



United States Department of the Interior



FISH AND WILDLIFE SERVICE

California and Nevada Region
2800 Cottage Way, Room W-2606
Sacramento, California 95825-1846

In reply refer to:
81420-2008-F-1481-5

Memorandum

To: Operation Manager, Bureau of Reclamation, Central Valley Operations Office
Sacramento, California

From: Regional Director, Fish and Wildlife Service, Region 8, Sacramento, California

Subject: Formal Endangered Species Act Consultation on the Proposed Coordinated
Operations of the Central Valley Project (CVP) and State Water Project (SWP)

This is in response to the Bureau of Reclamation's (Reclamation) May 16, 2008, request for formal consultation with the Fish and Wildlife Service (Service) on the coordinated operations of the CVP and SWP in California. Reclamation is the lead Federal agency and the California Department of Water Resources (DWR) is the Applicant for this consultation. Your revised biological assessment was received in our office on August 20, 2008. This document represents the Service's biological opinion on the effects of the subject action to the threatened delta smelt (*Hypomesus transpacificus*) and its designated critical habitat. This response is provided in accordance with the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Reclamation also requested consultation on the effects of the proposed action on the endangered riparian brush rabbit (*Sylvilagus bachmani riparius*), endangered riparian woodrat (*Neotoma fuscipes riparia*), endangered salt marsh harvest mouse (*Reithrodontomys raviventris*), endangered California clapper rail (*Rallus longirostris obsoletus*), threatened giant garter snake (*Thamnophis gigas*), threatened California red-legged frog (*Rana aurora draytonii*), threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), endangered soft bird's-beak (*Cordylanthus mollis ssp. Mollis*), and the endangered Suisun thistle (*Cirsium hydrophilum var. hydrophilum*). Reclamation determined that the proposed continued operations of the CVP and SWP are not likely to adversely affect these listed species. The Service concurs with Reclamation's determination that the coordinated operations of the CVP and SWP are not likely to adversely affect these species.

The Service conducted a comprehensive peer review of this biological opinion. We formed an Internal Peer Review Team (IPRT), which consisted of individuals from throughout the Service who are experts in the development of complex biological opinions under the ESA. The IPRT reviewed the biological opinion and provided substantive input and comments. Additionally, the Service assembled a team of delta smelt experts from within the Service, California Department

of Fish and Game, Environmental Protection Agency, Reclamation and other academics to provide scientific and technical expertise into the review of the biological assessment and the development of the biological opinion. The Service also contracted with PBS&J, an environmental consulting firm, who formed an independent review team consisting of experts on aquatic ecology and fishery biology to conduct a concurrent review of the draft Effects Section of the biological opinion at the same that we provided the Effects Section to Reclamation and DWR for their review. The Service received the results of the independent review of the draft Effects Section on October 23, 2008; DWR and Reclamation provided the results of their review on October 24, 2008. The Service modified the Effects Section of the biological opinion, as appropriate, based on the comments received from the IPRT, the independent review team, Reclamation and DWR. The Service also contracted with PBS&J to conduct an independent review of the draft Actions (Final shown in Attachment B), as well as a review of DWR's proposed actions. The Service simultaneously provided the draft Actions to Reclamation and DWR for their review. The Service received Reclamation's and DWR's comments on the draft Actions on November 5, 2008. The Service received the results of the independent review of both the Service's and DWR's draft Actions on November 19, 2008. The Service's actions were then modified to respond to comments from the independent review team and in consideration of comments received from DWR. A draft biological opinion was provided to Reclamation on November 21, 2008. Comments were received back from Reclamation and DWR on December 2, 2008. The Service has incorporated all comments and edits, as appropriate, into this biological opinion.

This biological opinion is based on information provided in Reclamation's biological assessment dated August 20, 2008, associated appendices, and input from the various internal and external review processes that the Service has utilized in this consultation, described immediately above. A complete administrative record is on file at the Sacramento Fish and Wildlife Office (SFWO).

Consultation History

July 30, 2004	The Service issued a biological opinion addressing <i>Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operations Criteria and Plan to Address Potential Critical Habitat Issues</i> (Service file # 1-1-04-F-0140).
February 15, 2005	The Department of the Interior is sued on the July 30, 2004 biological opinion.
February 16, 2005	The Service issued its <i>Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues</i> (Service file # 1-1-05-F-0055).
May 20, 2005	The Department of the Interior is sued on the February 16, 2005 biological opinion.
February 2006 through September 2008	Staff from the California Department of Fish and Game (DFG), DWR, National Marine Fisheries Service (NMFS), Reclamation, and the Service (OCAP Working Team) met monthly to bi-weekly to discuss the development of the biological assessment.
July 6, 2006	Reclamation requested informal consultation on coordinated operations of the CVP and SWP and their effects to delta smelt.
May 25, 2007	Judge Wanger issued a summary judgment that invalidated the 2005 biological opinion and ordered a new biological opinion be developed by September 15, 2008.
May 31, 2007	The Service provided Reclamation with guidance and recommendations concerning the project description used in the 2004 biological opinion.
August 20, 2007	The Service provided a memorandum to Reclamation containing a species list for the proposed action and clarification of the formal consultation timeline.
October 29, 2007	The Service received an electronic version of the draft project description for the biological assessment (Chapter 2) dated August 2007.
December 4, 2007	DFG, NMFS, and the Service received a draft project description dated December 4, 2007.

December 6, 2007	DFG, NMFS, and the Service provided Reclamation with joint preliminary guidance and recommendations for part of the draft project description of CVP operations received on December 4, 2007.
December 14, 2007	Judge Wanger issued an interim order to direct actions at the export facilities to protect delta smelt until a new biological opinion is completed.
December 20, 2007	DFG, NMFS, and the Service provided Reclamation with joint preliminary guidance and recommendations for parts of the draft project description of SWP operations received on December 4, 2007.
January 17, 2008	DFG, NMFS, and the Service provided Reclamation with joint preliminary guidance and recommendations for the remaining portion of the draft project description received on December 4, 2007.
January 21, 2008	The Service sent to Reclamation an electronic version of the entire draft project description with guidance and recommendations developed jointly by DFG, NMFS, and the Service.
January 22, 2008	Reclamation provided DFG, NMFS and the Service with an electronic version of the description of operations of the Suisun Marsh Salinity Control Gates (SMSCG) dated August 2007.
January 23, 2008	DFG, NMFS, and the Service provided DWR with joint preliminary guidance and recommendations on the December 4, 2007, draft project description.
March 4, 2008	The Service provided DWR with joint DFG and Service guidance and recommendations for the August 2007 version of the proposed Suisun Marsh Salinity Control Gate (SMSCG) operations description.
March 6, 2008	DWR provided the Service with an updated description of proposed operations of the SMSCG.
March 10, 2008	The Service received a draft description and effects analysis of aquatic weed management in Clifton Court Forebay.
March 24, 2008	DFG, NMFS, and the Service provided Reclamation with guidance and recommendations on the aquatic weed management section of the biological assessment.
April 21, 2008	Reclamation provided the Service with a revised draft project description for the biological assessment.

April 28 through May 2, 2008	Reclamation conducted an external technical review of their draft biological assessment.
May 2008 through December 2008	Numerous meeting between the Service, Reclamation, DWR, DFG and NMFS on the development of the biological assessment and the biological opinion.
May 8, 2008	The fisheries agencies provided Reclamation and DWR with guidance and recommendations on the draft project description dated April 21, 2008.
May 16, 2008	The Service received a letter from Reclamation dated May 16, 2008, requesting formal consultation on the proposed action. A biological assessment also dated May 16, 2008, was enclosed with the letter.
May 17, 2008	Reclamation provided the Service with a number of revisions and addenda to the May 16, 2008 biological assessment.
May 28, 2008	Reclamation and DWR provided the Service with additional revisions to the May 16, 2008 biological assessment.
May 29, 2008	The Service sent a memo to Reclamation stating that with the revisions provided on May 28, 2008, the Service had received enough information to start the 30-day review period.
June 27, 2008	The Service provided Reclamation with a memo requesting additional information.
July 2, 2008	The Service received a memorandum from Reclamation informing the Service that Reclamation is committed to providing a response to the Services' June 27, 2008, request for additional information by early August, 2008.
August 11, 2008	The Service received Reclamation's August 8, 2008, letter transmitting the revised biological assessment.
August 20, 2008	The Service received the revised biological assessment on electronically from Reclamation.
August 29, 2008	Judge Wanger extended the completion date for the coordination of the CVP and SWP biological opinion to December 15, 2008.
September 25, 2008	The Service received a letter dated September 24, 2008 from the San Luis & Delta-Mendota Water Authority and the State Water Contractors, which provided comments on the biological assessment.
October 17, 2008	The Service received DWR's October 16, 2008 draft conservation actions.

October 17 through 24, 2008	Review of the draft Effects section of the biological opinion by the Service’s Internal Peer Review Team (IPRT).
October 17 through 24, 2008	Independent Review of the draft Effects section of the biological opinion conducted by PBS&J.
October 23, 2008	The Service received a letter dated October 20, 2008 from the San Luis & Delta-Mendota Water Authority and the State Water Contractors, which provided comments on fall X2.
October 24, 2008	The Service received comments from Reclamation and DWR on the draft Effects section.
October 24 through November 19, 2008	Review of entire preliminary draft biological opinion by IPRT.
October 24 through November 19, 2008	Independent Review of the Service’s draft conservation actions and DWR’s draft conservation actions conducted by PBS&J. The Service’s draft actions were also submitted to Reclamation.
November 21, 2008	The Service transmitted the draft biological opinion to Reclamation.
November 24, 2008	The Service received a letter dated November 19, 2008 from the San Luis & Delta-Mendota Water Authority and the State Water Contractors, which provided comments on the Effects section and the review conducted by PBS&J.
December 2, 2008	The Service received comments from Reclamation and DWR on the draft biological opinion.

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Project Description

The proposed action is the continued long-term operation of the CVP and SWP. The proposed action includes the operation of the temporary barriers project in the South Delta and the 500 cubic feet per second (cfs) increase in SWP Delta export limit from July through September. In addition to current day operations, several other actions are included in this consultation. These actions are: (1) an intertie between the California Aqueduct (CA) and the Delta-Mendota Canal (DMC), (2) Freeport Regional Water Project (FRWP), (3) the operation of permanent gates that will replace the temporary barriers in the South Delta, (4) changes in the operation of the Red Bluff Diversion Dam (RBDD), and (5) Alternative Intake Project for the Contra Costa Water District (CCWD). A detailed summary of all operational components and associated modeling assumptions are included in the biological assessment in Chapter 9.

Table P-1 Assumptions for the Base and Future Studies

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	OCAP BA 2004 Today CVPIA 3406 (b)(2) with EWA	Today-OCAP BA 2004 Assumptions in Revised CalSim-II Model - EWA	Today-OCAP BA 2004 Assumptions in Revised CalSim-II Model - CVPIA (b)(2) - CONV	Today- Existing Conditions, (b)(2), EWA	Near Future- Existing Conditions and OCAP BA 2004 Consulted Projects, (b)(2), Limited EWA	Future - (b)(2), Limited EWA	Future Climate Change- D1641	Model Revision s since OCAP BA 2004
OCAP Base model: Common Assumptions: Common Model Package (Version 8D)								
<i>"Same" indicates an assumption from a column to the left</i>								
Planning horizon	2001	2005 ^a	Same	Same	Same	2030 ^a	Same	
Period of Simulation	73 years (1922-1994)	82 years (1922- 2003)	Same	Same	Same	Same	Same	Extended hydrolog y timeserie s
HYDROLOGY							Inflows are modified based on alternative climate inputs ^b	Revised level of detail in the Yuba and Colusa Basin including rice decompo sition operation s
Level of development (Land Use)	2001 Level	2005 level	Same	Same	Same	2030 level ^c	Same	
Sacramento Valley (excluding American R.)	CVP	Land-use based, limited by contract amounts ^d	Same	Same	Same	Same	CVP Land-use based, Full build out of CVP contract amounts ^d	Same

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
	SWP (FRSA)	Land-use based, limited by contract amounts ^e	Same	Same	Same	Same	Same	Same	
	Non-project	Land-use based	Same	Same	Same	Same	Same	Same	
	Federal refuges	Firm Level 2	Same	Same	Recent Historical Firm Level 2 water needs ^f	Same	Firm Level 2 water needs ^f	Same	
American River	Water rights	2001 ^g	Same	Same	2005 ^g	Same	2025 ^g	Same	
	CVP (PCWA American River Pump Station)	No project	Same	Same	CVP (PCWA modified) ^g	Same	Same	Same	
San Joaquin River^h	Friant Unit	Regression of Historical Demands	Limited by contract amounts, based on current allocation policy	Same	Same	Same	Same	Same	Developed land-use based demands, water quality calculations, and revised accretions/depletions in the East-Side San Joaquin Valley
	Lower Basin	Fixed Annual Demands	Land-use based, based on district level operations and constraints	Same	Same	Same	Same	Same	
	Stanislaus River	New Melones Interim Operations Plan	Same	Same	Same	Draft Transitional Operations Plan ⁱ	Same	Same	Initial storage conditions for New Melones Reservoir were

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
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increase
d.

South of Delta

(CVP/SWP project facilities)	CVP Demand based on contracts amounts ^d	Same	Same	Same	Same	Same	Same	
Contra Costa Water District	124 TAF/yr annual average	135 TAF/yr annual average CVP contract supply and water rights ⁱ	Same	Same	Same	195 TAF/yr annual average CVP contract supply and water rights ⁱ	Same	
SWP Demand - Table A	Variable 3.1-4.1 MAF/Yr	Same	Same	Variable 3.1-4.2 MAF/Yr ^{e,j}	Same	Full Table A	Same	Revised SWP delivery logic. Three patterns with Art 56 and more accurately defined Table A / Article 21 split modeled
SWP Demand - North Bay Aqueduct (Table A)	48 TAF/Yr	Same	Same	71 TAF/Yr ^u	Same	Same	Same	
SWP Demand - Article 21 demand	Up to 134 TAF/month December to March, total of other demands up to 84 TAF/month in all months	Same	Same	Up to 314 TAF/month from December to March, total of demands up to 214 TAF/month in all other months ^{e,j,w}	Same	Same	Same	

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Federal refuges	Firm Level 2	Same	Same	Recent Historical Firm Level 2 water needs ^f	Same	Firm Level 2 water needs ^f	Same	
FACILITIES								
Systemwide	Existing facilities ^a	Same	Same	Same	Same	Same	Same	
Sacramento Valley								
Red Bluff Diversion Dam	No diversion constraint	Same	Same	Diversion Dam operated May 15 - Sept 15 (diversion constraint)	Same	Diversion Dam operated July - August (diversion constraint)	Same	
Colusa Basin	Existing conveyance and storage facilities	Same	Same	Same	Same	Same	Same	
Upper American River	No project	Same	Same	PCWA American River pump station ^k	Same	Same	Same	
Sacramento River Water Reliability	No project	Same	Same	Same	Same	American/Sacra mento River Diversions ^l	Same	
Lower Sacramento River	No project	Same	Same	Same	Freeport Regional Water Project (Full Demand) ^l	Same	Same	
Delta Region								
SWP Banks Pumping Plant	South Delta Improvements Program Temporary Barriers, 6,680 cfs capacity in all months and an additional 1/3 of Vernalis flow from Dec 15 through Mar 15 ^a	Same	Same	Same	South Delta Improvements Program Permanent Operable Gates (Stage 1). 6,680 cfs capacity in all months and an additional 1/3 of Vernalis flow from Dec 15 through	Same	Same	

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
					Mar 15 ^a			
	CVP C.W. Bill Jones (Tracy) Pumping Plant	4,200 cfs + deliveries upstream of DMC constriction	Same	Same	Same	4,600 cfs capacity in all months (allowed for by the Delta-Mendota Canal-California Aqueduct Intertie)	Same	Same
	City of Stockton Delta Water Supply Project (DWSP)	No project	Same	Same	DWSP WTP 0 mgd	Same	DWSP WTP 30 mgd	Same
	Contra Costa Water District	Existing pump locations	Same	Same	Same	Same	Same ^m	Same
South of Delta (CVP/SWP project facilities)								
	South Bay Aqueduct (SBA)	Existing capacity 300 cfs	Same	Same	SBA Rehabilitation: 430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point	Same	Same	Same
REGULATORY STANDARDS								
Trinity River								
	Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/year)	Same	Same	Same	Same	Same	Same

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Clear Creek	Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same	Same	Same	Same	Same	
	Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to USFWS and NPS, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	
Upper Sacramento River	Shasta Lake	NMFS 2004 BO: 1.9 MAF end of Sep. storage target in non-critical years	Same	Same	Same	Same	Same	Same	
	Minimum flow below Keswick Dam	Flows for SWRCB WR 90-5 temperature control, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	
Feather River	Minimum flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 cfs)	Same	Same	Same	2006 Settlement Agreement (700 / 800 cfs)	Same	Same	
	Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1,700 cfs)	Same	Same	Same	Same	Same	Same	
Yuba River									

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
American River	Minimum flow below Daguerre Point Dam	Available Yuba River Data ^p	D-1644 Interim Operations ^p	Same	Yuba Accord Adjusted Data ^p	Same	Same	Same	
	Minimum flow below Nimbus Dam	SWRCB D-893 (see Operations Criteria), and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	(b)(2) Minimum Instream Flow management ^t	Same	American River Flow Management ^s	Same	
Lower Sacramento River	Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same	Same	Same	Same	Same	
	Minimum flow near Rio Vista	SWRCB D-1641	Same	Same	Same	Same	Same	Same	
Mokelumne River	Minimum flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 cfs)	Same	Same	Same	Same	Same	Same	
	Minimum flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	Same	Same	Same	Same	Same	Same	
Stanislaus River	Minimum flow below Goodwin Dam	1987 USBR, DFG agreement, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	
	Minimum dissolved oxygen	SWRCB D-1422	Same	Same	Same	Same	Same	Same	
Merced River									

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Tuolumne River	Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), Cowell Agreement	Same	Same	Same	Same	Same	Same	
	Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	Same	Same	Same	Same	Same	Same	
San Joaquin River	Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/year)	Same	Same	Same	Same	Same	Same	
	Maximum salinity near Vernalis	SWRCB D-1641	Same	Same	Same	Same	Same	Same	
Sacramento River–San Joaquin River Delta	Minimum flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Plan per San Joaquin River Agreement	Same	Same	Same	Same	Same	Same	
	Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	Same	Same	Same	Same	Same	Same	Revised Delta ANN (salinity estimation) ^v
	Delta Cross Channel gate operation	SWRCB D-1641	Same	Same	Same	Same	Same	Same	
	Delta exports	SWRCB D-1641, USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same	Same	Same	Same	

OPERATIONS CRITERIA: RIVER-SPECIFIC

Upper Sacramento River

		Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
American River	Flow objective for navigation (Wilkins Slough)	3,250 - 5,000 cfs based on CVP water supply condition	Same	Same	Same	Same	Same	Same	
	Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same	Same	Same	Same	Same	Same	
	Flow below Nimbus Dam	Discretionary operations criteria corresponding to SWRCB D-893 required minimum flow	Same	Same	(b)(2) Minimum Instream Flow management ^t	Same	American River Flow Management ^s	Same	
	Sacramento Area Water Forum "Replacement" Water	"Replacement" water is not implemented	Same	Same	Same	Same	Same	Same	
Stanislaus River	Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same	Draft Transitional Operations Plan ^r	Same	Same	
San Joaquin River	Flow at Vernalis	D1641	Same	Same	Same	Same	Same ^q	Same	
OPERATIONS CRITERIA: SYSTEMWIDE									
CVP water allocation									
	CVP Settlement and Exchange	100% (75% in Shasta critical years)	Same	Same	Same	Same	Same	Same	
	CVP refuges	100% (75% in Shasta critical years)	Same	Same	Same	Same	Same	Same	

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
CVP agriculture	100%-0% based on supply (South-of-Delta allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same	Same	Same	Same	Same	Same	
CVP municipal & industrial	100%-50% based on supply (South-of-Delta allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same	Same	Same	Same	Same	Same	
SWP water allocation								
North of Delta (FRSA)	Contract specific	Same	Same	Same	Same	Same	Same	
South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement	Same	Same	Same	Same	Same	Same	
CVP-SWP coordinated operations								

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Sharing of responsibility for in-basin-use	1986 Coordinated Operations Agreement (FRWP EBMUD and 2/3 of the North Bay Aqueduct diversions are considered as Delta Export, 1/3 of the North Bay Aqueduct diversion is considered as in-basin-use)	Same	Same	Same	Same	Same	Same	
Sharing of surplus flows	1986 Coordinated Operations Agreement	Same	Same	Same	Same	Same	Same	
Sharing of Export/Inflow Ratio	Equal sharing of export capacity under SWRCB D-1641; use of CVPIA 3406(b)(2) restricts only CVP and/or SWP exports	Same	Same	Same	Same	Same	Same	
Sharing of export capacity for lesser priority and wheeling related pumping	Cross Valley Canal wheeling (max of 128 TAF/year), CALFED ROD defined Joint Point of Diversion (JPOD)	Same	Same	Same	Same	Same	Same	
Study assumptions from above apply		Study 6a	Study 7a	Study 7a	Study 7.1a	Study 8a	NA	

CVPIA 3406(b)(2): Per May 2003 Dept. of Interior

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Decision								
Allocation	800 TAF, 700 TAF in 40-30-30 dry years, and 600 TAF in 40-30-30 critical years ⁿ	Same	Same	Same	Same	Same	NA	
Study assumptions from above apply		Study 6b	Study 7b	Study 7b	Study 7.1b	Study 8b	NA	
CALFED Environmental Water Account / Limited Environmental Water Account								
Actions	Dec-Feb reduce total exports by 50 TAF/mon relative to total exports without EWA; VAMP (Apr 15 - May 16) export restriction on SWP; Post (May 16-31) VAMP export restriction on SWP and potentially on CVP if B2 Post-VAMP action is not taken; Ramping of exports (Jun)	Dec/Jan 50 TAF/mon export reduction, Feb 50 TAF export reduction in Wet/AN years, Feb/Mar 100, 75, or 50 TAF reduction dependent on species habitat conditions; VAMP (Apr 15 - May 16) export restriction on SWP; Pre (Apr 1-14) VAMP export reduction in Dry/Crit years; Post (May 16-31) export restriction; June ramping restriction if PostVAMP action was done. Pre- and Post-VAMP and June actions done if foreseeable October debt at San Luis does not exceed 150 TAF.	NA	Same	VAMP (Apr 15 - May 16) 31-day export restriction on SWP; If stored assets and purchases from the Yuba are sufficient, Post (May 16-31) VAMP export restrictions apply to SWP ^{PQ}	Same	NA	The EWA actions, assets, and debt were revised and vetted as part of the Long Term Environmental Water Account EIS/R project

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Assets	Fixed Water Purchases 250 TAF/yr, 230 TAF/yr in 40-30-30 dry years, 210 TAF/yr in 40-30-30 critical years. The purchases range from 0 TAF in Wet years to approximately 153 TAF in Critical years NOD, and 57 TAF in Critical years to 250 TAF in Wet years SOD. Variable assets include the following: use of 50% of any CVPIA 3406(b)(2) releases pumped by SWP, flexing of Delta E/I Ratio (post-processed from CalSim-II results), additional 500 CFS pumping capacity at Banks in Jul-Sep	Fixed Water Purchases 250 TAF/yr, 230 TAF/yr in 40-30-30 dry years, 210 TAF/yr in 40-30-30 critical years. NOD share of annual purchase target ranges from 90% to 50% based on SWP Ag Allocation as an indicator of conveyance capacity. Variable/operational assets include use of 50% of any CVPIA 3406(b)(2) releases pumped by SWP, additional 500 CFS pumping capacity at Banks in Jul-Sep, source shifting, Semitropic Groundwater Bank, "spill" of San Luis carryover debt, and backed-up stored water from Spring EWA actions.	NA	Same	Purchase of Yuba River stored water under the Lower Yuba River Accord (average of 48 TAF/yr), use of 50% of any CVPIA 3406 (b)(2) releases pumped by SWP, additional 500 CFS pumping capacity at Banks in Jul-Sep.	Same	NA	

	Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
Debt	Delivery debt paid back in full upon assessment; Storage debt paid back over time based on asset/action priorities; SOD and NOD debt carryover is explicitly managed or spilled; NOD debt carryover must be spilled; SOD and NOD asset carryover is allowed	Same	NA	Same	No Carryover Debt	Same	NA	

Post Processing Assumptions

WATER MANAGEMENT ACTIONS (CALFED)

Water Transfers

Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users	Same	NA	Same	Same	Same	Same	NA
Phase 8 ^o	Evaluate available capacity	Same	NA	Same	Same	Same	Same	
Refuge Level 4 water	Evaluate available capacity	Same	NA	Same	Same	Same	Same	

Notes:

Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
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^a The OCAP BA project description is presented in Chapter 2.

^b Climate change sensitivity analysis assumptions and documentation are presented in Appendix R.

^c The Sacramento Valley hydrology used in the CALSIM II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of 2030 land-use assumptions are being coordinated with the California Water Plan Update for future models.

^d CVP contract amounts have been reviewed and updated according to existing and amended contracts as appropriate. Assumptions regarding CVP agricultural and M&I service contracts and Settlement Contract amounts are documented in Table 3A (North of Delta) and 5A (South of Delta) of Appendix D: Delivery Specifications section of the Technical Appendix.

^e SWP contract amounts have been reviewed and updated as appropriate. Assumptions regarding SWP agricultural and M&I contract amounts are documented in Table 1A (North of Delta) and Table 2A (South of Delta) of Appendix D: Delivery Specifications section.

^f Water needs for federal refuges have been reviewed and updated as appropriate. Assumptions regarding firm Level 2 refuge water needs are documented in Table 3A (North of Delta) and 5A (South of Delta) of Appendix D: Delivery Specifications. Incremental Level 4 refuge water needs have been documented as part of the assumptions of future water transfers.

^g PCWA demand in the foreseeable existing condition is 8.5 TAF/yr of CVP contract supply diverted at the new American River PCWA Pump Station. In the future scenario, PCWA is allowed 35 TAF/yr. Assumptions regarding American River water rights and CVP contracts are documented in Table 5 of Appendix D: Delivery Specifications section.

^h The new CalSim-II representation of the San Joaquin River has been included in this model package (CalSim-II San Joaquin River Model, Reclamation, 2005). Updates to the San Joaquin River have been included since the preliminary model release in August 2005. The model reflects the difficulties of on-going groundwater overdraft problems. The 2030 level of development representation of the San Joaquin River Basin does not make any attempt to offer solutions to on-going groundwater overdraft problems. In addition, a dynamic groundwater simulation is not yet developed for San Joaquin River Valley. Groundwater extraction/ recharge and stream-groundwater interaction are static assumptions and may not accurately reflect a response to simulated actions. These limitations should be considered in the analysis of results.

ⁱ Study 6.0 demands for CCWD are assumed equal to Study 7.0 due to data availability with the revised CalSim-II model framework. For all Studies, Los Vaqueros Reservoir storage capacity is 100 TAF.

Study 3a	Study 6.0 COMPARISON	Study 6.1 COMPARISON	Study 7.0 BASE MODEL	Study 7.1 ANALYTICAL	Study 8.0 ANALYTICAL	Study 9.0 - 9.5 SENSITIVITY	CalSim-II
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^j Table A deliveries into the San Francisco Bay Area Region for existing cases are based on a variable demand and a full Table A for future cases. The variable demand is dependent on the availability of other water during wet years resulting in less demand for Table A. In the future cases it is assumed that the demand for full Table A will be independent of other water sources. Article 21 demand assumes MWD demand of 100 TAF/mon (Dec-Mar), Kern demand of 180 TAF/mon (Jan-Dec), and other contractor demand of 34 TAF/mon (Jan-Dec).

^k PCWA American River pumping facility upstream of Folsom Lake is under construction.

^l Mokelumne River flows reflect EBMUD supplies associated with the Freeport Regional Water Project.

^m The CCWD Alternate Intake Project (AIP), an intake at Victoria Canal, which operates as an alternate Delta diversion for Los Vaqueros Reservoir is not included in Study 8.0. AIP is included as a separate consultation. AIP will be further evaluated after regulatory and operational management assumptions have been determined.

ⁿ The allocation representation in CalSim-II replicates key processes, shortage changes are checked by post-processing.

^o This Phase 8 requirement is assumed to be met through Sacramento Valley Water Management Agreement Implementation.

^p OCAP BA 2004 modeling used available hydrology at the time which was data developed based on 1965 Yuba County Water Agency -Department of Fish of Game Agreement. Since the OCAP BA 2004 modeling, Yuba River hydrology was revised. Interim D-1644 is assumed to be fully implemented with or without the implementation of the Lower Yuba River Accord. This is consistent with the future no-action condition being assumed by the Lower Yuba River Accord EIS/EIR study team. For studies with the Lower Yuba River Accord, an adjusted hydrology is used.

^q It is assumed that either VAMP, a functional equivalent, or D-1641 requirements would be in place in 2030.

^r The Draft Transitional Operations Plan assumptions are discussed in Chapter 2.

^s For Studies 7.0, 7.1, and 8.0 the flow components of the proposed American River Flow Management are included and applied using the CVPIA 3406(b)(2). For Study 8.0 the American River Flow Management is assumed to be the new minimum instream flow.

^t OCAP assumes the flexibility of diversion location but does not assume the Sacramento Area Water Forum Water Forum "replacement water" in drier water year types.

^u Aqueduct improvements that would allow an increase in South Bay Aqueduct demand at the time of model development were expected to be operational within 6 months. However, a delay in the construction has postponed the completion.

^v The Artificial Neural Network (ANN) was updated for both salinity and X2 calculations. Study 3a does not include an updated ANN, Study 6.1 has an updated salinity but not X2, and all remaining Studies include both the updated salinity and X2.

^w North Bay Article 21 deliveries are dependent on excess conditions rather than being dependent on San Luis storage.



Figure P-1 Map of California CVP and SWP Service Areas

Coordinated Operations of the CVP and SWP

Coordinated Operations Agreement

The CVP and SWP use a common water supply in the Central Valley of California. The DWR and Reclamation (collectively referred to as Project Agencies) have built water conservation and water delivery facilities in the Central Valley in order to deliver water supplies to affected water rights holders as well as project contractors. The Project Agencies' water rights are conditioned by the State Water Resources Control Board (SWRCB) to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Sacramento Valley and the Sacramento-San Joaquin Delta Estuary. The Project Agencies coordinate and operate the CVP and SWP to meet the joint water right requirements in the Delta.

The Coordinated Operations Agreement (COA), signed in 1986, defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards, as the standards existed in SWRCB Decision 1485 (D-1485) and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the CVP/SWP, and provides for periodic review of the agreement.

Implementing the COA

Obligations for In-Basin Uses

In-basin uses are defined in the COA as legal uses of water in the Sacramento Basin, including the water required under the SWRCB D-1485 Delta standards (D-1485 ordered the CVP and SWP to guarantee certain conditions for water quality protection for agricultural, municipal and industrial [M&I], and fish and wildlife use). The Project Agencies are obligated to ensure water is available for these uses, but the degree of obligation is dependent on several factors and changes throughout the year, as described below.

Balanced water conditions are defined in the COA as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equals the water supply needed to meet Sacramento Valley in-basin uses plus exports. Excess water conditions are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses plus exports. Reclamation's Central Valley Operations Office (CVOO) and DWR's SWP Operations Control Office jointly decide when balanced or excess water conditions exist.

During excess water conditions, sufficient water is available to meet all beneficial needs, and the CVP and SWP are not required to supplement the supply with water from reservoir storage. Under Article 6(g) of the COA, Reclamation and DWR have the responsibility (during excess water conditions) to store and export as much water as possible, within physical, legal and contractual limits. In excess water conditions, water accounting is not required. However, during balanced water conditions, the Projects share the responsibility in meeting in-basin uses.

When water must be withdrawn from reservoir storage to meet in-basin uses, 75 percent of the responsibility is borne by the CVP and 25 percent is borne by the SWP¹. When unstored water is available for export (i.e., Delta exports exceed storage withdrawals while balanced water conditions exist), the sum of CVP stored water, SWP stored water, and the unstored water for export is allocated 55/45 to the CVP and SWP, respectively.

Accounting and Coordination of Operations

Reclamation and DWR coordinate on a daily basis to determine target Delta outflow for water quality, reservoir release levels necessary to meet in-basin demands, schedules for joint use of the San Luis Unit facilities, and for the use of each other's facilities for pumping and wheeling.

During balanced water conditions, daily water accounting is maintained of the CVP and SWP obligations. This accounting allows for flexibility in operations and avoids the necessity of daily changes in reservoir releases that originate several days travel time from the Delta. It also means adjustments can be made "after the fact" using actual data rather than by prediction for the variables of reservoir inflow, storage withdrawals, and in-basin uses.

The accounting language of the COA provides the mechanism for determining the responsibility of each project for Delta outflow-influenced standards; however, real time operations dictate actions. For example, conditions in the Delta can change rapidly. Weather conditions combined with tidal action can quickly affect Delta salinity conditions, and therefore, the Delta outflow required to maintain joint standards. If, in this circumstance, it is decided the reasonable course of action is to increase upstream reservoir releases, then the response will likely be to increase Folsom releases first. Lake Oroville water releases require about three days to reach the Delta, while water released from Lake Shasta requires five days to travel from Keswick to the Delta. As water from the other reservoirs arrives in the Delta, Folsom releases can be adjusted downward. Any imbalance in meeting each project's designed shared obligation would be captured by the COA accounting.

Reservoir release changes are one means of adjusting to changing in-basin conditions. Increasing or decreasing project exports can immediately achieve changes to Delta outflow. As with changes in reservoir releases, imbalances in meeting each project's designed shared obligations are captured by the COA accounting.

During periods of balanced water conditions, when real-time operations dictate project actions, an accounting procedure tracks the designed sharing water obligations of the CVP and SWP. The Projects produce daily and accumulated accounting balances. The account represents the imbalance resulting from actual coordinated operations compared to the COA-designed sharing of obligations and supply. The project that is "owed" water (i.e., the project that provided more or exported less than its COA-defined share) may request the other project adjust its operations to reduce or eliminate the accumulated account within a reasonable time.

The duration of balanced water conditions varies from year to year. Some very wet years have had no periods of balanced conditions, while very dry years may have had long continuous periods of balanced conditions, and still other years may have had several periods of balanced

¹ These percentages were derived from negotiations between Reclamation and DWR for SWRCB D-1485 standards

conditions interspersed with excess water conditions. Account balances continue from one balanced water condition through the excess water condition and into the next balanced water condition. When the project that is owed water enters into flood control operations, at Shasta or Oroville, the accounting is zeroed out for that respective project. The biological assessment provides a detailed description of the changes in the COA.

State Water Resources Control Board Water Rights

1995 Water Quality Control Plan

The SWRCB adopted the 1995 Bay-Delta Water Quality Control Plan (WQCP) on May 22, 1995, which became the basis of SWRCB Decision-1641. The SWRCB continues to hold workshops and receive information regarding processes on specific areas of the 1995 WQCP. The SWRCB amended the WQCP in 2006, but to date, the SWRCB has made no significant changes to the 1995 WQCP framework.

Decision 1641

The SWRCB imposes a myriad of constraints upon the operations of the CVP and SWP in the Delta. With Water Rights Decision 1641, the SWRCB implements the objectives set forth in the SWRCB 1995 Bay-Delta WQCP and imposes flow and water quality objectives upon the Projects to assure protection of beneficial uses in the Delta. The SWRCB also grants conditional changes to points of diversion for the Projects with D-1641.

The various flow objectives and export restraints are designed to protect fisheries. These objectives include specific outflow requirements throughout the year, specific export restraints in the spring, and export limits based on a percentage of estuary inflow throughout the year. The water quality objectives are designed to protect agricultural, municipal and industrial, and fishery uses, and they vary throughout the year and by the wetness of the year.

Figure P-2 and Figure P-3 summarize the flow and quality objectives in the Delta and Suisun Marsh for the Projects from D-1641. These objectives will remain in place until such time that the SWRCB revisits them per petition or as a consequence to revisions to the SWRCB Water Quality Plan for the Bay-Delta (which is to be revisited periodically).

On December 29, 1999, SWRCB adopted and then revised (on March 15, 2000) Decision 1641, amending certain terms and conditions of the water rights of the SWP and CVP. Decision 1641 substituted certain objectives adopted in the 1995 Bay-Delta Plan for water quality objectives that had to be met under the water rights of the SWP and CVP. In effect, D-1641 obligates the SWP and CVP to comply with the objectives in the 1995 Bay-Delta Plan. The requirements in D-1641 address the standards for fish and wildlife protection, M&I water quality, agricultural water quality, and Suisun Marsh salinity. SWRCB D-1641 also authorizes SWP and CVP to jointly use each other's points of diversion in the southern Delta, with conditional limitations and required response coordination plans. SWRCB D-1641 modified the Vernalis salinity standard under SWRCB Decision 1422 to the corresponding Vernalis salinity objective in the 1995 Bay-Delta Plan. The criteria imposed upon the CVP and SWP are summarized in Figure P-2 (Summary Bay-Delta Standards), Figure P-3 (Footnotes for Summary Bay-Delta Standards), and Figure P-4 (CVP/SWP Map).

Summary Bay-Delta Standards

Contained in D-1641

CRITERIA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FLOW/OPERATIONAL												
• Fish and Wildlife												
SWP/CVP Export Limits					1,500cfs ^[1]							
Export/Inflow Ratio ^[2]	65%		35% of Delta Inflow ^[3]					65% of Delta Inflow				
Minimum Delta Outflow	^[4]							3,000 - 8,000 cfs ^[4]				
Habitat Protection Outflow			7,100 - 29,200 cfs ^[5]									
Salinity Starting Condition ^[6]		^[6]										
River Flows:												
@ Rio Vista								3,000 - 4,500 cfs ^[7]				
@ Vernalis - Base			710 - 3,420 cfs ^[8]			^[8]						
- Pulse					^[9]					+28TAF		
Delta Cross Channel Gates	^[10]		Closed									Conditional ^[10]
WATER QUALITY STANDARDS												
• Municipal and Industrial												
All Export Locations												≤ 250 mg/l Cl
Contra Costa Canal												150 mg/l Cl for the required number of days ^[12]
• Agriculture												
Western/Interior Delta												Max 14-day average EC mmhos/cm ^[13]
Southern Delta ^[14]		1.0 mS				30 day running avg EC 0.7 mS				1.0 mS		
• Fish and Wildlife												
San Joaquin River Salinity ^[15]					14-day avg; 0.44 EC							
Suisun Marsh Salinity ^[16]	12.5 EC	8.0 EC			11.0 EC					19.0 EC	^[17]	16.5 EC

^[1] See Footnotes

Figure P-2 Summary Bay Delta Standards (See Footnotes below)

Footnotes

[1] Maximum 3-day running average of combined export rate (cfs) which includes Tracy Pumping Plant and Clifton Court Forebay Inflow less Byron-Bethany pumping.

Year Type	All
Apr15 - May15*	The greater of 1,500 or 100% of 3-day avg. Vernalis flow

* This time period may need to be adjusted to coincide with fish migration. Maximum export rate may be varied by CalFed Op's group.

[2] The maximum percentage of average Delta inflow (use 3-day average for balanced conditions with storage withdrawal, otherwise use 14-day average) diverted at Clifton Court Forebay (excluding Byron-Bethany pumping) and Tracy Pumping Plant using a 3-day average. (These percentages may be adjusted upward or downward depending on biological conditions, providing there is no net water cost.)

[3] The maximum percent Delta inflow diverted for Feb may vary depending on the January BRI.

Jan BRI	Feb exp. limit
≤ 1.0 MAF	45%
between 1.0 & 1.5 MAF	35%-45%
> 1.5 MAF	35%

[4] Minimum monthly average Delta outflow (cfs). If monthly standard ≤ 5,000 cfs, then the 7-day average must be within 1,000 cfs of standard; if monthly standard > 5,000 cfs, then the 7-day average must be ≥ 80% of standard.

Year Type	All	W	AN	BN	D	C
Jan	4,500*					
Jul		8,000	8,000	6,500	5,000	4,000
Aug		4,000	4,000	4,000	3,500	3,000
Sep	3,000					
Oct		4,000	4,000	4,000	4,000	3,000
Nov-Dec		4,500	4,500	4,500	4,500	3,500

* Increase to 6,000 if the Dec BRI is greater than 800 TAF

[5] Minimum 3-day running average of daily Delta outflow of 7,100 cfs OR: either the daily average or 14-day running average EC at Collinsville is less than 2.64 mmhos/cm (This standard for March may be relaxed if the Feb BRI is less than 500 TAF. The standard does not apply in May and June if the May estimate of the SRI IS < 8.1 MAF at the 90% exceedence level in which case a minimum 14-day running average flow of 4,000 cfs is required.) For additional Delta outflow objectives, see TABLE A.

[6] February starting salinity: If Jan BRI > 900 TAF, then the daily or 14-day running average EC @ Collinsville must be ≤ 2.64 mmhos/cm for at least one day between Feb 1-14. If Jan BRI is between 650 TAF and 900 TAF, then the CalFed Op's group will determine if this requirement must be met.

[7] Rio Vista minimum monthly average flow rate in cfs (the 7-day running average shall not be less than 1,000 below the monthly objective).

Year Type	All	W	AN	BN	D	C
Sep	3,000					
Oct		4,000	4,000	4,000	4,000	3,000
Nov-Dec		4,500	4,500	4,500	4,500	3,500

[8] BASE Vernalis minimum monthly average flow rate in cfs (the 7-day running average shall not be less than 20% below the objective). Take the higher objective if X2 is required to be west of Chipps Island.

Year Type	All	W	AN	BN	D	C
Feb-Apr14 and May16-Jun		2,130 or 3,420	2,130 or 3,420	1,420 or 2,280	1,420 or 2,280	710 or 1,140

[9] PULSE Vernalis minimum monthly average flow rate in cfs. Take the higher objective if X2 is required to be west of Chipps Island.

Year Type	All	W	AN	BN	D	C
Apr15 - May15		7,330 or 8,620	5,730 or 7,020	4,620 or 5,480	4,020 or 4,880	3,110 or 3,540
Oct	1,000*					

* Up to an additional 28 TAF pulse/attraction flow to bring flows up to a monthly average of 2,000 cfs except for a critical year following a critical year. Time period based on real-time monitoring and determined by CalFed Op's group.

[10] For the Nov-Jan period, Delta Cross Channel gates may be closed for up to a total of 45 days.

[11] For the May 21-June 15 period, close Delta Cross Channel gates for a total of 14 days per CALFED Op's group. During the period the Delta cross channel gates may close 4 consecutive days each week, excluding weekends.

[12] Minimum # of days that the mean daily chlorides ≤ 150 mg/l must be provided in intervals of not less than 2 weeks duration. Standard applies at Contra Costa Canal Intake or Antioch Water Works Intake.

Year Type	W	AN	BN	D	C
# Days	240	190	175	165	155

Figure P-3 Footnotes for Summary Bay Delta Standards (continued on next page)

[13] The maximum 14-day running average of mean daily EC (mmhos/cm) depends on water year type.

Year Type	WESTERN DELTA				INTERIOR DELTA			
	Sac River @ Emmaton		SJR @ Jersey Point		Mokelumne R @ Terminous		SJR @ San Andreas	
	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15 *
W	Aug 15		Aug 15		Aug 15		Aug 15	
AN	Jul 1	0.63	Aug 15		Aug 15		Aug 15	
BN	Jun 20	1.14	Jun 20	0.74	Aug 15		Aug 15	
D	Jun 15	1.67	Jun 15	1.35	Aug 15		Jun 25	0.58
C		2.78		2.20		0.54		0.87

* When no date is shown, EC limit continues from April 1.

[14] As per D-1641, for San Joaquin River at Vernalis: however, the April through August maximum 30- day running average EC for San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge shall be 1.0 EC until April 1, 2005 when the value will be 0.7 EC.

[15] Compliance will be determined between Jersey Point & Prisoners Point.
Does not apply in critical years or in May when the May 90% forecast of SRI \leq 8.1 MAF.

[16] During deficiency period, the maximum monthly average mhtEC at Western Suisun Marsh stations as per SMPA is:

Month	mhtEC
Oct	19.0
Nov	16.5
Dec-Mar	15.6
Apr	14.0
May	12.5

[17] In November, maximum monthly average mhtEC = 16.5 for Western Marsh stations and maximum monthly average mhtEC = 15.5 for Eastern Marsh stations in all periods types.

TABLE A

Number of Days When Max. Daily Average Electrical Conductivity of 2.64 mmhos/cm Must Be Maintained. (This can also be met with a maximum 14-day running average EC of 2.64 mmhos/cm, or 3-day running average Delta outflows of 11,400 cfs and 29,200 cfs, respectively.) Port Chicago Standard is triggered only when the 14-day average EC for the last day of the previous month is 2.64 mmhos/cm or less. PMI is previous month's BRI. If salinity/flow objectives are met for a greater number of days than required for any month, the excess days shall be applied towards the following month's requirement. The number of days for values of the PMI between those specified below shall be determined by linear interpolation.

PMI (TAF)	Chippis Island (Chippis Island Station D10)				
	FEB	MAR	APR	MAY	JUN
\leq 500	0	0	0	0	0
750	0	0	0	0	0
1000	28*	12	2	0	0
1250	28	31	6	0	0
1500	28	31	13	0	0
1750	28	31	20	0	0
2000	28	31	25	1	0
2250	28	31	27	3	0
2500	28	31	29	11	1
2750	28	31	29	20	2
3000	28	31	30	27	4
3250	28	31	30	29	8
3500	28	31	30	30	13
3750	28	31	30	31	18
4000	28	31	30	31	23
4250	28	31	30	31	25
4500	28	31	30	31	27
4750	28	31	30	31	26
5000	28	31	30	31	29
5250	28	31	30	31	29
\geq 5500	28	31	30	31	30

*When 800 TAF < PMI < 1000 TAF, the number of days is determined by linear interpolation between 0 and 28 days.

PMI (TAF)	Port Chicago (continuous recorder at Port Chicago)				
	FEB	MAR	APR	MAY	JUN
0	0	0	0	0	0
250	1	0	0	0	0
500	4	1	0	0	0
750	8	2	0	0	0
1000	12	4	0	0	0
1250	15	6	1	0	0
1500	18	9	1	0	0
1750	20	12	2	0	0
2000	21	15	4	0	0
2250	22	17	5	1	0
2500	23	19	8	1	0
2750	24	21	10	2	0
3000	25	23	12	4	0
3250	25	24	14	6	0
3500	25	25	16	9	0
3750	26	26	18	12	0
4000	26	27	20	15	0
4250	26	27	21	18	1
4500	26	28	23	21	2
4750	27	28	24	23	3
5000	27	28	25	25	4
5250	27	29	25	26	6
5500	27	29	26	28	9
5750	27	29	27	28	13
6000	27	29	27	29	16
6250	27	30	27	29	19
6500	27	30	28	30	22
6750	27	30	28	30	24
7000	27	30	28	30	26
7250	27	30	28	30	27
7500	27	30	29	30	28
7750	27	30	29	31	28
8000	27	30	29	31	29
8250	28	30	29	31	29
8500	28	30	29	31	29
8750	28	30	29	31	30
9000	28	30	29	31	30
9250	28	30	29	31	30
9500	28	31	29	31	30
9750	28	31	29	31	30
10000	28	31	30	31	30
> 10000	28	31	30	31	30

Figure P-3 Footnotes for Summary Bay Delta Standards

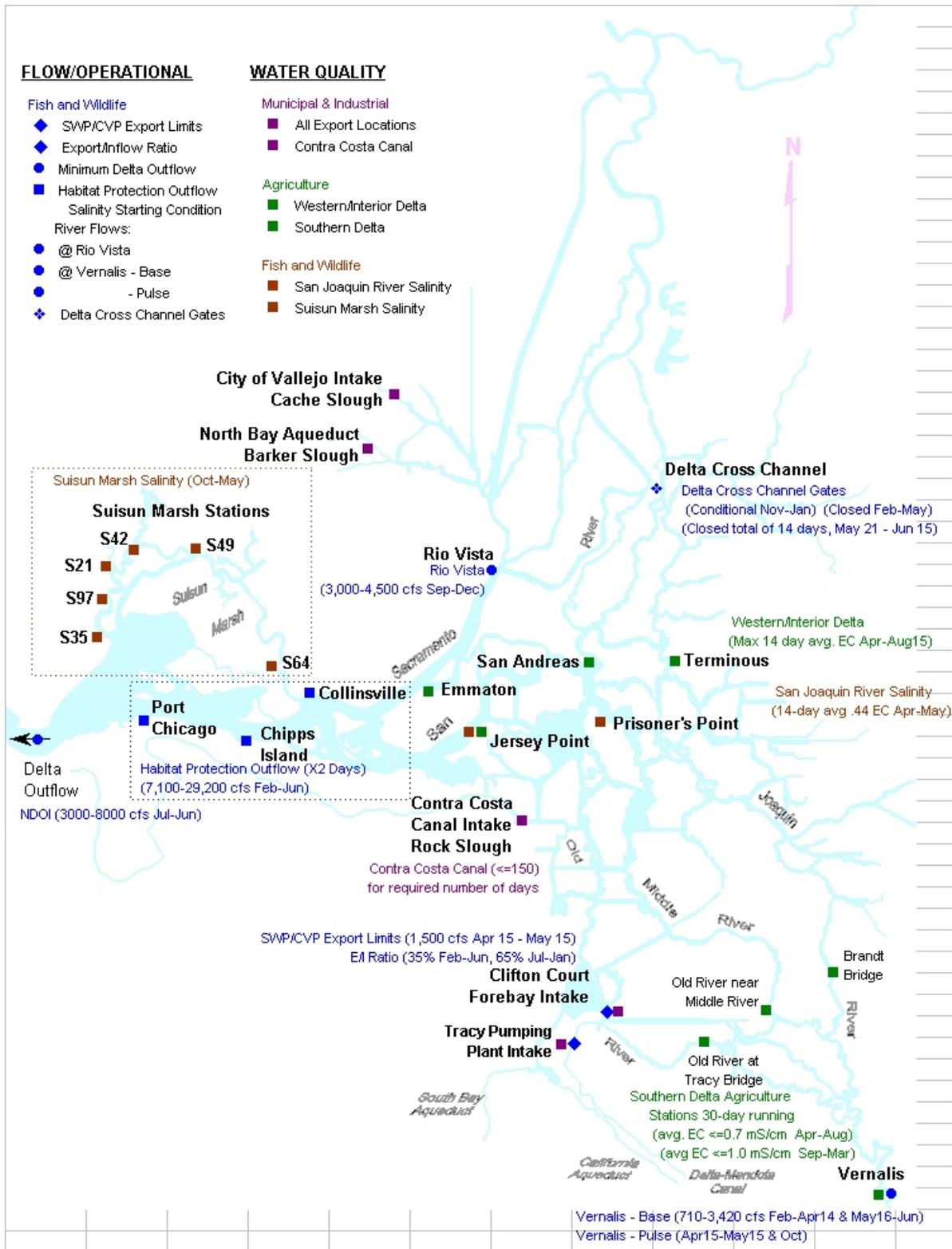


Figure P-4 CVP/SWP Delta Map

Joint Points of Diversion

SWRCB D-1641 granted Reclamation and DWR the ability to use/exchange each Project's diversion capacity capabilities to enhance the beneficial uses of both Projects. The SWRCB conditioned the use of Joint Point of Diversion (JPOD) capabilities based on a staged implementation and conditional requirements for each stage of implementation. The stages of JPOD in SWRCB D-1641 are:

- Stage 1 – for water service to Cross Valley Canal contractors, Tracy Veterans Cemetery and Musco Olive, and to recover export reductions taken to benefit fish.
- Stage 2 – for any purpose authorized under the current project water right permits.
- Stage 3 – for any purpose authorized up to the physical capacity of the diversion facilities. Stage 3 is not part of the project description.

Each stage of JPOD has regulatory terms and conditions which must be satisfied in order to implement JPOD.

All stages require a response plan to ensure water levels in the southern Delta will not be lowered to the injury of local riparian water users (Water Level Response Plan). All stages require a response plan to ensure the water quality in the southern and Central Delta will not be significantly degraded through operations of the JPOD to the injury of water users in the southern and Central Delta.

All JPOD diversion under excess conditions in the Delta is junior to Contra Costa Water District (CCWD) water right permits for the Los Vaqueros Project, and must have an X2 (the two parts per thousand (ppt) isohaline location in kilometers from the Golden Gate Bridge) located west of certain compliance locations consistent with the 1993 Los Vaqueros biological opinion for delta smelt.

Stage 2 has an additional requirement to complete an operations plan that will protect fish and wildlife and other legal users of water. This is commonly known as the Fisheries Response Plan. A Fisheries Response Plan was approved by the SWRCB in February 2007, but since it relied on the 2004 and 2005 biological opinions, the Fisheries Response Plan will need to be revised and re-submitted to the SWRCB at a future date.

Stage 3 has an additional requirement to protect water levels in the southern Delta under the operational conditions of Phase II of the South Delta Improvements Program, along with an updated companion Fisheries Response Plan.

Reclamation and DWR intend to apply all response plan criteria consistently for JPOD uses as well as water transfer uses.

In general, JPOD capabilities will be used to accomplish four basic CVP-SWP objectives:

- When wintertime excess pumping capacity becomes available during Delta excess conditions and total CVP-SWP San Luis storage is not projected to fill before the spring pulse flow period, the project with the deficit in San Luis storage may elect to use JPOD

capabilities. Concurrently, under the CALFED Record of Decision (ROD), JPOD may be used to create additional water supplies for the Environmental Water Account (EWA) or reduce debt for previous EWA actions.

- When summertime pumping capacity is available at Banks Pumping Plant and CVP reservoir conditions can support additional releases, the CVP may elect to use JPOD capabilities to enhance annual CVP south of Delta water supplies.
- When summertime pumping capacity is available at Banks or Jones Pumping Plant to facilitate water transfers, JPOD may be used to further facilitate the water transfer.
- During certain coordinated CVP-SWP operation scenarios for fishery entrainment management, JPOD may be used to shift CVP-SWP exports to the facility with the least fishery entrainment impact while minimizing export at the facility with the most fishery entrainment impact.

Revised WQCP (2006)

The SWRCB undertook a proceeding under its water quality authority to amend the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) adopted in 1978 and amended in 1991 and in 1995. Prior to commencing this proceeding, the SWRCB conducted a series of workshops in 2004 and 2005 to receive information on specific topics addressed in the Bay-Delta Plan.

The SWRCB adopted a revised Bay-Delta Plan on December 13, 2006. There were no changes to the Beneficial Uses from the 1995 Plan to the 2006 Plan, nor were any new water quality objectives adopted in the 2006 Plan. A number of changes were made simply for readability. Consistency changes were also made to assure that sections of the 2006 Plan reflected the current physical condition or current regulation. The SWRCB continues to hold workshops and receive information regarding Pelagic Organism Decline (POD), Climate Change, and San Joaquin salinity and flows, and will coordinate updates of the Bay-Delta Plan with on-going development of the comprehensive Salinity Management Plan.

Real Time Decision-Making to Assist Fishery Management

Introduction

Real time decision-making to assist fishery management is a process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. For the proposed action high uncertainty exists for how to best manage water operations while protecting listed species. Sources of uncertainty relative to the proposed action include:

- Hydrologic conditions
- Ocean conditions
- Listed species biology

Under the proposed action the goals for real time decision-making to assist fishery management are:

- Meet contractual obligations for water delivery
- Minimize adverse effects for listed species

Framework for Actions

Reclamation and DWR work closely with the Service, NMFS, and DFG to coordinate the operation of the CVP and SWP with fishery needs. This coordination is facilitated through several forums in a cooperative management process that allows for modifying operations based on real-time data that includes current fish surveys, flow and temperature information, and salvage or loss at the project facilities, (hereinafter “triggering event”).

Water Operations Management Team

The Water Operations Management Team (WOMT) is comprised of representatives from Reclamation, DWR, the Service, NMFS, and DFG. This management-level team was established to facilitate timely decision-support and decision-making at the appropriate level. The WOMT first met in 1999, and will continue to meet to make management decisions as part of the proposed action. Routinely, it also uses the CALFED Ops Group to communicate with stakeholders about its decisions. Although the goal of WOMT is to achieve consensus on decisions, the participating agencies retain their authorized roles and responsibilities.

Process for Real Time Decision- Making to Assist Fishery Management

Decisions regarding CVP and SWP operations to avoid and minimize adverse effects on listed species must consider factors that include public health, safety, water supply reliability, and water quality. To facilitate such decisions, the Project Agencies and the Service, NMFS, and DFG have developed and refined a set of processes for various fish species to collect data, disseminate information, develop recommendations, make decisions, and provide transparency. This process consists of three types of groups that meet on a recurring basis. Management teams are made up of management staff from Reclamation, DWR, the Service, NMFS, and DFG. Information teams are teams whose role is to disseminate and coordinate information among agencies and stakeholders. Fisheries and Operations Technical Teams are made up of technical staff from state and Federal agencies. These teams review the most up-to-date data and information on fish status and Delta conditions, and develop recommendations that fishery agencies’ management can use in identifying actions to protect listed species.

The process to identify actions for protection of listed species varies to some degree among species but follows this general outline: A Fisheries or Operations Technical Team compiles and assesses current information regarding species, such as stages of reproductive development, geographic distribution, relative abundance, and physical habitat conditions; it then provides a recommendation to the agency with statutory obligation to enforce protection of the species in question. The agency’s staff and management will review the recommendation and use it as a basis for developing, in cooperation with Reclamation and DWR, a modification of water

operations that will minimize adverse effects to listed species by the Projects. If the Project Agencies do not agree with the action, then the fishery agency with the statutory authority will make a final decision on an action that they deem necessary to protect the species.

The outcomes of protective actions that are implemented will be monitored and documented, and this information will inform future recommended actions.

Groups Involved in Real Time Decision-Making to Assist Fishery Management and Information Sharing

Information Teams

CALFED Ops and Subgroups

The CALFED Ops Group consists of the Project agencies, the fishery agencies, SWRCB staff, and the U.S. Environmental Protection Agency (EPA). The CALFED Ops Group generally meets eleven times a year in a public setting so that the agencies can inform each other and stakeholders about current the operations of the CVP and SWP, implementation of the CVPIA and State and Federal endangered species acts, and additional actions to contribute to the conservation and protection of State- and Federally-listed species. The CALFED Ops Group held its first public meeting in January 1995, and during the next six years the group developed and refined its process. The CALFED Ops Group has been recognized within SWRCB D-1641, and elsewhere, as one forum for coordination on decisions to exercise certain flexibility that has been incorporated into the Delta standards for protection of beneficial uses (e.g., E/I ratios, and some DCC closures). Several teams were established through the Ops Group process. These teams are described below:

Data Assessment Team (DAT)

The DAT consists of technical staff members from the Project and fishery agencies as well as stakeholders. The DAT meets frequently² during the fall, winter, and spring. The purpose of the meetings is to coordinate and disseminate information and data among agencies and stakeholders that is related to water project operations, hydrology, and fish surveys in the Delta.

Integrated Water Operations and Fisheries Forum

The Integrated Water Operations and Fisheries Forum (IWOFF) provides the forum for executives and managers of Reclamation, DWR, DFG, the Service, NMFS, USEPA and the SWRCB to meet and discuss current and proposed action planning, permitting, funding, and Endangered Species Act compliance, which affect the workloads and activities of these organizations. IWOFF provides a forum for elevation of these matters if staff is unable to reach resolution on process/procedures requiring interagency coordination. IWOFF may also elevate such decisions up to the Director level at their discretion.

² The DAT holds weekly conference calls and may have additional discussions during other times as needed.

B2 Interagency Team (B2IT)

The B2IT was established in 1999 and consists of technical staff members from the Project and fisheries agencies. The B2IT meets weekly to discuss implementation of section 3406 (b)(2) of the CVPIA, which mandates the dedication of CVP water supply for environmental purposes. B2IT communicates with WOMT to ensure coordination with the other operational programs or resource-related aspects of project operations, including flow and temperature issues.

Technical Teams

Fisheries Technical Teams

Several fisheries specific teams have been established to provide guidance and recommendations on resource management issues. These teams include:

The Sacramento River Temperature Task Group (SRTTG)

The SRTTG is a multiagency group formed pursuant to SWRCB Water Rights Orders 90-5 and 91-1, to assist with improving and stabilizing Chinook population in the Sacramento River.

Annually, Reclamation develops temperature operation plans for the Shasta and Trinity Divisions of the CVP. These plans consider impacts on winter-run and other races of Chinook salmon, and associated Project operations. The SRTTG meets initially in the spring to discuss biological, hydrologic, and operational information, objectives, and alternative operations plans for temperature control. Once the SRTTG has recommended an operation plan for temperature control, Reclamation then submits a report to the SWRCB, generally on or before June 1st each year.

After implementation of the operation plan, the SRTTG may perform additional studies and commonly holds meetings as needed, typically monthly through the summer and into fall, to develop revisions based on updated biological data, reservoir temperature profiles, and operations data. Updated plans may be needed for summer operations protecting winter-run, or in fall for fall-run spawning season. If there are any changes in the plan, Reclamation submits a supplemental report to SWRCB.

Smelt Working Group (SWG)

The SWG evaluates biological and technical issues regarding delta smelt and develops recommendations for consideration by the Service. Since the longfin smelt (*Spirinchus thaleichthys*) became a state candidate species in 2008, the SWG has also developed for DFG recommendations to minimize adverse effects to longfin smelt. The SWG consists of representatives from the Service, DFG, DWR, EPA, and Reclamation. The Service chairs the group, and members are assigned by each agency.

The SWG compiles and interprets the latest near real-time information regarding state- and federally-listed smelt, such as stages of development, distribution, and salvage. After evaluating available information and if they agree that a protection action is warranted, the SWG will submit their recommendations in writing to the Service and DFG.

The SWG may meet at any time at the request of the Service, but generally meets weekly during the months of December through June, when smelt salvage at Jones and Banks has occurred historically. However, the Delta Smelt Risk Assessment Matrix (see below) outlines the

conditions when the SWG will convene to evaluate the necessity of protective actions and provide the Service with a recommendation. Further, with the State listing of longfin smelt, the group will also convene based on longfin salvage history at the request of DFG.

