Three-Dimensional Chemical Transport Modeling of Selenium in the San Francisco Bay-Delta

James M. Bishop
Robin Stewart
Lisa V. Lucas
U.S. Geological Survey - National Research Program

Why selenium?

- Toxic contaminant shown to cause impairment in aquatic species primarily through dietary exposure.

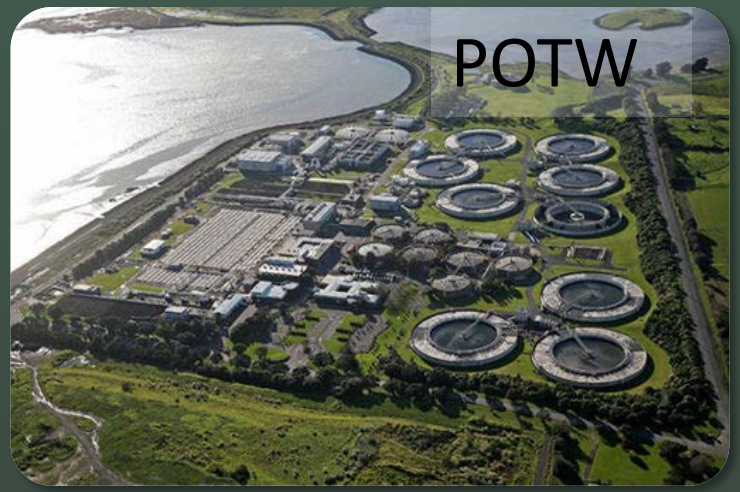
- Newly developed State TMDL recently put in effect and revised EPA criteria currently in development for Se.

Image: Monterey Bay Aquarium

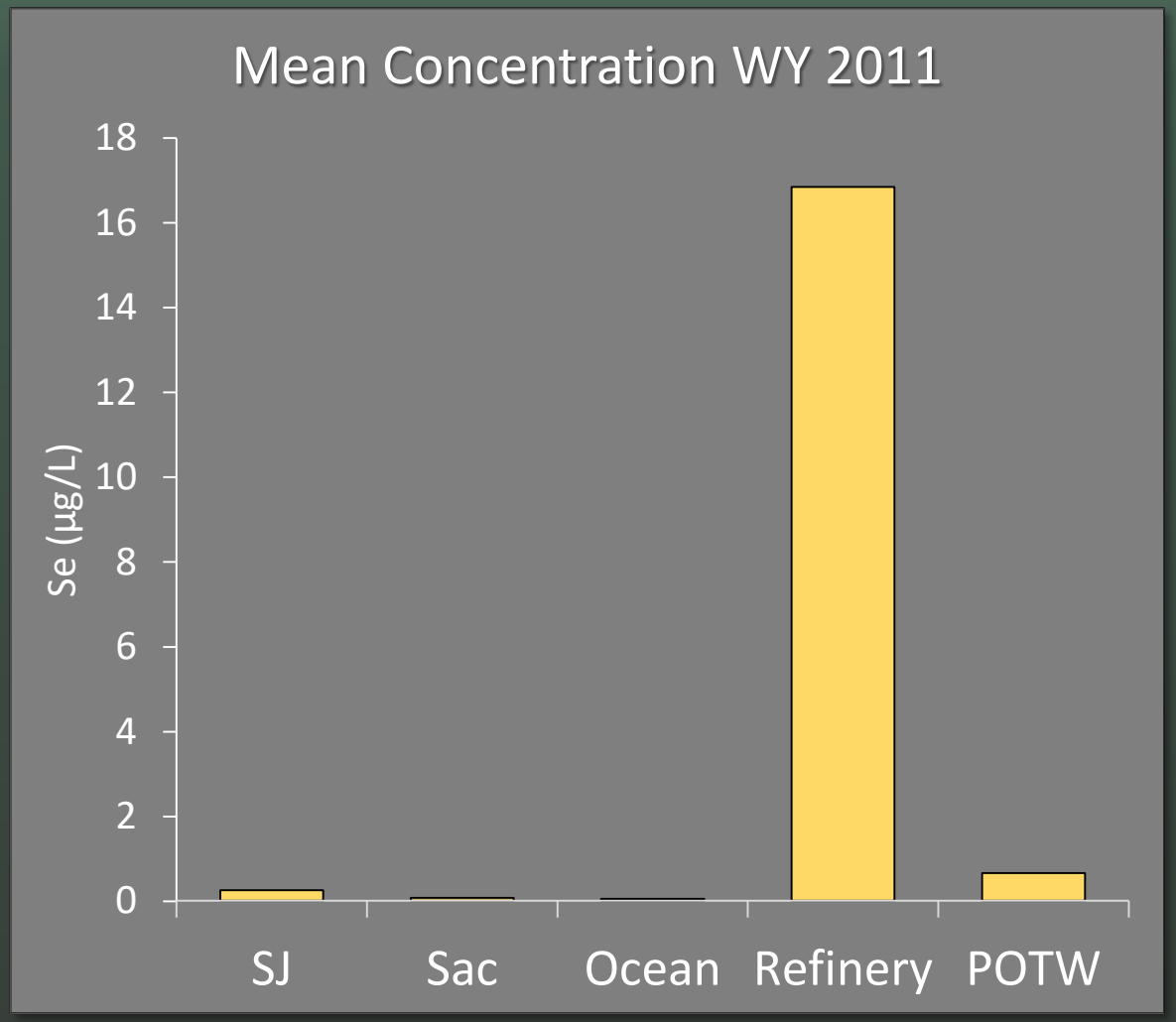
Image: Monterey Trail HS

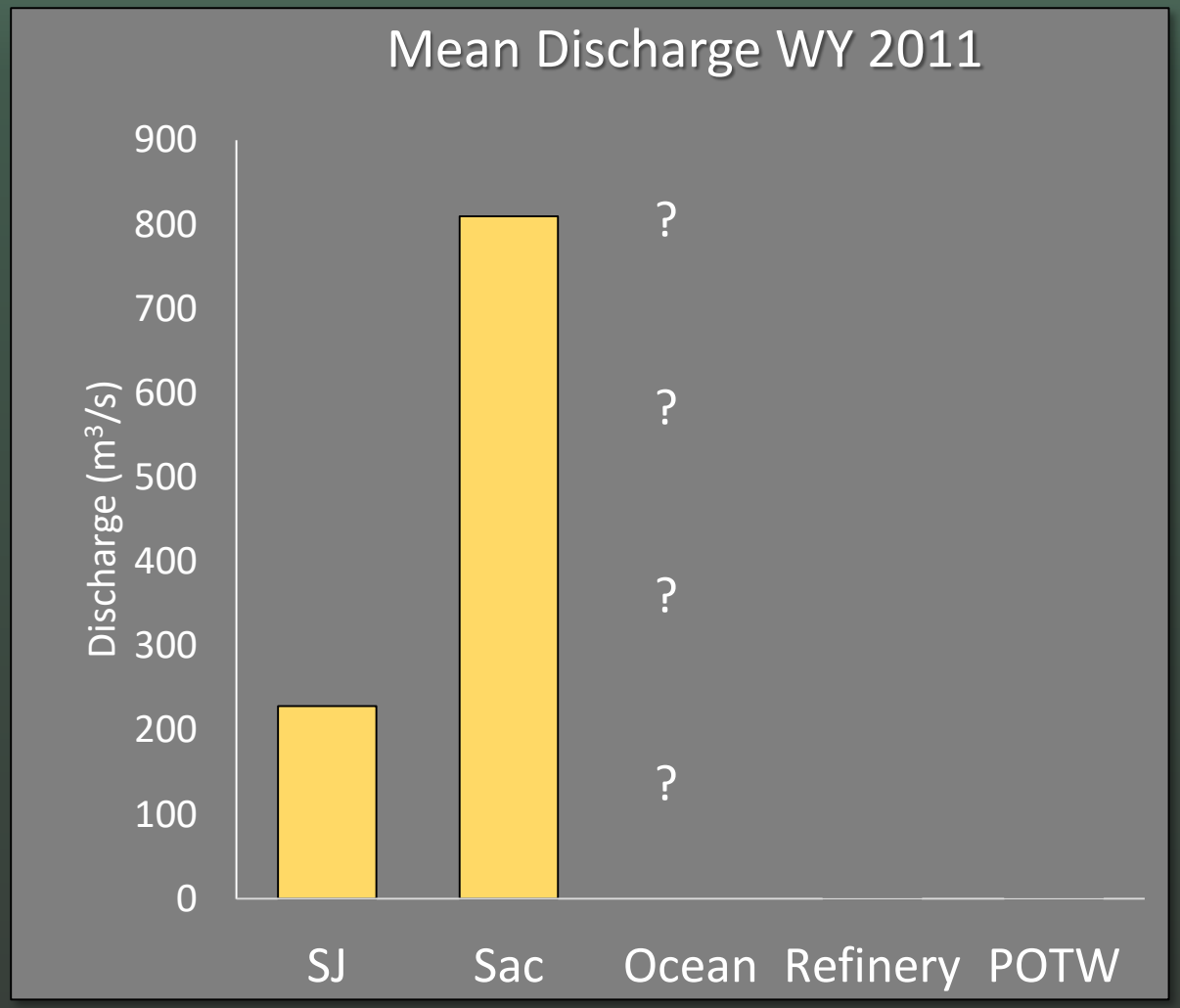
Image: Cal. Dept. Water Res.

