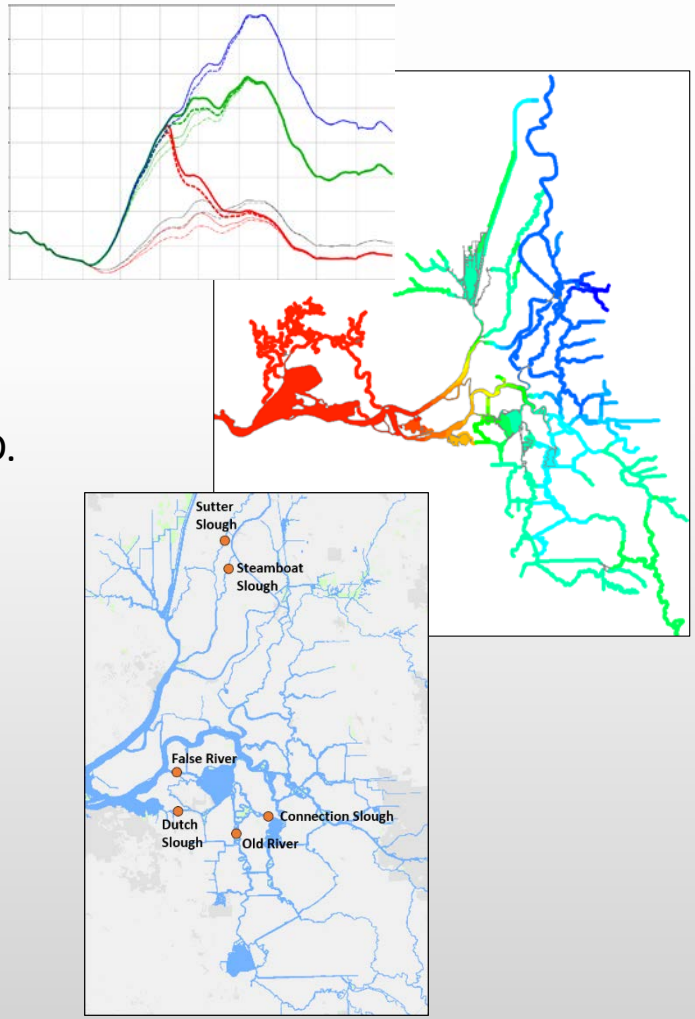
Modeling Potential Impacts of Channel Barriers and Levee Failures on Delta Water Quality



John DeGeorge, Ph.D., P.E.

Richard Rachiele, Stacie Grinbergs, P.E., Steve Andrews, Ph.D.

Resource Management Associates, Inc.

Delta Independent Science Board Meeting

October 15, 2015

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Overview

- *Delta Barriers, a general discussion*
- *A Range of Models*
- *Forecast Modeling for Emergency Barrier Placement*
- *Salinity Impacts of Levee Failures*
- *Delta-Emergency Response Tool*

Acknowledgements

Work presented here is the result of various projects funded by:

California Department of Water Resources
Metropolitan Water District of Southern California
State Water Contractors
North Delta Water Agency

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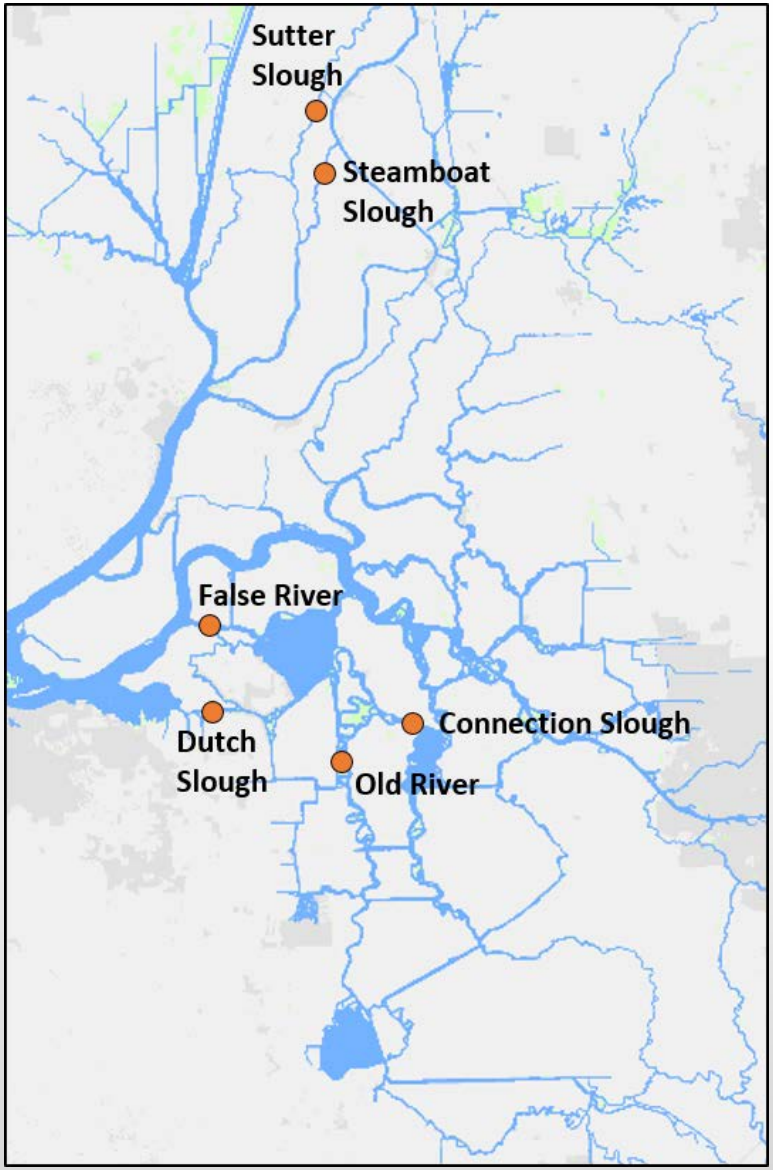
Potential Barrier Locations

The Delta is a highly interconnected system, blocking a channel may have far reaching impacts

- Sutter and Steamboat Slough barriers shift Sacramento inflow toward the east
- False River and Dutch Slough barriers limit the introduction of high salinity water into Franks Tract
- Connection Slough and Old River barriers create the "Middle River Corridor"



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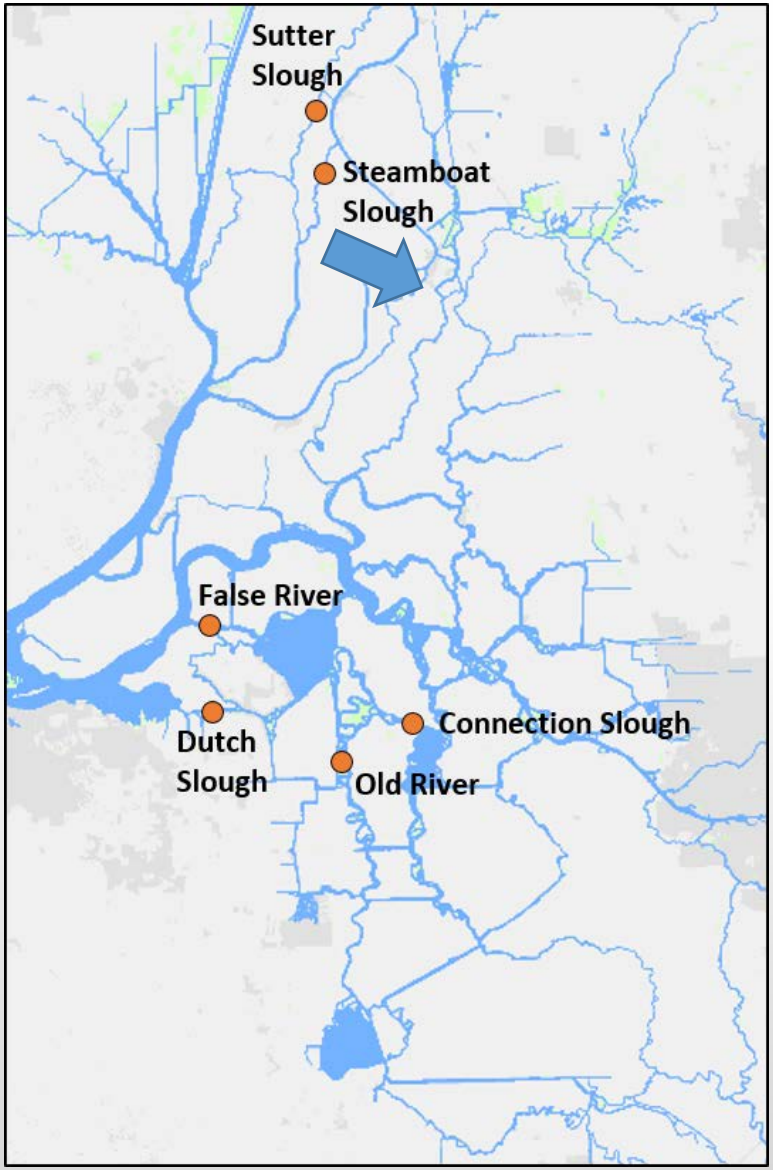

