From:	Matt Moses
To:	sha-MPR-RemandSEP
Cc:	Leah Orloff; Wendy Chriss; Milligan, Ronald E
Subject:	RE: CCWD stakeholder input on remand BiOps
Date:	Friday, September 21, 2012 4:42:18 PM
Attachments:	omr_flow_index.pdf

Attached is the referenced submittal to the State Water Resources Control Board. Please call with any questions.

Matt

From: Matt Moses
Sent: Friday, September 21, 2012 4:36 PM
To: 'RemandSEP@usbr.gov'
Cc: Leah Orloff; Wendy Chriss; 'Milligan, Ronald E'
Subject: CCWD stakeholder input on remand BiOps

Reclamation Team,

CCWD comments on the draft Project Description are attached. Because of file size limitations for email attachments, we are only attaching pages 1 – 57 of the Project Description, which contain all CCWD comments. Please call me at the number below if you have any problems with the attached files.

Regards,

Matt

Matt Moses, P.E.
Senior Water Resources Specialist
Contra Costa Water District
1331 Concord Avenue
Concord, CA 94524-2099
(925) 688-8106
(925) 688-8142 fax

<< File: Remand stakeholder process - CCWD comments on PD 9-21-12.pdf >> << File: Project_Description_2011_Remand_LTO_9-10-12 CCWD edits excerpts.docx >> << File: omr_flow_index_ltr.pdf >>

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Transmitted by email to RemandSEP@usbr.gov

September 21, 2012

Sue Fry
Bureau of Reclamation
Bay-Delta Office
801 I Street Suite 140
Sacramento, CA 95814-2536

Subject: Stakeholder Comments on the Project Description for the Coordinated Long-Term Operations of the Central Valley Project and State Water Project

Dear ~~Ms. Fry~~: Sue

Contra Costa Water District (CCWD) appreciates this opportunity to provide input through the Remand Stakeholder Engagement Process for the remanded Biological Opinions (remand BiOps) for the coordinated long-term operation of the Central Valley Project (CVP) and State Water Project (SWP). CCWD is providing comments and suggestions on the draft Project Description for your consideration, and we look forward to working on them with you throughout this process.

Our three major comments on the Project Description are summarized below, and an edited version of the draft Project Description is attached with proposed changes shown in tracked-changes format.

CCWD operations are covered under separate consultation

The environmental effects of CCWD water diversions at four intakes in the Delta are covered under Biological Opinions (BiOps) issued by the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) specifically for operations of the CCWD system. These BiOps impose operational constraints that are distinct from the requirements of the remand BiOps, and provide take coverage specific to operations of the CCWD system. CCWD operations are therefore fully covered outside of the remanded BiOps for Coordinated Long-Term Operations of the CVP and SWP. We have edited the section entitled "Contra Costa Water District Diversion Facilities" to clarify this point, and also to improve the description of CCWD's facilities and operations.

Determination of Compliance with Old and Middle River Flow Requirements Should Be Improved

The draft Project Description includes a section describing real-time decision making to assist fishery management; such decision making may include setting objectives for net flows in Old and Middle Rivers (OMR). In the event that it does, compliance with OMR objectives should be measured using an index based upon San Joaquin River flow at Vernalis, total exports at the Banks and Jones pumping plants, and the position of the Head of Old River Barrier Such an index can be shown to provide protection for the target species commensurate with the protection provided by measuring compliance using the sum of the daily averaged tidally filtered United States Geological Survey (USGS) flow measurements on Old and Middle Rivers, and it will address the issues of difficulty in implementation and lack of transparency associated with the use of the USGS data to measure compliance with OMR objectives. CCWD's September 14, 2012 submittal to the State Water Resources Control Board for Workshop 2 of the Delta flow objective processes addresses these issues in detail and is attached for your reference. We have inserted a brief section entitled "Measurement of Compliance with Old and Middle River Flow Objectives" in the Project Description, and would be happy to work with you to expand it if desired.

More Detail is Required for a Complete Review of Project Description

As noted, CCWD appreciates the opportunity to review the draft Project Description. However, our review indicated that insufficient information is provided to fully understand the effects of the proposed actions. More detailed information on future operations of the CVP and SWP under the BiOps is needed; the details required to perform a modeling analysis of the operations using the CalSim II and DSM2 models would be appropriate to include in the Project Description.

Thank you for this opportunity to provide comments on the draft Project Description. If you have any questions, please call me at (925) 688-8083, or call Matt Moses at (925) 688-8106.

Sincerely,

Leah Orloff
Water Resources Manager

LO/MM:wec

Attachments

cc: Ron Milligan, Bureau of Reclamation

Project Description for the Central Valley Project and State Water Project

Introduction

Reclamation and DWR propose to continue to operate the CVP and SWP to divert, store, and convey Project water consistent with applicable law. See map in Figure 2-1. The CVP's major storage facilities are Shasta, Trinity, Folsom and New Melones. The upstream reservoirs release water to provide water for the Delta of which can be exported a portion through Jones pumping plant to store in the joint reservoir San Luis or deliver down the Delta Mendota Canal. The SWP owns Lake Oroville upstream and releases water for the Delta that can be exported at Harvey O. Banks Pumping Plant (Banks) for delivery through the California Aqueduct. These operations are summarized in this BA with more detail.

The Proposed Action

The proposed action is the continued operation of the CVP and SWP. The proposed action includes the operation of the temporary barriers project in the south Delta and the 500 cfs increase in SWP Delta export limit July through September. In addition to recent historic operations, several other recent 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) changes in the operation of the Red Bluff Diversion Dam (RBDD), ~~(4) Middle River Intake Project for CCWD,~~ and (~~5~~4) minor operational changes that are identified in this chapter. The other actions will come online at various times in the future. As stated in Chapter 1, inclusion of future actions in the project description of this BA does not constitute a decision to take that action.

Comment [A1]: Middle River Intake is not operated by CVP or SWP. It is operated by CCWD, and that operation is covered by separate USFWS and NMFS BiOps and DFG ITP.

All site-specific/localized activities of the actions such as construction/screening and any other site-specific effects will be addressed in separate action-specific section 7 consultations. In addition, DWR will need to consult with the California Department of Fish and Game (DFG), as may be appropriate, to address applicable requirements of the State Endangered Species Act. This BA may assist DWR and DFG in their consultation to ensure that DWR is in compliance with the State ESA.

Table 2-1 summarizes the differences between current operational actions and future operational actions to be covered by this consultation. A detailed summary of all operational components and associated modeling assumptions are included in Table 9-5.

Table 2-1 Major Proposed Future Operational Actions for Consultation.

Area of Project	Today 2011	Future 2030
Trinity & Whiskeytown	Trinity Restoration Flows 368,600-815,000 af	Same
Shasta/Sacramento River	Red Bluff Diversion Dam (RBDD) 8 months gates out	New RBDD Operation 10 months gates out with pumping plant
Oroville and Feather River	Old FERC License and NMFS 2004 BO	Expect New FERC License
Folsom and American River	Current Demands	Build out of demands, New American River Flow Management, and Freeport Regional Water Project
New Melones and Stanislaus River	Interim Plan of Operations Guidance	Interim Plan of Operations Guidance
Friant Division	Historic Operations	Same
Sacramento-San Joaquin Delta	Current Demands	2030 Demands
Suisun Marsh	Same	Expect to Implement New Charter
WQCP	D-1641	Same
COA	1986 Guidance	Same
CVPIA	May 9, 2003 Decision	Same
Banks Pumping Plant	6680* cfs and Temporary Barriers	6680* cfs and Temporary Barriers
Jones Pumping Plant	Max of 4600 cfs with Flexibility of Intertie	Max 4600 cfs with Flexibility of Intertie

- This diversion rate is normally 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, one-third of the San Joaquin River flow at Vernalis may be pumped in addition. Furthermore, the SWP is 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.

Figure 2-1 Map of California CVP and SWP Service Areas

Coordinated Operation 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 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 Projects, 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). Each project is 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 SWP[1]. When unstored water is

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

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 also 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 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.

Changes in Coordinated Operation Since 1986

Implementation of the COA principles has continuously evolved since 1986 as changes have occurred to CVP and SWP facilities, to project operations criteria, and to the overall physical and regulatory environment in which the coordination of CVP and SWP operations takes place. Since 1986, new facilities have been incorporated into the operations that were not part of the original COA. New water quality and flow standards (D-1641) have been imposed by the SWRCB; the CVPIA has changed how the CVP is operated; and finally, the Federal Endangered Species Act (ESA) responsibilities have affected both the CVP and SWP operations. The following is a list of significant changes that have occurred since 1986. Included after each item is an explanation of how it relates to the COA and its general effect on the accomplishments of the Projects.

Sacramento River Temperature Control Operations

Water temperature control operations have changed the pattern of storage and withdrawal of storage at Shasta, Trinity, and Whiskeytown, for the purpose of improving temperature control and managing coldwater pool resources in the facilities. Water temperature operations have also constrained rates of flow, and changes in rates of flow below Keswick Dam in keeping with water temperature requirements. Such constraints have reduced the CVP's capability to respond efficiently to changes in Delta export or outflow requirements. Periodically, temperature requirements have caused the timing of the CVP releases to be significantly mismatched with Delta export capability, resulting in loss of water supply. On occasion, and in accordance with Articles 6(h) and 6(i) of the COA, the SWP has been able to export water released by the CVP for temperature control in the Sacramento River. The installation of the Shasta temperature control device has significantly improved Reclamation's ability to match reservoir releases and Delta needs.

Bay-Delta Accord, and Subsequent SWRCB Implementation of D-1641

The 1994 Bay-Delta Accord committed the CVP and SWP to a set of Delta habitat protective objectives that were eventually incorporated into the 1995 Water Quality Control Plan (WQCP), and later, along with the Vernalis Adaptive Management Plan (VAMP), were included by the SWRCB in D-1641 amending the water rights of the Projects. The actions taken by the CVP and SWP in implementing D-1641 significantly reduced the export water supply of both Projects. Article 11 of the COA describes the options available to the United States for responding to the establishment of new Delta standards.

Project operators must coordinate the day-to-day operations of the CVP and SWP to perform to the Projects water rights. The 1986 COA sharing formula has been used by Project operators for D-1641 Delta outflow and salinity based standards. SWRCB D-1641 contains significant new "export limitation" criteria such as the export to inflow (E/I) ratios and San Joaquin River pulse period "export limits". The 1986 COA framework never contemplated nor addressed the application of such criteria to CVP and SWP permits. When the E/I or pulse period export restrictions control Project operations, project operators attempt to utilize "equity principles" to determine how to comply with D-1641 standards. In most cases, the rate of export is attempted to be evened out over the restricted period. In some cases, a seasonal time shift of the SWP exports can occur to help facilitate an equitable sharing of responsibilities. Until the COA is updated to reflect SWRCB D-1641 conditions, project operators must continually work on a case-by-case basis in order to meet the Projects' combined water right requirements.

North Bay Aqueduct

North Bay Aqueduct, as described above, is a SWP feature that can convey up to about 175 cfs diverted from the SWP's Barker Slough Pumping Plant. North Bay Aqueduct Diversions are conveyed to Napa and Solano Counties. Pursuant to an agreement between Reclamation, DWR, and the CVP and SWP contractors in 2003, a portion of the SWP diversions will be treated as an export in COA accounting.

Freeport Regional Water Project

The FRWP is a new facility that will divert up to a maximum of 286 cubic feet per second (cfs) from the Sacramento River near Freeport for Sacramento County and East Bay Municipal Utility District (EBMUD). 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.

Loss of 195,000 af of D-1485 Condition 3 Replacement Pumping

The 1986 COA affirmed the SWP's commitment to provide replacement capacity to the CVP to make up for May and June pumping reductions imposed by SWRCB D-1485 in 1978. In the evolution of COA operations since 1986, SWRCB D-1485 was superseded by SWRCB D-1641 and SWP water demand growth and other pumping constraints have reduced the available surplus capacity at Banks Pumping Plant. The CVP has not received replacement pumping since 1993. Since then there have been (and in the current operations environment there will continue to be) many years in which the CVP will be limited by insufficient Delta export capacity to convey its water supply. The loss of the up to 195,000 af of replacement pumping capacity has diminished the water delivery anticipated by the CVP under the 1986 COA framework. The diminished water delivery accomplishments results in a charge to CVPIA (b)(2) water.

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 workshop 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 change 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 each project 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 2-2 and Figure 2-3 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 2-2 (Summary Bay-Delta Standards), Figure 2-3 (Footnotes for Summary Bay-Delta Standards), and Figure 2-4 (CVP/SWP Map).

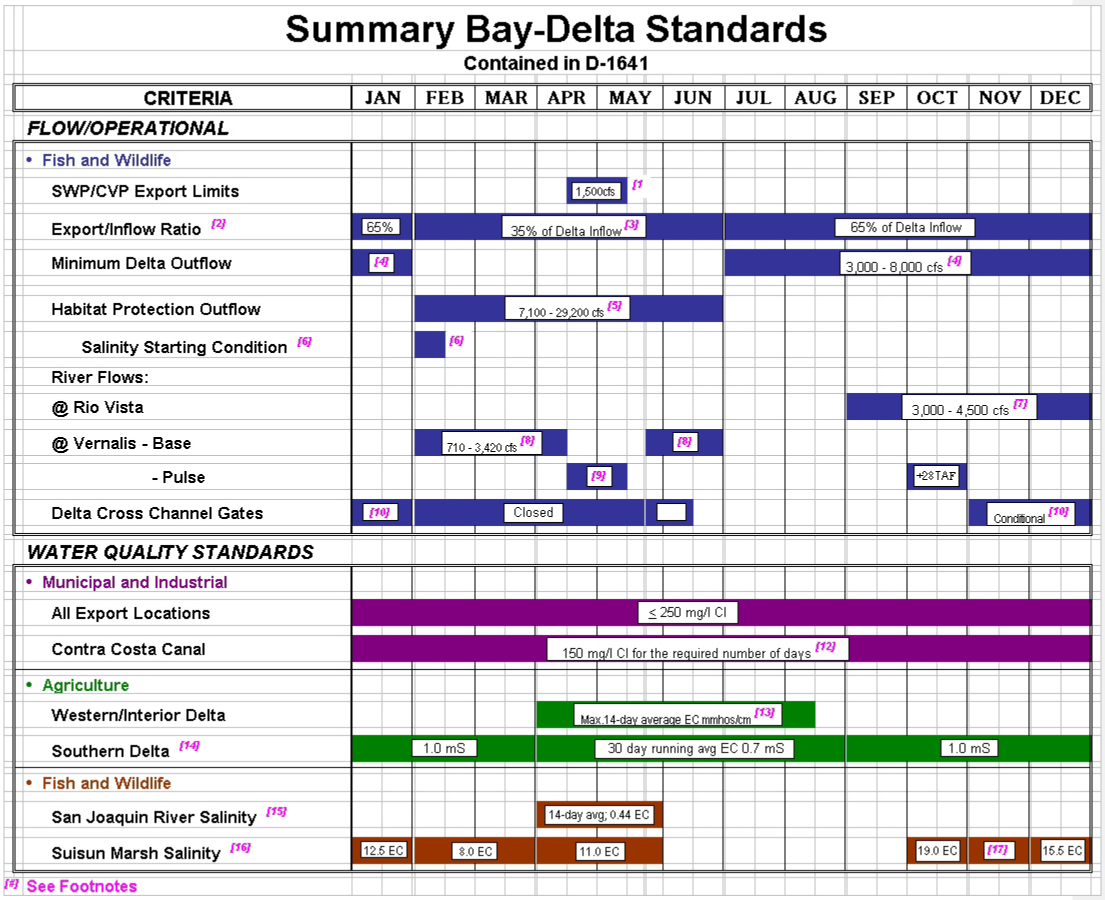

Figure 2-2 Summary Bay Delta Standards (See Footnotes below)

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 8RI.

Jan 8RI	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 8RI 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 8RI 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 8RI > 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 8RI 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

(Footnotes continued on next page)

[13] The maximum14-day running average of mean daily EC (mmhos/cm) depends on water year type.

	WESTERN DELTA				INTERIOR DELTA			
	Sac River @ Emmaton		SJR @ Jersey Point		Mokelumne R @ Terminous		SJR @ San Andreas	
Year Type	0.45 EC from April 1 to date shown	EC value from date shown to Aug15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug15 *	0.45 EC from April 1 to date shown	EC value from date shown to Aug15 *
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 ≤ 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 8RI. 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 day's for values of the PMI between those specified below shall be determined by linear interpolation.

PMI	Chipps Island (Chipps Island Station D10)				
(TAF)	FEB	MAR	APR	MAY	JUN
≤ 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	28
5000	28	31	30	31	29
5250	28	31	30	31	29
≥ 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	Port Chicago (continuous recorder at Port Chicago)				
(TAF)	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 2-3 Footnotes for Summary Bay Delta Standards

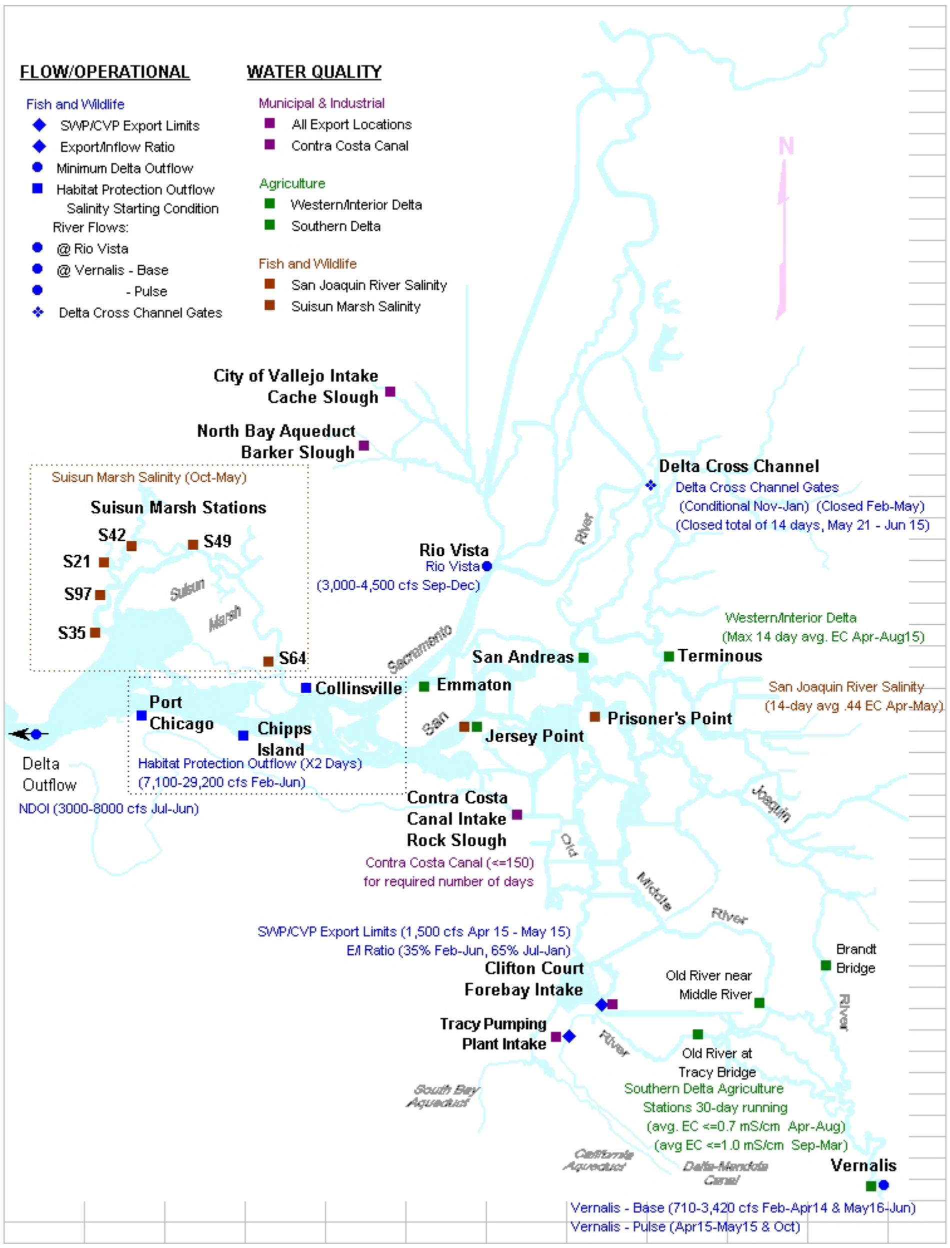

Figure 2-4 CVP/SWP Delta Map

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.

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 location west of certain compliance locations consistent with the 1993 Los Vaqueros Biological Opinion (BO) 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 relies in part on the 2004 and 2005 Biological Opinions. Once this consultation is complete, the Fisheries Response Plan will be re-examined. If modifications are required, the plan will 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.

- 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 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 our water operations while protecting listed species. Applying real time decision-making to assist fishery management to the proposed action requires the definition of management goals and a mechanism for new information and scientific understanding to be used in changing our operations to better meet the goals.

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 FWS, 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, FWS, 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 project. 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, and water supply reliability. To facilitate such decisions, the Project Agencies and the fishery agencies (consisting of FWS, 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, and the fishery agencies. 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, physical habitat conditions, 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. In the event it is not possible to refine the proposed action in order that it does not violate section 7(a)(2) of the ESA, the Project and fisheries agencies will reinitiate consultation.

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

Measurement of Compliance with Old and Middle River Flow Objectives

If protective actions include objectives for net flow in Old and Middle Rivers (OMR), compliance with those objectives will be measured using an index based upon San Joaquin River flow at Vernalis, total exports at the Banks and Jones pumping plants, and the position of the Head of Old River Barrier, provided that such an index can be shown to provide protection for the target species commensurate with the protection provided by measuring compliance using the sum of the daily averaged tidally filtered United States Geological Survey (USGS) flow measurements on Old and Middle Rivers. This method of measuring compliance will address the issues of difficulty in implementation and lack of transparency associated with the use of the USGS data to measure compliance with OMR objectives.

