APPENDIX F

Project Development

2-Gates Project Development Appendix

Introduction

A summary of the development process and supporting analyses leading to the proposed 2-Gates Project is described below. The development of the 2-Gates Project employed a deliberate process of model development and use, while applying progressively detailed model analyses from the site selection through final effects analyses phases. A more complete description of the models and assumptions are included in Appendices E and F. This section describes this process to achieve project objectives, and presents summary level results and essential findings leading to the development of the Project Description. A summary of the development and computer analysis process follows:

1. The Delta Simulation Model II (DSM2) particle tracking module (PTM) analyses were used to determine the optimum number of gates and locations.

2. Simulated neutrally buoyant particles were inserted at specific locations over a broad region of the Delta, to determine the approximate region of control of the gates through DSM2 PTM modeling.

3. DSM2 was used to identify the bounds of the hydrodynamic a region of control of the 2-Gates Project. This allows for the control of some of the constituent elements of delta smelt habitat

4. RMA11 was used to confirm the region of control of the Project with regard to adult and larvae/juvenile behavioral.

5. RMA11 was used to determine effects of QWEST [1] management on the entrainment of delta smelt, supplementing Old and Middle River (OMR) operations from the OCAP.

6. RMA11 was used to evaluate the combined use of the Project, OMR flow as defined in the OCAP BO and related QWEST through flow balancing and export modulation to manage the turbidity plume (the key constituent element for pre-spawning, adult delta smelt movement from the western Delta).

7. RMA11 was used to evaluate the potential for reduced adult smelt entrainment at potentially increased exports, while managing smelt distributions within the gates region of control.

8. Compare water costs of initiating gate operations upon the OMR 3-station turbidity trigger versus an early-start turbidity trigger at Prisoner's Point.

9. Achieve equal or better entrainment reduction with potentially increased exports for larvae/juvenile delta smelt, including adjustments for mortality/hatching.

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[1] Average daily flow in the San Joaquin River at Jersey Point

10. Confirm insignificant effects to Mokelumne River salmon and other sensitive fish population through combined 2-Gates, OMR and QWEST operations using DSM2 and RMA modeling approaches.

11. Through ample daily gate opening, confirm insignificant effects to Sacramento and San Joaquin River salmon, navigation and recreation during adult and larvae/juvenile stages.

Model Development and Deployment

Early in the analyses process, it was determined that complex delta smelt behavioral models would be useful to, with reasonable accuracy, predict distribution, abundance and fate of delta smelt under OCAP and 2-Gates operational conditions. Because the development of such a model would be time-consuming and its success could not be accurately predicted, a decision was made to initially use the One-Dimensional (1D) DSM2 model formulation for hydrodynamic, water quality and particle tracking to determine the most favorable location of gates, their region of control and their benefits under OCAP-modified flow conditions. While this effort was taking place, the RMA team developed an accurate behavioral model using a Two-Dimensional (2D) RMA formulation, as modified to characterize both the adult and larvae/juvenile dealt smelt behavior. The 2D behavioral models were used to determine effects of the 2-Gates Project for environmental documentation purposes under OCAP-adjusted hydrodynamic conditions. Project operations criteria and effects analyses were improved over the evaluation process through necessary, progressive refinements in modeling capabilities. For example, early simulations assumed particle tracking would be a reasonable simulation of delta smelt behavior, while the later simulations used more sophisticated delta smelt population distributions (from surveys) and enhanced simulations of adult delta smelt behavior. The valid conclusions drawn from initial simulations were found consistent with and supportive of the results of final model analyses.

One-Dimensional DSM2 Analyses

<u>Screening of Gate Alternatives, Determination of Region of Control, and Formation of Physical and Hydraulic Barrier Against Delta Smelt Migration.</u>

The gate analyses addressing alternatives, region of control, and formation of a physical/hydraulic barrier for the control of delta smelt entrainment and migration into the south Delta used the most recent historic DSM2 simulation software available from the Department of Water Resources (DWR) for analyses of 2 Gates Project and flow control measures. The initial Project formulation analyses used DSM2 to (1) evaluate hydrodynamics, fate and transport of neutrally buoyant particles for historic hydrologic conditions, conditions simulating hydrology using the operating rules contained within the OCAP BO and hydrology and operations with the 2-Gates Project, and (2) to provide technical analyses of alternatives to provide equal or better protection of delta smelt at reduced water cost compared to OCAP BO conditions. DSM2 simulates riverine systems, calculates stages, flows, velocities and particle transport; and simulates many mass transport processes, including salts, temperature and THM formation.

<u>Initial Site Screening Study using DSM2 Analyses.</u>

DSM2 PTM was used to evaluate 34 individual and combined gate alternatives in the central and south Delta to determine the optimum locations and number of gates. A 2-Gates Project on the Old River near Bacon Island and on Connection Slough provided optimum protection to delta smelt, while potentially allowing for additional water exports compared to OCAP BO operations. DSM2

analyses determined that other individual or combined gate alternative locations provided less favorable water supply and fish protective benefits, and were constrained by channel capacity or unfavorable geotechnical conditions. Other alternative locations studied, included: (1) two-gates on Old River at Quimby Island; (2) three-gates at Connection Slough, Railroad Cut, and Old River below Woodward; (3) four-gates on Connection Slough, Woodward and Railroad Cuts, and Old River below Woodward; (4) selective weir removal on Paradise Cut; (5) a weir on the San Joaquin River downstream of the head of Old River; and (6) Clifton Court Forebay gate tidal re-operations. Certain of these alternatives also included combined QWEST management. Table F-1 presents a summary of average annual water costs and percent reduction in the particle entrainment at export pumps compared to the baseline for all the scenarios analyzed. Note that Table F-1 presents results as a percent (%) reduction from historical entrainment levels.

