CALIFORNIA DEPARTMENT OF WATER RESOURCES

Modeling Delta water quality using coupled hydrodynamic and biogeochemical models

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Delta Modeling Section, DWR

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Acknowledgements

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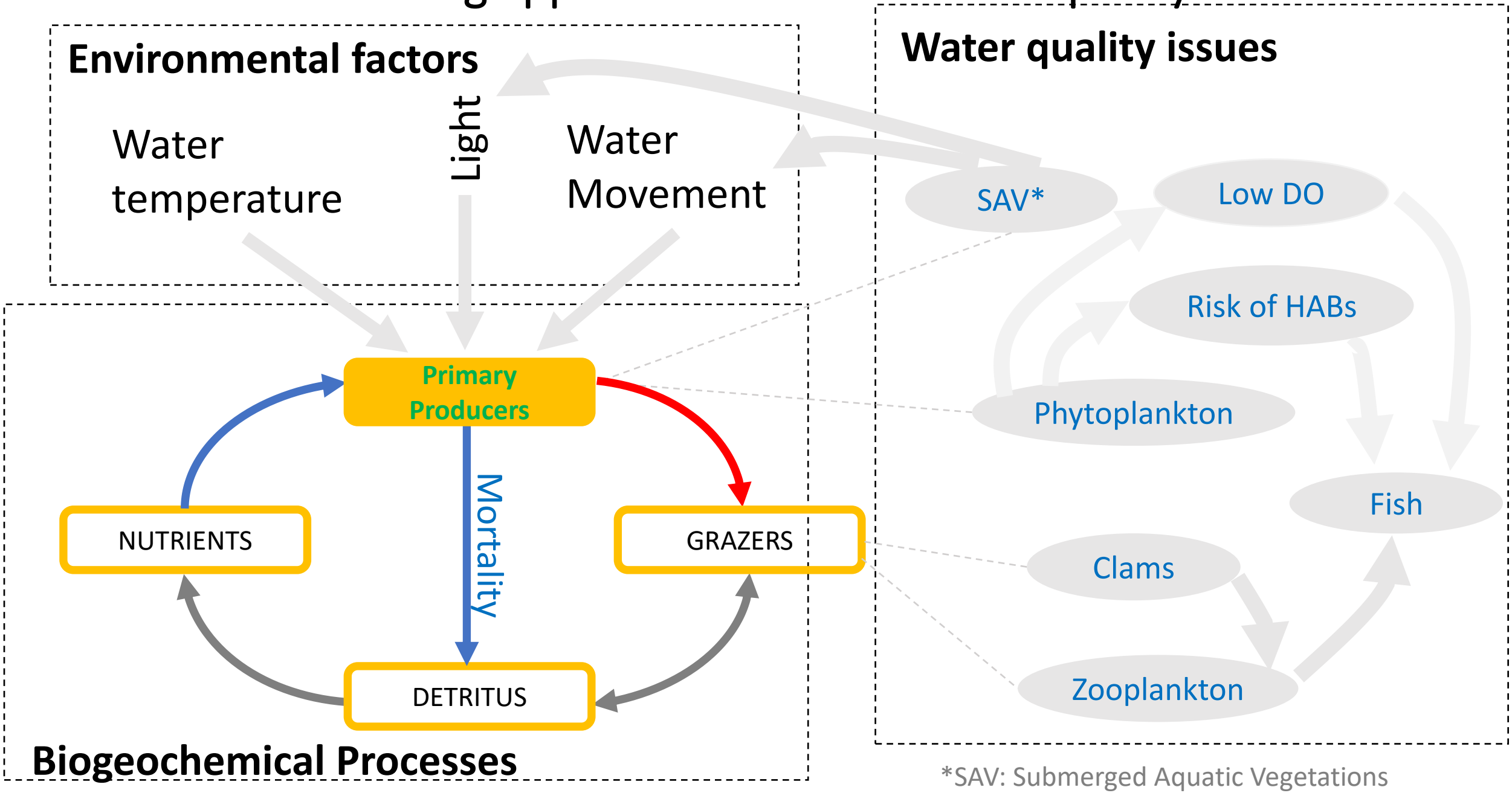
- SFSU
  – Frances Wilkerson, Richard Dugdale
- MWQI, EMP, DICE

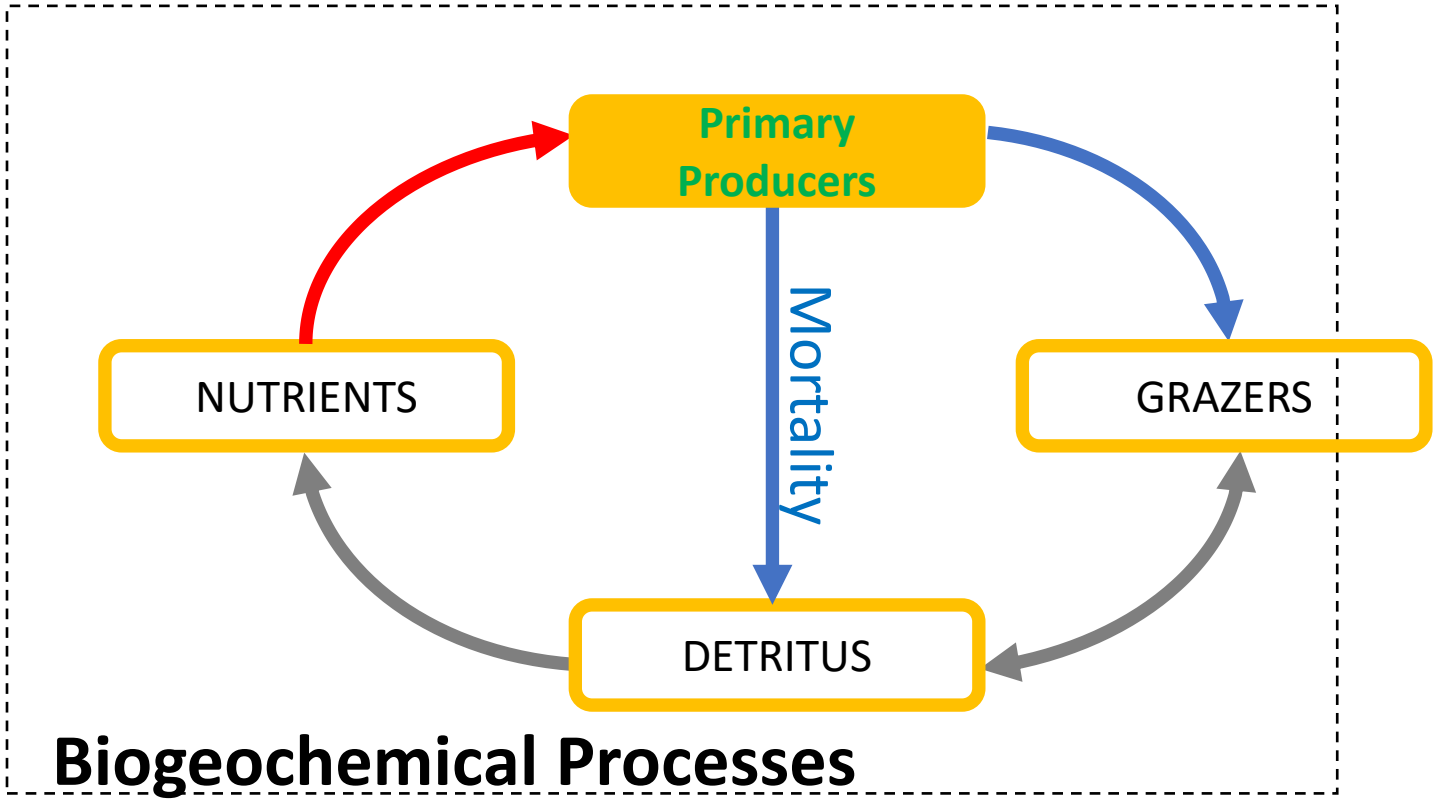
CALIFORNIA DEPARTMENT OF WATER RESOURCES

A mechanistic modeling approach to address water quality issues

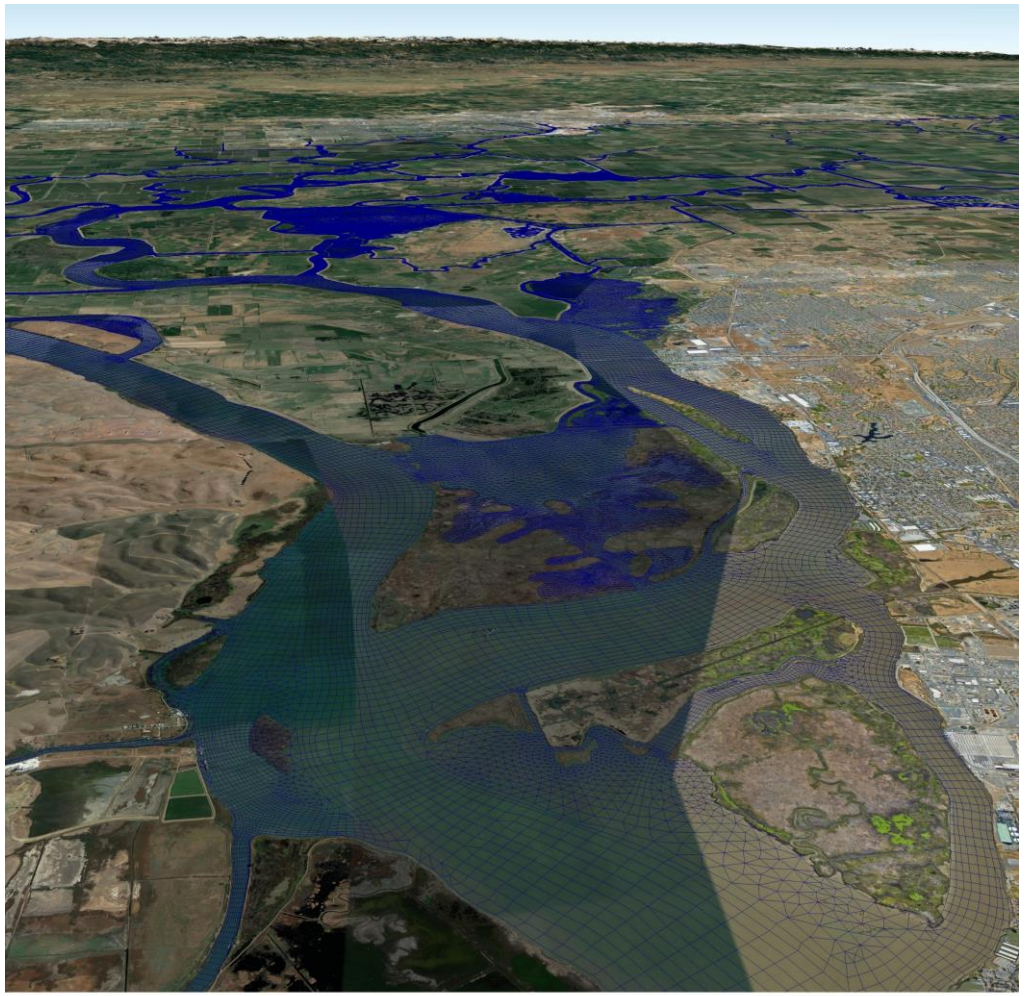


*SAV: Submerged Aquatic Vegetations

A coupled hydrodynamic and biogeochemical processes



Hydrodynamic Processes



Models: SCHISM* & CoSiNE (Carbon, Silicate, Nitrogen Ecosystem)

- ✓Open-source, unstructured-grid model, well-supported community model
- ✓Extensively calibrated for the Delta → Developing operational model
- ✓Peer-reviewed journal articles using SCHISM & biogeochemical models.
- ✓Coupled to FABM (Framework for Aquatic Biogeochemical Models), which includes ~20 different biogeochemical models.