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 eight times a year in a public setting so that the agencies can inform each other and stakeholders about current 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 frequently[2] 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.

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

Operations and Fishery Forum

The Operations and Fishery Forum (OFF) was established as an ad-hoc stakeholder-driven process to disseminate information regarding recommendations and decisions about the operations of the CVP and SWP. OFF members are considered the contact person for their respective agency or interest group when information regarding take of listed species, or other factors and urgent issues need to be addressed by the CALFED Ops Group. Alternatively, the OFF may be directed by the CALFED Ops Group to develop recommendations on operational responses for issues of concern raised by member agencies.

B2 Interagency Team (B2IT)

The B2IT was established in 1999 and consists of technical staff members from the Project agencies. The B2IT meets weekly to discuss implementation of section 3406 (b)(2) of the CVPIA, which defines the dedication of CVP water supply for environmental purposes. It 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 (Working Group): The Working Group evaluates biological and technical issues regarding delta smelt and develops recommendations for consideration by the FWS. Since the longfin smelt became a state candidate species in 2008, the Working Group has also developed for DFG recommendations to minimize adverse effects to longfin smelt. The Working Group consists of representatives from FWS, DFG, DWR, EPA, and Reclamation. FWS chairs the group, and a member is assigned by each agency.

The Smelt Working Group will compile and interpret 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 working group will submit their recommendations in writing to FWS and DFG.

The working group may meet at any time at the request of FWS, but generally meets weekly during the months of January through June, when smelt salvage at CVP and SWP has occurred historically. However, the Delta Smelt Risk Assessment Matrix (see below) outlines the conditions when the Working Group will convene to evaluate the necessity of protective actions and provide FWS 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 Working Group 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 Working Group and will be modified by the Working Group with the approval of FWS and DFG, in consultation with Reclamation and DWR, as new knowledge becomes available. The currently approved DSRAM is provided for information in Appendix A.

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

Delta Operations Salmonid and Sturgeon (DOSS) Group: The DOSS workgroup is a technical team with relevant expertise from Reclamation, DWR, DFG, FWS, SWRCB, USGS, EPA, and NMFS that provides advice to WOMT and to NMFS on issues related to fisheries and water resources in the Delta and recommendations on measures to reduce adverse effects of Delta operations of the CVP and SWP to salmonids and green sturgeon. The purpose of DOSS is to provide recommendations for real-time management of operations to WOMT and NMFS; review annually project operations in the Delta and the collected data from the different ongoing monitoring programs; and coordinate with the SWG to maximize benefits to all listed species.

American River Group: In 1996, Reclamation established a working group for the Lower American River, known as 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, FWS, NMFS, and DFG.

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

Operations Technical Teams

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

Delta Cross Channel (DCC) 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, FWS, NMFS, and the DFG, and possibly others as needs change. The interagency team will meet through a conference call, approximately once a week. DWR will be responsible for providing predictive modeling, and SWP Operations Control Office will provide operations forecasts and the conference call line. 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 FWS will generally rely on the SWG for recommendations regarding gate operations.

Uses of Environmental Water Accounts

CVPIA Section 3406 (b)(2)

On May 9, 2003, 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 habitat restoration action based on recommendations of the FWS (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 helps 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) actions are done cooperatively and occur 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 this BA 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 (**Error! Reference source not found.**). 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.

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 temperature criteria formalized in the 1993 NMFS Winter-run BO 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. 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. The ARG is another forum to discuss criteria for flow fluctuations. Since 1996 the group has provided input on a number of operational issues and has served as an aid towards adaptively managing releases, including flow fluctuation and stability, and managing water temperatures in the Lower American River to meet the needs of salmon and steelhead.

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 below 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. The volume determined by the IPO is a combination of fishery flows pursuant to the 1987 DFG Agreement and the FWS 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, 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.

Yuba Accord - Component 1 Water

Component 1 Water under the Yuba Accord can provide up to approximately 48,000 AF of replaced supply to cover the water costs of various fishery protection actions taken by the SWP and CVP. Component 1 water comprises the release of 60,000 AF annually from the Yuba River and ultimately to the Delta. After accounting for reasonable carriage water costs, an estimate of 48,000 AF of increased diversion in the Delta would occur during July, August, and September of each year.

In years where capacity to pump the Yuba Accord Component 1 Water is not available under the normal 6680 cfs maximum diversion capacity into Clifton Court Forebay (CCF).

The maximum allowable daily diversion rate into CCF during the months of July, August, and September will be increased 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 expires on September 30, 2012**,** but is expected to be renewed into the future. 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 90,000 AF each year. Increased diversions above the 48 taf discussed in the previous section (Environmental Water Account) 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%.
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 assets will be applied to earlier export reductions made due to the ESA or other actions taken to benefit fisheries resources that exceeded 48 TAF or held in the SWP share of San Luis Reservoir, as long as space is available, to be applied to subsequent export reductions made due to the ESA or other actions taken to benefit fisheries resources.

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 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.
4. Between July 1 and September 30, if the combined salvage of listed fish species reaches a level of concern, the relevant fish regulatory agency will determine whether the 500 cfs increased diversion is or continues to be implemented.

Central Valley Project

Project Management Objectives

Facilities are operated and maintained by local Reclamation area offices, with operations overseen by the Central Valley Operations Office (CVOO) at the Joint Operations Center in Sacramento, California. The CVOO is responsible for recommending CVP operating policy, developing annual operating plans, coordinating CVP operations with the SWP and other entities, establishing CVP-wide standards and procedures, and making day-to-day operating decisions.

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. Among the changes mandated by the CVPIA are:

- 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 (BOs) were issued on November 21, 2000.

Operations of the CVP reflect provisions of the CVPIA, particularly sections 3406(b)(1), (b)(2), and (b)(3). On May 9, 2003, Interior issued its decision on Implementation of Section 3406 (b)(2) of the CVPIA. The CVPIA Section 3406 (b)(2) Implementation Team (B2IT) formulates recommendations for implementing upstream and Delta actions with CVP delivery capability.

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

In most years, the combination of carryover storage and runoff into CVP reservoirs is sufficient to provide the water to meet CVP contractors' demands. Since 1992, increasing constraints placed on operations by legislative and ESA requirements have removed significant operational flexibility to deliver water to all CVP contractors. This reduction in flexibility has its greatest allocation effect on CVP water service contractors south of the Delta.

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 water year progresses. Beginning February 1, forecasts of water year 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) Wildlife refuges, (6) San Joaquin River Exchange settlement contractors, and (7) 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 3 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 2-4.

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.

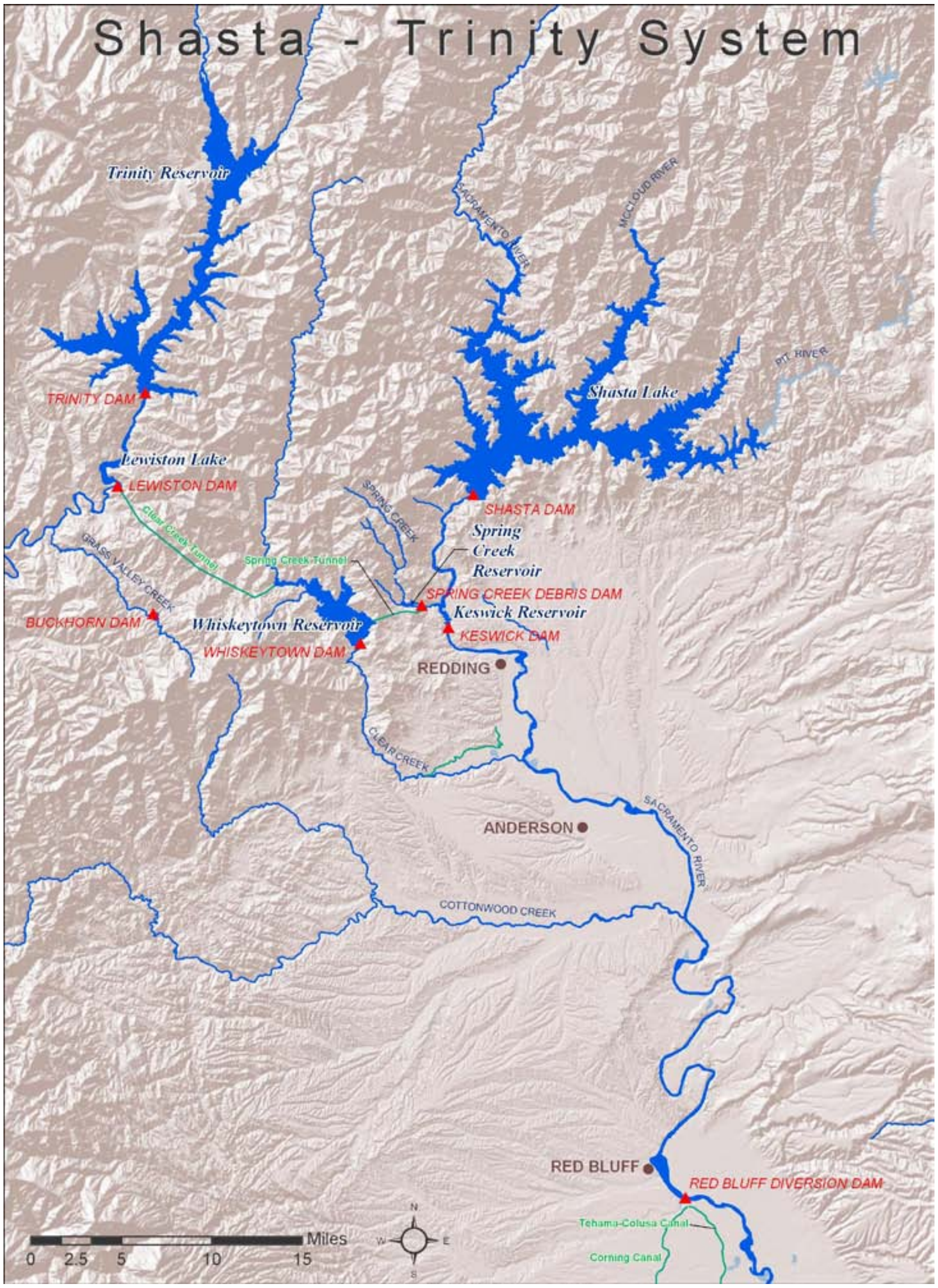

Figure 2-4 Shasta-Trinity System

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 often 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 from 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 the 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 Main-stem Fishery Restoration ROD, dated December 19, 2000, from 368,600 af to 815,000 af is allocated annually for Trinity River flows. This amount is scheduled in coordination with the U.S. Fish and Wildlife Service (FWS) 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. See also Table 2-5 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 September 30. 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 FWS in establishing a schedule of releases from Lewiston Dam that can best achieve these objectives.

For the purpose of determining the Trinity Basin water year 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 water year 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 temperature management for the diversions to Clear Creek Tunnel.

Table 2-5 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 2-5). 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.

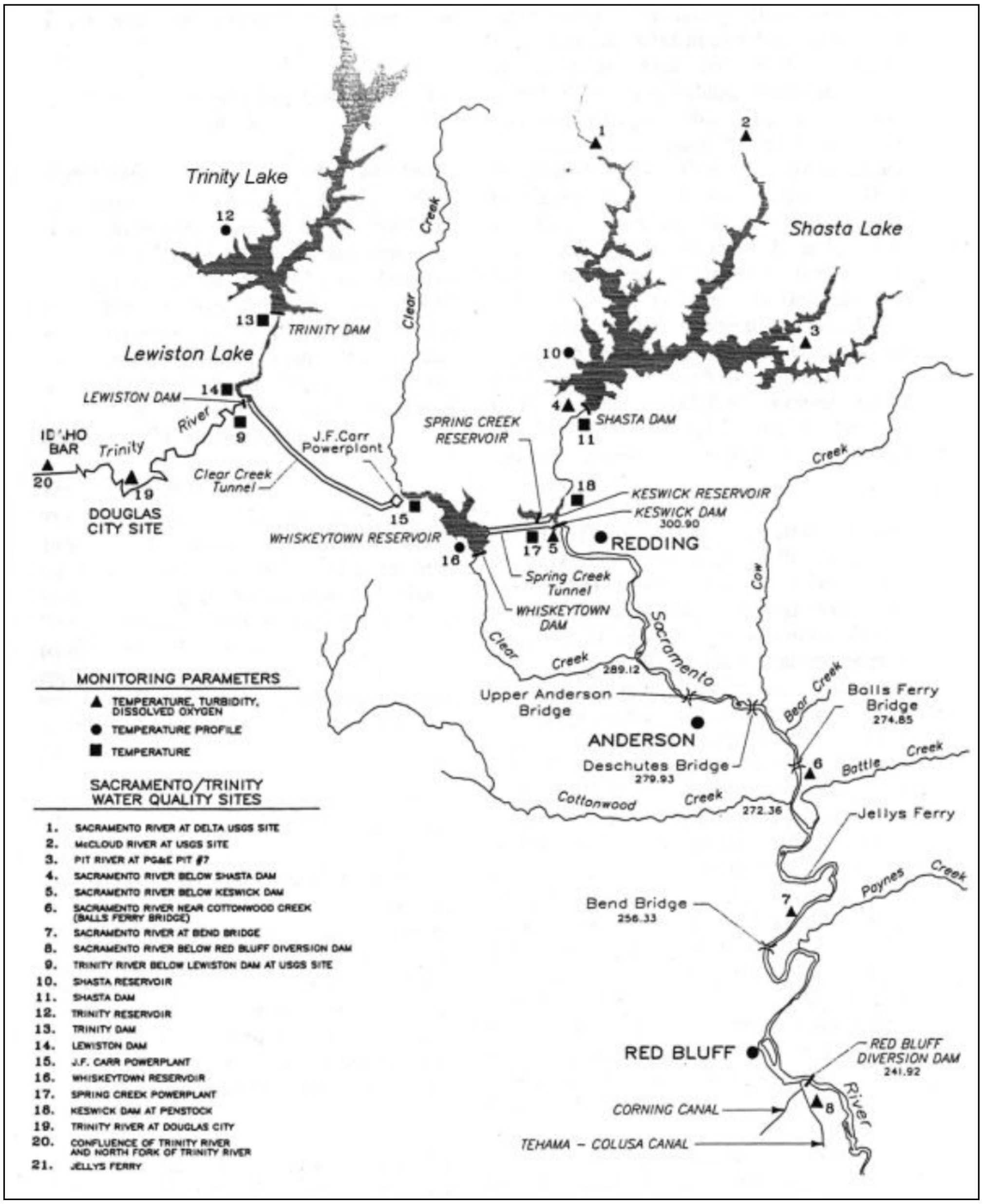

Figure 2-5 Sacramento-Trinity Water Quality Network (with river miles [RM]).

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 water year carryover on a case-by-case basis in dry and critically dry water year types with FWS 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 are two temperature curtains in Whiskeytown Reservoir.

Spillway Flows below Whiskeytown Lake

Whiskeytown Lake is annually drawn down approximately 35,000 af 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 2-6 below.

Table 2-6 Days of Spilling below Whiskeytown and 40-30-30 Index from Water Year 1978 to 2010

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
1986	17	W

Water Year	Days of Spilling	40-30-30 Index
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
2008	0	C
2009	0	D
2010	6	BN

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 2-7.
- A 1963 release schedule for Whiskeytown Dam was developed with FWS and implemented, but never finalized. Although this release schedule was never formalized, Reclamation has operated according to this proposed schedule since May 1963.

Table 2-7 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. Given improved water quality in Spring Creek and at the SCDD site, a modified MOU is under consideration that could modify and update several monitoring requirements and would slightly modify operations of the SCDD.

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. 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 2-8). 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 2-8 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 operations 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 attempts to reduce 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, and the CalSim-II model used here incorporates these effects. The increased water demand for fall rice field flooding and decomposition on the Sacramento River during this timeframe affects Reclamation’s ability to maintain a stable base flow.

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 and is consistent with past biological opinion 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 for 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, FWS, 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 Temperature Control Device (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 2-9). 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 2-9 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 will 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 developed in coordination with the Sacramento River Temperature Task Group (SRTTG). 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 ACIDs 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 improve passage conditions for winter-run Chinook salmon and spring-run Chinook salmon. As documented in the 2004 NMFS biological opinion addressing the long-term CVP and SWP operations and in the recent past, the gates are raised from approximately September 15 through May 14, each year. Future gate operations are further modified by the Red Bluff Fish Passage Improvement Project as detailed below.

Red Bluff Fish Passage Improvement Project and Red Bluff Diversion Dam Pumping Plant

Reclamation signed a ROD on July 16, 2008 for the Red Bluff Fish Passage Improvement Project. The project includes reoperation of the RBDD to allow future unrestricted fish passage and features construction of a new pumping plant to enhance pumping capacity while the RBDD gates are open. Reclamation completed ESA section 7 consultations with FWS and the NMFS to address construction and operation of the new pumping plant at a maximum capacity of 2,500 cfs.

The new pumping plant is currently under construction, and is scheduled to be operational by May 2012. In 2009 Reclamation agreed to only operate the RBDD with the gates in from June 15 to August 31 during the construction of the new pumping plant. In the absence of any unforeseen or unavoidable pumping plant construction delays, the RBDD will be operated with gates out permanently after May 15, 2012.

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 2-6.

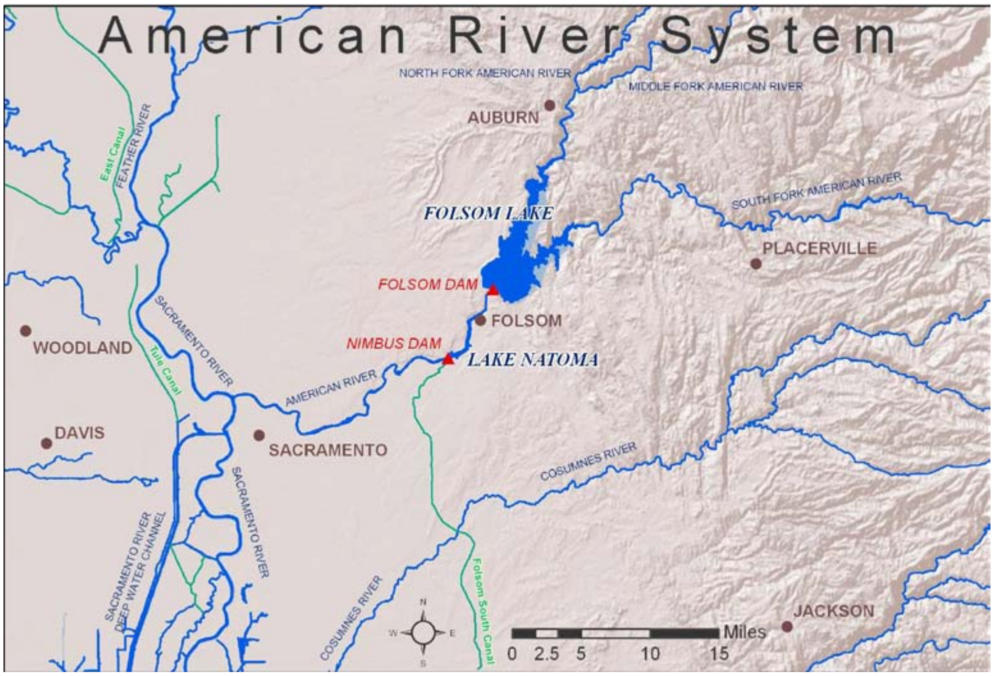

Figure 2-6 American River System

Table 2-10 provides Reclamation’s annual water deliveries for the period 2000 through 2010 in the American River Division. The totals reveal an increasing trend in water deliveries over that period. For this Biological Assessment, present level of American River Division water demands are modeled at 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 2-10 Annual Water Delivery - American River Division

Year	Water Delivery (taf)[1]
2000	174
2001	223
2002	221
2003	270
2004	266

2005	297
2006	280
2007	113
2008	233
2009	260
2010	125

1 Annual Water Delivery data has been enhanced and the annual totals include CVP contracts, water rights and other deliveries.

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, 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 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 the Folsom unit 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 thousand af 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 Reservoir storage permitted to fill completely on June 1.

Reclamation and the Corps are jointly working on construction of an auxiliary spillway that will assist in meeting the established flood damage reduction objectives for the Sacramento area (at least 1-in-200-year flood protection) while continuing to preserve and expedite safely passing the Probable Maximum Flood. This project is commonly referred as the Joint Federal Project. Other partners in this project include the Department of Water Resources and SAFCA.

The Corps is also undertaking a Folsom Dam Reoperation Study to develop, evaluate, and recommend changes to the flood control operations of the Folsom Dam project that will further the goal of reduced flood risk for the Sacramento area. Operational changes may be necessary to fully realize the flood risk reduction benefits of the additional operational capabilities created by completion of the Joint Federal Project, and the increased system capabilities provided by the implemented and authorized features of the Common Features Project (a project being carried by the Corps designed to strengthen the American River levees so they can safely pass a flow of 160,000 cfs), and those anticipated to be provided by completion of the authorized Folsom Dam Mini-Raise Project. The Folsom Dam Reoperation Study will also consider improved forecasts from the National Weather Service. Once a modified flood operation plan is complete, the Corps, in cooperation with Reclamation, will consult with FWS and NMFS relative to any changes to American River and/or system-wide CVP operations that may result.

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 water year 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.

In July 2006, Reclamation, the Sacramento Area Water Forum and other stakeholders completed a draft technical report establishing a flow regime intended to improve conditions for fish in the lower American River (i.e., the Lower American River Flow Management Standard [FMS]). Reclamation began operating to the FMS immediately thereafter. Reclamation continues to operate to this flow regime and the modeling assumptions herein include the operational components of the recommended Lower American River flows consistent with the proposed FMS (Appendix A). 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, if necessary.

Use of additional (b)(2) flows above the proposed flow standard is envisioned only 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 water year. 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.

A major challenge is determining the starting date at which time the objective is met. 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 operations 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 as discussed earlier in this Chapter.

