

Operations Plan

FORWARD

Operational Objectives

This conceptual operations plan is intended to characterize anticipated operations of the 2-Gates Project. The project is expected to reduce both the direct transport of smelt into Old River and Middle rivers from the Franks Tract area and the establishment of water quality conditions in the south Delta used by delta smelt for dispersal prior to spawning. Water supply benefits can be realized if demonstrated that entrainment at the CVP and SWP facilities is averted and that the general distribution of adult delta smelt are north and west of the region of control of the gates. The 2-Gates operations (1) can provide equal or better protection to delta smelt than is provided by the OCAP BO operations though the used of export curtailments, (2) can maintain the general distribution of smelt north and west of the region of control of the gates by balancing the negative flow in Old and Middle Rivers, and (3) and can achieve, under certain hydrologic conditions, reduced export curtailments from that prescribed under OCAP BO operations.

Testing and Evaluation Processes

For a particular field test, real time modeling would be performed to assess “with” and “without” project conditions. The modeled results would be evaluated in terms of benefits to delta smelt and effects to other species. It is not possible to perform directly comparable field tests of “with” and “without” project conditions, since testing cannot take place under exactly the same hydrologic conditions. However, field testing of gate operations can be performed to assess how well observed field conditions can be replicated through computer modeling. Testing and comprehensive monitoring would address potential operational effects to delta smelt and other species in the Delta region, and local effects such as habitat, water quality and predation conditions.

Entrainment and Export Reduction Relationships

The Project is expected to reduce entrainment with equivalent export water curtailment compared to OCAP BO baseline conditions, or achieve greater reduction in entrainment at similar export curtailment, or the same level of entrainment at reduce export restrictions. Under either condition the objective will be to place adult delta smelt and associated pre-spawning water quality factors north and west of the gates.

INTRODUCTION

Through extensive hydrodynamic modeling, the 2-Gates Project is predicted to be very effective at controlling particle entrainment at the south Delta export facilities for a region largely bounded by the Old River, False River, Dutch Slough and Fisherman’s Cut. The circulation pattern developed by the operation of the Project within this region promotes balanced negative flows Old and Middle rivers. Operation of the Project is expected to reduce both the entrainment of delta smelt and the establishment of water quality conditions in the south Delta used by smelt. These operations are also designed to reduce entrainment of other pelagic fish species and anadromous fish. Modeling results indicate that the effectiveness of Project operation is dependent on the distribution of delta smelt, estimated relative abundance, and water quality conditions of a particular survey date.

Due to the sensitivity of impacts, it is important to incorporate a real-time decision framework that evaluates the best course of action for particular delta smelt distributions and hydrodynamic conditions. The Project works in concert with other operational measures that seek to manage flows on the mainstem San Joaquin River during critical periods to maintain the general distribution of adult delta smelt north and west of the region of control of the gates. This conceptual operational plan for the Project is shown to be consistent with the protective actions proposed by the U.S. Fish and Wildlife Service’s OCAP Biological Opinion.

FACTORS AFFECTING SMELT ENTRAINMENT

Hydrodynamics and Water Quality Factors

Historical entrainment of delta smelt at the export facilities has occurred primarily during the period of December through June. The science related to smelt movement, behavior and entrainment is continuing to evolve, but it is recognized that the presence of water quality factors in the south Delta and net flow reversals in Old and Middle Rivers can be a significant cause for delta smelt entrainment. Adult delta smelt pre-spawning distribution is believed to be strongly related to specific ranges of salinity and turbidity. The recently released OCAP Biological Opinion (USFWS 2008) strongly supports the linkages between turbidity and delta smelt occurrence. These water quality factors (electrical conductivity greater than 400 μ mhos/cm and turbidity greater than 12 NTU) occurs in different parts of the Delta depending on hydrologic conditions and operation of the SWP and CVP facilities. These water quality factors normally occur in the regions of Suisun Marsh and Cache Slough. However, under certain hydrologic and operating conditions, the water quality factors can be substantially moved into the central and south Delta due to reversal of flows on the lower San Joaquin River. Adult pre-spawning delta smelt are believed to “seek-out” this water quality body by “surfing” the tides and in so doing transport themselves to more inland areas in advance of spawning, however the actual mechanisms supporting the pre-spawning movement of delta smelt to inland areas is unverified. Under the current configuration of the south Delta, high exports during these times cause net flow reversals of Old and Middle Rivers, drawing water quality factors into the south Delta which can lead to significant entrainment of pre-spawning adult delta smelt. In addition, delta smelt spawning in the central and south Delta is believed to cause subsequent larval and juvenile smelt entrainment due to the proximity of the export facilities.

Key Entrainment Measures

Consistent with the OCAP Biological Opinion, it is hypothesized that the movement of delta smelt pre-spawning water quality, factors into the central and south Delta and draws adults to this area that then spawn, and result in subsequent direct transport of early life stages of delta smelt to the south Delta export facilities. These unfavorable hydrodynamic conditions are believed to be key measures affecting entrainment.

POTENTIAL MEASURES FOR CONTROLLING ENTRAINMENT

Since the current hypotheses describing the mechanisms for delta smelt entrainment relate to either the movement of the water quality factors into the central and south Delta or the direct transport of the early life stages from this region to the export facilities, management strategies to reduce the risk of delta smelt entrainment should seek to control associated adverse hydrodynamic conditions. A dual hydrodynamic approach for protecting against delta smelt entrainment is believed to be the most appropriate strategy. The proposed strategy focuses on (1) the operation of a gate system on Old River and Connection Slough to balance negative flows in the Old and Middle river channels and the development of the habitat characteristics that would influence movement of delta smelt habitat into the south Delta, and (2) the management of flows on the San Joaquin River near San Andreas (defined here as Qwest consistent with OCAP BO OMR operations) to protect against negative flows on the San Joaquin River. Pre-spawning water quality factors and San Joaquin River flows near San Andreas could be managed through Delta Cross Channel re-operation, re-operation of the CCF, reduced exports, or a combination of these operations. The 2-Gates operation would provide the necessary control on Old and Middle rivers. These two actions need to work in concert to provide comprehensive management of entrainment effects at potentially reduced water costs.