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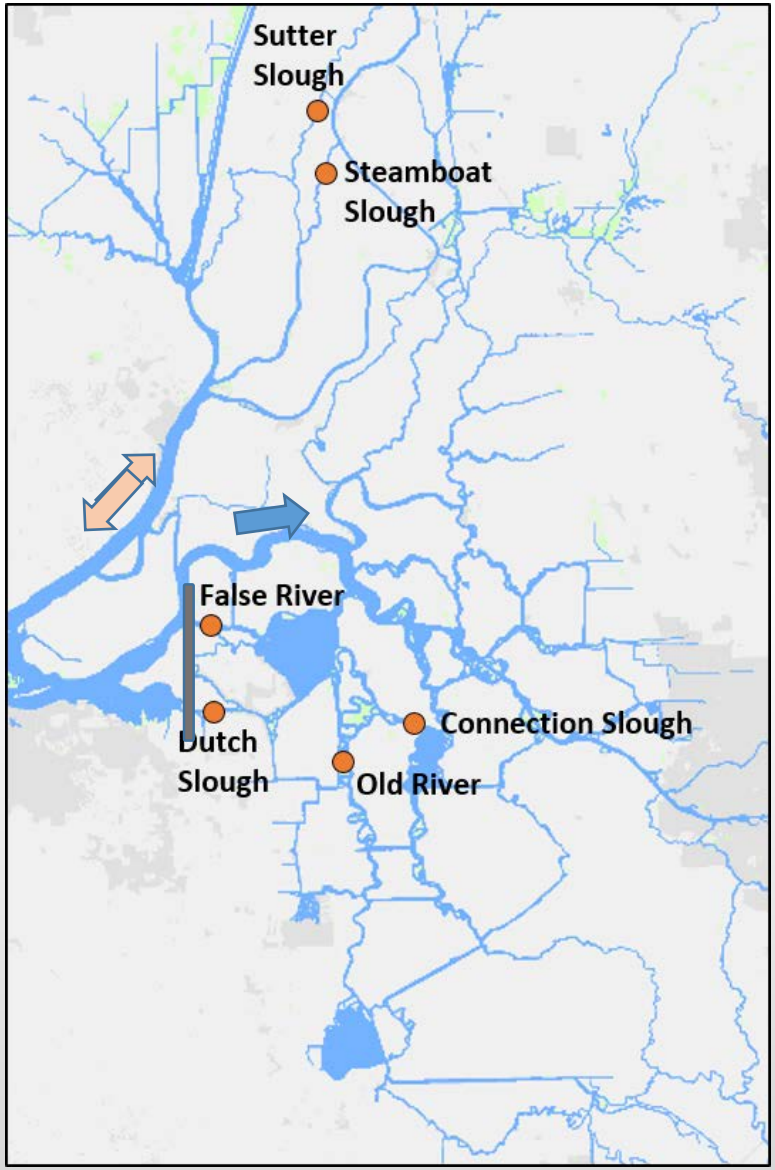

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Potential Barrier Locations

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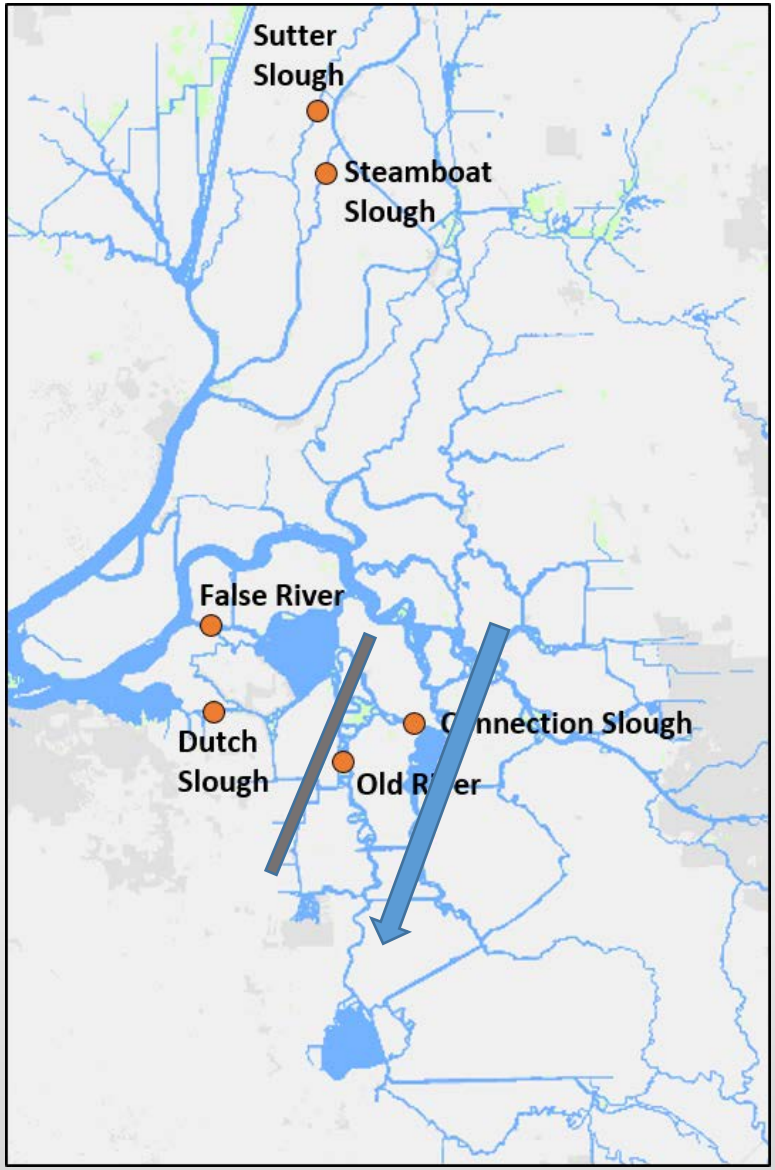

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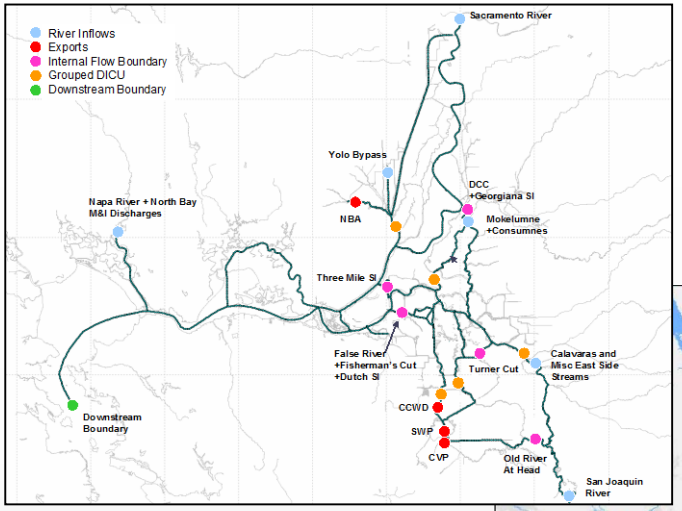
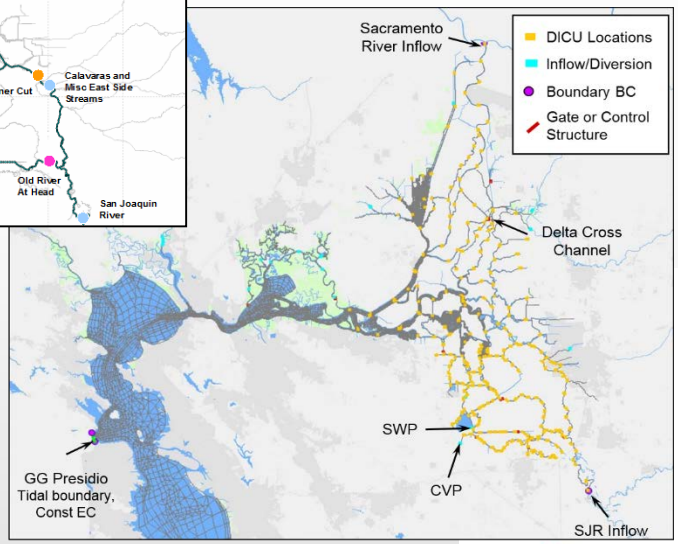
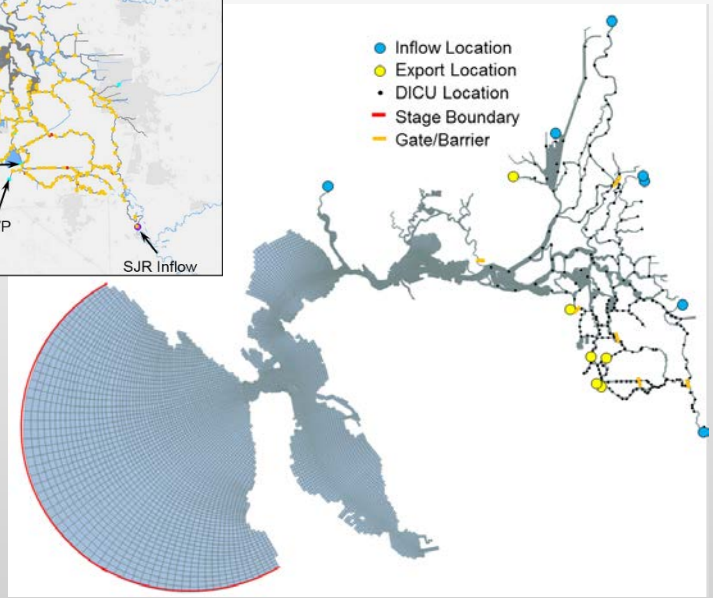
Range of Models



1-D Tidally Averaged Model



2-D and 1-D
RMA Bay-Delta Model



RMA/UCD 3D Model

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Early 2014 Forecast Modeling for Potential Placement of Emergency Barriers

- Barrier Configurations
  - No barriers
  - Sutter Slough
  - Sutter Slough and Steamboat Slough
  - West False River and Dutch Slough
  - Old River and Connection Slough
  - Sutter, Steamboat, False River, and Dutch Slough
  - Sutter, Steamboat, Old River, and Connection Slough
- Barrier Installation Dates
  - April 1
  - May 1
  - June 1
  - July 1
- Sacramento River Inflow
  - 75% Exceedance – 2000 cfs target NDO
  - 75% Exceedance – 3000 cfs target NDO
  - 75% Exceedance – 4000 cfs target NDO
  - 90% Exceedance
- Exports/Diversions
  - High
  - Low
- DICU
  - Historical
  - Run 3
- Delta Cross Channel Operations
  - Open
  - Operating