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 Folsom Dam standard operations involve 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 water temperature conditions, and the benefits to the cold water pool and determined that the spillway gates should be used to make the incremental releases above powerplant capacity, thereby conserving cold water for later use. The ability and necessity to take similar actions 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 Water Supply Intake TCD operations

A series of shutter management scenarios are then incorporated into the model to gain a better understanding of the potential for meeting water temperature needs for both over-summer rearing steelhead and spawning Chinook salmon in the fall. Most annual strategies contain significant tradeoffs and risks for water temperature management for steelhead and fall–run Chinook salmon goals and needs due to the frequently limited coldwater 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 American River Group (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 water temperature target at the downstream end of the compliance reach (i.e., Watt Avenue Bridge) while at the same time reserving the final shutter pull for fall-run Chinook salmon, or in some cases, continue to meet steelhead over-summer rearing 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 Folsom Water Supply Intake TCD has provided additional flexibility to conserve cold water for later use. As anticipated, the TCD has been operated during the summer months and delivers 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. Water 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. In years when mean daily water temperatures are forecast to approach 70°F, a significant number of steelhead may be released early in the summer. Stocked fish have the opportunity to find suitable rearing habitat within the river and reduced densities result in lower mortality in the group of fish that remain in the hatchery.

Reclamation operates Nimbus Dam to maintain the health of the hatchery fish while minimizing the loss of the coldwater pool for fish spawning in the river during fall. Evaluation of Nimbus Dam operations is done on a case-by-case basis and is different in various months and year types. Water temperatures above 70°F in the hatchery usually mean the fish need to be moved to another hatchery or released to the river. 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 FWS, NMFS, and DFG through B2IT when these types of difficult decisions are needed. In addition, Reclamation communicates with the American River Group (ARG) on real time data and operational tradeoffs.

A fish diversion weir at the hatcheries 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. Reclamation released the final environmental documentation in August 2011 that selected an alternative to extend the existing fishway up to Nimbus Dam as the solution to the issues associated with the weir. Construction of the new fishway is expected to begin in 2014.

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. Compete 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 (formerly Tracy 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 2-7.

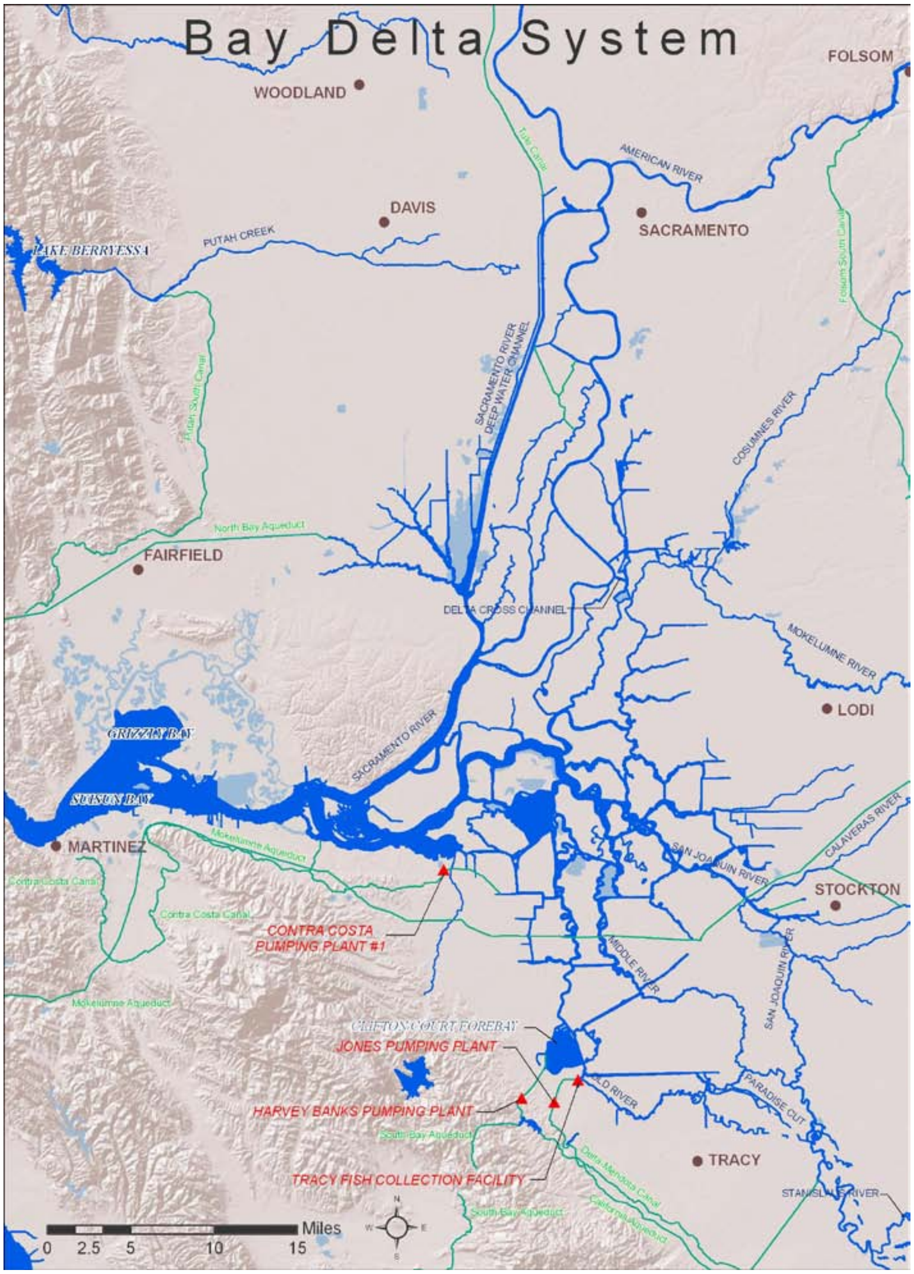

Figure 2-7. Bay-Delta System.

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. Because alternative routes around the DCC are quite long, Reclamation tries to provide adequate notice of DCC closures so boaters may plan for the longer excursion.

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 FWS, DFG, and NMFS. These discussions will occur through WOMT as part of the weekly review of CVP/SWP operations.

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 (see Appendix B) 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 the fishery agencies and project operators 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 life stage 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 and is expected to be used in the present or modified form in the future.

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 TFCF) 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 4,500 to 4,300 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 on page **Error! Bookmark not defined.**. The winter-time constraints at the Jones Pumping Plant are the result of a DMC freeboard constriction between Jones Pumping Plant and 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 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 2-8, 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.

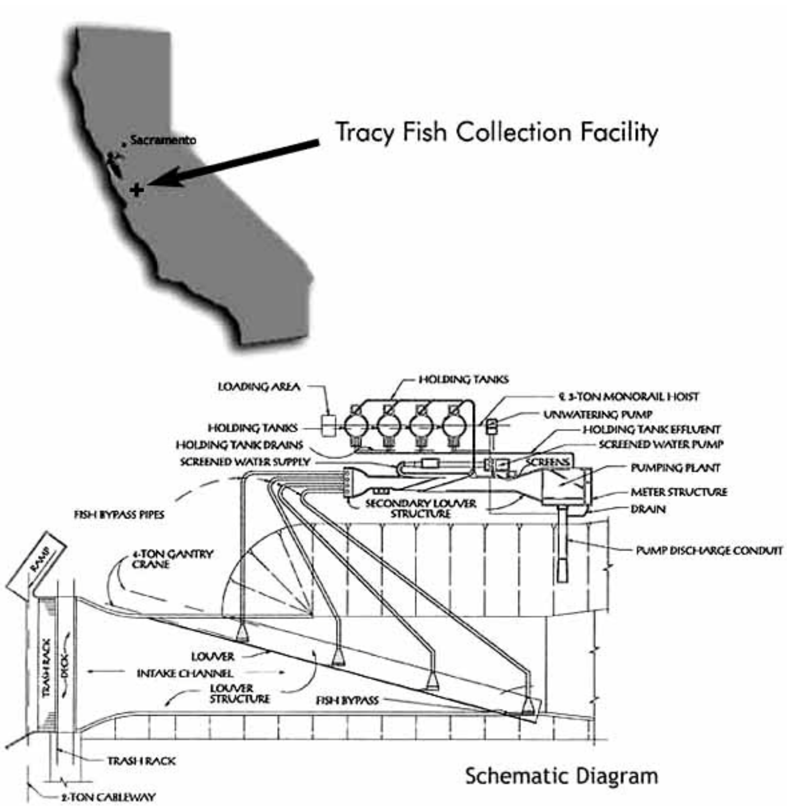

Figure 2-8 Tracy Fish Collection Facility Diagram

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 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 federal ESA BO objectives of achieving water approach 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 few fish are present, sampling intervals will be 10 minutes every 2 hours. Fish observed during sampling intervals are identified by 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, TFCF personnel are presently required, per the court order, to 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.

DFG is leading studies to look at fish survival during the Collection, Handling, Transportation and Release (CHTR) process examining delta smelt injury, stress, survival, and predation. Thus far they have presented initial findings at various interagency meetings (IEP, CVFFRT, and AFS) showing relatively high survival and low injury. Final reports are forthcoming and should be finished within the next year. DWR has concurrently been conducting focused studies examining the release phase of the salvage process including a study examining predation at the point of release and a study examining injury and survival of delta smelt and Chinook salmon through the release pipe. Data analyses for these studies are ongoing and reports should be available in early 2009. Based on these studies, improvements to release operations and/or facilities studies are being implemented.

There does not appear to be any previously generated information on present day efficiencies other than some very limited Tracy Research work for salmon that needs to be redone. The last efficiency and survival studies were the original studies when they were designing and testing the louver concept back in the 1950s/1960s. DFG and USFWS (Jerry Morinaka and Gonzalo Castillo, PI's) have recently begun a 3 year study examining pre-screen loss and facility/louver efficiency for juvenile and adult delta smelt at the skinner fish facility. DWR has also conducted pre-screen loss and facility efficiency studies for steelhead with a final report due for publication in the early fall 2008.

Contra Costa Water District Diversion Facilities

Contra Costa Water District (CCWD) diverts water from the Delta for irrigation and M&I uses under its CVP contract and under its own water right permits and license~~,~~ issued by the State Water Resources Control Board (SWRCB). CCWD's water system includes ~~intake facilities on~~the Mallard Slough Intake, Rock Slough Intake, Old River Intake, and Middle River Intake on Victoria Canal; the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir. The Rock Slough ~~intake~~ Intake facilities, the Contra Costa Canal, and the shortcut pipeline are owned by Reclamation, and operated and maintained by CCWD under contract with Reclamation. ~~Construction of t~~The fish screen at the Rock Slough intake ~~was completed by Reclamation in 2011~~is undergoing start-up testing as of September 2012. Mallard Slough Intake, Old River Intake, Middle 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 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 ~~d~~ water ~~rights~~ right license and permit (License No. 10514 and Permit No. 19856) authorize 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.

The Rock Slough Intake is located about four miles southeast of Oakley, where water flows through a positive barrier fish screen into the earth-lined portion of the Contra Costa Canal. The fish screen at this intake was constructed by Reclamation in accordance with the CVPIA and the 1993 FWS Biological Opinion for the Los Vaqueros Project, and is undergoing start-up testing as of September 2012. ~~Completed in 2011, t~~This new fish screen is expected to reduce take of fish through entrainment at the Rock Slough Intake. The Canal connects the fish screen at Rock Slough to Pumping Plant 1, approximately four miles to the west. The ~~earth-lined portion of the~~ Canal is earth-lined and open to tidal influence for approximately 3.7 miles from the Rock Slough fish screen. Approximately 0.3 miles of the Canal immediately east (upstream) of Pumping Plant 1 have been encased in concrete pipe, the first portion of the Contra Costa Canal Encasement Project to be completed. When completed, the Canal Encasement Project will eliminate tidal flows into the Canal, because the encasement pipe will be below the elevation of the tidal range. Pumping Plant 1 has capacity to pump up to 350 cfs into the concrete-lined portion of the Canal. Diversions at Rock Slough Intake are typically taken under CVP contract. With completion of the Rock Slough fish screen, CCWD may divert approximately 30 to 50 percent of its total supply through the Rock Slough Intake, depending on water quality.

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. The intake 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. Diversions at Old River to the Contra Costa Canal are typically taken under CVP contract ~~or under the District's Los Vaqueros water right (Permit 20749)~~. Pumping to storage in Los Vaqueros Reservoir is limited to 200 cfs by the terms of the Los Vaqueros Project biological opinions and by SWRCB Decision 1629, the SWRCB water right decision for the Los Vaqueros Project (Permit 20749). Diversions to storage in Los Vaqueros Reservoir are typically taken under CVP contract or under the Los Vaqueros water right permit. From 1998 through 2009, CCWD has diverted about 80 percent of its total supply through the Old River Intake; with the completion of the Rock Slough fish screen and Middle River Intake, the average percentage of CCWD supply diverted at Old River will decrease. The CCWD's water diversions that are not made at Rock Slough will now be split between the Middle River and Old River intakes, ~~contingent~~as -determined primarily by the CCWD water quality goals, as described below.

In 2010, CCWD completed construction of the Middle River Intake (formerly referred to as Alternative Intake Project~~,~~) on Victoria Canal. The Middle River Intake ~~consist of a~~has a capacity of ~~new~~ 250 cfs ~~capacity intake on Victoria Canal~~, with positive-barrier fish screens, and a conveyance pipeline to CCWD's existing conveyance facilities. ~~Similar to~~Like the Old River Intake, the Middle River Intake can be used to ~~either~~ pump either to the Contra Costa Canal or to fill ~~the~~ Los Vaqueros Reservoir. Diversions to the Contra Costa Canal are typically taken under CVP contract, while diversions to storage in the Los Vaqueros Reservoir can be taken either under CVP contract or under CCWD's Los Vaqueros water right (Permit 20749). The effects of the Middle River Intake on delta smelt are covered by the April 27, 2007 FWS biological opinion (amended on May 16, 2007). Effects on salmonids and green sturgeon are covered by the July 13, 2007 NMFS biological opinion for this intake project.

CCWD operates the Middle River Intake together with its other intake facilities to ~~better~~ meet its delivered water quality goals and to ~~better~~ protect listed species. The choice of which intake to use at any given time is based in large part upon salinity at the intakes, consistent with fish protection requirements in the biological opinions for the Middle River Intake and the Los Vaqueros Project. The Middle River Intake was built as a project to improve the water quality delivered to the CCWD service area, and does not increase CCWD's average annual diversions from the Delta. However, it can alter the timing and pattern of CCWD's diversions, because Middle River Intake salinity tends to be lower in the late summer and fall than salinity at CCWD's other intakes. This ~~could~~ allows CCWD to decrease winter and spring diversions while still meeting water quality goals in the summer and fall through use of the new intake.

Los Vaqueros Reservoir is an off-stream reservoir in the Kellogg Creek watershed to the west of the Delta. Originally constructed as a 100,000 acre foot reservoir in 1997 as part of the Los Vaqueros Project, the facility is used to improve delivered water quality and emergency storage reliability for CCWD's customers. Los Vaqueros Reservoir is filled with Delta water from either the Old River Intake or the Middle River Intake, when salinity in the Delta is low. ~~In the late~~When Delta salinity is high, typically in the ~~summer and~~ fall months, CCWD releases low salinity water from Los Vaqueros Reservoir to blend with ~~higher-salinity~~ direct diversions from the Delta to meet CCWD water quality goals. Releases from Los Vaqueros Reservoir are conveyed to the Contra Costa Canal via a pipeline.

Construction of expanded storage capacity at Los Vaqueros Reservoir ~~is ongoing in 2011, with completion scheduled in~~was completed in 2012. This expansion, to 160,000 acre feet, ~~will~~ provides additional water quality and water supply reliability benefits, and ~~will~~ maintains the existing functions of the reservoir. With the expanded reservoir, CCWD's average annual diversions from the Delta will remain the same as they have been with the 100 TAF reservoir. A Feasibility Study is ongoing to evaluate whether an additional expansion of this reservoir is in the federal interest; a draft Feasibility Report is scheduled for completion by ~~2013~~2014.

CCWD diverts approximately 127 TAF per year in total, and will continue to divert the same amount with the expanded reservoir. Approximately 110 TAF is CVP contract supply. In winter and spring months when the Delta is relatively fresh (generally January through July), deliveries to the CCWD service area are made 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 and Middle River Intake. The biological opinions for the Los Vaqueros Project, CCWD's Incidental Take Permit issued by 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 FWS, NMFS and DFG can change these dates to best protect the subject species. CCWD coordinates the filling of Los Vaqueros Reservoir with Reclamation and DWR to avoid water supply impacts to the CVP and SWP. During the no-diversion period, CCWD customer demand is met by releases from Los Vaqueros Reservoir.

Comment [A2]: Need to update when NMFS BO is finalized.

In addition to the existing 75-day no-fill period (March 15-May 31) and the concurrent no-diversion 30-day period, CCWD operates to an additional term in the Incidental Take Permit issued by DFG. Under this term, CCWD shall not divert water to ~~store~~ storage 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 February 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. These dates can be changed to better protect Delta fish species, at the direction of DFG.

CCWD's operation of the diversion, storage, and conveyance facilities in its system meets the permitting requirements of the Endangered Species Act through BiOps issued by USFWS and NMFS that are specific to the CCWD system. The NMFS BiOp issued on March 18, 1993 and USFWS BiOp 1-1-93-F-35 issued on September 9, 1993 cover the operation of the Los Vaqueros Project, including the Reservoir and the Mallard Slough, Rock Slough, and Old River intakes. NMFS BiOp 2005/00122 issued on July 13, 2007, and USFWS BiOp 1-1-07-F-0044 issued on April 27, 2007 and amended on May 16, 2007 cover the addition of the Middle River Intake to the CCWD system. Concurrence that expansion of Los Vaqueros Reservoir to 160 TAF is not likely to adversely affect listed Delta fish species was provided by NMFS on October 15, 2010 (2010/03457) and USFWS on November 1, 2010 (81410-2011-I-0001). CCWD and Reclamation are currently engaged in a consultation with NMFS to consolidate and update all NMFS Biological Opinions for CCWD operations.

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.

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September 14, 2012

State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Subject: Comprehensive Review of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, Bay-Delta Workshop 2 – Bay-Delta Fishery Resources

Dear Chair Hoppin and Members of the State Water Resources Control Board:

Contra Costa Water District (CCWD) appreciates this opportunity to respond to the revised notice of public workshops and request for information for the Comprehensive Review and Update to the Bay-Delta plan dated August 16, 2012. Attached for your consideration is a document titled *Use of an Index for Old and Middle River Flow Objectives*, which builds on a concept that CCWD proposed in the 2010 proceedings on Delta flow criteria. CCWD is committed to working with you and your staff to further develop and implement the proposed concept in the Water Quality Control Plan update.

If you have any questions, please call me at (925) 688-8083, or call Deanna Sereno at (925) 688-8079.

Sincerely,

for Leah Orloff
Water Resources Manager

Attachment

cc: Les Grober, SWRCB
Diane Riddle, SWRCB
Karen Niiya, SWRCB
Richard Satkowski, SWRCB
Brock Bernstein, Workshops Facilitator

Use of an Index for Old and Middle River Flow Objectives

September 14, 2012

Contra Costa Water District
P.O. Box H2O
Concord, CA 94524

Submitted for:

State Water Resources Control Board
Comprehensive (Phase 2) Review and Update to the Bay-Delta Plan
Workshop 2: Bay-Delta Fishery Resources

Scheduled to Commence
October 1, 2012

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Table of Contents

1 Executive Summary

On April 14, 2010, Contra Costa Water District (CCWD) submitted a closing statement in the State Water Board's Informational Proceeding to Develop Flow Criteria for the Delta Ecosystem. At the request of Chair Hoppin, that statement included discussion of an approach for Old and Middle River (OMR) flow criteria that would both protect the public trust resources and allow efficient water supply operations through the use of an index to measure compliance with OMR objectives.

In Phase 2 of the Comprehensive Review and Update to the Bay-Delta Plan, the State Board may consider adoption of OMR flow objectives. This submittal for Workshop 2 of the Phase 2 process presents new analyses, developed since the 2010 Flow Criteria proceedings, to support the use of an index such as that discussed in CCWD's 2010 submittal for meeting any OMR flow objectives that may be set by the State Water Board.

The key points of this submittal, covered in Sections 2, 3, and 4 below, are as follows:

A. The "measured" value for OMR, which is used for compliance with current OMR objectives imposed by the fisheries agencies, is in fact an index, and one that includes significant sources of error.

B. The "measured" value is difficult to operate to, and lacks transparency.

C. Use of a simpler index to determine compliance with OMR objectives can:

   1. solve the operational and transparency problems, and

   2. provide a level of protection for listed fish species in the Delta equal to that of the "measured" values.

Section 2, entitled ""Measured" net flow in Old and Middle Rivers (OMR)" reviews the steps taken to calculate the United State Geologic Survey's net daily flows ("USGS OMR"), which are not directly measured quantities. Instead, they are calculated based on index velocities, mathematically filtered and daily averaged for each river, then summed and used to determine compliance with current OMR objectives. More than 30% of the time net combined daily OMR flows are missing from the official record; thus, scientific analysis based on USGS OMR typically relies on estimated values, with significant errors, to fill these data gaps. USGS OMR, commonly considered a "measured" value, is in fact an index of Delta hydrodynamics.

Section 3, entitled "Implementation and Transparency Issues" covers these sorts of issues in the use of the USGS data for measuring compliance with OMR requirements. USGS OMR values cannot be known in real time, since the mathematical filtering algorithm used imposes a delay of at least 35 hours, difficulties with the instruments or calculations often cause further delays, and permanent gaps in the data record are frequent. CVP and SWP operators have difficulty reliably operating to values that are not known in real time and are challenging to predict. Furthermore, compliance with OMR restrictions is not transparent in that neither regulators nor the public can ever know, in real time, whether the objectives are being met, and often can never determine with certainty whether the objectives had been met.