*SCHISM stands for Semi-implicit Cross-scale Hydroscience Integrated System Model

CoSiNE (Carbon, Silicate, Nitrogen Ecosystem)

Nutrients

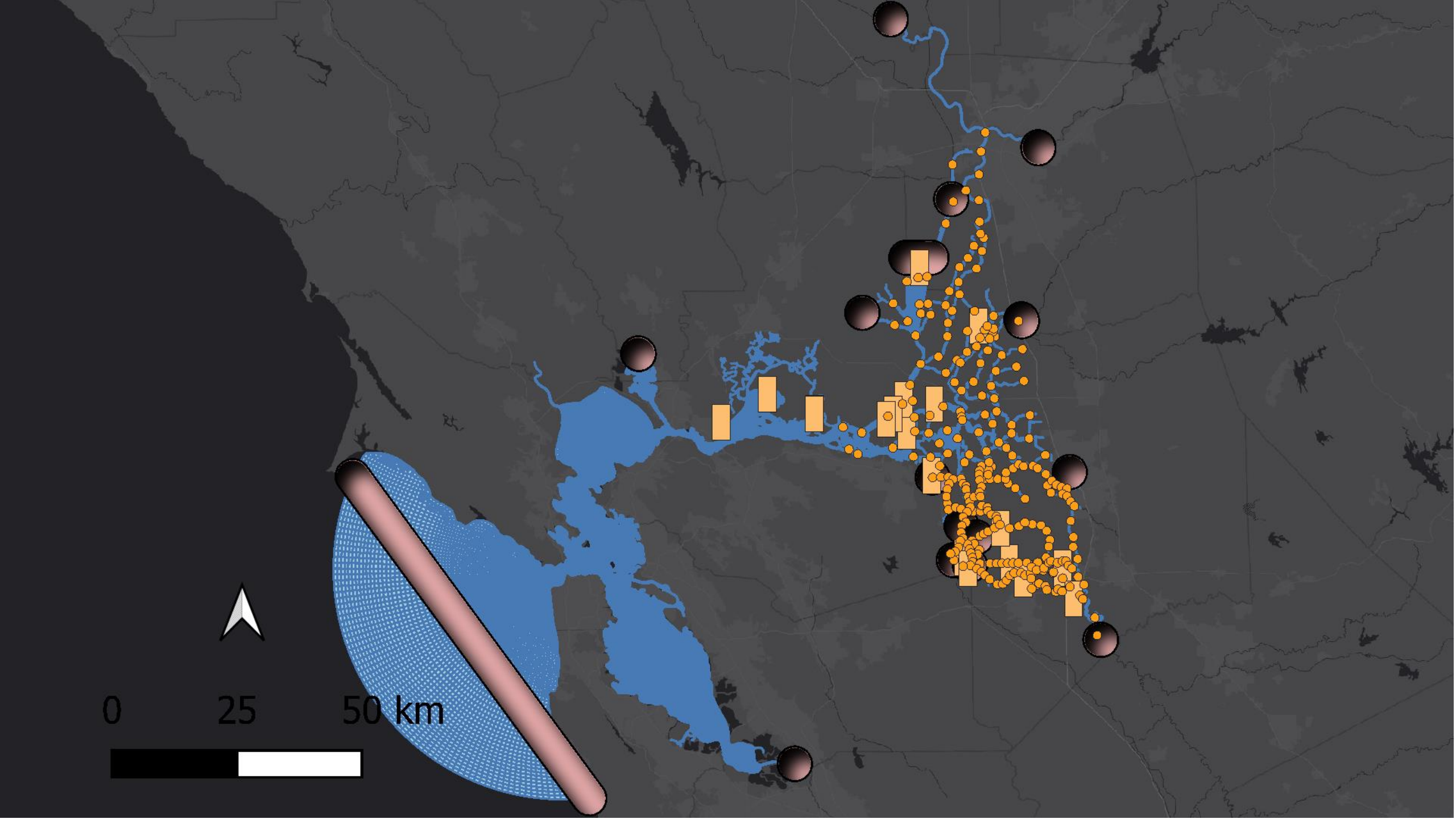
Phytoplankton

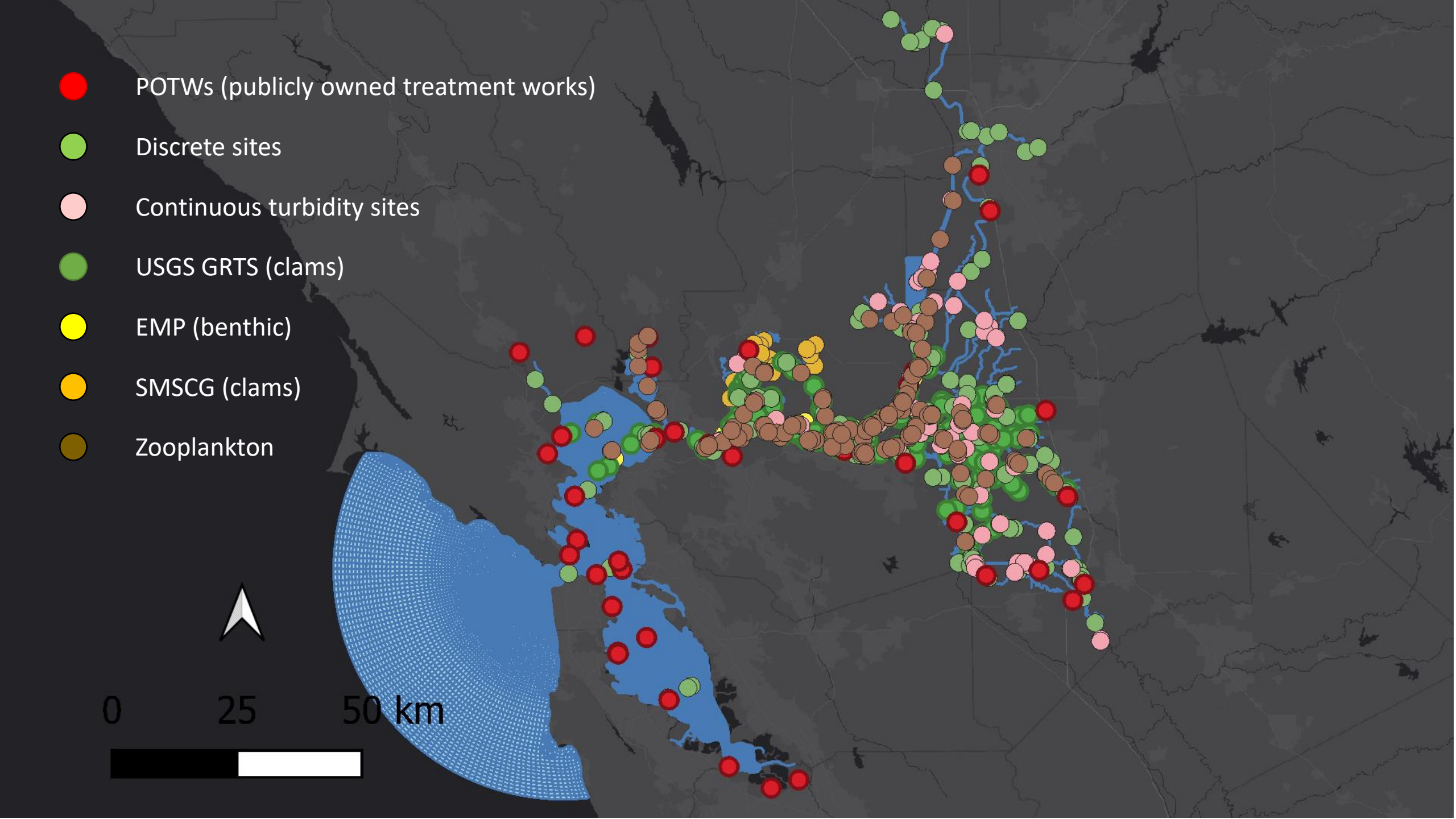
Zooplankton

Detritus

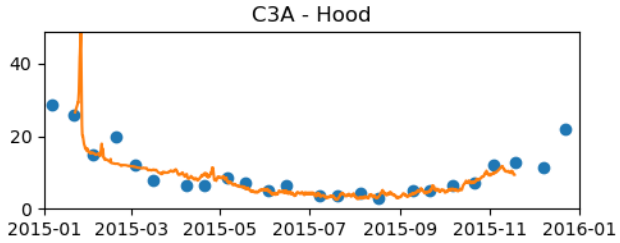
Name of State Variables	Symbol	Tracer Numbering in SCHISM (within CoSiNE module)	Unit
Nitrate	NO3	1	$mmol/m^3$
Silicate	SiO4	2	$mmol/m^3$
Ammonium	NH4	3	$mmol/m^3$
Small Phytoplankton	S1	4	$mmol/m^3$
Diatom	S2	5	$mmol/m^3$
Microzooplankton	Z1	6	$mmol/m^3$
Mesozooplankton	Z2	7	$mmol/m^3$
Detritus Nitrogen	DN	8	$mmol/m^3$
Detritus Silicon	DSi	9	$mmol/m^3$
Phosphate	PO4	10	$mmol/m^3$
Dissolved Oxygen	DOX	11	$mmol\ m^{-3}$
Dioxide Carbon	CO2	12	$mmol\ m^{-3}$
Alkalinity	ALK	13	meq/m^3

