

Reducing Uncertainty in the Design of in-Delta Sampling Experiments Using Particle-Tracking Models

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Bay-Delta Science Conference

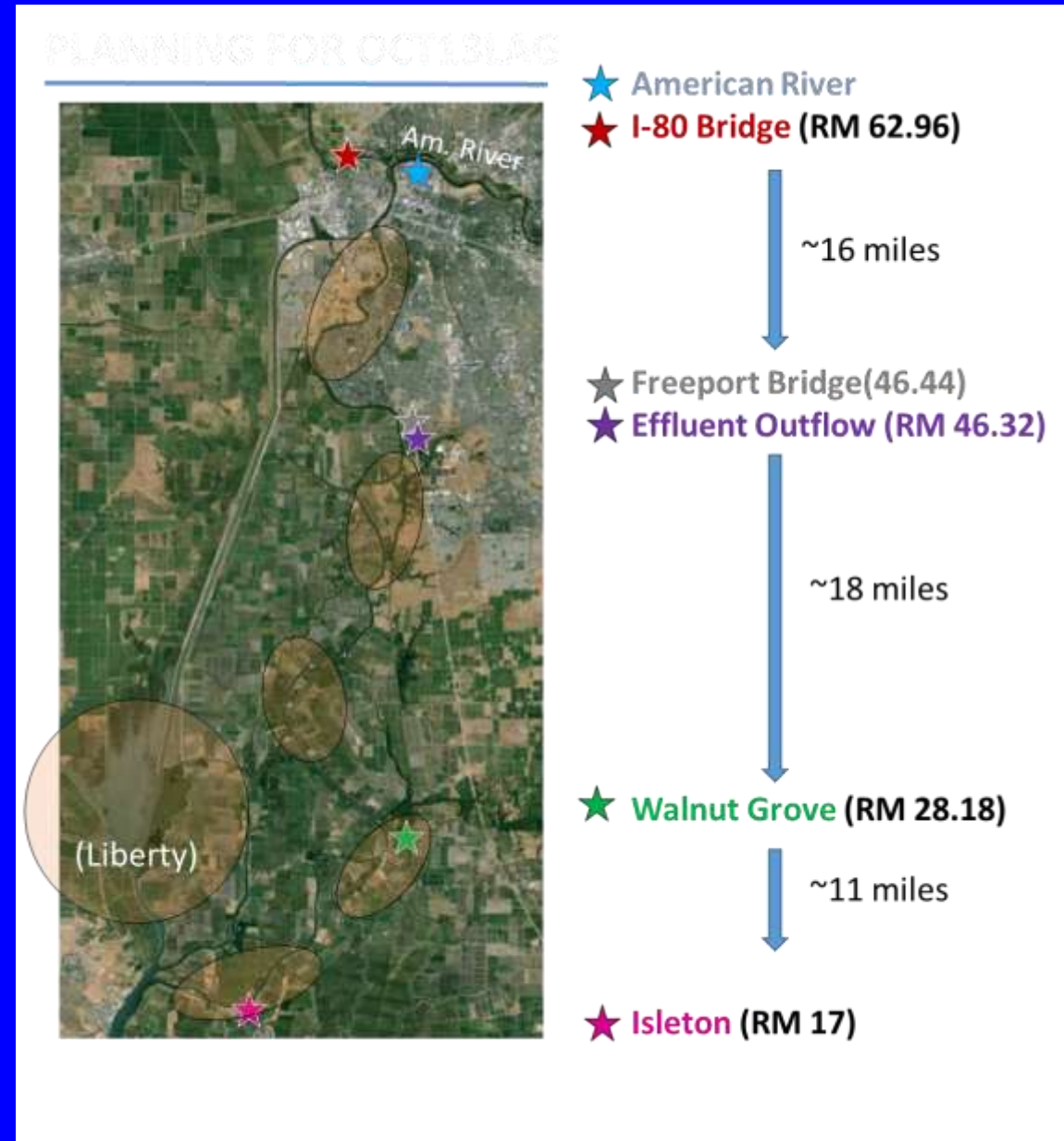


Acknowledgements:

- Funding for modeling work:
 - USGS
 - Carol Kendall for promoting modeling needs on project
 - Central Contra Costa Sanitary District
 - Mary Lou Esparza and Melody La Bella
- DWR/O&M and MWQI staff - data for predicting Delta operations
 - Bryant Giorgi and others
- Funding for Experiments: Sacramento Regional County Sanitation District (Sac Regional), IEP, SFCWA

