

Bay-Delta SCHISM: A Framework for Decision Support in the Sacramento San Joaquin Delta





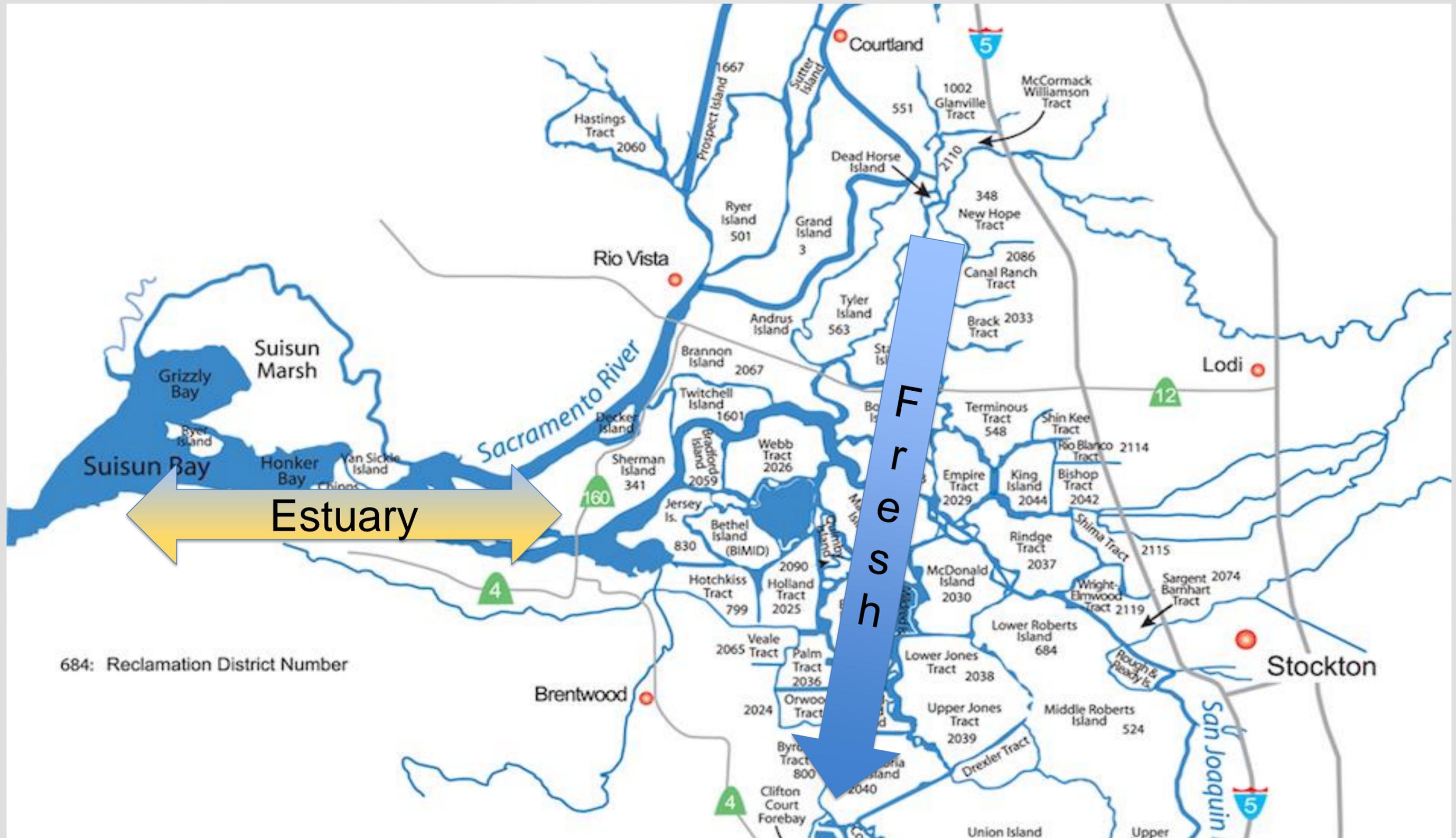
Pacific