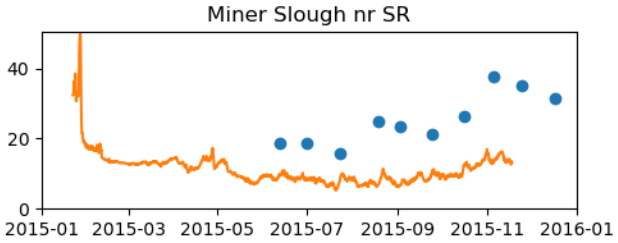
Sediment diagenesis model Clam grazing model

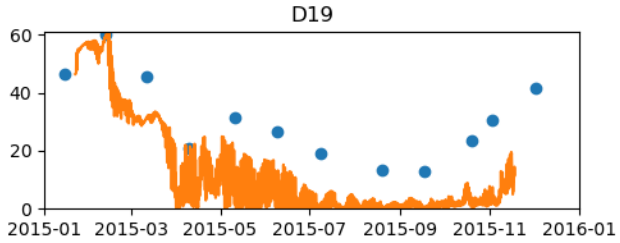

0
25
50 km

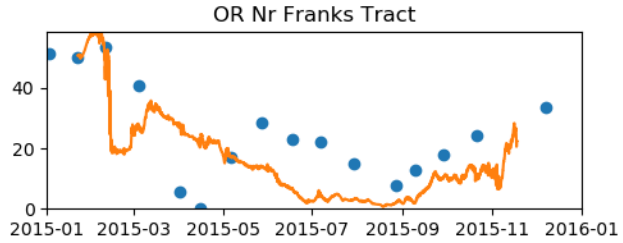

POTWs (publicly owned treatment works)
Discrete sites
Continuous turbidity sites
USGS GRTS (clams)
EMP (benthic)
SMSCG (clams)
Zooplankton
0
25
50 km

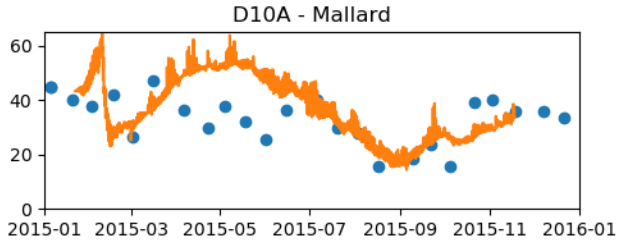
Nitrate + Nitrite (μM)