FORECASTED OPERATIONS AND MONITORING WITH ADULT AND LARVAE/JUVENILE BEHAVIOR MODELS

Forecasting Process

Effective real-time forecasting requires establishment of initial conditions using historic simulations; gathering and validation of data for real-time boundary conditions; timely agency interaction to determine inflow, quality, and operations forecasts; acquiring and interpreting smelt survey and salvage data; generating output forecasting products; field testing; and documentation.

Forecasts will be performed approximately every two weeks and will utilize the most recent field observations of delta smelt density; and 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 future operations with the objective of identifying operations that reduce expected delta smelt entrainment.

Adult Smelt Model

Several modified operations scenarios under the 2-Gates Project will be conducted using the current Adult Delta Smelt Behavioral Model roughly from December through February for the 1999, 2003, 2004, 2007 and 2008 historic periods to support completion of the Mitigated Negative Declaration/Environmental Assessment and Biological Assessment (MND/EA and BA) for the 2-Gates Project. The predicted delta smelt distribution, entrainment and fate for each scenario will be compared with the corresponding OCAP BO baseline period.

A real-time adult delta smelt distribution and entrainment forecasting system will be developed using the RMA Bay-Delta Model and applied to the 2009 delta smelt spawning and hatching season. The system will use an electrical conductivity and turbidity gradient based behavior model developed by RMA in cooperation with Metropolitan Water District. It will address scientific postulations that the adult smelt may be “surfing” the tides as a means of staying within their desirable habitat range. Additionally, patterns of salinity and turbidity habitat may correlate with smelt abundance, such that the smelt behavior model will impart habitat seeking behavior on the particles.

Juvenile and Larvae Model

To support the completion of the MND/EA and BA, the forecasting of behavior, distribution and entrainment of larval and juvenile delta smelt for historic conditions and scenarios would be evaluated by Bay Modeling (Ed Gross) using post-processing analysis of hatching and mortality in cooperation with USBR (Lenny Grimaldo) and DWR (Ted Sommer). RMA would perform passive particle tracking simulations using the RMA Bay-Delta Model and RMA-PTRK for use in the post-processing. Several modified operations scenarios under 2-Gates Project will be conducted roughly from March through June for the 1999, 2003, 2004 and 2008 historic periods for the larval and juvenile periods. The predicted delta smelt distribution, entrainment and fate for each scenario will be compared with the corresponding OCAP BO baseline period.

A real-time delta smelt distribution and entrainment forecasting system for juvenile and larval delta smelt will be developed through adaptation of the 3-D UnTRIM model to the 2-D RMA Bay-Delta Model to perform the most time efficient modeling analyses. Passive RMA particle tracking would be supported by post processing analysis of hatching and mortality by Bay Modeling, in cooperation with USBR and DWR. The model would address unique aspects of the larval stage, including observed behaviors associated with turbidity and light. Significant calibration work is required to be an effective operations forecasting tool. The

model would not be completed in time to support the MND/EA and BA, but is expected to be available in the operational phase of the 2-Gates Project.

Timely Information to Smelt Working Group (SWG)

One day is anticipated to gather new observed data, perform data validation, perform historic simulation with latest available data, gather best estimate future operations from delta operators, and prepare and run initial forecast alternatives. One day is anticipated to post-process initial forecast results, and prepare forecast products and transmits to SWG. Rapid forecasts casts are necessary, but will be governed by realistic and reliable data protocols.

PROPOSED INTEGRATED OCAP BO FLOW MANAGEMENT AND 2-GATES OPERATING PLAN

2-Gates operations would compliment the OCAP BO Old and Middle River RPAs. Flow, salinity, turbidity, and particle forecasting simulations would be performed to forecast timing of the Old River and Connection Slough gate operations consistent with the RPAs. OMR flows and related QWEST flow would be achieved primarily through export curtailments.

Since the 2-Gates Project is being proposed as a temporary solution aimed at reducing delta smelt entrainment, it is useful to describe an operating plan that is sufficiently flexible to adapt to real-time monitoring and predictive hydrodynamic, water quality, and delta smelt behavior modeling. DSM2 modeling results have shown that the operational effects of various measures of entrainment are strongly influenced by the initial distribution of delta smelt and relatively short duration adverse hydrodynamic conditions in winter and spring. The following operating measures are described as examples of different operations under changing field conditions.

Operation—December through February

The 2-Gates facilities, along with OMR and coincident QWEST flows would be operated to restrict the movement of water quality conditions into the central and south Delta (and thereby control the location of pre-spawning delta smelt) by performing two actions:

- Old River and Connection Slough Gates would be operated when triggering turbidity concentrations (> 12 NTU) begin to appear at the region of control of the 2-Gates, defined here as San Joaquin River at Jersey Point. As noted above, forecasting of these conditions would be accomplished through a real-time network of stations from which measurements of turbidity and salinity concentrations and other constituents can take place. These operations would be taken, in consultation with the Smelt Working Group (SWG) and the Water Operations Management Team (WOMT). Gates would be operated about an hour day to manage the movement of adult delta smelt habitat (turbidity plume) through flow balancing generally within the region of control of the gates. Export modulation to more actively control the turbidity plume consistent with OCAP is currently being evaluated.
- In field demonstrations, restriction of OMR negative flow rates under the OCAP BO would be demonstrated when the turbidity threshold (> 12 NTU) is exceeded at San Joaquin River at Prisoners Point, or alternatively upon the OCAP 3-station turbidity trigger. QWEST flows at San Andreas, coincidental with flows under the boundary conditions of OMR discretionary operations, would be managed in very isolated cases to maintain QWEST @ San Andreas ≥ 0 cfs. These operations would be taken until the 3-station daily mean water temperatures at Mossdale, Antioch and Rio Vista $\geq 12^{\circ}\text{C}$, in consultation with the Smelt Working Group (SWG) and the Water Operations Management Team (WOMT), signaling a transition from adult to larvae/juvenile delta smelt management actions. OMR controls and related flow management are designed to prevent habitat movement up the mainstem of the San Joaquin River, as depicted through a full range of scenarios explored in the OCAP BO Appendix S.

