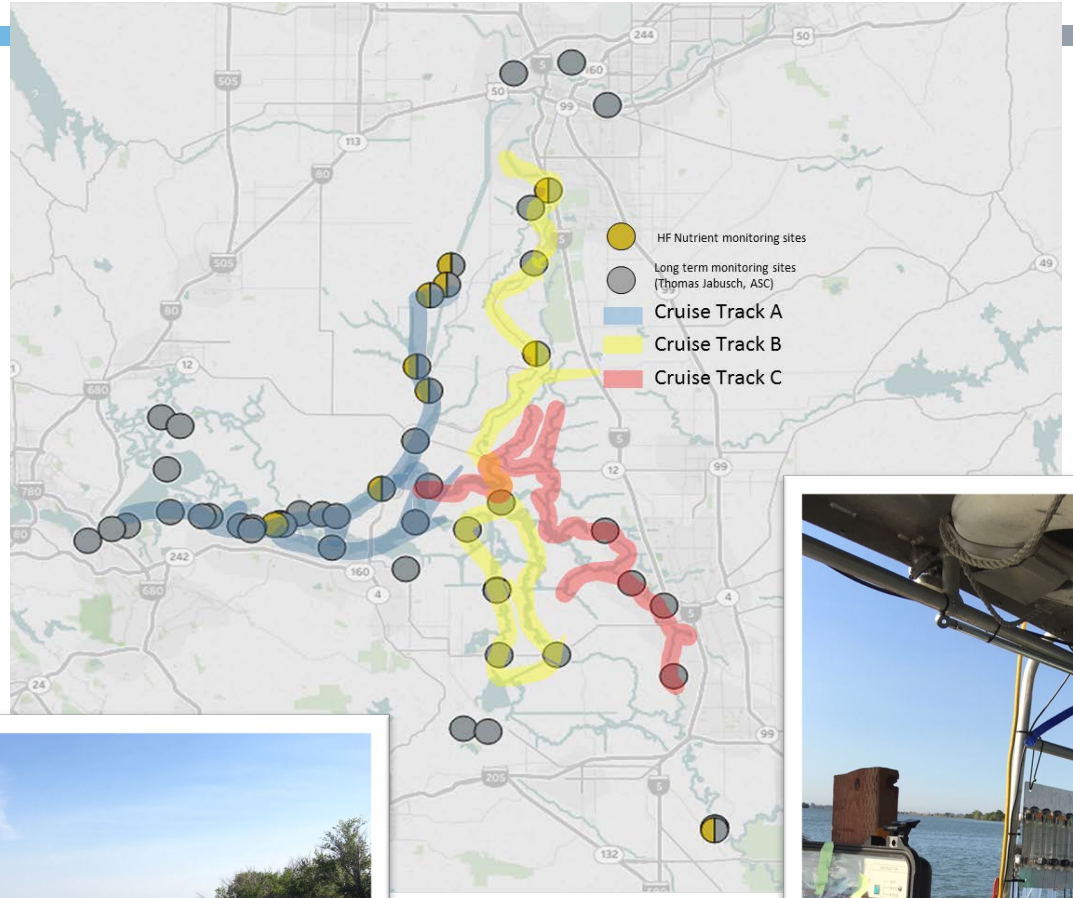
DNSRP – IMPORTANT NEXT STEPS

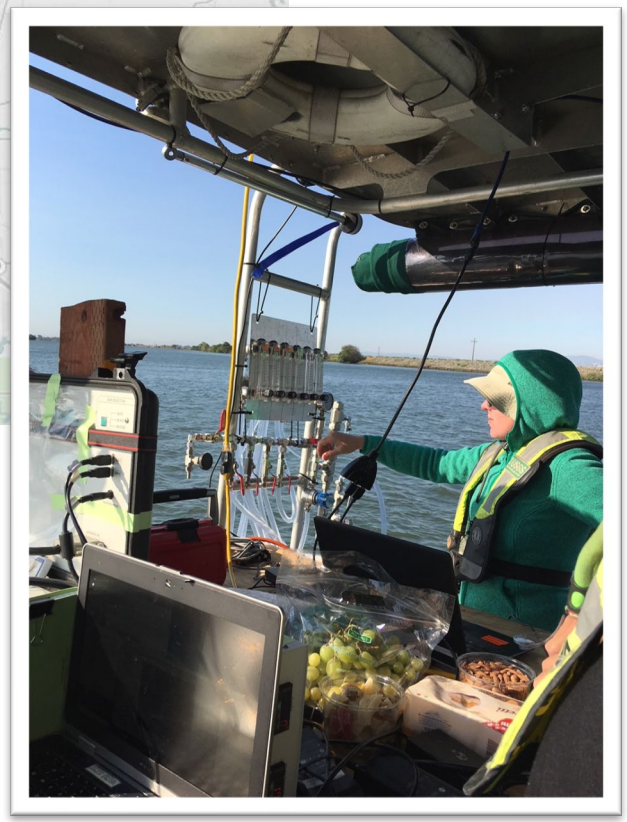
- Perform high priority monitoring, special studies and modeling actions (see Table 2 of DNRP)
- Develop range of potential nutrient thresholds developed in other programs
- Develop and implement Science Action Plan
  - seek collaboration, funding
  - develop and run range of management scenarios
  - evaluate thresholds

Activity: Studies, Modeling, Coordination & Collaboration

DELTA RMP
Regional Monitoring Program

- Nutrient data synthesis
- HABS – special studies
- New data – high speed cruises
- Biogeochemical Model development and calibration





THANK YOU – QUESTIONS?

Thomas Grovhoug, Larry Walker Associates, tomg@lwa.com

Links:

https://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/strategic_workplan_baydelta/2014_delta_strategic_workplan.pdf

https://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/delta_nutrient_research_plan/2018_0802_dnrp_final.pdf

Charter and White Papers available on request

Overview of Delta RMP Studies

TIM MUSSEN, REGIONAL SAN

LOOKING BACK: A REVIEW OF DELTA RMP – FUNDED NUTRIENT PROJECTS, 9:10 TO 9:40 AM

Looking Back:

A Summary of Completed Nutrient Projects Supported by the Delta Regional Monitoring Program

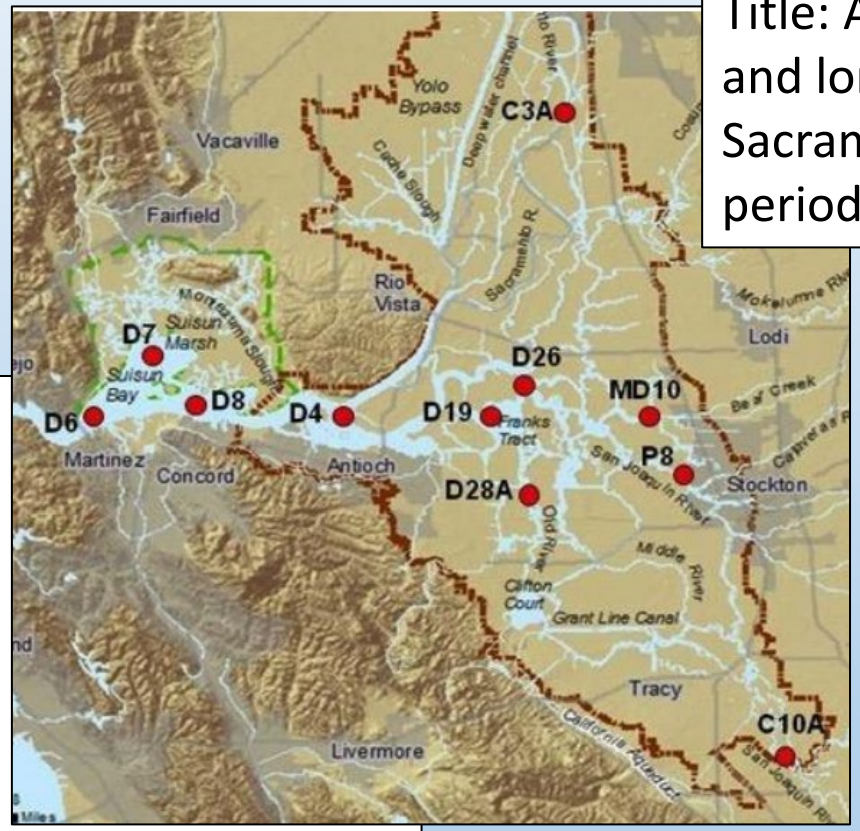
Project Reports:

1. Long-term Nutrient Concentration Trends in the Delta (1975-2013)
2. Nutrient Status and Trends in the Delta (2001–2016)
3. Modeling to Identify Data Gaps in Nutrient Monitoring
4. Chlorophyll-a Sensor and Sample Analysis Intercomparison
5. Nutrient Modeling and Mapping Projects (an introduction)

Presented by Tim Mussen, Scientist at Regional San, 9/27/2022

Delta RMP's first Nutrient Summary Report prepared by the San Francisco Estuary Institute in 2016

Title: Analysis of spatial, seasonal, and temporal variability, and long-term trends in nutrient concentrations in the Sacramento – San Joaquin Delta and Suisun Bay during the period 1975 – 2013



Prepared by:

Thomas Jabusch
Phil Trowbridge
Jennifer Sun
David Senn

San Francisco Estuary Institute
4911 Central Ave
Richmond, CA 94804

- 38 years of data from the Department of Water Resource's Environmental Monitoring Program (DWR – EMP – IEP)
- Monthly monitoring
- 11 sights included in the study

Conceptual model of factors causing nutrient variability in the Delta

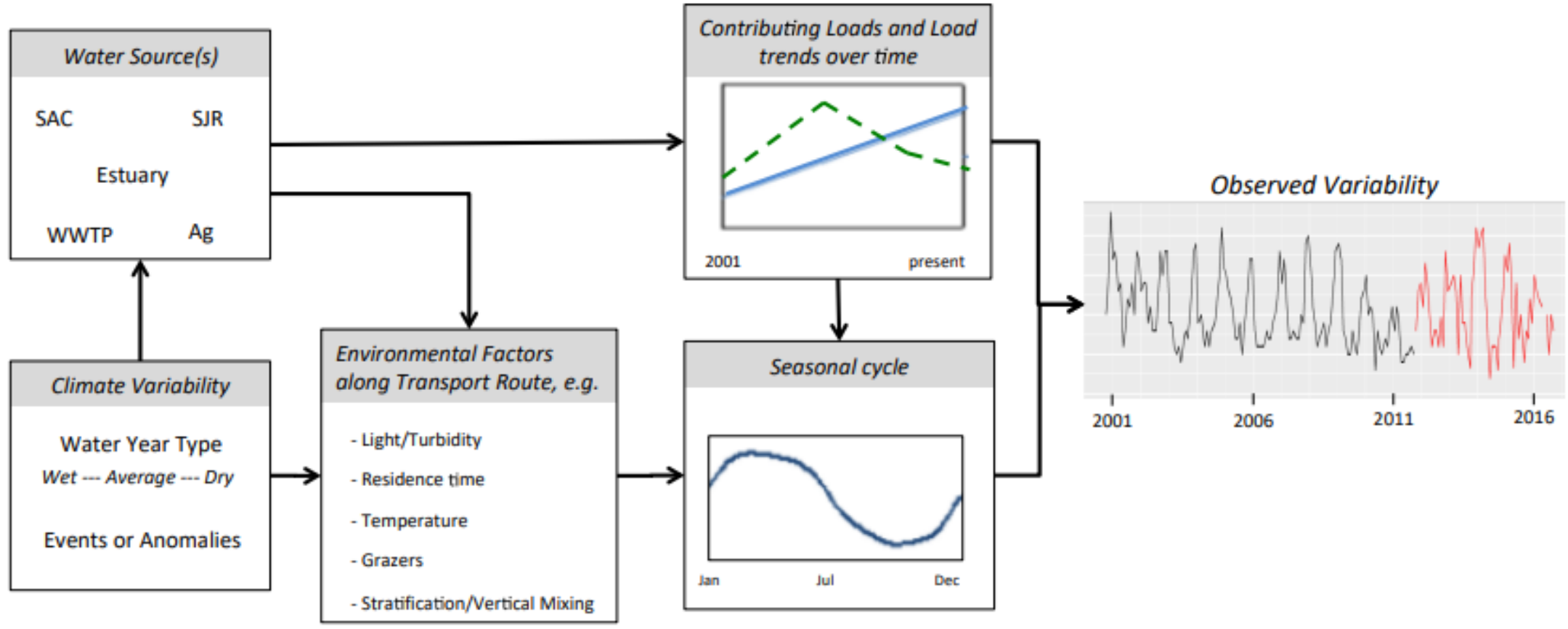
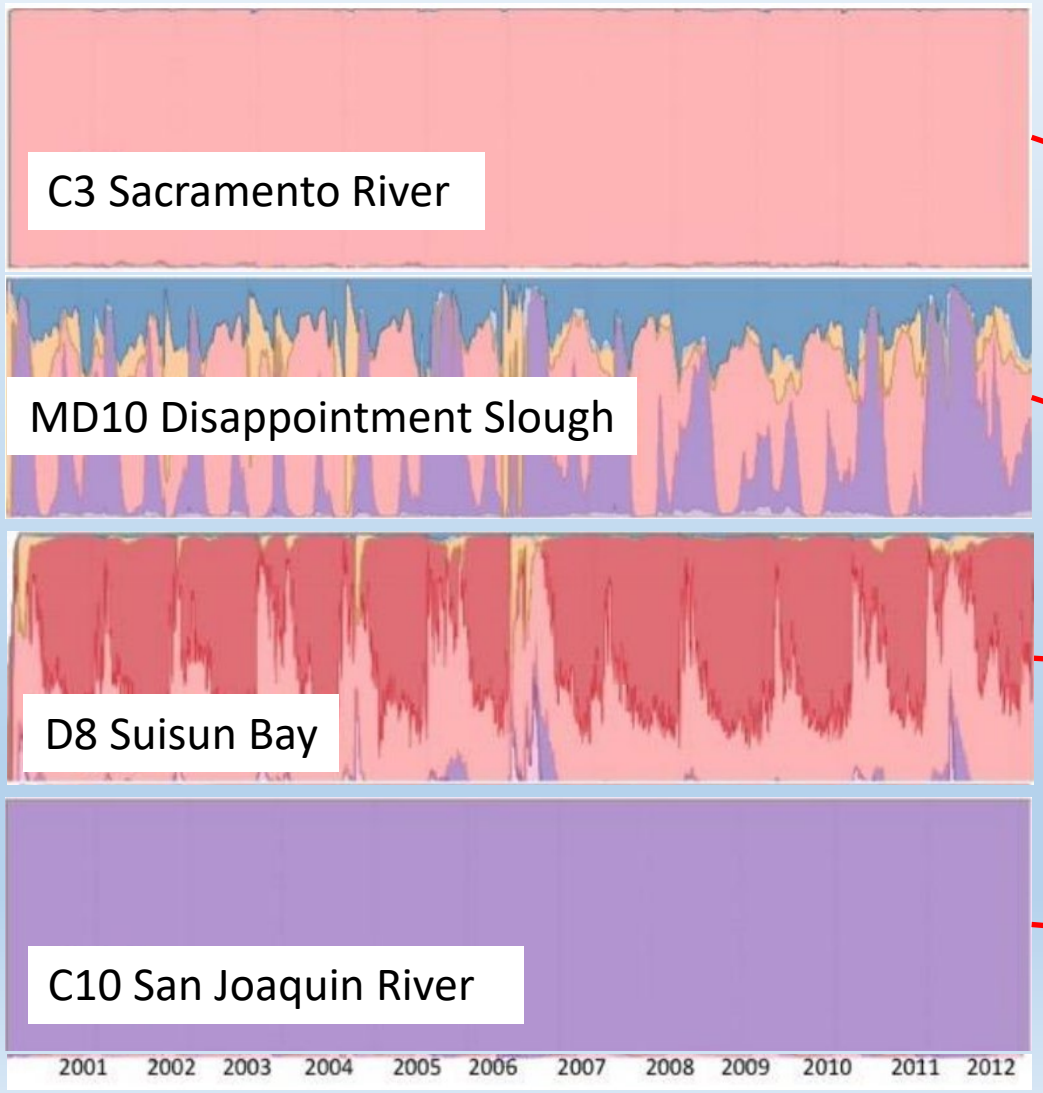


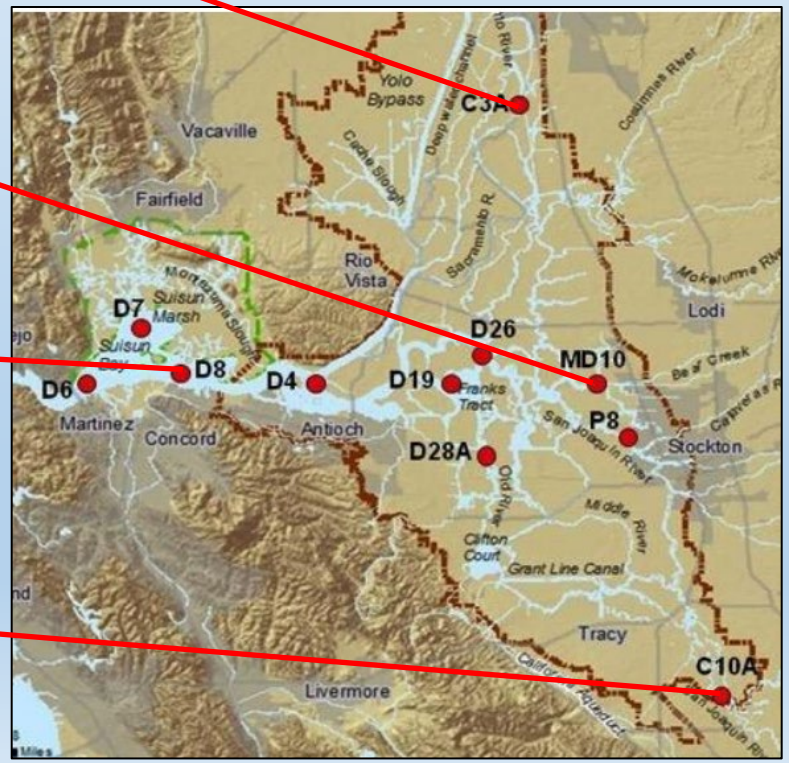
Figure 3. Conceptual model for nutrient variability in the Sacramento-San Joaquin Delta.