Section 4, entitled "Proposal for an Alternative Flow Index" presents an alternative hydrodynamic index for use in measuring compliance with OMR requirements that is based on information readily available in real time, that is both predictable and controllable by CVP and SWP operators, and that provides clear information regarding whether OMR requirements are being met. Analyses similar to those that support existing OMR requirements were performed for delta smelt, longfin smelt and steelhead, using both the alternative flow index and USGS OMR. (Analyses for Chinook salmon are underway but not yet complete.) These indicate that, for all three species considered, the relationships of salvage at the export pumps to the alternative flow index are very similar to the salvage/USGS OMR relationships, with the alternative flow index performing equivalently as a predictor of salvage.

2 "Measured" net flow in Old and Middle Rivers (OMR)

The values that are often referred to as "measured" net flow in Old and Middle Rivers (OMR) are not directly measured quantities. This section reviews the steps taken to calculate the values that are provided by the United State Geologic Survey (USGS) as tidally filtered daily flows. It is demonstrated that the "measured" net flow is an index that contains substantial error, including error induced from bad data and from periods when data are not available. An estimate of the error in the USGS calculation is presented, and will be compared with an alternative flow index in Section 4.1.

2.1 Calculation of "measured" OMR

Since 1987, the USGS has operated and maintained velocity meters in Old River on the west side of Bacon Island (station 11313405) and in Middle River on the east side of Bacon Island (station 11312676). The meters do not directly measure flow; they measure what the USGS terms an "index velocity", which is a measurement of velocity through a portion of each channel. Typically measurements of the index velocity are taken every 15 minutes. A measurement of the water level (i.e. stage) is also recorded at the same time. These are the actual measurements from which an estimate of net daily flow is calculated. The process used to estimate flow is reviewed briefly below to provide background for the error estimates in the following section.

To calculate flow, the USGS utilizes information collected during a limited number of site visits designed to calibrate the station. First, the geometry of the channel is surveyed to develop a relationship between the cross-sectional area and the water level. Second, velocity measurements are collected at many points along the channel cross section over a relatively short time period (typically about 12 or 13 hours) to capture tidal variability. The USGS incorporates the data collected during these field investigations to develop a calibration relationship called a "rating curve". Rating curves allow conversion of the index velocity to a mean channel velocity, which is then used to estimate flow by multiplying by the channel area. Channel area varies tidally with the water level, and is estimated based on stage measurements. (Ruhl and Simpson 2005) These calculations are all performed by the USGS to produce the 15-minute flow values reported to the USGS National Water Information System (NWIS) website.

Once the 15-minute flow is calculated at each station, the USGS applies a mathematical filter to remove the tidal fluctuations. For the Old River and Middle River stations, this is done with a Godin filter, which is a cascaded running mean filter and response function that smoothes the data twice using a 24-hour average and once using a 25-hour average. The USGS uses a centered filter that requires a minimum of 71 hours of continuous hourly data to generate a filtered estimate for one value at the center of that time period. Every filtered value is calculated using data from 35 hours before and 35 hours after that value. Finally, the filtered hourly data are averaged over 24 hours to determine a net daily value.

The USGS reports both the tidal (15-minute) data and the tidally filtered daily data on the NWIS website[1] in near real time, with tidal data updated every 15 minutes. However, since the filter method requires 35 hours of subsequent data to be collected before a value can be calculated, the

[1] http://waterdata.usgs.gov/nwis

most recent filtered data available at any time is generally 2-3 days old. It is these filtered values that are used to determine compliance under the current implementation of the OMR regulation.

The final step in the calculation of net flow in Old and Middle Rivers is to add the tidally filtered daily value for Old River and the tidally filtered daily value for Middle River, which is not done on the USGS website[2].

2.2 Error in Estimation of Missing Data

As with all field data collection programs, there are problems with instruments or information transfer that cause loss of data from the Old River and Middle River velocity meters at times. Due to the filtering technique described above, which relies on a 71-hour set of continuous data, small gaps in data time series can create large holes in the record of filtered values. For instance, if tidal data are missing, the filter leaves a gap of 35 hours spanning each side of the missing data. For a single missing data point, the gap is nearly 3 days. Calculating the daily average of tidally filtered values transforms the 3 day gap in the filtered data to a 4 day gap in the daily value, due to the loss of a single data point. Longer periods of data loss are fairly common in the official record, as shown in Figure 2-1.

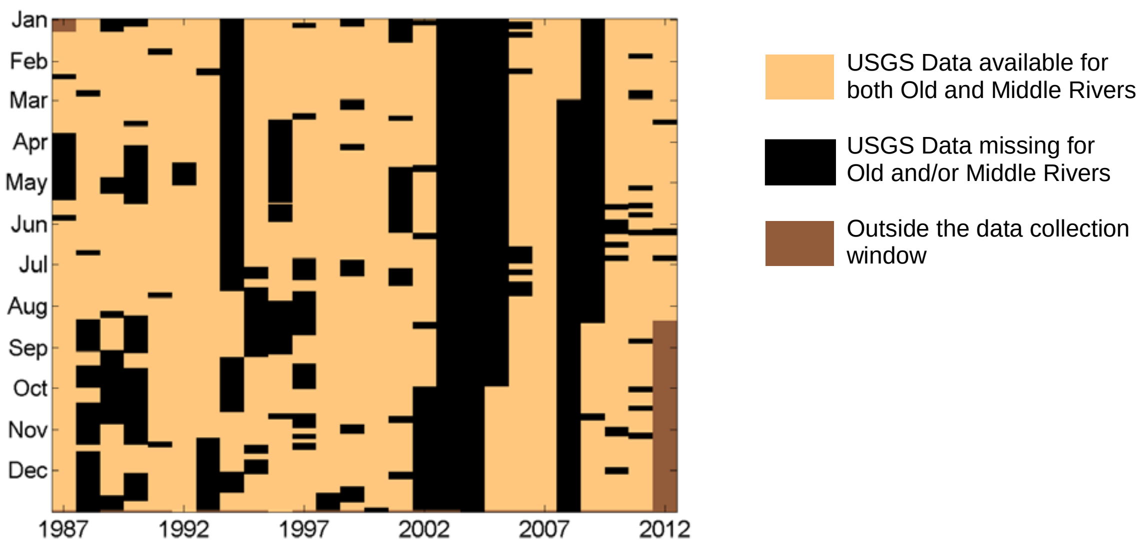

Figure 2-1: Data gaps in the official USGS tidally filtered daily Old River and Middle River data sets
Gaps in data exist throughout the USGS data record. While some gaps (colored in black) last only a few days, many gaps last weeks, months, and even years. [Data source: USGS tidally filtered flow from the NWIS website downloaded August 14, 2012]

The USGS NWIS website does not provide estimated values. USGS data are posted as provisional in near real time; USGS subsequently reviews the data and re-posts an approved data

[2] Due to the delay in posting of the USGS filtered values and the additional post-processing that is necessary to estimate OMR, DWR posts an estimated value of OMR on the California Data Exchange Center (CDEC) website at http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=omr. CDEC values are estimated and are not updated when data are quality controlled. The CDEC data set is discussed in Section 3.

set[3], replacing the provisional data. When a value is determined to be incorrect, either in real time or subsequently during the review process, it is simply removed from the website. Figure 2-1 shows when data are missing from the USGS NWIS website, and Table 2-1 lists the percentage of time when data are missing for either or both stations. As of August 2012, the USGS had reviewed (i.e. "approved") data through February 29, 2008. Data between March 1, 2008 and August 15, 2009 have been removed from the website, indicating a potential problem with that period. Provisional data are listed from August 15, 2009 through August 2012.

Table 2-1: Percent of time when data are missing from USGS stations at Old River and Middle River
From the time the sensors started operating in January 1987, a significant portion of the data has been invalid and is now missing values. Prior to analyses, the missing data must be estimated. [Data source: USGS tidally filtered flow from the NWIS website downloaded August 14, 2012]

	USGS "Approved" Data from January 11, 1987 to Feb 29, 2008	All USGS Data from January 11, 1987 to August 11, 2012
Old River	13%	17%
Middle River	21%	24%
Old River or Middle River, but not both	27%	23%
Old River and Middle River	4%	9%
Total time when OMR flow must be estimated	31%	32%

Most scientific analyses require a complete data set, so missing data has been estimated. The USGS developed a data set that incorporated estimates for missing data. This spreadsheet, originally developed in 2006 and updated in 2010, has become widely used in the scientific community. While the spreadsheet clearly indicates when data have been estimated, many scientists have not distinguished between estimated and measured values in their analysis; what is commonly referred to as the "measured" OMR flow data set comprises approximately 70% flows calculated from measured velocity indices and approximately 30% estimated values. The remainder of this section examines the amount of estimation error that has been introduced into the data set.

Typically, when the sensor in either Old River or Middle River is missing data, the tidally filtered daily flow is estimated based on the other river[4]. Figure 2-2 shows a scatter plot of the USGS approved tidally filtered daily flow at Middle River and Old River. The USGS developed piecewise quadratic relationships to estimate flow at one station based on flow at the other station, shown by the blue and red lines in Figure 2-2. The error in using these relationships is shown in Table 2-2. Similarly, Dr. Paul Hutton developed piecewise linear relationships for estimation of tidally filtered flow when one of the two flow values was available; the standard

[3] As of September 3, 2012, USGS-approved data are only available for the Old River station (11313405) and Middle River station (11312676) through February 29, 2008.
[4] Old River station and Middle River station are located approximately 3 miles apart as the bird flies, but 4 to 6.5 miles apart as the fish swims (through the connecting river channels).

error of estimation (SEE) for Hutton's estimation method is 298 cfs when Middle River is less than -4,000 cfs and 388 cfs when Middle River is greater than -4,000 cfs.

For the 23% of the time when tidally filtered flow in either Old River or Middle River is missing, the value is often estimated based on one of the above correlations.

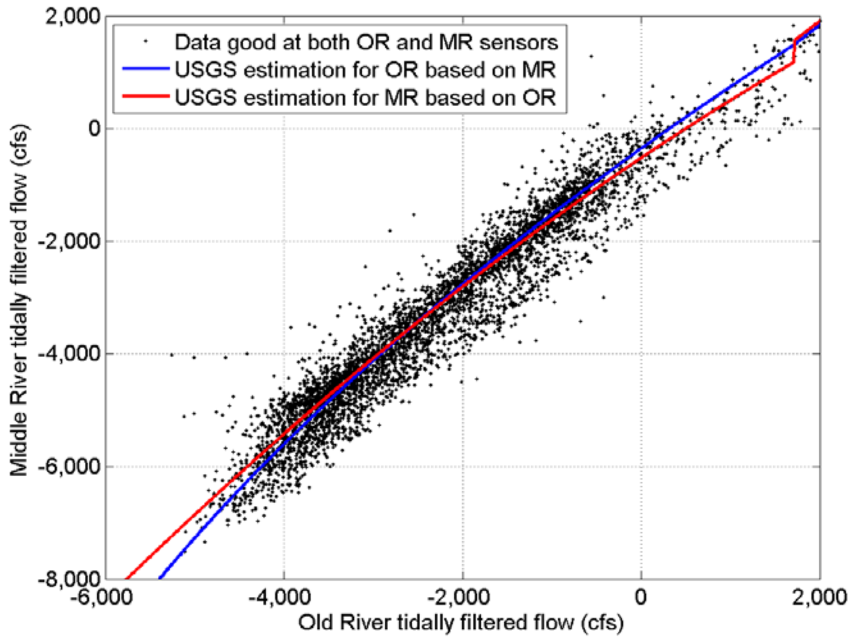

Figure 2-2: Relationship between tidally filtered flow in Old River (OR) and Middle River (MR). When tidally filtered flow from one of the stations is missing, it is common to estimate the value based on the known sensor. Substantial scatter exists in this relationship between the sensors, such that the prediction may be up to 2800 cfs from the actual value. [Data source: USGS tidally filtered flow from the NWIS website downloaded August 14, 2012.]

Table 2-2: Error in estimating flow at either Old River or Middle River
Use of the USGS estimation for tidally filtered daily average flow at either Old River or Middle River. The standard error of estimation (SSE) is a measure of the accuracy of predictions.

Estimation Method	SEE	Maximum Error
Old River based on Middle River	315 cfs	2,040 cfs
Middle River based on Old River	400 cfs	2,840 cfs

For the time periods when both the Old River and the Middle River sensors are missing data, multiple agencies have developed equations to estimate OMR based on other system variables. The California Department of Water Resources (DWR) and USGS developed estimates based on the total exports at the SWP and CVP facilities near Tracy, San Joaquin River flow at Vernalis, and the operation of a channel barrier at the head of Old River. The equation parameters and corresponding error estimates are listed in Table 2-3. Similarly, Paul Hutton developed a method to estimate Old and Middle River flows based on the above parameters as well as estimated net south Delta consumptive use and the position of the channel barrier in Grant Line Canal (Hutton 2008).

Table 2-3: Methods to estimate OMR based on Flow at Vernalis and Total Exports, with SEE
DWR and USGS independently developed methods to estimate OMR based on daily flow at Vernalis ($Q_{Vernalis}$) and Total Exports ($Q_{Exports}$) in the form Q_{OMR} (cfs) = A * $Q_{Vernalis}$ (cfs) + B * $Q_{Exports}$ (cfs) + C. The standard error of estimation (SEE) for these estimation methods ranges from 973 cfs to 1,295 cfs. SEE and maximum error for the DWR method is calculated based on the approved USGS OMR data set (as of August 2012). SEE for the USGS method is provided in Ruhl et al (2006), but the maximum error is not reported (NR).

Estimation Author	$Q_{Vernalis}$	Barriers	A	B	C	SEE	Maximum Error
DWR	All	All	0.58	-0.913	0	1,070 cfs	4,360 cfs
USGS	<10,000cfs	In	0	-0.8129	-365	973 cfs	NR
USGS	<10,000cfs	Out	0	-0.8738	1137	1,295 cfs	NR
USGS	≥10,000cfs	All	0.7094	-0.7094	-4619	1,090 cfs	NR

A secondary method to estimate OMR is a simple linear interpolation over the data gaps. The SEE for linear interpolation depends on the number of data points that are missing (Table 2-4). As discussed above, the shortest data gap in the tidally filtered daily values is 4 days (due to filter method). As shown in Figure 2-1, many data gaps are much longer than 4 days.

Table 2-4: Error of estimating tidally filtered daily OMR by linear interpolation over gaps in observed data
A viable method to fill small gaps in the tidally filtered daily average USGS values is to linearly interpolate over the data gap. However, the estimation error increases with the length of time that is missing data such that interpolating over more than 4 days can lead to significant maximum error in the estimate.

Length of Gap in Data (days)	SEE	Maximum Error
4	816 cfs	5,600 cfs
10	1,190 cfs	14,300 cfs
20	1,570 cfs	19,400 cfs

In summary, with data missing from the USGS sensors 32% of the time, the USGS OMR data that is typically used for analysis to determine and justify regulations on net flows in Old and Middle River incorporates error due to the necessity of estimating values. As described above, the standard error of estimation ranges from 300 to 1,300 cfs with a maximum error between 2,000 and 6,000 cfs. This error is simply part of what is often termed the "measured" OMR data set.

2.3 "Measured" OMR is itself an index

As discussed in Section 2.1, the values that are often colloquially referred to as "measured" OMR are calculated based on index velocities that are measured at two point locations in the

Delta. The 15-minute OMR flow values are calculated estimates of flow based on the localized measured velocities. USGS then filters and averages the flow values to describe a hydrodynamic parameter that is more useful for fish protection in the Delta than the actual measured values. This type of value is often referred to as an index because it indicates useful information about the system.

As discussed in Section 2.2, "measured" OMR is missing for a significant portion of the historical record, and the error of estimating the values is significant. However, even with the estimation error, the USGS OMR index has proven useful to deciphering complicated Delta hydrodynamics. OMR is hypothesized to reflect "the hydrodynamic influence of the water projects' diversions on the southern half of the Delta and thus the degree of entrainment risk for fishes in that region (Kimmerer 2008; Grimaldo et al. 2009)." (FWS 2011)

To explore the risk of entrainment under varying Delta hydrodynamics conditions, studies have utilized a particle tracking model (PTM), which simulates the transport and fate of neutrally buoyant particles in the Delta channels and estimates the probability that a parcel of water starting at one location will arrive at another location in a given time frame. The use of PTM for entrainment risk analysis and the modeling assumptions used for this report are discussed in Appendix A, Section A.2.

Results from hundreds of PTM simulations are summarized below to illustrate the extent to which OMR reflects Delta hydrodynamics. For these studies, particle releases were simulated with the PTM model at select fish survey locations within the Delta as shown in Figure 2-3. Particle movement was tracked throughout the simulation, and the total percentage of particles entrained at the SWP and CVP export facilities in the south Delta was determined for 28 day periods after each simulated particle release. In Figure 2-4, total percent entrainment is plotted against the average USGS OMR[5] during the simulation period to illustrate how well OMR predicts entrainment risk.

As expected, the entrainment risk is highly dependent on the starting location for the particles[6]. For instance, no more than 5% of the particles released near the confluence of the Sacramento and San Joaquin River were entrained during any of the simulations (panel A), yet nearly 90% of the particles released on the San Joaquin River near mouth of Old River were entrained during a few simulations (panel D).

The entrainment risk varies for different levels of average OMR flow, with considerable scatter in the results. For instance, for particles starting on the San Joaquin River near the mouth of Old River (panel D), at OMR equal to -3,000 cfs, entrainment varies from 8% to 24%, and at OMR equal to -5,000 cfs, entrainment varies from 4% to 64%. So while OMR clearly reflects some characteristics of Delta hydrodynamics, the value of OMR alone is not sufficient to predict particle movement, even in the idealized case of a numerical model.

[5] For the analyses presented in this section, "USGS OMR" includes both the calculated flows from the USGS NWIS website whenever available and estimates of the values using the USGS estimation methods for the periods when data is missing (see Section 2.2).

[6] Implementation of the current OMR regulations allows for consideration of the spatial distribution of delta smelt and longfin smelt to some extent; this is typically done currently through application of judgment of fishery experts in the adaptive management process. However, the regulations include a minimum value of OMR (-5,000 cfs) that cannot be exceeded regardless of spatial distribution.

The uncertainty between measured and modeled OMR is shown in Figure 2-5 for the historical period February 1990 through March 2012.

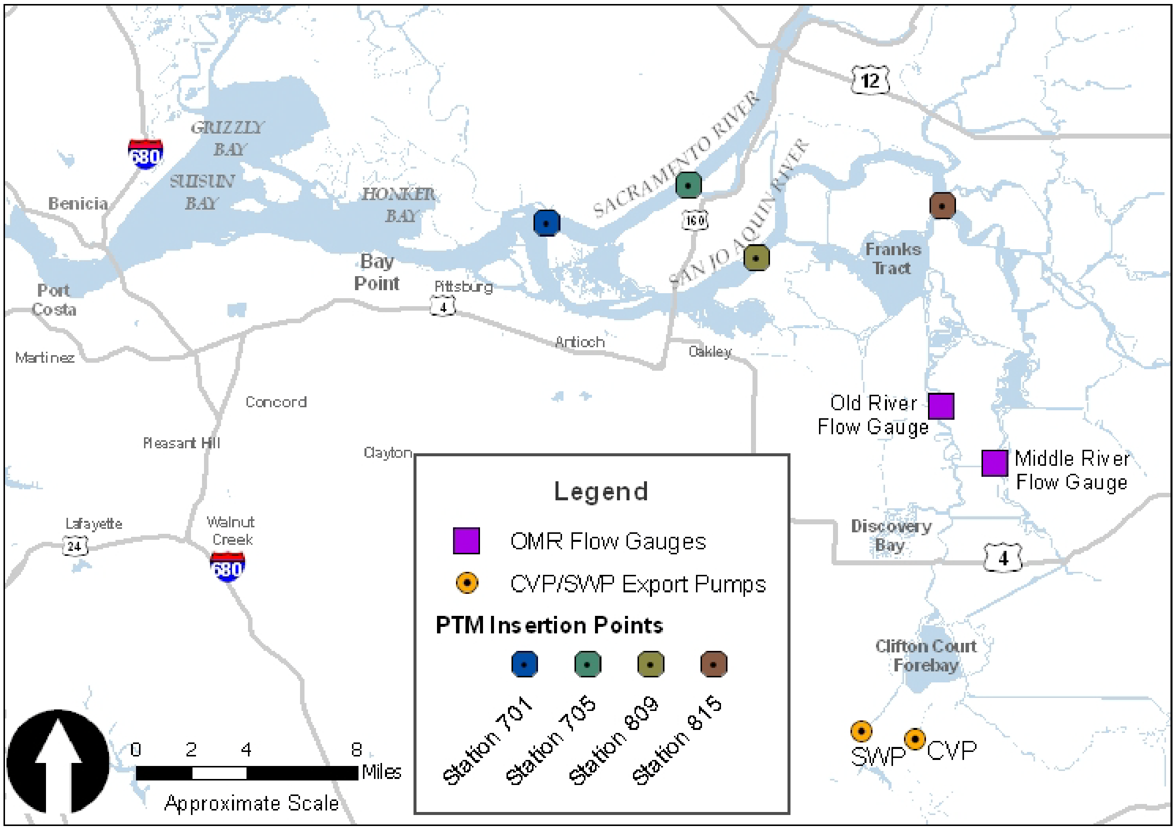

Figure 2-3: Map of PTM insertion locations

Particle tracking modeling is used to determine the movement of neutrally buoyant particles after release from specific locations within the Delta (Stations 701, 705, 809, and 815 shown in the map above). After release, particle movement is simulated with tidal hydrodynamics and the final particle fate (e.g. where the particle ends up after a defined amount of time) is determined.