Ocean

San Francisco Bay

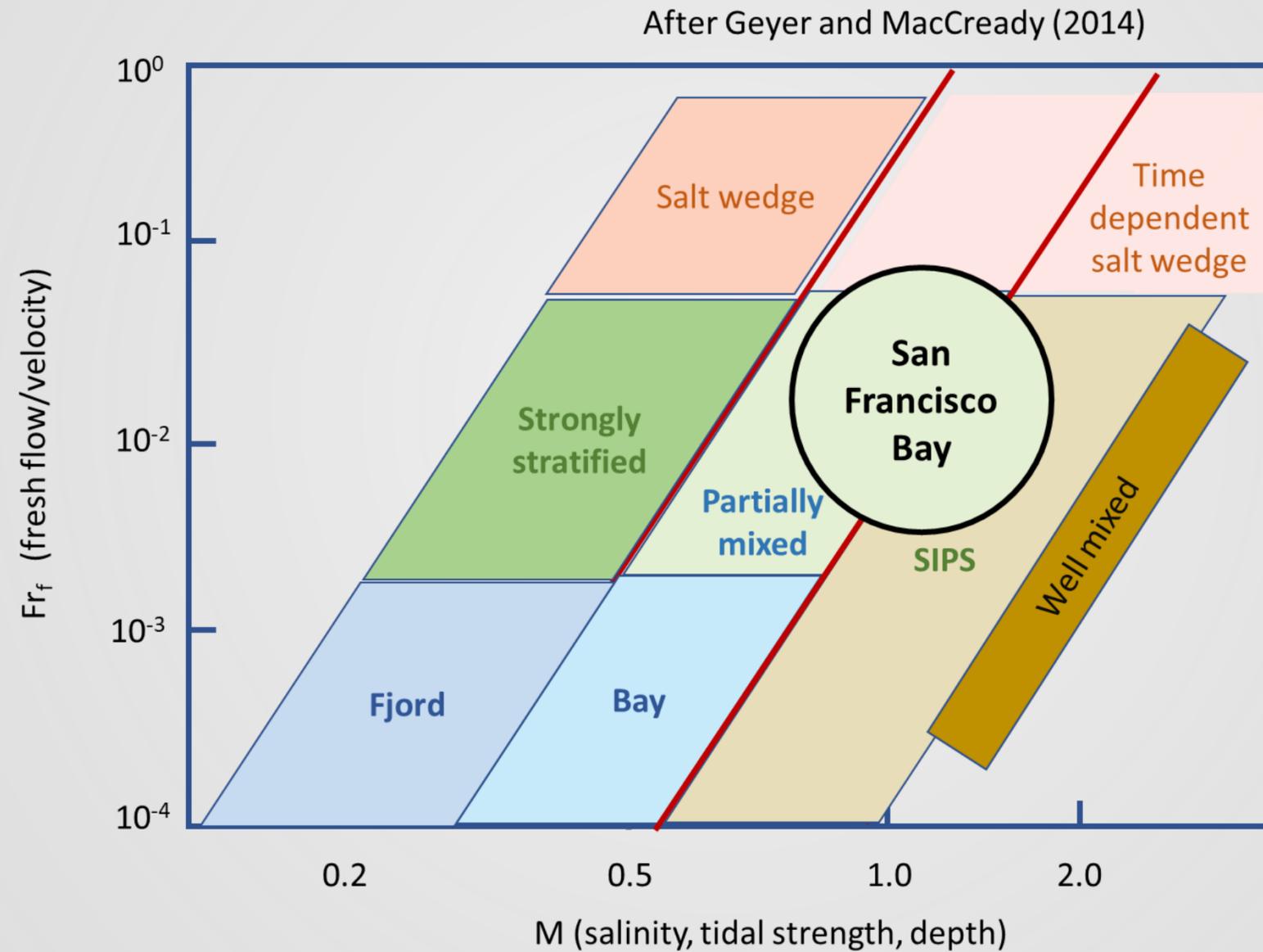
Suisun Bay

Outflow

Delta



Estuarine Characteristics of SF Bay



