United States Department of the Interior

FISH AND WILDLIFE SERVICE
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IN REPLY REFER TO:
1-1-05-F-0055

FEB 16 2005

Memorandum

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

From: Field Supervisor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues

This is in response to the Bureau of Reclamation's (Reclamation) November 3, 2004 request for reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP) and the Operating Criteria and Plan (OCAP) in California to address potential critical habitat issues. The OCAP describes the coordinated operations of the CVP and SWP. Reclamation and the California Department of Water Resources (DWR) operate the CVP and SWP through the Coordinated Operations Agreement (COA) (Reclamation 2004). The COA is the federal nexus for consultation on SWP operations under section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). Your request was received in our office on November 4, 2004. This document represents the Service's biological opinion on the effects of the action to the threatened delta smelt (*Hypomesus transpacificus*) and its critical habitat in accordance with the Act.

Reclamation also requested consultation on the endangered riparian brush rabbit (*Sylvilagus bachmani riparius*), the endangered riparian woodrat (*Neotoma fuscipes riparia*), the endangered salt marsh harvest mouse (*Reithrodontomys raviventris*), the endangered California clapper rail (*Rallus longirostris*), the threatened giant garter snake (*Thamnophis gigas*), the threatened California red-legged frog (*Rana aurora draytonii*), the threatened valley elderberry longhorn beetle (*Desmocercus californicus dimporphus*), the endangered soft bird's beak (*Corylanthus mollis ssp. mollis*) and the endangered Suisun thistle (*Cirsium hydrophilum var. hydrophilum*). The Service concurs with Reclamation's determination that the coordinated operations of the

CVP and SWP and the OCAP for formal and early consultation are not likely to aversely affect these species. No additional effects are expected to the threatened bald eagle (*Haliaeetus leucocepalus*) as a result of implementation of the formal or the early consultation beyond those analyzed in the Service's *Formal Endangered Species Act Consultation on Effects of Implementing Long Term Operational Criteria and Plan for Central Valley Project Reservoirs* for the bald eagle dated February 12, 1993 (Service file # 1-1-93-F-10). Therefore, the Service opinion dated February 12, 1993 still applies for effects to the bald eagle.

This biological opinion is based on information provided in Reclamation's biological assessment dated June 30, 2004, the CH2MHill Trinity document dated November 5, 2003, and all associated enclosures. A complete administrative record is on file at the Sacramento Fish and Wildlife Office (SFWO).

This biological opinion covers formal and early consultation for the operations of the CVP and SWP. The formal consultation effects described in this biological opinion cover the proposed 2020 operations of the CVP including the Trinity River Mainstem ROD (Trinity ROD) flows on the Trinity River, the increased water demands on the American River, the delivery of CVP water to the proposed Freeport Regional Water Project (FRWP), water transfers, the long term Environmental Water Account (EWA), the operation of the Tracy Fish Facility, and the operation of the SWP-CVP intertie. The effects of operations of the SWP are also included in this opinion and include the operations of the North Bay Aqueduct, the Suisun Marsh Salinity Control Gates, the Skinner Fish Facility and water transfers.

Early consultation effects include the effects of operations of components of the South Delta Improvement Program (SDIP). These operations include pumping of 8500 cubic feet per second (cfs) at the SWP and Banks Pumping Plant (hereafter referred to as 8500 Banks), permanent barrier operations in the South Delta, the long term EWA, water transfers, and CVP and SWP operational integration. There are two separate effects sections in this biological opinion, one for Formal Consultation and one for Early Consultation. In addition, there is an incidental take for formal consultation and a preliminary incidental take for early consultation.

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

Early Consultation Process

This biological opinion includes an effects determination and take statement for the formal consultation items described above. This biological opinion also includes a preliminary effects determination and take statement for the early consultation items described above. An Early Consultation as stated in the regulations "is designed to reduce the likelihood of conflicts between listed species or critical habitat and proposed actions and occurs prior to the filing of and application for a Federal permit or license." The early consultation will result in a preliminary biological opinion except that the incidental take statement provided for the early consultation does not constitute authority to take listed species. Once the South Delta Action Specific Implementation Plan (ASIP) is completed, the Service will re-examine the project description and effects in the ASIP and in this opinion. If the project description and effects to the delta smelt are the same as in the early consultation effects section of this biological opinion, the Service will formalize the early consultation portion of this biological opinion. If there are additional effects or project elements that are not addressed in the early consultation section of this biological opinion, Reclamation and DWR will reinitiate on this biological opinion to cover smelt effects described in the South Delta ASIP.

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CONSULTATION HISTORY

On February 12, 1993, the Service issued its biological opinion on the Long Term Operations Criteria and Plan for CVP Reservoirs for the bald eagle, salt marsh harvest mouse and California clapper rail (Service file #1-1-93-F-10).

On May 23, 1993, the Service issued a biological opinion on the Operations Criteria and Plan for the bald eagle, salt marsh harvest mouse and the California clapper rail (Service file #1-1-93-F-32).

On May 26, 1993, the Service issued the *Formal Consultation on Central Valley Project Operations Criteria and Plan for 1993: Effects on Delta Smelt* (Service file #1-1-93-F-32).

On February 4, 1994, the Service issued its *Formal Consultation on the 1994 Operation of the Central Valley Project and State Water Project: Effect on Delta Smelt.*

On November 2, 1994, the Service issued its *Formal Endangered Species Consultation on the Environmental Protection Agency's proposed Water Quality Standards for the San Francisco Bay/Sacramento-San Joaquin Rivers and Delta* (Service file #1-1-93-F-61).

On March 6, 1995, the Service issued its *Formal Consultation and Conference on Effects of Long-term Operation of the Central Valley Project and State Water Project on the Threatened Delta Smelt, Delta Smelt Critical Habitat, and Proposed Threatened Sacramento Splittail* (Service File #1-1-94-F-70).

On September 14, 1995, the Service issued its *Informal Endangered Species Consultation on the Replacement of the U.S. Environmental Protection Agency's Water Quality Standards for the San Francisco Bay/Sacramento-San Joaquin Rivers and Delta with the California State Water Resources Control Board's Water Quality Control Plan for the Bay/Delta* (Service file #1-1-95-I-1509).

Starting in November 2002, the Service, along with other fishery and project agencies met monthly to discuss the development of the biological assessment.

On February 12, 2003, the Service submitted the document *Information Needs for Consultations on Delta smelt and Sacramento Splittail for the South Delta Improvement Program and the Central Valley Project and State Water Project Operations* to Reclamation and DWR which provided information that the Service needed to have included in Reclamation's biological assessment.

On April 25, 2003, the Service submitted the document *Additional Information Needs for Consultation an Delta smelt and Sacramento Splittail for the Central Valley Project and State Water Project* to Reclamation which requested additional information to be included in the biological assessment.

On May 6, 2003, the Service submitted the document *Request for Additional Information to Initiate Formal Consultation for Central Valley Project Water Deliveries to Sacramento County Water Agency in Sacramento County, and East Bay Municipal Utility District in Contra Costa, California* to Reclamation.

On July 23, 2003, the Service submitted the document *Service Comments on the Bureau of Reclamation's Draft long-Term Central Valley Project Operations, Criteria and Plan and Biological Assessment.*

On September 2003, the Service, along with other fishery and project agencies began meeting weekly to develop the project description and the effects sections of the biological assessment.

On February 13, 2004, the Service received a draft of the biological assessment for the coordinated operations of the CVP and SWP and the OCAP

On March 15, 2004, the Service received the Reclamation's March 15, 2004, request for formal and early consultation and transmittal of their biological assessment on the coordinated operations of the CVP and SWP and the OCAP. However, this letter did not include a biological assessment.

On March 22, 2004, the Service received the biological assessment from Reclamation on the coordinated operations of the CVP and SWP and the OCAP. Also on March 22, 2004, the Service received Reclamation's February 2004, *Long-term Central Valley Project and State Water Project Operations Criteria and Plan Biological Assessment for Terrestrial Species*. The Service received on March 22, 2004, the Department of Water Resources' *Long Term Central Valley Project Operating Criteria and Plan Biological Assessment for Terrestrial Species Protected Under the State Endangered Species Act.*

On May 24, 2004, the Service received an updated version of the biological assessment and the OCAP from Reclamation which included separate effects for the early and formal consultation.

On June 30, 2004, the Service received an updated version of the biological assessment from Reclamation.

On July 30, 2004, the Service issued its biological opinion on OCAP: *Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan.*

On November 4, 2004, the Service received Reclamation's November 3, 2004 memorandum requesting reinitiation of formal consultation with the Service to address potential critical habitat issues.

BIOLOGICAL OPINION

Description of Proposed Action

Introduction

Reclamation and California Department of Water Resources (DWR) propose to operate the CVP and SWP (collectively the Project) to divert, store, and convey Project water consistent with applicable law. These operations are summarized in this Biological Assessment (BA) and are described in further detail in the CVP-OCAP.

The Proposed Action

The proposed action is to continue to operate the CVP and SWP in a coordinated manner. In addition to current day operations, several future actions are to be included in this consultation. These actions are: (1) increased flows in the Trinity River, (2) 8500 Banks, (3) permanent barriers operated in the South Delta, (4) an intertie between the California Aqueduct (CA) and the Delta-Mendota Canal (DMC), (5) a long-term EWA, (6) delivery of CVP water to the FRWP, and (7) various operational changes that are identified in this project description. Some of these items will be part of early consultation including 8500 Banks, permanent barriers and the long-term EWA. These proposed actions will come online at various times in the future. Thus, the proposed action is continued operation of the Project without these actions, and operations as they come online.

The actions listed in the preceding paragraph are not being implemented at present; however, they are part of the future proposed action on which Reclamation is consulting. Only the operations associated with the proposed activities are addressed in this consultation; i.e., the activities do not include construction of any facilities to implement the actions. 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. Table 1 summarizes the differences between current operational actions and future operational actions to be covered by this consultation.

Table 1 Proposed future changes in operational actions for consultation.

Area of Project	Circa 1997	Today 2004	Future 2030
Trinity & Whiskeytown	340,000 af	368,600-452,600 af	368,600- 815,000 af
Shasta/Sacramento River	Red Bluff Diversion Dam (RBDD) 8 months gates out	Same	Same
Oroville and Feather River	Same	Same	Same
Folsom and American River	Current Demands	Current Demands	Build out of demands and Freeport Regional Water Project
New Melones and Stanislaus River	Interim Plan of Operations Guidance	Same	Same
Friant	Same	Same	Same
Sacramento-San Joaquin Delta	2001 Demands	2001 Demands	2020 Demands
Suisun March	Same	Same	Same
WQCP	D-1641	D-1641	Same
COA	1986 Guidance	1986 Guidance	Integrated Operations
CVPIA	May 9, 2003 Decision	May 9, 2003 Decision	Same
CALFED	None	EWA	Same
Banks	6680 cfs & Temp Barriers	6680 cfs & Temp Barriers	8500 Banks and Permanent barriers
Tracy	Max of 4600 cfs in summer	Max of 4600 cfs in summer	Intertie

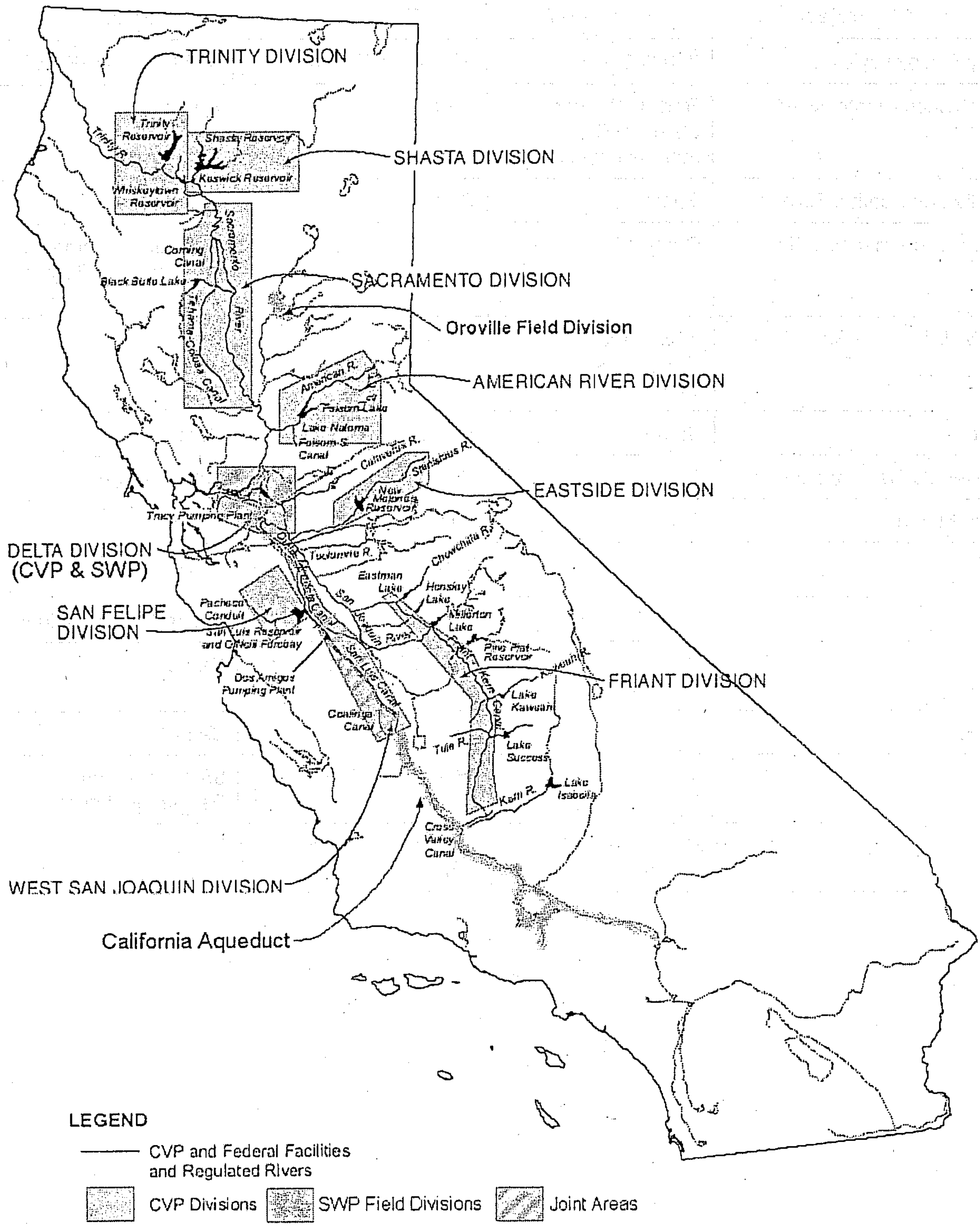

Figure A: CVP and SWP Service Areas

Coordinated Operation of the CVP and SWP

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 California State Water Resources Control Board (SWRCB) to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Sacramento Valley and the Sacramento-San Joaquin Delta Estuary Delta. The Project Agencies operate the CVP and SWP to meet these requirements through the Coordinated Operations Agreement (COA) (Reclamation 2004).

The COA 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 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 every 5 years.

The CVP and the SWP use the Sacramento River and the Delta as common conveyance facilities. Reservoir releases and Delta exports must be coordinated to ensure each project achieves its share of benefit from shared water supplies and bears its share of joint obligations to protect beneficial uses.

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 Decision 1485 (D-1485) (Reclamation 2004) 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.

Balanced water conditions are defined in the COA as periods when it is 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 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), Reclamation and DWR have the responsibility (during excess water conditions) to store and export as much water as possible, within physical and contractual limits.

In these Studies, accountability is not required. However, during balanced water conditions, the Projects share the responsibility in meeting in-basin uses. Balanced water conditions are further defined according to whether water from upstream storage is required to meet Sacramento Valley in-basin use or unstored water is available for export.

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 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 accounts are 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" 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; 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 objective. 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 5 days to travel from Keswick to the Delta. As water from the other reservoirs arrives in the Delta, Folsom releases could be adjusted downward. Any imbalance in meeting each project's obligation would be captured by the COA accounting.

Reservoir release changes are one means of adjusting to changing in-basin conditions. Changes in Delta outflow can also be immediately achieved by increasing or decreasing project exports. As with changes in reservoir releases, imbalances in meeting project obligations are counted in the COA accounting.

During periods of balanced water conditions, when real-time operations dictate project actions, an accounting procedure tracks the water obligations of the CVP and SWP. The Projects maintain a daily and accumulated accounting. The account represents the imbalance resulting from actual coordinated operations compared to the COA-defined 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

1 These percentages were derived from negotiations between Reclamation and DWR

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 Operations Coordination Environment since 1986

Implementation of the COA has evolved continually 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 operations coordination 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 Central Valley Project Improvement Act (CVPIA) has changed how the CVP is operated; and finally, the Act responsibilities have effected 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

Temperature operations have constrained the pattern of storage and withdrawal of storage at Shasta, Trinity, and Whiskeytown, for the purpose of improving temperature control. They have also constrained rates of flow, and changes in rates of flow below Keswick Dam in keeping with 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 timing of the CVP releases to be 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.

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

The December 1994 Bay-Delta Accord (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) (Reclamation 2004), and later, along with Vernalis Adaptive Management Program (VAMP) (Reclamation 2004), were implemented by D-1641. 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.

The first option is to amend the COA to provide for continued implementation to accomplish the purposes of the 1986 COA. Although the CVP and SWP continue to be operated in coordination to meet D-1641, neither an amendment of the COA nor an evaluation of the new Delta standards (for consistency with Congressional directives) has been undertaken. Significant new elements in the D-1641 standards include: (1) the X2 standards, (2) export to inflow (E/I) ratios, (3) Real-time Delta Cross Channel (DCC) operation, (4) San Joaquin flow standards, and (5) recognition of the CALFED Operations Coordination Group (Ops Group) process for flexibility in applying or relaxing certain standards.