Water Sources

Volumetric fingerprint time series derived from hydrologic model output

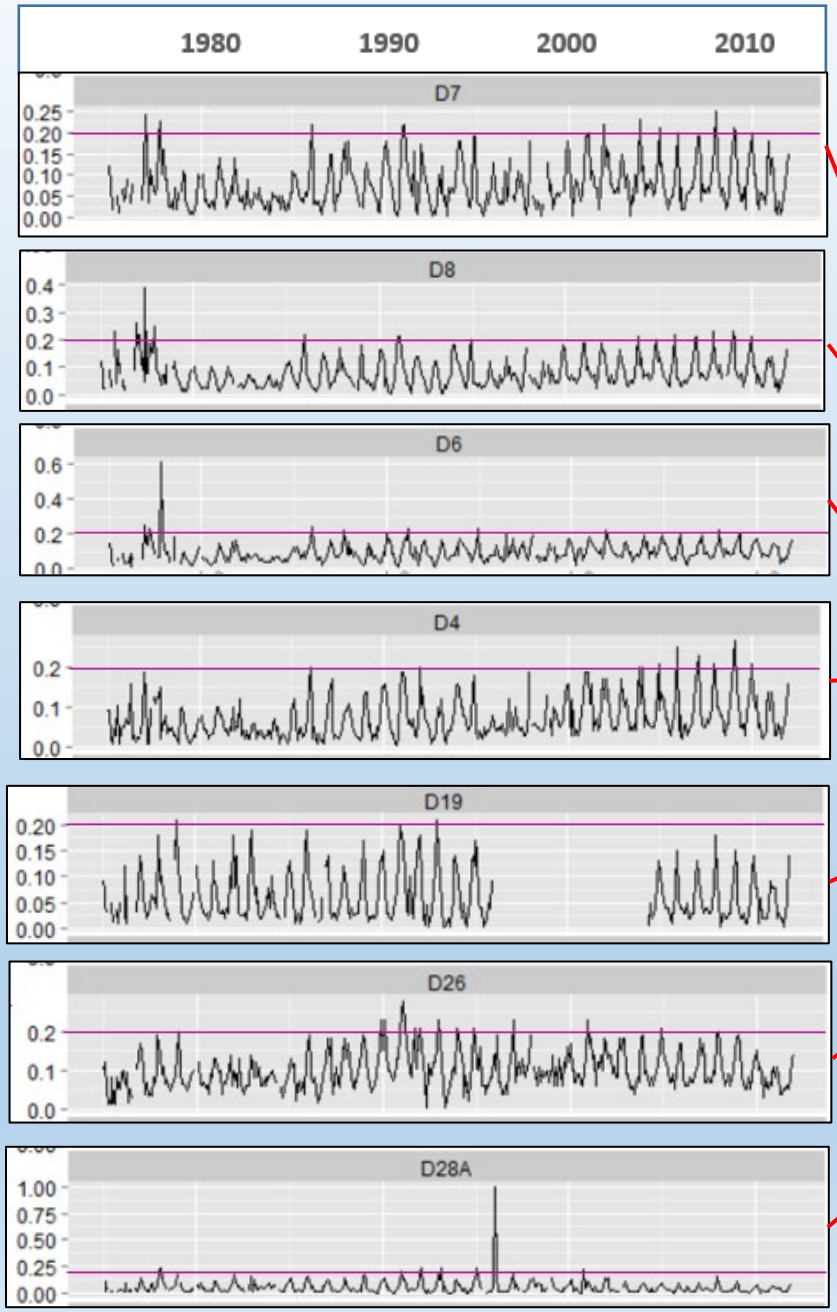


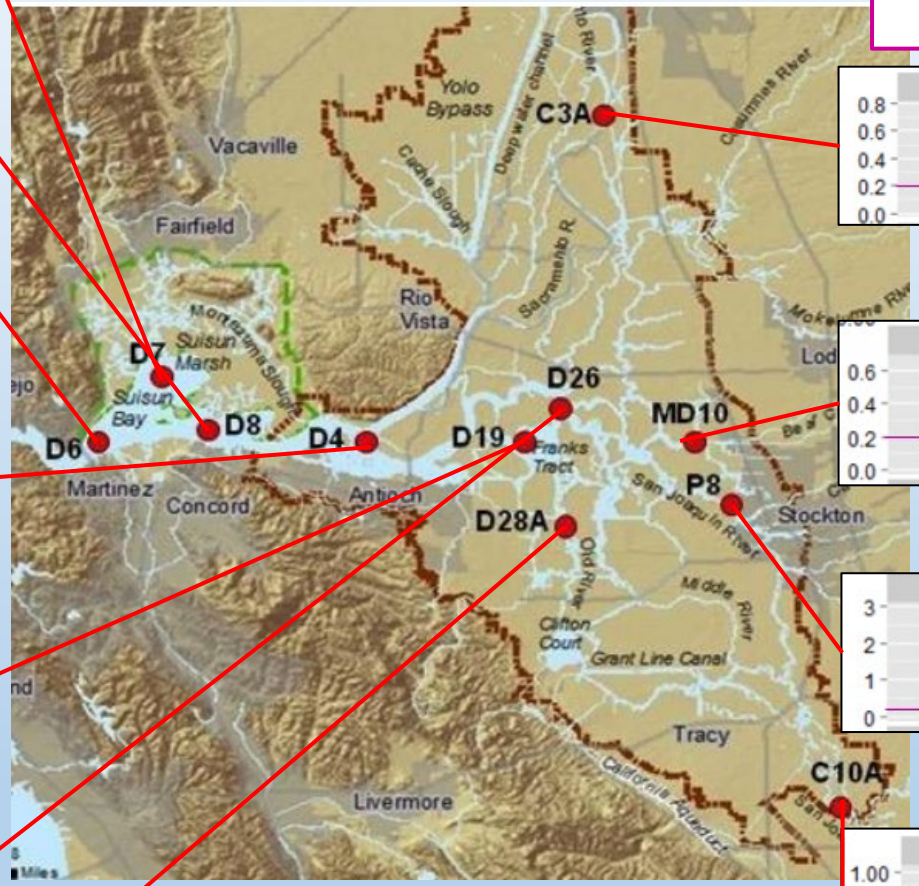
- Sacramento River
- San Joaquin River
- In-Delta Agricultural Return
- Eastside Tributaries
- SF Bay water

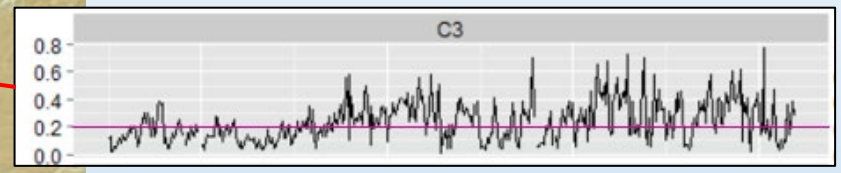


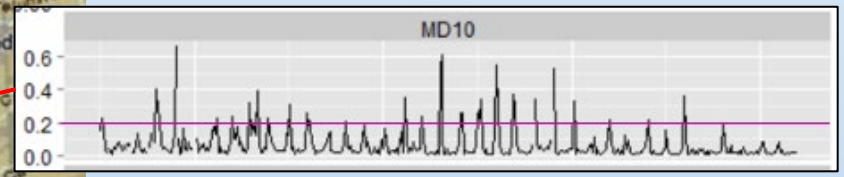
Ammonium data, 1975 - 2013

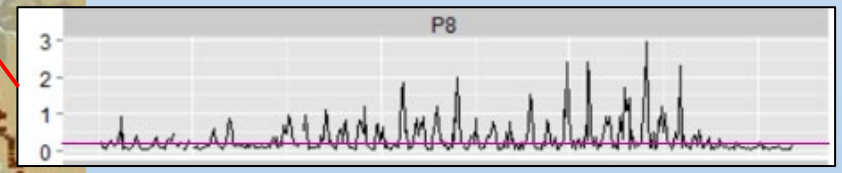
Purple line at 0.2 mg/L $NH4^{+}$-N

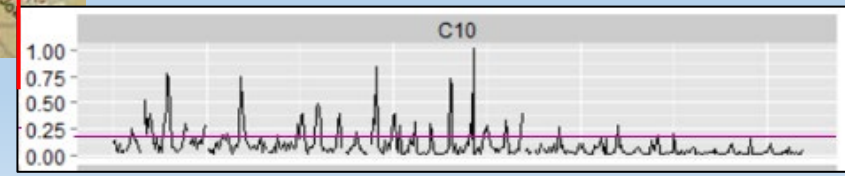




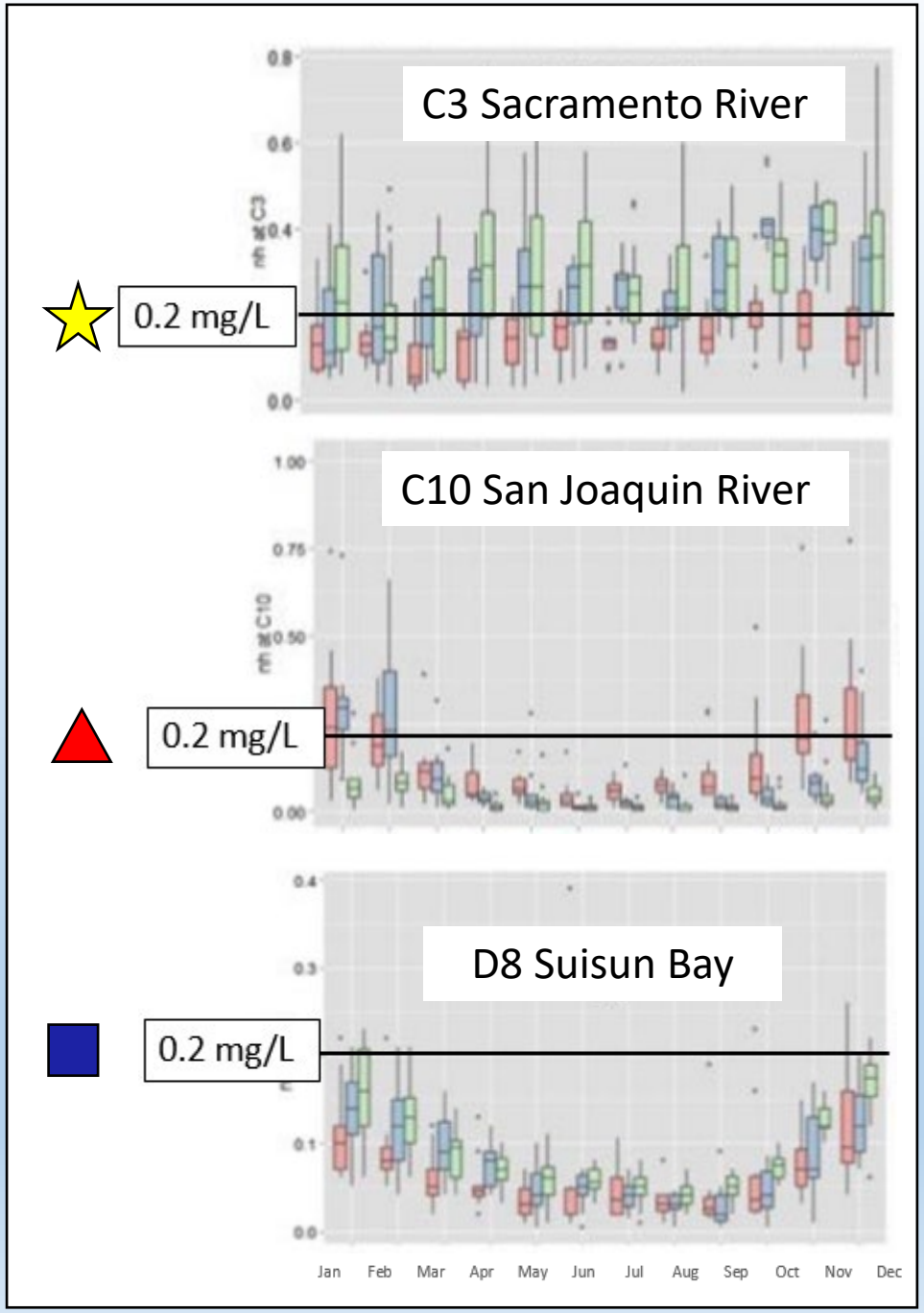




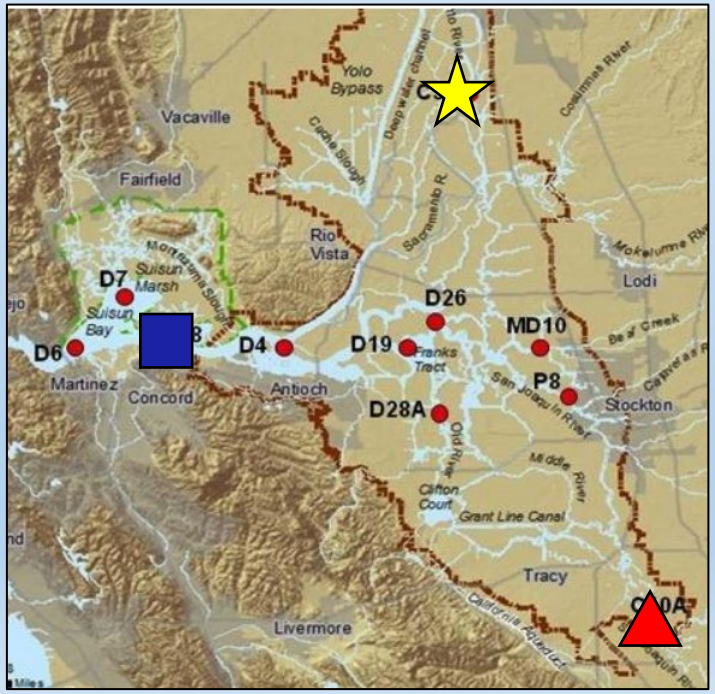




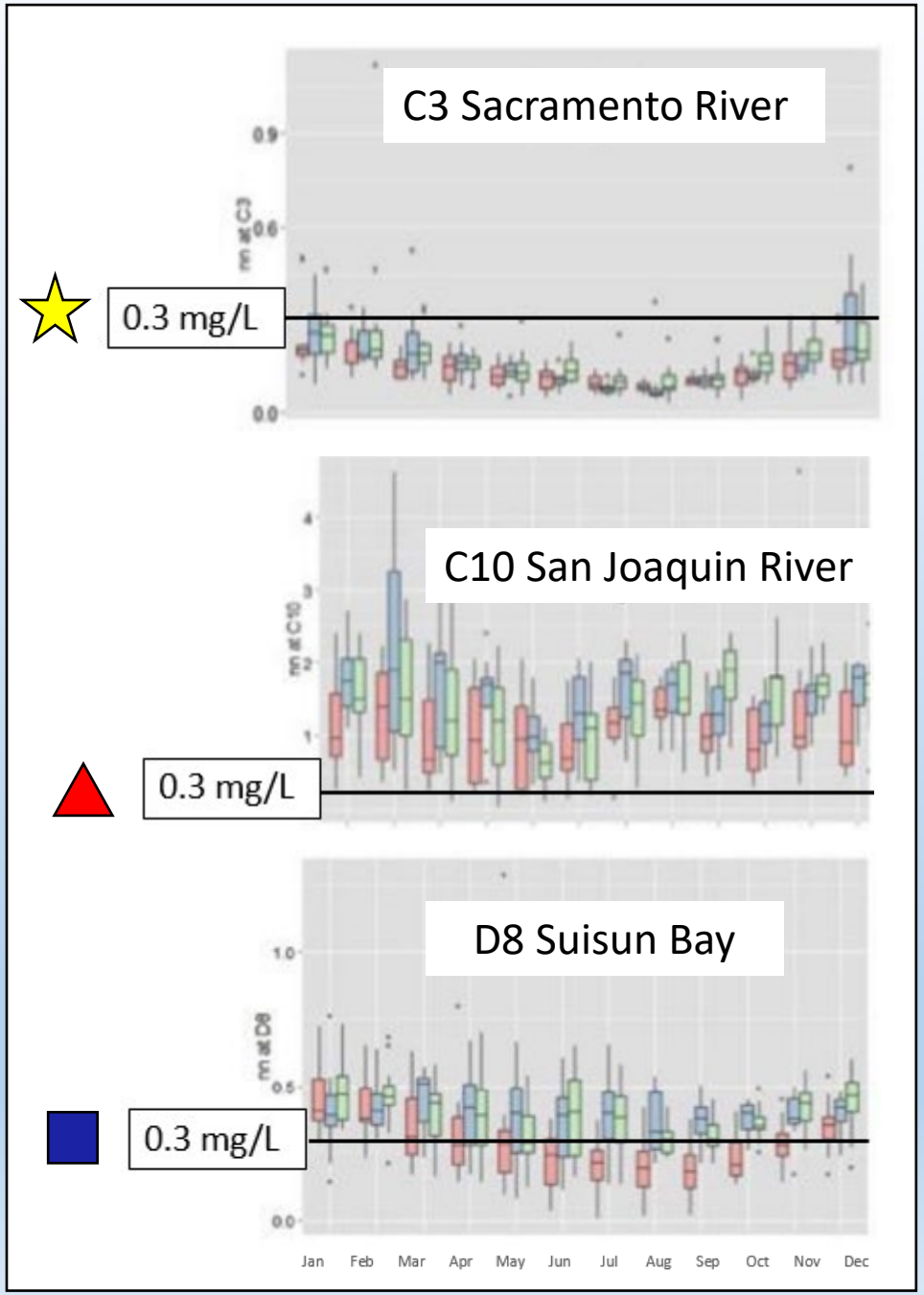
NH_4^+ concentrations (as N)



