Department of Water Resources

Testimony for SWRCB Public Hearing on June 25, 2009

Regarding Modeling Project Operations' Effects in the South Delta

Tara Smith, Chief Delta Modeling, Bay-Delta Office

The purpose of my testimony is to give a review of the hydrodynamics and water quality in the South Delta and describe how changes in Delta Operations, specifically Project exports and additional Sacramento releases, cannot control the Southern Delta water quality at the objective locations [Slide 2]. I will be using a PowerPoint slide presentation as a visual aid for the testimony. The slides are included in this testimony and the computer animations have been submitted electronically. The major points that I will cover are the following:

- South Delta Salinity objective locations are upstream from the CVP and SWP exports and therefore the exports have minimal impact and control on the water quality at those locations.
- These stations' water quality is naturally dominated by the San Joaquin River and in Delta return sources. [Slide 3]
- Temporary barriers and permanent gates can move water upstream by using the flood tide. This water will not reach the Brandt Bridge Station.
- Temporary barriers are more limited in how much water can be moved upstream and there is a tradeoff between water levels and water circulation in the South Delta when temporary barrier configurations are modified. [Slide 4]
- Sacramento River water can be pulled upstream due to exports and in Delta diversions but movement of the water further upstream of the exports is limited by how well the tidal flow can be manipulated by gates or barriers.
- Increasing Sacramento River inflow cannot significantly improve water quality at the South Delta Salinity stations. [Slide 5]

To these points, I am presenting a series of computer modeling animations. The first four animations are particle tracking simulations. The hydrology used for these simulations is synthetic (not historical) and was developed to more easily illustrate how changes in export levels and gate operations affect the movement of water in the Delta [Slide 6].

The first animation represents a high pumping scenario with temporary barriers. The Sacramento River flow is 15,000 cfs, the San Joaquin River is 1,500 cfs, the State Water Project is exporting 6680 cfs, and the CVP is exporting 4600 cfs. The left animation shows the movement of particles inserted in the Sacramento River at Sacramento. The right animation shows the movement of particles inserted in the San Joaquin River at Vernalis. For high export levels, Sacramento particles are pulled upstream towards

exports. They do not make it upstream to the three southern Delta water quality objective locations. SJR particles move through south Delta. Some are lost to in delta diversions prior to exports taking them. Some make it downstream passed Brandt Bridge and circle around to the Central and South Delta.

The second animation, labeled low pumping, keeps the same barrier configuration and same inflows at the first animation but the State Water Project and Central Valley Project Exports are now 1500 cfs and 1000 cfs respectively. Less Sacramento particles are pulled upstream towards the exports and the particles take a longer time to move upstream. Particles do not make it upstream to the southern Delta water quality objective locations. SJR particles move through south Delta. Some are lost to in delta diversions. More make it downstream passed Brandt Bridge and circle around to the Central Delta.

The third animation with no exports, keeps the same barrier configuration and same San Joaquin inflows as the first two animations but there are no State Water Project or Central Valley Water Project exports and the Sacramento inflow has been increased to 20,000 cfs. With no pumping, less Sacramento particles are pulled upstream towards exports; however, there are some particles moving upstream due to Delta Consumptive use being greater than San Joaquin Flows. Particles again do not make it upstream to the water quality locations. San Joaquin particles that move through the south Delta don't make it much past Woodward Island. Some pass Brandt Bridge and circle around. Some start to move out to the Western Delta.

These temporary barrier animations represent historical designs of the barriers. In Mark Holderman's testimony, he describes how modifications to those barriers can improve the circulation making it closer to the circulation provided by the permanent gates.

The forth animation, labeled medium pumping with permanent gates keeps the same inflows as the first two animations but implements a permanent gate operation and the exports for the State Water Project and the Central Valley Project are each 3000 cfs. For this hydrology and gate configuration, the Sacramento River particles make it past the exports upstream to the Tracy and Old River at Middle River water quality objective locations. San Joaquin River particles remain in the San Joaquin, moving past Brandt Bridge, and also moving through Grant Line Canal.

Slide 7 shows a static view of the influence of the San Joaquin River in the Delta as demonstrated by the particle tracking modeling. This shows the influence with the more historic temporary barriers. Slide 8 shows the influence with the permanent south Delta Gates.

The next two animations are animations of salinity from a planning study representing current conditions (1995 Agricultural Level of Development (LOD) with Projects)[Slide 9]. There are two sets of years that represent different hydrologies. The first animation shows a wetter group of years and the second shows a dryer group of years. As you look at this animation, you will see that the colors cover the whole Delta. This does not mean that the Delta is flooded. The animation was created this way so that the colors would be more easily seen than if the colors were restricted to inside of each channel. Sacramento (blue) has lowest EC level (best salinity). San Joaquin (green and blue in wet periods) tends to have a higher EC and the Ocean (red) has the highest salinity. The movement of EC shows a similar pattern as demonstrated by the particle tracking.