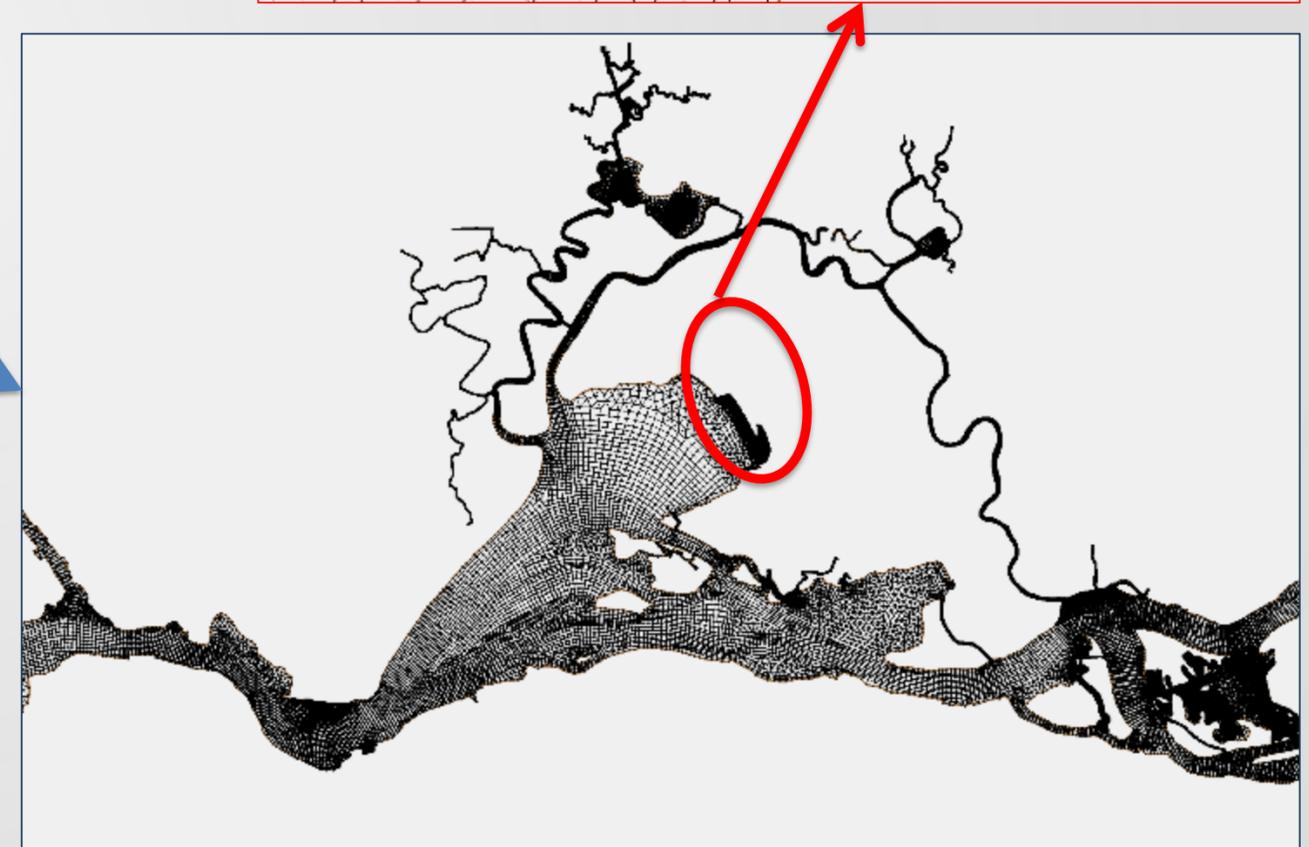
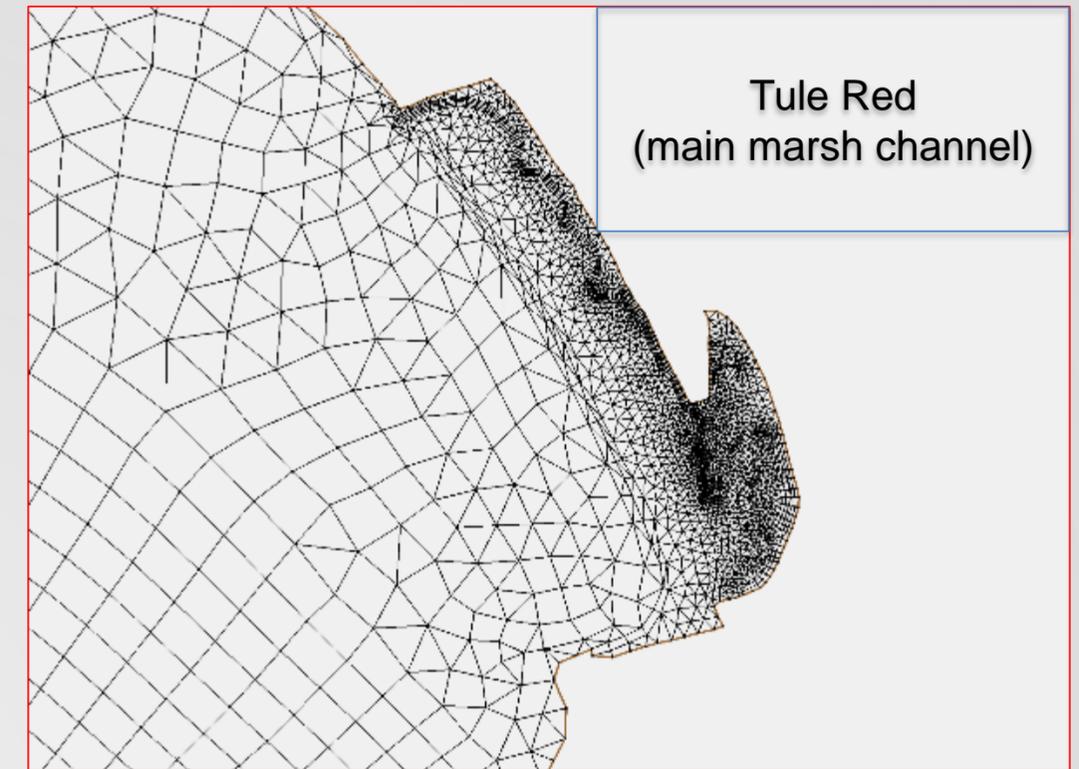
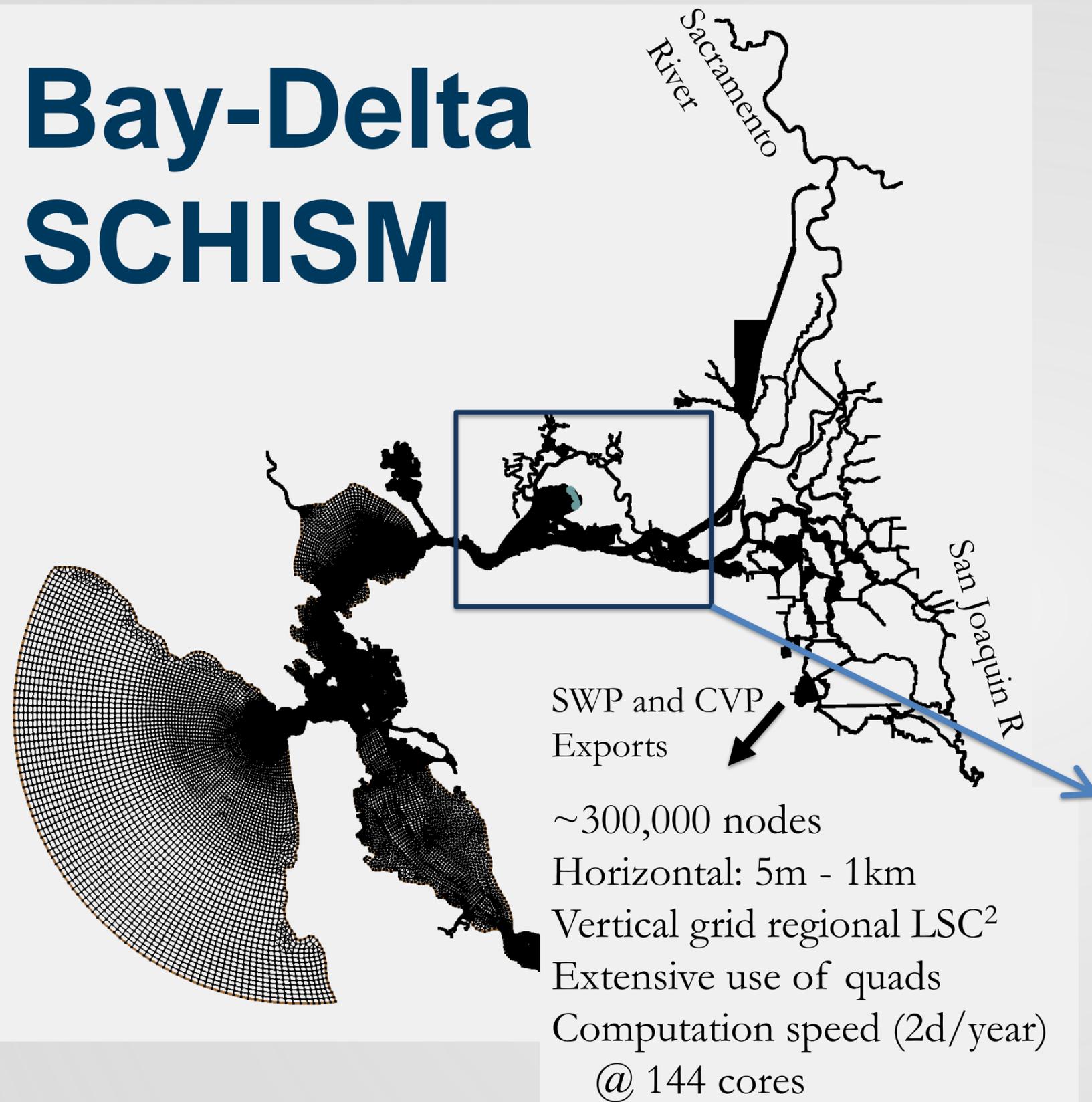
Planning and Operational Examples

