Impact of SRWTP Upgrade on Ecosystem

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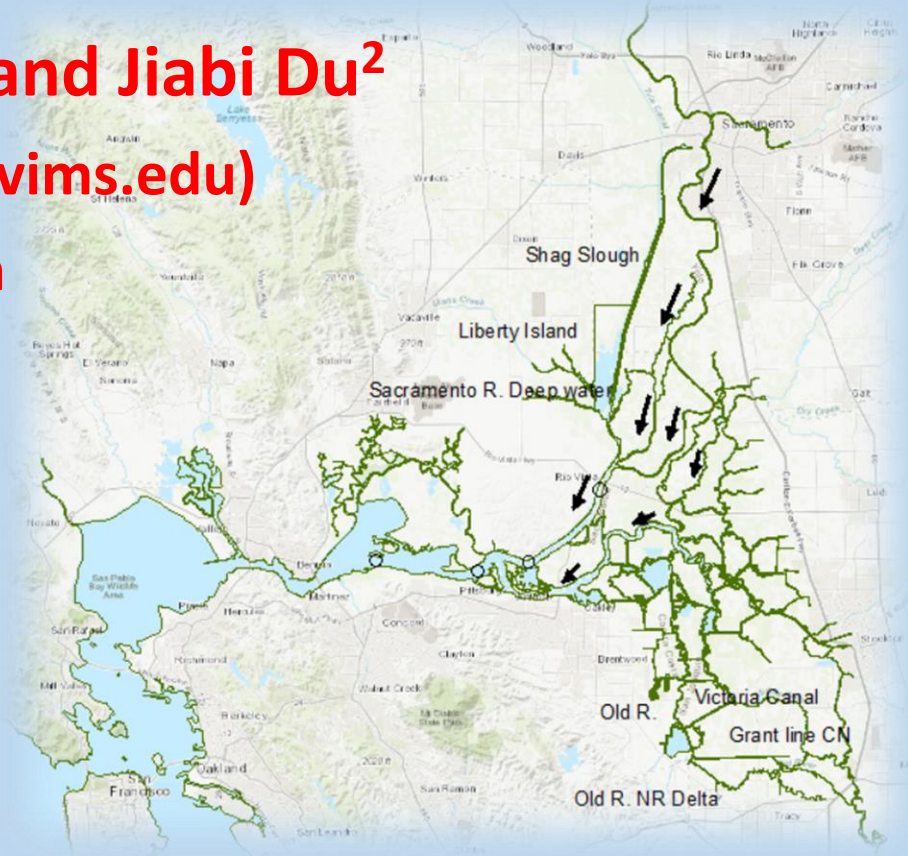

2023 CWEMF Annual Meeting

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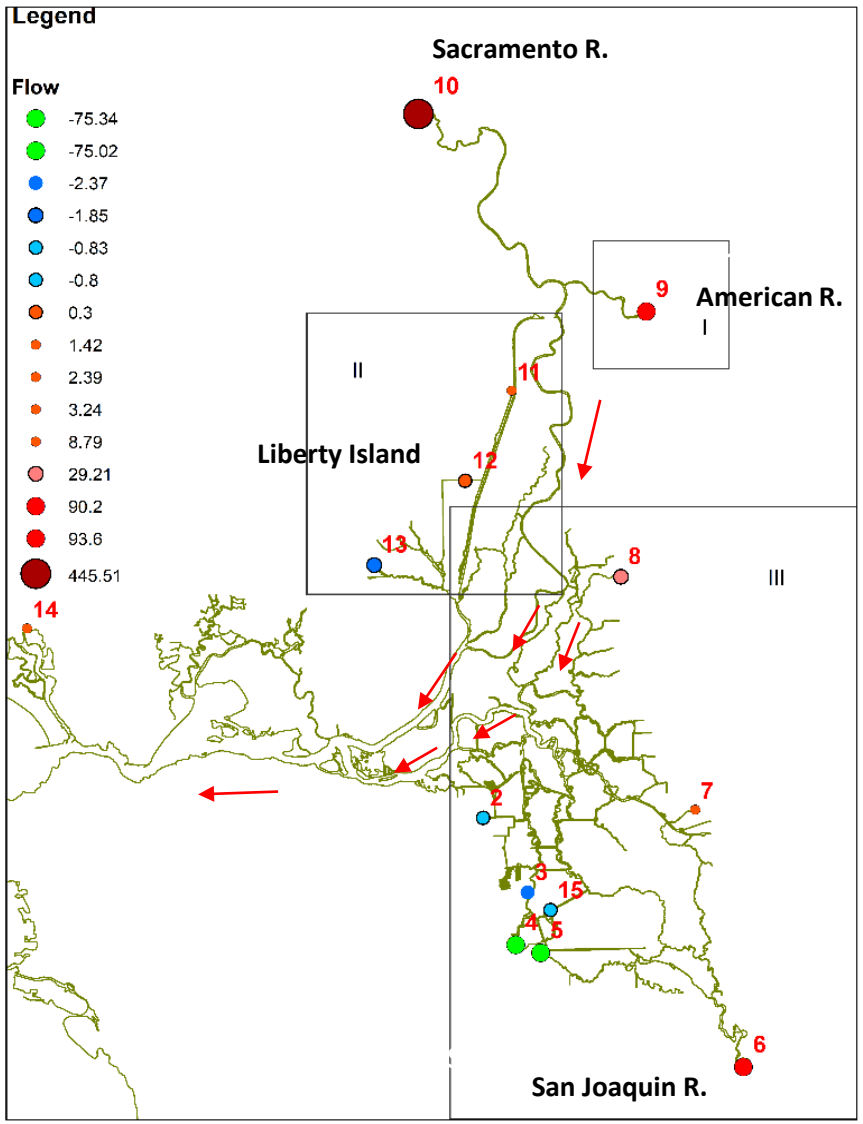
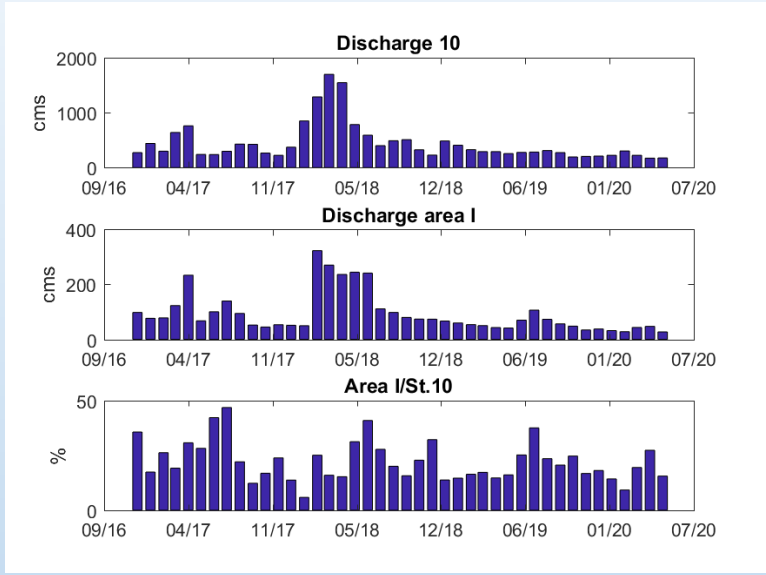
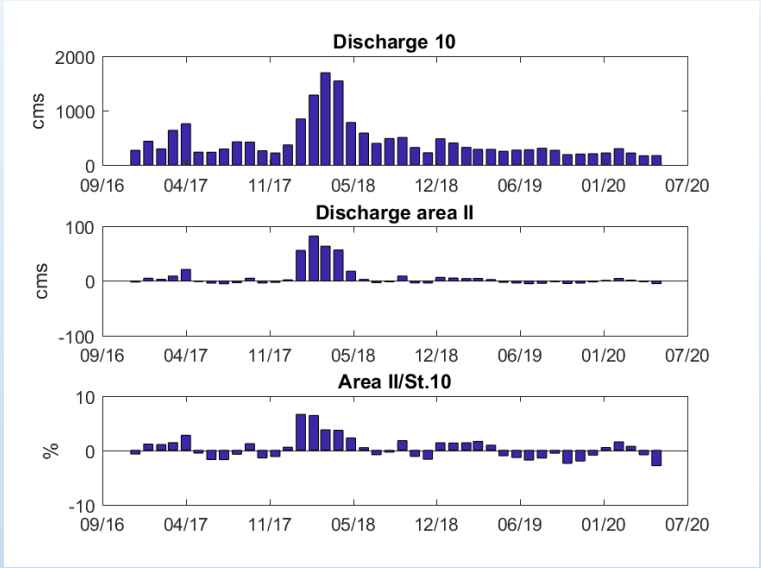
Outlines

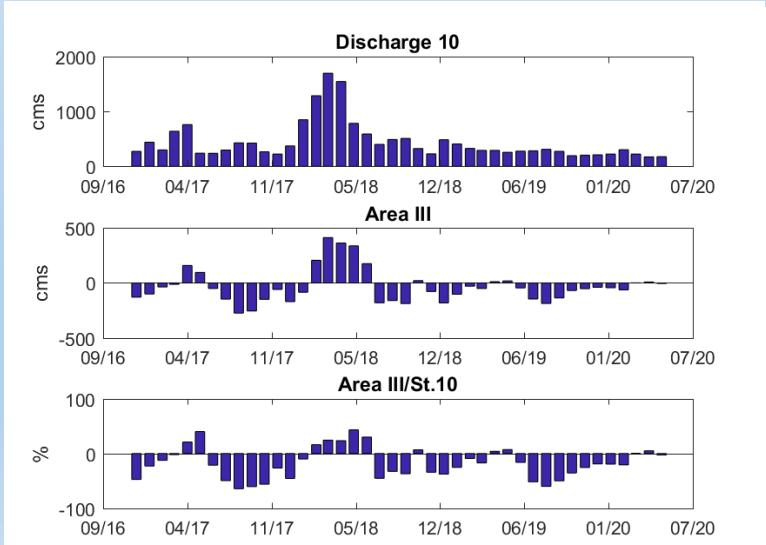
- Environmental condition
- Impact of nutrient reduction on environment (SRWTP)
- Summary

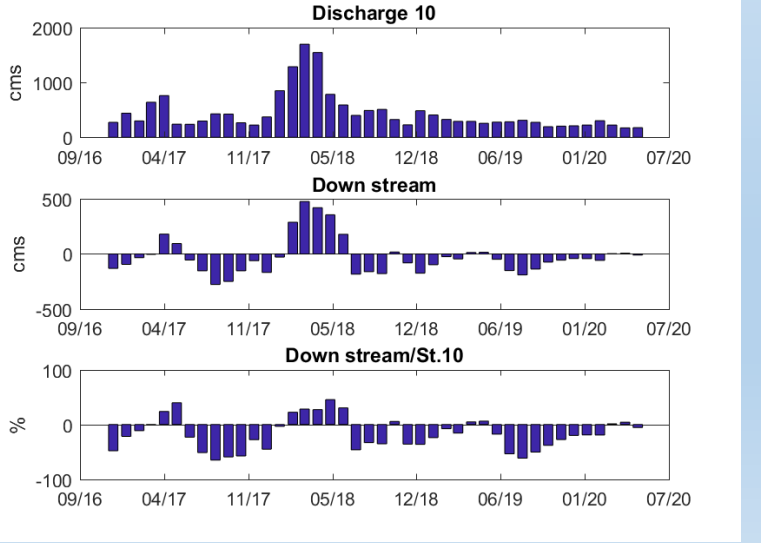
Discharge


Legend
Flow
-75.34
-75.02
-2.37
-1.85
-0.83
-0.8
0.3
1.42
2.39
3.24
8.79
29.21
90.2
93.6
445.51
Sacramento R.
American R.
Liberty Island
San Joaquin R.
I
II
III
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


Discharge 10
Discharge area I
Area I/St.10
cms
%
09/16
04/17
11/17
05/18
12/18
06/19
01/20
07/20