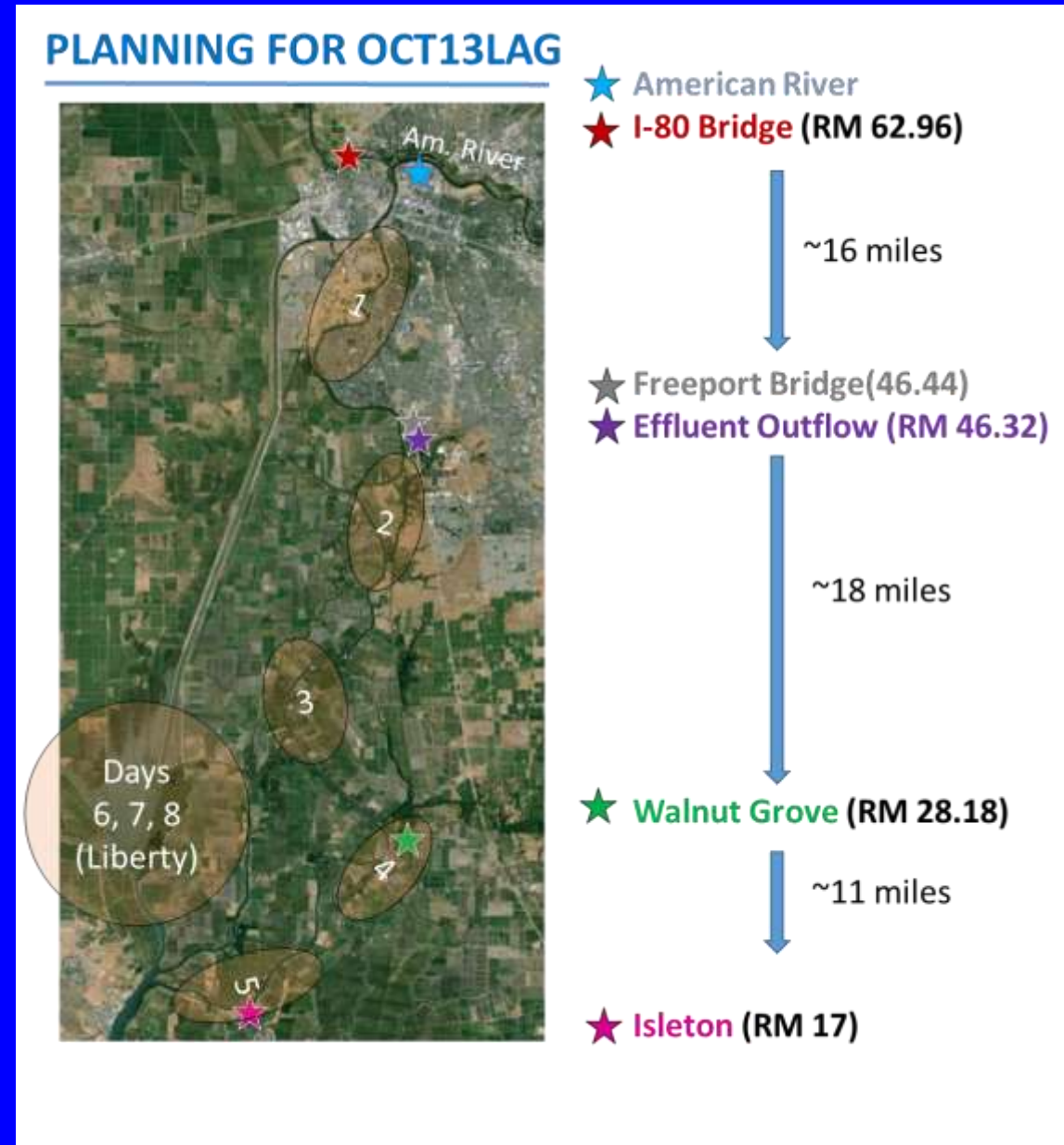
Experimental Setting

- USGS/Sac Regional collaboration to evaluate effect of effluent shutdown on Sacramento River nutrient dynamics/food web
- Idea - Track the progress of water parcels with and without effluent – “Lagrangian experiment”
 - October 2013
 - May 2014



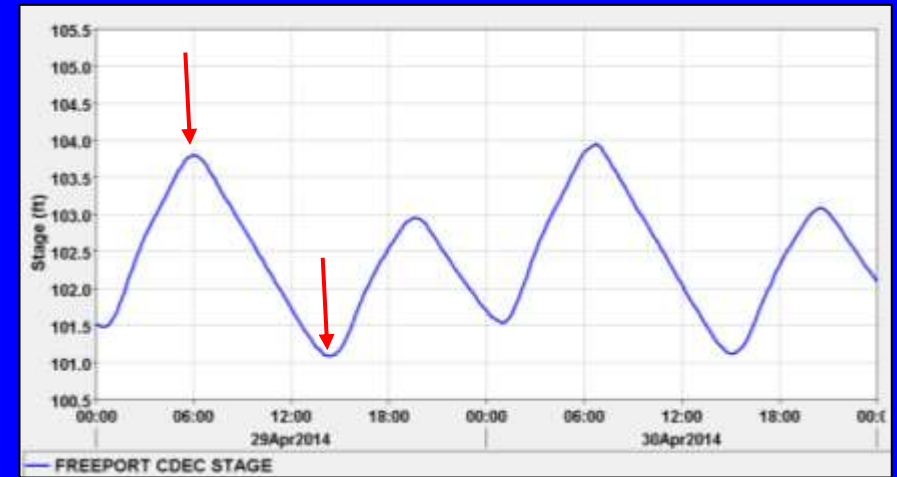
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 - October 2013
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- Oct. 2013 experiment:
 - 45 miles, + effluent, - effluent tracking
 - 5 days each, separated by 1 day
- RMA modeling of both experiments