Sources of Se to SF Bay/Delta

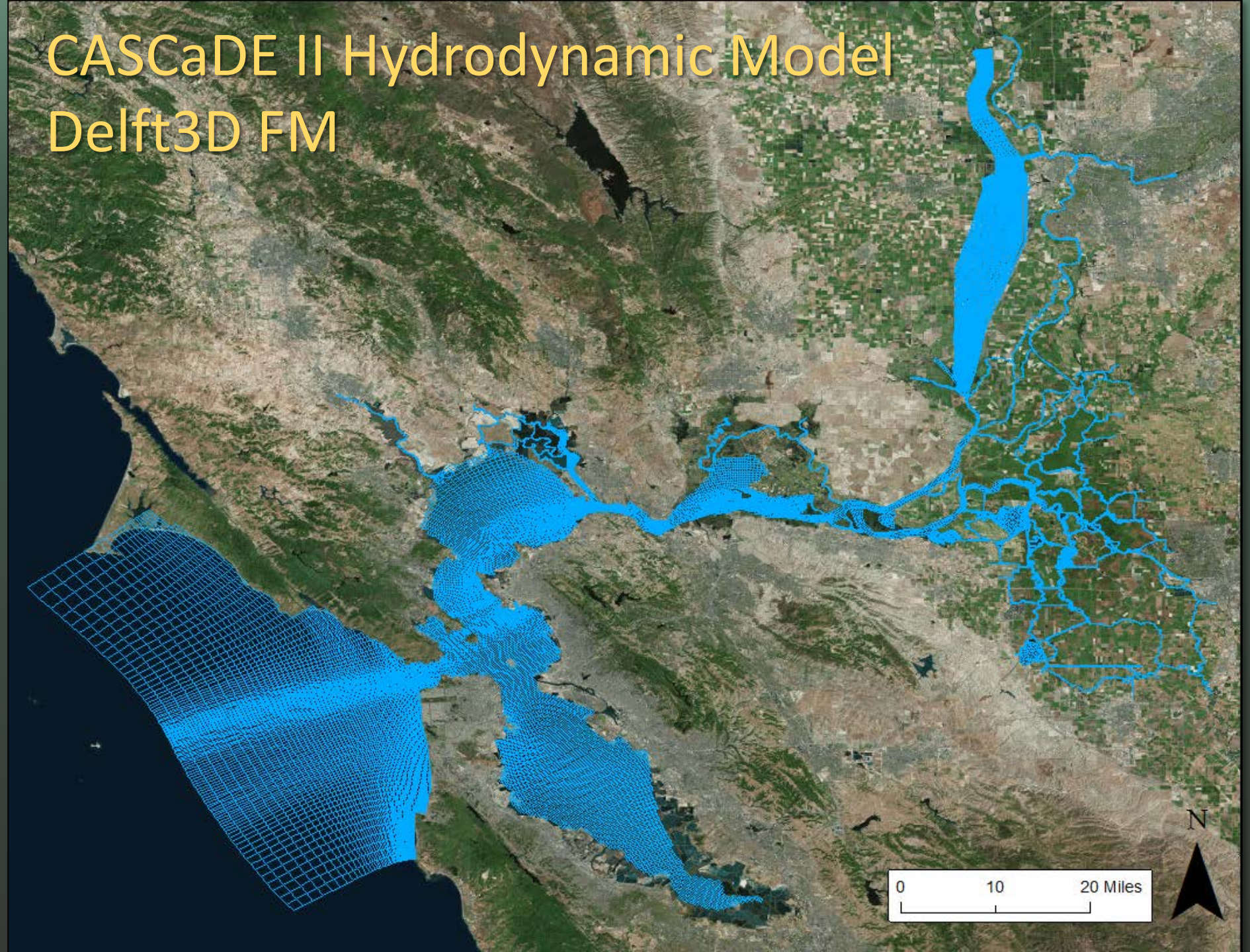


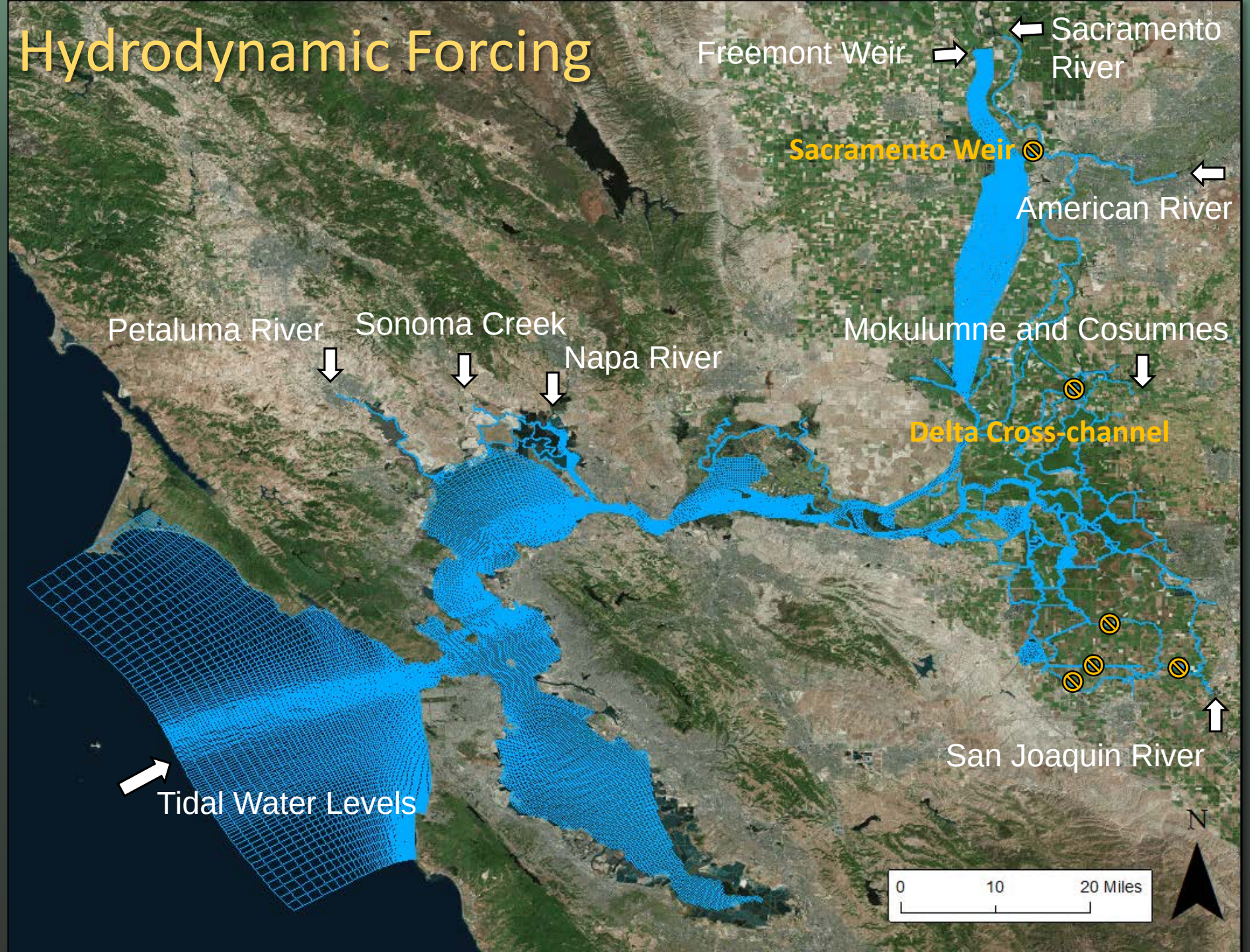
Source variability in concentration and discharge

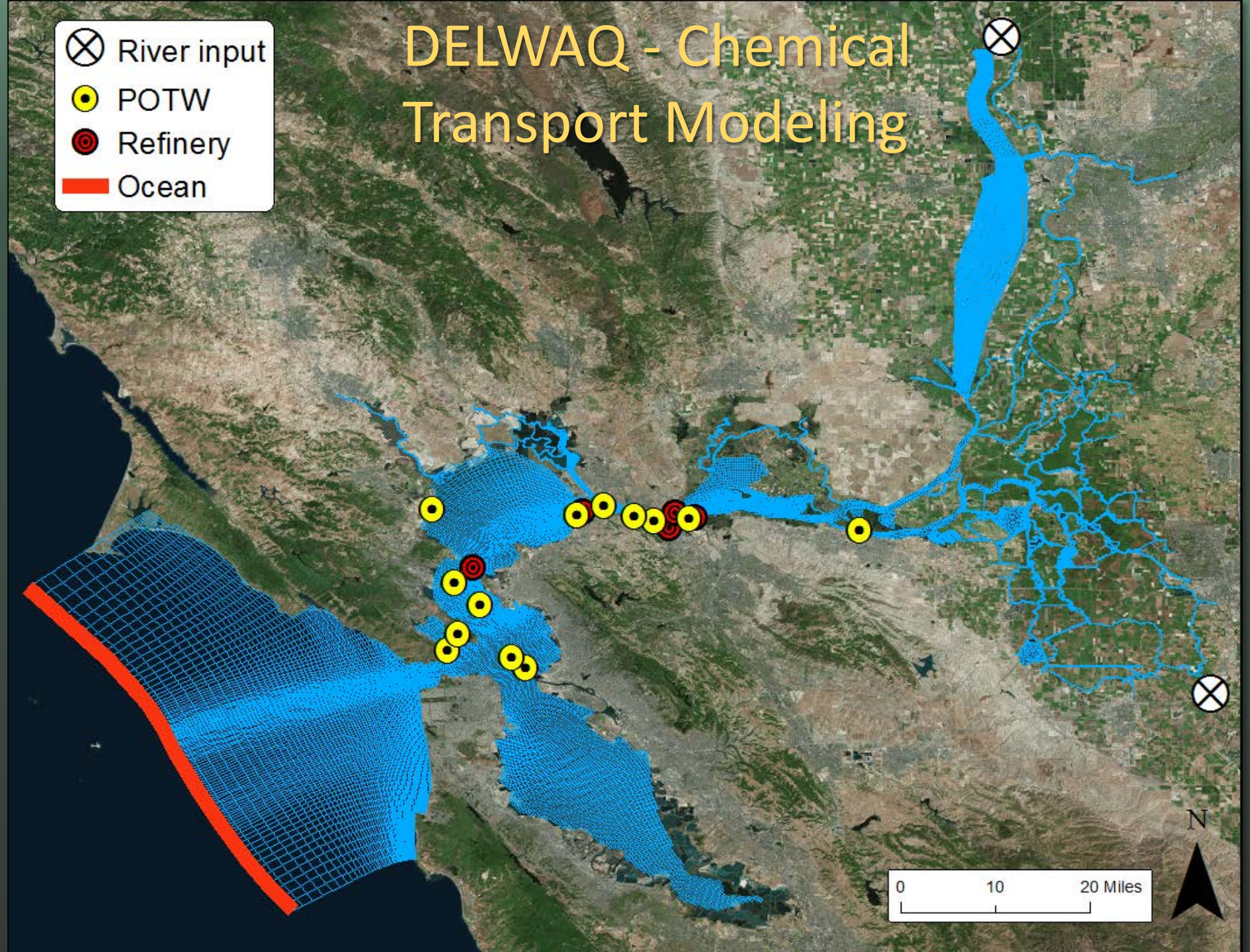




CASCaDE II Hydrodynamic Model
Delft3D FM




Hydrodynamic Forcing
Freemont Weir
Sacramento River
Sacramento Weir
American River
Petaluma River
Sonoma Creek
Napa River
Mokulumne and Cosumnes
Delta Cross-channel
San Joaquin River
Tidal Water Levels
N
0
10
20 Miles

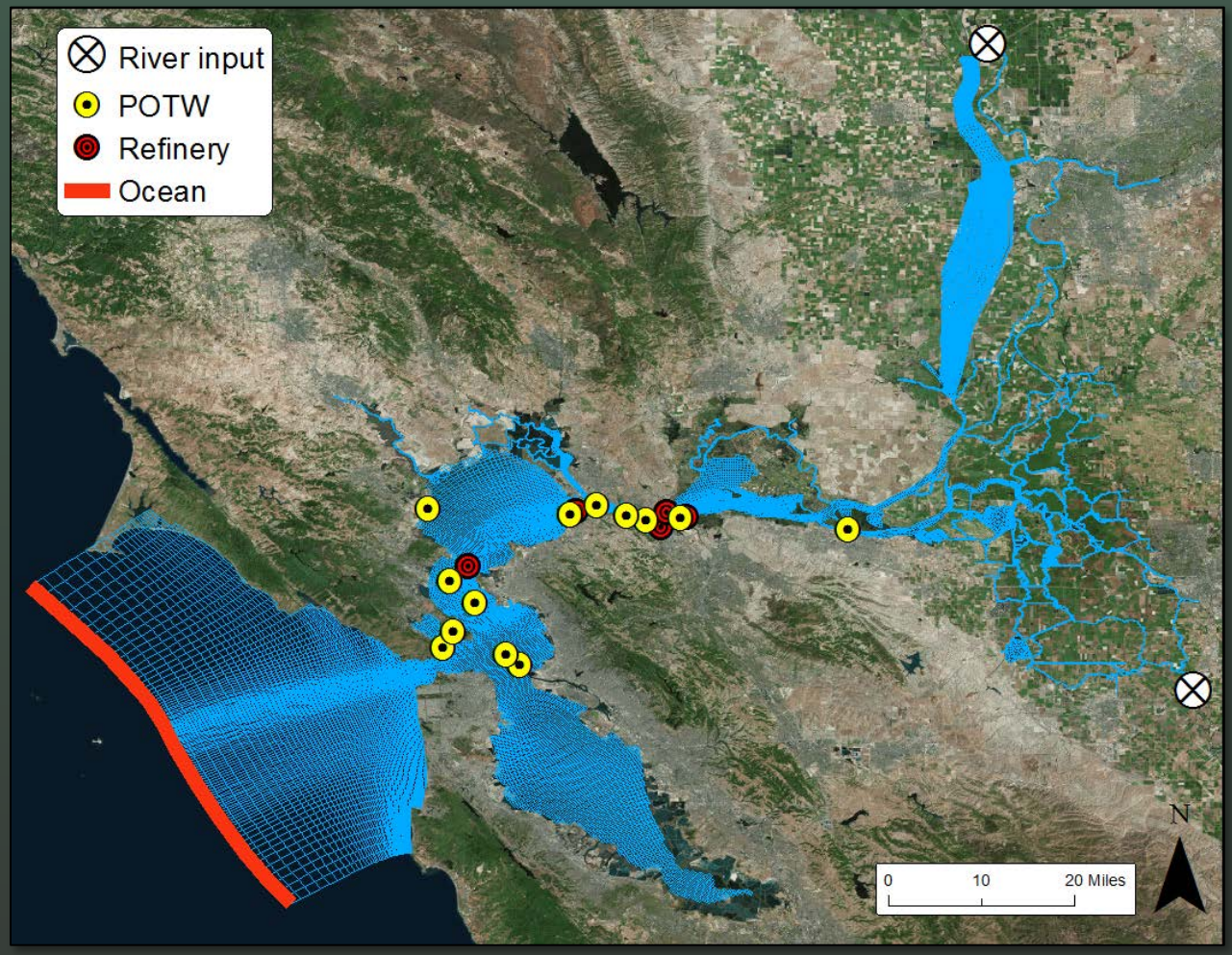

River input
POTW
Refinery
Ocean
DELWAQ - Chemical Transport Modeling
N
0
10
20 Miles