- Habitat quantification (salinity, temp, turbidity, food, weeds)
- Drought management (emergency drought barrier)
- Restoration projects
- Submerged vegetation effects on nutrients and fish
- Sea Level Rise impacts and threats to engineering projects
- Flooding: Overtopping/Seismic Island Flood & Salinity

Underline = Under Development

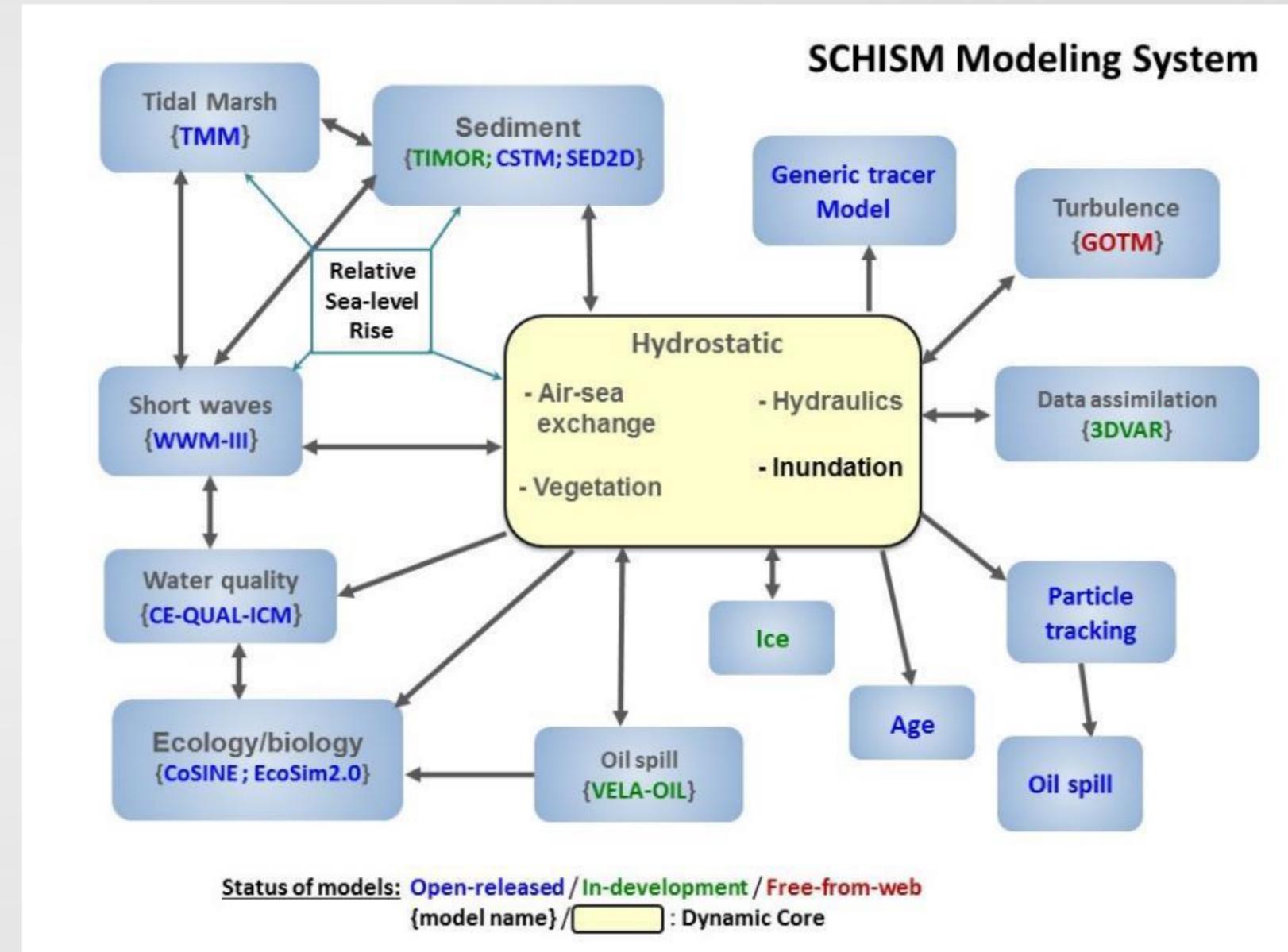


Bay-Delta SCHISM



SCHISM Model

- 3D shallow water model
- Free and open source on GitHub
- Primary development at Virginia Institute of Marine Sciences (VIMS)
- Semi-implicit time stepping, mixed FEM and FVM formulation
- Widely used, 150+ publications
- Major funding and contributions
 - DWR
 - NOAA
 - EPA & Chesapeake Bay
- Numerous Bay-Delta Applications
- See <http://ccrm.vims.edu/schismweb/>



Bay-Delta SCHISM Project

- SCHISM Model, Calibration
 - structures, source terms, vegetation, integration with local models
 - Bay-Delta, Bay-only and Cache Complex subdomain variants
- Bathymetry (with USGS/DWR Bathy groups)
- schimpy Python package and other preprocessing
- VisIt visualization
- Data for application
- Testing/use of cloud systems
- Training/documentation
- Contributor to domains model-neutral user groups (Min Yu)



schimpy processor

- YAML interface, workflow based
- Reproducible prep of mesh/spatial inputs
- Georeferenced inputs
- Structures/sources/vgrid
- Conversions (2dm, shapefiles, etc)
- Initialization schemes
- Station management
- Some Bay-Delta-only stuff (for our boundaries)
- schimpy encodes workflow to produce gr3/etc files. Not in-memory model run

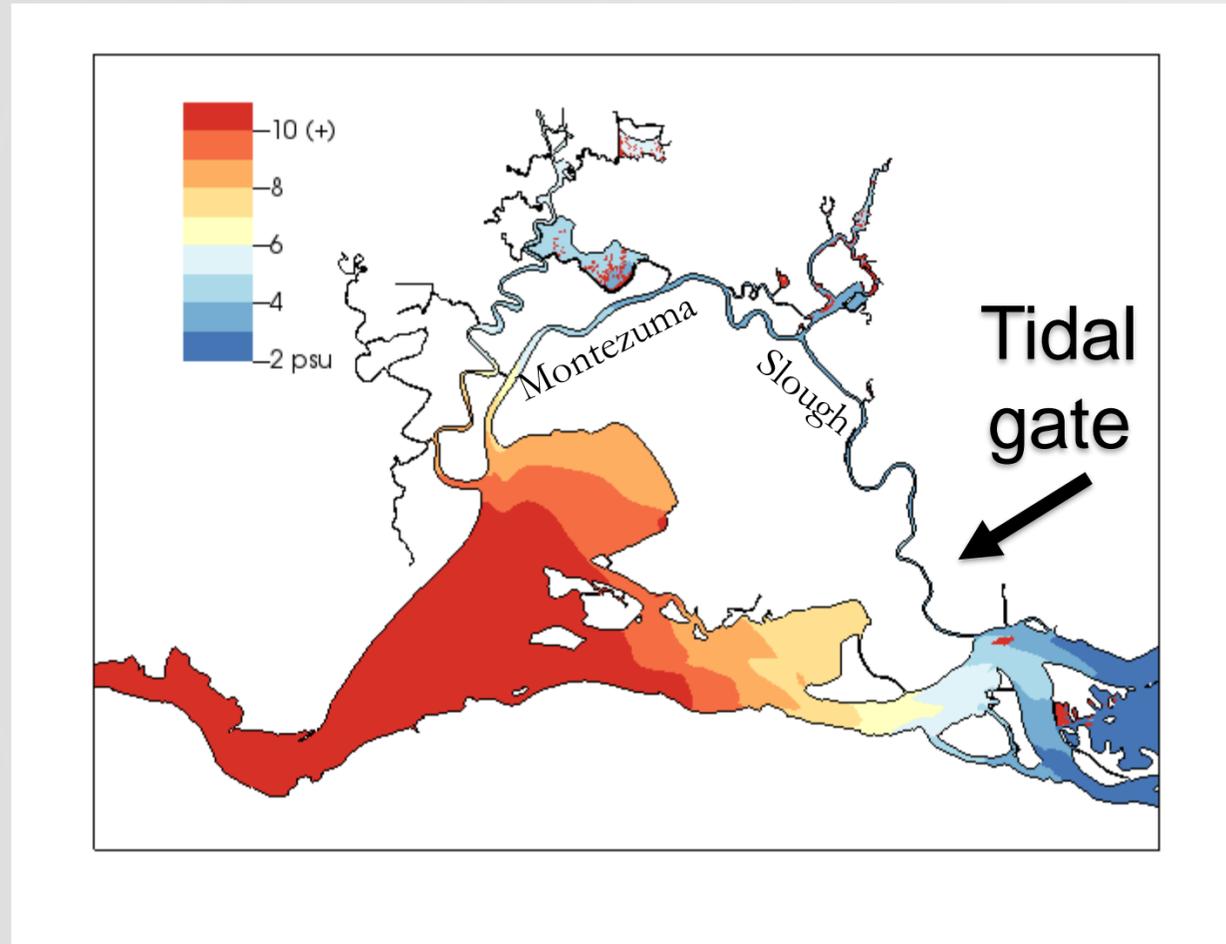
```
1 nudging: 0.05
2 structures:
3 - name: delta_cross_channel
4   type: radial
5   end_points:
6     [[630430., 4234237.],
7      [630418., 4234200.]]
8   configuration:
9     n_dupli
10    elevati
11    width:
12    height:
13    coeffic
14    op_down
15    op_upst
16    use_tim
17    reference
18
19 - name: ccf
20   type: rad
21   end_point
22     [[62698
23      [627006
24   configura
25     n_dupli
26     elevati
27     width:
28     height:
29     coeffic
30     coeffic
31     op_down
32     op_upst
33     use_tim
```

```
1 mesh:
2   mesh_inputfile: bay_delta_105_hist_2dm
3
4   split_quad:
5     minangle: 30.
6     maxangle: 140.
7     propfile: split_quad.prop
8
9   small_areas:
10    warn: 10.
11    fail: 4.
12    # includes restoration sites at top of list
13    dem_list: !include dem_4.1_hist.yaml
14    depth_optimization: !include depth_opt_params.yaml
15    open_boundaries: !include open_boundary.yaml
16    depth_enforcement: !include depth_enforcement.yaml
17    ll_outputfile: hgrid.ll
18    gr3_outputfile: hgrid.gr3
19
20 gr3:
21   xlsc.gr3:
22     default: 0.1
23   diffmin.gr3: !include diffmin.yaml # Updated 105
24   rough.gr3: !include rough.yaml # Updated 105
25
```