Delta Smelt Risk Assessment Matrix (DSRAM)

The SWG will employ a delta smelt risk assessment matrix to assist in evaluating the need for operational modifications of SWP and CVP to protect delta smelt. This document will be a product and tool of the SWG and will be modified by the SWG with the approval of the Service, in consultation with Reclamation, DWR and DFG, as new knowledge becomes available. The currently approved DSRAM is Attachment A.

If an action is taken, the SWG will follow up on the action to attempt to ascertain its effectiveness. The ultimate decision-making authority rests with the Service. An assessment of effectiveness will be attached to the notes from the SWG's discussion concerning the action.

The Salmon Decision Process

The Salmon Decision Process is used by the fishery agencies and Project agencies to facilitate the often complex coordination issues surrounding DCC gate operations and the purposes of fishery protection closures, Delta water quality, and/or export reductions. Inputs such as fish lifestage and size development, current hydrologic events, fish indicators (such as the Knight's Landing Catch Index and Sacramento Catch Index), and salvage at the export facilities, as well as current and projected Delta water quality conditions, are used to determine potential DCC closures and/or export reductions. The coordination process has worked well during the recent fall and winter DCC operations in recent years and is expected to be used in the present or modified form in the future.

American River Group

In 1996, Reclamation established a working group for the Lower American River, known as American River Group (ARG). Although open to the public, the ARG meetings generally include representatives from several agencies and organizations with on-going concerns and interests regarding management of the Lower American River. The formal members of the group are Reclamation, the Service, NMFS, and DFG.

The ARG convenes monthly or more frequently if needed, with the purpose of providing fishery updates and reports to Reclamation to help manage Folsom Reservoir for fish resources in the Lower American River.

San Joaquin River Technical Committee (SJRTC)

The SJRTC meets for the purposes of planning and implementing the Vernalis Adaptive Management Plan (VAMP) each year and oversees two subgroups: the Biology subgroup, and the Hydrology subgroup. These two groups are charged with certain responsibilities, and must also coordinate their activities within the San Joaquin River Agreement (SJRA) Technical Committee.

Operations Technical Teams

An operations specific team is established to provide guidance and recommendations on operational issues and one is proposed for the South Delta Improvement Program (SDIP) operable gates. These teams are:

Delta Cross Channel Project Work Team

The DCC Project Work Team is a multiagency group under CALFED. Its purpose is to determine and evaluate the affects of DCC gate operations on Delta hydrodynamics, water quality, and fish migration.

Gate Operations Review Team

When the gates proposed under SDIP Stage 1 are in place and operational, a federal and state interagency team will be convened to discuss constraints and provide input to the existing WOMT. The Gate Operations Review Team (GORT) will make recommendations for the operations of the fish control and flow control gates to minimize impacts on resident threatened and endangered species and to meet water level and water quality requirements for South Delta water users. The interagency team will include representatives of DWR, Reclamation, the Service, NMFS, and DFG. DWR will be responsible for providing predictive modeling, and SWP Operations Control Office will provide operations forecasts. Reclamation will be responsible for providing CVP operations forecasts, including San Joaquin River flow, and data on current water quality conditions. Other members will provide the team with the latest information related to South Delta fish species and conditions for crop irrigation. Operations plans would be developed using the Delta Simulation Model 2 (DSM2), forecasted tides, and proposed diversion rates of the projects to prepare operating schedules for the existing CCF gates and the four proposed operable gates. The Service will use the SWG for recommendations regarding gate operations.

Uses of Environmental Water Accounts

CVPIA Section 3406 (b)(2)

On May 9, 2003, the Department of the Interior issued its Decision on Implementation of Section 3406 (b)(2) of the CVPIA. Dedication of (b)(2) water occurs when Reclamation takes a fish, wildlife, or habitat restoration action based on recommendations of the Service (and in consultation with NMFS and DFG), pursuant to Section 3406 (b)(2). Dedication and management of (b)(2) water may also assist in meeting WQCP fishery objectives and help meet the needs of fish listed under the ESA as threatened or endangered since the enactment of the CVPIA.

The May 9, 2003, decision describes the means by which the amount of dedicated (b)(2) water is determined. Planning and accounting for (b)(2) action is done cooperatively and occurs primarily through weekly meetings of the B2IT. Actions usually take one of two forms: in-stream flow augmentation below CVP reservoirs or CVP Jones pumping reductions in the Delta. Chapter 9 of the biological assessment contains a more detailed description of (b)(2) operations, as characterized in the CALSIM II modeling assumptions and results of the modeling are summarized.

CVPIA 3406 (b)(2) Operations on Clear Creek

Dedication of (b)(2) water on Clear Creek provides actual in-stream flows below Whiskeytown Dam greater than those that would have occurred under pre-CVPIA regulations, e.g., the fish and wildlife minimum flows specified in the 1963 proposed release schedule. In-stream flow objectives are usually taken from the AFRP's plan, in consideration of spawning and incubation of fall-run Chinook salmon. Augmentation in the summer months is usually in consideration of water temperature objectives for steelhead and in late summer for spring-run Chinook salmon.

Reclamation will provide Townsend with up to 6,000 AF of water annually. If the full 6,000 AF is delivered, then 900 AF will be dedicated to (b)(2) according to the August 2000 agreement.

CVPIA 3406 (b)(2) Operations on the Upper Sacramento River

Dedication of (b)(2) water on the Sacramento River provides actual in-stream flows below Keswick Dam greater than those that would have occurred under pre-CVPIA regulations, e.g., the fish and wildlife requirements specified in WR 90-5 and the criteria formalized in the 1993 NMFS Winter-run biological opinion as the base. In-stream flow objectives from October 1 to April 15 (typically April 15 is when water temperature objectives for winter-run Chinook salmon become the determining factor) are usually selected to minimize dewatering of redds and provide suitable habitat for salmonid spawning, incubation, rearing, and migration.

CVPIA 3406 (b)(2) Operations on the Lower American River

Dedication of (b)(2) water on the American River provides actual in-stream flows below Nimbus Dam greater than those that would have occurred under pre-CVPIA regulations, (e.g. the fish and wildlife requirements previously mentioned in the American River Division). In-stream flow objectives from October through May generally aim to provide suitable habitat for salmon and steelhead spawning, incubation, and rearing, while considering impacts to American River operations the rest of the year. In-stream flow objectives for June to September endeavor to provide suitable flows and water temperatures for juvenile steelhead rearing while balancing the effects on temperature operations into October and November.

- **Flow Fluctuation and Stability Concerns:**

Through CVPIA, Reclamation has funded studies by DFG to better define the relationships of Nimbus release rates and rates of change criteria in the Lower American River to minimize the negative effects of necessary Nimbus release changes on sensitive fishery objectives. Reclamation is presently using draft criteria developed by DFG. The draft criteria have helped reduce the incidence of anadromous fish stranding relative to past historic operations. The primary operational coordination for potentially sensitive Nimbus Dam release changes is conducted through the B2IT process.

CVPIA 3406 (b)(2) Operations on the Stanislaus River

Dedication of (b)(2) water on the Stanislaus River provides actual in-stream flows below Goodwin Dam greater than the fish and wildlife requirements discussed in the East Side Division, and in the past has been generally consistent with the Interim Plan of Operation (IPO) for New Melones. In-stream fishery management flow volumes on the Stanislaus River, as part of the IPO, are based on the New Melones end-of-February storage plus forecasted March to

September inflow as shown in the IPO. The volume determined by the IPO is a combination of fishery flows pursuant to the 1987 DFG Agreement and the Service AFRP in-stream flow goals. The fishery volume is then initially distributed based on modeled fish distributions and patterns used in the IPO.

Actual in-stream fishery management flows below Goodwin Dam will be determined in accordance with the Decision on Implementation of Section 3406 (b)(2) of the CVPIA. Reclamation has begun a process to develop a long-term operations plan for New Melones. The ultimate long-term plan will be coordinated with B2IT members, along with the stakeholders and the public before it is finalized.

CVPIA 3406 (b)(2) Operations in the Delta

Export curtailments at the CVP Jones Pumping Plant and increased CVP reservoir releases required to meet SWRCB D-1641's Objectives for Fish and Wildlife Beneficial Uses, as well as direct export reductions for fishery management using dedicated (b)(2) water at the CVP Jones Pumping Plant, will be determined in accordance with the Interior Decision on Implementation of Section 3406 (b)(2) of the CVPIA. Direct Jones Pumping Plant export curtailments for fishery management protection will be based on coordination with the weekly B2IT meetings and vetted through WOMT, as necessary.

Environmental Water Account

The original Environmental Water Account (EWA) was established in 2000 by the CALFED ROD, and operating criteria area described in detail in the EWA Operating Principles Agreement attachment to the ROD. In 2004, the EWA was extended to operate through the end of 2007. Reclamation, the Service, and NMFS have received Congressional authorization to participate in the EWA at least through September 30, 2010, per the CALFED Bay-Delta Authorization Act (PL-108-361). However, for these Federal agencies to continue participation in the EWA beyond 2010, additional authorization will be required.

The original purpose of the EWA was to enable diversion of water by the SWP and CVP from the Delta to be reduced at times when at risk fish species may be harmed while preventing the uncompensated loss of water to SWP and CVP contractors. Typically the EWA replaced water loss due to curtailment of pumping by purchase of surface or groundwater supplies from willing sellers and by taking advantage of regulatory flexibility and certain operational assets. Under past operations, from 2001 through 2007, when there were pumping curtailments at Banks Pumping Plant to protect Delta fish the EWA often owed a debt of water to the SWP, usually reflected in San Luis Reservoir.

The EWA agencies (the Project and fisheries agencies) are currently undertaking environmental review to determine the future of EWA. Because no decision has yet been made regarding EWA, for the purposes of this project description, EWA is analyzed with limited assets, focusing on providing assets to support VAMP and in some years, the "post – VAMP shoulder". The EWA assets include the following:

- Implementation of the Yuba Accord Component 1 Water, which is an average 60,000 AF of water released annually from the Yuba River to the Delta, is an EWA asset through 2015, with a possible extension through 2025. The 60,000 AF is expected to be reduced

by carriage water costs in most years, estimated at 20 percent, leaving an EWA asset of 48,000 AF per year. The SWP will provide the 48,000 AF per year asset from Project supplies beyond 2015 in the event that Yuba Accord Component 1 Water is not extended.

- Purchases of assets to the extent funds are available.
- Operational assets granted the EWA in the CALFED ROD:
 - A 50 percent share of SWP export pumping of (b)(2) water and ERP water from upstream releases;
 - A share of the use of SWP pumping capacity in excess of the SWP's needs to meet contractor requirements with the CVP on an equal basis, as needed (such use may be under Joint Point of Diversion);
 - Any water acquired through export/inflow ratio flexibility; and
 - Use of 500 cubic-feet per second (cfs) increase in authorized Banks Pumping Plant capacity in July through September (from 6,680 to 7,180 cfs).
 - Storage in Project reservoirs upstream of the Delta as well as in San Luis Reservoir, with a lower priority than Project water. Such stored water will share storage priority with water acquired for Level 4 refuge needs.

Operational assets averaged 82,000 AF from 2001-2006, with a range from 0 to 150,000 AF.

500 cfs Diversion Increase During July, August, and September

Under this operation, the maximum allowable daily diversion rate into Clifton Court Forebay (CCF) during the months of July, August, and September increases from 13,870 AF to 14,860 AF and three-day average diversions from 13,250 AF to 14,240 AF (500 cfs per day equals 990 AF). The increase in diversions has been permitted and in place since 2000. The current permit expired on September 30, 2008. An application has been made to the U.S. Army Corps of Engineers (Corps) for permitting the implementation of this operation. The description of the 500 cfs increased diversion in the permit application to the Corps will be consistent with the following description:

The purpose of this diversion increase into CCF for use by the SWP is to recover export reductions made due to the ESA or other actions taken to benefit fisheries resources. The increased diversion rate will not result in any increase in water supply deliveries than would occur in the absence of the increased diversion rate. This increased diversion over the three-month period would result in an amount not to exceed 90 TAF each year. Increased diversions above the 48 TAF discussed previously could occur for a number of reasons including:

- 1) Actual carriage water loss on the 60 TAF of current year's Yuba Accord Component 1 Water is less than the assumed 20 percent.
- 2) Diversion of Yuba Accord Component 1 Water exceeds the current year's 60 TAF allotment to make up for a Yuba Accord Component 1 deficit from a previous year.
- 3) In very wet years, the diversion of excess Delta outflow goes above and beyond the Yuba Accord Component 1 Water allotment.

Variations to hydrologic conditions coupled with regulatory requirements may limit the ability of the SWP to fully utilize the proposed increased diversion rate. Also, facility capabilities may limit the ability of the SWP to fully utilize the increased diversion rate.

In years where the accumulated export under the 500 cfs increased diversion exceeds 48 TAF, the additional asset will be held in the SWP share of San Luis Reservoir, as long as space is available, to be applied to an export reduction specified by the fish agencies for the immediate water year (WY). For example, if 58 TAF were exported under the increased diversion during July through September, then 10 TAF of additional asset would be in San Luis Reservoir on September 30. The fish agencies may choose to apply this asset to an export reduction during the early winter or take a risk that space for storing the asset will remain in the SWP share of San Luis Reservoir and be available to be applied to the VAMP or post-VAMP export reduction in the spring. If the asset remains available for the VAMP and post-VAMP shoulder, it would increase the export reduction during that period by an equal amount. In this example, the export would be reduced an additional 10 TAF.

As the winter and spring progress, the SWP share of San Luis Reservoir may fill and the space will no longer be available to store the asset. If this happens, the asset will be converted to SWP supply stored in San Luis Reservoir and the SWP exports from the Delta will be reduced at that time by the same volume as the asset. Any reductions in exports resulting from this situation are expected to occur in the December-March period.

Implementation of the proposed action is contingent on meeting the following conditions:

1. The increased diversion rate will not result in an increase in annual SWP water supply allocations other than would occur in the absence of the increased diversion rate. Water pumped due to the increased capacity will only be used to offset reduced diversions that occurred or will occur because of ESA or other actions taken to benefit fisheries.
2. Use of the increased diversion rate will be in accordance with all terms and conditions of existing biological opinions governing SWP operations.
3. All three temporary agricultural barriers (Middle River, Old River near Tracy and Grant Line Canal) must be in place and operating when SWP diversions are increased. When the temporary barriers are replaced by the permanent operable flow-control gates, proposed as Stage 1 of the South Delta Improvements Program, the gates must be operating to their specified criteria.
4. Between July 1 and September 30, prior to the start of or during any time at which the SWP has increased its diversion rate in accordance with the approved operations plan, if the combined salvage of listed fish species reaches a level of concern, real-time decision making will be implemented. The relevant fish regulatory agency will determine whether the 500 cfs increased diversion is or continues to be implemented.

Central Valley Project

Central Valley Project Improvement Act

On October 30, 1992, Public Law 102-575, (Reclamation Projects Authorization and Adjustment Act of 1992) was passed. Included in the law was Title 34, the Central Valley Project Improvement Act (CVPIA). The CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement having an equal priority with power generation. Changes mandated by the CVPIA include:

- Dedicating 800,000 AF annually to fish, wildlife, and habitat restoration
- Authorizing water transfers outside the CVP service area
- Implementing an anadromous fish restoration program
- Creating a restoration fund financed by water and power users
- Providing for the Shasta Temperature Control Device
- Implementing fish passage measures at Red Bluff Diversion Dam (RBDD)
- Calling for planning to increase the CVP yield
- Mandating firm water supplies for Central Valley wildlife refuges
- Improving the Tracy Fish Collection Facility (TFCF)
- Meeting Federal trust responsibility to protect fishery resources (Trinity River)

The CVPIA is being implemented as authorized. The Final Programmatic Environmental Impact Statement (PEIS) for the CVPIA analyzed projected conditions in 2022, 30 years from the CVPIA's adoption in 1992. The Final PEIS was released in October 1999 and the CVPIA Record of Decision (ROD) was signed on January 9, 2001. The biological opinions were issued on November 21, 2000.

Water Service Contracts, Allocations and Deliveries

Water Needs Assessment

Water needs assessments have been performed for each CVP water contractor eligible to participate in the CVP long-term contract renewal process. Water needs assessments confirm a contractor's past beneficial use and determine future CVP water supplies needed to meet the contractor's anticipated future demands. The assessments are based on a common methodology used to determine the amount of CVP water needed to balance a contractor's water demands with available surface and groundwater supplies. All of the contractor assessments have been finalized.

Future American River Operations - Water Service Contracts and Deliveries

Surface water deliveries from the American River are made to various water rights entities and CVP contractors. Total American River Division annual demands on the American and Sacramento Rivers are estimated to increase from about 324,000 acre-feet in 2005 and 605,000 acre-feet in 2030 without the Freeport Regional Water Project maximum of 133,000 acre-feet during drier years. Reclamation is negotiating the renewal of 13 long-term water service contracts, four Warren Act contracts, and has a role in six infrastructure or Folsom Reservoir operations actions influencing the management of American River Division facilities and water use.

Water Allocation – CVP

The water allocation process for CVP begins in the fall when preliminary assessments are made of the next year's water supply possibilities, given current storage conditions combined with a range of hydrologic conditions. These preliminary assessments may be refined as the WY progresses. Beginning February 1, forecasts of WY runoff are prepared using precipitation to date, snow water content accumulation, and runoff to date. All of CVP's Sacramento River Settlement water rights contracts and San Joaquin River Exchange contracts require that contractors be informed no later than February 15 of any possible deficiency in their supplies. In recent years, February 20th has been the target date for the first announcement of all CVP contractors' forecasted water allocations for the upcoming contract year. Forecasts of runoff and operations plans are updated at least monthly between February and May.

Reclamation uses the 90 percent probability of exceedance forecast as the basis of water allocations. Furthermore, NMFS reviews the operations plans devised to support the initial water allocation, and any subsequent updates to them, for sufficiency with respect to the criteria for Sacramento River temperature control.

CVP M&I Water Shortage Operational Assumptions

The CVP has 253 water service contracts (including Sacramento River Settlement Contracts). These water service contracts have had varying water shortage provisions (e.g., in some contracts, municipal and industrial (M&I) and agricultural uses have shared shortages equally; in most of the larger M&I contracts, agricultural water has been shorted 25 percent of its contract entitlement before M&I water was shorted, after which both shared shortages equally).

The M&I minimum shortage allocation does not apply to contracts for the (1) Friant Division, (2) New Melones interim supply, (3) Hidden and Buchanan Units, (4) Cross Valley contractors, (5) San Joaquin River Exchange settlement contractors, and (6) Sacramento River settlement contractors. Any separate shortage-related contractual provisions will prevail.

There will be a minimum shortage allocation for M&I water supplies of 75 percent of a contractor's historical use (i.e., the last three years of water deliveries unconstrained by the availability of CVP water). Historical use can be adjusted for growth, extraordinary water conservation measures, and use of non-CVP water as those terms are defined in the proposed policy. Before the M&I water allocation is reduced, the irrigation water allocation would be reduced below 75 percent of contract entitlement.

When the allocation of irrigation water is reduced below 25 percent of contract entitlement, Reclamation will reassess the availability of CVP water and CVP water demand; however, due to limited water supplies during these times, M&I water allocation may be reduced below 75 percent of adjusted historical use during extraordinary and rare times such as prolonged and severe drought. Under these extraordinary conditions allocation percentages for both South of Delta and North of Delta irrigation and M&I contractors are the same.

Reclamation will deliver CVP water to all M&I contractors at not less than a public health and safety level if CVP water is available, if an emergency situation exists, but not exceeding 75 percent on contract total (and taking into consideration water supplies available to the M&I contractors from other sources). This is in recognition, however, that the M&I allocation may, nevertheless, fall to 50 percent as the irrigation allocation drops below 25 percent and approaches zero due to limited CVP supplies.

Allocation Modeling Assumptions:

Ag 100% to 75% then M&I is at 100%

Ag 70% M&I 95%

Ag 65% M&I 90%

Ag 60% M&I 85%

Ag 55% M&I 80%

Ag 50% to 25% M&I 75%

Dry and Critical Years:

Ag 20% M&I 70%

Ag 15% M&I 65%

Ag 10% M&I 60%

Ag 5% M&I 55%

Ag 0% M&I 50%

Project Facilities

Trinity River Division Operations

The Trinity River Division, completed in 1964, includes facilities to store and regulate water in the Trinity River, as well as facilities to divert water to the Sacramento River Basin. Trinity Dam is located on the Trinity River and regulates the flow from a drainage area of approximately 720 square miles. The dam was completed in 1962, forming Trinity Lake, which has a maximum storage capacity of approximately 2.4 million acre-feet (MAF). See map in Figure P-5.

The mean annual inflow to Trinity Lake from the Trinity River is about 1.2 MAF per year. Historically, an average of about two-thirds of the annual inflow has been diverted to the Sacramento River Basin (1991-2003). Trinity Lake stores water for release to the Trinity River and for diversion to the Sacramento River via Lewiston Reservoir, Clear Creek Tunnel, Whiskeytown Reservoir, and Spring Creek Tunnel where it commingles in Keswick Reservoir with Sacramento River water released from both the Shasta Dam and Spring Creek Debris Dam.

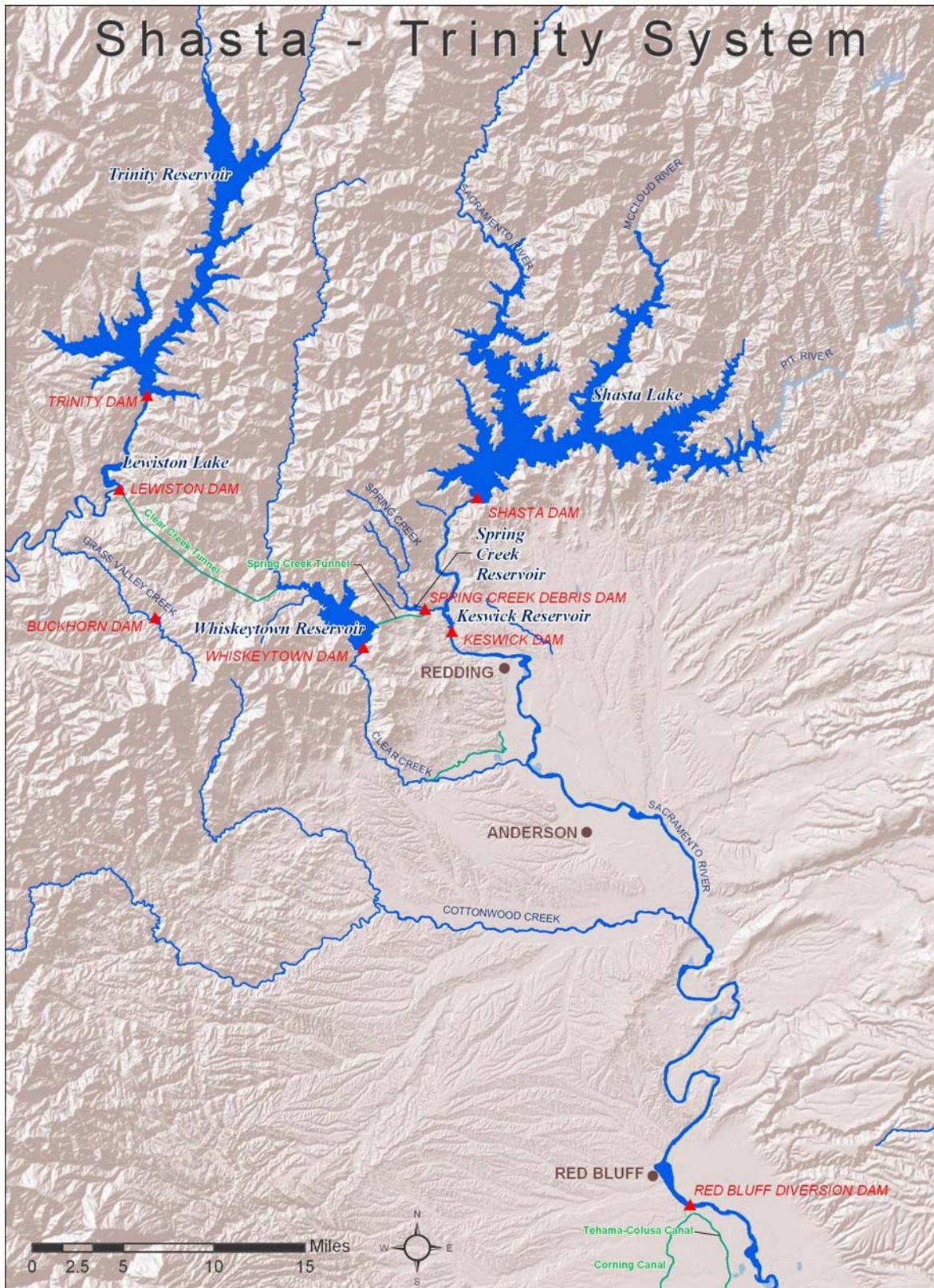


Figure P-5 Shasta-Trinity System

Safety of Dams at Trinity Reservoir

Periodically, increased water releases are made from Trinity Dam consistent with Reclamation Safety of Dams criteria intended to prevent overtopping of Trinity Dam. Although flood control is not an authorized purpose of the Trinity River Division, flood control benefits are provided through normal operations.

The Safety of Dams release criteria specifies that Carr Powerplant capacity should be used as a first preference destination for Safety of Dams releases made at Trinity Dam. Trinity River releases are made as a second preference destination. During significant Northern California high water flood events, the Sacramento River water stages are also at concern levels. Under such high water conditions, the water that would otherwise move through Carr Powerplant is routed to the Trinity River. Total river release can reach up to 11,000 cfs below Lewiston Dam (under Safety of Dams criteria) due to local high water concerns in the flood plain and local bridge flow capacities. The Safety of Dam criteria provides seasonal storage targets and recommended releases November 1 to March 31. During May 2006 the river flows were over 10,000 cfs for several days.

Fish and Wildlife Requirements on Trinity River

Based on the Trinity River Mainstem Fishery Restoration ROD, dated December 19, 2000, 368,600 to 815,000 AF is allocated annually for Trinity River flows. This amount is scheduled in coordination with the Service to best meet habitat, temperature, and sediment transport objectives in the Trinity Basin.

Temperature objectives for the Trinity River are set forth in SWRCB order WR 90-5 (Also see Table P-2 below). These objectives vary by reach and by season. Between Lewiston Dam and Douglas City Bridge, the daily average temperature should not exceed 60 degrees Fahrenheit (°F) from July 1 to September 14, and 56°F from September 15 to October 1. From October 1 to December 31, the daily average temperature should not exceed 56°F between Lewiston Dam and the confluence of the North Fork Trinity River. Reclamation consults with the Service in establishing a schedule of releases from Lewiston Dam that can best achieve these objectives.

For the purpose of determining the Trinity Basin WY type, forecasts using the 50 percent exceedance as of April 1st are used. There are no make-up/or increases for flows forgone if the WY type changes up or down from an earlier 50 percent forecast. In the modeling, actual historic Trinity inflows were used rather than a forecast. There is a temperature curtain in Lewiston Reservoir that provides for lower temperature water releases into the Trinity River.

Table P-2 Water temperature objectives for the Trinity River during the summer, fall, and winter as established by the CRWQCB-NCR (California Regional Water Quality Control Board North Coast Region)

Date	Temperature Objective (°F)	
	Douglas City (RM 93.8)	North Fork Trinity River (RM 72.4)
July 1 through Sept 14	60	-
Sept 15 through Sept 30	56	-
Oct 1 through Dec 31	-	56

Transbasin Diversions

Diversion of Trinity water to the Sacramento Basin provides limited water supply and hydroelectric power generation for the CVP and assists in water temperature control in the Trinity River and upper Sacramento River. The amounts and timing of the Trinity exports are determined by subtracting Trinity River scheduled flow and targeted carryover storage from the forecasted Trinity water supply.

The seasonal timing of Trinity exports is a result of determining how to make best use of a limited volume of Trinity export (in concert with releases from Shasta) to help conserve cold water pools and meet temperature objectives on the upper Sacramento and Trinity rivers, as well as power production economics. A key consideration in the export timing determination is the thermal degradation that occurs in Whiskeytown Lake due to the long residence time of transbasin exports in the lake.

To minimize the thermal degradation effects, transbasin export patterns are typically scheduled by an operator to provide an approximate 120,000 AF volume to occur in late spring to create a thermal connection to the Spring Creek Powerhouse before larger transbasin volumes are scheduled to occur during the hot summer months (Figure P-6). Typically, the water flowing from the Trinity Basin through Whiskeytown Lake must be sustained at fairly high rates to avoid warming and to function most efficiently for temperature control. The time period for which effective temperature control releases can be made from Whiskeytown Lake may be compressed when the total volume of Trinity water available for export is limited.

Export volumes from Trinity are made in coordination with the operation of Shasta Reservoir. Other important considerations affecting the timing of Trinity exports are based on the utility of power generation and allowances for normal maintenance of the diversion works and generation facilities.

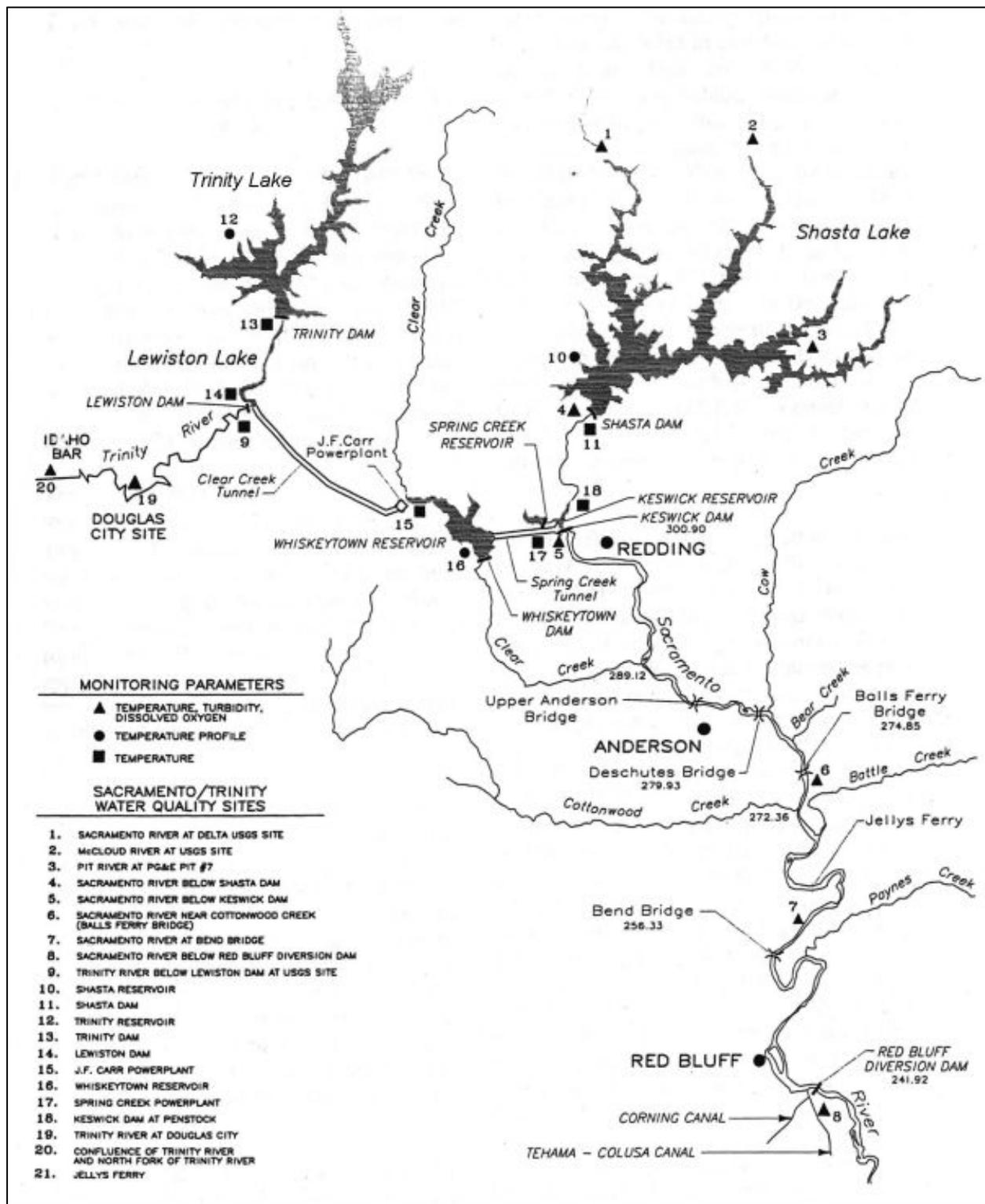


Figure P-6 Sacramento-Trinity Water Quality Network (with river miles [RM])

Trinity Lake historically reached its greatest storage level at the end of May. With the present pattern of prescribed Trinity releases, maximum storage may occur by the end of April or in early May.

Reclamation maintains at least 600,000 AF in Trinity Reservoir, except during the 10 to 15 percent of the years when Shasta Reservoir is also drawn down. Reclamation will address end of WY carryover on a case-by-case basis in dry and critically dry WY types with the Service and NMFS through the WOMT and B2IT processes.

Whiskeytown Reservoir Operations

Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through the CVP facilities. Water is diverted from the Trinity River at Lewiston Dam via the Clear Creek Tunnel and passes through the Judge Francis Carr Powerhouse as it is discharged into Whiskeytown Lake on Clear Creek. From Whiskeytown Lake, water is released through the Spring Creek Power Conduit to the Spring Creek Powerplant and into Keswick Reservoir. All of the water diverted from the Trinity River, plus a portion of Clear Creek flows, is diverted through the Spring Creek Power Conduit into Keswick Reservoir.

Spring Creek also flows into the Sacramento River and enters at Keswick Reservoir. Flows on Spring Creek are partially regulated by the Spring Creek Debris Dam. Historically (1964-1992), an average annual quantity of 1,269,000 AF of water has been diverted from Whiskeytown Lake to Keswick Reservoir. This annual quantity is approximately 17 percent of the flow measured in the Sacramento River at Keswick.

Whiskeytown is normally operated to (1) regulate inflows for power generation and recreation; (2) support upper Sacramento River temperature objectives; and (3) provide for releases to Clear Creek consistent with the CVPIA Anadromous Fish Restoration Program (AFRP) objectives. Although it stores up to 241,000 AF, this storage is not normally used as a source of water supply. There is a temperature curtain in Whiskeytown Reservoir.

Spillway Flows below Whiskeytown Lake

Whiskeytown Lake is drawn down approximately 35,000 AF per year of storage space during November through April to regulate flows for power generation. Heavy rainfall events occasionally result in spillway discharges to Clear Creek, as shown in Table P-3 below.

Table P-3 Days of Spilling below Whiskeytown and 40-30-30 Index from Water Year 1978 to 2005, WY Types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critical

Water Year	Days of Spilling	40-30-30 Index
1978	5	AN
1979	0	BN
1980	0	AN
1981	0	D
1982	63	W
1983	81	W
1984	0	W
1985	0	D

Water Year	Days of Spilling	40-30-30 Index
1986	17	W
1987	0	D
1988	0	C
1989	0	D
1990	8	C
1991	0	C
1992	0	C
1993	10	AN
1994	0	C
1995	14	W
1996	0	W
1997	5	W
1998	8	W
1999	0	W
2000	0	AN
2001	0	D
2002	0	D
2003	8	AN
2004	0	BN
2005	0	AN
2006	4	W
2007	0	D

Operations at Whiskeytown Lake during flood conditions are complicated by its operational relationship with the Trinity River, Sacramento River, and Clear Creek. On occasion, imports of Trinity River water to Whiskeytown Reservoir may be suspended to avoid aggravating high flow conditions in the Sacramento Basin.

Fish and Wildlife Requirements on Clear Creek

Water rights permits issued by the SWRCB for diversions from Trinity River and Clear Creek specify minimum downstream releases from Lewiston and Whiskeytown Dams, respectively. Two agreements govern releases from Whiskeytown Lake:

- A 1960 Memorandum of Agreement (MOA) with the DFG established minimum flows to be released to Clear Creek at Whiskeytown Dam, Table P-4 .
- A 1963 release schedule for Whiskeytown Dam was developed with the Service and implemented, but never finalized. Although this release schedule was never formalized, Reclamation has operated according to this proposed schedule since May 1963.

Table P-4 Minimum flows at Whiskeytown Dam from 1960 MOA with the DFG

Period	Minimum flow (cfs)
1960 MOA with the DFG	
January 1 - February 28(29)	50
March 1 - May 31	30
June 1 - September 30	0
October 1 - October 15	10
October 16 - October 31	30
November 1 - December 31	100
1963 FWS Proposed Normal year flow (cfs)	
January 1 - October 31	50
November 1 - December 31	100
1963 FWS Proposed Critical year flow (cfs)	
January 1 - October 31	30
November 1 - December 31	70

Spring Creek Debris Dam Operations

The Spring Creek Debris Dam (SCDD) is a feature of the Trinity Division of the CVP. It was constructed to regulate runoff containing debris and acid mine drainage from Spring Creek, a tributary to the Sacramento River that enters Keswick Reservoir. The SCDD can store approximately 5,800 AF of water. Operation of SCDD and Shasta Dam has allowed some control of the toxic wastes with dilution criteria. In January 1980, Reclamation, the DFG, and the SWRCB executed a Memorandum of Understanding (MOU) to implement actions that protect the Sacramento River system from heavy metal pollution from Spring Creek and adjacent watersheds.

The MOU identifies agency actions and responsibilities, and establishes release criteria based on allowable concentrations of total copper and zinc in the Sacramento River below Keswick Dam. The MOU states that Reclamation agrees to operate to dilute releases from SCDD (according to these criteria and schedules provided) and that such operation will not cause flood control parameters on the Sacramento River to be exceeded and will not unreasonably interfere with other project requirements as determined by Reclamation. The MOU also specifies a minimum schedule for monitoring copper and zinc concentrations at SCDD and in the Sacramento River below Keswick Dam. Reclamation has primary responsibility for the monitoring; however, the DFG and the RWQCB also collect and analyze samples on an as-needed basis. Due to more extensive monitoring, improved sampling and analyses techniques, and continuing cleanup efforts in the Spring Creek drainage basin, Reclamation now operates SCDD targeting the more stringent Central Valley Region Water Quality Control Plan (Basin Plan) criteria in addition to the MOU goals. Instead of the total copper and total zinc criteria contained in the MOU,

Reclamation operates SCDD releases and Keswick dilution flows to not exceed the Basin Plan standards of 0.0056 mg/L dissolved copper and 0.016 mg/L dissolved zinc. Release rates are estimated from a mass balance calculation of the copper and zinc in the debris dam release and in the river.

In order to minimize the build-up of metal concentrations in the Spring Creek arm of Keswick Reservoir, releases from the debris dam are coordinated with releases from the Spring Creek Powerplant to keep the Spring Creek arm of Keswick Reservoir in circulation with the main water body of Keswick Lake.

The operation of SCDD is complicated during major heavy rainfall events. SCDD reservoir can fill to uncontrolled spill elevations in a relatively short time period, anywhere from days to weeks. Uncontrolled spills at SCDD can occur during major flood events on the upper Sacramento River and also during localized rainfall events in the Spring Creek watershed. During flood control events, Keswick releases may be reduced to meet flood control objectives at Bend Bridge when storage and inflow at Spring Creek Reservoir are high.

Because SCDD releases are maintained as a dilution ratio of Keswick releases to maintain the required dilution of copper and zinc, uncontrolled spills can and have occurred from SCDD. In this operational situation, high metal concentration loads during heavy rainfall are usually limited to areas immediately downstream of Keswick Dam because of the high runoff entering the Sacramento River adding dilution flow. In the operational situation when Keswick releases are increased for flood control purposes, SCDD releases are also increased in an effort to reduce spill potential.

In the operational situation when heavy rainfall events will fill SCDD and Shasta Reservoir will not reach flood control conditions, increased releases from CVP storage may be required to maintain desired dilution ratios for metal concentrations. Reclamation has voluntarily released additional water from CVP storage to maintain release ratios for toxic metals below Keswick Dam. Reclamation has typically attempted to meet the Basin Plan standards but these releases have no established criteria and are dealt with on a case-by-case basis. Since water released for dilution of toxic spills is likely to be in excess of other CVP requirements, such releases increase the risk of a loss of water for other beneficial purposes.

Shasta Division and Sacramento River Division

The CVP's Shasta Division includes facilities that conserve water in the Sacramento River for (1) flood control, (2) navigation maintenance, (3) agricultural water supplies, (4) M&I water supplies (5) hydroelectric power generation, (6) conservation of fish in the Sacramento River, and (7) protection of the Sacramento-San Joaquin Delta from intrusion of saline ocean water. The Shasta Division includes Shasta Dam, Lake, and Powerplant; Keswick Dam, Reservoir, and Powerplant, and the Shasta Temperature Control Device.

The Sacramento River Division was authorized after completion of the Shasta Division. Total authorized diversions for the Sacramento River Division are approximately 2.8 MAF. Historically the total diversion has varied from 1.8 MAF in a critically dry year to the full 2.8 MAF in wet year. It includes facilities for the diversion and conveyance of water to CVP contractors on the west side of the Sacramento River. The division includes the Sacramento

Canals Unit, which was authorized in 1950 and consists of the RBDD, the Corning Pumping Plant, and the Corning and Tehama-Colusa Canals.

The unit was authorized to supply irrigation water to over 200,000 acres of land in the Sacramento Valley, principally in Tehama, Glenn, Colusa, and Yolo counties. Black Butte Dam, which is operated by the U.S. Army Corps of Engineers (Corps), also provides supplemental water to the Tehama-Colusa Canals as it crosses Stony Creek. The operations of the Shasta and Sacramento River divisions are presented together because of their operational inter-relationships.

Shasta Dam is located on the Sacramento River just below the confluence of the Sacramento, McCloud, and Pit Rivers. The dam regulates the flow from a drainage area of approximately 6,649 square miles. Shasta Dam was completed in 1945, forming Shasta Lake, which has a maximum storage capacity of 4,552,000 AF. Water in Shasta Lake is released through or around the Shasta Powerplant to the Sacramento River where it is re-regulated downstream by Keswick Dam. A small amount of water is diverted directly from Shasta Lake for M&I uses by local communities.

Keswick Reservoir was formed by the completion of Keswick Dam in 1950. It has a capacity of approximately 23,800 AF and serves as an afterbay for releases from Shasta Dam and for discharges from the Spring Creek Powerplant. All releases from Keswick Reservoir are made to the Sacramento River at Keswick Dam. The dam has a fish trapping facility that operates in conjunction with the Coleman National Fish Hatchery on Battle Creek.

Flood Control

Flood control objectives for Shasta Lake require that releases be restricted to quantities that will not cause downstream flows or stages to exceed specified levels. These include a flow of 79,000 cfs at the tailwater of Keswick Dam, and a stage of 39.2 feet in the Sacramento River at Bend Bridge gauging station, which corresponds to a flow of approximately 100,000 cfs. Flood control operations are based on regulating criteria developed by the Corps pursuant to the provisions of the Flood Control Act of 1944. Maximum flood space reservation is 1.3 MAF, with variable storage space requirements based on an inflow parameter.

Flood control operation at Shasta Lake requires the forecasting of runoff conditions into Shasta Lake, as well as runoff conditions of unregulated creek systems downstream from Keswick Dam, as far in advance as possible. A critical element of upper Sacramento River flood operations is the local runoff entering the Sacramento River between Keswick Dam and Bend Bridge.

The unregulated creeks (major creek systems are Cottonwood Creek, Cow Creek, and Battle Creek) in this reach of the Sacramento River can be very sensitive to a large rainfall event and produce large rates of runoff into the Sacramento River in short time periods. During large rainfall and flooding events, the local runoff between Keswick Dam and Bend Bridge can exceed 100,000 cfs.

The travel time required for release changes at Keswick Dam to affect Bend Bridge flows is approximately 8 to 10 hours. If the total flow at Bend Bridge is projected to exceed 100,000 cfs, the release from Keswick Dam is decreased to maintain Bend Bridge flow below 100,000 cfs. As the flow at Bend Bridge is projected to recede, the Keswick Dam release is increased to

evacuate water stored in the flood control space at Shasta Lake. Changes to Keswick Dam releases are scheduled to minimize rapid fluctuations in the flow at Bend Bridge.

The flood control criteria for Keswick releases specify releases should not be increased more than 15,000 cfs or decreased more than 4,000 cfs in any 2-hour period. The restriction on the rate of decrease is intended to prevent sloughing of saturated downstream channel embankments caused by rapid reductions in river stage. In rare instances, the rate of decrease may have to be accelerated to avoid exceeding critical flood stages downstream.

Fish and Wildlife Requirements in the Sacramento River

Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet (to the extent possible) the provisions of SWRCB Order 90-05. If Reclamation cannot meet the SWRCB order an exception will be requested. An April 5, 1960, MOA between Reclamation and the DFG originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critically dry years (Table P-5). Since October 1981, Keswick Dam has operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with an agreement between Reclamation and DFG. This release schedule was included in Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and RBDD from September through the end of February in all water years, except critically dry years.

Table P-5 Current Minimum Flow Requirements and Objectives (cfs) on the Sacramento River below Keswick Dam

Water Year Type	MOA	WR 90-5	MOA and WR 90-5	Proposed Flow Objectives below Keswick
Period	Normal	Normal	Critically Dry	All
January 1 - February 28(29)	2600	3250	2000	3250
March 1 - March 31	2300	2300	2300	3250
April 1 - April 30	2300	2300	2300	---*
May 1 - August 31	2300	2300	2300	---*
September 1 - September 30	3900	3250	2800	---*
October 1 - November 30	3900	3250	2800	3250
December 1 - December 31	2600	3250	2000	3250

Note: * No regulation.

The 1960 MOA between Reclamation and the DFG provides that releases from Keswick Dam (from September 1 through December 31) are made with minimum water level fluctuation or change to protect salmon to the extent compatible with other operational requirements. Releases

from Shasta and Keswick Dams are gradually reduced in September and early October during the transition from meeting Delta export and water quality demands to operating the system for flood control and fishery concerns from October through December.

Reclamation proposes a minimum flow of 3,250 cfs from October 1 through March 31 and ramping constraints for Keswick release reductions from July 1 through March 31 as follows:

- Releases must be reduced between sunset and sunrise.
- When Keswick releases are 6,000 cfs or greater, decreases may not exceed 15 percent per night. Decreases also may not exceed 2.5 percent in one hour.
- For Keswick releases between 4,000 and 5,999 cfs, decreases may not exceed 200 cfs per night. Decreases also may not exceed 100 cfs per hour.
- For Keswick releases between 3,250 and 3,999 cfs, decreases may not exceed 100 cfs per night.
- Variances to these release requirements are allowed under flood control operations.

Reclamation usually reduces releases from Keswick Dam to the minimum fishery requirement by October 15 each year and to minimize changes in Keswick releases between October 15 and December 31. Releases may be increased during this period to meet unexpected downstream needs such as higher outflows in the Delta to meet water quality requirements, or to meet flood control requirements. Releases from Keswick Dam may be reduced when downstream tributary inflows increase to a level that will meet flow needs. Reclamation attempts to establish a base flow that minimizes release fluctuations to reduce impacts to fisheries and bank erosion from October through December.

A recent change in agricultural water diversion practices has affected Keswick Dam release rates in the fall. This program is generally known as the Rice Straw Decomposition and Waterfowl Habitat Program. Historically, the preferred method of clearing fields of rice stubble was to systematically burn it. Today, rice field burning has been phased out due to air quality concerns and has been replaced by a program of rice field flooding that decomposes rice stubble and provides additional waterfowl habitat. The result has been an increase in water demand to flood rice fields in October and November, which has increased the need for higher Keswick releases in all but the wettest of fall months.

The changes in agricultural practice over the last decade related to the Rice Straw Decomposition and Waterfowl Habitat Program have been incorporated into the systematic modeling of agricultural use and hydrology effects as described in the biological assessment.

Minimum Flow for Navigation – Wilkins Slough

Historical commerce on the Sacramento River resulted in a CVP authorization to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation. Currently, there is no commercial traffic between Sacramento and Chico Landing, and the Corps has not dredged this reach to preserve channel depths since 1972. However, long-time water users diverting from the river have set their pump intakes just below this level. Therefore, the CVP is operated to meet the navigation flow requirement of 5,000 cfs to Wilkins Slough, (gauging station on the

Sacramento River), under all but the most critical water supply conditions, to facilitate pumping and use of screened diversions.

At flows below 5,000 cfs at Wilkins Slough, diverters have reported increased pump cavitation as well as greater pumping head requirements. Diverters are able to operate for extended periods at flows as low as 4,000 cfs at Wilkins Slough, but pumping operations become severely affected and some pumps become inoperable at flows lower than this. Flows may drop as low as 3,500 cfs for short periods while changes are made in Keswick releases to reach target levels at Wilkins Slough, but using the 3,500 cfs rate as a target level for an extended period would have major impacts on diverters.

No criteria have been established specifying when the navigation minimum flow should be relaxed. However, the basis for Reclamation's decision to operate at less than 5,000 cfs is the increased importance of conserving water in storage when water supplies are not sufficient to meet full contractual deliveries and other operational requirements.

Water Temperature Operations in the Upper Sacramento River

Water temperature in the upper Sacramento River is governed by current water right permit requirements. Water temperature on the Sacramento River system is influenced by several factors, including the relative water temperatures and ratios of releases from Shasta Dam and from the Spring Creek Powerplant. The temperature of water released from Shasta Dam and the Spring Creek Powerplant is a function of the reservoir temperature profiles at the discharge points at Shasta and Whiskeytown, the depths from which releases are made, the seasonal management of the deep cold water reserves, ambient seasonal air temperatures and other climatic conditions, tributary accretions and water temperatures, and residence time in Keswick, Whiskeytown and Lewiston Reservoirs, and in the Sacramento River.

SWRCB Water Rights Order 90-05 and Water Rights Order 91-01

In 1990 and 1991, the SWRCB issued Water Rights Orders 90-05 and 91-01 modifying Reclamation's water rights on the Sacramento River. The orders stated Reclamation shall operate Keswick and Shasta Dams and the Spring Creek Powerplant to meet a daily average water temperature of 56°F as far downstream in the Sacramento River as practicable during periods when higher temperature would be harmful to fisheries. The optimal control point is the RBDD.

Under the orders, the water temperature compliance point may be modified when the objective cannot be met at RBDD. In addition, Order 90-05 modified the minimum flow requirements initially established in the 1960 MOA for the Sacramento River below Keswick Dam. The water right orders also recommended the construction of a Shasta Temperature Control Device (TCD) to improve the management of the limited cold water resources.

Pursuant to SWRCB Orders 90-05 and 91-01, Reclamation configured and implemented the Sacramento-Trinity Water Quality Monitoring Network to monitor temperature and other parameters at key locations in the Sacramento and Trinity Rivers. The SWRCB orders also required Reclamation to establish the Sacramento River Temperature Task Group (SRTTG) to formulate, monitor, and coordinate temperature control plans for the upper Sacramento and Trinity Rivers. This group consists of representatives from Reclamation, SWRCB, NMFS, the Service, DFG, Western, DWR, and the Hoopa Valley Indian Tribe.

Each year, with finite cold water resources and competing demands usually an issue, the SRTTG will devise operation plans with the flexibility to provide the best protection consistent with the CVP's temperature control capabilities and considering the annual needs and seasonal spawning distribution monitoring information for winter-run and fall-run Chinook salmon. In every year since the SWRCB issued the orders, those plans have included modifying the RBDD compliance point to make best use of the cold water resources based on the location of spawning Chinook salmon. Reports are submitted periodically to the SWRCB over the temperature control season defining our temperature operation plans. The SWRCB has overall authority to determine if the plan is sufficient to meet water right permit requirements.

Shasta Temperature Control Device

Construction of the TCD at Shasta Dam was completed in 1997. This device is designed for greater flexibility in managing the cold water reserves in Shasta Lake while enabling hydroelectric power generation to occur and to improve salmon habitat conditions in the upper Sacramento River. The TCD is also designed to enable selective release of water from varying lake levels through the power plant in order to manage and maintain adequate water temperatures in the Sacramento River downstream of Keswick Dam.

Prior to construction of the Shasta TCD, Reclamation released water from Shasta Dam's low-level river outlets to alleviate high water temperatures during critical periods of the spawning and incubation life stages of the winter-run Chinook stock. Releases through the low-level outlets bypass the power plant and result in a loss of hydroelectric generation at the Shasta Powerplant. The release of water through the low-level river outlets was a major facet of Reclamation's efforts to control upper Sacramento River temperatures from 1987 through 1996.

The seasonal operation of the TCD is generally as follows: during mid-winter and early spring the highest elevation gates possible are utilized to draw from the upper portions of the lake to conserve deeper colder resources (see Table P-6). During late spring and summer, the operators begin the seasonal progression of opening deeper gates as Shasta Lake elevation decreases and cold water resources are utilized. In late summer and fall, the TCD side gates are opened to utilize the remaining cold water resource below the Shasta Powerplant elevation in Shasta Lake.

Table P-6 Shasta Temperature Control Device Gates with Elevation and Storage

TCD Gates	Shasta Elevation with 35 feet of Submergence	Shasta Storage
Upper Gates	1035	~3.65 MAF
Middle Gates	935	~2.50 MAF
Pressure Relief Gates	840	~0.67 MAF
Side Gates	720*	~0.01 MAF

* Low Level intake bottom.

The seasonal progression of the Shasta TCD operation is designed to maximize the conservation of cold water resources deep in Shasta Lake, until the time the resource is of greatest management value to fishery management purposes. Recent operational experience with the Shasta TCD has demonstrated significant operational flexibility improvement for cold water

conservation and upper Sacramento River water temperature and fishery habitat management purposes. Recent operational experience has also demonstrated the Shasta TCD has significant leaks that are inherent to TCD design.

Reclamation's Proposed Upper Sacramento River Temperature Objectives

Reclamation will continue a policy of developing annual operations plans and water allocations based on a conservative 90 percent exceedance forecast. Reclamation is not proposing a minimum end-of-water-year (September 30) carryover storage in Shasta Reservoir.

In continuing compliance with Water Rights Orders 90-05 and 91-01 requirements, Reclamation will implement operations to provide year round temperature protection in the upper Sacramento River, consistent with the intent of Order 90-05 that protection be provided to the extent controllable. Among factors that affect the extent to which river temperatures will be controllable include Shasta TCD performance, the availability of cold water, the balancing of habitat needs for different species in spring, summer, and fall, and the constraints on operations created by the combined effect of the projects and demands assumed to be in place in the future.

Under all but the most adverse drought and low Shasta Reservoir storage conditions, Reclamation proposes to continue operating CVP facilities to provide water temperature control at Ball's Ferry or at locations further downstream (as far as Bend Bridge) based on annual plans. Reclamation and the SRTTG will take into account projections of cold water resources, numbers of expected spawning salmon, and spawning distribution (as monitoring information becomes available) to make the decisions on allocation of the cold water resources.

Locating the target temperature compliance at Ball's Ferry (1) reduces the need to compensate for the warming effects of Cottonwood Creek and Battle Creek during the spring runoff months with deeper cold water releases and (2) improves the reliability of cold water resources through the fall months. Reclamation proposes Sacramento River temperature control point to be consistent with the capability of the CVP to manage cold water resources and to use the process of annual planning in coordination with the SRTTG to arrive at the best use of that capability.

Anderson-Cottonwood Irrigation District (ACID) Diversion Dam

ACID holds senior water rights and has diverted into the ACID Canal for irrigation along the west side of the Sacramento River between Redding and Cottonwood since 1916. The United States and ACID signed a contract providing for the project water service and agreement on diversion of water. ACID diverts to its main canal (on the right bank of the river) from a diversion dam located in Redding about five miles downstream from Keswick Dam.

Close coordination is required between Reclamation and ACID for regulation of river flows to ensure safe operation of ACID's diversion dam during the irrigation season. The irrigation season for ACID runs from April through October.

Keswick release rate decreases required for the ACID operations are limited to 15 percent in a 24-hour period and 2.5 percent in any one hour. Therefore, advance notification is important when scheduling decreases to allow for the installation or removal of the ACID diversion dam.

Red Bluff Diversion Dam Operations

The Red Bluff Diversion Dam (RBDD), located on the Sacramento River approximately two miles southeast of Red Bluff, is a gated structure with fish ladders at each abutment. When the gates are lowered, the impounded water rises about 13 feet, creating Lake Red Bluff and allowing gravity diversions through a set of drum fish screens into the stilling basin servicing the Tehama-Colusa and Corning canals. Construction of RBDD was completed in 1964.

The Tehama-Colusa Canal is a lined canal extending 111 miles south from the RBDD and provides irrigation service on the west side of the Sacramento Valley in Tehama, Glenn, Colusa, and northern Yolo counties. Construction of the Tehama-Colusa Canal began in 1965, and it was completed in 1980.

The Corning Pumping Plant lifts water approximately 56 feet from the screened portion of the settling basin into the unlined, 21 mile-long Corning Canal. The Corning Canal was completed in 1959, to provide water to the CVP contractors in Tehama County that could not be served by gravity from the Tehama-Colusa Canal. The Tehama-Colusa Canal Authority (TCCA) operates both the Tehama-Colusa and Corning canals.

Since 1986, the RBDD gates have been raised during winter months to allow passage of winter-run Chinook salmon. As documented in the 2004 NMFS biological opinion addressing the long-term CVP and SWP operations, the gates are raised from approximately September 15 through May 14, each year. In the near term, Reclamation proposes the continued operation of the RBDD using the eight-month gate-open procedures of the past ten years, and to use the research pumping plant to provide water to the canals during times when the gates-out configuration precludes gravity diversions during the irrigation season. Additionally, although covered under a separate NMFS biological opinion, Reclamation proposes the continued use of rediversions of CVP water stored in Black Butte Reservoir to supplement the water pumped at RBDD during the gates-out period. This water is rediverted with the aid of temporary gravel berms through an unscreened, constant head orifice (CHO) into the Tehama-Colusa Canal.

In addition to proposing to operate the RBDD with the gates in for 8 months annually to enable gravity diversion of water into the Tehama-Colusa Canal, Reclamation proposes retention of the provision for a 10-day emergency gate closure, as necessary, contingent upon a case-by-case consultation with NMFS. Reclamation most recently coordinated such an emergency gate closure with NMFS in the spring of 2007. Around that time, dead green sturgeon were discovered in the vicinity of the dam, and Reclamation worked with the other resource agencies to review the gate operation protocol to try and reduce future potential adverse affects to adult green sturgeon that pass the dam. The resulting, new protocol for all gates in operation is to open individual gates to a minimum height of 12 inches to substantially reduce the possibility of injury should adult green sturgeon pass beneath the gates.

American River Division

Reclamation's Folsom Lake, the largest reservoir in the watershed, has a capacity of 977,000 AF. Folsom Dam, located approximately 30 miles upstream from the confluence with the Sacramento River, is operated as a major component of the CVP. The American River Division includes facilities that provide conservation of water on the American River for flood control, fish and wildlife protection, recreation, protection of the Delta from intrusion of saline ocean water, irrigation and M&I water

supplies, and hydroelectric power generation. Initially authorized features of the American River Division included Folsom Dam, Lake, and Powerplant; Nimbus Dam and Powerplant, and Lake Natoma. See map in Figure P-7.

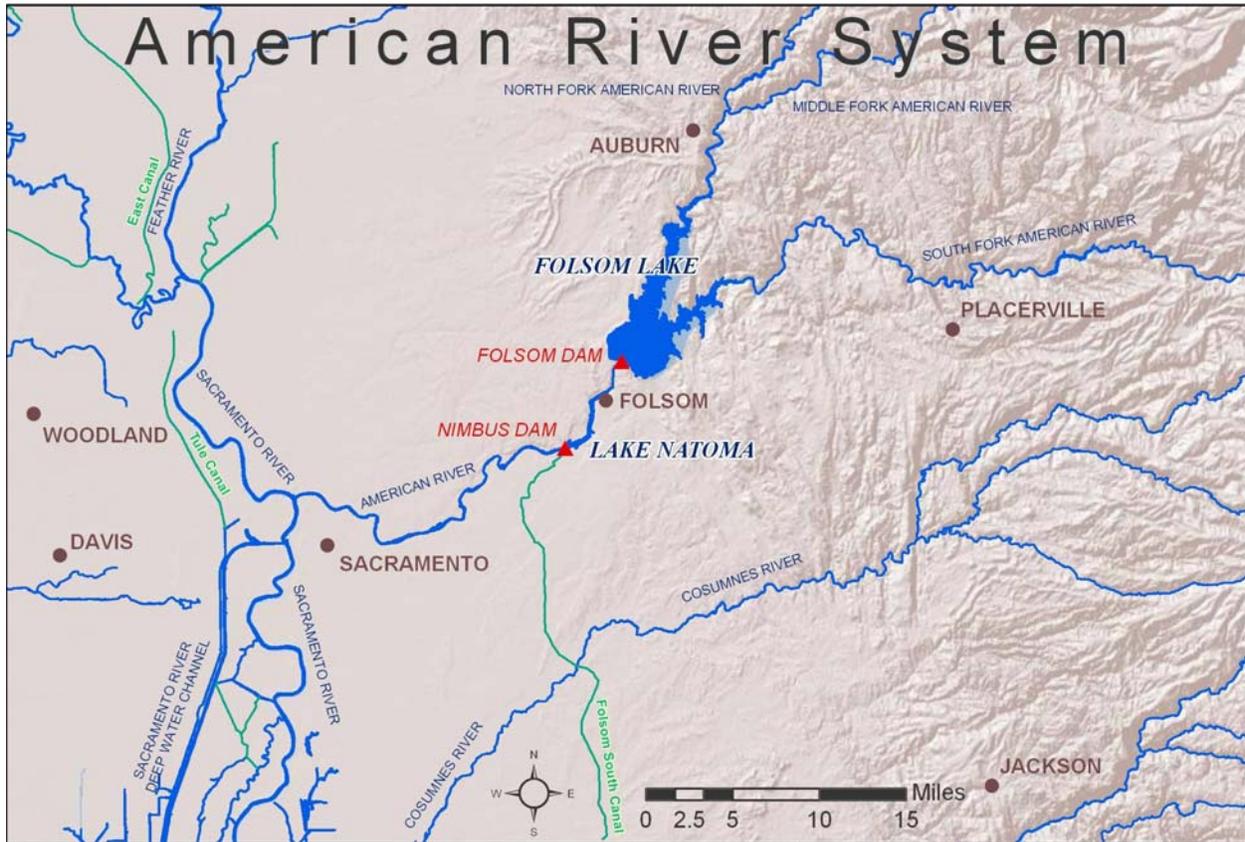


Figure P-7 American River System

Table P-7 provides Reclamation’s annual water deliveries for the period 2000 through 2006 in the American River Division. The totals reveal an increasing trend in water deliveries over that period. Present level of American River Division water demands are about 325 TAF per year. Future level (2030) water demands are modeled at near 800 TAF per year. The modeled deliveries vary depending on modeled annual water allocations.