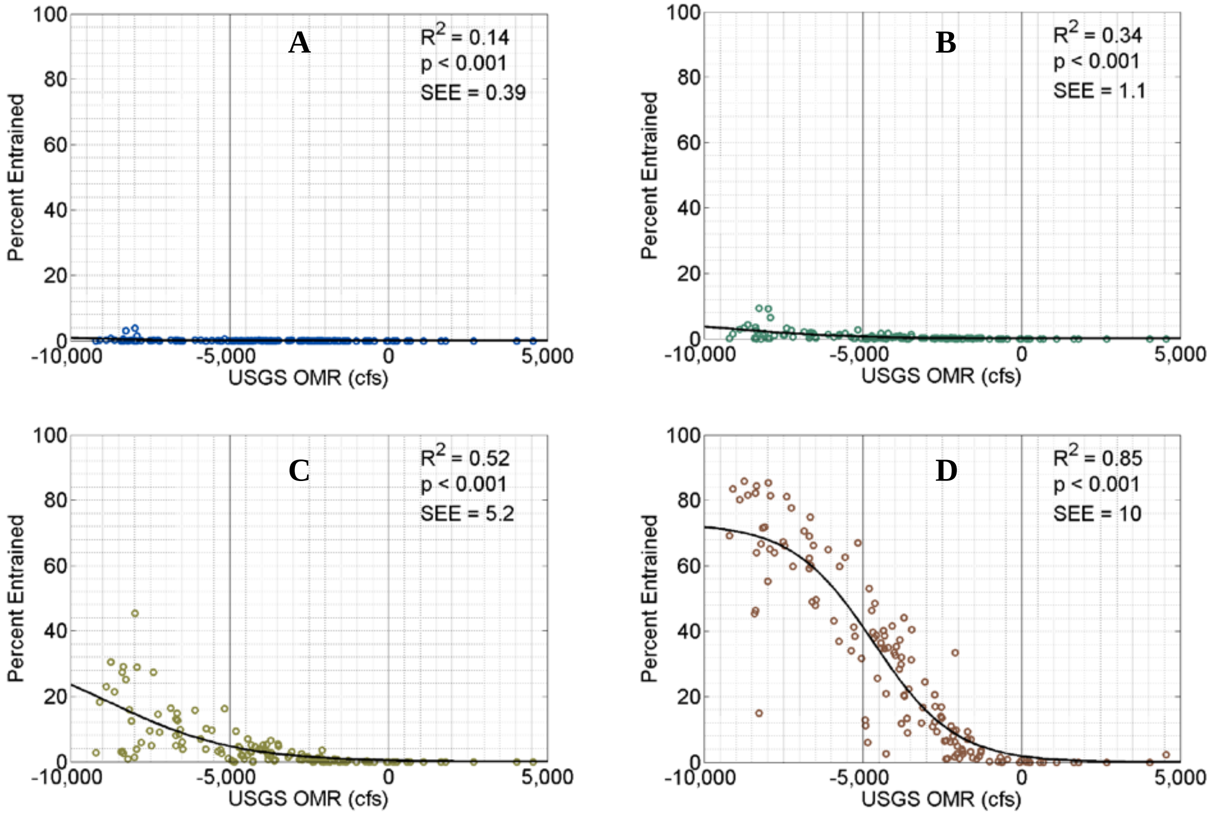

Figure 2-4: Entrainment of Particles as a function of OMR
Percent of particles entrained at the CVP and SWP export facilities in the south Delta depends on both the particle starting location and Delta hydrodynamics, indexed here by the average of the USGS OMR during the historical period that was simulated by the model. Particles were released at (A) the confluence of the Sacramento and San Joaquin Rivers (station 701), (B) the Sacramento River at Decker Island (station 705), (C) the San Joaquin River at Jersey Point (station 809), and (D) the San Joaquin River near mouth of Old River (station 815).

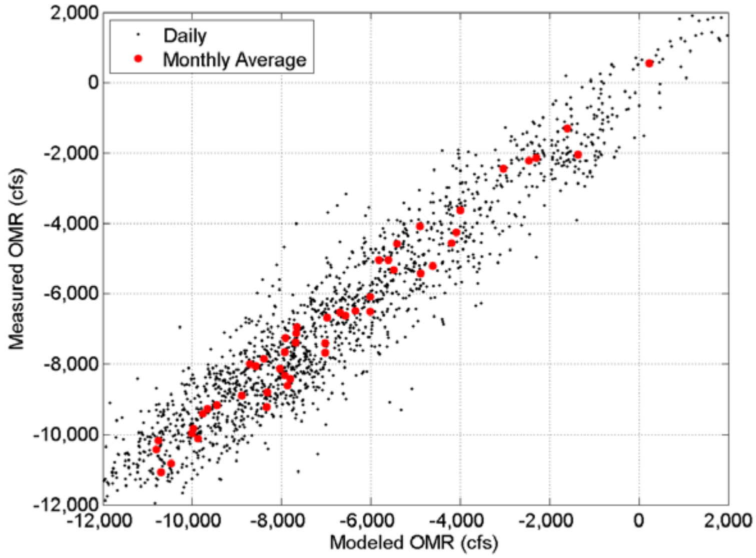

Figure 2-5: Comparison between "measured" OMR and the Modeled OMR as reported by DSM2
The DSM2 model outputs calculated values of flow in Old and Middle Rivers at the locations of the USGS stations. For historical boundary conditions, the DSM2 output (termed "modeled OMR") is an indicator of USGS OMR, with a SEE of 980 cfs for the daily values and SEE of 470 cfs for the monthly average. Modeled OMR will differ from USGS OMR due to inaccurate estimates of Delta consumptive use in the model, lack of effects of weather conditions in the model, or noise or other error in the "measured" values.

2.4 Conclusion

USGS OMR values are not directly measured quantities. Instead, they are calculated based on index velocities, mathematically filtered and daily averaged for each river, then summed and used to determine compliance with current OMR objectives. More than 30% of the time net combined daily OMR flows missing; scientific analysis based on USGS OMR typically relies on estimated values, with significant errors, to fill these data gaps. USGS OMR, commonly considered a "measured" value, is in fact an index of delta hydrodynamic conditions related to entrainment risk at the Banks and Jones Pumping Plants.

Issues that result from relying on USGS OMR for measuring compliance with OMR requirements are discussed in Section 3. An alternative flow index that avoids or resolves these issues is presented in Section 4, along with evidence that use of the proposed index provides a level of protection for listed fish species in the Delta that is equal to the protection provided by use of USGS OMR.

3 Implementation and Transparency Issues

OMR flow requirements are currently implemented under the Biological Opinions (BiOps) and incidental take permit for the operation of the Central Valley Project (CVP) and State Water Project (SWP)[7]. The values used to determine compliance are 14-day and 5-day averages of the USGS tidally filtered daily average values. Use of the USGS OMR data for compliance presents issues with implementation and transparency: CVP and SWP operators have difficulty reliably operating to the USGS values, and neither they, nor the public, can know, in real time, whether the objectives are being met.

3.1 Implementation Issues

Several factors make the current implementation of OMR difficult to use in practice:

3.1.1 Waiting time for results

USGS values for tidally filtered daily values of OMR flow are not available until at least 2 days after the fact, because the Godin filter used to process the data must be applied to flows that have not yet been measured; the daily average for Monday's OMR flow, for example, cannot be calculated until mid-day on Wednesday. Often difficulties with the instruments or calculations cause further delays.

Because of the delay, Project operators must make operational decisions based on their own estimated values for OMR. One such estimate is reported on the California Data Exchange Center (CDEC) website maintained by DWR[8]. Unfortunately, the CDEC data set incorporates errors from the USGS real-time data. The data are reviewed for such errors and corrected if possible during the USGS qa/qc process, which explains some of the differences in reported values between the CDEC and USGS data sets. However, by the time the qa/qc takes place, it is too late to make any operational adjustments.

3.1.2 Difficulty in predicting near-future OMR

Furthermore, the considerable variability in USGS OMR makes it difficult to predict, which complicates operational decisions and forecasting. Electrical power required to pump Delta water is typically scheduled 3 days in advance, and 5 or more days in advance over weekends or holidays. Compliance metrics that can be predicted 3 to 5 days in advance would greatly improve water operations planning, and could help improve power and water efficiency for the state.

Inflow on the San Joaquin River at Vernalis (SJR), combined CVP and SWP exports at Jones and Banks Pumping Plants, and the condition of the Head of Old River Barrier (HORB), are the dominant factors that drive OMR, but natural factors beyond the control of the Projects may act singly or together to affect OMR. Among these factors are sometimes unpredictable tidal action,

[7] Existing BiOps and permit include the 2008 U.S. Fish and Wildlife Service (FWS) and 2009 National Marine Fisheries Service (NMFS) BiOps for the coordinated operation of the SWP and CVP and the 2009 Department of Fish and Game (DFG) incidental take permit for longfin smelt for the SWP.

[8] http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=OMR

winds, variations in atmospheric pressure, and uncertainties regarding diversions, discharges, and seepage in the south Delta.

Figure 3-1 illustrates short term variability in the tidally filtered daily USGS OMR that remains unexplained in hindsight, and could not have been predicted. The plots show the daily deviation of flow values from the period average of flow values. The periods selected have relatively constant exports and SJR flow (small deviations from the period average) but OMR flow varies more significantly (larger deviations from the period average) up to +/- 1,500cfs. This indicates that, while SJR flow and exports are the primary drivers of OMR, there are other significant environmental influences on OMR as well. These unpredictable influences on OMR make water pumping operations difficult to plan with certainty in advance, and can force sudden actions in an attempt to avoid OMR violations when unexpected changes occur.

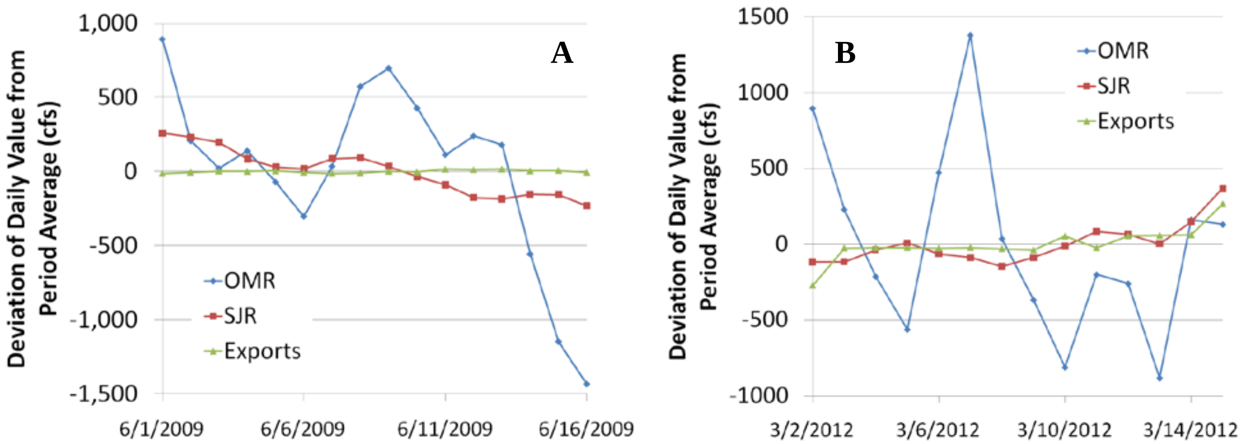

Figure 3-1: Unexplained variability in tidally filtered daily "measured" OMR
(A) June 1-16, 2009: Exports are essentially constant throughout the entire period, and Vernalis flow decreases slightly (by less than 500 cfs) and steadily over the period. OMR fluctuates by nearly 2,500 cfs, with the largest change occurring over the last few days of the period. (B) March 2-15, 2012: Exports and Vernalis flow are essentially constant, but OMR fluctuates.

3.1.3 Measurement errors cannot be avoided

Errors or lack of values in the posted USGS data add an additional level of difficulty for operators attempting to meet OMR requirements. The variability illustrated in panel A of Figure 3-1 may be due to instrument error. The data for June 2009 was downloaded as provisional data from the USGS NWIS website in June 2012. However, the June 2009 data has now (as of September 2012) been removed from the USGS NWIS website indicating that errors may have been found during the quality control process. Occasional errors are to be expected of any values originating in field measurements, and these comments are not intended as criticism of the USGS process. However, modifications to the current OMR regulation to reduce the reliance on such values would improve the implementation.

3.2 Transparency Issues

Because of the delay in calculating and posting the USGS OMR data, it is impossible to determine if the Projects are in compliance in real time. The regulators that set the OMR objectives, the Project operators and the general public cannot know whether objectives have been met on any given day until at least 2 days later. And because errors in the USGS data are sometimes corrected months or years after the fact (as discussed in Section 2.2 above), the determination of compliance may change.

Without knowing whether objectives are being met, the effectiveness of the adaptively managed objectives cannot be accurately assessed in real time. Adopting a compliance metric that could be easily calculated with readily available information would improve transparency.

3.3 Solution

As discussed in Section 2.3, USGS OMR flow is itself an index that reflects Delta hydrodynamics, which is used to measure compliance with OMR regulations for the protection of listed fish species. And as shown in Sections 3.1 and 3.2 above, the USGS OMR index is difficult to use in practice. An alternative hydrodynamic index, based on information that is readily available in real time and that is both predictable and controllable by CVP and SWP operators, would simplify implementation and improve transparency. Of course, such an index should be used only if it would provide a level of protection for Delta fish equal to that provided by operating to the USGS flows. An index that meets these requirements is proposed in Section 4.

4 Proposal for an Alternative Flow Index

As illustrated in Section 2.3, the OMR values reported by USGS are an index of Delta hydrodynamics. As discussed in Section 3, measuring compliance with current OMR requirements based on the USGS OMR creates operational difficulty and lacks transparency. This section presents an alternative flow index of Delta hydrodynamics for use in measuring compliance with OMR requirements that will improve implementation and transparency, and will provide an equal level of protection for listed fish species in the Delta as is provided by measuring compliance using USGS OMR.

4.1 Alternative Flow Index Definition

The largest drivers of net flow in Old and Middle Rivers are the total combined exports and the San Joaquin River inflow into the Delta. The alternative flow index proposed herein is defined as a function of total exports at Banks and Jones pumping plants ($Q_{Exports}$), the average San Joaquin River flow over the prior 3 days ($\overline{Q_{SJR}}$), and the condition of the channel barrier at the head of Old River (Head of Old River Barrier, HORB) (Equation 4-1). The flow index was calculated as the best fit linear relationships of these variables with USGS OMR[9].

If HORB is not installed: $Flow\ Index = 0.42 * \overline{Q_{SJR}} - 0.87 * Q_{Exports}$
If HORB is installed: $Flow\ Index = -0.79 * Q_{Exports}$ **Equation 4-1**

This alternative flow index is designed to address issues with implementability and transparency that are experienced under the current OMR requirements. To this end it makes use of measured flow values that are easily available in real time, and does not include other parameters that have an order of magnitude lower influence on hydrodynamics and/or require estimation; results presented below indicate that use of this simple index for measuring compliance with OMR requirements provides a level of protection for listed fish species commensurate with use of USGS OMR. The 3 day averaging of San Joaquin River flows was included to smooth short term variations and account for a short time lag of the influence on San Joaquin River inflow on interior Delta hydrodynamics.

Section 4.2 below shows a comparison of the alternative flow index with USGS OMR and examines how both the index and USGS OMR reflect Delta hydrodynamics using the particle tracking model. Section 4.3 examines both the index and USGS OMR as predictors of fish salvage.

[9] To ensure the flow index is acceptable during time periods of interest, the calibration period was limited to time periods with Delta hydrodynamics similar to the regulated period. For instance, the Jones Tract levee breach period (June – Dec 2004) was excluded from the calibration period due to the unique hydrodynamics present during the breach and pump out (Hutton 2008). Similarly, the 1997 winter storms were excluded due to the extensive flooding on the San Joaquin River (USGS 2006, Hutton 2008). Furthermore, only values from December through June with negative tidally filtered daily USGS OMR that have been approved by the USGS were used to calibrate the flow index.

4.2 Comparison of Alternative Flow Index with USGS OMR

The alternative flow index is strongly correlated with USGS OMR, as shown in Figure 4-1. The scatter between values can be as much as ± 2,000 cfs and the SSE is 810 cfs, which is similar to the error for the methods used to estimate missing values of USGS OMR discussed in Section 2.2. Hence, the alternative flow index does not induce error greater than that generated when creating an index from measured values. The scatter in itself is not a cause for concern, since the purpose of the flow index is not to emulate USGS OMR values. Instead, the purpose of the flow index is to reflect Delta hydrodynamics in a way that is useful for fish protection. The utility of the alternative index is demonstrated in the following materials.

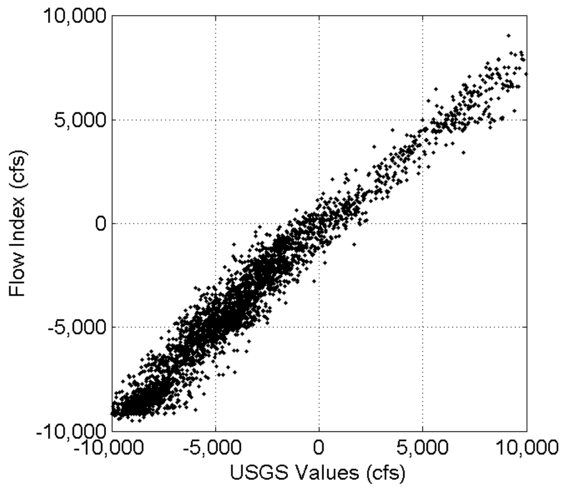

Figure 4-1: Comparison between USGS OMR and the Flow Index
The alternative flow index shows a strong correlation with USGS OMR during periods of negative net flow. As USGS OMR increases above +2,000 cfs, the flow index generally under-predicts USGS OMR values. The difference in positive net flows is not a focus of this discussion because the typical regulatory values for net OMR flow are less than zero.

To evaluate how well the alternative flow index reflects Delta hydrodynamics, we return to the PTM example provided in Section 2.3. Figure 4-2 shows the percent of particles entrained at the export facilities as a function of two indices: the first index (left column: panels A1, B1, C1, and D1) is the average USGS OMR[10] during the simulation period. The second index (right column: panels A2, B2, C2, and D2) is the alternative flow index defined in Equation 4-1. Particle entrainment is used here as an indicator of hydrodynamic conditions that predict fish salvage at the export pumps. The use of PTM for entrainment risk analysis and the modeling assumptions used for this report are discussed in Appendix A, Section A.2.

[10] For the analyses presented in this section, "USGS OMR" includes both the calculated flows from the USGS website whenever available and estimates of the values using the USGS estimation methods for the periods when data is missing (see Section 2.2).

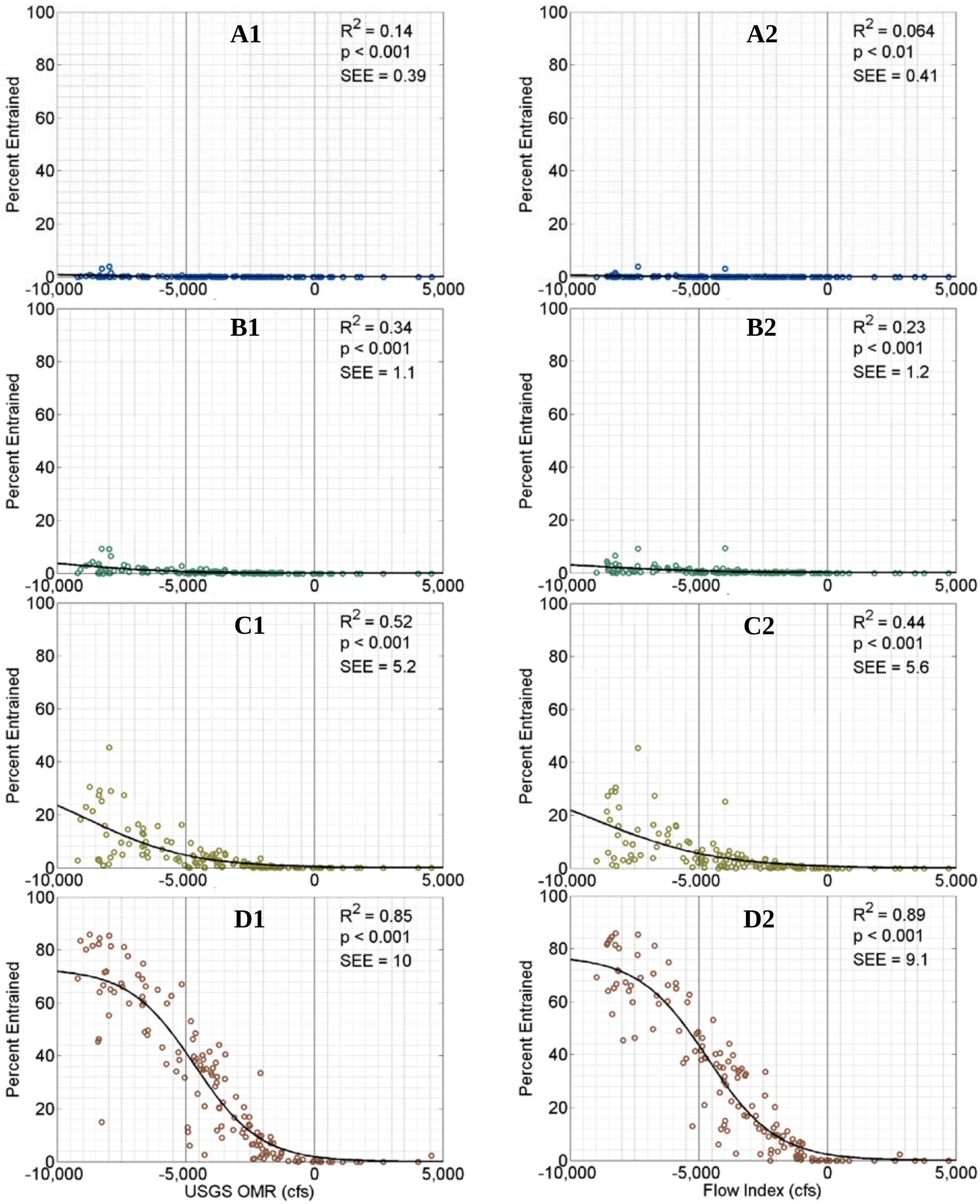

Figure 4-2: Entrainment of Particles as a function of Modeled OMR and the Flow Index

Percent of particles entrained at the CVP and SWP export facilities can be represented by the USGS OMR (panels A1, B1, C1, and D1) and the alternative flow index (panels A2, B2, C2, and D2). Particles were released at (A) the confluence of the Sacramento and San Joaquin Rivers (station 701), (B) the Sacramento River at Decker Island (station 705), (C) the San Joaquin River at Jersey Point (station 809), and (D) the San Joaquin River near mouth of Old River (station 815). See Figure 2-3 for a map of these locations.