Freeport Regional Water Project

The FRWP will be a new facility that will divert up to a maximum of about 300 cfs from the Sacramento River near Freeport for Sacramento County Water Agency (SCWA) 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 (Reclamation 2004), diversions to EBMUD will be treated as an export in the COA accounting and diversions to SCWA will be treated as an in-basin use.

North Bay Aqueduct

North Bay Aqueduct 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.

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, D-1485 was superseded and SWP growth and other pumping constraints reduced available surplus capacity. 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 has diminished the accomplishments anticipated by the CVP under the 1986 COA.

Periodic Review of the COA

The language of the COA incorporates a provision for the periodic review of the Agreement. Article 14a of the COA specifies the parties to review operations every 5 years.
The Agreement proceeds to state that the parties shall:

- Compare the relative success each party has had in meeting its objectives
- Review operation studies supporting the COA
- Assess the influence of the factors and procedures of Article 6 in meeting each party's future objectives

Article 14a further states, "The parties shall agree upon revisions, if any, of the factors and procedures in Article 6, Exhibits B and D, and the Operation Study used to develop Exhibit B." Beginning in 1995, and continuing under D-1641, the Projects have been operating to meet the revised Delta standards. The changes that have occurred to the CVP and SWP since 1986 suggest a COA review would be appropriate. The August 2000 CALFED Record of Decision (CALFED ROD) (Reclamation 2004) included as an "Implementation Commitment" that DWR and Reclamation intend to modify the 1986 COA to reflect the many changes in regulatory standards, operating conditions, and new project features such as EWA, that have evolved. Should that process indicate a change in the coordinated operation of the CVP and SWP, a review will be completed to determine the need to re-initiate consultation under Section 7 of the Act.

SWRCB D-1641

The SWRCB imposed 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 vary throughout the year and by the wetness of the year.

Figure 1(and footnotes) summarizes the flow and quality objectives in the Delta and Suisun Marsh for the Projects from D1641. 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 WQCP for the Bay-Delta (which is to be revisited periodically).

On December 29, 1999, SWRCB adopted and then revised (on March 15, 2000) D-1641, amending certain terms and conditions of the water rights of the SWP and CVP. D-1641 substituted certain objectives adopted in the WQCP 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 WQCP. The requirements in D-1641 address the standards for fish and wildlife protection, M&I water quality, agricultural water quality, and Suisun Marsh salinity. 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. D-1641 modified the Vernalis salinity standard under SWRCB Decision 1422 to the corresponding Vernalis salinity objective in the WQCP. The criteria imposed upon the CVP and SWP are summarized in Figure 1 (Summary Bay-Delta Standards and Footnotes for Summary Bay-Delta Standards), and Figure 1 (CVP/SWP Map).

Summary Bay-Delta Standards

Contained in D-1641

CRITERIA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FLOW/OPERATIONAL												
• Fish and Wildlife												
SWP/CVP Export Limits					1,500cfs [1							
Export/Inflow Ratio [2]	65%			35% of Delta Inflow [3]						65% of Delta Inflow		
Minimum Delta Outflow	[4]									3,000 - 8,000 cfs [4]		
Habitat Protection Outflow				7,100 - 29,200 cfs [5]								
Salinity Starting Condition [6]		[6]										
River Flows:												
@ Rio Vista										3,000 - 4,500 cfs [7]		
@ Vernalis - Base			710 - 3,420 cfs [8]			[8]						
- Pulse					[9]					+28 TAF		
Delta Cross Channel Gates	[10]			Closed								Conditional [10]
WATER QUALITY STANDARDS												
• Municipal and Industrial												
All Export Locations						≤ 250 mg/l Cl						
Contra Costa Canal						150 mg/l Cl for the required number of days [12]						
• Agriculture												
Western/Interior Delta						Max 14-day average EC mmhos/cm [13]						
Southern Delta [14]		1.0 mS				30 day running avg EC 0.7 mS					1.0 mS	
• Fish and Wildlife												
San Joaquin River Salinity [15]					14-day avg; 0.44 EC							
Suisun Marsh Salinity [16]	12.5 EC	8.0 EC			11.0 EC					19.0 EC	[17]	15.5 EC

[#] See Footnotes

Figure 1 Summary Bay Delta Standards (Also See Footnotes)

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

Year Type	WESTERN DELTA: Sac River @ Emmaton: 0.45 EC from April 1 to date shown	Sac River @ Emmaton: EC value from date shown to Aug15 *	SJR @ Jersey Point: 0.45 EC from April 1 to date shown	SJR @ Jersey Point: EC value from date shown to Aug15 *	INTERIOR DELTA: Mokelumne R @ Terminous: 0.45 EC from April 1 to date shown	Mokelumne R @ Terminous: EC value from date shown to Aug15 *	SJR @ San Andreas: 0.45 EC from April 1 to date shown	SJR @ San Andreas: 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 (TAF)	Chipps Island (Chipps Island Station D10): 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 (TAF)	Port Chicago (continuous recorder at Port Chicago): FEB	MAR	APR	MAY	JUN
0	0	0	0	0	0
250	1	0	0	0	0
500	4	1	0	0	0
750	8	2	0	0	0
1000	12	4	0	0	0
1250	15	6	1	0	0
1500	18	9	1	0	0
1750	20	12	2	0	0
2000	21	15	4	0	0
2250	22	17	5	1	0
2500	23	19	8	1	0
2750	24	21	10	2	0
3000	25	23	12	4	0
3250	25	24	14	6	0
3500	25	25	16	9	0
3750	26	26	18	12	0
4000	26	27	20	15	0
4250	26	27	21	18	1
4500	26	28	23	21	2
4750	27	28	24	23	3
5000	27	28	25	25	4
5250	27	29	25	26	6
5500	27	29	26	28	9
5750	27	29	27	28	13
6000	27	29	27	29	16
6250	27	30	27	29	19
6500	27	30	28	30	22
6750	27	30	28	30	24
7000	27	30	28	30	26
7250	27	30	28	30	27
7500	27	30	29	30	28
7750	27	30	29	31	28
8000	27	30	29	31	29
8250	28	30	29	31	29
8500	28	30	29	31	29
8750	28	30	29	31	30
9000	28	30	29	31	30
9250	28	30	29	31	30
9500	28	31	29	31	30
9750	28	31	29	31	30
10000	28	31	30	31	30
> 10000	28	31	30	31	30

Footnotes for Figure 1: Summary Bay Delta Standards

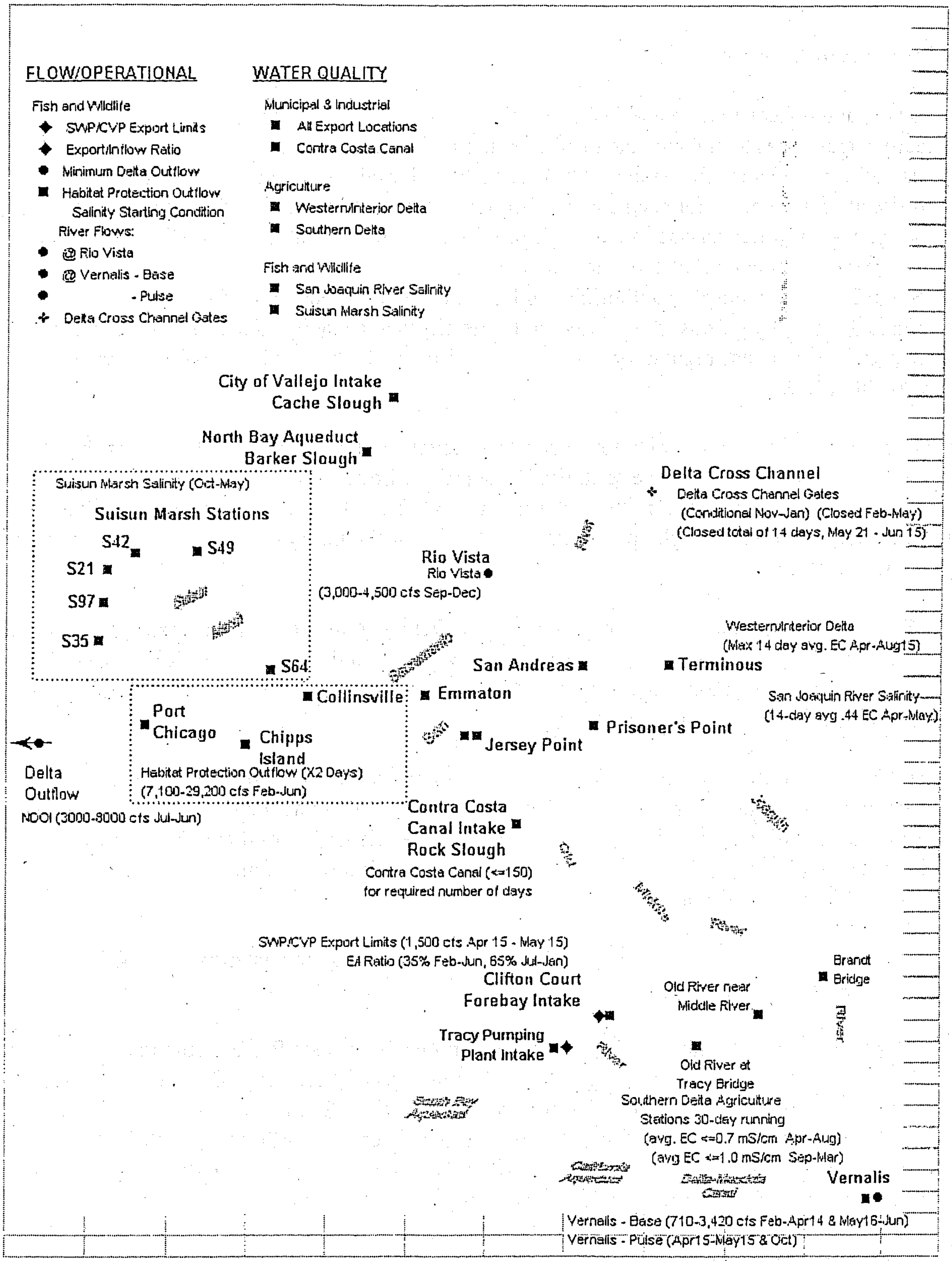

Figure 1 CVP/SWP Delta Map

Joint Point of Diversion

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 D-1641 are:

- Stage 1 – for water service to Cross Valley Canal contractors 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 water users in the southern Delta (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 Service's 1993 Los Vaqueros Biological Opinion (BO) for delta smelt (Service 1993b).

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. Stage 3 has an additional requirement to protect water levels in the southern Delta under the operational conditions of the permanent South Delta Barrier 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 Project objectives:

- When wintertime excess pumping capacity becomes available during Delta excess conditions and total Project San Luis storage is not projected to fill before the spring pulse flow period, the project with the deficit in San Luis storage may elect to use JPOD capabilities. Concurrently, under the CALFED ROD, JPOD may be used to create additional water supplies for the EWA or reduce debt for previous EWA actions.

- When summertime pumping capacity is available at Banks Pumping Plant and CVP reservoir conditions can support additional releases, the CVP may elect to use JPOD capabilities to enhance annual CVP south of Delta water supplies.

- When summertime pumping capacity is available at Banks or Tracy Pumping Plant to facilitate water transfers, JPOD may be used to further facilitate the water transfer.
- During certain coordinated Project operation scenarios for fishery entrainment management, JPOD may be used to maximize Project exports at the facility with the least fishery entrainment impact while minimizing export at the facility with the most fishery entrainment impact.

Adaptive Management

Reclamation and DWR work closely with the Service, the National Marine Fisheries Service (NOAA Fisheries), and the California Department of Fish and Game (DFG) to coordinate Project operations with fishery needs. This coordination is facilitated through several forums discussed below.

CALFED Ops Group

The CALFED Ops Group consists of the Project Agencies, the Service, NOAA Fisheries, and DFG (collectively referred to as the Management Agencies), SWRCB staff, and the Federal Environmental Protection Agency (EPA). The CALFED Ops Group generally meets eleven times a year in a public setting to discuss the operation of the CVP and SWP, as wells as implementation of the CVPIA and coordination with endangered species protection. The CALFED Ops Group held its first public meeting in January 1995, and during the next 6 years the group developed and refined its process. The CALFED Ops Group has been recognized within D-1641, and elsewhere, as a forum for consultation on decisions to exercise certain flexibility that has been incorporated into the Delta standards for protection of beneficial uses (e.g., Export/Inflow (E/I) ratios, and some DCC Closures). Several teams were established through the Ops Group process. These teams are described below:

Operations and Fishery Forum: The Operations and Fishery Forum (OFF) was established as a 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.

Data Assessment Team (DAT): The DAT consists of technical staff members from the Project and Management agencies, as well as stakeholders. The DAT meets frequently[2] during the fall, winter, and spring to review and interpret data relating to fish movement, location, and behavior. Based upon its assessment and input concerning the CVP and SWP operations from the Project Agencies, the DAT makes recommendations regarding potential changes in operations to protect fish. These recommendations are a key element to the implementation of the EWA (discussed

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

later).

B2 Interagency Team (B2IT): The B2IT was established in 1999 and consists of technical staff members from the Project and Management 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 the Environmental Water Account Team (EWAT) and Water Operations Management Team (WOMT) to ensure coordination with the other operational programs or resource-related aspects of project operations.

Environmental Water Account Team: The EWAT consists of members from the Project and Management agencies. The EWAT is responsible for implementation and reporting of actions to acquire water for the EWA. It also coordinates with the B2IT to develop strategies that maximize benefits derived from implementation of actions under CVPIA and the EWA.

Fisheries Technical Teams

Several fisheries specific teams have been established to provide guidance 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 (Reclamation 2004), 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 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 1 each year.

After implementation of the operation plan, the SRTTG may perform additional studies and holds meetings as needed 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.

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 lifestage and size development, current hydrologic events, fish indicators (such as the Knight's Landing Catch Index and Sacramento Catch Index), and salvage at the export facilities, as well as current and projected Delta water quality conditions, are used to determine potential DCC closures and/or export reductions. The coordination process has worked well during the recent fall and winter DCC operations and is expected to be used in the present or modified form in the future. See Appendix B of the biological assessment.

Delta Smelt Working Group (Working Group): The Working Group was established in 1995 to resolve biological and technical issues regarding delta smelt and to develop recommendations for consideration by the Service. It is generally activated when Reclamation and DWR seek consultation with Service on delta smelt or when unusually high salvage of delta smelt occurs. It can also be activated, and has been activated, to assist with the development of strategies to improve habitat conditions for delta smelt.

The Working Group will consist of representatives from the Service, DFG, DWR, EPA, Reclamation and the California Bay-Delta Authority. The Service will chair the group and a designated lead will be assigned by each agency. At a minimum, representatives must be present from the Service, DWR and Reclamation at a Working Group meeting for any recommendation to be decided upon and transmitted to the WOMT. The Working Group may meet at the request of any member of the group.

Delta Smelt Risk Assessment Matrix: The Working Group will employ a Delta Smelt Risk Assessment Matrix (DSRAM) to assist in formulating recommendations. This document will be a product and tool of the Working Group and will be modified by the Working Group with the approval of WOMT as new knowledge becomes available. The current DSRAM has been provided by the Working Group (see the DSRAM section for more information).

Recommendations formulated by the Working Group will be forwarded to the WOMT. The working group will not decide what actions will be taken, but will merely advise the WOMT. The working group will not supplant the DAT, but will provide an additional source of advice to the WOMT. The group may propose operations modifications that the group believes will protect delta smelt by reducing take at the export facilities or by preserving smelt habitat.

American River Operations Work Group (AROG): In 1996, Reclamation established an operational working group for the lower American River, known as AROG. Although open to anyone, the AROG meetings generally include representatives from several agencies and organizations with on-going concerns regarding management of the lower American River. The group includes Reclamation, Service, NOAA Fisheries, DFG, Sacramento Area Flood Control Agency (SAFCA), Water Forum, City of Sacramento, County of Sacramento, Western Area Power Administration (Western), and Save the American River Association.
The AROG convenes monthly, or more frequently if needed, with the purpose of providing fishery updates and reports for Reclamation to better manage Folsom Reservoir for fish resources in the lower American River.

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

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. The work team coordinates with the DAT and OFF groups to conduct gate experiments and members may be used as a resource to estimate impacts from real time gate operations.

Water Operations Management Team

To facilitate timely decision-support and decision-making at the appropriate level, a management-level team was established. The WOMT first met in 1999, and consists of management level participants from the Project and Management agencies. The WOMT meets frequently[3] to provide oversight and decision-making that must routinely occur within the CALFED Ops Group process. The WOMT relies heavily upon the DAT and B2IT for recommendations on fishery actions. 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 agencies retain their authorized roles and responsibilities.

Process for Using Adaptive Management

Decisions regarding Project operations must consider many factors that include public safety, water supply reliability, cost, as well as regulatory and environmental requirements. To facilitate such decisions, the Project and Management agencies have developed and refined a process to collect data, disseminate information, develop recommendations, and make decisions.

A workgroup makes a recommendation for a change in Project operations. Generally, operational adjustments to protect fish are initiated as the result of concern expressed over the interpretation of data that have been collected or as a part of an overarching strategic plan to improve habitat conditions. Examples of conditions that could signal concern include observance of large numbers of juvenile Chinook entering the Delta, high salvage of delta smelt at the export facilities, or unfavorable distribution of delta smelt throughout the Delta. Examples of strategic plans include maintaining higher releases for in-stream needs or closing the DCC gates to keep emigrating juvenile Chinook from entering the central Delta.