Table P-7 Annual Water Delivery - American River Division

Year	Water Delivery (TAF)
2000	196
2001	206
2002	238
2003	271
2004	266
2005	297
2006	282

Releases from Folsom Dam are re-regulated approximately seven miles downstream by Nimbus Dam. This facility is also operated by Reclamation as part of the CVP. Nimbus Dam creates Lake Natoma, which serves as a forebay for diversions to the Folsom South Canal. This CVP facility serves water to M&I users in Sacramento County. Releases from Nimbus Dam to the American River pass through the Nimbus Powerplant, or, at flows in excess of 5,000 cfs, the spillway gates.

Although Folsom Lake is the main storage and flood control reservoir on the American River, numerous other small reservoirs in the upper basin provide hydroelectric generation and water supply. None of the upstream reservoirs have any specific flood control responsibilities. The total upstream reservoir storage above Folsom Lake is approximately 820,000 AF. Ninety percent of this upstream storage is contained by five reservoirs: French Meadows (136,000 AF); Hell Hole (208,000 AF); Loon Lake (76,000 AF); Union Valley (271,000 AF); and Ice House (46,000 AF). Reclamation has agreements with the operators of some of these reservoirs to coordinate operations for releases.

French Meadows and Hell Hole reservoirs, located on the Middle Fork of the American River, are owned and operated by the Placer County Water Agency (PCWA). The PCWA provides wholesale water to agricultural and urban areas within Placer County. For urban areas, the PCWA operates water treatment plants and sells wholesale treated water to municipalities that provide retail delivery to their customers. The cities of Rocklin and Lincoln receive water from the PCWA. Loon Lake (also on the Middle Fork), and Union Valley and Ice House reservoirs on the South Fork, are all operated by the Sacramento Municipal Utilities District (SMUD) for hydropower purposes.

Flood Control

Flood control requirements and regulating criteria are specified by the Corps and described in the Folsom Dam and Lake, American River, California Water Control Manual (Corps 1987). Flood control objectives for Folsom require the dam and lake are operated to:

- Protect the City of Sacramento and other areas within the Lower American River floodplain against reasonable probable rain floods.
- Control flows in the American River downstream from Folsom Dam to existing channel capacities, insofar as practicable, and to reduce flooding along the lower Sacramento River and in the Delta in conjunction with other CVP projects.
- Provide the maximum amount of water conservation storage without impairing the flood control functions of the reservoir.
- Provide the maximum amount of power practicable and be consistent with required flood control operations and the conservation functions of the reservoir.

From June 1 through September 30, no flood control storage restrictions exist. From October 1 through November 16 and from April 20 through May 31, reserving storage space for flood control is a function of the date only, with full flood reservation space required from November 17 through February 7. Beginning February 8 and continuing through April 20, flood reservation space is a function of both date and current hydrologic conditions in the basin.

If the inflow into Folsom Reservoir causes the storage to encroach into the space reserved for flood control, releases from Nimbus Dam are increased. Flood control regulations prescribe the following releases when water is stored within the flood control reservation space:

- Maximum inflow (after the storage entered into the flood control reservation space) of as much as 115,000 cfs, but not less than 20,000 cfs, when inflows are increasing.
- Releases will not be increased more than 15,000 cfs or decreased more than 10,000 cfs during any two-hour period.
- Flood control requirements override other operational considerations in the fall and winter period. Consequently, changes in river releases of short duration may occur.

In February 1986, the American River Basin experienced a significant flood event. Folsom Dam and Reservoir moderated the flood event and performed the flood control objectives, but with serious operational strains and concerns in the Lower American River and the overall protection of the communities in the floodplain areas. A similar flood event occurred in January 1997. Since then, significant review and enhancement of Lower American River flooding issues has occurred and continues to occur. A major element of those efforts has been the Sacramento Area Flood Control Agency (SAFCA) sponsored flood control plan diagram for Folsom Reservoir.

Since 1996, Reclamation has operated according to modified flood control criteria, which reserve 400 to 670 TAF of flood control space in Folsom and in a combination of three upstream reservoirs. This flood control plan, which provides additional protection for the Lower American River, is implemented through an agreement between Reclamation and the SAFCA. The terms of the agreement allow some of the empty reservoir space in Hell Hole, Union Valley, and French Meadows to be treated as if it were available in Folsom.

The SAFCA release criteria are generally equivalent to the Corps plan, except the SAFCA diagram may prescribe flood releases earlier than the Corps plan. The SAFCA diagram also relies on Folsom Dam outlet capacity to make the earlier flood releases. The outlet capacity at

Folsom Dam is currently limited to 32,000 cfs based on lake elevation. However, in general the SAFCA plan diagram provides greater flood protection than the existing Corps plan for communities in the American River floodplain.

Required flood control space under the SAFCA diagram will begin to decrease on March 1. Between March 1 and April 20, the rate of filling is a function of the date and available upstream space. As of April 21, the required flood reservation is about 225,000 AF. From April 21 to June 1, the required flood reservation is a function of the date only, with Folsom storage permitted to fill completely on June 1.

Fish and Wildlife Requirements in the Lower American River

The minimum allowable flows in the Lower American River are defined by SWRCB Decision 893 (D-893), which states that in the interest of fish conservation, releases should not ordinarily fall below 250 cfs between January 1 and September 15 or below 500 cfs at other times. D-893 minimum flows are rarely the controlling objective of CVP operations at Nimbus Dam. Nimbus Dam releases are nearly always controlled during significant portions of a WY by either flood control requirements or are coordinated with other CVP and SWP releases to meet downstream Sacramento-San Joaquin Delta WQCP requirements and CVP water supply objectives. Power regulation and management needs occasionally control Nimbus Dam releases. Nimbus Dam releases are expected to exceed the D-893 minimum flows in all but the driest of conditions.

Reclamation continues to work with the Sacramento Water Forum, the Service, NMFS, DFG, and other interested parties to integrate a revised flow management standard for the Lower American River into CVP operations and water rights. This project description and modeling assumptions include the operational components of the recommended Lower American River flows and is consistent with the proposed flow management standard. Until this action is adopted by the SWRCB, the minimum legally required flows will be defined by D-893. However, Reclamation intends to operate to the proposed flow management standard using releases of additional water pursuant to Section 3406 (b)(2) of the CVPIA. Use of additional (b)(2) flows above the proposed flow standard is envisioned on a case-by-case basis. Such additional use of (b)(2) flows would be subject to available resources and such use would be coupled with plans to not intentionally cause significantly lower river flows later in a WY. This case-by-case use of additional (b)(2) for minimum flows is not included in the modeling results.

Water temperature control operations in the Lower American River are affected by many factors and operational tradeoffs. These include available cold water resources, Nimbus release schedules, annual hydrology, Folsom power penstock shutter management flexibility, Folsom Dam Urban Water Supply TCD management, and Nimbus Hatchery considerations. Shutter and TCD management provide the majority of operational flexibility used to control downstream temperatures.

During the late 1960s, Reclamation designed a modification to the trashrack structures to provide selective withdrawal capability at Folsom Dam. Folsom Powerplant is located at the foot of Folsom Dam on the right abutment. Three 15-foot-diameter steel penstocks for delivering water to the turbines are embedded in the concrete section of the dam. The centerline of each penstock intake is at elevation 307.0 feet and the minimum power pool elevation is 328.5 feet. A reinforced concrete trashrack structure with steel trashracks protects each penstock intake.

The steel trashracks, located in five bays around each intake, extend the full height of the trashrack structure (between 281 and 428 feet). Steel guides were attached to the upstream side of the trashrack panels between elevation 281 and 401 feet. Forty-five 13-foot steel shutter panels (nine per bay) and operated by the gantry crane, were installed in these guides to select the level of withdrawal from the reservoir. The shutter panels are attached to one another, in a configuration starting with the top shutter, in groups of three, two, and four.

Selective withdrawal capability on the Folsom Dam Urban Water Supply Pipeline became operational in 2003. The centerline to the 84-inch-diameter Urban Water Supply intake is at elevation 317 feet. An enclosure structure extending from just below the water supply intake to an elevation of 442 feet was attached to the upstream face of Folsom Dam. A telescoping control gate allows for selective withdrawal of water anywhere between 331 and 401 feet elevation under normal operations.

The current objectives for water temperatures in the Lower American River address the needs for steelhead incubation and rearing during the late spring and summer, and for fall-run Chinook spawning and incubation starting in late October or early November.

Establishing the start date requires a balancing between forecasted release rates, the volume of available cold water, and the estimated date at which time Folsom Reservoir turns over and becomes isothermic. Reclamation will work to provide suitable spawning temperatures as early as possible (after November 1) to help avoid temperature related pre-spawning mortality of adults and reduced egg viability. Operations will be balanced against the possibility of running out of cold water and increasing downstream temperatures after spawning is initiated and creating temperature related effects to eggs already in the gravel.

The cold water resources available in any given year at Folsom Lake needed to meet the stated water temperature goals are often insufficient. Only in wetter hydrologic conditions is the volume of cold water resources available sufficient to meet all the water temperature objectives. Therefore, significant operational tradeoffs and flexibilities are considered part of an annual planning process for coordinating an operation strategy that realistically manages the limited cold water resources available. Reclamation's coordination on the planning and management of cold water resources is done through the B2IT and ARG groups.

The management process begins in the spring as Folsom Reservoir fills. All penstock shutters are put in the down position to isolate the colder water in the reservoir below an elevation of 401 feet. The reservoir water surface elevation must be at least 25 feet higher than the sill of the upper shutter (426 feet) to avoid cavitation of the power turbines. The earliest this can occur is in the month of March, due to the need to maintain flood control space in the reservoir during the winter. The pattern of spring run-off is then a significant factor in determining the availability of cold water for later use. Folsom inflow temperatures begin to increase and the lake starts to stratify as early as April. By the time the reservoir is filled or reaches peak storage (sometime in the May through June period), the reservoir is highly stratified with surface waters too warm to meet downstream temperature objectives. There are, however, times during the filling process when use of the spillway gates can be used to conserve cold water.

In the spring of 2003, high inflows and encroachment into the allowable storage space for flood control required releases that exceeded the available capacity of the power plant. Under these conditions, standard operations of Folsom calls for the use of the river outlets that would draw

upon the cold water pool. Instead, Reclamation reviewed the release requirements, Safety of Dams issues, reservoir temperature conditions, and the benefits to the cold water pool and determined that it could use the spillway gates to make the incremental releases above powerplant capacity, thereby conserving cold water for later use. The ability to take similar actions (as needed in the future) will be evaluated on a case-by-case basis.

The annual temperature management strategy and challenge is to balance conservation of cold water for later use in the fall, with the more immediate needs of steelhead during the summer. The planning and forecasting process for the use of the cold water pool begins in the spring as Folsom Reservoir fills. Actual Folsom Reservoir cold water resource availability becomes significantly more defined through the assessment of reservoir water temperature profiles and more definite projections of inflows and storage. Technical modeling analysis begins in the spring for the projected Lower American River water temperature management plan. The significant variables and key assumptions in the analysis include:

- Starting reservoir temperature conditions
- Forecasted inflow and outflow quantities
- Assumed meteorological conditions
- Assumed inflow temperatures
- Assumed Urban Water Supply TCD operations

A series of shutter management scenarios are then incorporated into the model to gain a better understanding of the potential for meeting both summer steelhead and fall salmon temperature needs. Most annual strategies contain significant tradeoffs and risks for water temperature management for steelhead and fall-run salmon goals and needs due to the frequently limited cold water resource. The planning process continues throughout the summer. New temperature forecasts and operational strategies are updated as more information on actual operations and ambient conditions is gained. This process is shared with the ARG.

Meeting both the summer steelhead and fall salmon temperature objectives without negatively impacting other CVP project purposes requires the final shutter pull be reserved for use in the fall to provide suitable fall-run Chinook salmon spawning temperatures. In most years, the volume of cold water is not sufficient to support strict compliance with the summer temperature target at the downstream end of the compliance reach (Watt Avenue Bridge) while at the same time reserving the final shutter pull for salmon, or in some cases, continue to meet steelhead objectives later in the summer. A strategy that is used under these conditions is to allow the annual compliance location water temperatures to warm towards the upper end of the annual water temperature design value before making a shutter pull. This management flexibility is essential to the annual management strategy to extend the effectiveness of cold water management through the summer and fall months.

The Urban Water Supply TCD has provided additional flexibility to conserve cold water for later use. Initial studies are being conducted evaluating the impact of warmer water deliveries to the water treatment plants receiving the water. It is expected that the TCD will be operated during the summer months and deliver water that is slightly warmer than that which could be used to

meet downstream temperatures (60°F to 62°F), but not so warm as to cause significant treatment issues.

Water temperatures feeding the Nimbus Fish Hatchery were historically too high for hatchery operations during some dry or critical years. Temperatures in the Nimbus Hatchery are generally in the desirable range of 42°F to 55°F, except for the months of June, July, August, and September. When temperatures get above 60°F during these months, the hatchery must begin to treat the fish with chemicals to prevent disease. When temperatures reach the 60°F to 70°F range, treatment becomes difficult and conditions become increasingly dangerous for the fish. When temperatures climb into the 60°F to 70°F range, hatchery personnel with Reclamation to determine a compromise operation of the temperature shutter at Folsom Dam for the release of cooler water.

Reclamation operates Nimbus to maintain the health of the hatchery fish while minimizing the loss of the cold water pool for fish spawning in the river during fall. This is done on a case-by-case basis and is different in various months and year types. Temperatures above 70°F in the hatchery usually mean the fish need to be moved to another hatchery. The real time implementation of CVPIA AFRP objective flows and meeting SWRCB D-1641 Delta standards with the limited water resources of the Lower American River requires a significant coordination effort to manage the cold water resources at Folsom Lake. Reclamation consults with the Service, NMFS, and DFG through B2IT when these types of difficult decisions are needed. In addition, Reclamation communicates with ARG on real time data and operational trade offs.

A fish diversion weir at the hatchery blocks Chinook salmon from continuing upstream and guides them to the hatchery fish ladder entrance. The fish diversion weir consists of eight piers on 30-foot spacing, including two riverbank abutments. Fish rack support frames and walkways are installed each fall via an overhead cable system. A pipe rack is then put in place to support the pipe pickets (¾-inch steel rods spaced on 2½-inch centers). The pipe rack rests on a submerged steel I-beam support frame that extends between the piers and forms the upper support structure for a rock filled crib foundation. The rock foundation has deteriorated with age and is subject to annual scour which can leave holes in the foundation that allow fish to pass if left unattended.

Fish rack supports and pickets are installed around September 15, of each year and correspond with the beginning of the fall-run Chinook salmon spawning season. A release equal to or less than 1,500 cfs from Nimbus Dam is required for safety and to provide full access to the fish rack supports. It takes six people approximately three days to install the fish rack supports and pickets. In years after high winter flows have caused active scour of the rock foundation, a short period (less than eight hours) of lower flow (approximately 500 cfs) is needed to remove debris from the I-beam support frames, seat the pipe racks, and fill holes in the rock foundation. Complete installation can take up to seven days, but is generally completed in less time. The fish rack supports and pickets are usually removed at the end of fall-run Chinook salmon spawning season (mid-January) when flows are less than 2,000 cfs. If Nimbus Dam releases are expected to exceed 5,000 cfs during the operational period, the pipe pickets are removed until flows decrease.

Delta Division and West San Joaquin Division

CVP Facilities

The CVP's Delta Division includes the Delta Cross Channel (DCC), the Contra Costa Canal and Pumping Plants, Contra Loma Dam, Martinez Dam, the Jones Pumping Plant, the Tracy Fish Collection Facility (TFCF), and the Delta Mendota Canal (DMC). The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. The Contra Costa Water District (CCWD) diversion facilities use CVP water resources to serve district customers directly and to operate CCWD's Los Vaqueros Project. The Jones Pumping Plant diverts water from the Delta to the head of the DMC. See map in Figure P-8.

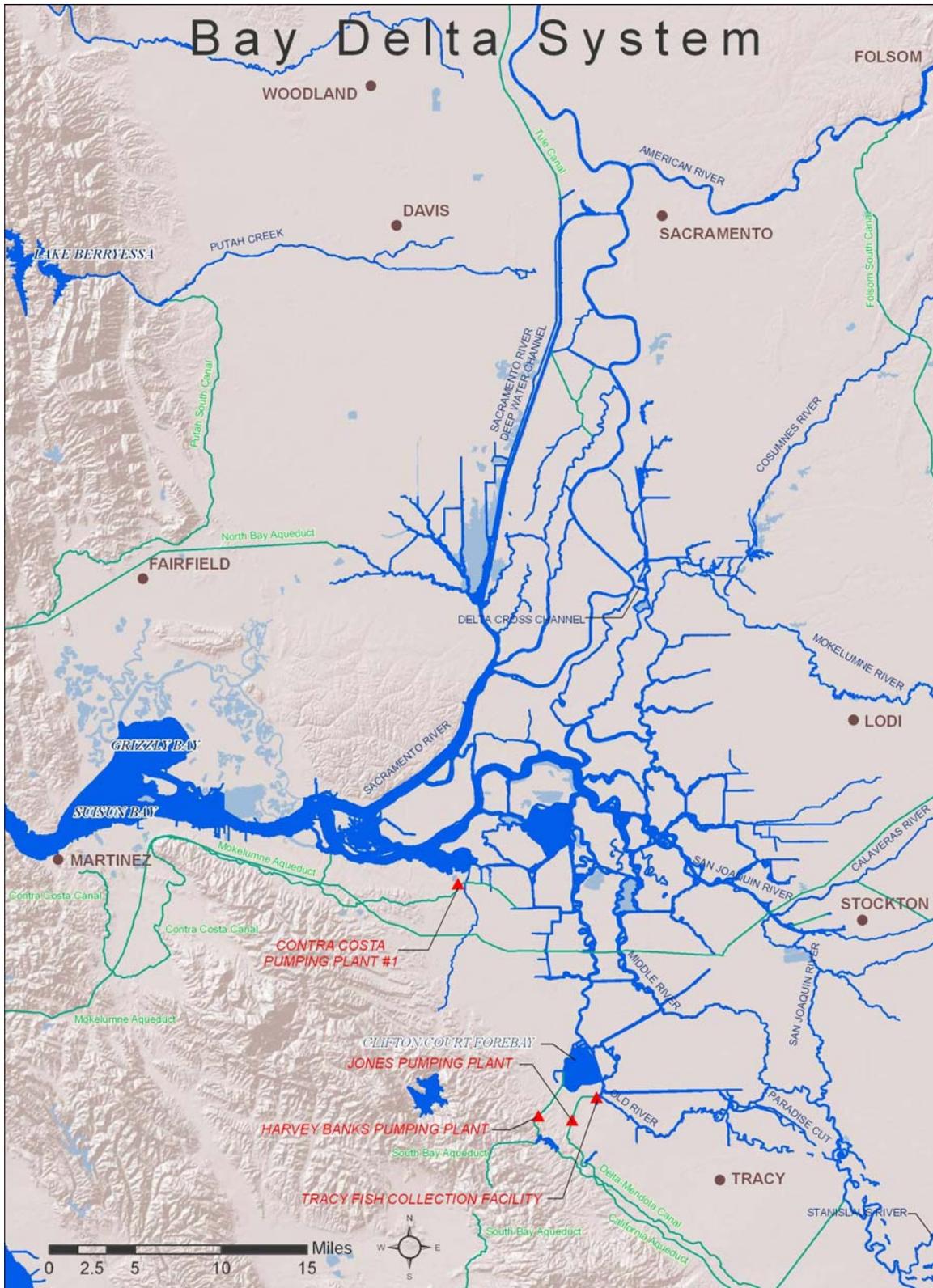


Figure P-8 Bay Delta System

Delta Cross Channel Operations

The DCC is a gated diversion channel in the Sacramento River near Walnut Grove and Snodgrass Slough. Flows into the DCC from the Sacramento River are controlled by two 60-foot by 30-foot radial gates. When the gates are open, water flows from the Sacramento River through the cross channel to channels of the lower Mokelumne and San Joaquin Rivers toward the interior Delta. The DCC operation improves water quality in the interior Delta by improving circulation patterns of good quality water from the Sacramento River towards Delta diversion facilities.

Reclamation operates the DCC in the open position to (1) improve the transfer of water from the Sacramento River to the export facilities at the Banks and Jones Pumping Plants, (2) improve water quality in the southern Delta, and (3) reduce salt water intrusion rates in the western Delta. During the late fall, winter, and spring, the gates are often periodically closed to protect out-migrating salmonids from entering the interior Delta. In addition, whenever flows in the Sacramento River at Sacramento reach 20,000 to 25,000 cfs (on a sustained basis) the gates are closed to reduce potential scouring and flooding that might occur in the channels on the downstream side of the gates.

Flow rates through the gates are determined by Sacramento River stage and are not affected by export rates in the South Delta. The DCC also serves as a link between the Mokelumne River and the Sacramento River for small craft, and is used extensively by recreational boaters and fishermen whenever it is open.

SWRCB D-1641 DCC standards provide for closure of the DCC gates for fisheries protection at certain times of the year. From November through January, the DCC may be closed for up to 45 days for fishery protection purposes. From February 1 through May 20, the gates are closed for fishery protection purposes. The gates may also be closed for 14 days for fishery protection purposes during the May 21 through June 15 time period. Reclamation determines the timing and duration of the closures after discussion with the Service, DFG, and NMFS. These discussions will occur through WOMT.

WOMT typically relies on monitoring for fish presence and movement in the Sacramento River and Delta, the salvage of salmon at the Tracy and Skinner facilities, and hydrologic cues when considering the timing of DCC closures. However, the overriding factors are current water quality conditions in the interior and western Delta. From mid-June to November, Reclamation usually keeps the gates open on a continuous basis. The DCC is also usually opened for the busy recreational Memorial Day weekend, if this is possible from a fishery, water quality, and flow standpoint.

The Salmon Decision Process (as provided in the biological assessment) includes “Indicators of Sensitive Periods for Salmon” such as hydrologic changes, detection of spring-run salmon or spring-run salmon surrogates at monitoring sites or the salvage facilities, and turbidity increases at monitoring sites to trigger the Salmon Decision Process.

The Salmon Decision Process is used by NMFS, DFG, the Service and Reclamation to facilitate the often complex coordination issues surrounding DCC gate operations and the purposes of fishery protection closures, Delta water quality, and/or export reductions. Inputs such as fish lifestage and size development, current hydrologic events, fish indicators (such as the Knight’s

Landing Catch Index and Sacramento Catch Index), and salvage at the export facilities, as well as current and projected Delta water quality conditions, are used to determine potential DCC closures and/or export reductions.

Jones Pumping Plant

The CVP and SWP use the Sacramento River, San Joaquin River, and Delta channels to transport water to export pumping plants located in the South Delta. The CVP's Jones Pumping Plant, about five miles north of Tracy, consists of six available pumps. The Jones Pumping Plant is located at the end of an earth-lined intake channel about 2.5 miles in length. At the head of the intake channel, louver screens (that are part of the Tracy Fish Collection Facility) intercept fish, which are then collected, held, and transported by tanker truck to release sites far away from the pumping plants.

Jones Pumping Plant has a permitted diversion capacity of 4,600 cfs with maximum pumping rates typically ranging from 4500 to 4300 cfs during the peak of the irrigation season and approximately 4,200 cfs during the winter non-irrigation season until construction and full operation of the proposed DMC/California Aqueduct Intertie, described later in the project description. The winter-time constraints at the Jones Pumping Plant are the result of a DMC freeboard constriction near O'Neill Forebay, O'Neill Pumping Plant capacity, and the current water demand in the upper sections of the DMC.

Tracy Fish Collection Facility

The Tracy Fish Collection Facility (TFCF) is located in the south-west portion of the Sacramento-San Joaquin Delta and uses behavioral barriers consisting of primary and secondary louvers as illustrated in Figure P-9, to guide entrained fish into holding tanks before transport by truck to release sites within the Delta. The original design of the TFCF focused on smaller fish (<200 mm) that would have difficulty fighting the strong pumping plant induced flows since the intake is essentially open to the Delta and also impacted by tidal action.

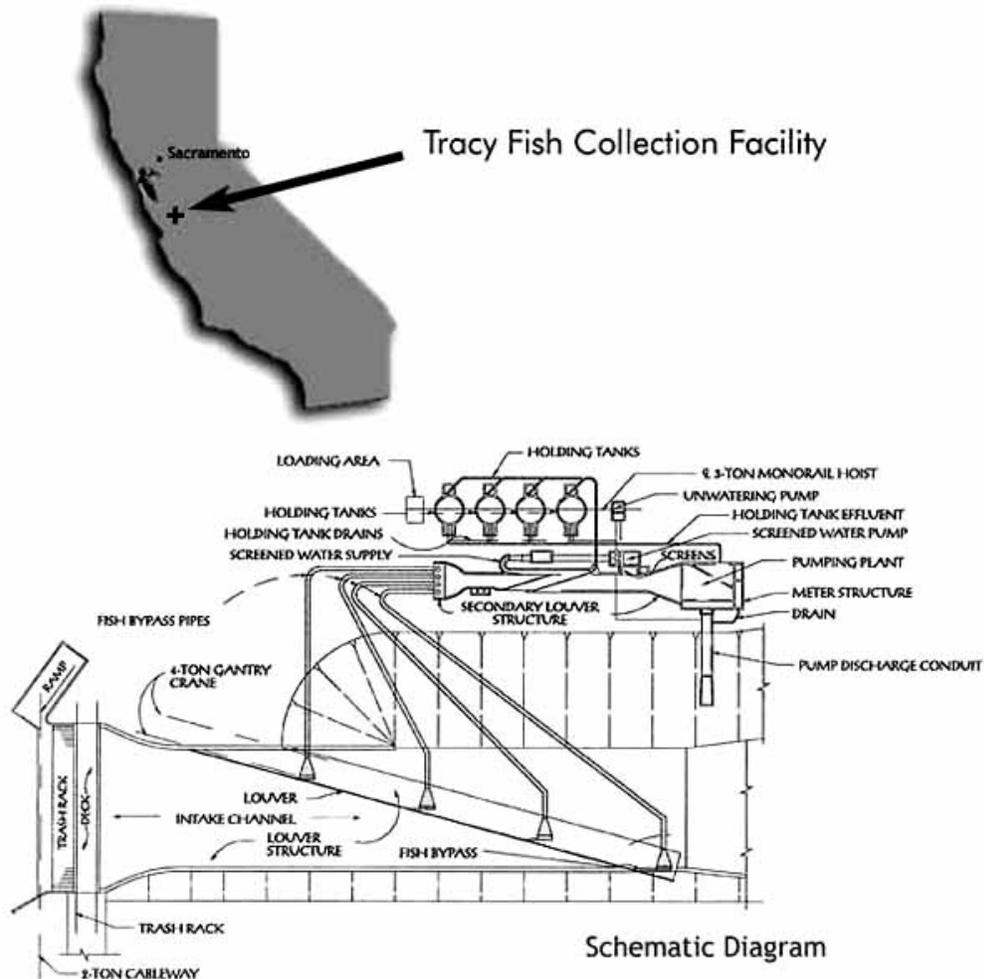


Figure P-9 Tracy Fish Collection Facility Diagram

The primary louvers are located in the primary channel just downstream of the trashrack structure. The secondary louvers are located in the secondary channel just downstream of the traveling water screen. The louvers allow water to pass through onto the pumping plant but the openings between the slats are tight enough and angled against the flow of water such a way as to prevent most fish from passing between them and instead enter one of four bypass entrances along the louver arrays.

There are approximately 52 different species of fish entrained into the TFCF per year; however, the total numbers are significantly different for the various species salvaged. Also, it is difficult if not impossible to determine exactly how many safely make it all the way to the collection tanks awaiting transport back to the Delta. Hauling trucks used to transport salvaged fish to release sites inject oxygen in the tanks and contain an eight parts per thousand salt solution to reduce stress. The CVP uses two release sites, one on the Sacramento River near Horseshoe Bend and the other on the San Joaquin River immediately upstream of the Antioch Bridge. During a facility inspection a few years ago, TFCF personnel noticed significant decay of the transition boxes and conduits between the primary and secondary louvers. The temporary rehabilitation of these transition boxes and conduits was performed during the fall and winter of

2002. Extensive rehabilitation of the transition boxes and conduits was completed during the San Joaquin pulse period of 2004.

When South Delta hydraulic conditions allow, and within the original design criteria for the TFCF, the louvers are operated with the D-1485 and the following water velocities: for striped bass of approximately 1 foot per second (ft/s) from May 15 through October 31, and for salmon of approximately 3 ft/s from November 1 through May 14. Channel velocity criteria are a function of bypass ratios through the facility. Due to changes in South Delta hydrology over the past fifty years, the present-day TFCF is able to meet these conditions approximately 55 percent of the time.

Fish passing through the facility will be sampled at intervals of no less than 20 minutes every 2 hours when listed fish are present, generally December through June. When fish are not present, sampling intervals will be 10 minutes every 2 hours. Fish observed during sampling intervals are identified to species, measured to fork length, examined for marks or tags, and placed in the collection facilities for transport by tanker truck to the release sites in the North Delta away from the pumps. In addition, Reclamation will monitor for the presence of spent female delta smelt in anticipation of expanding the salvage operations to include sub 20 mm larval delta smelt detection.

Contra Costa Water District Diversion Facilities

CCWD diverts water from the Delta for irrigation and M&I uses under CVP contract, under its own permit and license at Mallard Slough, and under its own Los Vaqueros water right permit at Old River near State Route 4. CCWD's system includes intake facilities at Mallard Slough, Rock Slough, and Old River near State Route 4; the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir. CCWD will be adding a fourth diversion point on Victoria Canal (the Alternative Intake Project described below) to help meet its water quality goals. The Rock Slough intake facilities, the Contra Costa Canal, and the shortcut pipeline are owned by Reclamation, and operated and maintained by CCWD under contract with Reclamation. Mallard Slough Intake, Old River Intake, and Los Vaqueros Reservoir are owned and operated by CCWD.

The Mallard Slough Intake is located at the southern end of a 3,000-foot-long channel running due south from Suisun Bay, near Mallard Slough (across from Chipps Island). The Mallard Slough Pump Station was refurbished in 2002, which included constructing a positive barrier fish screen at this intake. The Mallard Slough Intake can pump up to 39.3 cfs. CCWD's permit issued by the SWRCB authorizes diversions of up to 26,780 acre-feet per year at Mallard Slough. However, this intake is rarely used due to the generally high salinity at this location. Pumping at the Mallard Slough Intake since 1993 has on average accounted for about 3 percent of CCWD's total diversions. When CCWD diverts water at the Mallard Slough Intake, CCWD reduces pumping of CVP water at its other intakes, primarily at the Rock Slough Intake.

The Rock Slough Intake is located about four miles southeast of Oakley, where water flows through a trash rack into the earth-lined portion of the Contra Costa Canal. This section of the canal is open to tidal influence and continues for four miles to Pumping Plant 1, which has capacity to pump up to 350 cfs into the concrete-lined portion of the canal. Prior to completion of the Los Vaqueros Project in 1997, this was CCWD's primary diversion point. Pumping Plant 1 is not screened. Reclamation, in collaboration with CCWD, is responsible for constructing a

fish screen as authorized by CVPIA and required by the 1993 Service biological opinion for the Los Vaqueros Project. Reclamation has received an extension on fish screen construction until December 2008, and is preparing to request a further extension until 2013 because the requirements for screen design will change when CCWD completes the Contra Costa Canal Replacement Project, which will replace the earth-lined section of canal from Rock Slough to Pumping Plant 1 with a pipeline. When completed, the Canal Replacement project will eliminate tidal flows into the Canal intake section and should significantly reduce entrainment impacts and improve the feasibility of screening Rock Slough. Typically, CCWD diverts about 17 percent of its total supply through the Rock Slough intake.

Construction of the Old River Intake was completed in 1997 as a part of the Los Vaqueros Project. The Old River Intake is located on Old River near State Route 4. It has a positive-barrier fish screen and a pumping capacity of 250 cfs, and can pump water via pipeline either to the Contra Costa Canal or to Los Vaqueros Reservoir. Pumping to storage in Los Vaqueros Reservoir is limited to 200 cfs by the terms of the Los Vaqueros Project biological opinions and by D-1629, the State Board water right decision for the Project. Typically, CCWD diverts about 80 percent of its total supply through the Old River Intake.

As described above, the first four miles of the Contra Costa Canal is earth-lined; after Pumping Plant 1, the Contra Costa Canal is concrete-lined and continues for 44 miles to its termination point in Martinez Reservoir. Pumping Plants 1 through 4 lift the water to an elevation of 127 feet. A blending facility just downstream of Pumping Plant 4 allows water from the Los Vaqueros Project pipeline and water from the Contra Costa Canal to mix to maintain CCWD's delivered water quality goals for salinity. Canal capacity is 350 cfs at this blending facility and decreases to 22 cfs at the terminus at Martinez Reservoir, which provides flow regulation. The Contra Loma Reservoir is connected to the Canal and provides flow regulation and emergency storage. Two short canals, Clayton Canal and Ygnacio Canal, are integrated into the distribution system. The Clayton Canal is no longer in service.

Los Vaqueros Reservoir is an off-stream reservoir with a capacity of 100 thousand acre-feet (TAF). Construction was completed and filling started in 1998 as part of the Los Vaqueros Project to improve delivered water quality and emergency storage reliability for CCWD's customers. Releases from Los Vaqueros Reservoir are conveyed to the Contra Costa Canal via a pipeline.

CCWD diverts approximately 127 TAF per year in total, of which approximately 110 TAF is CVP contract supply. In winter and spring months when the Delta is relatively fresh (generally January through July), demand is supplied by direct diversion from the Delta. In addition, when salinity is low enough, Los Vaqueros Reservoir is filled at a rate of up to 200 cfs from the Old River Intake. However, the biological opinions for the Los Vaqueros Project and the Alternative Intake Project, CCWD's memorandum of understanding with the DFG, and SWRCB D-1629 of the State Water Resources Control Board include fisheries protection measures consisting of a 75-day period during which CCWD does not fill Los Vaqueros Reservoir and a concurrent 30-day period during which CCWD halts all diversions from the Delta, provided that Los Vaqueros Reservoir storage is above emergency levels. The default dates for the no-fill and no-diversion periods are March 15 through May 31 and April 1 through April 30, respectively. The Service, NMFS and DFG can change these dates to best protect the subject species. During the no-diversion period, CCWD customer demand is met by releases from Los Vaqueros Reservoir.

In the late summer and fall months, CCWD releases water from Los Vaqueros Reservoir to blend with higher-salinity direct diversions from the Delta to meet CCWD water quality goals.

In addition to the existing 75-day no-fill period (March 15-May 31) and the concurrent no-diversion 30-day period, beginning in the February following the first operation of the Alternative Intake Project, CCWD shall not divert water to store in Los Vaqueros Reservoir for 15 days from February 14 through February 28, provided that reservoir storage is at or above 90 TAF on February 1; if reservoir storage is at or above 80 TAF on February 1 but below 90 TAF, CCWD shall not divert water to storage in Los Vaqueros Reservoir for 10 days from February 19 through February 28; if reservoir storage is at or above 70 TAF on Feb 1, but below 80 TAF CCWD shall not divert water to storage in Los Vaqueros Reservoir for 5 days from February 24 through February 28.

Water Demands—Delta Mendota Canal (DMC) and San Luis Unit

Water demands for the DMC and San Luis Unit are primarily composed of three separate types: CVP water service contractors, exchange contractors, and wildlife refuge contractors. A significantly different relationship exists between Reclamation and each of these three groups. Exchange contractors “exchanged” their senior rights to water in the San Joaquin River for a CVP water supply from the Delta. Reclamation thus guaranteed the exchange contractors a firm water supply of 840,000 AF per annum, with a maximum reduction under the Shasta critical year criteria to an annual water supply of 650,000 AF.

Conversely, water service contractors did not have water rights. Agricultural water service contractors also receive their supply from the Delta, but their supplies are subject to the availability of CVP water supplies that can be developed and reductions in contractual supply can exceed 25 percent. Wildlife refuge contractors provide water supplies to specific managed lands for wildlife purposes and the CVP contract water supply can be reduced under critically dry conditions up to 25 percent.

To achieve the best operation of the CVP, it is necessary to combine the contractual demands of these three types of contractors to achieve an overall pattern of requests for water. In most years sufficient supplies are not available to meet all water demands because of reductions in CVP water supplies which are due to restricted Delta pumping capability. In some dry or critically dry years, water deliveries are limited because there is insufficient storage in northern CVP reservoirs to meet all in-stream fishery objectives including water temperatures, and to make additional water deliveries via the Jones Pumping Plant. The scheduling of water demands, together with the scheduling of the releases of water supplies from the northern CVP to meet those demands, is a CVP operational objective that is intertwined with the Trinity, Sacramento, and American River operations.

East Side Division

New Melones Operations

The Stanislaus River originates in the western slopes of the Sierra Nevada and drains a watershed of approximately 900 square miles. The average unimpaired runoff in the basin is approximately 1.2 MAF per year; the median historical unimpaired runoff is 1.1 MAF per year. Snowmelt contributes the largest portion of the flows in the Stanislaus River, with the highest runoff occurring in the months of April, May, and June. See map in Figure P-10.

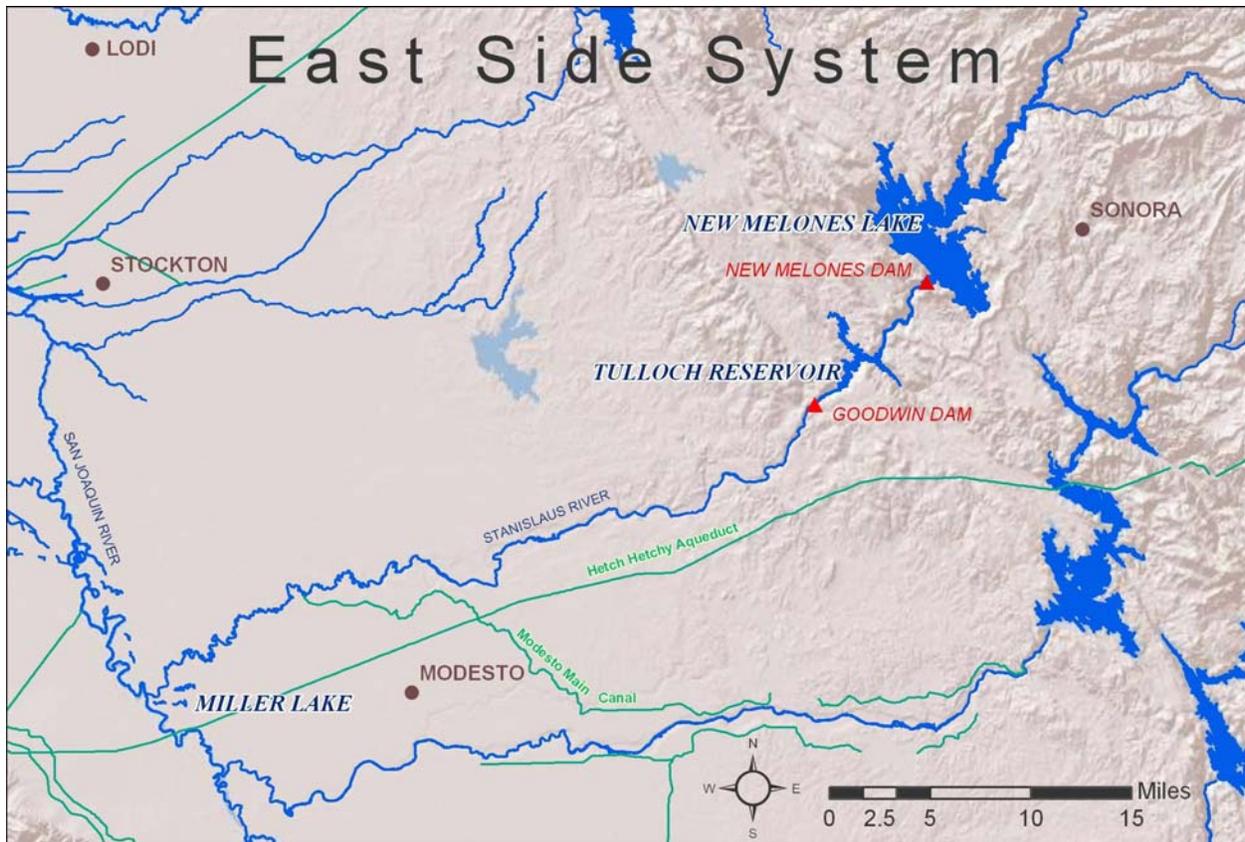


Figure P-10 East Side System

Currently, the flow in the lower Stanislaus River is primarily controlled by New Melones Reservoir, which has a storage capacity of about 2.4 MAF. The reservoir was completed by the Corps in 1978 and approved for filling in 1983. New Melones Reservoir is located approximately 60 miles upstream from the confluence of the Stanislaus River and the San Joaquin River and is operated by Reclamation. Congressional authorization for New Melones integrates New Melones Reservoir as a financial component of the CVP, but it is authorized to provide water supply benefits within the defined Stanislaus Basin per the 1980 ROD before additional water supplies can be used out of the defined Stanislaus Basin.

New Melones Reservoir is operated primarily for purposes of water supply, flood control, power generation, fishery enhancement, and water quality improvement in the lower San Joaquin River. The reservoir and river also provide recreation benefits. Flood control operations are conducted in conformance with the Corps' operational guidelines.

Another major water storage project in the Stanislaus River watershed is the Tri-Dam Project, a power generation project that consists of Donnell and Beardsley Dams, located upstream of New Melones Reservoir on the middle fork Stanislaus River, and Tulloch Dam and Powerplant, located approximately 6 miles downstream of New Melones Dam on the main stem Stanislaus River. New Spicer Reservoir on the north fork of the Stanislaus River has a storage capacity of 189,000 AF and is used for power generation.

Releases from Donnell and Beardsley Dams affect inflows to New Melones Reservoir. Under contractual agreements between Reclamation, the Oakdale Irrigation District (OID), and South San Joaquin Irrigation District (SSJID), Tulloch Reservoir provides afterbay storage to re-regulate power releases from New Melones Powerplant. The main water diversion point on the Stanislaus River is Goodwin Dam, located approximately 1.9 miles downstream of Tulloch Dam.

Goodwin Dam, constructed by OID and SSJID in 1912, creates a re-regulating reservoir for releases from Tulloch Powerplant and provides for diversions to canals north and south of the Stanislaus River for delivery to OID and SSJID. Water impounded behind Goodwin Dam may be pumped into the Goodwin Tunnel for deliveries to the Central San Joaquin Water Conservation District and the Stockton East Water District.

Twenty ungaged tributaries contribute flow to the lower portion of the Stanislaus River, below Goodwin Dam. These streams provide intermittent flows, occurring primarily during the months of November through April. Agricultural return flows, as well as operational spills from irrigation canals receiving water from both the Stanislaus and Tuolumne Rivers, enter the lower portion of the Stanislaus River. In addition, a portion of the flow in the lower reach of the Stanislaus River originates from groundwater accretions.

Flood Control

The New Melones Reservoir flood control operation is coordinated with the operation of Tulloch Reservoir. The flood control objective is to maintain flood flows at the Orange Blossom Bridge at less than 8,000 cfs. When possible, however, releases from Tulloch Dam are maintained at levels that would not result in downstream flows in excess of 1,250 cfs to 1,500 cfs because of seepage problems in agricultural lands adjoining the river associated with flows above this level. Up to 450,000 AF of the 2.4 MAF storage volume in New Melones Reservoir is dedicated for flood control and 10,000 AF of Tulloch Reservoir storage is set aside for flood control. Based upon the flood control diagrams prepared by the Corps, part or all of the dedicated flood control storage may be used for conservation storage, depending on the time of year and the current flood hazard.

Requirements for New Melones Operations

The operating criteria for New Melones Reservoir are affected by (1) water rights, (2) in-stream fish and wildlife flow requirements (3) SWRCB D-1641 Vernalis water quality requirements, (4) dissolved oxygen (DO) requirements on the Stanislaus River, (5) SWRCB D-1641 Vernalis flow requirements, (6) CVP contracts, and (7) flood control considerations. Water released from New Melones Dam and Powerplant is re-regulated at Tulloch Reservoir and is either diverted at Goodwin Dam or released from Goodwin Dam to the lower Stanislaus River.

Flows in the lower Stanislaus River serve multiple purposes concurrently. The purposes include water supply for riparian water right holders, fishery management objectives, and DO requirements per SWRCB D-1422. In addition, water from the Stanislaus River enters the San Joaquin River where it contributes to flow and helps improve water quality conditions at Vernalis. Requirement D-1422, issued in 1973, provided the primary operational criteria for New Melones Reservoir and permitted Reclamation to appropriate water from the Stanislaus River for irrigation and M&I uses. D-1422 requires the operation of New Melones Reservoir

include releases for existing water rights, fish and wildlife enhancement, and the maintenance of water quality conditions on the Stanislaus and San Joaquin Rivers.

Water Rights Obligations

When Reclamation began operations of New Melones Reservoir in 1980, the obligations for releases (to meet downstream water rights) were defined in a 1972 Agreement and Stipulation among Reclamation, OID, and SSJID. The 1972 Agreement and Stipulation required Reclamation release annual inflows to New Melones Reservoir of up to 654,000 AF per year for diversion at Goodwin Dam by OID and SSJID, in recognition of their prior water rights. Actual historical diversions prior to 1972 varied considerably, depending upon hydrologic conditions. In addition to releases for diversion by OID and SSJID, water is released from New Melones Reservoir to satisfy riparian water rights totaling approximately 48,000 AF annually downstream of Goodwin Dam.

In 1988, following a year of low inflow to New Melones Reservoir, the Agreement and Stipulation among Reclamation, OID, and SSJID was superseded by an agreement that provided for conservation storage by OID and SSJID. The new agreement required Reclamation to release New Melones Reservoir inflows of up to 600,000 AF each year for diversion at Goodwin Dam by OID and SSJID.

In years when annual inflows to New Melones Reservoir are less than 600,000 AF, Reclamation provides all inflows plus one-third the difference between the inflow for that year and 600,000 AF per year. The 1988 Agreement and Stipulation created a conservation account in which the difference between the entitled quantity and the actual quantity diverted by OID and SSJID in a year may be stored in New Melones Reservoir for use in subsequent years. This conservation account has a maximum storage limit of 200,000 AF, and withdrawals are constrained by criteria in the agreement.

In-stream Flow Requirements

Under D-1422, Reclamation is required to release 98,000 AF of water per year, with a reduction to 69,000 AF in critical years, from New Melones Reservoir to the Stanislaus River on a distribution pattern to be specified each year by DFG for fish and wildlife purposes. In 1987, an agreement between Reclamation and DFG provided for increased releases from New Melones to enhance fishery resources for an interim period, during which habitat requirements were to be better defined and a study of Chinook salmon fisheries on the Stanislaus River would be completed.

During the study period, releases for in-stream flows would range from 98,300 to 302,100 AF per year. The exact quantity to be released each year was to be determined based on a formulation involving storage, projected inflows, projected water supply, water quality demands, projected CVP contractor demands, and target carryover storage. Because of dry hydrologic conditions during the 1987 to 1992 drought period, the ability to provide increased releases was limited. The Service published the results of a 1993 study, which recommended a minimum in-stream flow on the Stanislaus River of 155,700 AF per year for spawning and rearing.

Dissolved Oxygen Requirements

SWRCB D-1422 requires that water be released from New Melones Reservoir to maintain DO standards in the Stanislaus River. The 1995 revision to the WQCP established a minimum DO concentration of 7 milligrams per liter (mg/L), as measured on the Stanislaus River near Ripon.

Vernalis Water Quality Requirement

SWRCB D-1422 also specifies that New Melones Reservoir must operate to maintain average monthly level total dissolved solids (TDS), commonly measured as a conversion from electrical conductivity, in the San Joaquin River at Vernalis as it enters the Delta. SWRCB D-1422 specifies an average monthly concentration of 500 parts per million (ppm) TDS for all months. Historically, releases were made from New Melones Reservoir for this standard, but due to shortages in water supply and high concentrations of TDS upstream of the confluence of the Stanislaus River, the D-1422 standard was not always met during the 1987-1992 drought. Reclamation has always met the D-1641 standard since 1995.

In the past, when sufficient supplies were not available to meet the water quality standards for the entire year, the emphasis for use of the available water was during the irrigation season, generally from April through September. SWRCB D-1641 modified the water quality objectives at Vernalis to include the irrigation and non-irrigation season objectives contained in the 1995 Bay-Delta WQCP. The revised standard is an average monthly electric conductivity 0.7 milliSiemens per centimeter (mS/cm) (approximately 455 ppm TDS) during the months of April through August, and 1.0 mS/cm (approximately 650 ppm TDS) during the months of September through March.

Bay-Delta Vernalis Flow Requirements

SWRCB D-1641 sets flow requirements on the San Joaquin River at Vernalis from February to June. These flows are commonly known as San Joaquin River base flows.

Table P-8 San Joaquin base flows-Vernalis

Water Year Class	February-June Flow (cfs)*
Critical	710-1140
Dry	1420-2280
Below Normal	1420-2280
Above Normal	2130-3420
Wet	2130-3420

*the higher flow required when X2 is required to be at or west of Chipps Island

Since D-1641 has been in place, the San Joaquin base flow requirements have at times, been an additional demand on the New Melones water supply beyond that provided for in the Interim Plan of Operation (IPO).

CVP Contracts

Reclamation entered into water service contracts for the delivery of water from New Melones Reservoir, based on a 1980 hydrologic evaluation of the long-term availability of water in the

Stanislaus River Basin. Based on this study, Reclamation entered into a long-term water service contract for up to 49,000 AF per year of water annually (based on a firm water supply), and two long-term water service contracts totaling 106,000 AF per year (based on an interim water supply). Water deliveries under these contracts were not immediately available prior to 1992 for two reasons: 1) new diversion facilities were required to be constructed and prior to 1992 were not yet fully operational; and 2) water supplies were severely limited during the 1987 to 1992 drought.

New Melones Operations

Since 1997, the New Melones IPO has guided CVP operations on the Stanislaus River. The IPO was developed as a joint effort between Reclamation and the Service, in conjunction with the Stanislaus River Basin Stakeholders (SRBS). The process of developing the plan began in 1995 with a goal to develop a long-term management plan with clear operating criteria, given a fundamental recognition by all parties that New Melones Reservoir water supplies are over-committed on a long-term basis, and consequently, unable to meet all the potential beneficial uses designated as purposes. Reclamation will continue to use the interim plan.

The IPO defines categories of water supply based on storage and projected inflow. It then allocates annual water quantities for in-stream fishery enhancement (1987 DFG Agreement and CVPIA Section 3406(b)(2) management), SWRCB D-1641 San Joaquin River water quality requirements (Water Quality), SWRCB D-1641 Vernalis flow requirements (Bay-Delta), and use by CVP contractors.

Table P-9 Inflow characterization for the New Melones IPO

Annual water supply category	March-September forecasted inflow plus end of February storage (TAF)
Low	0 – 1400
Medium-low	1400 – 2000
Medium	2000 – 2500
Medium-high	2500 – 3000
High	3000 – 6000

Table P-10 New Melones IPO flow objectives (in thousand AF)

Storage plus inflow		Fishery		Vernalis water quality		Bay-Delta		CVP contractors	
From	To	From	To	From	To	From	To	From	To
1400	2000	98	125	70	80	0	0	0	0
2000	2500	125	345	80	175	0	0	0	59
2500	3000	345	467	175	250	75	75	90	90
3000	6000	467	467	250	250	75	75	90	90

When the water supply condition is determined to be in the “Low” IPO designation, the IPO proposes no operations guidance. In this case, Reclamation would meet with the SRBS group to coordinate a practical strategy to guide annual New Melones Reservoir operations under this very limited water supply condition. In addition, the IPO is limited in its ability to fully provide for the D-1641 Vernalis salinity and base flow objectives using Stanislaus River flows in all year types. If the Vernalis salinity standard cannot be met using the IPO designated Goodwin release pattern, then an additional volume of water is dedicated to meet the salinity standard. This permit obligation is met before an allocation is made to CVPIA (b)(2) uses or CVP Eastside contracts.

CVPIA Section 3406 (b)(2) releases from New Melones Reservoir consist of the portion of the fishery flow management volume utilized that is greater than the 1987 DFG Agreement and the volume used in meeting the Vernalis water quality requirements and/or Ripon dissolved oxygen requirements.

New Melones Reservoir – Future Operations

To provide a basis to develop a long-term operating plan, Reclamation sponsored updates to the San Joaquin River Basin component of CALSIM II to better represent and model how river flows and water quality in the San Joaquin River are likely to affect operations at New Melones Reservoir.

This new information and the resulting CALSIM II model improvements were peer reviewed in 2004 and additional refinements were made to the model based on that review. The resulting model is considered by Reclamation to be the best representation of the significant hydrologic and water quality dynamics that currently affect New Melones operations.

The relationships developed for the current model are significantly different than the assumptions used to develop the 1997 IPO. Given that the 1997 IPO was only meant to be a temporary management tool and that water quality conditions are changing in the basin, the fundamental operating assumptions of the 1997 IPO are not entirely consistent with the improved CALSIM II model.

As an important first step in evaluating the effects of a permanent operating plan for New Melones, Reclamation concludes that the following general assumptions best represents future New Melones operations for the purpose of this consultation. These operational parameters recognize existing priorities in beneficial uses, and the 1928 to 1934 drought is used as the basis to evaluate risks associated with successive dry years. The current analysis of future New Melones operations is based on two sets of project beneficial uses: a primary set of uses tied to pre-existing water rights and long-standing permit terms, and a secondary set of uses that came into effect after the primary set.

The operational parameters for allocation to Eastside Division water service contracts and CVPIA (b)(2) are based on available yield over the 1928-34 drought period. The available project quantity is allocated between water service contracts and CVPIA (b)(2) use.

Table P-11 Fundamental considerations used to define the New Melones Reservoir operations parameters.

<p>CVP Beneficial Uses (Prior to 1992). The pre-1992 long-term beneficial uses for Reclamation’s water supply/water rights at New Melones Reservoir are as follows:</p> <ul style="list-style-type: none"> • Existing OID/SSJID Settlement Contract • D-1641 Vernalis Salinity Objective • Stanislaus River Dissolved Oxygen • 1987 DFG Fishery Agreement <p>CVP Beneficial Uses (After 1992). The beneficial uses for Reclamation’s water supply/water rights at New Melones Reservoir established after 1992 are as follows:</p> <ul style="list-style-type: none"> • D-1641 Vernalis Feb-June Base Flow objective • CVPIA (b)(2) water to increase Goodwin Dam releases for AFRP instream flow objectives • CVP Eastside Division water services contracts
<p>Basic Allocation Bands. Similar to the 1997 IPO, the representation of future New Melones operations defines categories of water supply based on projected storage and inflows.</p>
<p>1) High Allocation Years (Projected New Melones Carryover Storage greater than 1.7 MAF End of September)</p> <ul style="list-style-type: none"> • DFG allocation is 302 TAF • Vernalis flow objectives are met • CVPIA (b)(2) water allocation is 155 TAF • CVP Eastside contract allocation is 155 TAF • Vernalis Salinity and Stanislaus River DO objectives are met <p>2) Mid-Allocation Years</p> <ul style="list-style-type: none"> • DFG allocation is 98.3 TAF • Vernalis flow objectives are met • CVPIA B2 water allocation to meet instream fishery needs is to be determined in coordination with USFWS, DFG and NMFS in a collaborative planning process • Vernalis Salinity and Stanislaus River DO objectives are met • CVP Eastside contract allocation is to be determined after all the instream needs are met <p>3) “Conference Year” conditions - New Melones Index is less than 1.0 MAF.</p> <ul style="list-style-type: none"> • As with the IPO, if the projected end of September New Melones Index (i.e. projected inflow plus storage) is less than 1.0 MAF, Reclamation would meet with USFWS stakeholders, DFG, and NMFS to coordinate a practical strategy to guide New Melones Reservoir operations to meet the most basic needs associated with Stanislaus River instream flows, DO, and Vernalis salinity. Allocation for CVPIA (b)(2) flows would be determined in coordination with USFWS, DFG and NMFS.

San Joaquin River Agreement/Vernalis Adaptive Management Plan (VAMP)

Adopted by the SWRCB in D-1641, the San Joaquin River Agreement (SJRA) includes a 12-year program providing for flows and exports in the lower San Joaquin River during a 31-day pulse flow period during April and May. It also provides for the collection of experimental data during that time to further the understanding of the effects of flows, exports, and the barrier at the head of Old River on salmon survival. This experimental program is commonly referred to as the VAMP (Vernalis Adaptive Management Plan). The SWRCB indicates that VAMP experimental data will be used to create permanent objectives for the pulse flow period. Reclamation and DWR intend to continue a VAMP-like action for the foreseeable future or until the SWRCB adopts new permanent objectives that replace the current program. It is anticipated that new SWRCB objectives will be as protective as the current program and that such protections will remain in place through 2030.

Continuation of the VAMP operations for a period of time after the expiration of SJRA may be considered reasonably foreseeable because it could be accomplished using well established capabilities and authorities already available to Reclamation and DWR. Specifically, flow increases to achieve VAMP targets could be provided using CVPIA section 3406 (b)(1), (b)(2), and (b)(3). Export reductions would be provided by Reclamation using CVPIA section 3406 (b)(1) or (b)(2), and by DWR using the substitution of the water supply acquired from the Yuba Accord flows. The combination of those operations elements would enable Reclamation and DWR to meet VAMP objectives in most years. Chapter 9 of the biological assessment contains an analysis of the capability of DWR to provide for export reduction during the VAMP pulse flow period, using the 48,000 acre feet of substitute supply assumed to be available from the Yuba Accord.

Within the SJRA, the 1997 IPO has been assumed as the baseline operation for New Melones Reservoir, which forms part of the existing flow condition. The existing flow condition is used to compute the supplemental flows which will be provided on the San Joaquin River to meet the target flows for the 31-day pulse during April and May. These supplemental flows that will be provided from other sources in the San Joaquin River Basin under the control of the parties to the SJRA.

The parties to the SJRA include several agencies that contribute flow to the San Joaquin, divert from or store water on the tributaries to the San Joaquin, or have an element of control over the flows in the lower San Joaquin River. These include Reclamation; OID; SSJID; Modesto ID; Turlock ID; Merced ID; and the San Joaquin River Exchange Contractors. The VAMP is based on coordination among these participating agencies in carrying out their operations to meet a steady target flow objective at Vernalis.

The target flow at Vernalis for the spring pulse flow period is determined each year according to the specifications contained in the SJRA. The target flow is determined prior to the spring pulse flows as an increase above the existing flows, and so “adapts” to the prevailing hydrologic conditions. Possible target flows specified in the agreement are (1) 2000 cfs, (2) 3200 cfs, (3) 4450 cfs, (4) 5700 cfs, and (5) 7000 cfs.

The Hydrology Group of the SJRTC develops forecasts of flow at Vernalis, determines the appropriate target flow, devises an operations plan including flow schedules for each contributing agency, coordinates implementation of the VAMP flows, monitors conditions that may affect the objective of meeting the target flow, updates and adjusts the planned flow contributions as needed, and accounts for the flow contributions. The Hydrology Group includes designees with technical expertise from each agency that contributes water to the VAMP. During VAMP, the Hydrology group communicates via regular conference calls, shares current information and forecasts via e-mail and an internet website. The Hydrology group has two lead coordinators, one from Reclamation and one designated by the SJRG. Subsequent to the end of the VAMP, a group similar to the Hydrology Group, with the same or similar role, will be maintained as part of the ongoing coordination of operations in the San Joaquin River basin.

CVP-SWP operations forecasts include Vernalis flows that meet the appropriate pulse flow targets for the predicted hydrologic conditions. The flows in the San Joaquin River upstream of the Stanislaus River are forecasted for the assumed hydrologic conditions. The upstream of the Stanislaus River flows are then adjusted so when combined with the forecasted Stanislaus River flow based on the 1997 IPO, the combined flow would provide the appropriate Vernalis flows consistent with the pulse flow target identified in the SJRA. An analysis of how the flows are produced upstream of the Stanislaus River is included in the SJRA Environmental Impact Statement /Environmental Impact Report. For purposes of CVP/SWP operations forecasts, the VAMP target flows are simply assumed to exist at the confluence of the Stanislaus and San Joaquin Rivers. The assessment of the effects of CVP/SWP operations in the Delta begins downstream of that point.

The VAMP program has two distinct components, a flow objective and an export restriction. The flow objectives were designed to provide similar protection to those defined in the WQCP. Fishery releases on the Stanislaus above that called for in the 1987 DFG Agreement are typically considered WQCP (b)(2) releases. The export reduction involves a combined State and Federal pumping limitation on the Delta pumps. The combined export targets for the 31 days of VAMP are specified in the SJRA: 1500 cfs (when target flows are 2000, 3200, 4450, or 7000 cfs), and 2250 cfs (when target flow is 5700 cfs, or 3000 cfs [alternate export target when flow target is 7000 cfs]). Pumping reductions which cannot be recovered by adjustments in CVP operations are considered a WQCP (b)(2) expense. Reductions of SWP pumping are limited to the amount that can be recovered through operations adjustments and the export of up to 48 TAF of transferred water made available from the Yuba Accord.

Water Temperatures

Water temperatures in the lower Stanislaus River are affected by many factors and operational tradeoffs. These include available cold water resources in New Melones reservoir, Goodwin release rates for fishery flow management and water quality objectives, as well as residence time in Tulloch Reservoir, as affected by local irrigation demand.