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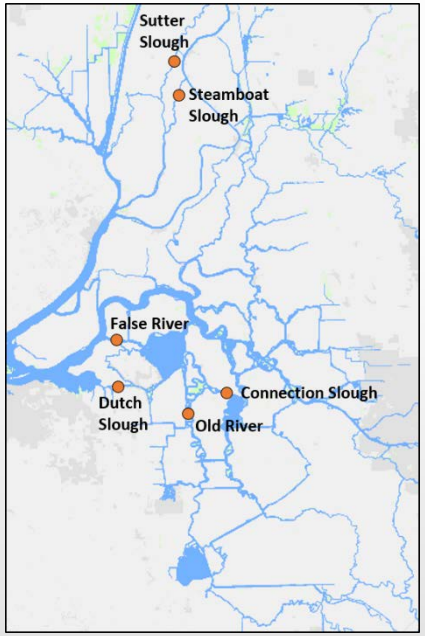
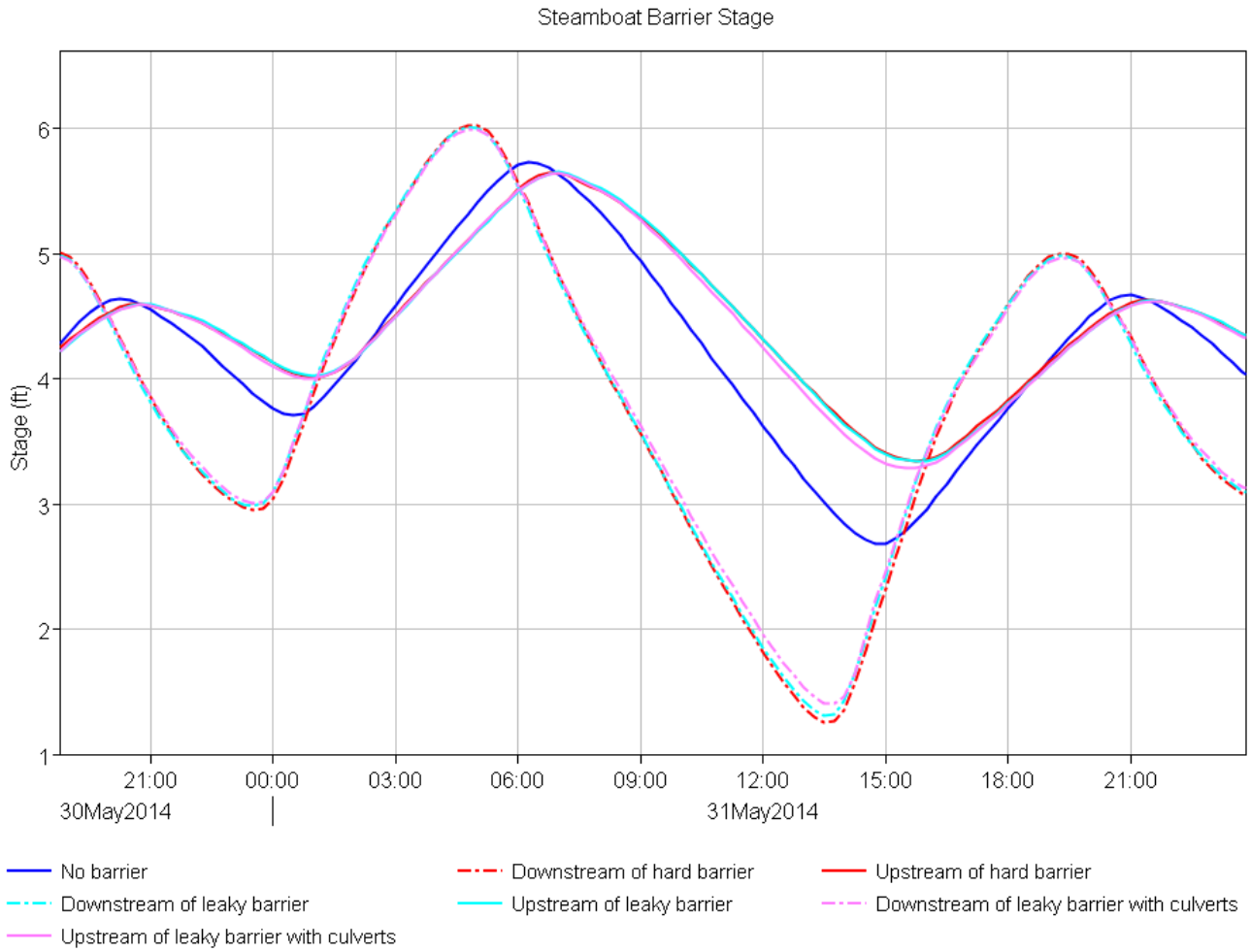
Stage Impact





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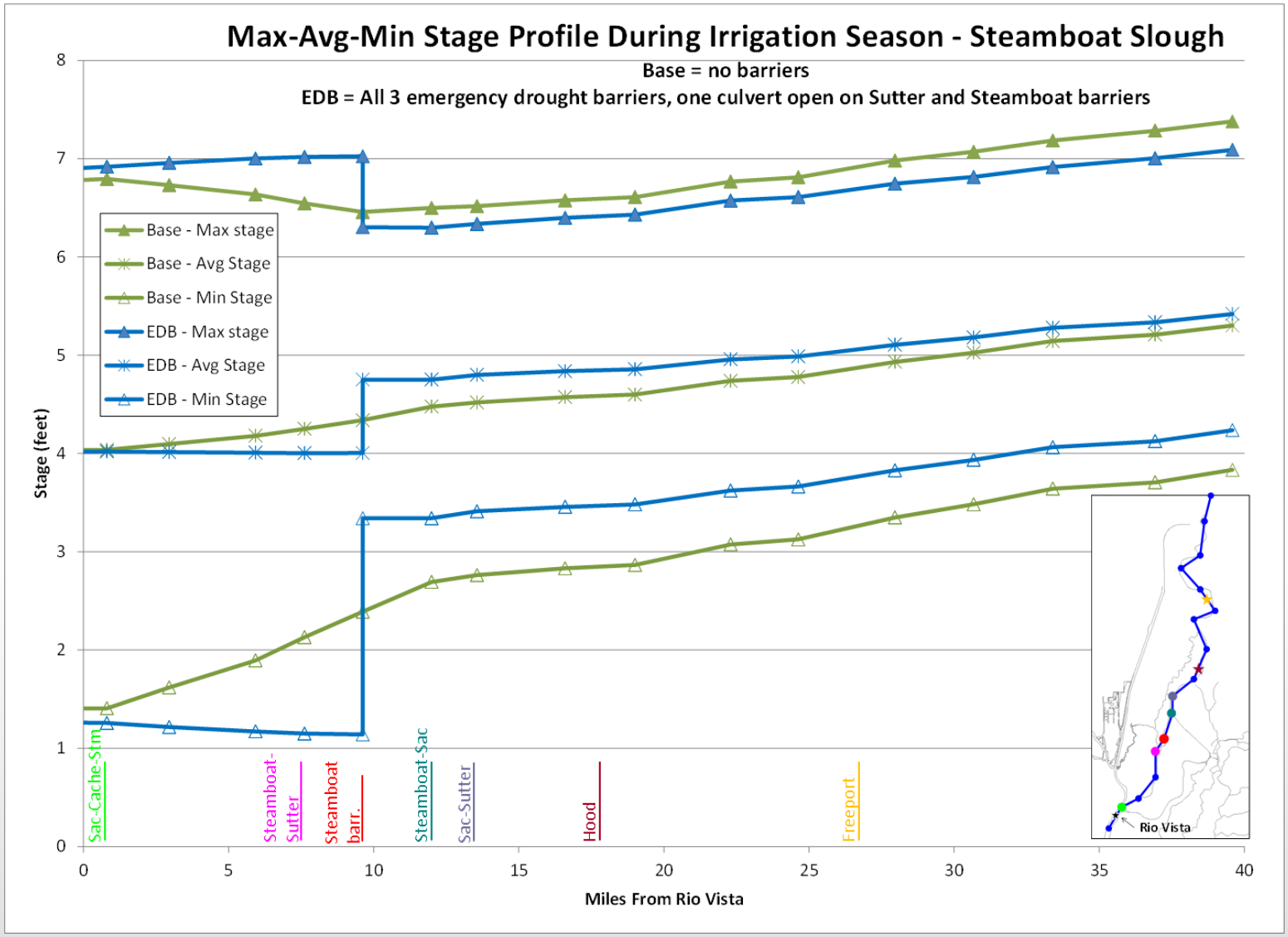

Plot created by RMA from DWR numerical modeling results referenced in Appendix C, "DSM2 Modeling of Tidal Flows and Salinity", of the Initial Study/Proposed Mitigated Negative Declaration for the Emergency Drought Barriers Project, January 2015.