The following slides show static representations of what was presented in the animations. First I will give a quick review of the basic general flow patterns in the southern Delta and relative locations of project operations. These graphs reflect tidally averaged flows. Looking at the yellow arrows, this slide [Slide 10] shows that with a higher San Joaquin flow what the flow in the South Delta would be without exports and without barriers. Basically it shows what the natural flow conditions would show. Water flows from the San Joaquin River down the San Joaquin River but also downstream in Old and Middle River towards the Ocean. The green dots on the map show the locations of the water quality objective locations. Slide 11 shows that the export locations and the Influence of the Sacramento River are downstream of the objective locations.

This next slide [Slide 12] shows the general flow patterns with project exports. Water is pulled upstream towards the export locations, shown by the pink arrows.

Although water is pulled upstream by the exports, the exports still remain downstream of the objective locations [Slide 13]. The yellow arrows still indicate the flow coming from the San Joaquin side.

So this tells us that without any additional structures in the Southern Delta, exports can't cause any significant changes in water quality at those locations. This was verified by modeling work previously presented (Cease and Desist Hearing exhibit, 2005, http://www.swrcb.ca.gov/waterrights/water_issues/programs/hearings/delta_salinity/exhibits/dwr/dwr20.pdf), for over a 16 year historical period, either by increasing or decreasing the exports no significant changes in water quality occurred. Any very small differences (reflecting both improvements and degradations) reflected a change in relative proportions of San Joaquin and agricultural drainage.

So without any barriers or gates, exports do not significantly affect water quality at any of the locations. One exception may occur in situations with very low San Joaquin river flow. Reverse flow may occur at Brandt Bridge, pulling water upstream and affecting the water quality.

This next slide [Slide 14] shows the movement of water upstream from the Sacramento side with two temporary barriers (Old River and Middle River) and the Fish Barrier (Old River at Head). Water is pulled upstream by the exports and then the temporary barriers with the aid of tidal action move the water into the south Delta area. The orange double arrows indicate that sometimes the flow makes it upstream to that location and sometimes the flow is downstream.

Circulation upstream is improved with the Head of Old River Barrier, as shown by the pink upstream arrow at the Old River at Tracy location.

This slide [Slide 15] shows the flow pattern with three temporary barriers. Water is pulled upstream by the exports and then the temporary barriers with the aid of tidal action move the water into the south Delta area. The orange double arrows indicate that sometimes the flow makes it upstream to that location and sometimes the flow is downstream. Again, Brandt Bridge does not receive the Sacramento side water.

We previously looked at and presented modeling drastic changes in SWP exports for the years 2002 and 2003 to see how salinity would be affected. With the barriers installed and after eliminating exports for several months, there was an effect at only one of the stations, Old River at Tracy road for several days. In 2002 the elimination of exports resulted in an improvement of water quality. In 2003 the elimination of exports resulted in a degradation of water quality. The timing of the improvements and degradation at Old River at Tracy did not correspond to the timing of when there would have been the greatest concern about the water quality level.

Additionally, 2002 historical simulations with a modification of Sacramento flow increased by 5000 cfs through the April through August was simulated. The additional flow did not improve water quality at the South Delta Water Quality Objective locations.

Slides 16-24 describe these simulations.

Slide 16 is a summary of results when State Water Project exports were modified from historical. The table describes the differences in salinity between historical and the modified exports for three different scenarios. It also describes the differences occurring with and without barriers.

The next slide [Slide 17], outlines additional simulations completed that evaluated impacts due to both Central Valley and State Water Project exports changes and changes in Sacramento inflow. These will be described in more detail in the following slides.

Slide 18, shows how well DSM2 matches observed data at the three water quality objective locations for 2002. The observed values are the lighter gray line and the dotted vertical blue line shows the timing of the installation of the temporary barriers. From the analysis of the flow data and the location of the water quality objective stations relative to Vernalis, any differences seen can be attributed primarily to the boundary input to the model for in Delta sources such as agricultural uses and treatment plants. DSM2 requires, boundary flows and water quality to model hydrodynamics and water quality within the channels. These boundary conditions include the major inflows including the Sacramento and San Joaquin River and project exports and also other in Delta diversions and returns. Since there is very limited observed flow and water quality data for diversions and returns to the islands, diversions and returns are estimated using another model, Delta Island Consumptive Use (DICU), which takes into account land use practices in its estimation. The limitation of this data from DICU affects the accuracy of the model.

So , the bottom line for this slide is that when looking at the results we should keep in mind the times when we underestimate the observed data.

The next slide [Slide 20] has four graphs that show the Modeled EC output for four different simulations and four locations, Old River near DMC, Old River at Tracy Road, Middle River about 1 mile downstream of the Old River at Middle River location (this shows if there is circulation a bit more), and Brandt Bridge. The blue dashed line shows the timing of the installation of the barriers. I'll be focusing on the results in the bottom three graphs.