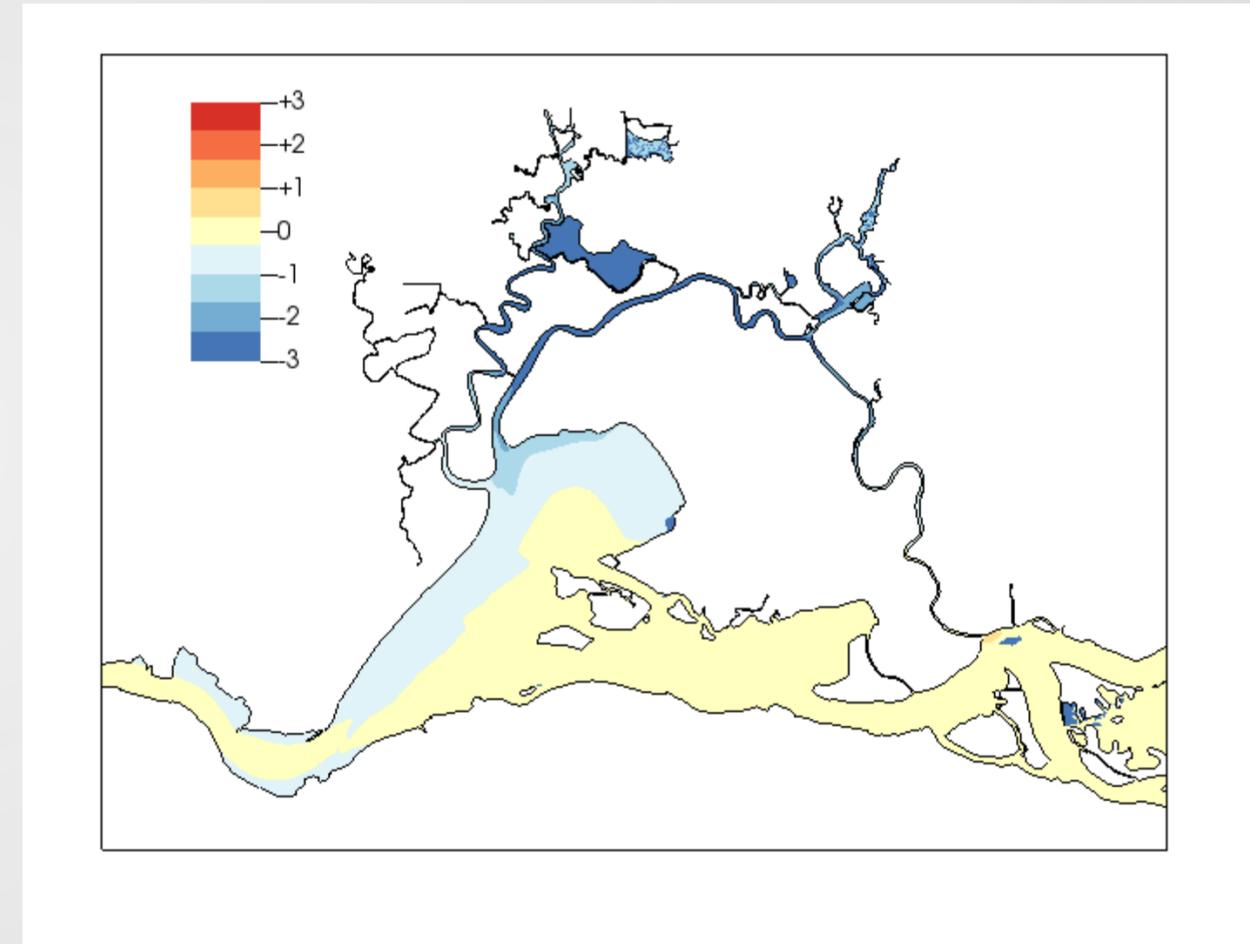


Example: Suisun Slough Low Salinity Zone Habitat

Historical Salinity
With Tidal Operations



Difference Relative to
Fully Open Alternative



SCHISM August 2 – September 7 2018 Average
Graphic: Qiang Shu

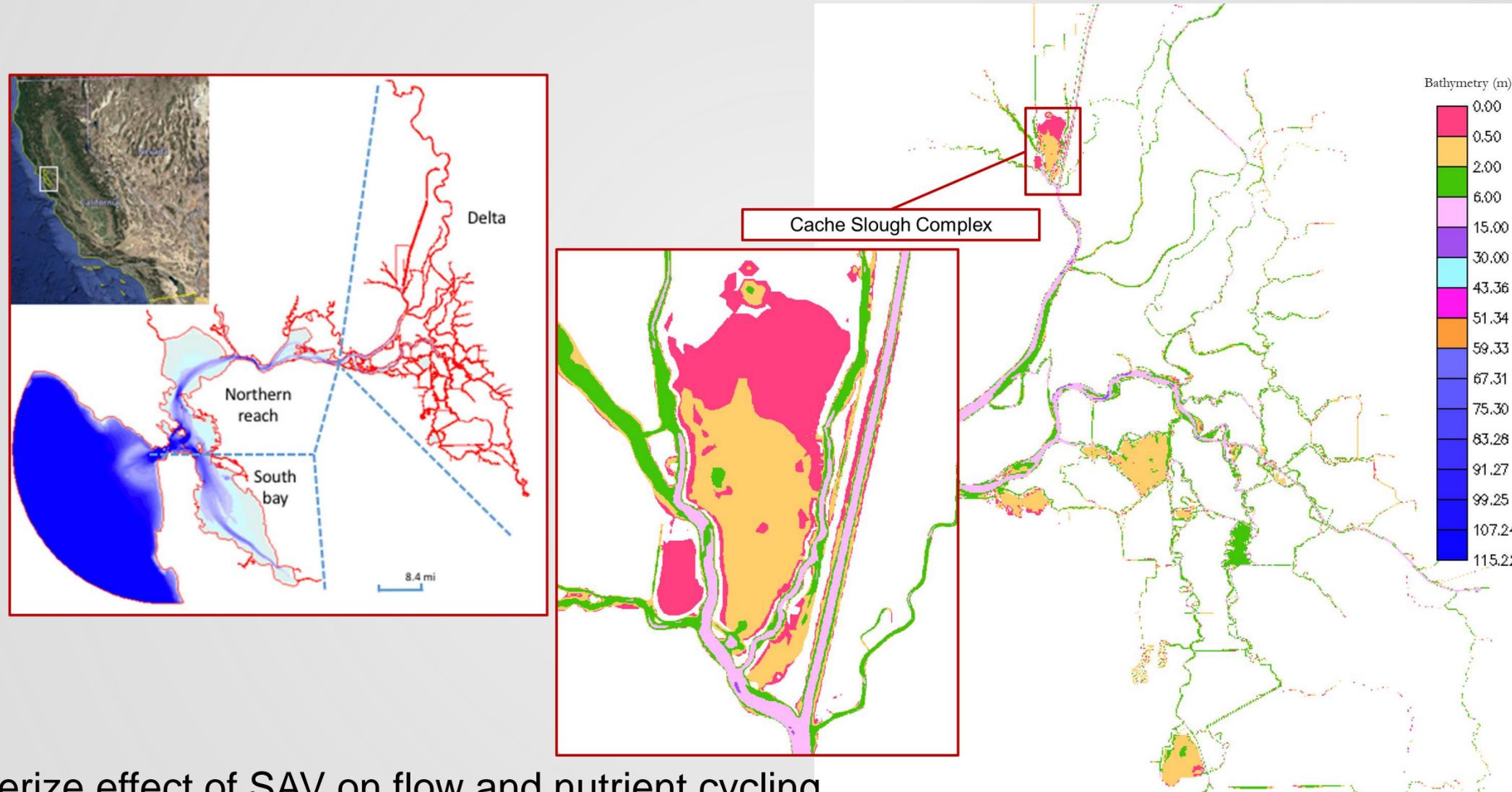


Application Notes

- Suisun gate modeled using ensemble of structures
 - asymmetric parameters and time series