Chemical Transport Input Data

Rivers – Monthly Se concentrations from USGS gages at Freeport and Vernalis

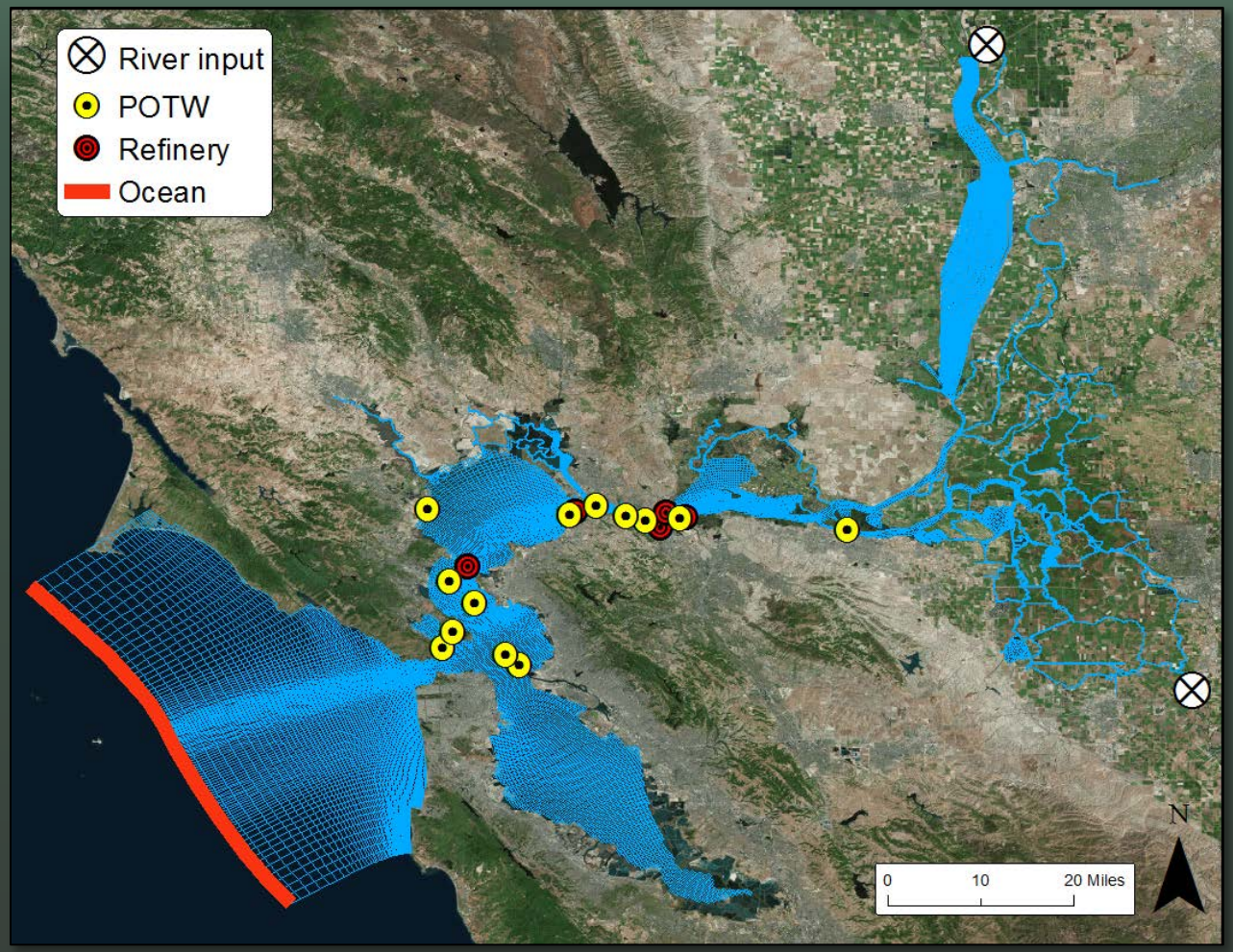
Refinery and POTW – sub-monthly to annual concentrations and discharges from State Water Board (B. Baginska)

Ocean – Discrete concentration (0.059 ug/L, Cutter and Bruland, 1984)



Model Assumptions

- Total dissolved Se (non-speciated)
- Conservative Transport

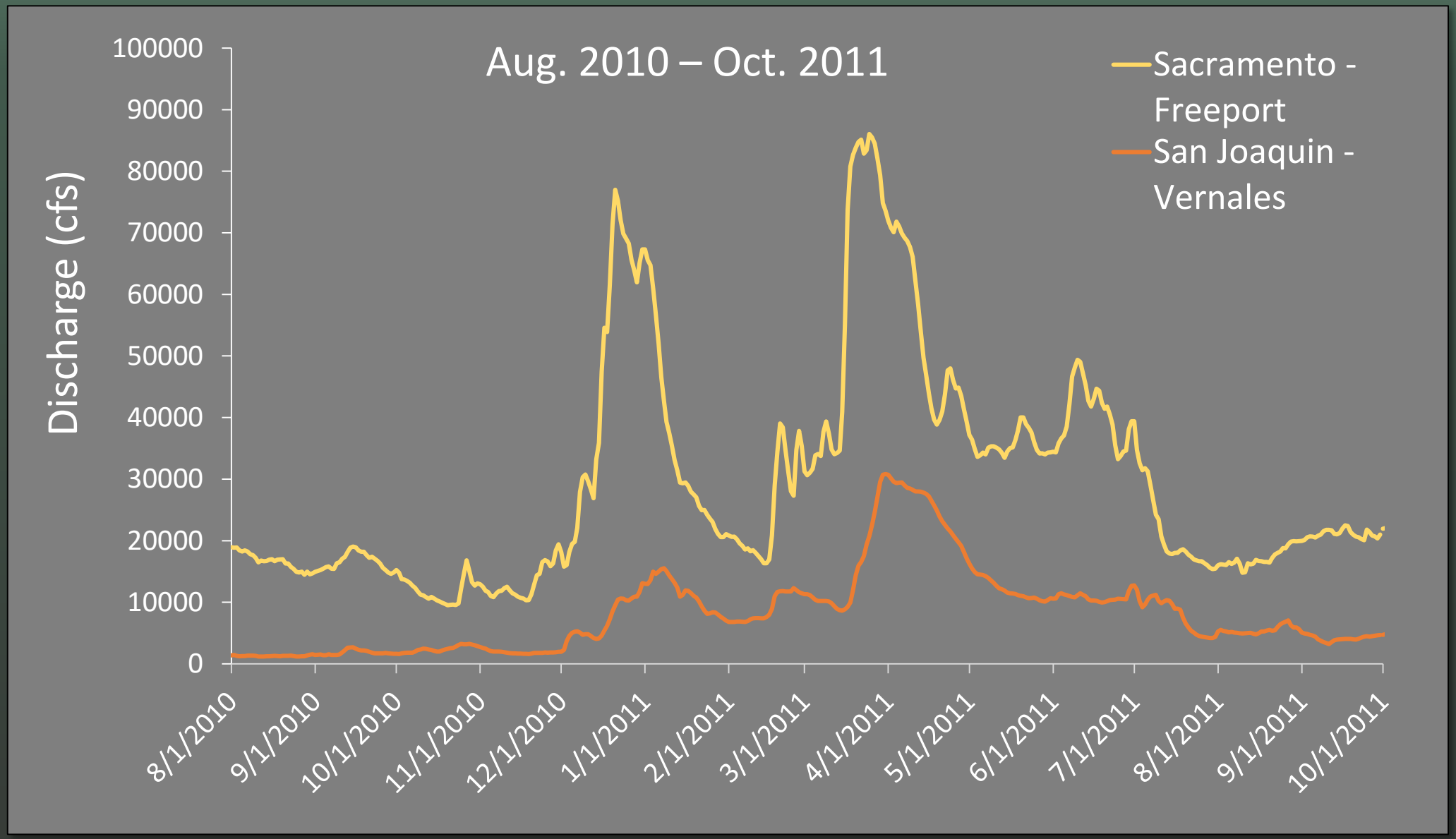


Research Questions:

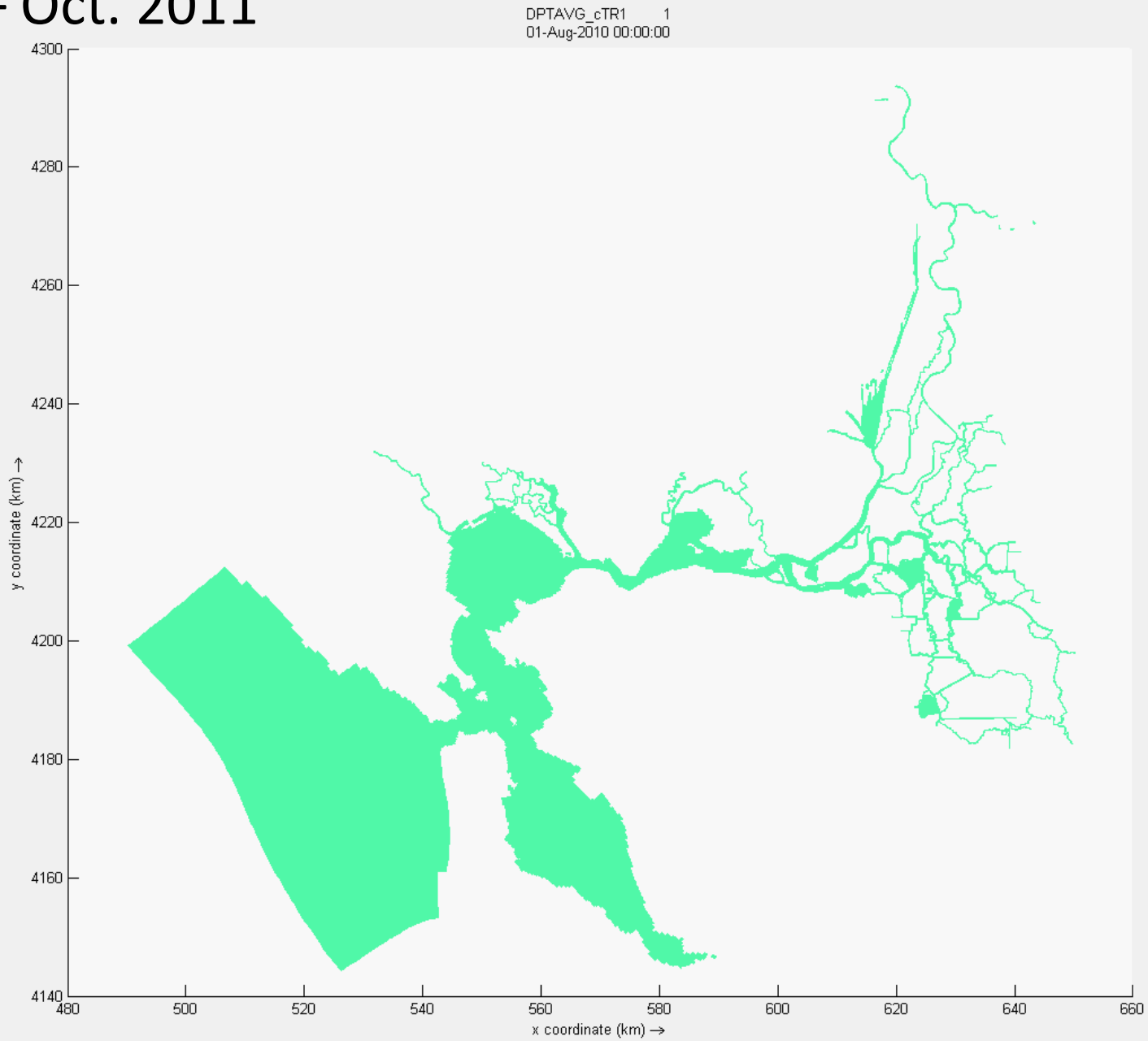
Do Se sources and 3D transport processes help explain the spatial and temporal variability in Se concentrations in biota?

What are the dominant sources of Se in space and time?

