Salinity Intrusion in a shifting Delta in a changing climate

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Image Credit: Ken James / California Department of Water Resources

We are the salinity use-case team associated with COEQWAL (Just Transitions in the Delta)

Overarching question: What if we considered a wide range of scenarios for equitable water management in the Sacramento-San Joaquin Delta under a shifting climate of uncertainty?

- "Wicked problem": **no one solution** that works for everyone
- Turn to **other forms of expertise** to identify trade-offs
- Social science collaborators conducted **interviews with diverse stakeholders** to identify **scenarios** and testing criteria of interest

Image Credit Justin Marsh

Building and testing scenarios

- Six scenarios in development based on interviews
- Combination of grey and green infrastructure and management changes in the Delta
- Evaluation process of scenarios focuses on “stress testing” including:
  - Drought
  - Sea level rise
  - **Changes in operations**
    - Changes in exports

→ Key Area of public interest and connection with COEQWAL

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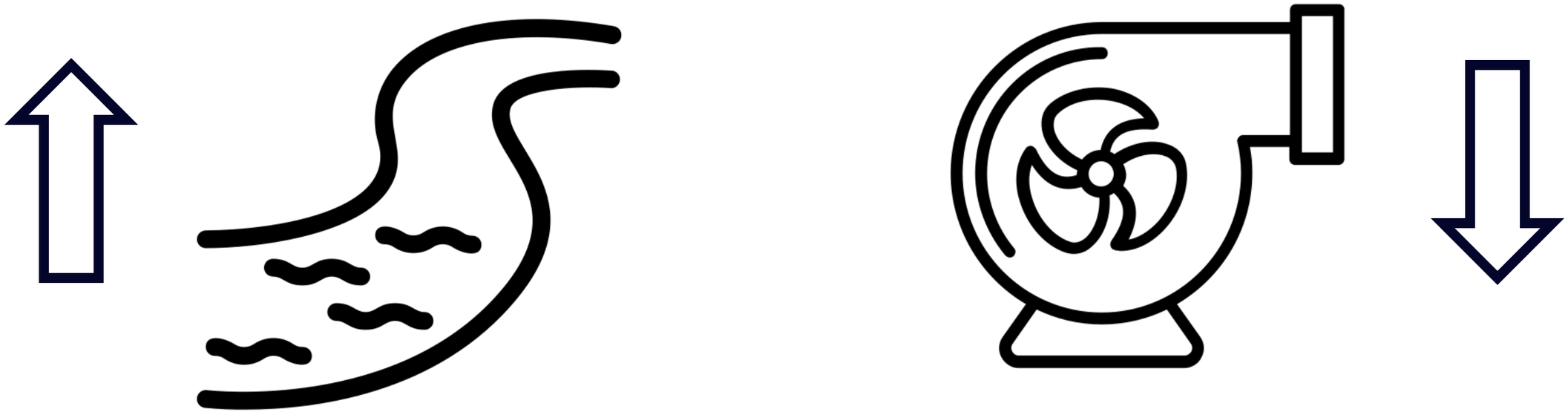
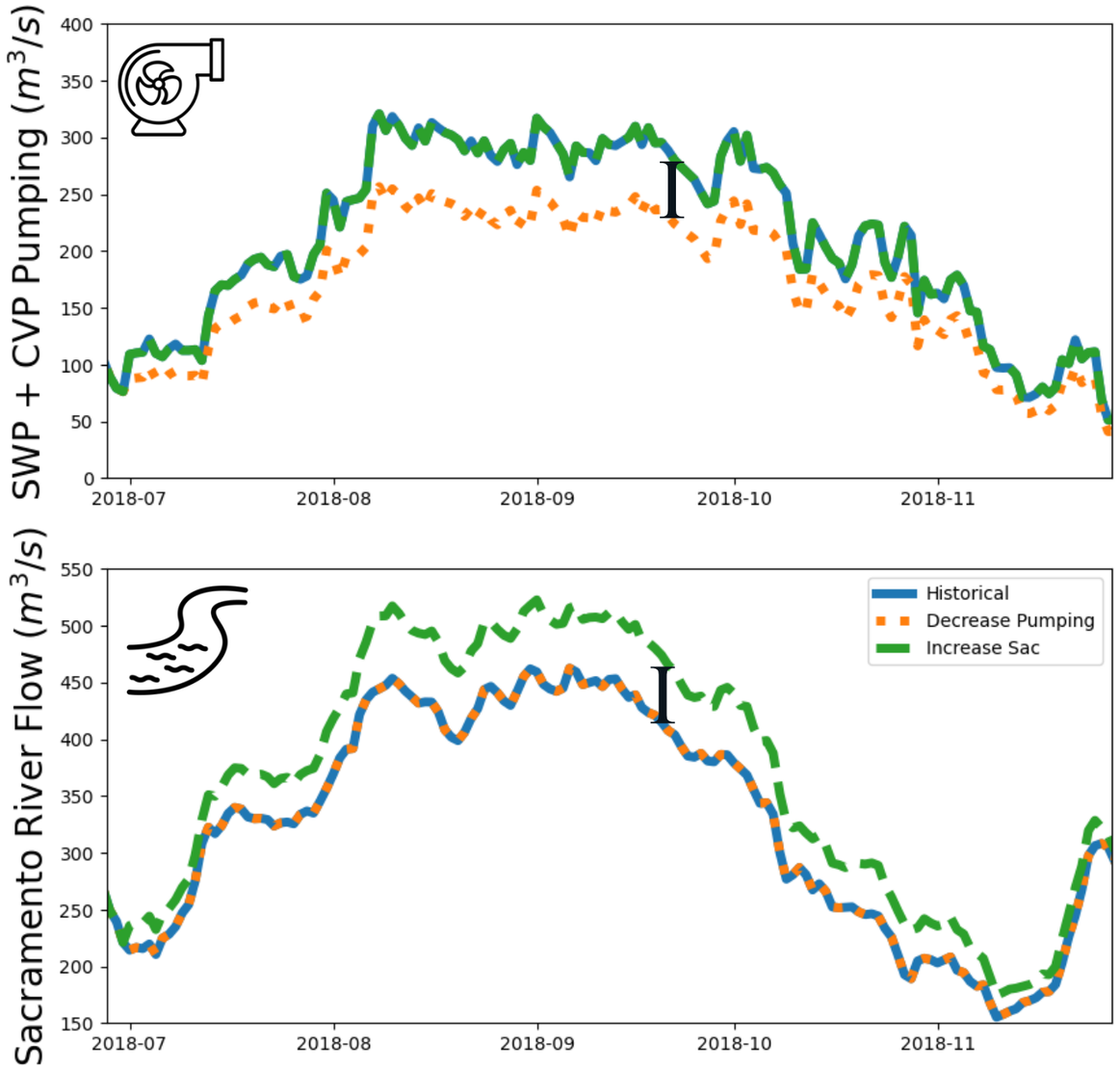
Today's talk: How does the implementation of changing net Delta outflow impact salinity in the Delta?