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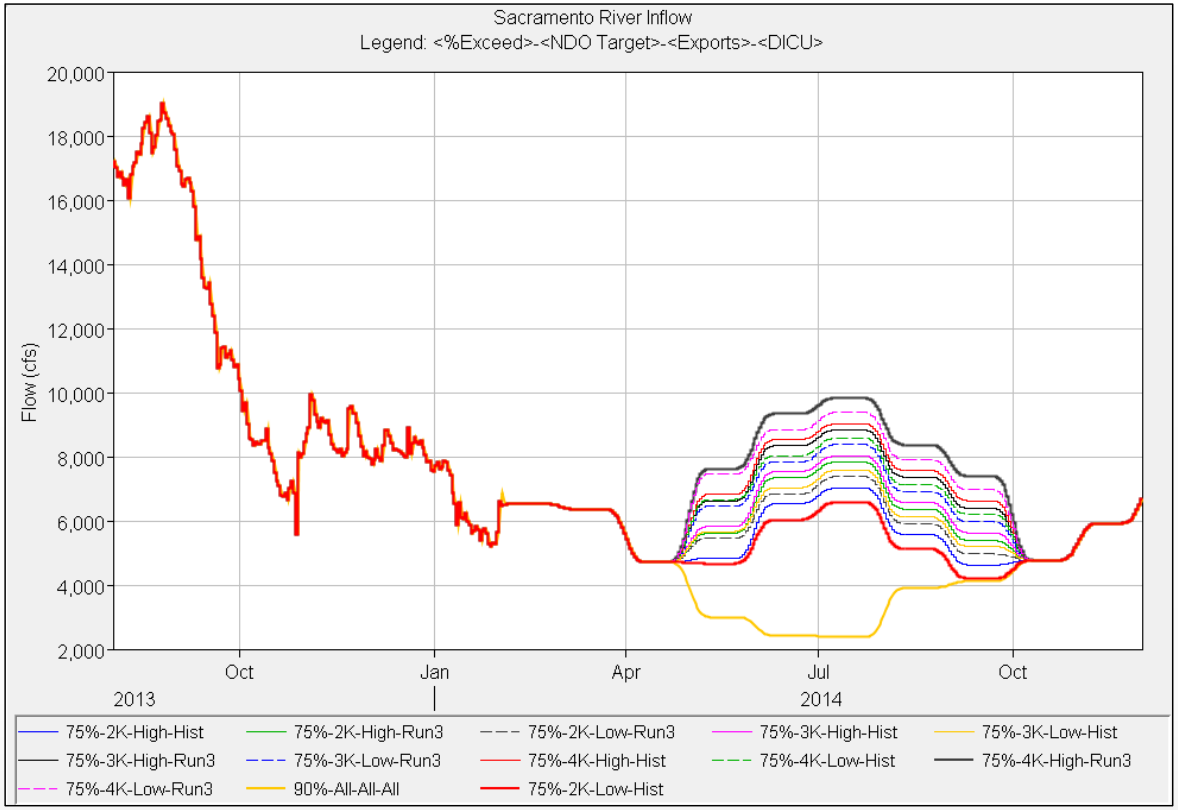
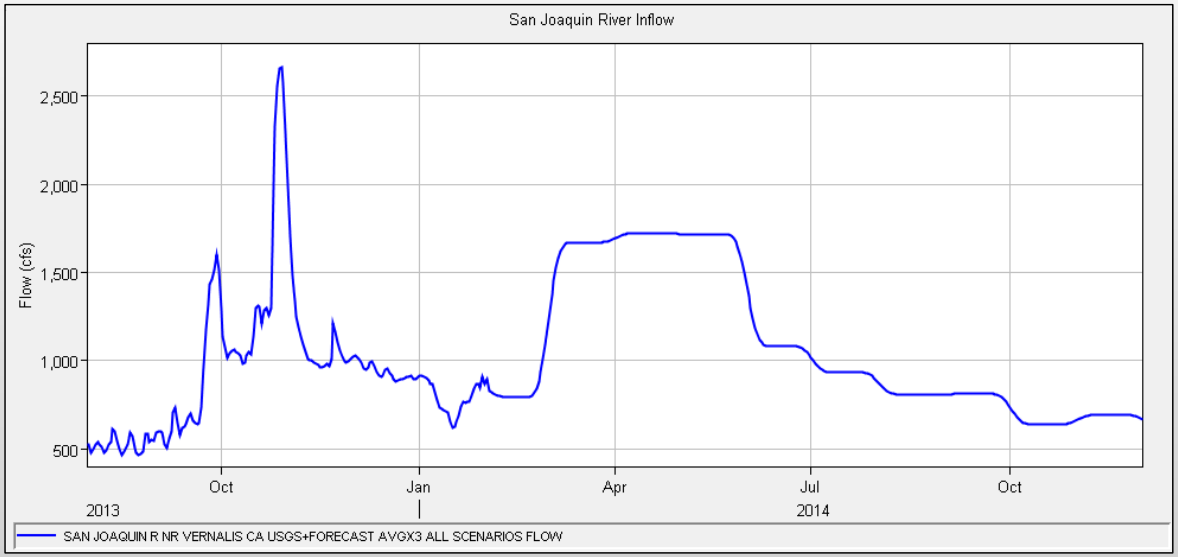
Primary Inflows

Sacramento River



San Joaquin River



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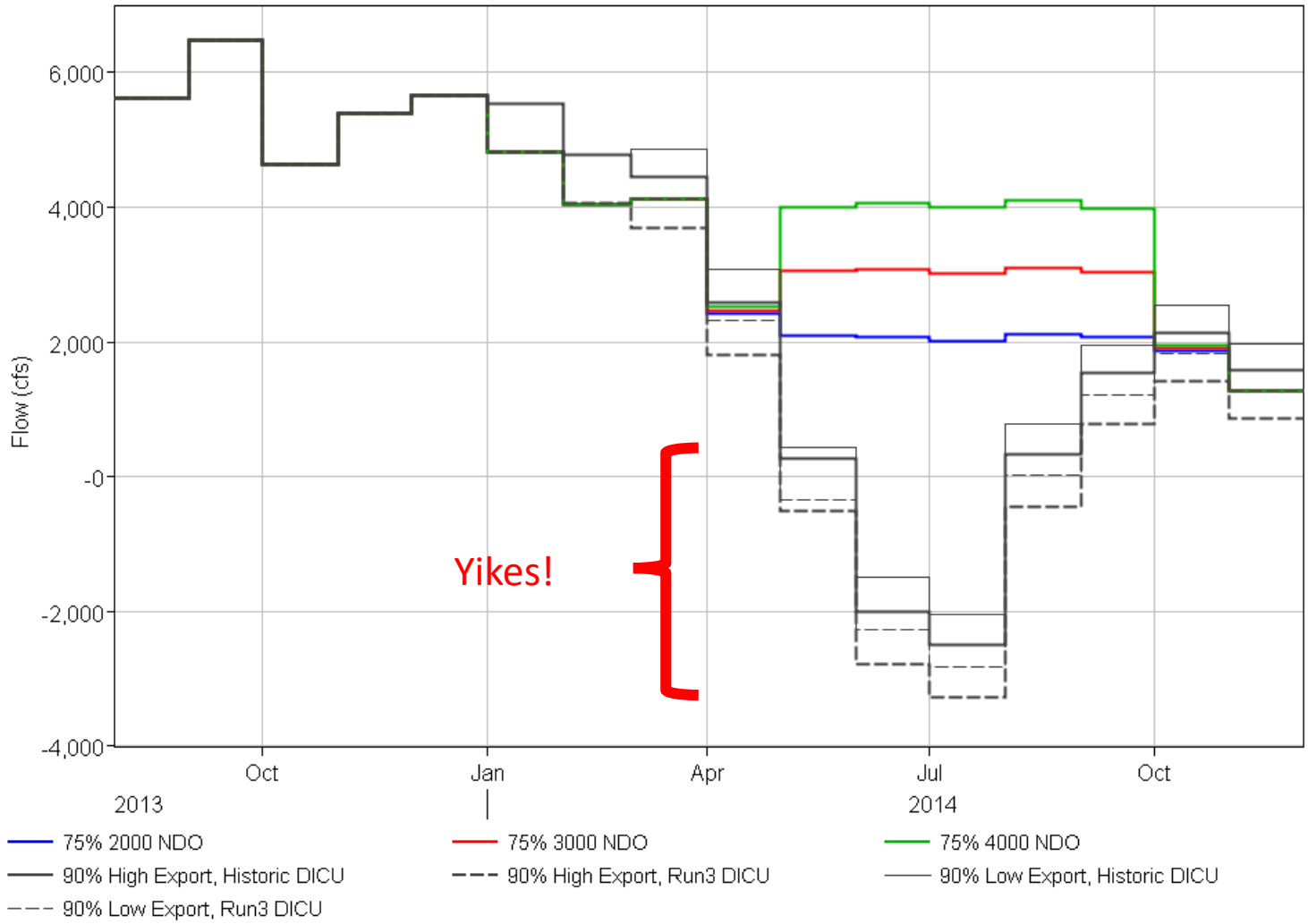
Net Delta Outflow



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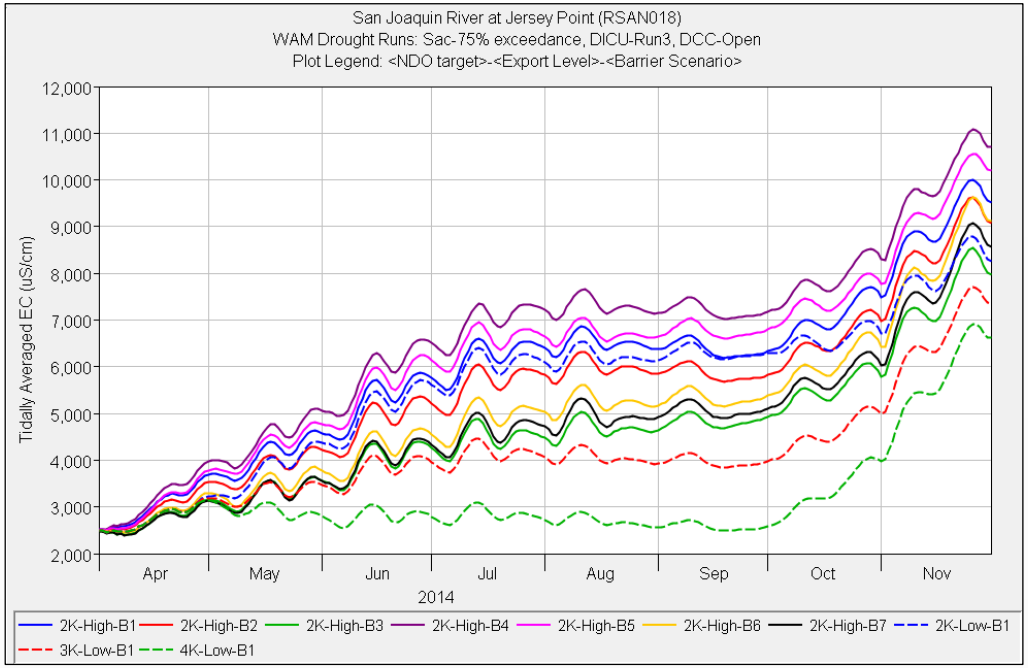
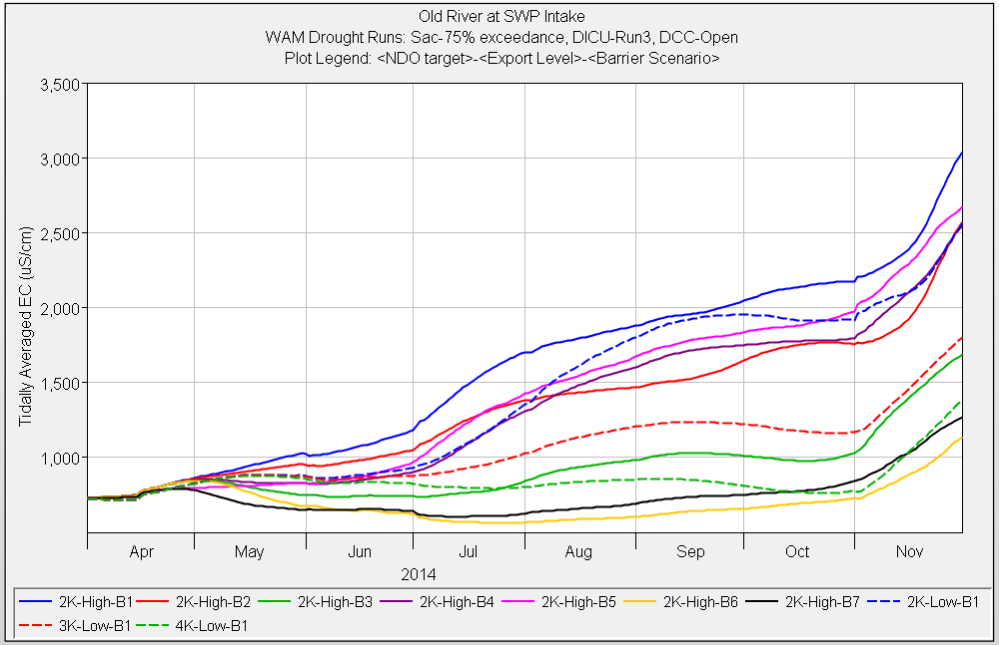
75% Exceedance Scenarios - EC