Slide20 shows the graph for Old River at Tracy Road. The historical and the additional Sacramento flow simulation results lie on top of each other. The no barrier simulations for both the no exports and no SWP export simulations also lie on top of each other. The green dashed vertical lines indicate the time period that the Delta pictures below apply to.

The Delta figure on the left shows the flow pattern for the no export scenario and the right picture shows the flow pattern for the historical simulation. There are no temporary barriers during this time period for any of the simulations and the EC results reflect this. The figures show that the flow at Old River at Tracy Road is from the San Joaquin side – so no real differences in results between any of the alternatives.

Slide 21 shows the same location but a new time period. The green dashed lines show the second time period for the results at Old River at Tracy Road. When the two agricultural barriers and the Head of Old River Barrier are installed, the flow pattern changes in this area. The no barrier, no export EC results are lower than the historical and added Sacramento River results. This is primarily due to the addition of agricultural drainage as the water moves upstream. (The water quality at Old River near Delta Mendota Canal was used to come to this conclusion).

The final period that I will show for Old River at Tracy Road reflects in addition to a change in the hydrology a change in the barrier configuration [Slide 22]. In the figure on the bottom left, the no exports and no barrier simulation, there is a movement upstream of water due to in Delta uses and a lower San Joaquin River Flow (about 1370 cfs). Even with this upstream flow, the flow at the three locations, including Old River at Tracy still maintains a downstream flow.

The historical simulation figure shows circulation upstream into the south Delta but the circulation is not as strong as when the Old River at Head Barrier was installed.

So with no barriers, there was no difference for SWP operations, including the time period when the objective was exceeded. With barriers, the circulation during this time period resulted in a degradation in water quality for part of the time that barriers were in place.

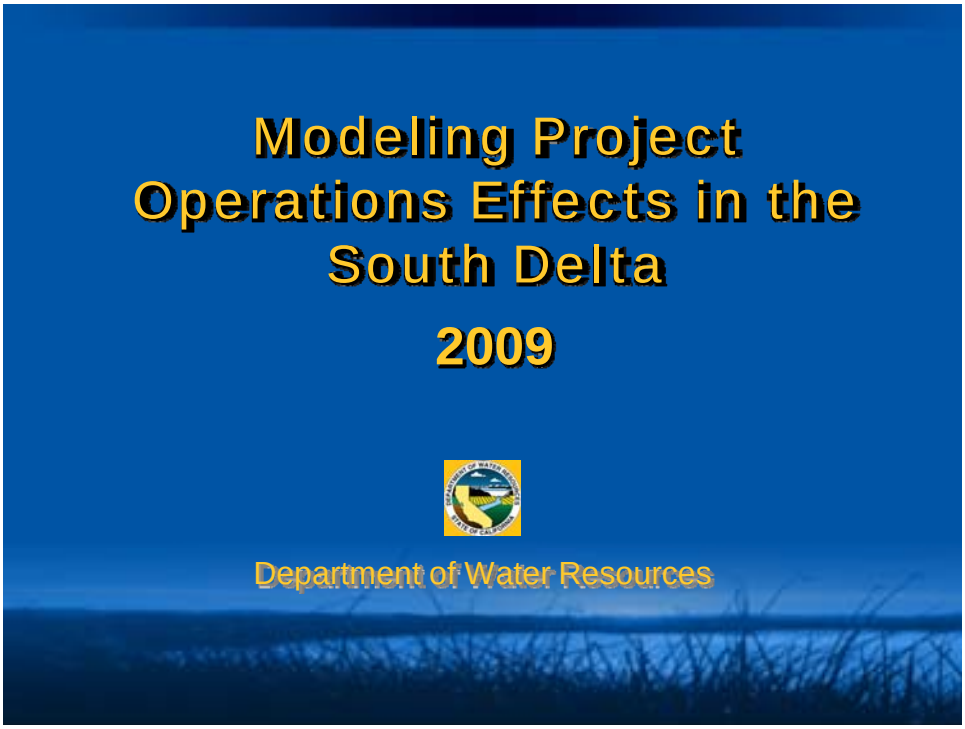
Slide 23 shows a time series plot of EC for a station one mile downstream from the Old River at Middle River location. The results reflect the circulation due to the barriers, similar to the analysis of the Old River at Tracy location. With no barriers, there is no visible difference in results.

The final location Brandt Bridge [Slide 24] shows no significant differences between the four simulations in the results. The downstream actions could not affect the water quality at that location.

To restate the major points again:

- South Delta Salinity objective locations are upstream from the CVP and SWP exports and therefore the exports have minimal impact and control on the water quality at those locations.