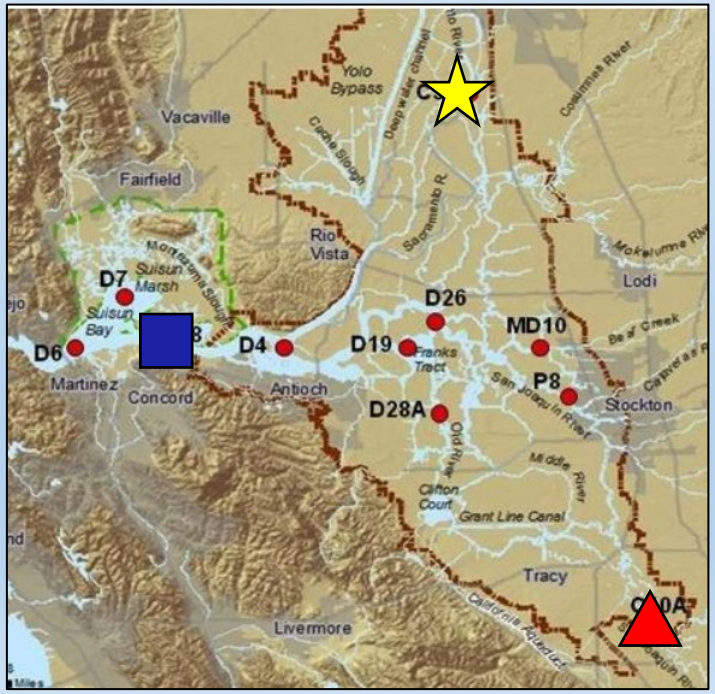
Era
- 1975-1986
- 1987-1997
- 1996-2013

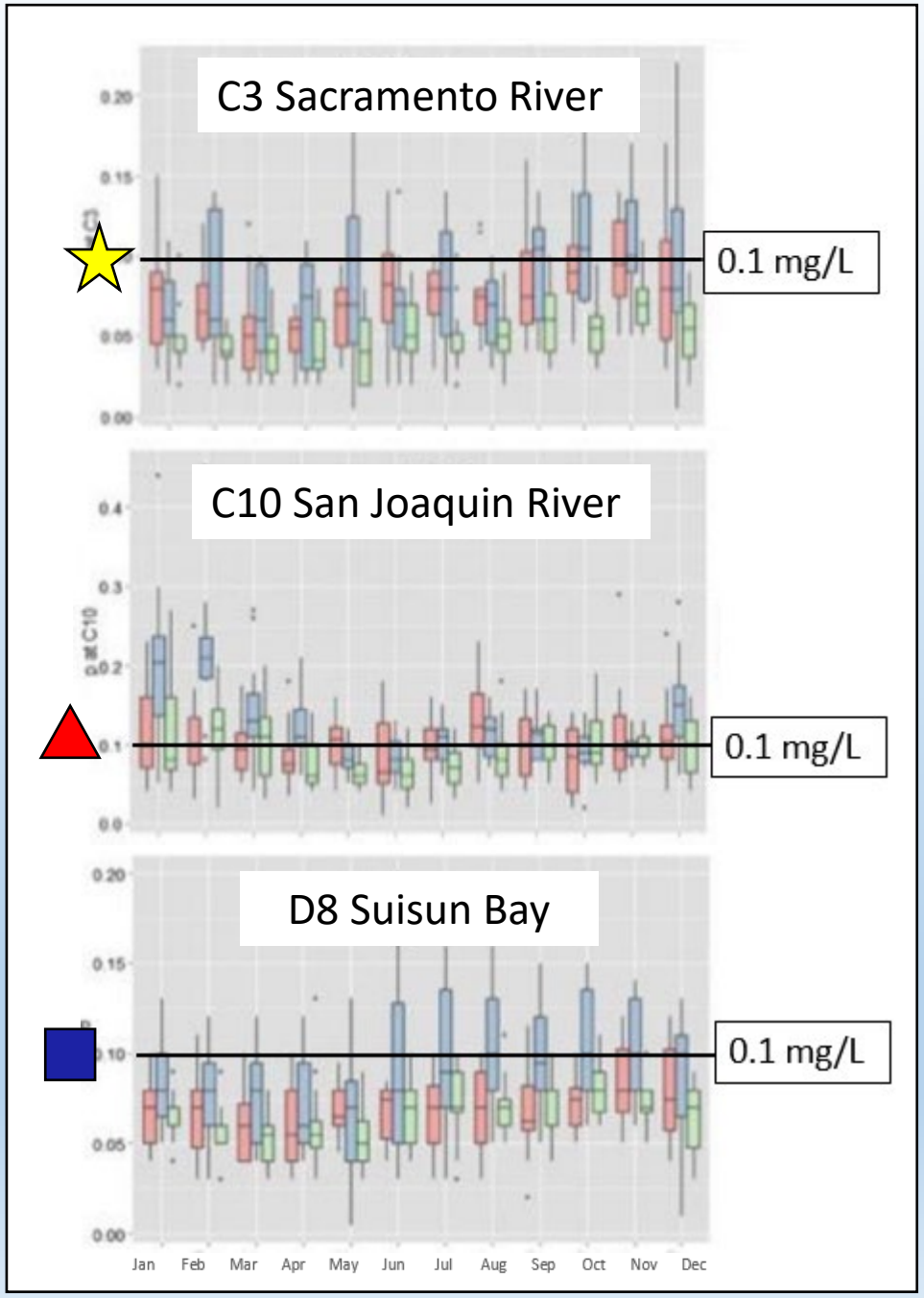


NO_3^- concentrations (as N)



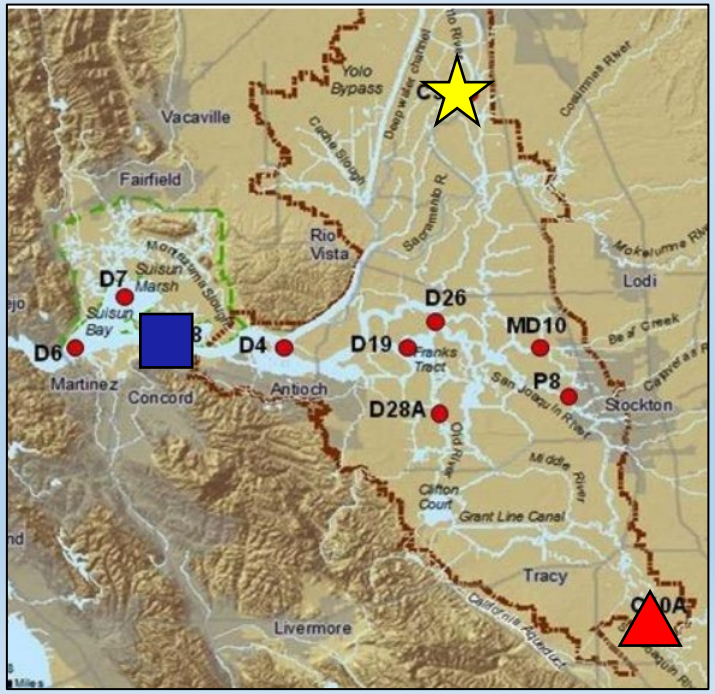
Era
- 1975-1986
- 1987-1997
- 1996-2013



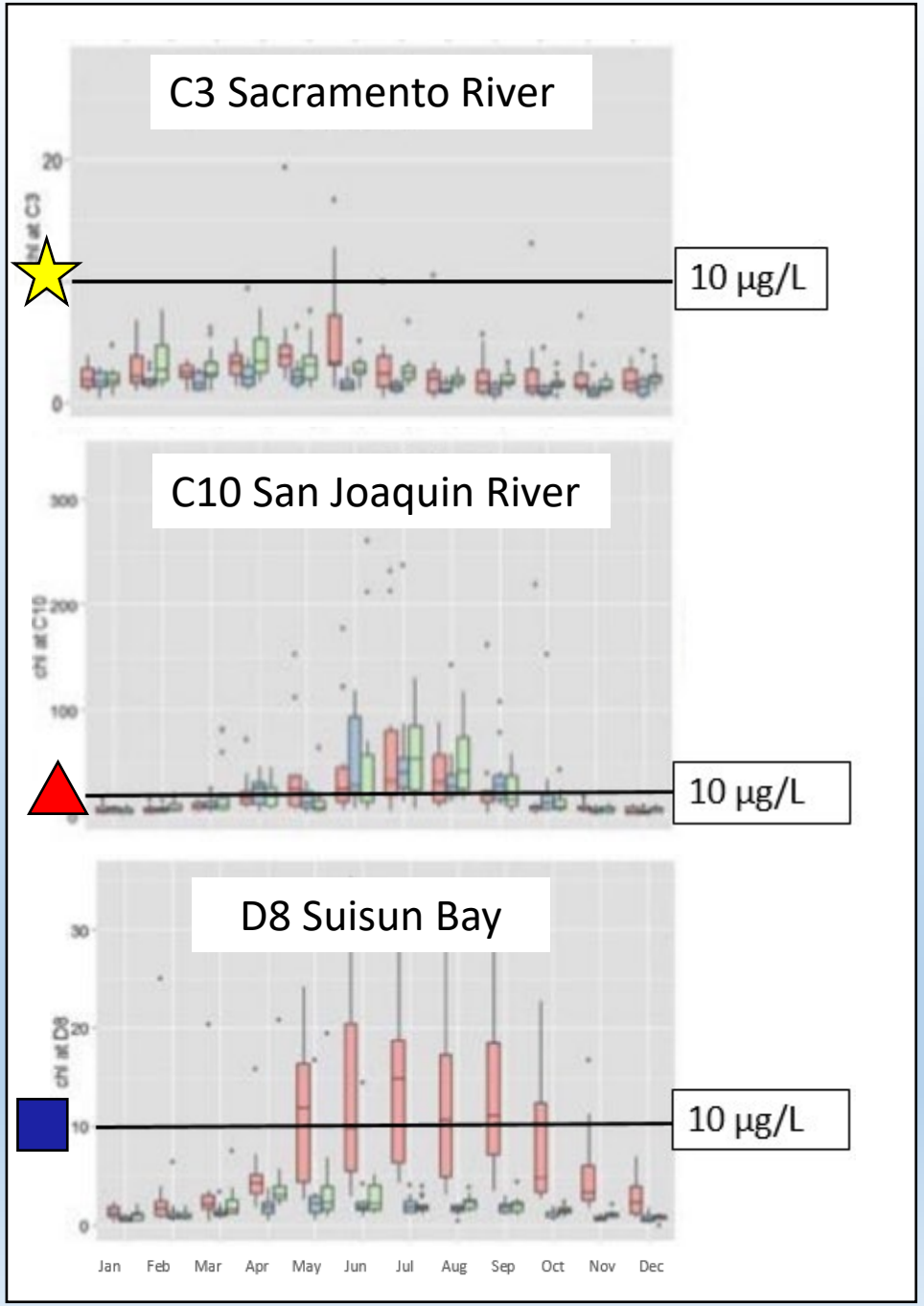


PO_4^{3-} concentrations (as P)

Era
- 1975-1986
- 1987-1997
- 1996-2013



Chlorophyll-a concentrations



Era
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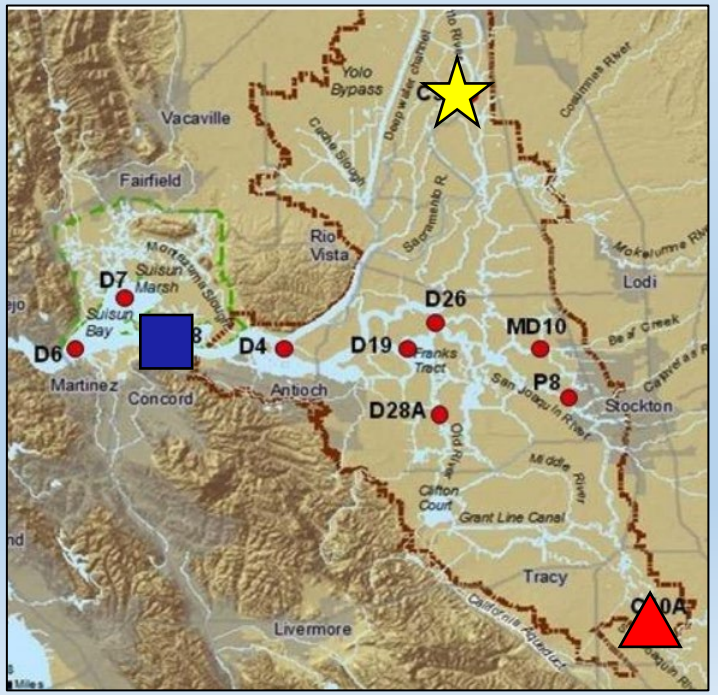


Findings

- Nutrient trends are not consistent within or among stations over time, so extrapolations should not be made to unmonitored areas, such as the North Delta, South Delta, or Eastside tributaries.

- Additional stations are needed to evaluate conditions and trends at unmonitored regions. Given the large amount of variability, adding these stations would also increase the power for detecting significant larger-scale and longer-term trends.

Delta RMP Nutrient Synthesis Update
Prepared by SFEI in 2018

Assessment of Nutrient Status and Trends in the Delta in 2001–2016: Effects of drought on ambient concentrations and trends

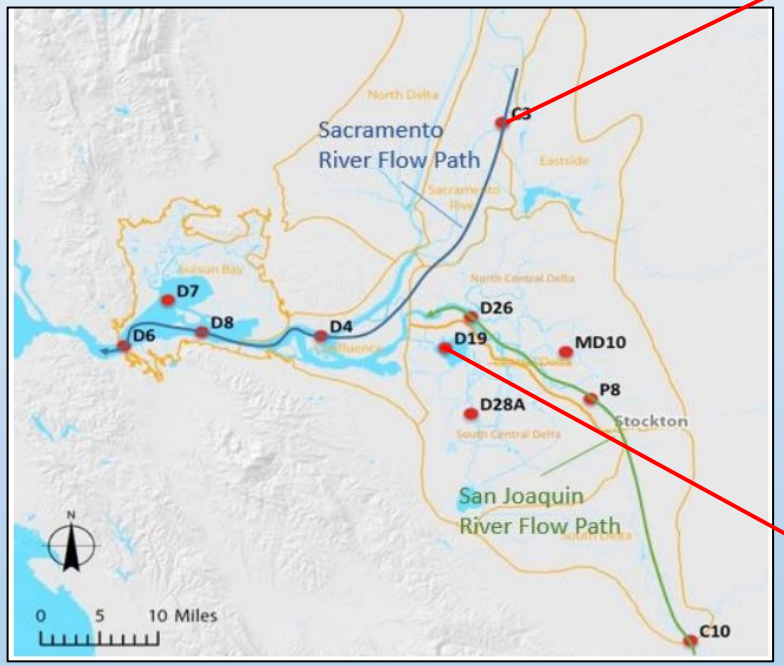
Prepared by the
Aquatic Science Center
Thomas Jabusch, Phil Trowbridge,
Adam Wong, and Matthew Heberger