 - some interest in trigger-based ops on user list?
- vgrid uses regional LSC2 approach
- Post-processed using combo of xarray, numpy, and VisIt API processing



Example: Submerged Aquatic Vegetation and Delta Smelt (VIMS/DWR)



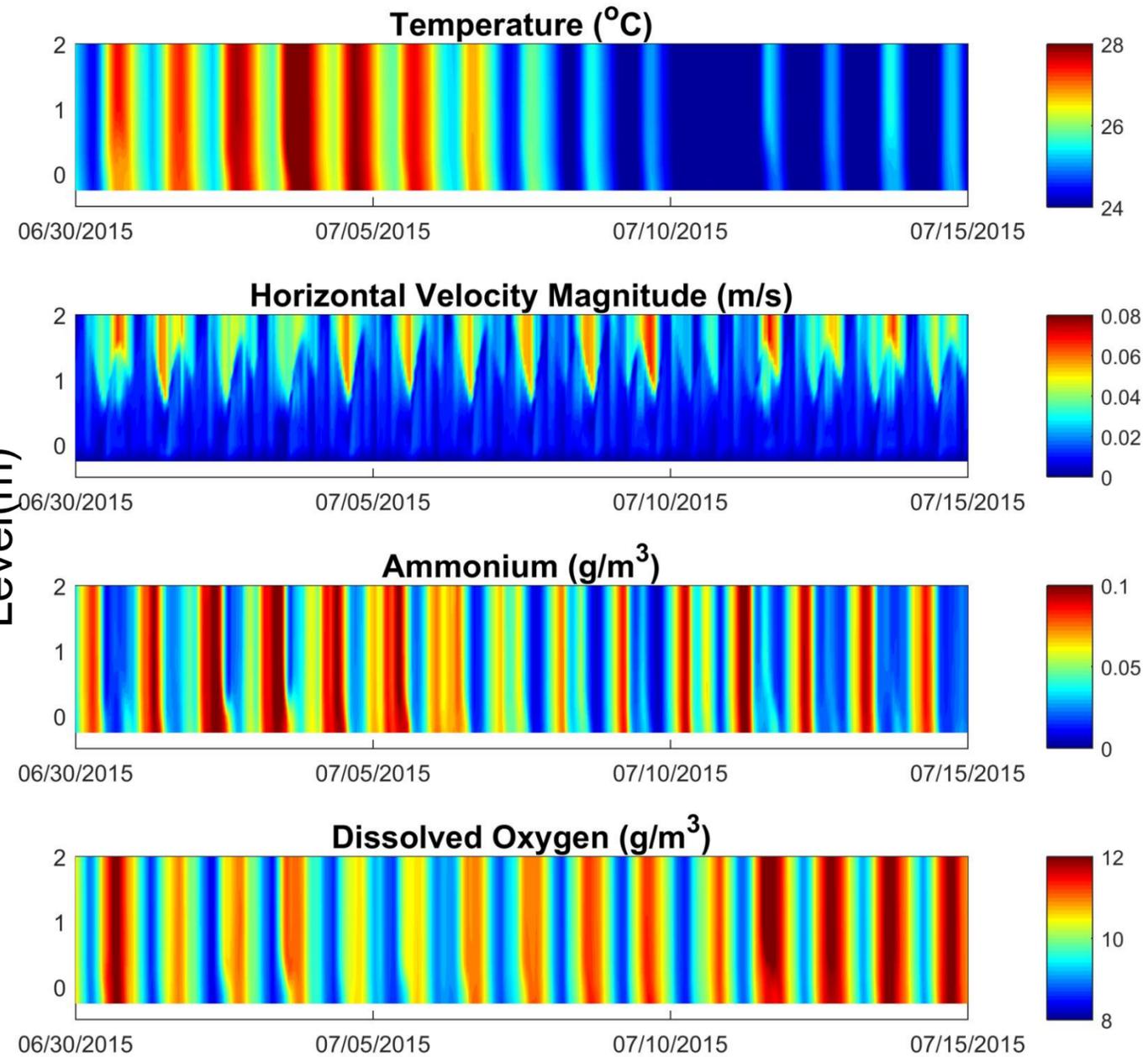
Goals:

- 1) Characterize effect of SAV on flow and nutrient cycling
- 2) Characterize the feedback to SAV growth and density