Three Scenarios, Two Delta Outflows

1) **Historical** climate and operations (historical outflows)
2) Only difference is **20% decrease in exports** from SWP and CVP
3) Only difference is **20% increase in inflows** from Sacramento river



Study Period: Water year 2018

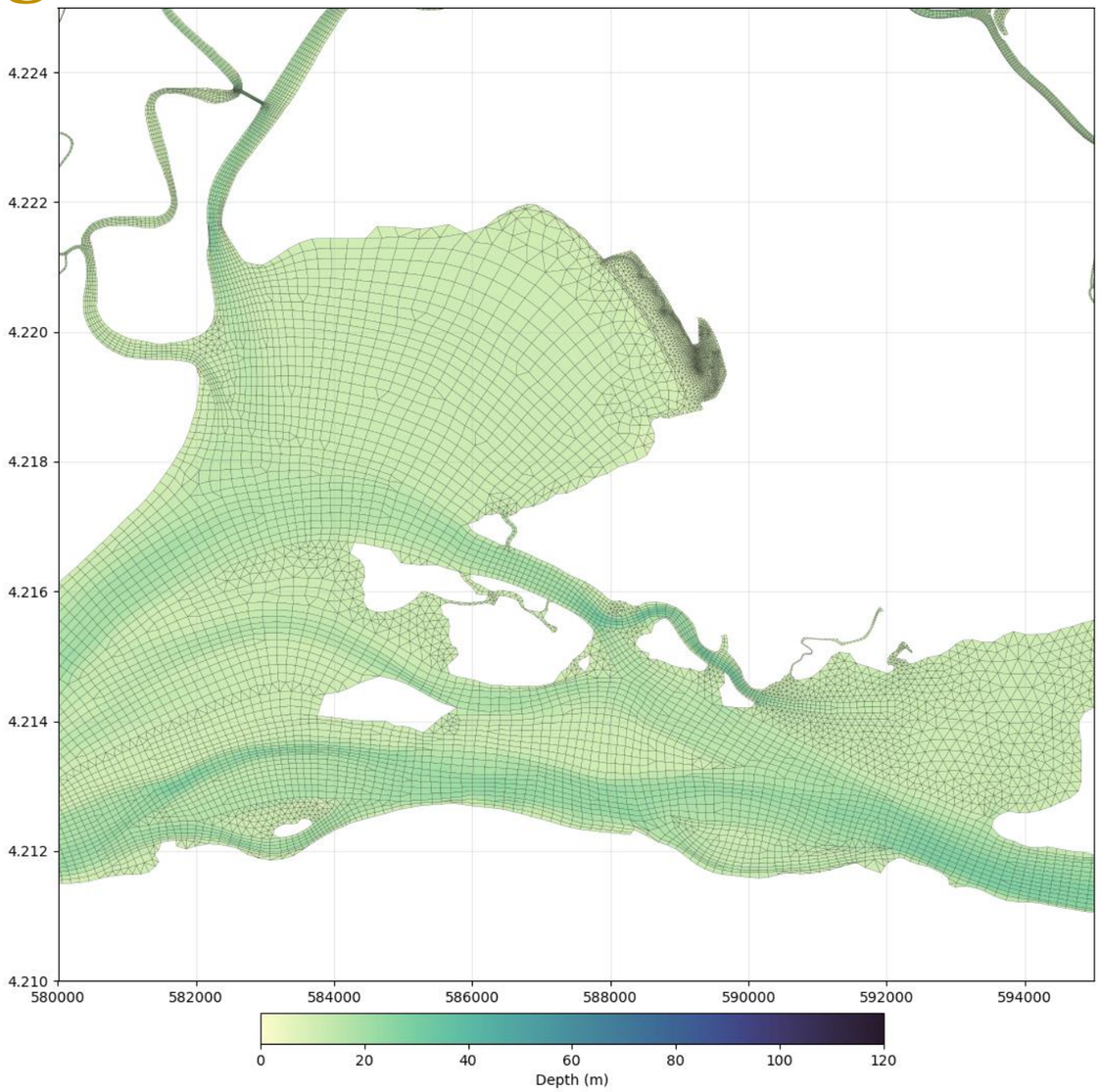
- Below normal year for San Joaquin and Sacramento Valleys after the wet year of 2017
- Changes in flows applied July 1, 2018 – December 31, 2018
- Dry enough there is a change with more flow, wet enough that health and safety levels can still be met with decreased exports*