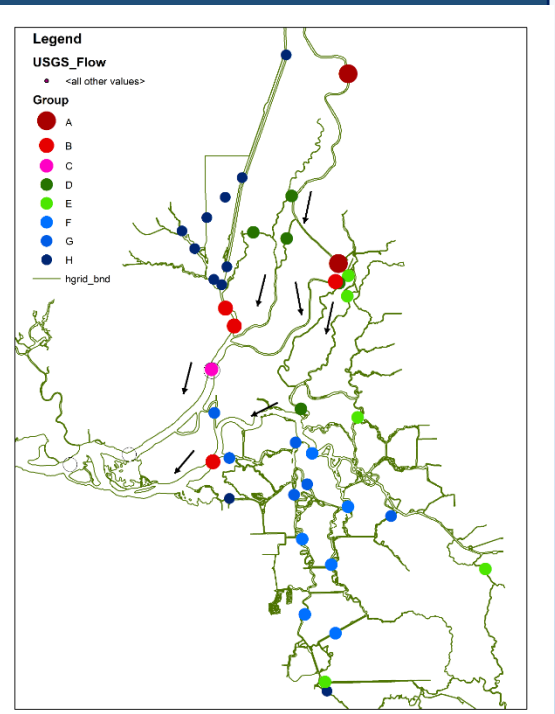

Discharge 10
Discharge area II
Area II/St.10
cms
%
09/16
04/17
11/17
05/18
12/18
06/19
01/20
07/20

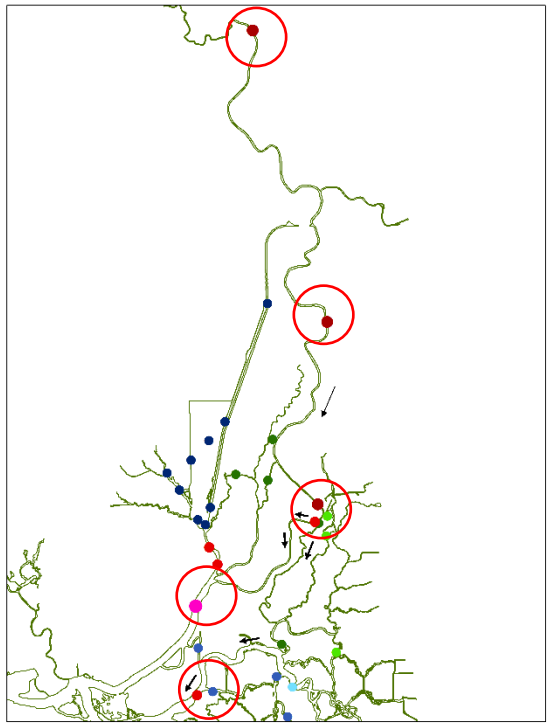

Discharge 10
Area III
Area III/St.10
cms
%
09/16
04/17
11/17
05/18
12/18
06/19
01/20
07/20

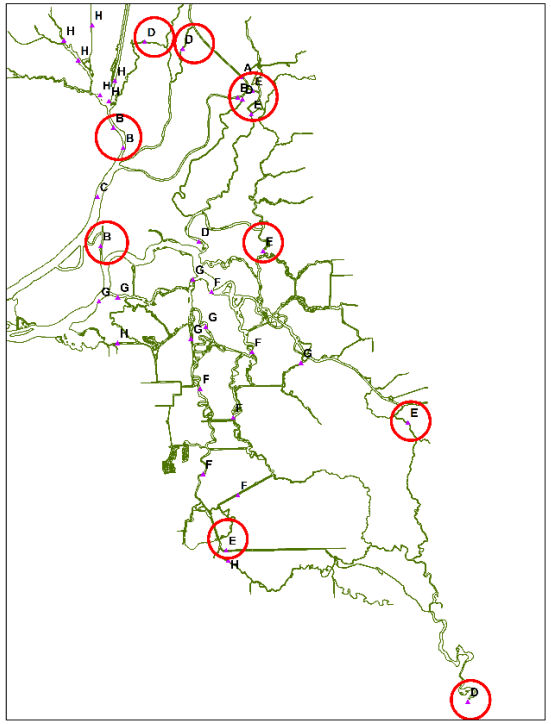

Discharge 10
Down stream
Down stream/St.10
cms
%
09/16
04/17
11/17
05/18
12/18
06/19
01/20
07/20

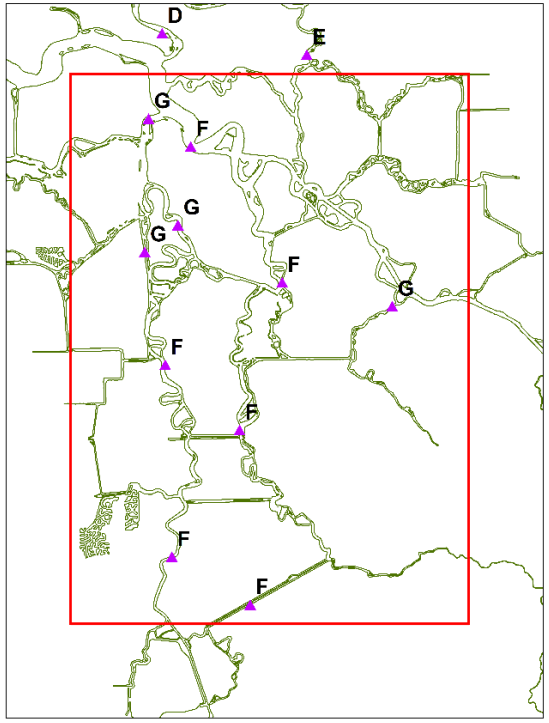
Distribution

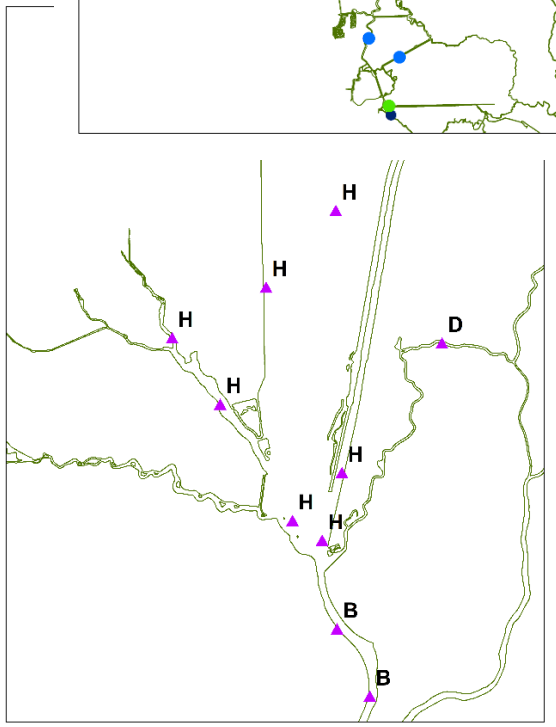
- Principal analysis shows there are four large groups with different characteristics









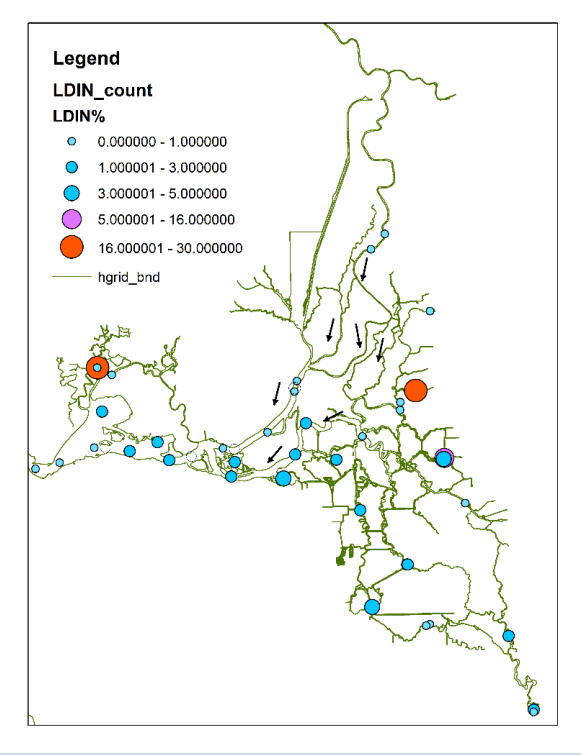


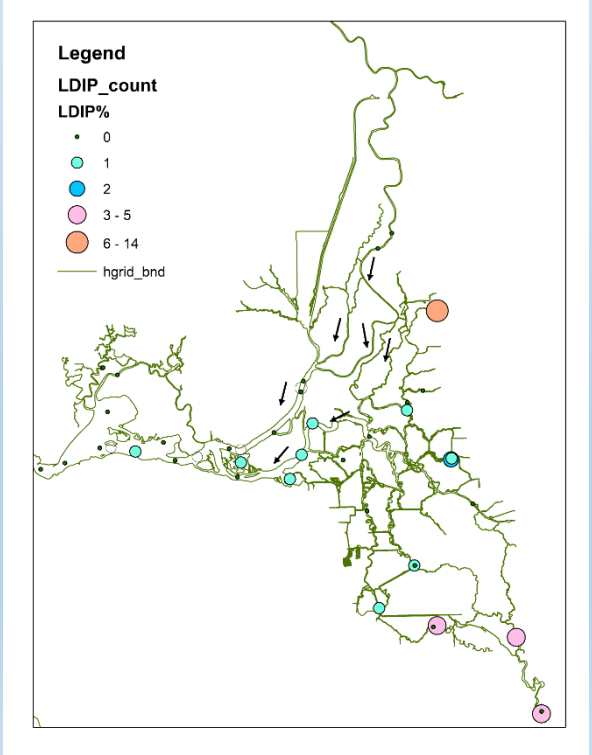
Water Quality Data Analysis

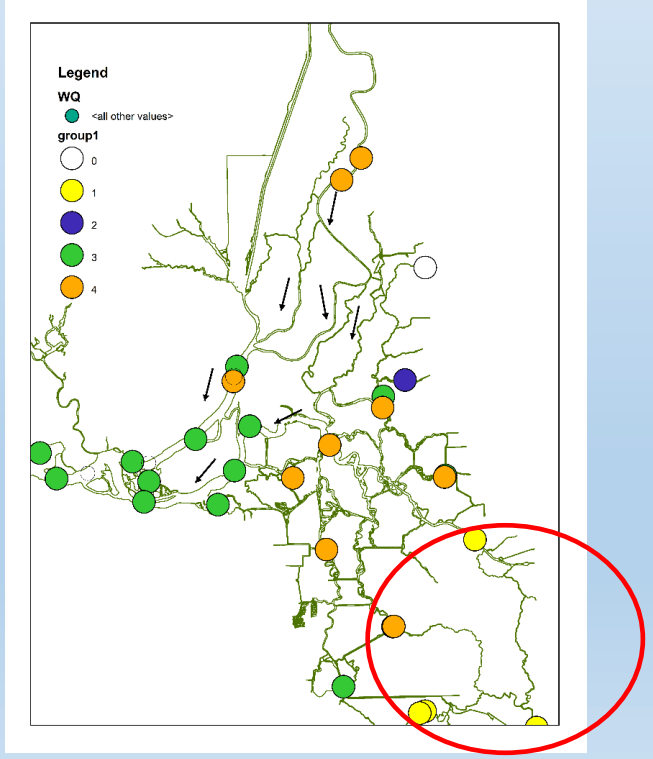
- Computed statistics for Chl a, DIN, DOP, N-P limiting, TKN/TOP4, and turbidity
- Group them using a Self-organizing map (SOM)
- Nutrients are not limited most of time

	Chl a			DIN		DOP		N-P Limiting		Tubidity		TKN/TOP4	
Group	10th	50th	std	10th	50th	10th	50th	DIN %	DIP%	50th	Std	50th	Std
1	3.26	13.51	39.90	0.48	1.36	0.06	0.08	0.56	12.05	17.62	11.22	3.44	1.37
2	3.40	9.39	10.54	0.04	0.16	0.03	0.04	30.00	45.45	11.00	4.27	3.33	1.49
3	1.20	3.36	6.37	0.21	0.38	0.05	0.06	2.10	19.46	17.51	16.51	3.11	1.37
4	0.88	2.00	5.82	0.21	0.39	0.04	0.05	1.19	33.22	7.63	11.01	4.43	1.80