Jersey Point



Barrier Location	Scenario						
	1	2	3	4	5	6	7
Sutter Slough		X	X			X	X
Steamboat Slough			X			X	X
West False River				X		X	
Dutch Slough				X		X	
Old River					X		X
Connection Slough					X		X

SWP



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Phase II Scenarios

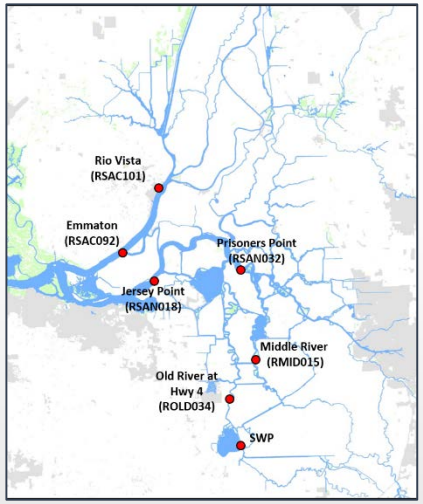
- Sacramento River Inflow
  - 90% Exceedance
  - 99% Exceedance
- Exports
  - 90% Exceedance based; provided by DWR OCO
  - 99% Exceedance based; provided by DWR OCO
- DICU
  - Run 3
- Delta Cross Channel Operations
  - Open
  - Operating

- Barrier Configurations
  - No barriers (scenario B1)
  - Sutter + Steamboat (scenario B3)
  - Sutter, Steamboat, False, Dutch (scenario B6 or "all barriers" case)
- Barrier Installation Dates
  - April 1
  - May 1
  - June 1
  - July 1

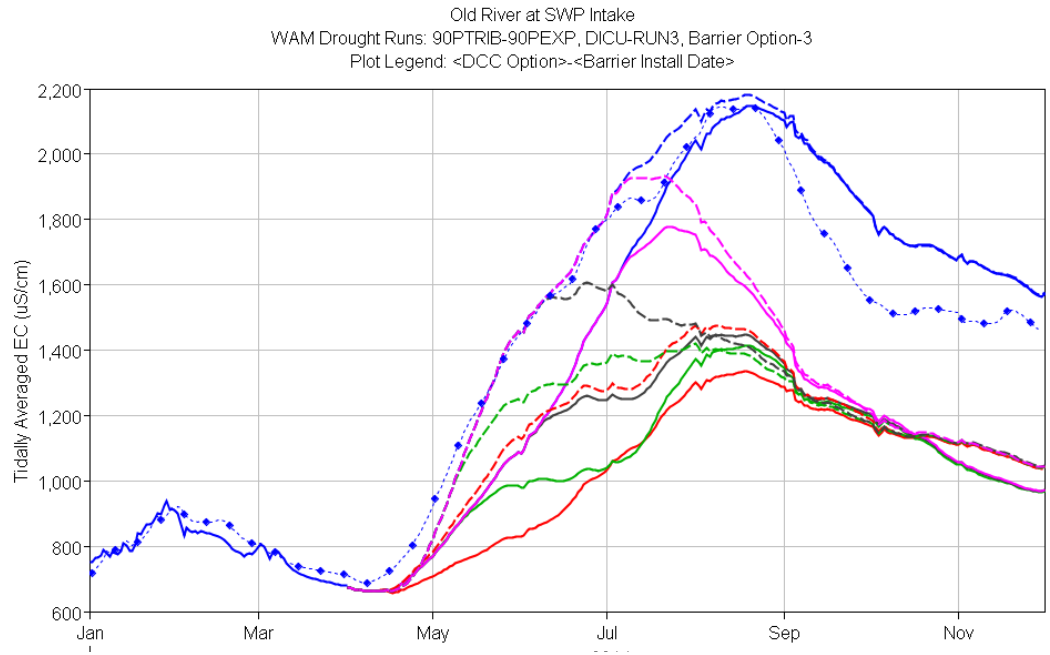
This 90% Sacramento River inflow exceedance case differs from the Phase I WAM 90% exceedance case because of modified forecast data, based on updated Sacramento Basin hydrology.

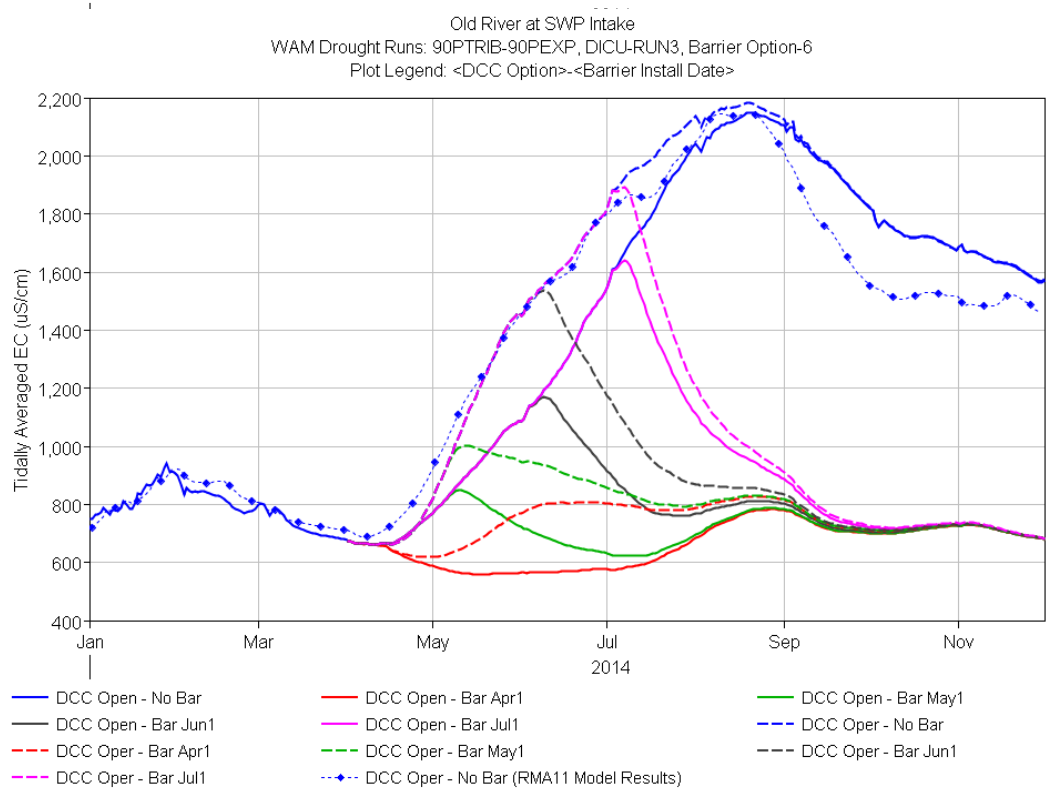
Installation Date Analysis EC

Sutter and Steamboat Barriers
SWP



Sutter, Steamboat, False River, Dutch Slough Barriers
SWP





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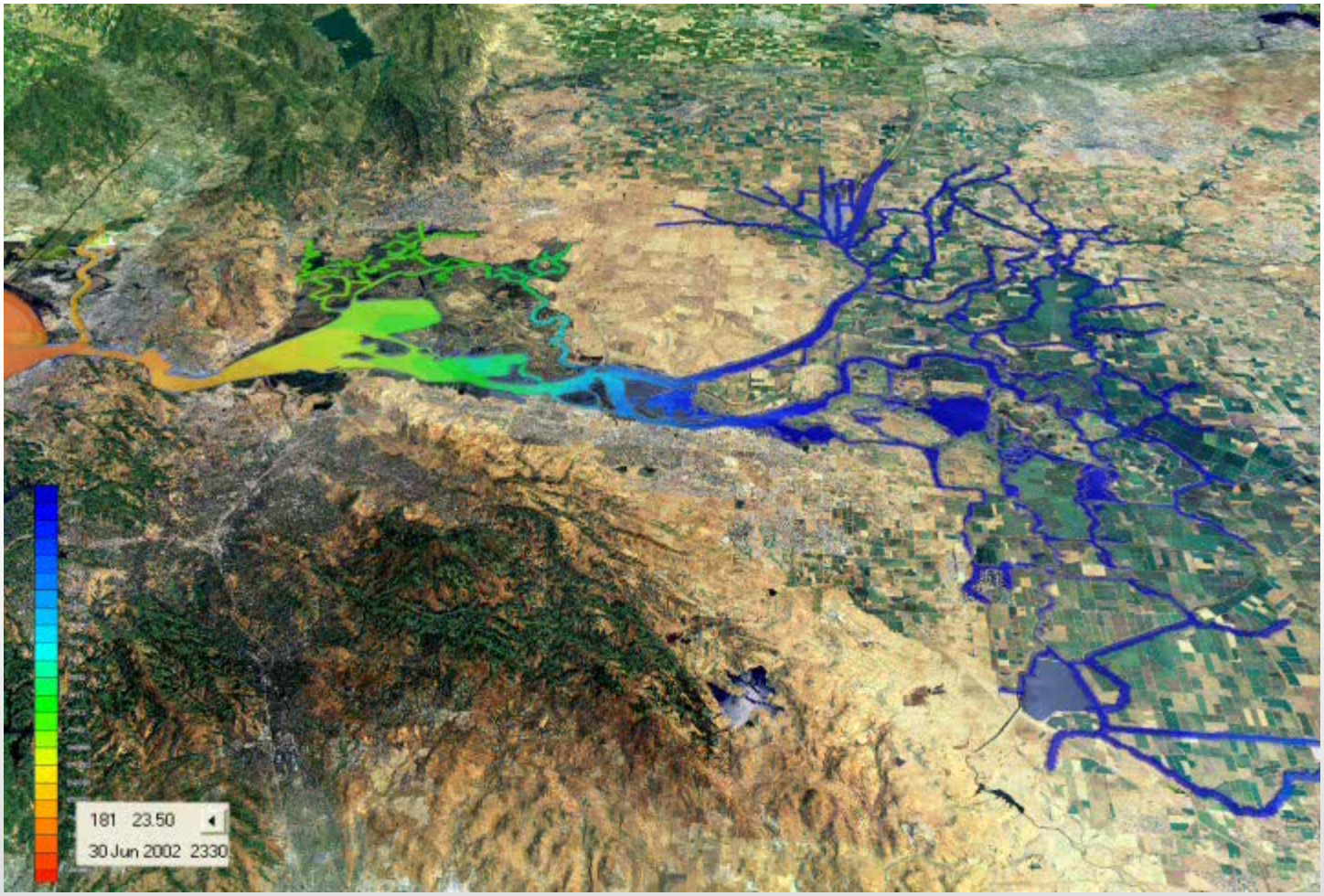
Potential Salinity Impact of a Levee Failure Event flooding 20 Delta Islands