* There are 5 partial days in November 2018 that go below 1500 cfs (~42.48 m^3/s)

Hydrodynamic Modeling with SCHISM

Semi-Implicit Cross-scale Hydroscience Integrated System Model

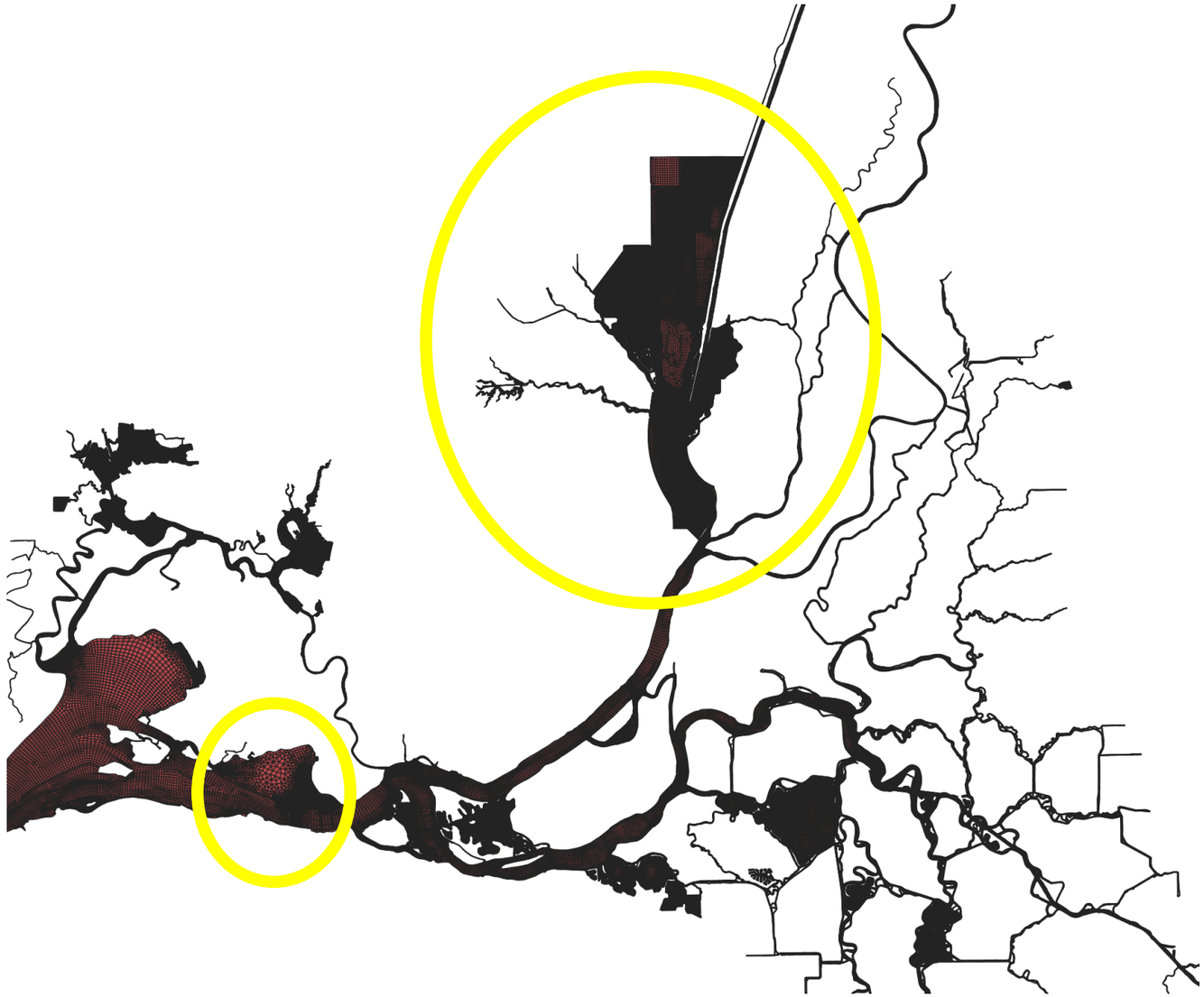
- Solve equations of momentum and scalar transport in three dimensions
- Unstructured grid
- Already in use in SF Bay-Delta system by the California Department of Water Resources