Hydrologic Conditions



Aug. 2010 – Oct. 2011



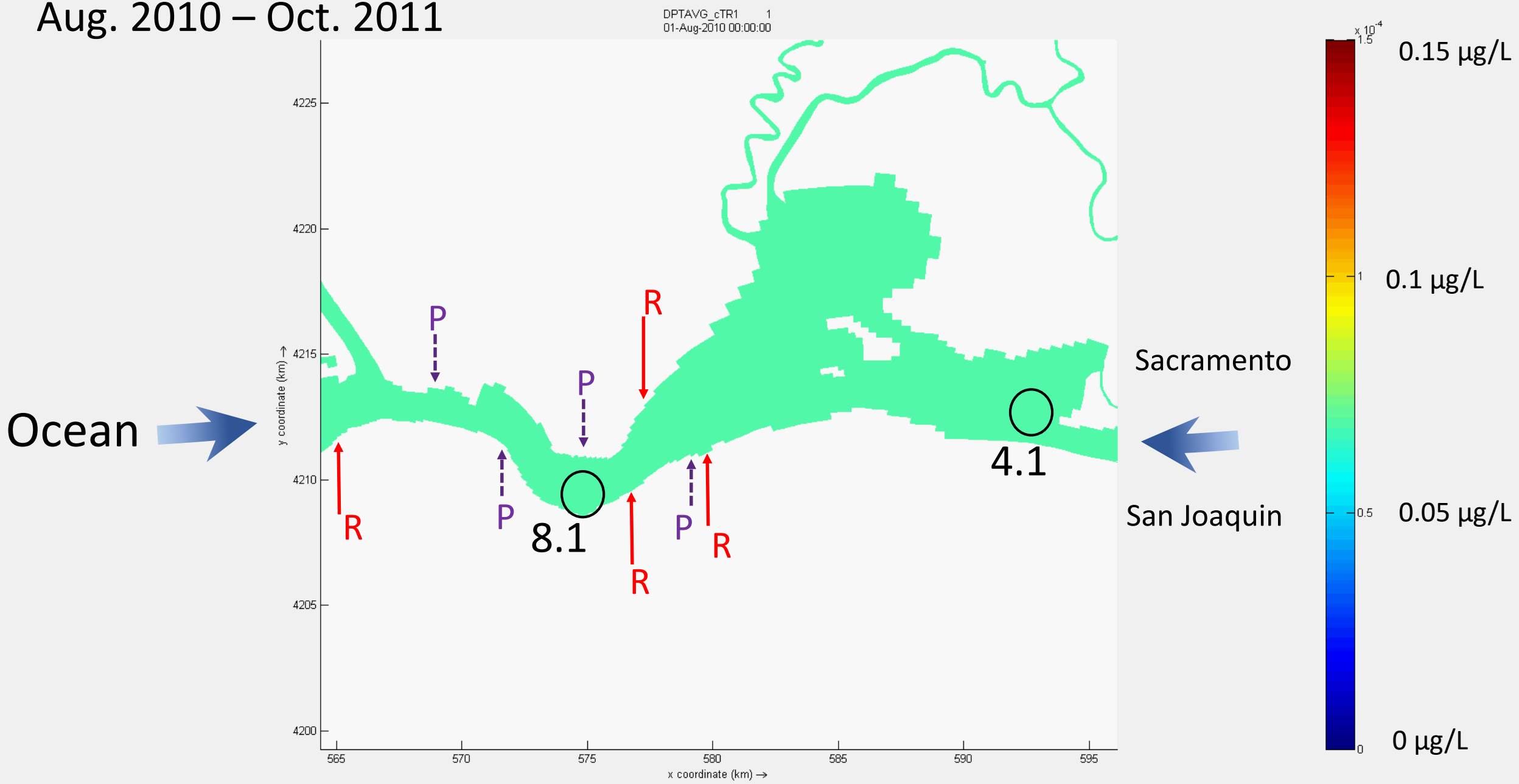
0.15 µg/l

0.10 µg/l

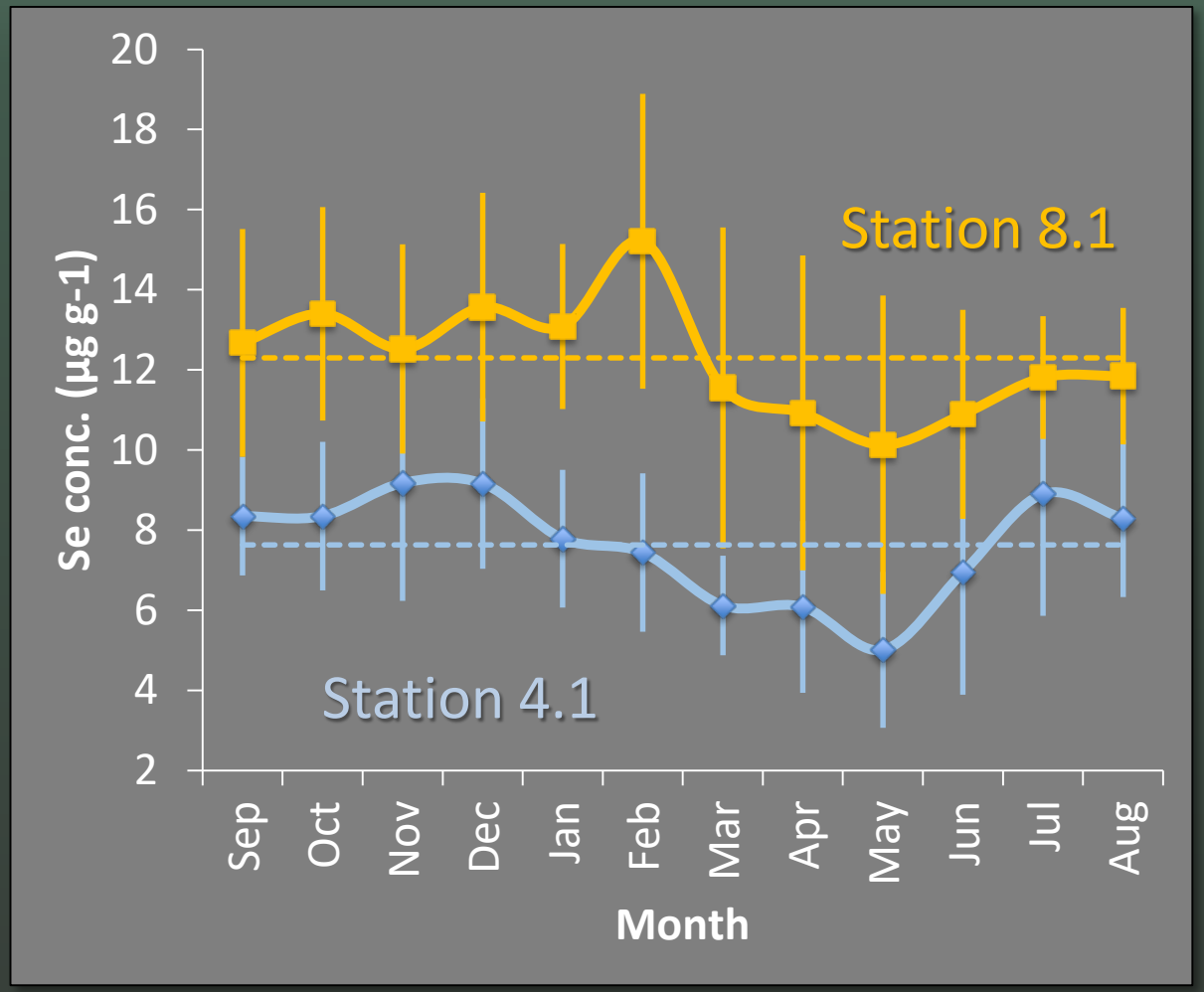
0.05 µg/l

0 µg/l

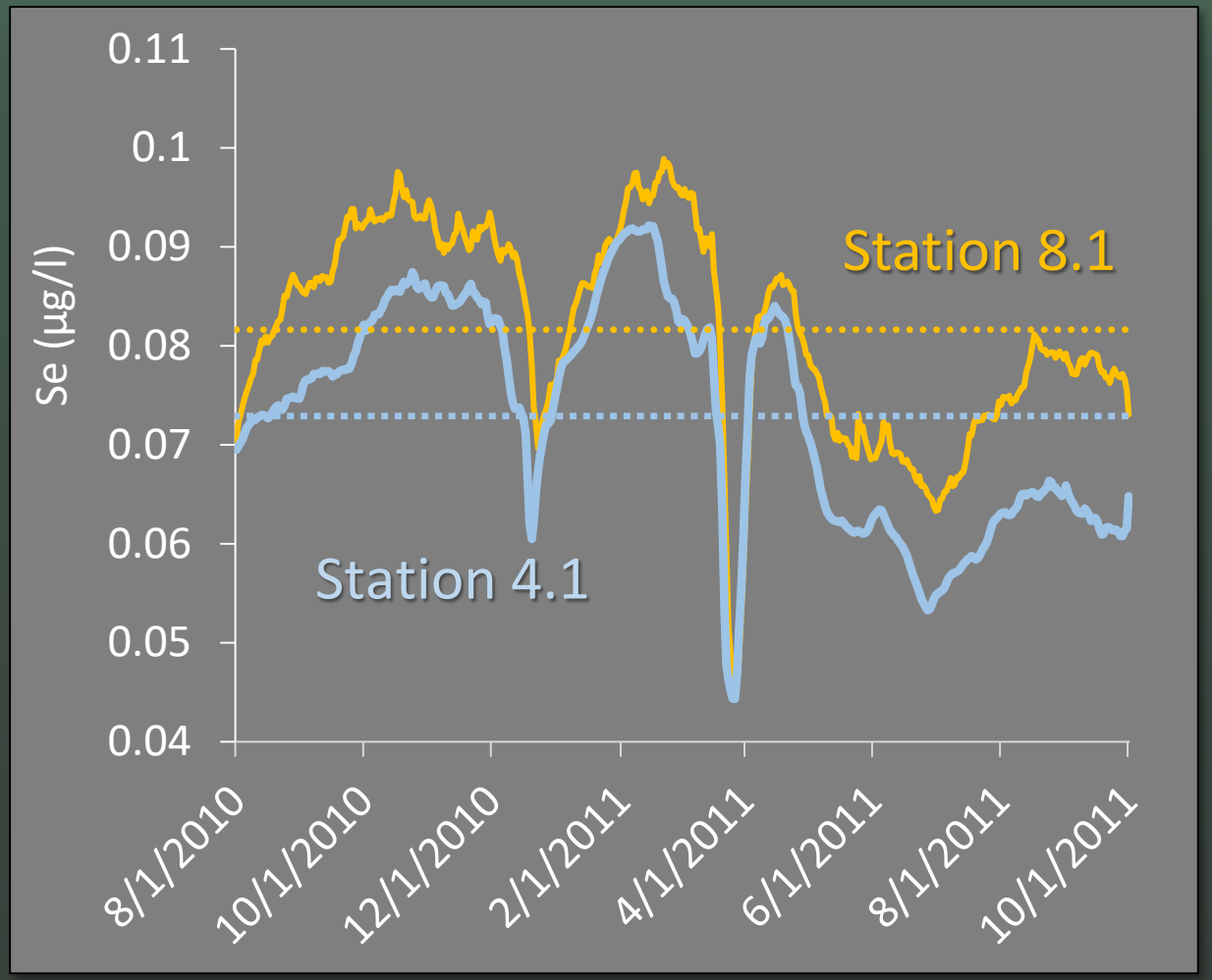
Aug. 2010 – Oct. 2011



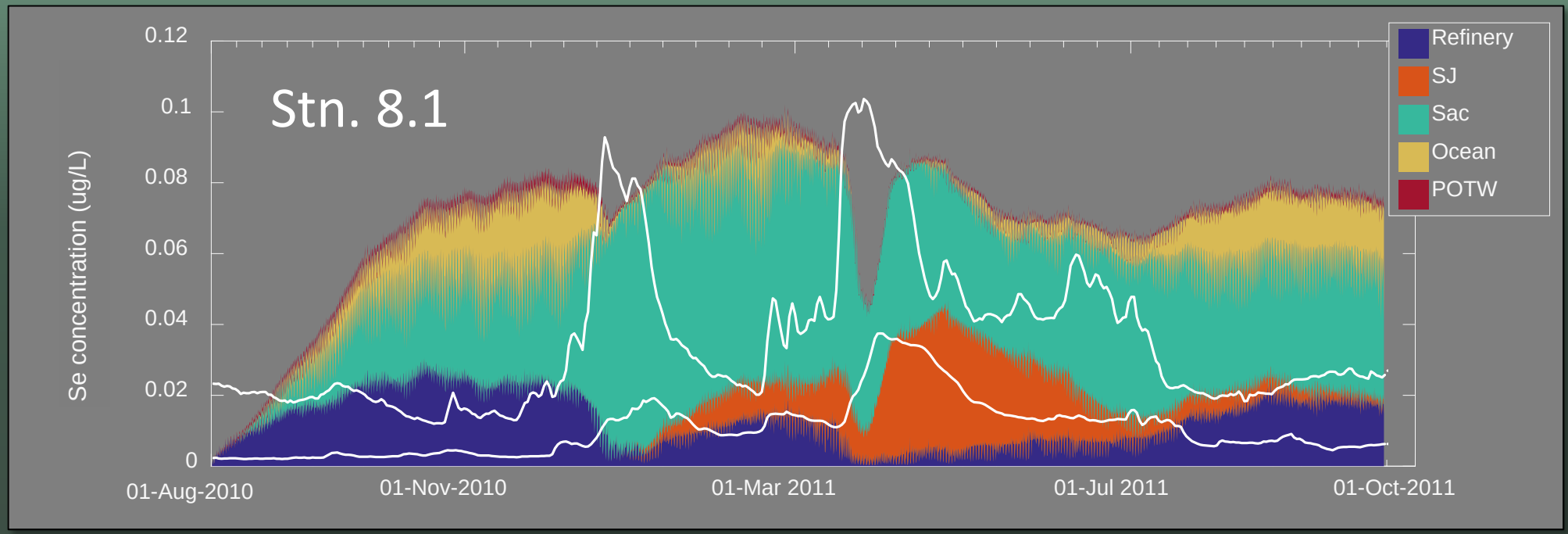
Measured clam tissue Se concentration (17 yr. record)