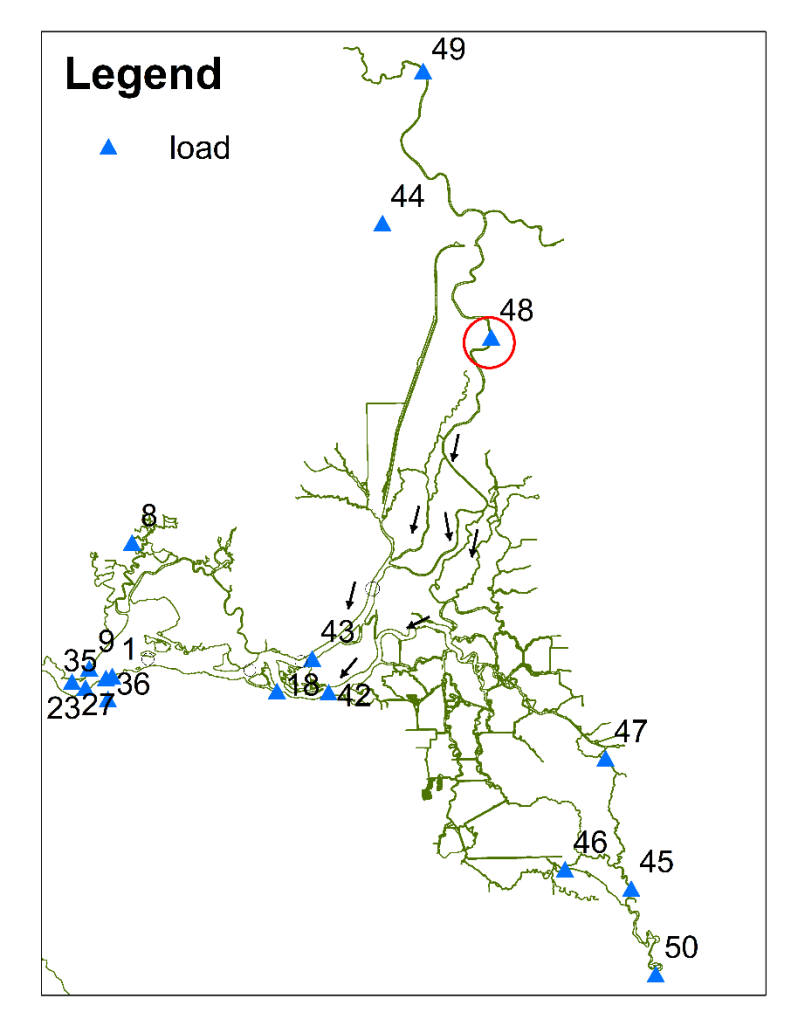
DIN <0.07 mg/L
DPO4 <0.05 mg.L



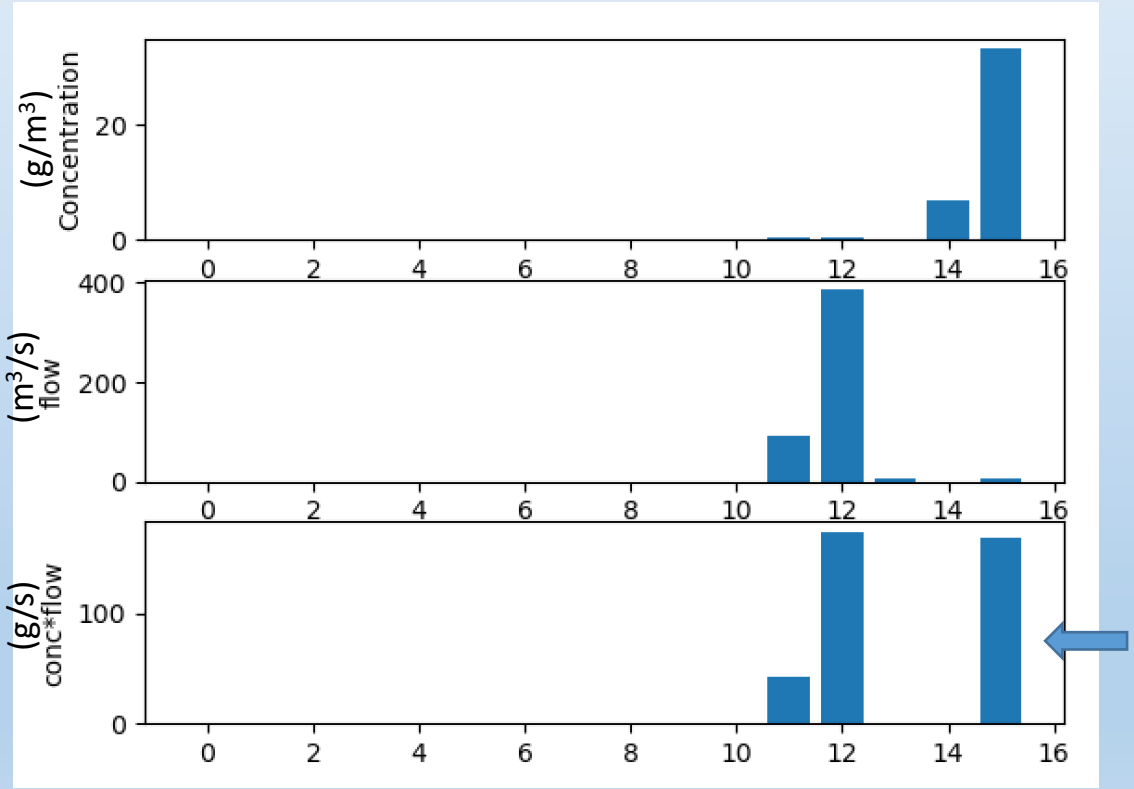




Nutrient Loadings



- Sacramento Rive dominates the discharge of NH4. SRWTP accounts for about 50% of the loading

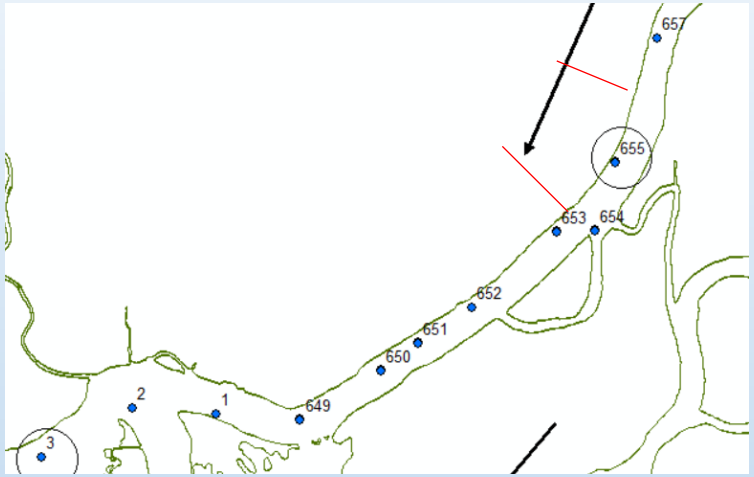


Loading Analysis

Consider downstream region under steady state condition

$L-Q_oC-kVC=0$

Where L is nutrient loading, C is monthly mean concentration, Q_o is outflow, k is removal rate and V is volume



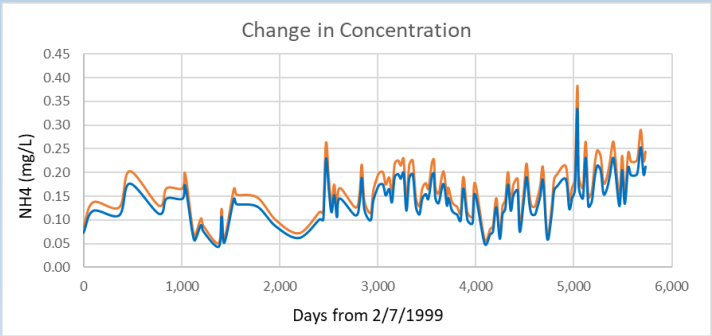
Assuming a large portion of loading is from Sacramento River (L =a Ls, Ls is loading from Sacramento R.), and Q_o ($Q_o = Q'_o$, Q'_o is flow at USGS station) proportion to Sacramento River discharge