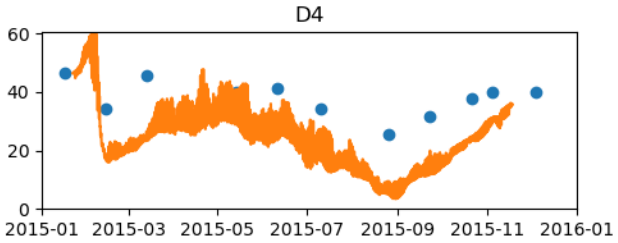


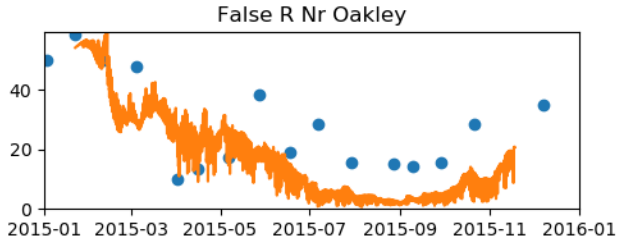


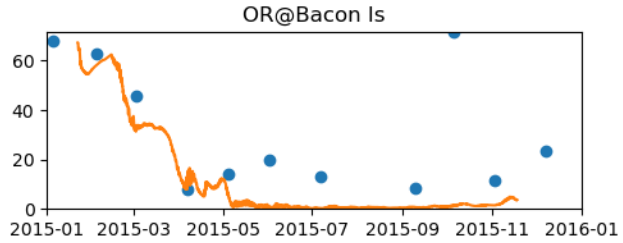


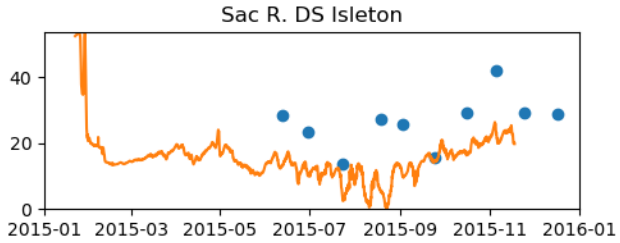


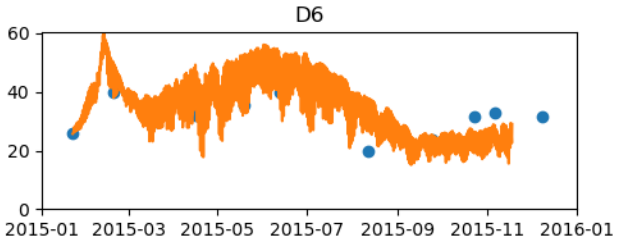


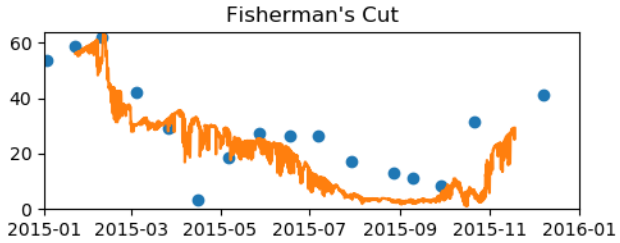


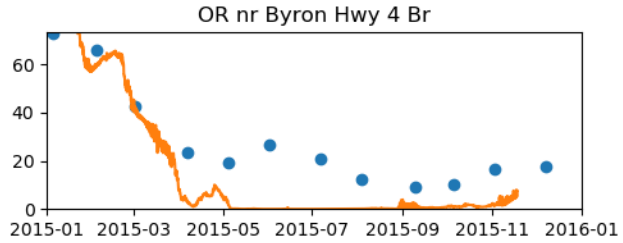


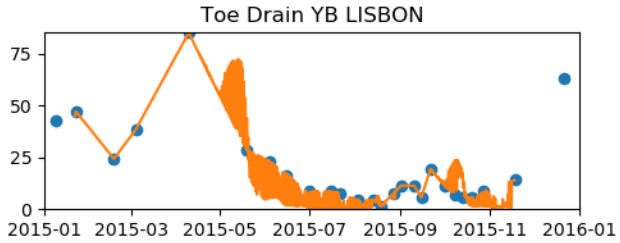


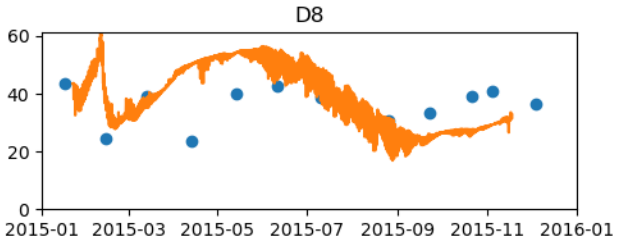


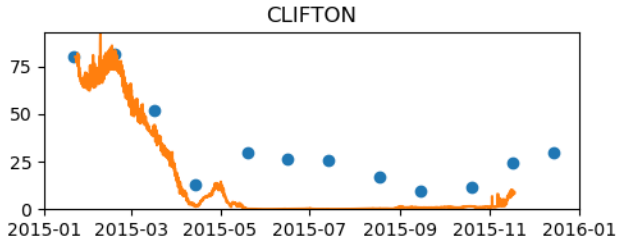


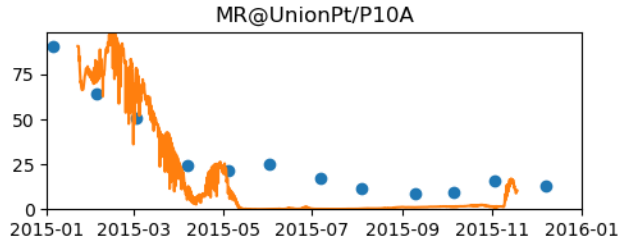


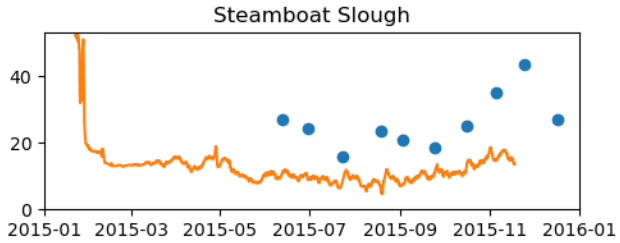


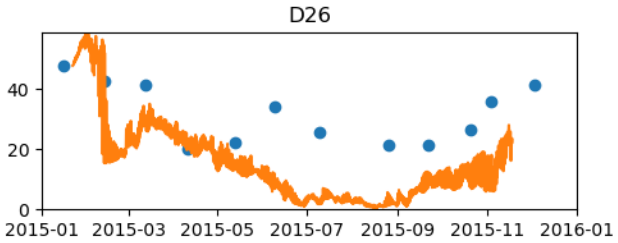


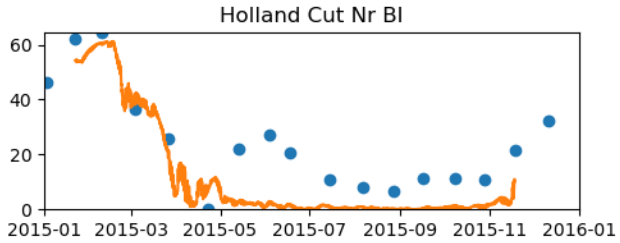


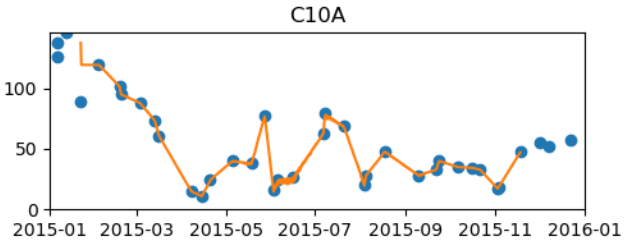




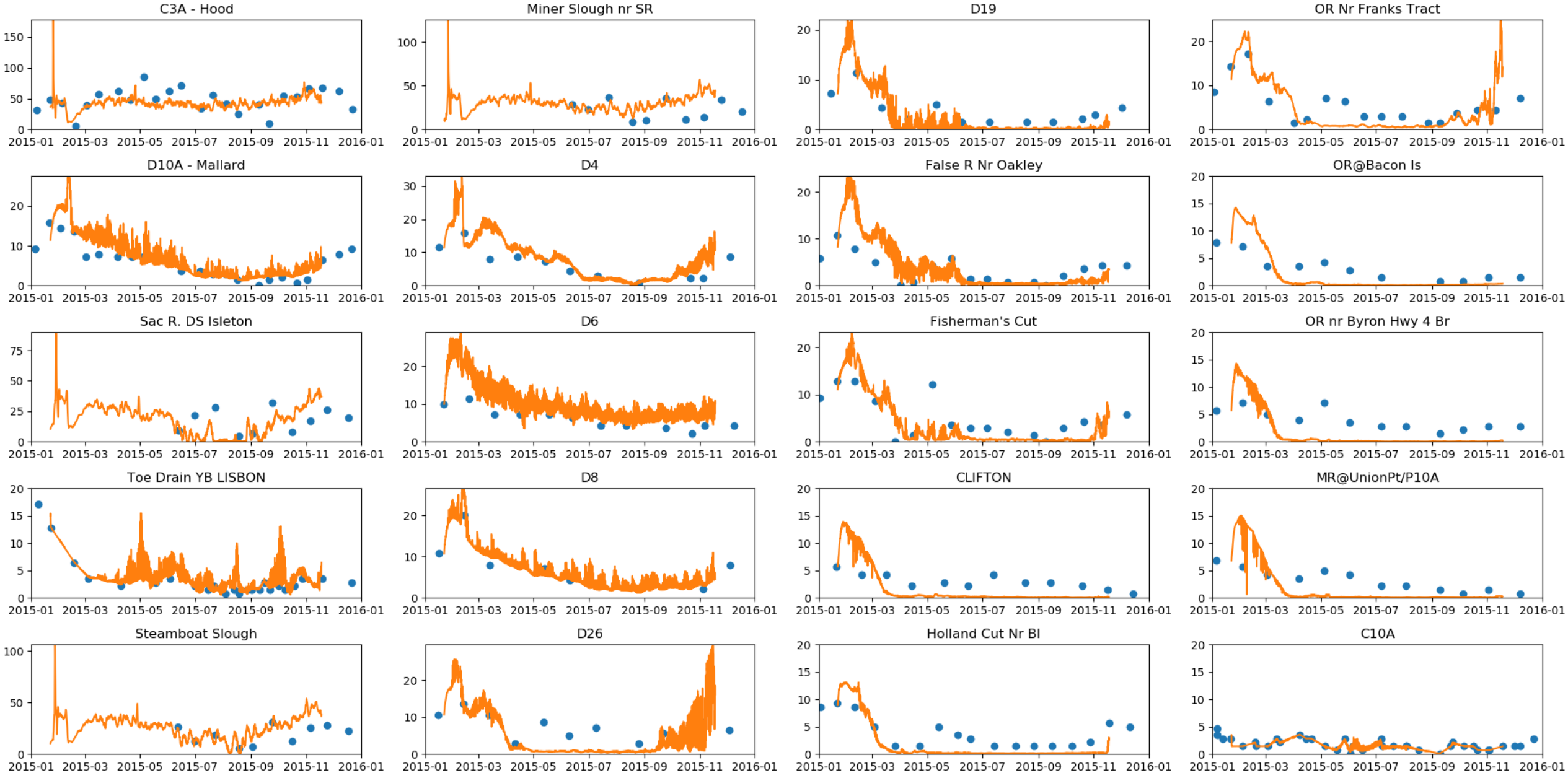




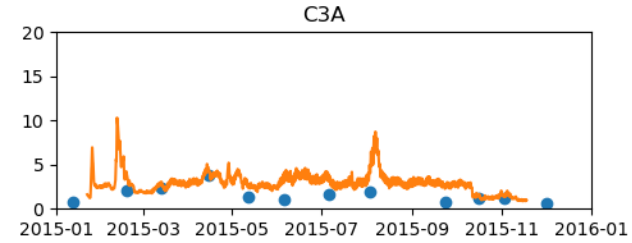


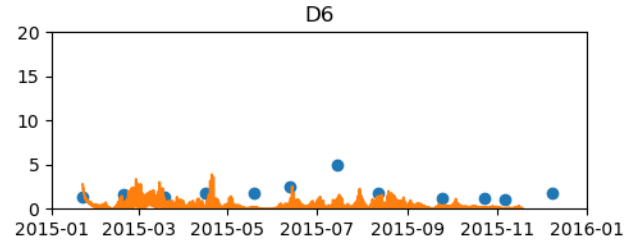


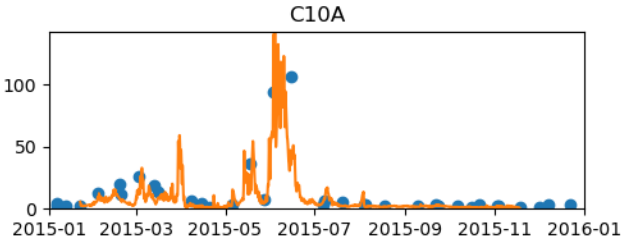
Ammonia (µM)

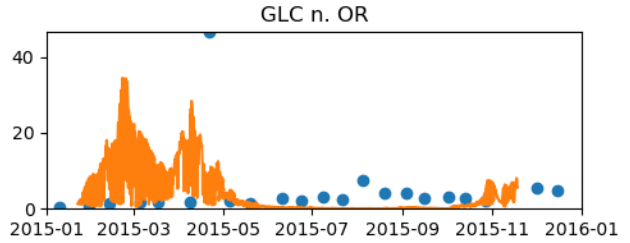

C3A - Hood
Miner Slough nr SR
D19
OR Nr Franks Tract
D10A - Mallard
D4
False R Nr Oakley
OR@Bacon Is
Sac R. DS Isleton
D6
Fisherman's Cut
OR nr Byron Hwy 4 Br
Toe Drain YB LISBON
D8
CLIFTON
MR@UnionPt/P10A
Steamboat Slough
D26
Holland Cut Nr BI
C10A
2015-01 2015-03 2015-05 2015-07 2015-09 2015-11 2016-01

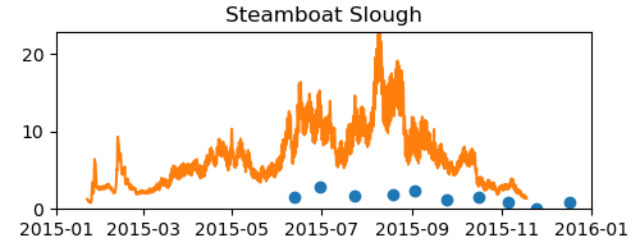
Chlorophyll a (µg/l)