Reclamation intends to plan and manage flows to meet a 65° F water temperature objective at Orange Blossom Bridge for steelhead incubation and rearing during the late spring and summer. However, during critically dry years and low reservoir storages this objective cannot be met. The Service, in coordination with NMFS and DFG, identifies the schedule for Reclamation to provide fall pulse attraction flows for salmon. The pulse flows are a combination of water

purchased under the San Joaquin River Agreement and CVPIA (b)(2) and (3) water. This movement of water also helps to transport cold water from New Melones Reservoir into Tulloch Reservoir before the spawning season begins.

San Felipe Division

Construction of the San Felipe Division of the CVP was authorized in 1967 (Figure P-11). The San Felipe Division provides a supplemental water supply (for irrigation, M&I uses) in the Santa Clara Valley in Santa Clara County, and the north portion of San Benito County.

The San Felipe Division delivers both irrigation and M&I water supplies. Water is delivered within the service areas not only by direct diversion from distribution systems, but also through in-stream and offstream groundwater recharge operations being carried out by local interests. A primary purpose of the San Felipe Division in Santa Clara County is to provide supplemental water to help prevent land surface subsidence in the Santa Clara Valley. The majority of the water supplied to Santa Clara County is used for M&I purposes, either pumped from the groundwater basin or delivered from treatment plants. In San Benito County, a distribution system was constructed to provide supplemental water to about 19,700 arable acres.

The facilities required to serve Santa Clara and San Benito counties include 54 miles of tunnels and conduits, two large pumping plants, and one reservoir. Water is conveyed from the Delta of the San Joaquin and Sacramento Rivers through the DMC. It is then pumped into the San Luis Reservoir and diverted through the 1.8-mile long of Pacheco Tunnel inlet to the Pacheco Pumping Plant. Twelve 2,000-horse-power pumps lift a maximum of 490 cfs a height varying from 85 feet to 300 feet to the 5.3-mile-long Pacheco Tunnel. The water then flows through the tunnel and without additional pumping, through 29 miles of concrete, high-pressure pipeline, varying in diameter from 10 feet to 8 feet, and the mile-long Santa Clara Tunnel. In Santa Clara County, the pipeline terminates at the Coyote Pumping Plant, which is capable of pumping water to into Anderson Reservoir or Calero Reservoir for further distribution at treatment plants or groundwater recharge.

Santa Clara Valley Water District is the non-Federal operating entity for all the San Felipe Division facilities except for the Hollister Conduit and San Justo Reservoir. The San Benito County Water District operates San Justo Reservoir and the Hollister Conduit

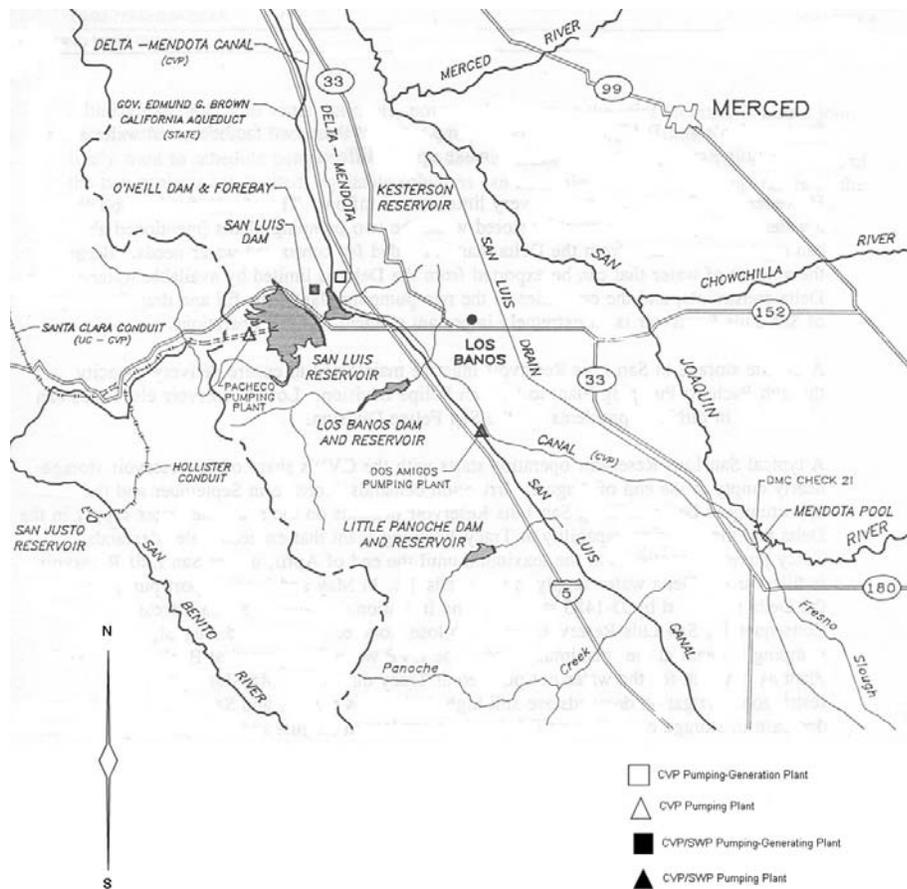


Figure P-11 West San Joaquin Division and San Felipe Division

The Hollister Conduit branches off the Pacheco Conduit 8 miles from the outlet of the Pacheco Tunnel. This 19.1-mile-long high-pressure pipeline, with a maximum capacity of 83 cfs, terminates at the San Justo Reservoir.

The 9,906 AF capacity San Justo Reservoir is located about three miles southwest of the City of Hollister. The San Justo Dam is an earthfill structure 141 feet high with a crest length of 722 feet. This project includes a dike structure 66 feet high with a crest length of 918 feet. This reservoir regulates San Benito County’s import water supplies, allows pressure deliveries to some of the agricultural lands in the service area, and provides storage for peaking of agricultural water.

Friant Division

This division operates separately from the rest of the CVP and is not integrated into the CVP OCAP. Friant Dam is located on the San Joaquin River, 25 miles northeast of Fresno where the San Joaquin River exits the Sierra foothills and enters the valley. The drainage basin is 1,676 square miles with an average annual runoff of 1,774,000 AF. Completed in 1942, the dam is a concrete gravity structure, 319-feet high, with a crest length of 3,488 feet. Although the dam was completed in 1942, it was not placed into full operation until 1951.

The dam provides flood control on the San Joaquin River, provides downstream releases to meet senior water rights requirements above Mendota Pool, and provides conservation storage as well as diversion into Madera and Friant-Kern Canals. Water is delivered to a million acres of agricultural land in Fresno, Kern, Madera, and Tulare counties in the San Joaquin Valley via the Friant-Kern Canal south into Tulare Lake Basin and via the Madera Canal northerly to Madera and Chowchilla IDs. A minimum of 5 cfs is required to pass the last water right holding located about 40 miles downstream near Gravelly Ford.

Flood control storage space in Millerton Lake is based on a complex formula, which considers upstream storage in the Southern California Edison reservoirs. The reservoir, Millerton Lake, first stored water on February 21, 1944. It has a total capacity of 520,528 AF, a surface area of 4,900 acres, and is approximately 15-miles long. The lake's 45 miles of shoreline varies from gentle slopes near the dam to steep canyon walls farther inland. The reservoir provides boating, fishing, picnicking, and swimming.

At this time, the Friant Division is generally hydrologically disconnected from the Delta as the San Joaquin River is dewatered in two reaches between Friant Dam and the confluence of the Merced River, except in extremely wet years. Under flood conditions, water is diverted into two bypass channels that carry flood flows to the confluence of the Merced River.

In 2006, parties to NRDC v. Rodgers executed a stipulation of settlement that calls for, among other things, restoration of flows from Friant Dam to the confluence of the Merced River. Implementation of the settlement is not included in this consultation as it is a large project which has not been sufficiently developed to allow for analysis of the effects of implementation of settlement action on listed aquatic species at this time. At some point in the future, consultation may need to be reinitiated to evaluate the effects of the Restoration Program on continued CVP and SWP operations.

State Water Project

The DWR holds contracts with 29 public agencies in Northern, Central and Southern California for water supplies from the SWP. Water stored in the Oroville facilities, along with excess water available in the Sacramento-San Joaquin Delta is captured in the Delta and conveyed through several facilities to SWP contractors.

The SWP is operated to provide flood control and water for agricultural, municipal, industrial, recreational, and environmental purposes. Water is conserved in Oroville Reservoir and released to serve three Feather River area contractors and two contractors served from the North Bay Aqueduct, and to be pumped at the Harvey O. Banks Pumping Plant (Banks) in the Delta and delivered to the remaining 24 contractors in the SWP service areas south of the Delta. In addition to pumping water released from Oroville Reservoir, the Banks pumps water from other sources entering the Delta.

Project Management Objectives

Clifton Court Forebay

Inflows to Clifton Court Forebay (CCF) are controlled by radial gates, whose real-time operations are constrained by a scouring limit (i.e. 12,000 cfs) at the gates and by water level concerns in the South Delta for local agricultural diverters. An interim agreement between DWR and South Delta Water Agency specifies three modes, or “priorities” for CCF gate operation. Of the three priorities, Priority 1 is the most protective of South Delta water levels. Under Priority 1, CCF gates are only opened during the ebb tides, allowing the flood tides to replenish South Delta channels. Priority 2 is slightly less protective because the CCF gates may be open as in Priority 1, but also during the last hour of the higher flood tide and through most of the lower flood tide. Finally, Priority 3 requires that the CCF gates be closed during the rising limb of the higher flood tide and also during the lowest part of the lower tide, but permits the CCF gates to be open at all other times.

When a large head differential exists between the outside and the inside of the gates, theoretical inflow can be as high as 15,000 cfs for a very short time. However, existing operating procedures identify a maximum design flow rate of 12,000 cfs, to minimize water velocities in surrounding South Delta channels, to control erosion, and to prevent damage to the facility.

The SWP is managed to maximize the capture of water in the Delta and the usable supply released to the Delta from Oroville storage. The maximum daily pumping rate at Banks is controlled by a combination of the D-1641, the real-time decision making to assist in fishery management process described previously, and permits issued by the Corps that regulate the rate of diversion of water into Clifton Court Forebay (CCF) for pumping at Banks. This diversion rate is normally restricted to 6,680 cfs as a three-day average inflow to CCF and 6,993 cfs as a one-day average inflow to CCF. CCF diversions may be greater than these rates between December 15 and March 15, when the inflow into CCF may be augmented by one-third of the San Joaquin River flow at Vernalis when those flows are equal to or greater than 1,000 cfs. Additionally, the SWP has a permit to export an additional 500 cfs between July 1 and September 30 (further details on this pumping are found later in the Project Description). The purpose for the current permitted action is to replace pumping foregone for the benefit of Delta fish species, making the summer limit effectively 7,180 cfs.

The hourly operation of the CCF radial gates is governed by agreements with local agricultural interests to protect water levels in the South Delta area. The radial gates controlling inflow to the forebay may be open during any period of the tidal cycle with the exception of the two hours before and after the low-low tide and the hours leading up to the high-high tide each day. CCF gate operations are governed by agreements and response plans to protect South Delta water users, and a more detailed discussion of these operations and agreement will follow under CCF and JPOD sections.

Banks is operated to minimize the impact to power loads on the California electrical grid to the extent practical, using CCF as a holding reservoir to allow that flexibility. Generally more pump units are operated during off-peak periods and fewer during peak periods. Because the installed capacity of the pumping plant is 10,300 cfs, the plant can be operated to reduce power grid

impacts, by running all available pumps at night and a reduced number during the higher energy demand hours, even when CCF is admitting the maximum permitted inflow.

There are years (primarily wetter years) when Banks operations are demand limited, and Banks is able to pump enough water from the Delta to fill San Luis Reservoir and meet all contractor demands without maximizing its pumping capability every day of the year. This has been less likely in recent years, where the contractors request all or nearly all of their contract Table A amount every year. Consequently, current Banks operations are more often supply limited. Under these current full demand conditions, Banks pumping plant is almost always operated to the maximum extent possible to maximize the water captured, subject to the limitations of water quality, Delta standards, and a host of other variables, until all needs are satisfied and all storage south of the Delta is full.

San Luis Reservoir is an offstream storage facility located along the California Aqueduct downstream of Banks. San Luis Reservoir is used by both projects to augment deliveries to their contractors during periods when Delta pumping is insufficient to meet downstream demands.

San Luis Reservoir operates like a giant regulator on the SWP system, accepting any water pumped from Banks that exceeds contractor demands, then releasing that water back to the aqueduct system when Banks pumping is insufficient to meet demands. The reservoir allows the SWP to meet peak-season demands that are seldom balanced by Banks pumping.

San Luis Reservoir is generally filled in the spring or even earlier in some years. When it and other SWP storage facilities south of the Delta are full or nearly so, when Banks pumping is meeting all current Table A demands, and when the Delta is in excess conditions, DWR will use any available excess pumping capacity at Banks to deliver Article 21 water to the SWP contractors.

Article 21 water is one of several types of SWP water supply made available to the SWP contractors under the long-term SWP water supply contracts between DWR and the SWP contractors. As its name implies, Article 21 water is provided for under Article 21 of the contracts³. Unlike Table A water, which is an allocated annual supply made available for scheduled delivery throughout the year, Article 21 water is an interruptible water supply made available only when certain conditions exist. As with all SWP water, Article 21 water is supplied under existing SWP water rights permits, and is pumped from the Delta under the same environmental, regulatory, and operational constraints that apply to all SWP supplies.

When Article 21 water is available, DWR may only offer it for a short time, and the offer may be discontinued when the necessary conditions no longer exist. Article 21 deliveries are in addition to scheduled Table A deliveries; this supply is delivered to contractors that can, on relatively short notice, put it to beneficial use. Typically, contractors have used Article 21 water to meet

³Article 21 provides, in part: “Each year from water sources available to the project, the State shall make available and allocate interruptible water to contractors. Allocations of interruptible water in any one year may not be carried over for delivery in a subsequent year, nor shall the delivery of water in any year impact a contractor’s approved deliveries of annual [Table A water] or the contractor’s allocation of water for the next year. Deliveries of interruptible water in excess of a contractor’s annual [Table A water] may be made if the deliveries do not adversely affect the State’s delivery of annual [Table A water] to other contractors or adversely affect project operations...”

needs such as additional short-term irrigation demands, replenishment of local groundwater basins, and storage in local surface reservoirs, all of which provide contractors with opportunities for better water management through more efficient coordination with their local water supplies. When Article 21 of the long-term water supply contracts was developed, both DWR and the contractors recognized that DWR was not capable of meeting the full contract demands in all years because not all of the planned SWP facilities had been constructed.

Article 21 water is typically offered to contractors on a short-term (daily or weekly) basis when all of the following conditions exist: the SWP share⁴ of San Luis Reservoir is physically full, or projected to be physically full within approximately one week at permitted pumping rates; other SWP reservoirs south of the Delta are at their storage targets or the conveyance capacity to fill these reservoirs is maximized; the Delta is in excess condition; current Table A demand is being fully met; and Banks has export capacity beyond that which is needed to meet current Table A and other SWP operational demands. The increment of available unused Banks capacity is offered as the Article 21 delivery capacity. Contractors then indicate their desired rate of delivery of Article 21 water. It is allocated in proportion to their Table A contractual quantities if requests exceed the amount offered. Deliveries can be discontinued at any time, when any of the above factors change. In the modeling for Article 21, deliveries are only made in months when the State share of San Luis Reservoir is full. In actual operations, Article 21 may be offered a few days in advance of actual filling. Article 21 water will not be offered until State storage in San Luis Reservoir is either physically full or projected to be physically full within approximately one week at permitted pumping rates. Also, any carried-over EWA water asset stored in the State share of San Luis Reservoir (whether it be from the use of the 500 cfs or other operational assets) will not be considered part of the SWP storage when determining the availability of Article 21. This will ensure that the carried-over EWA water asset does not result in increased Article 21 deliveries.

During parts of April and May, the VAMP takes effect as described in the CVP section above. The state and federal pumps reduce their export pumping to benefit fish in the San Joaquin River system. Around this same time, water demands from both agricultural and M&I contractors are increasing, Article 21 water is usually discontinued, and San Luis supplies are released to the SWP facilities to supplement Delta pumping at Banks, thereby meeting contractor demands. The SWP intends to continue VAMP-type export reductions through 2030 to the extent that the limited EWA assets, (as described in an earlier section) will meet the associated water costs. Chapter 9 of the biological assessment includes an analysis of modeling results that illustrates the frequency on which assets are available under a limited EWA to meet the SWP portion of VAMP.

Immediately following VAMP, a “post –VAMP shoulder” may occur. This action is an extension of the reduced pumping levels that occur during VAMP depending on the availability of EWA and limited EWA assets. Chapter 9 includes an analysis of modeling results that illustrates the frequency on which assets are available under a limited EWA to meet the “post –VAMP shoulder”.

⁴ Not including any carried-over EWA or limited EWA asset which may reside in the SWP share of San Luis Reservoir.

After VAMP and the “post-VAMP shoulder”, Delta pumping at Banks can be increased depending on Delta inflow and Delta standards. By late May, demands usually exceed the restored pumping rate at Banks, and continued releases from San Luis Reservoir are needed to meet contractor demands for Table A water.

During this summer period, DWR is also releasing water from Oroville Reservoir to supplement Delta inflow and allow Banks to export the stored Oroville water to help meet demand. These releases are scheduled to maximize export capability and gain maximum benefit from the stored water while meeting fish flow requirements, temperature requirements, Delta water quality, and all other applicable standards in the Feather River and the Delta.

DWR must balance storage between Oroville and San Luis Reservoirs carefully to meet flood control requirements, Delta water quality and flow requirements, and optimize the supplies to its contractors consistent with all environmental constraints. Oroville Reservoir may be operated to move water through the Delta to San Luis Reservoir via Banks under different schedules depending on Delta conditions, reservoir storage volumes, and storage targets. Predicting those operational differences is difficult, as the decisions reflect operator judgment based on many real-time factors as to when to move water from Oroville Reservoir to San Luis Reservoir.

As San Luis Reservoir is drawn down to meet contractor demands, it usually reaches its low point in late August or early September. From September through early October, demand for deliveries usually drops below the ability of Banks to divert from the Delta, and the difference in Banks pumping is then added to San Luis Reservoir, reversing its spring and summer decline. From early October until the first major storms in late fall or winter unregulated flow continues to decline and releases from Lake Oroville are restricted (due to flow stability agreements with DFG) resulting in export rates at Banks that are somewhat less than demand typically causing a second seasonal decrease in the SWP’s share of San Luis Reservoir. Once the fall and winter storms increase runoff into the Delta, Banks can increase its pumping rate and eventually fill (in all but the driest years) the state portion of San Luis Reservoir before April of the following year.

Water Service Contracts, Allocations, and Deliveries

The following discussion presents the practices of DWR in determining the overall amount of Table A water that can be allocated and the allocation process itself. There are many variables that control how much water the SWP can capture and provide to its contractors for beneficial use.

The allocations are developed from analysis of a broad range of variables that include:

- Volume of water stored in Oroville Reservoir
- Flood operation restrictions at Oroville Reservoir
- End-of-water-year (September 30) target for water stored in Oroville Reservoir
- Volume of water stored in San Luis Reservoir
- End-of-month targets for water stored in San Luis Reservoir
- Snow survey results

- Forecasted runoff
- Feather River flow requirements for fish habitat
- Feather River service area delivery obligations
- Feather River flow for senior water rights river diversions
- Anticipated depletions in the Sacramento River basin
- Anticipated Delta conditions
- Precipitation and streamflow conditions since the last snow surveys and forecasts
- Contractor delivery requests and delivery patterns

From these and other variables, the Operations Control Office within DWR estimates the water supply available to allocate to contractors and meet other project needs. The Operations Control Office transmits these estimates to the State Water Project Analysis Office, where staff enters the water supply, contractor requests, and Table A amounts into a spreadsheet and computes the allocation percentage that would be provided by the available water supply.

The staffs of the Operations Control Office and State Water Project Analysis Office meet with DWR senior management, usually including the Director, to make the final decision on allocating water to the contractors. The decision is made, and announced in a press release followed by Notices to Contractors.

The initial allocation announcement is made by December 1 of each year. The allocation of water is made with a conservative assumption of future precipitation, and generally in graduated steps, carefully avoiding over-allocating water before the hydrologic conditions are well defined for the year.

Both the DWR and the contractors are conservative in their estimates, leading to the potential for significant variations between projections and actual operations, especially under wet hydrologic conditions.

Other influences affect the accuracy of estimates of annual demand for Table A and the resulting allocation percentage. One factor is the contractual ability of SWP contractors to carry over allocated but undelivered Table A from one year to the next if space is available in San Luis Reservoir. Contractors will generally use their carryover supplies early in the calendar year if it appears that San Luis reservoir will fill. By using the prior year's carryover, the contractors reduce their delivery requests for the current year's Table A allocation and instead schedule delivery of carryover supplies.

Carryover supplies left in San Luis Reservoir by SWP contractors may result in higher storage levels in San Luis Reservoir at December 31 than would have occurred in the absence of carryover. If there were no carryover privilege, contractors would seek to store the water within their service areas or in other storage facilities outside of their service areas. As project pumping fills San Luis Reservoir, the contractors are notified to take or lose their carryover supplies. If

they can take delivery of and use or store the carryover water, San Luis Reservoir storage then returns to the level that would have prevailed absent the carryover program.

If the contractors are unable to take delivery of all of their carryover water, that water then converts to project water as San Luis Reservoir fills, and Article 21 water becomes available for delivery to contractors.

Article 21 water delivered early in the calendar year may be reclassified as Table A later in the year depending on final allocations, hydrology, and contractor requests. Such reclassification does not affect the amount of water carried over in San Luis Reservoir, nor does it alter pumping volumes or schedules. The total water exported from the Delta and delivered by the SWP in any year is a function of a number of variables that is greater than the list of variables shown above that help determine Table A allocations.

If there are no carryover or Article 21 supplies available, Table A requests will be greater in the January-April period, and there would be a higher percentage allocation of Table A for the year than if carryover and Article 21 were available to meet demand.

Monterey Agreement

In 1994, DWR and certain representatives of the SWP contractors agreed to a set of principles known as the Monterey Agreement, to settle long-term water allocation disputes, and to establish a new water management strategy for the SWP. This project description only includes the system-wide water operations consistent with the Monterey Agreement and not the specific actions by DWR and State Water Contractors needed to implement the agreement.

The Monterey Agreement resulted in 27 of the 29 SWP contractors signing amendments to their long-term water supply contracts in 1995, and the Monterey Amendment has been implemented as part of SWP operations for these 27 SWP contractors since 1996. The original Environmental Impact Report prepared for the Monterey Agreement was challenged, and the EIR was required to be decertified. DWR is currently preparing an EIR on the Monterey Amendment following that litigation and approval of a settlement agreement with the plaintiffs in May 2003. A draft of the new EIR was released in October 2007, the comment period closed in January 2008, and a final EIR is scheduled for completion in the fall of 2008.

The alternatives evaluated in the EIR include continuation of the Monterey Amendment, certain No Project alternatives that would revert some contract terms to pre-Monterey Amendment terms, and two “court ordered no-project” alternatives that would impose a reduction in Table A supplies by implementing a permanent shortage provision together with an offsetting increase in the supply of Article 21 water.

Adoption of any of the alternatives would not measurably change SWP Delta operations, although the internal classification of water provided to SWP contractors could change as to the balance between Table A and Article 21 water, as could the relative allocation of water between urban and agricultural contractors. The Monterey Amendment provides for certain transfers of water from agricultural to urban contractors; impacts from those transfers are all south of the Delta and have no effect on the Delta.

The only impact of Monterey Amendment operations on Delta exports is identified in the draft EIR as the facilitation of approval for out-of-service-area storage programs. Because DWR had

previously approved water storage programs outside of individual SWP contractor's service areas and many such storage programs now exist, this water management method is unlikely to be voided by future actions of DWR. These increased exports can only occur if they are within the diversions permitted at the time. None of the alternatives being considered would result in demand for added Delta diversions above currently assumed levels and all are subject to whatever regulatory restrictions are in force at the time.

Changes in DWR's Allocation of Table A Water and Article 21 Water

The Monterey Amendment revised the temporary shortage provision that specified an initial reduction of supplies for agricultural use when requests for SWP water exceeded the available supply. The Amendment specifies that whenever the supply of Table A water is less than the total of all contractors' requests, the available supply of Table A water is allocated among all contractors in proportion to each contractor's annual Table A amount.

The Monterey Amendment amended Article 21 by eliminating the category of scheduled "surplus water," which was available for scheduled delivery and by renaming "unscheduled water" to "interruptible water." Surplus water was scheduled water made available to the contractors when DWR had supplies beyond what was needed to meet Table A deliveries, reservoir storage targets, and Delta regulatory requirements. Surplus water and unscheduled water were made available first to contractors requesting it for agricultural use or for groundwater replenishment. Because of the contractors' increasing demands for Table A water and the increasing regulatory requirements imposed on SWP operations, DWR is now able to supply water that is not Table A water only on an unscheduled, i.e., interruptible basis.

Pursuant to the revised Article 21, DWR allocates the available interruptible supply to requesting contractors in proportion to their annual Table A amounts.

The result of these contractual changes are that DWR now allocates Table A and interruptible water among contractors in proportion to annual Table A amounts without consideration of whether the water would be used for M&I or agricultural purposes. Agricultural and M&I contractors share any reductions in deliveries or opportunities for surplus water in proportion to their annual Table A amounts.

Historical Water Deliveries to Southern California

The pumping from the Delta to serve southern California has been influenced by changes in available water supply sources to serve the region. The Colorado River and the SWP have been the major supply sources for southern California.

The Quantification Settlement Agreement (QSA) signed in 2003 resulted in a decrease in the amount of Colorado River water available to California. To illustrate the impact of that decrease on demand from the Sacramento-San Joaquin Delta, it is instructive to look at the magnitude of the two imported supply sources available to MWDSC.

During part of this period, MWDSC was also filling Diamond Valley Lake (810,000 acre-feet, late 1998-early 2002) and adding some water to groundwater storage programs. In wetter years, demand for imported water may often decrease because local sources are augmented and local rainfall reduces irrigation demand. Table P-12 below illustrates the effects of the wet years from

1995-1998 on demand for imported water and the effect of reduced Colorado River diversions under the QSA on MWDSC deliveries from the Delta.

Table P-12 Wet Year effects

Calendar Year	Sacramento Valley Water Year Type	Delta Supplies	Colorado Supplies	Total
1994	Critically Dry	807,866	1,303,212	2,111,078
1995	Wet	436,042	997,414	1,433,456
1996	Wet	593,380	1,230,353	1,823,733
1997	Wet	721,810	1,241,821	1,963,631
1998	Wet	410,065	1,073,125	1,483,190
1999	Wet	852,617	1,215,224	2,067,841
2000	Above Normal	1,541,816	1,303,148	2,844,964
2001	Dry	1,023,169	1,253,579	2,276,748
2002	Dry	1,408,919	1,241,088	2,650,007
2003	Above Normal	1,686,973	688,043	2,375,016
2004	Below Normal	1,724,380	733,095	2,457,475
2005	Above Normal	1,616,710	839,704	2,456,414
2006	Wet	1,521,681*	594,544	2,116,225
2007	Dry	1,395,827*	713,456*	2,109,283

* - These figures are preliminary.

Project Facilities

Oroville Field Division

Oroville Dam and related facilities comprise a multipurpose project. The reservoir stores winter and spring runoff, which is released into the Feather River to meet the Project's needs. It also provides pumpback capability to allow for on-peak electrical generation, 750,000 acre-feet of flood control storage, recreation, and freshwater releases to control salinity intrusion in the Sacramento-San Joaquin Delta and for fish and wildlife protection.

The Oroville facilities are shown in Figure P-12. Two small embankments, Bidwell Canyon and Parish Camp Saddle Dams, complement Oroville Dam in containing Lake Oroville. The lake has a surface area of 15,858 acres, a storage capacity of 3,538,000 AF, and is fed by the North, Middle, and South forks of the Feather River. Average annual unimpaired runoff into the lake is about 4.5 million AF.

A maximum of 17,000 cfs can be released through the Edward Hyatt Powerplant, located underground near the left abutment of Oroville Dam. Three of the six units are conventional

generators driven by vertical-shaft, Francis-type turbines. The other three are motor-generators coupled to Francis-type, reversible pump turbines. The latter units allow pumped storage operations. The intake structure has an overflow type shutter system that determines the level from which water is drawn.

Approximately four miles downstream of Oroville Dam and Edward Hyatt Powerplant is the Thermalito Diversion Dam. Thermalito Diversion Dam consists of a 625-foot-long, concrete gravity section with a regulated ogee spillway that releases water to the low flow channel of the Feather River. On the right abutment is the Thermalito Power Canal regulating headwork structure.

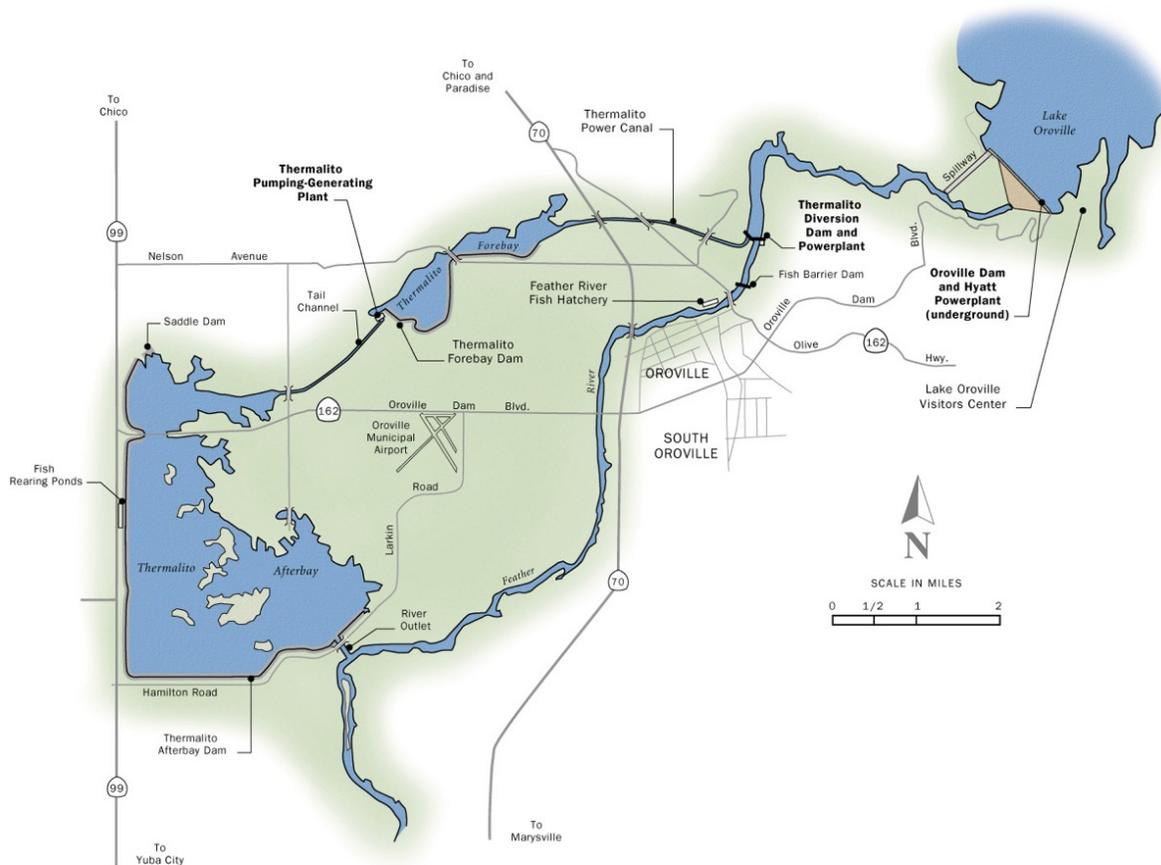


Figure P-12 Oroville Facilities on the Feather River

The purpose of the diversion dam is to divert water into the 2-mile long Thermalito Power Canal that conveys water in either direction and creates a tailwater pool (called Thermalito Diversion Pool) for Edward Hyatt Powerplant. The Thermalito Diversion Pool acts as a forebay when Hyatt is pumping water back into Lake Oroville. On the left abutment is the Thermalito Diversion Dam Powerplant, with a capacity of 600 cfs that releases water to the low-flow section of the Feather River.

Thermalito Power Canal hydraulically links the Thermalito Diversion Pool to the Thermalito Forebay (11,768 AF), which is the off-stream regulating reservoir for Thermalito Powerplant. Thermalito Powerplant is a generating-pumping plant operated in tandem with the Edward Hyatt Powerplant. Water released to generate power in excess of local and downstream requirements is conserved in storage and, at times, pumped back through both powerplants into Lake Oroville during off-peak hours. Energy price and availability are the two main factors that determine if a pumpback operation is economical. A pumpback operation most commonly occurs when energy prices are high during the weekday on-peak hours and low during the weekday off-peak hours or on the weekend. The Oroville Thermalito Complex has a capacity of approximately 17,000 cfs through the powerplants, which can be returned to the Feather River via the Afterbay's river outlet.

Local agricultural districts divert water directly from the afterbay. These diversion points are in lieu of the traditional river diversion exercised by the local districts whose water rights are senior to the SWP. The total capacity of afterbay diversions during peak demands is 4,050 cfs.

The Feather River Fish Hatchery (FRFH), mitigation for the construction of Oroville Dam, produces Chinook salmon and steelhead and is operated by DFG. The FRFH program, operations and production, is detailed in the FERC biological assessment for the Oroville Project and will be detailed in the NMFS FERC biological opinion. Both indirect and direct take resulting from FRFH operations will be authorized through section 4(d) of the Endangered Species Act, in the form of NMFS-approved Hatchery and Genetic Management Plans (HGMPs). DWR is preparing HGMPs for the spring and fall-run Chinook and steelhead production programs at the Feather River Fish Hatchery.

Current Operations - Minimum Flows and Temperature Requirements

Operation of Oroville will continue under existing criteria, consistent with past project descriptions, until a final decision is made in the FERC relicensing process. The release temperatures from Oroville Dam are designed to meet Feather River Fish Hatchery and Robinson Riffle temperature schedules included in the 1983 DFG Agreement, "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife", concerning the operations of the Oroville Division of the State Water Project for Management of Fish and Wildlife while also conserving the coldwater pool in Lake Oroville. Current operation indicates that water temperatures at Robinson Riffle are almost always met when the hatchery objectives are met. Due to temperature requirements of endangered fish species and the hatchery and overriding meteorological conditions, the temperature requests for agriculture can be difficult to satisfy.

Water is withdrawn from Lake Oroville at depths that will provide sufficiently cold water to meet the Feather River Fish Hatchery and Robinson Riffle temperature targets. The reservoir depth from which water is released initially determines the river temperatures, but atmospheric conditions, which fluctuate from day to day, modify downstream river temperatures. Altering the reservoir release depth requires installation or removal of shutters at the intake structures. Shutters are held at the minimum depth necessary to release water that meets the Feather River Fish Hatchery and Robinson Riffle criteria. In order to conserve the coldwater pool during dry years, DWR has strived to meet the Robinson Riffle temperatures by increasing releases to the LFC rather than releasing colder water.

Additionally, DWR maintains a minimum flow of 600 cfs within the Feather River Low Flow Channel (LFC) (except during flood events when flows are governed by the Flood Operations Manual and under certain other conditions as described in the 1984 FERC order). Downstream of the Thermalito Afterbay Outlet, in the High Flow Channel (HFC), a minimum release for flows in the Feather River is to be 1,000 cfs from April through September and 1,700 cfs from October through March, when the April-to-July unimpaired runoff in the Feather River is greater than 55 percent of normal. When the April-to-July unimpaired runoff is less than 55 percent of normal, the License requires minimum flows of 1,000 cfs from March to September and 1,200 cfs from October to February (Table P-13). In practice, flows are maintained below 2,500 cfs from October 15 to November 30 to prevent spawning in the overbank areas.

According to the 1983 Agreement, if during the period of October 15 to November 30, the average highest 1-hour flow of combined releases exceeds 2,500 cfs; with the exception of flood management, accidents, or maintenance; then the minimum flow must be no lower than 500 cfs less than that flow through the following March 31. The 1983 Agreement also states that if the April 1 runoff forecast in a given year indicates that the reservoir level will be drawn down to 733 feet, water releases for fish may be reduced, but not by more than 25 percent.

Table P-13 Combined Minimum Instream Flow Requirements in the Feather River Below Thermalito Afterbay Outlet When Lake Oroville Elevation is Projected to be Greater vs. Less Than 733' in the Current Water Year

Conditions	Period	Minimum Flows
When Lake Oroville Elevation is Projected to be Greater Than 733' & the Preceding Water Year's April – July Water Conditions are ≥ 55% of Normal (1)	October - February	1,700 cfs
	March	1,700 cfs
	April - September	1,000 cfs
When Lake Oroville Elevation is Projected to be Greater Than 733' & the Preceding Water Year's April – July Water Conditions are < 55% of Normal (1)	October - February	1,200 cfs
	March	1,000 cfs
	April - September	1,000 cfs
When Lake Oroville Elevation is Projected to be Less Than 733' in the Current Water Year (2)	October - February	900 cfs < Q < 1,200 cfs
	March	750 cfs < Q < 1,000 cfs
	April - September	750 cfs < Q < 1,000 cfs

Notes:

- 1) Normal is defined as the Mean April – July Unimpaired Runoff of the Feather River near Oroville of 1,942,000 AF (1911 – 1960).
- 2) In accordance with FERC's Order Amending License dated September 18, 1984, Article 53 was amended to provide a third tier of minimum flow requirements defined as follows: If the April 1 runoff forecast in a given water year indicates that, under normal operation of Project 2100, the reservoir level will be drawn to elevation 733 feet (approximately 1,500,000 AF), releases for fish life in the above schedule may suffer monthly deficiencies in the same proportion as the respective monthly deficiencies imposed upon deliveries of water for agricultural use from the Project. However, in no case shall the fish water releases in the above schedule be reduced by more than 25 percent.

Current operations of the Oroville Facilities are governed by water temperature requirements at two locations: the FRFH and in the LFC at Robinson Riffle. DWR has taken various temperature management actions to achieve the water temperature requirements, including curtailing pumpback operations, removing shutters at intakes of the Hyatt Pumping-Generating Plant, releasing flow through the river valves (for FRFH only), and redirecting flows at the Thermalito Diversion Dam to the LFC (for Robinson Riffle only).

To date, the river valves have been used infrequently. Prior to 1992, they were used twice: first in 1967 during the initial construction of the dam, and second in 1977 during the drought of record. Since 1992, the river valves have only been used twice for temperature control: in 2001 and 2002. To ensure that the river valves will operate reliably, DWR exercises them annually. When operated to meet temperature criteria, DWR can and does operate the river valves at a flow rate up to the 1,500 cfs needed for FRFH temperature management purposes.

Other than local diversions, outflow from the Oroville Complex is to the Feather River, combining flows from the LFC and Thermalito Afterbay. Outflow typically varies from spring seasonal highs averaging 8,000 cfs to about 3,500 cfs in November. The average annual outflow from the Project is in excess of 3 MAF to support downstream water supply, environmental, and water quality needs.

Table P-14 shows an example of releases from Oroville for various downstream uses during dry hydrologic conditions (WYs 2001 and 2002). As a practical matter, water supply exports are met with water available after Delta requirements are met. Some of the water released for instream and Delta requirements may be available for export by the SWP after Delta standards have been met.

Table P-14 Historical Records of Releases from the Oroville Facilities in 2001 and 2002, by Downstream Use

Downstream Use	Water Year 2001 Release		Water Year 2002 Release	
	Volume (TAF)	Percentage	Volume (TAF)	Percentage
Feather River Service Area	1,024	46	925	34
Instream and Delta Requirements	1,099	50	1,043	38
Flood Management	0	0	0	0
Support of Exports	93	4	773	28
Total	2,216	100	2,741	100

Source: DWR SWP Operations Control Office

Feather River Flow Requirements

The existing Feather River flow requirements below Oroville Dam are based on an August 1983 Agreement between the DWR and DFG. The 1983 Agreement established criteria and objectives for flow and temperatures in the LFC, FRFH, and HFC. This agreement includes the following:

- Established minimum flows between the Thermalito Afterbay Outlet and Verona that vary by WY type
- Required flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except flood management operations
- Required flow stability during the peak of the fall-run Chinook spawning season
- Set an objective of suitable water temperature conditions during the fall months for salmon and during the later spring/summer months for shad and striped bass
- Established a process whereby DFG would recommend each year, by June 1, a spawning gravel maintenance program to be implemented during that calendar year

Low Flow Channel

The 1983 Agreement specifies that DWR release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fishery purposes. This is the total volume of flows from the Diversion Dam Outlet, Diversion Dam Powerplant, and FRFH Pipeline.

High Flow Channel

Based on the 1983 Agreement, Table P-15 summarizes the minimum flow requirement for the HFC when releases would not draw Oroville Reservoir below elevation 733 feet above mean sea level (ft msl).

Table P-15 High Flow Channel minimum flow requirements as measured downstream from the Thermalito Afterbay Outlet.

Forecasted April-through-July unimpaired runoff (percent of normal ¹)	Minimum Flow in HFC (cfs)		
	October through February	March	April through September
55 percent or greater	1,700	1,700	1,000
Less than 55 percent	1,200	1,000	1,000

Source: 1983 Agreement

¹ The preceding water year's unimpaired runoff shall be reported in Licensee's Bulletin 120, "Water Conditions in California-Fall Report." The term "normal" is defined as the April-through-July mean unimpaired runoff near Oroville of 1,942,000 AF in the period of 1911 through 1960.

Key:

cfs – cubic feet per second

HFC – High Flow Channel

If the April 1 forecast in a given WY indicates that Oroville Reservoir would be drawn down to elevation 733 ft msl, minimum flows in the HFC may be diminished on a monthly average basis,

in the same proportion as the respective monthly deficiencies imposed on deliveries for agricultural use of the Project. However, in no case shall the minimum flow releases be reduced by more than 25 percent. If between October 15 and November 30, the highest total 1-hour flow exceeds 2,500 cfs, DWR shall maintain a minimum flow within 500 cfs of that peak flow, unless such flows are caused by flood flows, or an inadvertent equipment failure or malfunction.

Temperature Requirements

Low Flow Channel

NMFS has established a water temperature requirement for steelhead trout and spring-run Chinook salmon at Feather River RM 61.6 (Robinson Riffle in the LFC) from June 1 through September 30. The water temperature should be maintained at less than or equal to 65°F on a daily average basis.

High Flow Channel

While no numeric temperature requirement currently exists for the HFC, the 1983 Agreement requires DWR to provide suitable Feather River water temperatures for fall-run salmon not later than September 15, and to provide for suitable water temperatures below the Thermalito Afterbay Outlet for shad, striped bass, and other warm water fish between May 1 and September 15.

Current FRFH intake water temperature, as required by the 1983 DFG and DWR Agreement are in Table P-16.

Table P-16 Feather River Fish Hatchery Temperature Requirements

Period	Degrees F (± 4 °F allowed)
April 1 – November 30	
April 1 – May 15	51
May 16 – May 31	55
June 1 – June 15	56
June 16 – August 15	60
August 16 – August 31	58
September 1 – September 30	52
October 1 – November 30	51
December 1 – March 31	No greater than 55

Table P-17 summarizes current flow and temperature management in the Feather River Fish Hatchery and the Lower Feather River below Oroville Dam. These operational measures are in place in compliance with FERC license terms, agency agreements or ESA biological opinions and are provided to fully describe the baseline conditions.

Table P-17 Lower Feather River Flows and Temperature Management under Existing Conditions

Type of Measure	Title	Description
Minimum Flows	Minimum Release to Low Flow Channel (this includes water that returns from hatchery)	Maintain minimum flow of 600 cubic feet per second (cfs) within the Feather River downstream of the Thermalito Diversion Dam and the Feather River Fish Hatchery. FERC 1984. [Low Flow Channel Flow Standard]
	Minimum Release to High Flow Channel	Release water necessary to maintain flows in the Feather River below the Thermalito Afterbay Outlet in accordance with the minimum flow schedule presented in the Federal Energy Regulatory Commission (FERC) order, provided that releases will not cause Lake Oroville to be drawn below elevation 733 feet (ft) (approximately 1.5 million acre-feet [maf] of storage). If the April 1 runoff forecast in a given year indicates that the reservoir level will be drawn to 733 ft, water releases for fish may be reduced, but not by more than 25 percent.
Maximum Flows (non-flood control)	Maximum Flow into Feather River Fish Hatchery	Maximum flow into Feather River Fish Hatchery from the Diversion Pool is 115 cfs year round.
	Maximum Flow in the High Flow Channel	Maximum flow at Feather River below Thermalito Afterbay Outlet is 10,000 cfs when Lake Oroville inflow is less than 10,000 cfs. [High Flow Channel Flow Standard] When Lake Oroville inflow is greater than 10,000 cfs, the maximum flow in the river below Thermalito Afterbay Outlet will be limited to inflow. If higher flow releases coincide with Chinook spawning activity, the ramping rate used to return to the minimum flow requirement will be chosen to avoid redd dewatering.
Ramping Rates	Ramping Rate Criteria	Flows less than 2,500 cfs cannot be reduced more than 300 cfs during any 24-hour period, except for flood releases, failures, etc.
Water Supply	Releases from Lake Oroville	Releases for water supply, flood control, Sacramento–San Joaquin Delta (Delta) water quality requirements, and instream flow requirements of an average of 3 million acre-feet per year (maf/year) and approximately 1 maf/year to the Feather River Service Area (FRSA) for agricultural, municipal, and industrial uses in accordance with SWP contracts, DWR agreements, and water rights.
	Diversions from Feather River	Diversion of an estimated 60–70 thousand acre-feet per year (TAF/year) from the Feather River by senior water right holders per State Water Resources Control Board (SWRCB) licenses or permits for appropriate users.

Type of Measure	Title	Description
Flood Protection/Management	Flood Protection	<p>The Oroville Facilities are operated for flood control purposes in conformance with the flood management regulations prescribed by the Secretary of the Army under the provisions of an Act of Congress (58 Stat. 890; 33 United States Code [USC] 709).</p> <ul style="list-style-type: none"> - During floods, water releases from Oroville Dam and Thermalito Afterbay Dam will not increase floodflows above those prior to project existence. Operation of the project in the interest of flood control shall be in accordance with Section 204 of the Flood Control Act of 1958. - At high flows, fluctuate releases at least every couple of days to avoid riverbank/levee damage at one level. - Avoid extended periods of flow over the quantities listed above as much as possible to minimize the risk of seepage damage to orchards adjacent to the Feather River. - Maximum allowable flow is 180,000 cfs year round at the Feather River above the Yuba River. Maximum allowable flow is 300,000 cfs year round at the Feather River below the Yuba River. - Maximum allowable flow is 320,000 cfs year round at the Feather River below the Bear River.

Type of Measure	Title	Description
Temperature Criteria/Targets	At the Feather River Fish Hatchery and Robinson Riffle	<p>Water temperature at Robinson Riffle must be less than 65 degrees between June and September.</p> <p>Water temperature during the fall months, after September 15, should be suitable for fall-run Chinook salmon.</p> <p>Water temperature from May through August should be suitable for American shad, striped bass, etc.</p> <p>At the Feather River Fish Hatchery</p> <p>Temperature (+/- 4°F)</p> <p>April 1–May 15 51°</p> <p>May 16–May 31 55°</p> <p>June 1–June 15 56°</p> <p>June 16–August 15 60°</p> <p>August 16–August 31 58°</p> <p>September 1–September 30 52°</p> <p>October 1–November 30 51°</p> <p>December 1–March 31 no greater than 55°</p>
	Thermalito Afterbay Temperature Control	Operate facilities pursuant to the May 1968 Joint Water Agreement.
Natural Salmonid Spawning and Rearing Habitat	Salmonid Habitat Improvement – Endangered Species Act (ESA) Species Recovery Measures	Maintain conditions in the Low Flow Channel pursuant to 1983 Operating Agreement between DFG and DWR which is to prevent damage to fish and wildlife resources from operations and construction of the project.

Excerpt from Appendix B of the FERC Preliminary Draft Environmental Assessment, Oroville Facilities—FERC Project No. 2100

Flood Control

Flood control operations at Oroville Dam are conducted in coordination with DWR's Flood Operations Center and in accordance with the requirements set forth by the Corps. The Federal Government shared the expense of Oroville Dam, which provides up to 750,000 AF of flood control space. The spillway is located on the right abutment of the dam and has two separate elements: a controlled gated outlet and an emergency uncontrolled spillway. The gated control structure releases water to a concrete-lined chute that extends to the river. The uncontrolled emergency spill flows over natural terrain.

Table P-18 Water Year/Days in Flood Control/40-30-30 Index

Water Year	Days in Flood Control	40-30-30 Index
1981	0	D
1982	35	W
1983	51	W
1984	16	W
1985	0	D
1986	25	W
1987	0	D
1988	0	C
1989	0	D
1990	0	C
1991	0	C
1992	0	C
1993	8	AN
1994	0	C
1995	35	W
1996	22	W
1997	57	W
1998	0	W
1999	58	W
2000	0	AN
2001	0	D
2002	0	D

Feather River Ramping Rate Requirements

Maximum allowable ramp-down release requirements are intended to prevent rapid reductions in water levels that could potentially cause redd dewatering and stranding of juvenile salmonids and other aquatic organisms. Ramp-down release requirements to the

LFC during periods outside of flood management operations, and to the extent controllable during flood management operations, are shown in Table P-19.

Table P-19 Lower Feather River Ramping Rates

Releases to the Feather River Low Flow Channel (cfs)	Rate of Decrease (cfs)
5,000 to 3,501	1,000 per 24 hours
3,500 to 2,501	500 per 24 hours
2,500 to 600	300 per 24 hours

Key:

cfs = cubic feet per second

Source: NMFS 2004a

Proposed Operational Changes with the Federal Energy Regulatory Commission (FERC) Relicensing of the Oroville Project– Near Term and Future Operations

Until FERC issues the new license for the Oroville Project, DWR will not significantly change the operations of the facilities and when the FERC license is issued, it is assumed that downstream of Thermalito Afterbay Outlet, the future flows will remain the same.

There is a great deal of uncertainty as to when the license will be issued and what conditions will be imposed by FERC and the State Water Resources Control Board (SWRCB). The process that DWR has to go through to get the new license is as follows: DWR will finalize the Final Environment Impact Report in May 2008, the SWRCB will prepare the Clean Water Act Section 401 Certification (401 Cert) for the project which may take up to a year and the 401 Cert may have additional requirements for DWR operations of Oroville. Once the 401 Cert is issued, FERC can issue the new license; however, in the interim, the documents or process may be challenged in court. When the new FERC license is issued, additional flow or temperature requirements may be required. At this time, DWR can only assume that the flow and temperature conditions required will be those in the FERC Settlement Agreement (SA); therefore, those are what DWR proposes for the near-term and future Oroville operations.

The proposed future operations in the SA described in the Project Description include 100-200 cfs increase in flows in the LFC of the Lower Feather River and reduced water temperatures at the Feather River Hatchery and in the Low Flow and High Flow channels, after further analysis of alternatives and construction of one or more temperature control facilities. These are described in more detail in the SA. The flows in the HFC downstream of the TAO will not change. It is unlikely that either the proposed minor flow changes in the LFC or the reduced water temperatures will affect conditions in the Sacramento River downstream of the confluence but if they were detectable, they would be beneficial to anadromous fish in the Sacramento River.

The original FERC license to operate the Oroville Project expired in January 2007 and until a new license is issued, DWR will operate to the existing FERC license. FERC has and will continue to issue an annual license until it is prepared to issue the new 50-year license. In preparation for the expiration of the FERC license, DWR began working on the relicensing process in 2001. As part of the process, DWR entered into a SA with State, federal and local agencies, State Water Contractors, Non-Governmental Organizations, and Tribal governments to implement improvements within the FERC Boundary. The FERC boundary includes all of the Oroville Project facilities, extends upstream into the tributaries of Lake Oroville, includes portions of the LFC on the lower Feather River and downstream of the Thermalito Afterbay Outlet into the HFC. In addition to the Settlement Agreement signed in 2006, a Habitat Expansion Agreement was negotiated to address the fish passage issue over Oroville Dam and NMFS and the Service' Section 18 Authority under the Federal Power Act. FERC prepared an EIS for the proposed license and DWR prepared an EIR and biological assessments for FERC based on the terms and conditions in the Settlement Agreement. The SWRCB is working on the Section 401 Certification process and when all the environmental documents and permits are complete, the new 50-year FERC license will be issued for the Oroville Project, possibly in 2009.

FERC requested consultation with NMFS on the Oroville Project SA and DWR prepared and submitted the FERC biological assessment in June 2007 to NMFS and FERC. The SA does not change the flows in the HFC although there will be a proposed increase in minimum flows in the LFC. The SA includes habitat restoration actions such as side-channel construction, structural habitat improvement such as boulders and large woody debris, spawning gravel augmentation, a fish counting weir, riparian vegetation and floodplain restoration, and facility modifications to improve coldwater temperatures in the low and high flow channels. The SA and the FERC biological assessment provide substantial detail on the restoration actions in the Lower Feather River.

Below is a summary of articles in the SA referred to by number and is by no means a complete description of the terms and conditions therein. The numbering of the tables in this section is consistent with the numbering in the SA for direct comparison.

Minimum Flows in the Low Flow and High Flow Channels

When the FERC license is issued, DWR will release a minimum flow of 700 cfs into the LFC. The minimum flow shall be 800 cfs from September 9 to March 31 of each year to accommodate spawning of anadromous fish, unless the NMFS, the Service, DFG, and California SWRCB provide a written notice that a lower flow (between 700 cfs and 800 cfs) substantially meets the needs of anadromous fish. If the DWR receives such a notice, it may operate consistent with the revised minimum flow. HFC flows will remain the same as the existing license, consistent with the 1983 DWR and DFG Operating Agreement to continue to protect Chinook salmon from redd dewatering.

Water Temperatures for the Feather River Fish Hatchery

When the FERC license is issued, DWR will use the temperatures in Table P-20 as targets, and will seek to achieve them through the use of operational measures described below.

Table P-20 Maximum Mean Daily Temperatures,

September 1-September 30	56 °F
October 1 – May 31	55 °F
June 1 – August 31	60°F

The temperatures in Table P-20 are Maximum Mean Daily Temperatures, calculated by adding the hourly temperatures achieved each day and dividing by 24. DWR will strive to meet Maximum Mean Daily Temperatures through operational changes including but not limited to (i) curtailing pump-back operation and (ii) removing shutters on Hyatt intake and (iii) after river valve refurbishment. DWR will consider the use of the river valve up to a maximum of 1500 cfs; however these flows need not exceed the actual flows in the HFC, and should not be less than those specified in HFC minimum flows described above, which will not change with the new FERC license. During this interim period, DWR shall not be in violation if the Maximum Mean Daily Temperatures are not achieved through operational changes.

Prior to FERC license implementation, DWR agreed to begin the necessary studies for the refurbishment or replacement of the river valve. On October 31, 2006, DWR submitted to specific agencies a Reconnaissance Study of Facilities Modification to address temperature habitat needs for anadromous fisheries in the Low Flow Channel and the HFC. Under the provisions of Settlement Agreement Appendix B Section B108(a), DWR has begun a study to evaluate whether to refurbish or replace the river valve that may at times be used to provide cold water for the Feather River Fish Hatchery.

Upon completion of Facilities Modification(s) as provided in A108, and no later than the end of year ten following license issuance, Table P-20 temperatures shall become requirements, and DWR shall not exceed the Maximum Mean Daily Temperatures in Table P-20 for the remainder of the License term, except in Conference Years as referenced in A107.2(d).

During the term of the FERC license, DWR will not exceed the hatchery water temperatures in Table P-21. There will be no minimum temperature requirement except for the period of April 1 through May 31, during which the temperatures shall not fall below 51 °F.

Table P-21 Hatchery Water Temperatures

September 1-September 30	56 °F
October 1 – November 30	55 °F
December 1 – March 31	55 °F

April 1 – May 15	55 °F
May 16-May 31	59°F
June 1-June 15	60°F
June 16- August 15	64°F
August 16 – August 31	62°F

Upon completion of Facilities Modification(s) as provided in A108 (discussed below), DWR may develop a new table for hatchery temperature requirements that is at least as protective as Table P-21. If a new table is developed, it shall be developed in consultation with the Ecological Committee, including specifically the Service, NMFS, DFG, California SWRCB, and RWQCB. The new table shall be submitted to FERC for approval, and upon approval shall become the temperature requirements for the hatchery for the remainder of the license term.

During Conference Years, as defined in A108.6, DWR shall confer with the Service, NMFS, DFG, and California SWRCB to determine proper temperature and hatchery disease management goals.

Water Temperatures in the Lower Feather River

Under the SA, DWR is committing to a Feasibility Study and Implementation Plan to improve temperature conditions (Facilities Modification(s)) for spawning, egg incubation, rearing and holding habitat for anadromous fish in the Low Flow Channel and HFC (A108.4). The Plan will recommend a specific alternative for implementation and will be prepared in consultation with the resource agencies.

Prior to the Facilities Modification(s) described in Article A108.4, if DWR does not achieve the applicable Table P-22 Robinson Riffle temperature upon release of the specified minimum flow, DWR shall singularly, or in combination perform the following actions:

- (1) Curtail pump-back operation,
- (2) Remove shutters on Hyatt Intake, and
- (3) Increase flow releases in the LFC up to a maximum of 1500 cfs, consistent with the minimum flow standards in the HFC. Table P-22 temperatures are targets and if they are not met there is no license violation.

If in any given year DWR anticipates that these measures will not achieve the temperatures in Table P-22, DWR shall consult with the NMFS, the Service, DFG, and California SWRCB to discuss potential approaches to best managing the remaining coldwater pool in Lake Oroville, which may result in changes in the way Licensee performs actions (1), (2), and (3) listed above.

Table P-22 LFC as Measured at Robinson Riffle.

(all temperatures are in daily mean value (degrees F))

Month	Temperature (° F)
January	56
February	56
March	56
April	56
May 1-15	56-63*
May 16-31	63
June 1 – 15	63
June 16 – 30	63
July	63
August	63
September 1-8	63-58*
September 9 – 30	58
October	56
November	56
December	56
* Indicates a period of transition from the first temperature to the second temperature.	

After completion of the Facilities Modification(s), DWR shall no longer be required to perform the measures listed in (1), (2), and (3), unless Table P-22 temperatures are exceeded. DWR shall operate the project to meet temperature requirements in Table P-22 in the LFC, unless it is a Conference Year as described in Article 108.6. The proposed water temperature objectives in Table P-23 (in Article 108), measured at the southern FERC project boundary, will be evaluated for potential water temperature improvements in the HFC. DWR will study options for Facilities Modification(s) to achieve those temperature benefits.

There would be a testing period of at least five years in length to determine whether the HFC temperature benefits are being realized (A108.5). At the end of the testing period, DWR will prepare a testing report that may recommend changes in the facilities, compliance requirements for the HFC and the definition of Conference Years (those

years where DWR may have difficulties in achieving the temperature requirements due to hydrologic conditions.) The challenges of implementing Table P-23 temperatures will require the phased development of the Table P-23 water temperature objective and likely, a revision to Table P-23 prior to Table P-23 becoming a compliance obligation.

Table P-23 HFC as measured at Downstream Project Boundary

(all temperatures are in daily mean value (degrees F))

Month	Temperature
January	56
February	56
March	56
April	61
May	64
June	64
July	64
August	64
September	61
October	60
November	56
December	56

Habitat Expansion Agreement

The Habitat Expansion Agreement is a component of the 2006 SA to address DWR obligations in regard to blockage and fish passage issues in regard to the construction of Oroville Dam. Because it deals with offsite mitigation it will not be included in the new FERC license.

Construction of the Oroville Facilities and Pacific Gas and Electric Company's construction of other hydroelectric facilities on the upper Feather River tributaries blocked passage and reduced available habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead. The reduction in spring-run habitat resulted in spatial overlap with fall-run Chinook salmon and has led to increased redd superimposition, competition for limited habitat, and genetic introgression. FERC relicensing of hydroelectric projects in the Feather River basin has focused attention on the desirability of expanding spawning, rearing and adult holding habitat available for Central Valley spring-run and steelhead. The SA Appendix F includes a provision to establish a habitat enhancement program with an approach for identifying, evaluating, selecting and implementing the most promising action(s) to expand such spawning, rearing and adult holding habitat in the Sacramento River Basin as a contribution to the

conservation and recovery of these species. The specific goal of the Habitat Expansion Agreement is to expand habitat sufficiently to accommodate an estimated net increase of 2,000 to 3,000 spring-run or steelhead for spawning (Habitat Expansion Threshold). The population size target of 2,000 to 3,000 spawning individuals was selected because it is approximately the number of spring-run and steelhead that historically migrated to the upper Feather River. Endangered species issues will be addressed and documented on a specific project-related basis for any restoration actions chosen and implemented under this Agreement.

Anadromous Fish Monitoring on the Lower Feather River

Until the new FERC license is issued and until a new monitoring program is adopted, DWR will continue to monitor anadromous fish in the Lower Feather River in compliance with the project description set out in Reclamation's 2004 OCAP biological assessment.

As required in the FERC SA (Article A101), within three years following the FERC license issuance, DWR will develop a comprehensive Lower Feather River Habitat Improvement Plan that will provide an overall strategy for managing the various environmental measures developed for implementation, including the implementation schedules, monitoring, and reporting. Each of the programs and components of the Lower Feather River Habitat Improvement Plan shall be individually evaluated to assess the overall effectiveness of each action within the Lower Feather River Habitat Improvement Plan.

Delta Field Division

SWP facilities in the southern Delta include Clifton Court Forebay, John E. Skinner Fish Facility, and the Banks Pumping Plant. CCF is a 31,000 AF reservoir located in the southwestern edge of the Delta, about ten miles northwest of Tracy. CCF provides storage for off-peak pumping, moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta channels, and collects sediment before it enters the California Aqueduct. Diversions from Old River into CCF are regulated by five radial gates.

The John E. Skinner Delta Fish Protective Facility is located west of the CCF, two miles upstream of the Banks Pumping Plant. The Skinner Fish Facility screens fish away from the pumps that lift water into the California Aqueduct (CA). Large fish and debris are directed away from the facility by a 388-foot long trash boom. Smaller fish are diverted from the intake channel into bypasses by a series of metal louvers, while the main flow of water continues through the louvers and towards the pumps. These fish pass through a secondary system of screens and pipes into seven holding tanks, where a subsample is counted and recorded. The salvaged fish are then returned to the Delta in oxygenated tank trucks.