Credit: Cai 2018

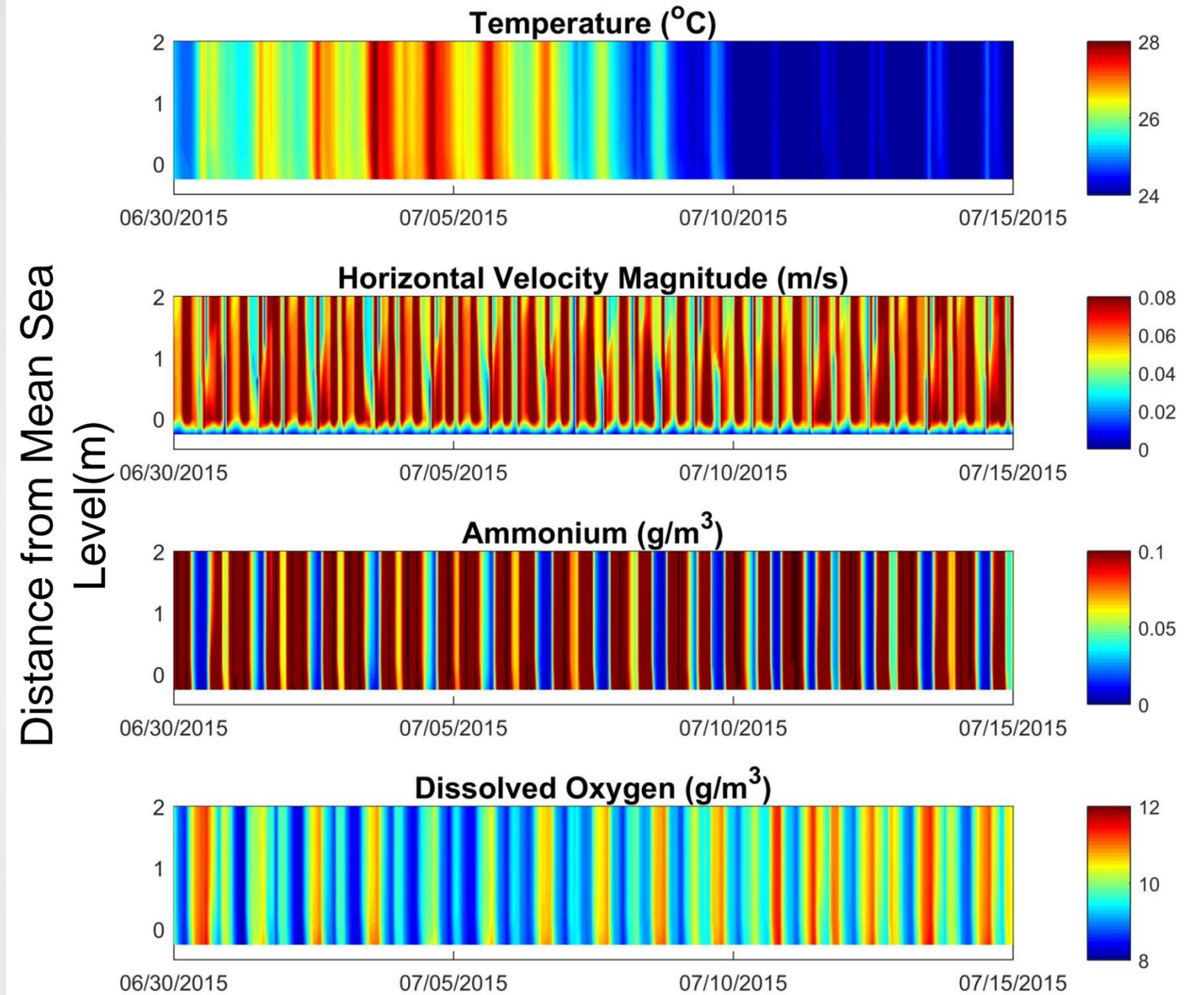


Distance from Mean Sea Level(m)



With SAV (static)

Middle of Little Hastings Tract



No SAV

- There are less salt intrusion and large variation on temperature with SAV.
- Horizontal velocity is largely reduced by SAV.
- Ammonium concentration is smaller with SAV.