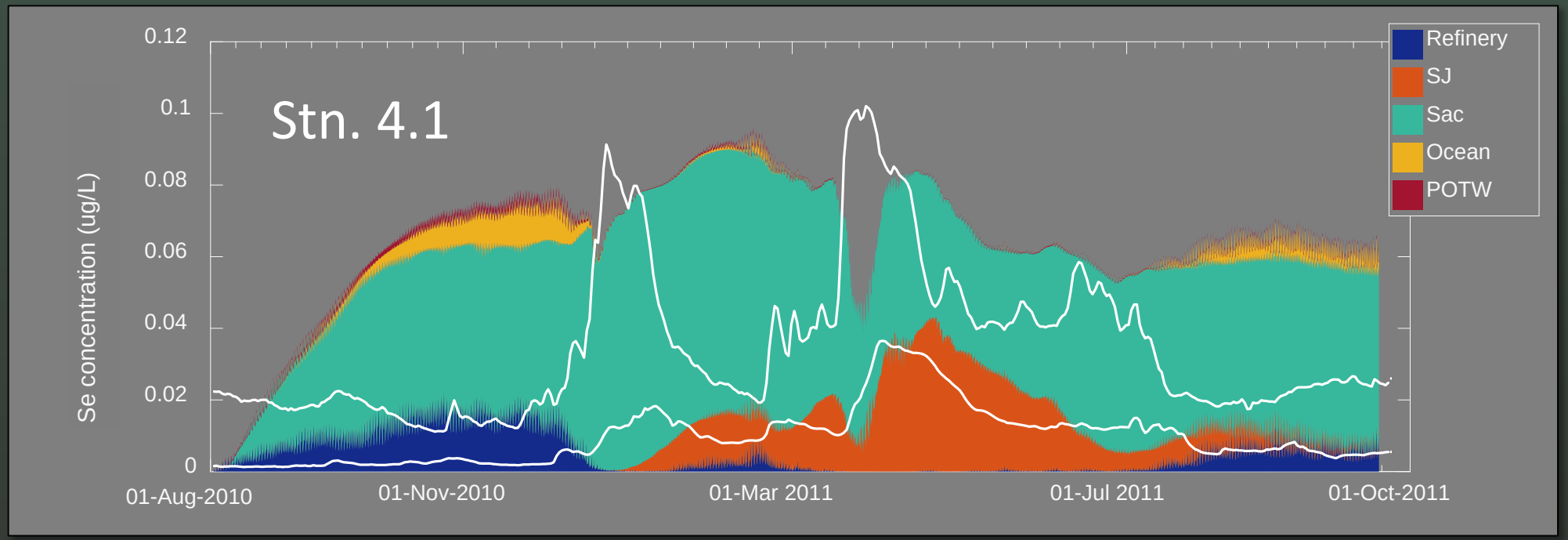


Modeled bottom water Se concentration (WY 2011)



(Stewart et al., 2013)


Stn. 8.1
Se concentration (ug/L)
0.12
0.1
0.08
0.06
0.04
0.02
0
01-Aug-2010
01-Nov-2010
01-Mar 2011
01-Jul 2011
01-Oct-2011
Refinery
SJ
Sac
Ocean
POTW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0.08
0.06
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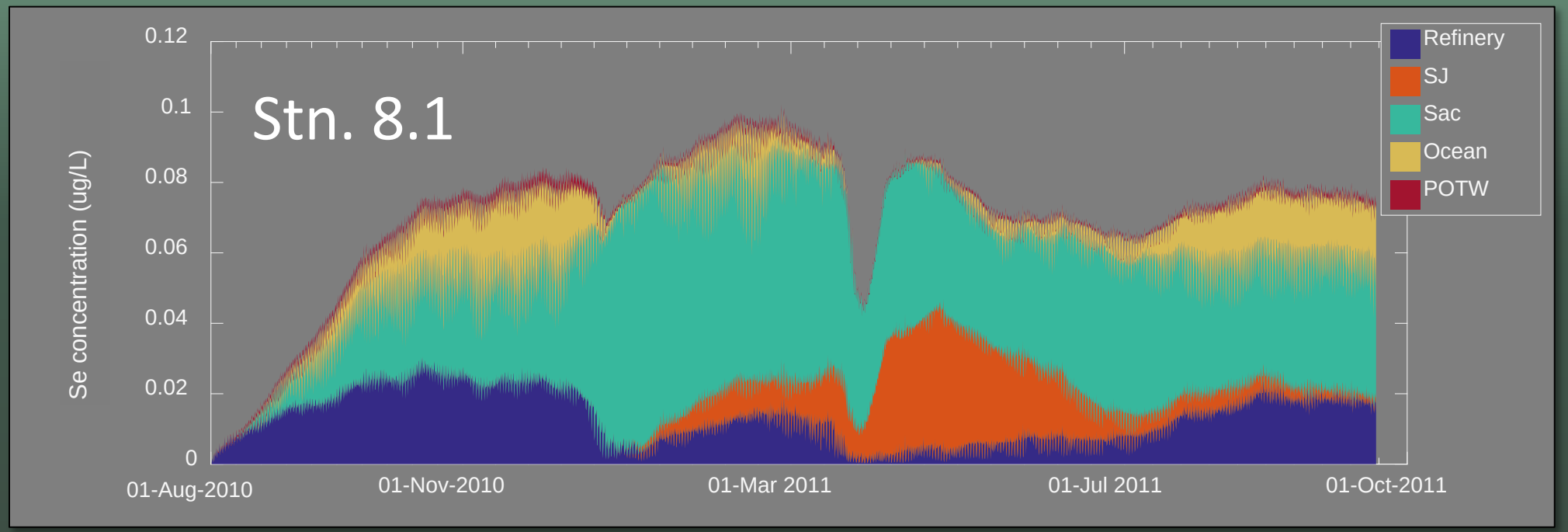
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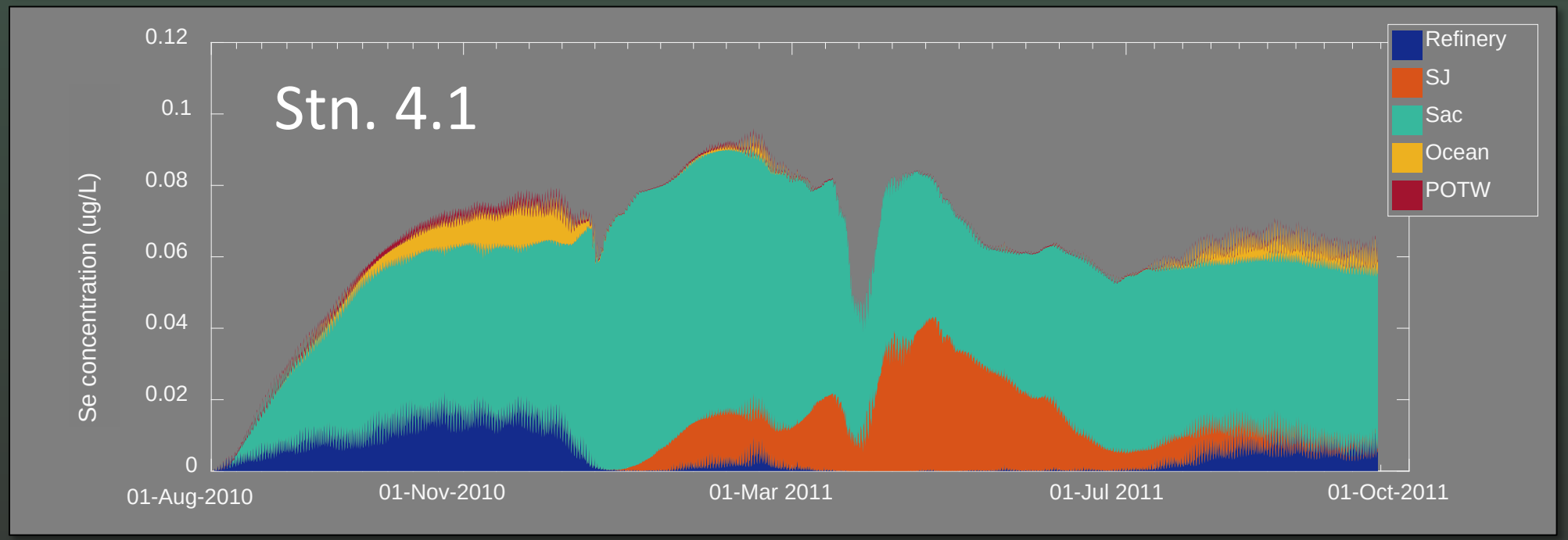
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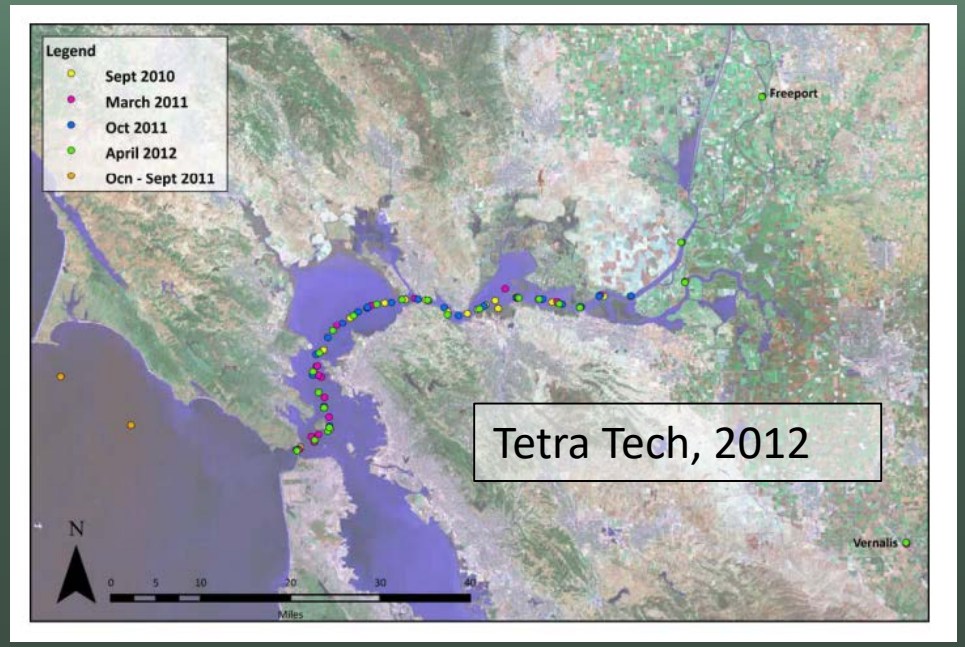
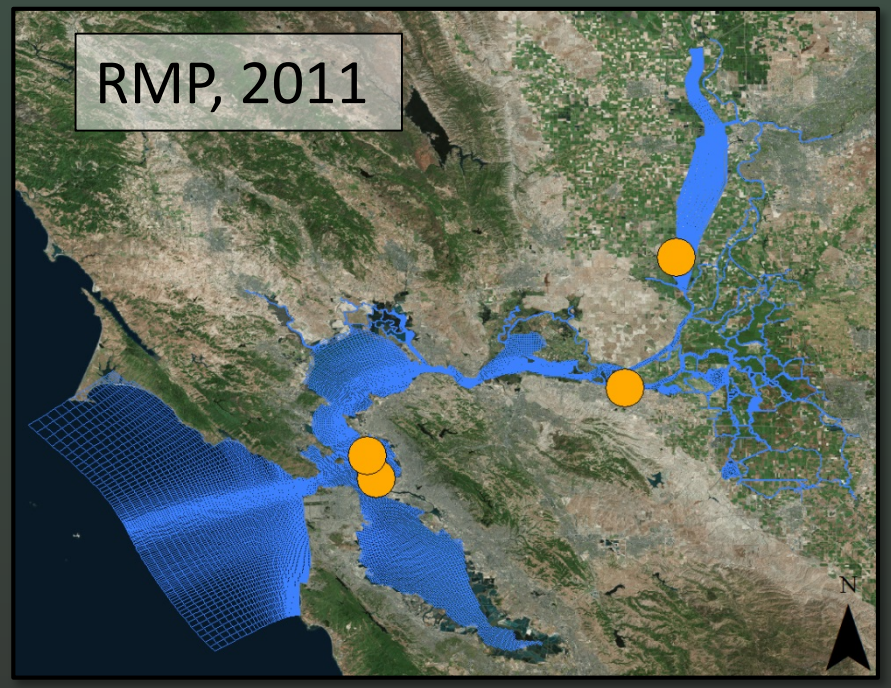
Model Validation

- Sparse validation data available
- Initial results indicate modeled concentrations are low by ~ 10-50%