The Banks Pumping Plant is in the South Delta, about eight miles northwest of Tracy and marks the beginning of the CA. By means of 11 pumps, including two rated at 375 cfs capacity, five at 1,130 cfs capacity, and four at 1,067 cfs capacity, the plant provides the

initial lift of water 244 feet into the CA. The nominal capacity of the Banks Pumping Plant is 10,300 cfs.

Other SWP operated facilities in and near the Delta include the North Bay Aqueduct (NBA), the Suisun Marsh Salinity Control Gates (SMSCG), Roaring River Distribution System (RRDS), and up to four temporary barriers in the South Delta. Each of these facilities is discussed further in later sections.

Clifton Court Forebay Aquatic Weed Control Program

DWR will apply copper based herbicide complexes including copper sulfate pentahydrate, Komeen,[®] and Nautique[®] on an as-needed basis to control aquatic weeds and algal blooms in Clifton Court Forebay (Forebay). Komeen[®] is a chelated copper herbicide (copper-ethylenediamine complex and copper sulfate pentahydrate) and Nautique[®] is a copper carbonate compound (see Sepro product labels). These products are used to control algal blooms so that such algae blooms do not degrade drinking water quality through tastes and odors and production of algal toxins. Dense growth of submerged aquatic weeds, predominantly *Egeria densa*, can cause severe head loss and pump cavitation at Banks Pumping Plant when the stems of the rooted plant break free and drift into the trashracks. This mass of uprooted and broken vegetation essentially forms a watertight plug at the trashracks and vertical louver array. The resulting blockage necessitates a reduction in the pumping rate of water to prevent potential equipment damage through cavitation at the pumps. Cavitation creates excessive wear and deterioration of the pump impeller blades. Excessive floating weed mats also reduce the efficiency of fish salvage at the Skinner Fish Facility. Ultimately, this all results in a reduction in the volume of water diverted by the State Water Project.

Herbicide treatments will occur only in July and August on an as needed basis in the Forebay dependent upon the level of vegetation biomass in the enclosure. However, the frequency of herbicide applications is not expected to occur more than twice per year. Herbicides are typically applied early in the growing season when plants are susceptible to the herbicides due to rapid growth and formation of plant tissues, or later in the season, when plants are mobilizing energy stores from their leaves towards their roots for over wintering senescence. Past use of aquatic herbicides is presented in Table P-24.

Table P-24 Aquatic herbicide applications in Clifton Court Forebay, 1995- Present.

Note: The past applications are provided to give the reader an indication of the frequency of herbicide applications in the past (baseline).

Year	Date	Aquatic Herbicide
1995	5/15/1995	Komeen [®]
1995	8/21/1995	Komeen [®]
1996	6/11/1996	Komeen [®]
1996	9/10/1996	Komeen [®]

Year	Date	Aquatic Herbicide
1997	5/23/1997	Komeen®
1997	7/14/1997	Komeen®
1998	7/13/1998	Komeen®
1999	6/11/1999	Komeen®
2000	7/31/2000	Komeen®
2001	6/29/2001	Nautique
2002	6/24/2002	Komeen®
2003	5/12/2003	Nautique
2003	8/13/2003	Copper Sulfate
2004	6/3/2004	Komeen®
2004	7/22/2004	Copper Sulfate
2005	5/3/2005	Komeen®
2005	6/21/2005	Komeen®
2006	6/1/2006	Komeen®
2006	6/29/2006	Komeen®

Additionally, copper sulfate pentahydrate was applied once in 2003 and 2004 by helicopter to control taste and odor producing benthic cyanobacteria.

Aquatic weed management problems in the Forebay have to date been limited to about 700 acres of the 2,180 total water surface acres. Application of the herbicide is limited to only those areas in the Forebay that require treatment. The copper based herbicides, Komeen® or Nautique, are applied by helicopter or boat to only those portions where aquatic weeds present a management problem to the State.

To date, algal problems in the Forebay have been caused by attached benthic cyanobacteria which produce unpleasant tastes and odors in the domestic drinking water derived from the SWP operations. Copper sulfate is applied to the nearshore areas of the Forebay when results of Solid phase microextraction (SPME) (APHA, 2005) analysis exceed the control tolerances (MIB < 5 ng/L and geosmin < 10 ng/L are not detected by consumers in drinking water supplies)(Aquatic Pesticide Application Plan, 2004). Highest biomass of taste and odor producing cyanobacteria was present in the nearshore areas but not limited to shallow benthic zone. Annually, application areas may vary considerably based on the extent of the algal infestation in the Forebay.

DWR receives Clean Water Act pollutant discharge coverage under the National Pollutant Discharge Elimination System (NPDES) Permit No. CAG990005 (General Permit) issued by the SWRCB for application of aquatic pesticides to the SWP aqueducts, forebays, and reservoirs when necessary to achieve management goals. The State Board functions as the Environmental Protection Agency's non-federal representative for implementation of the Clean Water Act in California.

A Mitigated Negative Declaration was prepared by DWR to comply with CEQA requirements associated with regulatory requirements established by the SWRCB. DWR, a public entity, was granted a Section 5.3 Exception by the SWRCB (Water Quality Order 2004-0009-DWQ) and is not required to meet the copper limitation in receiving waters during the exception period from March 1 to November 30 as described in the DWR's Aquatic Pesticide Application Plan. .

Proposed Measures to Reduce Fish Mortality

Komeen® will be applied according to the product label directions as required by state and federal law. The Forebay elevation will be raised to +2 feet above mean sea level for an average depth of about 6 feet within the 700-water surface acre treatment zone. The herbicide will be applied at a rate of 13 gallons per surface acre to achieve a final operational concentration in the water body of 0.64 mg/L Cu²⁺. (640 ppb). Application rate of 13 gallons per surface area is calculated based on mean depth. The product label allows applications up to 1 mg/L (1000 ppb or 1 ppm). DWR applies Komeen in accordance with the specimen label that states, "If treated water is a source of potable water, the residue of copper must not exceed 1 ppm (mg/L)".

In 2005, 770 surface acres were treated with Komeen®. Clifton Court Forebay has a mean depth of 6 feet at 2 feet above mean sea level; thus the volume treated is 4620 acre-feet.

The concentration of the active ingredient (Cu²⁺) is calculated from the following equation:

$$\text{Cu}^{2+} \text{ (ppm)} = \text{Komeen (gallon)} / (\text{Mean Depth (feet)} * 3.34)$$
 Source: Komeen® Specimen Label EPA reg No. 67690-25

The calculated concentration of Cu²⁺ for the 2005 application was 0.65 mg/L Cu²⁺. The copper level required to control *Egeria densa* (the main component of the Clifton Court Forebay aquatic plant community) is 0.5 - 0.75 mg/L Cu²⁺. Source: Komeen® Specimen Label.

Prior to application of copper based herbicides, toxicity testing and literature review of LC-50 levels for salmon, steelhead, delta smelt, and green sturgeon may be conducted. Once applied, the initial stock copper concentration is reduced rapidly (hours) by dilution (Komeen® applied according to the Specimen Label (SePro Corporation) of the product in the receiving water to achieve final concentration levels. Based on the treatment elevation of +2 feet, only about 20 percent (4,630 AF) of the 22,665 AF Forebay will be treated (AF = Acre-feet= volume). The copper will be applied beginning on one side of

the Forebay allowing fish to move out of the treatment area. In addition, Komeen® will be applied by boats at a slower rate than in previous years when a helicopter was used.

In 2006 DWR proposed the following actions to reduce fish mortality in coordination with DFG and NMFS. Also, the hydroacoustical aquatic plant survey was continued in 2007 when no Komeen application was done. A survey in 2008 is also planned. These actions will continue to be followed in the future.

1. Komeen® or copper sulfate will only be applied in July and August.
2. The salvage of listed fish species at Skinner Fish Facility will be monitored prior to the Komeen® application.
3. The intake (radial) gates at Clifton Court Forebay will be closed 24 hours prior to the scheduled application to improve fish passage out of the designated treatment areas.
4. The radial gates will not be re-opened to allow inflow into the Forebay for 24 hours following the end of the aquatic herbicide application. The Clifton Court intake gates will therefore be closed for 48 hours. The Komeen® Specimen Label recommends a 12-24 hours contact with target weeds to provide effective control. Twenty-four hours is at the high end for recommended contact time according to the Komeen® Specimen Label.
5. Komeen® will be applied by boat, first to the nearshore areas and then outwards in transects away from the shore. The application will be conducted by a private contractor and supervised by a California Certified Pest Control Advisor.
6. The herbicide treatment will be scheduled and planned for minimizing the treatment area by using hydroacoustical plant mapping technology to locate and estimate the area of submerged vegetation beds. The smallest possible area will be treated to minimize both the volume of aquatic herbicide applied and lessen the impacts to fish in the Forebay. Examples of figures from the 2005 hydroacoustical survey are enclosed.
7. Copper monitoring and analysis will follow the procedures described in the DWR Quality Assurance Project Plan submitted to the State Water Resources Control Board in February 2002. There are no plans to measure sediment and detrital copper concentrations. The Quality Assurance Plan was submitted to the SWRCB on February 26, 2002 and no comments were received.

North Bay Aqueduct Intake at Barker Slough

The Barker Slough Pumping Plant diverts water from Barker Slough into the North Bay Aqueduct (NBA) for delivery in Napa and Solano Counties. Maximum pumping capacity is 175 cfs (pipeline capacity). During the past few years, daily pumping rates have ranged between 0 and 140 cfs. The current maximum pumping rate is 140 cfs because an additional pump is required to be installed to reach 175 cfs. In addition, growth of biofilm in a portion of the pipeline is also limiting the NBA ability to reach its full capacity.

The NBA intake is located approximately 10 miles from the main stem Sacramento River at the end of Barker Slough. Per salmon screening criteria, each of the ten NBA pump bays is individually screened with a positive barrier fish screen consisting of a series of flat, stainless steel, wedge-wire panels with a slot width of 3/32 inch. This configuration is designed to exclude fish approximately one inch or larger from being entrained. The bays tied to the two smaller units have an approach velocity of about 0.2 ft/s. The larger units were designed for a 0.5 ft/s approach velocity, but actual approach velocity is about 0.44 ft/s. The screens are routinely cleaned to prevent excessive head loss, thereby minimizing increased localized approach velocities.

Delta smelt monitoring was required at Barker Slough under the March 6, 1995 OCAP BO. Starting in 1995, monitoring was required every other day at three sites from mid-February through mid-July, when delta smelt may be present and continued monitoring was stopped in 2005. As part of the Interagency Ecological Program (IEP), DWR has contracted with the DFG to conduct the required monitoring each year since the biological opinion was issued. Details about the survey and data are available on DFG's website (<http://www.delta.dfg.ca.gov/data/NBA>).

Beginning in 2008, the NBA larval sampling will be replaced by an expanded 20-mm survey (described at <http://www.delta.dfg.ca.gov/data/20mm>) that has proven to be fairly effective at tracking delta smelt distribution and reducing entrainment. The expanded survey covers all existing 20-mm stations, in addition to a new suite of stations near NBA. The expanded survey also has an earlier seasonal start and stop date to focus on the presence of larvae in the Delta. The gear type was a surface boom tow, as opposed to oblique sled tows that have traditionally been used to sample larval fishes in the San Francisco Estuary.

Coordinated Facilities of the CVP and SWP

Joint Project Facilities

Suisun Marsh

Since the early 1970's, the California Legislature, SWRCB, Reclamation, DFG, Suisun Resource Conservation District (SRCD), DWR, and other agencies have worked to preserve beneficial uses of Suisun Marsh in mitigation for perceived impacts of reduced Delta Outflow on the salinity regime. Early on, salinity standards set by the SWRCB to protect alkali bulrush production, a primary waterfowl plant food. The most recent standard under SWRCB D-1641 acknowledges that multiple beneficial uses deserve protection.

A contractual agreement between DWR, Reclamation, DFG and SRCD contains provisions for DWR and Reclamation to mitigate the effects on Suisun Marsh channel water salinity from the SWP and CVP operations and other upstream diversions. The Suisun Marsh Preservation Agreement (SMPA) requires DWR and Reclamation to meet salinity standards (Figure P-13), sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements. In addition to the contractual

agreement, SWRCB D-1485 codified salinity standards in 1978, which have been carried forward to SWRCB D-1641.

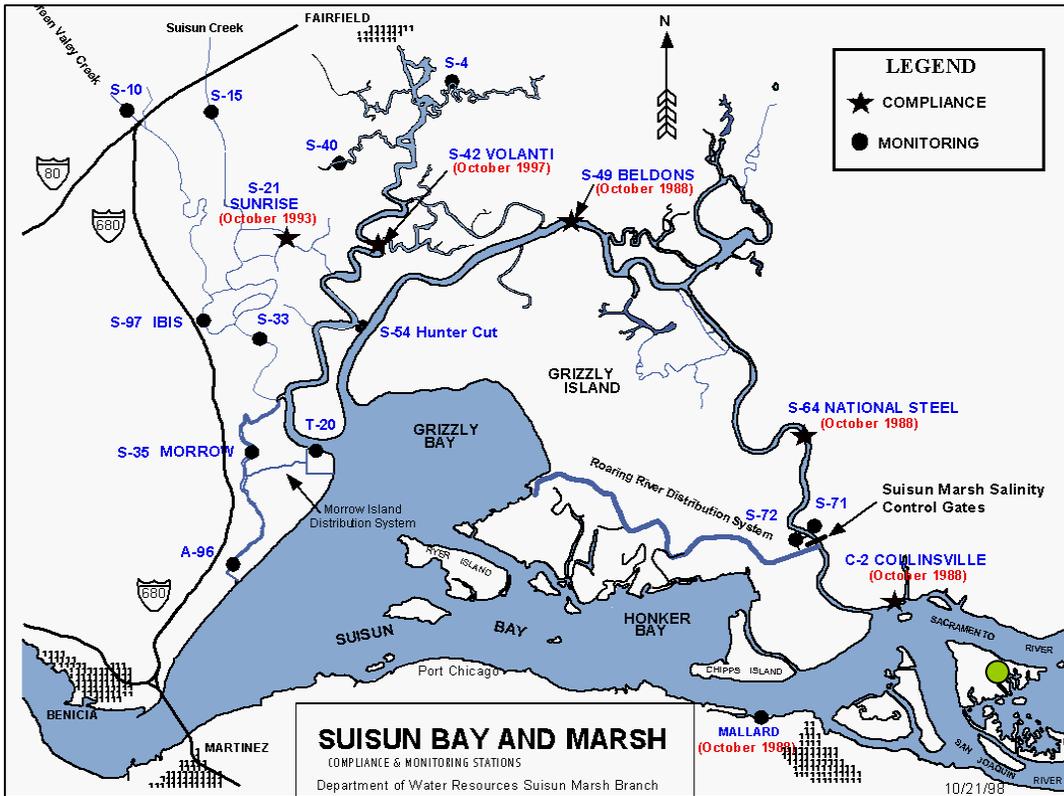


Figure P-13 Compliance and monitoring stations and salinity control facilities in Suisun Marsh.

There are two primary physical mechanisms for meeting salinity standards set forth in D-1641 and the SMPA: (1) the implementation and operation of physical facilities in the Marsh; and (2) management of Delta outflow (i.e. facility operations are driven largely by salinity levels upstream of Montezuma Slough and salinity levels are highly sensitive to Delta outflow). Physical facilities (described below) have been operating since the early 1980s and have proven to be a highly reliable method for meeting standards. However, since Delta outflow cannot be actively managed by the Suisun Marsh Program, Marsh facility operations must be adaptive in response to changing salinity levels in the Delta.

CALFED Charter for Development of an Implementation Plan for Suisun Marsh Wildlife Habitat Management and Preservation

The goal of the CALFED Charter is to develop a regional plan that balances implementation of the CALFED Program, SMPA, and other management and restoration programs within Suisun Marsh. This is to be conducted in a manner that is responsive to the concerns of stakeholders and based upon voluntary participation by private land owners. The Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh (Suisun Marsh Plan) and its accompanying Programmatic Environmental Impact Statement/Report will develop, analyze, and evaluate potential effects of various actions

in the Suisun Marsh. The actions are intended to preserve and enhance managed seasonal wetlands, implement a comprehensive levee protection/improvement program, and protect ecosystem and drinking water quality, while restoring habitat for tidal marsh-dependent sensitive species, consistent with the CALFED Bay-Delta Program's strategic goals and objectives. The Service and Reclamation are NEPA co-leads while DFG is the lead state CEQA agency.

Suisun Marsh Salinity Control Gates

The SMSCG are located on Montezuma Slough about 2 miles downstream from the confluence of the Sacramento and San Joaquin Rivers, near Collinsville. Operation of the SMSCG began in October 1988 as Phase II of the Plan of Protection for the Suisun Marsh. The objective of SMSCG operation is to decrease the salinity of the water in Montezuma Slough. The facility, spanning the 465 foot width of Montezuma Slough, consists of a boat lock, a series of three radial gates, and removable flashboards. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west.

When Delta outflow is low to moderate and the gates are not operating, tidal flow past the gate is approximately +/- 5,000-6,000 cfs while the net flow is near zero. When operated, flood tide flows are arrested while ebb tide flows remain in the range of 5,000-6,000 cfs. The net flow in Montezuma Slough becomes approximately 2,500-2,800 cfs. The Corps of Engineers permit for operating the SMSCG requires that it be operated between October and May only when needed to meet Suisun Marsh salinity standards. Historically, the gate has been operated as early as October 1, while in some years (e.g. 1996) the gate was not operated at all. When the channel water salinity decreases sufficiently below the salinity standards, or at the end of the control season, the flashboards are removed and the gates raised to allow unrestricted movement through Montezuma Slough. Details of annual gate operations can be found in "Summary of Salinity Conditions in Suisun Marsh During WYs 1984-1992", or the "Suisun Marsh Monitoring Program Data Summary" produced annually by DWR, Division of Environmental Services.

The approximately 2,800 cfs net flow induced by SMSCG operation is effective at moving the salinity downstream in Montezuma Slough. Salinity is reduced by roughly one-hundred percent at Beldons Landing, and lesser amounts further west along Montezuma Slough. At the same time, the salinity field in Suisun Bay moves upstream as net Delta outflow (measured nominally at Chipps Island) is reduced by gate operation (Figure P-14). Net outflow through Carquinez Strait is not affected. Figure P-14 indicates the approximate position of X2 and how is transported upstream when the gate is operated.

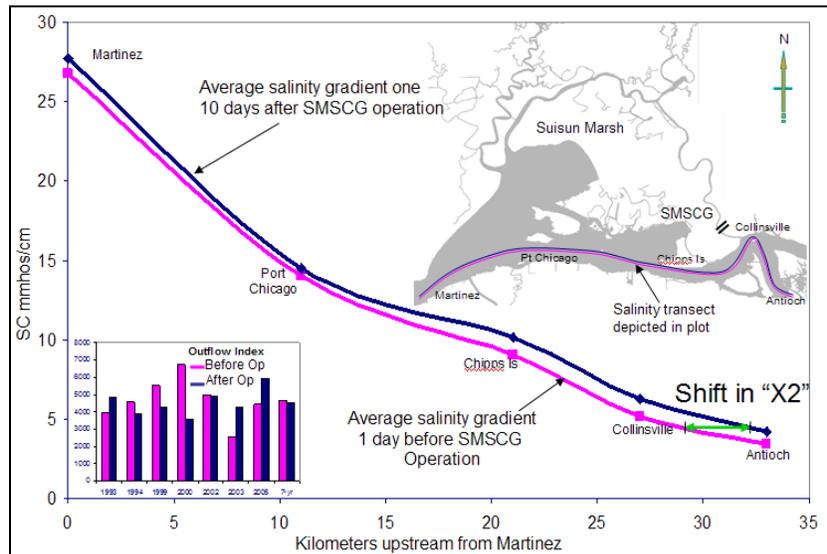
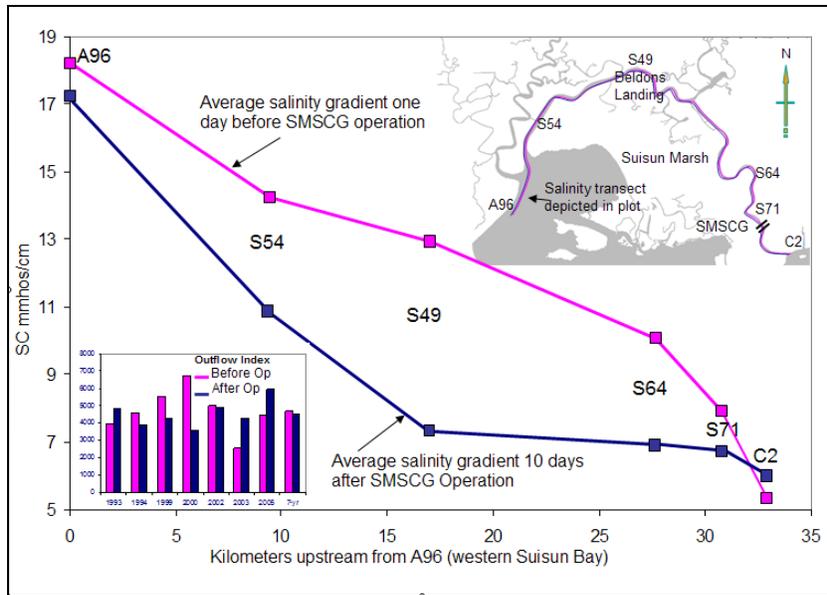


Figure P-14 Average of seven years salinity response to SMSCG gate operation in Montezuma Slough and Suisun Bay.

Note: Magenta line is salinity profile 1 day before gate operation, blue line is salinity 10 days after gate operation.

It is important to note that historical gate operations (1988 – 2002) were much more frequent than recent and current operations (2006 – May 2008). Operational frequency is affected by many drivers (hydrologic conditions, weather, Delta outflow, tide, fishery considerations, etc). The gates have also been operated for scientific studies. Figure P-15 shows that the gates were operated between 60 and 120 days between October and December during the early years (1988-2004). Salmon passage studies between 1998 and 2003 increased the number of operating days by up to 14 to meet study requirements. After discussions with NMFS based on study findings, the boat lock portion of the gate is now held open at all times during SMSCG operation to allow for continuous salmon

passage opportunity. With increased understanding of the effectiveness of the gates in lowering salinity in Montezuma Slough, salinity standards have been met with less frequent gate operation since 2006. Despite very low outflow in the fall of the two most recent WYs, gate operation was not required at all in fall 2007 and was limited to 17 days in winter 2008. Assuming no significant, long-term changes in the drivers mentioned above, this level of operational frequency (10 – 20 days per year) can generally be expected to continue to meet standards in the future except perhaps during the most critical hydrologic conditions and/or other conditions that affect Delta outflow.

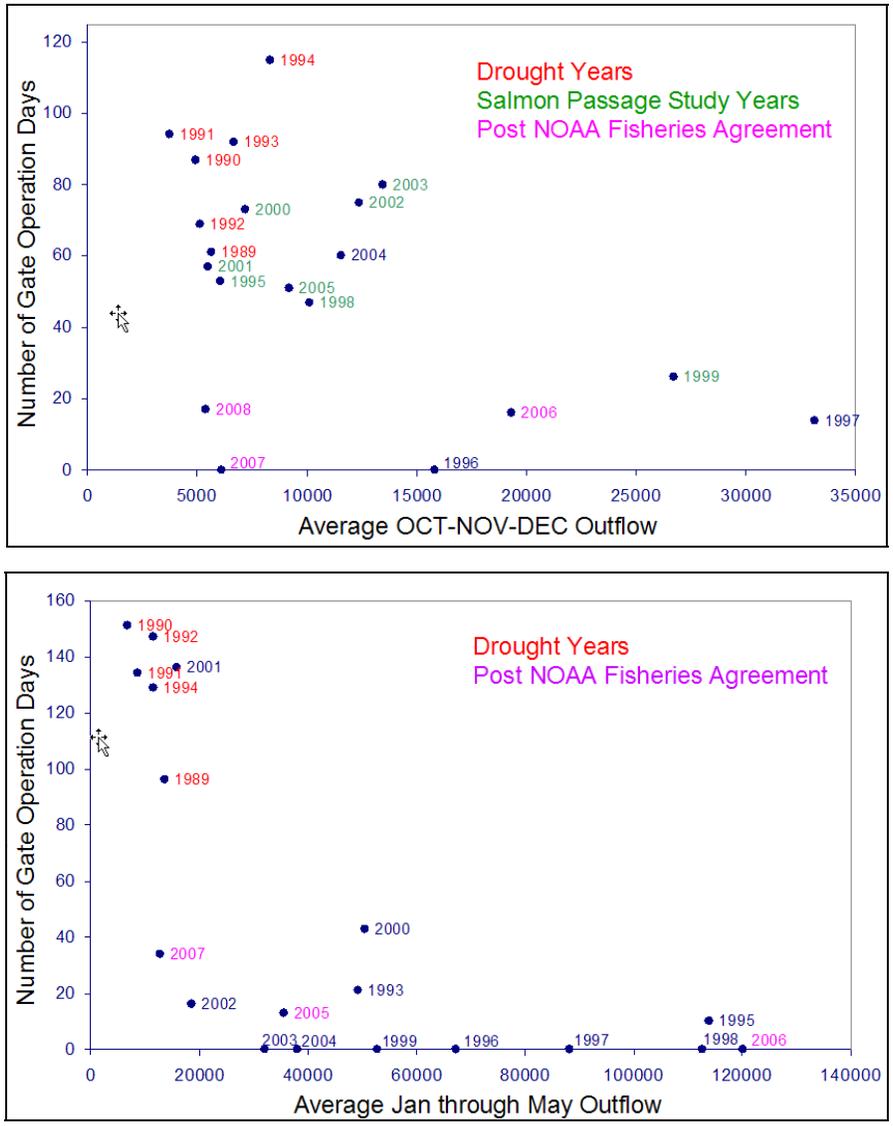


Figure P-15 SMSCG operation frequency versus outflow since 1988.

SMSCG Fish Passage Study

The SMSCG were constructed and operate under Permit 16223E58 issued by the Corps, which includes a special condition to evaluate the nature of delays to migrating fish.

Ultrasonic telemetry studies in 1993 and 1994 showed that the physical configuration and operation of the gates during the Control Season have a negative effect on adult salmonid passage (Tillman et al 1996; Edwards et al 1996).

DWR coordinated additional fish passage studies in 1998, 1999, 2001, 2002, 2003, and 2004. Migrating adult fall-run Chinook salmon were tagged and tracked by telemetry in the vicinity of the SMSCG to assess potential measures to increase the salmon passage rate and decrease salmon passage time through the gates.

Results in 2001, 2003, and 2004 indicate that leaving the boat-lock open during the Control Season when the flashboards are in place at the SMSCG and the radial gates are tidally operated provides a nearly equivalent fish passage to the Non-Control Season configuration when the flashboards are out and the radial gates are open. This approach minimizes delay and blockage of adult Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead migrating upstream during the Control Season while the SMSCG is operating. However, the boat-lock gates may be closed temporarily to stabilize flows to facilitate safe passage of watercraft through the facility.

Reclamation and DWR are continuing to coordinate with the SMSCG Steering Committee in identifying water quality criteria, operational rules, and potential measures to facilitate removal of the flashboards during the Control Season that would provide the most benefit to migrating fish. However, the flashboards would not be removed during the Control Season unless it was certain that standards would be met for the remainder of the Control Season without the flashboards installed.

Roaring River Distribution System

The Roaring River Distribution System (RRDS) was constructed during 1979 and 1980 as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh. The system was constructed to provide lower salinity water to 5,000 acres of private and 3,000 acres of DFG managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands.

The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Motorized slide gates in Montezuma Slough and flap gates in the pond control flows through the culverts into the pond. A manually operated flap gate and flashboard riser are located at the confluence of Roaring River and Montezuma Slough to allow drainage back into Montezuma Slough for controlling water levels in the distribution system and for flood protection. DWR owns and operates this drain gate to ensure the Roaring River levees are not compromised during extremely high tides.

Water is diverted through a bank of eight 60-inch-diameter culverts equipped with fish screens into the Roaring River intake pond on high tides to raise the water surface elevation in RRDS above the adjacent managed wetlands. Managed wetlands north and south of the RRDS receive water, as needed, through publicly and privately owned turnouts on the system.

The intake to the RRDS is screened to prevent entrainment of fish larger than approximately 25 mm. DWR designed and installed the screens based on DFG criteria. The screen is a stationary vertical screen constructed of continuous-slot stainless steel wedge wire. All screens have 3/32-inch slot openings. After the listing of delta smelt, RRDS diversion rates have been controlled to maintain an average approach velocity below 0.2 ft/s at the intake fish screen. Initially, the intake culverts were held at about 20 percent capacity to meet the velocity criterion at high tide. Since 1996, the motorized slide gates have been operated remotely to allow hourly adjustment of gate openings to maximize diversion throughout the tide.

Routine maintenance of the system is conducted by DWR and primarily consists of maintaining the levee roads and fish screens. RRDS, like other levees in the marsh, have experienced subsidence since the levees were constructed in 1980. In 1999, DWR restored all 16 miles of levees to design elevation as part of damage repairs following the 1998 flooding in Suisun Marsh. In 2006, portions of the north levee were repaired to address damage following the January 2006 flooding.

Morrow Island Distribution System

The Morrow Island Distribution System (MIDS) was constructed in 1979 and 1980 in the south-western Suisun Marsh as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh. The contractual requirement for the Reclamation and DWR is to provide water to the ownerships so that lands may be managed according to approved local management plans. The system was constructed primarily to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough (GYS).

The MIDS is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor through three 48-inch culverts. Drainage water from Morrow Island is discharged into Grizzly Bay by way of the C-Line Outfall (two 36-inch culverts) and into the mouth of Suisun Slough by way of the M-Line Outfall (three 48-inch culverts), rather than back into Goodyear Slough. This helps prevent increases in salinity due to drainage water discharges into Goodyear Slough. The M-Line ditch is approximately 1.6 miles in length and the C-Line ditch is approximately 0.8 miles in length.

The 1997 Service biological opinion issued for dredging of the facility included a requirement for screening the diversion to protect delta smelt. Due to the high cost of fish screens and the lack of certainty surrounding their effectiveness at MIDS, DWR and Reclamation proposed to investigate fish entrainment at the MIDS intake with regard to fishery populations in Goodyear Slough and to evaluate whether screening the diversion would provide substantial benefits to local populations of listed fish species.

To meet contractual commitments, the typical MIDS annual operations are described in detail in the biological assessment. There are currently no plans to modify operations.

South Delta Temporary Barriers Project

The South Delta Temporary Barrier Project (TBP) was initiated by DWR in 1991. Permit extensions were granted in 1996 and again in 2001, when DWR obtained permits to extend the Temporary Barriers Project through 2007. The Service has approved the extension of the permits through 2008. Continued coverage by the Service for the TBP will be assessed under this biological opinion for the operational effects and under a separate Section 7 consultation for the construction and demolition effects. The NMFS recently submitted a biological opinion to the Corps which provides incidental take coverage for the continuation of the TBP through 2010.

The project consists of four rock barriers across South Delta channels. In various combinations, these barriers improve water levels and San Joaquin River salmon migration in the South Delta. The existing TBP consists of installation and removal of temporary rock barriers at the following locations:

- Middle River near Victoria Canal, about 0.5 miles south of the confluence of Middle River, Trapper Slough, and North Canal
- Old River near Tracy, about 0.5 miles east of the DMC intake
- Grant Line Canal near Tracy Boulevard Bridge, about 400 feet east of Tracy Boulevard Bridge
- The head of Old River at the confluence of Old River and San Joaquin River

The barriers on Middle River, Old River near Tracy, and Grant Line Canal are flow control facilities designed to improve water levels for agricultural diversions and are in place during the growing season. Under the Service biological opinion for the Temporary Barriers, operation of the barriers at Middle River and Old River near Tracy can begin May 15, or as early as April 15 if the spring barrier at the head of Old River is in place. From May 16 to May 31 (if the barrier at the head of Old River is removed) the tide gates are tied open in the barriers in Middle River and Old River near Tracy. After May 31, the barriers in Middle River, Old River near Tracy, and Grant Line Canal are permitted to be operational until they are completely removed by November 30.

During the spring, the barrier at the head of Old River is designed to reduce the number of out-migrating salmon smolts entering Old River. During the fall, this barrier is designed to improve flow and DO conditions in the San Joaquin River for the immigration of adult fall-run Chinook salmon. The barrier at the head of Old River barrier is typically in place between April 15 to May 15 for the spring, and between early September to late November for the fall. Installation and operation of the barrier also depends on San Joaquin flow conditions.

Proposed Installation and Operations of the Temporary Barriers

The installation and operation of the TBP will continue until the permanent gates are constructed. The proposed installation schedule through 2010 will be identical to the current schedule. However, because of recent court rulings to protect Delta smelt, the installation of the spring HOR barrier was prohibited in 2008. As a result, the

agricultural barriers installations were delayed according to the current permits until mid-May.

To improve water circulation and quality, DWR in coordination with the South Delta Water Agency and Reclamation, began in 2007 to manually tie open the culvert flap gates at the Old River near Tracy barrier to improve water circulation and untie them when water levels fell unacceptably. This operation is expected to continue in subsequent years as needed to improve quality. Adjusting the barrier weir heights is being considered to improve water quality and circulation. DWR will consult with the Service and NMFS if changes in the height of any or all of the weirs is sought.

As the permanent gates are being constructed, temporary barrier operations will continue as planned and permitted. Computer model forecasts, real time monitoring, and coordination with local, State, and federal agencies and stakeholders will help determine if the temporary rock barriers operations need to be modified during the transition period.

Conservation Strategies and Mitigation Measures

Various measures and conditions required by regulatory agencies under past and current permits to avoid, minimize, and compensate for the TBP impacts have been complied with by DWR. An ongoing monitoring plan is implemented each year the barriers are installed and an annual monitoring report is prepared to summarize the activities. The monitoring elements include fisheries monitoring and water quality analysis, Head of Old River fish entrainment and Kodiak trawling study, salmon smolt survival investigations, barrier effects on SWP and CVP entrainment, Swainson's Hawk monitoring, water elevation, water quality sampling, and hydrologic modeling. DWR operates fish screens at Sherman Island.

San Luis Complex

Water in the mainstem of the California Aqueduct flows south by gravity into the San Luis Joint-Use Complex (Figure P-16), which was designed and constructed by the federal government and is operated and maintained by the DWR. This section of the California Aqueduct serves both the SWP and the federal CVP.

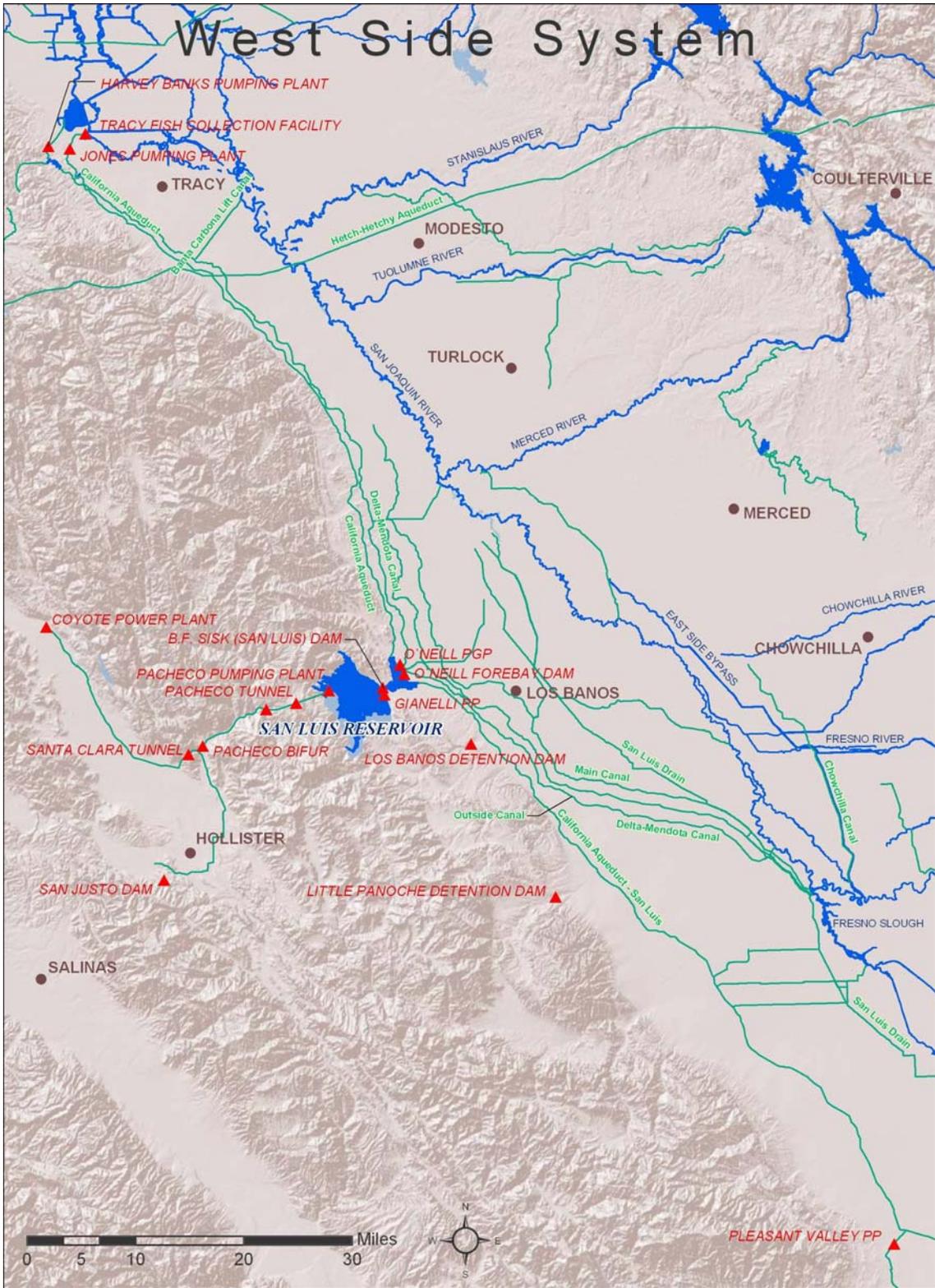


Figure P-16 San Luis Complex

San Luis Reservoir, the nation's largest offstream reservoir (it has no natural watershed), is impounded by Sisk Dam, lies at the base of the foothills on the west side of the San Joaquin Valley in Merced County, about two miles west of O'Neill Forebay. The reservoir provides offstream storage for excess winter and spring flows diverted from the Delta. It is sized to provide seasonal carryover storage. The reservoir can hold 2,027,840 AF, of which 1,062,180 AF is the state's share, and 965,660 AF is the federal share. Construction began in 1963 and was completed in 1967. Filled in 1969, the reservoir also provides a variety of recreational activities as well as fish and wildlife benefits.

In addition to the Sisk Dam, San Luis Reservoir and O'Neill Dam and Forebay, the San Luis Complex consists of the following: (1) O'Neill Pumping-Generating Plant (Federal facility); (2) William R. Gianelli Pumping-Generating Plant (joint Federal-State facilities); (3) San Luis Canal (joint Federal-State facilities); (4) Dos Amigos Pumping Plant (joint Federal-State facilities); (5) Coalinga Canal (Federal facility); (6) Pleasant Valley Pumping Plant (Federal facility); and (7) the Los Banos and Little Panoche Detention Dams and Reservoirs (joint Federal-State facilities).

The O'Neill Pumping-Generating Plant pumps water from the Delta-Mendota Canal to the O'Neill Forebay where it mixes with water from the California Aqueduct. From O'Neill Forebay, the water can either be pumped up into San Luis Reservoir via Gianelli Pumping-Generating Plant or leave via the San Luis Canal. The Dos Amigos Pumping Plant is located on the San Luis Canal and 18 miles southeast of Sisk Dam. It lifts water 113 feet from the Aqueduct as it flows south from O'Neill Forebay.

Los Banos Detention Dam and Reservoir provide flood protection for San Luis Canal, Delta Mendota Canal, the City of Los Banos, and other downstream developments. Between September and March, 14,000 AF of space is maintained for flood control under specified conditions. Little Panoche Detention Dam and Reservoir provide flood protection for San Luis Canal, Delta Mendota Canal and other downstream developments. Water is stored behind the dam above dead storage of 315 AF only during the period that inflow from Little Panoche Creek exceeds the capacity of the outlet works.

To provide water to CVP and SWP contractors: (1) water demands and anticipated water schedules for water service contractors and exchange contractors must be determined; (2) a plan to fill and draw down San Luis Reservoir must be made; and (3) Delta pumping and San Luis Reservoir use must be coordinated.

The San Luis Reservoir has very little natural inflow. Water is redirected during the fall, winter and spring months when the two pumping plants can divert more water from the Delta than is needed for scheduled demands. Because the amount of water that can be diverted from the Delta is limited by available water supply, Delta constraints, and the capacities of the two pumping plants, the fill and drawdown cycle of San Luis Reservoir is an extremely important element of Project operations.

Reclamation attempts to maintain adequate storage in San Luis Reservoir to ensure delivery capacity through Pacheco Pumping Plant to the San Felipe Division. Delivery capacity is significantly diminished as reservoir levels drop to the 326 ft elevation (79,000 acre-feet), the bottom of the lowest Pacheco Tunnel Inlet pipe. Lower reservoir

elevations can also result in turbidity and algal treatment problems for the San Felipe Division water users. These conditions of reduced or impending interruption in San Felipe Division deliveries require operational responses by Santa Clara Valley Water District to reduce or eliminate water deliveries for in-stream and offstream groundwater recharge, and to manage for treatment plant impacts. Depending on availability of local supplies, prolonged reduction or interruption in San Felipe Division deliveries may also result in localized groundwater overdraft.

A typical San Luis Reservoir annual operation cycle starts with the CVP's share of the reservoir storage nearly empty at the end of August. Irrigation demands decrease in September and the opportunity to begin refilling San Luis Reservoir depends on the available water supply in the northern CVP reservoirs and the pumping capability at Jones Pumping Plant that exceeds water demands. Jones Pumping Plant operations generally continue at the maximum diversion rates until early spring, unless San Luis Reservoir is filled or the Delta water supply is not available. As outlined in the Interior's Decision on Implementation of Section 3406 (b)(2) of the CVPIA, Jones Pumping Plant diversion rates may be reduced during the fill cycle of the San Luis Reservoir for fishery management.

In April and May, export pumping from the Delta is limited during the SWRCB D-1641 San Joaquin River pulse period standards as well as by the Vernalis Adaptive Management Program. During this same time, CVP-SWP irrigation demands are increasing. Consequently, by April and May the San Luis Reservoir has begun the annual drawdown cycle. In some exceptionally wet conditions, when excess flood water supplies from the San Joaquin River or Tulare Lake Basin occur in the spring, the San Luis Reservoir may not begin its drawdown cycle until late in the spring.

In July and August, the Jones Pumping Plant diversion is at the maximum capability and some CVP water may be exported using excess Banks Pumping Plant capacity as part of a Joint Point of Diversion operation. Irrigation demands are greatest during this period and San Luis continues to decrease in storage capability until it reaches a low point late in August and the cycle begins anew.

San Luis Unit Operation

The CVP operation of the San Luis Unit requires coordination with the SWP since some of its facilities are entirely owned by the State and others are joint State and Federal facilities. Similar to the CVP, the SWP also has water demands and schedules it must meet with limited water supplies and facilities. Coordinating the operations of the two projects avoids inefficient situations (for example, one entity pumping water at the San Luis Reservoir while the other is releasing water).

Total CVP San Luis Unit annual water supply is contingent on coordination with the SWP needs and capabilities. When the SWP excess capacity is used to support additional pumping for the CVP JPOD allowance it may be of little consequence to SWP operations, but extremely critical to CVP operations. The availability of excess SWP capacity for the CVP is contingent on the ability of the SWP to meet its SWP contractors' water supply commitments. Generally, the CVP will utilize excess SWP capacity; however, there are times when the SWP may need to utilize excess CVP capacity.

Additionally, close coordination by CVP and SWP is required during this type of operation to ensure that water pumped into O'Neill Forebay does not exceed the CVP's capability to pump into San Luis Reservoir or into the San Luis Canal at the Dos Amigos Pumping Plant.

Although secondary to water management concerns, power scheduling at the joint facilities also requires close coordination. Because of time-of-use power cost differences, both entities will likely want to schedule pumping and generation simultaneously. When facility capabilities of the two projects are limited, equitable solutions are achieved between the operators of the SWP and the CVP.

From time to time, coordination between the Projects is also necessary to avoid sustained rapid drawdown limit at San Luis Reservoir which can cause sloughing of the bank material into the reservoir, resulting in water quality degradation and requiring additional maintenance on the dam.

With the existing facility configuration, the operation of the San Luis Reservoir could impact the water quality and reliability of water deliveries to the San Felipe Division, if San Luis Reservoir is drawn down too low. Reclamation has an obligation to address this condition and may solicit cooperation from DWR, as long as changes in SWP operations to assist with providing additional water in San Luis Reservoir (beyond what is needed for SWP deliveries and the SWP share of San Luis Reservoir minimum storage) does not impact SWP allocations and/or deliveries. If the CVP is not able to maintain sufficient storage in San Luis Reservoir, there could be potential impacts to resources in Santa Clara and San Benito Counties. Solving the San Luis low point problem or developing an alternative method to deliver CVP water to the San Felipe Division would allow Reclamation to utilize the CVP share of San Luis Reservoir fully without impacting the San Felipe Division water supply. If Reclamation pursues changes to the operation of the CVP (and SWP), such changes would have to be consistent with the operating criteria of the specific facility. If alternate delivery methods for the San Felipe Division are implemented, it may allow the CVP to utilize more of its available storage in San Luis Reservoir, but may not change the total diversions from the Delta. For example, any changes in Delta pumping that would be the result of additional effective storage capacity in San Luis Reservoir would be consistent with the operating conditions for the Banks and Jones Pumping Plants.

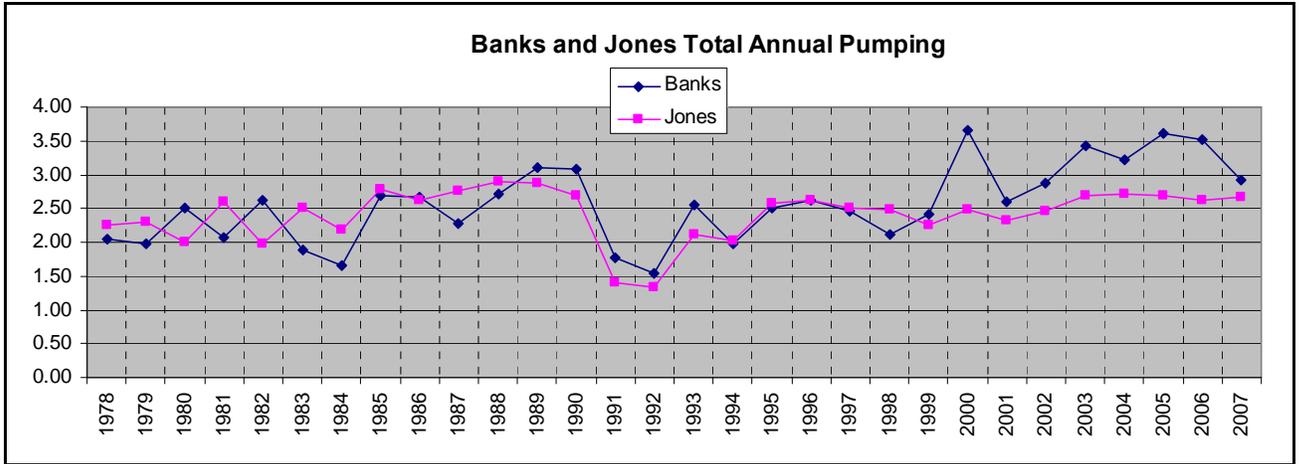


Figure P-17 Total Annual Pumping at Banks and Jones Pumping Plant 1978-2007 (MAF)

Table P-25 Total Annual Pumping at Banks and Jones Pumping Plant 1978-2007 (MAF)

WY	Hydrologic Index 40-30-30	Banks			Jones			Contra Costa	CVP Total Delta Pumping	SWP Total Delta Pumping	CVP SOD-Ag Allocation	Shasta Index Critical
		SWP	CVP	Total	SWP	CVP	Total					
1978	AN	2.01	0.04	2.05	0.00	2.26	2.26	0.08	2.38	2.01	100%	
1979	BN	1.76	0.23	1.98	0.00	2.30	2.30	0.09	2.61	1.76	100%	
1980	AN	2.17	0.34	2.52	0.00	2.00	2.00	0.09	2.43	2.17	100%	
1981	D	1.97	0.10	2.07	0.00	2.60	2.60	0.11	2.80	1.97	100%	
1982	W	2.43	0.20	2.63	0.00	1.97	1.97	0.08	2.25	2.43	100%	
1983	W	1.76	0.13	1.89	0.00	2.51	2.51	0.08	2.72	1.76	100%	
1984	W	1.40	0.25	1.65	0.00	2.19	2.19	0.10	2.54	1.40	100%	
1985	D	2.16	0.53	2.68	0.00	2.79	2.79	0.11	3.43	2.16	100%	
1986	W	2.46	0.21	2.67	0.00	2.62	2.62	0.11	2.94	2.46	100%	
1987	D	2.01	0.27	2.28	0.00	2.76	2.76	0.13	3.16	2.01	100%	
1988	C	2.32	0.38	2.71	0.00	2.90	2.90	0.14	3.42	2.32	100%	
1989	D	2.70	0.39	3.10	0.00	2.87	2.87	0.13	3.40	2.70	100%	
1990	C	2.85	0.24	3.09	0.00	2.70	2.70	0.14	3.07	2.85	50%	
1991	C	1.64	0.14	1.78	0.00	1.41	1.41	0.11	1.65	1.64	25%	C
1992	C	1.51	0.04	1.55	0.00	1.34	1.34	0.10	1.49	1.51	25%	C
1993	AN	2.53	0.02	2.56	0.00	2.11	2.11	0.10	2.22	2.53	50%	
1994	C	1.73	0.24	1.97	0.00	2.02	2.02	0.11	2.37	1.73	35%	C
1995	W	2.48	0.03	2.50	0.00	2.58	2.58	0.09	2.70	2.48	100%	
1996	W	2.60	0.01	2.61	0.06	2.57	2.63	0.10	2.68	2.66	95%	
1997	W	2.12	0.34	2.46	0.00	2.51	2.51	0.11	2.96	2.12	90%	
1998	W	2.07	0.04	2.11	0.01	2.46	2.47	0.16	2.66	2.09	100%	
1999	W	2.37	0.04	2.41	0.00	2.26	2.26	0.13	2.44	2.37	70%	
2000	AN	3.45	0.22	3.66	0.00	2.49	2.49	0.13	2.83	3.45	65%	

WY	Hydrologic	Banks			Jones			Contra	CVP Total	SWP Total	CVP	Shasta
	Index	SWP	CVP	Total	SWP	CVP	Total	Costa	Delta	Delta	SOD-Ag	Index
	40-30-30								Pumping	Pumping	Allocation	Critical
2001	D	2.37	0.23	2.60	0.01	2.31	2.32	0.10	2.65	2.38	49%	
2002	D	2.70	0.17	2.87	0.00	2.46	2.46	0.12	2.75	2.70	70%	
2003	AN	3.39	0.04	3.43	0.00	2.68	2.68	0.14	2.86	3.39	75%	
2004	BN	3.14	0.09	3.23	0.00	2.72	2.72	0.12	2.93	3.14	70%	
2005	AN	3.58	0.03	3.61	0.00	2.68	2.68	0.12	2.83	3.58	85%	
2006	W	3.50	0.01	3.51	0.00	2.62	2.62	0.12	2.74	3.50	100%	
2007	D	2.82	0.11	2.93	0.00	2.67	2.67	0.11	2.90	2.82	50%	

Source: CVO Operations Data Base

Transfers

Parties seeking water transfers generally acquire water from sellers who have surplus reservoir storage water, sellers who can pump groundwater instead of using surface water, or sellers who will fallow crops or substitute a crop that uses less water in order to reduce normal consumptive use of surface diversions.

Water transfers (relevant to this document) occur when a water right holder within the Delta or Sacramento-San Joaquin watershed undertakes actions to make water available for transfer by export from the Delta. With the exception of the Component 1 water pursuant to the Yuba River Accord, this biological opinion does not address the upstream operations that may be necessary to make water available for transfer. Also, this document does not address the impacts of water transfers to terrestrial species. The flows for the Yuba River Accord may provide up to 60,000 acre feet annually for EWA, in the lower Yuba River (estimated to provide up to 48,000 acre feet of additional Delta export), and may provide additional water to the CVP and SWP and their contractors in drier years. The upstream effects of other transfers and effects to terrestrial species would require a separate ESA consultation.

Transfers requiring export from the Delta are done at times when pumping and conveyance capacity at Banks or Jones is available to move the water. Additionally, operations to accomplish these transfers must be carried out in coordination with CVP and SWP operations, such that the capabilities of the Projects to exercise their own water rights or to meet their legal and regulatory requirements are not diminished or limited in any way.

In particular, parties to the transfer are responsible for providing for any incremental changes in flows required to protect Delta water quality standards. All transfers will be in accordance with all existing regulations and requirements.

Purchasers of water for water transfers may include Reclamation, DWR, SWP contractors, CVP contractors, other State and Federal agencies, or other parties. DWR

and Reclamation have operated water acquisition programs in the past to provide water for environmental programs and additional supplies to SWP contractors, CVP contractors, and other parties. The DWR programs include the 1991, 1992, and 1994 Drought Water Banks and Dry Year Programs in 2001 and 2002. Reclamation operated a forbearance program in 2001 by purchasing CVP contractors' water in the Sacramento Valley for CVPIA in-stream flows, and to augment water supplies for CVP contractors south of the Delta and wildlife refuges. Reclamation administers the CVPIA Water Acquisition Program for Refuge Level 4 supplies and fishery in-stream flows. The CALFED Ecosystem Restoration Program will, in the future, acquire water for fishery and ecosystem restoration. DWR, and potentially Reclamation in the future, has agreed to participate in a Yuba River Accord that will provide fish flows on the Yuba River and also water supply that may be transferred at DWR and Reclamation Delta Facilities. It is anticipated that Reclamation will join in the Accord and fully participate in the Yuba Accord upon completion of this consultation. The Yuba River Accord water would be transferred to offset VAMP water costs.

Also in the past, CVP and SWP contractors have also independently acquired water and arranged for pumping and conveyance through SWP facilities. State Water Code provisions grant other parties access to unused conveyance capacity, although SWP contractors have priority access to capacity not being used by the DWR to meet SWP contract amounts.

The Yuba River Accord includes three separate but interrelated agreements that would protect and enhance fisheries resources in the lower Yuba River, increase local water supply reliability, and provide DWR with increased operational flexibility for protection of Delta fisheries resources through Project re-operation, and provision of added dry-year water supplies to state and federal water contractors. These proposed agreements are the:

- Principles of Agreement for Proposed Lower Yuba River Fisheries Agreement (Fisheries Agreement)
- Principles of Agreement for Proposed Conjunctive Use Agreements (Conjunctive Use Agreements)
- Principles of Agreement for Proposed Long-term Transfer Agreement (Water Purchase Agreement)

The Fisheries Agreement was developed by state, federal, and consulting fisheries biologists, fisheries advocates, and policy representatives. Compared to the interim flow requirements of the SWRCB Revised Water Right Decision 1644, the Fisheries Agreement would establish higher minimum instream flows during most months of most WYs.

To assure that Yuba County Water Agency's (YCWA) water supply reliability would not be reduced by the higher minimum instream flows, YCWA and its participating Member Units would implement the Conjunctive Use Agreements. These agreements would establish a comprehensive conjunctive use program that would integrate the surface water and groundwater supplies of the local irrigation districts and mutual water companies that

YCWA serves in Yuba County. Integration of surface water and groundwater would allow YCWA to increase the efficiency of its water management.

Under the Water Purchase Agreement, DWR would enter into an agreement with YCWA to purchase water from YCWA to off-set water costs resulting from VAMP as long as operational and hydrological conditions allow. Additional water purchased by DWR would be available for south-of-Delta CVP and SWP contractors in drier years. The limited EWA would take delivery of 60,000 AF (48,000 AF export) of water in every year; the CVP/SWP would receive additional water in the drier years. In the future Reclamation may become a party to the Water Purchase Agreement.

The Fisheries Agreement is the cornerstone of the Yuba Accord Alternative. To become effective, however, all three agreements (Fisheries, Conjunctive Use, and Water Purchase) must undergo CEQA and NEPA review and be fully approved and executed by the individual parties to each agreement. Also, implementation of the Yuba Accord Alternative would require appropriate SWRCB amendments of YCWA's water-right permits and SWRCB D-1644.

Transfer Capacity

Reclamation assumes as part of the project description that the water transfer programs for environmental and water supply augmentation will continue in some form, and that in most years (all but the driest), the scope of annual water transfers will be limited by available Delta pumping capacity, and exports for transfers will be limited to the months July-September. As such, looking at an indicator of available transfer capacity in those months is one way of estimating an upper boundary to the effects of transfers on an annual basis.

The CVP and SWP may provide Delta export pumping for transfers using pumping capacity at Banks and Jones beyond that which is being used to deliver project water supply, up to the physical maximums of the pumps, consistent with prevailing operations constraints such as E/I ratio, conveyance or storage capacity, and any protective criteria in effect that may apply as conditions on such transfers. For example, pumping for transfers may have conditions for protection of Delta water levels, water quality, fisheries, or other beneficial uses.

The surplus capacity available for transfers will vary a great deal with hydrologic conditions. In general, as hydrologic conditions get wetter, surplus capacity diminishes because the CVP and SWP are more fully using export pumping capacity for Project supplies. CVP's Jones Pumping Plant, with no forebay for pumped diversions and with limited capability to fine tune rates of pumping, has little surplus capacity, except in the driest hydrologic conditions. SWP has the most surplus capacity in critical and some dry years, less or sometimes none in a broad middle range of hydrologic conditions, and some surplus again in some above normal and wet years when demands may be lower because contractors have alternative supplies.

The availability of water for transfer and the demand for transfer water may also vary with hydrologic conditions. Accordingly, since many transfers are negotiated between willing buyers and sellers under prevailing market conditions, price of water also may be

a factor determining how much is transferred in any year. This document does not attempt to identify how much of the available and useable surplus export capacity of the CVP and SWP will actually be used for transfers in a particular year, but recent history, the expectations for the future limited EWA, and the needs of other transfer programs suggest a growing reliance on transfers.

Under both the present and future conditions, capability to export transfers will often be capacity-limited, except in Critical and some Dry years. In these Critical and some Dry years, both Banks and Jones have more available capacity for transfers, so export capacity is less likely to limit transfers. Rather, either supply or demand for transfers may be a limiting factor. During such years, low project exports and high demand for water supply could make it possible to transfer larger amounts of water.

Proposed Exports for Transfers

Although transfers may occur at any time of year, proposed exports for transfers apply only to the months July through September. For transfers outside those months, or in excess of the proposed amounts, Reclamation and DWR would request separate consultation. In consideration of the estimates of available capacity for export of transfers during July-September, and in recognition of the many other possible operations contingencies and constraints that may limit actual use of that capacity for transfers, the proposed use of SWP/CVP export capacity for transfers is as follows:

<u>Water Year Class</u>	<u>Maximum Transfer Amount</u>
Critical	up to 600 TAF
Dry (following Critical)	up to 600 TAF
Dry (following Dry)	up to 600 TAF
All other Years	up to 360 TAF

Other Projects

The following projects may not have final approval. However, Reclamation believes they may be implemented in the near term. Reclamation is including these actions in the project description so that the effects of these actions on aquatic species may be analyzed as it pertains to operations. The analysis does not include any effects to terrestrial species. These will be addressed in separate construction consultation.

DMC/CA Intertie Proposed Action

The proposed action, known as the DMC and CA Intertie (DMC/CA Intertie), consists of construction and operation of a pumping plant and pipeline connections between the

DMC and the CA. The DMC/CA Intertie alignment is proposed for DMC milepost 7.2 where the DMC and the CA are about 500 feet apart.

The DMC/CA Intertie would be used in a number of ways to achieve multiple benefits, including meeting current water supply demands, allowing for the maintenance and repair of the CVP Delta export and conveyance facilities, and providing operational flexibility to respond to emergencies. The Intertie would allow flow in both directions, which would provide additional flexibility to both CVP and SWP operations. The Intertie includes a 467 cfs pumping plant at the DMC that would allow up to 467 cfs to be pumped from the DMC to the CA. Up to 900 cfs flow could be conveyed from the CA to the DMC using gravity flow. The intertie will not be used to increase total CVP exports until certain criteria are in place.

The DMC/CA Intertie will be operated by the San Luis and Delta-Mendota Water Authority (Authority). A three-way agreement among Reclamation, DWR, and the Authority would identify the responsibilities and procedures for operating the Intertie. The Intertie would be owned by Reclamation. A permanent easement would be obtained by Reclamation where the Intertie alignment crossed State property.

Location

The site of the proposed action is an unincorporated area of Alameda County, west of the City of Tracy. The site is situated in a rural area zoned for general agriculture and is under Federal and State ownership. The DMC/CA Intertie would be located at milepost 7.2 of the DMC, connecting with milepost 9.0 of the CA.

Operations

The Intertie would be used under three different scenarios:

1. Up to 467 cfs would be pumped from the DMC to the CA to help meet water supply demands of CVP contractors. This would allow Jones Pumping Plant to pump to its authorized capacity of up to 4,600 cfs, subject to all applicable export pumping restrictions for water quality and fishery protections.
2. Up to 467 cfs would be pumped from the DMC to the CA to minimize impacts to water deliveries due to temporary restrictions in flow or water levels on the lower DMC (south of the Intertie) or the upper CA (north of the Intertie) for system maintenance or due to an emergency shutdown.
3. Up to 900 cfs would be conveyed from the CA to the DMC using gravity flow to minimize impacts to water deliveries due to temporary restrictions in flow or water levels on the lower CA (south of the Intertie) or the upper DMC (north of the Intertie) for system maintenance or due to an emergency shutdown.