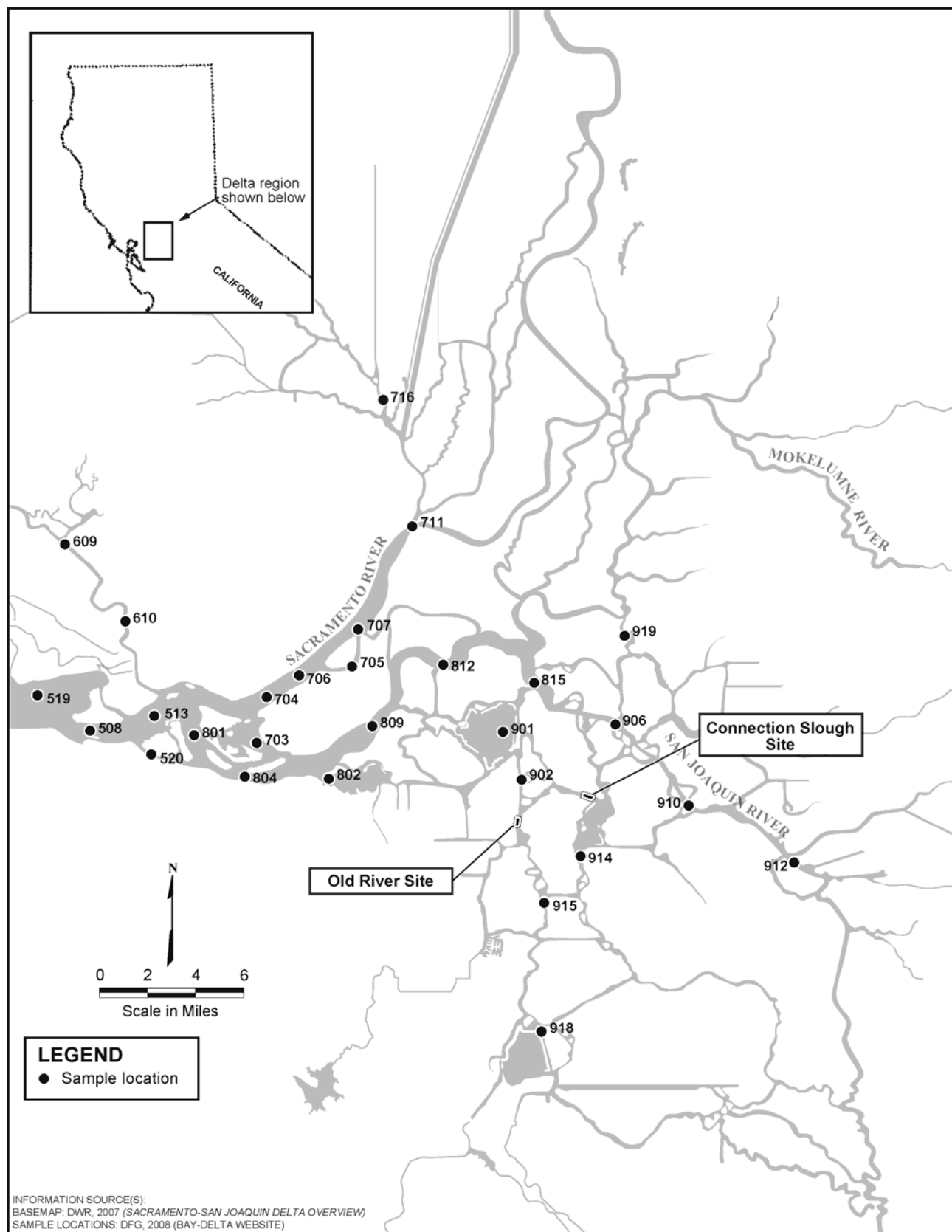
Operation—March through June

The 2-Gates facilities would be operated during the pre-Vernalis Adaptive Management Plan (VAMP) (March 1–April 15) and post-VAMP (May 16–June 30) periods. These operations are intended to limit the location of juvenile and larval delta smelt and would be based on real-time monitoring of delta smelt densities, spawning areas, and biweekly predictive modeling to better ascertain the projected location of smelt, as detailed below:

Based on the real-time monitoring of hydrodynamic conditions, 2-Gate operations, along with OMR restrictions be taken in consultation with the Smelt Working Group (SWG) and the Water Operations Management Team (WOMT), when the 3-station daily mean water temperatures at Mossdale, Antioch and Rio Vista $\geq 12^{\circ}\text{C}$ signaling a transition from adult to larvae/juvenile delta smelt management actions.

-Gate operations, along with OMR restrictions would be implemented, consistent with boundary conditions of OMR discretionary operations, until June 30 or until the daily average temperature reaches 25°C for 3 consecutive days at Clifton Court Forebay.

Flow management measures are expected to prevent transport of delta smelt or pre-spawning water quality conditions up the mainstem of the San Joaquin River, while the 2-Gates operation simultaneously prevents the entrainment of delta smelt from the Franks Tract and Old River regions.