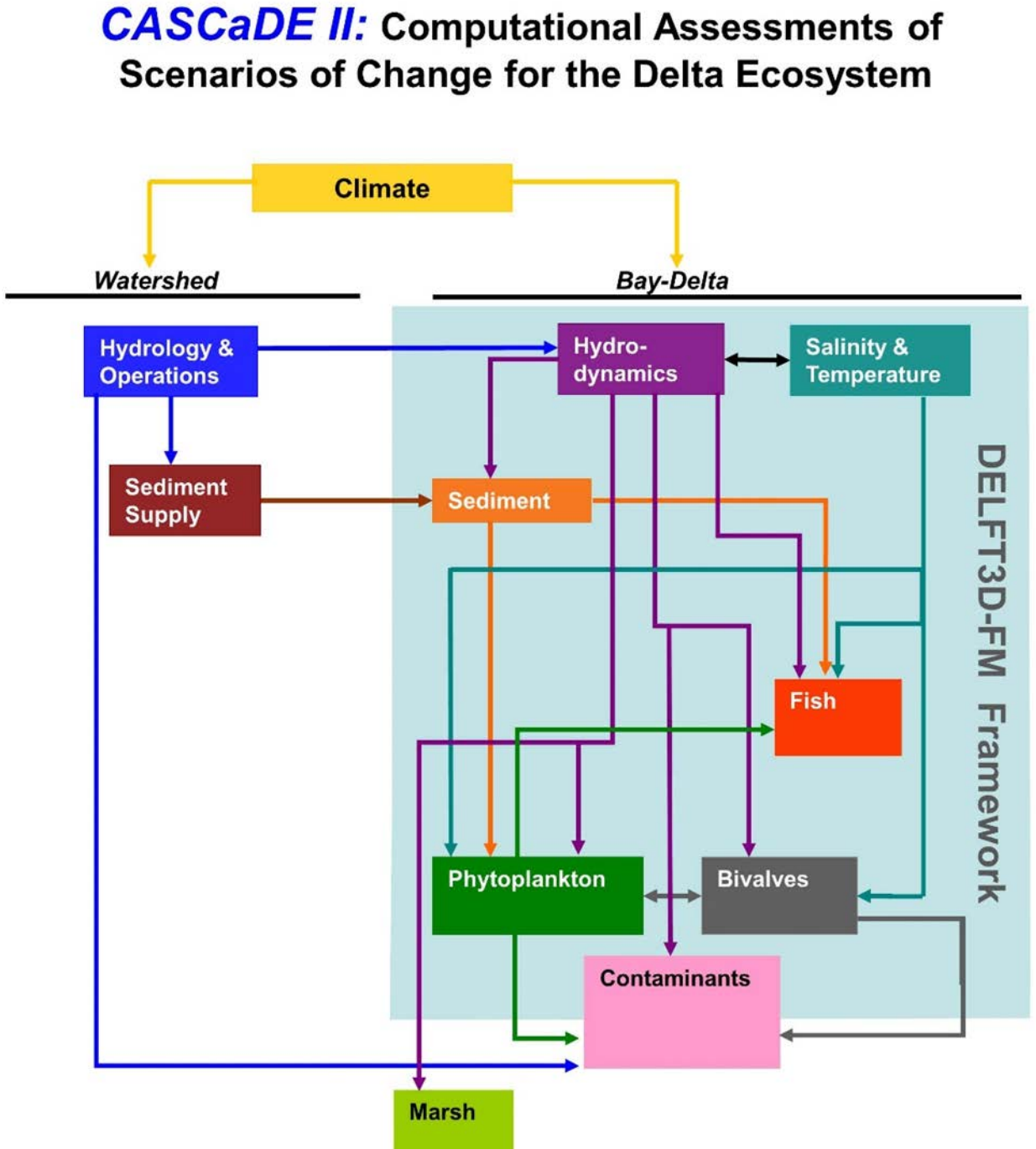


Moving forward:

- Integrate with phytoplankton and habitat models

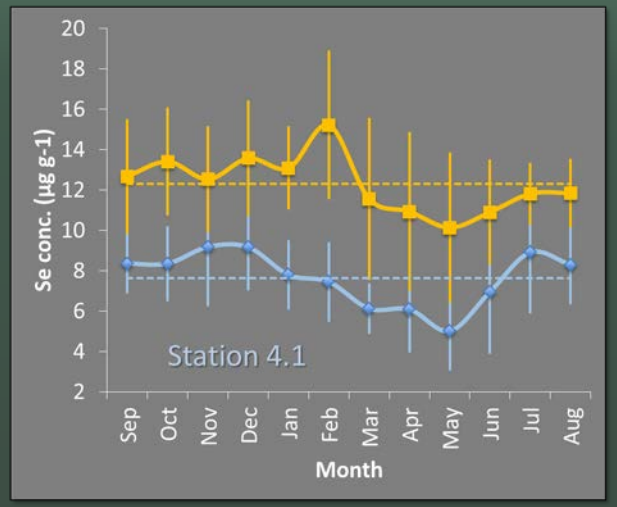
Short term goals:

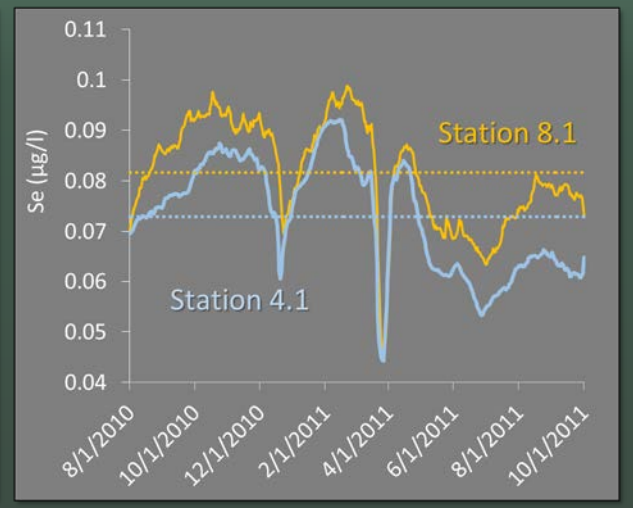
- Add additional Se sources
- Complete runs for 2012
- Validate concentrations with 2012 data



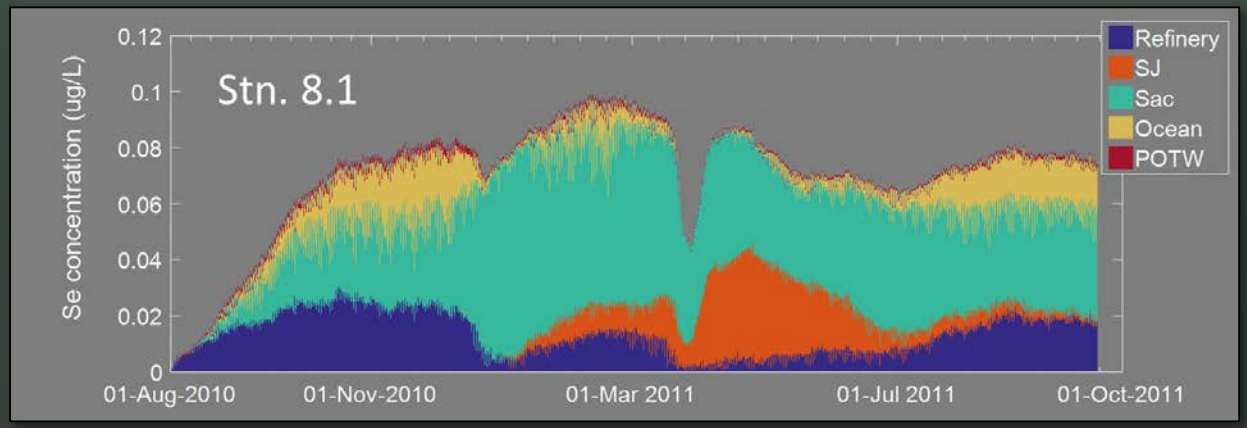
Conclusions:

Conservative transport DOES help explain spatial and temporal variability in Se concentrations of biota.





San Joaquin River and Oil Refineries appear to contribute substantial above-background Se to biota – maybe seasonal.



Acknowledgements:

CASCaDE II
Rose Martyr-Koller - USGS
Barbara Baginska - State Water Board
Chris Eacock - USBR
Calvin Yang - SWAMP SWRCB

Thank you for listening! Questions?

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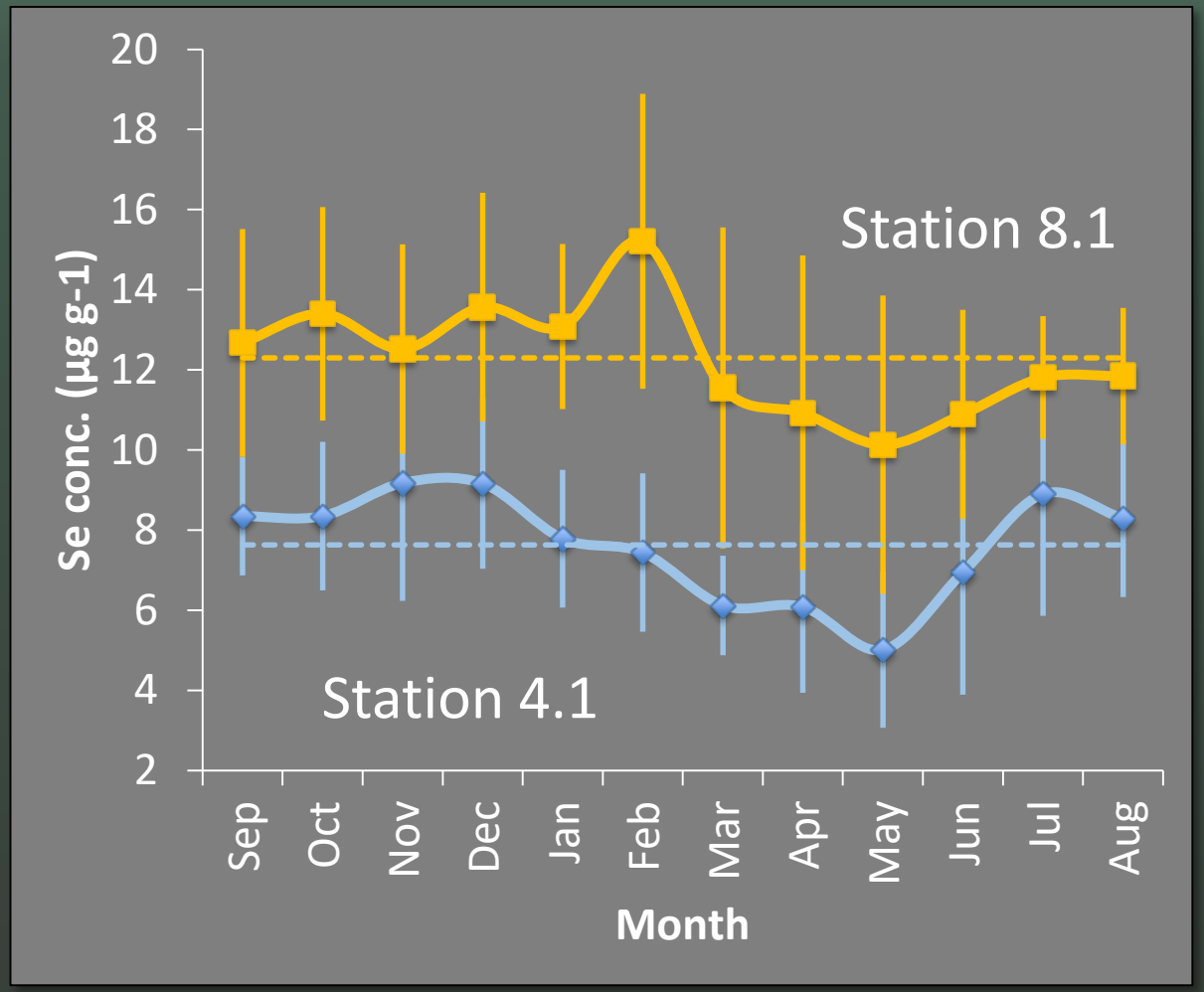