- These stations' water quality is naturally dominated by the San Joaquin River and in Delta return sources. [Slide 3]
- Temporary barriers and permanent gates can move water upstream by using the flood tide. This water will not reach the Brandt Bridge Station.
- Temporary barriers are more limited in how much water can be moved upstream and there is a tradeoff between water levels and water circulation in the South Delta when temporary barrier configurations are modified. [Slide 4]
- Sacramento River water can be pulled upstream due to exports and in Delta diversions but movement of the water further upstream of the exports is limited by how well the tidal flow can be manipulated by gates or barriers.
- Increasing Sacramento River inflow cannot significantly improve water quality at the South Delta Salinity stations. [Slide 5]



Slide 1

Objective of Presentation

Using Delta Modeling Results

- Provide a review of hydrodynamics and salinity in the South Delta
- Describe how changes in Delta Operations (exports and Sacramento inflow) cannot control Southern Delta water quality

Slide 2

Major Points

- South Delta Salinity objective locations are upstream from the CVP and SWP exports and therefore the exports have minimal impact and control on the water quality at those locations.
- These stations' water quality are naturally dominated by the San Joaquin River and in Delta return sources.

Slide 3

Major Points (cont)

•Temporary barriers and permanent gates can move fresher water upstream by utilizing tidal movement. This water will not reach the Brandt Bridge Station.

•Temporary barriers as compared to permanent gates are more limited in how much water can be moved upstream and there is a tradeoff between water levels and water circulation in the South Delta when temporary barrier configurations are modified.

Slide 4

Major Points (cont)

•Sacramento River water can be pulled upstream due to exports and in Delta diversions but movement of the water further upstream of the exports is limited by how well the tidal flow can be manipulated by gates.

•Increasing Sacramento River inflow cannot significantly improve water quality at the South Delta Salinity stations.

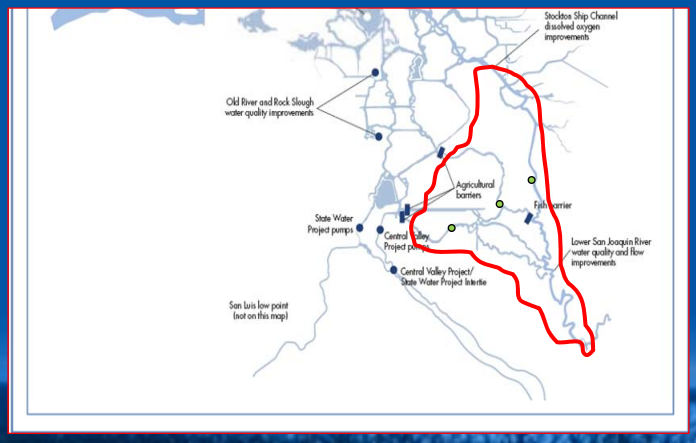
Slide 5

Four PTM Animations

- Temporary Barriers
- 1- High Pumping
- 2- Low Pumping
- 3- No Pumping+Increase Sacramento R. Flow
-
- Permanent Gates
- 4- Medium Pumping

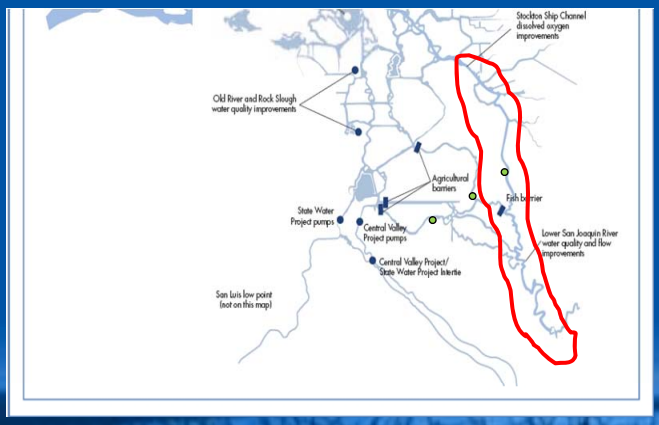
Slide 6

Zone of San Joaquin River Dominance (Temporary Barriers)



Slide 7

Zone of San Joaquin River Dominance (Permanent Gates)