Table F-1 Summary of average annual water costs and percent reduction in the particle entrainment at export pumps compared to the baseline for all the scenarios analyzed

Option	Average Annual Water Cost (TAF)	% Reduction from Historical	
		San Joaquin River downstream of Big Break Insertion	Old River upstream of Quimby Island Insertion
Wanger (> -5000 cfs)	630	82%	8%
Wanger (> -750 cfs)	1,400	100%	90%
QWEST (>0 cfs)	276	55%	4%
QWEST (> 500 cfs)	427	75%	6%
DCC Re-Ops	0	53%	0%
False River Gate	0	14%	0%
3-Mile Slough Gate	0	93%	1%
2-Gate (Inoperable)	0	17%	72%
2-Gate (Operable)	0	15%	55%
3-Gate (Inoperable)	0	20%	81%
4-Gate (Inoperable)	1,007	79%	88%
DCC Re-Ops + QWEST (> 0 cfs)	146	71%	2%
DCC Re-Ops + QWEST (> 500 cfs)	249	78%	2%
DCC Re-Ops + QWEST (> 1000 cfs)	297	81%	4%
DCC Re-Ops + QWEST (> 1500 cfs)	354	87%	4%
2-Gate (inoperable) + QWEST (>0 cfs)	286	75%	82%
2-Gate (operable) + QWEST (>0 cfs)	288	65%	67%
2-Gate (inoperable) + QWEST (>500 cfs)	448	86%	85%
2-Gate (operable) + QWEST (>500 cfs)	448	84%	78%
2-Gate (inoperable) + DCC Re-Ops	0	72%	83%
2-Gate (operable) + DCC Re-Ops	0	60%	74%

Table F-1 Summary of average annual water costs and percent reduction in the particle entrainment at export pumps compared to the baseline for all the scenarios analyzed

Option	Average Annual Water Cost (TAF)	% Reduction from Historical	
		San Joaquin River downstream of Big Break Insertion	Old River upstream of Quimby Island Insertion
2-Gate (inoperable) + DCC Re-Ops + QWEST ≥ 0 cfs	154	86%	89%
2-Gate (operable) + DCC Re-Op + QWEST ≥ 0 cfs	156	81%	78%
2-Gate (inoperable) + DCC Re-Ops + QWEST ≥ 500 cfs	267	94%	92%
2-Gate (operable) + DCC Re-Ops + QWEST ≥ 500 cfs	268	91%	80%
3-Mile Slough Gate + DCC Re-Ops	0	98%	0%

Region of Control Studies using DSM2 Analyses.

More than one-hundred and forty (140) PTM analyses using the DSM2 model determined the 2 Gates Project to be effective in controlling particle entrainment at south Delta export facilities. The region of effectiveness of the 2 Gates Project is generally bounderd by the Old River, False River, Dutch Slough and Fisherman's Cut. Particle insertion locations used in these analyses are shown on Figure F-1. Circulation patterns developed by one of the principle operations of the 2-Gate facilities (open on flood-tide and closed on ebb-tide) also promotes seaward movement of particles in Old River and away from the pumps. Further, operation of the 2-Gates is expected to improve water quality conditions in the south Delta. Table F-2 shows the particle insertion locations, hydrologic periods of analyses and particle entrainment results for the cases modeled. The blue colored values define the region of the control of the gates operating under historical conditions. Operation of the 2-Gates facilities was also found to improve water quality conditions in the central and south Delta.

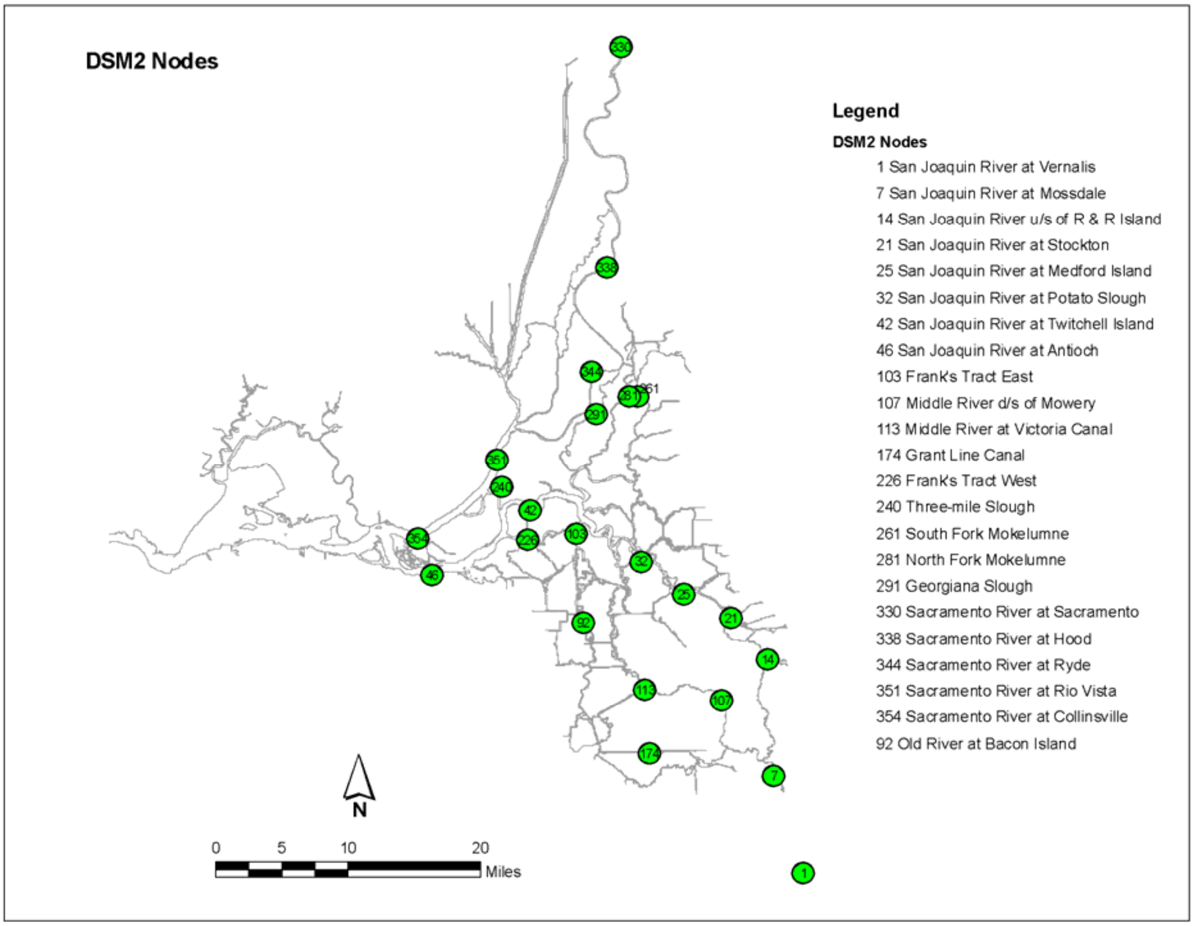

Figure F-1. Location of DSM2 particle tracking simulation insertion points

Table F-2 Particle Insertion Locations and Resulting Particle Entrainment to Determine the Region of Control of the Gates