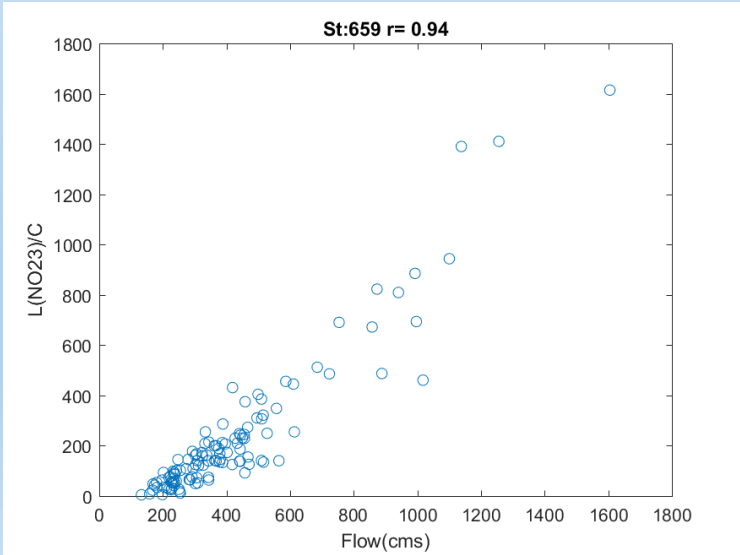
$aL'-(bQ'_o+kV)C=0$

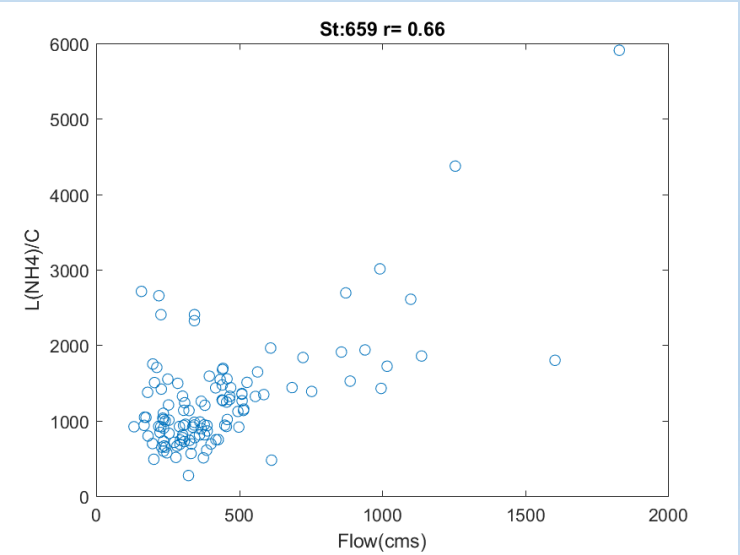
$L/C= (bQ'_o+kV)/a$

L/C is linear correlated with flow

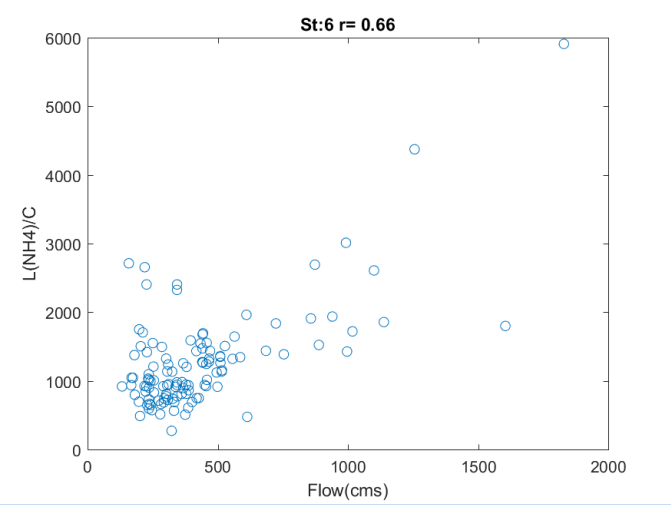
The expected change is about 10-12%

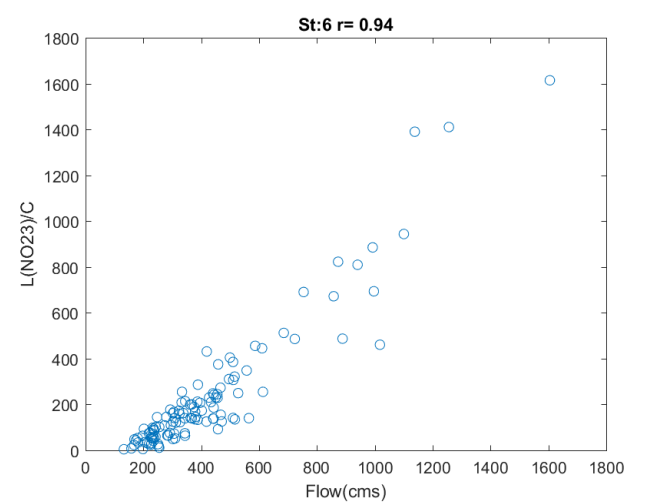


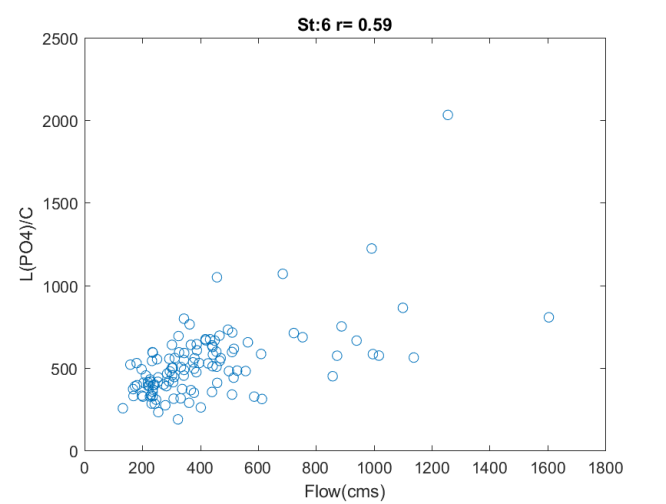


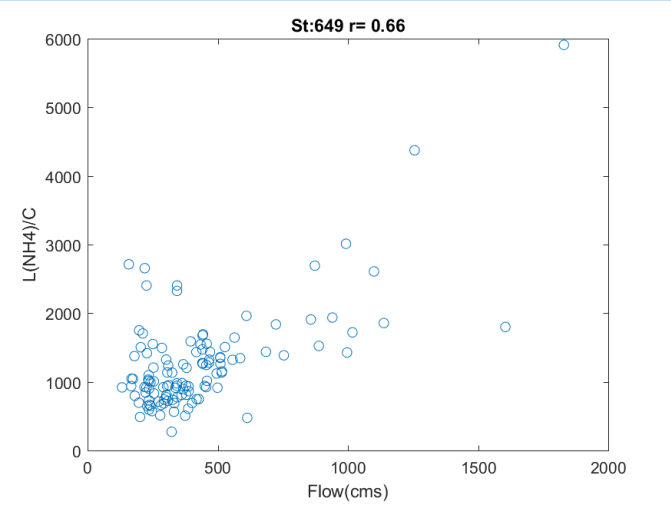


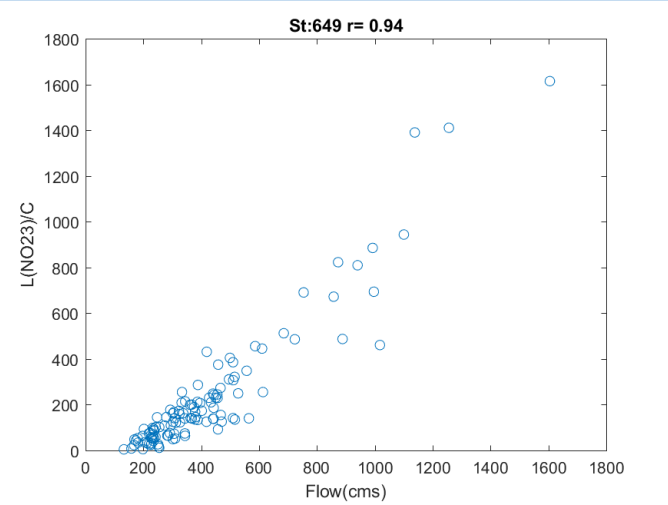
Loading Analysis

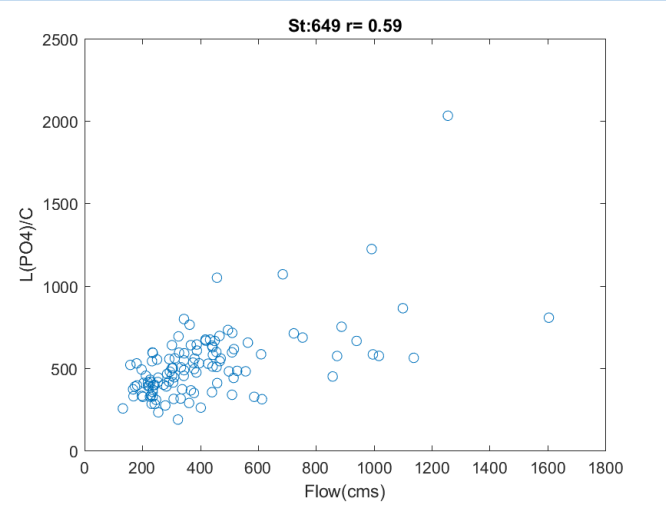






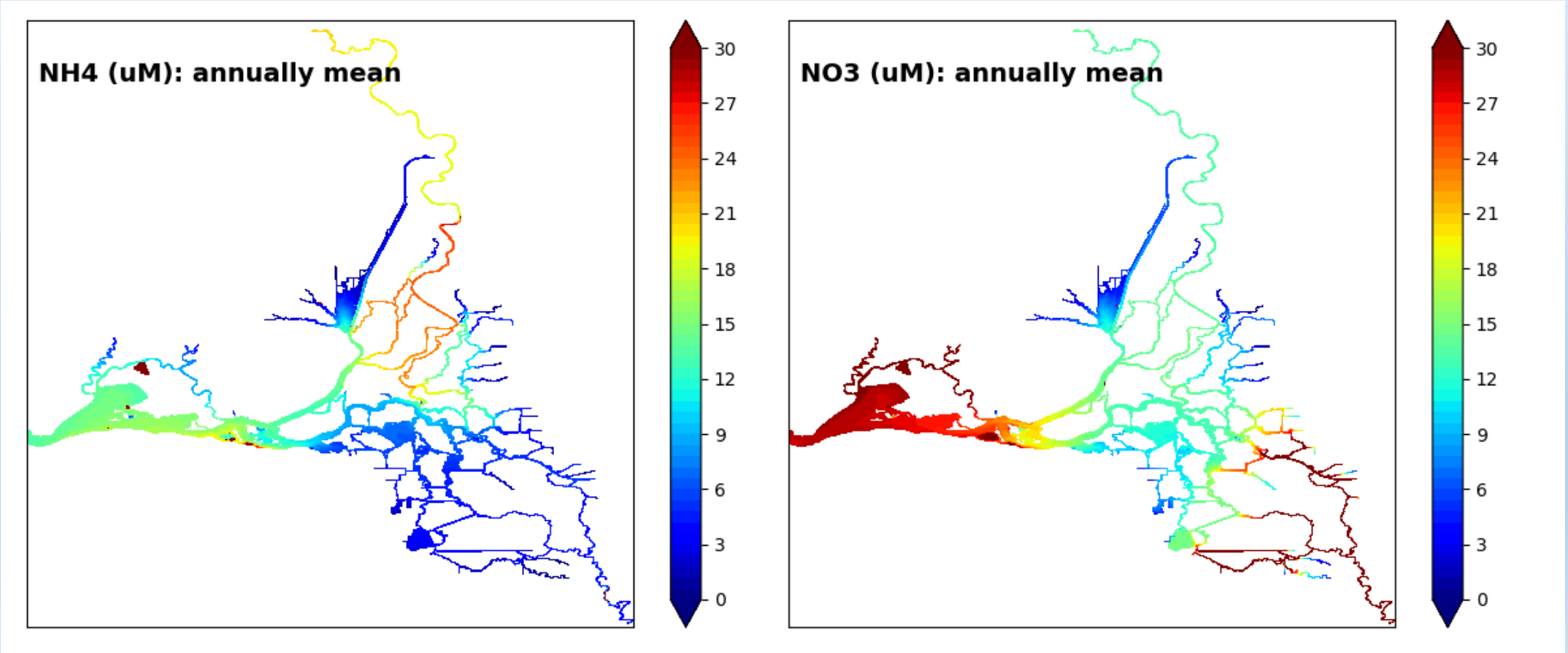




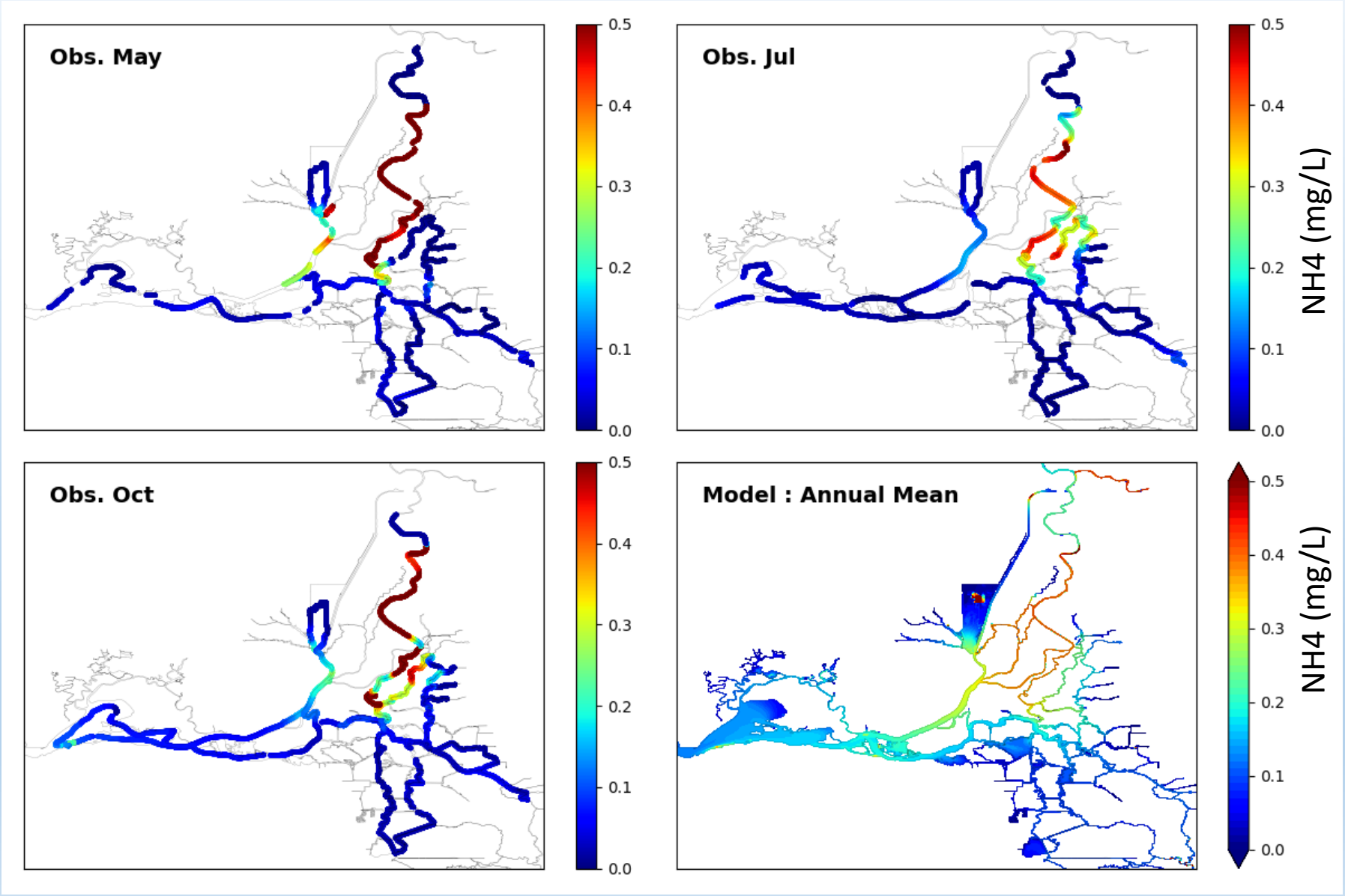


Annually Mean DIN Distribution

1. High NO3 appears in SJR and Suisun Bay, and low NO3 appears in SCR and Central Delta
2. High NH4 appears in SCR (point source.)