PTM = Particle Tracking Model

Figure 2-6 IEP Monitoring Stations for Long Term Delta Fish Surveys

Project Operations linkage to the OCAP BO Objectives

The 2-Gates Project has the ability to assist water management agencies in meeting the objectives of the OCAP BO and would complement the actions by:

- **Controlling the movement of delta smelt pre-spawning water quality conditions into the south Delta:** Under the proposed 2-Gates operating plan, operation of the gates during the winter period could reduce the potential for the turbidity and salinity regime that is used by smelt for pre-spawning movement from being drawn into the south Delta.
- **Reducing entrainment at the SWP and CVP export facilities:** The 2-Gates operation is likely to reduce juvenile delta smelt salvage at the pumps under certain distributions. Reducing the adult delta smelt movement into the south Delta, by managing movement of pre-spawning water quality conditions, would result in the spawning outside of the south Delta.
- **Minimize delta smelt distributions that are most likely at risk to entrainment.** The 2-Gates Project, if properly managed and integrated with OCAP BO OMR operations, could reduce entrainment of juvenile delta smelt in the south Delta. With spawning occurring further to the west, larvae and juvenile delta smelt would have reduced potential for subsequent entrainment. Within the region of control, the 2-Gates operation modeling has been shown to reduce particle entrainment.

Specific 2-Gates Project protective measures associated with each OCAP BO action are identified in Tables 2-2a, 2-2b, and 2-2c. The 2-Gates Project serves as a tool for water management agencies to integrate with other actions to help reduce entrainment of delta smelt at the SWP and CVP export facilities. The Project is being proposed with temporary, cost-effective, and immediately implementable facilities to test water and natural resource management hypotheses and provide insight into alternative management techniques for protection of delta smelt while having less impact on water exports.

The OCAP BA identifies the protective measures for delta smelt with relation to CVP and SWP operations. These measures are summarized in Tables 2-2a, 2-2b, and 2-2c. These protective measures often identify a range of operational values. In order to simplify the modeling analyses included in this MND/EA (and associated BA) specific values were selected from within each of these ranges. The modeling assumption used in this analysis are shown in Table 2-2b. Specific 2-Gates Project protective measures associated with each OCAP BO action are identified in Table 2-2a. The 2-Gates Project serves as a tool for water management agencies to integrate with other actions to help reduce entrainment of delta smelt at the SWP and CVP export facilities. The Project is being proposed with temporary, cost-effective, and immediately implementable facilities to test water and natural resource management hypotheses and provide insight into alternative management techniques for protection of delta smelt while having less impact on water exports.

December through February (Adult Delta Smelt)

Hypothesis: Adult delta smelt are attracted to pre-spawning water quality factors consisting of salinity and turbidity preferences. Adults are attracted to this water quality body and can take advantage of the tides to seek these conditions. These factors normally exists in Suisun Marsh and Cache Slough areas, but during high flow conditions on the Sacramento River pre-spawning turbidity conditions can be brought into the central and south Delta while pumping remains high. A key point to this hypothesis is that the delta smelt are following these factors and that control of the water quality factors can control adult delta smelt movement.

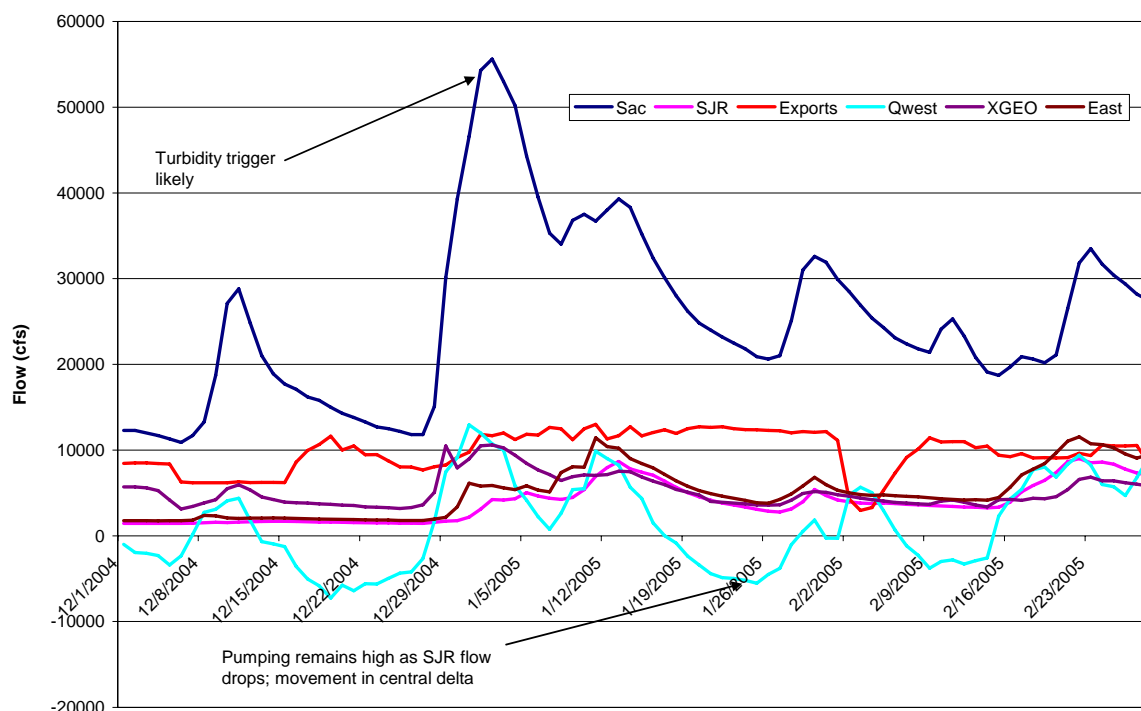
Operation: Under this hypothesis, the 2-Gates facilities and Qwest flows would be operated to restrict the movement of water quality factors into the central and south Delta by performing two actions:

- Old River and Connection Slough Gates to be operated to reduce delta smelt entrainment at the export pumps, if triggering turbidity concentrations begin to appear at the region of control of the 2-Gates and Qwest operations, defined here as San Joaquin River at Jersey Point turbidity > 12 NTU. As noted above,

forecasting of these conditions would be accomplished through a real-time network of stations from which measurements of turbidity and salinity concentrations and other constituents can take place. The gates will be operated until turbidity and salinity concentrations are no longer consistent with pre-spawning water quality factors for delta smelt. The RMA Adult Smelt Model would be used to forecast and recommend the most suitable near-term operations to reduce the possibility of entrainment, primarily through operations that would discourage the creation of a continuum of delta smelt desired turbidity and salinity conditions into the south Delta.