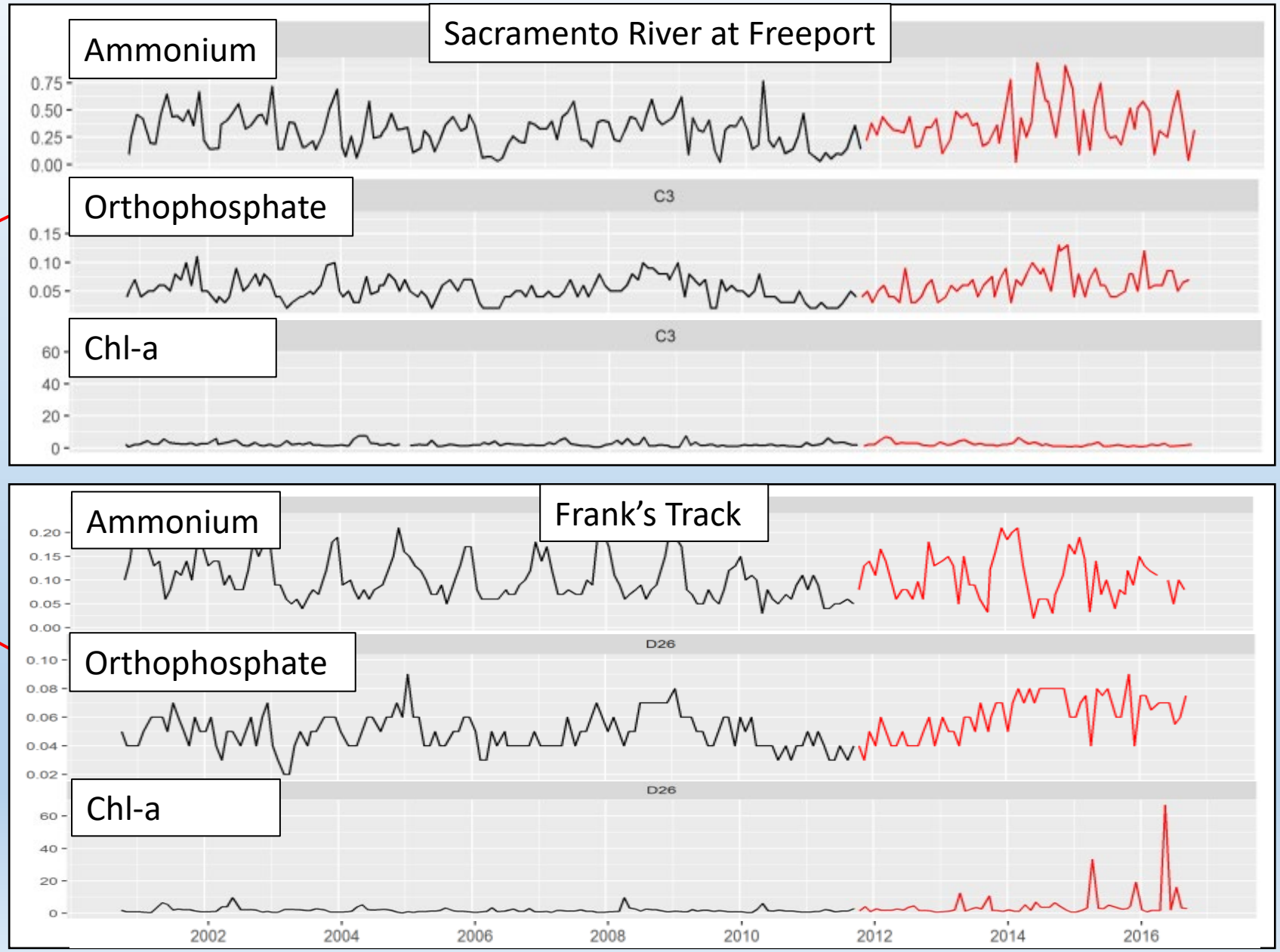
AQUATIC SCIENCE CENTER

Prepared for the
Delta Regional Monitoring Program
Technical Advisory Committee

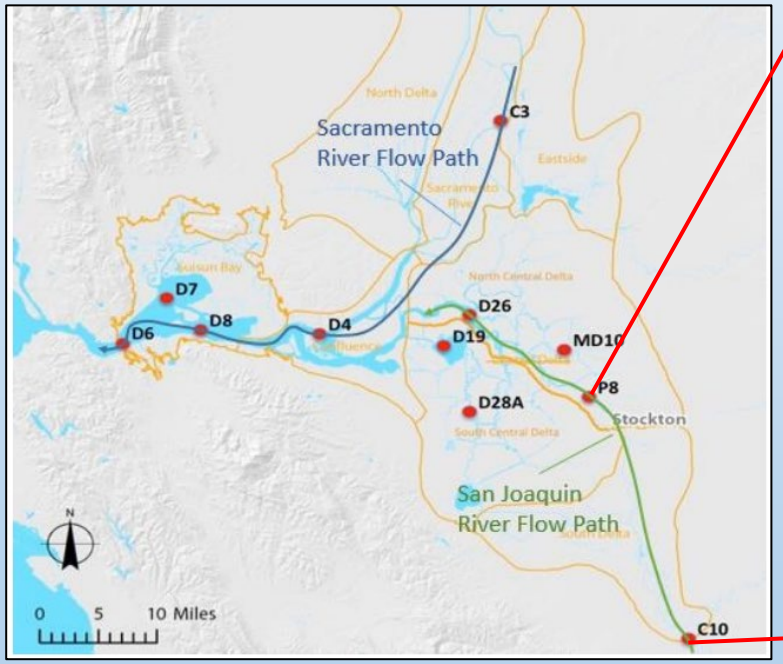
DELTA
REGIONAL MONITORING PROGRAM

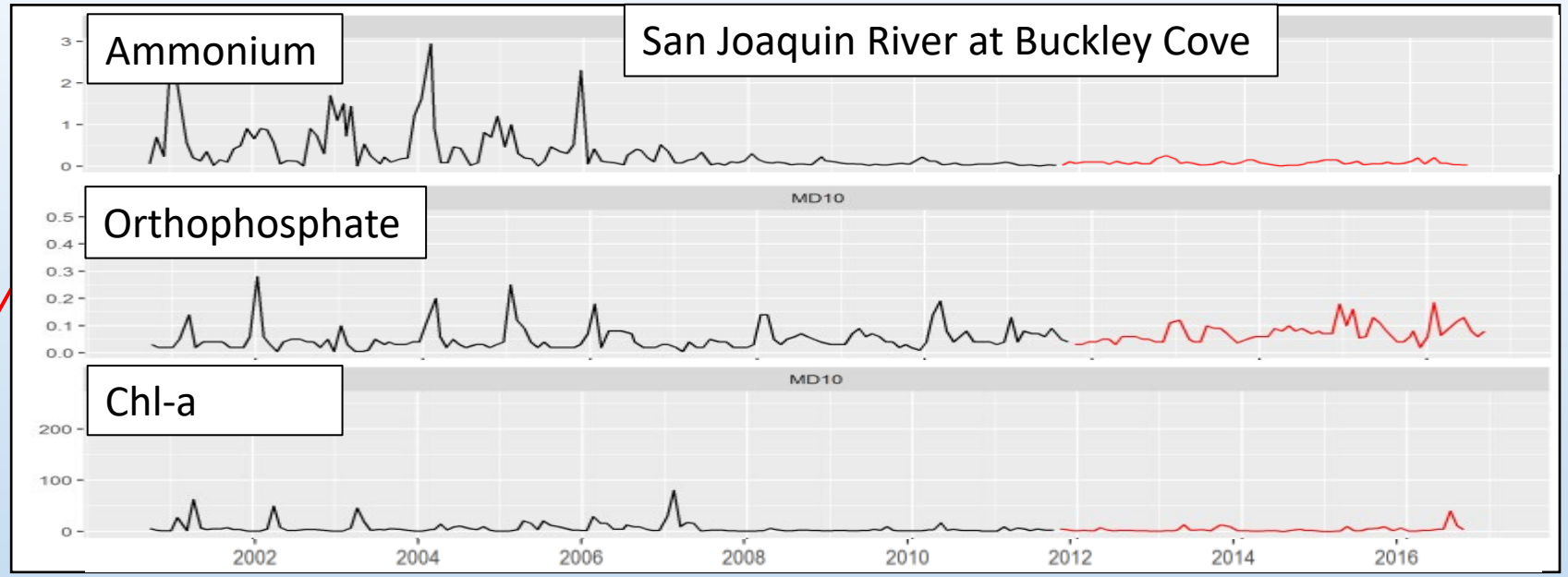
Updated Time Series Plots for Water Year 2012–16

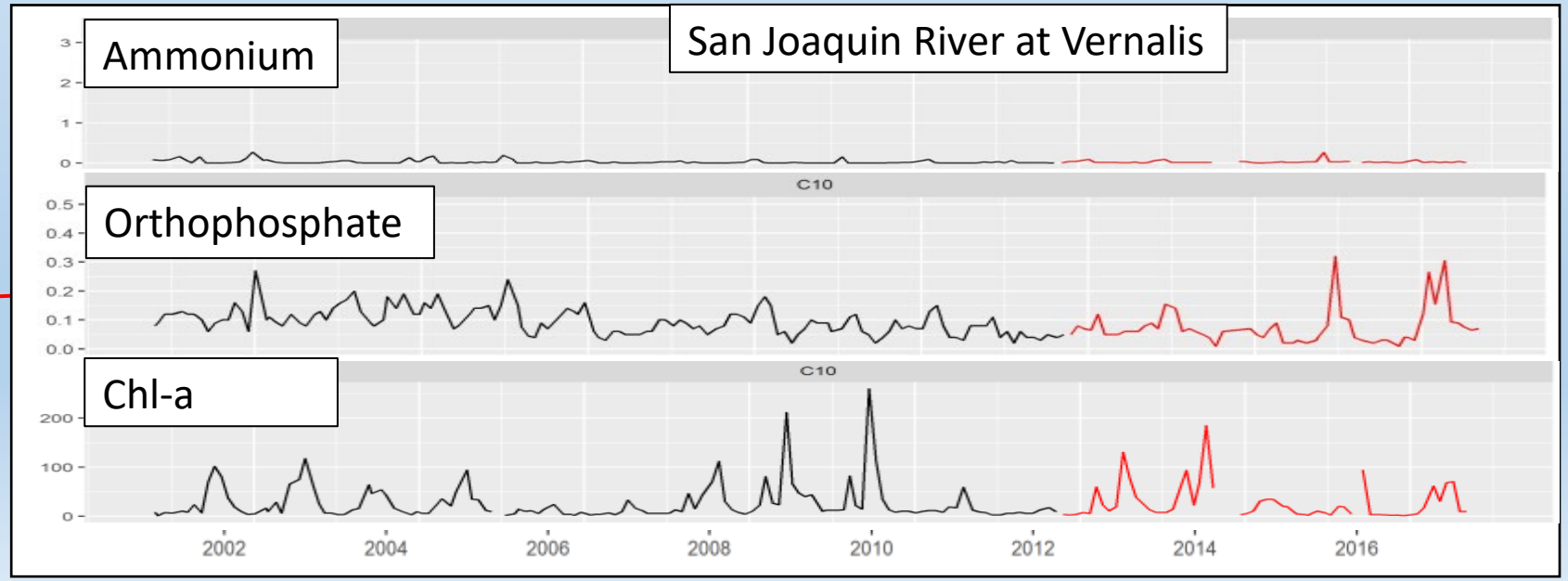




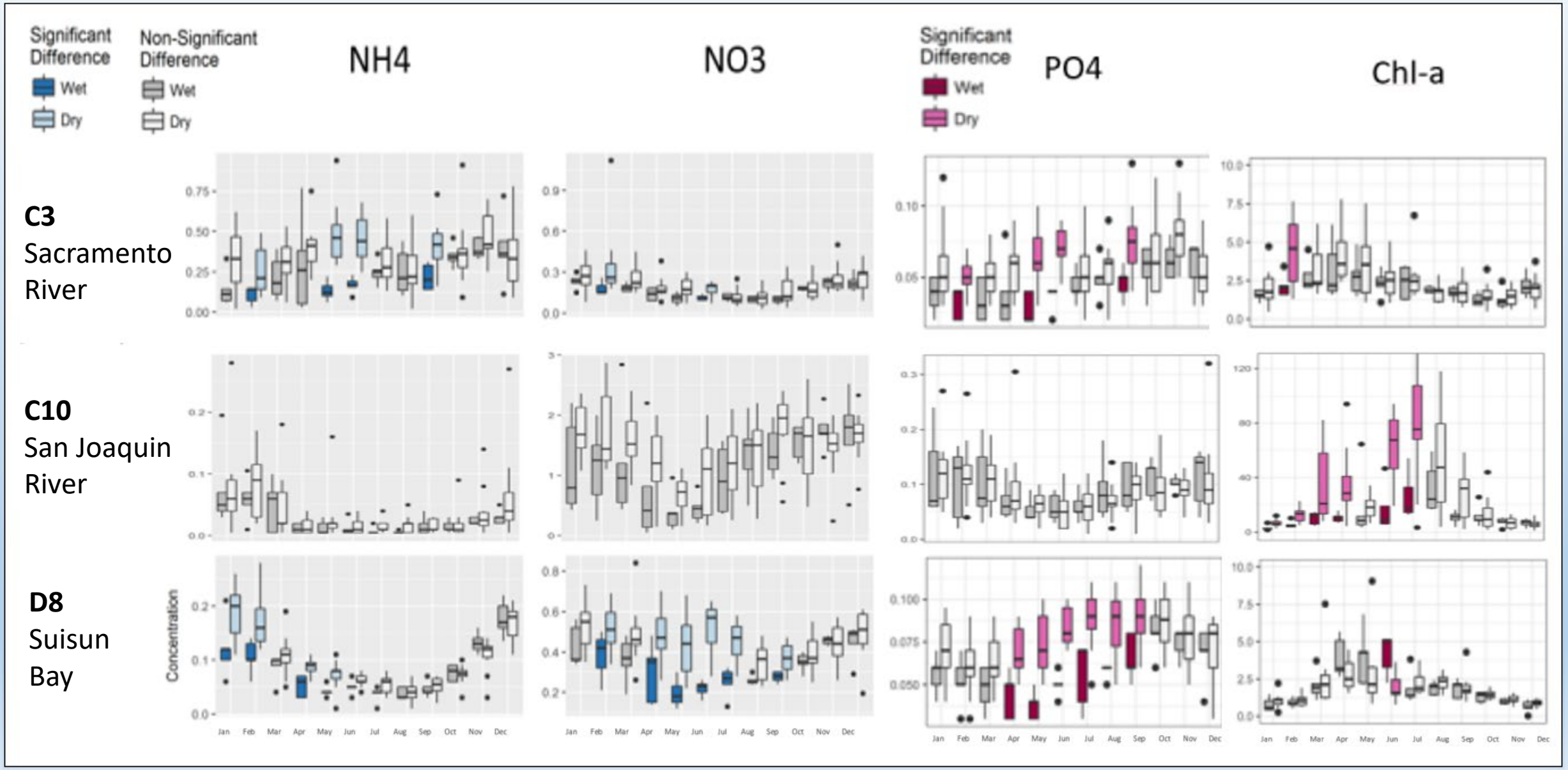
Updated Time Series Plots for Water Year 2012–16







Wet vs. Dry Water Year Comparisons



Trend Analysis (2001 – 2016)

Ammonium

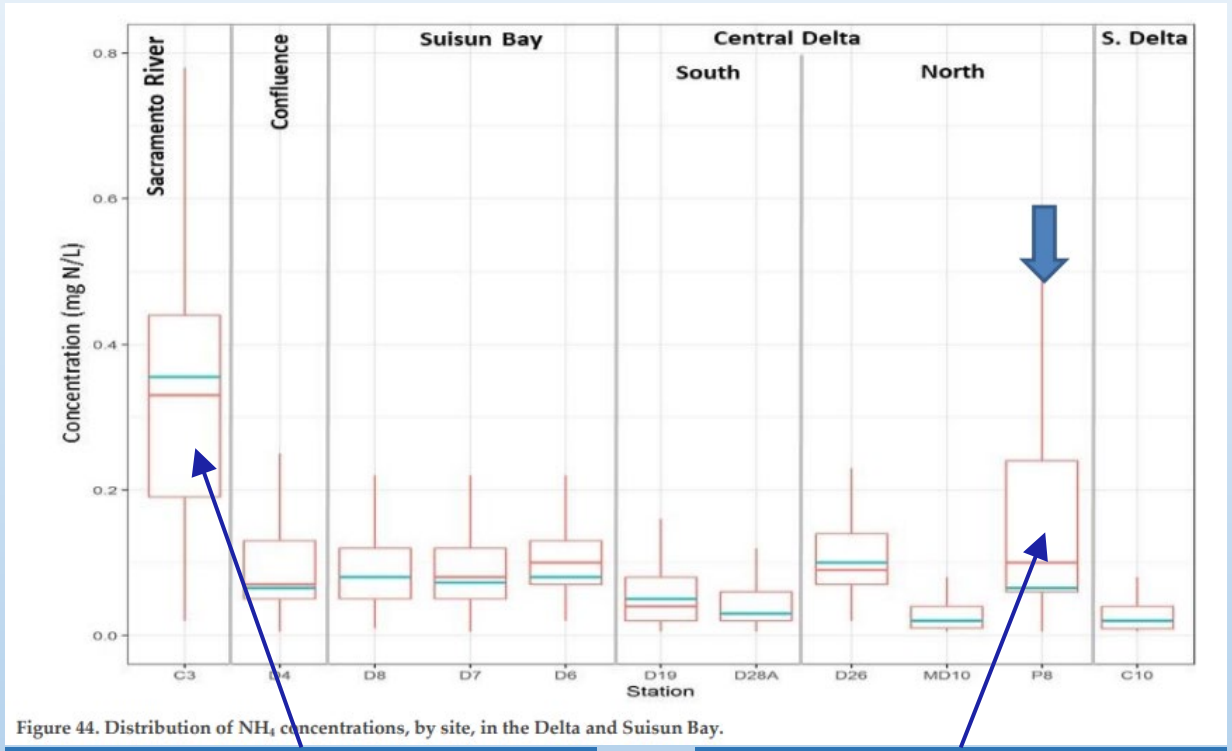


Figure 44. Distribution of NH_4 concentrations, by site, in the Delta and Suisun Bay.