3D Animation produced by 34North using RMA Bay-Delta Model results

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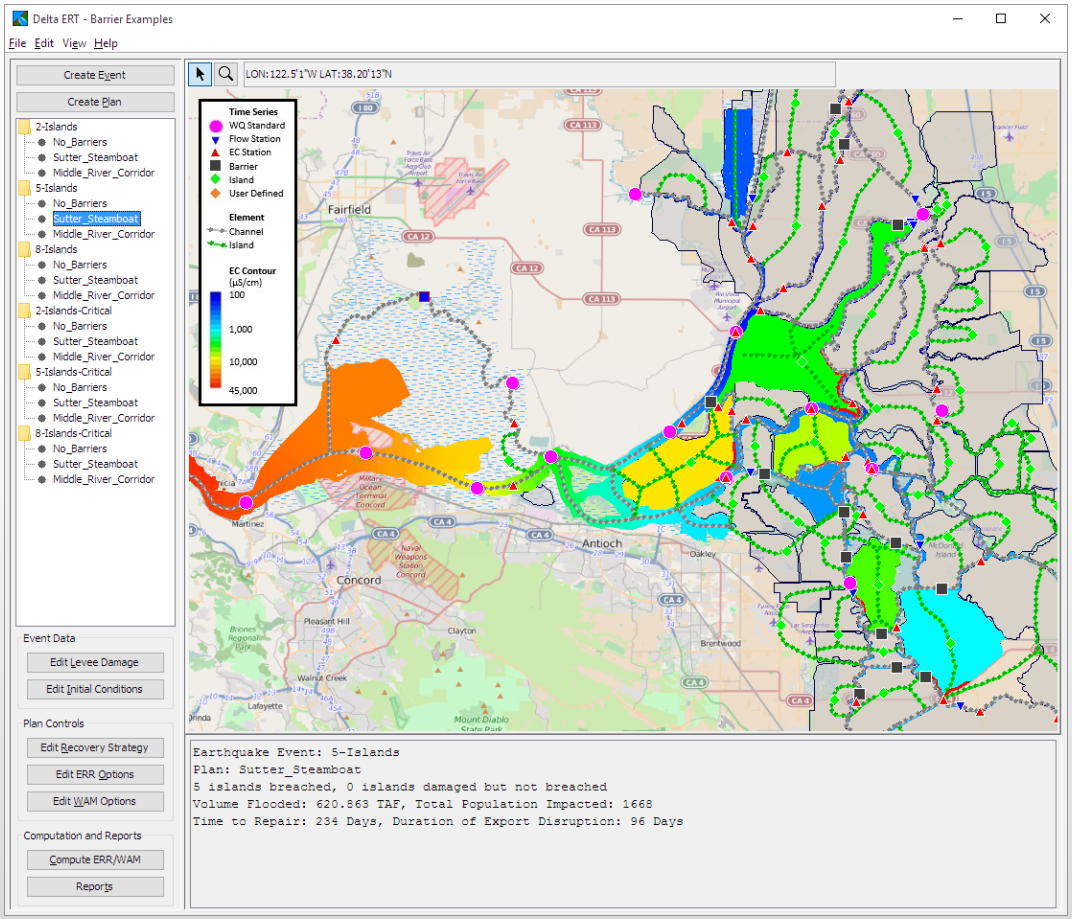
Delta Emergency Response Tool

- Development Funded by DWR, Division of Flood Management
- Delta Emergency Response Tool (Delta-ERT or D-ERT) is an outgrowth of planning tools developed as part of the Delta Risk Management Strategy (DRMS) Project; 2006-2010
- The original DRMS tools were developed for risk analysis and risk reduction studies.
  - Phase 1: Risk Assessments;
  - Phase 2: Risk Reduction Measures
- DRMS prompted and confirmed need for DWR's Delta Flood Emergency Preparedness, Response and Recovery Program (DFEPRRP)

Contact: Jeremy Hill, P.E., Flood System Analysis Section, Chief
DWR, Division of Flood Management
3310 El Camino Avenue, Suite 200, Sacramento, CA 95821
Email: Jeremy.Hill@water.ca.gov

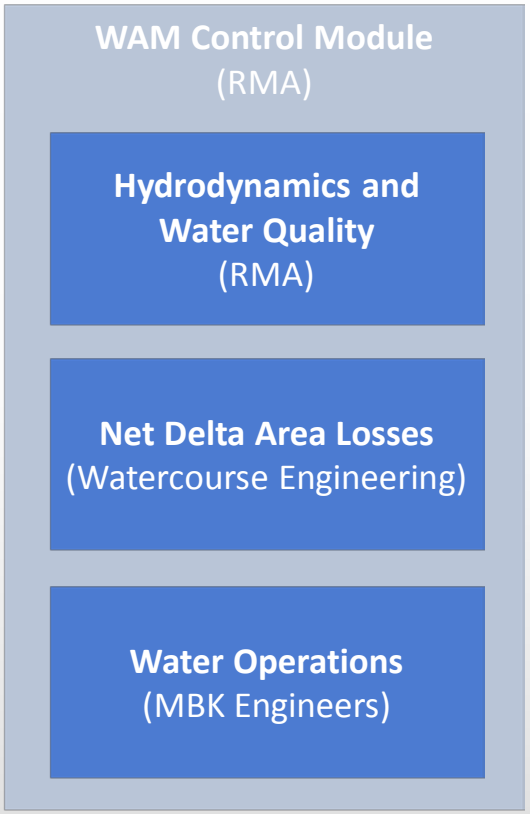
Delta-Emergency Response Tool User Interface

- Project Organization by Damage Events and Response/Recovery Plans
- Workflow
  - Enter Event Data
  - Enter ERR/WAM Plan Options
  - Compute Model
  - View Reports

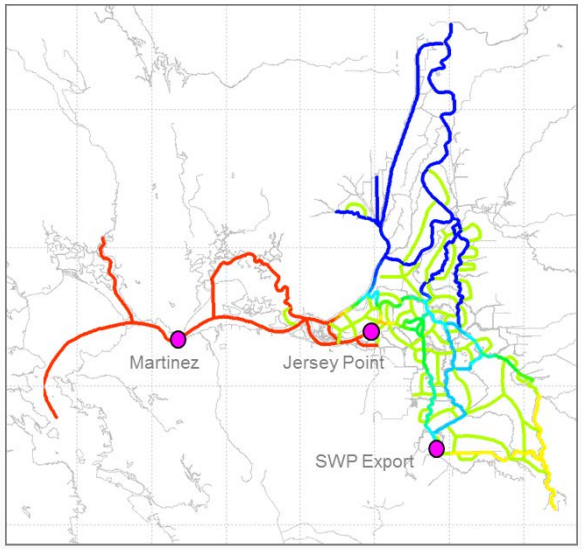


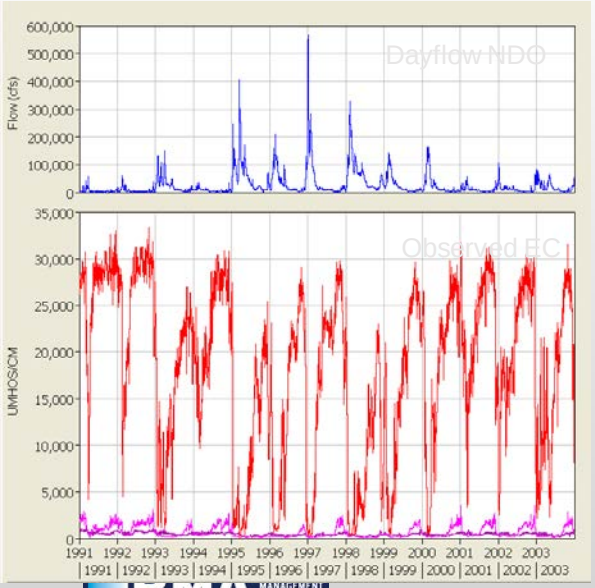
Water Analysis Module (WAM)