Altered grid to include more restorations

This project is concerned with the 2050 planning horizon

- Includes existing and approved tidal wetland restorations from the Delta Plan Interagency Implementation Committee and Delta Adapts
- Most notable changes are inclusion of Chipps Island, Prospect Island, Little Egbert, and Lookout Slough
  - *from DWR's restoration library*

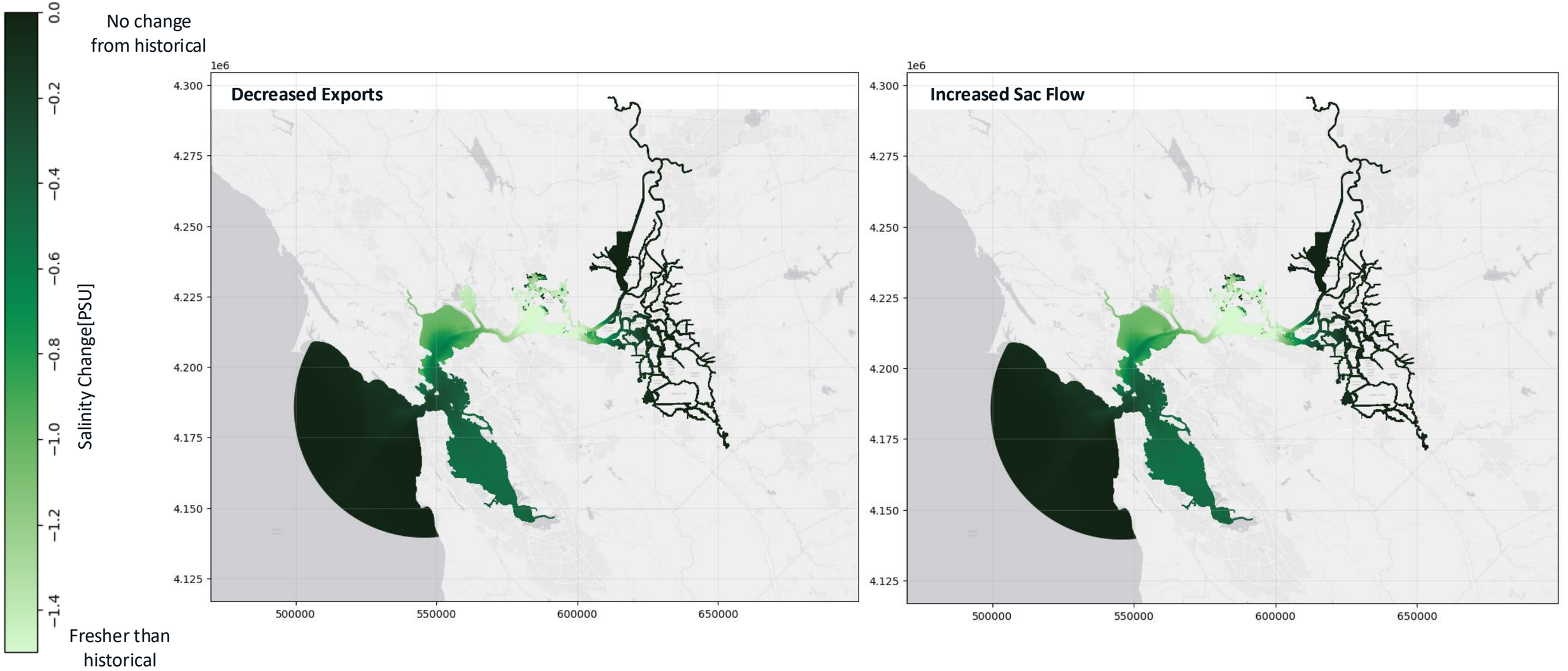


PRELIMINARY RESULTS

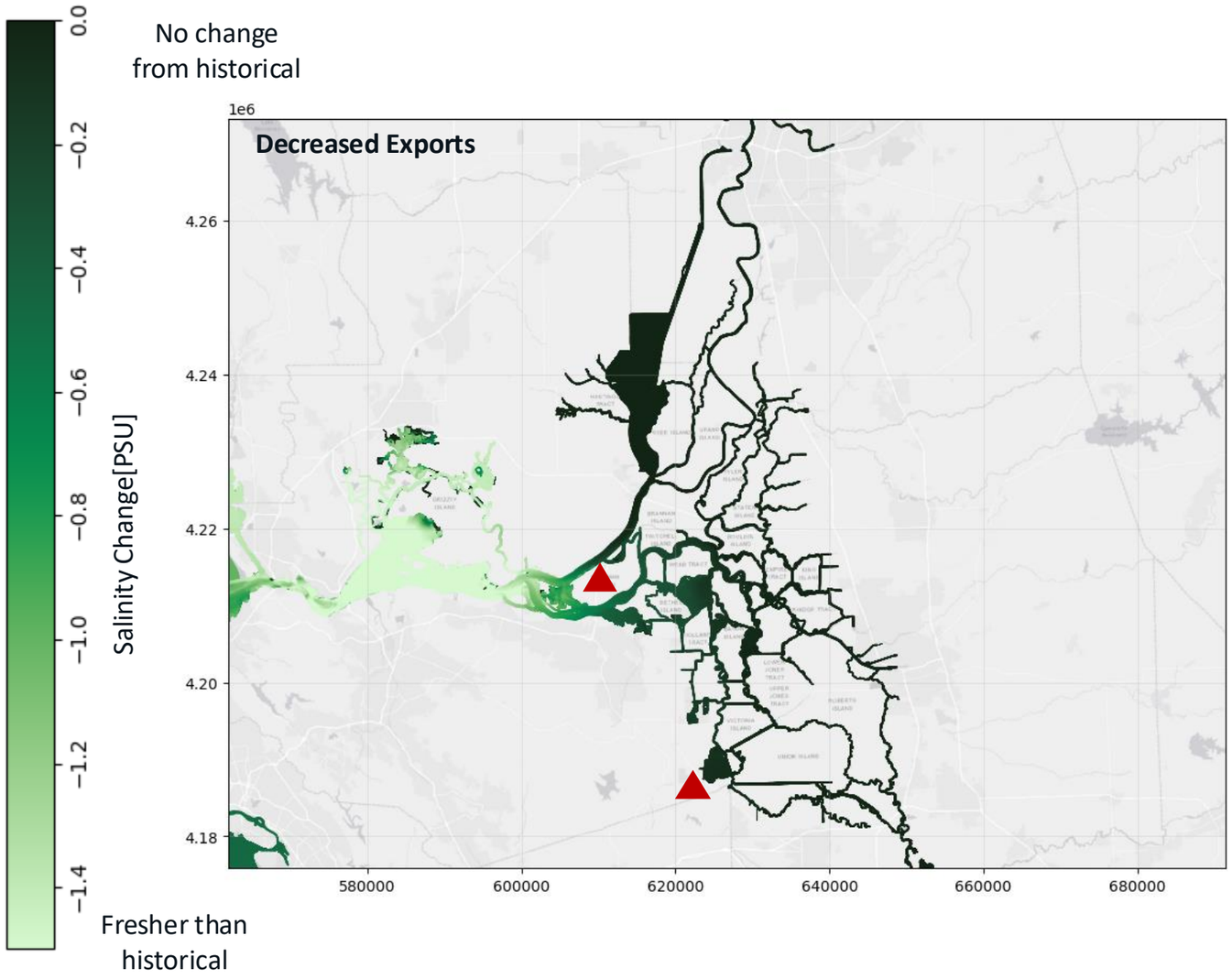
Work in progress

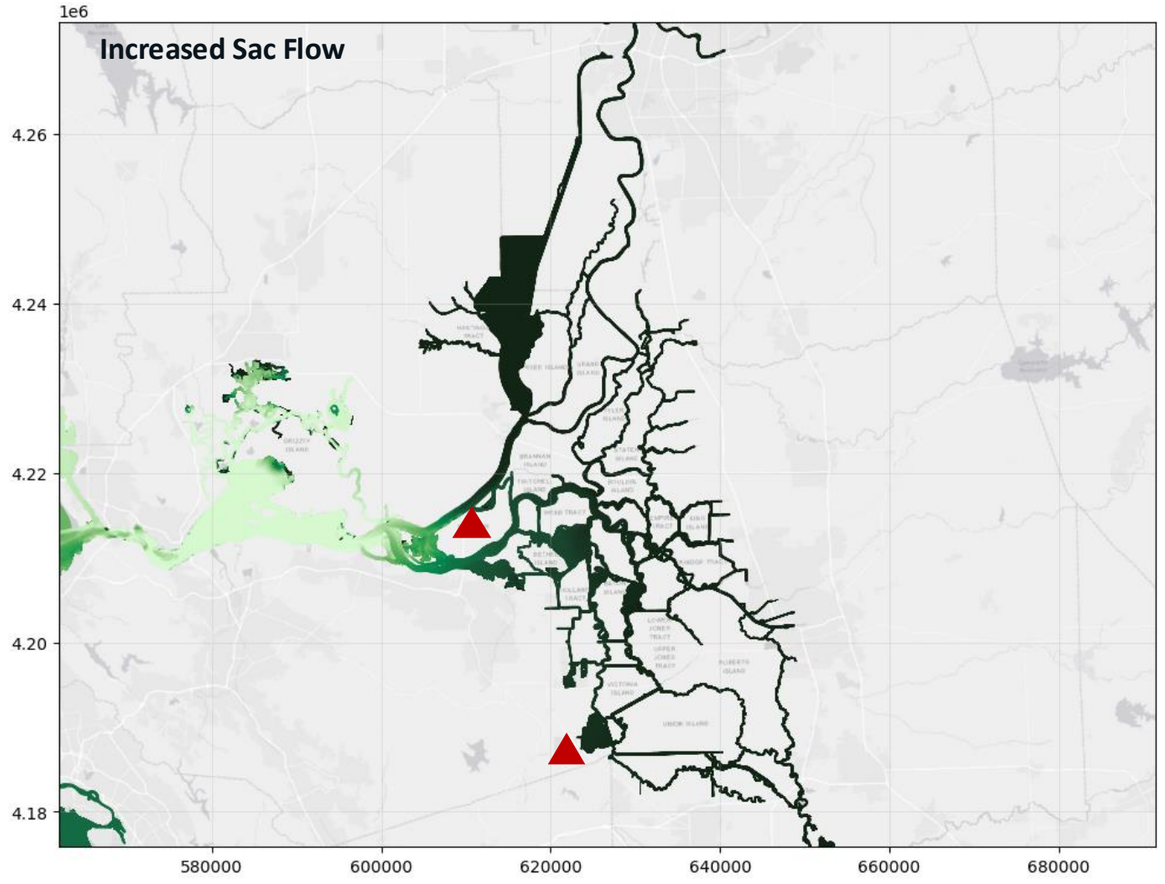
All maps are depth averaged for the timepoint with highest salinity at Emmaton (November 12, 2018 16:00)