No.	Location	DSM2 Node	Change in % Entrainment at Export Pumps				
			2-Mar-03	1-Apr-91	1-Mar-01	1-Feb-95	27-Mar-03
1	San Joaquin River at Vernalis	1	6	12	8	4	7
2	San Joaquin River at Mossdale	7	7	16	9	3	8
3	San Joaquin River at Stockton	21	-7	-13	-4	9	1
4	San Joaquin River at Empire Tract	25	-6	-6	3	6	-2
5	San Joaquin River at Rindge Pump	32	-4	-3	-5	8	2
6	San Joaquin River at Twitchell Island	42	14	17	6	-1	18
7	San Joaquin River at Antioch	46	0	-1	-1	0	-2
8	Old River at Bacon Island	92	-84	-80	-97	1	-90
9	Frank's Tract East	103	-51	-47	-53	-3	-58
10	Frank's Tract West	226	-11	-13	-12	-5	-14
11	Middle River at Victoria Canal	113	1	-1	0	0	0
12	Three-mile Slough	240	4	1	-2	0	6
13	South Fork Mokelumne	261	9	24	21	6	10
14	North Fork Mokelumne	281	16	26	16	1	15
15	Georgiana Slough	291	12	17	19	-1	20
16	Sacramento River at Sacramento	330	3	3	4	0	3
17	Sacramento River at Hood	338	1	3	2	0	4
18	Sacramento River at Ryde	344	2	0	-1	0	0
19	Sacramento River at Rio Vista	351	-1	0	0	0	0
20	Sacramento River at Collinsville	354	0	0	0	0	0
21	Middle River at North of Mowry	107	0	4	-8	-	0
22	SJR south of Rough and Ready Island	14	-7	31	9	5	-3
23	Grant Line Canal	174	0	0	0	0	0
24	San Joaquin River downstream of Big Break	461	-1	-3	-1	0	-1
25	Old River near Quimby Island	99	-78	-83	-91	1	-87
26	Mokelumne River downstream of Cosumnes Confluence	258	6	23	17	2	11
27	Mokelumne River downstream of Georgiana Confluence	272	10	19	19	-2	19
28	Little Potato Slough	249	3	1	15	0	5

<u>2-Gate and QWEST Studies to form Physical/Hydraulic Control using DSM2 Analyses.</u>

More than 320 PTM analyses determined that the 2-Gates Project operates compatibly with flow management measures on the San Joaquin River generated through OMR restriction during critical periods. These operations maintained the general distribution of adult delta smelt north and west of the region of control of the gates, forming a physical/hydraulic barrier to inadvertent entrainment or upstream smelt migration into the south Delta. Operations of the 2-Gate Project are shown to be consistent with the protective actions proposed by the U.S. Fish and Wildlife Service's OCAP BO

(USFWS 2008).Several hundred DSM2 PTM analyses were conducted to determine operations of the 2-Gates together with flow management on the San Joaquin River generated through OMR restrictions during critical periods. These operations generally maintained the distributions of adult delta smelt within or north/west of the region of control of the gates, forming an effective physical/hydraulic barrier to upstream smelt inadvertent entrainment or migration into the south Delta. Operations of the 2-Gate Project are shown to be consistent with the protective actions proposed by the U.S. Fish and Wildlife Service's OCAP BO (USFWS 2008).

The outputs of DSM2 analyses of the 2-Gate Project provide insight into how to effectively operate the gates and derive potential benefits from flow rate modification. In these analyses, thirty four (34) PTM analyses were performed to determine the optimum locations/number of gates.[2] One-hundred and forty (140) PTM analyses were conducted to determine region of control of 2-Gates operations.[3] Three-hundred and twenty (320) PTM analyses were conducted at 20 mm smelt survey locations (Figure F-2) using DSM2 to determine operational effects of combined 2-Gates and QWEST operations. The latter studies were performed in anticipation of potential operation in conjunction with the new OCAP BO and subsequent RMA delta smelt behavioral analyses.[4] The 2-Gates Project and modest QWEST operations were found to provide a physical/hydraulic barrier to delta smelt passage, and were found effective in preventing particle entrainment within in the region of control of Project and QWEST controls (Tables F-3 and F-4):

2 Release date: 2Mar03
3 Release dates: 1Apr91, 1Mar 01, 2Mar03, 27Mar03, 1Feb05
4 Release dates: 9Jun99, 12Jun02, 15May02, 30May02, 21May03, 1May04, 16Dec03, 30Dec04