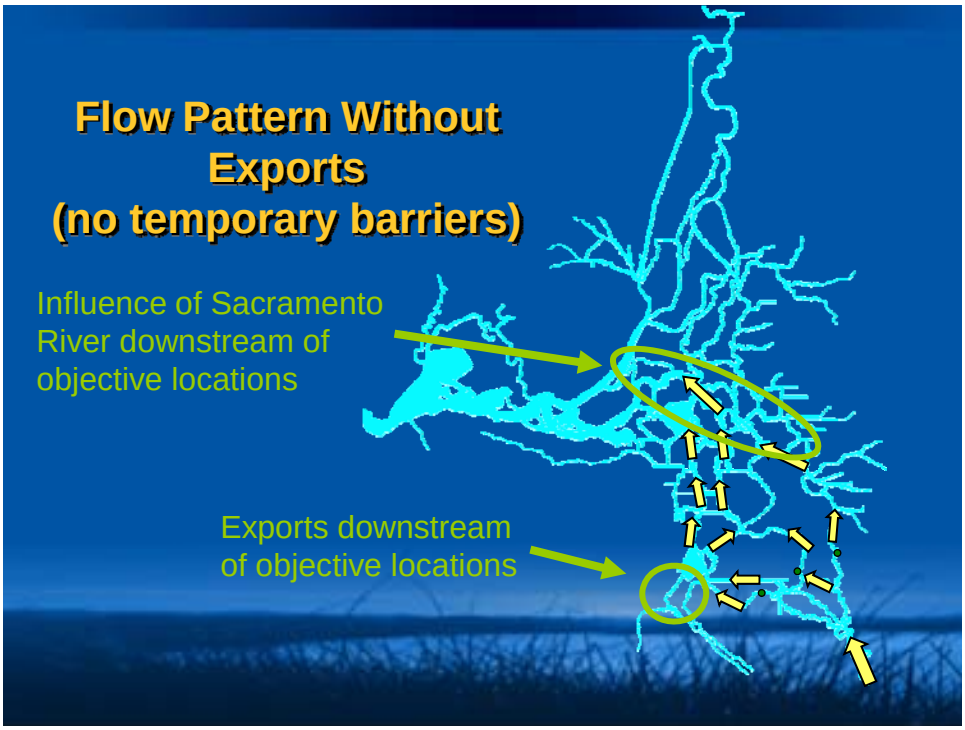
Slide 8

Salinity Animation

- Current Condition Planning Study
  - 1982-1984 (wet)
  - 1989-1992 (dry)