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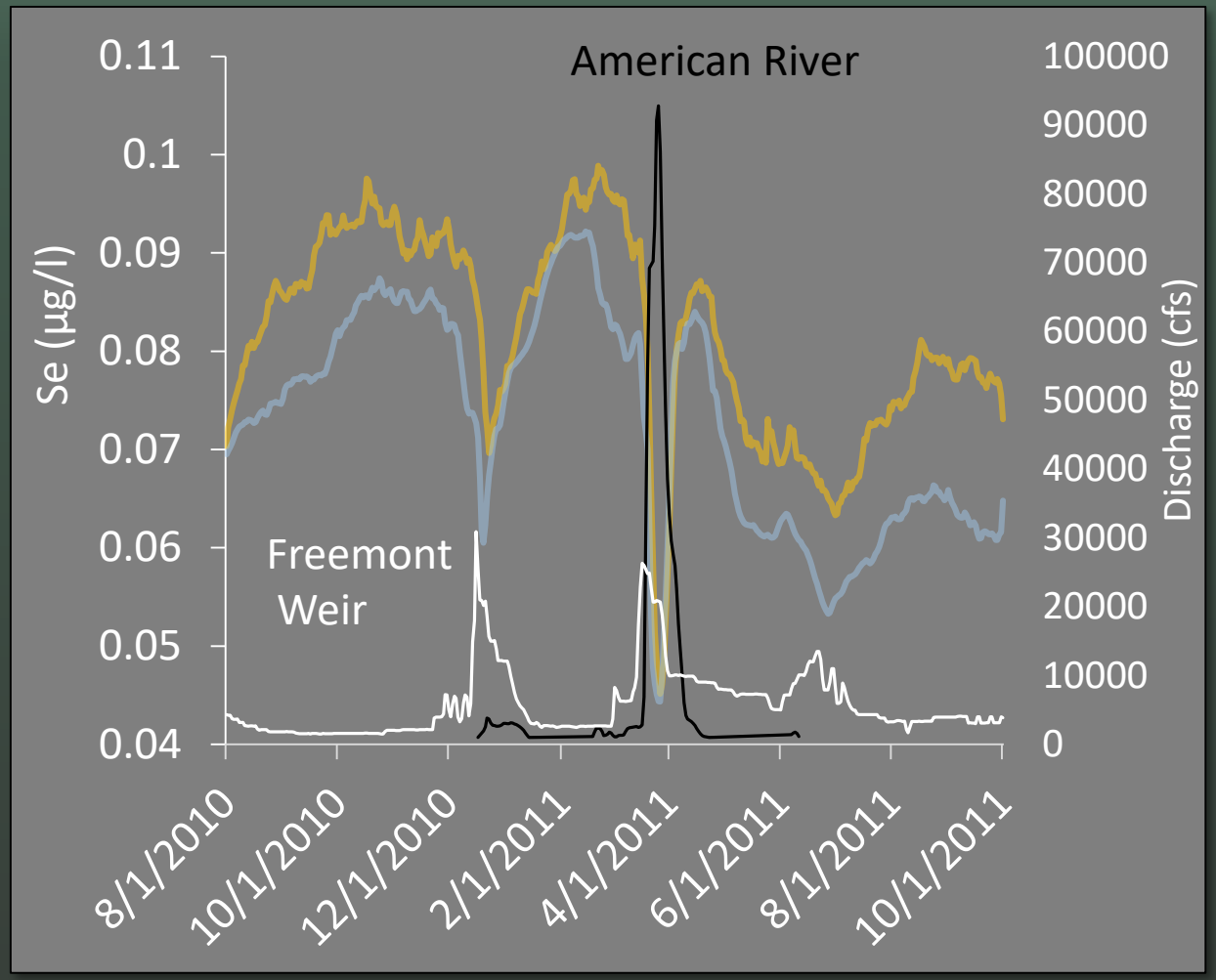
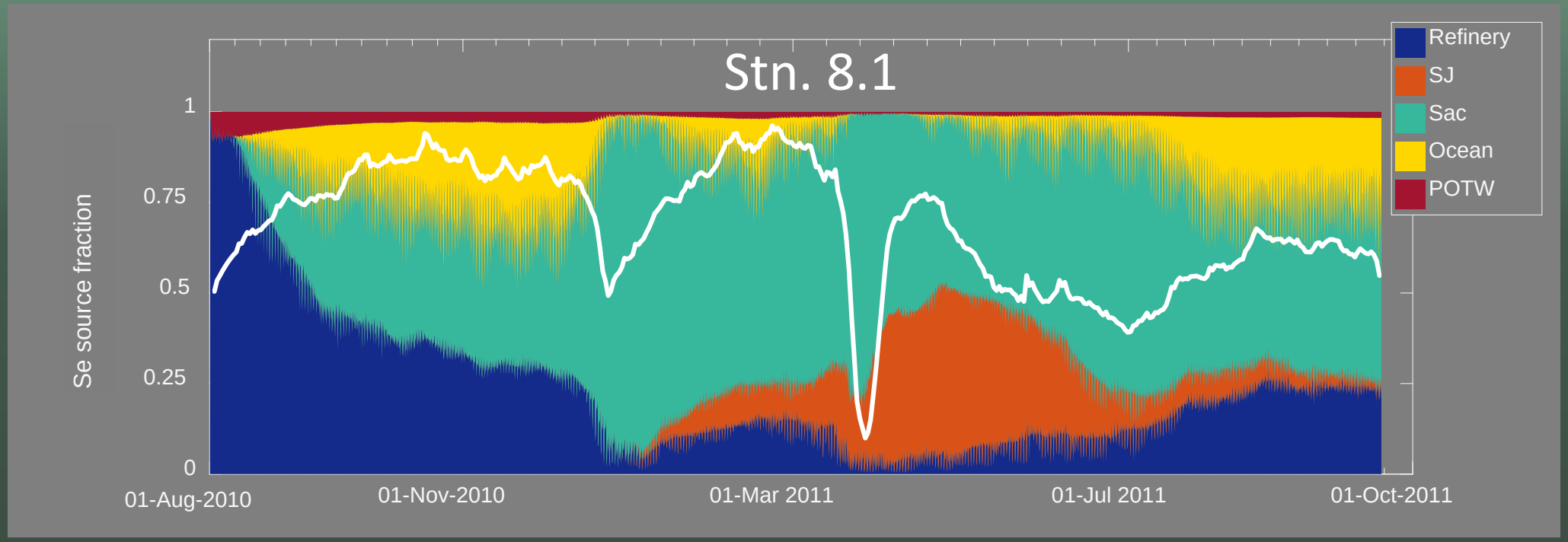


(Stewart et al., 2013)