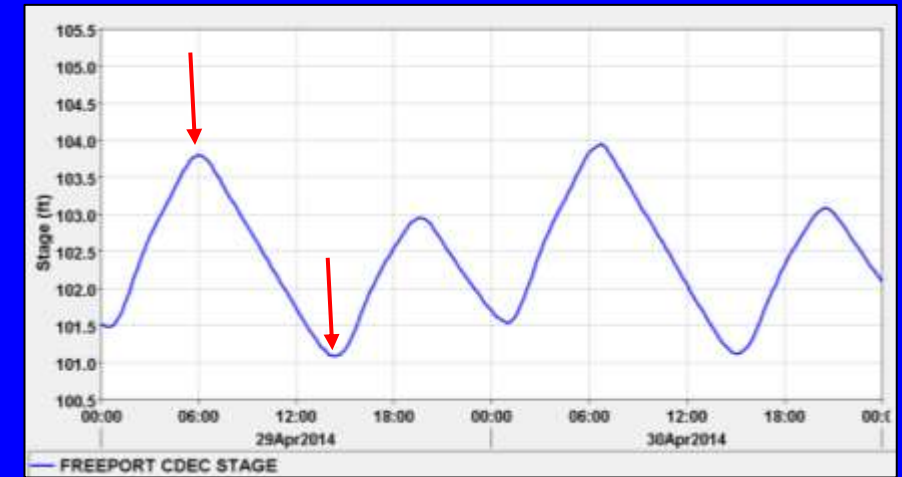
Predictive Uncertainty Abounds!

- Timing aspects for experiment:
 - Should effluent shut off begin at high, low or slack tide
 - Length of effluent holding period
 - Timeliness of results vs. current information



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- Timing aspects for experiment:
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 - Length of effluent holding period
 - Timeliness of results vs. current information
- Delta operations predictions:
 - Delta Cross Channel operation
 - Net Delta Outflow –
 - Sacramento River flow at Freeport
 - South Delta export levels
 - Consumptive use by agriculture
- Sac Regional operations:
 - Storage capacity for wastewater vs. supply
 - Receiving water quality constraints



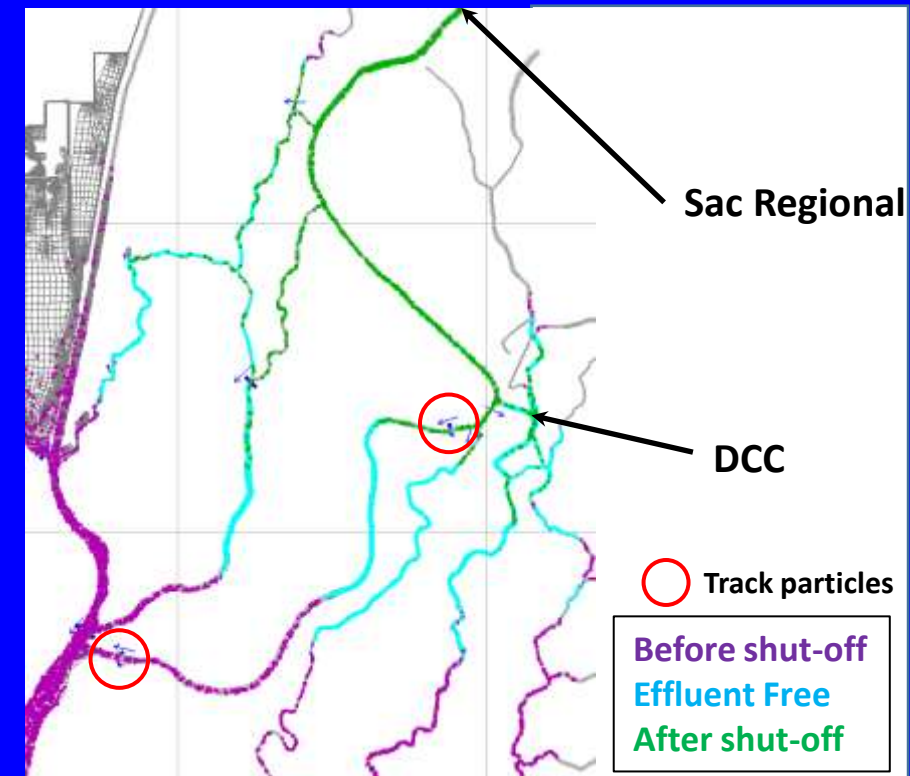
RMA Modeling Objective: Reduce Uncertainty

- RMA 2-D hydrodynamic scenarios used to inform field experiment set-up:
 - Timing and duration of effluent shutdown to track length of effluent-free section
 - Reduce uncertainty associated with Delta operations
 - Positioning boats sampling parcels with and without effluent – logistics!