Near Regional San's WWTP

Near Stockton's WWTP

Nitrate

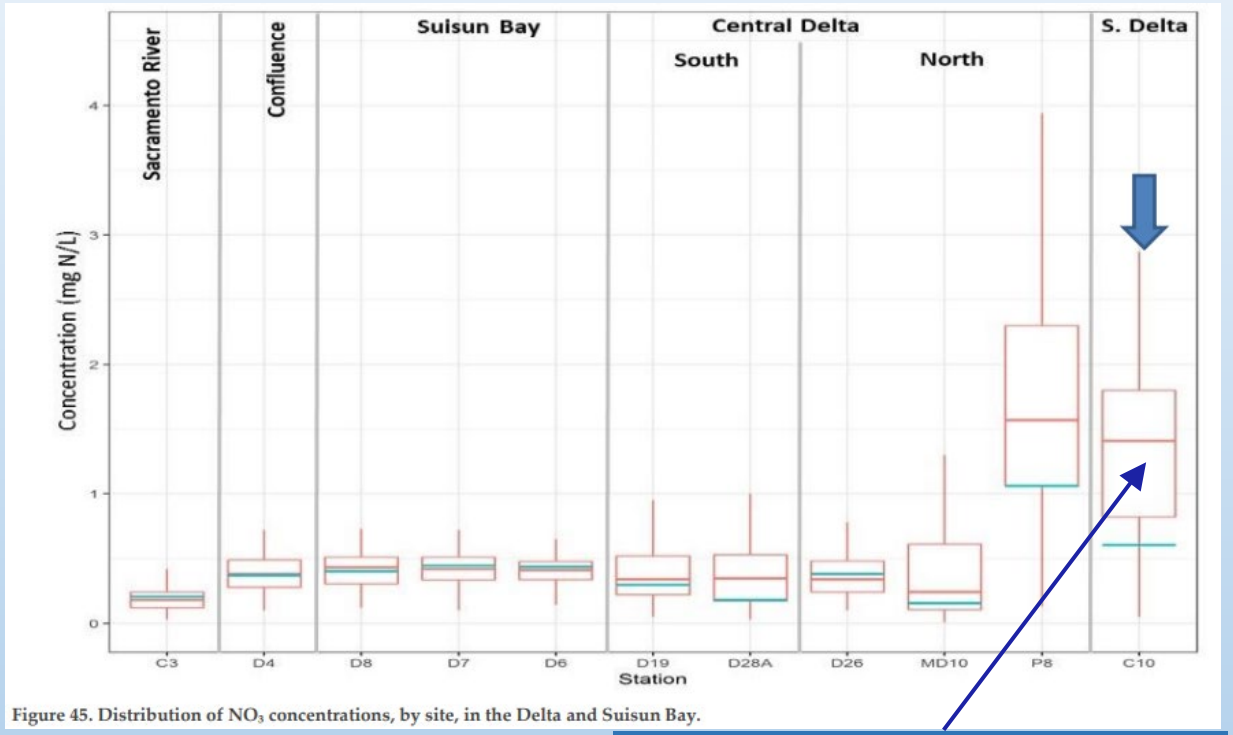


Figure 45. Distribution of NO_3 concentrations, by site, in the Delta and Suisun Bay.

San Joaquin River at Vernalis

16-year dataset was analyzed for temporal trends at individual stations.

The statistical method used was a Seasonal Kendall Test on flow adjusted data

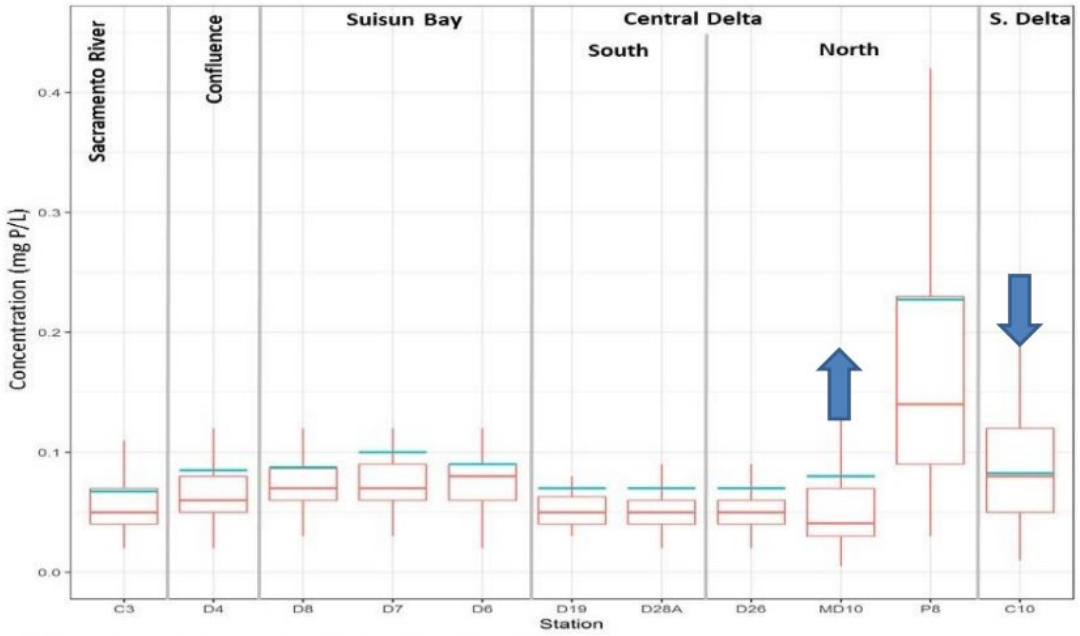


Figure 48. Distribution of PO_4 concentrations, by site, in the Delta and Suisun Bay.

Phosphate Treads

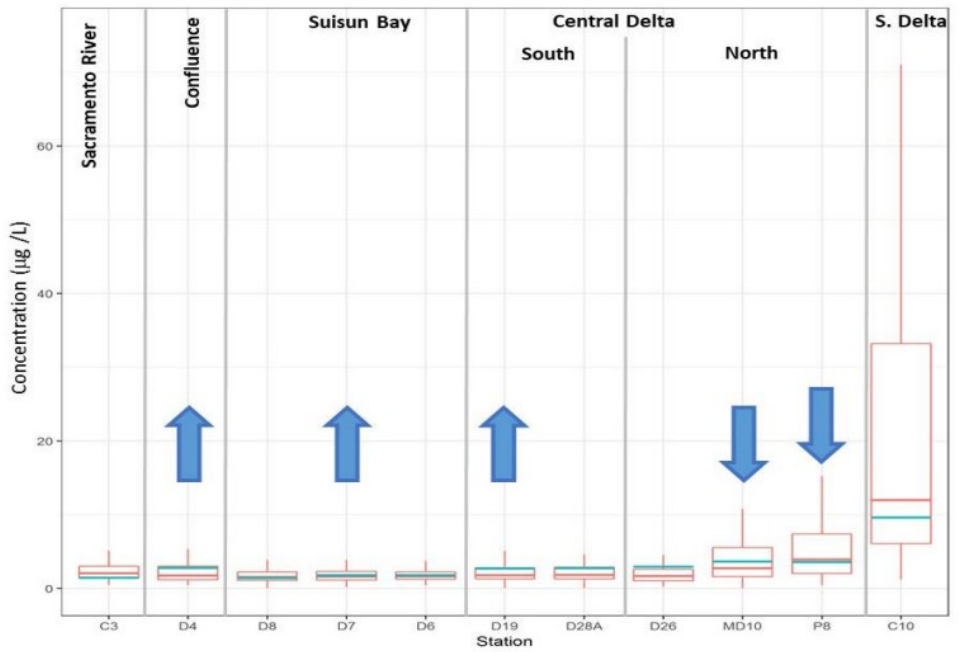


Figure 50. Distribution of chlorophyll-a concentrations, by site, in the Delta and Suisun Bay.

Chlorophyll-a Treads

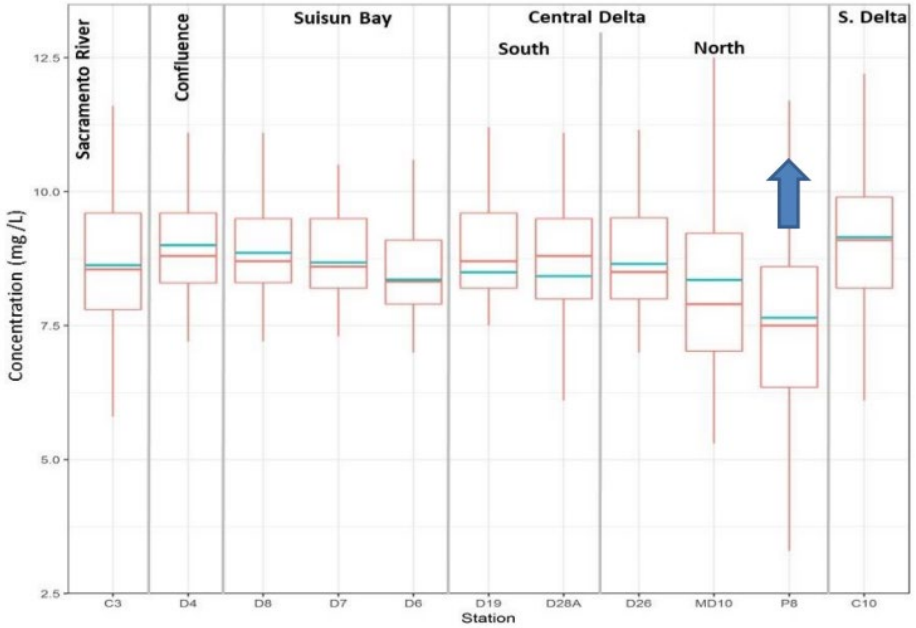
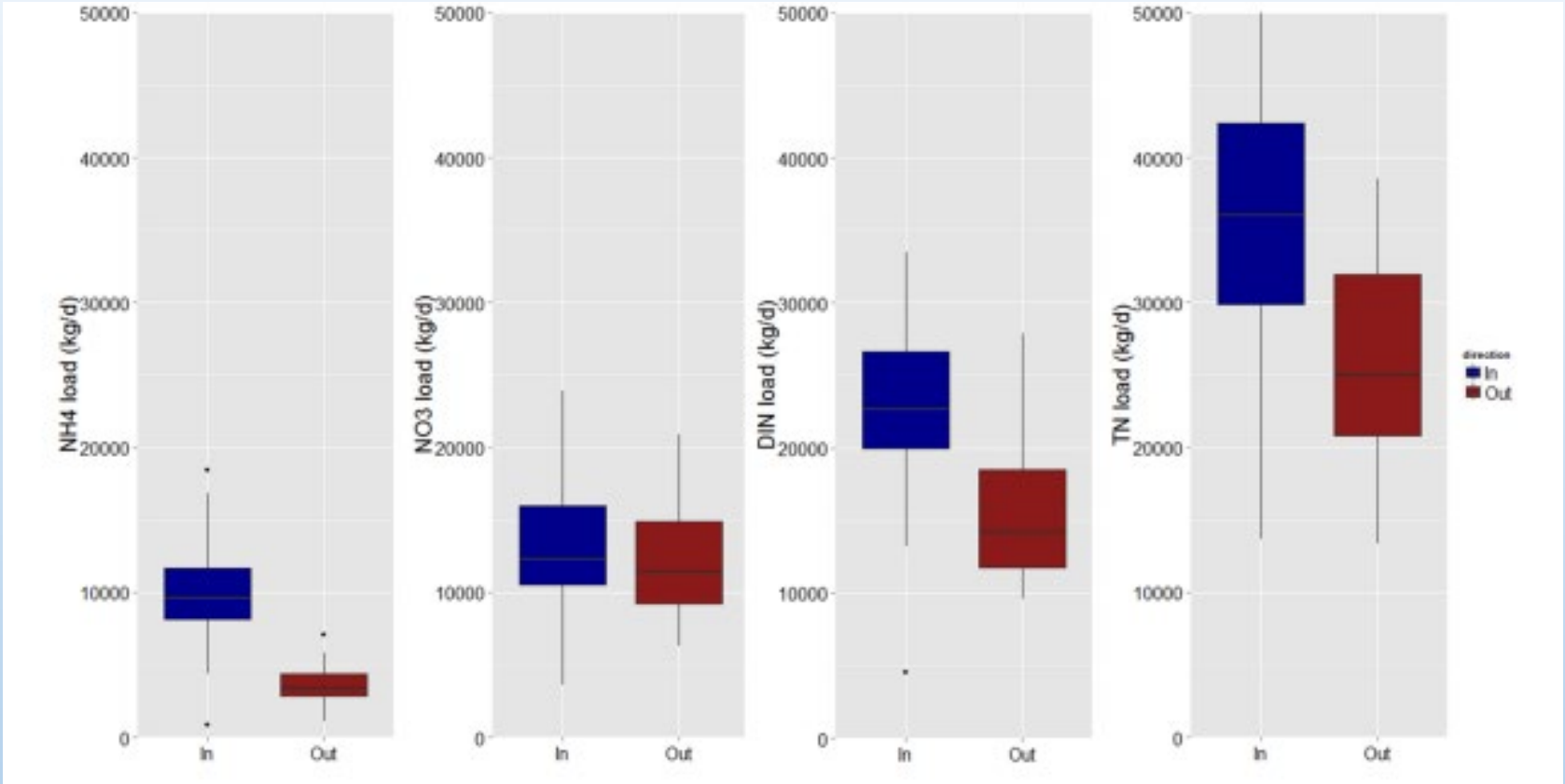


Figure 51. Distribution of DO concentrations, by site, in the Delta and Suisun Bay.

Dissolved Oxygen Treads

Delta-Scale Nitrogen Mass Balance (2006–2011)



Novick E., R. Holleman, T. Jabusch, J. Sun, P. Trowbridge, D. Senn, M. Guerin, C. Kendall, M. Young, and S. Peek. 2015. Characterizing and quantifying nutrient sources, sinks and transformations in the Delta: Synthesis, modeling, and recommendations for monitoring. San Francisco Estuary Institute, Richmond, CA. Funded by DWR
http://www.sfei.org/documents/delta-nutrient-source

Delta subregions can be net sources or sinks for different nitrogen forms

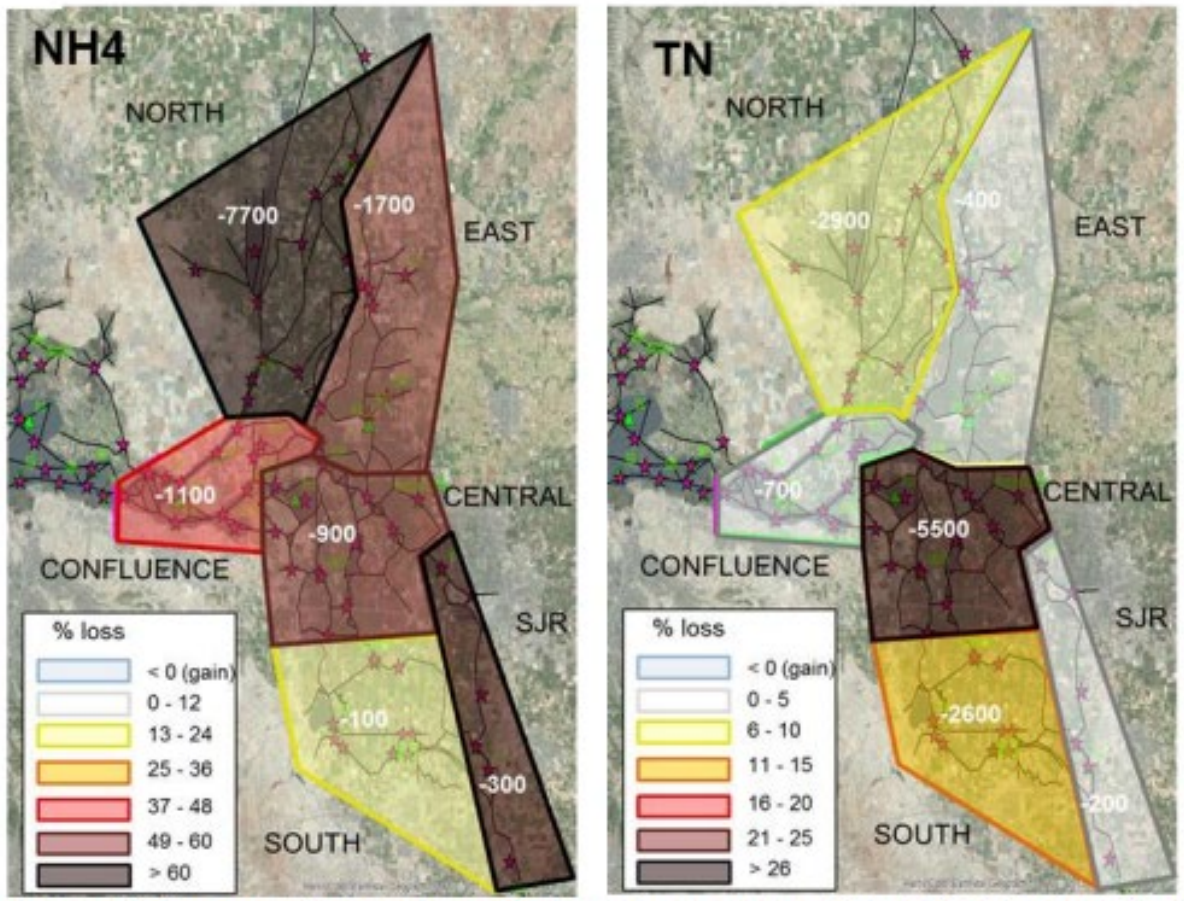


Figure 54. Average nitrogen loss within each subregion of the DSM2 model, for June-October of 2006–2011.