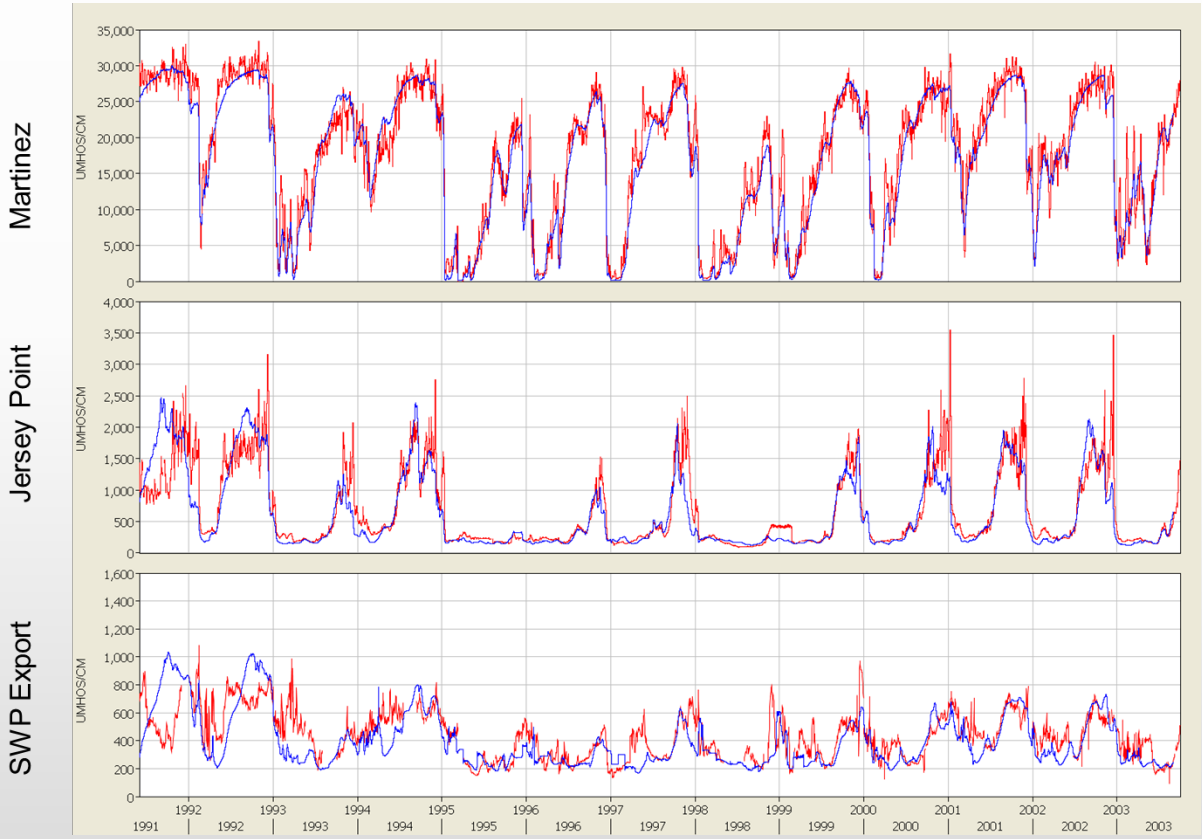
- Original development in support of DRMS
  - Evaluate export disruption, time to recovery, reservoir storage impacts of salinity intrusion associated with Delta Island Flooding
- Delta Emergency Response/Recovery
  - Evaluate effectiveness of alternate repair ordering, recovery strategies (e.g. Middle River Corridor), and control thresholds
- Perform thousands of simulations (WAM compute time is on the order of 2-3 minutes for 5 years of simulation)



WAM Calibration - 1991 to 2003







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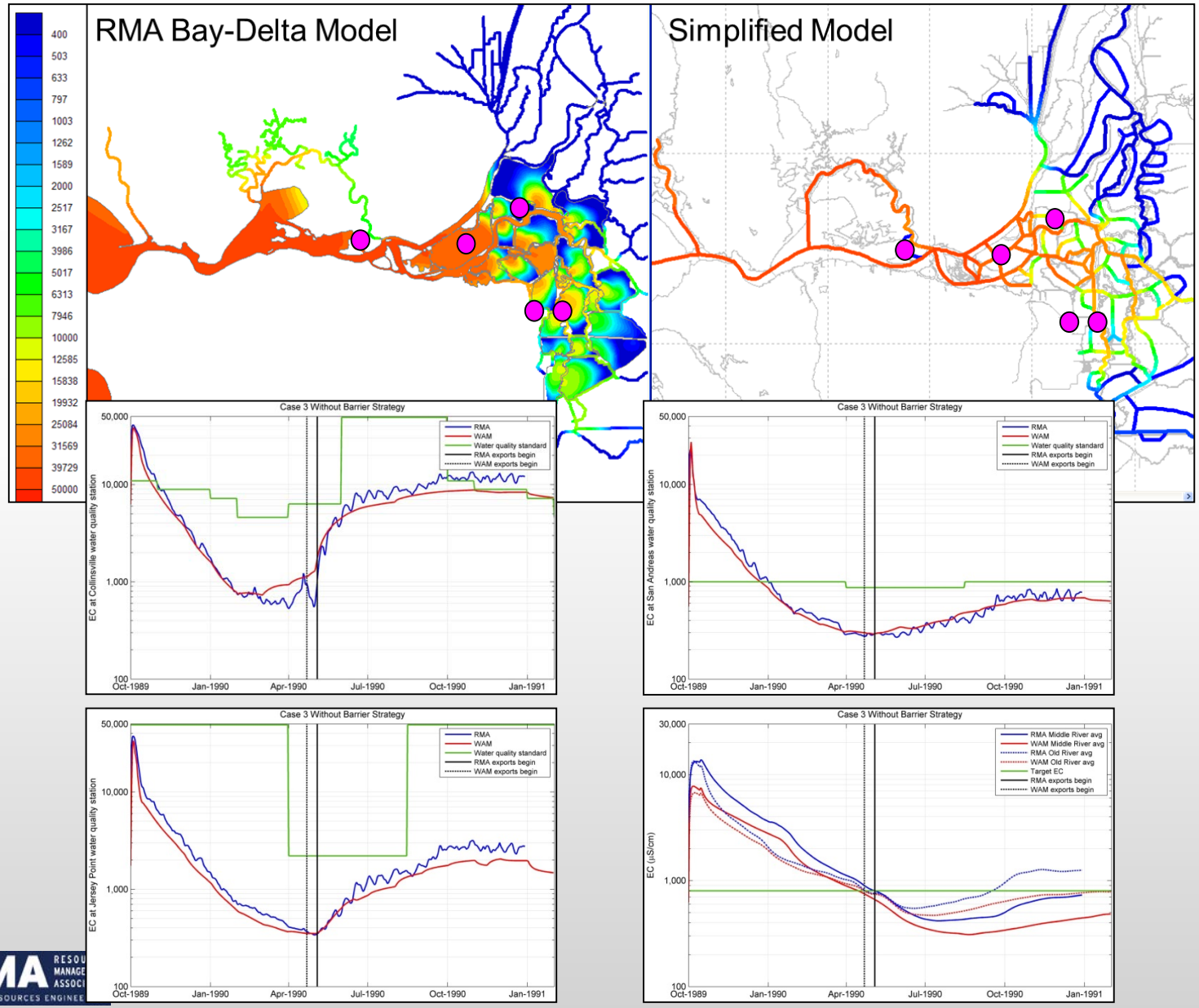
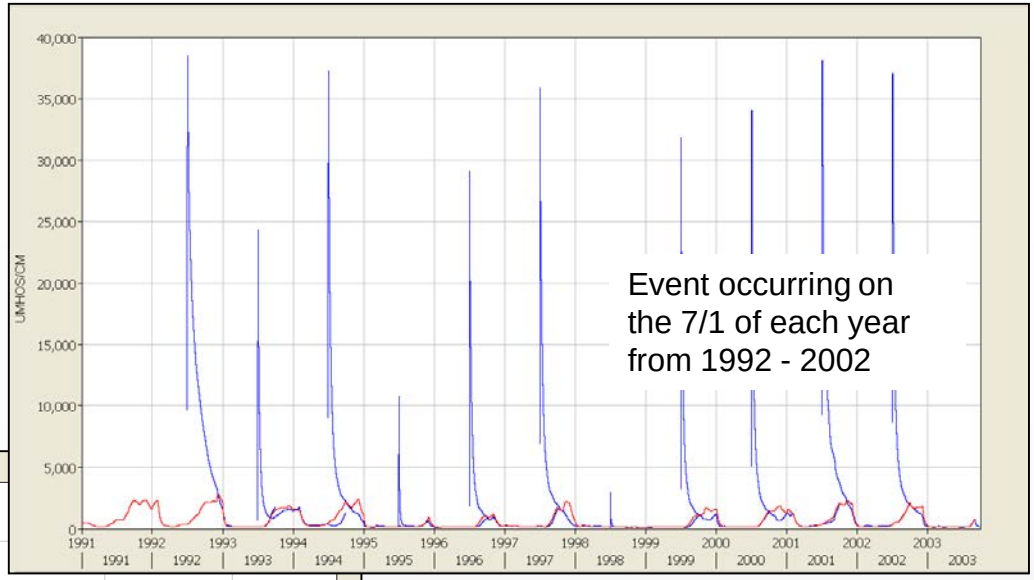
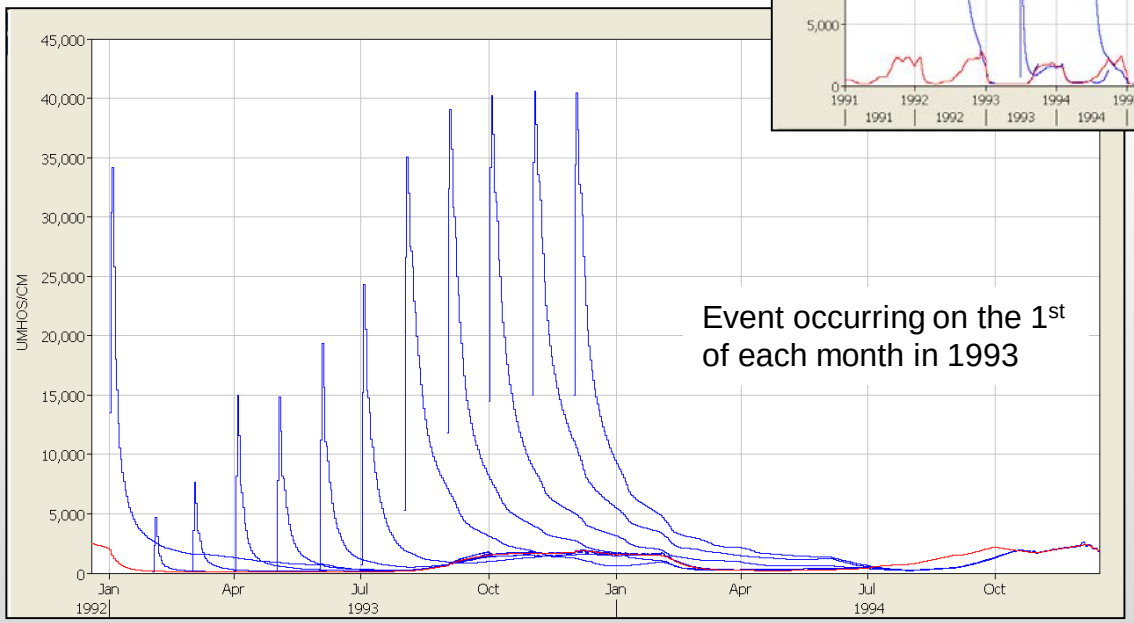
20 Island Breach Case Comparison



Hydrologic Variability

The hydrologic conditions at the time of an event and in the months following an event have a dramatic impact on the severity of the event in terms of water management.