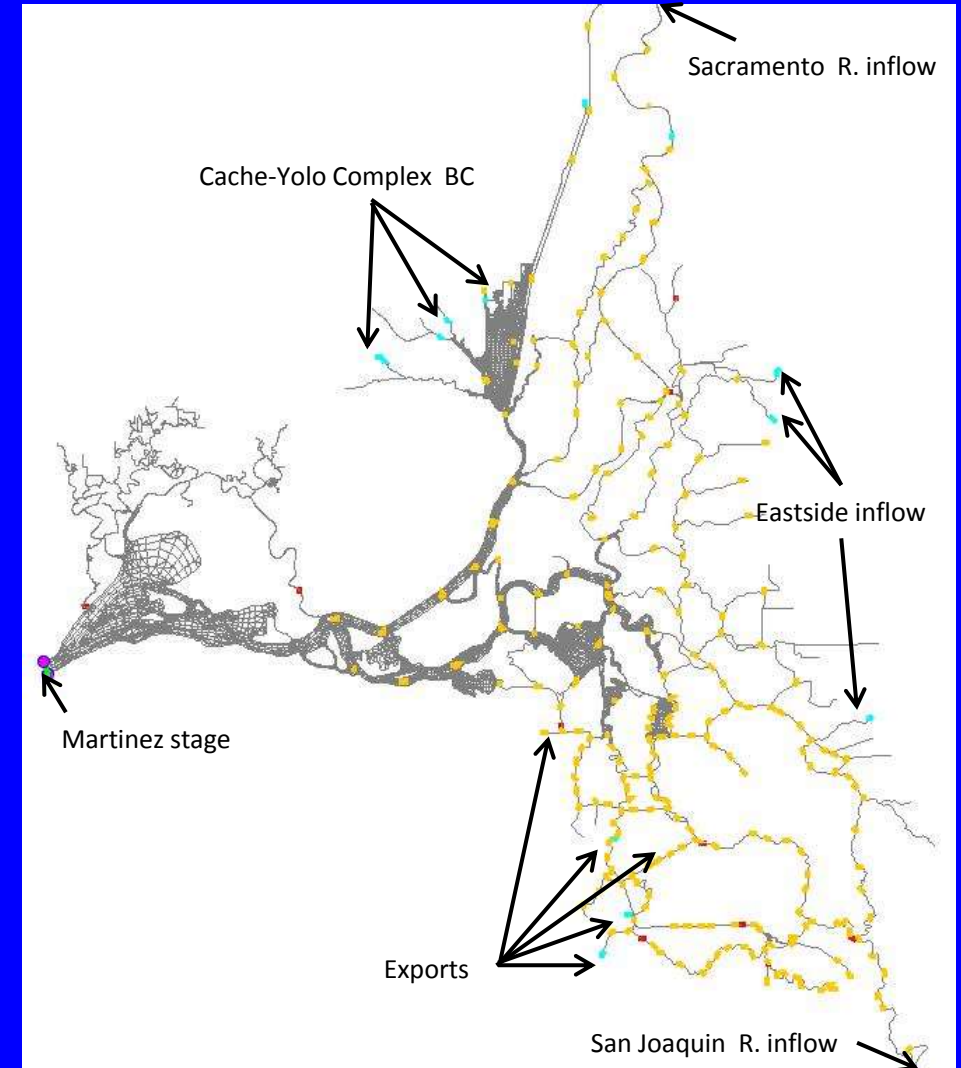
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- Particle Tracking scenarios:
 - Animations depict waters with effluent (purple and green) and without (cyan)
 - Tracking to estimate length of effluent-free region near confluence of Sacramento R. and Georgiana and Cache Sloughs