The DMC/CA Intertie provides operational flexibility between the DMC and CA. It would not result in any changes to authorized pumping capacity at Jones Pumping Plant or Banks Delta Pumping Plant.

Water conveyed at the Intertie to minimize reductions to water deliveries during system maintenance or an emergency shutdown on the DMC or CA could include pumping of CVP water at Banks Pumping Plant or SWP water at Jones Pumping Plant through use of JPOD. In accordance with COA Articles 10(c) and 10(d), JPOD may be used to replace conveyance opportunities lost because of scheduled maintenance, or unforeseen outages. Use of JPOD for this purpose could occur under Stage 2 operations defined in SWRCB D-1641, or could occur as a result of a Temporary Urgency request to the SWRCB. Use of JPOD in this case does not result in any net increase in allowed exports at CVP and SWP export facilities. When in use, water within the DMC would be transferred to the CA via the Intertie. Water diverted through the Intertie would be conveyed through the CA to O'Neill Forebay.

Freeport Regional Water Project

The Freeport Regional Water Project (FRWP) is currently under construction. Once completed FRWP will divert up to a maximum of about 286 cubic feet per second (cfs) from the Sacramento River near Freeport for Sacramento County (deliveries expected in 2011) and East Bay Municipal Utility District (EBMUD) deliveries expected in late 2009. EBMUD will divert water pursuant to its amended contract with Reclamation. The County will divert using its water rights and its CVP contract supply. This facility was not in the 1986 COA, and the diversions will result in some reduction in Delta export supply for both the CVP and SWP contractors. Pursuant to an agreement between Reclamation, DWR, and the CVP and SWP contractors in 2003, diversions to EBMUD will be treated as an export in the COA accounting and diversions to Sacramento County will be treated as an in-basin use.

Reclamation proposes to deliver CVP water pursuant to its respective water supply contracts with SCWA and EBMUD through the FRWP, to areas in central Sacramento County. SCWA is responsible for providing water supplies and facilities to areas in central Sacramento County, including the Laguna, Vineyard, Elk Grove, and Mather Field communities, through a capital funding zone known as Zone 40.

The FRWP has a design capacity of 286 cfs (185 millions of gallons per day [mgd]). Up to 132 cfs (85 mgd) would be diverted under Sacramento County's existing Reclamation water service contract and other anticipated water entitlements and up to 155 cfs (100 mgd) of water would be diverted under EBMUD's amended Reclamation water service contract. Under the terms of its amendatory contract with Reclamation, EBMUD is able to take delivery of Sacramento River water in any year in which EBMUD's March 1 forecast of its October 1 total system storage is less than 500,000 AF. When this condition is met, the amendatory contract entitles EBMUD to take up to 133,000 AF annually. However, deliveries to EBMUD are subject to curtailment pursuant to CVP shortage conditions and project capacity (100 mgd), and are further limited to no more than 165,000 AF in any 3-consecutive-year period that EBMUD's October 1 storage forecast remains below 500,000 AF. EBMUD would take delivery of its entitlement at a maximum rate of 100 mgd (112,000 AF per year). Deliveries would start at the beginning of the CVP contract year (March 1) or any time afterward. Deliveries would cease when EBMUD's CVP allocation for that year is reached, when the 165,000 AF

limitation is reached, or when EBMUD no longer needs the water (whichever comes first). Average annual deliveries to EBMUD are approximately 23,000 AF. Maximum delivery in any one WY is approximately 99,000 AF.

The primary project components are (1) an intake facility on the Sacramento River near Freeport, (2) the Zone 40 Surface Water Treatment Plant (WTP) located in central Sacramento County, (3) a terminal facility at the point of delivery to the Folsom South Canal (FSC), (4) a canal pumping plant at the terminus of the FSC, (5) an Aqueduct pumping plant and pretreatment facility near Comanche Reservoir, and (6) a series of pipelines carrying water from the intake facility to the Zone 40 Surface WTP and to the Mokelumne Aqueducts. The existing FSC is part of the water conveyance system. See Chapter 9 for modeling results on annual diversions at Freeport in the American River Section, Modeling Results Section subheading.

Alternative Intake Project

CCWD's Alternative Intake Project (AIP) consists of a new 250 cfs screened intake in Victoria Canal, and a pump station and ancillary structures, utilities, and access and security features; levee improvements; and a conveyance pipeline to CCWD's existing conveyance facilities.

CCWD will operate the intake and pipeline together with its existing facilities to better meet its delivered water quality goals and to better protect listed species. Operations with the AIP will be similar to existing operations: CCWD will deliver Delta water to its customers by direct diversion when salinity at its intakes is low enough, and will blend Delta water with releases from Los Vaqueros Reservoir when salinity at its intakes exceeds the delivered water quality goal. Los Vaqueros Reservoir will be filled from the existing Old River intake or the new Victoria Canal intake during periods of high flow in the Delta, when Delta salinity is low. The choice of which intake to use at any given time will be based in large part upon salinity, consistent with fish protection requirements in the biological opinions; salinity at the Victoria Canal intake site is at times lower than salinity at the existing intakes. The no-fill and no-diversion periods described above will continue as part of CCWD operations, as will monitoring and shifting of diversions among the four intakes to minimize impacts to listed species.

The AIP is a water quality project, and will not increase CCWD's average annual diversions from the Delta. However, it will alter the timing and pattern of CCWD's diversions in two ways: winter and spring diversions will decrease while late summer and fall diversions increase because Victoria Canal salinity tends to be lower in the late summer and fall than salinity at CCWD's existing intakes; and diversions at the unscreened Rock Slough Intake will decrease while diversions at screened intakes will increase. It is estimated that with the AIP, Rock Slough intake diversions will fall to about 10 percent of CCWD's total diversions, with the remaining diversions taking place at the other screened intakes. About 88 percent of the diversions will occur at the Old River and Victoria Canal intakes, with the split between these two intakes largely depending on water quality.

The effects of the AIP are covered by the April 27, 2007 Service biological opinion for delta smelt (amended on May 16, 2007).

Red Bluff Diversion Dam Pumping Plant

Reclamation signed the ROD July 16, 2008 for RBDD pumping plant and plans to change the operation of the RBDD to improve fish passage problems. The project features construction of a new pumping plant and operation of the RBDD gates in the out position for approximately 10 months of the year. Reclamation is calling for the construction of a pumping plant upstream from the dam that could augment existing capabilities for diverting water into the Tehama-Colusa Canal during times when gravity diversion is not possible due to the RBDD gates being out. Reclamation completed ESA section 7 consultations with the Service and the NMFS to address construction of a new pumping plant at maximum capacity of 2,500 cfs.

The new pumping plant would be capable of operating throughout the year, providing both additional flexibility in dam gate operation and water diversions for the Tehama-Colusa Canal Authority (TCCA) customers. In order to improve adult green sturgeon passage during their spawning migrations (generally March through July) the gates could remain open during the early part of the irrigation season and the new pumping plant could be used alone or in concert with other means to divert water to the Tehama-Colusa and Corning canals.

Green sturgeon spawn upstream of the diversion dam and the majority of adult upstream and downstream migrations occur prior to July and after August. After the new pumping plant has been constructed and is operational, Reclamation proposes to operate the Red Bluff Diversion Dam with the gates in during the period from four days prior to the Memorial Day weekend to three days after the holiday weekend (to facilitate the Memorial Day boat races in Lake Red Bluff), and between July 1 and the end of the Labor Day weekend. This operation would provide for improved sturgeon and salmon passage.

The pumping plant project will occur in three phases. The first, completion of the NEPA/CEQA process has already been accomplished. The design and permitting phase is commencing, subject to the availability of funding, and is anticipated to take about 18-36 months. As funding permits, property acquisition will also occur during this phase, and further funding commitments would be secured during this time. The final phase, facilities construction, is anticipated to take approximately 18-36 months but this timeline will be updated during final design and permitting.

South Delta Improvements Program Stage 1

The objectives of the SDIP are to: 1) reduce the movement of outmigrating salmon from the San Joaquin River into Old River, 2) maintain adequate water levels and circulation

in South Delta channels, and 3) increase water delivery and reliability to the SWP and CVP by increasing the diversion limit at Clifton Court Forebay to 8500 cfs.⁵

The decision to implement the proposed action is being done in two stages. Stage 1 will address the first two objectives and involves the construction and operation of gates at four locations in the South Delta channels. A decision to implement Stage 2 would address increasing the water delivery reliability of the SWP and CVP by increasing the diversion limit at Clifton Court Forebay. This decision has been deferred indefinitely.

The Final EIR/EIS was completed in December 2006. DWR certified the final EIR as meeting the requirements of the California Environmental Quality Act at that time. The Department plans to issue a Notice of Determination to proceed with implementing Stage 1 of the SDIP once the biological opinions on the continued long term operations of the CVP/SWP and the biological opinions for the dredging and construction of the gates are received.

Reclamation and DWR are seeking to construct and operate the gates proposed for the four locations. Key operational features of these gates are included as part of this project description. Separate biological opinions will be conducted for the impacts of constructing the gates and the channel dredging contained in Stage 1.

The permanent operable gates, which are planned to be constructed in the South Delta in late 2012, will be operated within an adaptive management framework, as described below under “Gate Operations Review Team,” so that the benefits from these gate operations can be maximized. The gates can be opened or closed at any time in response to the local tidal level and flow conditions within the South Delta. In this regard, they are very different from the temporary barriers that have been installed for the past several years.

Because these operable gates are designed as “lift gates” that are hinged at the bottom of the channel, “closure” of the gates can be specified at any tidal level, leaving a weir opening for some tidal flow over the gate. The ability to operate the tidal gates to a specified weir crest elevation (i.e., top of the gates) that is relatively precise provides a great deal of flexibility. The top elevation of each individual gate can be slightly different (i.e., steps) to provide less weir flow as the tidal level declines. The top elevation of the gates can also be slowly raised or lowered to adjust the tidal level and/or tidal flow in response to local South Delta conditions.

South Delta Gates

The proposed management of South Delta tidal level and tidal flow conditions involves the use of five gates:

- CCF intake tidal gate (existing),

⁵ This project description does not include any aspect of the SDIP that is not explicitly identified in the text. Examples of SDIP actions that are not included are construction of the four permanent gates and dredging. Both of these activities will be covered by subsequent consultation.

- Grant Line Canal (at western end) flow control gate,
- Old River at DMC flow control gate,
- Middle River flow control gate, and
- Head of Old River fish control gate.

The CCF intake gate already exists and has been used since SWP began Banks operations in 1972 to control flows from Old River and maintain the water level inside of CCF. Unlike the existing CCF intake gate, the four other gates are proposed by SDIP and are not in place. The operation of the CCF intake gate is directly related to SWP export operations, but the operation of the fish and flow control gates, will serve the primary purpose of protecting fisheries and beneficial uses.

These five gates in the South Delta would be operated to accomplish the following purposes:

1. Maintain a relatively high water level within the CCF to allow SWP to maximize Banks pumping during the off-peak (nighttime) hours. The CCF level cannot be allowed to fall below -2 feet msl because of cavitation concerns at the SWP's Banks pumps. The CCF gates are closed when the outside tidal level in Old River drops below the CCF level (to avoid outflow from CCF). As described earlier in this chapter, the CCF gates are also operated under three "gate priorities" to reduce water level impacts to other South Delta water users.
2. Control the inflow to CCF below the design flow of about 15,000 cfs to prevent excessive erosion of the entrance channel. The CCF gates are partially closed when the difference between the CCF level and Old River tidal level is more than 1.0 foot to avoid inflow velocities of greater than 10 feet/sec.
3. Maintain the high-tide conditions in the South Delta by not diverting into CCF during the flood-tide period that precedes the higher-high tide each day. The CCF intake gates are closed for about 6 hours each day to preserve the high-tide level in Old River to supply sufficient water for Tom Paine Slough siphons. This CCF tidal gate operation is referred to as priority 3 by DWR, as described earlier in this chapter.
4. Control the minimum tidal level elevation upstream of the flow-control gates to be greater than a selected target elevation (i.e., 0.0 feet msl). The flow-control gates can be closed (raised) to maintain a specified top elevation (e.g., 0.0 feet msl) as the upstream tidal level declines during ebb tide.
5. Control the tidal flushing upstream of the flow-control gates with relatively low-salinity water from Old River and Middle River downstream of the gates (i.e., high fraction of Sacramento River water). The flow-control gates would remain fully open during periods of flood tide (i.e., upstream flow) and then two of the gates would be fully closed (i.e., top elevation of gates above upstream water surface) during periods of ebb tide (i.e., downstream flow). The remaining gate (i.e., Grant Line) would be maintained at a lower elevation (i.e., 0.0 feet msl) to

allow the ebb tide flow to exit from the South Delta channels so that the flood-tide flow over the gates can be maximized during each tidal cycle.

Control the San Joaquin River flow diversion into Old River. This could increase the flow past Stockton and raise the low DO concentrations in the San Joaquin Deep Water Ship Channel. Reduced flow to Old River might also reduce salinity in the South Delta channels by limiting the volume of relatively high-salinity water from the San Joaquin River that enters the South Delta channels. The head of Old River temporary barrier has been installed in October and November of many years to improve flow and DO conditions in the San Joaquin Deep Water Ship Channel for up-migrating Chinook salmon. In recent years, the barrier has also been installed in April and/or May during a portion of the outmigration period to reduce the percentage of Chinook salmon smolts that are diverted into Old River and toward Banks and Jones. The proposed SDIP gate operations will increase the tidal circulation in the South Delta channels. Gate operations to promote circulation would raise the Old River at Tracy and Middle River gates at each high tide to produce a circulation of water in the South Delta channels down Grant Line Canal. The Old River at Tracy and Middle River gates remain raised (closed) until the next flood-tide period when the downstream level is above the upstream water level. These gates are then lowered (opened) to allow flood-tide (upstream) flows across the gates. Gate operations to promote circulation use a Grant Line gate weir crest at -0.5 feet msl during most periods of ebb tide (downstream flow) to protect the minimum level elevation of 0.0 feet msl. All gates are lowered (i.e., opened) during floodtide periods as soon as the downstream tidal level is above the upstream water level.

Head of Old River Fish Control Gate

Spring Operations/ Real Time Decision Making

Operation (closing) of the head of Old River fish control gate is proposed to begin on April 15. Spring operation is generally expected to continue through May 15, to protect outmigrating salmon and steelhead. During this time, the head of Old River gate would be fully closed, unless the San Joaquin River is flowing above 10,000 cfs or the GORT recommends a partial opening for other purposes. The real time decision making process is described in detail previously.

Summer and Fall Operations

When the Spring operation is completed and through November 30, the head of Old River fish control gate would be operated to improve flow in the San Joaquin River, thus helping to avoid historically-present low dissolved oxygen conditions in the lower San Joaquin River near Stockton. During this period, partial operation of the gate (partial closure to restrict flows from the San Joaquin River into Old River to approximately 500 cfs) may also be warranted to protect water quality in the South Delta channels. Generally, water quality in the South Delta channels is acceptable through June.

Operations during the months of October and November to improve flow and water quality conditions (i.e., low dissolved oxygen) in the San Joaquin River for adult migrating Chinook salmon is expected to provide a benefit similar to that achieved with the temporary barrier. Operations would not occur if the San Joaquin River flow at

Vernalis is greater than 5,000 cfs because it is expected that this flow would maintain sufficient DO in the San Joaquin River.

When the gate is not operated, it is fully lowered in the channel. Operation of the gate is not proposed during the period December through March.

Flow Control Gates

The flow control gates in Middle River, Grant Line Canal, and Old River near the DMC, would be operated (closed during some portion of the tidal cycle) throughout the agricultural season of April 15 through November 30. As with the head of Old River fish control gate, when the gates are not operated, they are fully lowered in the channel. Operation of the gates is not proposed during the period December through March. Any operation of the gates proposed for the December-March period would require re-initiation of ESA consultation.

Spring Operations

During April 15 through May 15 (or until the Spring operation of the head of Old River gate is completed), water quality in the South Delta is acceptable for the beneficial uses, but closure of the head of Old River fish control gate has negative impacts on water levels in the South Delta. Therefore, the flow control gates would be operated to control minimum water levels in most year types. In the less frequent year types, dry or critically dry, when water quality in the South Delta is threatened by this static use of the gates, circulation may be induced to improve water quality in the South Delta channels. Circulation using the flow control gates is described in the summer operations section which follows. During these times, Reclamation and DWR have committed to maintaining 0.0 foot msl water levels in Old River near the CVP Tracy facility and at the west end of Grant Line Canal.

Summer and Fall Operations

When the Spring operation of the head of Old River fish control gate is completed and through November 30, the gates would be operated to control minimum water levels and increase water circulation to improve water quality in the South Delta channels. Reclamation and DWR have committed to maintaining water levels during these times at 0.0 foot msl in Old River near the CVP Tracy facility, 0.0 foot msl at the west end of Grant Line Canal, and 0.5 foot msl in Middle River at Mowry Bridge. It is anticipated that the target level in Middle River would be lowered to 0.0 foot msl following extension of some agricultural diversions.

The proposed gate operations will increase the tidal circulation in the South Delta channels. This is accomplished by tidal flushing upstream of the flow-control gates with relatively low-salinity water from Old River and Middle River downstream of the gates (i.e., high fraction of Sacramento River water). The flow-control gates would remain fully open during periods of flood tide (i.e., upstream flow) and then two of the gates would be fully closed (i.e., top elevation of gates above upstream water surface) during periods of ebb tide (i.e., downstream flow). The remaining gate (i.e., Grant Line) would be maintained at a lower elevation (i.e., 0.0 feet msl) to allow the ebb tide flow to exit from the South Delta channels so that the flood-tide flow over the gates can be

maximized during each tidal cycle. This is the same operation described as Purpose 5 earlier in the description of the SDIP gates.

Gate Operations and Jones and Banks Exports

Because of the hydraulic interconnectivity of the South Delta channels, the CCF, and the export facilities, the permanent operable gates would not be operated entirely independent of Banks and Jones exports. The flow control gate opening and closing frequencies and durations would be adjusted to meet the water level and circulation objectives. Furthermore, the head of Old River Fish Control Gate operation period and duration would be adjusted to address the presence of fish species and the water quality conditions in the San Joaquin River. Opportunities to adjust gate operations in a manner that reduces entrainment and impingement of aquatic species or improves in-Delta water supply conditions that are associated with Delta exports could result.

As described in the Flow Control Gates operations sections, the Middle River, Grant Line Canal, and Old River near DMC flow control gates are operated to improve stage and water quality in the South Delta. The flow control gates increase the stage upstream of the barriers while Banks and Jones are all downstream of the permanent operable gates. The gates are designed to capture the flood tide upstream of the structures, and the operation of the flow control gates is not based on exports.

ESA coverage for the SDIP operable gates is being accomplished through two consultation processes. A separate biological opinion will address terrestrial and aquatic effects from channel dredging and construction and will be included in a separate consultation process.

State Water Project Oroville Facilities

Implementation of the new FERC license for the Oroville Project will occur when FERC issues the new license. Because it is not known exactly when that will occur, it is considered a near term and future project. The current, near term and future operations for the Oroville Facilities were previously described.

Analytical Framework for the Jeopardy Determination

The following analysis relies on four components to support the jeopardy determination for the delta smelt: (1) the *Status of the Species*, which evaluates the delta smelt's range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the delta smelt in the action area, the factors responsible for that condition, and the role of the action area in the delta smelt's survival and recovery; in this case the action area covers nearly the entire range of the delta smelt so the *Status of the Species/Environmental Baseline* sections are combined into one section; (3) the *Effects of the Action*, which determines

the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the delta smelt; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the delta smelt.

In accordance with the implementing regulations for section 7 and Service policy, the jeopardy determination is made in the following manner: the effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the delta smelt's current status and, for non-Federal activities in the action area, those actions likely to affect the delta smelt in the future, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the delta smelt in the wild.

The following analysis places an emphasis on using the range-wide survival and recovery needs of the delta smelt and the role of the action area in providing for those needs as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Analytical Framework for the Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

The following analysis relies on four components to support the adverse modification determination: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the delta smelt in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall, as well as the intended recovery function of discrete critical habitat units; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; in this case the action area covers nearly the entire range of delta smelt critical habitat so the *Status of the Critical Habitat/Environmental Baseline* sections are combined into one section; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

In accordance with Service policy and guidance, the adverse modification determination is made in the following manner: the effects of the proposed Federal action on critical habitat are evaluated in the context of the aggregate effects of all factors that have contributed to the current status of the critical habitat range-wide and, for non-Federal activities in the action area, those actions likely to affect the critical habitat in the future, to determine if the critical habitat would remain functional (or retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve the intended recovery role for the species with implementation of the proposed Federal action.

The following analysis places an emphasis on using the intended range-wide recovery function of delta smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species/Environmental Baseline

The action area for this consultation covers the entire range of the delta smelt, except for the Napa River. For that reason, the Status of the Species and Environmental Baseline sections are combined into one section in this document.

Delta Smelt

Delta Smelt Species Description and Taxonomy

The Service proposed to list the delta smelt as threatened with proposed critical habitat on October 3, 1991 (56 FR 50075). The Service listed the delta smelt as threatened on March 5, 1993 (58 FR 12854), and designated critical habitat for this species on December 19, 1994 (59 FR 65256). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (Service 1995). A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004); that review affirmed the need to retain the delta smelt as a threatened species. The Service is currently considering information to determine if the listing status of delta smelt should be upgraded from threatened to endangered.

The delta smelt is a member of the Osmeridae family (northern smelts) (Moyle 2002) and is one of six species currently recognized in the *Hypomesus* genus (Bennett 2005). The delta smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002) (Figure S-1). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The delta smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

The delta smelt is a slender-bodied fish, generally about 60 to 70 millimeters (mm) (2 to 3 inches (in)) long, although they can reach lengths of up to 120 mm (4.7 in) (Moyle 2002). Live delta smelt are nearly translucent and have a steely blue sheen to their sides. Delta smelt usually aggregate but do not appear to be a strongly schooling species.

Genetic analyses have confirmed that *H. transpacificus* presently exists as a single intermixing population (Stanley et al. 1995; Trenham et al. 1998). The most closely-related species is the surf smelt (*H. pretiosus*), a marine species common along the western coast of North America. Despite its morphological similarity, the delta smelt is less-closely related to wakasagi (*H. nipponensis*), an anadromous western Pacific species introduced into California Central Valley reservoirs in 1959 and now distributed in the historic range of the delta smelt (Trenham et al. 1998). Genetic introgression among *H. transpacificus* and *H. nipponensis* is low.

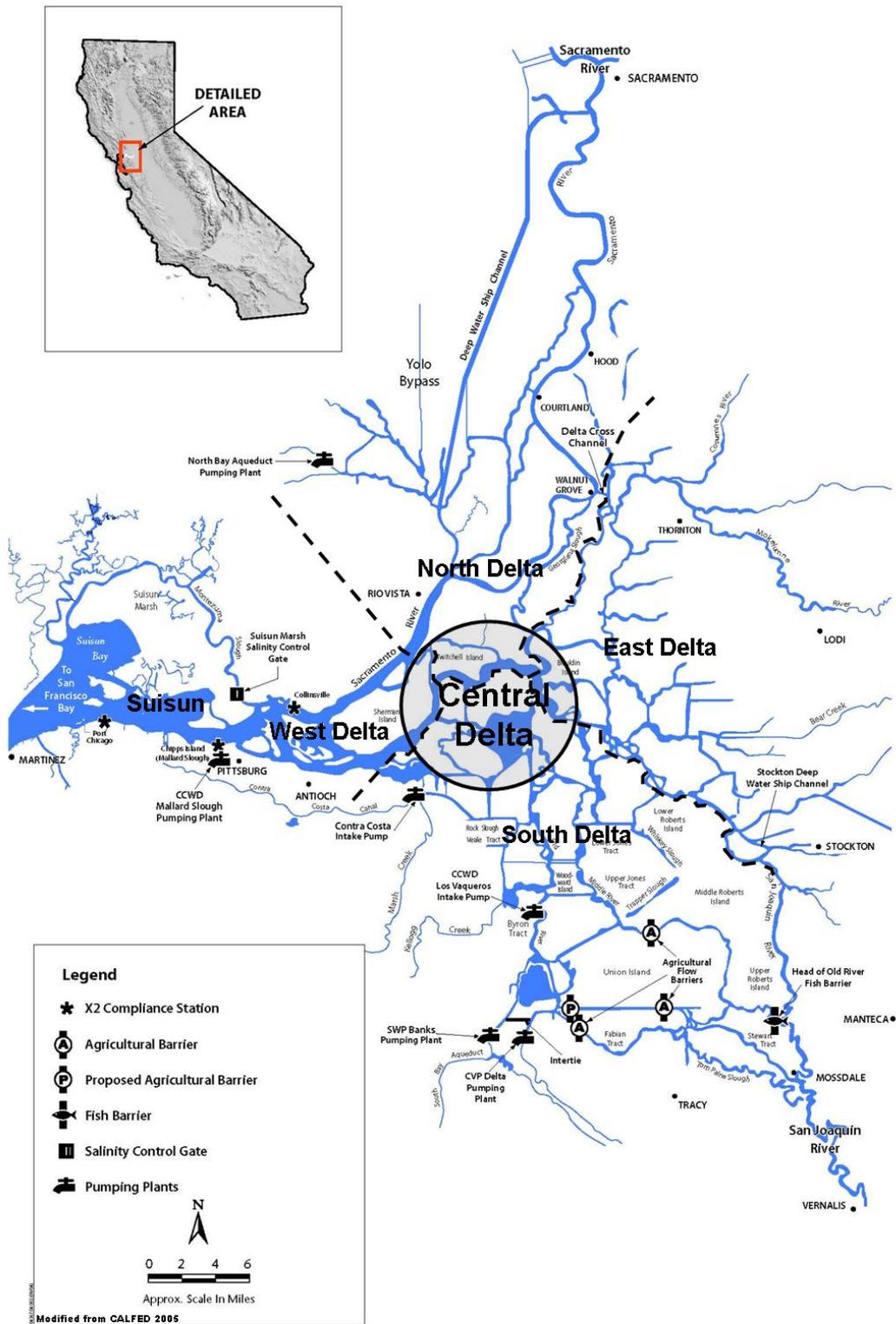


Figure S-1 Map of the Delta with Delta Regions Identified

Existing Monitoring Programs

Most research and monitoring of fish populations in the Bay-Delta is coordinated through the Interagency Ecological Program (IEP). The IEP is a cooperative effort led by state and federal agencies with university and private partners. There are currently 16 fish monitoring programs that are implemented year-round across the entire Bay-Delta system (Honey et al. 2004). Figure S-2 shows the monitoring stations that are sampled in the Bay-Delta Estuary. Each of these programs captures delta smelt to some degree, however, only a select few are commonly used to index the abundance or distribution of delta smelt, and only two are designed specifically to capture delta smelt.

The Fall Midwater Trawl Survey (FMWT) and the Summer Trawl Survey (TNS) are the two longest running IEP fish monitoring programs that are used to index delta smelt abundance. They work well because they were originally designed to target age-0 striped bass, which have similar habitat requirements to delta smelt. Two more recent programs, the 20-mm Survey and the Spring Kodiak Trawl Survey (SKT), were designed specifically to sample delta smelt and are also commonly used to evaluate relative abundance and distribution. Each of these four sampling programs targets different life stages and encompasses the entire distribution of delta smelt for the given life stage and time of year. The efficiency of sampling gears used for delta smelt is unknown. However, they were all designed to target open-water pelagic fishes and data from these programs have been used extensively in prior studies of delta smelt abundance and distribution (e.g., Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995; Dege and Brown 2004; Bennett 2005; Feyrer et al. 2007).

Data from the FMWT are used to calculate indices of relative abundance for delta smelt. The program has been conducted each year since 1967, except that no sampling was done in 1974 or 1979. Samples (10-minute tows) are collected at 116 sites each month from September to December throughout the Bay-Delta. Detailed descriptions of the sampling program are available from Stevens and Miller (1983) and Feyrer et al. (2007). The delta smelt recovery index includes distribution and abundance components and is calculated from a subset of the September and October FMWT sampling (<http://www.delta.dfg.ca.gov/>). The details on the calculation of the recovery index can be found in the Delta Native Fishes Recovery Plan (Service 1995).

Data from the TNS are used to calculate indices of abundance for young-of-year delta smelt during the summer. The TNS has been conducted annually since 1959 (Turner and Chadwick 1972). It involves sampling at up to 32 stations with three replicate tows to complete a survey. A minimum of two surveys is conducted each year. The delta smelt index is generated from the first two TNS surveys (Moyle et al. 1992). The TNS sampling has had an average survey starting date of July 13, but surveys have been conducted as early as June 4 and as late as August 28 in some years (Nobriga et al. 2008).

Data from the 20-mm survey are used to examine the abundance and distribution of young post-larval/early juvenile delta smelt during the spring (Dege and Brown 2004). The survey has been conducted each year since 1995, and involves the collection of three replicate samples at up to 48 sites; additional sites have been added in recent years. A complete set of samples from each site is termed a survey and 5-9 surveys are completed

each year from approximately March through June. This survey also simultaneously samples zooplankton with a Clarke-Bumpus net during one of the three sampling tows at each site.

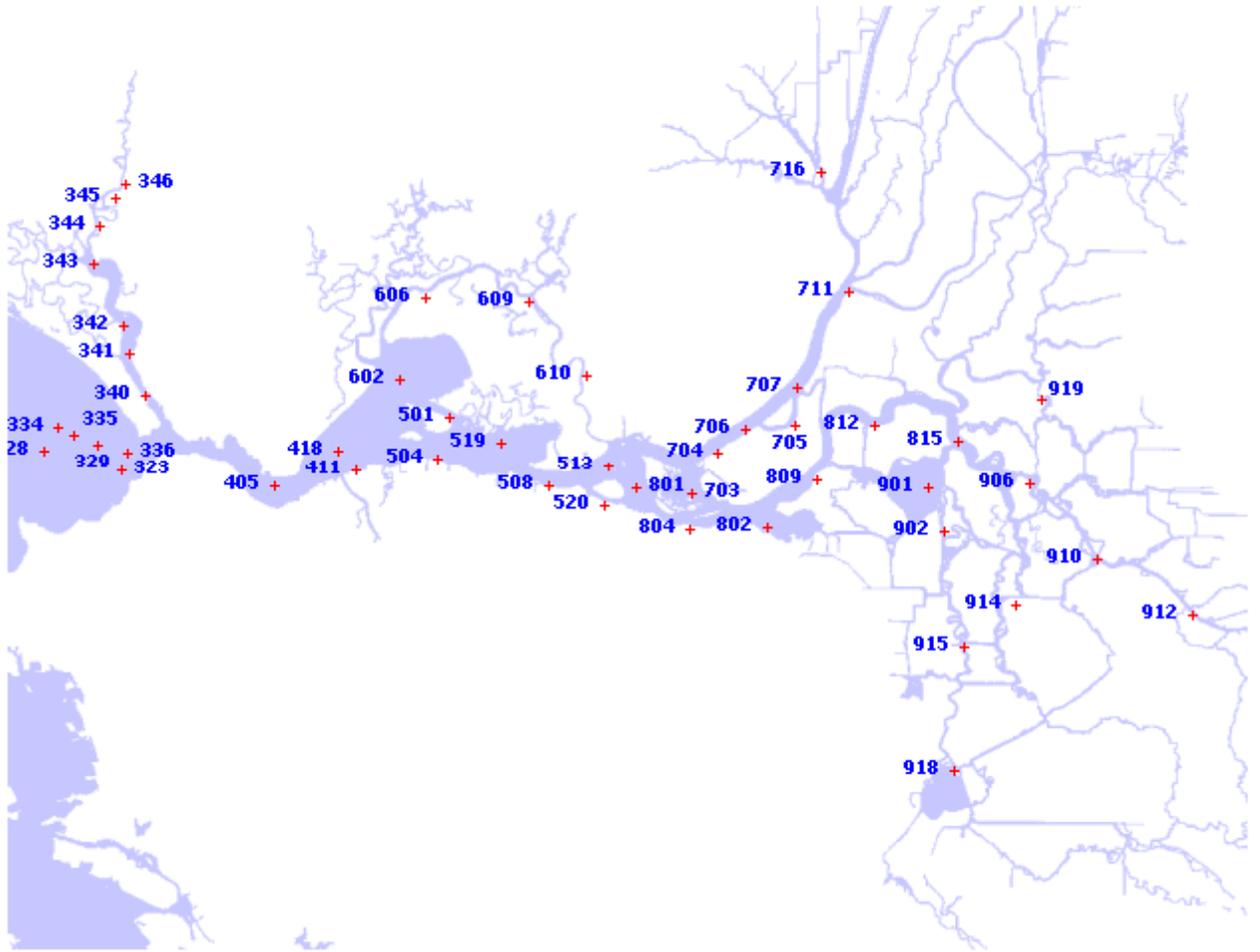


Figure S-2 Map of Bay Delta Estuary Sampling Locations for the TNS and 20-mm Survey (DFG Bay Delta website 2008)

Data from the SKT are used to monitor and provide information on the pre-spawning and spawning distributions of delta smelt. The survey also quantifies the reproductive maturity status of all adult delta smelt collected. SKT sampling has been done since 2002 at approximately 39 stations. Sampling at each station is completed five or more times per year from January to May. Supplemental surveys are often completed when additional information is requested by managers to assist with decisions relating to water project operations.

An additional source of information on delta smelt comes from salvage operations at the Banks and Jones fish facilities. Banks and Jones are screened with fish-behavioral louvers designed to salvage young Chinook salmon and striped bass before they enter the pumps (Brown et al. 1996). In general, the salvage process consists of fish capture,

transport, and ultimately release at locations where they are presumed safe from further influence of Banks and Jones. However, unlike some species, it is commonly acknowledged that delta smelt often do not survive the salvage process. Data on the salvage of delta smelt is typically used to provide an index of entrainment into the diversion pumps, but not as an index of general population abundance. However, there are a number of caveats with these data including unknown sampling efficiency, unknown pre-screen mortality in Clifton Court Forebay, and no sampling of fish smaller than 20mm (Kimmerer 2008). Fortunately, some of this information may become available in the future because of targeted studies on efficiency and pre-screen mortality being conducted by the IEP and Reclamation. Although monitoring from Banks and Jones is limited in geographic range compared to the other surveys, they sample substantially larger volumes of water, and therefore may have a greater likelihood to detect low densities of delta smelt larger than 20mm.

Delta smelt entrainment is presently estimated (or indexed) by extrapolating catch data from periodic samples of salvaged fish (≥ 20 mm). Fish are counted from a sub-sample of water from the facility holding tanks and numbers are extrapolated based on the volume of water diverted during collection of that sample to estimate the number of fish entrained into Banks and Jones during the sampling interval. Intervals typically range from 1-24 hours depending on time of year, debris loads, etc.

Overview of Delta Smelt's Life Cycle

The delta smelt life cycle is completed within the freshwater and brackish LSZ of the Bay-Delta. Figure S-3 portrays the conceptual model used for delta smelt. Delta smelt are moderately euryhaline (Moyle 2002). However, salinity requirements vary by life stage. Delta smelt are a pelagic species, inhabiting open waters away from the bottom and shore-associated structural features (Nobriga and Herbold, 2008). Although delta smelt spawning has never been observed in the wild, clues from the spawning behavior of related osmerids suggests delta smelt use bottom substrate and nearshore features during spawning. However, apart from spawning and egg-embryo development, the distribution and movements of all life stages are influenced by transport processes associated with water flows in the estuary, which also affect the quality and location of suitable open-water habitat (Dege and Brown 2004; Feyrer et al. 2007; Nobriga et al. 2008).

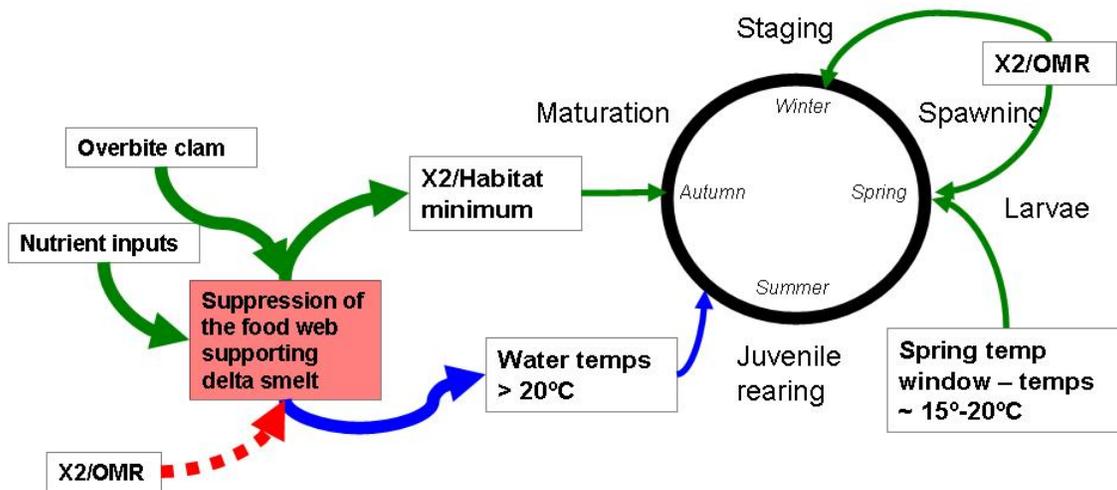


Figure S-3 Lifecycle Conceptual Model For Delta Smelt. The Larger the Arrow Size, the Stronger the Influence on the Process Box

Delta smelt are weakly anadromous and undergo a spawning migration from brackish water to freshwater annually (Moyle 2002). In early winter, mature delta smelt migrate from brackish, downstream rearing areas in and around Suisun Bay and the confluence of the Sacramento and San Joaquin rivers upstream to freshwater spawning areas in the Delta. Delta smelt historically have also spawned in the freshwater reaches of Suisun Marsh. In winters featuring high Delta outflow, the spawning range of delta smelt shifts west to include the Napa River (Hobbs et al. 2007).

The upstream migration of delta smelt, which ends with their dispersal into river channels and sloughs in the Delta (Radtke 1966; Moyle 1976, 2002; Wang 1991), seems to be triggered or cued by abrupt changes in flow and turbidity associated with the first flush of winter precipitation (Grimaldo et al, accepted manuscript) but can also occur after very high flood flows have receded. Grimaldo et al (accepted manuscript) noted salvage often occurred when total inflows exceeded over 25,000 cfs or when turbidity elevated above 12 NTU (CCF station). Delta smelt spawning may occur from mid-winter through spring; most spawning occurs when water temperatures range from about 12^oC to 18^oC (Moyle 2002). Most adult delta smelt die after spawning (Moyle 2002). However, some fraction of the population may hold over as two-year-old fish and spawn in the subsequent year.

During and after a variable period of larval development, the young fish migrate downstream until they reach the low-salinity zone (LSZ) (indexed as X2) where they reside until the following winter (Moyle 2002). The location of the delta smelt population follows changes in the location of the LSZ which depends primarily on delta outflow.

Biology and Life History

Spawning

Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta. Delta smelt spawning has also been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Although spawning may occur at temperatures up to 22°C, hatching success of the larvae is very low (Bennett 2005).

Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). Moyle et al. (1992) considered delta smelt fecundity to be “relatively low.” However, based on Winemiller and Rose (1992), delta smelt fecundity is fairly high for a fish its size. In captivity, females survive after spawning and develop a second clutch of eggs (Mager et al. 2004); field collections of ovaries containing eggs of different size and stage indicate that this also occurs in the wild (Adib-samii 2008). Captive delta smelt can spawn up to 4-5 times. While most adults do not survive to spawn a second season, a few (<5 percent) do (Moyle 2002; Bennett 2005). Those that do survive are typically larger (90-110 mm SL) females that may contribute disproportionately to the population’s egg supply (Moyle 2002 and references therein). Two-year-old females may have 3-6 times as many ova as first year spawners.

Most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the SKT and 20-mm survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges et al. 2000; Mager et al. 2004). Other smelts, including marine beach spawning species and estuarine populations and the landlocked Lake Washington longfin smelt, are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory and eggs have not been found in the wild. Consequently, what is known about the mechanics of delta smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 mm diameter and are adhesive and negatively buoyant (Moyle 1976, 2002; Mager et al. 2004; Wang 1986, 2007). Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the

bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg et al. 2003; Wang 2007).

The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may move (“tumble”) with water currents and turbulence (Hay 2007; slideshow available at http://www.science.calwater.ca.gov/pdf/workshops/workshop_smelt_presentation_Hay_11508.pdf). It is not known whether delta smelt eggs “tumble incubate” in the wild, but tumbling of eggs may moderately disperse them, which might reduce predation risk within a localized area.

Presence of newly hatched larvae likely indicates regions where spawning has occurred. The 20-mm trawl has captured small (~5 mm Standard Length [SL]) larvae in Cache Slough, the lower Sacramento River, San Joaquin River, and at the confluence of these two rivers (e.g., 20-mm trawl survey 1 in 2005). Larger larvae and juveniles (size > 23 mm SL), which are more efficiently sampled by the 20-mm trawl gear, have been captured in Cache Slough (Sacramento River) and the Sacramento Deep Water Channel in July (e.g. 20-mm trawl survey 9 in 2008). Because they are small fish inhabiting pelagic habitats with strong tidal and river currents, delta smelt larval distribution depends on both the spawning area from which they originate and the effect of transport processes caused by flows. Larval distribution is further affected by water salinity and temperature. Hydrodynamic simulations reveal that tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monson et al 2007). This could result in rapid dispersion of larvae away from spawning sites.

Sampling of larval delta smelt in the Bay-Delta in 1989 and 1990 suggested that spawning occurred in the Sacramento River; in Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs; in the San Joaquin River adjacent to Bradford Island and Fisherman’s Cut; and possibly other areas (Wang 1991). However, in recent years, the densest concentrations of both spawners and larvae have been recorded in the Cache Slough/Sacramento Deepwater Ship Channel complex in the North Delta. Some delta smelt spawning occurs in Napa River, Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999; Wang 1991; Hobbs et al. 2007). Early stage larval delta smelt have also been recorded in Montezuma Slough near Suisun Bay (Wang 1986).

Larval Development

Mager et al. (2004) reported that embryonic development to hatching takes 11-13 days at 14-16° C for delta smelt, and Baskerville-Bridges et al. (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17° C. Lindberg et al. (2003) reported high hatching rates of delta smelt eggs in the laboratory at 15° C, and Wang (2007) reported high hatching rates at temperatures between 14-17° C. Bennett (2005) showed hatching success peaks near 15° C. Swim bladder inflation occurring at 60-70 days post-hatch at 16-17° C (Mager et al. 2004).

At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager et al. 2004). As

development continues, newly hatched delta smelt become semi-buoyant and sink in stagnant water. However, larvae are unlikely to encounter stagnant water in the wild.

In the laboratory, a turbid environment (>25 Nephelometric Turbidity Units [NTU]) was necessary to elicit a first feeding response (Baskerville-Bridges et al. 2000; Baskerville-Bridges 2004). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges *et al.* 2000; Mager et al. 2004; Baskerville-Bridges *et al.* 2004).

Growth rates of wild-caught delta smelt larvae are faster than laboratory-cultured individuals. Mager et al. (2004) reported growth rates of captive-raised delta smelt reared at near-optimum temperatures (16°C-17°C). Their fish were about 12 mm long after 40 days and about 20 mm long after 70 days. In contrast, analyses of otoliths indicated that wild delta smelt larvae were 15-25 mm, or nearly twice as long at 40 days of age (Bennett 2005). By 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987).

Laboratory-cultured delta smelt larvae have generally been fed rotifers at first-feeding (Baskerville-Bridges et al. 2004; Mager et al. 2004). However, rotifers rarely occur in the guts of wild delta smelt larvae (Nobriga 2002). The most common first prey of wild delta smelt larvae is the larval stages of several copepod species. These copepod 'nauplii' are larger and have more calories than rotifers. This difference in diet may enable the faster growth rates observed in wild-caught larvae.

The food available to larval fishes is constrained by mouth gape and status of fin development. Larval delta smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval delta smelt are visual feeders. They find and select individual prey organisms and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Thus, delta smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval delta smelt have particularly restricted diets (Nobriga 2002). They do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding delta smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the delta smelt larvae grow, their gape increases, and they become stronger swimmers.

The triggers for and duration of delta smelt larval movement from spawning areas to rearing areas are not known. Hay (2007) noted that eulachon larvae are probably flushed into estuaries from upstream spawning areas within the first day after hatching, but downstream movement of delta smelt larvae occurs much later. Most larvae gradually move downstream toward the two parts per thousand (ppt) isohaline (X2). X2 is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby et al. 1995). It is a

physical attribute of the Bay-Delta that is used as a habitat indicator and as a regulatory standard in the SWRCB D-1641, as described in the project description.

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow (above normal to wet WYs), delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish but the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Juveniles

Young-of-the-year delta smelt rear in the LSZ from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm SL long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm SL) by early fall (Moyle 2002). Delta smelt growth during the fall months slows considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966).

Nobriga *et al.* (2008) found that delta smelt capture probabilities in the TNS are highest at specific conductance levels of 1,000 to 5,000 $\mu\text{S cm}^{-1}$ (approximately 0.6 to 3.0 practical salinity unit [psu]). Similarly, Feyrer *et al.* (2007) found a decreasing relationship between abundance of delta smelt in the FMWT and specific conductance during September through December. The location of the LSZ and changes in delta smelt habitat quality in the San Francisco Estuary can be indexed by changes in X2 (see effects section). The LSZ historically had the highest primary productivity and is where zooplankton populations (on which delta smelt feed) were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). However, this has not always been true since the invasion of the overbite clam (Kimmerer and Orsi 1996). The abundance of many local aquatic species has tended to increase in years when winter-spring outflow was high and X2 was pushed seaward (Jassby *et al.* 1995), implying that the quantity and quality (overall suitability) of estuarine habitat increases in years when outflows are high. However, delta smelt is not one of the species whose abundance has statistically covaried with winter-spring freshwater flows (Stevens and Miller 1983; Moyle *et al.* 1992; Kimmerer 2002; Bennett 2005). As presented in this biological opinion, there is evidence that X2 in the fall influences delta smelt population dynamics.

Delta smelt seem to prefer water with high turbidity, based on a negative correlation between the frequency of delta smelt occurrence in survey trawls during summer, fall and early winter and water clarity. For example, the likelihood of delta smelt occurrence in trawls at a given sampling station decreases with increasing Secchi depth at the stations (Feyrer *et al.* 2007, Nobriga *et al.* 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over one half meter and capture probabilities for delta smelt are highest at 0.40 m depth or less. The delta smelt's preference for turbid water

may be related to increased foraging efficiency (Baskerville-Bridges et al. 2004) and reduced risk of predation.

Temperature also affects delta smelt distribution. Swanson and Cech (1995) and Swanson et al. (2000) indicate delta smelt tolerate temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures are usually less than 25° C in summer (Nobriga et al. 2008).

Foraging Ecology

Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Juvenile-stage delta smelt prey upon copepods, cladocerans, amphipods, and insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi* has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta, especially in summer, when it replaces *E. affinis* in the plankton community (Moyle 2002). Another smaller copepod, *Limnoithona tetraspina*, which was introduced into the Bay-Delta in the mid-1990s, is now one of the most abundant copepods in the LSZ, but not abundant in delta smelt diets. *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but *Pseudodiaptomus* remains a dominant prey (Baxter et al. 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). In contrast, higher residence times, which result from low tributary flows, can result in higher plankton biomass but water diversions, overbite clam grazing (Jassby et al. 2002) and possibly contaminants (Baxter et al. 2008) remove a lot of plankton biomass when residence times are high. These factors all affect food availability for planktivorous fishes that utilize the zooplankton in Delta channels. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008). Thus, there is the potential for mismatches between regions of high zooplankton abundance in the Delta and delta smelt distribution now that the overbite clam has decimated LSZ zooplankton densities (see effects section).

The delta smelt compete with and are prey for several native and introduced fish species in the Delta. The introduced inland silverside may prey on delta smelt eggs and/or larvae and compete for copepod prey (Bennett and Moyle 1996; Bennett 2005). Young striped bass also use the LSZ for rearing and may compete for copepod prey and eat delta smelt. Centrarchid fishes and coded wire tagged Chinook salmon smolts released in the Delta for survival experiments since the early 1980s may potentially also prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000). Studies during the

early 1960s found delta smelt were only an occasional prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). However, delta smelt were a comparatively rare fish even then, so it is not surprising they were a rare prey. Striped bass appear to have switched to piscivorous feeding habits at smaller sizes than they historically did, following severe declines in the abundance of mysid shrimp (Feyrer et al. 2003). Nobriga and Feyrer (in press) showed that inland silverside, which is similar in size to delta smelt, was only eaten by subadult striped bass less than 400 mm fork length. While largemouth bass are not pelagic, they have been shown to consume some pelagic fishes (Nobriga and Feyrer 2007).

Habitat

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002b). For instance, in the early 1900s, the location of maximum salinity intrusion into the Delta during dry periods varied from Chipps Island in the lower Delta to Stockton along the San Joaquin River and Merritt Island in the Sacramento River (DWR Delta Overview). Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows (Knowles 2002), though Delta outflows have been tightly constrained during late summer-fall for several decades (see Effects section).

Channelization, conversion of Delta islands to agriculture, and water operations have substantially changed the physical appearance, water salinity, water clarity, and hydrology of the Delta. As a consequence of these changes, most life stages of the delta smelt are now distributed across a smaller area than historically (Arthur et al. 1996, Feyrer et al. 2007). Wang (1991) noted in a 1989 and 1990 study of delta smelt larval distribution that, in general, the San Joaquin River was used more intensively for spawning than the Sacramento River. Though not restricting spawning *per se*, based on particle tracking modeling, export of water by the CVP and SWP would usually restrict reproductive success of spawners in the San Joaquin River by entraining most larvae during downstream transport from spawning sites to rearing areas (Kimmerer and Nobriga 2008). There is one, non-wet year exception to this generalization: in 2008, delta smelt entrainment was managed under a unique system of restrictions imposed by the Court in *NRDC v Kempthorne*. In 2008, CVP/SWP operations were constrained in accordance with recommendations formulated by the Service expressly to limit entrainment of delta smelt from the Central Delta.

Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey production. Further, agricultural fields in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to *Hyalella azteca* (Werner et al. 2008). The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects. The extent to which delta smelt larvae are exposed to contaminants varies with flow entering the Delta. Flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations entering the Delta from wastewater treatment plants.

The distribution of juvenile delta smelt has also changed over the last several decades. During the years 1970 through 1978, delta smelt catches in the TNS survey declined rapidly to zero in the Central and South Delta and have remained near zero since. A similar shift in FMWT catches occurred after 1981 (Arthur et al. 1996). This portion of the Delta has also had a long-term trend increase in water clarity during July through December (Arthur et al. 1996; Feyrer et al. 2007; Nobriga et al. 2008).

The position of the LSZ where delta smelt rear has also changed over the years. Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. These changes may be due to increased upstream water diversions for flooding rice fields (Kawakami et al. 2008). The confluence of the Sacramento and San Joaquin rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that most of the juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 FMWT survey were captured at statistically significantly higher salinities than what would be expected based upon historical distribution data generated by Feyrer et al. (2007). During the same year, the annual bloom of toxic cyanobacteria (*Microcystis aeruginosa*) spread far downstream to the west Delta and beyond during the summer (Peggy Lehman, pers comm). This has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (Reclamation 2008).

Delta Smelt Population Dynamics and Abundance Trends

The FMWT provides the best available long-term index of the relative abundance of delta smelt (Moyle et al. 1992; Sweetnam 1999). The indices derived from these surveys closely mirror trends in catch per unit effort (Kimmerer and Nobriga 2005), but do not at present support statistically reliable population abundance estimates, though substantial progress has recently been made (Newman 2008). FMWT derived data are generally

accepted as providing a reasonable basis for detecting and roughly scaling interannual trends in delta smelt abundance.

The FMWT derived indices have ranged from a low of 27 in 2005 to 1,653 in 1970 (Figure S-5). For comparison, TNS-derived indices have ranged from a low of 0.3 in 2005 to a high of 62.5 in 1978 (Figure S-4). Although the peak high and low values have occurred in different year, the TNS and FMWT indices show a similar pattern of delta smelt relative abundance; higher prior to the mid-1980s and very low in the past seven years.

From 1969-1981, the mean delta smelt TNS and FMWT indices were 22.5 and 894, respectively. Both indices suggest the delta smelt population declined abruptly in the early 1980s (Moyle et al. 1992). From 1982-1992, the mean delta smelt TNS and FMWT indices dropped to 3.2 and 272 respectively. The population rebounded somewhat in the mid-1990s (Sweetnam 1999); the mean TNS and FMWT indices were 7.1 and 529, respectively, during the 1993-2002 period. However, delta smelt numbers have trended precipitously downward since about 2000.

Figure S-4. TNS abundance indices for delta smelt.

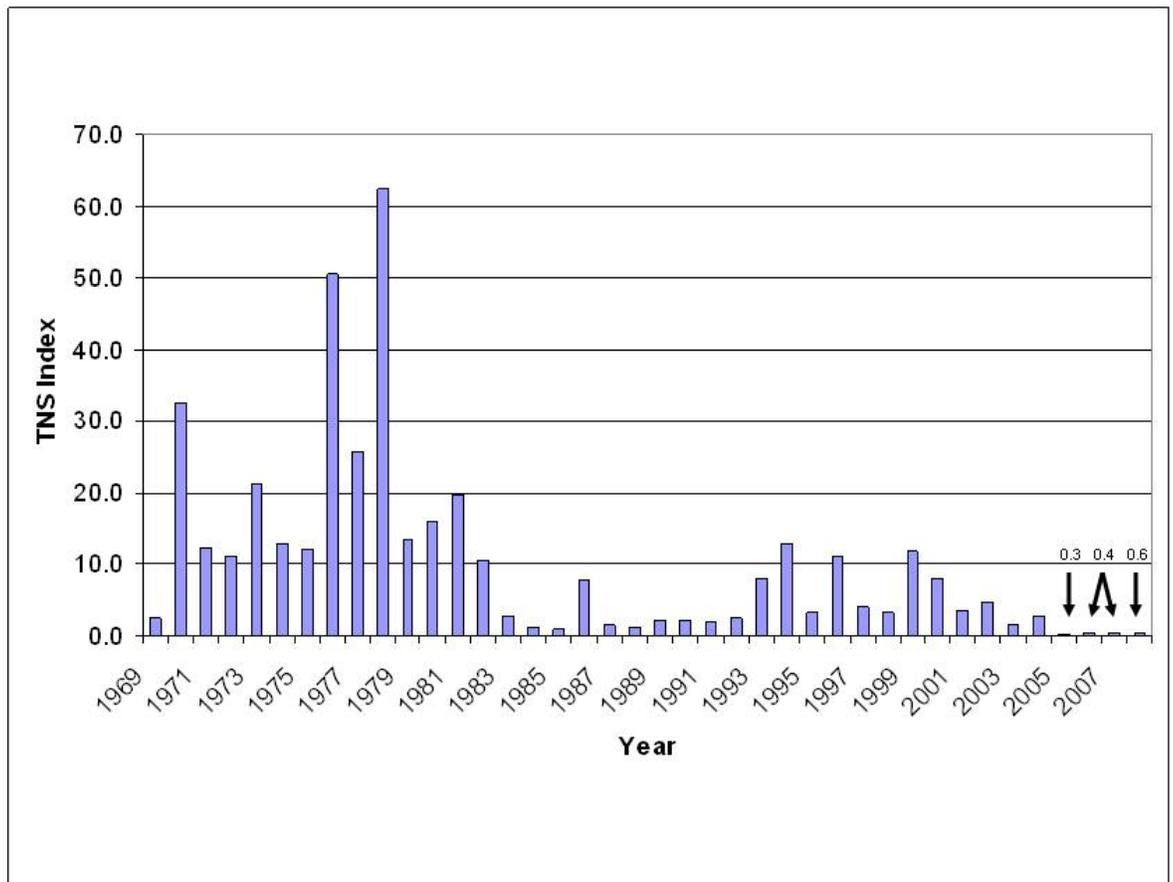
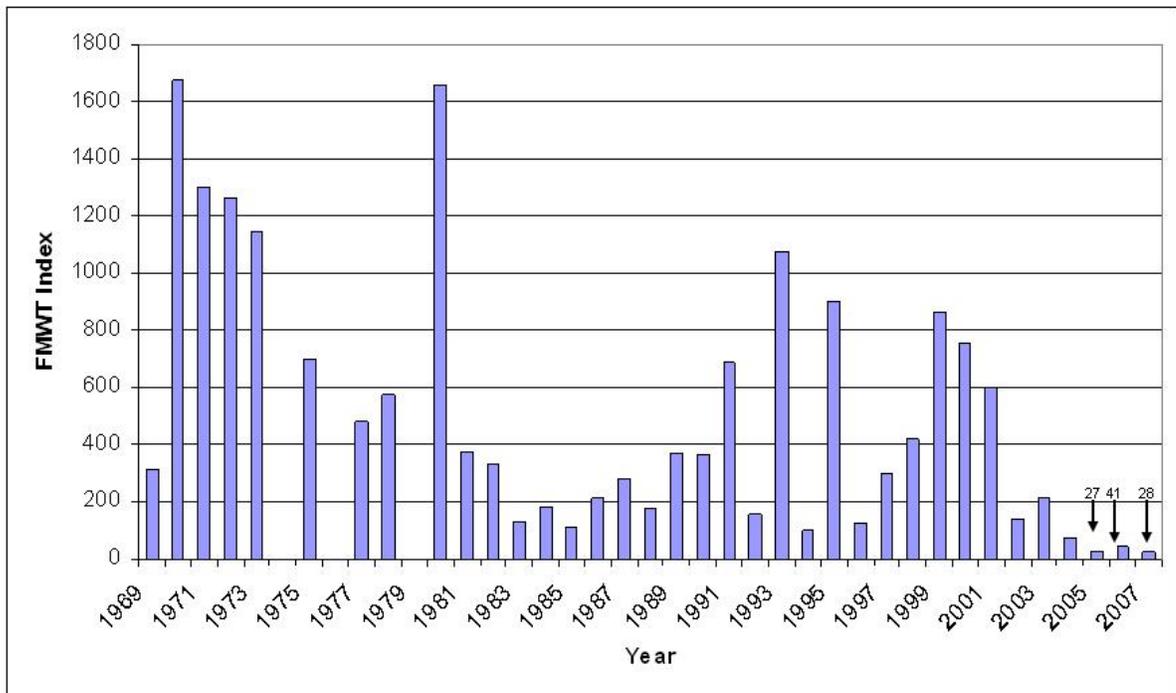


Figure S-4. FMWT abundance indices for delta smelt.



Currently, the delta smelt population indices are two orders of magnitude smaller than historical highs (Figures S-4 and S-5) and recent population abundance estimates are up to three orders of magnitude below historical highs (Newman 2008). After 1999 both the FMWT and the TNS population indices showed declines, and from 2000 through 2007 the median FMWT index was 106.5. The lowest FMWT abundance indices ever obtained were recorded during 2004-2007 (74, 27, 41, and 28, respectively; Figure S-5). The median TNS index during the period from 2000 through 2008 fell similarly to 1.6, and has also dropped to its lowest levels during the last four years with indexes of 0.3, 0.4, 0.4, and 0.6 during 2005 through 2008, respectively (Figure S-4). It is highly unlikely that the indices from 2004-2007 can be considered statistically different from one another (see Sommer et al. 2007), but they are very likely lower than at any time prior in the period of record.

The total number of delta smelt collected in the 20-mm Survey decreased substantially during the years from 2002 to 2008 (4917 to 587 fish) compared to the period 1995 through 2001 (98 to 1084 fish) (Figure S-6). Similarly, the number of delta smelt caught in the SKT has decreased steadily since the survey started in 2002 (Figure S-6)

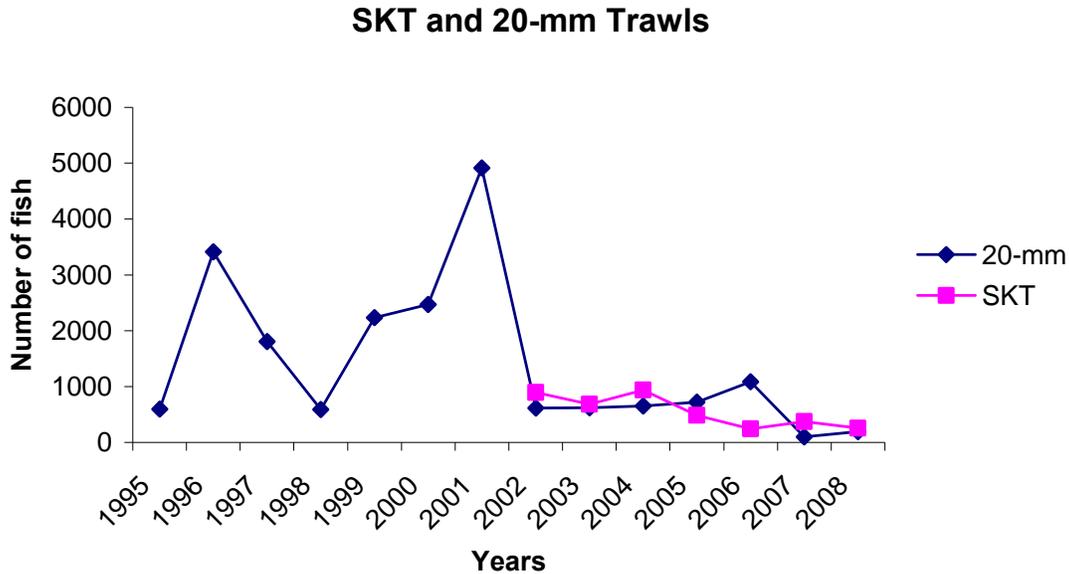


Figure S-6. Number of fish collected in the Spring Kodiak Trawl and the 20-mm surveys. Only the eight first 20-mm trawl surveys are included and only data from the four first full surveys of the SKT. SKT data from DFG at <http://www.delta.dfg.ca.gov/> and 20-mm trawl catch data provided by DFG.