Color indicates % loss in each region (note different scales for % loss categories). Mass losses are in units of kg N/day. From Novick et al. (2015).

USGS California Water Science Center (CAWSC) reports:

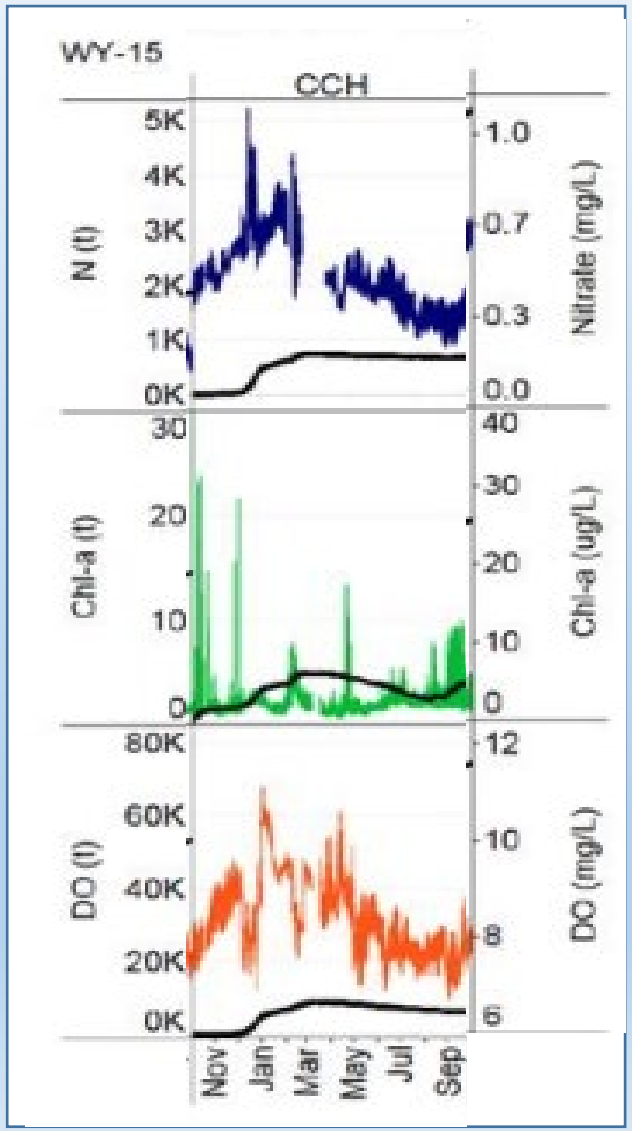
How to build a high-frequency nutrient and biogeochemistry monitoring network in the Delta

Kraus T.E.C., B.A. Bergamaschi, and B.D. Downing. 2017. *An introduction to high-frequency nutrient monitoring for the Sacramento-San Joaquin Delta, northern California.* U.S. Geological Survey Open File Report 2017-5071. U.S. Geological Survey, Reston, Virginia. https://pubs.er.usgs.gov/publication/sir20175071

Downing B.D., B.A. Bergamaschi, and T.E.C. Kraus. 2017. *Synthesis of high-frequency nutrient and associated biogeochemical monitoring in the Sacramento-San Joaquin Delta, northern California*. U.S. Geological Survey Open File Report 2017-5066. U.S. Geological Survey, Reston, Virginia. https://pubs.er.usgs.gov/publication/sir20175066

Bergamaschi B.A., B.D. Downing, T.E.C. Kraus, and B.A. Pellerin. 2017. *Designing a high-frequency nutrient and biogeochemistry monitoring network: the Sacramento-San Joaquin Delta, northern California*. U.S. Geological Survey Open File Report 2017-5058. U.S. Geological Survey, Reston, Virginia. https://pubs.er.usgs.gov/publication/sir20175058

High-frequency monitoring could help address nutrient questions



ATTRIBUTES OF A HIGH FREQUENCY NUTRIENT MONITORING NETWORK FOR THE DELTA

HIGH FREQUENCY (HF): In tidal systems, measurements must be made at least once every 15-20 minutes.

CONTINUOUS: Data are collected continuously over an extended period (months-years) of time.

REAL TIME: Data are delivered to users in real time, facilitating decision making by managers, improving data quality and acting as a trigger for additional data collection efforts. *Data collected in the Delta are available at* http://waterdata.usgs.gov/nwis.

FIUX BASED: Simultaneous collection of flow data permits calculation of mass fluxes and loads. *Most current nutrient stations in the Delta are co-located with the Delta's Flow-Station network (http://dx.doi.org/10.3133/fs20153061).*

MULTI PARAMETER: Simultaneous collection of related water quality parameters improves understanding of nutrient sources, sinks, processing, and effects. *In the Delta, stations that are equipped with nitrate sensors also measure temperature, pH conductivity, dissolved oxygen, turbidity, fluorescence of dissolved organic matter, chlorophyll-a fluorescence and blue-green algal fluorescence.*

NETWORK: Stations are spatially distributed so that sources, transport, and fate of nutrients can be tracked and their effects on Delta habitats can be assessed at multiple spatial scales.

For details see Kraus et al. (2016)

Knowledge Gaps identified in the Second Nutrient Synthesis Report

- **How is the Delta ecosystem influenced by nutrients?**
- **What are the primary nutrient sinks, sources, and processes in the Delta?**

Recommendations:

- Use mechanistic, water quality-hydrodynamic models to define important processes, time-scales, and spatial scales
- Augment existing monitoring programs with additional parameters, stations, and sampling events to inform modeling data gaps
- Conduct short-term intensive monitoring and special studies to test nutrient management actions and elucidate mechanisms and parameterization

Water Source and Residence Time Report

Modeling to Assist Identification of Temporal and Spatial Data Gaps for Nutrient Monitoring

Prepared by

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Prepared for the

Delta Regional Monitoring Program

DELTA
REGIONAL MONITORING PROGRAM

March 2018

Volumetric fingerprints used to identify subregions in the Delta with similar water sources

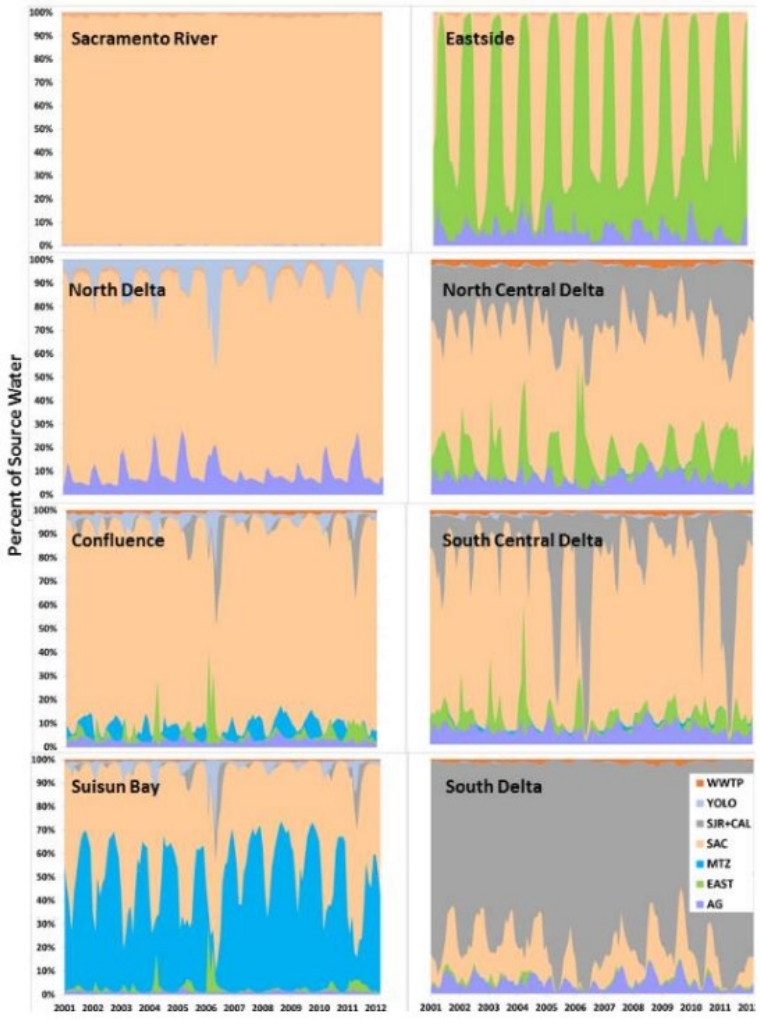


Figure 1. DSM2 volumetric fingerprints, comparison of regional averages.

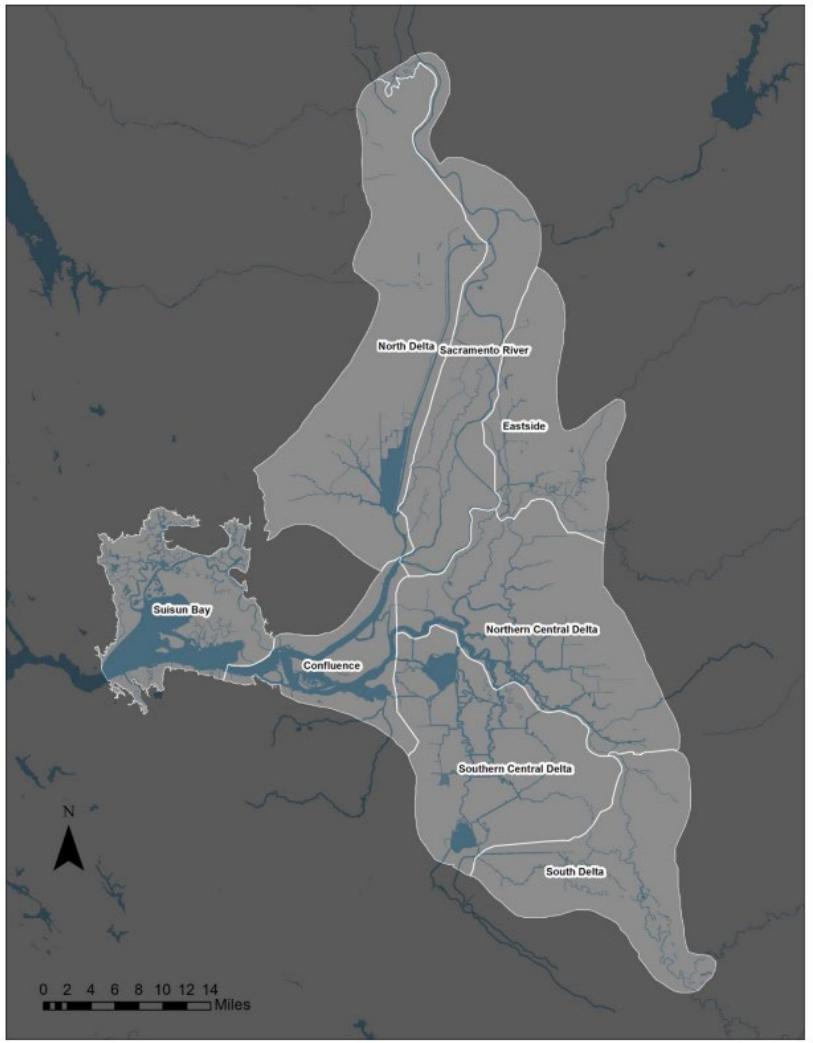


Figure 2. Subregions used in the modeling analyses.

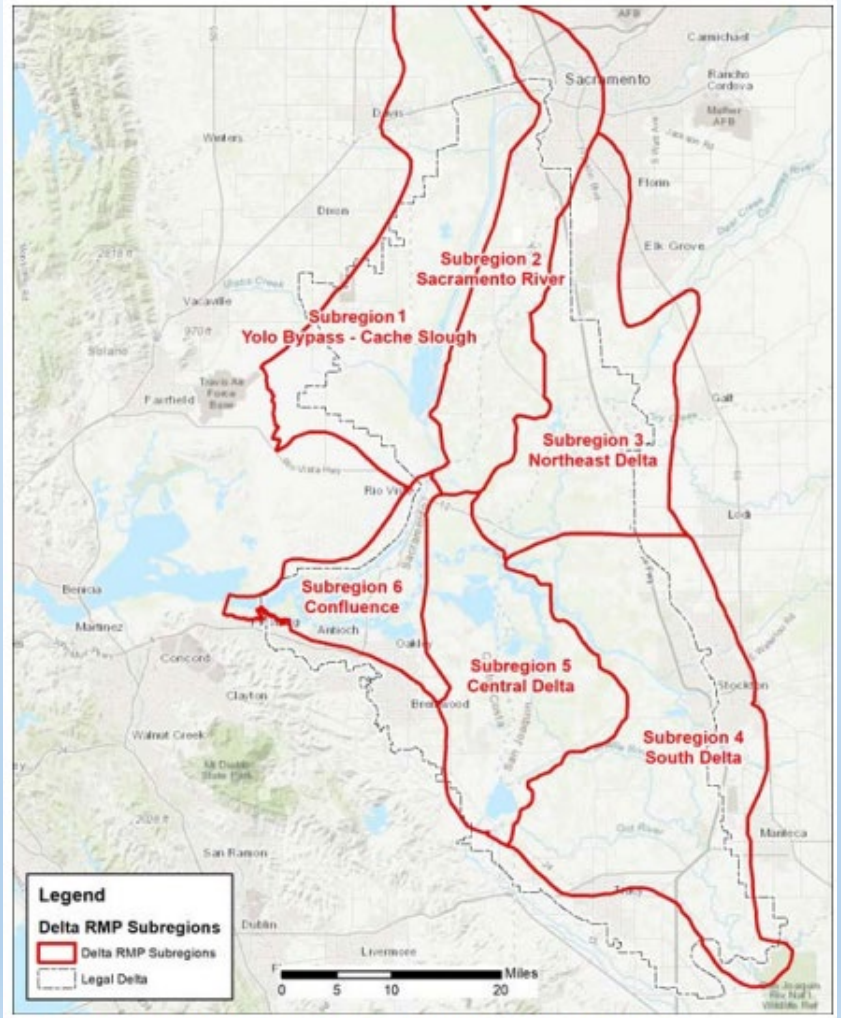
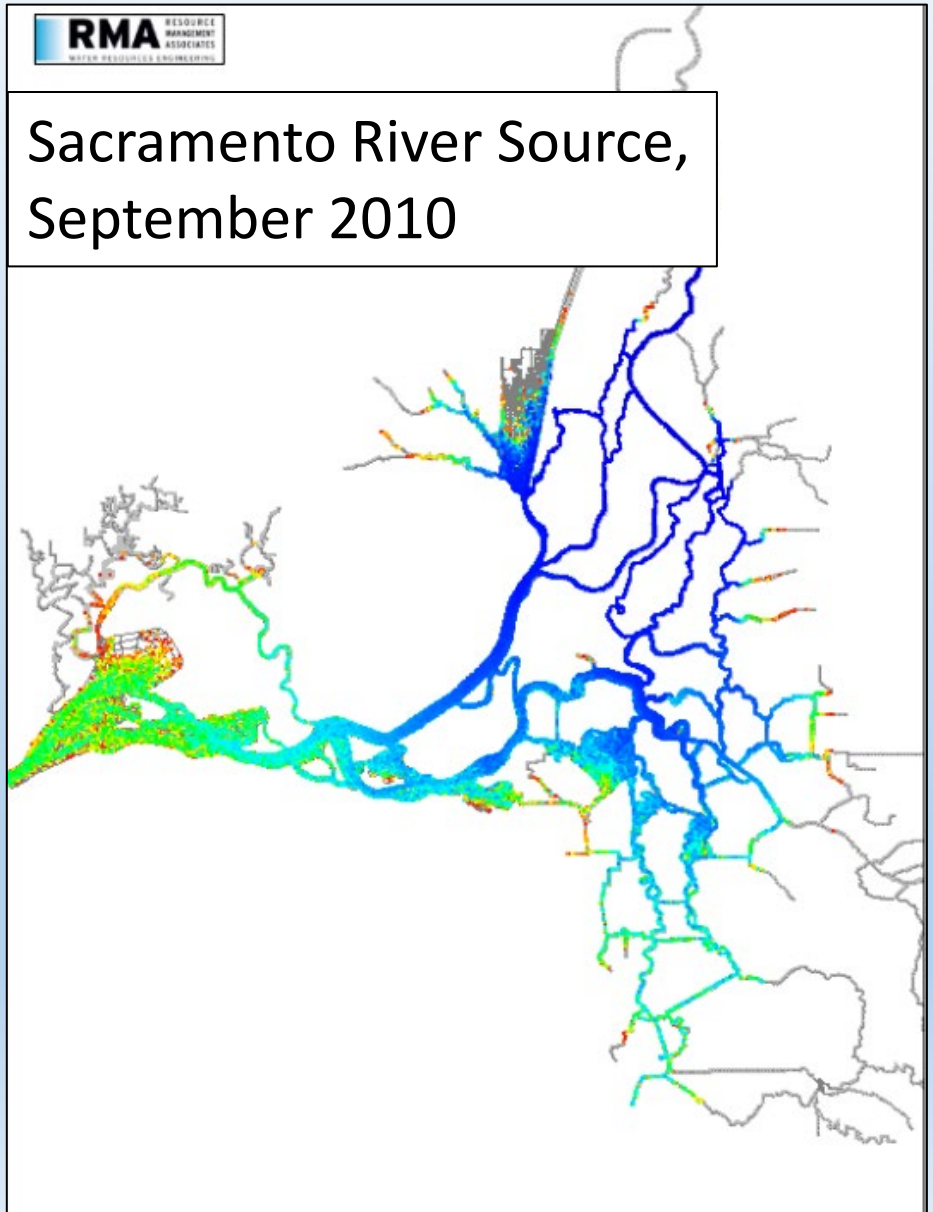
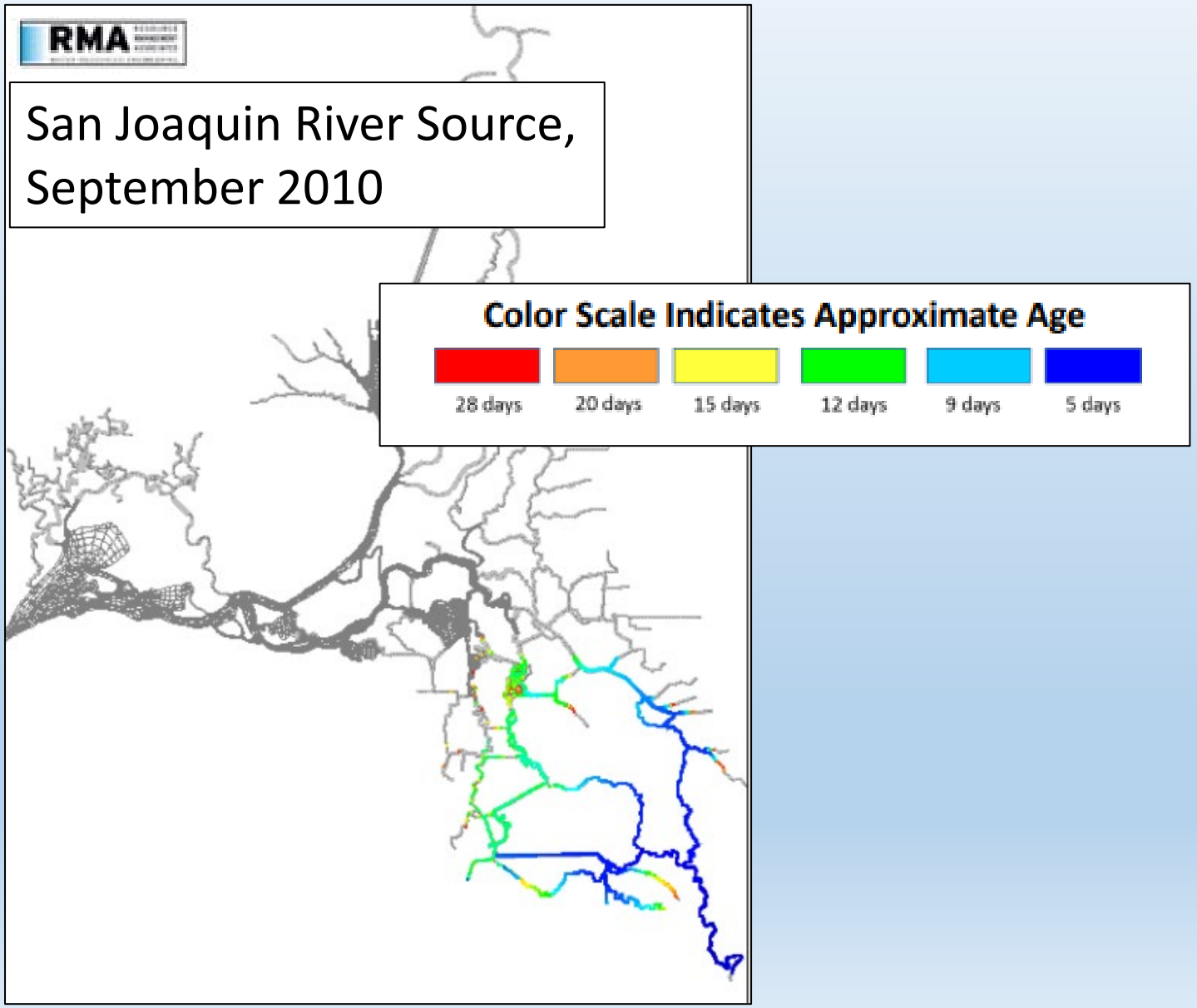