- OMR operations under the OCAP BO would be initiated when turbidity concentrations begin to reach San Joaquin River at Prisoners Point, defined here as > 12 NTU. Qwest flows at San Andreas would be consistent with flows under the boundary conditions of OMR discretionary operations. While the OCAP Biological Opinion focuses all actions on Old and Middle River flows, it is proposed to manage the flow conditions further to the west since this is more practical under a 2-Gates operation (no upstream flow in Old River). Qwest augmentation may also be available through Delta Cross Channel diurnal re-operations or Clifton Court Forebay re-operation. This Qwest control will be sustained until turbidity and salinity concentrations are no longer consistent with delta smelt pre-spawning water quality factors as demonstrated through monitoring and projected through the RMA Adult Smelt Model. OMR controls and related Qwest management is designed to prevent habitat movement up the mainstem of the San Joaquin River. The Qwest targets to achieve net positive flow are within the range of scenarios explored in the OCAP BA Appendix S.
- Based on real-time monitoring of turbidity and salinity concentrations, salvage events and 2-D RMA Adult Delta Smelt Model forecasts, the Old River and Connection Slough Gates would be operated and Qwest management undertaken until the absence of adult smelt are validated by (1) the turbidity and salinity concentrations abating sufficiently to no longer be consistent with delta smelt pre-spawning water quality factors, and (2) no delta smelt are salvaged or captured in the Spring Kodiak Trawl at sites south of gates for five consecutive days, indicating that they were not at high risk for entrainment.

Flows Conditions during Significant January and February 2005 Delta Smelt Salvage Events

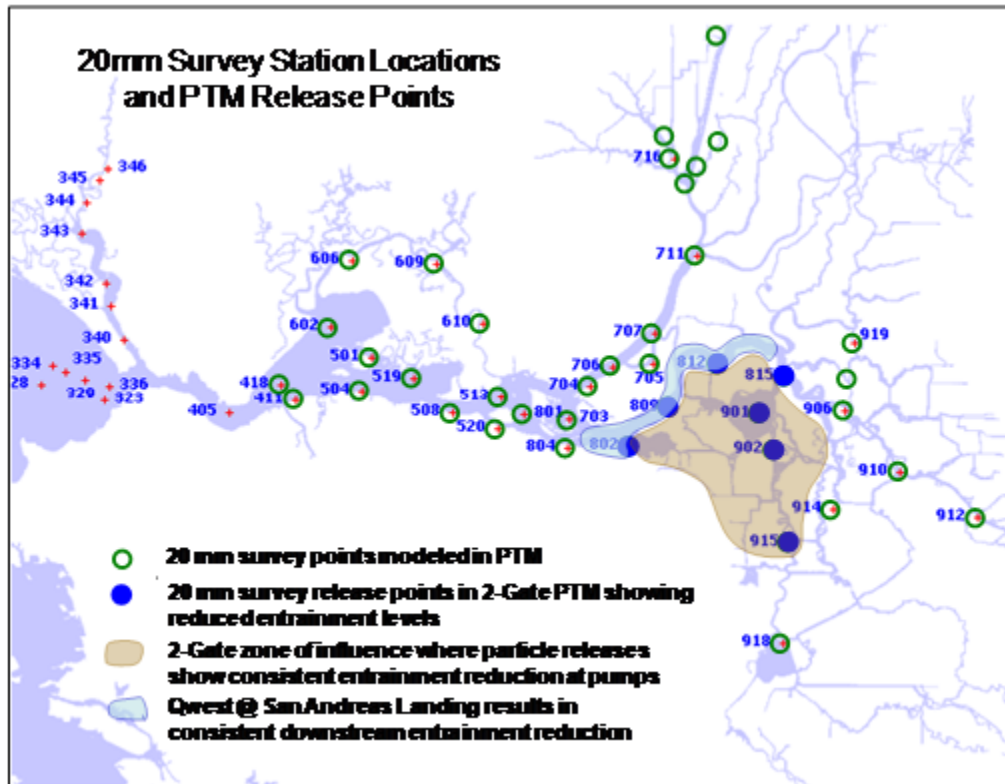


March through June (Juvenile Delta Smelt)

Hypothesis: Juvenile delta smelt are largely transported through the velocity fields of the water column (advection) and, while seeking desirable habitat, do not possess the strong capability to move significantly outside of the advective field. Their initial location is largely governed by the spawning areas of the adults. While it is desirable, for water export actions, to have spawning occur in the west Delta and upstream in the Sacramento River watershed, the location will be dependent on the effectiveness of the December through February operation.

Operation: Under this hypothesis, the 2-Gates facilities would be operated during the pre-Vernalis Adaptive Management Plan (VAMP) (March 1 – April 15) and post-VAMP (May 16 – June 30) periods, based on real-time monitoring of delta smelt densities, spawning areas, and bi-weekly predictive modeling to better ascertain the projected location of smelt.