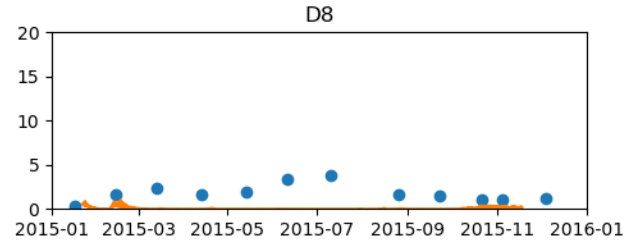


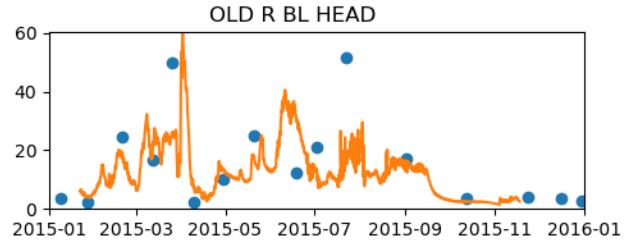


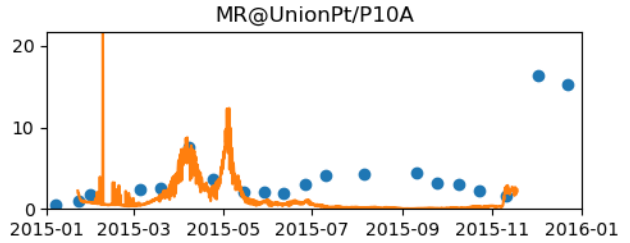


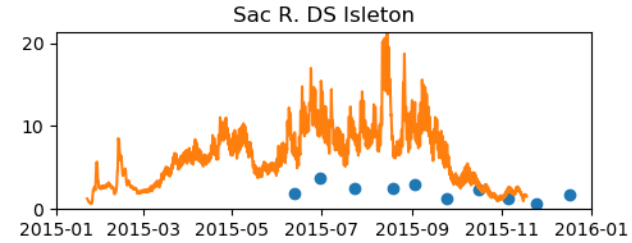


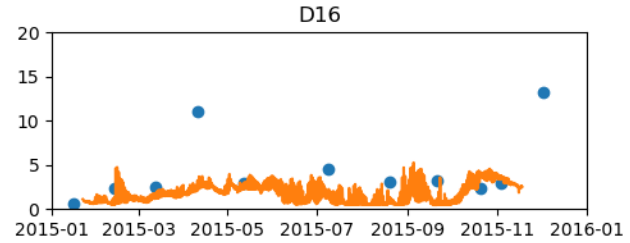


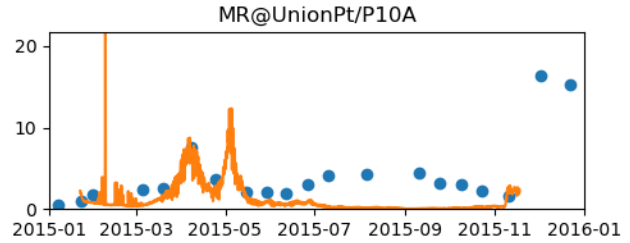


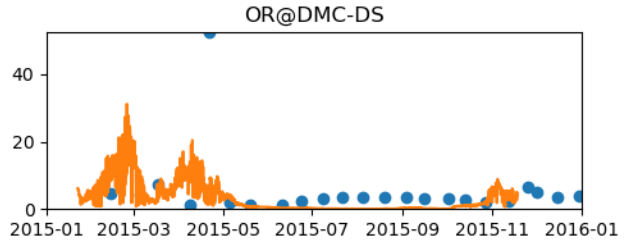


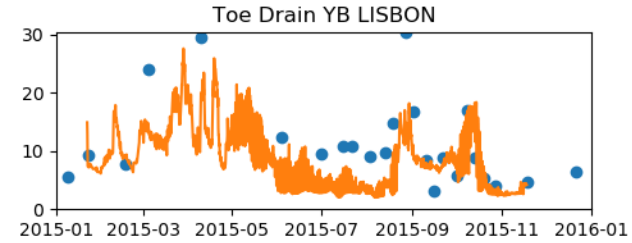


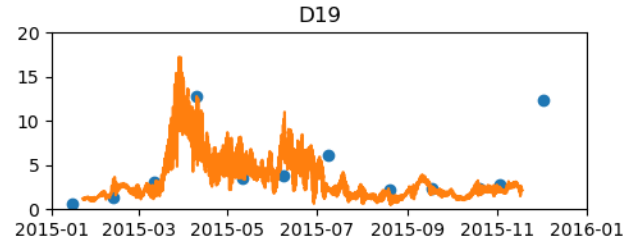


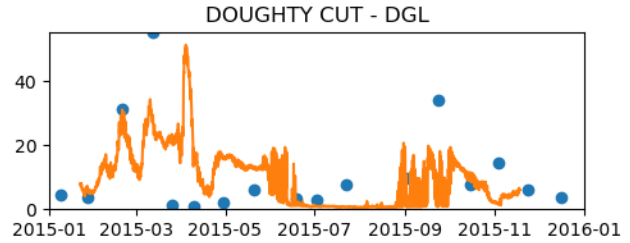


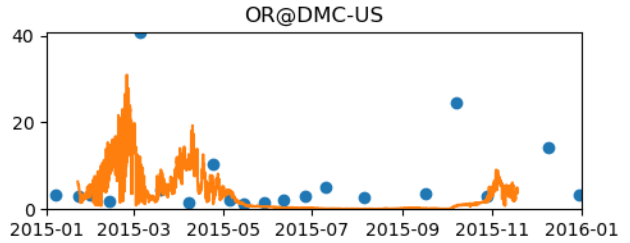


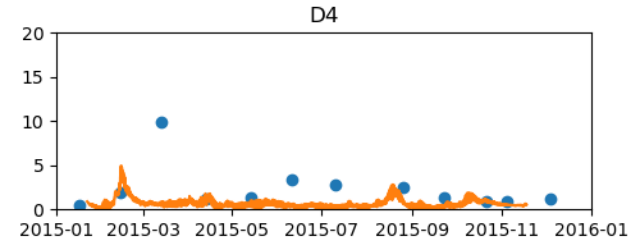


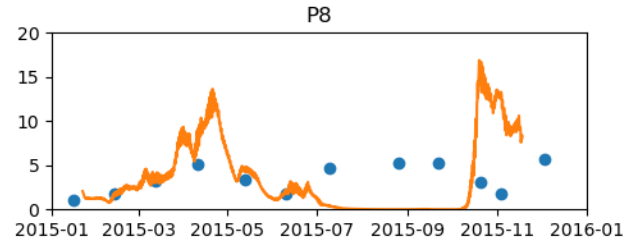


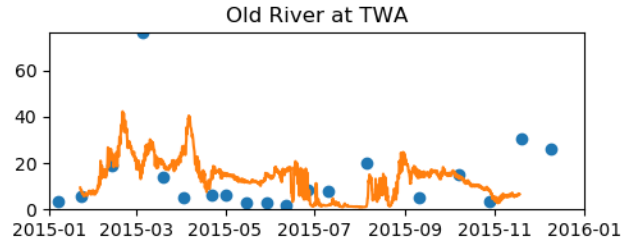


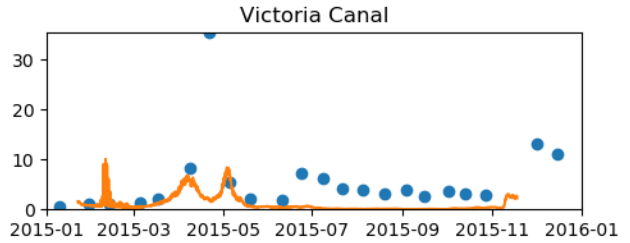




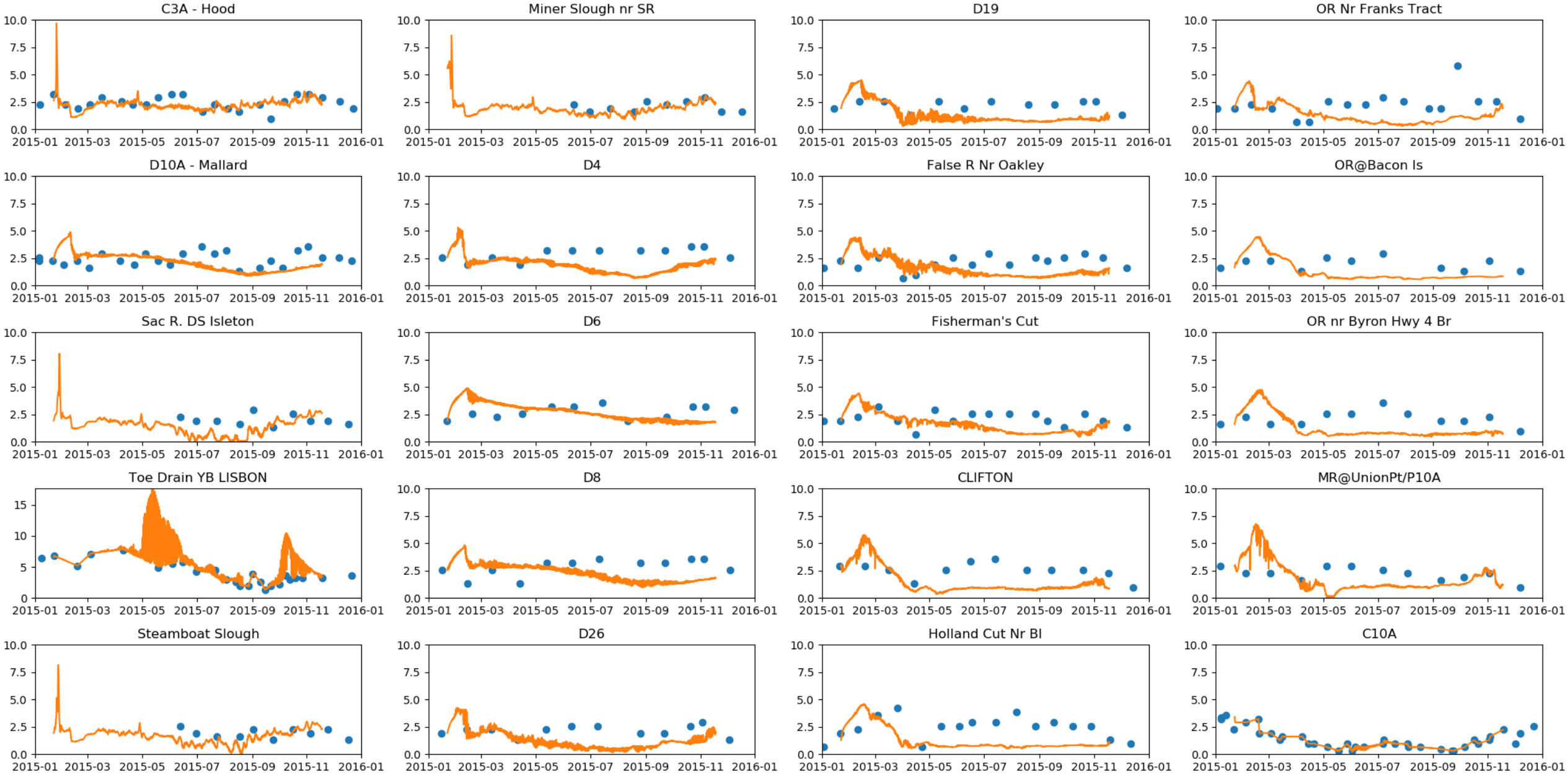




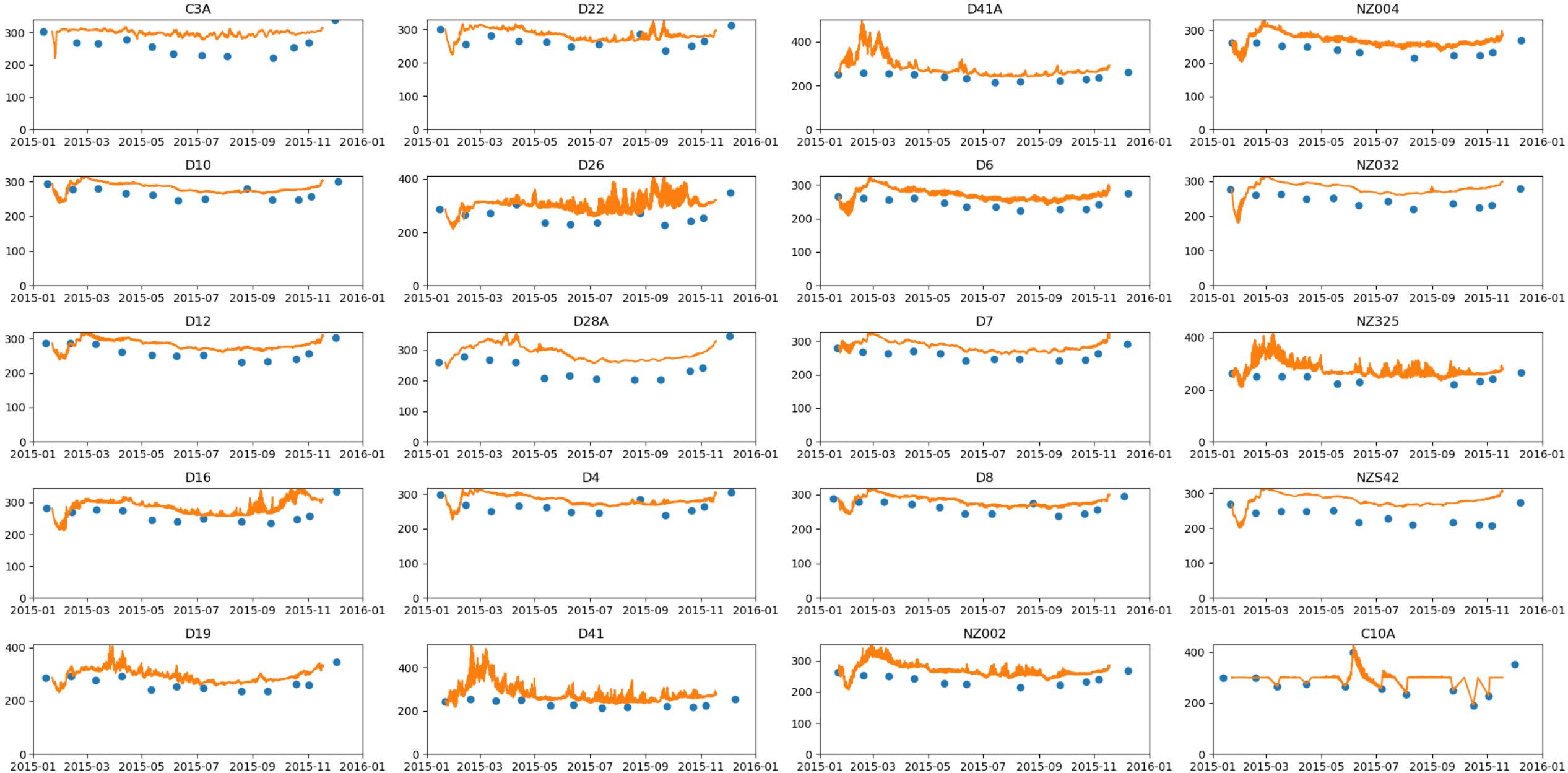




Phosphate (μM)