Since about 2002, delta smelt is one of four pelagic fish species subject to what has been termed the Pelagic Organism Decline or POD (Sommer et al. 2007). The POD denotes the sudden, overlapping declines of San Francisco Estuary pelagic fishes first recognized in data collected from 2002-2004. The POD species include delta smelt, longfin smelt, threadfin shad (*Dorosoma petenense*), and (age-0) striped bass (*Morone saxatilis*), which together account for the bulk of the resident pelagic fish biomass in the tidal water upstream of X2. The year 2002 is often recognized as the start of the POD because of the striking declines of three of the four POD species between 2001 and 2002; however, statistical review of the data (e.g., Manly and Chotkowski 2006) has revealed that for at least delta smelt, the POD downtrend really began earlier (around 1999). Post-2001 abundance indices for the POD species have included record lows for all but threadfin shad. The causes of the POD and earlier declines are not fully understood, but appear to be layered and multifactorial (Baxter et al. 2008). Several analyses have concluded that the shift in pelagic fish species abundance in the early 1980s was caused by a decrease in habitat carrying capacity or production potential (Moyle et al. 1992, Bennett 2005; Feyrer et al. 2007).

There is some evidence that the recruitment of delta smelt may have sometimes responded to springtime flow variation (Herbold et al. 1992; Kimmerer 2002). However, the weight of evidence suggests that delta smelt abundance does not (statistically)

respond to springtime flow like the abundance of the species mentioned above (Stevens and Miller 1983; Jassby et al. 1995; Bennett 2005). The number of days of suitable spawning temperature during spring is correlated with subsequent abundance indices in the autumn (Bennett 2005). This is evidence that cool springs, which allow for multiple larval cohorts, can contribute to population resilience. However, these relationships do not explain a large proportion of variance in autumn abundance. Depending on which abundance index is used, the r^2 are 0.24-0.29.

The relationship between numbers of spawning fish and the numbers of young subsequently recruiting to the adult population is known as a stock-recruit relationship. Analysis of stock-recruit relationships using delta smelt survey data indicate that a weak density dependent effect has occurred during late summer/fall (Bennett 2005, Reclamation 2008), suggesting that delta smelt year-class strength has often been set during late summer and fall. This is supported by studies suggesting that the delta smelt is food limited (Bennett 2005; IEP 2005) and evidence for density dependent mortality has been presented by Brown and Kimmerer (2001). However, the number of days during the spring that water temperature remained between 15 °C and 20 °C, with a density-dependence term to correct for the saturating TNS-FMWT relationship (described above), predicts FMWT indices fairly well ($r^2 \approx 0.70$; $p < 0.05$; Bennett, unpublished presentation at the 2003 CALFED Science Conference). This result shows that of the quantity of young delta smelt produced also contributes to future spawner abundance. Bennett (2005) analyzed the relationship between delta smelt spawner population and spawner recruits using data before and after the 1980s decline. He concluded that density dependence pre-1982 may have occurred at FMWT values of 600 to 800 and at FMWT values of 400 to 500 for the period 1982 through 2002.

Bennett (2005) also conducted extensive stock-recruit analyses using the TNS and FMWT indices. He provided statistical evidence that survival from summer to fall is nonlinear (= density-dependent). He also noted that carrying capacity had declined. Bennett (2005) surmised that density-dependence and lower carrying capacity during the summer and fall could happen in a small population if habitat space was smaller than it was historically. This hypothesis was recently demonstrated to be true (Feyrer et al. 2007). Reduced Delta outflow during autumn has led to higher salinity in Suisun Bay and the Western Delta while the proliferation of submerged vegetation has reduced turbidity in the South Delta. Together, these mechanisms have led to a long-term decline in habitat suitability for delta smelt. High summer water temperatures also limit delta smelt distribution (Nobriga et al. 2008) and impair health (Bennett et al. 2008).

A minimum amount of suitable habitat during summer-autumn may interact with a suppressed pelagic food web to create a bottleneck for delta smelt (Bennett 2005; Feyrer et al. 2007; Bennett et al. 2008). Prior to the overbite clam invasion, the relative abundance of maturing adults collected during autumn was unrelated to the relative abundance of juveniles recruiting the following summer (i.e., the stock-recruit relationship was density-vague). Since the overbite clam became established, autumn relative abundance explains 40 percent of the variability in subsequent juvenile abundance (Feyrer et al. 2007). When autumn salinity is factored in, 60 percent of the variance in subsequent juvenile abundance is accounted for statistically.

Since 2000, the stock-recruit relationship for delta smelt has been stronger still ($r^2 = 0.88$ without autumn habitat metrics factored in; Baxter et al. 2008). This has led to speculation about Allee effects. Allee effects occur when reproductive output per fish declines at low population levels (Allee 1931, Berec et al. 2006). Below a certain threshold the individuals in a population can no longer reproduce rapidly enough to replace themselves and the population spirals to extinction. For delta smelt, possible mechanisms for Allee effects include mechanisms directly related to reproduction and genetic fitness such as difficulty finding enough males to maximize egg fertilization during spawning (e.g., Purchase et al. 2007). Genetic problems arising from small population sizes like inbreeding and genetic drift also can contribute to Allee effects, but genetic bottlenecks occur after demographic problems like the example of finding enough mates (Lande 1988). Other mechanisms related to survival such as increased vulnerability to predation are also possible based on studies of other species.

These data provide evidence that factors affecting juvenile delta smelt during summer-autumn are also impairing delta smelt reproductive success. Thus, the interaction of warm summer water temperatures, suppression of the food web supporting delta smelt, and spatially restricted suitable habitat during autumn affect delta smelt health and ultimately survival and realized fecundity (Figure S-3).

Another possible contributing driver of reduced delta smelt survival, health, fecundity, and resilience that occurs during winter is the “Big Mama Hypothesis” (Bill Bennett, UC Davis, pers. comm. and various oral presentations). As a result of his synthesis of a variety of studies, Bennett proposed that the largest delta smelt (whether the fastest growing age-1 fish or fish that manage to spawn at age-2) could have a large influence on population trends. Delta smelt larvae spawned in the South Delta have high risk of entrainment under most hydrologic conditions (Kimmerer 2008), but water temperatures often warm earlier in the South Delta than the Sacramento River (Nobriga and Herbold 2008). Thus, delta smelt spawning often starts and ends earlier in the Central and South Delta than elsewhere. This differential warming may contribute to the “Big Mama Hypothesis” by causing the earliest ripening females to spawn disproportionately in the South Delta, putting their offspring at high risk of entrainment. Although water diversion strategies have been changed to better protect the ‘average’ larva, the resilience historically provided by variable spawn timing may be reduced by water diversions and other factors that covary with Delta inflows and outflows.

Substantial increases in winter salvage at Banks and Jones that occurred contemporaneously with recent declines in delta smelt and other POD species (Kimmerer 2008, Grimaldo et al. accepted manuscript) support the interpretation that entrainment played a role in the POD-era depression of delta smelt numbers. Increased winter entrainment of delta smelt represents a loss of pre-spawning adults and all their potential progeny (Sommer et al. 2007). Note that winter salvage levels subsequently decreased to very low levels for all POD species during the winters of 2005-2006 and 2006-2007, possibly due to the very low population sizes during those periods. Reduced pumping for protection of delta smelt also substantially reduced OMR flow towards the pumps and subsequently reduced number of delta smelt entrained during the winters of 2006-2007 and 2007-2008.

The hydrologic and statistical analyses of relationships between OMR flows and salvage suggest a reasonable mechanism by which winter entrainment increased with increased exports during the POD years; however, entrainment is not a substantial source of mortality every year. Manly and Chotkowski (2006; IEP 2005) found that monthly or semi-monthly measures of exports or Old and Middle rivers flow had a reliable, statistically significant effect on delta smelt abundance; however, individually they explained a small portion (no more than a few percent) of the variability in the fall abundance index of delta smelt across the entire survey area and time period. Kimmerer (2008) addressed delta smelt entrainment by means of particle tracking, and estimated historical entrainment rates for larvae and juvenile delta smelt to be as high as 40 percent; however, he concluded that non-entrainment mortality in the summer had effects on FMWT delta smelt numbers. Hence, there are other factors that often mask the effect of entrainment loss on delta smelt fall abundance in these analyses. Among them, availability and quality of summer and fall habitat (see Effects section) are clearly affected by CVP/SWP operations.

We conclude that entrainment and habitat availability/quality jointly contribute to downward pressure on spawner recruitment in and one or both of these general mechanisms is operating throughout the year. The intensity of constraints of the other threats affecting the delta smelt carrying capacity varies between years, and the importance of contributing stressors changes as outflow, export operations, weather, and the abundances of other ecosystem elements vary. For instance, Bennett (2005) noted that seasonally low outflow and warmer water temperatures may concentrate delta smelt and other planktivorous fishes into relatively small patches of habitat during late summer. This would increase competition and limit food availability during low outflow. Higher outflow that expands and moves delta smelt habitat downstream of the Delta is expected to improve conditions for delta smelt (Feyrer et al. 2007). The high proportion of the delta smelt population that has been entrained during some years (Kimmerer 2008) would be expected to reduce the ability of delta smelt to respond to the improved conditions, thereby limiting the potential for increased spawner recruitment. Further, the smaller sizes of maturing adults during fall may have affected delta smelt fecundity (Bennett, 2005). This would further reduce the species' ability to respond to years with improved conditions.

Factors Affecting the Species

Water Diversions and Reservoir Operations

Banks and Jones Export Facilities

In 1951, the Tracy Pumping Plant (now referred to as the Jones Pumping Plant), with a capacity of 4,600 cfs, was completed along with the Delta Mendota Canal which conveys water from the Jones Pumping Plant (Jones) for use in the San Joaquin Valley. Simultaneously, Reclamation also constructed the Delta Cross Channel to aid in transferring water from the Sacramento River across the Delta to the Jones Pumping Plant. From its inception and formulation, the CVP (inclusive of upstream reservoirs, river and Delta conveyance, the Jones Pumping Plant, Delta-Mendota Canal, and San

Luis Reservoir) was intended to function as an integrated system to deliver and export water, not as a grouping of separate or independent units.

In 1968 the first stage of the Banks Pumping Plant for the SWP was completed with seven units having a combined capacity of 6,400 cfs. In 1973, the California Aqueduct was completed. In 1974 Clifton Court Forebay was completed. In 1991 an additional four pumping units were added, increasing Banks Pumping plant capacity to 10,300 cfs. However, this diversion rate has historically been restricted to 6,680 cfs as a three-day average inflow to Clifton Court Forebay, although between December 15 and March 15, when the San Joaquin River is above 1,000 cfs, pumping in excess of 6680 at a rate equal to one-third of the San Joaquin River flow at Vernalis has historically been permissible. Furthermore, under the EWA, the SWP has been permitted to pump an additional 500 cfs between July 1 and September 30 to offset water costs associated with fisheries actions making the summer limit effectively 7,180 cfs. The Army Corps of Engineers' permit for increased pumping at Banks expired and is no longer authorized. The completion and operation of the Jones and Banks pumping plants have increased Delta water exports (Figure P-18).

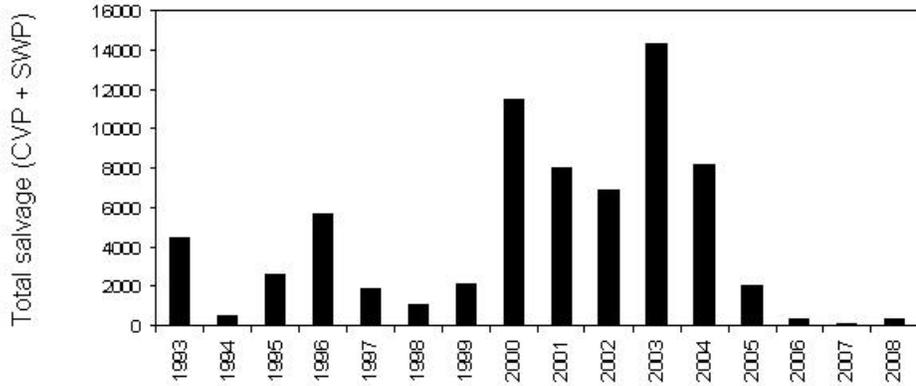
Export of water from the Delta has long been recognized to have multiple effects on the estuarine ecosystem upon which species such as the delta smelt depend (Stevens and Miller 1983; Arthur et al. 1996; Bennett and Moyle 1996). In general, water is conveyed to Jones and Banks via the Old and Middle River channels resulting in a net (over a tidal cycle or tidal cycles) flow towards Jones and Banks. When combined water export exceeds San Joaquin River inflows, the additional water is drawn from the Sacramento River through the Delta Cross Channel, Georgina Slough, and Three-Mile Slough. At high pumping rates, net San Joaquin River flow is toward Banks and Jones (Arthur et al. 1996). Combined flow in the Old and Middle Rivers is measured as "OMR" flows while flow in the San Joaquin River at Jersey Island is calculated as "Qwest" (Dayflow at <http://www.iep.ca.gov/dayflow/>). Flow towards the pumps is characterized as negative flow for both measurements. Further, OMR flow towards the pumps is increased seasonally by installation of the South Delta Temporary Barriers. In particular, the Head of Old River barrier reduces flow from the San Joaquin River downstream into Old River so more water is drawn from the Central Delta via Old and Middle Rivers.

Because large volumes of water are drawn from the Estuary, water exports and fish entrainment at Jones and Banks are among the best-studied sources of fish mortality in the San Francisco Estuary (Sommer et al. 2007). As described in the Project Description, the Tracy Fish Collection Facility (CVP) and the Skinner Fish Facility (SWP) serve to reduce the mortality of fish entrained at Jones and Banks. The export facilities are known to entrain all species of fish inhabiting the Delta (Brown et al. 1996), and are of particular concern in dry years, when the distribution of young striped bass, delta smelt, and longfin smelt shift upstream, closer to the diversions (Stevens et al. 1985; Sommer et al. 1997). As an indication of the magnitude of entrainment effects caused by Banks and Jones, approximately 110 million fish were salvaged at the Skinner Fish Facility screens and returned to the Delta over a 15-year period (Brown et al. 1996). However, this number greatly underestimates the actual number of fish entrained. It does not include losses through the guidance louvers at either facility. For Banks in particular, it does not

account for high rates of predation on fish in CCF (Gingras 1997). Fish less than 30 mm forklength (FL) are not efficiently collected by the fish screens (Kimmerer 2008).

The entrainment of adult delta smelt at Jones and Banks occurs mainly during their upstream spawning migration between December and April (Figure S-7). Entrainment risk depends on the location of the fish relative to the export facilities and the level of exports (Grimaldo et al. accepted manuscript). The spawning distribution of adult delta smelt varies widely among years. In some years a large proportion of the adult population migrates to the Central and South Delta, placing both spawners and their progeny in relatively close proximity to the export pumps and increasing entrainment risk. In other years, the bulk of adults migrate to the North Delta, reducing entrainment risk. In very wet periods, some spawning occurs west of the Delta.

Adult delta smelt salvage (Dec-Mar) by Water year



Adult delta smelt salvage (Dec-Mar) by hydrological variables and turbidity

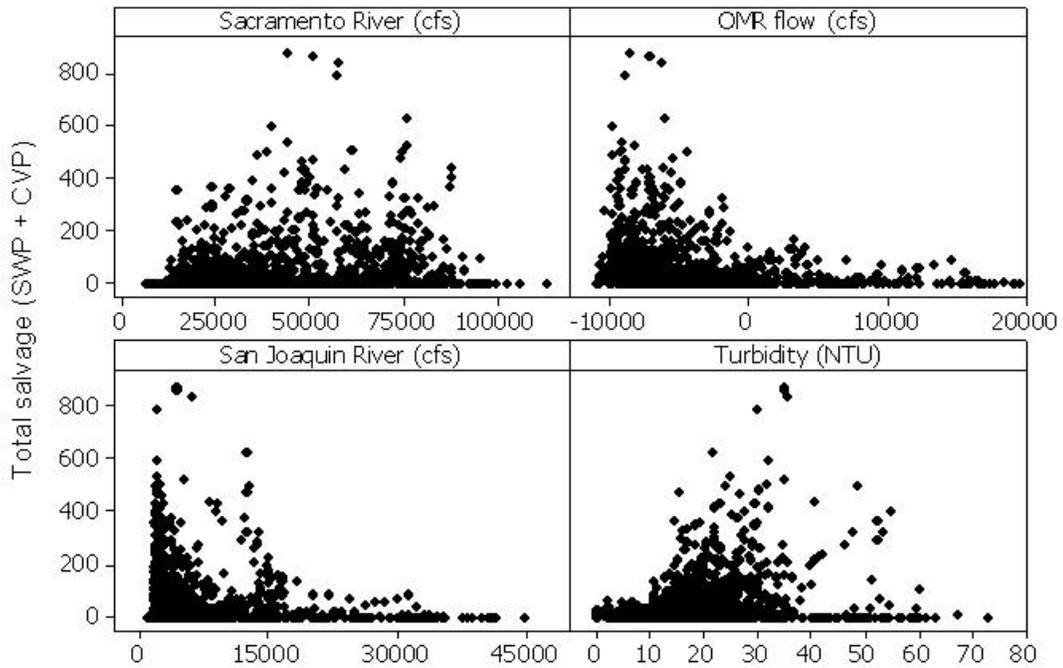
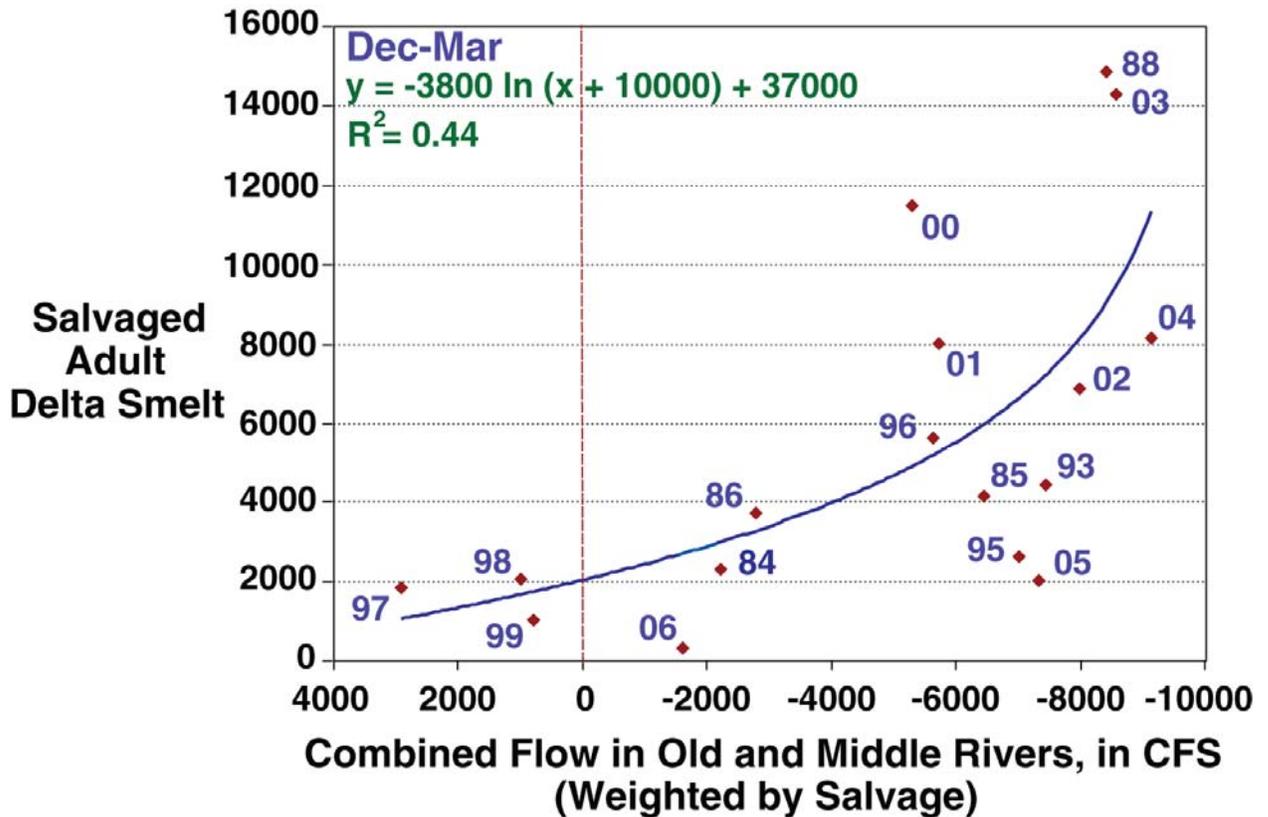


Figure S-7, Adult delta smelt salvage December through March by WY and by hydrological variables and turbidity

The CVP and SWP water operations are thought to have a minor impact on delta smelt eggs because they remain attached to substrates or at least strongly negatively buoyant due to attached sand grains (see Spawning section above). Shortly after hatching, larvae become subject to flow-mediated transport, and are vulnerable to entrainment. However, delta smelt and other fish are not officially counted at Banks or Jones unless they are 20 mm or greater in total length and transitioning to the juvenile stage. Juvenile delta smelt are vulnerable to entrainment and are counted in salvage operations once they reach 20-25 mm in length, but the fish facilities remain inefficient collectors of delta smelt until they surpass 30 mm in length (Kimmerer 2008). Most salvage of juvenile delta smelt occurs from April-July with a peak in May-June (Grimaldo et al, accepted manuscript).

High winter entrainment has been suspected as a contributing cause of both the early 1980s (Moyle et al. 1992) and the POD-era declines of delta smelt (Baxter et al. 2008). To address the increases in winter salvage during 2002-2004, three key issues were evaluated. First, there was an increase in exports during winter as compared to previous years, attributable to the SWP (Figure P-17). Second, the proportion of tributary inflows shifted. Specifically, San Joaquin River inflow decreased as a fraction of total inflow around 2000, while Sacramento River inflow increased (Figure 7-12, Reclamation 2008).

Overall, these operational changes may have contributed to a shift in Delta hydrodynamics that increased fish entrainment. The hydrodynamic change can be indexed using tidally averaged net flows through OMR that integrate changes in inflow, exports, and barrier operations (Monsen et al. 2007, Peter Smith, USGS, unpublished data). Several analyses have revealed strong, non-linear inverse relationships between net OMR flow and winter salvage of delta smelt at the Banks and Jones (Fig. 7-6 in Reclamation 2008; P. Smith, unpublished data; Grimaldo et al accepted manuscript; Kimmerer 2008) (See Figure S-8). While the specific details of these relationships vary by species and life stage, net OMR flow generally works very well as a binary switch: negative OMR is associated with some degree of entrainment, while positive OMR is usually associated with no, or very low, entrainment. Particle tracking modeling (PTM) also shows that entrainment of particles and residence time is highly related to the absolute magnitude of negative OMR flows, and that the zone of influence of the pumps increases as OMR becomes more negative. The rapid increase in the extent of the zone of entrainment at high negative OMR likely accounts for the faster-than-linear increase in entrainment as OMR becomes more negative. Adult delta smelt do not behave as passive particles, but they still use tidal flows to seek suitable staging habitats prior to spawning. When the water being exported is suitable staging habitat, for instance, when turbidity is > 12 NTU, delta smelt do not have a reason to avoid net southward transport toward the pumps so the OMR/entrainment relationship reinforces that tidally averaged net flow is an important determinant of the migratory outcome for delta smelt.



Note: Data shown are for the period 1984-2007, excluding years 1987, 1989-92, 1994, and 2007 that had low (<12ntu) average water turbidity during Jan-Feb at Clifton Court Forebay.

Figure S-8 – Relationship for the total number of adult delta smelt salvaged at the State and Federal fish facilities in the south Delta during the winter months of December through March with the combined, tidally averaged flow in Old and Middle Rivers near Bacon Island (AVG_OMR_i).

PTM that simulates water movement using particles injected at various stations in the Delta gives a fairly good representation of the relative likelihood of larval and juvenile delta smelt entrainment (Kimmerer 2008; Kimmerer and Nobriga 2008). Predicted entrainment is high for the San Joaquin River region given recent winter and spring operations. Depending on Delta conditions, up to 70 percent of small organisms in the Old River south of Franks Tract would be entrained within 30 days at moderate flows in San Joaquin River and an OMR of negative 3,000 cfs (SWG notes 2008). Ten to twenty percent of larval delta smelt located in the San Joaquin River at Fisherman’s Cut would be expected to be entrained during the same period and OMR flows. This percentage increases to about 30 percent if OMR net flow is negative 5,000 cfs (DWR March 4, 2008, PTM runs: <http://www.fws.gov/sacramento/>).

Larvae are not currently sampled effectively at the fish-screening facilities and very small larvae (< 15-20 mm) are not sampled well by IEP either. Kimmerer and Nobriga (2008) and Kimmerer (2008) addressed larval delta smelt entrainment by coupling PTM with 20-mm survey results to estimate historical larval entrainment. These approaches suggest

that larval entrainment losses could exceed 50 percent of the population if low flow and high export conditions coincide with a spawning distribution that includes the San Joaquin River. Although this does not occur every year, the effect of larval entrainment is substantial when it does. Since delta smelt are an annual fish, one year with distribution within the footprint of entrainment by the pumps can lead to a serve reduction in that year's production. In order to minimize the entrainment of undetected larval delta smelt, export reductions have recently focused on the time period when larval smelt are thought to be in the South Delta (based on adult distributions) to proactively protect these fish.

Salvage of delta smelt has historically been greatest in drier years when a high proportion of young of the year (YOY) rear in the Delta (Moyle et al. 1992; Reclamation and DWR 1994; and Sommer et al. 1997). In recent years however, salvage also has been high in moderately wet conditions (Nobriga et al. 2000; 2001; Grimaldo et al., accepted manuscript: springs of 1996, 1999, and 2000) even though a large fraction of the population was downstream of the Sacramento-San Joaquin River confluence. Nobriga et al. (2000; 2001) attributed recent high wet year salvage to a change in operations for the VAMP that began in 1996. The VAMP provides a San Joaquin River pulse flow from mid-April to mid-May each year that probably improves rearing conditions for delta smelt larvae and also slows the entrainment of fish rearing in the Delta. The high salvage events may have resulted from smelt that historically would have been entrained as larvae and therefore not counted at the fish salvage facilities growing to a salvageable size before being entrained. However, a more recent analysis provides an additional explanation. Delta smelt salvage in 1996, 1999, and 2000 was not outside of the expected historical range when three factors are taken into account, (1) delta smelt distribution as indexed by X2, and (2) delta smelt abundance as indexed by the TNS. Herbold, B. et al. (unpublished:

http://198.31.87.66/pdf/ewa/EWA_Herbold_historical_patterns_113005.pdf) showed that salvage during 2003 through 2005 was relatively high compared to previous years given the low abundance indicated by the FMWT index (Figure S-9). Therefore, it is uncertain that operations changes for VAMP have influenced delta smelt salvage dynamics as suggested by Nobriga et al. (2000). In addition, assets from the EWA are often used during this time of year to further reduce delta smelt entrainment, though the temporary export curtailments from EWA have not likely decreased delta smelt entrainment by more than a few percent (Brown et al. 2008). Although the population level benefits of these actions are ultimately sometimes minor, they have been successful at keeping delta smelt salvage under the limits set in the Service's OCAP biological opinions (Brown and Kimmerer 2002).

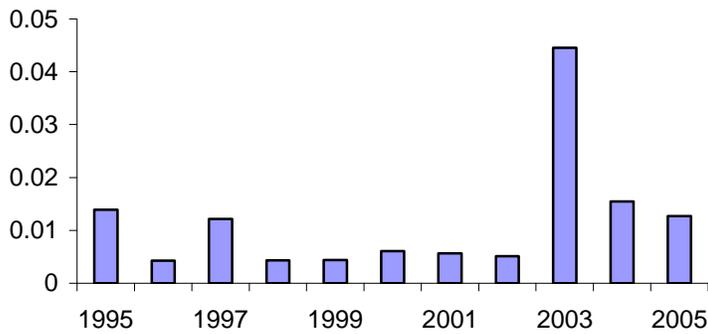


Figure S-9. Ratio of salvage density to the previous FMWT index.

In 2007 and 2008, CVP and SWP implemented actions to reduce entrainment at the pumps, including maintaining higher (less negative) OMR flows (Smelt Working Group Notes and Water Operations Management Team Notes at <http://www.fws.gov/>). During these two years estimated number of delta smelt salvaged decreased considerably. Estimated adult salvage was 60 and 350 in 2007 and 2008, respectively. Total (adults and young-of-the-year) estimated salvage was 2,327 and 2,038 delta smelt, respectively. These were down from a high of 14,338 in 2003.

Environmental Water Account

The EWA, as described in the Project Description, was established in 2000. The EWA agencies acquired assets and determined how the assets should be used to benefit the at-risk native fish species of the Bay-Delta estuary. The EWA reduced diversions of water at Banks and Jones when listed fish species were present in the Delta and prevented the uncompensated loss of water to SWP and CVP contractors. Typically the EWA replaced water lost due to curtailment of pumping by purchase of surface or groundwater supplies from willing sellers and by taking advantage of regulatory flexibility and certain operational assets. These assets were moved through the Delta during the summer and fall, when entrainment effects to listed fish were minimal.

Generally, under past actions, the EWA has reduced water exports out of the Delta during the winter and spring and increased exports during the summer and early winter. These actions reduced entrainment at the facilities, but only by modest amounts (Brown et al. 2008). The movement of water in the summer and fall may have negatively influenced habitat suitability and prey availability (see effects section).

500 cfs Diversion at Banks

This operation allowed the maximum allowable daily diversion rate into CCF during the months of July, August, and September to increase from 13,870 AF to 14,860 AF and three-day average diversions from 13,250 AF to 14,240 AF. The increase in diversions was permitted by the U.S. Army Corps of Engineers and has been in place since 2000.

The current permit expired on September 30, 2008 and DWR is currently seeking an extension.

The purpose of this diversion increase into CCF was for the SWP to recover export reductions made due to the ESA or other actions like the EWA taken to benefit fisheries resources. This increased capacity allowed EWA assets to be moved through the Delta during the summer, when entrainment of listed species was minimal. This additional diversion rate was included as part of the EWA operating principles. This additional pumping occurred during the summer and likely did not result in much direct entrainment of delta smelt, but did likely result in entrainment of food for delta smelt, such as *Pseudodiaptomus* and contributed to lower habitat suitability as summer-fall export to inflow ratios increased to high levels regardless of preceding winter-spring flows.

CVP/SWP Actions Taken since the 2005 OCAP Biological Opinion was Issued

After the issuance of the 2005 biological opinion, the SWG used the DSRAM (Attachment A) to provide guidance for when the group needed to meet to analyze the most recent real-time delta smelt abundance and distribution data. Using the latest data, the SWG then determined if a recommendation to the Service to protect delta smelt from excessive entrainment was warranted. For the 2006 WY, a wet WY, based on the Service's recommendations, the Projects reduced exports to protect delta smelt by operating to an E/I ratio limit. The export curtailment operated to an E/I ratio of 15 percent beginning January 3 until February 21, 2006, when the E/I was expected to increase above 20 percent due to wet hydrologic conditions. No further actions were taken to protect fish that season as the E/I ratio was maintained at about 10 percent because of high spring flows. VAMP was implemented in May 2006, although the HORB was not installed due to high flows on the San Joaquin River.

For the 2007 WY, a dry year, the Service recommended a winter pulse flow increasing OMR flows to a daily average of negative 3500 cfs or if there were not Sacramento River flows above 25,000 cfs for three days, to moderate OMR to a range of negative 5000 cfs to negative 3500 cfs until February 15th. This action was implemented by the Projects, but since the Sacramento River never achieved 25,000 cfs for three days, the Projects operated to not exceed a 5-day average OMR flow of negative 4,000 cfs starting on January 15. To protect pre-spawning adult delta smelt from becoming entrained and based on the Service's recommendation, the Projects maintained OMR above negative 4,000 cfs and on March 13 the Project operated to a 5-day average OMR of negative 5,000 cfs.

To protect larval and juvenile delta smelt from entrainment the Projects operated the export facilities to achieve a non-negative daily net OMR flow. The Projects implemented the following actions: reduced combined Banks and Jones exports from 1,500 cfs to combined 1,200 cfs (850 cfs at the CVP and 350 cfs at the SWP) and evaluated increasing New Melones releases to 1,500 cfs for steelhead emigration. VAMP was then implemented and the HORB was removed on May 15. The South Delta agricultural barriers maintained their flap gates in the open position and Reclamation increased exports from 850 cfs to 1,200 cfs on June 13 while DWR maintained an export level of 400 cfs.

Water Year 2008 Interim Remedial Order Following Summary Judgment and Evidentiary Hearing (Wanger Order)

For the 2008 WY, a dry WY, the Service, Reclamation and DWR implemented the direction contained in the Wanger Order.

A modified Adaptive Process was used during 2008. The SWG continued to use the DSRAM to identify the most recent delta smelt data and to help and provide a framework for the level of protection needed to protect delta smelt from entrainment. The SWG provided guidance to the Service, who then made a recommendation to WOMT. If WOMT did not agree to the Service's determination, WOMT would develop a counter proposal which was then sent back to Service, who would decide if WOMT's action was adequate to protect delta smelt or if the Service's original determination should be implemented instead.

For 2008, the first action to protect delta smelt was a 10-day winter pulse flow that was implemented based on a turbidity trigger. The turbidity trigger was exceeded on December 25 and by December 28, the CVP and SWP began to operate such that a daily OMR flow would not be more negative than 2,000 cfs. This action was completed on January 6, 2008.

Second, OMR flow was limited to provide a net daily upstream OMR flow not to exceed 5,000 cfs to protect pre-spawning adult delta smelt from entrainment. This flow was calculated based on a 7-day running average. On January 7, 2008, immediately following the termination of the 10-day winter pulse flow, the CVP and SWP started to operate to achieve an average net upstream flow in OMR not to exceed 5,000 cfs over a 7-day running average period.

Next, OMR was limited to provide a net daily net upstream OMR flow of 750 to 5000 cfs to protect larval and juvenile delta smelt. These flows were determined by the Service, in consultation with Reclamation and DWR, on a weekly basis and were based upon the best available scientific and commercial information concerning delta smelt distribution and abundance. The Service used a control point method using PTM to limit predicted entrainment at Station 815 to 1 percent. When delta smelt abundances are low (the 2007 delta smelt FMWT Index was 28), the control point method is an appropriate method to protect delta smelt from entrainment at Banks and Jones. This is due in part because when delta smelt abundance is low, an accurate delta smelt distribution may not be determined from survey results. The control point method also sets a limit of entrainment from the Central Delta and it does not need distributional data to be protective. The CVP and SWP maintained OMR flow between -2000 and -3000 cfs, with an OMR flow agreed upon each week until June 20 (details on the OMR flow for each week can be found on the Sacramento Fish and Wildlife's website at http://www.fws.gov/sacramento/Delta_popup.htm). The CVP and SWP also implemented VAMP during this period, with San Joaquin River flows of 3,000 cfs and 1,500 cfs export flows. The HORB was not installed in 2008 and the SDTB maintained their flap gates in the open position.

Water Transfers

As described in the Project Description, purchasers of water for transfers have included Reclamation, DWR, SWP contractors, CVP contractors, other State and Federal agencies, or other parties. To date, transfers requiring export from the Delta have been done at times when pumping and conveyance capacity at Banks or Jones is available to move the water. Exports for transfers can not infringe upon the capability of the Projects to comply with the terms of SWQCP D-1641 and the existing biological opinions. Parties to the transfer are responsible for providing for any incremental changes in flows required to protect Delta water quality standards. All transfers have been in accordance with all existing regulations and requirements. Recent transfer amounts were 1,000 TAF in 2001-02, 608 TAF in 2002-03, 700 TAF in 2003-04, and 851 TAF in 2004-05 (DWR website: <http://www.watertransfers.water.ca.gov>). Generally, water transfers occur in the summer (July-September), when entrainment of listed fish is minimized. Most transfers have occurred at Banks because reliable capacity is generally only available at Jones in the driest 20 percent of years.

Article 21 and changes to Water Deliveries to Southern California

Changes in pumping in accordance with Article 21 and the associated changes in water deliveries have lead to recent increases in SWP water exports from the Delta. Article 21 deliveries are made when San Luis Reservoir is physically full or projected to be full and may result in export levels that are higher than if Article 21 was not employed. Recent changes in how Article 21 is invoked and used have increased the amount of Article 21 and Table A SWP water that has been pumped from the Delta.

Diamond Valley Lake was completed in 1999 and provided Metropolitan Water District of Southern California (MWDSC) an additional location for water storage in Southern California. Diamond Valley Lake holds 800,000 acre-feet of water, which makes it the largest reservoir in Southern California. MWDSC began filling the reservoir in November 1999 and the lake was filled by early 2002. Another factor involving water deliveries in southern California that changed Delta diversions is the Quantification Settlement Agreement (QSA) signed in 2003, which resulted in a decrease in the amount of Colorado River water available to California.

Since 1999, MWDSC was filling Diamond Valley Lake and adding water to groundwater storage programs. Generally, in wetter years, demand for imported water decreases because local sources are augmented and local rainfall reduces irrigation demands. However, with the increased storage capacity in Southern California, the recent wet years did not result in lower exports from the Delta or the Colorado River. Table P-12 illustrates the demands for imported water during the recent wet years and the effect of reduced Colorado River diversions under the QSA on MWDSC deliveries from the Delta.

Vernalis Adaptive Management Plan

As described in the project description, VAMP was initiated in 2000 as part of the SWRCB D- 1641. VAMP schedules and maintains pulse flows in the San Joaquin River and reduced exports at Banks and Jones for a one month period, typically from April 15-May 15 (May 1-31 in 2005/06). Tagged salmon smolts released in the San Joaquin River are monitored as they move through the Delta in order to determine their fate. While

VAMP-related studies attempt to limit CVP and SWP impacts to salmonids, the associated reduction in exports reduces the upstream flows that occur in the South and Central Delta. This reduction limits the southward draw of water from the Central Delta, and thus reduces the Projects' entrainment of delta smelt.

Based on Bennett's unpublished analysis, reduced spring exports resulting from VAMP have selectively enhanced the survival of delta smelt larvae spawned in the Central Delta that emerge during VAMP by reducing their entrainment. Initial otolith studies by Bennett's lab suggest that these spring-spawned fish dominate subsequent recruitment to adult life stages. By contrast, delta smelt spawned prior to and after the VAMP have been poorly-represented in the adult stock in recent years. The data suggests that the differential fate of early, middle and late cohorts affects sizes of delta smelt in fall because the later cohorts have a shorter growing season. These findings suggest that direct entrainment of larvae and juvenile delta smelt during the spring are relevant to population dynamics.

Other SWP/CVP Facilities

North Bay Aqueduct

The North Bay Aqueduct (NBA) diverts Sacramento River water from Barker Slough through Lindsay Slough. The 1995 OCAP biological opinion included monitoring delta smelt at the three stations in Barker Slough and the surrounding areas on a "recent-time" (within 72 hours) basis, and the posting of delta smelt information on the internet so that interested parties can use the information for water management decisions.

DWR contracted with DFG for the monitoring from 1995-2004 to estimate and evaluate larval delta smelt loss at the NBA due to entrainment, and to monitor the abundance and distribution of larval delta smelt in the Cache Slough complex and near Prospect Island. The sampling season for this monitoring was mid-February to mid-July with high priority stations (Barker and Lindsey Sloughs) sampled every two days and the remaining stations (Cache and Miner sloughs, and the Sacramento Deep Water Channel) sampled every four days.

NBA pumping was regulated by a weighted mean of the actual catch of delta smelt at the three Barker Slough stations. The weight assigned to each station was dependent on its proximity to the NBA intake. Station 721 had a 50 percent weighting, 727 had a 30 percent weighting and station 720 had a 20 percent weighting. As stated in the Service's 1995 OCAP biological opinion, the diversions at NBA were restricted to a 5-day running average of 65 cfs for five days when delta smelt were detected. In mathematical terms, the NBA restrictions were in place when the following equation was true:

$$0.5*(\text{Catch at 721}) + 0.3*(\text{Catch at 727}) + 0.2*(\text{Catch at 720}) \geq 1.0$$

An entrainment estimate was then calculated as the weighted mean density of delta smelt multiplied by the total water exported for the sampling day and the day after. Based on this method, estimated annual entrainment of delta smelt at NBA was as follows: 1995 = 375; 1996 = 12,817; 1997 = 18,964; 1998 = 1,139; 1999 = 1,578; 2000 = 10,650; 2001 = 32,323; 2002 = 10,814; 2003 = 9,978; and 2004 = 8,246. However, a study of a fish

screen in Horseshoe Bend built to delta smelt standards excluded 99.7 percent of fish from entrainment even though most of these were only 15-25 mm long (Nobriga et al. 2004). Thus, the fish screen at NBA may protect many of the delta smelt larvae that do hatch and rear in Barker Slough, so actual entrainment was probably lower.

In the Service's 2005 OCAP biological opinion, a broader larval smelt survey was included in the Project Description in lieu of the NBA monitoring. This change was suggested due to the low numbers of delta smelt caught in the NBA monitoring and it was thought that a broader sampling effort would be more helpful in determining where larval delta smelt are located. This broader monitoring effort was conducted during the spring of 2006, and used a surface boom tow at the existing 20-mm survey stations. The sampling was successful, and helped show that larval delta smelt could be caught in the Delta. However, this monitoring was not continued after 2006. Starting in 2009, an expanded larval survey in the Delta will be conducted. As discussed above, the number of delta smelt entrained at the NBA is unknown, but it may be low so long as the fish screen is maintained properly. There may be years, however, that large numbers of delta smelt are in the Cache Slough complex and could be subject to the entrainment at the NBA.

Contra Costa Water District (CCWD)

CCWD diverts water from the Delta for irrigation and municipal and industrial uses in the Bay Area. CCWD's system includes intake facilities at Mallard Slough, Rock Slough, and Old River near State Route 4; the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir as described in the Project Description. The total diversion by CCWD is approximately 127 TAF per year. Most CCWD diversions are made through facilities that are screened; the Old River (80 percent of CCWD diversions) and Mallard Slough (3 percent of CCWD diversions) facilities have fish screens to protect delta smelt. However, the fish screens on these facilities may not protect larval fish from becoming entrained. For that reason, in part, there are also no-fill and no-diversion periods at the CCWD facilities.

Before 1998, the Rock Slough Intake was CCWD's primary diversion point. It has been used less since 1998 when Los Vaqueros Reservoir and the Old River Pumping Plant began operating and now only accounts for 17 percent of CCWD's diversions. To date, the Rock Slough Intake is not screened. Reclamation, as described in the Project Description, is responsible for constructing a fish screen at this facility under the authority of the CVPIA. Reclamation has received an extension for construction of the screen until 2008 and is seeking a further extension until 2013. The diversion at the Rock Slough Intake headworks structure is currently sampled with a sieve net three times per week from January through June and twice per week from July through December. A plankton net is fished at the headworks structure twice per week during times when larval delta smelt could be present in the area (generally March through June). A sieve net is fished at Pumping Plant #1 two times per week from the time the first Sacramento River winter-run Chinook salmon is collected at the Jones and Banks (generally January or February) through June. The numbers of delta smelt entrained by the facility since 1998 have been extremely low, with only a single fish observed in February 2005 (Reclamation 2008).

Other Delta Diversions and Facilities

In 2006, the Service issued a biological opinion on the construction and operation of the Stockton Delta Water Supply Facility located on Empire Tract along the San Joaquin River. This facility is expected to be completed and online by 2010. The maximum diversion rate for this facility will be 101 AF per day. Fish screens and pumping restrictions in the spring are expected to considerably limit entrainment of delta smelt. However, limited pumping will occur during the spring and the fish screens are not expected to fully exclude fish smaller than 20 mm TL, so delta smelt may be entrained at this facility.

There are 2,209 known agricultural diversions in the Delta and an additional 366 diversions in Suisun Marsh used for enhancement of waterfowl habitat (Herren and Kawasaki 2001). The vast majority of these diversions do not have fish screens to protect fish from entrainment. It has been recognized for many years that delta smelt are entrained in these diversions (Hallock and Van Woert 1959). Determining the effect of this entrainment has been limited because previous studies either (1) did not quantify the volumes of water diverted (Hallock and Van Woert 1959, Pickard et al. 1982) or (2) did not sample at times when, or locations where, delta smelt were abundant (Spaar 1994, Cook and Buffaloe 1998). Delta smelt primarily occur in large open-water habitats, but early life stages move downstream through Delta channels where irrigation diversions are concentrated (Herren and Kawasaki 2001). At smaller spatial scales, delta smelt distribution can be influenced by tidal and diel cycles (Bennett et al. 2002), which also may influence vulnerability to shore-based diversions.

In the early 1980s, delta smelt were commonly entrained in the Roaring River diversion in Suisun Marsh (Pickard et al. 1982), suggesting that it and similar diversions can adversely affect delta smelt. However, delta smelt may not be especially vulnerable to many Delta agricultural diversions for several reasons. First, adult delta smelt move into the Delta to spawn during winter-early spring when agricultural diversion operations are at a minimum. Second, larval delta smelt only occur transiently in most of the Delta and now avoid the South Delta during summer when diversion demand peaks. Third, Nobriga et al. (2004) examined delta smelt entrainment at an agricultural diversion in Horseshoe Bend during July 2000 and 2001, when much of the YOY population was rearing within one tidal excursion of the diversion. Delta smelt entrainment was an order of magnitude lower than density estimates from the DFG 20-mm Survey. Low entrainment was attributed to the offshore distribution of delta smelt, and the extremely small hydrodynamic influence of the diversion relative to the channel it was in. Because Delta agricultural diversions are typically close to shore and probably take small amounts of water relative to what is in the channels they draw water from, delta smelt vulnerability may be low despite their small size and their poor performance near simulated fish screens in laboratory settings (Swanson et al. 1998; White et al. 2007).

The impact on fish populations of individual diversions is likely highly variable and depends upon size, location, and operations (Moyle and Israel 2005). Given that few studies have evaluated the effectiveness of screens in preventing losses of fish, much less declines in fish populations, further research is needed to examine the likely population-level effects of delta smelt mortality attributed to agricultural diversions (Nobriga et al.

2004; Moyle and Israel 2005). Note however, that most of the irrigation diversions are in the Delta, so low flow conditions that compel delta smelt to rear in the Delta fundamentally mediate loss to these irrigation diversions. PTM evidence for this covariation of Delta hydrodynamics and cumulative loss to irrigation diversions was provided by Kimmerer and Nobriga (2008).

Delta Power Plants

There are two major power plants located near the confluence of the Sacramento and San Joaquin Rivers. The upstream-most facility is commonly referred to as the Contra Costa Power Plant while the downstream-most facility is commonly referred to as the Pittsburg Power Plant. Both facilities are located in the low salinity rearing habitats of delta smelt. The following assessment of the Contra Costa and Pittsburg Power Plants comes from information collected by Matica and Sommer (2005).

The Contra Costa Power Plant is located 2.5 miles upstream from the city of Antioch. The first units were operational in June 1951. By 1975, with expansions, the power plant incorporated 7 main power-generating units and 3 smaller house units. In 1995, Units 1-5 were decommissioned. When all units were operating, the cooling water flows into Units 1-5 and Units 6-7 were up to 946 and 681 cfs, respectively. Cooling water was diverted by two separate intake arrangements. Water for Units 1-5 was taken from near the river bottom 410 feet offshore and for Units 6-7 from a shoreline intake system. Water was carried at 3.8 ft/sec to five recessed onshore traveling trash screens, with 3/8-inch square-opening wire mesh. Calculated screen approach velocities averaged about 1.3 ft/sec with velocities of 2.0 ft/sec through the mesh. Discharge canals return the heated water to the river. For Units 1-5 water was returned 750 ft west of its uptake and for Units 6-7 it is returned 750 ft east of its uptake. Under normal full-load operation the temperature of the discharge water was raised a mean of 16.2 °F and at peak loads the maximum differential between intake and discharge temperature was 21 °F, creating a thermal plume, concentrated near the surface and shoreline, extending over an area of approximately 100 acres.

The Pittsburg Power Plant is located on the south shore of Suisun Bay just west of Pittsburg. This steam generation plant consists of 7 power generating units. Construction began in 1953 and the 7 units were commissioned in 3 phases: Units 1-4 in 1954; Units 5 and 6 in 1960; and Unit 7 in 1961. Units 1-6 withdraw and return cooling water to Suisun Bay. Their intake structures are located on the shoreline about 1,000 feet to the west of the discharge structure. Discharge is located 10-30 feet offshore in about 10 feet of water. Total cooling water flow for Units 1-6 when all pumps are running is 1,612 cfs. Entrainment effects may occur at the plants from large pressure decreases across the condenser at both power plants, and impingement on fish screens.

Overall, the total maximum non-consumptive intake of cooling water for the two facilities is 3,240 cfs, which can exceed 10 percent of the total net outflow of the Sacramento and San Joaquin rivers, depending on hydrology. However, pumping rates are often significantly lower under normal operation. Potential impacts to aquatic species include chemical and thermal pollution, and entrainment. Chemical impacts may occur as a result of chlorination for control of “condenser slime”, which was historically

conducted weekly. This treatment at Contra Costa Power Plant consumed a little over 1 ton of chlorine a month, or 13 tons per year. The discharge water was not historically dechlorinated or subject to regular monitoring for residual chlorine.

Thermal pollution represents an additional concern for aquatic species. Temperature objectives set by the California Regional Water Quality Control Board include: “No discharge shall cause a surface water temperature rise greater than 4 °F above the natural temperature of the receiving water at any time or place”; and “The maximum temperature of thermal waste discharge shall not exceed 86 °F.” Both plants discharge water at temperatures in excess of 86 °F 10 percent of the time, and surface water temperature plumes in the receiving water at each plant exceed +4 °F for areas up to 100 acres. The previous owner of these two plants, Pacific Gas and Electric (PG&E), sought and received exemptions to the above limitations.

In 1951, DFG recognized the power plants presented a potential issue for the salmon and striped bass resources of the area as both plants were originally equipped with inefficient fish barriers. At the time, DFG estimated that as many as 19 million small striped bass might pass through the Contra Costa plant and be killed each year between April and mid-August. As a result of these concerns, DFG and PG&E conducted a monitoring study to evaluate entrainment. In 1979, consultants estimated the total average annual entrainment to be 86 million smelt (delta smelt and longfin smelt not differentiated). The total average annual impingement was estimated to be 178,000 smelt. It’s unclear whether these numbers are relevant to current entrainment trends. Further, power plant operations have been reduced such that the plants only operate to meet peak power needs. The current owner of the power plants, Mirant, is currently undergoing a monitoring program that is sampling entrainment and impingement at the Contra Costa and Pittsburg powerplants to compile more recent information on how many delta smelt are affected by the two plants.

Delta Cross Channel

When the DCC is open, water flows from the Sacramento River through the cross channel to channels of the lower Mokelumne and San Joaquin Rivers toward the Central Delta. The closures for salmonid protection, as described in the Project Description, are likely to create more natural hydrologies in the Delta, by keeping Sacramento River flows in the Sacramento River and in Georgiana Slough, which may provide flow cues for migrating adult delta smelt. Larval and juvenile delta smelt are probably not strongly affected by the DCC if it is closed or open. Previous PTM modeling done for the SWG has shown that having the DCC open or closed does not significantly affect flows in the Central Delta (Kimmerer and Nobriga 2008). There could be times, however, when the DCC closure affects delta smelt by generating flows that draw them into the South Delta.

South Delta Temporary Barriers

The SDTB was initiated by DWR in 1991. The U.S. Army Corps of Engineers (Corps) permit extensions for this project were granted in 1996 and again in 2001, when DWR obtained permits to extend the Project through 2007. The Service has approved the extension of the permits through 2008. Continued coverage by Service for the SDTB will

be assessed in this biological opinion for the operational effects and under a separate Section 7 consultation for the construction and demolition effects.

Under the Service's 2001 biological opinion for the SDTB, operation of the barriers at Middle River and Old River near Tracy can begin May 15 or as early as April 15 if the spring barrier at the head of Old River is in place. From May 16 to May 31 (if the barrier at the head of Old River is removed) the tide gates are tied open in the barriers in Middle River and Old River near Tracy. After May 31, the barriers in Middle River, Old River near Tracy, and Grant Line Canal are permitted to be operational until they are completely removed by November 30.

During the spring, the HORB is designed to reduce the number of out-migrating salmon smolts entering Old River. During the fall, this barrier is designed to improve flow and DO conditions in the San Joaquin River for the immigration of adult fall-run Chinook salmon. The HORB is typically in place from April 15 to May 15 in the spring, and from early September to late November in the fall. Installation and operation of the barrier also depends on San Joaquin River flow conditions.

The SDTB cause changes in the hydraulics of the Delta that affect fish. The SDTB cause hydrodynamic changes within the interior of the Delta. When the HORB is in place, most water flow is effectively blocked from entering Old River. This, in turn, increases the flow to the west in Turner and Columbia cuts, two major Central Delta channels that flow toward Banks and Jones.

Suisun Marsh Salinity Control Gates

When Delta outflow is low to moderate and the SMSCG are not operating, tidal flow past the gates is approximately +/- 5,000-6,000 cfs while the net flow is near zero. When these gates are operated, flood tide flows are arrested while ebb tide flows remain in the range of 5,000-6,000 cfs. The net flow moves into Suisun Marsh via Montezuma Slough at approximately 2,500-2,800 cfs. The Army Corps of Engineers permit for operating the SMSCG requires that it be operated between October and May only when needed to meet Suisun Marsh salinity standards set forth in SWRCB D-1641. Historically, the gates have been operated as early as October 1, while in some years (e.g., 1996) the gates were not operated at all. When the channel water salinity decreases sufficiently below the salinity standards, or at the end of the control season, the flashboards are removed and the gates are raised to allow unrestricted fish movement through Montezuma Slough.

The approximately 2,800 cfs net flow induced by SMSCG operation is effective at repelling the salinity in Montezuma Slough. Salinity is reduced by roughly one-hundred percent at Beldons Landing, and lesser amounts further west along Montezuma Slough. At the same time, the salinity field in Suisun Bay moves upstream as net Delta outflow is reduced by SMSCG operation. Net outflow through Carquinez Strait is not demonstrably affected.

It is important to note that historical gate operations (1988-2002) were much more frequent than recent and current operations (2006-May 2008). Operational frequency is affected by many factors (e.g., hydrologic conditions, weather, Delta outflow, tide, fishery considerations, etc). The gates have also been operated for scientific studies.

Salmon passage studies between 1998 and 2003 increased the number of operating days by up to 14 to meet study requirements. After discussions with NMFS based on study findings, the boat lock portion of the gates are now held open at all times during SMSCG operation to allow for continuous salmon passage opportunity. With increased understanding of the effectiveness of the gates in lowering salinity in Montezuma Slough, salinity standards have been met with less frequent gate operation since 2006. Despite very low outflow in the fall of the two most recent WYs, gate operation was not required at all in fall of 2007 and was limited to 17 days in the winter 2008. When the SMSCG are operated or closed frequently, delta smelt may become trapped behind the gates in Montezuma Slough, which may prevent delta smelt from migrating upstream into the Delta to spawn. Salinity changes in Montezuma Slough could also affect delta smelt by changing or masking flow cues in the Delta which delta smelt use to migrate. However, the recent reduced operations likely have resulted in few adverse effects to delta smelt, since the reduced closures have minimized the migration blockage and salinity changes.

Upstream Diversion and Reservoir Operations

Construction and operation of reservoirs and water delivery systems upstream of the Delta, including CVP and SWP reservoirs, have changed the historical timing and quantity of flows through the Delta. The past and current operations of upstream diversions and reservoirs combined with the Delta water diversions affect the net Delta outflow and the location of the LSZ.

Delta smelt lives its entire life in the tidally-influenced fresh- and brackish waters of the San Francisco Estuary (Moyle 2002). It is an open-water species and does not associate strongly with structure. It may use nearshore habitats for spawning, but free-swimming life stages mainly occupy offshore waters. Thus, the population is strongly influenced by river flows because the quantity of fresh water flowing through the estuary changes the amount and location of suitable low-salinity, open-water habitat (Feyrer et al. 2007; Nobriga and Herbold 2008). Outflow plays a prominent role in delta smelt population dynamics year-round (Nobriga and Herbold 2008). X2 is an indicator of delta outflow (Jassby et al. 1995) and a useful metric by which to determine effects on delta smelt distribution and habitat suitability.

Trinity River

The Trinity River Division includes facilities to divert water to the Sacramento River Basin. The mean annual inflow to Trinity Lake from the Trinity River is about 1.2 MAF per year. Historically, an average of about two-thirds of the annual inflow has been diverted to the Sacramento River Basin (1991-2003).

Diversion of Trinity water to the Sacramento Basin provides limited water supply and hydroelectric power generation for the CVP and assists in water temperature control in the Trinity River and upper Sacramento River. The seasonal timing of Trinity exports is a result of determining how to make best use of a limited volume of Trinity export (in concert with releases from Shasta) to help conserve cold water pools and meet

temperature objectives on the upper Sacramento and Trinity rivers, as well as power production economics.

The diversions from the Trinity River have been reduced in recent years after the Trinity River Main-stem Fishery Restoration ROD, dated December 19, 2000, which mandated 368,600 to 815,000 AF is allocated annually for Trinity River flows. This amount is scheduled in coordination with the Service to best meet habitat, temperature, and sediment transport objectives in the Trinity Basin. These higher flows in the Trinity River system mean less water diverted to the Sacramento River. This reduced water results in less flexibility in releases for Sacramento River flows and can result in increased releases from Shasta Lake.

Seasonal Life History of Delta Smelt

Winter (December-February)

Adult delta smelt are generally distributed in low salinity habitats of the greater Suisun Bay region and the Sacramento and San Joaquin River confluence during fall. Variation in outflow appears to initiate their migration from Suisun Bay upstream to freshwater habitats for spawning. This is because initial catches upstream normally occur in close association with increased turbidity associated with the first strong flow pulse of the winter (Grimaldo et al. accepted manuscript). As a result, entrainment of adult delta smelt at Banks and Jones is also closely associated with factors controlled by outflow or X2 (Grimaldo et al. accepted manuscript). Specifically, salvage of adult delta smelt is significantly negatively associated with flows in OMR flows, and when the flows are highly negative the starting location of the fish indexed by X2 the month prior to entrainment also has an effect (Grimaldo et al. accepted manuscript).

Outflow during winter also affects the entrainment of early-spawned larvae when their distribution is within the hydrodynamic zone affected by pumping operations (Kimmerer 2008). Winter outflow also affects the distribution of spawning fish in major regions. For example, the Napa River is used for spawning only in years when outflow is sufficient to connect the Napa River with low salinity habitat in the estuary (Hobbs et al. 2007).

Spring (March-May)

During spring, YOY delta smelt generally move from upstream spawning locations downstream into low salinity rearing habitats. There is some evidence that recruitment variability of delta smelt may have sometimes responded to springtime flow variation (Herbold et al. 1992; Kimmerer 2002). For example, the number of days X2 is in Suisun Bay during spring is weakly positively correlated with abundance as measured by the FMWT index. However, the weight of evidence suggests that delta smelt abundance does not statistically respond to springtime flow in a similar manner to other species for which the spring X2 requirements were developed (Stevens and Miller 1983; Jassby et al. 1995; Bennett 2005).

However, studies have demonstrated that outflow has a strong effect on the distribution of YOY delta smelt (Dege and Brown 2004) and that it therefore also ultimately influences entrainment at Jones and Banks (Kimmerer 2008). Dege and Brown (2004) found that X2 had a strong influence on the geographic distribution of delta smelt, but distribution with respect to X2 was not affected, indicating that distribution is closely associated with habitat conditions proximal to X2. YOY delta smelt are consistently located just upstream of X2 in freshwater until they become juveniles and enter the low salinity habitats of Suisun Bay later in the year.

Outflow affects the entrainment of YOY delta smelt at the Jones and Banks facilities in several ways. First, because outflow affects adult spawning migration and juvenile distribution, it affects their position relative to the hydrodynamic influence of the diversions (Kimmerer 2008). Second, OMR is the best predictor of salvage and entrainment for adult delta smelt and it is also relevant to larval and juvenile entrainment when considered in the context of X2 (see effects section). In general, the more water that is exported relative to that which is dedicated to outflow enhances negative flows in OMR flow towards the diversions, which in turn increases salvage (Baxter et al. 2008; Kimmerer 2008; Grimaldo et al. accepted manuscript).

Summer (June-August)

Summer represents a primary growing season for delta smelt while they are distributed in low salinity habitats of the estuary. X2 affects delta smelt distribution during summer (Sweetnam 1999). Food supply and habitat suitability are currently believed to be important factors for delta smelt during summer (Bennett 2005; Baxter et al. 2008; Nobriga and Herbold 2008). The CVP/SWP affect summer habitat suitability and might affect summer prey co-occurrence through their effect on Delta hydrodynamics.

Fall

During fall, delta smelt are typically fully distributed in low salinity rearing habitats located around the confluence of the Sacramento and San Joaquin Rivers. Suitable abiotic habitat for delta smelt during fall has been defined as relatively turbid water (Secchi depths < 1.0 m) with a salinity of approximately 0.6-3.0 psu (Feyrer et al. 2007). The amount of suitable abiotic habitat available for delta smelt, measured as hectares of surface area, is negatively related to X2 (see effects section). The average X2 during fall has exhibited a long-term increasing trend (movement further upstream), which has resulted in a corresponding reduction the amount and location of suitable abiotic habitat (Feyrer et al. 2007, 2008).

The available data provide evidence to suggest that the amount of suitable abiotic habitat available for delta smelt during fall affects the population in a measurable way. There is a statistically significant stock-recruit relationship for delta smelt in which pre-adult abundance measured by the FMWT positively affects the abundance of juveniles the following year in the TNS (Bennett 2005; Feyrer et al. 2007). Incorporating suitable abiotic habitat into the stock-recruit model as a covariate improves the model by

increasing the amount of variability explained by 43 percent, r-squared values improved from 46 percent to 66 percent (Feyrer et al. 2007).