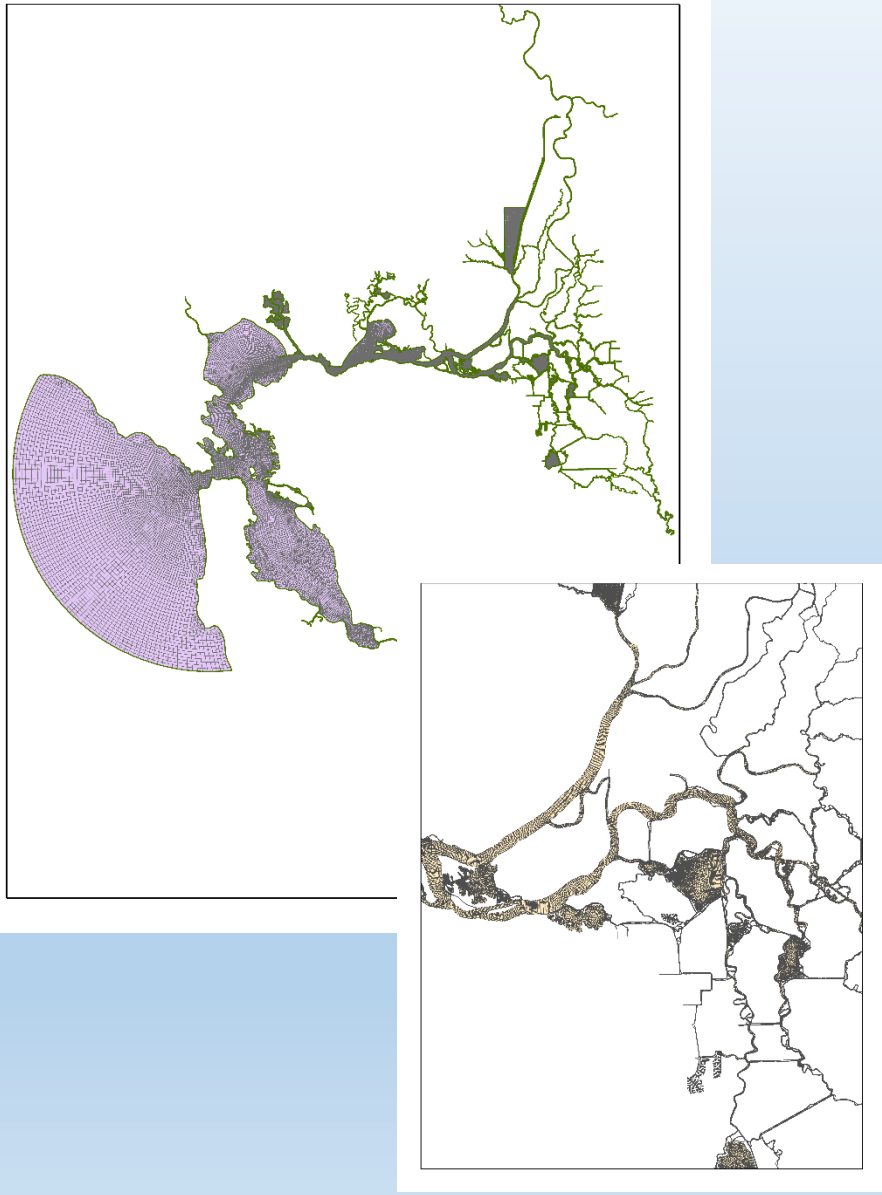


Comparison with Mapping Data in 2018:

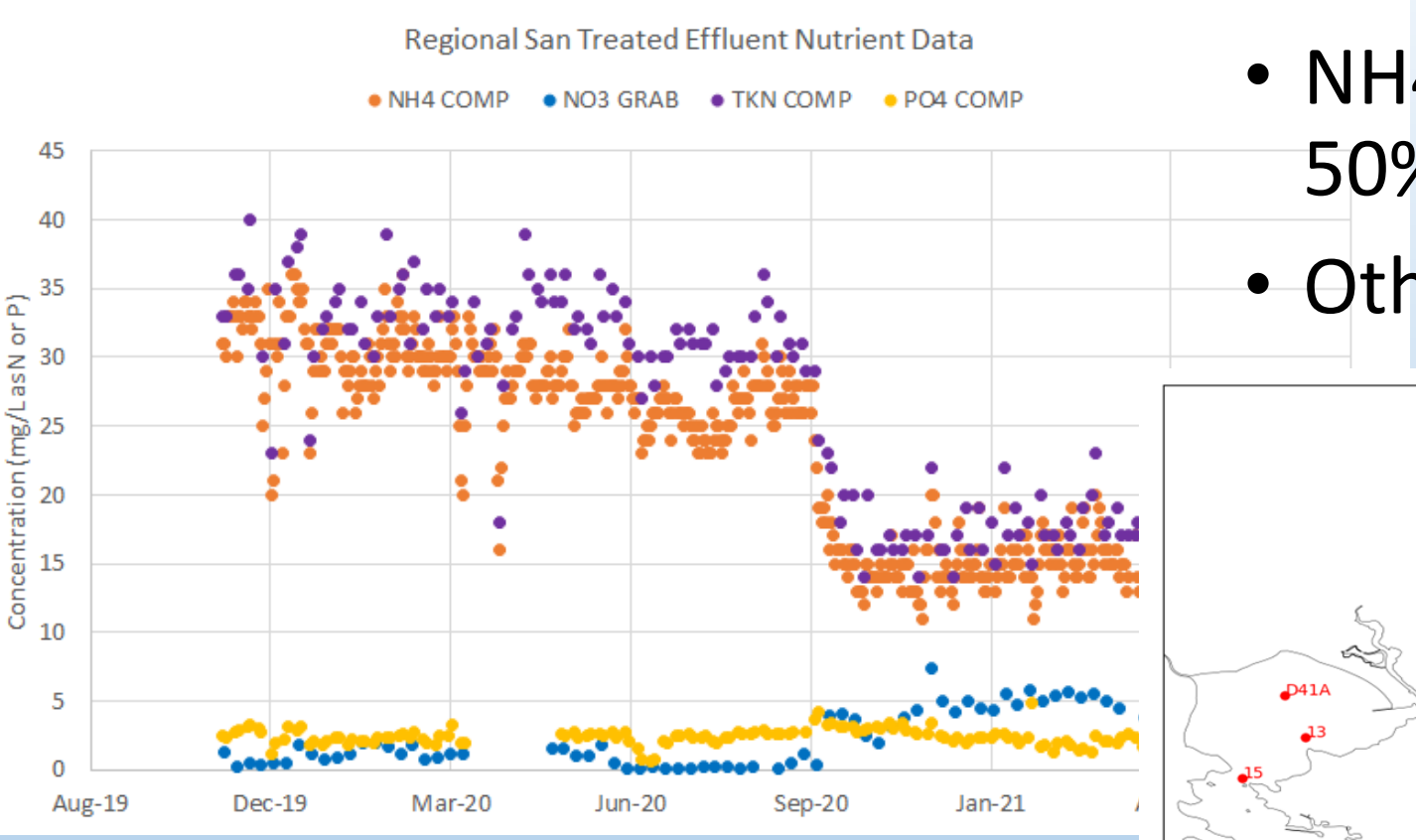


Description of the Water Quality Model

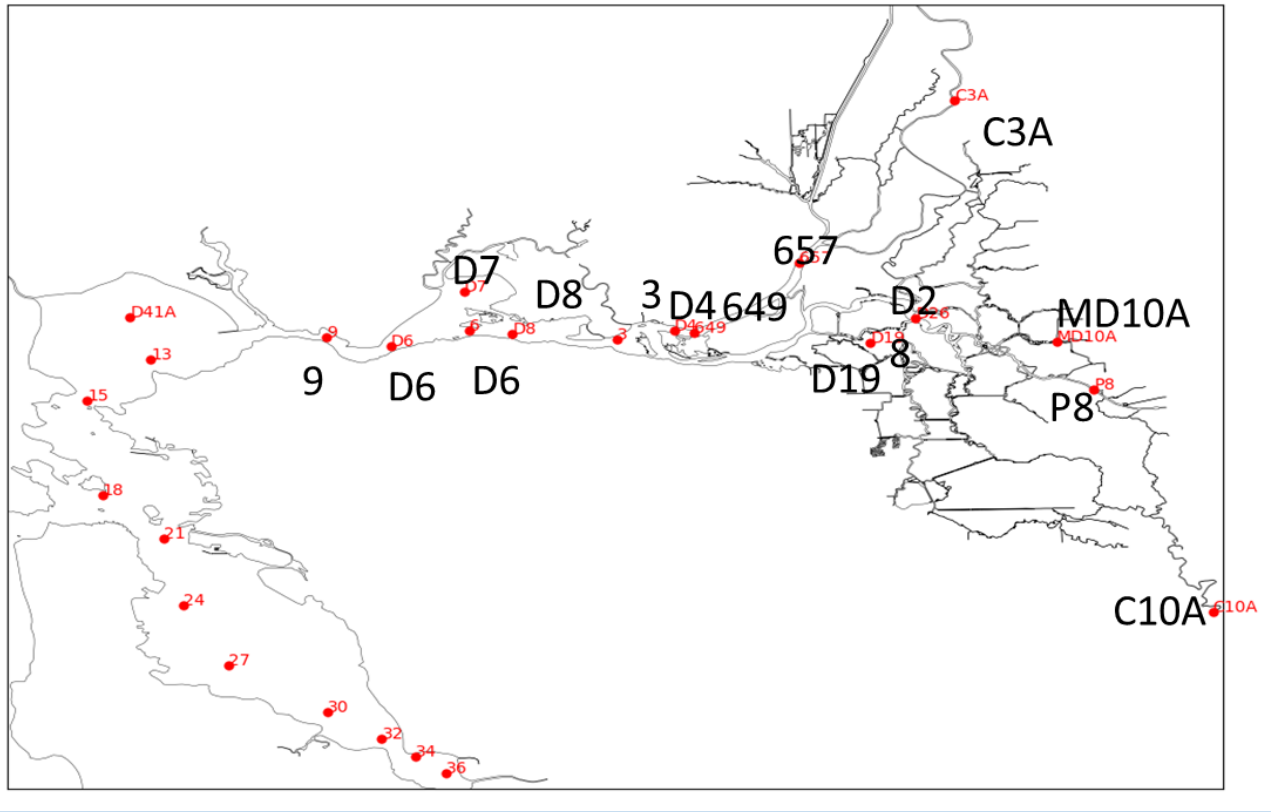
- Use SCHIM (Semi-implicit Cross-scale Hydroscience Integrated System Model) model
- Total elements = 312,941, total nodes = 293,330.
- Water quality model (ICM) with 21 state variables and SAV
- Discharge of flows and nutrients include major rivers and point source discharge and withdrawal
- The model was calibrated based on field observations
- The largest discharge of NH4 is from Sacramento Regional Wastewater Treatment Plant (SRWTP)
- Reduction of 50% of NH4 from SRWTP as conducted to evaluate the impact to the Delta region