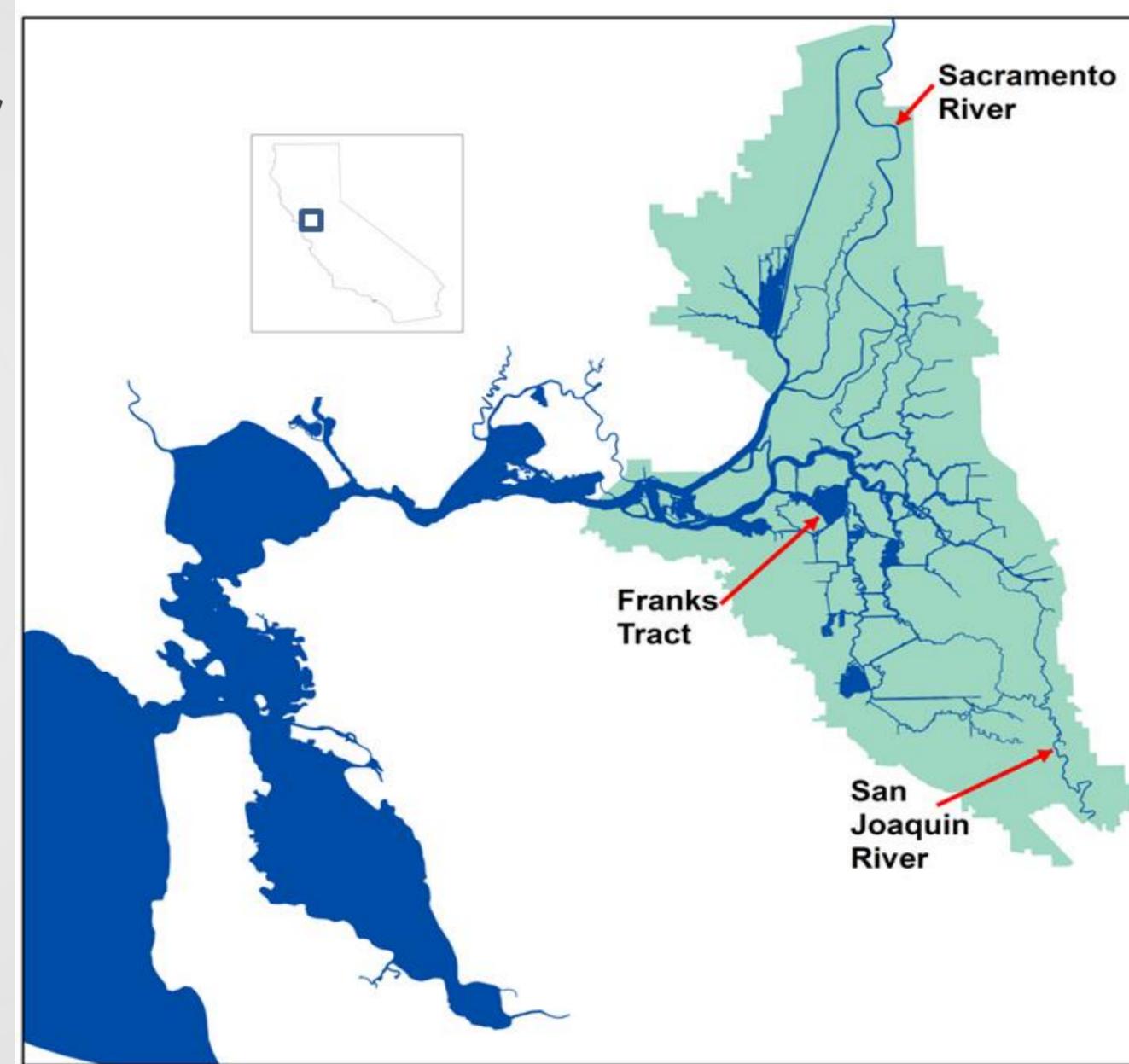
Application Notes

- Lead to development of SAV drag/turbulence
- Uses the ICM water quality module
 - Juxtaposed with CoSINE, shows need for modularization and consolidation
- Also leads to choice of turbulence closure

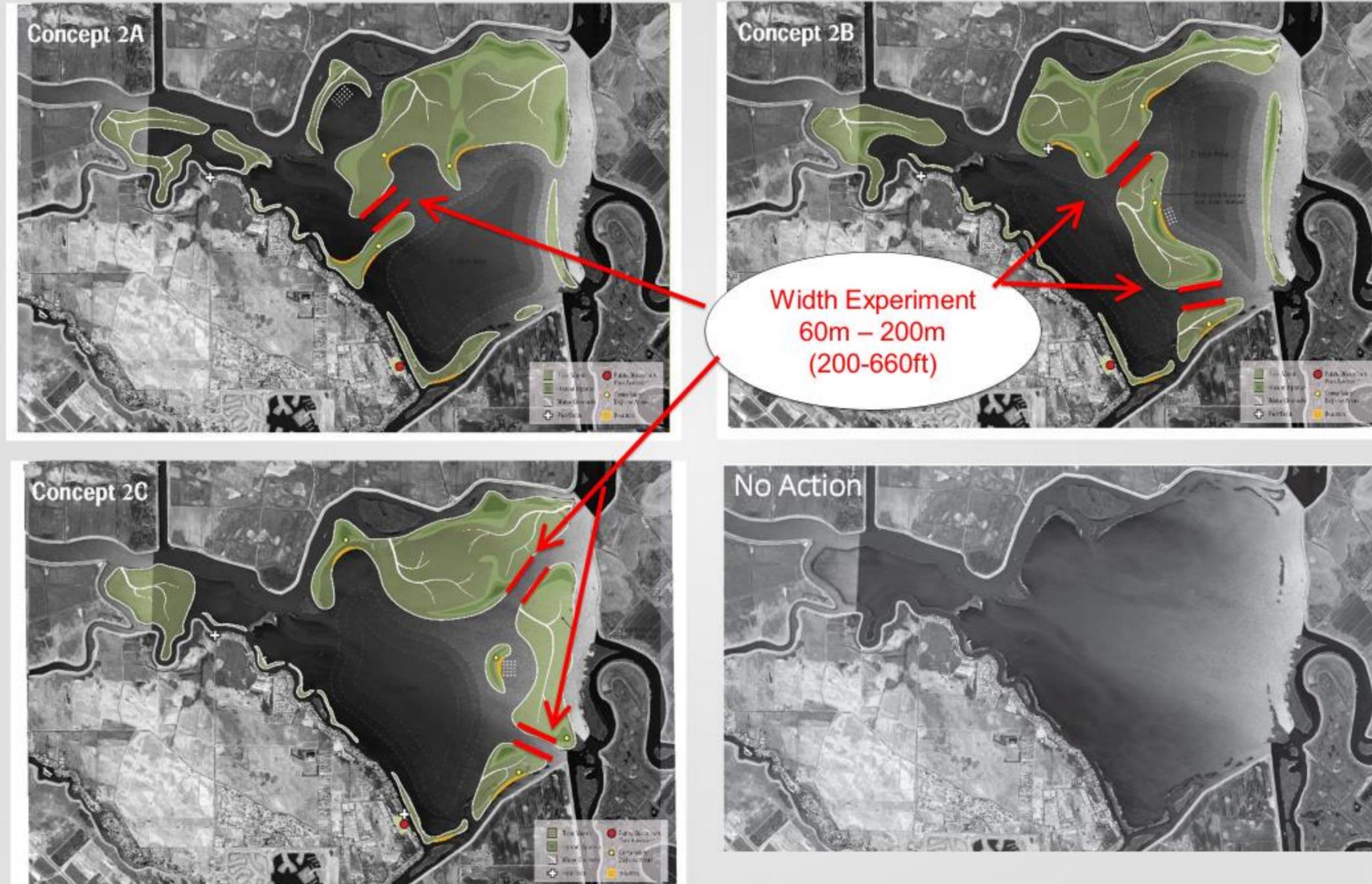


Example: Franks Tract Restoration

- Nexus of estuarine/freshwater
- Open water -> Tidal marsh
- Produce food/habitat
- Regulated area, salinity relief
- Significant rec/economic area



Tidal Marsh Restoration of Franks Tract



Application notes

- Normalized Difference Vegetation Index (NDVI) as approximate surrogate for submerged vegetation
- CAD conversion needs to be better – mixed meshing tools
- Once surfaces/mesh generated, rest reapplied automatically
- 2015 Drought Barrier as structure
- Delta channel depletion using source/sink
- Marsh evolution would be of interest



Example: Flooding

- Two big physical variations:
 - Surge/streamflow interaction in winter storms
 - Seismic events and levee breaks around “islands”
- Two big modes of study:
 - Offline preparedness: statistics, heuristics
 - Operational response: in progress
- Public safety, property, infrastructure and salinity of concern



Library of Island Meshes



Sample of Meshes:
Zhenlin Zhang and Ines Ferreira

Application notes

- 2D works well on barotropic/water level part
- For salinity, need to reinitialize from parent grid
- Library of pre-gridded islands
- Floods sites: Hydraulic structures, Tsunami-inspired overtopping
- For storm-induced: offshore surge, wind important



Bay-Delta SCHISM Directions

- Consolidation of Bay Delta biogeochemistry models under FABM (CoSINE, FABM, benthic, light, sediment)
- Operational modeling and linkage to CenCOOS
 - Event ready
- Modernize release and training materials
- Continued refinement of hydrodynamics



Acknowledgments

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- VIMS Collaborators: Joseph Zhang, Nicole Cai, Zhengui Wang
- Nicky Sandhu, Tara Smith, DWR
- Many others at U. Maine, SF State University



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- Plus: Technical reports on Franks Tract Restoration, Clifton Court Transit Time Under Bathymetry Interventions and 2015 Drought Barrier Performance



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