Entrainment of particles released at the San Joaquin River near the mouth of Old River shows a strong response to both the recommended alternative index values (panel D2) and the USGS OMR values (panel D1). As particle release points move farther from the export pumps the entrainment response decreases, until there is almost no response during the 28 day simulation period for particles released at the confluence of the Sacramento and San Joaquin Rivers. The correlations and SEEs for the relationships between entrainment and the alternative index are similar to those for the relationships between entrainment and USGS OMR; R^2 is slightly higher for the alternative index for the particle release point with the strongest entrainment response, and slightly lower for the alternative index for other particle release points. Any conclusions or operational recommendations drawn from these relationships would not be materially different, whether USGS OMR or the alternative flow index was used.

4.3 Fish Protection with the Alternative Index

To evaluate whether the alternative flow index is useful for protection of listed fish species in the Delta, analyses similar to those in the existing BiOps, ITP, and technical workgroup presentations were performed for both the alternative flow index and USGS OMR. As new analyses are developed to support hydrodynamic indices for the remanded BiOps or in other venues, they can be similarly used to evaluate the alternative flow index, and to refine it as indicated.

Analyses are presented below for delta smelt, longfin smelt, and steelhead; analyses for Chinook salmon are underway but not yet complete. For all three species considered here, the relationships of salvage at the export pumps to the alternative flow index are very similar to the relationship of salvage to the USGS OMR flow index[11], with the alternative flow index performing slightly better as a predictor of salvage.

4.3.1 Delta Smelt

Both the daily (Figure 4-3) and seasonal (Figure 4-4) normalized salvage of adult delta smelt are plotted against USGS OMR and against the alternative flow index. For the daily salvage, visual inspection of the plots shows similar distributions for the two indices. The seasonal salvage plots also indicate the equivalence of the two indices, and have similar values of R^2 and SEE for both log-log and linear data fits.

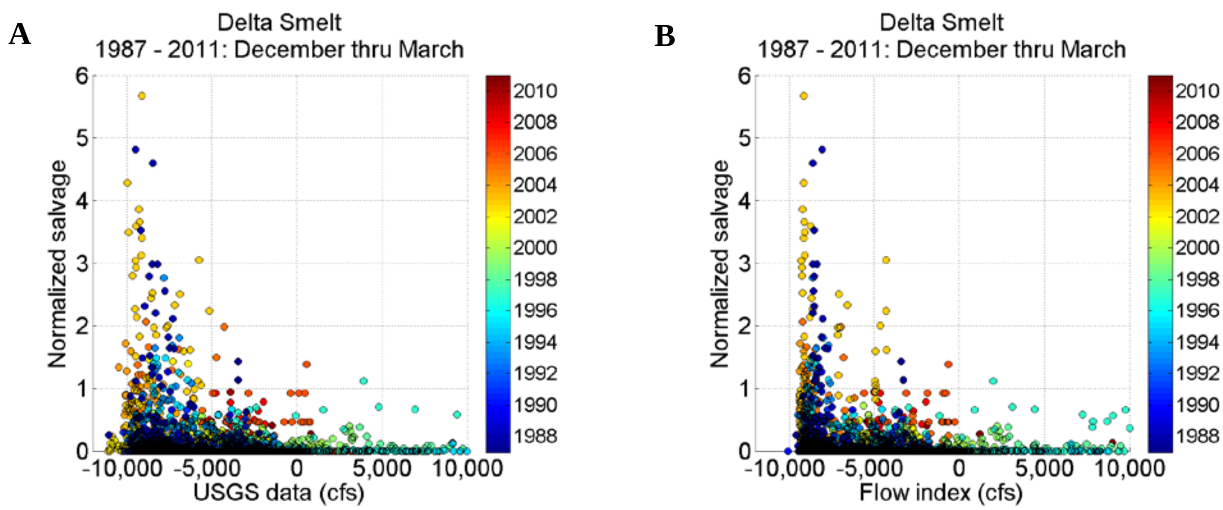

Figure 4-3: Daily salvage of adult delta smelt normalized by the prior FMWT index
Daily salvage of delta smelt from December through March of 1987-2011 is normalized by an annual population index (i.e. the Fall Midwater Trawl (FMWT) index) for each year and plotted against (A) the USGS OMR flow and (B) the alternative flow index. Data points are colored by the water year.

[11] For the analyses presented in this section, "USGS OMR" includes both the calculated flows from the USGS website whenever available and estimates of the values using the USGS estimation methods for the periods when data is missing (see Section 2.2).

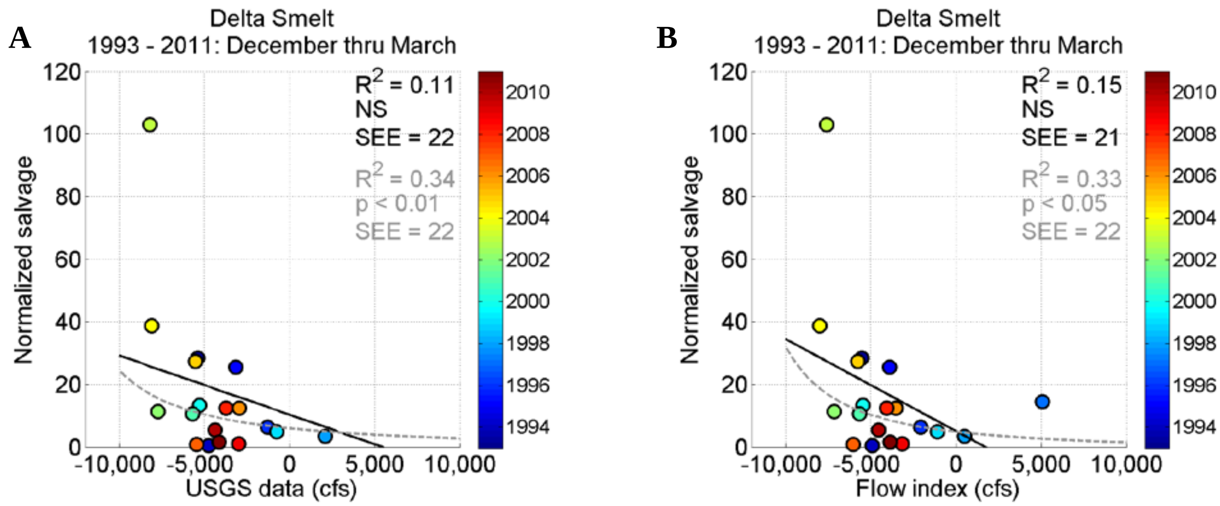

Figure 4-4: Seasonal (December through March) salvage of adult delta smelt normalized by previous FMWT index

Daily data from Figure 4-3 are summarized seasonally in this figure by showing the total salvage for December through March, normalized by the annual FMWT index, plotted against (A) the average USGS OMR during the period, or (B) the average alternative flow index during the period. Linear (black line) and log-log (grey dashed line) least squares fits are shown with the statistical parameters listed in the upper right corner of each plot. NS = not statistically significant ($p>0.05$)

USFWS, following the work of Deriso (2011), have developed analyses of delta smelt salvage that include Delta turbidity conditions in addition to south Delta hydrodynamic conditions. This work appears to show a relationship between normalized salvage of adult delta smelt, turbidity conditions measured at Clifton Court Forebay, and OMR net flow conditions, as illustrated in Figure 4-5. 4-5(A) is reproduced from the USFWS draft BiOp (2011), in which USGS OMR values are used. Figure 4-5(B) shows the relationship between adult delta smelt salvage, turbidity and the alternative flow index. By inspection, the alternative flow index is equally useful in describing the Delta hydrodynamic conditions that contribute to salvage of adult delta smelt. In fact, the vertical scatter may be slightly reduced in Figure 4-5(B).

Figure 4-5(C) is also reproduced from the 2011 USFWS draft BiOp. This figure presents the same relationship between turbidity, OMR net flows and adult delta smelt salvage, with salvage data points sorted into bins of magnitude relative to the previous Fall Midwater Trawl abundance index. Figure 4-5(D) presents the same relationship using the alternative flow index. Again, the alternative flow index appears to provide an equivalent utility in predicting adult delta smelt salvage, as compared to USGS OMR.

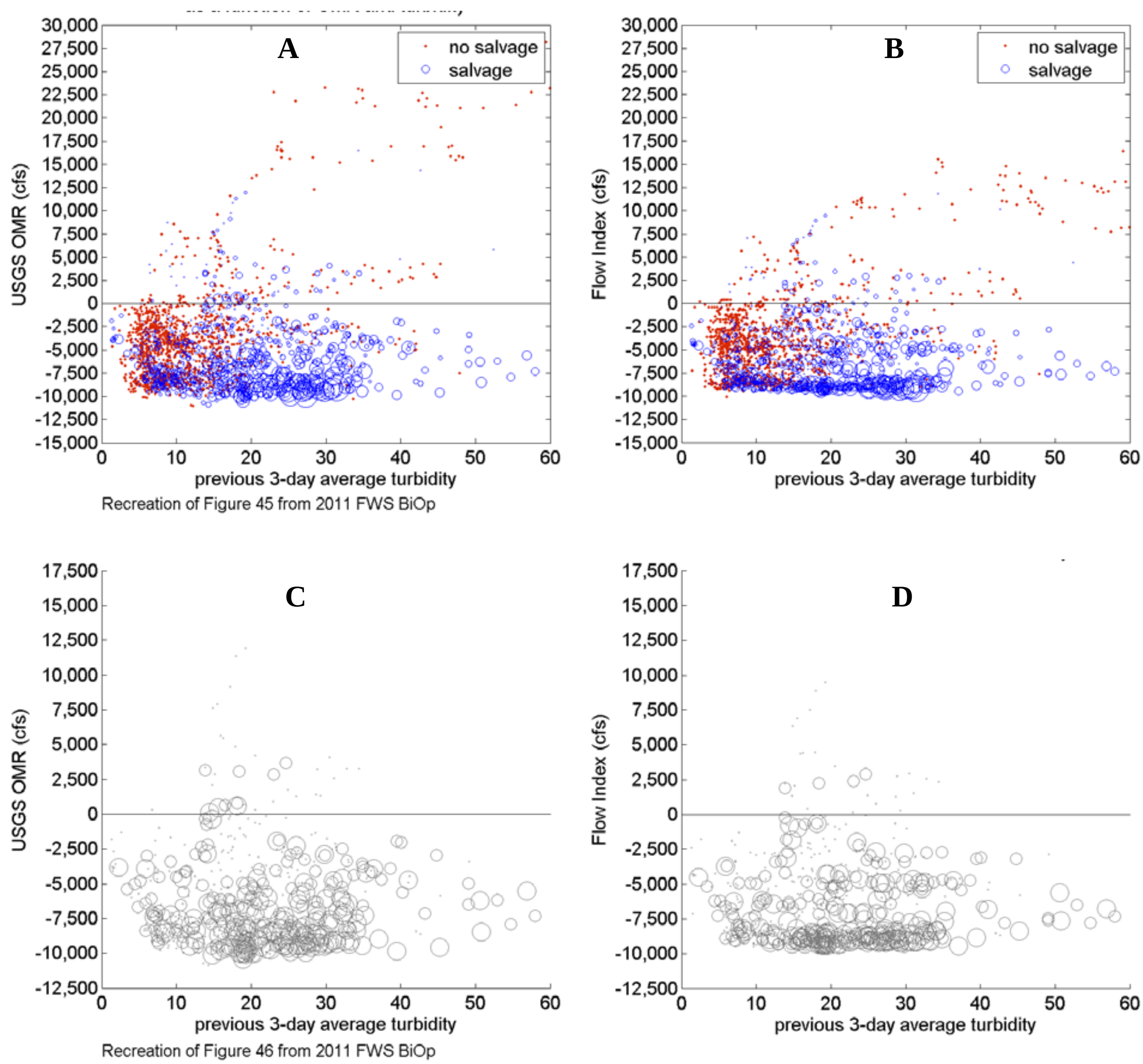

Figure 4-5: Normalized salvage of delta smelt as a function of turbidity and OMR
Panels A and B show normalized salvage (size of bubble) as a function of 3-day average turbidity at Clifton Court Forebay and either USGS OMR (Panel A) or the alternative flow index (Panel B). Panels C and D show normalized salvage (classified into 3 bubble sizes) as a function of 3-day average turbidity at Clifton Court Forebay and either USGS OMR (Panel C) or the alternative flow index (Panel D). [Data source: Panels A and C are recreated from the USFWS 2011 BiOp using data provided by USFWS]

In Figure 4-6, a familiar plot format is used to illustrate the data relating turbidity, south Delta hydrodynamics and adult delta smelt salvage. These data are the same presented in Figure 4-5. Here, turbidity is represented by the color of the data points, as indicated by the color bar on the right side of the plot. Figure 4-6(A) shows USGS OMR versus normalized salvage, and Figure 4-6(B) shows the alternative flow index versus normalized salvage. A comparison of these plots illustrates the similar utility of the USGS OMR index and the alternative flow index.

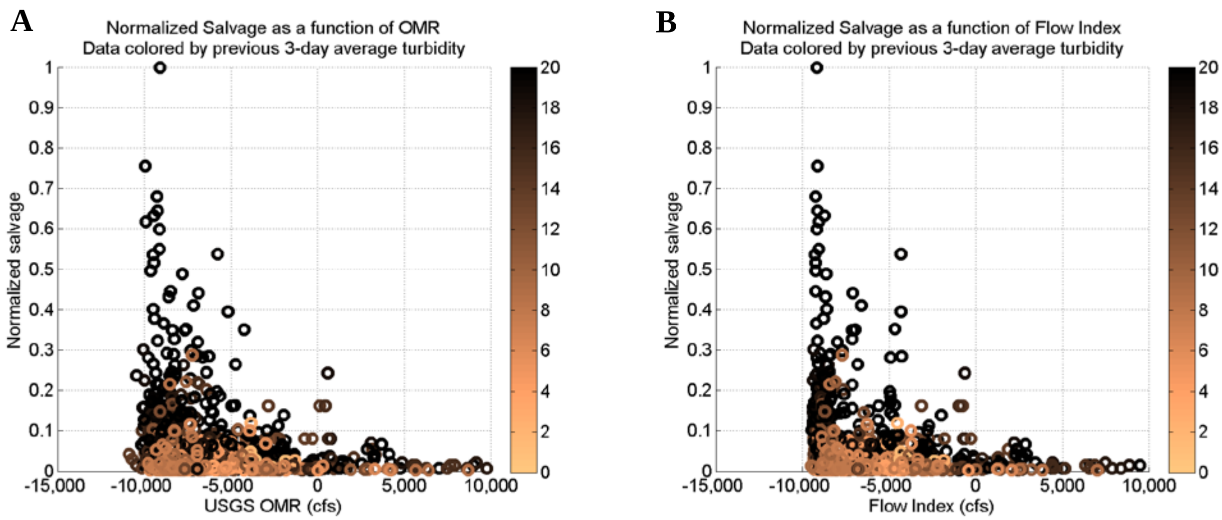

Figure 4-6: Normalized salvage of delta smelt as a function of OMR and turbidity
Panels A and B recast the same data that was shown in Figure 4-5panels A and B into a format similar to Figure 4-3. The difference between Figure 4-3 and Figure 4-6 is that the y-scale here was "normalized" by dividing the normalized salvage in Figure 4-3 by the maximum normalized daily salvage. The data points are now colored by turbidity instead of water year. [Data source: provided by USFWS]

4.3.2 Longfin smelt

Longfin smelt salvage was examined in the same way as delta smelt salvage: both the daily (Figure 4-7) and seasonal (Figure 4-8) salvage of adult longfin smelt is plotted against USGS OMR and against the alternative flow index. For longfin smelt, the plots were done for salvage normalized by prior FMWT, and also for salvage that has not been normalized, since there has been some concern that normalizing the longfin smelt numbers may obscure the true response of salvage to Delta hydrodynamics.

Results for longfin smelt are similar to those for delta smelt: each comparison shows, either visually or through statistics (values for R^2 and SEE), that the alternative flow index is an equally good predictor of salvage at the export pumps as is USGS OMR. Note that correlations for longfin smelt salvage may not be statistically significant without the incorporation of other variables, so conclusions regarding the relationship between salvage and any flow indices should be judged accordingly. However, the USGS OMR and the alternative flow index are both presented to allow comparison of these indices.

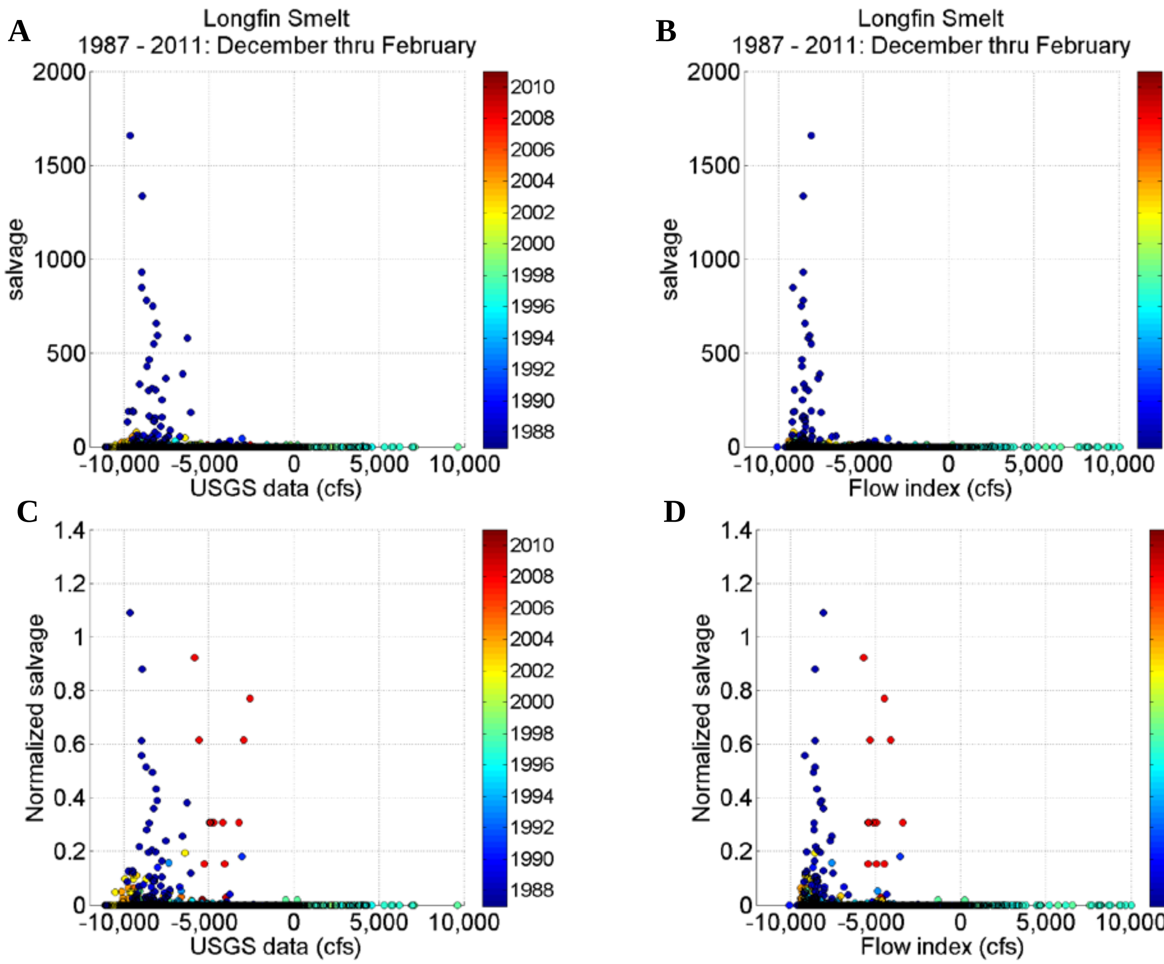

Figure 4-7: Daily salvage of longfin smelt December through February

Daily salvage of longfin smelt from December through February of 1987-2011 is normalized by an annual population index (i.e. the Fall Midwater Trawl (FMWT) index) for each year and plotted against (A) the USGS OMR flow and (B) the alternative flow index. Data points are colored by the water year.