Loading Reduction Sensitivity Test



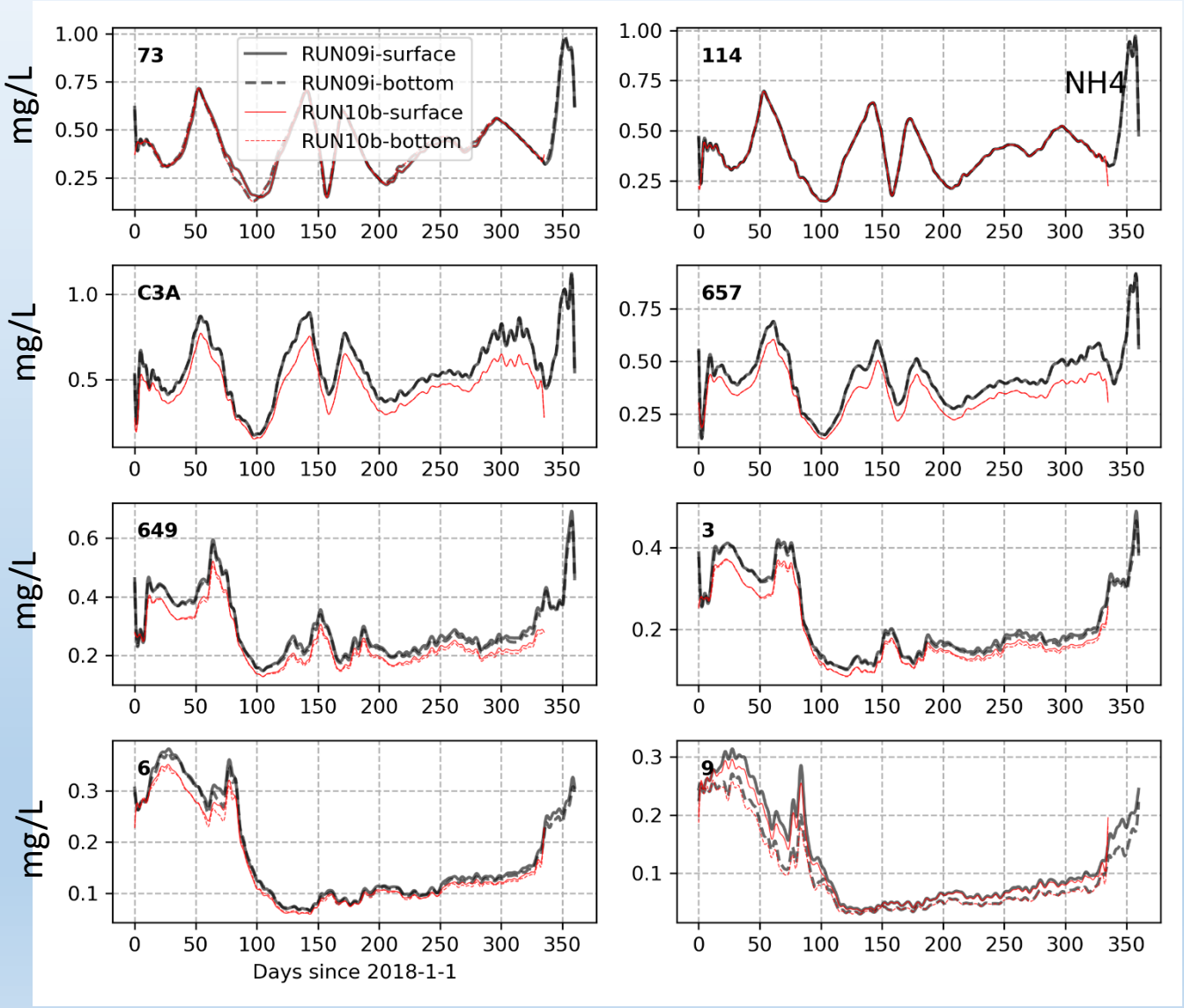
- NH4 concentration reduced by 50% at regional sand
- Others loadings unchanged



Source: Courtesy of Tamara Kraus

Results comparison at USGS observation stations

Changes in HN4 after Reduction



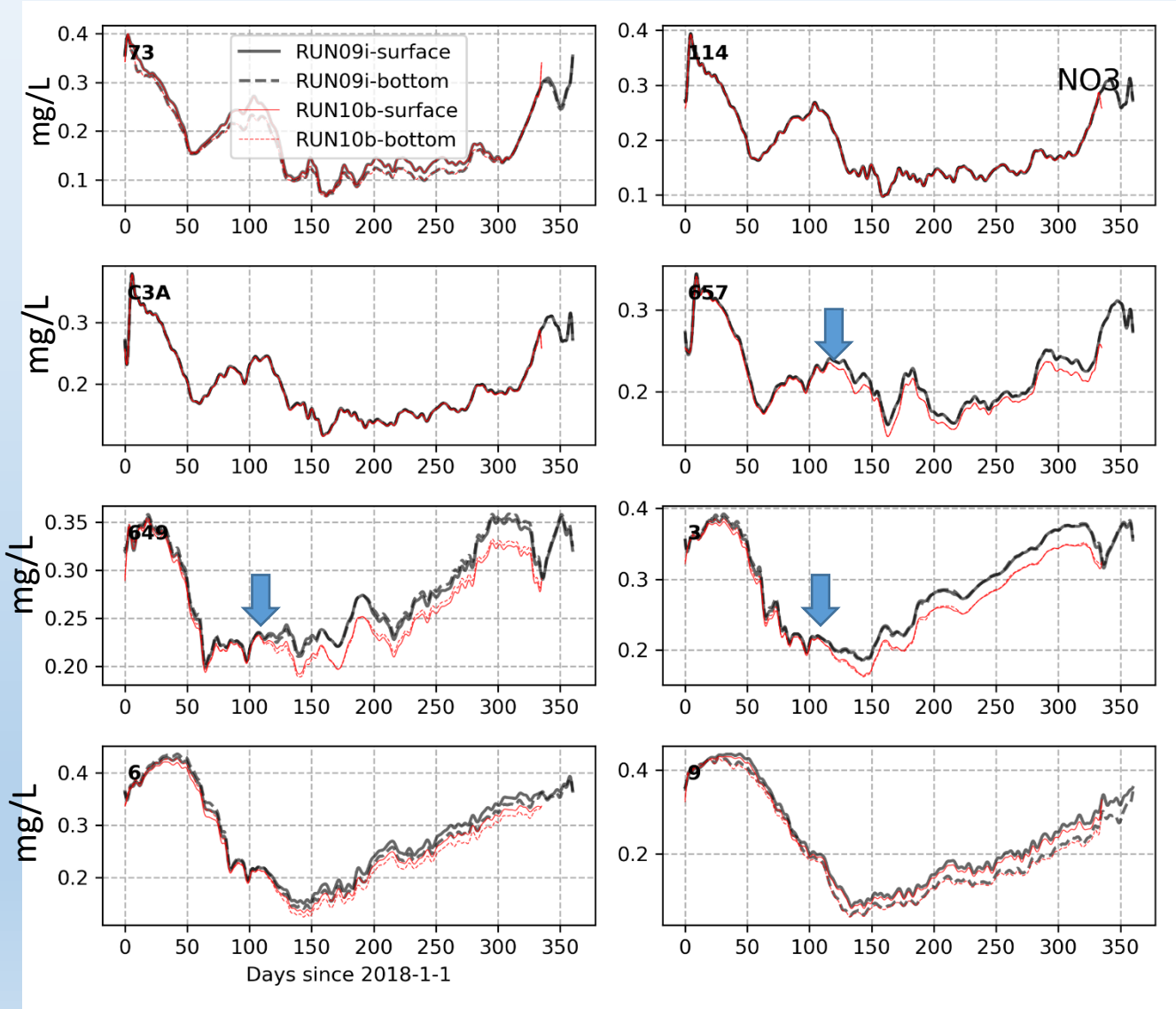
Station upstream of Regional San, near the river boundary

Station downstream of Regional San

NH4

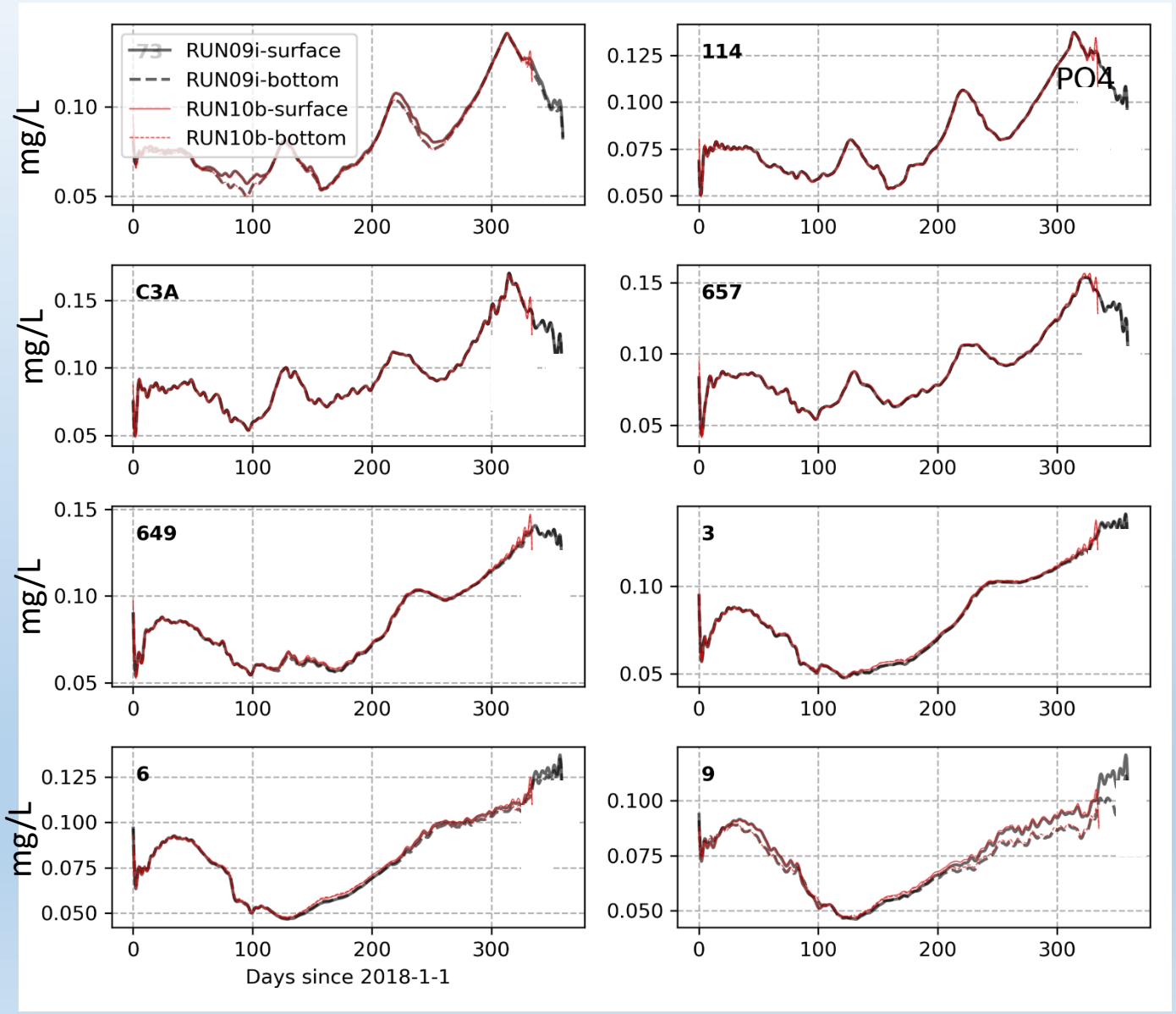
Only starting from C3A, impact of nutrient reduction is noticeable