The Project Agencies consider the recommendation and seek consensus with the Management Agencies. Decisions regarding changes to the Project operations must be made quickly to be effective. To accomplish this, recommendations are vetted with the management-level staff of the Project and Management agencies. This provides for appropriate consideration of the many factors that must be taken into consideration.

The recommendations and decisions are disseminated. Numerous stakeholders have a keen interest in Project operations. In fact, workgroups established through the Ops Group process (DAT and OFF are two prime examples) have significant stakeholder involvement. In addition, decisions regarding the projects can have significant policy-related implications that must be

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3 As with the DAT, WOMT holds weekly meetings during the critical fish periods. In addition, it will hold impromptu meetings or conference calls to consider recommendations for changes in the operations of the CVP and SWP.

presented to the State and Federal administrations. To facilitate adequate feedback to stakeholders, Reclamation and DWR disseminate recommendations and the resulting decisions to agencies and stakeholders through the OFF and DAT.

Annual reporting is performed to summarize when decision trees are used and results are updated. Example: The DAT determines adult delta smelt are migrating upstream to spawn in sufficient numbers to warrant a change in pumping levels. After careful consideration of the water supply costs to the EWA and CVPIA b(2) water assets, DAT recommends a 5-day reduction in exports.

The WOMT meets and considers the recommendation of the DAT, and after careful consideration of the recommendation, WOMT agrees that EWA and CVPIA b(2) assets may be used to implement the export reduction. Reclamation and DWR then implement the export reduction as prescribed.

In addition, South Delta barrier operations will be further studied and refined by WOMT/DAT representatives, including Reclamation, DWR, DFG, NOAA Fisheries, Delta stakeholders and representatives of the delta smelt Working Group. Representatives from these groups will meet to determine how best to operate South Delta barriers in order to balance fish needs with water levels and water quality needs. Forecast modeling as well as monitoring of real-time barrier operations will be used to modify operations as needed.

Central Valley Project

Project Management Objectives

The CVP is the Mid-Pacific Region's largest project. Facilities are operated and maintained by local Reclamation area offices, with operations overseen by the 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. Figure 1-4 shows the relationship between the CVOO and Reclamation area offices in the Mid-Pacific Region.

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 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
- 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 on a broad front. The Final Programmatic Environmental Impact Statement (PEIS) (Reclamation 2004) for the CVPIA analyzes projected conditions in 2022, 30 years from the CVPIA's adoption in 1992. The Final PEIS was released in October 1999 and the CVPIA ROD was signed on January 9, 2001. The BOs were issued on November 21, 2000 (Service 2000).

Operations of the CVP reflect provisions of the CVPIA, particularly sections 3406(b)(1), (b)(2), and (b)(3). On May 9, 2003, the U.S. Department of the Interior (Interior) issued its Decision on Implementation of Section 3406 (b)(2) of the CVPIA (Reclamation 2004). The B2IT provides the basis 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.

As of December 2003, most of the contractor assessments have been finalized. However, a couple of assessments remain under analysis and require either additional information from the contractor or do not fit into the assumptions incorporated into the methodology used for the rest of the CVP. The contractors are located primarily in the American River and San Felipe Divisions of the CVP. It is anticipated that all the assessments will be concluded by summer of 2004. Because of the remaining assessments, the total supply required to meet the all the demands for the CVP cannot be determined at this time.

For modeling purposes, assumptions for future conditions have been made, even though the water assessments continue. The 2020 level of development's demands include higher amounts than the 2001 level of development's demands on the American River.

Future American River Operations - Water Service Contracts and Deliveries

Surface water deliveries from the American River are made by various water rights entities and CVP contractors. Total annual demands on the American and Sacramento Rivers are estimated to increase from about 255,850 af in 2001 to about 687,550 af in 2020, including the FRWP. 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 Act requirements have removed some of the capability and operations flexibility required to actually deliver the water to CVP contractors. Water allocations south of the Delta have been most affected by changes in operations ensuing from passage of the CVPIA and the biological opinions covering protection of the winter-run Chinook salmon and the delta smelt.

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 water rights contracts and San Joaquin Exchange contracts require that contractors be informed no later than February 15 of any possible deficiency in their supplies. In recent years, February 15th has been the target date for the first announcement of all CVP contractors' forecasted water allocations for the upcoming contract year.

The NOAA Fisheries Biological Opinion (Reclamation 2004) requires Reclamation to use a conservative (at least 90 percent probability of exceedance) forecast as the basis of water allocations. Furthermore, NOAA Fisheries 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.

Forecasts of runoff and operations plans are updated at least monthly between February and May. Water allocations may or may not change as the year unfolds. Because a conservative forecast of runoff is used, it is quite likely that forecasted water supply will increase as the year progresses. While this may result in increased allocations, it also means that knowledge of the final allocation of water may be delayed until April, May, or June. This adds to the uncertainty facing Agricultural contractors who need reliable forecasts of available supply as early as possible to assist in decision-making for farm management.

CVP M&I Water Shortage Policy

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, 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, and then both shared shortages equally). Since 1991, Reclamation has been attempting to develop an M&I Water shortage policy applicable to as many CVP M&I contractors as appropriate.

For a contractor to receive the M&I minimum shortage allocation by means of the proposed policy, its water service contract must reference the proposed policy. For various reasons, Reclamation expects the proposed policy will not be referenced in contracts for the (1) Friant Division, (2) New Melones interim supply, (3) Hidden and Buchanan Units, (4) Cross Valley contractors, (5) Sugar Pine Units (subjects of title transfer legislation), (6) San Joaquin settlement contractors, and (7) Sacramento River settlement contractors. Any separate shortage- related contractual provisions will prevail.

The proposed policy provides 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.

The proposed policy also provides that 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. Shortages for South of Delta and North of Delta irrigation allocations and M&I allocations are the same.

The proposed policy provides that 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, (taking into consideration water supplies available to the M&I contractors from other sources), and in recognition that the M&I allocation may, nevertheless, fall to 50 percent when the irrigation allocation drops below 25 percent due to limited CVP supplies. It should be noted the minimum shortage allocation of 75 percent, as proposed in the September 11, 2001 draft (Reclamation 2004) (which was made available for public review and comment) would apply only to that portion of CVP water identified as of September 30, 1994, as shown on Schedule A-12 of the 1996 M&I Water Rates book, (Reclamation 2004) and for those contract quantities specified in section 206 of Public Law 101-514. However, under the proposed policy a contractor may request an M&I minimum shortage allocation for post-1994 identified water that is transferred or assigned, converted, provided significant impacts upon irrigation supplies, or upon irrigation and M&I supplies, respectively, are mitigated.

Due to the development of policy alternatives generated by Reclamation after consideration of public comment, that portion of CVP water to which the minimum shortage allocation would apply could change prior to policy finalization. Prior to such finalization, Reclamation will meet the requirements of the National Environmental Policy Act (NEPA) and the Act.

Ag 100% to 75% then M&I is at 100%	
Ag 70%	M&I is 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 has a modeling assumption

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%

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).

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, Carr 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 (SCDD).

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.

Trinity Dam has limited release capacity below the spillway crest elevation. Studies completed by the U.S. Army Corps of Engineers (Corps) in 1974 and Reclamation in 1975 (Reclamation 2004) showed the spillway and outlet works at Trinity Dam are not sufficient to safely pass the anticipated design flood inflow. Therefore, Reclamation implemented safety of dams criteria stipulating flood season release and storage criteria at Trinity Dam to reduce the potential for overtopping during large flood events. The safety of dams criteria attempt to prevent storage from exceeding 2.1 maf from November through March. The safety of dams criteria begin to prescribe reservoir releases when storage in Trinity Dam is forecast to exceed 2.0 maf during November through March, see appendix C for the historic times safety of dams releases have been made.

The safety of dams release criteria specifies that Carr Powerplant capacity should be used as a first preference destination for safety of dams releases made at Trinity Dam. Trinity River releases are made as a second preference destination. During significant Northern California high water flood events, the Sacramento River water stages are also at concern levels. Under such high water conditions, the water that would otherwise move through Carr Powerplant is routed to the Trinity River. Total river release is limited to 6,000 cfs below Lewiston Dam (under safety of dams criteria) due to local high water concerns and local bridge flow capacities; until local inflows to Lewiston Lake and Trinity Dam spillway flows exceed 6,000 cfs; and also the Carr Powerplant discharge.

Fish and Wildlife Requirements on Trinity River

Based on the December 19, 2000, Trinity ROD(Reclamation 2004), 368,600 to 815,000 af is allocated annually for Trinity River flows. Due to ongoing litigation on the Trinity ROD, the Federal District Court for the Eastern District of California issued a December 10, 2002, Order (Reclamation 2004) that directed the CVP to release 368,600 af during critical Trinity River inflow years and 452,000 af during all other conditions. This amount is scheduled in coordination with the Service to best meet habitat, temperature, and sediment transport objectives in the Trinity Basin.

Temperature objectives for the Trinity River are set forth in SWRCB WR 90-5. These vary by reach and by season. Between Lewiston Dam and Douglas City Bridge, the daily average temperature should not exceed 60 degrees Fahrenheit (°F) (16 degrees Celsius (°C)) from July 1 to September 14 and 56°F (13°C) from September 15 to October 1. From October 1 to December 31, the daily average temperature should not exceed 56°F (13°C) between Lewiston Dam and the confluence of the North Fork Trinity River. Reclamation consults with Service in establishing a schedule of releases from Lewiston Dam that can best achieve these objectives.

For the purpose of determining the Trinity water year type, forecasts using a 50 percent exceedance will be used. Trinity River flow regimes will be planned and adjusted, if necessary, to be consistent with forecasts prepared during the April 1 through May period. There will be 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.

Transbasin Exports

Export of Trinity water to the Sacramento Basin provides 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. Typically, to avoid warming and function most efficiently for temperature control, the water flowing from the Trinity Basin through Whiskeytown must be sustained at fairly high rates. When the total volume of Trinity water available for export is limited, that may, in turn, compress the time period for which effective temperature control releases can be made from Whiskeytown Lake.

To increase CVP water supply, export volumes from Trinity are made in coordination with the operation of other CVP water supply reservoirs generally based on reservoir refill potential and CVP Delta export water demand. 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.

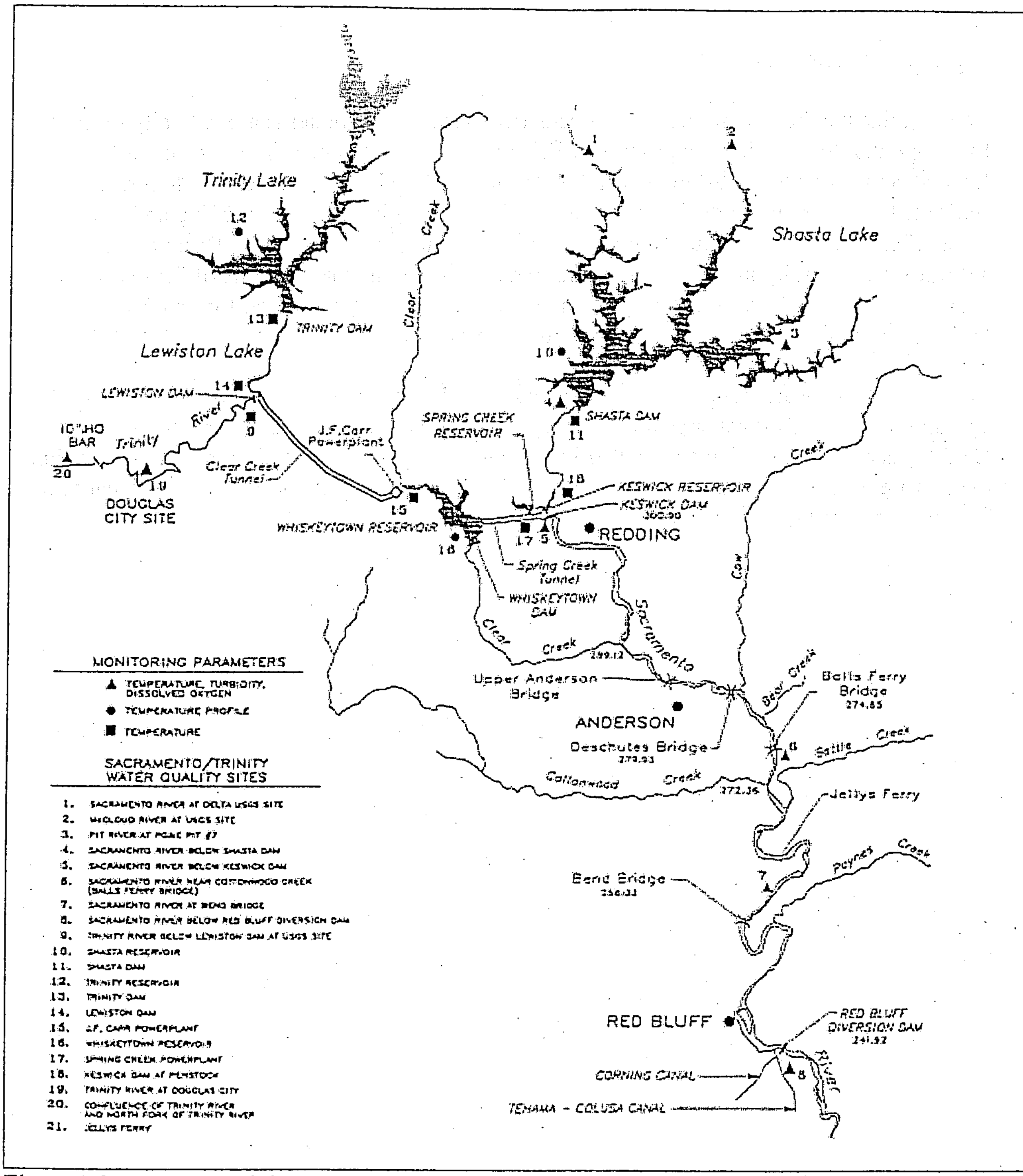

Figure 2 Sacramento-Trinity Water Quality Network (with river miles)

Power production, as a result of cross-basin diversion of Trinity River water through Trinity Division powerplants, is approximately three times greater than power production at Shasta Dam for an equivalent amount of water released. 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, until the 10 to 15 percent of the years when Shasta Reservoir is also drawn down. Reclamation will discuss end of water year carryover on a case-by-case basis in dry and critically dry water year types with the Service and NOAA Fisheries.

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 SCDD. 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 AFRP objectives. Although it stores up to 241,000 af, this storage is not normally used as a source of water supply. There is a temperature curtain in Whiskeytown Reservoir.

Spillway flows below Whiskeytown Lake

Whiskeytown Lake is drawn down approximately 35,000 af per year of storage space during November through April to regulate flows for power generation. Heavy rainfall events occasionally result in spillway discharges to Clear Creek, as shown in Table 1 below.

Table 1 Days of Spilling below Whiskeytown and 40-30-30 Index from Water Year 1978 to 2002

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

Table 1 Days of Spilling below Whiskeytown and 40-30-30 Index from Water Year 1978 to 2002

Water Year	Days of Spilling	40-30-30 Index
1983	81	W
1984	0	W
1985	0	D
1986	17	W
1987	0	D
1988	0	C
1989	0	D
1990	8	C
1991	0	C
1992	0	C
1993	10	AN
1994	0	C
1995	14	W
1996	0	W
1997	5	W
1998	8	W
1999	0	W
2000	0	AN
2001	0	D
2002	0	D

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 (Reclamation 2004) established minimum flows to be released to Clear Creek at Whiskeytown Dam.
- A 1963 release schedule from Whiskeytown Dam (Reclamation 2004) was developed and implemented, but never finalized. Although the release schedule was never formalized, Reclamation has operated according to the proposed schedule since May 1963.

Table 2 Minimum flows at Whiskeytown Dam from 1960 MOA with the DFG

Period	Minimum flow (cfs)
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)	

Period	Minimum 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 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) (Reclamation 2004) to implement actions that protect the Sacramento River system from heavy metal pollution from Spring Creek and adjacent watersheds.

The MOU identifies agency actions and responsibilities, and establishes release criteria based on allowable concentrations of total copper and zinc in the Sacramento River below Keswick Dam.

The MOU states that Reclamation agrees to operate to dilute releases from SCDD (according to these criteria and schedules provided) and that such operation will not cause flood control parameters on the Sacramento River to be exceeded and will not unreasonably interfere with other project requirements as determined by Reclamation. The MOU also specifies a minimum schedule for monitoring copper and zinc concentrations at SCDD and in the Sacramento River below Keswick Dam. Reclamation has primary responsibility for the monitoring; however, the DFG and the RWQCB also collect and analyze samples on an as-needed basis. Due to more extensive monitoring, improved sampling and analyses techniques, and continuing cleanup efforts in the Spring Creek drainage basin, Reclamation now operates SCDD targeting the more stringent WQCP 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. SCCD 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 flood control events in the upper Sacramento River and also during non-flood control rainfall events. 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 SC DD 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 Spring Creek Debris Dam. 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 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. 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 Red Bluff Diversion Dam (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 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. During the construction of Shasta Dam, the Toyon Pipeline was constructed to supply water from the Sacramento River to the camp used to house the workers at Toyon. The pipeline remains in use today, supplying M&I water to small communities in the area.

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 (Reclamation 2004) and the winter-run Chinook salmon BO (Reclamation 2004). An April 5, 1960, MOA between Reclamation and the DFG (Reclamation 2004) 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. 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 3 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	1993 NOAA Fisheries winter-run BO
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, and if when doing so, is 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.