Peak Salinity Intrusion at Jersey Point on the San Joaquin River (shown here as EC, electrical conductivity) is a key indicator of the overall impact of island flooding

No Breach Case

20 Island Breach Case

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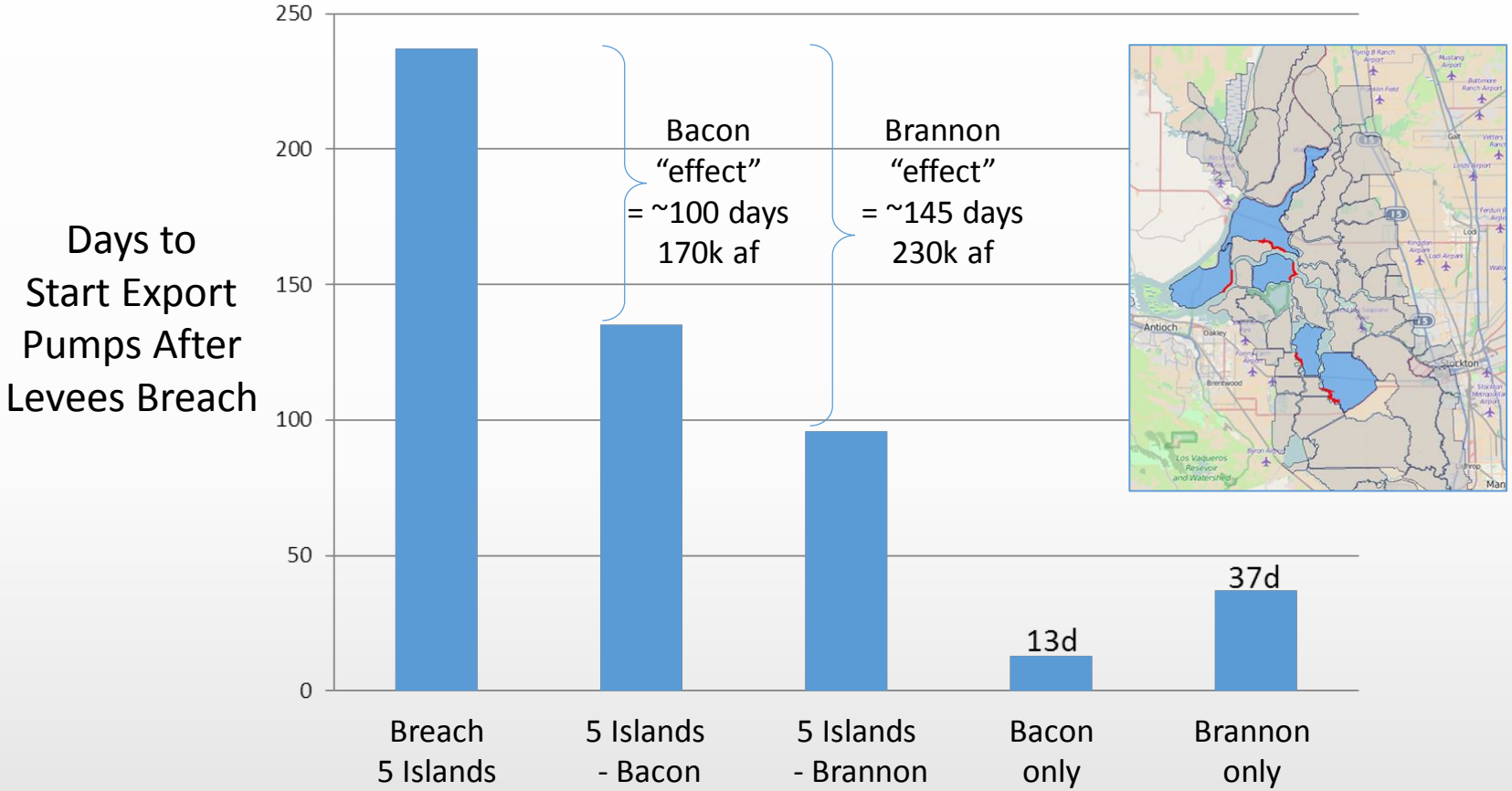
WAM Summary Output

- Sequence ID, number of islands breached, volume breached
- X2 position – before event, at peak salt intrusion
- Statistics at re-start of exports, Delta recovery, North of Delta Recovery, South of Delta Recovery, Repairs Complete, End of Simulation
  - Duration (time in days)
  - Export Deficit
  - Delivery Deficit
  - North of Delta Deficit
- Statistics between time exports re-start and Delta recovery
  - Export EC – average, max, min
  - Base Case and Breach Case Salt Mass Exported
  - Base Case and Breach Case Volume Exported

Example Effect of Island Breaches Alone and in Combination with other Islands



	Breach 5 Islands	5 Islands - Bacon	5 Islands - Brannon	Bacon only	Brannon only
Export Deficit (acre feet)	660k	490k	430k	50k	190k

Notes:

- Example Result Based on Delta ERT model analysis for a single hydrology
- Starts with critical year CALSIM hydrology (Aug 1991) followed by 2nd critical year
- Slide originally created by Chis Enright, Delta Science Program

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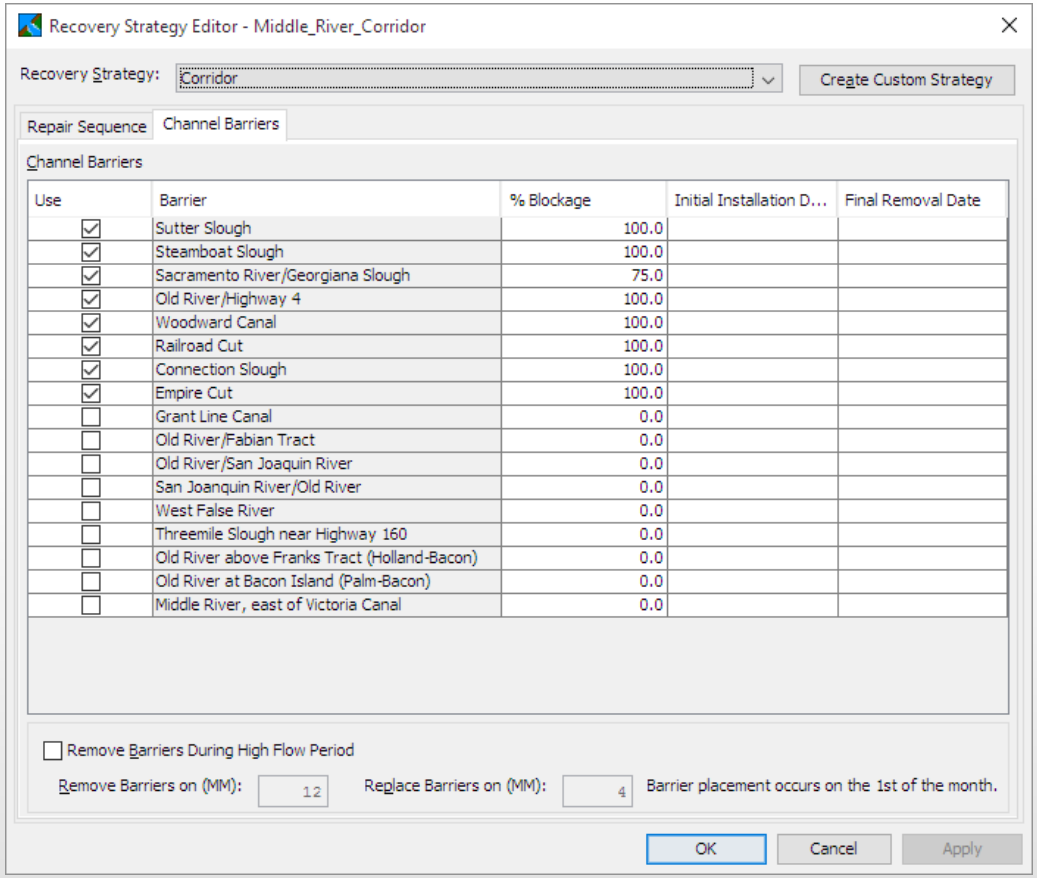
Barrier Analysis with the Delta-ERT

Metrics:

- Days to Restart Exports
- Days to Delta Recovery
- Export WQ between time of Restarting Exports and Delta Recovery
- Mass of Salt Exported prior to Delta Recovery



Use	Barrier	% Blockage	Initial Installation D...	Final Removal Date
☑	Sutter Slough	100.0		
☑	Steamboat Slough	100.0		
☑	Sacramento River/Georgiana Slough	75.0		
☑	Old River/Highway 4	100.0		
☑	Woodward Canal	100.0		
☑	Railroad Cut	100.0		
☑	Connection Slough	100.0		
☑	Empire Cut	100.0		
☐	Grant Line Canal	0.0		
☐	Old River/Fabian Tract	0.0		
☐	Old River/San Joaquin River	0.0		
☐	San Joanquin River/Old River	0.0		
☐	West False River	0.0		
☐	Threemile Slough near Highway 160	0.0		
☐	Old River above Franks Tract (Holland-Bacon)	0.0		
☐	Old River at Bacon Island (Palm-Bacon)	0.0		
☐	Middle River, east of Victoria Canal	0.0		

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Summary

- Barrier impact flow and salinity over the entire Delta
- The 1-D tidally average model in general provided useful reconnaissance level results
- Tidally average misses some of the dynamics related to False River Barrier
- Barrier Timing is important
- The Delta-ERT will be a valuable tool for reconnaissance level modeling and gaming the Delta

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