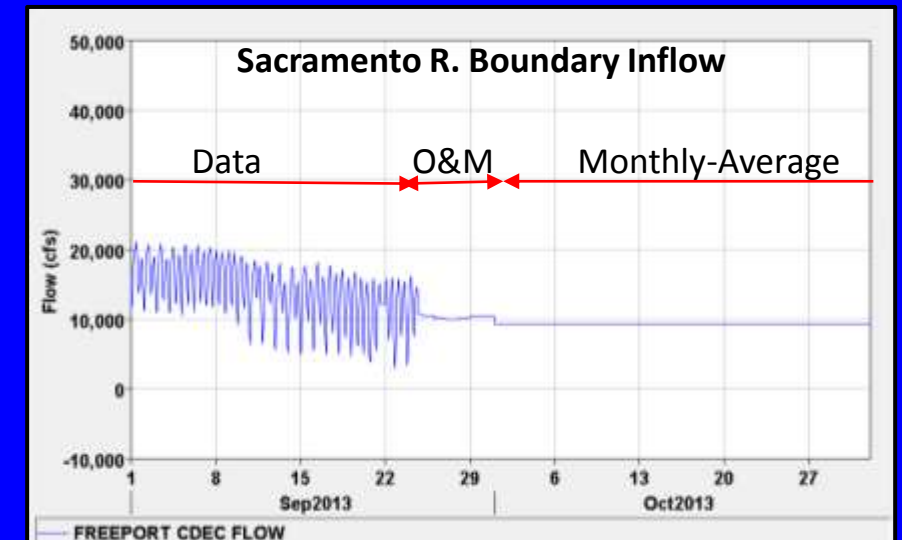
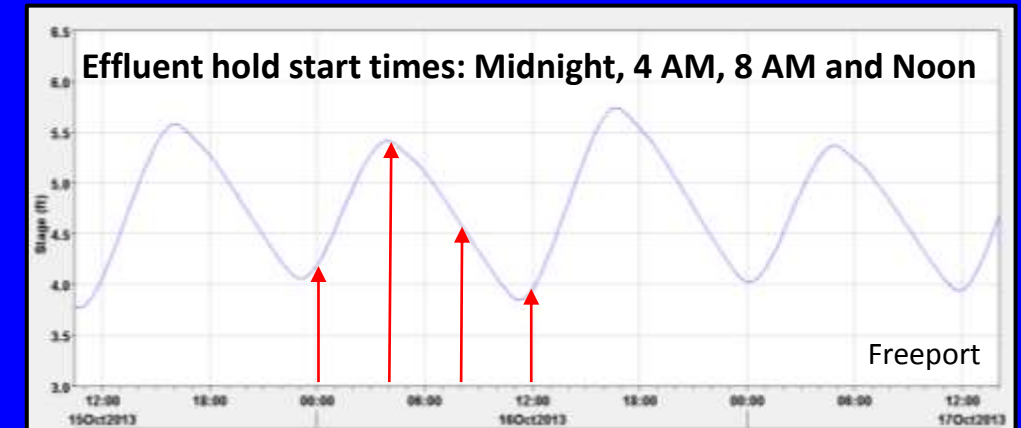
Model Scenario Design: October 16, 2013 Experiment

- Hydrodynamic model:
 - Need historical data for inflow, outflow and stage boundaries and for gate operations
 - Need same boundary condition data for the prediction period
- Particle Tracking model
 - Need a reasonable set of assumptions to test
 - Background information on effluent hold