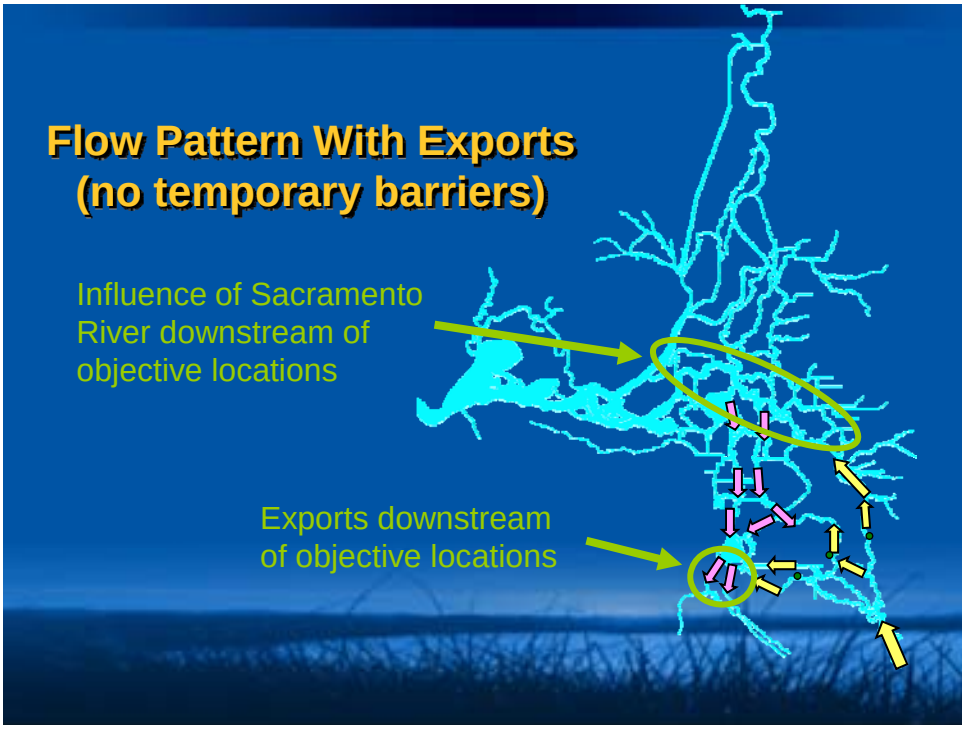
Slide 9

Slide 10



Slide 11

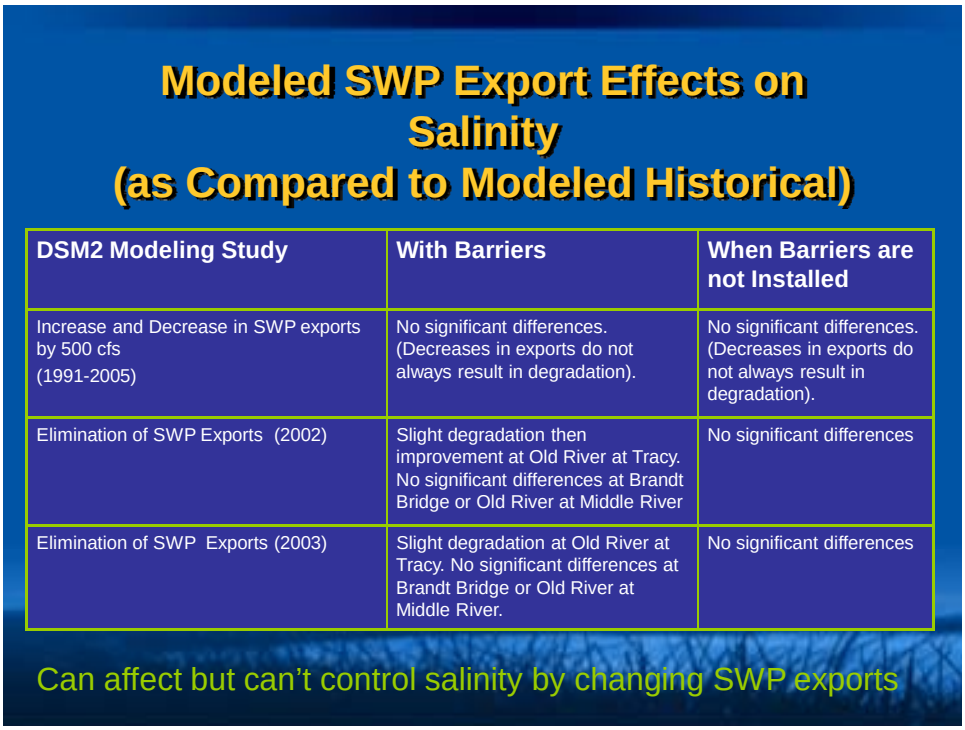
Slide 12



Slide 13

Slide 14

Slide 15


Modeled SWP Export Effects on Salinity
(as Compared to Modeled Historical)
DSM2 Modeling Study
With Barriers
When Barriers are not Installed
Increase and Decrease in SWP exports by 500 cfs
(1991-2005)
No significant differences. (Decreases in exports do not always result in degradation).
No significant differences. (Decreases in exports do not always result in degradation).
Elimination of SWP Exports (2002)
Slight degradation then improvement at Old River at Tracy. No significant differences at Brandt Bridge or Old River at Middle River
No significant differences
Elimination of SWP Exports (2003)
Slight degradation at Old River at Tracy. No significant differences at Brandt Bridge or Old River at Middle River.
No significant differences
Can affect but can't control salinity by changing SWP exports

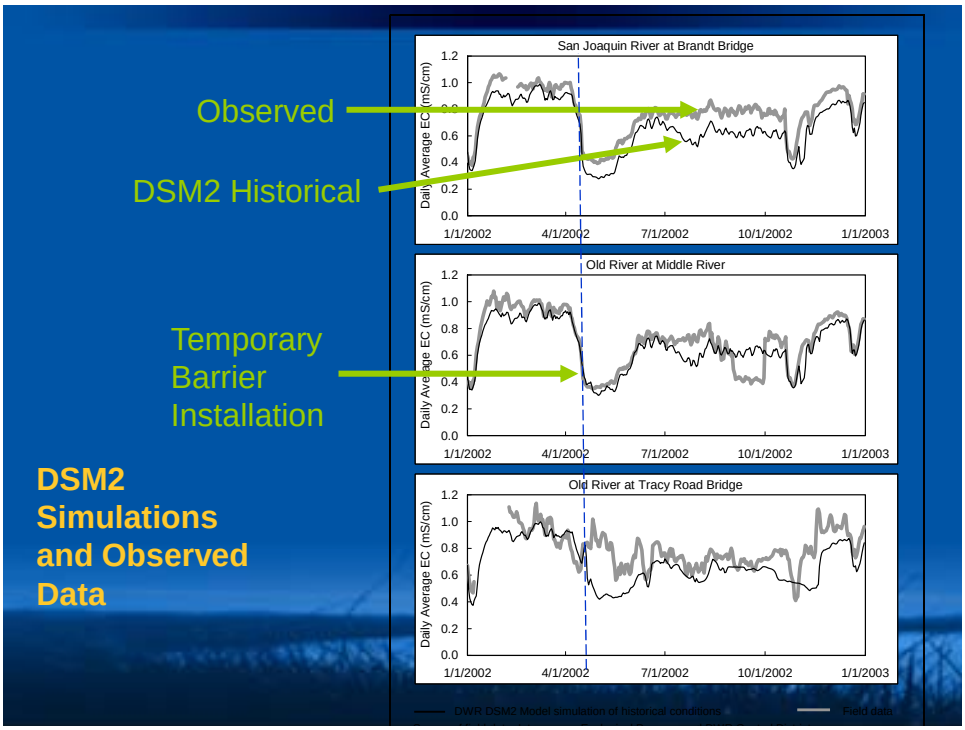
Slide 16

Modeled Export, Barriers, and Sacramento Flow Effects on Salinity

- **DSM2 Simulations (Appendix C)**
  - –2002 Historical simulation
  - –No CVP or SWP exports and no temporary barriers (modified 2002 historical)
  - –No SWP exports and no temporary barriers (modified 2002 historical)
  - –Additional Sacramento Flow of 5000 cfs ,Apr through Aug (modified 2002 historical)