- Based on the real-time monitoring of distribution and forecasted distribution of delta smelt, Qwest action and 2-Gates operations will not be taken if more than 80% of the delta smelt are to the west and north of the region of control of the 2-Gates facilities, as predicted the 2-D RMA Bay-Delta and RMA-PTRK particle tracking and the Bay Modeling post-processing models for juvenile and larvae delta smelt. These models would be used to forecast and recommend the most suitable near-term operations to reduce the possibility of entrainment.
- Based on the real-time monitoring of distribution and forecasted distribution of delta smelt, the Old River and Connection Slough gates would be operated and Qwest flows at San Andreas consistent with boundary conditions of OMR discretionary operations would be applied until the absence of larval and juvenile delta smelt are demonstrated by (1) less than 20% of delta smelt easterly of the San Joaquin River at Jersey Point, as projected by 20 mm surveys and model projections predicted through the 2-D RMA Bay-Delta and RMA-PTRK particle tracking and the Bay Modeling post-processing models for juvenile and larvae delta smelt, and (2) no delta smelt salvage for five consecutive days, indicating that they are not being drawn up Old River or otherwise moving into the area.
- Qwest management consistent with OCAP BO operations is designed to prevent transport of delta smelt or pre-spawning water quality factors up the mainstem of the San Joaquin River, while the 2-Gates operation simultaneously prevents the entrainment of delta smelt originating within the Franks Tract and Old River regions (see Figure 1).



The 2-Gates Project has the ability to assist water management agencies in meeting the objectives of the OCAP Biological Opinion and would compliment the actions by:

Controlling the Movement of Delta Smelt Pre-spawning Water Quality Factors into the South Delta

Under the proposed 2-Gates operating plan, operation of the gates during the winter period could reduce the potential for the turbidity and salinity regime that is used by smelt for pre-spawning movement from being drawn into the south Delta.

Reducing Entrainment at the SWP and CVP Export Facilities

The 2-Gates operation is likely to reduce juvenile delta smelt entrainment at the pumps under certain distributions. Within the region of control, the 2-Gates operation has been shown to significantly reduce particle entrainment.

Minimize Delta Smelt Distributions That Are Most Likely At Risk to Entrainment

The 2-Gates plan, if properly managed and integrated with Qwest consistent with OCAP BO OMR operations, could prevent significant distributions of juvenile delta smelt in the south Delta. Reducing the adult delta smelt movement into the south Delta, by managing movement of pre-spawning water quality factors, would trigger spawning further to the west and, integrated with 2-Gates operations in the spring, could reduce the potential for subsequent entrainment.

Specific 2-Gates Project protective measures associated with each OCAP Biological Option actions are identified in Table 1.

The 2-Gates Project serves as a tool for water management agencies to integrate with other actions to help reduce entrainment of delta smelt at the SWP and CVP export facilities. The project is being proposed as a pilot program to test hypotheses and provide insight into alternative management techniques for protection of delta smelt while having less impact on water exports.

Table 1 OCAP Biological Opinion Actions and Related 2-Gates Project Protective Measures (OCAP Baseline RMA Modeling)

OCAP Biological Opinion RPAs						
RPA Component	Action Number	Action	Timing	Triggers	Suspension of Action	Off-Ramps
1 Protection of the Adult Delta Smelt Life Stage	1 Designed to protect upmigrating delta smelt <u>Objective:</u> <ul style="list-style-type: none"> Protect pre-spawning adult delta smelt from entrainment during 1st flush Provide advantageous hydrodynamic conditions early in the migration period 	Step A Limit Exports so OMR Negative flows ≤ 2,000 cfs (14-day average) w/ 5-day running avg. ≤ 2,500 cfs (± 25%)	Step A Part A: Dec. 1 to Dec. 20 (Low-Entrainment Risk Period)	Step A <u>Turbidity:</u> 3-day avg. ≥ 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three) FWS discretion based on turbidity, flows, FMWT, and salvage		<u>Temperature:</u> 3 Station daily mean water temps. at Mossdale, Antioch & Rio Vista ≥ 12°C OR <u>Biological:</u> Onset of spawning (presence of spent females in SKT or at Banks or Jones)
		Step B Limit Exports so OMR Negative flows ≤ 2,000 cfs	Step B Part B: After Dec. 20 (High Entrainment Risk Period)	Step B Turbidity: 3-day avg. > 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three) OR Salvage: daily salvage index value > 0.5 (daily delta smelt salvage > 1/2 prior yr. FMWT index value)		Same as above
	2 Designed to protect adult delta smelt that have migrated upstream and are residing in the Delta prior to spawning <u>Objective:</u> Same as action 1 above	Step C Net daily OMR Negative flows ≥ 1,250 to 5,000 cfs (determined by SWG)	Step C Immediately after Action 1 If Action 1 not implemented, SWG will determine start date		Flow: 3 day Avg. Q on Sac. R. at Rio Vista > 9,000 cfs AND on San Joaquin R. at Vernalis > 10,000 cfs	Same as above
2 Protection of Larval & Juvenile Delta Smelt	3 Entrainment protection of larval smelt <u>Objective:</u> Minimize the number of larval delta smelt entrained at the CVP/SWP facilities	Step D Net daily OMR Negative flows ≥ 1,250 to 5,000 cfs based on a 14-day running avg. w/ 5-day running avg. ± 25% of required OMR	Step D (RMA modeling: likely continuous from adult actions; to be confirmed by trigger data) Initiate action when triggers met	Step D <u>Temperature:</u> 3 Station daily mean water temps. at Mossdale, Antioch & Rio Vista ≥ 12°C OR <u>Biological:</u> Onset of spawning (presence of spent females in SKT or at Banks or Jones)		<u>Temporal:</u> June 30 OR <u>Temperature:</u> daily avg. of 25°C for 3 consecutive days @ Clifton Court Forebay

Table 2 OCAP Biological Opinion Actions and Related 2-Gates Project Protective Measures (OCAP Baseline + 2-Gates Action)