DO (µM)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D41A
NZ004
D10
D26
D6
NZ032
D12
D28A
D7
NZ325
D16
D4
D8
NZS42
D19
D41
NZ002
C10A
2015-01 2015-03 2015-05 2015-07 2015-09 2015-11 2016-01

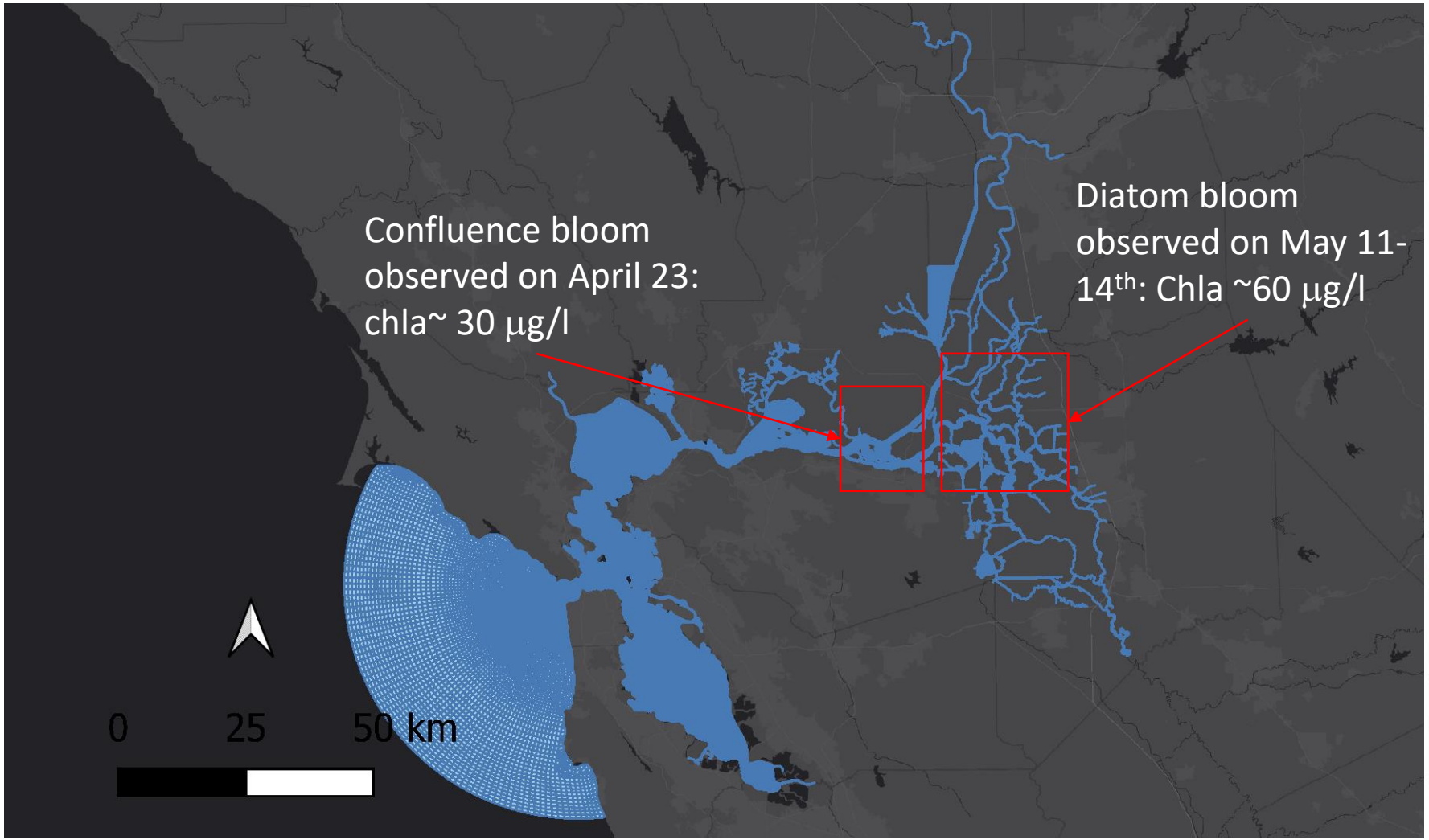
Conclusions

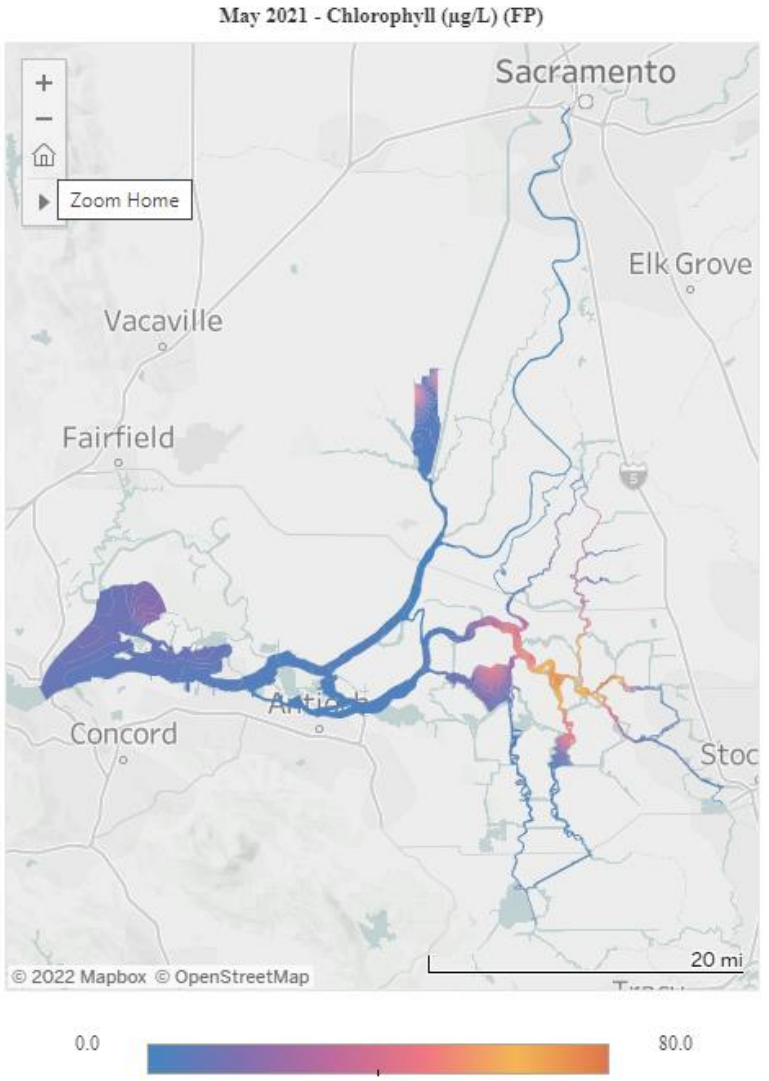
- This project is an infrastructural level of modeling effort and a working progress: a test run for 2015 showed that SCHISM & CoSiNE is capable of modeling the seasonal variability of observed nutrients, Chlorophyll a, and DO for most part of the domain.
- Further tuning is required to improve the model.

Future work

- Model calibration for other years (particularly 2021).
- Long-term model calibration (2008 to 2018, particularly for 2016 and 2018).
- Zooplankton model validation.
- Further data validation using USGS high resolution mapping data.
- Dynamic clam grazing model: modeling clam growth based on food availability.
- HABs modeling.

Why is 2021 our next target year?





USGS Delta survey by Bergamaschi et al.

Other important events in 2021

- Upgrade of Regional San (Sacramento Regional Wastewater Treatment Plant) in May.
- Emergency Drought Barrier on False River.
- HAB event observed in July and August 2021 in Franks Tract.

Questions and Comments

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What are the data gaps identified in the DNRP addressed by this study/model?

- Clam grazing rate.
- Better data on light attenuation.
- Calibration of continuous Chl-a data.