- **Why 2002?**
  - –Builds upon work presented previously
  - –See how well the model performs (results can be compared with observed data)

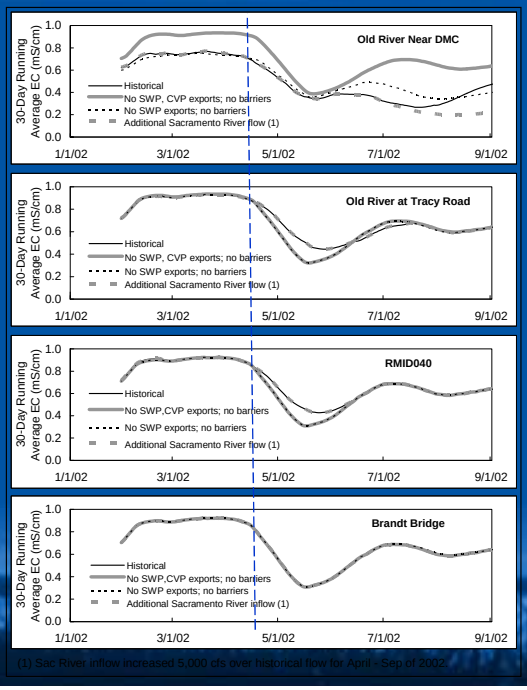
Slide 17



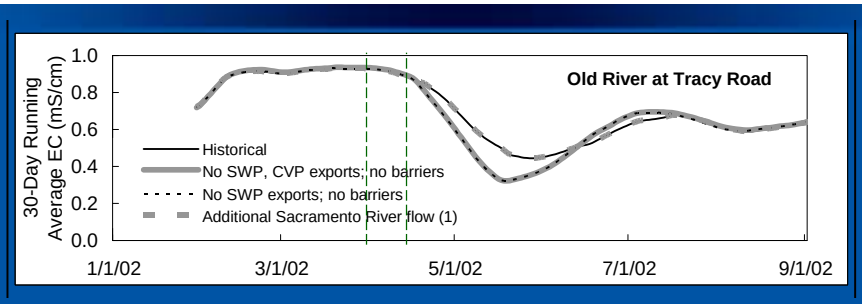
Slide 18

DSM2 Simulations

- Four Simulations
  - DSM2 2002 Historical
  - No SWP and CVP exports, no barriers
  - No SWP exports and no barriers
  - Additional Sacramento Flow (5000 cfs)