RPA Component	Action Number and Combined Objectives	Action	Timing	Triggers	Suspension of RPA Action	Off-Ramps	Remarks
1 Protection of the Adult Delta Smelt Life Stage	1- Designed to protect upmigrating delta smelt <i>Objective:</i> Protect pre-spawning adult delta smelt from entrainment during 1st flush Provide advantageous hydrodynamic conditions early in the migration period 2-Gates Modeling ≤ OCAP BO salvage and maintain habitat west of gates	Step A OCAP Action: Limit Exports so negative OMR flows ≤ 2,000 cfs (14-day average) w/ 5-day running avg. ≤ 2,500 cfs (+ 25%) 2-Gates ACTION: Begin operating Gates ACTION: OMR operates in discretionary range (as determined by SWG).	Step A Part A: Dec. 1 to Dec. 20 (Low-Entrainment Risk Period)	Step A 1. Gates: Turbidity >12 NTU @ Jersey Pt. 2. OMR Alt: Turbidity >12 NTU @ Prisoners Pt. 3. OMR Alt: : Turbidity: 3-day avg. > 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three)		Temperature: 3 Station daily mean water temps. at Mossdale, Antioch & Rio Vista > 12°C OR Biological: Onset of spawning (presence of spent females in SKT or at TCFC or SFF)	Turbidity: Under the proposed 2-Gates operating plan, the gates would be operated during this period based on turbidity triggers at Jersey Pt. and Prisoner's Pt. RMA real-time adult smelt behavior model will be used to guide sophisticated operations of the 2-Gates. This 2-Gates operation could reduce the potential for the turbidity and salinity regime that is used by delta smelt from being drawn into the south Delta. Turbidity monitoring and action triggering based on Jersey Pt. and Prisoners Pt. may provide more proactive management of conditions in the south Delta. Spawning and Salvage: Reducing the adult delta smelt movement into the south Delta, by managing movement of water quality factors, would trigger spawning further to the west and reduce potential entrainment of adults
		Step B OCAP Limit Exports so negative OMR flows ≤ 2,000 cfs Optional Actions to influence smelt distribution - Options may include export cuts/DCC re-ops + 2-Gates Actions	Step B (RMA modeling: Part B continuous from Dec. 1-20 action) Part B: After Dec. 20 (High Entrainment Risk Period)	Step B 1. Gates: Turbidity >12 NTU @ Jersey Pt. 2. OMR Alt: Turbidity >12 NTU @ Prisoners Pt. 3. OMR Alt: Turbidity: 3-day avg. > 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three) OR Gates & OMR: Salvage: daily salvage index value > 0.5 (daily delta smelt salvage > 1/2 prior yr. FMWT index value)		Same as above	

Table 2 OCAP Biological Opinion Actions and Related 2-Gates Project Protective Measures (OCAP Baseline + 2-Gates Action)

RPA Component	Action Number and Combined Objectives	Action	Timing	Triggers	Suspension of RPA Action	Off-Ramps	Remarks
	<p>2 - Designed to protect adult delta smelt that have migrated upstream and are residing in the Delta prior to spawning</p> <p><i>Objective:</i></p> <p>Same as action 1 above</p>	<p>Step C</p> <p>Net daily negative OMR flows \leq 1,250 to 5,000 cfs (determined by SWG)</p> <p>Action: Gates operate when turbidity falls within or immediately west of their region of control: Turbidity >12 NTU @ Jersey Pt. OMR operates in discretionary range</p> <p>Optimized Actions:</p> <p>Options may include export cuts/DCC re-ops + 2-Gates Actions</p>	<p>Step C</p> <p>Immediately after Action 1</p> <p>If Action 1 not implemented, SWG will determine start date</p>	<p>Step C</p> <p>1. Gates: Turbidity >12 NTU @ Jersey Pt.</p> <p>2. OMR Alt: Turbidity >12 NTU @ Prisoners Pt.</p> <p>3. OMR Alt: Turbidity: 3-day avg. > 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three)</p> <p>OR</p> <p>Gates & OMR: Salvage: daily salvage index value > 0.5 (daily delta smelt salvage $> 1/2$ prior yr. FMWT index value)</p> <p>(net daily negative OMR flows \leq 1,250 to 5,000 cfs)</p>	<p>Step C</p> <p>Flow: 3 day Avg. flow on Sacramento River at Rio Vista $> 9,000$ cfs</p> <p>AND</p> <p>on San Joaquin R. at Vernalis $> 10,000$ cfs</p>	<p>Same as above</p>	<p>Migration: Proactive management of turbidity and salinity regime with 2-Gates operations may reduce the movement of water quality factors into the south Delta. Integration with QWEST management consistent with OMR controls would attempt to locate water quality factors to the west of Old and Middle Rivers</p> <p>Entrainment: The proposed action is expected to reduce entrainment with equivalent export water reduction or can achieve the same entrainment at lesser export water reduction. Under either condition the objective will be to place smelt and its water quality factors westerly of the gates.</p>

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RPA Component	Action Number and Combined Objectives	Action	Timing	Triggers	Suspension of RPA Action	Off-Ramps	Remarks
2 Protection of Larval & Juvenile Delta Smelt	3 - Entrainment protection of larval smelt <i>Objective:</i> Minimize the number of larval delta smelt entrained at the CVP/SWP facilities	Step D Net daily negative OMR flows ≤ 1,250 to 5,000 cfs based on a 14-day running avg. w/ 5-day running avg. + 25% of required OMR Action: Gates operate and OMR operates in discretionary range Optimized Actions: Options may include export cuts/DCC re-ops + 2-Gates Actions	Step D Initiate action when triggers met	Step D Temperature: 3-station daily mean water temps. at Mossdale, Antioch & RV > 12°C OR Biological: Onset of spawning (presence of spent females in SKT or at TCFC or SFF) (net daily negative OMR flows ≤ 1,250 to 5,000 cfs)		Temporal: June 30 OR Temperature: daily avg. of 25°C for 3 consecutive days @ Clifton Court Forebay	Entrainment: The 2-Gates operation is likely to reduce juvenile smelt salvage at the pumps under certain distributions. Within the region of direct control, the 2-Gates operation has been shown to reduce particle entrainment. Salvage: Reducing the adult smelt movement into the south Delta, by managing movement of water quality factors, would trigger spawning further to the west and, if properly managed and integrated with QWEST consistent with OMR controls, the 2-Gates could reduce the extent and timing of initial salvage.