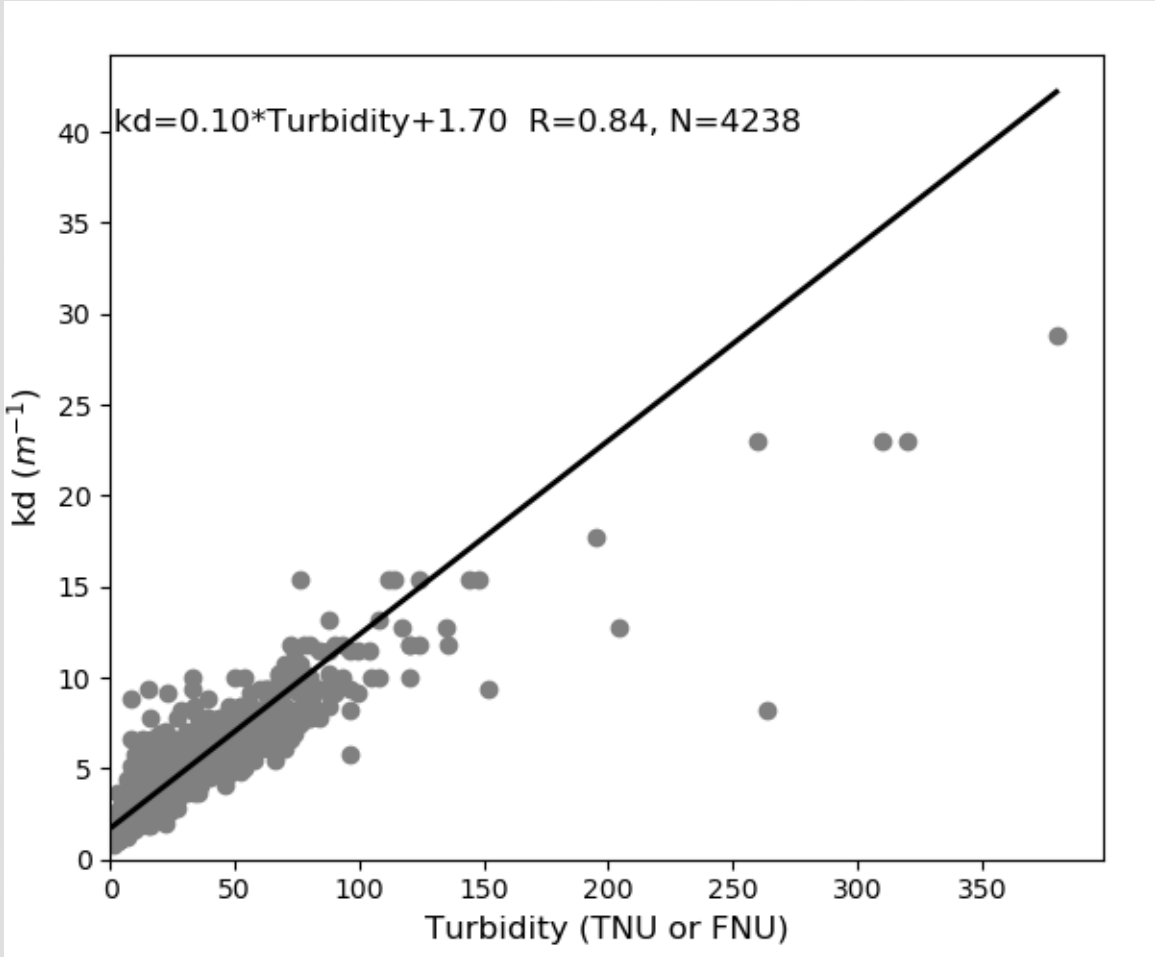
Potential questions

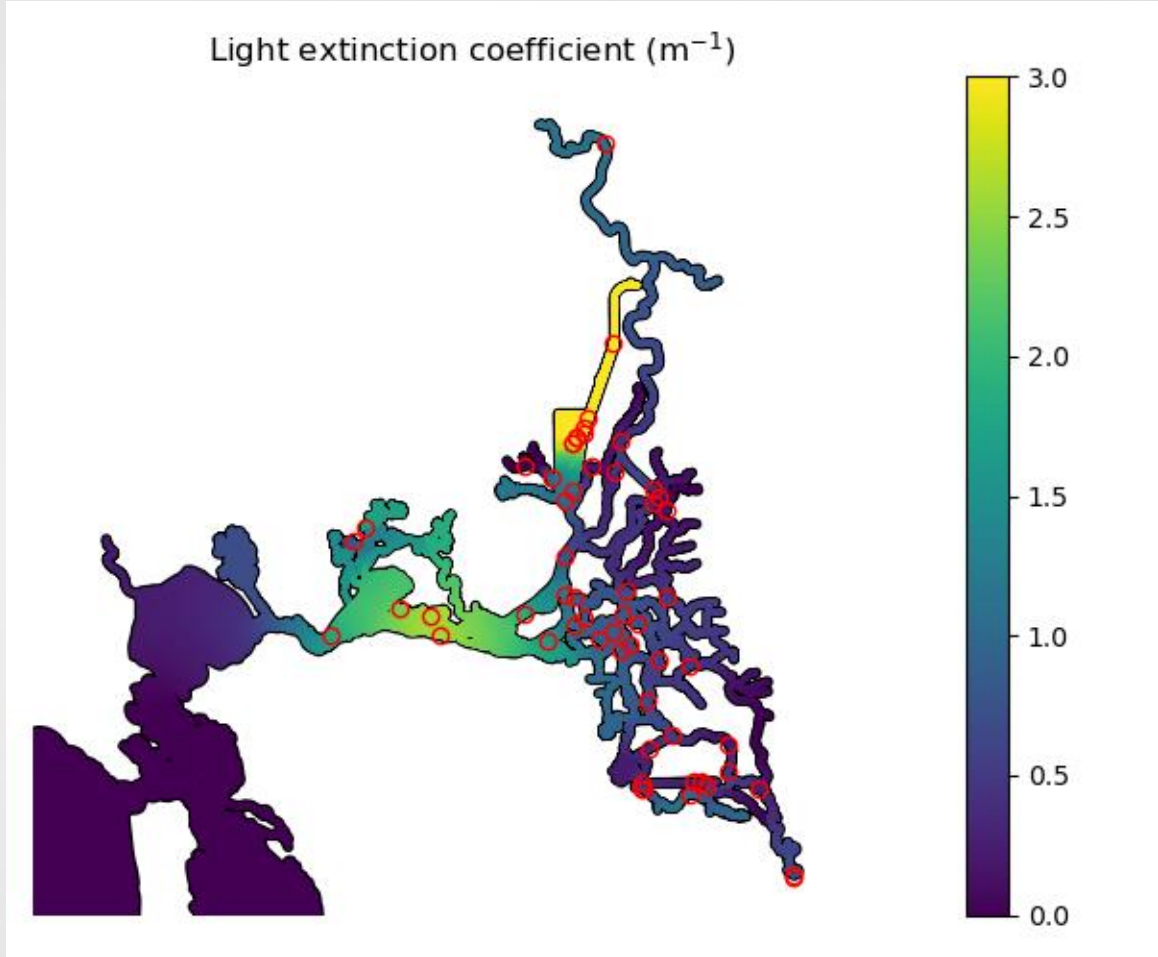
- How can we model HABs?

Why a mechanistic model?

- Prognostic issues, e.g., what caused harmful algal blooms in the Delta.
- Management planning, e.g., model scenarios for restoration areas.
- Science questions, e.g., did clams cause a reduction in fish biomass in the Delta?

Turbidity and Light field





Light extinction coefficient (Kd) ~ 0.1 FNU or TNU

Data source: EMP (Environmental Monitoring Program)

Spatial interpolation using fdaPDE (Functional Data Analysis and Partial Differential Equations)
https://cran.r-project.org/web/packages/fdaPDE/index.html

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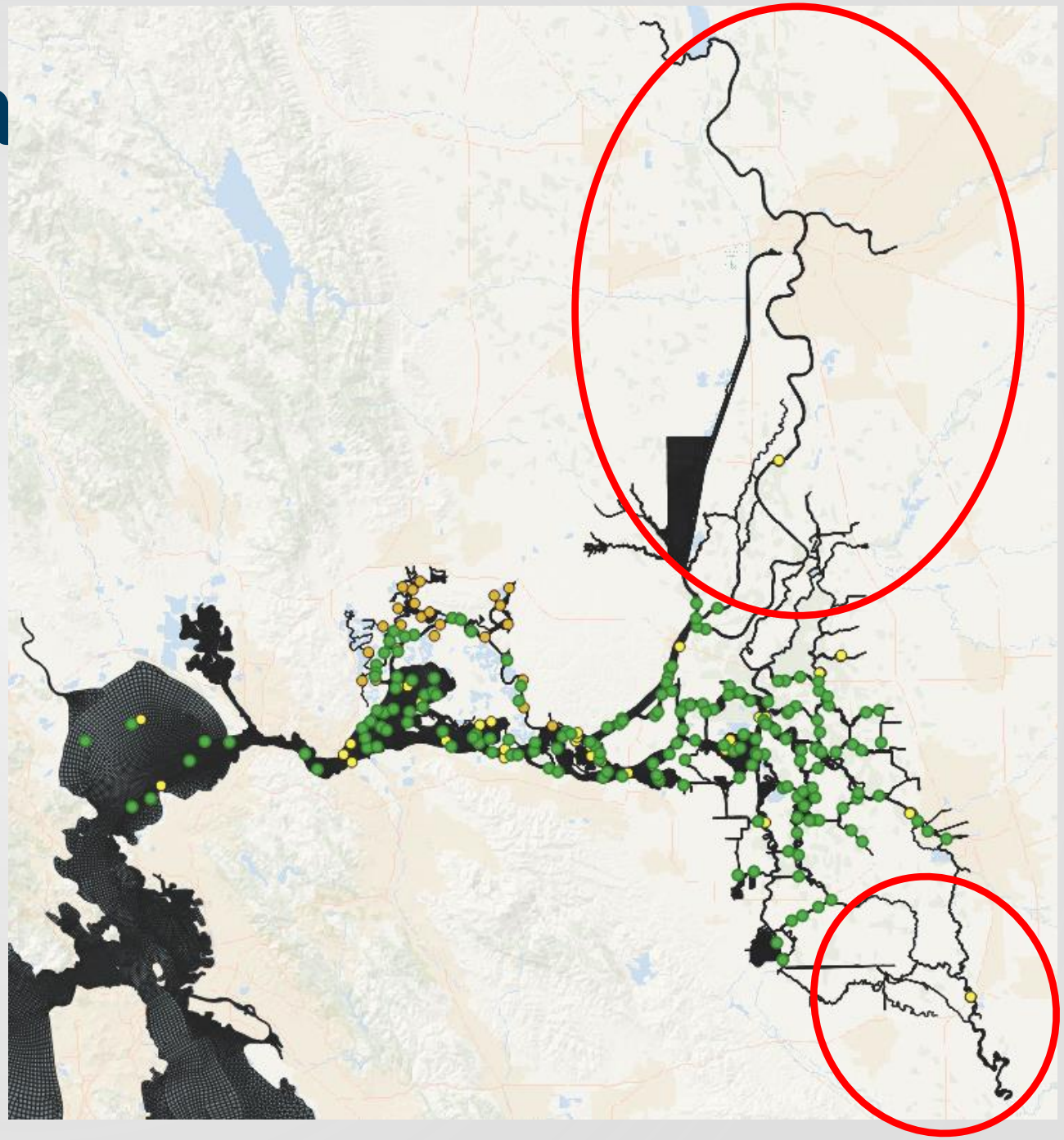
Clam grazing data

- EMP: monthly 2014 - 2019
https://doi.org/10.5066/P9Q57NL0
- USGS GRTS: May, Oct 2007 – 2019
https://www.sciencebase.gov/catalog/item/5fe575f7d34ea5387deb52ee
- SMSCG: July, Sep 2018-2020
https://portal.edirepository.org/nis/mapbrowse?packageid=edi.876.1