Increasing outflow decreases salinity west of the confluence (both for changing exports and inflows, simulation day 134)

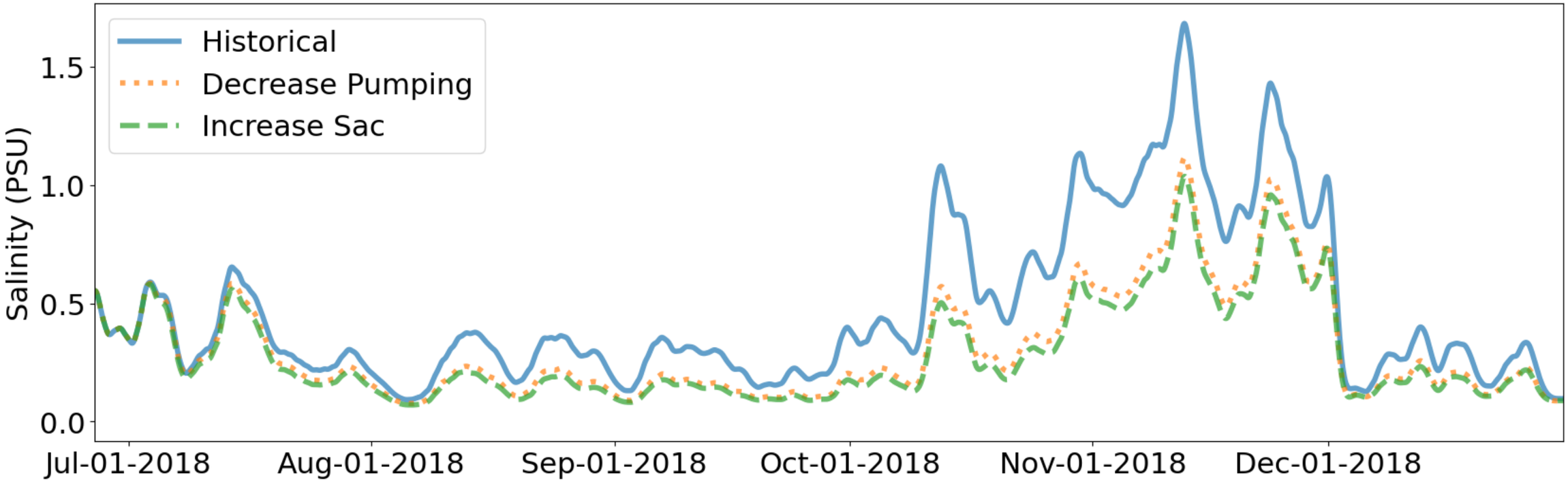


Zooming into the Delta: Differences with between scenarios are subtle

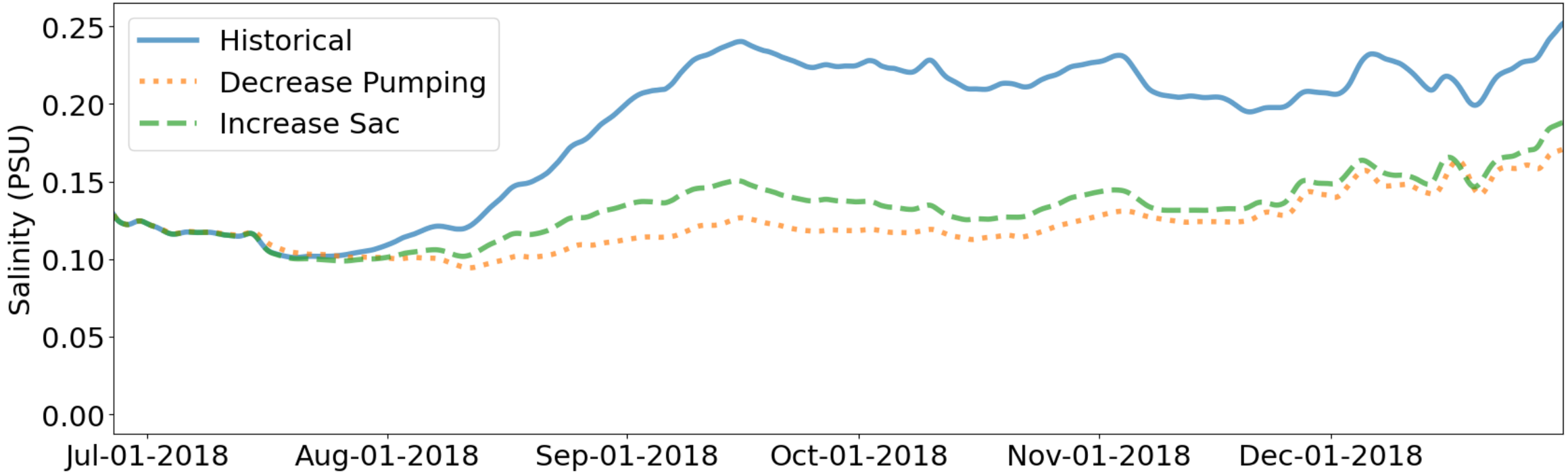




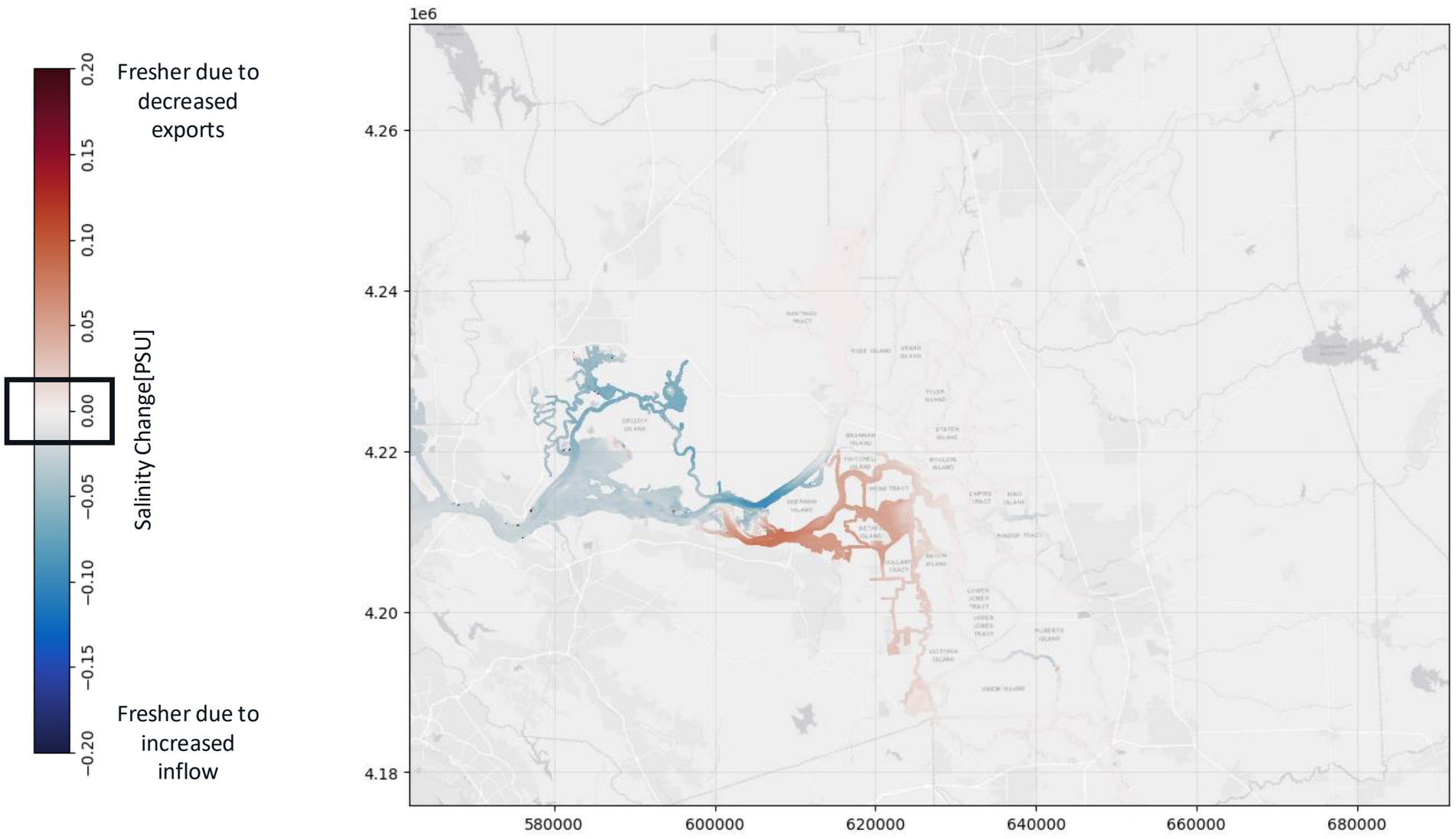
Time Series at a Emmaton (tidally filtered)



Time Series at Harvey O. Banks Pumping Plant (tidally filtered)



Increased Inflows - Decreased Exports (simulation day 134)



Future Work

- Longer study period
- What are the other hydrodynamic signatures of changing exports?
  - Tidal excursion? Flows?
- Test other levels of decreased exports and inflows
  - Are there thresholds of non-linearity?
- Are the impacts symmetrical if exports increase?
- Impact of changing exports in different scenarios
  - How do added barriers and/ or restorations impact spatial implications?
- Impacts of other operations changes
  - Reservoir operations
  - Upstream diversions
- How can we integrate this analysis with CalSim3?

Conclusions

- Changes are subtle at first, but over time spatial differences emerge

- Decreasing exports has a greater impact in the south Delta and increasing inflows has a greater impact in the confluence

- The salinity response to changing net Delta outflow will depend on where changes in outflow occur

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References & Acknowledgements

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Hanak, E.; Lund, J.; Fleenor, W.; Mount, J.; Howitt, R.; Moyle, P. Envisioning Futures for the Sacramento-San Joaquin Delta. *Report prepared for Public Policy Institute of California* **2007,** Introduction, 3.