Changes in NO3 after Reduction



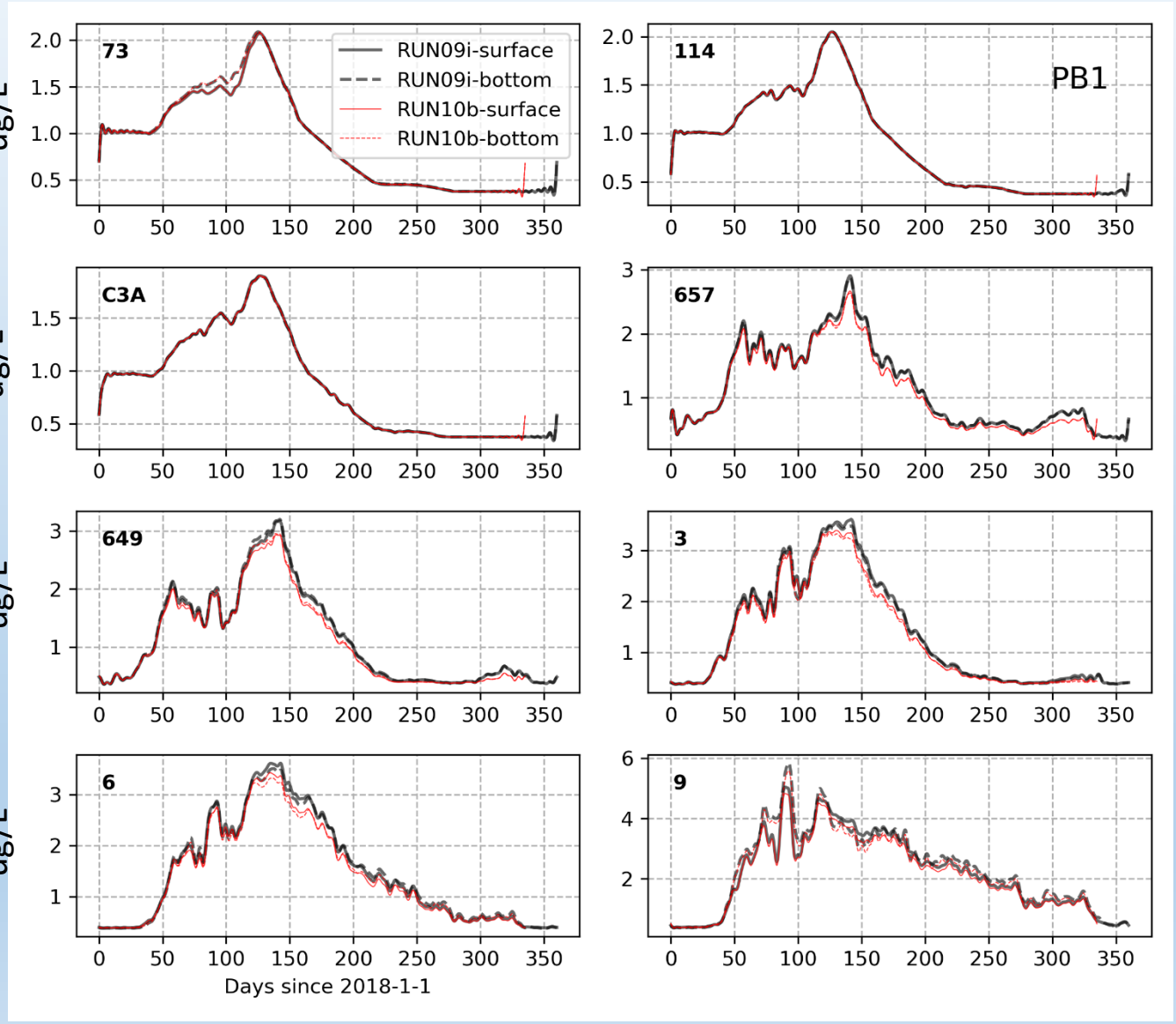
- While NO3 loading is not reduced, nutrient load reduction (NH4) affects the total N, leading to decrease of NO3 in downstream, esp. at station **649** and **3**

Changes in PO4 after Reduction



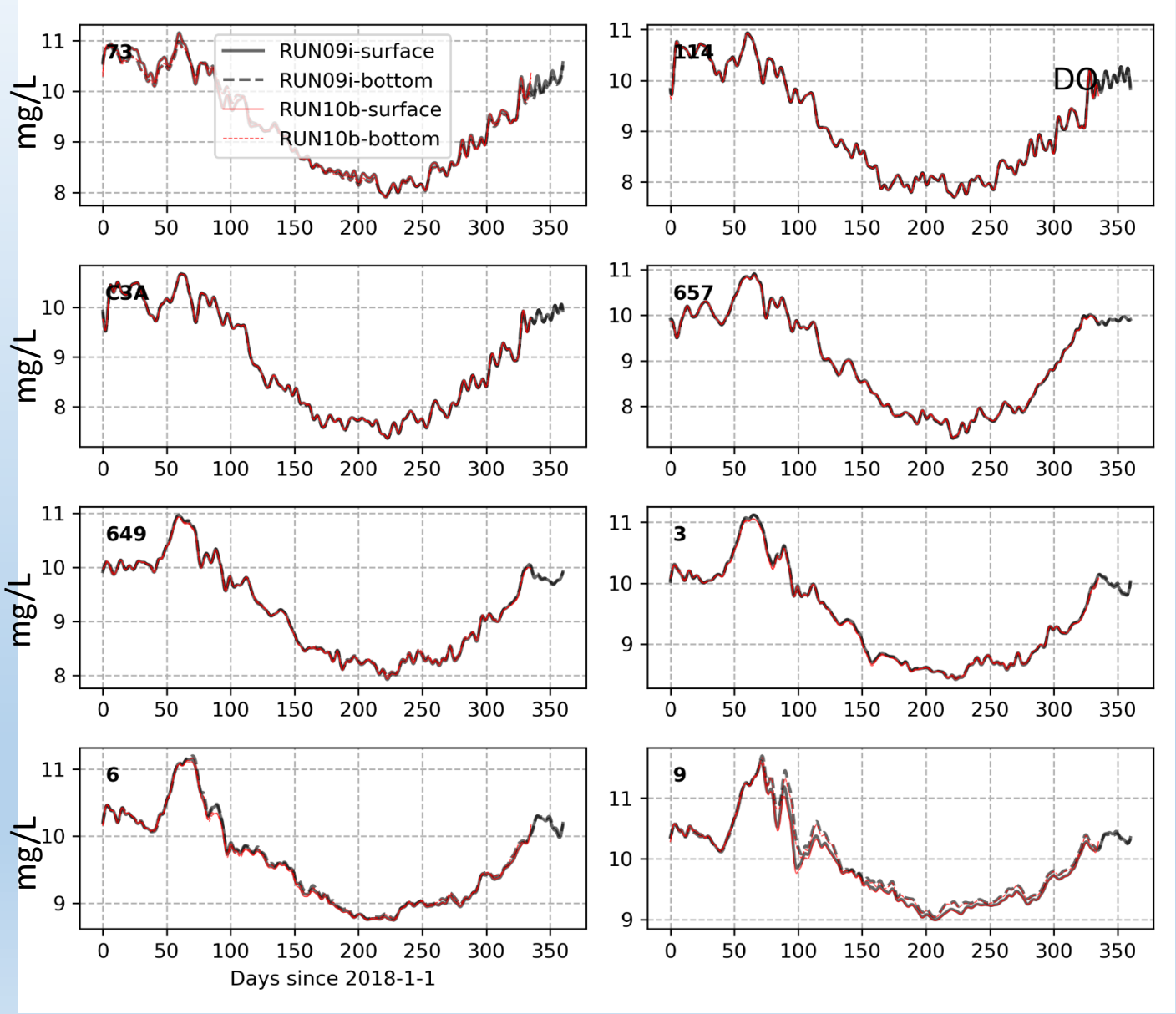
- Only subtidal signal is shown here.

Changes in Chl a after Reduction



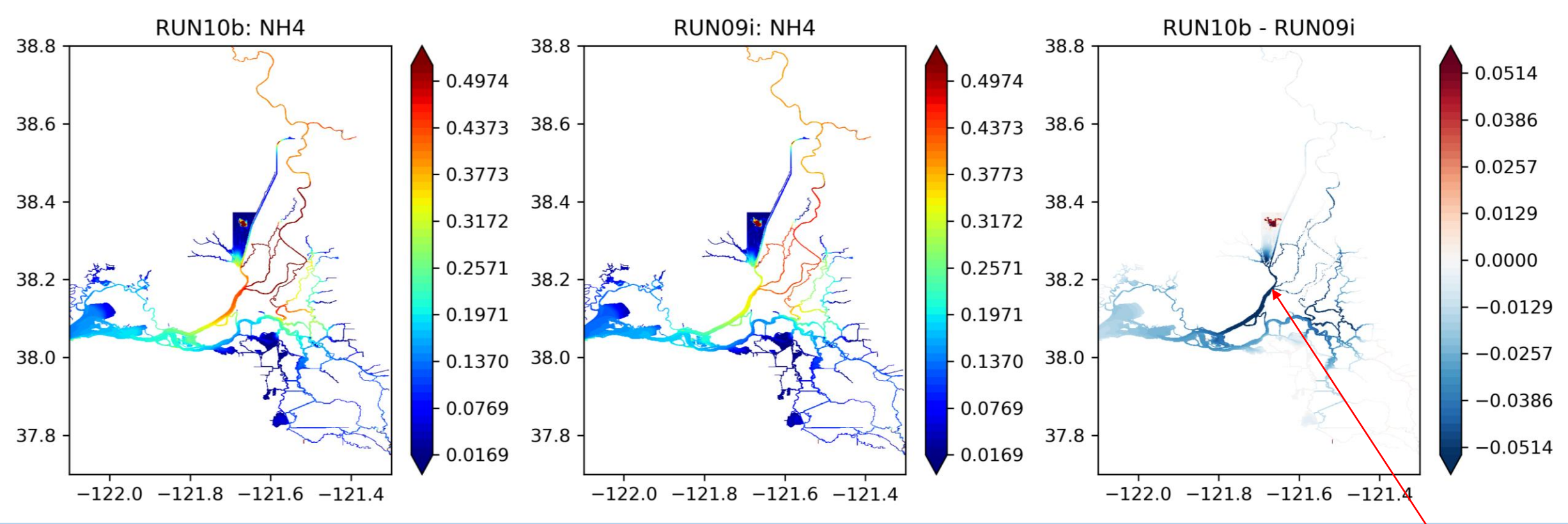
- Concentration of phytoplankton assemblage (diatom) decreases slightly
- Impacts only show after day 100, because of no nutrient limiting during non-bloom season (e.g., day 0-100)

Changes in DO after Reduction



- Difference in DO is negligible.
- As the bottom and surface is quite well-mixed and the DO is more controlled by the air-sea exchange