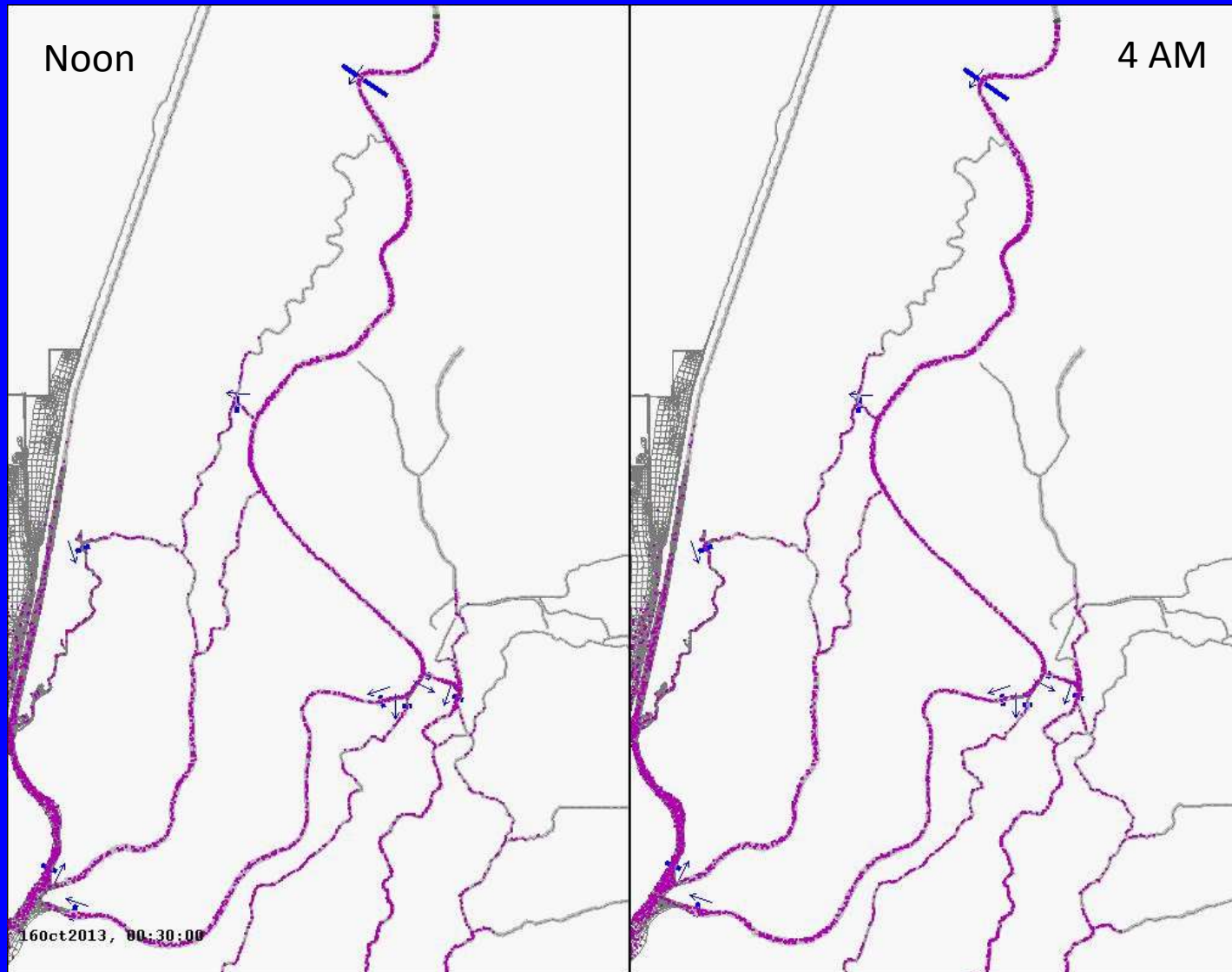


Model Scenario Design: October 16, 2013 Experiment

- Proposed 12-hour effluent hold – Scenario start time varied over 12 hours for particle tracking model
- Delta operations prediction – DWR/O&M
- 2003 monthly-average data used for rest of October
- Forecast stage from DWR-Delta Modeling Section methodology
- DCC open