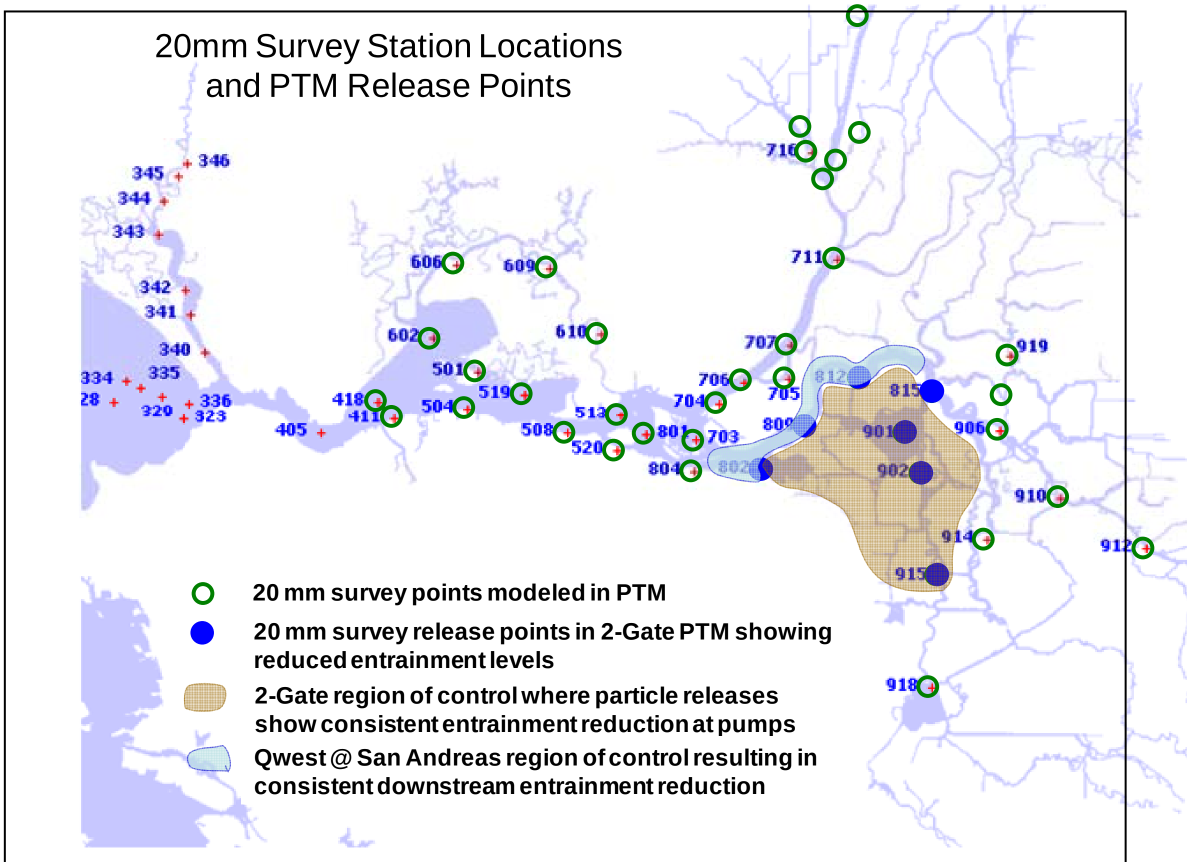

Figure F-2. 20 mm Smelt Survey, Particle Release Points and Region of Control

Table F-3 Entrainment Results for Release Point #809

Survey Location /Release Point	% Entrainment from Release Location #809							
	Feb-Jun						Dec-Feb	
	9-Jun-99	12-Jun-02	15-May-02	30-May-02	21-May-03	12-May-04	16-Dec-03	30-Dec-04
Historic	2	5	0	2	2	1	29	3
Historic + 2-Gates	0	2	0	1	1	0	25	1
Historic + 2-Gates + QWEST > -1,000 cfs	1	1	0	1	0	0	9 [5]	0
Historic + 2-Gates + QWEST > 0 cfs	1	0	0	0	0	0	6 [5]	0

[5] 0% entrainment observed in Historic + 2-Gates + QWEST >-1,000 cfs, when exports were curtailed to match San Joaquin River flow during the gate closure.

Table F-4 Entrainment Results for Release Point #902

Survey Location Release Point	% Entrainment from Release Location #902							
	February-June						Dec-Feb	
	9-Jun-99	12-Jun-02	15-May-02	30-May-02	21-May-03	12-May-04	16-Dec-03	30-Dec-04
Historic	51	60	20	50	56	24	97	92
Historic + 2-Gates	1	2	0	1	6	1	11	4
Historic + 2-Gates + QWEST > -1,000 cfs	1	1	1	0	2	1	4 [5]	3
Historic + 2-Gates + QWEST > 0 cfs	1	0	1	0	2	1	4 [5]	3

[5] 0% entrainment observed in Historic + 2-Gates + QWEST >-1,000 cfs, when exports were curtailed to match San Joaquin River flow during the gate closure.

Further analyses were conducted to determine potential mitigating effects of combined 2-Gates and QWEST flow control measures, consistent with OCAP OMR restrictions, on Mokelumne River salmon. Tables F-5 and F-6 show examples of adding such QWEST flows to 2-Gate Project operations to prevent significantly increased particle entrainment or to reduce entrainment originating from the Mokelumne and San Joaquin River regions. The red symbols on Figure F-3 depict regions that would otherwise be impacted without the application of such QWEST controls. Adding QWEST @ San Andreas > -1,000 cfs to 0 cfs to the 2-Gates Project operations was found to prevent increased entrainment or to reduce entrainment of particles from the Mokelumne and San Joaquin River regions in two-thirds of the model runs. Project facilities can also be left open or operated with additional QWEST flow depending on severity of forecasted conditions.