Figure 6.2 Map of Delta RMP subregions for pesticides and toxicity sampling.

Water age estimated by particle tracking models





Water residence time varied considerably among subregions and decreased with increasing flows

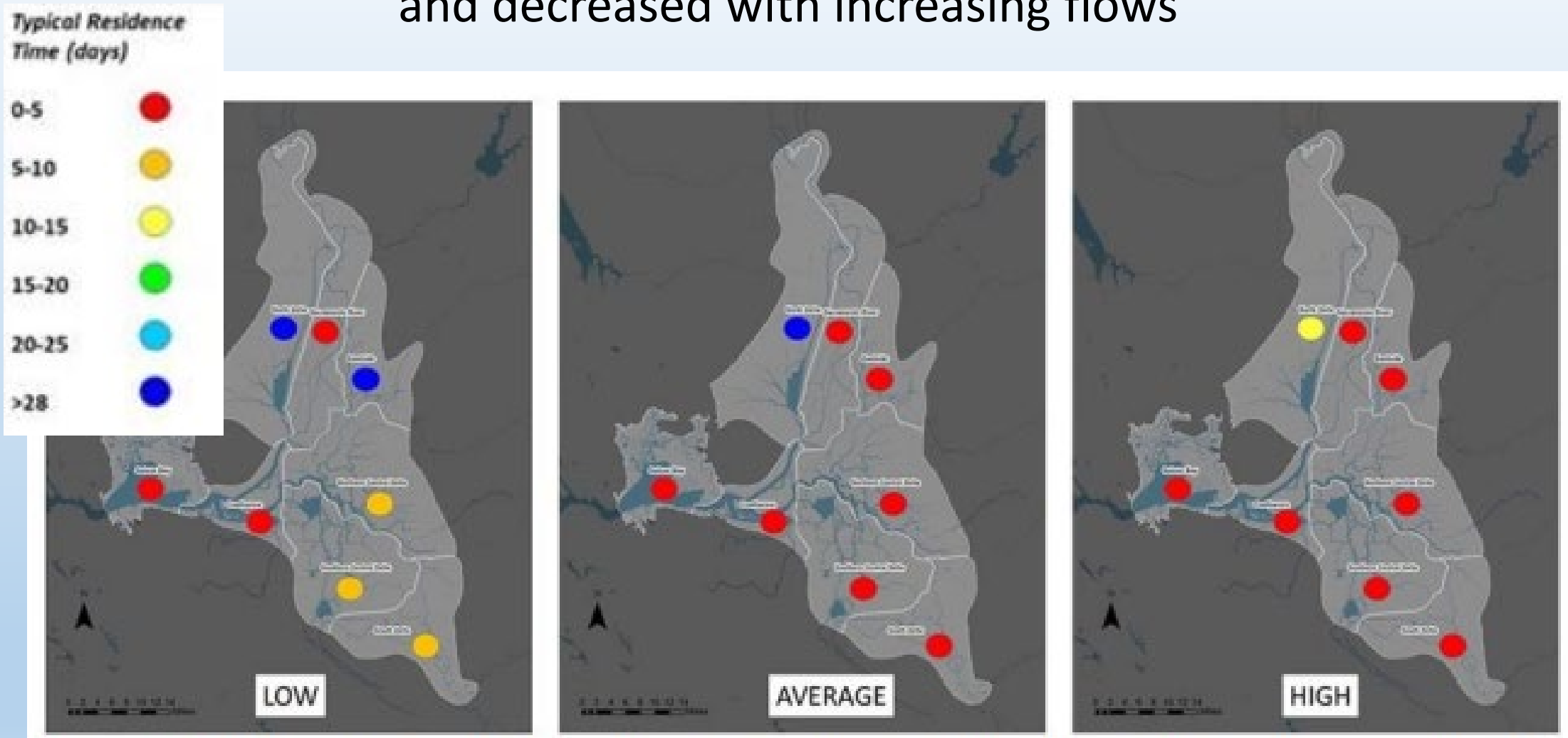
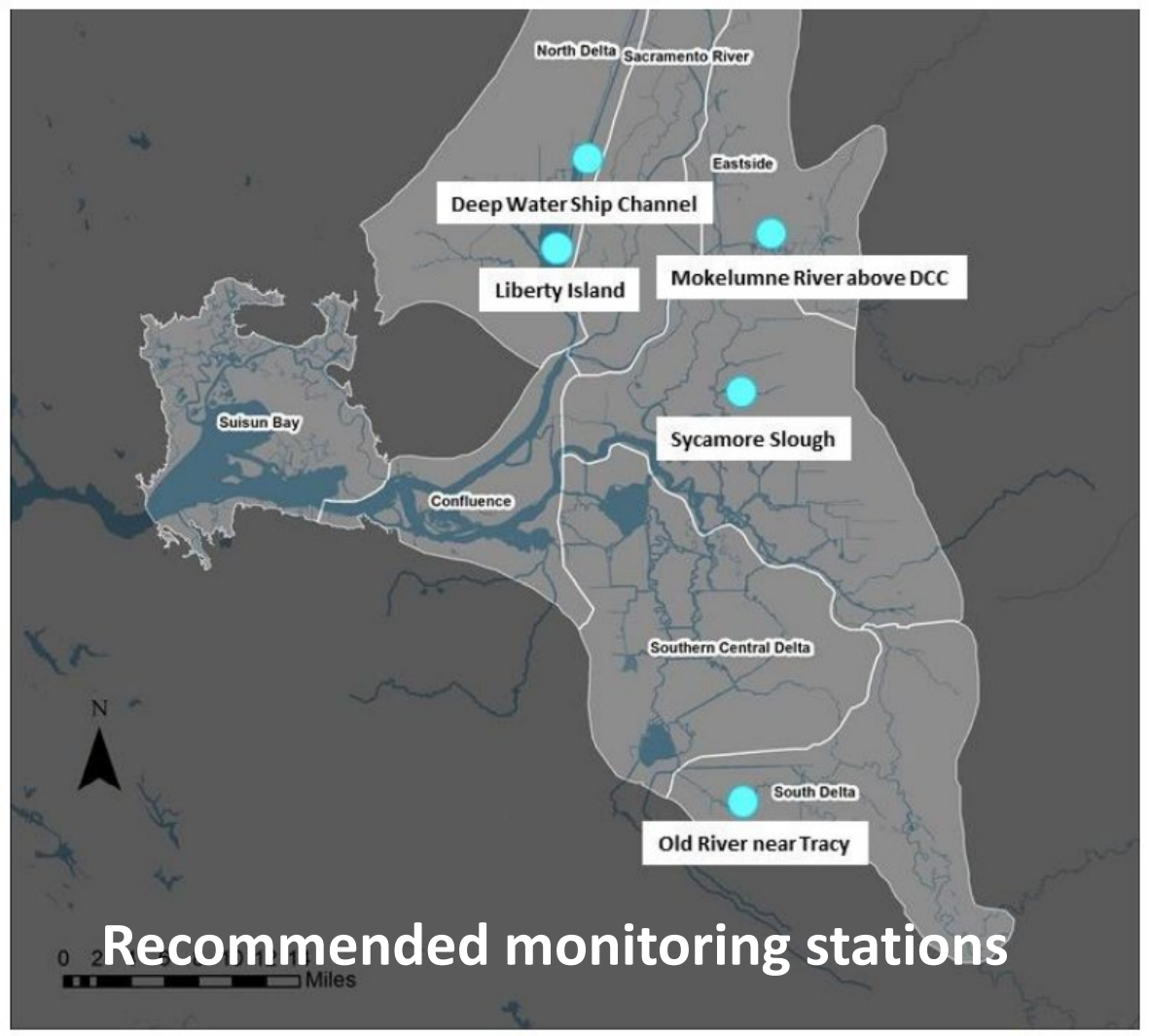
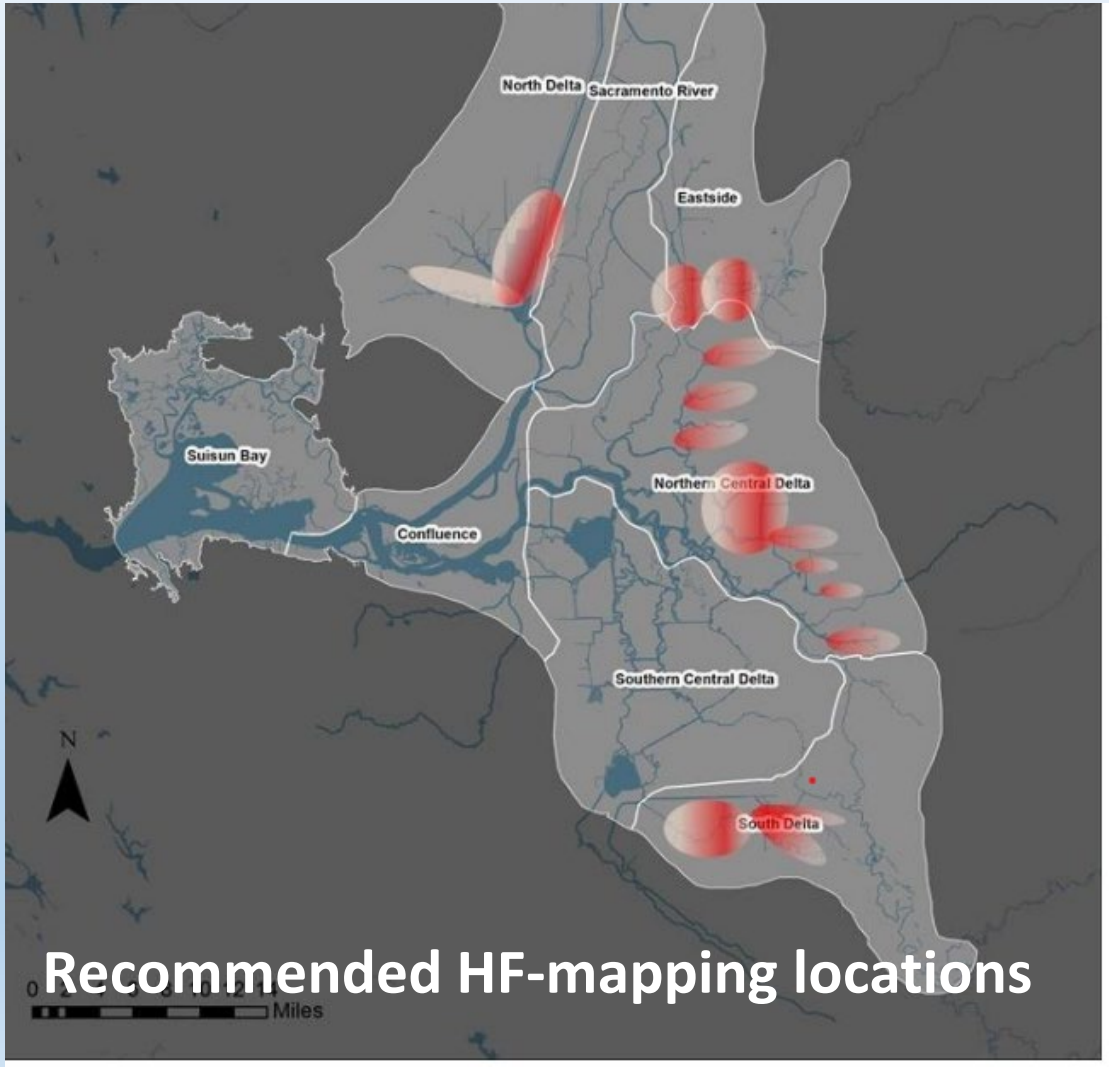


Figure 21. Median estimated residence time of water in each subregion in different flow scenarios (see also Table 3).