It is likely that changes in X2 and the corresponding amount of suitable abiotic habitat are important to the long-term decline of delta smelt but may have been of lesser importance in the more recent POD. Over the long-term, the amount of suitable abiotic habitat for delta smelt during fall has decreased anywhere from 28 percent to 78 percent, depending on the specific habitat definitions that are considered (Feyrer et al. 2008). The majority of this habitat loss has occurred along the periphery, limiting the distribution of delta smelt mainly to a core region in the vicinity of the confluence of the Sacramento and San Joaquin Rivers (Feyrer et al. 2007). Concurrently, delta smelt abundance as measured by the FMWT decreased by 63 percent. This correspondence and the significant stock-recruit relationship with the habitat covariate strongly suggest that delta smelt have been negatively affected by long-term changes in X2 and habitat. However, at the onset of the POD, delta smelt abundance and suitable abiotic habitat had already declined to a point where it was unlikely that Feyrer's two variable definition of habitat was the primary limiting factor constraining the population.

Nevertheless, X2 (Figure S-10) and inflow-corrected X2 (Figure S-11) during fall in the years following the POD (2000-2005) was several km upstream compared to that for the pre-pod years (1995-1999). This suggests that operations in the Delta have exported more water relative to inflow, which has had a negative effect on X2 by moving it upstream. This is confirmed by a long-term positive trend in the E:I ratio for all months from June through December (Figure S-12). In fact, long-term trends in X2 (Figure S-13), inflow-corrected X2 (Figure S-14), and the E:I ratio (Figure S-12) indicate this pattern has been in effect for many years and likely one of the factors responsible for the long-term decline in habitat suitability for delta smelt.

Figure S-10. X2 in years preceding and immediately following the Pelagic Organism Decline.

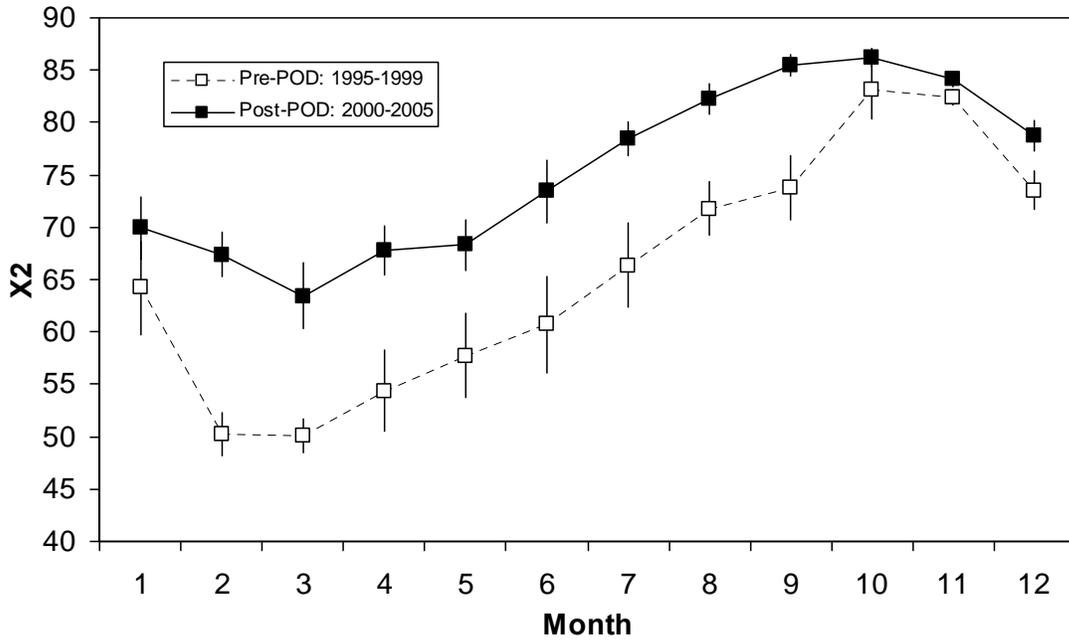


Figure S-11. Inflow-corrected X2 in years preceding and immediately following the Pelagic Organism Decline.

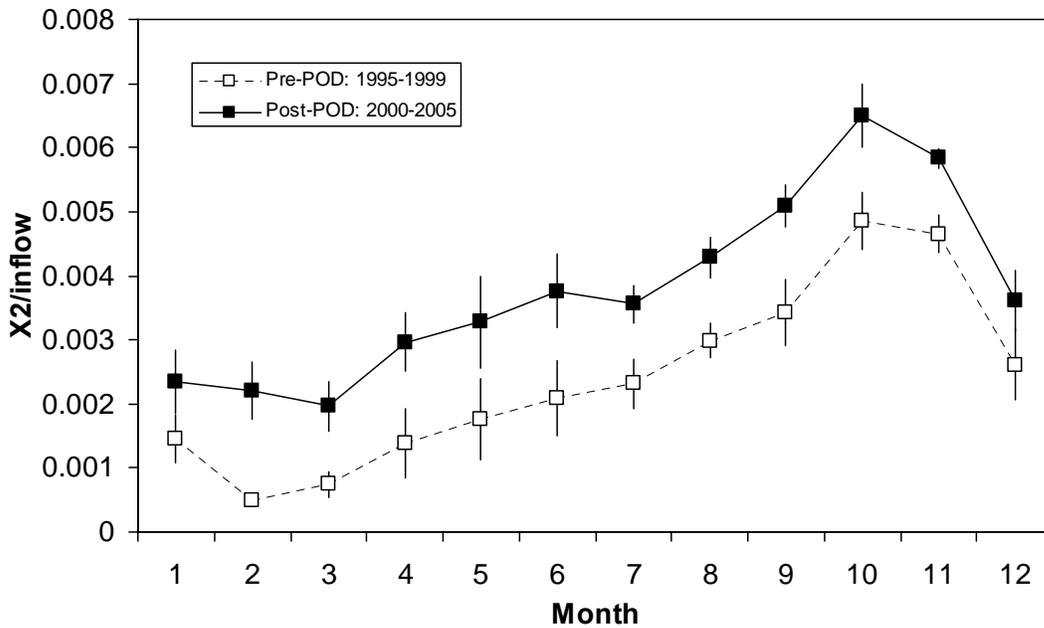


Figure S-12. Monthly time trends of the ratio of project exports to Delta inflow.

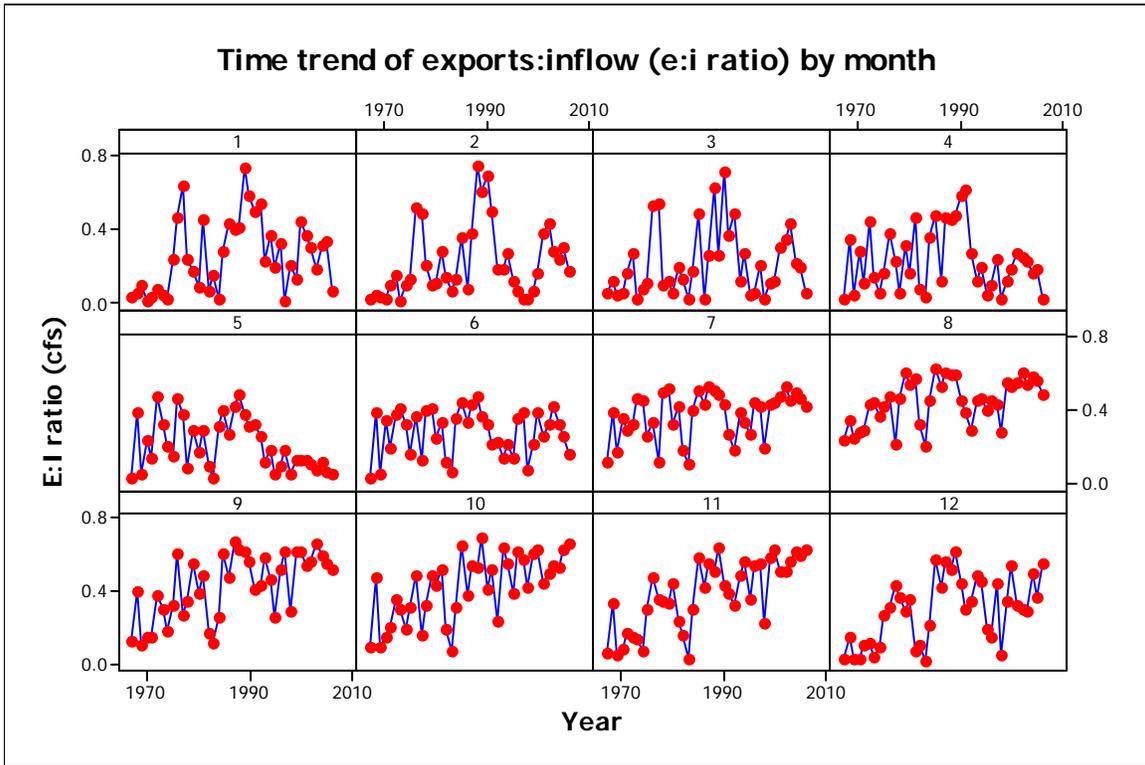


Figure S-13. Monthly time trends of X2.

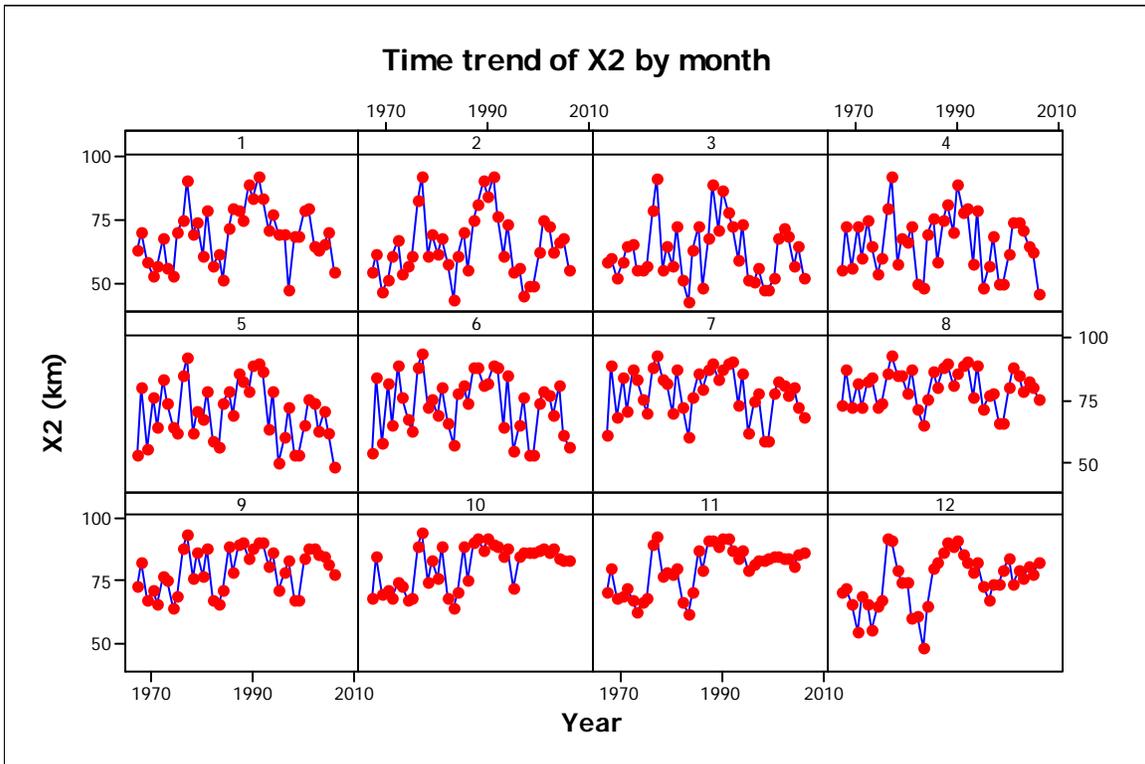
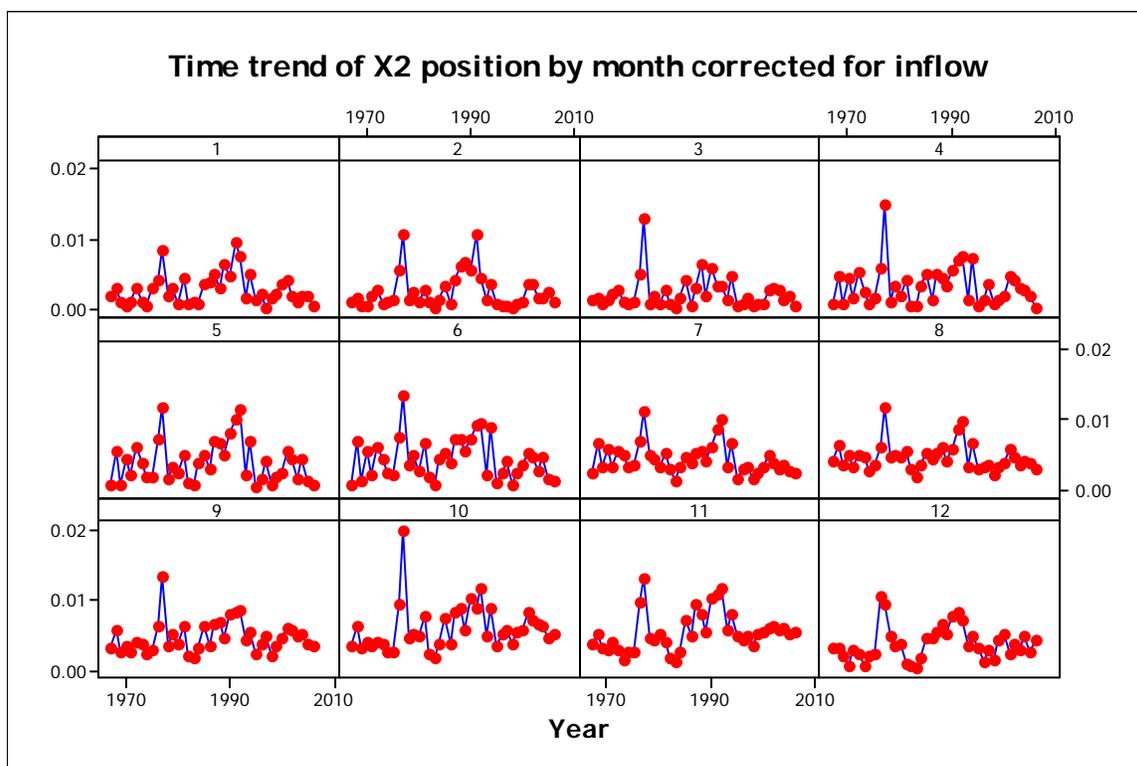


Figure S-14. Monthly time trends of inflow-corrected X2.



Other Stressors

Aquatic Macrophytes

In the last two decades, the interior Delta has been extensively colonized by submerged aquatic vegetation. The dominant submerged aquatic vegetation is *Egeria densa*, a non-native from South America that thrives under warm water conditions. Research suggests that *Egeria densa* has altered fish community dynamics in the Delta, including increasing habitat for centrarchid fishes including largemouth bass (Nobriga et al. 2005; Brown and Michniuk 2007), reducing habitat for native fishes (Brown 2003; Nobriga et al. 2005; Brown and Michniuk 2007), and supporting a food web pathway for centrarchids and other littoral fishes (Grimaldo et al in review). *Egeria densa* has increased its surface area coverage by up to 10 percent per year depending on hydrologic conditions and water temperature (Erin Hestir personal communication University of California Davis).

Egeria densa and other non-native submerged aquatic vegetation (e.g., *Myriophyllum spicatum*) can affect delta smelt in direct and indirect ways. Directly, submerged aquatic vegetation can overwhelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning. Indirectly, submerged aquatic

vegetation decreases turbidity (by trapping suspended sediment) which has contributed to a decrease in both juvenile and adult smelt habitat (Feyrer et al. 2007; Nobriga et al. 2008). Increased water transparency may delay feeding and may also make delta smelt more susceptible to predation pressure.

Predators

Delta smelt is a rare fish and has been a rare fish (compared to other species) for at least the past several decades (Nobriga and Herbold 2008). Therefore, it has also been rare in examinations of predator stomach contents. Delta smelt were occasional prey fish for striped bass, black crappie and white catfish in the early 1960s (Turner and Kelley 1966) but went undetected in a recent study of predator stomach contents (Nobriga and Feyrer 2007). Striped bass are likely the primary predator of juvenile and adult delta smelt given their spatial overlap in pelagic habitats. Despite major declines in age-0 abundance, there remains much more biomass of striped bass in the upper estuary than delta smelt. This means it is not possible for delta smelt to support any significant proportion of the striped bass population. It is unknown whether incidental predation by striped bass (and other lesser predators) represents a substantial source of mortality for delta smelt.

Delta smelt may experience high predation mortality around water diversions where smelt are entrained and predators aggregate. The eggs and newly-hatched larvae of delta smelt are thought to be prey for inland silversides in littoral habitats (Bennett 2005). Other potential predators of eggs and larvae of smelt in littoral habitats are yellowfin goby, centrarchids, and Chinook salmon.

The Delta-wide increase in water transparency may have intensified predation pressures on delta smelt and other pelagic fishes in recent years. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm 2002; Horpilla et al. 2004). There has been limited research to address predation of pelagic fishes in offshore habitats. Stevens (1966) examined diets of striped bass in pelagic habitats, finding that they varied by geographical area and prey abundance but no information was provided on the physical variables that may have influenced predation rates. Research is underway to determine the specific factors responsible for increased water transparency in the Delta (David Schoelhammer, personal communication, University of California at Davis) but recent findings suggest the trend is related to the submerged aquatic vegetation invasion in recent years.

Competition

It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including inland silversides, (Bennett and Moyle 1995) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with inland silversides (Bennett 2005) but there is no empirical evidence to support the conclusion that competition between these species is a factor that influences the abundance of delta smelt in the wild. There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008). It is unknown how intensively overbite clam grazing and delta smelt directly compete for food, but overbite clam consumption of

shared prey resources does have other ecosystem consequences that appear to have affected delta smelt indirectly.

Delta Smelt Feeding

The DRERIP conceptual model for delta smelt (summarized in figure S-3) provides a thorough summary of delta smelt feeding behavior (Nobriga and Herbold 2008), much of which is described in this section and the Delta food web section. Delta smelt are visual feeders that select prey individually rather than by filtering-feeding. Juvenile and adult smelt primarily eat copepods, but they are also known to prey on cladocerans, mysids, amphipods, and larval fish (Moyle et al. 1992; Lott 1998; Feyrer et al. 2003). During the 1970s and 1980s, delta smelt diets were dominated by *Eurytemora affinis*, *Neomysis mercedis*, and *Bosmina longirostus* (Moyle et al. 1992; Feyrer et al. 2003), however, none of these are important prey now (Steve Slater personal communication California Department of Fish and Game). When delta smelt diets were examined again between 1988 and 1996, they were consistently dominated by the copepod *Pseudodiaptomus forbesi*, which was introduced and became abundant following the overbite clam invasion (Lott 1998). *Pseudodiaptomus forbesi* was introduced into the San Francisco Bay-Delta in 1988 and became a significant part of the summertime zooplankton assemblage and is now an important prey item for Delta smelt and other small fishes (Kimmerer and Orsi 1996; Nobriga 2002; Hobbs et al. 2006; Bryant and Arnold 2007). Recent diet studies have shown that *Pseudodiaptomus forbesi* (all lifestages) remains an important prey for juvenile delta smelt during summer, but that several other copepods introduced into the system in the mid-1990s, are also frequently being eaten (Steven Slater unpublished data California Department of Fish and Game).

Delta Food Web

Suisun Bay Region

Following the introduction of the overbite clam into the lower Estuary in 1986, a dramatic decline in primary production in the Estuary was documented (Alpine and Cloern 1992; Jassby et al 2002). The overbite clam is a highly efficient grazer with a wide salinity range. It does not encroach into freshwater but its grazing effect does, presumably due to tides (Jassby et al. 2002). With a high metabolism, the overbite clam has been able to reduced standing stocks of phytoplankton to fractions of historic levels. As a consequence, many zooplankton and fish species experienced sharp declines in abundance (Kimmerer and Orsi 1996, Kimmerer 2002, Kimmerer 2007). Clam grazing on copepod nauplii also may affect copepods directly. Despite its impact on the estuarine pelagic food web, to date, there is no direct evidence linking the effects of overbite clam grazing to adverse effects to delta smelt (Kimmerer 2002; Bennett 2005). It has been noted that delta smelt fork lengths have decreased since 1990, but it is uncertain whether this is a direct consequence of the overbite clam. The Feyrer (2007) effect of fall habitat assumes delta smelt have been chronically food-limited since the overbite clam invasion.

There have been two notable zooplankton introductions into the estuarine food web in recent years that have the potential to adversely affect delta smelt trophic dynamics. In the mid 1990s, the estuary was invaded by *Limnoithona tetraspina* and *Acartiella*

sinensis, both which originated from Asia and are believed to have been introduced via ballast water. *Limnoithona tetraspina* is now the most abundant copepod in the LSZ but evidence suggests that it is not an important food item for delta smelt and other pelagic fishes because of its small size, generally sedentary behavior, and predator-avoidance capability (Bouley and Kimmerer 2006). The consequences of these copepod invasions on the diet of delta smelt feeding remains unknown, but the likely effect is fewer calories per unit when delta smelt prey on *Limnoithona tetraspina*. Experimental studies are currently under way to determine the feeding dynamics of delta smelt on the newly introduced invaders in relation to the current zooplankton fauna of the Delta/Estuary (Lindsay Sullivan RTC 2008 CALFED Science Conference Presentation).

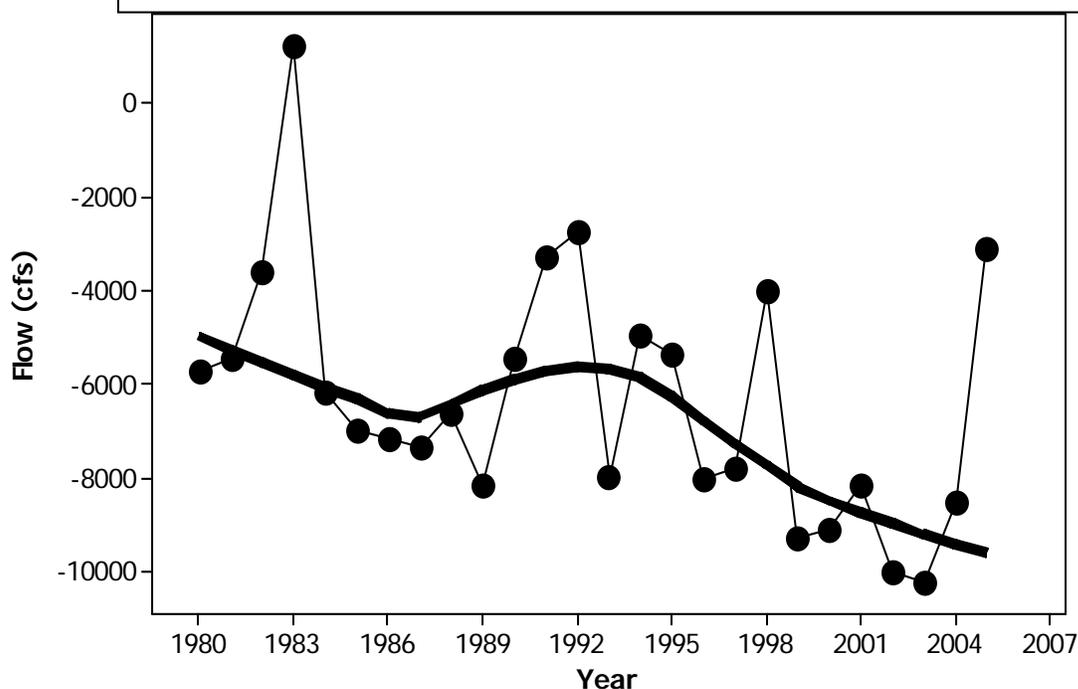
Delta

Water diversions represent one of the major factors controlling lower trophic level production in the Delta (Jassby et al. 2002). Water diversions directly entrain zooplankton and phytoplankton biomass which might impact food availability to delta smelt. Entrainment impacts to lower trophic level production are of concern during the spring and summer when newly hatched delta smelt larvae and juveniles are vulnerable to starvation and thermal stress; food limitation may lead to disease, poor growth, or death (Bennett 2005; Bennett et al. 2008).

Water diversions can also influence the residence time of water in the Eastern and Central Delta that can greatly influence phytoplankton production (Jassby 2005). Low export conditions can result in a doubling of primary production in the Eastern Delta. However, during periods of high exports, such as the summer (Figure S-15), much of the lower trophic level production is entrained rather than dispersed downstream to Suisun Bay. Summer entrainment of phytoplankton and zooplankton could therefore adversely affect delta smelt if food supplies are not transported to the LSZ. Preliminary evidence shows that the abundance of *Pseudodiaptomus forbesi*, a dominant prey of delta smelt in the summer, has steadily declined in the lower Estuary since 1995, while its numbers have increased in the South Delta (Figure 7-19 in the biological assessment; Kimmerer et al. in prep.). This copepod has blooms that originate in the Delta. Thus, its availability to delta smelt rearing to the west of the summer blooms may be impaired by high export to inflow ratios.

As stated above, clam grazing represents another major factor influencing primary and secondary production in the Delta. In the Western Delta, the food web may be compromised by overgrazing effects of the overbite clam (Kimmerer and Orsi 1996, Jassby et al. 2002). Within the Central Delta, grazing by the introduced river clam (*Corbicula fluminea*) can deplete resident phytoplankton biomass, especially in flooded island areas (Lucas et al 2002; Lopez et al 2006). Given that the food web supporting delta smelt depends on phytoplankton, these effects are likely to adversely affect its survival and reproduction by limiting food resources.

Figure S-15 Combined OMR flow (June-August)



Microcystis

Large blooms of toxic blue-green alga, *Microcystis aeruginosa*, were first detected in the Delta during the summer of 1999 (Lehman et al. 2005). Since then, *M. aeruginosa* has bloomed each year, forming large colonies throughout most of the Delta and increasingly down into eastern Suisun Bay. Blooms typically occur between late spring and early fall (peak in the summer) when temperatures are above 20 °C. *Microcystis aeruginosa* can produce natural toxins that pose animal and human health risks if contacted or ingested directly. Preliminary evidence indicates that the toxins produced by local blooms are not toxic to fishes at current concentrations. However, it appears that *M. aeruginosa* is toxic to copepods that delta smelt eat (Ali Ger 2008 CALFED Science Conference). In addition, *M. aeruginosa* could out-compete diatoms for light and nutrients. Diatoms are a rich food source for zooplankton in the Delta (Mueller-Solger et al. 2002). Studies are underway to determine if zooplankton production is compromised during *M. aeruginosa* blooms to an extent that is likely to adversely affect delta smelt. *Microcystis* blooms may also decrease dissolved oxygen to lethal levels for fish (Saiki et al. 1998), although delta smelt do not strongly overlap the densest *Microcystis* concentrations, so dissolved oxygen is not likely a problem. *Microcystis* blooms are a symptom of eutrophication and high ammonia to nitrate ratios in the water.

Contaminants

Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated

during the POD years, concern over contaminants in the Delta is not new. There are long-standing concerns related to mercury and selenium levels in the watershed, Delta, and San Francisco Bay (Linville et al. 2002; Davis et al. 2003). Phytoplankton growth rate may, at times, be inhibited by high concentrations of herbicides (Edmunds et al. 1999). New evidence indicates that phytoplankton growth rate is chronically inhibited by ammonium concentrations in and upstream of Suisun Bay (Wilkerson et al. 2006, Dugdale et al. 2007). Contaminant-related toxicity to invertebrates has been noted in water and sediments from the Delta and associated watersheds (e.g., Kuivila and Foe 1995, Giddings 2000, Werner et al. 2000, Weston et al. 2004). Undiluted drainwater from agricultural drains in the San Joaquin River watershed can be acutely toxic (quickly lethal) to fish and have chronic effects on growth (Saiki et al. 1992). Evidence for mortality of young striped bass due to discharge of agricultural drainage water containing rice herbicides into the Sacramento River (Bailey et al. 1994) led to new regulations for water discharges. Bioassays using caged Sacramento sucker (*Catostomus occidentalis*) have revealed deoxyribonucleic acid strand breakage associated with runoff events in the watershed and Delta (Whitehead et al. 2004). Kuivila and Moon (2004) found that peak densities of larval and juvenile delta smelt sometimes coincided in time and space with elevated concentrations of dissolved pesticides in the spring. These periods of co-occurrence lasted for up to 2-3 weeks, but concentrations of individual pesticides were low and much less than would be expected to cause acute mortality. However, the effects of exposure to the complex mixtures of pesticides actually present are unknown.

The POD investigators initiated several studies beginning in 2005 to address the possible role of contaminants and disease in the declines of Delta fish and other aquatic species. Their primary study consists of twice-monthly monitoring of ambient water toxicity at fifteen sites in the Delta and Suisun Bay. In 2005 and 2006, standard bioassays using the amphipod *Hyaella azteca* had low (<5 percent) frequency of occurrence of toxicity (Werner et al. 2008). However, preliminary results from 2007, a dry year, suggest the incidence of toxic events was higher than in the previous (wetter) years. Parallel testing with the addition of piperonyl butoxide, an enzyme inhibitor, indicated that both organophosphate and pyrethroid pesticides may have contributed to the pulses of toxicity. Most of the tests that were positive for *H. azteca* toxicity have come from water samples from the lower Sacramento River. Pyrethroids are of particular interest because use of these insecticides has increased within the Delta watershed (Ameg et al. 2005, Oros and Werner 2005) as use of some organophosphate insecticides has declined. Toxicity of sediment-bound pyrethroids to macroinvertebrates has also been observed in small, agriculture-dominated watersheds tributary to the Delta (Weston et al. 2004, 2005). The association of delta smelt spawning with turbid winter runoff and the association of pesticides including pyrethroids with sediment is of potential concern.

In conjunction with the POD investigation, larval delta smelt bioassays were conducted simultaneously with a subset of the invertebrate bioassays. The water samples for these tests were collected from six sites within the Delta during May-August of 2006 and 2007. Results from 2006 indicate that delta smelt are highly sensitive to high levels of ammonia, low turbidity, and low salinity. There is some preliminary indication that reduced survival may be due to disease organisms (Werner et al. 2008). No significant mortality of larval delta smelt was found in the 2006 bioassays, but there were two

instances of significant mortality in June and July of 2007. In both cases, the water samples were collected from sites along the Sacramento River and had relatively low turbidity and salinity levels and moderate levels of ammonia. It is also important to note that no significant *H. azteca* mortality was detected in these water samples. While the *H. azteca* tests are very useful for detecting biologically relevant levels of water column toxicity for zooplankton, interpretation of the *H. azteca* test results with respect to fish should proceed with great caution. The relevance of the bioassay results to field conditions remains to be determined.

The POD investigations into potential contaminant effects also include the use of biomarkers that have been used previously to evaluate toxic effects on POD fishes (Bennett et al. 1995, Bennett 2005). The results to date have been mixed. Histopathological and viral evaluation of young longfin smelt collected in 2006 indicated no histological abnormalities associated with exposure to toxics or disease (Foott et al. 2006). There was also no evidence of viral infections or high parasite loads. Similarly, young threadfin shad showed no histological evidence of contaminant effects or of viral infections (Foott et al. 2006). Parasites were noted in threadfin shad gills at a high frequency but the infections were not considered severe. Both longfin smelt and threadfin shad were considered healthy in 2006. Adult delta smelt collected from the Delta during the winter of 2005 also were considered healthy, showing little histopathological evidence for starvation or disease (Teh et al., unpublished data). However, there was some evidence of low frequency endocrine disruption. In 2005, 9 of 144 (6 percent) of adult delta smelt males sampled were intersex, having immature oocytes in their testes (Teh et al., unpublished data).

In contrast, preliminary histopathological analyses have found evidence of significant disease in other species and for POD species collected from other areas of the estuary. Massive intestinal infections with an unidentified myxosporean were found in yellowfin goby *Acanthogobius flavimanus* collected from Suisun Marsh. Severe viral infection was also found in inland silverside and juvenile delta smelt collected from Suisun Bay during summer 2005. Lastly, preliminary evidence suggests that contaminants and disease may impair survival of age-0 striped bass. Baxter et al. 2008 found high occurrence and severity of parasitic infections, inflammatory conditions, and muscle degeneration in young striped bass collected in 2005; levels were lower in 2006. Several biomarkers of contaminant exposure including P450 activity (i.e., detoxification enzymes in liver), acetylcholinesterase activity (i.e., enzyme activity in brain), and vitellogenin induction (i.e., presence of egg yolk protein in blood of males) were also reported from striped bass collected in 2006 (Ostrach 2008).

Climate Change

There is currently no quantitative analysis of how ongoing climate change is currently affecting delta smelt and the Delta ecosystem. Climate change could have caused shifts in the timing of flows and water temperatures in the Delta which could lead to a change in the timing of migration of adult and juvenile delta smelt.

Summary of Delta Smelt Status and Environmental Baseline

Given the long list of stressors discussed, the rangewide status of the delta smelt is currently declining and abundance levels are the lowest ever recorded. This abundance trend has been influenced by multiple factors, some of which are affected or controlled by CVP and SWP operations and others that are not. Although it is becoming increasingly clear that the long-term decline of the delta smelt was very strongly affected by ecosystem changes caused by non-indigenous species invasions and other factors influenced, but not controlled by CVP and SWP operations, The CVP and SWP have played an important direct role in that decline, especially in terms of entrainment and habitat-related impacts that add increments of additional mortality to the stressed delta smelt population. Further, past CVP and SWP operations have played an indirect role in the decline of the delta smelt by creating an altered environment in the Delta that has fostered both the establishment of non-indigenous species and habitat conditions that exacerbate their adverse influence on delta smelt population dynamics. Past CVP and SWP operations have been a primary factor influencing delta smelt abiotic and biotic habitat suitability, health, and mortality.

Survival and Recovery Needs of Delta Smelt

Based on the above discussion of the current condition of the delta smelt, the factors responsible for that condition, and the final *Recovery Plan for the Delta Smelt* (Service 1995), the Service has identified the following survival and recovery needs for this species:

- Increase the abundance of the adult population and the potential for recruitment of juveniles into the adult population.
- Increase the quality and quantity of spawning, rearing, and migratory habitat with respect to turbidity, temperature, salinity, freshwater flow, and adequate prey availability by mimicking natural (i.e., pre-water development) water and sediment transport processes in the San Francisco Bay-Delta watershed to enhance reproduction and increase survival of adults and juveniles.
- Reduce levels of contaminants and other pollutants in smelt habitat to increase health, fecundity and survival of adults and juveniles.
- Reduce delta smelt exposure to disease and toxic algal blooms to increase health, fecundity and survival of adults and juveniles.
- Reduce entrainment of adult, larval, and juvenile delta smelt at CVP-SWP pumping facilities, over and above reductions achieved under the Vernalis Adaptive Management Plan and the Environmental Water Account, to increase

the abundance of the spawning adult population and the potential for recruitment of juveniles into the adult population. Best available information indicates that delta smelt entrainment at CVP-SWP pumping facilities can be substantially reduced by maintaining a positive flow in the Old and Middle rivers. Entrainment reduction at other water diversion-related structures within the Bay-Delta where delta smelt adults or juveniles are known or likely to be entrained might also be needed to increase the adult population and the potential for recruitment of juveniles into the adult population, but there are secondary to reducing Banks and Jones entrainment.

- Restore the structure of the food web in the Bay-Delta to a condition that enhances diatom-based pelagic food chains in the LSZ.
- Maximize the resilience of the delta smelt population to the adverse effects of ongoing climate change. Achieving the above conditions should help with this need. In general, the management of CVP-SWP water storage and delivery facilities could have an important role to play in tempering the adverse effects of climate change on the Bay-Delta ecosystem upon which the delta smelt depends.

Delta Smelt Critical Habitat

The action area for this consultation covers nearly the entire range of delta smelt critical habitat. For that reason, the Status of Critical Habitat and Environmental Baseline sections are combined into one section in this document.

The Service designated critical habitat for the delta smelt on December 19, 1994 (59 FR 65256). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (USFWS 1994).

Description of the Primary Constituent Elements

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species:

1. “Physical habitat” is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary’s LSZ (Bennett et al. 2002).

2. “Water” is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt and are discussed in detail in the Status of the Species/Environmental Baseline section, above. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.
3. “River flow” is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and OMR influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones (refer to Status of the Species/Environmental Baseline section, above). River flow interacts with the fourth primary constituent element, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.
4. “Salinity” is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 psu (parts per thousand salinity; Kimmerer 2004). The 2 psu isohaline is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby et al. 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu isohaline to the Golden Gate Bridge (X2); X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby et al. 1995; Kimmerer 2002). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low.

During the past 40 years, monthly average X2 has varied from as far downstream as San Pablo Bay (45 km) to as far upstream as Rio Vista on the Sacramento River (95 km). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle (see Biology and Life History section above). In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish the more frequently and further the LSZ moves upstream, toward the confluence.

Conservation Role of Delta Smelt Critical Habitat

The Service’s primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful spawning, larval and juvenile transport, rearing, and adult migration. Delta smelt are endemic to the Bay-Delta and the vast majority only live one year. Thus, regardless of annual hydrology, the Delta must

provide suitable habitat all year, every year. Different regions of the Delta provide different habitat conditions for different life stages, but those habitat conditions must be present when needed, and have sufficient connectivity to provide migratory pathways and the flow of energy, materials and organisms among the habitat components. The entire Delta and Suisun Bay are designated as critical habitat; over the course of a year, the entire habitat is occupied.

Overview of Delta Smelt Habitat Requirements and the Primary Constituent Elements

As previously described in the Status of the Species/Environmental Baseline section, Delta smelt live their entire lives in the tidally-influenced fresh- and brackish waters of the San Francisco Estuary (Moyle 2002). Delta smelt are an open-water, or pelagic, species. They do not associate strongly with structure. They may use nearshore habitats for spawning (PCE #1), but free-swimming life stages mainly occupy offshore waters (PCE #2). Thus, the distribution of the population is strongly influenced by river flows through the estuary (PCE #3) because the quantity of fresh water flowing through the estuary changes the amount and location of suitable low-salinity, open-water habitat (PCE #4). This is true for all life stages. During periods of high river flow into the estuary, delta smelt distribution can transiently extend as far west as the Napa River and San Pablo Bay. Delta smelt distribution is highly constricted near the Sacramento-San Joaquin river confluence during periods of low river flow into the estuary (Feyrer et al. 2007).

In the 1994 designation of critical habitat, the best available science held that the delta smelt population was responding to variation in spring X2. In the intervening 14 years, the scientific understanding of delta smelt habitat has improved. The current understanding is that X2 and OMR both must be considered to manage entrainment and that X2 indexes important habitat characteristics throughout the year.

Conservation Function of Primary Constituent Elements by Life History Stage

The conservation function and important attributes of each constituent element in each life stage are further described below.

Spawning

Spawning delta smelt require all four PCEs, but spawners and embryos are the only life stages of delta smelt that are known to require specific structural components of habitat (PCE # 1; see Biology and Life History section). Spawning delta smelt require sandy or small gravel substrates for egg deposition. Migrating, staging, and spawning delta smelt also require low-salinity and freshwater habitats, turbidity, and water temperatures less than 20°C (68°F) (attributes of PCE #2 and #4 for spawning). The developing embryos likewise may remain associated with sandy substrate until they hatch. Hatching success is only about 20 percent at 20°C in the laboratory and declines to zero at higher temperatures (Bennett 2005).

Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the bottom over substrates of sand or pebble (DWR and Reclamation 1994; Lindberg et al. 2003; Wang 2007). Rather than stick to immobile substrates, the adhesive eggs might adhere to sand particles, which keeps them negatively buoyant but not immobile (Hay 2007).

Spawning occurs primarily during April through mid-May (Moyle 2002) in sloughs and shallow edge areas in the Delta. Spawning also has been recorded in Suisun Marsh and the Napa River (Hobbs et al. 2007). Historically, delta smelt ranged as far up the San Joaquin River as Mossdale, indicating that areas of the lower San Joaquin and its tributaries support conditions appropriate for spawning. Little data exists on delta smelt spawning activity in the lower San Joaquin region. Larval and young juvenile delta smelt collected at South Delta stations in DFG's 20-mm Survey, indicate that appropriate spawning conditions exist there. However, the few delta smelt that are collected in the lower San Joaquin region is a likely indicator that changes in flow patterns entrain spawning adults and newly-hatched larvae into water diversions (Moyle et al 1992).

Once the eggs have hatched, larval distribution depends on both the spawning area from which they originate (PCE#1 and PCE#2) and the effect of Delta hydrodynamics on transport (PCE#3). Larval distribution is further affected by salinity and temperature (attributes of PCE#4 and #3). Tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monson et al. 2007), which in some cases might result in rapid dispersal of larvae away from spawning sites.

In the laboratory, a turbid environment (>25 NTU) was necessary to elicit a first feeding response (Baskerville-Bridges et al. 2000; Baskerville-Bridges 2004) (attribute of PCE#2). Successful feeding depends on a high density of food organisms and turbidity. The ability of delta smelt larvae to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Their diet is comprised of small planktonic crustaceans that inhabit the estuary's turbid, low-salinity, open-water habitats (attribute of PCE#2).

Larval and Juvenile Transport

Delta smelt larvae require PCEs # 2-4. The distribution of delta smelt larvae follows that of the spawners; larvae emerge near where they are spawned. Thus, they are distributed more widely during high outflow periods. Delta smelt larvae mainly inhabit tidal freshwater at temperatures between 10°C-20°C (Bennett 2005). The center of distribution for delta smelt larvae < 20 mm is usually 5-20 km upstream of X2, but larvae move closer to X2 as the spring progresses into summer (Dege and Brown 2004). The primary influences the water projects have on larval delta smelt critical habitat are that they influence water quality, the extent of the LSZ, and larval transport via capture of runoff in reservoirs and subsequent manipulation of Delta inflows and exports that affect OMR flows, and resultant Delta outflows that affect X2.

Changes to delta smelt larval and juvenile transport attributable to the SWP and CVP include water diversions that create net reverse flows in the Delta that entrain larval and

juvenile delta smelt; permanent and temporary barrier installations and operation that change Delta hydrology and salinity and increase entrainment risk; and diminished river inflows that seasonally bring the LSZ into the Delta for increasingly longer periods of time, resulting in lower quality and quantity of rearing habitat.

Juvenile Rearing

Rearing juvenile delta smelt mainly require PCEs # 2 and # 4. Juvenile delta smelt are most abundant in the LSZ, specifically at the upstream edge of the LSZ where salinity is < 3 psu, water transparency is low (Secchi disk depth < 0.5 m), and water temperatures are cool (< 24°C) (Feyrer et al. 2007; Nobriga et al. 2008). Because high freshwater inflows that push X₂ well into Suisun Bay are not sustained through the juvenile stage (July-December), many juvenile delta smelt rear near the Sacramento-San Joaquin river confluence. This reflects a long-term change in distribution. During surveys in the latter 1940s, juvenile delta smelt reared throughout the Delta during summer (Erkkila 1950). Currently, young delta smelt rear throughout the Delta into June or the first week of July, but thereafter, distribution shifts to the Sacramento-San Joaquin river confluence where water temperatures are cooler and water transparencies are lower (Feyrer et al. 2007; Nobriga et al. 2008). Note that this change in distribution has often been mischaracterized as a migration into brackish water.

- The primary influences the water projects have on juvenile delta smelt critical habitat are that they influence water quality, the extent of the LSZ, and early summer (June) transport via capture of runoff in reservoirs and subsequent manipulation of Delta inflows and exports that affect OMR flows, and resultant Delta outflows that affect X₂. The projects are the primary influence on freshwater inflows and outflows during the juvenile stage. The SWP and CVP control almost all Delta inflow during summer-fall. The primary effects these highly controlled flows have on juvenile delta smelt are a possible impact on summertime prey availability in the LSZ and a strong effect on the extent of the LSZ and dilution flows and thus, habitat suitability during fall (see Effects section).
- Estuarine turbidity varies with Delta outflow and it is higher during periods of high outflow (Kimmerer 2004). The interannual variation in peak flows to the estuary is not always controlled by the projects, so they have little effect on interannual variation in estuary turbidity during delta smelt's spawning season. The CVP/SWP have had a long-term influence on turbidity in the estuary because project dams have retained sediment originating in project tributaries, especially in the Sacramento River basin (Wright and Schoelhamer 2004). However, the CVP/SWP have not been shown to have influenced shorter-term decreases in turbidity due to the proliferation of aquatic plants like *Egeria densa*.
- The water projects have little if any ability to affect water temperatures in the Estuary (Kimmerer 2004). Estuarine and Delta water temperatures are driven by air temperature. Water temperatures at Freeport can be cooled up to about 3°C by high Sacramento River flows, but only by very high river flows that cannot be sustained by the projects. Note also that the cooling effect of the Sacramento

River is not visible in data from the west Delta at Antioch (Kimmerer 2004) so the area of influence is limited.

Adult Migration

Successful delta smelt adult migration habitat is characterized by conditions that attract migrating adult delta smelt, attributes of PCE #2, #3, and #4, and that help them migrate to spawning habitats (PCE #3). Delta smelt are weakly anadromous and move from the LSZ into freshwater to spawn, beginning in late fall or early winter and likely extending at least through May (see Delta Smelt Life Cycle section in the Status and Baseline). Although the physiological trigger for the movement of delta smelt up the Estuary is unknown, movement is associated with pulses of freshwater inflow, which are cool, less saline and turbid (attributes of PCE #2 and #4 for adult migration). As they migrate, delta smelt increase their vulnerability to entrainment if they move closer to Banks and Jones (Grimaldo et al accepted manuscript). Analyses indicate that delta smelt become less vulnerable to entrainment when reverse flows in the Delta are minimized. Inflows in early winter must be of sufficient magnitude to provide the cool, fresh and highly turbid conditions needed to attract migrating adults and of sufficient duration to allow connectivity with the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries (attributes of PCE #2 for adult migration). These areas are vulnerable to physical disturbance and flow disruption during migratory periods. Once adults have moved into the Delta, freshwater inflows must remain of sufficient magnitude to minimize their vulnerability to entrainment.

Changes to delta smelt adult migration habitat include water diversions that have increased net negative OMR flows that entrain migrating adult smelt and reservoir operations that reduce seasonal inflow that provides flow and turbidity cues for migration. In addition, the proliferation of nonnative aquatic plants that trap sediment has reduced overall turbidity and may have increased the deposition of fine sediments in historical spawning habitats.

Current Condition of Delta Smelt Critical Habitat and Factors that Contribute to that Condition

As stated in the previous section on the status of the delta smelt, the physical appearance, salinity, water clarity, and hydrology of the Delta have been modified significantly by channelization, conversion of Delta islands to agriculture, and water operations. As a consequence of these changes, most life stages of the delta smelt are now distributed across a smaller area than historically (Arthur et al. 1996, Baxter et al. 2008).

In general, the CVP/SWP operations have decreased springtime flows (PCE #3) relative to the natural hydrograph, as reservoir operations change over from flood management to water storage (Kimmerer 2004). Further, summer and early fall inflows (PCE #2, #3, and #4) may be increased over the natural hydrograph as reservoirs release stored water to support export operations. Changes in inflow affect the location of the historically highly-productive LSZ, affecting habitat volume and quality (effect on PCE #2, #3 and

#4). The combined influence of these changes since the 1980s and earlier has had the effect of distributing delta smelt narrowly and in areas with high risk of mortality from many known sources (e.g., entrainment in water diversions large and small) and plausible sources (intensified predation loss, sublethal contaminant exposure, etc.) (combined effect on the condition of PCE #2, #3, and #4). Second, a more upstream distribution of maturing adult delta smelt places them at greater vulnerability to entrainment by CVP and SWP export operations once they begin their spawning migration (Grimaldo et al, accepted manuscript) (combined effect on the condition of PCE #2, #3, and #4).

PCE #1 - Physical Habitat for Spawning

We are aware of no conditions attributable to SWP and CVP operations that limit the availability of spawning substrate.

Routine dredging of various Delta channels to facilitate shipping periodically may disrupt or eliminate spawning substrate availability, but is not known to substantially modify location, extent, or quality of available spawning substrate (PCE #1) for delta smelt.

Nonnative submerged aquatic vegetation, particularly *Egeria densa*, overwhelms littoral habitats (inter-tidal shoals and beaches) where delta smelt spawn, possibly making them unsuitable for spawning.

The cumulative effects of locally small or isolated losses or degradations of physical habitat associated with construction and maintenance of water conveyance facilities, together with increasing exposure in physical habitat to chemical pollutants from other sources, and the increase of nonnative submerged aquatic vegetation likely have reduced both the quality and extent of physical habitat. Overall, this primary constituent element remains capable of fulfilling its intended conservation function, but the trend is downward and will likely remain so unless ways are found to control *Egeria*.

PCE #2 - Water for All Life Stages (Suitable Quality)

The condition of PCE #2 has been substantially reduced. Pelagic habitat in the Delta has been highly altered and degraded by many factors discussed in the Baseline and Effects Sections. The historic Delta consisted primarily of tidal freshwater marshes, tributary river channels and their associated floodplains, and sloughs. The current Delta has little (< 1 percent) of its historic intertidal marsh habitat, its patterns of sloughs and channels have been modified, changing its hydrodynamic characteristics, and the pattern and quantity and inflow to, through and out of the estuary has been altered. When compared to estuaries around the world, the Delta is unique in its low levels of productivity (Clipperton and Kratville, in review). Current conditions for larval and juvenile transport, rearing, and adult migration in particular have been modified to an extent that this primary constituent element is substantially impaired in its ability to fulfill its conservation function at least seasonally in all water year-types. Special management is needed to address the degraded condition of this primary constituent element. Many factors that have contributed to the current condition are described below.

Factors that Impair/Degrade the Function of PCE #2

CVP and SWP

Operations of the Banks and Jones (inclusive of 500 cfs diversion at Banks, Article 21, upstream diversion and reservoir operations, North Bay Aqueduct, South Delta Temporary Barriers and Permanent Operable Gates, pumping plants water transfers) have diminished the ability of PCE #2 to fulfill its intended conservation purpose. Disconnecting inflow and outflow via water exports in the South Delta probably represents the single largest stressor for this primary constituent element. The manipulation of inflow and outflow with a goal of maintaining “balanced conditions” also has adversely affected the functionality of the other primary constituent elements and is discussed in more detail under each of the primary constituent elements. Though not restricting spawning *per se*, export of water by the CVP and SWP has usually restricted reproductive success of spawners in the San Joaquin River portion of the Delta as many adults and most larvae have been entrained and lost during transport to and from spawning sites to rearing areas (see Effects Section). Persistent confinement of the effective spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawning population could be adversely affected by catastrophic event or localized chronic threat, such as localized contaminant releases.

The additional interaction of PCE #2 with salinity, PCE #4, has resulted in a lengthening seasonal shift in the distribution of delta smelt to areas that are generally upstream of where they once occurred. See additional discussion below in the section on Rearing.

Preliminary evidence shows that the abundance of *Pseudodiaptomus forbesi*, a dominant prey of delta smelt in the summer, has steadily declined in the lower Estuary since 1995, while its numbers have increased in the Southern Delta (Kimmerer et al. in prep.). This copepod has blooms that originate in the Delta. Its availability to delta smelt rearing to the west of the summer blooms may be impaired by pumping at Banks and Jones.

The operation of upstream diversions and reservoirs can, depending on how they are managed, substantially influence the pelagic environment in the Delta by controlling timing and volume of releases. Over time, the operation of project dams and diversions has had the additional effect of making water in the Delta more clear by trapping sediment behind dams and diverting sediment that otherwise would be transported to the Delta (effect on the condition of PCE #2). Delta smelt seem to prefer water with high turbidity (see Baseline Section). In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin River was highly seasonal and more strongly and reliably affected by precipitation than it is today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of Delta water was larger than now (Kimmerer 2002b). Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows, but through time more and more of the summer-fall inflow and been exported, reducing outflows.

Aquatic Macrophytes

As stated in the Status and Baseline Section, research suggests that the nonnative South American aquatic plant *Egeria densa* has altered fish community dynamics in the Delta. In addition to the above-mentioned effect of overwhelming spawning habitat (PCE #1), *Egeria* and other submerged aquatic vegetation decreases turbidity by trapping suspended sediment, thereby decreasing juvenile and adult smelt habitat (Feyrer et al. 2007; Nobriga et al. 2008). Increased water transparency may also make delta smelt more susceptible to predation. It appears that aquatic macrophytes may have a role in degrading pelagic habitat to the extent that the Delta's ability to fulfill its intended conservation purpose continues to diminish. *Egeria* has the additional effect of decreasing turbidity, described above as important to successful feeding of newly-hatched larval delta smelt. However, there is still enough turbidity in the Central and South Delta to initiate larval feeding responses because larvae collected in the South Delta have comparatively high growth rates. So while *Egeria* may reduce or eliminate the extent and quality of spawning habitat for delta smelt, it is not at this time considered to have detectable effects on spawning or early feeding success.

Contaminants

While contaminants are thought to reduce habitat quality and thus reduce the ability of PCE #2 to fulfill its intended conservation function, contaminant loading and its ecosystem effects within the Delta are still not well understood. There are long-standing concerns related to methyl mercury and selenium levels in the watershed, Delta, and San Francisco Bay (Linville et al. 2002; Davis et al. 2003). There is evidence that contaminants may inhibit phytoplankton growth rates at times (Wilkerson et al. 2006; Dugdale et al. 2007). Pulses of sediment-bound pesticides can co-occur in space and time with delta smelt reproduction (Kuivila and Moon 2004). There is also recent evidence of low frequency of intersex delta smelt suggesting exposure to estrogenic chemicals (Teh 2008).

Nonnative Species

Within the Delta, grazing by the introduced clams *Corbula amurensis* and *Corbicula fluminea* can deplete resident phytoplankton biomass (Jassby et al. 2002; Lucas et al. 2002; Lopez et al. 2006). The former has had a demonstrable effect on phytoplankton standing stock and zooplankton abundance throughout the estuary (Kimmerer and Orsi 1996), but the effect of the latter is mainly limited to freshwater flooded island areas (Lucas et al. 2002; Lopez et al. 2006). Given that phytoplankton help support the production of prey items eaten by delta smelt, these nonnative species are likely to adversely affect the ability of PCE #2 to fulfill its intended conservation function, which results in degraded condition.

PCE #3 - River Flow for Larval and Juvenile Transport, Rearing, and Adult Migration

Management of Delta inflows results in conditions for river flow that frequently do not meet the intended conservation function of this primary constituent element in certain

WYs. PCE #3 is probably the most significantly degraded of all the PCEs, and requires the most intensive management in order for it to continue to fulfill its intended conservation role. The primary factors that have contributed to this condition are discussed below.

Factors that Impair/Degrade the Function of PCE #3

CVP and SWP

Operations of the CVP and SWP manipulate inflows, outflows and OMR flows. This probably represents the single largest stressor for PCE #3. Banks and Jones entrain delta smelt and delta smelt food items, thereby affecting the quality of PCE #2 as well. While tides and climate affect flow into and within the Delta, Banks and Jones are the single most prominent factor in determining whether transport flows are sufficient to allow larval and juvenile delta smelt to move out of the Central and South Delta before water temperatures reach lethal levels. Baseline operation of the CVP/SWP represents a downward trend in the ability of this primary constituent element to fulfill its intended conservation function.

Management of Article 21 water at the SWP has changed since 2000. The result is more water exported than historically during the late fall and winter months, and increasing SWP exports overall relative to historic conditions (Table P-12). This additional pumping has contributed to the downward trend in the ability of PCE #3 to meet its intended conservation function by increasing the entrainment risk of adults migrating upstream to spawn.

Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows. Reservoir operations have played a significant role in modifying conditions in the Delta to the extent that this primary constituent element is unable to fulfill its intended conservation purpose in most years. The SWRCB D-1641 has helped provide Delta outflow during the spring, but outflows are reduced during other times by increased pumping at Jones and Banks.

Environmental Water Account

Implementation of the EWA provided brief export cutbacks in winter and spring, but also increased exports during early winter and summer, and it contributed to increased exports in summer and fall to levels that would not have occurred if EWA assets had not been purchased. This may have negatively affected habitat suitability and prey availability for delta smelt (see Effects Section). So while EWA was intended to moderate effects of CVP and SWP operations, its ability to do so measured over time was small (Brown et al. 2008). While EWA may have provided short-term transport opportunities in the early part of the year, it contributed to low outflows during other times of the year, which diminished the ability of this primary constituent element to fulfill its intended conservation purpose.

Special Management for PCE #3

Vernalis Adaptive Management Plan

VAMP represents one of the management measures that has been applied to CVP and SWP operations to assist this primary constituent element in fulfilling its intended conservation role. VAMP flows are thought to have selectively enhanced survival of delta smelt larvae that emerge in the Central Delta during VAMP by reducing entrainment. VAMP has enhanced the ability of this primary constituent element to fulfill its intended conservation purpose for 31 days each year.

PCE #4 - Salinity for Rearing

Summer and fall environmental quality, represented by PCE #4, has decreased overall in the Delta, but less so for the Sacramento River-San Joaquin River confluence. The rivers' confluence has, as a result, become increasingly important as a rearing location, as delta smelt's range has been restricted to an increasingly small area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that juvenile and maturing adult delta smelt are exposed to chronic and cyclic environmental stressors, or localized catastrophic events. The many changes imposed on the Delta have had the effect of concentrating the distribution of delta smelt to an area that is generally upstream of where they once were. This upstream location of rearing habitat has reduced habitat quantity and quality, making larval and juvenile delta smelt more susceptible to marginal water temperatures, cyanobacterium blooms, and other habitat-related effects.

Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008). Thus, there is the potential for mismatches between regions of high zooplankton abundance in the Delta and delta smelt distribution now that the overbite clam has decimated historical delta smelt prey in the LSZ. A minimum amount of suitable habitat during summer-autumn may interact with a suppressed pelagic food web to create a bottleneck for delta smelt (Bennett 2005; Feyrer et al. 2007; Bennett et al. 2008). As discussed in the preceding section on Population Dynamics-Abundance Trends, there is evidence that factors affecting juvenile delta smelt during summer-autumn are strongly impairing delta smelt reproductive success. The interaction of warm summer water temperatures, suppression of the food web supporting delta smelt, and spatially restricted suitable habitat during autumn all affect delta smelt health and ultimately survival and realized fecundity. The preceding factors have contributed to the current condition of seasonally low outflow and the inability of PCE #4 to fulfill its intended conservation purpose in most years.

Factors that Impair/Degrade the Function of PCE #4

CVP and SWP

Operations of the CVP and SWP pumping plants manipulate outflow and represent probably the single largest factor affecting the condition of this primary constituent

element. The facilities entrain delta smelt and delta smelt food items. While tides and climate affect flow into and within the Delta, the export facilities are the single most prominent factor in determining whether transport flows for migrating larvae, juveniles, and adults are sufficient to move fish out of the Central Delta before water temperatures reach lethal levels, are sufficient to maintain rearing habitat at a more downstream position where smelt also are not at risk of entrainment from export facilities, and are sufficient to cue adults to migrate to upstream spawning habitat without being entrained at the export facilities. Baseline operation of these facilities represents a downward trend in the ability of this primary constituent element to fulfill its intended conservation purpose with the possible exception of specific actions taken recently, the results of which, however, remain uncertain.

Management of Article 21 water at the SWP has changed since 2000. The result is more water exported than historically during the late fall and winter months when Article 21 water normally is moved, and increasing SWP exports overall relative to historic conditions. This additional pumping has contributed considerably to the downward trend in the ability of this primary constituent element to meet its intended conservation purpose.

Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage and in some years may increase late summer and fall inflows. Reservoir operations have played a significant role in modifying conditions in the Delta to the extent that this primary constituent element is unable to fulfill its intended conservation purpose in most years.

Environmental Water Account

Implementation of the EWA provided brief export cutbacks in winter and spring, but also increased exports during early winter and summer, and it contributed to increased exports in summer and fall to levels that would not have occurred if EWA assets had not been purchased. This may have negatively affected habitat suitability and prey availability for delta smelt (see Effects Section). So while EWA was intended to moderate effects of CVP and SWP operations, its ability to do so measured over time was small (Brown et al. 2008). While EWA may have provided short-term transport opportunities in the early part of the year, it contributed to low outflows during other times of the year, which diminished the ability of this primary constituent element to fulfill its intended conservation purpose.

Other Factors that May Influence the Condition of PCE #4

Aquatic Macrophytes

As stated in the preceding section on Other Stressors, research suggests that the nonnative South American aquatic plant *Egeria densa* has altered fish community dynamics in the Delta. However, we are not aware of evidence that aquatic macrophytes such as *Egeria*,

affect flows. Thus, this factor is considered to have no influence on the current condition of PCE #4

Nonnative Species

A dramatic decline in primary production in the Estuary was documented following the introduction of the overbite clam into the lower Estuary in 1986 (Alpine and Cloern 1992; Jassby et al 2002).

In the Western Delta, the food web may be compromised by overgrazing by overbite clam that can suppress phytoplankton biomass, and the abundance of delta smelt's prey (Kimmerer and Orsi 1996, Jassby et al 2002). The chronic low outflow conditions during summer and fall may increase the reproductive success and upstream range of overbite clam.

Climate Change

There are currently no published analyses of how ongoing climate change has affected the current condition of any of the primary constituent elements of delta smelt critical habitat. Climate change could have caused shifts in the timing of flows and water temperatures in the Delta which could lead to a change in the timing of migration of adult and juvenile delta smelt.

Effects of the Proposed Action

Introduction

The Status of the Species/Environmental Baseline section of this document described the multitude of factors that affect delta smelt population dynamics including predation, contaminants, introduced species, entrainment, habitat suitability, food supply, aquatic macrophytes, and *microcystis*. The extent to which these factors adversely affect delta smelt is related to hydrodynamic conditions in the Delta, which in turn are controlled to a large extent by CVP and SWP operations. Other sources of water diversion (NBA, CCWD, local agricultural diversions, power plants) adversely affect delta smelt largely through entrainment (see following discussion), but when taken together do not control hydrodynamic conditions throughout the Delta to any degree that approaches the influence of the Banks and Jones export facilities. So while many of the other stressors that have been identified as adversely affecting delta smelt were not caused by CVP and SWP operations, the likelihood and extent to which they adversely affect delta smelt is highly influenced by how the CVP/SWP are operated in the context of annual and seasonal hydrologic conditions. While research indicates that there is no single primary driver of delta smelt population dynamics, hydrodynamic conditions driven or influenced by CVP/SWP operations in turn influence the dynamics of delta smelt interaction with these other stressors (Bennett and Moyle 1996).