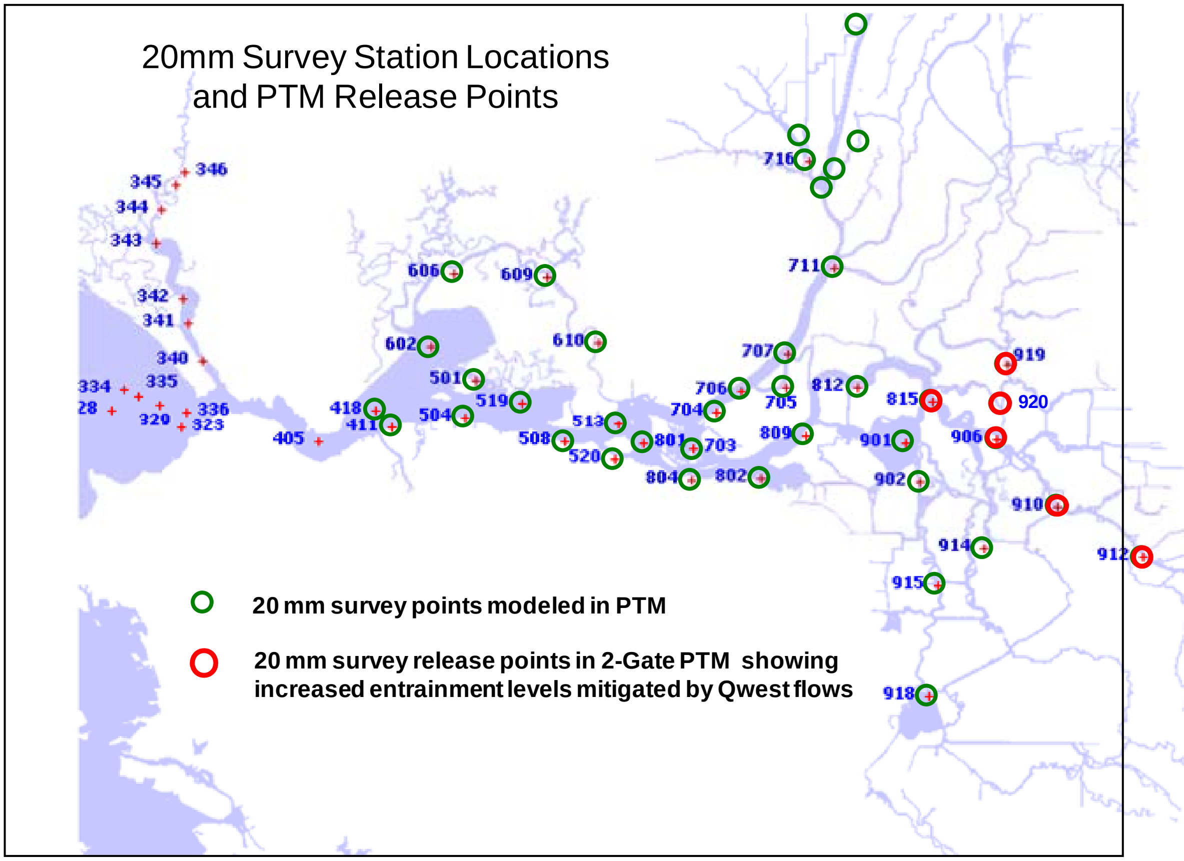

Figure F-3 20 mm Smelt Survey, Particle Release Points and 2-Gate/QWEST Operations

Table F-5 % Change in Entrainment from Release Point #919

Survey Location /Release Point	% Change in Entrainment from Release Point #919							
	February-June						Dec-Feb	
	9-Jun-99	12-Jun-02	15-May-02	30-May-02	21-May-03	12-May-04	16-Dec-03	30-Dec-04
Historic + 2-Gates	+12	+16	+12	+24	+14	+12	-7	+9
Historic + 2-Gates + QWEST > -1,000 cfs	+9	+1	+7	+4	+4	+12	-21 [5]	+7
Historic + 2-Gates + QWEST > 0 cfs	+8	-10	+7	-8	0	+8	-26 [5]	+4

[5] -74% change in entrainment observed in Historic + 2-Gates + QWEST>-1,000 cfs, when exports were curtailed to match San Joaquin River flow during the gate closure.

Table F-6 % Change in Entrainment from Release Point #906

Survey Location /Release Point	% Change in Entrainment from Release Point #906							
	Feb-Jun						Dec-Feb	
	9-Jun-99	12-Jun-02	15-May-02	30-May-02	21-May-03	12-May-04	16-Dec-03	30-Dec-04
Historic + 2-Gates	+6	+4	+9	+17	+10	+7	-10	-2
Historic + 2-Gates + QWEST > -1,000 cfs	+2	-9	+8	0	+1	+4	-21 [5]	-3
Historic + 2-Gates + QWEST > 0 cfs	0	-21	+6	-14	-1	+1	-26 [5]	-6

[5] -86% change in entrainment observed in Historic + 2-Gates + QWEST >-1,000 cfs, when exports were curtailed to match San Joaquin River flow during the gate closure.

Mode of Gate Operations Considered during Larvae/Juvenile Stage.

The DWR Potential Entrainment Index methodology, a measure to govern export levels to achieve entrainment levels deemed not to jeopardize the species, was used to test operational modes of the Project facilities during the March through June period when larvae/juvenile entrainment is of greatest concern. Using this methodology, differing 2-Gate operations and flow control measures were tested to reduce entrainment of simulated larval and juvenile delta smelt depending on the targeted distribution. Conditions were evaluated based on both gates closed, the Old River and Connection Slough Gates closed on flood-tide and open on ebb-tide and, and with only the Old River gate operated closed on flood-tide and open on ebb-tide. In real-time operations, an operation with Old River gate be closed on flood-tide and open on ebb-tide about 10 hours daily, would be accompanied by the Connection Slough gate open during slack-water up to 4 hours daily. Table F-7 describes the ranges of gates operation and other operational factors considered in these analyses.

Table F-7 Simulated change in potential entrainment with both Gates operated closed on flood-tide and open on ebb-tide, and with only the Old River gate operated.

OMR Conditions	Operation Alternatives			Operating Criteria
OMR ≥ - 1,250 cfs	Gates Closed	OR (closed - flood/ open - ebb) CS (open - slack water)	OR & CS (closed flood/ open - ebb)	Start gate operations when 3 station daily mean water temperature ≥ 12° C OCAP-adjusted QWEST @ San Andreas ≥ 0 cfs Gates open during VAMP
OMR ≥ - 5,000 cfs	Gates Closed	OR (closed - flood/ open - ebb) CS (open - slack water)	OR & CS (closed - flood/ open - ebb)	

A comparison of either one or both gates operating closed on flood-tide and open on ebb-tide was evaluated and results are summarized in Table F-8. Operation of both the Old River and Connection Slough closed on flood-tide and open on ebb-tide increases the number of events in which there was a simulated net reduction in potential entrainment. However, under certain conditions the tidal operation of the Old River gate alone proves significantly more effective, particularly when distributions fall within the western Delta and generally within region of control of the gates. Considering this evaluation, a gate operation mode with Old River gate closed on flood-tide and open on ebb-tide and Connection Slough gate closed during such operations was selected for evaluation in the RMA analyses. This operation was applied to distributions of larvae/juvenile generally falling within in the region of control of the gates, which would be expected at completion of adult simulations. An operational protocol is being established to guide the most favorable protections to smelt and water supply for testing in the demonstration program. Flexibility would be applied during field demonstrations to operate one or both gates in the flood-ebb operational mode.

Table F-8 Simulated change in potential entrainment with only the Old River gate operated tidally and with both Gates operated tidally

20 mm Survey	Change in Potential Entrainment	
	OR Gate Tidal Operation % Change	OR & CS Gate Tidal Operation % Change
09 June 1999, Survey 5	-50.4%	-20.6%
15 May 2002, Survey 5	11.4%	-4.5%
30 May 2002, Survey 6	3.4%	-14.3%
12 June 2002, Survey 7	5.2%	-7.6%
21 May 2003, Survey 5	-12.3%	11.9%
12 May 2004, Survey 4	-32.4%	-26.2%

Two-Dimensional RMA-2 Analyses

Real-Time Operations with OCAP BO restrictions using Adult and Larvae/Juvenile Smelt Behavioral Models.