The reasonable and prudent alternative (RPA) contained in the 1993 NOAA Fisheries BO (Reclamation 2004) required a minimum flow of 3,250 cfs from October 1 through March 31. Also, as part of the Reasonable and Prudent Alternative (RPA), ramping constraints for Keswick release reductions from July 1 through March 31 are required 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. To minimize release fluctuations, the base flow is selected with the intent of maintaining the desired target storage levels in Shasta Lake 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 is being phased out due to air quality concerns and goals and is being 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 recent change in agricultural practice has not been incorporated into the systematic modeling of agricultural practices and hydrology effects, and therefore, the OCAP CALSIM basis used here does not incorporate this effect (see modeling section for a discussion of CALSIM II). The increased water demand for fall rice field flooding and decomposition on the Sacramento River can produce a conflict during this timeframe with the goal of fall fishery flow stability management.

Minimum Flow for Navigation – Wilkins Slough

Historical commerce on the Sacramento River resulted in the requirement 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 (Reclamation 2004). 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.

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 has been recognized as a key factor of the habitat needs for Chinook salmon stocks inhabiting the river. 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 (Reclamation 2004) modifying Reclamation's water rights for the Sacramento River. The orders included a narrative water temperature objective for the Sacramento River and stated Reclamation shall operate Keswick and Shasta Dams and the Spring Creek Powerplant to meet a daily average water temperature of 56°F (13°C) at RBDD in the Sacramento River during periods when higher temperature would be harmful to fisheries.

Under the orders, the water temperature compliance point may be modified when the objective cannot be met at RBDD. In addition, Order 90-05 (Reclamation 2004) modified the minimum flow requirements initially established in the 1960 MOA for the Sacramento River below Keswick Dam (Reclamation 2004). 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 to formulate, monitor, and coordinate temperature control plans for the upper Sacramento and Trinity Rivers. This group consists of representatives from Reclamation, SWRCB, NOAA Fisheries, Service, DFG, Western, DWR, and the Hoopa Valley Indian Tribe.

Each year, with finite cold water resources and competing demands usually an issue, the Temperature Task Group has been effective in devising 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.

Shasta Temperature Control Device

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

Prior to construction of the 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 4). 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 4 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	985	~2.50 MAF
Pressure Relief Gates	850	~0.67 MAF
Side Gates		

The seasonal progression of the 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 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 TCD has significant leaks that are inherent to TCD design. Also, operational uncertainties cumulatively impair the seasonal performance of the TCD to a greater degree than was anticipated in previous analysis and modeling used to describe long-term TCD benefits.

Act related Upper Sacramento River temperature objectives.
In February 1993, NOAA Fisheries issued the long-term BO for the Operation of the Projects for the Sacramento River winter-run Chinook salmon (Reclamation 2004). The BO includes a RPA addressing CVP operations criteria for temperature control objectives. The Shasta-Trinity Division section of the 1993 BO includes the following operational elements relating to temperature control objectives. This section of the RPA was not modified in the 1995 amendment to the BO.

Under the current RPA, Reclamation must make its February 15 forecast of deliverable water based on an estimate of precipitation and runoff at least as conservatively as 90 percent probability of exceedance. Subsequent updates of water delivery commitments must be based on at least as conservatively as 90 percent probability of exceedance forecast.

The use of the conservatively based forecasting approach reduces the risk of over committing potential annual cold water reserves by limiting the Central Valley water supply estimates to a one in ten chance of remaining annual hydrologic conditions being drier than the estimate. This forecasting strategy places an allocation emphasis on reserving sufficient cold water resources during the winter-run Chinook salmon incubation and spawning seasons. The BO also requires a technical demonstration that the water temperature compliance point for winter–run needs can be met using the 90 percent hydrology.

Under the current RPA, Reclamation must maintain a minimum end-of-water-year (September 30) carryover storage in Shasta Reservoir of 1.9 maf. The 1.9 maf Shasta Reservoir carryover target is intended to increase the probability of sufficient cold water resources to maintain suitable water temperature conditions for the following water year winter–run incubation and spawning season needs.

The carryover target does not ensure that adequate cold water reserves (and therefore, winter–run incubation and spawning habitat water temperature) are available during the year the 1.9 maf carryover is required. The BO recognized that it may not be possible to maintain the minimum carryover of 1.9 maf in the driest ten percent of hydrologic circumstances. If Reclamation forecasts end-of-water-year storage levels in Shasta will drop below 1.9 maf, re-initiation of consultation is required prior to the first water allocation announcement for that year.

The current RPA sets water temperature compliance location(s) from April 15 through October 31 for winter–run needs based on a systematic set of Shasta carryover and annual hydrologic conditions.

The BO segregates annual Shasta Reservoir carryover and hydrologic conditions in order to assess the potential cold water resources available from Trinity Reservoir and Shasta Reservoir and to determine a strategy for water temperature compliance location. Generally, the BO sets the compliance location at Bend Bridge on the Sacramento River in conditions of high carryover storage or above normal hydrologic conditions.

For lower carryover storage conditions and dry or critical hydrologic conditions, the BO sets the compliance location at a further upstream location of Jelly's Ferry on the Sacramento River. For low carryover storage and critical or very critical hydrologic conditions (generally associated with extended drought conditions) the BO requires re-initiation of consultation to determine the temperature compliance location.

In almost every year since 1993, Reclamation has reconsulted with NOAA Fisheries to modify the compliance point or allow short-term fluctuation above the 56° F (13°C) objective because of insufficient cold water resources, extreme ambient air temperature events, or high downstream tributary flows of warm water. The reconsultation actions have been coordinated through the SRTTG to the extent possible. Decisions by Reclamation to reconsult and the resulting decisions by NOAA Fisheries have reflected the best available information on cold water resources and locations of Chinook salmon spawning activity.

Reclamation's Proposed Upper Sacramento River Temperature Objectives

Since the issuance of the temperature objectives contained in the February 1993 NOAA Fisheries BO, the long-term cold water management operation of the Trinity-Shasta reservoir system has been changed and influenced by several significant water management actions that have occurred during the intervening period. The water management actions include:

- Implementation of CVPIA Section 3406 (b)(2)
- Implementation of D-1641
- Continuing implementation of the Trinity ROD as currently ordered by the District Court
- Installation and actual performance characteristics of the TCD

Each of these water management actions has changed the availability and the management of cold water resources to the Upper Sacramento River. Future actions addressed in the Proposed Action will affect temperature control as demands on the yield of Shasta Reservoir increase. Concurrently, the spawning distribution of salmon in the upper Sacramento River has changed. Improved fish passage management actions at RBDD and the Anderson-Cottonwood Irrigation District (ACID) Diversion Dam have allowed winter-run salmon to utilize spawning habitat closer to Keswick Dam. Recent review of the spawning distribution for winter-run salmon has shown conclusively the vast majority spawn above the Ball's Ferry location, with only minor spawning below the Ball's Ferry location.

Reclamation will continue a policy of developing annual operations plans and water allocations based on a conservative 90 percent exceedance forecast. Reclamation is not assuming 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 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 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. Based on cumulative affects of changes to cold water resources and spawning distribution changes, Reclamation has analyzed the capability to manage water temperatures in the upper Sacramento River under future conditions. Reclamation used the water temperature model with an updated calibration of the TCD and the salmon mortality model with the recent spawning distribution to compare results of targeting different compliance points. One set of results represented operating to target compliance points identified in the 1993 BO (Reclamation 2004). Another set of results represented operating to target compliance at Ball's Ferry, which is further upstream. The analysis under future conditions supports moving the target compliance point upstream to avoid exhausting the available cold water resources too early in the salmon spawning and rearing season.

Under all but the most adverse drought and low Shasta Reservoir storage conditions, CVP facilities should be operated 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 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 this change in Sacramento River temperature control objectives 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 Sacramento River Temperature Task Group to arrive at the best use of that capability.

Anderson-Cottonwood Irrigation District Diversion Dam

Since 1916, water has been diverted into the ACID Canal for irrigation along the west side of the Sacramento River between Redding and Cottonwood. The United States and ACID signed a contract (Number 14-06-200-3346A) (Reclamation 2004) 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. The diversion dam consists of boards supported by a pinned steel superstructure anchored to a concrete foundation across the Sacramento River. The boards are manually set from a walkway supported by the steel superstructure. The number of boards set in the dam varies depending upon flow in the river and desired head in the canal.

Because the diversion dam is a flashboard dam installed for seasonal use only, close coordination is required between Reclamation and ACID for regulation of river flows to allow safe installation and removal of the flashboards. The contract between ACID and the United States allows for ACID to notify Reclamation as far in advance as possible each time it intends to install or remove boards from its diversion dam. Reclamation similarly notifies ACID each time it intends to change releases at Keswick Dam. In addition, during the irrigation season, ACID notifies Reclamation of the maximum flow the diversion dam can safely accommodate (with the current setting of boards). Reclamation notifies ACID (at least 24 hours in advance) of any change in releases at Keswick Dam that exceed such maximum flow designated by ACID.

The irrigation season for ACID runs from April through October. Therefore, around April 1 of each year, ACID erects the diversion dam. This consists of raising the steel superstructure, installing the walkway, and then setting the boards. Around November 1 of each year, the reverse process occurs. The dates of installation and removal can vary depending on hydrologic conditions. Removal and installation of the dam cannot be done safely at flows greater than 6,000 cfs. ACID usually requests Reclamation to limit the Keswick release to a 5,000 cfs maximum for five days to accomplish the installation and removal of the dam. As indicated previously, there may be times during the irrigation season when the setting of the boards must be changed due to changes in releases at Keswick Dam. When boards must be removed due to an increase at Keswick, the release may initially have to be decreased to allow work to be done safely. If an emergency exists, Reclamation personnel from the Northern California Area Office can be dispatched to assist ACID in removing the boards.

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 dam.

Red Bluff Diversion Dam Operations

The 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 screens into the a 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. The RBDD diverts water to the Corning and Tehama-Colusa Canals. Construction of the Tehama-Colusa Canal began in 1965, enlargement approved in 1967, first operational in 1969 and 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 serve water to the CVP contractors in Tehama County that could not be served by gravity from the Tehama-Colusa Canal. Both Canals are operated by the Tehama-Colusa Canal Authority (TCCA). The gates are currently lowered on May 15 to impound water for diversion and raised on September 15 to allow river flow-through.

Since 1986, the RBDD gates have been raised during winter months to allow passage of winter-run Chinook salmon. Since the 1993 NOAA Fisheries BO for winter-run Chinook salmon (Reclamation 2004), the gates have been raised from September 15 through May 14 each year. This eight-month gates-up operation has eliminated passage impedance of upstream migration for all species which need to migrate above the RBDD to spawn, with the exception of 70 percent of the spring-run Chinook and an estimated 35 percent of the green sturgeon migrants (TCCA and Reclamation, 2002).

Reclamation proposes the continued operation of the RBDD using the eight-month gate-open procedures of the past ten years. However, Reclamation proposes to change the status of the research pumping plant from research to production status, along with adding a fourth pump if funding becomes available and the cost-benefit ratios prove favorable. Should a fourth pump be added, Reclamation would install another centrifugal pump. Reclamation also proposes the continued use of rediversions of CVP water stored in Black Butte Reservoir to supplement the water pumped at RBDD during the gates-out period. This water is rediverted with the aid of temporary gravel berms through an unscreened, constant head orifice into the Tehema-Colusa Canal.

This arrangement has successfully met the water demand for the past ten years, but the supply has consistently been quite tight. To date, Reclamation has not had to use the provision of the RPA of the winter-run BO allowing up to one closure per year of the gates for up to ten days. While mandatory use of this temporary gates closure provision has been minimized so far, it was used in 1997, a year with an exceptionally dry spring. Its use in another year was avoided only at the last minute by an exceptionally heavy, late storm. Reclamation will implement with NOAA Fisheries a decision-making protocol to ensure such gate closure decisions can be achieved on short notice.

American River Division

The American River originates in the mountains of the Sierra Nevada range, drains a watershed of approximately 1,895 square miles, and enters the Sacramento River at river mile 60 in the City of Sacramento. The American River contributes approximately 15 percent of the total flow in the Sacramento River. The American River watershed ranges in elevation from 23 feet to over 10,000 feet, and receives approximately 40 percent of its flow from snowmelt. Development on the American River began in the earliest days of the California Gold Rush, when numerous small diversion dams, flumes, and canals were constructed. Currently, 19 major reservoirs in the drainage area have a combined storage capacity of about 1.8 maf.

Folsom Lake, the largest reservoir in the watershed, was formed with the completion of Folsom Dam in 1956 and has a capacity of 977,000 af. Folsom Dam, located approximately 30 miles upstream from the confluence with the Sacramento River, is operated by Reclamation as a major component of the CVP. Water released from Folsom Lake is used to generate hydroelectric power, meet downstream water rights obligations, contribute to Delta inflow requirements, and provide water supplies to CVP contractors.

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 and began operation in 1955. Nimbus Dam creates Lake Natoma, which serves as a forebay for diversions to the Folsom South Canal. This CVP facility began operation in 1973 and serves water to agricultural and M&I users in Sacramento County. The first two reaches of the canal, extending to just south of Highway 104, were completed in 1973. Construction of the remainder of the canal has been suspended pending reconsideration of alternatives. 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 has 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).

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

American River Operations

The Corps constructed major portions of the American River Division under the authorization of Congress. The American River Basin Development Act of 1949 subsequently authorized its integration into 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.

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

- Protect the City 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 and 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 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 acre feet (TAF) of flood control space in Folsom and in a combination of three upstream reservoirs. This flood control plan, which provides additional protection for the Lower American River, is implemented through an agreement between Reclamation and the SAFCA. The terms of the agreement allow some of the empty reservoir space in Hell Hole, Union Valley, and French Meadows to be treated as if it were available in Folsom.

The SAFCA release criteria are generally equivalent to the Corps plan, except the SAFCA diagram may prescribe flood releases earlier than the Corps plan. The SAFCA diagram also relies on Folsom Dam outlet capacity to make the earlier flood releases. The outlet capacity at Folsom Dam is currently limited to 32,000 cfs based on lake elevation. However, in general the SAFCA plan diagram provides greater flood protection than the existing the Corps plan for communities in the American River floodplain.

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

Fish and Wildlife Requirements in the Lower American River

The minimum allowable flows in the lower American River are defined by SWRCB Decision 893 (D-893) (Reclamation 2004) 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. Reclamation is participating in continuing discussions with the Sacramento Water Forum, Service, NOAA Fisheries, DFG, and other interested parties regarding integration of a revised flow standard for the lower American River into CVP operations and water rights. Reclamation intends to accomplish such incorporation, including associated revisions to the OCAP Project Description, in coordination with the parties. That revised project description, amending the lower American River flows to make them consistent with the revised flow standard, will be presented to the agencies, together with supporting material and analysis needed for review under Section 7 of the Act. Until such an action is presented to and adopted by the SWRCB, minimum flows will be limited by D-893. Releases of additional water are made pursuant to Section 3406 (b)(2) of the CVPIA.

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 3-2-4.

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.

The steelhead temperature objectives in the lower American River, as provided by NOAA Fisheries, state:

> Reclamation shall, to the extent possible, control water temperatures in the lower river between Nimbus Dam and the Watt Avenue Bridge (River mile (RM) 9.4) from June 1 through November 30, to a daily average temperature of less than or equal to 65°F to protect rearing juvenile steelhead from thermal stress and from warm water predator species. The use of the cold water pool in Folsom Reservoir should be reserved for August through October releases.

Prior to the listing of steelhead and the subsequent BOs on operations, the cold water resources in Folsom Reservoir were used to lower downstream temperatures in the fall when fall-run Chinook salmon entered the lower river and began to spawn. The flexibility once available is now gone because of the need to use the cold water to maintain suitable summer steelhead rearing conditions. The operational objective in the fall spawning season is to provide 60°F (16°C) or less in the lower river, as soon as available cold water supplies can be used.

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 start providing suitable spawning temperatures as early as possible (after November 1) to avoid temperature related pre-spawning mortality of adults and reduced egg viability. Reclamation 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.

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

In the spring of 2003, high inflows and encroachment into the allowable storage space for flood control required releases that exceeded the available capacity of the power plant. Under these conditions, standard operations of Folsom calls for the use of the river outlets that would draw upon the cold water pool. Instead, Reclamation reviewed the release requirements, safety of dams issues, reservoir temperature conditions, and the benefits to the cold water pool and determined that it could use the spillway gates to make the incremental releases above powerplant capacity, thereby conserving cold water for later use. The ability to take similar actions, (as needed in the future), will be evaluated on a case-by-case basis.

A temperature control management strategy must be developed that balances 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 of the projected lower American River water temperature management can begin. The significant variables and key assumptions in the analysis include:

- Starting reservoir temperature conditions

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

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

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

The Urban Water Supply TCD has provided additional flexibility to conserve cold water for later use. Initial studies are being conducted evaluating the impact of warmer water deliveries to the water treatment plants receiving the water. As water supply temperatures increase into the upper-60°F (16°C) range, treatment costs, the potential for taste and odor and disinfection byproducts, and customer complaints increase. It is expected that the TCD will be operated during the summer months and deliver water that is slightly warmer than that which could be used to meet downstream temperatures (60°F (16°C) to 62°F(17°C)), but not so warm as to cause significant treatment issues.

Water temperatures feeding the Nimbus Fish Hatchery were historically too high for hatchery operations during some dry or critical years. Temperatures in the Nimbus Hatchery are generally in the desirable range of 42°F(6°C) to 55°F(13°C), except for the months of June, July, August, and September. When temperatures get above 60°F(16°C) during these months, the hatchery must begin to treat the fish with chemicals to prevent disease. When temperatures reach the 60°F(16°C) to 70°F(21°C) range, treatment becomes difficult and conditions become increasingly dangerous for the fish. When temperatures climb into the 60°F(16°C) to 70°F(21°C) range, hatchery personnel may confer with Reclamation to determine a compromise operation of the temperature shutter at Folsom Dam for the release of cooler water.