Stn. 8.1
Se source fraction
1
0.75
0.5
0.25
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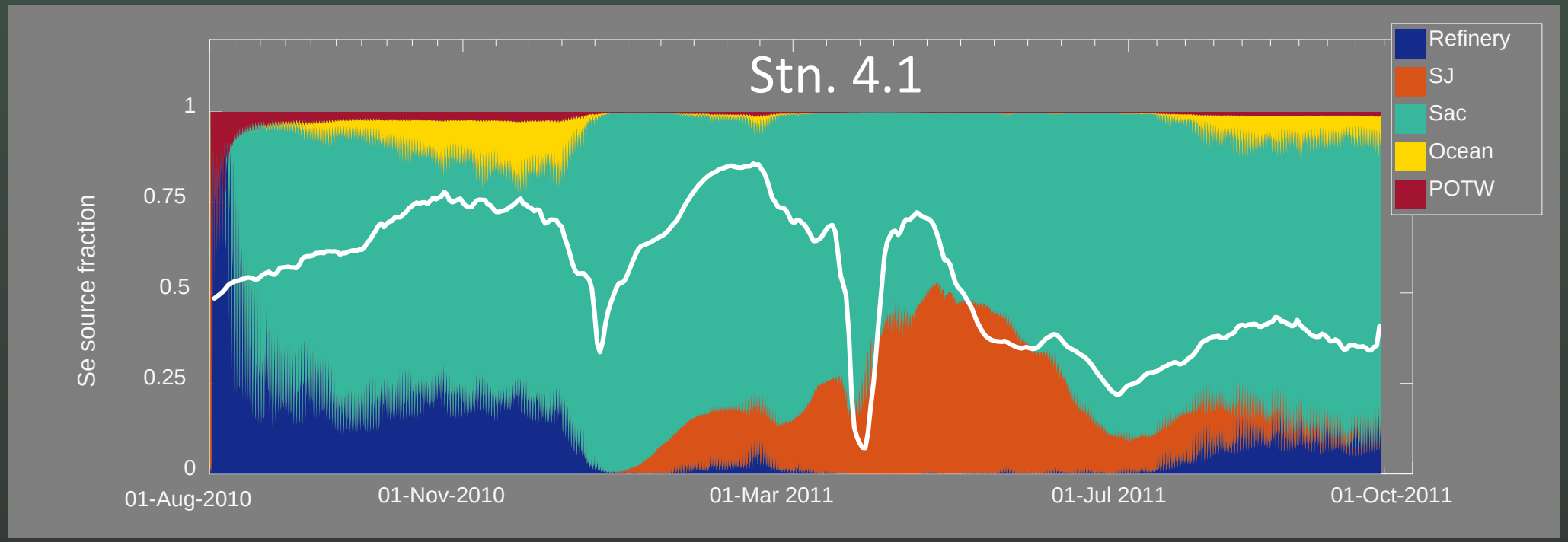
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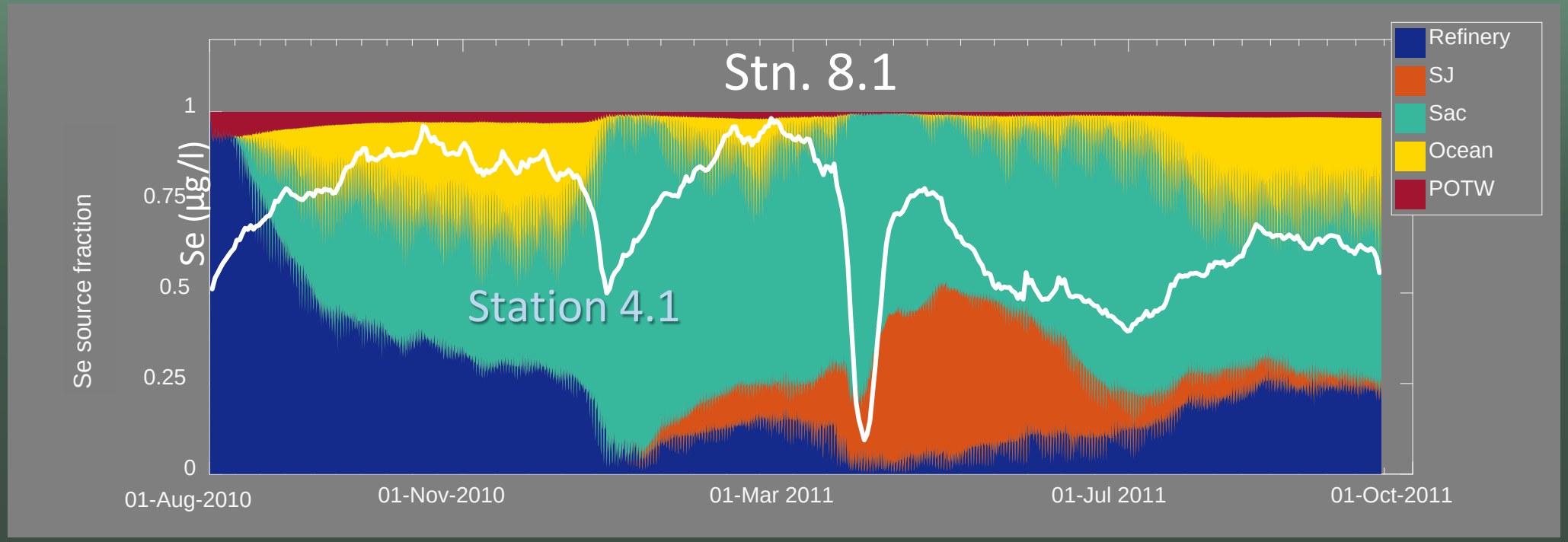
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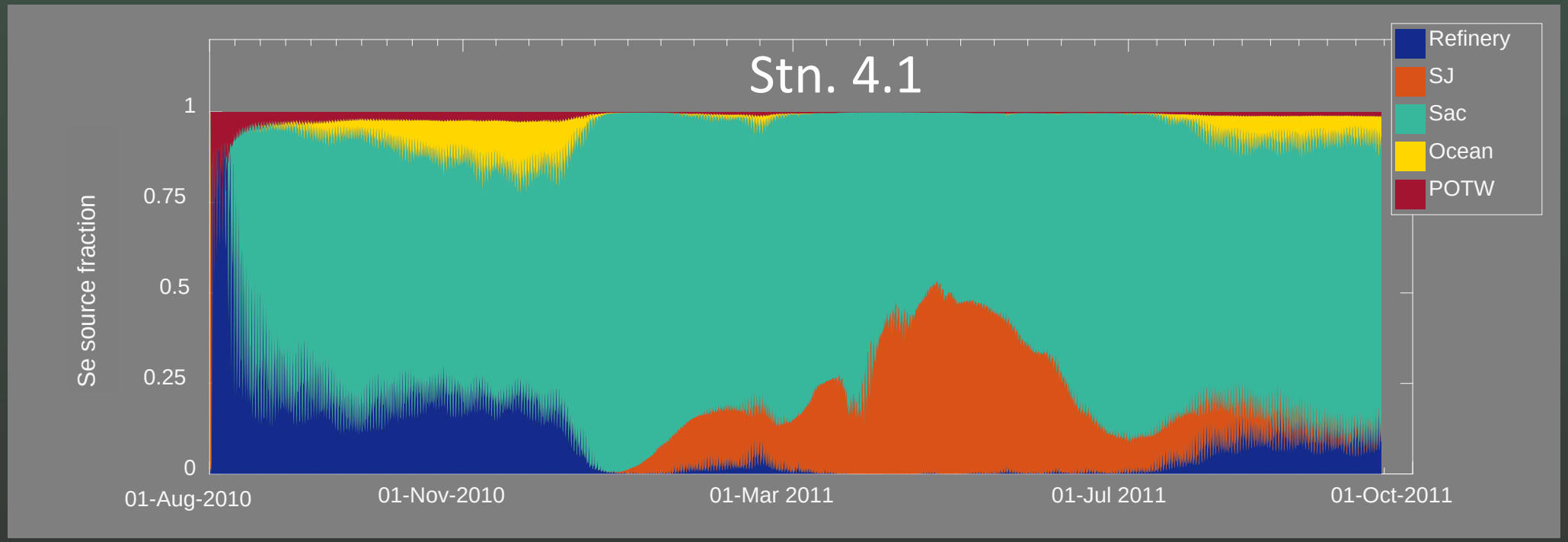
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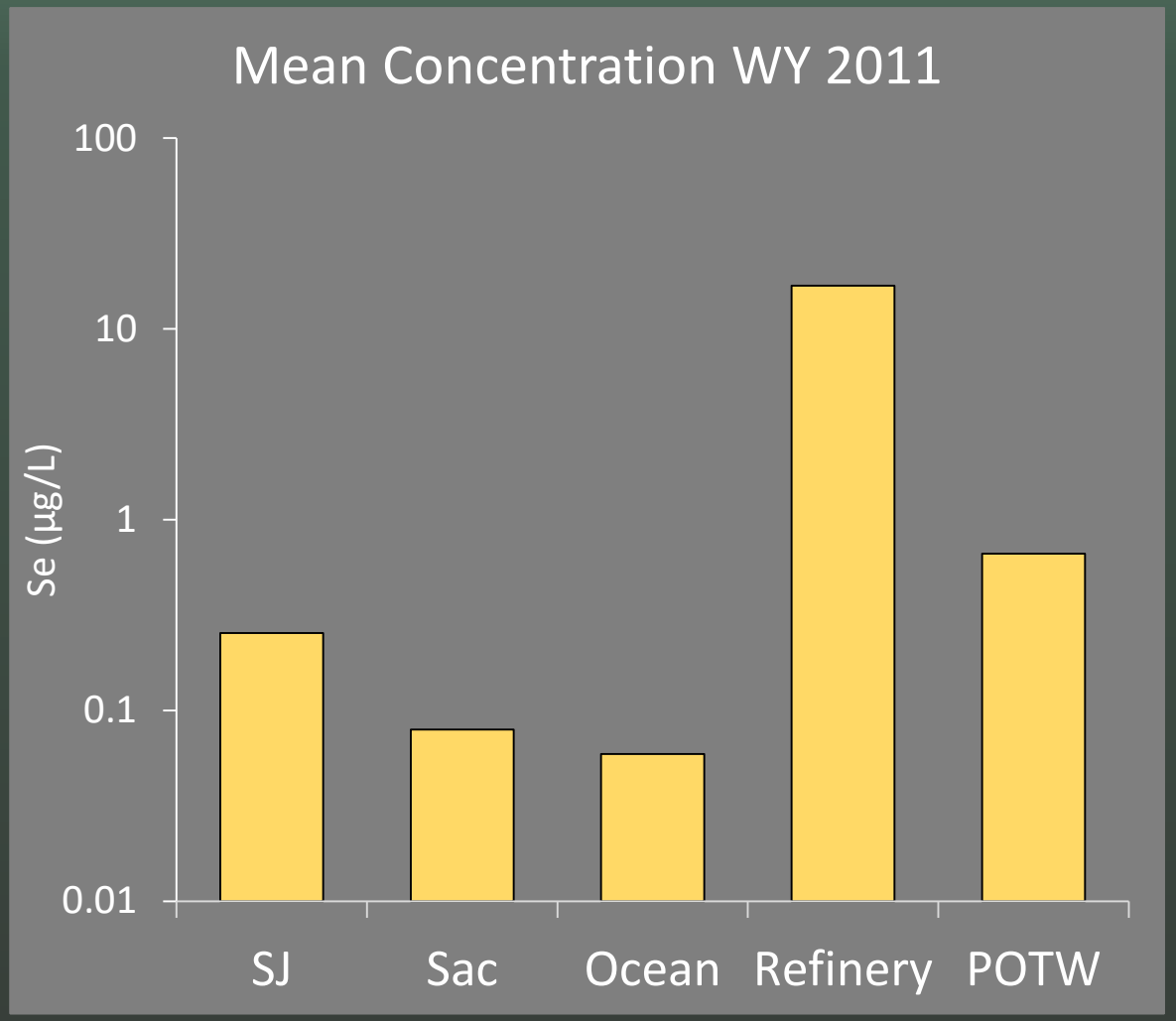
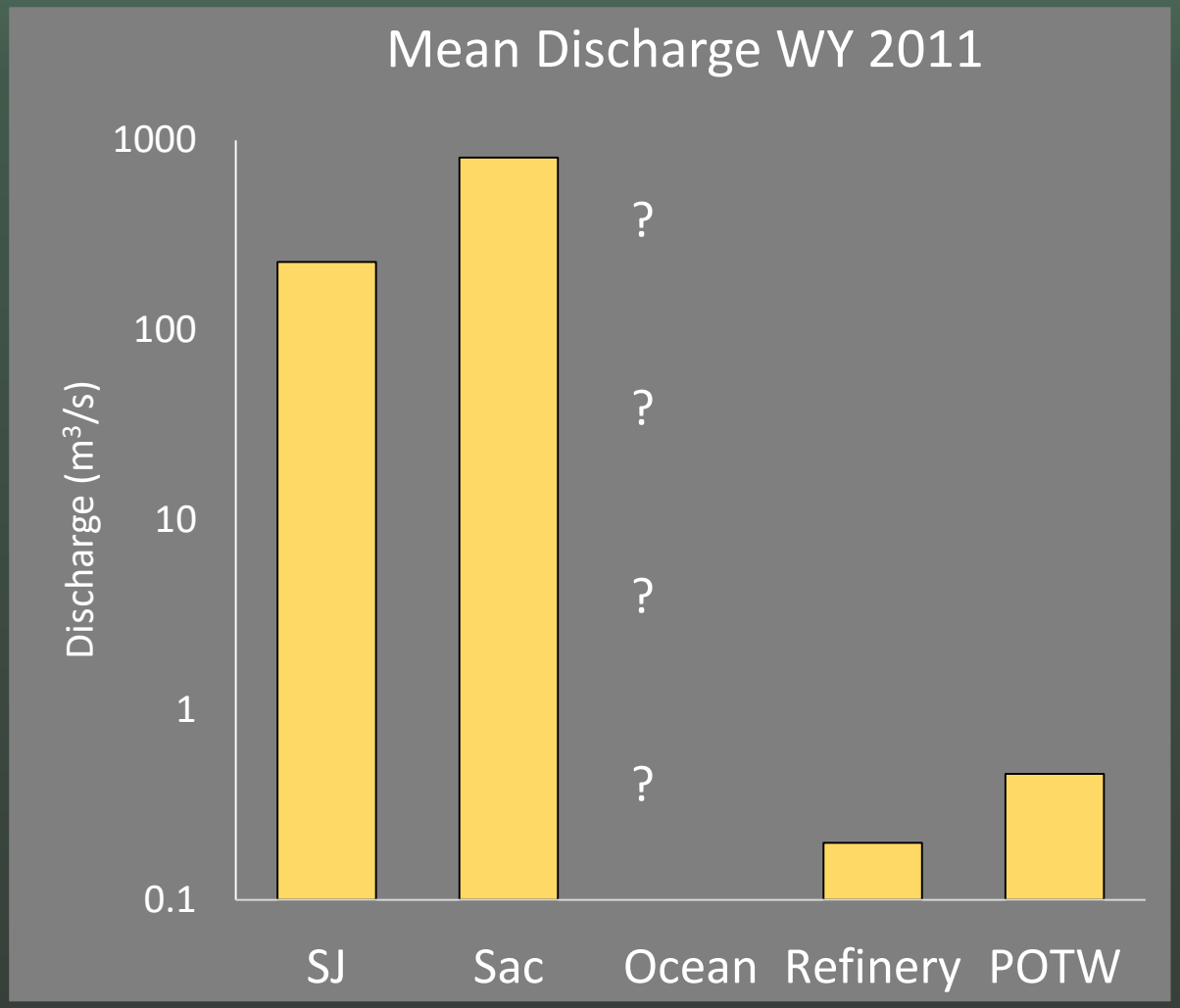
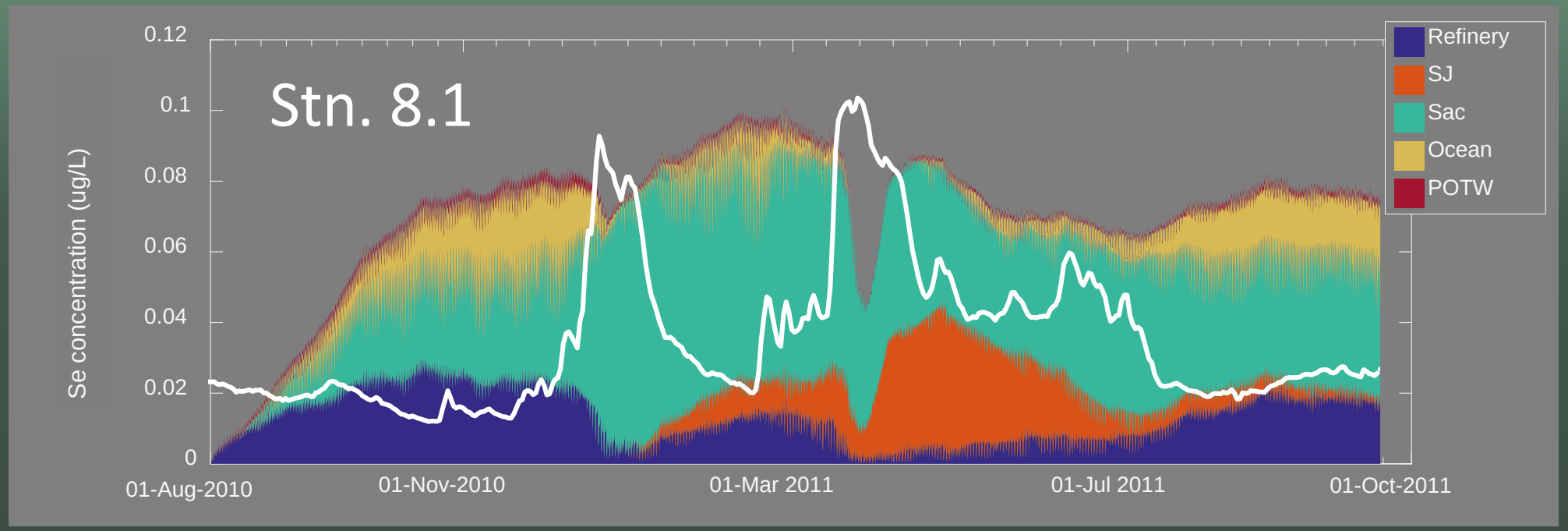
Source variability in flow and discharge



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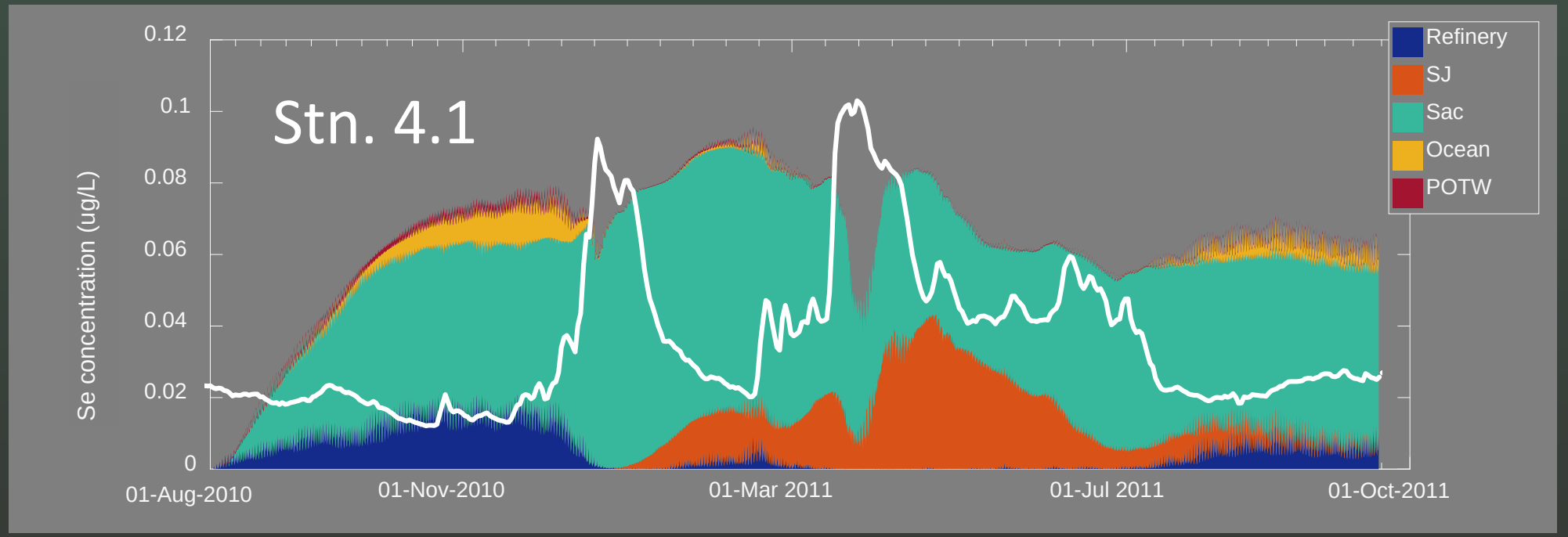
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