OCAP Biological Opinion RPAs

2-Gate Fish Protection Measures

RPA Component	Action Number	Action	Timing	Triggers	Suspension of Action	Off-Ramps	Triggers	Suspension of Action	Remarks
1 Protection of the Adult Delta Smelt Life Stage	1 <i>Objective:</i> Designed to protect upmigrating delta smelt Protect pre-spawning adult delta smelt from entrainment during 1 st flush Provide advantageous hydrodynamic conditions early in	Step A Limit Exports so OMR Negative flows ≤ 2,000 cfs (14-day average) w/ 5-day running avg. ≤ 2,500 cfs (+ 25%)	Step A Part A: Dec. 1 to Dec. 20 (Low-Entrainment Risk Period)	Step A <i>Turbidity:</i> 3-day avg. ≥ 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three) FWS discretion based on turbidity, flows, FMWT, and salvage	Step A <i>Adult Smelt Distribution</i> w/ gates is west & north of region of control. <i>Salinity/Turbidity</i> w/ gates abated west/no. of region of control.	<i>Temperature:</i> 3 Station daily mean water temps. at Mossdale, Antioch & Rio Vista ≥ 12°C OR <i>Biological:</i> Onset of spawning (presence of spent females in SKT or at Banks or Jones)	Step A & B <i>Action:</i> Gates operate when turbidity falls within or immediately west of their region of control: Turbidity >12 NTU @ Jersey Pt. OMR operates in discretionary range with turbidity >12 NTU @ Prisoners Pt. <i>Optimized Actions:</i> Options may include	Step A <i>Adult Smelt Distribution</i> w/ gates is west & north of region of control. <i>Salinity/Turbidity</i> w/ gates abated west/no. of region of control.	<i>Turbidity:</i> Under the proposed 2-Gates operating plan, the gates would be operated during this period based on turbidity triggers at Jersey Pt. and Prisoner's Pt. RMA real-time adult smelt behavior model will be used to guide sophisticated operations of the 2-Gates. This 2-Gates operation could reduce the potential for the turbidity and salinity regime that is used by delta smelt from being drawn into the south Delta. Turbidity

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RPA Component	Action Number and Combined Objectives	Action	Timing	Triggers	Suspension of RPA Action	Off-Ramps	Remarks		
	the migration period <u>RMA Modeling</u> ≤ OCAP BO salvage and maintain habitat west of gates	Step B Limit Exports so OMR Negative flows ≤ 2,000 cfs	Step B (RMA modeling: Part B continuous from Dec.1-20 action) Part B: After Dec. 20 (High Entrainment Risk Period)	Step B Turbidity: 3-day avg. > 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three) OR Salvage: daily salvage index value > 0.5 (daily delta smelt salvage > 1/2 prior yr. FMWT index value)	Step B Adult Smelt Distribution w/ gates is west & north of region of control. Salinity/Turbidity w/ gates abated west/no. of region of control.	Same as above	export cuts/DCC re-ops + 2-Gates Actions		monitoring and action triggering based on Jersey Pt. and Prisoners Pt. may provide more proactive management of conditions in the south Delta. <u>Spawning and Salvage:</u> Reducing the adult delta smelt movement into the south Delta, by managing movement of water quality factors, would trigger spawning further to the west and reduce potential entrainment of adults
	2 Designed to protect adult delta smelt that have migrated upstream and are residing in the Delta prior to spawning <u>Objective:</u> Same as action 1 above	Step C Net daily OMR Negative flows ≥ 1,250 to 5,000 cfs (determined by SWG)	Step C (RMA modeling: ~Jan 1; confirm w/ R. Sitts for modeling purposes) Immediately after Action 1 If Action 1 not implemented, SWG will determine start date	Step C Turbidity: 3-day avg. > 12 NTU @ Prisoner's Pt., Holland Cut & Victoria Canal (all three) <					

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RPA Component	Action Number and Combined Objectives	Action	Timing	Triggers	Suspension of RPA Action	Off-Ramps	Remarks
2 Protection of Larval & Juvenile Delta Smelt	3 Entrainment protection of larval smelt <u>Objective:</u> Minimize the number of larval delta smelt entrained at the CVP/SWP facilities	Step D Net daily OMR Negative flows $\geq 1,250$ to 5,000 cfs based on a 14-day running avg. w/ 5-day running avg. $\pm 25\%$ of required OMR	Step D (RMA modeling: likely continuous from adult actions; to be confirmed by trigger data) Initiate action when triggers met	Step D <u>Larvae/ Juvenile Distribution:</u> $>20\%$ smelt within region of control. <u>Temperature:</u> 3 sta. daily mean water temps. at Mossd., Antioch & RV $\geq 12^{\circ}\text{C}$ OR <u>Biological:</u> Onset of spawning (presence of spent females in SKT or at Banks or Jones	Step D <u>Larvae/ Juvenile Smelt Distribution:</u> $>80\%$ smelt consistently west & north of region of control.	<u>Temporal:</u> June 30 OR <u>Temperature:</u> daily avg. of 25°C for 3 consecutive days @ Clifton Court Forebay <u>Action:</u> Gates operate and OMR operates in discretionary range (net daily OMR flows $\geq -1,250$ to - 5,000 cfs) when more than 20% of the distribution and predicted distribution of Delta smelt fall within gates region of control. <u>Optimized Actions:</u> Options may include export cuts/DCC re-ops + 2-Gates Actions	Step D <u>Larvae/ Juvenile Smelt Distribution:</u> $>80\%$ smelt consistently west & north of region of control. <u>Entrainment:</u> The 2-Gates operation is likely to reduce juvenile smelt salvage at the pumps under certain distributions. Within the region of direct control, the 2-Gates operation has been shown to reduce particle entrainment. <u>Salvage:</u> Reducing the adult smelt movement into the south Delta, by managing movement of water quality factors, would trigger spawning further to the west and, if properly managed and integrated with Qwest consistent with OMR controls, the 2-Gates could reduce the extent and timing of initial salvage.