The goal is to maintain the health of the hatchery fish while minimizing the loss of the cold water pool for fish spawning in the river during fall. This is done on a case-by-case basis and is different in various months and year types. Temperatures above 70°F (21°C) in the hatchery usually mean the fish need to be moved to another hatchery. The real time implementation needs for the CVPIA AFRP objective flow management and D-1641 (Reclamation 2004) standards from the limited water resources of the lower American River has made cold water resource management at Folsom Lake a significant compromise coordination effort. Reclamation consults with the Service, NOAA Fisheries, and the DFG using the B2IT process (see CVPIA section) when making the difficult compromise decisions. In addition, Reclamation communicates and coordinates with the AROG on real time decision issues.

The Nimbus Fish Hatchery and the American River Trout Hatchery were constructed to mitigate the loss of riverine habitat caused by the construction of Nimbus and Folsom Dam. The hatcheries are located approximately one-quarter mile downstream from Nimbus Dam on the south side of the American River. To meet the mitigation requirement, annual production goals are approximately 4.2 million salmon smolts and 430,000 steelhead yearlings.

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.

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 Dams 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.

East Side Division

New Melones Operations

The Stanislaus River originates in the western slopes of the Sierra Nevada Mountain Range and drains a watershed of approximately 900 square miles. The average unimpaired runoff in the basin is approximately 1.2 maf per year; the median historical unimpaired runoff is 1.1 maf per year. Snowmelt contributes the largest portion of the flows in the Stanislaus River, with the highest runoff occurring in the months of April, May, and June. Agricultural water supply development in the Stanislaus River watershed began in the 1850s and has significantly altered the basin's hydrologic conditions.

Currently, the flow in the lower Stanislaus River is primarily controlled by New Melones Reservoir, which has a storage capacity of about 2.4 maf. The reservoir was completed by the Corps in 1978 and approved for filling in 1983. New Melones Reservoir is located approximately 60 miles upstream from the confluence of the Stanislaus River and the San Joaquin River and is operated by Reclamation. Congressional authorization for New Melones integrates New Melones Reservoir as a financial component of the CVP, but it is authorized to provide water supply benefits within the defined Stanislaus Basin per a 1980 ROD (Reclamation 2004) before additional water supplies can be used out of the defined Stanislaus Basin.

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

Another major water storage project in the Stanislaus River watershed is the Tri-Dam Project, a hydroelectric generation project that consists of Donnells and Beardsley Dams, located upstream of New Melones Reservoir on the middle fork Stanislaus River, and Tulloch Dam and Powerplant, located approximately 6 miles downstream of New Melones Dam on the main stem Stanislaus River.

Releases from Donnells and Beardsley Dams affect inflows to New Melones Reservoir. Under contractual agreements between Reclamation, the Oakdale Irrigation District (OID) (Reclamation 2004), and South San Joaquin Irrigation District (SSJID), Tulloch Reservoir provides afterbay storage to re-regulate power releases from New Melones Powerplant. The main water diversion point on the Stanislaus River is Goodwin Dam, located approximately 1.9 miles downstream of Tulloch Dam.

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

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

Flood Control

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

Requirements for New Melones Operations

The operating criteria for New Melones Reservoir are affected by (1) water rights, (2) in-stream fish and wildlife flow requirements (including Interior's CVPIA 3406 (b)(2) fishery management objectives), (3) D-1641 Vernalis flow requirements, (4) dissolved oxygen (DO) requirements, (5) D-1641 Vernalis water quality requirements, (6) CVP contracts, and (7) flood control considerations. Water released from New Melones Dam and Powerplant is re-regulated at Tulloch Reservoir and is either diverted at Goodwin Dam or released from Goodwin Dam to the lower Stanislaus River.

Flows in the lower Stanislaus River serve multiple purposes concurrently. The purposes include water supply for riparian water rights, fishery management objectives, and DO requirements per D-1422 (Reclamation 2004). In addition, water from the Stanislaus River enters the San Joaquin River where it contributes to flow and helps improve water quality conditions at Vernalis. D-1422, issued in 1973, provided the primary operational criteria for New Melones Reservoir and permitted Reclamation to appropriate water from the Stanislaus River for irrigation and M&I uses. D-1422 requires the operation of New Melones Reservoir include releases for existing water rights, fish and wildlife enhancement, and the maintenance of water quality conditions on the Stanislaus and San Joaquin Rivers.

Water Rights Obligations

When Reclamation began operations of New Melones Reservoir in 1980, the obligations for releases (to meet downstream water rights) were defined in a 1972 Agreement and Stipulation among Reclamation, OID, and SSJID (Reclamation 2004). The 1972 Agreement and Stipulation required Reclamation release annual inflows to New Melones Reservoir of up to 654,000 af per year for diversion at Goodwin Dam by OID and SSJID, in recognition of their prior water rights. Actual historical diversions prior to 1972 varied considerably, depending upon hydrologic conditions. In addition to releases for diversion by OID and SSJID, water is released from New Melones Reservoir to satisfy riparian water rights totaling approximately 48,000 af annually downstream of Goodwin Dam.

In 1988, following a year of low inflow to New Melones Reservoir, the Agreement and Stipulation among Reclamation, OID, and SSJID (Reclamation 2004) was superseded by an agreement that provided for conservation storage by OID and SSJID. The new agreement required Reclamation to release New Melones Reservoir inflows of up to 600,000 af each year for diversion at Goodwin Dam by OID and SSJID.

In years when annual inflows to New Melones Reservoir are less than 600,000 af, Reclamation provides all inflows plus one-third the difference between the inflow for that year and 600,000 af per year. The 1988 Agreement and Stipulation (Reclamation 2004) created a conservation account in which the difference between the entitled quantity and the actual quantity diverted by OID and SSJID in a year may be stored in New Melones Reservoir for use in subsequent years. This conservation account has a maximum storage limit of 200,000 af, and withdrawals are constrained by criteria in the agreement.

In-stream Flow Requirements

Under D-1422, Reclamation is required to release 98,000 af of water per year, with a reduction to 69,000 af in critical years, from New Melones Reservoir to the Stanislaus River on a distribution pattern to be specified each year by DFG for fish and wildlife purposes. In 1987, an agreement between Reclamation and DFG (Reclamation 2004) provided for increased releases from New Melones to enhance fishery resources for an interim period, during which habitat requirements were to be better defined and a study of Chinook salmon fisheries on the Stanislaus River would be completed.

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

Bay-Delta Vernalis Flow Requirements

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

Table 5 San Joaquin Base Flows-Vernalis

Water Year Class	February-June Flow (cfs)*
Critical	710-1140
Dry	1420-2280
Below Normal	1420-2280
Above Normal	2130-3420
Wet	2130-3420
*the higher flow required when X2 is required to be at or west of Chipps Island	

Reclamation committed to provide these flows during the interim period of the Bay-Delta Accord. Since D-1641 has been in place, the San Joaquin base flow requirements have at times, been an additional demand on the New Melones water supply beyond that anticipated in the Interim Plan of Operation (IPO) (Reclamation 2004). The IPO describes the commitment Reclamation made regarding the operation of New Melones Reservoir.

Dissolved Oxygen Requirements

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

Vernalis Water Quality Requirement

D-1422 also specifies that New Melones Reservoir must operate to maintain average monthly level total dissolved solids (TDS), commonly measured as a conversion from electrical conductivity, in the San Joaquin River at Vernalis as it enters the Delta. D-1422 specifies an average monthly concentration of 500 parts per million (ppm) TDS for all months. Historically, releases have been made from New Melones Reservoir for this standard, but due to shortfalls in water supply, Reclamation has not always been successful in meeting this objective.

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

CVP Contracts

Reclamation entered into water service contracts for the delivery of water from New Melones Reservoir, based on a 1980 hydrologic evaluation of the long-term availability of water in the Stanislaus River Basin. Based on this study, Reclamation entered into a long-term water service contract for up to 49,000 af per year of water annually (based on a firm water supply), and two long-term water service contracts totaling 106,000 af per year (based on an interim water supply). Because diversion facilities were not yet fully operational and water supplies were not available during the 1987 to 1992 drought, water was not made available from the Stanislaus River for delivery to CVP contractors prior to 1992.

New Melones Interim Plan of Operations (IPO)

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

In 1996, the focus shifted to the development of an interim operations plan for 1997 and 1998. At an SRBS meeting on January 29, 1997, a final interim plan of operation was agreed to in concept. The IPO was transmitted to the SRBS on May 1, 1997. Although meant to be a short-term plan, it continues to be the guiding operations criteria in effect for the annual planning to meet beneficial uses from New Melones storage.

In summary, the IPO defines categories of water supply based on storage and projected inflow. It then allocates annual water release for in-stream fishery enhancement (1987 DFG Agreement (Reclamation 2004) and CVPIA Section 3406(b)(2) management), D-1641 San Joaquin River water quality requirements (Water Quality), D-1641 Vernalis flow requirements (Bay-Delta), and use by CVP contractors.

Table 6 Inflow characterization for the New Melones IPO

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

Table 7 New Melones IPO flow objectives (in thousand af)

Storage plus inflow		Fishery		Vernalis water quality		Bay-Delta		CVP contractors	
From	To	From	To	From	To	From	To	From	To

1400	2000	98	125	70	80	0	0	0	0
2000	2500	125	345	80	175	0	0	0	59
2500	3000	345	467	175	250	75	75	90	90
3000	6000	467	467	250	250	75	75	90	90

From inspection of the above IPO allocation structure, two key New Melones-Stanislaus River water policies are inferred:

> When the water supply condition is determined to be in the "Low" IPO designation, no CVP operations guidance is given. It is assumed Reclamation would meet with the SRBS group to coordinate a practical strategy to guide New Melones Reservoir annual operations under the very limited water supply conditions.
>
> The IPO only supports meeting the D-1641 Vernalis Base flow standards from Stanislaus River water resources when the water supply condition are determined to be in the "High" or "Medium-High" IPO designation, and then are limited to 75,000 af of reservoir release.

The IPO supports only limited reservoir release volumes towards meeting the Vernalis salinity standards. The limited reservoir release volumes dedicated in the IPO may not fully meet the annual SWRCB standard requirement for the Vernalis salinity standard in the "Medium Low" and "Medium" years. If the Vernalis salinity standard cannot be met using the IPO designated Goodwin release pattern, then additional volume is dedicated to meeting the salinity standard. The permit obligations must be met before an allocation can be made to CVPIA Section 3406 (b)(2) uses or CVP contracts. This is a consequence of Vernalis salinity standards existing prior to passage of CVPIA.

In water years 2002, 2003 and 2004, Reclamation deviated from the IPO to provide additional releases for Vernalis salinity and Vernalis base flow standards. Several consecutive years of dry hydrology in the San Joaquin River Basin have demonstrated the limited ability of New Melones to fully satisfy the demands placed on its yield. Despite the need to consider annual deviations, the IPO remains the initial guidance for New Melones Reservoir operations.

CVPIA Section 3406 (b)(2) releases from New Melones Reservoir consist of the portion of the fishery flow management volume utilized that is greater than the 1987 DFG Agreement (Reclamation 2004) and the volume used in meeting the Vernalis Base flows.

San Joaquin River Agreement/Vernalis Adaptive Management Plan

Adopted by the SWRCB in D-1641, the SJRA (Reclamation 2004) includes a 12-year experimental program providing for flows and exports in the lower San Joaquin River during a 31-day pulse flow period during April and May. It also provides for the collection of experimental data during that time to further the understanding of the effects of flows, exports, and the barrier at the head of Old River on salmon survival. This experimental program is commonly referred to as the VAMP.

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

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

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

The Hydrology Group develops forecasts of flow at Vernalis, determines the appropriate target flow, devises an operations plan including flow schedules for each contributing agency, coordinates implementation of the VAMP flows, monitors conditions that may affect the objective of meeting the target flow, updates and adjusts the planned flow contributions as needed, and accounts for the flow contributions. The Hydrology Group includes designees with technical expertise from each agency that contributes water to the VAMP. During VAMP, the Hydrology group communicates via regular conference calls, shares current information and forecasts via e-mail and an internet website. The Hydrology group has two lead coordinators, one from Reclamation's CVO and one designated by the SJRG.

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

The VAMP program has two distinct components, a flow objective and an export restriction. The flow objectives were designed to provide similar protection to those defined in the WQCP. fishery releases on the Stanislaus above that called for in the 1987 DFG Agreement are typically considered WQCP (b)(2) releases. The export reduction involves a combined State and Federal pumping limitation on the Delta pumps. The combined export targets for the 31 days of VAMP are specified in the SJRA: 1500 cfs (when target flows are 2000, 3200, 4450, or 7000 cfs), and 2250 cfs (when target flow is 5700 cfs, or 3000 cfs [alternate export target when flow target is 7000 cfs]). Typically, the Federal pumping reduction is considered a WQCP (b)(2) expense and the State reduction is covered by EWA actions. In 2003, however, EWA also provided coverage for the VAMP shoulder portion of the Federal pumping reduction.

Water Temperatures

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

The current stated goal for water temperatures in the lower Stanislaus River is 65°F at Orange Blossom Bridge for steelhead incubation and rearing during the late spring and summer. This goal is often unachieved. Fall pulse attraction flows for salmon managed by Service resources helps to transport cold water resources from New Melones Reservoir into Tulloch Reservoir before the spawning season begins.

Friant Division

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

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

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

San Felipe Division

Construction of the San Felipe Division of the CVP was authorized in 1967 (Figure 3). The San Felipe Division provides a supplemental water supply (for irrigation, M&I uses) in the Santa Clara Valley in Santa Clara County, and the north portion of San Benito County. It prevents further mining of the groundwater in Santa Clara County and replaces boron-contaminated water in San Benito County.

The San Felipe Division was designed to supply about 216,000 af annually by the year 2020. Water is delivered to the service areas not only by direct diversion from the distribution systems, but also through the expansion of the large groundwater recharge operation now being carried out by local interests. The majority of the water supply, about 150,000 af, is used for M&I purposes. The facilities required to serve Santa Clara and San Benito Counties include 54 miles of tunnels and conduits, two large pumping plants, and one reservoir. About 50 percent of the water conveyed to Santa Clara County is percolated to the underground for agricultural and M&I uses, and the balance is treated for direct M&I delivery. Nearly all of the water provided to San Benito County is delivered via surface facilities. A distribution system was constructed in San Benito County to provide supplemental water to about 19,700 arable acres.

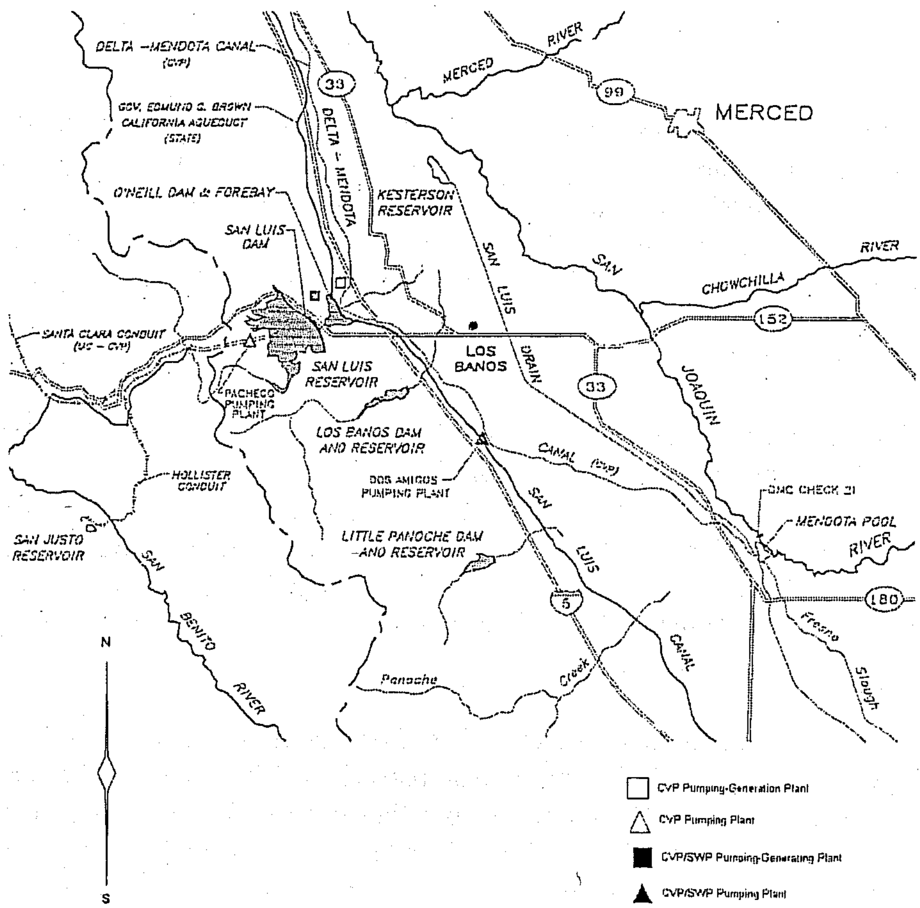

Figure 3 West San Joaquin Division and San Felipe Division

Water is conveyed from the Delta of the San Joaquin and Sacramento Rivers through the DMC. It is then pumped into the San Luis Reservoir and diverted through the 1.8 miles of Pacheco Tunnel Reach 1 to the Pacheco Pumping Plant. Twelve 2,000-horse-power pumps lift a maximum of 480 cfs a distance varying from 85 feet to 300 feet to the 5.3-mile-long Reach 2 of Pacheco Tunnel. The water then flows through the tunnel and without additional pumping, through 29 miles of concrete, high-pressure pipeline, varying in diameter from 10 feet to 8 feet and a mile-long Santa Clara Tunnel. The pipeline terminates at the Coyote Pumping Plant, which is capable of pumping water to Coyote Creek or the Calero Reservoir.