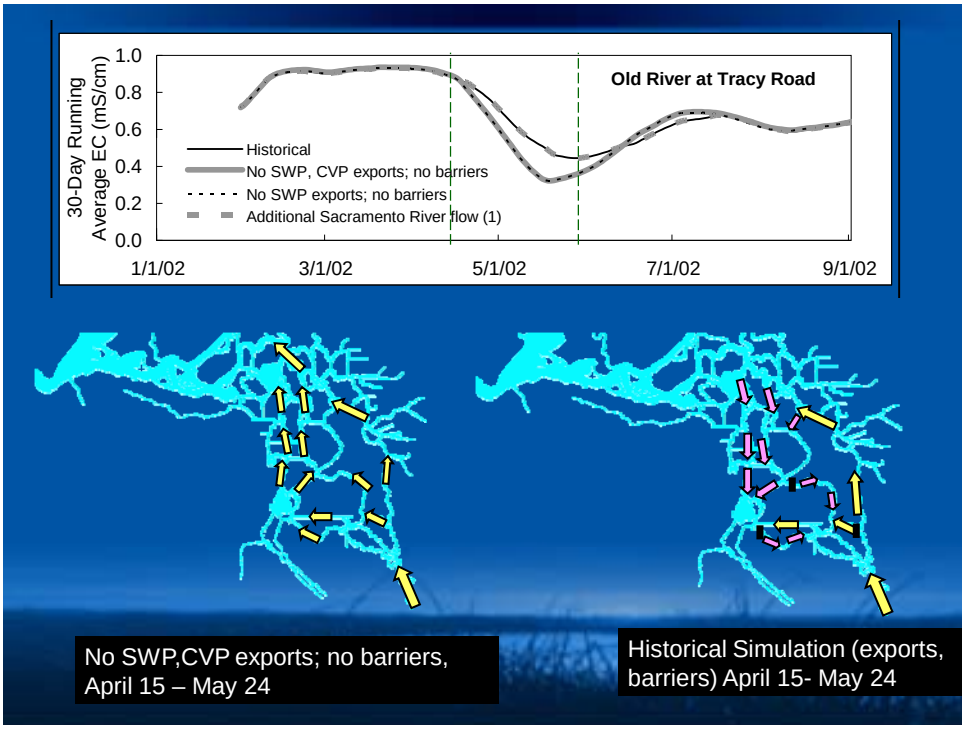
Slide 19



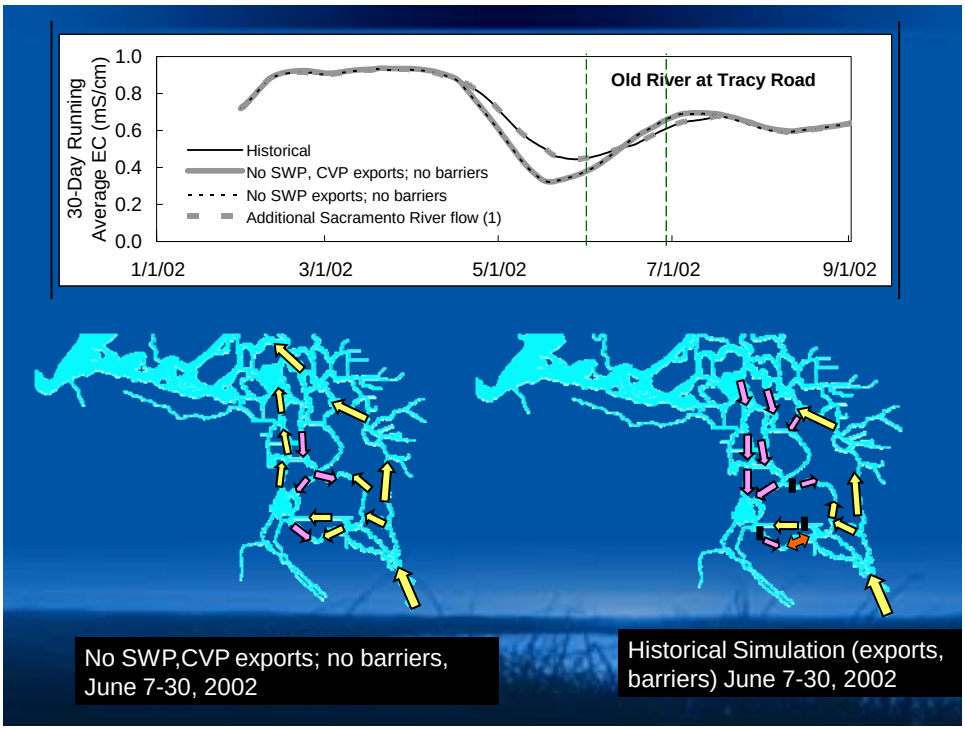
No SWP,CVP exports; no barriers, April 1 –15

Historical Simulation (exports, no barriers) April 1 - 15

Slide 20

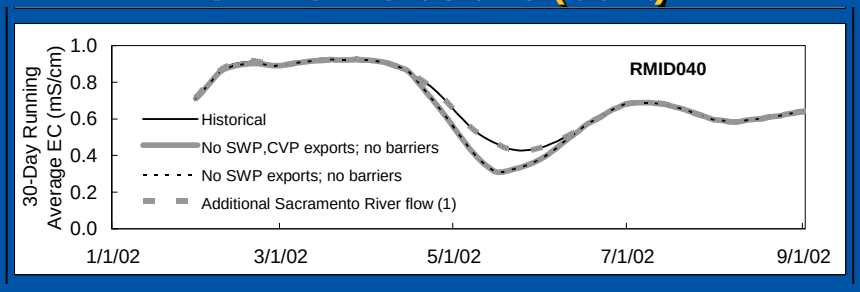


Slide 21



Slide 22

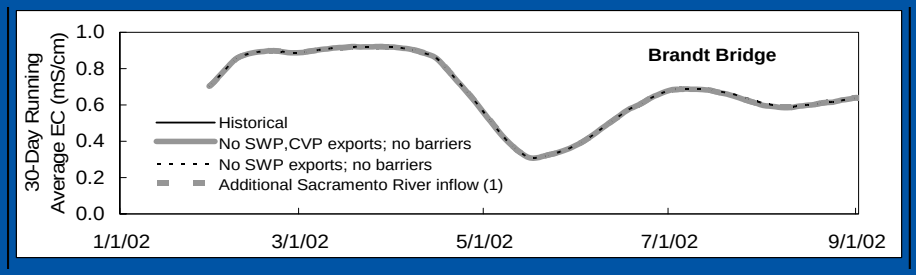
DSM2 Simulations (cont)



- RMID040 (one mile downstream of Old River at Middle River)
  - Differences reflect movement of water upstream due to barriers

Slide 23

DSM2 Simulations (cont)



- Brandt Bridge
  - No Significant difference in results between the four simulations

Slide 24