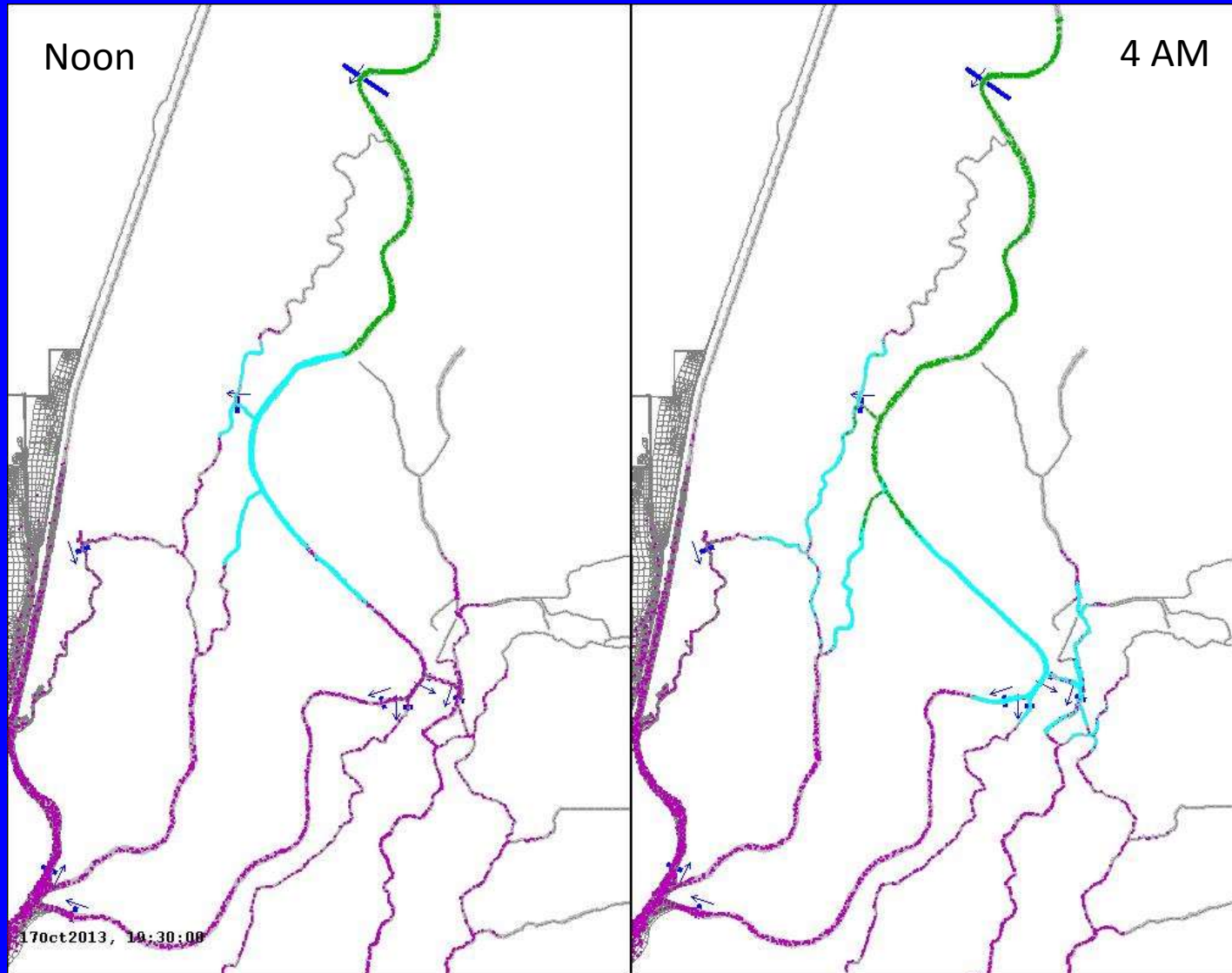
Comparison – Noon and 4 AM Scenarios



October 2013 simulation

Before shut-off
Effluent Free
After shut-off

Comparison – Noon and 4 AM Scenarios



October 2013 simulation

Before shut-off
Effluent Free
After shut-off

4:00 AM Effluent start scenario
provided longer effluent-free region

Late May 2014 Experiment

- Severe drought conditions significantly increased uncertainty!
- DCC closes in low Delta outflow to battle with salinity intrusion
 - BUT, DCC usually open over Memorial Day weekend, coincides with experiment
- Agricultural consumptive use reported to vary by several thousand cfs
- Actual Delta operations varied to maintain D-1641 compliance standards
- Sac Regional effluent released on a tidal basis, exact timing hard to predict
- Political considerations
- Result: Two rounds of model scenarios

Focus on Eight Scenarios in May 2014:

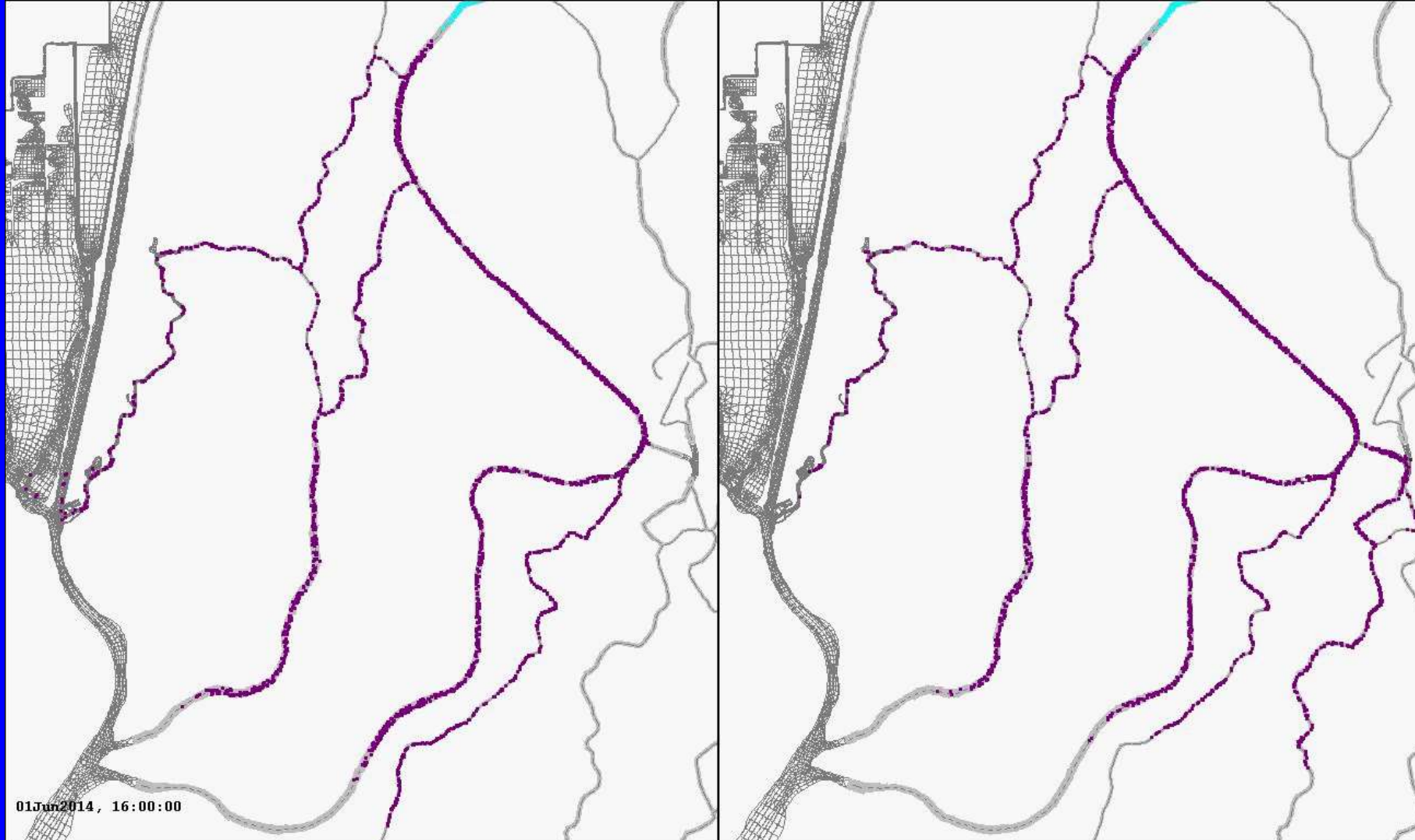
- Four hydrodynamic scenarios:
 - Freeport flow 6300 or 6800 cfs to obtain NDO at 3500 or 4000 cfs
 - DCC closed, or, DCC ‘operating’. i.e., closed, open May 30th to June 2nd, then closed again
- Two effluent hold scenarios, 20-hour and 18-hour :