Santa Clara Valley Water District operates the Pacheco Tunnel, Pacheco Pumping Plant, Santa Clara Tunnel and Coyote Pumping Plant.

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

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

The San Benito County Water District operates San Justo Reservoir and the Hollister Conduit.

State Water Project

The DWR holds contracts with 29 public agencies throughout Central and Southern California for water supplies from the SWP. Water stored in the Oroville facilities, along with surplus water from the Sacramento-San Joaquin Delta are captured in the Delta and conveyed through several facilities to SWP contractors. The operation of these facilities is the subject of this project description. The facilities include the primary conservation storage complex on the Feather River, export facilities located in the North and South Delta, tidally operated gates in the Suisun Marsh, and operable barriers in the South Delta.[4]

Feather River

SWP Oroville Facilities

Oroville Dam and its appurtenances comprise a multipurpose project encompassing water conservation, power generation, flood control, recreation, and fish and wildlife enhancement. Oroville Lake stores winter and spring runoff that is released into the Feather River, as necessary,

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4 Permanent operable barriers are planned for future construction and operation. Only the operation of these facilities is included in this project description. Construction effects will be addressed through a separate consultation process.

for project purposes. Pumped storage capability permits maximization of the power value produced by these releases.

The Oroville facilities are shown in Figure 4. Two small embankments, Bidwell Canyon and Parish Camp Saddle Dams, complement Oroville Dam in containing Lake Oroville. The lake has a surface area of 15,858 acres, a storage capacity of 3,538,000 af, and is fed by the North, Middle, and South forks of the Feather River. Average annual unimpaired runoff into the lake is about 4.5 million af.

A maximum of 17,000 cfs can be released through the Edward Hyatt Powerplant, located underground near the left abutment of Oroville Dam. Three of the six units are conventional generators driven by vertical-shaft, Francis-type turbines. The other three are motor-generators coupled to Francis-type, reversible pump turbines. The latter units allow pumped storage operations. The intake structure has an overflow type shutter system that determines the level from which water is drawn.

Approximately 4 miles downstream of Oroville Dam and Edward Hyatt Powerplant is the Thermalito Diversion Dam. Thermalito Diversion Dam consists of a 625-foot-long, concrete gravity section with a regulated ogee spillway that releases water to the low flow channel of the Feather River. On the right abutment is the Thermalito Power Canal regulating headwork structure.

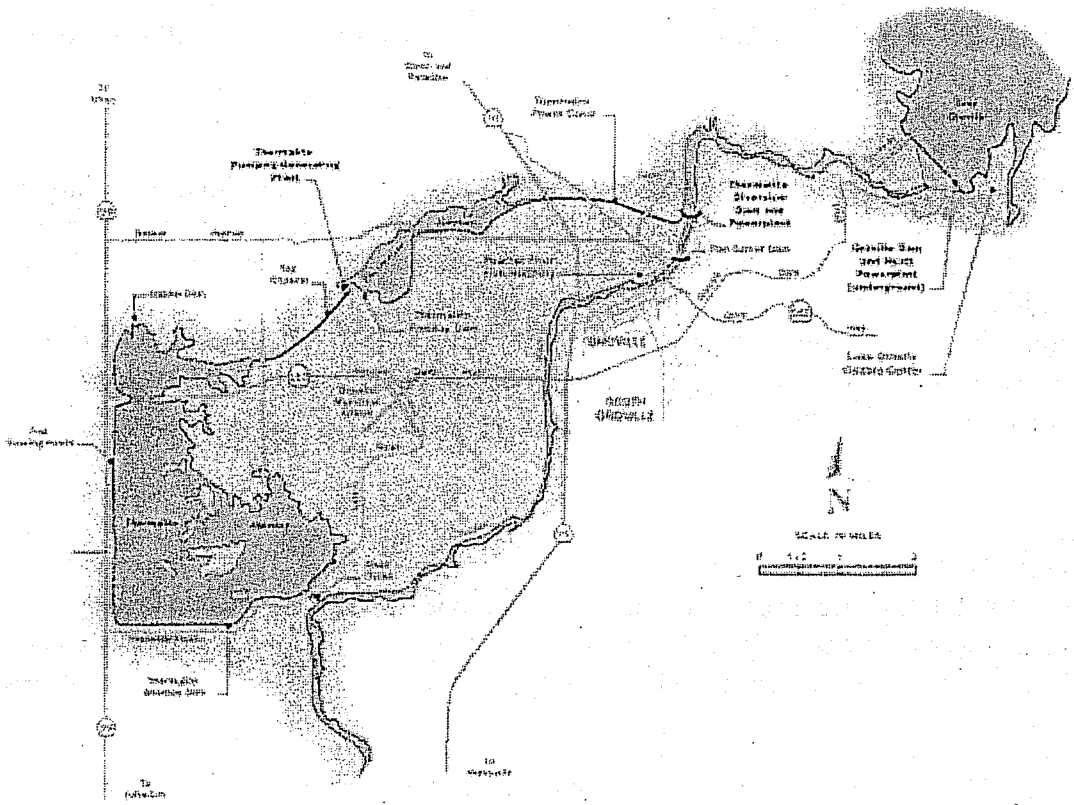

Figure 4 Oroville Facilities on the Feather River

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

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

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

The DFG operates the Feather River Fish Hatchery for the production of Chinook salmon and steelhead. The hatchery is located downstream of the Thermalito Diversion Dam. Water is provided to the hatchery via a pipeline from the diversion dam. The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the afterbay outlet. The Fish Barrier Dam prevents further upstream migration by adult salmon and steelhead and helps direct them to the fish ladder entrance located on the right (west) embankment.

Temperature Control

The August 1983 agreement between DWR and DFG, "Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife," (Reclamation 2004) sets criteria for flow and temperature for the low-flow section of the Feather River, the fish hatchery, and the reach of the Feather River below the river outlet to the confluence with the Sacramento River.

Flood Control

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

Table 8 Water Year/Days in Flood Control/40-30-30 Index

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

DWR Feather River Fish Studies

DWR initiated fish studies in the lower Feather River in 1991. The present program consists of several elements to monitor salmonid spawning, rearing, and emigration and to document presence and relative abundance of non-salmonid fishes. The focus and methods used for these studies were altered in 2003 as a result of consultations with NOAA Fisheries, DFG, and others to gather information needed to relicense the Oroville facilities with the Federal Energy Regulatory Commission (FERC).

SWP/CVP Delta Facilities

CVP Facilities

The CVP's Delta Division includes the DCC, the CCWD diversion facilities, the Tracy Pumping Plant, the TFCF, and the DMC. The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. The CCWD diversion facilities use CVP water resources to serve district customers directly and to operate CCWD's Los Vaqueros Project. The Tracy Pumping Plant diverts water from the Delta to the head of the DMC.

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 Tracy 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.

The 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 period. Reclamation determines the timing and duration of the closures after consultation with Service, DFG, and NOAA Fisheries. Consultation with the CALFED Ops Group will also satisfy the consultation requirement.

The CALFED Ops Group 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 for the timing of DCC closures, subject also to 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 of the BA) included "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 . In November 2000, the previously entitled Spring Run Protection Plan was replaced by a CALFED Ops Group plan (Reclamation 2004) designed to provide broader protections for juvenile salmon emigrating through the Delta from October through January.

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 lifestage and size development, current hydrologic events, fish indicators (such as the Knight's Landing Catch Index and Sacramento Catch Index), and salvage at the export facilities, as well as current and projected Delta water quality conditions, are used to determine potential DCC closures and/or export reductions. The coordination process has worked well during the recent fall and winter DCC operations and is expected to be used in the present or modified form in the future.

Tracy Pumping Plant

The Projects use the Sacramento River and Delta channels to transport water to export pumping plants in the south Delta. The CVP's Tracy Pumping Plant, about five miles north of Tracy, consists of six available pumps. The Tracy Pumping Plant is located at the end of an earth-lined intake channel about 2.5 miles long. At the head of the intake channel, louver screens (that are part of the TFCF) intercept fish, which are then collected and transported by tanker truck to release sites away from the pumps. Tracy Pumping Plant diversion capacity is approximately 4,600 cfs during the peak of the irrigation season and approximately 4,200 cfs during the winter non-irrigation season before the Intertie, described on page 93. The capacity limitations at the Tracy Pumping Plant are the result of a DMC freeboard constriction near O'Neill Forebay, O'Neill Pumping Plant capacity, and the current water demand in the upper sections of the DMC.

Tracy Fish Collection Facility

The TFCF uses behavioral barriers consisting of primary and secondary louvers to guide targeted fish into holding tanks before transport by truck to release sites within the Delta. Hauling trucks used to transport salvaged fish to release sites 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 compatible with export operations, and technically feasible, the louvers are operated with the objective of achieving water approach velocities: for stripped 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.

Fish passing through the facility are sampled at intervals of no less than 10 minutes every 2 hours. Fish observed during sampling intervals are identified to species, measured to fork length, examined for marks or tags, and placed in the collection facilities for transport by tanker truck to the release sites away from the pumps.

Studies will also be conducted at the TFCF to help determine screening criteria and improve delta smelt handling and survival in the salvage process.

Contra Costa Water District Diversions Facilities

CCWD diverts CVP water from the Delta for irrigation and M&I uses. Prior to 1997, CCWD's primary diversion facility in the Delta originated at Rock Slough, about four miles southeast of Oakley. At Rock Slough, the water is lifted 127 feet by a series of four pumping plants into the Contra Costa Canal (CCC), a 47.7-mile canal that terminates in Martinez Reservoir. Two short canals, Clayton and Ygnacio, are integrated into the distribution system. The Clayton Canal is no longer in service

Rock Slough diversion capacity of 350 cfs gradually decreases to 22 cfs at the terminus. Historically, actual Rock Slough pumping rates have ranged from about 50 to 250 cfs with seasonal variation. Rock Slough Pumping Plant is an unscreened facility. The fish-screening of the Rock Slough Pumping Plant is directed under the CVPIA and is included in the CCWD's BO for the Los Vaqueros Project (Service 1993b). Reclamation, in collaboration with CCWD, is responsible for constructing the fish screen. Reclamation asked for an extension until December 2008 to allow completion of current CALFED project studies that might affect frequency of usage of the Rock Slough intake and therefore, the screen design.

As part of the Los Vaqueros Project, CCWD also diverts from the Delta on Old River near Highway 4 at a fish-screened diversion facility with a capacity of 250 cfs. The Los Vaqueros Project was constructed to improve the delivered water quality and emergency storage reliability to CCWD's customers. The Old River facility allows CCWD to directly divert up to 250 cfs of CVP water to a blending facility with the existing CCC, in addition to the Rock Slough direct diversions. The Old River facility can also divert up to 200 cfs of CVP and Los Vaqueros water rights water for storage in the 100,000 af Los Vaqueros Reservoir.

The water rights for the Los Vaqueros Project were approved by SWRCB Decision 1629 (Reclamation 2004). A NOAA Fisheries BO for the Los Vaqueros winter-run Chinook salmon was provided on March 18, 1993 (Reclamation 2004). A Service BO for Los Vaqueros (Service 1993b) covering delta smelt was provided on September 9, 1993 and clarified by letter on

September 24, 1993. The Service BO requires CCWD to preferentially divert CVP water from the fish-screened Old River intake from January through August each year.

The Service BO also requires CCWD to operate all three of its intakes (including CCWD's Mallard Slough intake) and Los Vaqueros Reservoir as an integrated system to minimize impacts to endangered species. The 1993 BO calls for monitoring at all three intakes to determine diversion of water at Rock Slough, Old River, and Mallard Slough to minimize take of delta smelt during the spawning and rearing period.

Due to the water quality objectives of the Los Vaqueros Project, CCWD's total diversions from the Delta are reduced during the late summer and fall when Delta water quality and flows are the poorest of the annual cycle. The CCWD fills the Los Vaqueros Reservoir only when Delta water quality conditions are good, which generally occurs from January to July.

Additionally, under the Los Vaqueros BOs, CCWD is required to cease all diversions from the Delta for 30 days in the spring if stored water is available in Los Vaqueros Reservoir above emergency storage levels and to use releases from the reservoir to meet CCWD demands. To provide additional fisheries protection, CCWD is not allowed to divert water to Los Vaqueros storage for an additional 45-day period in the winter or spring months.

The CCWD's third diversion facility in the Delta is located at the southern end of a 3,000-foot-long channel running due south of Suisun Bay, near Mallard Slough (across from Chipps Island). The old Mallard Slough Pump Station was replaced in 2002 with a new pump station that has a state-of-the-art fish screen The Mallard Slough Pump Station can pump up to 39.3 cfs, but is only used by CCWD during periods of very high Delta outflows (about 40,000 cfs or greater), when the water quality is good enough in Suisun Bay to meet CCWD's delivered chloride goal of 65 mg/L.

The CCWD has one license and one permit for Diversion and Use of Water issued by the SWRCB, which authorize CCWD to divert up to 26,780 af per year at Mallard Slough (Reclamation 2004). Although the Mallard Slough intake is very small and is only used under extremely high Delta outflow conditions, it is an integral part of CCWD's operations. In 2003, CCWD used Mallard Slough (in conjunction with storage in Reclamation's Contra Loma Reservoir) to optimize its ability to fill Los Vaqueros Reservoir while the Rock Slough intake was out of service for replacement of a section of the CCC. All three Delta intake facilities are being considered in this project description chapter.

Project Delta Export Facilities Operations Coordination

The Delta serves as a natural system of channels to transport river flows and reservoir storage to the Project facilities in the south Delta, which export water to the Projects' service areas. Reclamation and DWR closely coordinate the operations of the Tracy and Banks Pumping Plants with operations of the joint CVP and SWP San Luis Reservoir near Los Banos (Figure 6). The Tracy Pumping Plant is usually operated at a constant and uninterrupted rate. When water supply supports it, the Tracy Pumping Plant is usually operated to the capacity limits of the DMC, except when restrictions are imposed by regulatory or fishery requirements. Currently, maximum daily diversions into the Clifton Court Forebay (CCF) are governed by agreement with the Corps. This agreement allows for daily diversion rates of about 13,250 af on a 3-day average and 13,870 af on a daily average[5].

Between mid-December and mid-March, an additional amount of water may be diverted equal to one-third of the San Joaquin River (as measured at Vernalis) when the river flow is 1,000 cfs or greater. The CCF is operated to minimize effects to water levels during the low-low tide of the day. Banks Pumping Plant has 11 fixed-speed pumps of varying size, which are run to the extent possible during off-peak power periods to convey water into the CA.

The DWR proposes to operate the CCF at a higher rate than is currently used. Referred to as "8500 Banks," the higher rate would result in greater utilization of the full pumping capability of the Banks Pumping Plant. Details regarding the increased diversion rates are covered under the section titled "8500 cfs Operational Criteria."

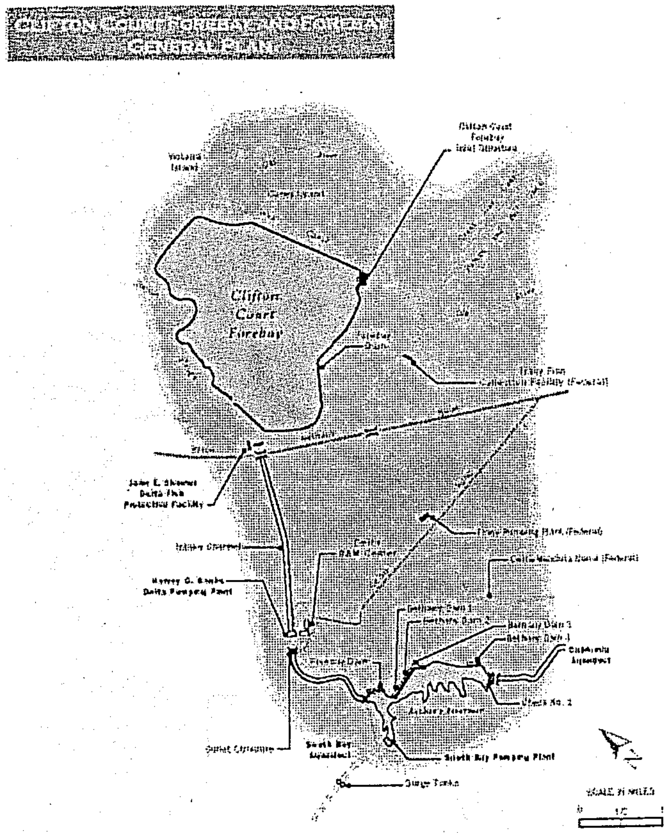

Figure 6 CCF, Tracy and Banks Pumping Plants

[5]Up to an additional 500 cfs of diversion may be allowed from July through September as part of the Environmental Water Account operations. See the section titled "The CALFED Environmental Water Account" for further details.