Adult Delta Smelt. All prior simulations of near-term solutions had modeled adult delta smelt as neutrally-buoyant particles. While reasonably accurate for the larval stage, researchers have observed behaviors associated with increased turbidity and light in the adult stage. Analyses have also shown patterns of salinity and turbidity habitat may correlate with smelt abundance. Scientists have postulated that the adult smelt may be "surfing" the tides as a means of staying within their desirable habitat range. A new modeling package was developed to impart the turbidity and tidal 'surfing' behaviors on the particles in the RMA11 model. Once the delta smelt behavior model reasonably reproduced delta smelt distribution patterns in the Delta and at the export facilities, additional simulations were done with barriers in the Old River and Connection Slough. Simulations employing Project facilities operations and the modulation of exports during December through February, demonstrate that the turbidity plume (and therefore the distribution of adult delta smelt) can be managed generally within the region of control of the Project. Within this region, Project operations and related flow control measures have been shown to be effective in significantly reducing neutrally buoyant particles (and therefore larvae/juvenile) entrainment by the CVP and SWP export pumps.

Larvae/Juvenile Delta Smelt. To correlate observed and modeled distributions and abundance of larvae/juvenile delta smelt, the RMA11, RMA2 and RMA-PTRK models have evaluated the full larval and juvenile delta smelt period, roughly from March through June, for differing hydrologic periods. For each period, hatching rates have been determined by "tuning" to match 20mm survey observations and, if possible, observed salvage. The hatching period and mortality rates used in the simulations have been specified based on published findings from credible researchers. Delta smelt density predictions were compared with 20mm survey observations and the predicted delta smelt salvage was compared with salvage observations at the Skinner Fish Facility and the Tracy Fish Facility. The percent of combined delta smelt larval/juvenile population entrainment at exports, flushed from Delta, and contained within Delta were estimated, to determine the fate of fish by region of the Delta. As noted above, it is expected that the result of Project facilities operation and flow control measures during the adult stage, would place the turbidity plume (key habitat constituent) and anticipated adult distributions generally within the region of control of the Project. Beginning with adult distributions generally in the region of control of the gates, Project facilities operations and flow control measures have been shown to be effective in significantly reducing larvae/juvenile entrainment.

<u>Two-Dimensional RMA Model Numerical Basis.</u>

Resource Management Associates (RMA) has developed and refined models of the Sacramento-San Joaquin Delta system (Delta model) utilizing the RMA finite element models for surface waters (see Appendix D). The RMA models are a generalized hydrodynamic model that is used to compute two-dimensional depth-averaged velocity and water surface elevation (RMA2) and another model (RMA11) is a generalized two-dimensional depth-averaged water quality model that computes a temporal and spatial description of water quality parameters. RMA11 uses stage and velocity results from RMA2. The Delta model extends from Martinez to the confluence of the American and Sacramento Rivers and to Vernalis on the San Joaquin River. Daily average flows in the model are applied for the Sacramento River, Yolo Bypass, San Joaquin River, Cosumnes River, Mokelumne River, and miscellaneous eastside flows which include Calaveras River and other minor flows. The model interpolates between the daily average flows at noon each day. Delta Islands Consumptive Use (DICU) values address channel depletions, infiltration, evaporation, and precipitation, as well as Delta island agricultural use. DICU values are applied on a monthly average basis and were derived from monthly DSM2 input values. Delta exports applied in the model include SWP, CVP, Contra Costa exports at Rock Slough and Old River intakes, and North Bay Aqueduct intake at Barker Slough. Dayflow and IEP database data are used to set daily average export flows for the CVP, North Bay Aqueduct and Contra Costa's exports.

<u>Real-Time Operational Modeling Tools</u>

The 2-Gate Project includes the goal to develop a real-time delta smelt distribution and entrainment forecasting system based on the RMA Bay-Delta Model to guide real-time operations. It is expected that juvenile and larval delta smelt simulation will utilize passive particle tracking with post processing analysis of hatching and mortality developed by RMA in cooperation with USBR and DWR staff. The adult delta smelt simulation will use an salinity (as measured by Electrical Conductivity (EC)) and turbidity gradient based behavior model developed by RMA in cooperation with Metropolitan Water District of Southern California staff.

Forecasts will be performed approximately every two weeks and will utilize the most recently available field observations of delta smelt density as well as forecasted estimates of inflow, inflow water quality, and operations from system operators and data collection groups. For each forecast period, several simulations may be performed using alternative estimates of future conditions. An initial set of forecast simulations will be performed using best estimates of future operations provided by USBR and DWR system operators. Upon review of particle distribution and entrainment estimates by the Smelt Working Group (SWG) a second set of forecast simulations may be performed with revised Delta operations with the objective of identifying operations that reduce expected delta smelt entrainment.

Results: 2-Gates Project and OCAP Studies for OCAP BO Baseline and 2-Gates Conditions for Adult Delta Smelt using RMA Behavioral Analyses.

Computer simulations of adult delta smelt distribution with habitat seeking behavior were performed for historic periods. Simulation points representing adult delta smelt were initially placed in regions of acceptable habitat at the start of the simulation period. Key constituent elements of adult delta smelt habitat was characterized by salinity (EC) and turbidity. Options were added to the model to influence sensitivity to habitat gradients, chance of incorrect directional choices, and resistance to tidal flow velocity. Behavioral characteristics were adjusted to attempt to replicate entrainment (salvage) at water export facilities. The 2-Gates Project operations were coupled to be compatible with flow management measures of the U.S. Fish and Wildlife Service's OCAP Biological Opinion.

Adult delta smelt distribution, entrainment at the SWP and CVP pumps and fate were determined through simulation using modified operations scenarios for the OCAP BO baseline and OCAP + the 2-Gate Project conditions using the RMA Adult Behavioral Model from December through February for the 2000, 2002, 2004 and 2008 historic periods. See Appendix E for more details. Some sample results are shown in Figure F-4. A comparison of Figures F-4 and F-5 shows that in addition to the OCAP required OMR controls, the control of remaining QWEST $\geq$ 0 cfs at San Andreas is effective in reducing entrainment at the SWP and CVP pumps to nearly 0%. It is expected that proper application of such QWEST control through export modulation during the adult stage will be effective in managing the turbidity plume and attracted adult distributions generally within the region of control of the gates. Within this region, subsequent gate and flow control operations during larvae/juvenile stages have been shown to significantly reduce entrainment.