Recommendations for future nutrient monitoring



Recommended monitoring stations



Recommended HF-mapping locations

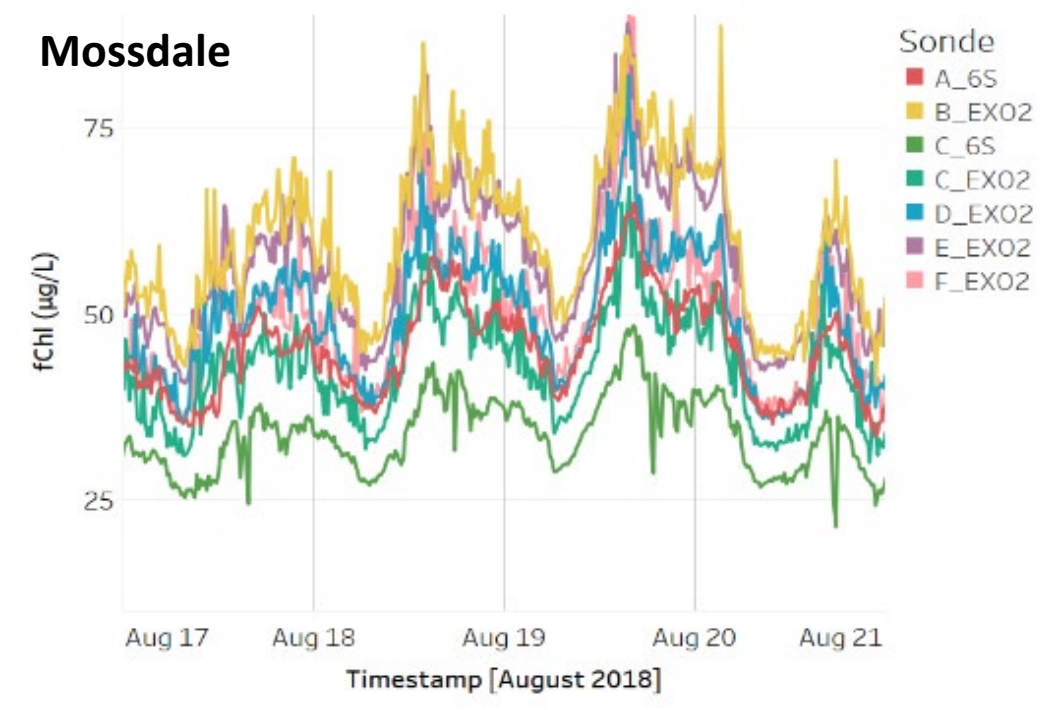
DELTA
Regional Monitoring Program

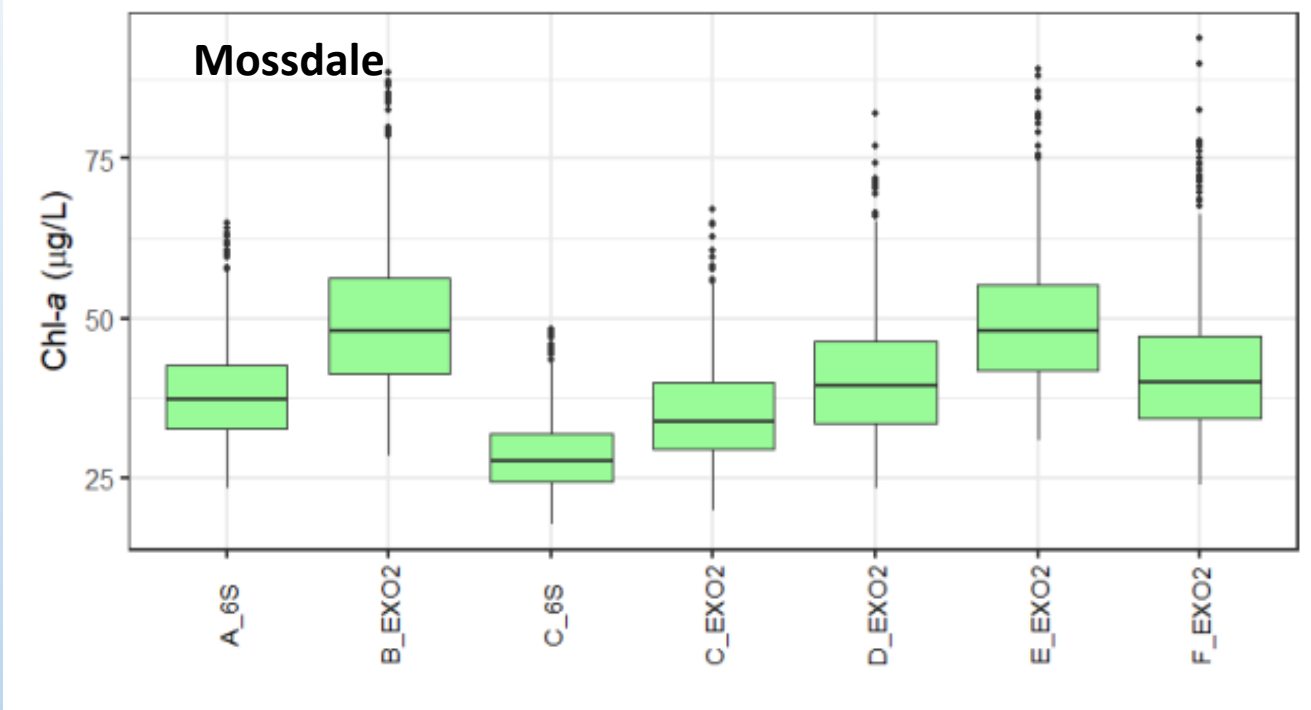
San Francisco Estuary Chlorophyll Sensor and Sample Analysis Intercomparison

Chlorophyll-a Intercomparison Study

- Chl-a data collected by different agencies needs to be comparable for synthesis
- Delta RMP provided funding for the Chl-a Intercomparison Study in 2018
- Side-by-side site deployments of fluorescence sensors at Mossdale and Liberty Island
- Split samples from Grizzly Bay and Lisbon Weir sent to 12 laboratories

Chlorophyll-a *in Situ* Sensor Intercomparison





- At Mossdale, Chl-a peaked near the end of daylight and was lowest near mid-morning
- YSI EXO2 generally recorded higher Chl-a (~ 40 µg/L) than the YSI 6-series sonde (~ 22 µg/L, at Mossdale)
- Combining historical YSI 6-series Chl-a data will require careful review
- Calibration practices and post collection data treatment should ensure that values are not negative
- Recommendations a long-term ‘experimental’ station for multiple algal fluorescence sensor deployment

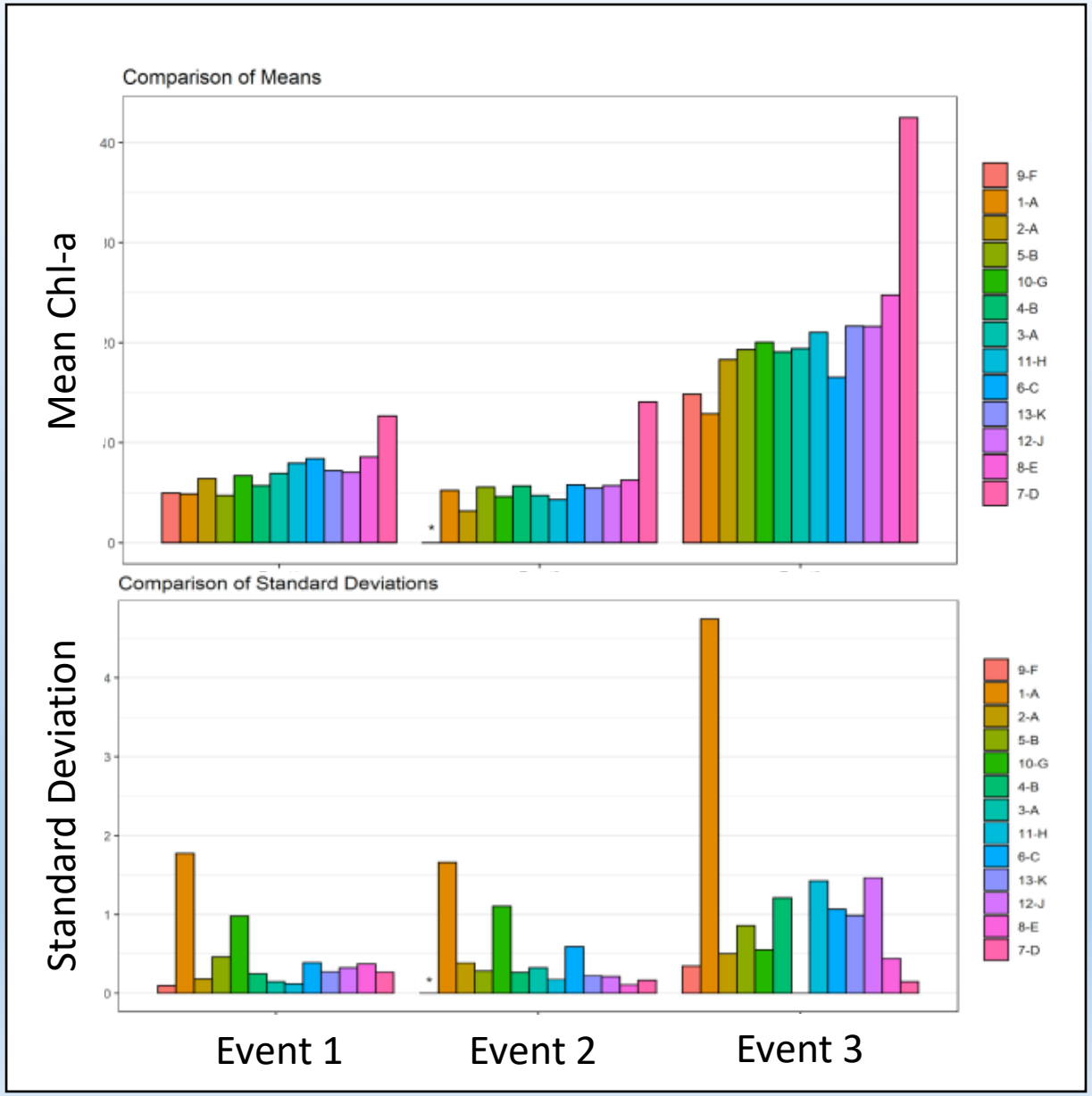
Chlorophyll-a Laboratory Sample Intercomparison

Outlier labs removed from analysis:
- One had significantly high values
- One had significantly high variability

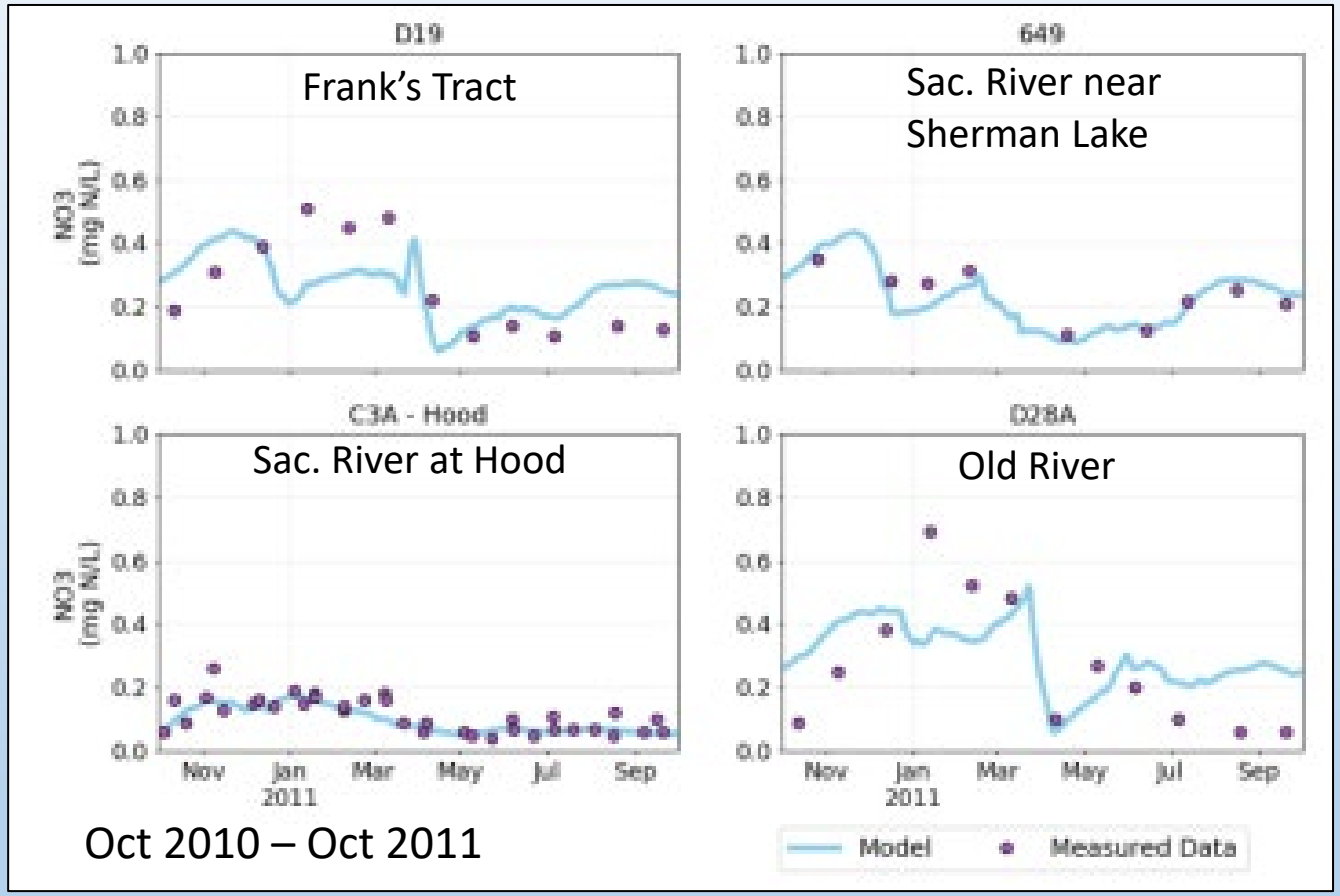
Factors not effecting Chl-a:
- Filter pore size
- Filter grinding vs. non-grinding
- Fluorometric vs. spectrophotometric analysis
- Holding times < 24h

Important Technique:
Homogenize stored samples prior to filtration

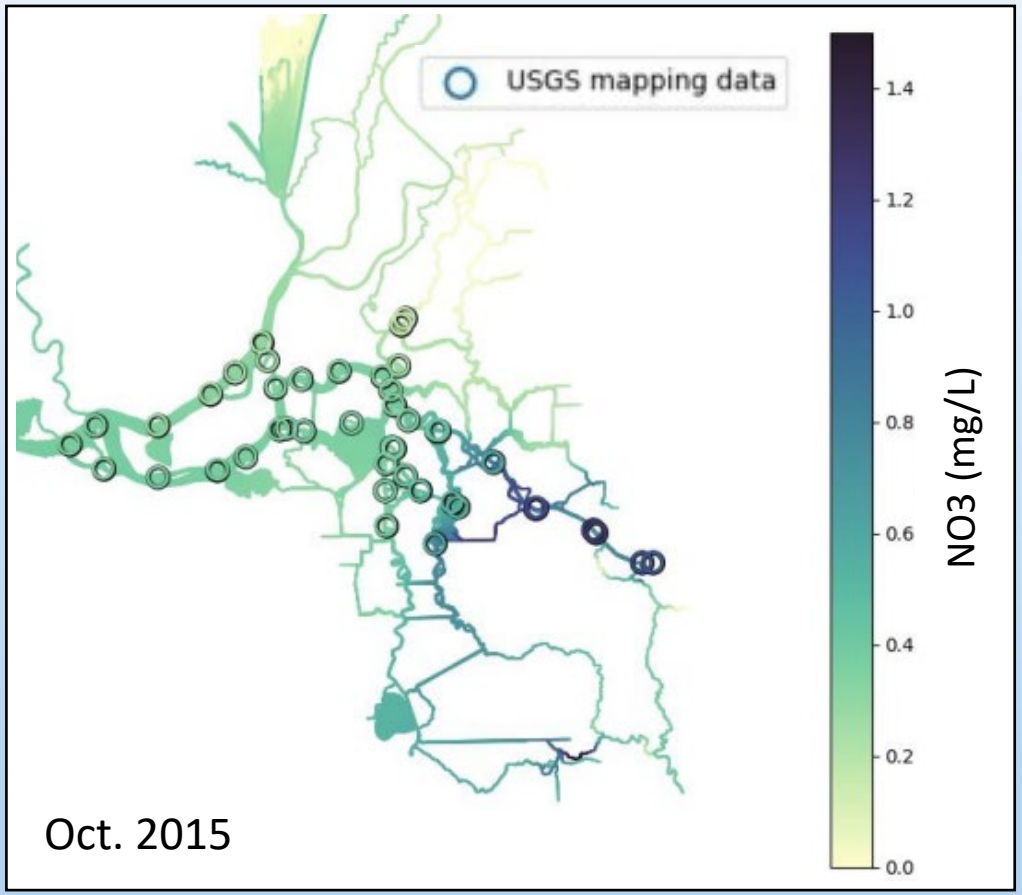
Future Recommendation:
Investigate Chl-a variability using algal cultures and a standardized serial dilution



Delta RMP's Nutrient Modeling and Mapping



Oct 2010 – Oct 2011



Oct. 2015

Nitrate comparisons among the SFEI biogeochemical model, DWR EMP monitoring, and USGS high-frequency mapping projects

Considerations for Future Delta RMP Nutrient Research

1. The Delta RMP will require a continued understanding of nutrient status and trends to evaluate potential environmental effects specified in the Delta Nutrient Research Plan

2. Biogeochemical modeling and high frequency monitoring are likely needed to explain and predict the rapid changes in nutrient concentrations that occur within the Delta

Questions and Discussion

LOOKING BACK: A REVIEW OF DELTA RMP – FUNDED NUTRIENT PROJECTS, 9:40 TO 9:50 AM