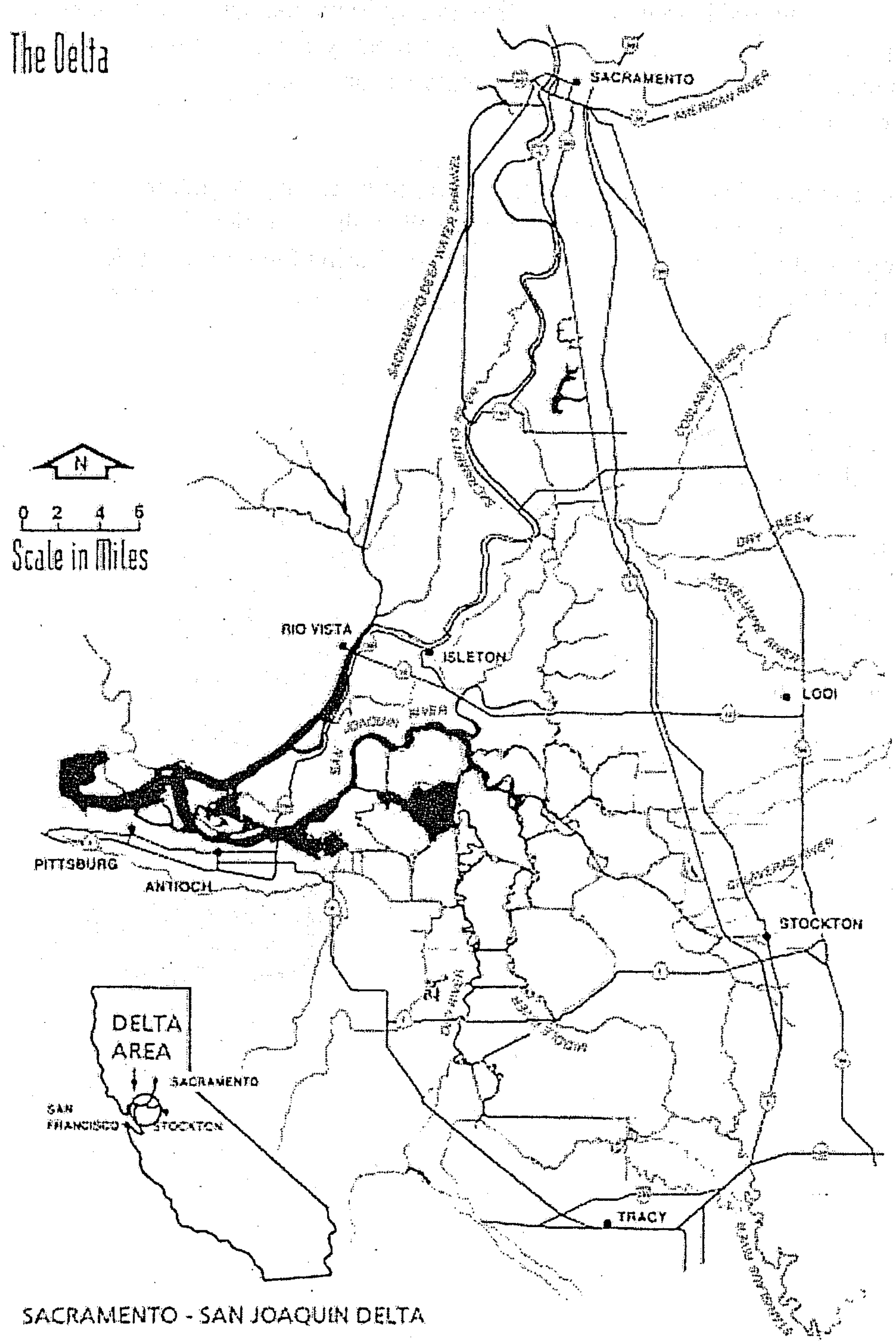

Figure 7 Sacramento-San Joaquin Delta

Sacramento-San Joaquin Delta- SWP Facilities

SWP facilities in the southern Delta include CCF, John E. Skinner Fish Facility, and the Harvey O. Banks Pumping Plant. CCF is a 31,000 af reservoir located in the southwestern edge of the Delta, about 10 miles northwest of Tracy. CCF provides storage for off-peak pumping, moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta channels, and collects sediment before it enters the CA. Diversions from Old River into CCF are regulated by five radial gates.

The John E. Skinner Delta Fish Protective Facility is located west of the CCF, 2 miles upstream of the Harvey O. Banks Delta Pumping Plant. The Skinner Fish Facility screens fish away from the pumps that lift water into the CA. Large fish and debris are directed away from the facility by a 388-foot-long trash boom. Smaller fish are diverted from the intake channel into bypasses by a series of metal louvers, while the main flow of water continues through the louvers and towards the pumps. These fish pass through a secondary system of screens and pipes into seven holding tanks, where they are later counted and recorded. The salvaged fish are then returned to the Delta in oxygenated tank trucks.

The Harvey O. Banks Delta Pumping Plant is in the South Delta, about 8 miles northwest of Tracy and marks the beginning of the CA. By means of 11 pumps, including 2 rated at 375 cfs capacity, 5 at 1,130 cfs capacity, and 4 at 1,067 cfs capacity, the plant provides the initial lift of water 244 feet into the CA. The nominal capacity of the Banks Pumping Plant is 10,300 cfs.

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

Since its conception the State Water Project's water supply has been highly dependent upon unregulated flow into the Delta. The delivery of water within the SWP in any given year is a function of operational requirements, Project storage conditions, demands (and the pattern of those demands), and the availability of unregulated flow into the Delta. To the extent that unregulated water has been available in the Delta, beyond that necessary to meet scheduled Project purposes and obligations, said water has been made available to any contractor who can make use of it. The original water supply contracts for SWP contractors included various labels for this Project water depending on the intended use–including the prominently used label of "interruptible".

In 1994, the contracts were amended in what is commonly referred to as the Monterey Amendment (Reclamation 2004). The basic objective of the amendment was to improve the management of SWP supplies–it did not affect the Project operations in the Delta or on the Feather River. Article 21 of the amendment stipulates that any SWP contractor is entitled to water available to the SWP when excess water to the Delta exceeds the Project's need to fulfill scheduled deliveries, meet operational requirements, or meet storage goals for the current or following years. This includes the water that was before known as "interruptible" as well as some other lesser known labels of water diverted under the same conditions. Article 21 water is and always has been an important source of water for various contractors during the wet winter months and is used to fill groundwater storage and off-stream reservoirs in the SWP service areas. It is also used to pre-irrigate croplands thereby preserving groundwater and local surface water supplies for later use during dry periods.

Clifton Court Forebay

CCF is a regulated reservoir at the head of the CA in the south Delta. Inflows to the CCF are controlled by radial gates, which are generally operated during the tidal cycle to reduce approach velocities, prevent scour in adjacent channels, and minimize impacts to water level in the south Delta. Generally, the concern is potential effects to the lower of the two low tides in during the day; thus, the gates are operated in a manner to reduce the impact to this low tide condition.

When a large head differential exists between the outside and the inside of the gates, theoretical inflow can be as high as 15,000 cfs for a short time. However, existing operating procedures identify a maximum design rate of 12,000 cfs, which prevents water velocities from exceeding three ft/s to control erosion and prevent damage to the facility. Figure 8 shows an example of when the gates could be opened and still minimize impacts to the lowest tide of the day.

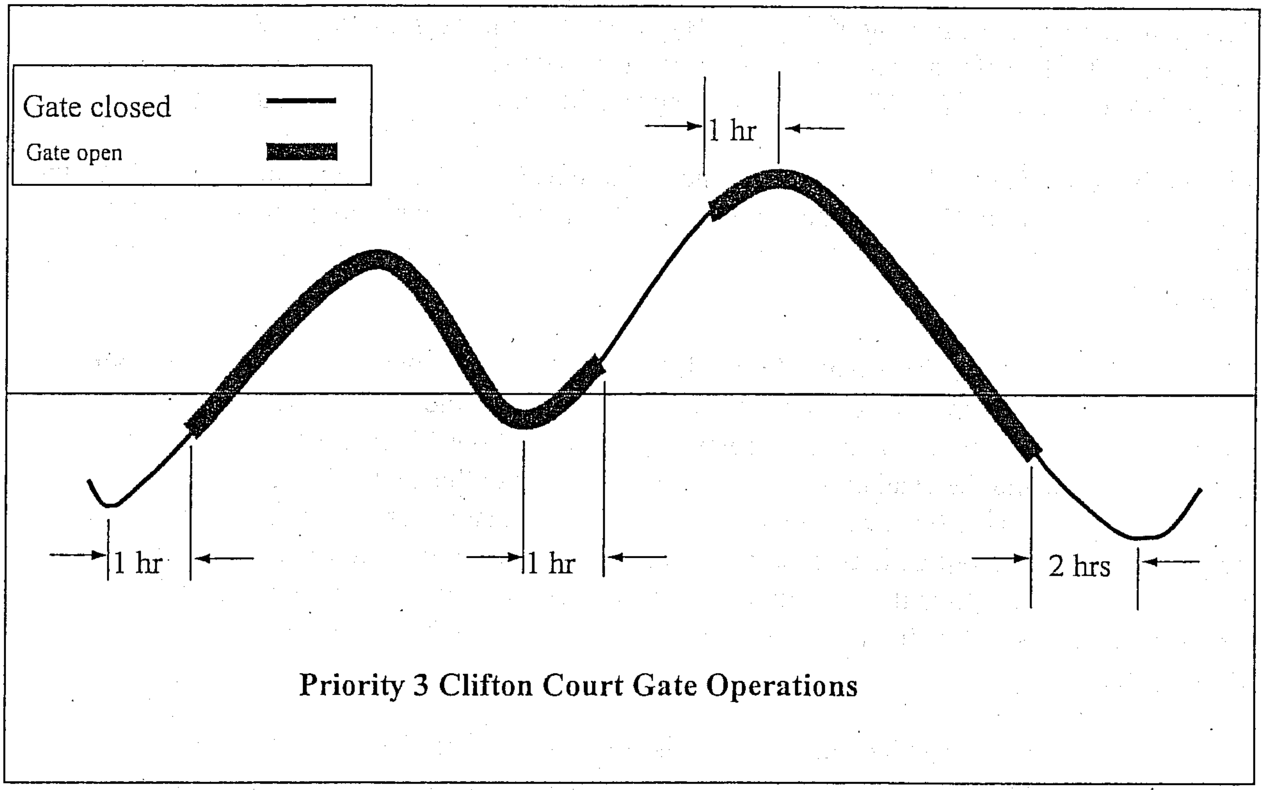

Figure 8 Clifton Court Gate Operations

North Bay Aqueduct Intake at Barker Slough

The Barker Slough Pumping Plant diverts water from Barker Slough into the NBA for delivery in Napa and Solano Counties. Maximum pumping capacity is 175 cfs (pipeline capacity). During the past few years, daily pumping rates have ranged between 0 and 140 cfs.

The NBA intake is located approximately 10 miles from the main stem Sacramento River at the end of Barker Slough. Each of the ten NBA pump bays is individually screened with a positive barrier fish screen consisting of a series of flat, stainless steel, wedge-wire panels with a slot width of 3/32 inch. This configuration is designed to exclude fish 25 millimeters (mm) or larger from being entrained. The bays tied to the two smaller units have an approach velocity of about 0.2 ft/s. The larger units were designed for a 0.5 ft/s approach velocity, but actual approach velocity is about 0.44 ft/s. The screens are routinely cleaned to prevent excessive head loss, thereby minimizing increased localized approach velocities.

Delta smelt monitoring presently required at Barker Slough under the March 6, 1995 OCAP Biological Opinion (Service 1995). Since 1995, monitoring has been required every other day at three sites from mid-February through mid-July, when delta smelt may be present. As part of the Interagency Ecological Program (IEP), DWR has contracted with the Department of Fish and Game to conduct the required monitoring each year since the Biological Opinion was issued.

A recent review by the IEP indicates that the present NBA monitoring program is not very effective for the management of smelt. Data from the past 9 years of monitoring show that catch of delta smelt in Barker Slough has been consistently very low, an average of just five percent of the values for nearby north Delta stations (Cache, Miner and Lindsey sloughs) (see Figure 12). These results are discussed in further detail in the effects section.

Based on these findings, the Working Group has recommended a broader regional survey during the primary period when delta smelt are most vulnerable to water project diversions. An alternative sampling approach would be conducted as a 1-2 year pilot effort in association with the DFG's existing 20-mm survey (http://www.delta.dfg.ca.gov/data/20mm). The survey would cover all existing 20-mm stations, but would have an earlier seasonal start and stop date to focus on the presence of larvae in the Delta. The proposed gear type is a surface boom tow, as opposed to oblique sled tows that have traditionally been used to sample larval fishes in the San Francisco Estuary. Under the proposed work plan, the Working Group will evaluate utility of the study and effectiveness of the gear in each year of the pilot work.

South Delta Temporary Barriers

The South Delta Temporary Barriers (SDTB) are not a project element for purposes of this biological assessment or the resulting consultation. A description of the SDTB is included only to provide information on a related project. A separate biological assessment has been prepared for the Temporary Barriers Project (DWR 1999a).

The existing SDTB Project consists of installation and removal of temporary rock barriers at the following locations:

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

- The head of Old River at the confluence of Old River and San Joaquin River

The barriers on Middle River, Old River near Tracy, and Grant Line Canal are tidal control facilities designed to improve water levels and circulation for agricultural diversions and are in place during the growing season. Installation and operation of the barriers at Middle River and Old River near Tracy can begin May 15, or as early as April 15 if the spring head of Old River barrier is in place. From May 16 to May 31 (if the head of Old River barrier is removed) the tide gates are tied open at both Middle River and Old River near the Tracy barriers. After May 31, the Middle River, the Old River near Tracy, and the Grant Line Canal barriers are permitted to be operational until September 30.

During the spring, the barrier at the head of Old River is designed to reduce the number of out-migrating salmon smolts entering Old River. During the fall, the head of Old River barrier is designed to improve flow and DO conditions in the San Joaquin River for the immigration of adult fall-run Chinook salmon. Operations of the head of Old River barrier are typically between April 15 to May 15 for the spring barrier, and between early September to late November for the fall barrier. Installation and operation of the barrier also depend on San Joaquin flow conditions. DWR was permitted to install and operate these barriers between 1992 and 2000. In 2001, DWR obtained approvals to extend the Temporary Barriers Project for an additional 7 years.

West San Joaquin Division

San Luis Operations

As part of the West San Joaquin Division, the San Luis Unit was authorized in 1960 to be built and operated jointly with the State of California. The San Luis Unit consists of the following: (1) Sisk San Luis Dam and San Luis Reservoir, joint Federal-State facilities; (2) O'Neill Dam and Forebay, joint Federal-State facilities; (3) O'Neill Pumping-Generating Plant, a Federal facility; (4) William R. Gianelli Pumping-Generating Plant, a joint Federal-State facility; (5) San Luis Canal, a joint Federal-State facility; (6) Dos Amigos Pumping Plant, a joint Federal-State facility; (7) Coalinga Canal, a Federal facility; (8) Pleasant Valley Pumping Plant, a Federal facility; and (9) the Los Banos and Little Panoche Detention Dams and Reservoirs, joint Federal-State facilities).

The management of the San Luis Unit depends on the operation of the northern features of the CVP, while simultaneously influencing the operation of the northern CVP system. This relationship results from the need to deliver about half of the CVP's annual water supply through the DMC and the San Luis Unit, while essentially all of the water supply must originate from the northern Central Valley.

To accomplish the objective of providing water to CVP contractors in the San Joaquin Valley, three conditions must be considered: (1) water demands and anticipated water schedules for CVP water service contractors and exchange contractors must be determined; (2) a plan to fill and draw down San Luis Reservoir must be made; and (3) coordinating Delta pumping and using San

Luis Reservoir must be established. Only after these three conditions are made can the CVP operators incorporate the DMC and San Luis operations into plans for operating the northern CVP system.

Water Demands--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 contracts. A significantly different relationship exists between Reclamation and 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 defined hydrologic conditions of 25 percent.

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 contracts provide water supplies to specific managed lands for wildlife purposes and the CVP contract water supply can be reduced under critically dry conditions by up to 25 percent.

Combining the contractual supply of these three types of contractors with the pattern of requests for water is necessary to achieve the best operation of the CVP. In most years, because of reductions in CVP water supplies due to insufficient Delta pumping capability, sufficient supplies are not available to meet all water demands. In some dry or drought years, water deliveries are limited because of insufficient northern CVP reservoir storage to meet all in-stream fishery objectives, including water temperatures, and to use the delivery capacity of Tracy Pumping Plant. The scheduling of water demands, together with the scheduling of the releases of supplies from the northern CVP to meet those demands, is a CVP operational objective intertwined with the Trinity, Sacramento, and American River operations.

San Luis Reservoir Operations

Two means of moving water from its source in the Delta are available for the DMC and the San Luis Unit (Figure 9). The first is Reclamation's Tracy Pumping Plant, which pumps water into the DMC. The second is the State's Banks Pumping Plant, which pumps water into the CA. During the spring and summer, water demands and schedules are greater than Reclamation's and DWR's capability to pump water at these two facilities, and water stored in the San Luis Reservoir must be used to make up the difference.