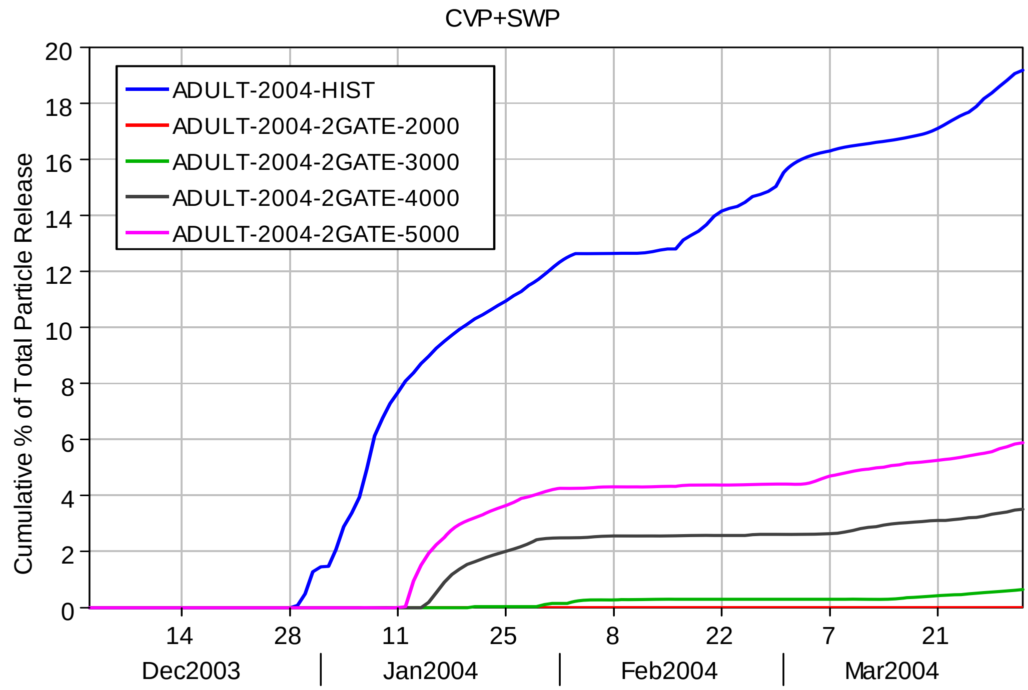

Figure 1 **Cumulative entrainment as percent of total particles released at the CVP and SWP export locations, December 2003 through March 2004, with alternative OMR flow limits**

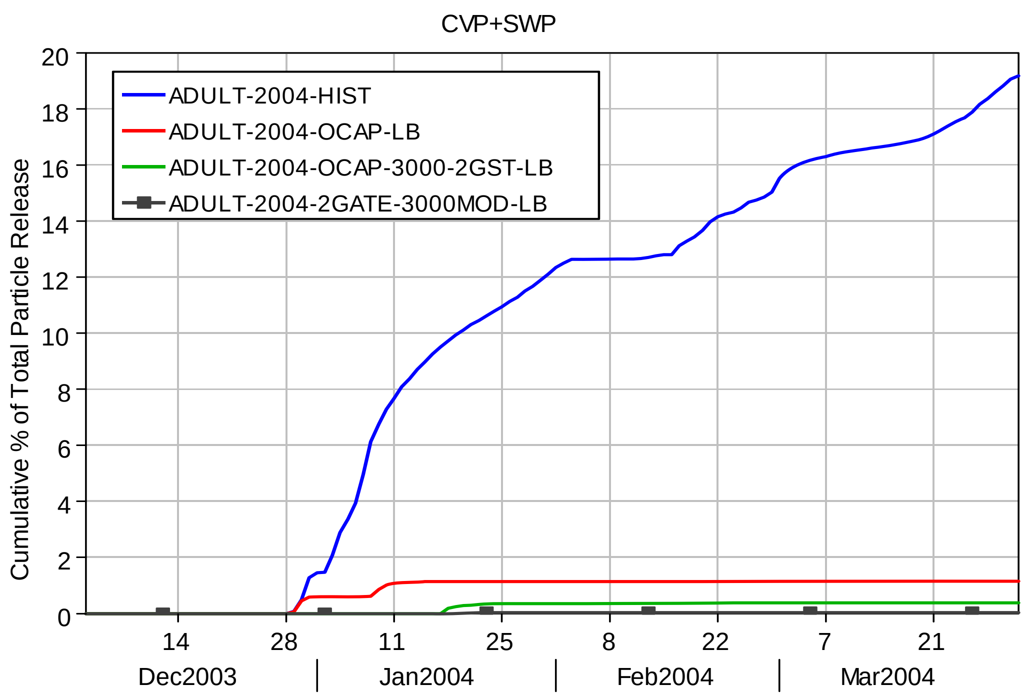

Figure 2 **Cumulative entrainment as percent of total particles released at the CVP and SWP export locations, December 2003 through March 2004, with -3000 cfs OMR flows during RPA1 and lower bound flows during RPA2. For the 2-gate case, exports were reduced briefly near the end of January to maintain positive QWEST at San Andreas Landing.**

Results: 2-Gate Project and OCAP Studies for OCAP BO Baseline and 2-Gates Condition for Juvenile and Larvae Delta Smelt using RMA Behavioral Analyses.

These simulations used the RMA Bay-Delta Model and RMA-PTRK for passive particle tracking with post processing analysis of hatching and mortality. Modified operations scenarios were simulated for revised export flows according to OCAP guidelines and OCAP + the 2-Gates to determine resulting larval and juvenile delta smelt distribution and entrainment. Simulations were conducted roughly from March through June for the 2002 and 2004 historic periods. Analyses to adjust simulation results for mortality/hatching are underway and will be reflected in the final simulation results. The hatching rates estimated for historic conditions will be applied without modification to the various operations scenarios, focusing on the effects after initial hatching.

Figure F-5 (year 2004), indicates supplementing flows to achieve QWEST ≥ 0 cfs at San Andreas together with 2-Gate operations and OMR -3,000 cfs restrictions, resulted in near 0% entrainment at the export pumps. As necessary, QWEST ≥ 0 cfs was applied about two days in late January 2004 to ensure habitat and accompanying smelt distributions fall generally west of San Andreas, within and north/west of the region of control of the gates. On Figure F-6, Source Regions, the aggregated areas of “San Joaquin near Confluence + San Joaquin at False River + Franks Tract + Old” generally define the region of control of the gates and related flow control measures. The combined effects of the 2-Gates, OMR -5,000 cfs restrictions, and supplemental QWEST ≥ 0 cfs suggests resulting larvae/juvenile entrainment (Figure F-4) can be maintained near OCAP OMR -1,250 cfs entrainment levels. Further, Figure F-7 displays the forecast of reduced entrainment at the expert pumps with the implementation of the Project. Each of the Project simulation displays less predicted entrainment than either of the simulation of the OCAP BO restricted OMR flow regimes.