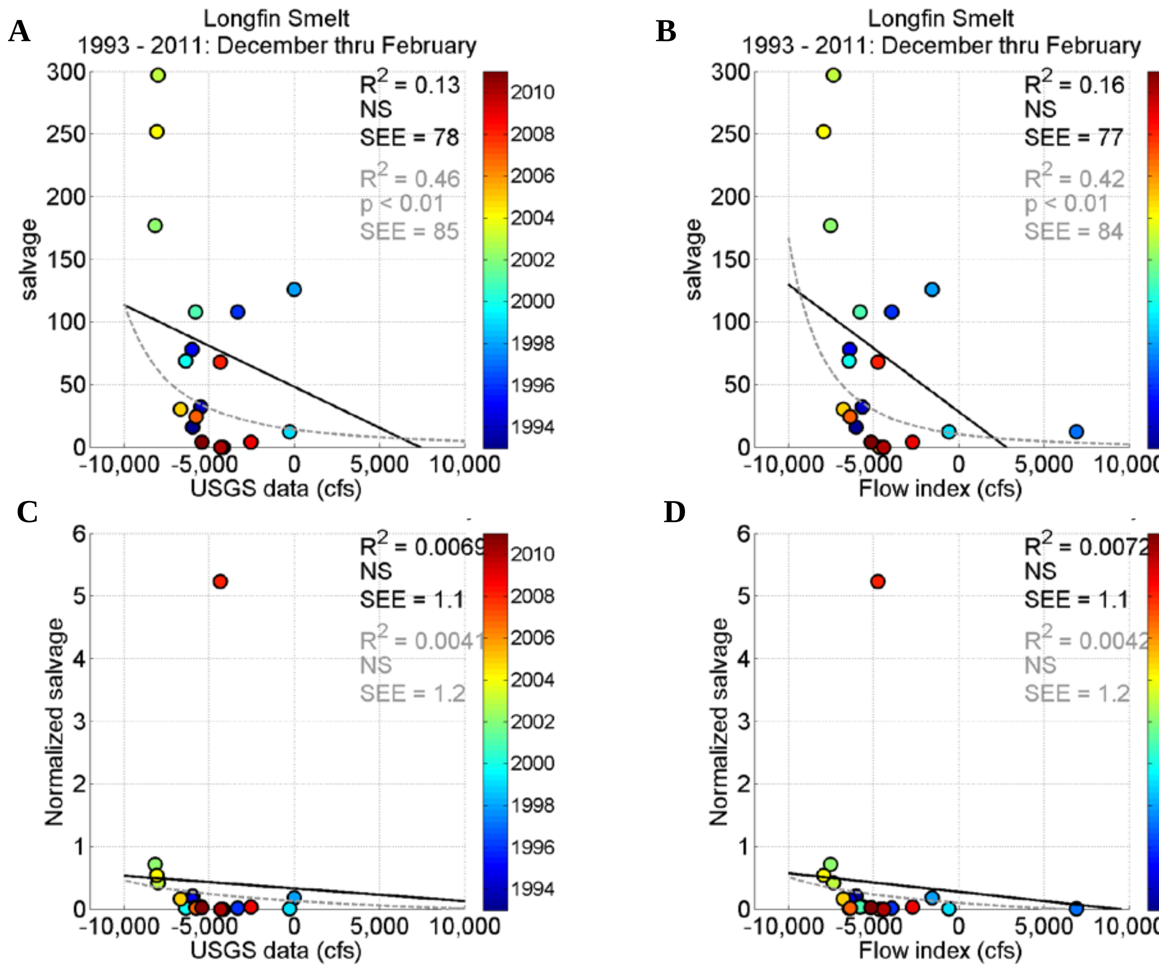

Figure 4-8: Annual total salvage of adult longfin smelt normalized by previous FMWT index

Daily data from Figure 4-7 are summarized seasonally in this figure by showing the total salvage for December through February normalized by the annual FMWT index plotted against (A) the average USGS OMR during the period, or (B) the average alternative flow index during the period. Linear (black line) and log-log (grey dashed line) least squares fits are shown with the statistical parameters listed in the upper right corner of each plot. NS = not statistically significant ($p>0.05$). Note that only the statistically significant relationship is the log-log function form in panels A and B.

4.3.3 Steelhead

Following technical analyses presented to the IEP steelhead project work team (Grimaldo 2012), Figure 4-9 shows steelhead salvage at the export pumps plotted against the alternative flow index and against USGS OMR. The top set of plots shows total steelhead salvage, which cannot be normalized because no population estimates are available. The bottom set shows salvage of steelhead with clipped adipose fins, normalized by total hatchery release[12].

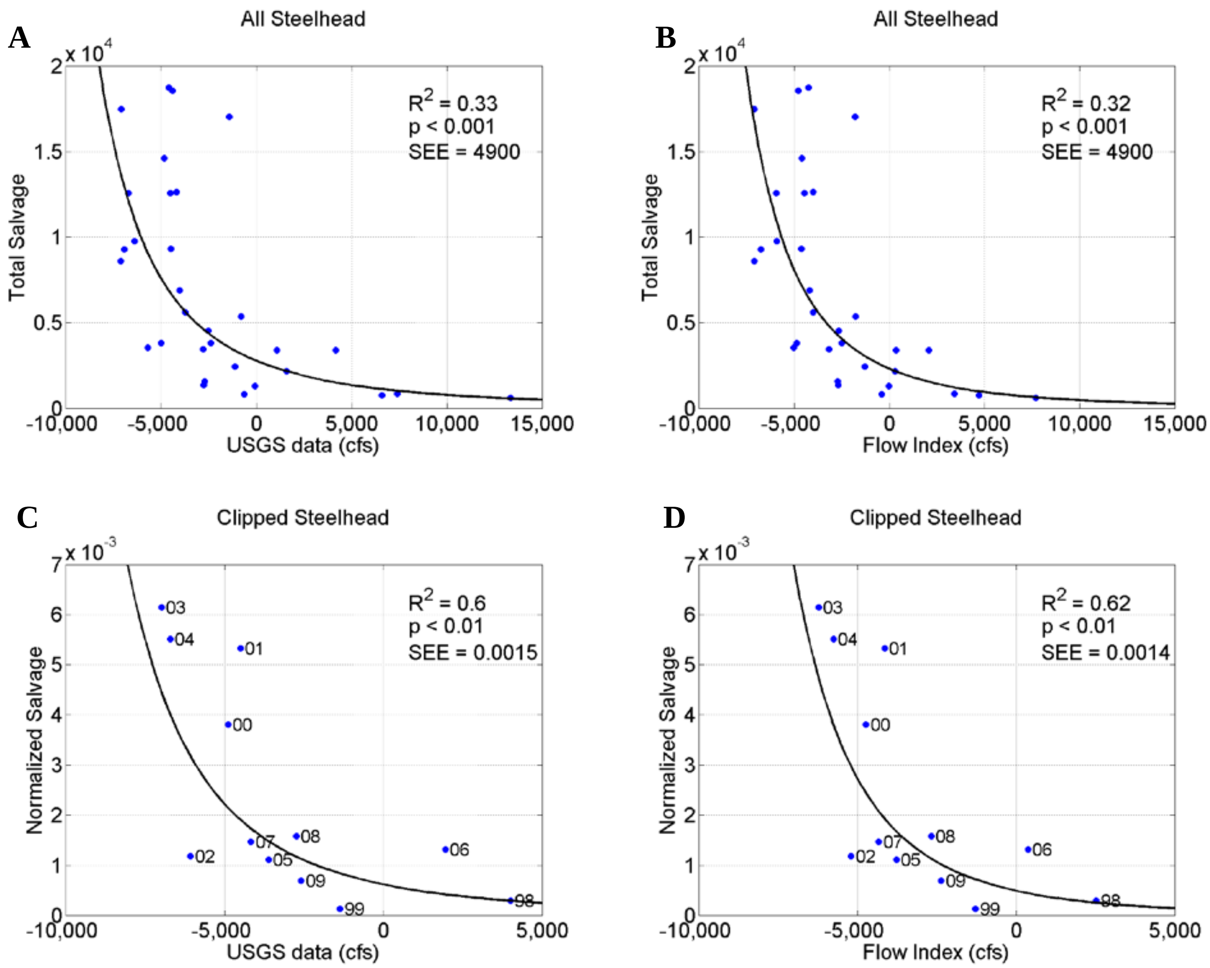

Figure 4-9: Seasonal Steelhead salvage as a function of OMR flow

Panels A and B show the seasonal (December through June) salvage of all steelhead for all steelhead 1981-2009 as a function of either (A) USGS OMR or (B) the alternative flow index. The total steelhead salvage cannot be normalized because no population estimation is available for wild steelhead. Panels C and D show the seasonal (December through June) salvage of steelhead with clipped adipose fins normalized by the total hatchery release for 1998 through 2009 as a function of either (C) USGS OMR or (D) the alternative flow index.

[12] Daily salvage data and annual hatchery releases were provided by Lenny Grimaldo, Bureau of Reclamation, Bay-Delta Office. The analysis was recreated here for comparison with the alternative flow index.

For both total steelhead salvage and hatchery steelhead salvage, results follow the same pattern as those for delta smelt and longfin smelt: salvage response to the alternative flow index is very similar to salvage response to USGS OMR.

It has been demonstrated herein that reliance on field measurements to obtain an index of south Delta hydrodynamics has significant issues with data error and data loss. Reliance on tidally filtered field data also creates issues with operational implementation and regulatory transparency. These include the inability to accurately forecast the index value, delay in knowing if regulations are met, and changes in the index values in the QA/QC process that occur well after the timeframe for compliance, or operational changes to meet compliance. The alternative flow index presented here resolves the above issues and provides relationships to fish salvage data that are as good as the currently used USGS OMR index.

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Appendix A Conceptual Model regarding influence of Old and Middle Rivers

Net flow in Old and Middle Rivers is sometimes perceived to "pull" fish and constituents into the south Delta towards, and ultimately into, the export pumps. However, net flow is a mathematical construct, and nothing actually moves with net flow. Tidal currents in the Bay and a significant part of the Delta dominate transport in the region. Net flow may be an indicator of system dynamics, but when considering the effects of flow on fish, it seems important to understand the actual flow conditions, and how they differ from averages such as net flow.

A.1 Tidal Dynamics

The Bay-Delta estuary is strongly tidal. Only when net velocities are a significant fraction of the tidal velocity do they start to influence hydrodynamics in a strong way.

A.1.1 Spatial and Temporal Variability

Strong tidal influence extends into the Delta along the mainstems of both the Sacramento and San Joaquin Rivers (Figure A-1). Velocity reaches a maximum positive value twice a day during ebb tide, with movement towards the Bay, and minimum negative value twice a day during flood tide. Peak maximum and minimum velocity is typically an order of magnitude greater than the filtered (or "net") velocity.

With tidal velocity peaking around 3 feet per second (ft/s) near the western edge of the Delta (panel A), an item drifting in the water column could move around 8-10 miles on one phase of the tide. Of course, as the item drifts, it will be subject to local velocity at the new location (i.e. the tidal influence changes with location); thus, looking at a single location (e.g. panel A) presents a limited perspective of the regional hydrodynamics and does not capture the movement of a floating item as it reacts to local velocities at different locations (i.e. spatial variability).

During the period illustrated in Figure A-1, Sacramento River inflow near Sacramento was around 10,000 cubic feet per second (cfs) in December, with a peak near 55,000 cfs in January (a moderate winter storm pulse). The winter pulse is most evident at station C, upstream of Rio Vista (panel C), where this flood pulse eliminates the flood tide from late January through late February. Downstream on the Sacramento River along Sherman Island (panel B), and near the western edge of the Delta (panel A), the winter pulse is evident in the filtered (i.e. "net") velocity; however the instantaneous velocity still shows a very strong tidal signal on both ebb and flood tide.

During this same time period, there is a similar, although much smaller, pulse of San Joaquin River inflow at Vernalis, which is approximately 1,200 cfs in December and peaks near 4,500 cfs in January. On the lower San Joaquin River (panels D and E), filtered velocity remains near zero for the entire period, without any evidence of the observed pulse. On Old River, near the flow gauges currently used for compliance of the Old and Middle River net flow regulations, net velocity is slightly negative, but the instantaneous velocity still shows strong tidal variability in both flood and ebb tides.

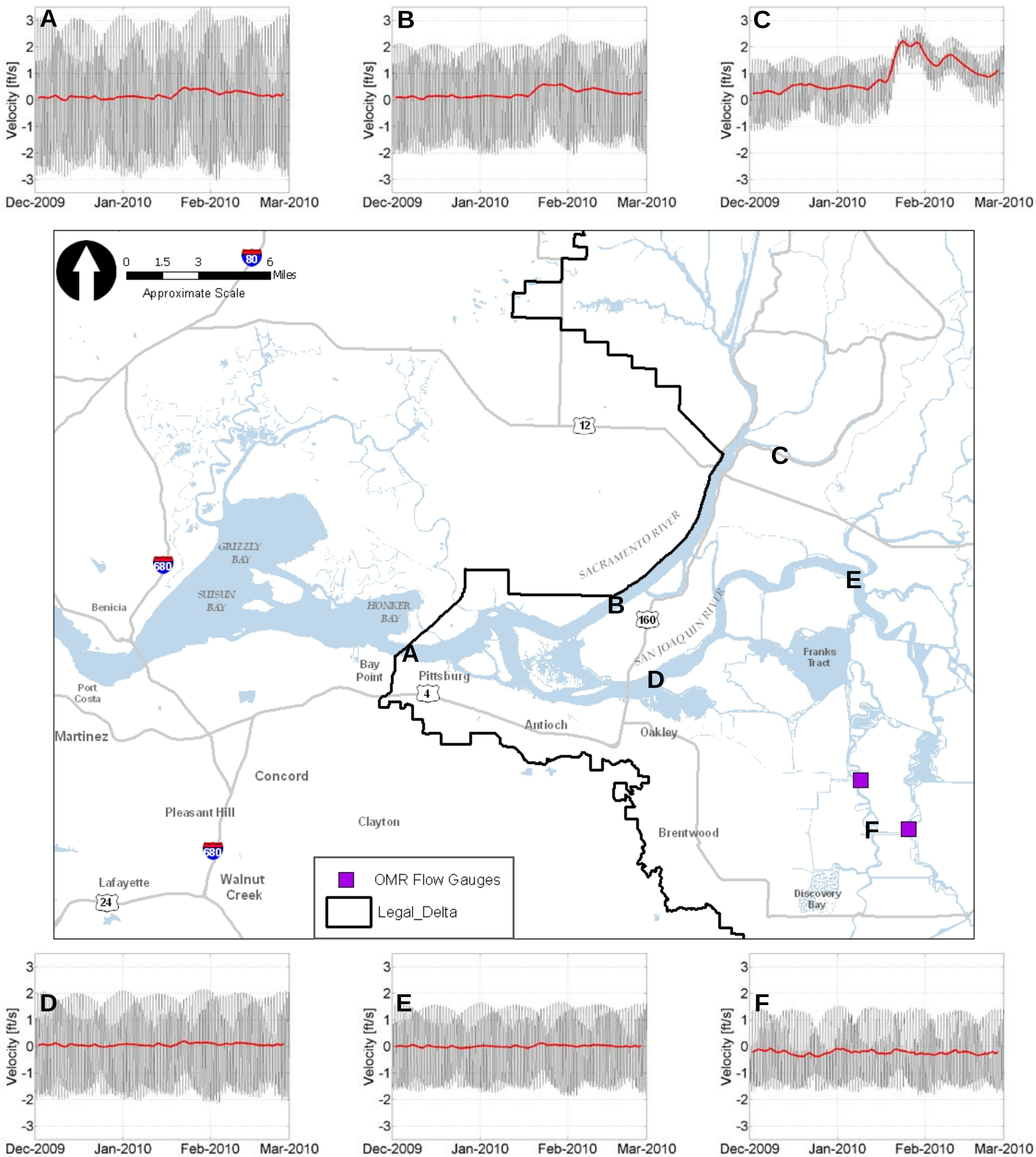


Figure A-1: Tidal velocities at specific locations within the Delta

Strong tidal influence extends into the Delta along the mainstems of both the Sacramento and San Joaquin Rivers. Panels A-F illustrate tidal and filtered (i.e. "net") velocity at the corresponding locations in the map. With tidal velocity peaking around 3 feet per second (ft/s) near the western edge of the Delta (subplot A), an item drifting in the water column could move around 8-10 miles on one phase of the tide. [Data source: DSM2 simulation using historical inputs from December 2009 to March 2010]

A.1.2 Loss of Ebb Tide

As shown in the prior section, instantaneous tidal velocity in the Delta is typically much greater than filtered (or "net") velocity. However, tidal flows can be altered. During periods of low San Joaquin River inflow, export pumping can shift the tidal signal in the southern Delta. As shown later in this section, the effect of the exports in this case is to reduce the ebb tide and enhance the flood tide. Peak tidal velocity can still be a factor.

The following discussion is condensed from a technical memorandum from Greg Gartrell to the NRC Committee on Sustainable Water and Environmental Management in the California Bay-Delta, dated January 20, 2010. It demonstrates the important factors in transport in the south Delta and how tidal and net flows interact.

Figure A-2 shows Delta flows[13] with the ebb and flood flows generally of the same magnitude in opposite directions. The average net flow is much smaller than any flow affecting the fish at a given moment.

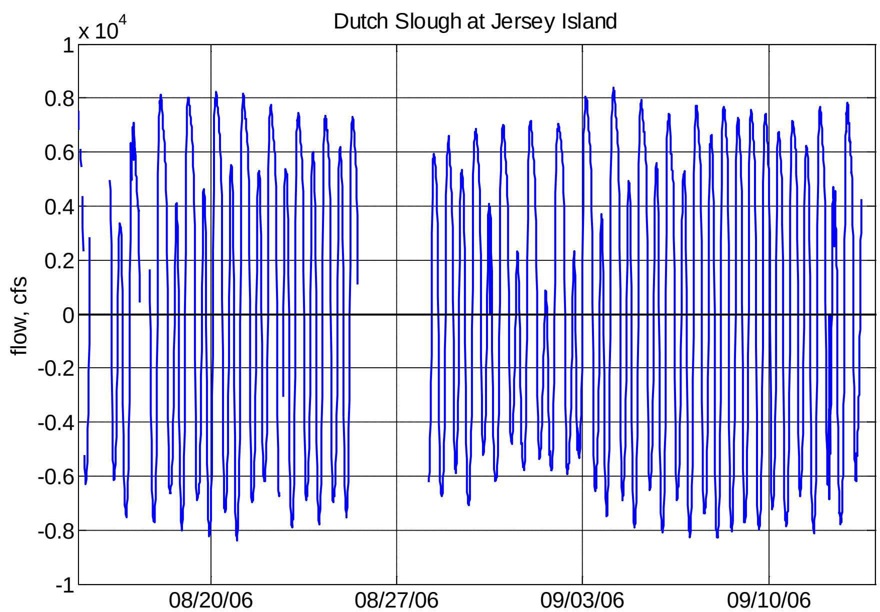


Figure A-2: Tidal flow in the Delta with flood and ebb flows nearly balanced.
Tidal flow measured at Dutch Slough at Jersey Island. Note that the y-scale shows values from -1×10^4 to 1×10^4 cubic feet per second (-10,000 to 10,000 cfs).

Figure A-3 shows tidal flows with a stronger flood than ebb. An aquatic organism at this location has a chance to move in the opposite direction from the flood flow (and opposite the average) if it uses the tides correctly (i.e., if it gets into the high velocity part of the channel on

[13] Data are from the California Data Exchange Center (http://cdec.water.ca.gov). Data shown in Figures A-2, A-3 and A-4 are for the period August 15 to September 14, 2006.

the ebb, and stays near the channel sides on the flood[14]). On the other hand, an organism in the high velocity part of the channel on the flood tide will move a long way south in one excursion, much farther than the net flow would have them move.

The point of this discussion is not to ignore net flows, but rather to caution against over-reliance on averaging that simplifies key dynamics into oblivion. Tidal flows are responsible for salinity intrusion and moving organisms around. Net flows alter the tides, sometimes substantially, but often not. Both must be considered carefully as is seen in the next discussion.

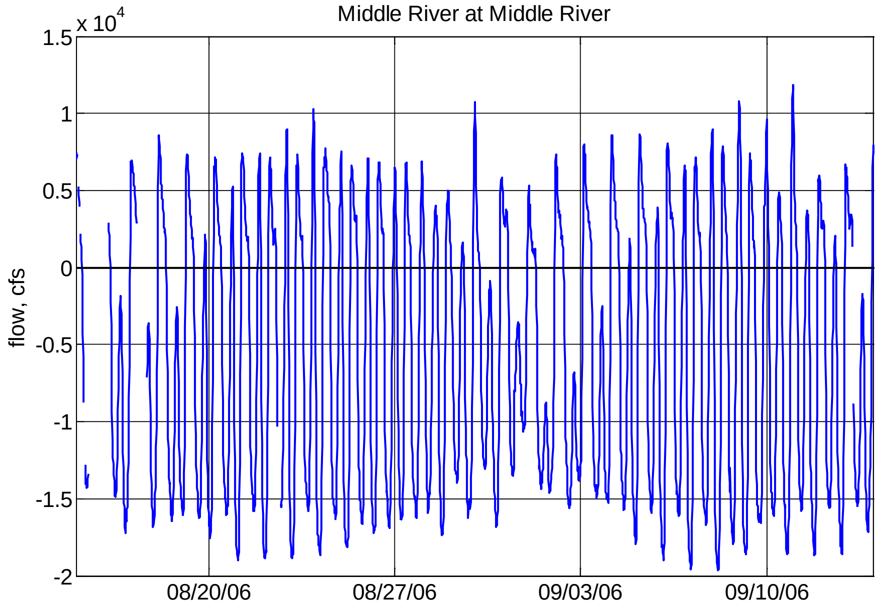


Figure A-3: Tidal flow with a strong flood tide compared to ebb
Tidal flow measured at Middle River at Middle River (west of Bacon Island). Note that the y-scale shows values from $-2x10^4$ to $1.5x10^4$ cubic feet per second (-20,000 to 15,000 cfs).

Figure A-4 shows an example where tidal flows are dominated by net flows. In this case, the tidal signal is still evident, but the net flow is so strong it has eliminated any ebb flow during certain periods. In this case, flow is essentially unidirectional, with varying velocity over the day.

[14] Data from fish surveys and special studies provide evidence of such behavior. For instance, juvenile salmon clearly have the ability to pick the right tide based on cues, or they could not get from north of Rio Vista to Chipps Island in just a few days.