GRTS: Generalized Random Tessellation Stratified Program

EMP: Environmental Monitoring Program

SMSCG: The Suisun Marsh Salinity Control Gates

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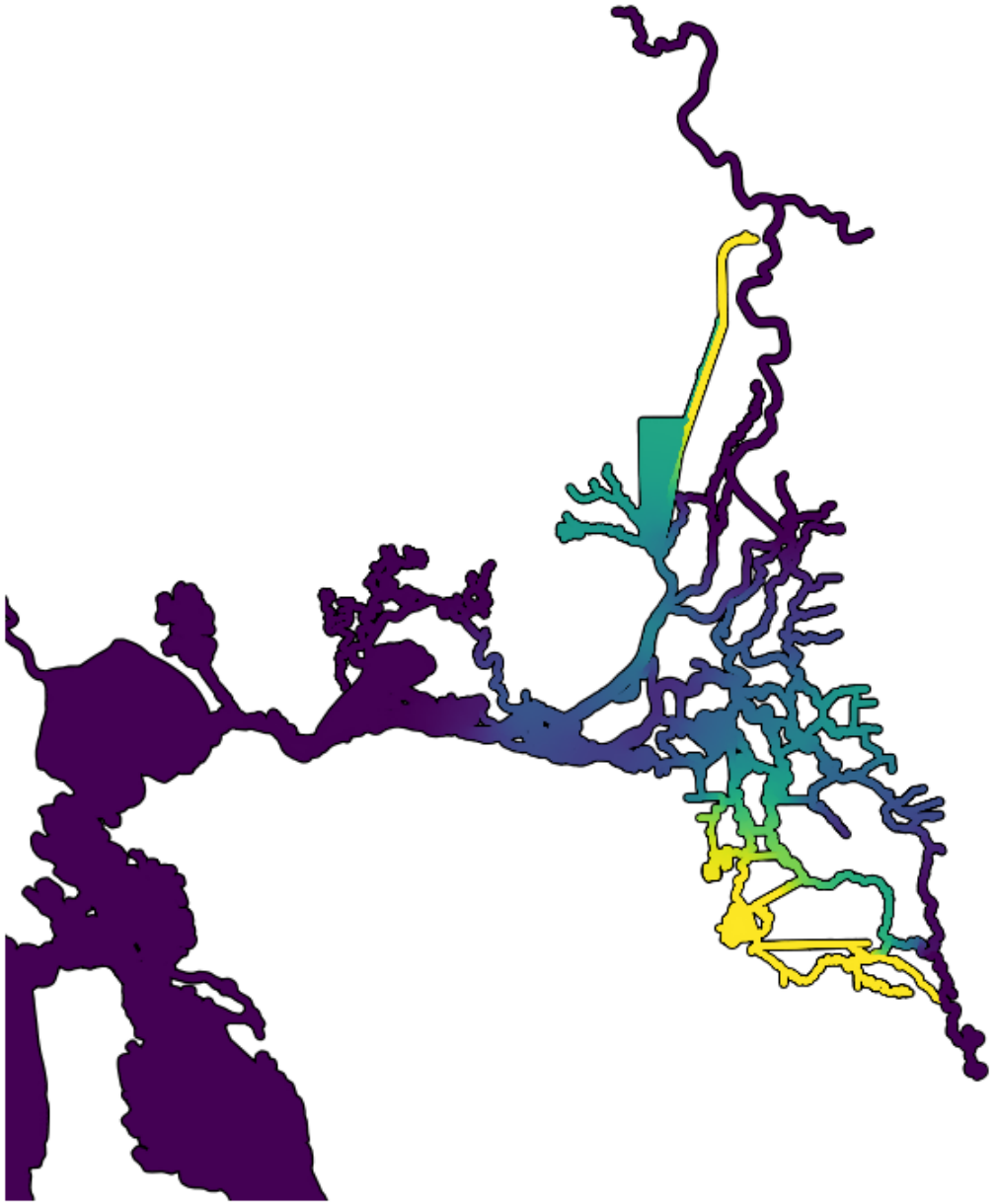
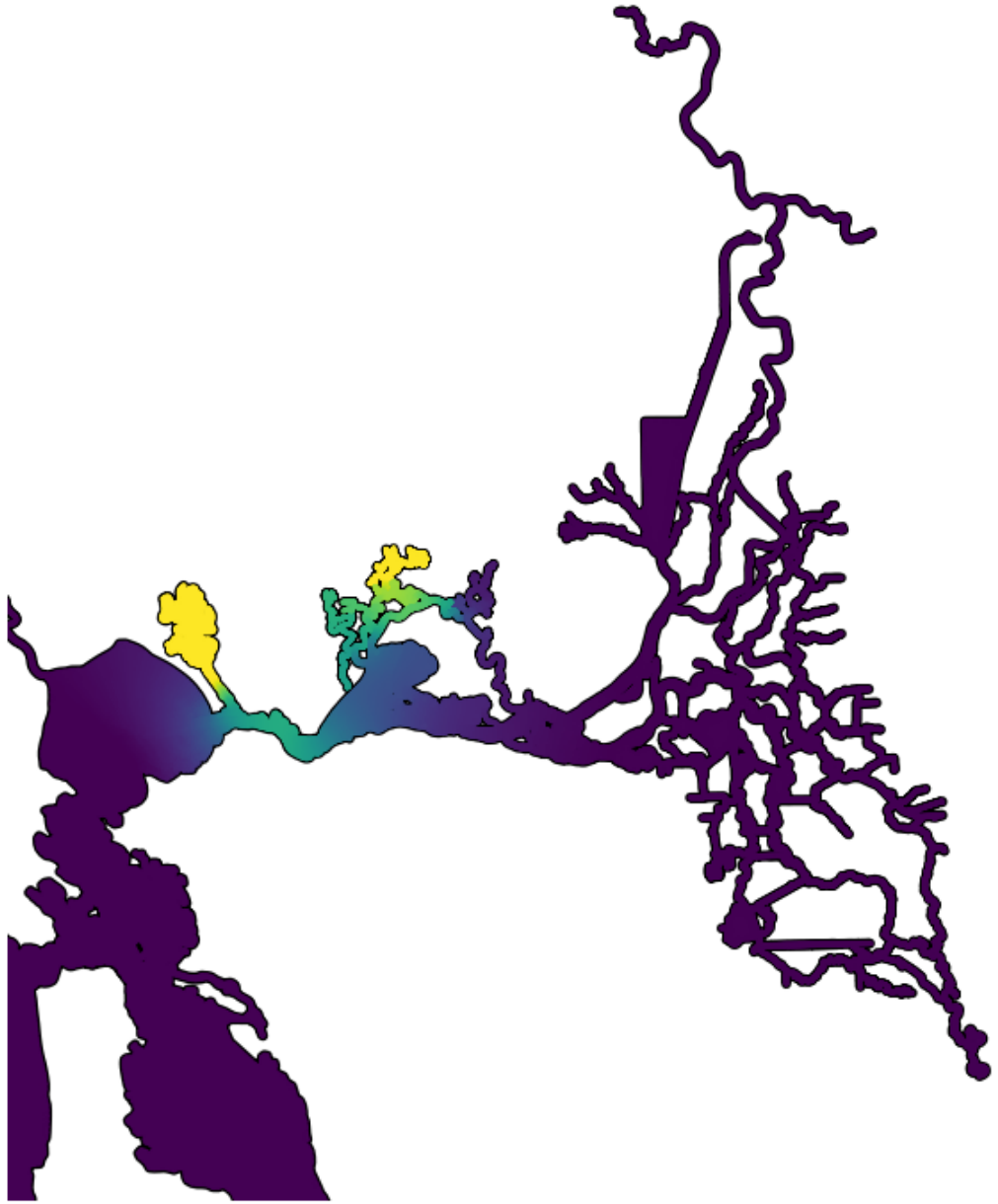
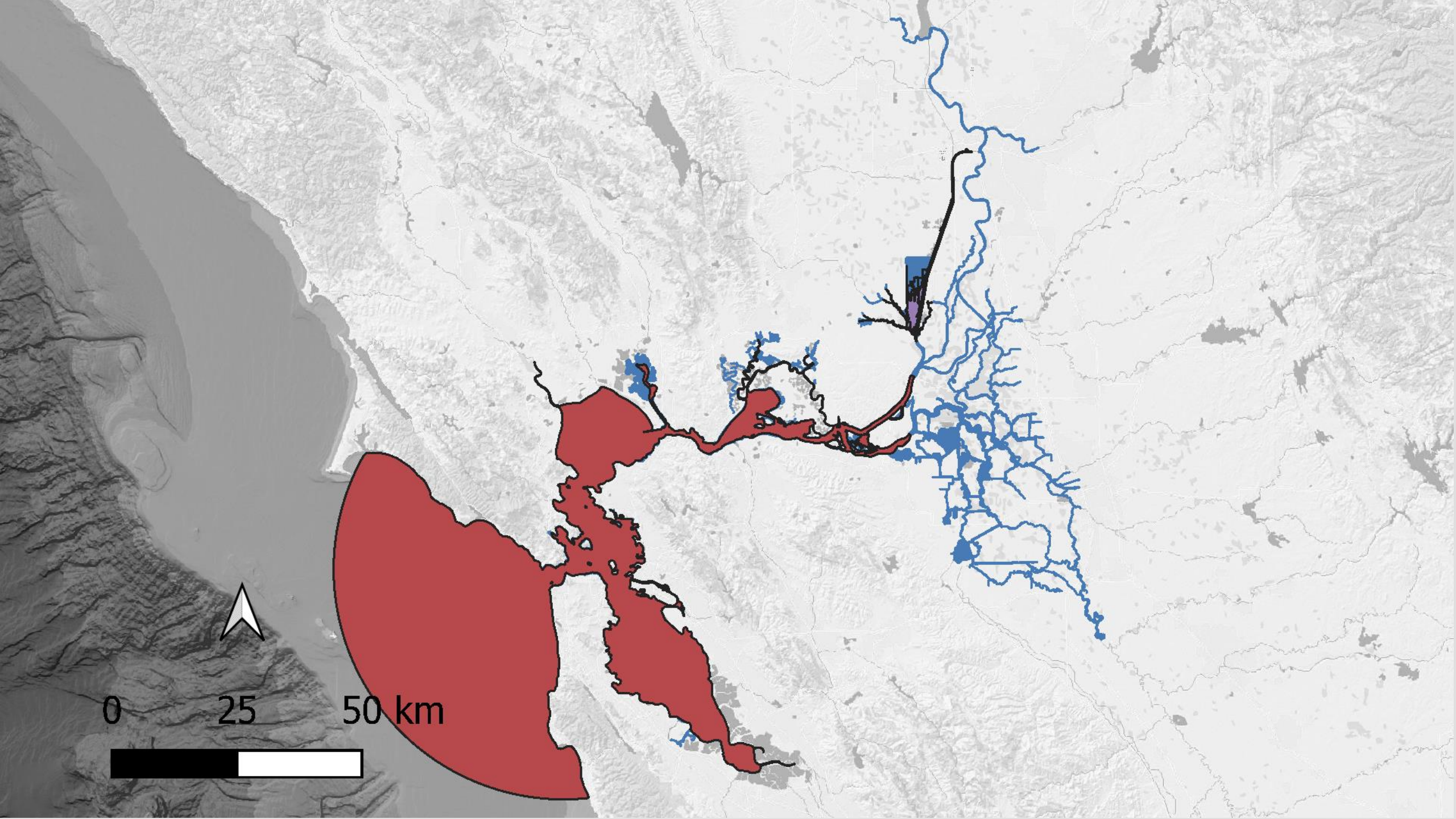
Corbicula



Potamocorbula

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