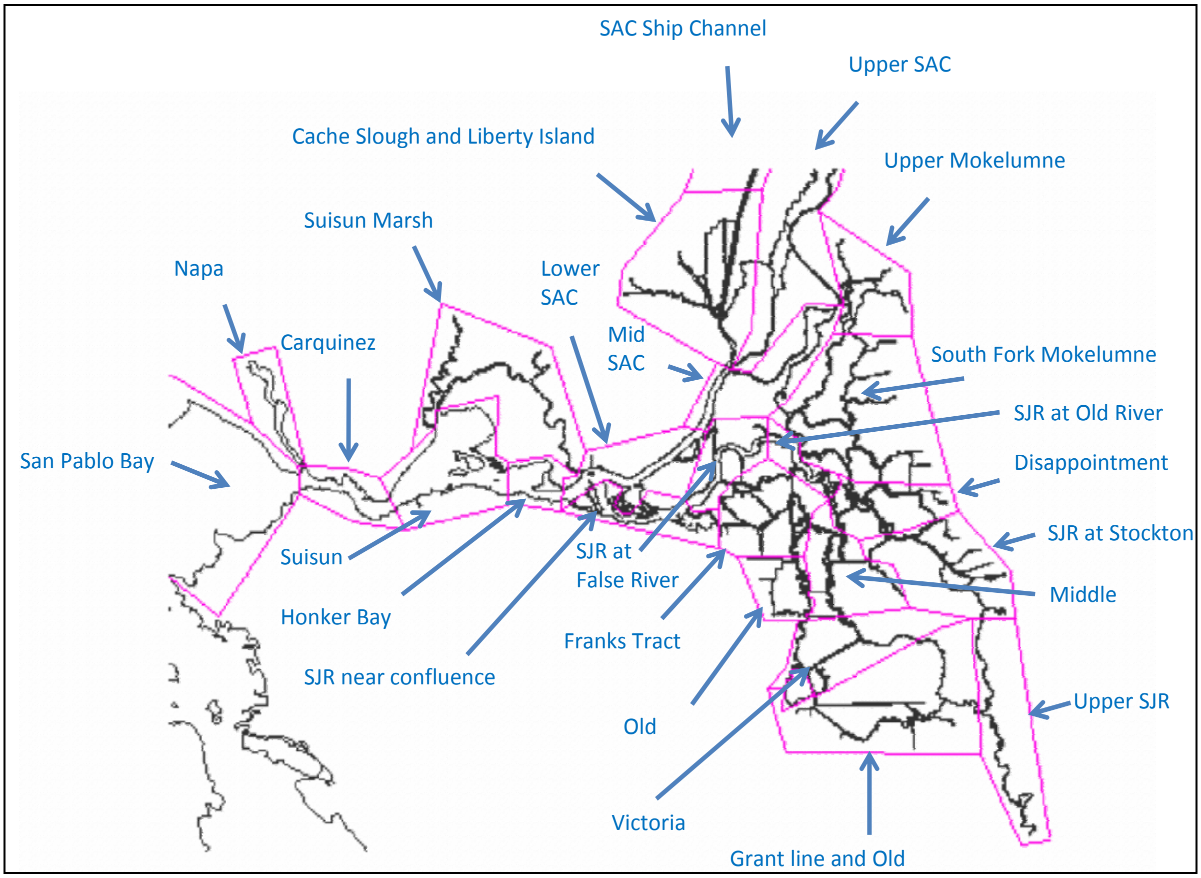

Figure 3	**Source regions for simulation of entrainment from the Project. When Project operations include modest amounts of well-timed flow in the region of control, simulations indicate that the Project would offer enhanced protection to delta smelt and allow greater water diversions at the SWP and CVP pumps.**

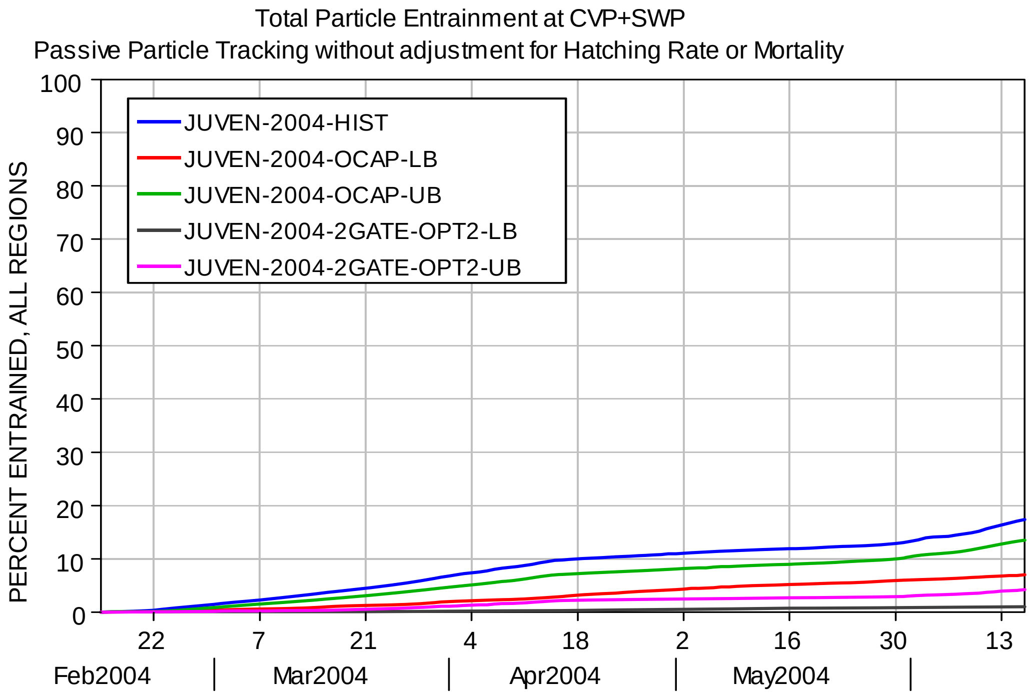

Figure 4 **Percent particles (larval and juvenile delta smelt) entrained at the CVP+SWP originating from the region "Source Region". Both simulations of the Project Operations display results that provide enhanced protection for delta smelt (lower entrainment) that could allow lower restrictions on water management actions at the SWP and CVP pumps.**