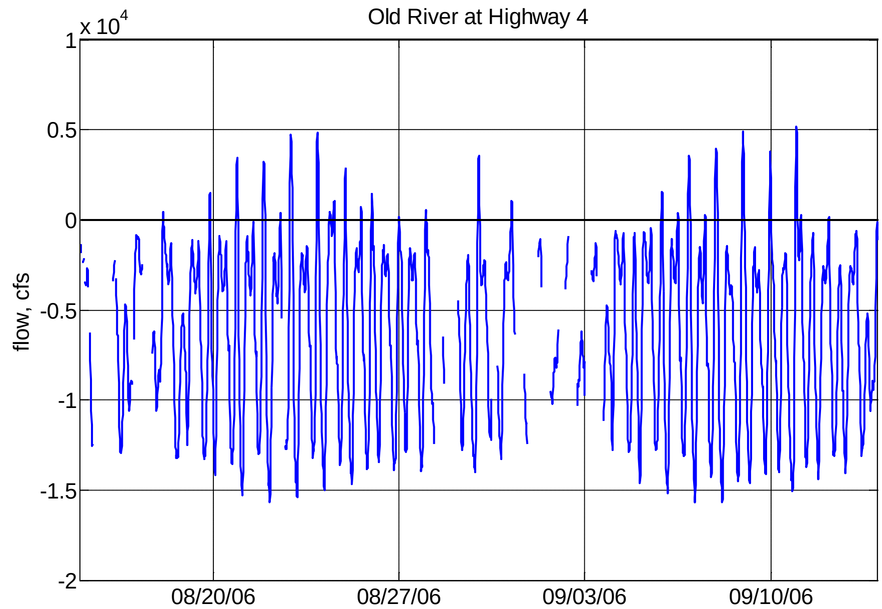


Figure A-4: Tidal flow when the ebb tide is entirely lost for substantial periods over the neap-spring tidal cycle.
Tidal flow measured at Old River near Highway 4. Note that the y-scale shows values from $-2x10^4$ to $1x10^4$ cubic feet per second (-20,000 to 10,000 cfs).

Figures A-2, A-3 and A-4 are measurements from the same time period. However, they all show different responses, and this is important. An aquatic organism moving in the channel does not experience the flows as represented in these figures: these are Eulerian representation and an organism experiences the velocities in its own Lagrangian system (i.e., the velocities as it moves). That Lagrangian excursion can be large (tidal movements are on the order of 4 to 5 miles). Consequently, if an organism starts at a location where there is still a substantial ebb tide but moves up the river on the flood tide and ends up in a location where the ebb has been substantially lost, it will not "slosh back" as the tides change: the velocities become unidirectional at some point along its path. It can be shown the threshold level for significant (Lagrangian) motion ending in salvage is when the alternative flow index reaches about 6,000 cfs (see technical memorandum from Greg Gartrell to the NRC Committee on Sustainable Water and Environmental Management in the California Bay-Delta, dated January 20, 2010). Note that it is not necessary for the ebb tide to be substantially lost at each point in the river, but for the excursion of a particle to reach a point where the ebb tide is substantially lost.

A.2 Particle Tracking as a Tool

PTM uses velocity, flow, and water elevation information from DSM2-Hydro to simulate the movement of virtual particles in the Delta on a 15-minute time-step throughout the simulation period. If a particle leaves the Delta system by way of an export or diversion or through any other model boundary, this information is recorded for later analysis and termed the "fate" of the particle. Additionally, the percentage of particles remaining within channels in each geographic region is tabulated and analyzed.

Use of PTM for fishery analysis has gained popularity over the last decade; however, the PTM tool has a number of limitations in application to fishery analysis. Chiefly, since the particles simulated in the model are neutrally buoyant (and therefore have no swimming behavior or other independent movement), results of these analyses are most relevant to the planktonic early larval stages of various organisms that do not move independently in the water column. The particles are not considered to reflect movements of juvenile or adult fish within the Delta, or of larvae that are able to move independently in the water column (for example, by varying their buoyancy). Recognizing these limitations, PTM is used in this report as an indicator of Delta hydrodynamics and potential risk for entrainment.

To evaluate hydrologic and operational variability, particle releases were simulated at the start of each month from January 1990 through March 2012, using historical Delta inflows and tides as inputs for the DSM2 model.

One thousand particles were released over a period of 25 hours (to encompass a full tidal cycle). Particle movement was tracked for 120 days; particle location is reported at 28 days and classified as flux past a specific location, potential entrainment at water intakes, or the percent remaining in channels in specific regions of the Delta and Suisun Bay and Marsh.

Appendix B OMR Compliance 2009-2012

The following plots are provided to illustrate the difficulties in operating the CVP and SWP exports to meet regulations set with the USGS OMR index. Each figure in this Appendix includes time series of the USGS tidally filtered daily average flow in Old and Middle Rivers (labeled as "Daily), running averages of the daily values (labeled as "5 Day Average" in the top subplot and "14 Day Average" in the bottom subplot), and the regulatory limit (labeled as "5 Day Control" in the top subplot and "14 Day Control" in the bottom subplot). The data are plotted in terms of negative cubic feet per second (-cfs); in these plots, compliance with the OMR regulation is indicated when the running average values (solid lines) are below the control values (dashed lines). However, the control values are not applicable until the control has been in effect for the averaging period (i.e. the 5-day control does not apply until the 5th day after the decision is made to set the control value).

The plots below also show data drop-outs, periods when meeting the regulatory requirement was missed and periods when it was met by large margins; discussions with operators indicate that the inability to predict outside factors leads them to use large "safety factors" at times, which make operation unnecessarily inefficient.

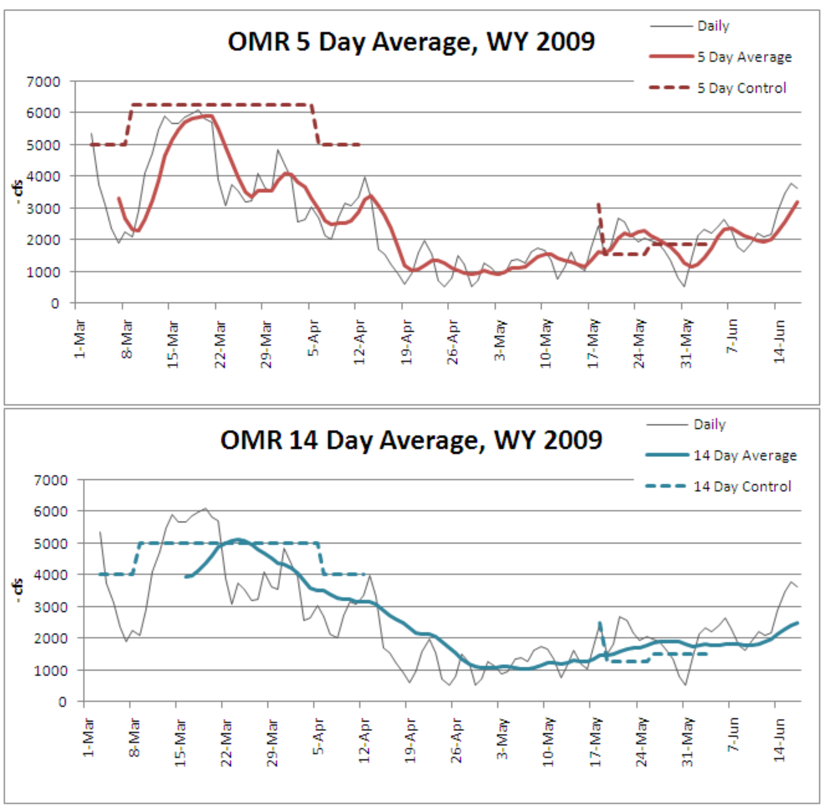
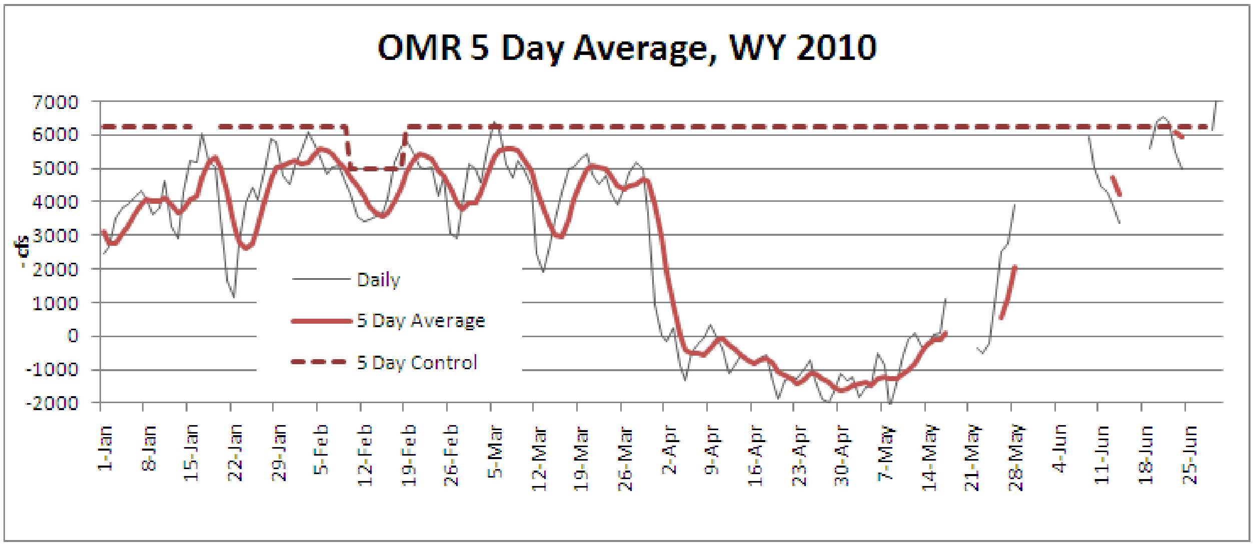


Figure B-1: Time series of measured OMR and Regulatory Controls for WY 2009

OMR Measurements from USGS stream flow data for Old River (station 11313405) and Middle River (station 11312676), tidally filtered by USGS. OMR Control values are provided in USFWS Determinations and note from the smelt working group (SWG) and the Delta Operations for Salmon and Sturgeon (DOSS) Group.



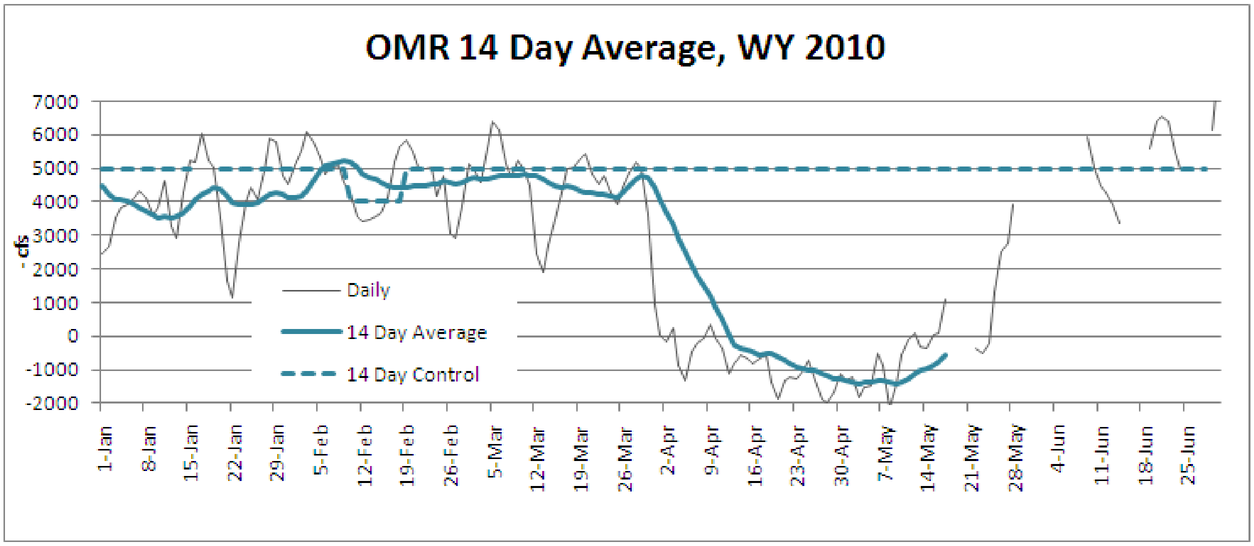
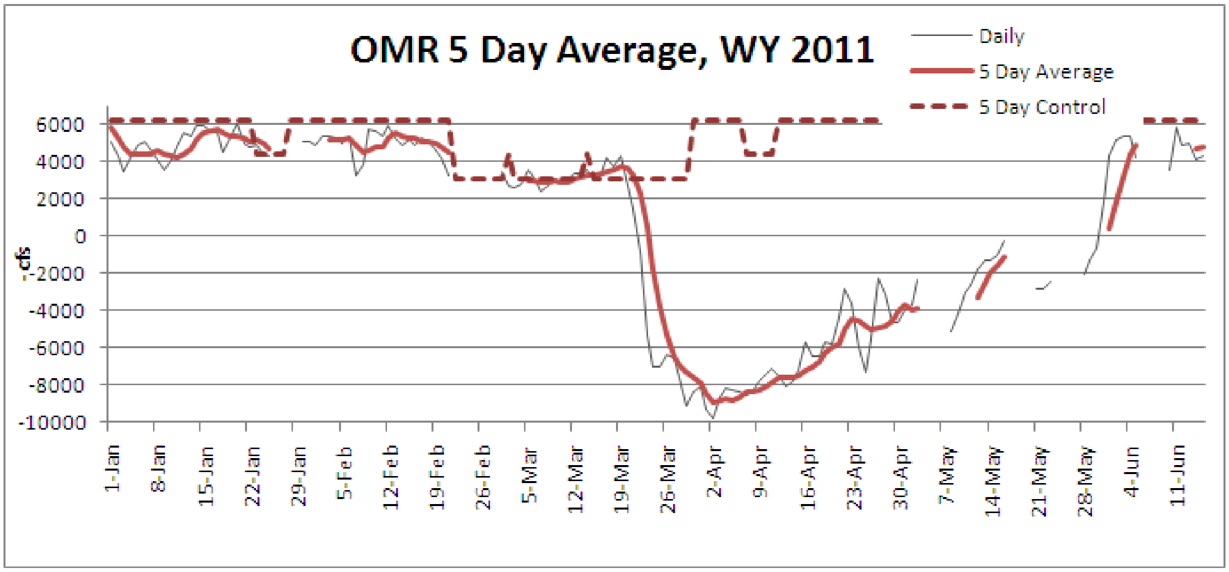


Figure B-2: Time series of measured OMR and Regulatory Controls for WY 2010
OMR Measurements from USGS stream flow data for Old River (station 11313405) and Middle River (station 11312676), tidally filtered by USGS. OMR Control values are from materials for the 2010 OCAP Integrated Annual Review Workshop.



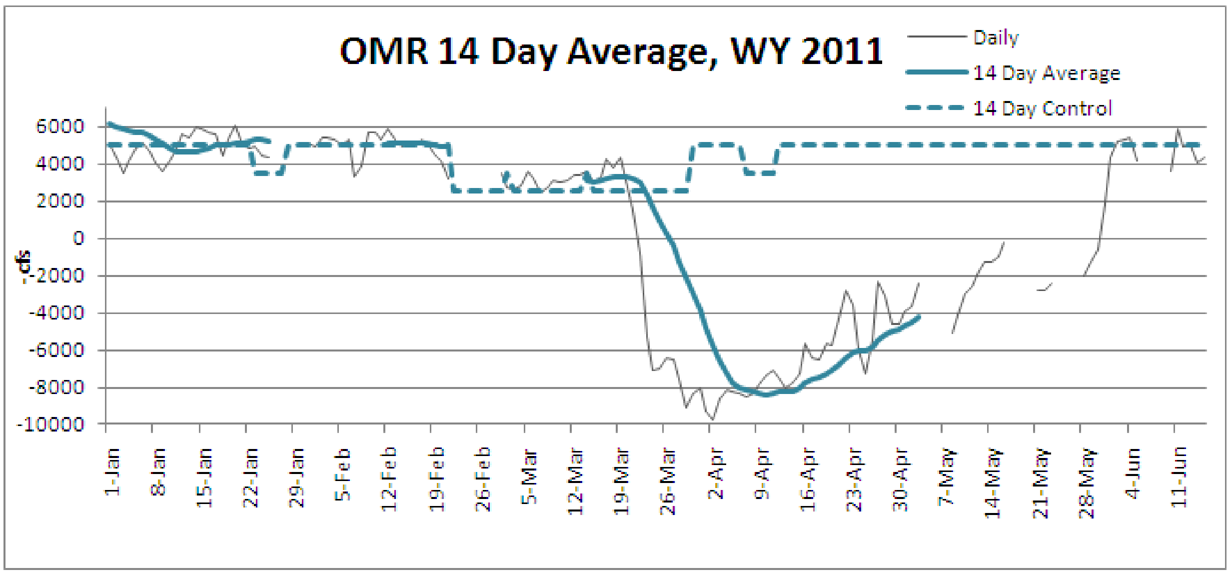
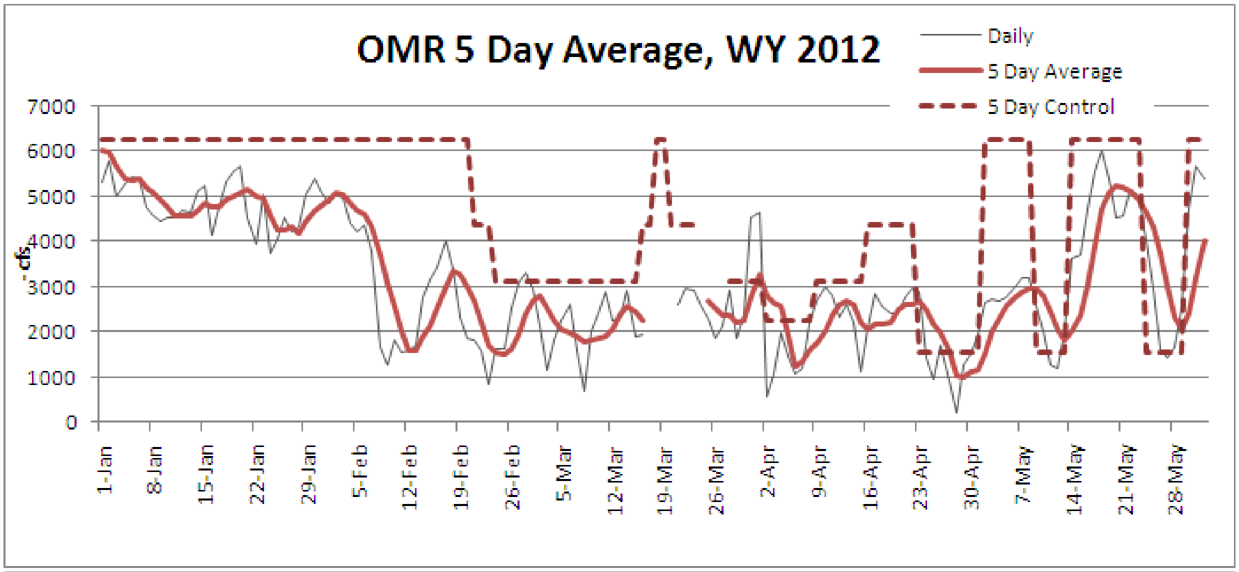


Figure B-3: Time series of measured OMR and Regulatory Controls for WY 2011

OMR Measurements from USGS stream flow data for Old River (station 11313405) and Middle River (station 11312676), tidally filtered by USGS. OMR Control values are from materials for the 2011 OCAP Integrated Annual Review Workshop.



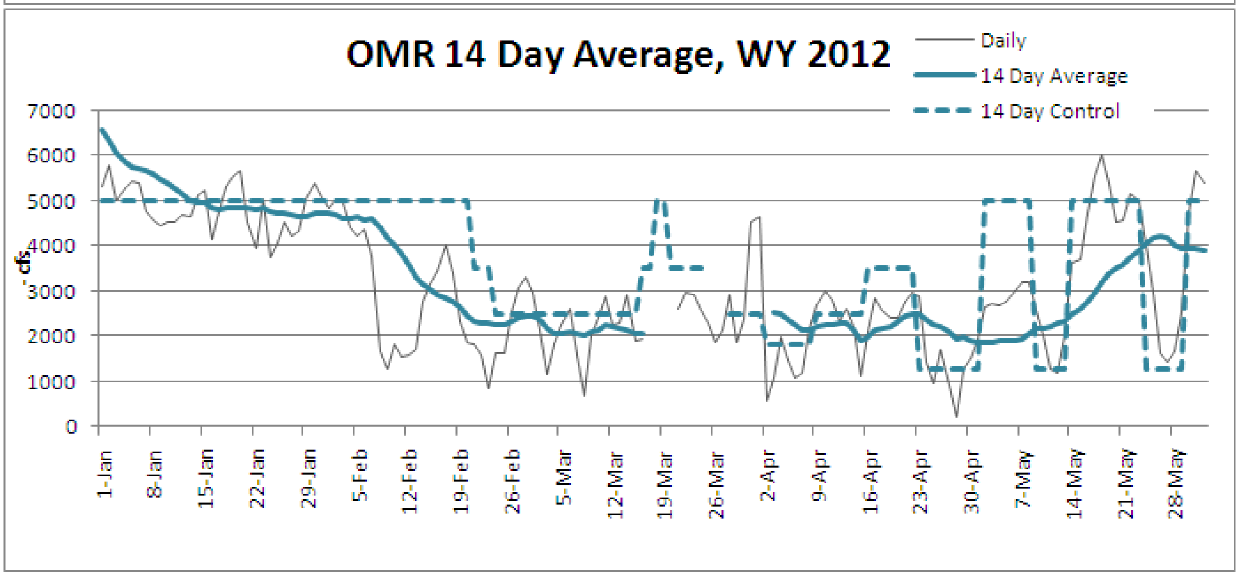


Figure B-4: Time series of measured OMR and Regulatory Controls for WY 2012

OMR Measurements from USGS stream flow data for Old River (station 11313405) and Middle River (station 11312676), tidally filtered by USGS. OMR Control values are provided in USFWS Determinations and note from the smelt working group (SWG) and the Delta Operations for Salmon and Sturgeon (DOSS) Group.