Changes in NH4 Distribution

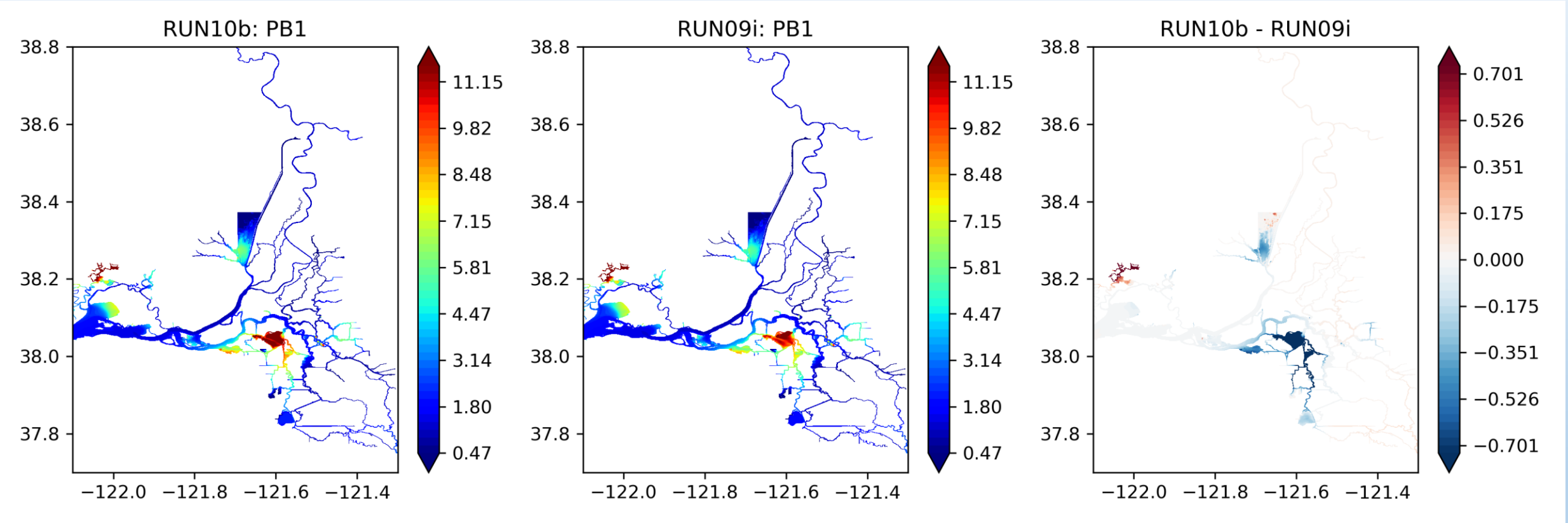


Run10b: existing condition

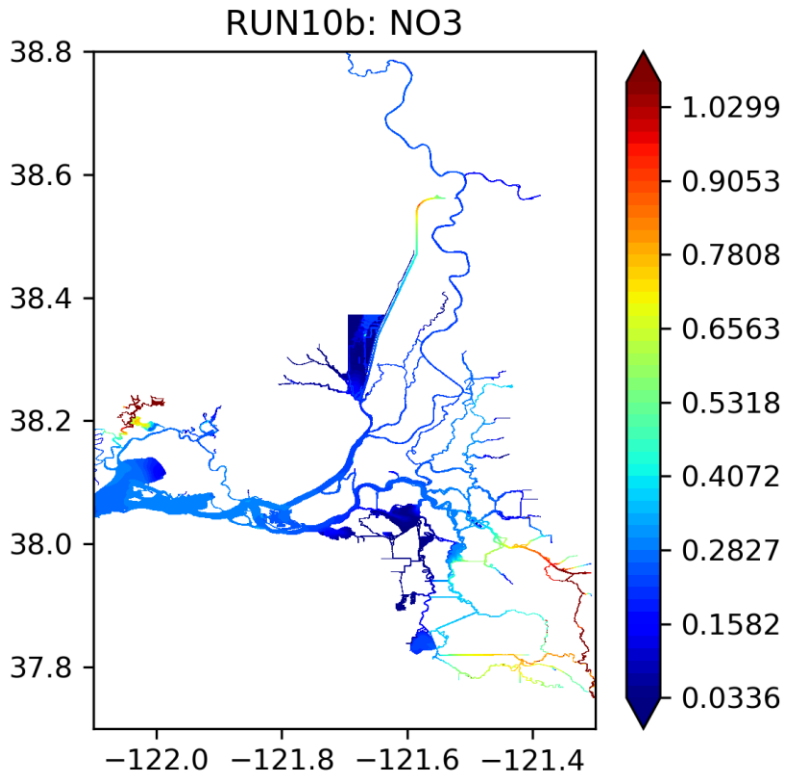
Run09i: simulation with 50% reduction of NH4 from SRWTP

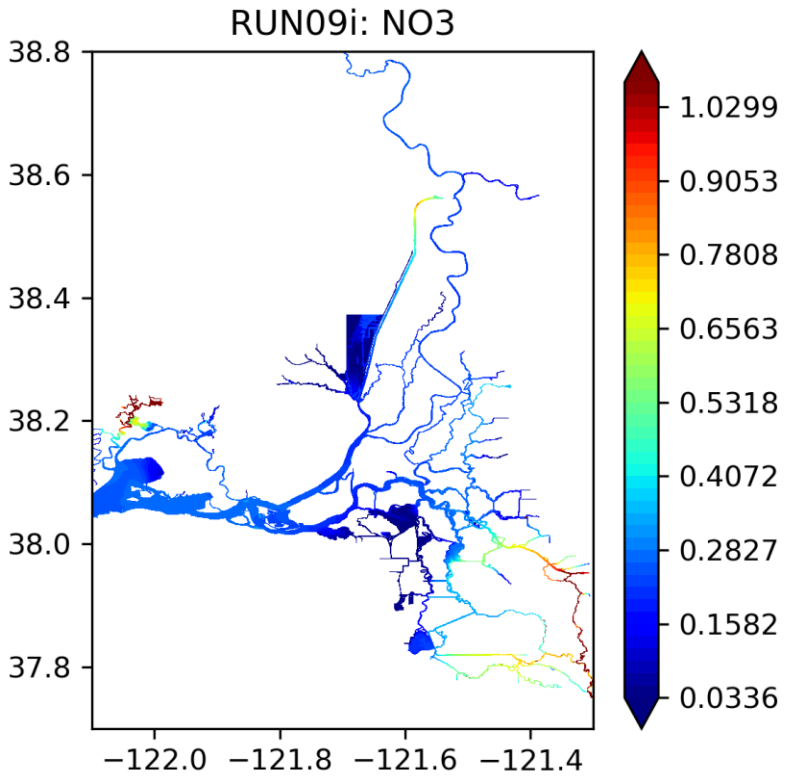
Could be associated with wetting-drying

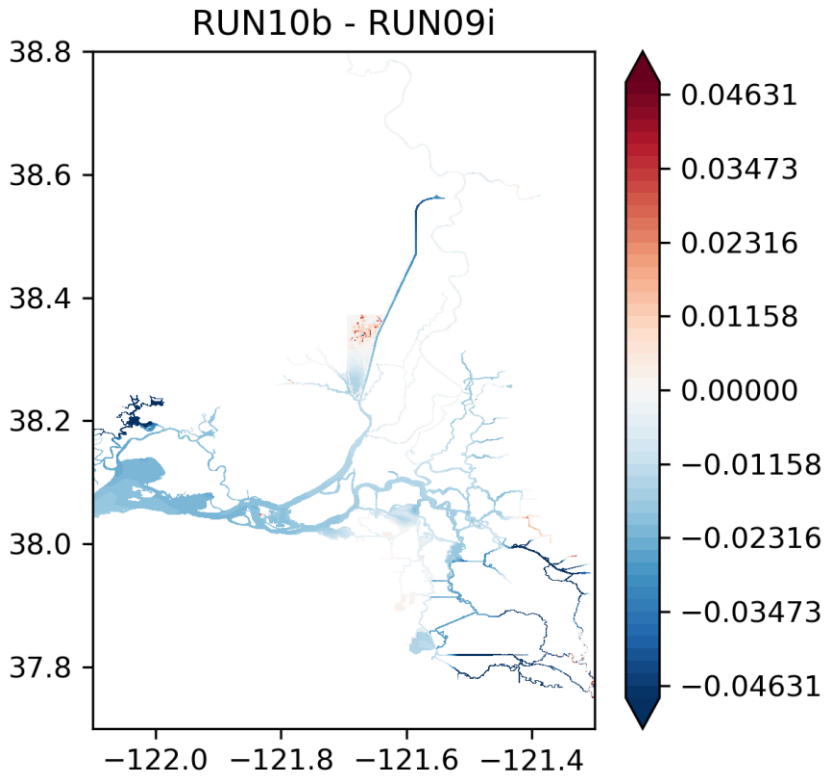
Changes in Chl a Distribution



Changes in NO3 Distribution

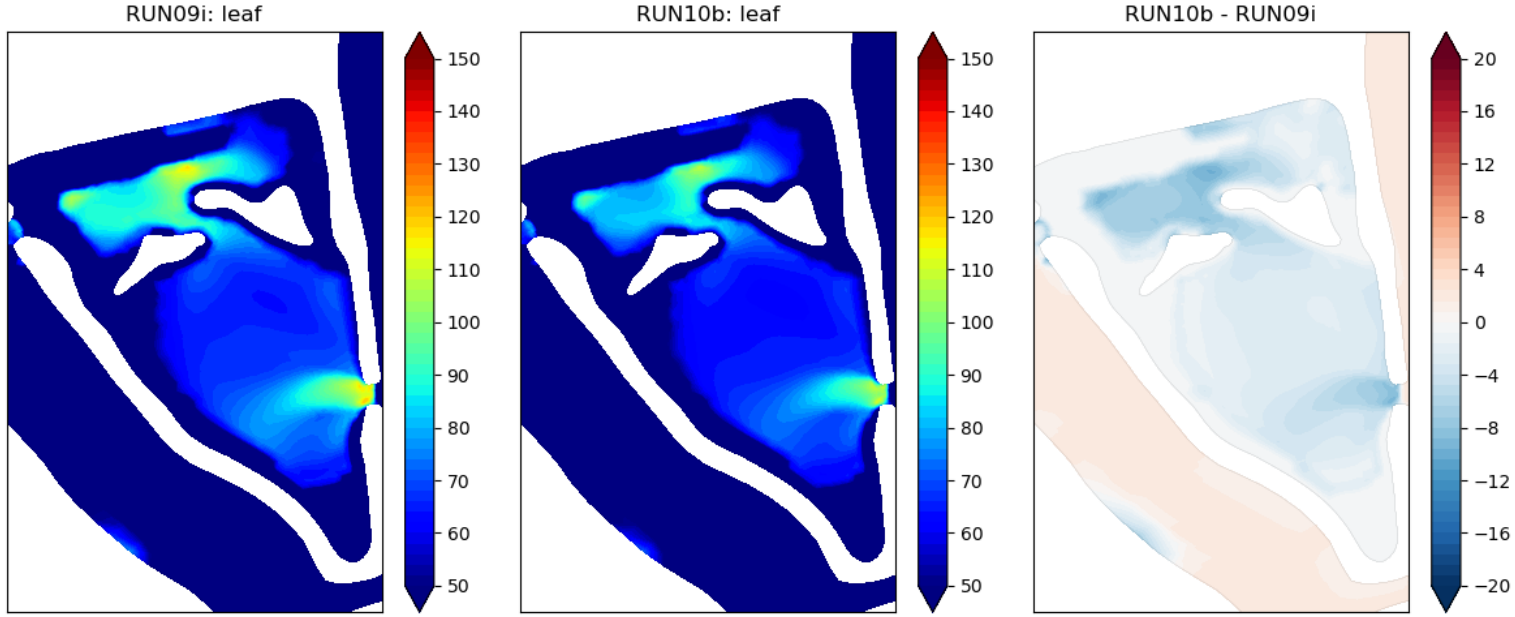


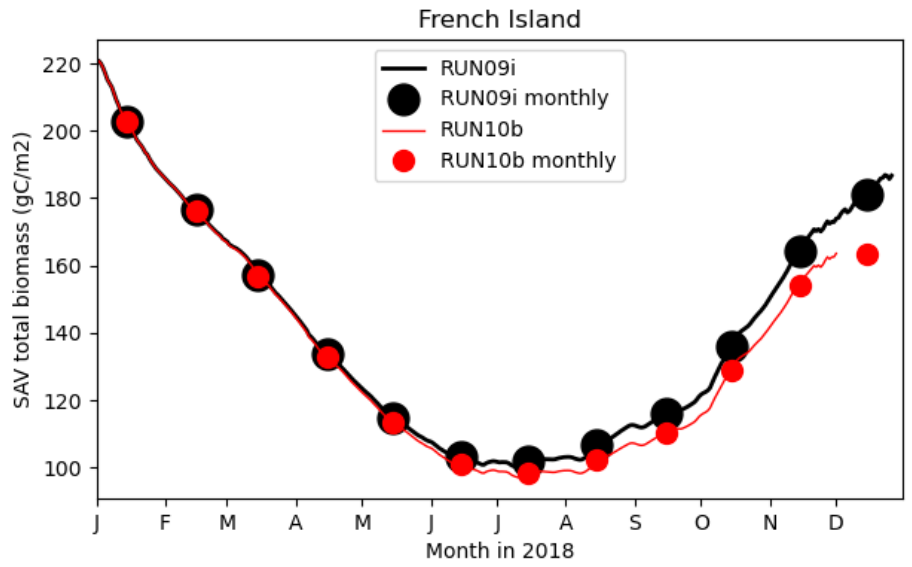




Impact on DAV in French Island

- Slightly decreased of SAV, as nutrient in water column is reduced





Conclusions

- The Delta region is not highly nutrient limited.
- The existing condition suggests that less than 2% of the time is limited by DIN. Algal is often limited by flow
- About 50% NH_4 sources from Sacramento River are from SRWTP
- HN4 concentration decreases by about 10% after reducing 50% of NH4 from SRWTP.
- Reduction of HN4 by 50% has less impact on water quality due to existing high nutrient imputes.