20 hr Hold Scenario #1		
Start Particles	Stop Particles	Hrs
Effluent		
may 29 2000	may 30 0200	6
may 30 0700	may 30 1700	10
may 30 2100	may 31 0300	6
may 31 0700	may 31 1400	7
No Effluent:		
may 31 1500	jun 01 1100	20
Effluent		
jun 01 1200	jun 01 1900	7
jun 01 2200	jun 02 0500	7
jun 02 0800	jun 02 1900	11
jun 02 2300	jun 03 0600	7
jun 03 0900	jun 03 1900	10

18hr Hold Scenario #2		
Start Particles	Stop Particles	Hrs
Effluent		
may 30 0700	may 30 1700	11
may 30 2100	may 31 0300	6
may 31 0700	may 31 1800	10
may 31 2100	jun01 0300	6
No Effluent:		
jun 01 0400	jun 01 2200	18
Effluent		
jun 01 2300	jun 02 0500	6
jun 02 0800	jun 02 1900	11
jun 02 2300	jun 03 0600	7
jun 03 0900	jun 03 1900	10
jun 03 2300	jun 04 0800	9

“Effluent” particles
inserted when
Sacramento flow at
least 2000 cfs
downstream

Higher Sacramento R. Inflow, 6800 cfs, DCC comparison, 20-Hour Effluent Hold



Before shut-off
Effluent Free
After shut-off

Results For May 2014 Scenarios:

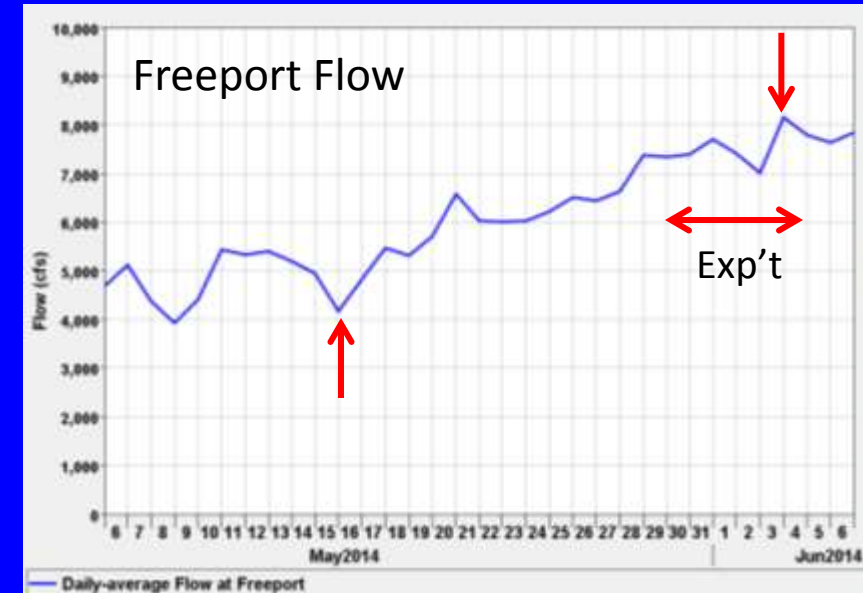
- Little effect of DCC operation on effluent-free length
 - Some local mixing effect
- Length of effluent-free regions as a function of Sacramento Inflow:
 - Sacramento inflow had small effect on 20-hour effluent hold results:
 - Effluent-free region ~14 hours below confluence with Georgiana Slough
 - Effluent-free region 9-10 hours above confluence with Cache Slough
 - Sacramento inflow showed tidal effects in 18-hour hold:
 - Lower inflow had greater tidal effect below confluence with Georgiana Slough
 - Higher inflow had enhanced effluent-free region on the Sacramento mainstem

Final Thoughts:

- **The modeling served to:**
 - Reduce uncertainty in experimental decisions
 - Increase intuitive understand of:
 - Hydrodynamics of the Sacramento River in this region
 - Effect of DCC operation
 - Tidal mixing at Sac. tributaries and confluence regions

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 - Tidal mixing at Sac. tributaries and confluence regions
- **Reality in late May 2014: Experiment May 30 – June 04:**
 - Conditions much different than the assumptions of the scenarios!
 - The DCC closed during the experiment (5/27/14 AM – 6/6/14 AM)
 - Daily-average Sacramento inflow above 8000 cfs, but < 5000 cfs for initial scenario runs
 - Wastewater hold period 19 hours



Thank-you!

See Tamara's talk Room 307, Thursday 9:00 AM for results of the experiments

CWEMF – Annual Meeting March 9-11, 2015, Lake Natoma Inn at Folsom