Hanak, E.; Lund, J.; Mount, J.; Howitt, R.; Moyle, P.; Dinar, A.; Gray, B.; Thompson, B. Managing California's Water: From Conflict to Reconciliation. *Report prepared for Public Policy Institute of California* **2011**.

Myers, N.; Mittermeier, R. A.; Mittermeier, C. G.; da Fonseca, G. A. B.; Kent, J. Biodiversity hotspots for conservation priorities. *Nature* **2000**, *403*, 853–858.₩

Robinson, I. S. Chapter 7 Tidally Induced Residual Flows. In *Elsevier Oceanography Series*; Johns, B., Ed.; Physical Oceanography of Coastal and Shelf Seas; Elsevier, 1983; Vol. 35, pp 321–356.

Zhang, Y. J.; Ye, F.; Stanev, E. V.; Grashorn, S. Seamless Cross-Scale Modeling with SCHISM. *Ocean Modelling* **2016**, *102*, 64–81.

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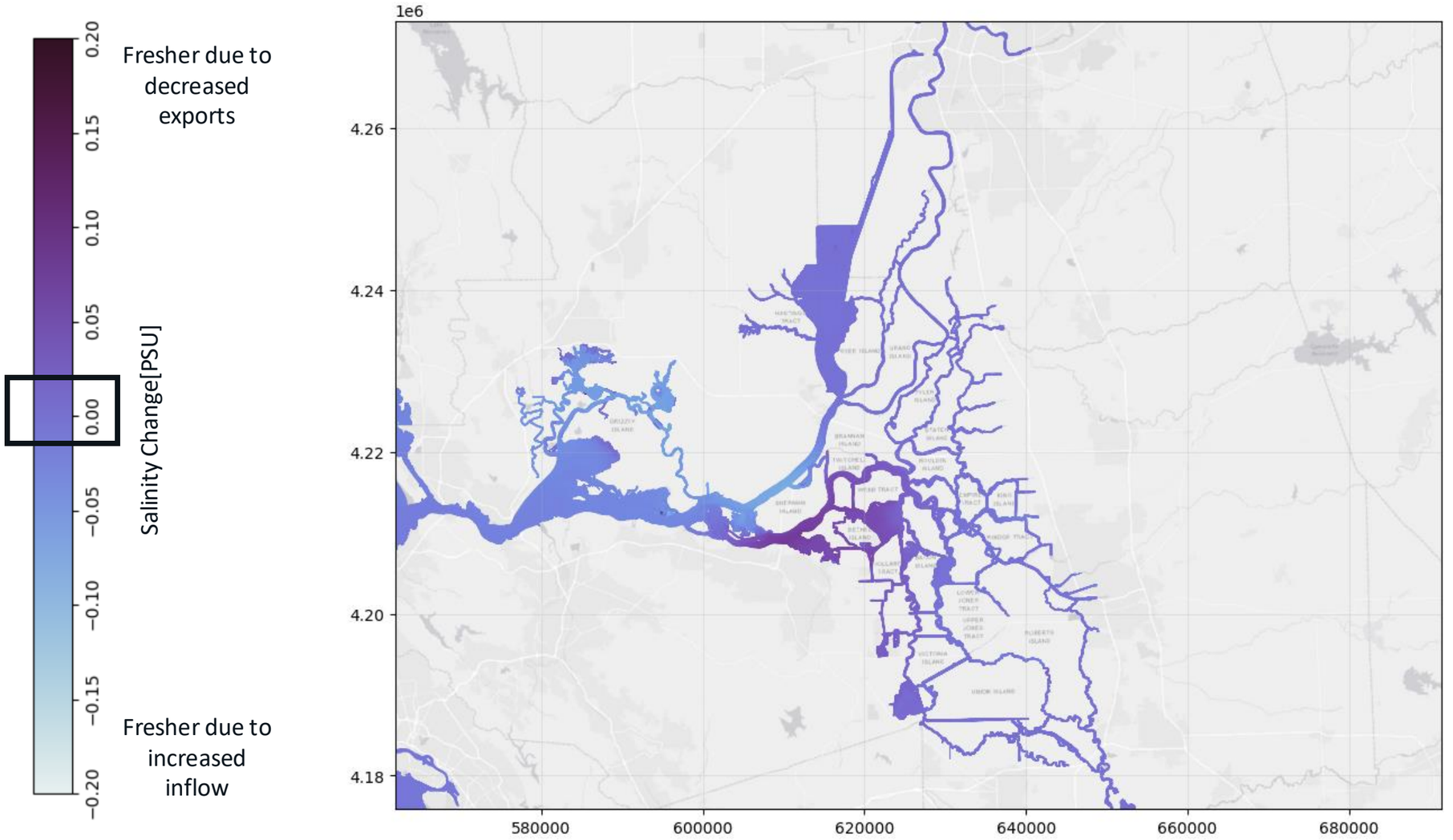

Scenarios

1. Business as usual
2. Tunnel vision
3. Ecomachine
4. New green watershed
5. Calling on reserves
6. Bolstered and fortified