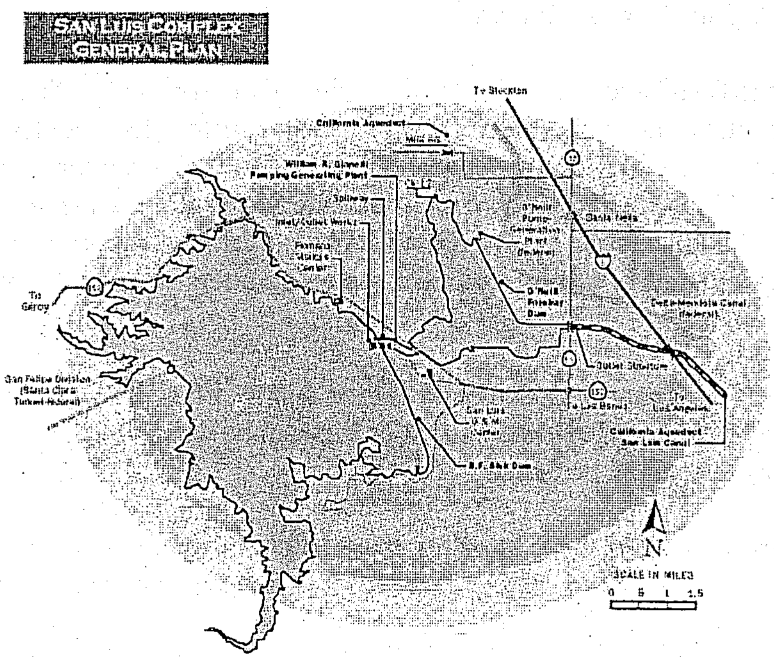

Figure 9 San Luis Complex

The San Luis Reservoir has very little natural inflow, therefore, if it is to be used for a water supply, the water must be stored during the fall and winter months when the two pumping plants can export more water from the Delta than is needed for scheduled water demands. Because the amount of water that can be exported from the Delta is limited by available water supply, Delta constraints, and the capacities of the two pumping plants, the fill and drawdown cycle of San Luis Reservoir is an extremely important element of CVP operations.

Adequate storage in San Luis Reservoir must be maintained to ensure delivery capacity through Pacheco Pumping Plant to the San Felipe Division. Lower reservoir elevations can also result in turbidity and water quality treatment problems for the San Felipe Division users.

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

(Reclamation 2004), Tracy Pumping Plant diversion rates may be reduced during the fill cycle of the San Luis Reservoir for fishery management.

In April and May, export pumping from the Delta is limited by D-1641 San Joaquin River pulse period standards as well as B2/EWA fishery management during the spring months. During this same time, CVP-SWP irrigation demands are increasing. Consequently, by April and May the San Luis Reservoir has begun the annual drawdown cycle. In some exceptionally wet conditions, when excess flood water supplies from the San Joaquin River or Tulare Lake Basin occur in the spring, the San Luis Reservoir may not begin its drawdown cycle until late in the spring.

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

San Luis Unit Operation--State and Federal Coordination

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

Total San Luis Unit annual water supply is contingent on coordination with the SWP needs and capabilities. When the SWP excess capacity is used to support CVP JPOD water for the CVP, it may be of little consequence to SWP operations, but extremely critical to CVP operations. The availability of excess SWP capacity by the CVP is contingent on the ability of the SWP to meet its SWP contractors' water supply commitments. Additionally, close coordination by CVP and SWP is required to ensure that water pumped into O'Neill Forebay does not exceed the CVP's capability to pump into San Luis Reservoir or into the San Luis Canal at the Dos Amigos Pumping Plant.

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

With the existing facility configuration, the operation of the San Luis Reservoir could impact the water quality and reliability of water deliveries to the San Felipe Division, if San Luis Reservoir is drawn down too low. This operation could have potential impacts to resources in Santa Clara and San Benito Counties. Implementation of a solution to the San Luis low point problem would allow full utilization of the storage capacity in San Luis Reservoir without impacting the San Felipe Division water supply. Any changes to the operation of the Projects, as a result of solving the low point problem, would be consistent with the operating criteria of the specific facility. For example, any change in Delta pumping that would be the result of additional effective storage capacity in San Luis Reservoir, would be consistent with the operating conditions for the Banks and Tracy Pumping Plants.

Suisun Marsh

Suisun Marsh Salinity Control Gates

The SMSCG are located about 2 miles northwest of the eastern end of Montezuma Slough, near Collinsville (Figure 10). The SMSCG span Montezuma Slough, a width of 465 feet. In addition to permanent barriers adjacent to each levee, the structure consists of the following components (from west to east): (1) a flashboard module which provides a 68-foot-wide maintenance channel through the structure during June through September when the flashboards are not installed (the flashboards are only installed between September and May, as needed, and can be removed if emergency work is required. Installation and removal of the flashboards requires a large, barge-mounted crane); (2) a radial gate module, 159 feet across, containing three radial gates, each 36-feet wide; and (3) a boat-lock module, 20 feet across, which is operated when the flashboards are in place.

An acoustic velocity meter is located about 300-feet upstream (south) of the gates to measure water velocity in Montezuma Slough. Water level recorders on both sides of the structure allow operators to determine the difference in water level on both sides of the gates. The three radial gates open and close automatically using the water level and velocity data.

Operation of the SMSCG began in October 1988. The facility was implemented as Phase II of the Plan of Protection for the Suisun Marsh (Reclamation 2004). Operating the SMSCG is essential for meeting eastern and central marsh standards in SWRCB D-1641 and the Suisun Marsh Preservation Agreement (SMPA) (Reclamation 2004), and for lowering salinity in the western marsh. Gate operation retards the upstream flow of higher salinity water from Grizzly Bay during flood tides while allowing the normal flow of lower salinity water from the Sacramento River near Collinsville during ebb tides.

During full operation, the gates open and close twice each tidal day. The net flow through the gates during full operation is about 1,800 cfs in the downstream direction when averaged over one tidal day. Typically in summer, when the gates are not operating and the flashboards are removed, the natural net flow in Montezuma Slough is low and often in the upstream direction from Grizzly Bay toward Collinsville.

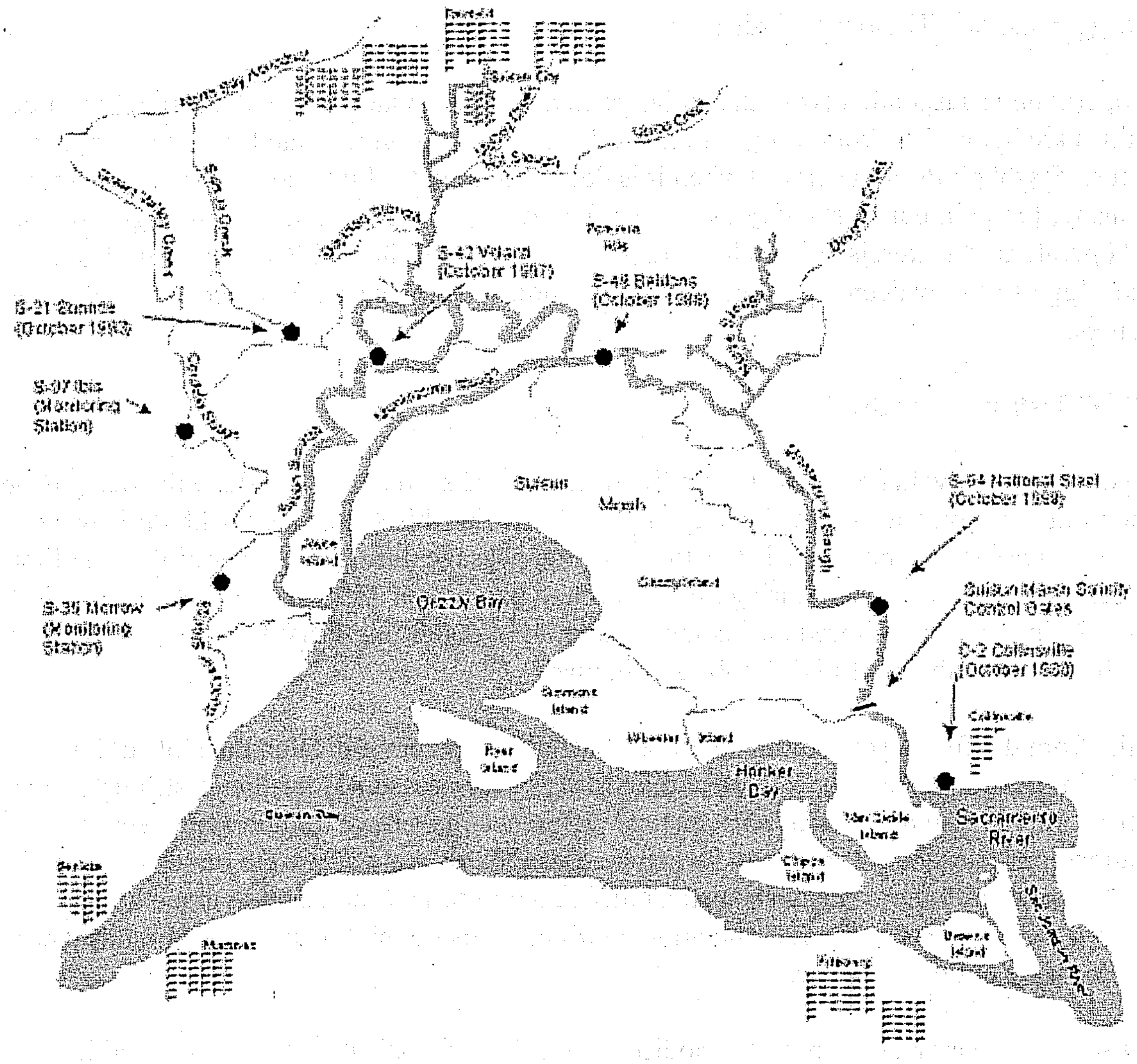

Figure 10 Suisun Bay and Suisun Marsh showing the location of the Suisun Marsh Salinity Control Gates and Salinity Control Stations

SMSCG are not in operation June 1 through August 31. When not in operation, the maintenance channel is open, the flashboards are stored in the maintenance yard, the three radial gates are held open, and the boat lock is closed.

The SMSCG are operated (as needed) from September through May 31 to meet SWRCB and SMPA standards (Reclamation 2004) in October through May. Operation of the SMSCG will commence in September if high-tide channel water salinity is above 17 mS/cm at any trigger station (2 mS/cm below the October standard)6. Trigger stations are S-35, S-42, S-49, and S-64 (Figure). Otherwise, the operation will occur October 1 through May 31 if two consecutive high-tide salinities are within 2 mS/cm below the current and subsequent months' standards at

6Since 1988, the SMSCG have been operated in September during 5 years (1989, 1990, 1993, 1994, and 1999), either for testing the effectiveness of gate operations, to help reduce channel salinity for initial flooding of managed wetlands during drought conditions, or to test salmon passage.

any trigger station. The flashboards are installed prior to operation.

The operation is suspended (with the radial gates held open) when two consecutive high-tide salinities are below 2 mS/cm of the current and subsequent months' standards at all trigger stations. Flashboards are removed when it is determined that salinity conditions at all trigger stations will remain below standards for the remainder of the control season through May 31. SWP operators can exercise discretion with the operations of the SMSCG deviating from the stated triggers as they deem appropriate for the conditions, forecasts, or to accommodate special activities.

SMSCG Fish Passage Study

A 3-year study to evaluate whether a modified flashboard system could reduce the delay in adult salmon immigration was initiated in September 1998. For this study, the flashboards were modified, creating two horizontal slots to allow fish passage during gate operation. The first two field seasons were conducted during September and November 1998 and 1999 (Reclamation 2004). Salinity was monitored during the evaluation to determine if SWRCB salinity standards could be met with the modified flashboards in place.

Results from the first 2 years of the modified flashboard system indicated the slots did not provide improved passage for salmon at the SMSCG. The reason(s) for this is still unknown. In addition, the 1999 study showed no statistical difference in passage numbers between the full operation configuration (no slots) and when the flashboards and gates were out of the water. In both 1998 and 1999 there was no statistical difference in time of passage (average hours, indicating delay) between the full operation configurations (no slots) and when the flashboards and gates were out of the water.

Because preliminary results from the modified SMSCG test indicate the slots resulted in less passage than the original flashboards, the SMSCG Steering Group decided to postpone the third year of the test until September 2001 and to reinstall the original flashboards if gate operation was needed during the 2000-2001 control season. The SMSCG Steering Group is evaluating leaving the boat lock open as a means of providing unimpeded passage to adult salmon migrating upstream. Studies were completed during the 2001-2002 and 2002-2003 control seasons and plans are in place for the 2003-2004 control season (Reclamation 2004). The studies included three phases, in varying order, each year:

Full Open Operation. The SMSCG flashboards are out, the gates are fixed in the up position, and the boat lock is closed.

Full Bore Operation with Boat Lock Open. The SMSCG flashboards are in, the gates are tidally operated, and the boat lock is held open.

Full Bore Operation with Boat Lock Closed. The SMSCG flashboards are in, the gates are tidally operated, and the boat lock is closed.

Roaring River Distribution System

The RRDS was constructed during 1979 and 1980 as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh (Reclamation 2004). The system was constructed to provide lower salinity water to 5,000 acres of both public and privately managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands. Construction involved enlarging Roaring River Slough and extending its western end. Excavated material was used to widen and strengthen the levees on both sides of the system.

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

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

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

Routine maintenance of the system is conducted by DWR and primarily consists of maintaining the levee roads. DWR provides routine screen maintenance. RRDS, like other levees in the marsh, have experienced subsidence since the levees were constructed in 1980. In 1999, DWR restored all 16 miles of levees to design elevation.

Morrow Island Distribution System

The Morrow Island Distribution System (MIDS) was constructed in 1979 and 1980 as part of the Initial Facilities in the Plan of Protection for the Suisun Marsh (Reclamation 2004). The systems was constructed to provide water to privately managed wetlands on Morrow Island and to channel drainage water from the adjacent managed wetlands for discharge into Grizzly Bay rather than Goodyear Slough. The MIDS is used year-round, but most intensively from September through June.

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

The Service 1997 BO (Reclamation 2004) included a requirement for screening the diversion of the MIDS. Reclamation and DWR continue to coordinate with the Service and NOAA Fisheries in the development of alternatives to screening that may provide greater benefit for listed aquatic species in Suisun Marsh.

Goodyear Slough Outfall

The Goodyear Slough Outfall was constructed in 1979 and 1980 as part of the Initial Facilities. A channel approximately 69-feet wide was dredged from the south end of Goodyear Slough to Suisun Bay (about 2,800 feet). The Outfall consists of four 48-inch culverts with flap gates on the bay side and vertical slide gates on the slough side. The system was designed to increase circulation and reduce salinity in Goodyear Slough by draining water from the southern end of Goodyear Slough into Suisun Bay. The system also provides lower salinity water to the wetland managers who flood their ponds with Goodyear Slough water. No impacts to fish occur in the outfall since fish moving from Goodyear Slough into the outfall would end up in Suisun Bay.

Lower Joice Island Unit

The Lower Joice Island Unit consists of two 36-inch-diameter intake culverts on Montezuma Slough near Hunter Cut and two 36-inch-diameter culverts on Suisun Slough, also near Hunter Cut. The culverts were installed in 1991. The facilities include combination slide/flap gates on the slough side and flap gates on the landward side. In 1997, DWR contracted with the Suisun Resources Conservation District to construct a conical fish screen on the diversion on Montezuma Slough. The fish screen was completed and has been operating since 1998.

Cygnus Unit

A 36-inch drain gate with flashboard riser was installed in 1991 on a private parcel located west of Suisun Slough and adjacent to and south of Wells Slough. The property owner is responsible for the operation and maintenance of the gate. No impacts to fish are known to occur because of operation of the drain.

CVPIA Section 3406 (b)(2)

On May 9, 2003, the Interior issued its Decision on Implementation of Section 3406 (b)(2) of the CVPIA (Reclamation 2004). Dedication of (b)(2) water occurs when Reclamation takes a fish, wildlife habitat restoration action based on recommendations of the Service (and in consultation with NOAA Fisheries and the DFG), pursuant to the primary purpose of Section 3406 (b)(2) or contributes to the AFRP's flow objectives for CVP streams. 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 Act 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 (b)(2) Interagency Team. Actions usually take one of two forms—in-stream flow augmentation below CVP reservoirs or CVP Tracy pumping reductions in the Delta. Chapter 8 of this BA contains a more detailed description of (b)(2) operations, as characterized in the CALSIM II modeling for the CVP OCAP, 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 the fish and wildlife minimum flows specified in the 1963 proposed release schedule (Table 2). 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.

In 2000, the McCormick-Saeltzer Dam was removed on Clear Creek thereby removing a significant fishery passage impediment. As part of the overall dam removal effort, a new agreement was reached among Townsend Flat Water Ditch Company, its shareholders, Service, and Reclamation (Reclamation 2004). Townsend Flat Water Ditch Company had an annual diversion capability of up to 12,500 af of Clear Creek flows at McCormick-Saeltzer Dam. With the dam removed, Reclamation will provide (under the new agreement) Townsend with up to 6,000 af of water annually. If the full 6,000 af is delivered, then 900 af will be dedicated to (b)(2) according to the August 2000 agreement.

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

Dedication of (b)(2) water on the Sacramento River provides actual in-stream flows below Keswick Dam greater than the fish and wildlife requirements specified in WR 90-5 and the Winter-run Biological Opinion. 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, and rearing.

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 the fish and wildlife requirements previously mentioned in the American River Division. In-stream flow objectives from October through May generally aim to provide suitable habitat for salmon and steelhead spawning, incubation, and rearing. While considering impacts to temperature operations through the summer into fall, objectives for June to September endeavor to provide suitable flows and water temperatures for juvenile steelhead rearing.

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 operational downside of the draft criteria is that ramping rates are relatively slow and can potentially have significant effects to water storage at Folsom Reservoir if uncertain future hydrologic conditions do not refill the impact to storage at Folsom Reservoir.

The operational coordination for potentially sensitive Nimbus Dam release changes is conducted through the B2IT process. An ad hoc agency and stakeholders group (known as AROG) was formed in 1996 to assist in reviewing the criteria for flow fluctuations. Since that time, the group has addressed a number of operational issues in periodic meetings and the discussions have served as an aid towards adaptively managing releases, including flow fluctuation and stability, and managing water temperatures in the lower American River to better meet the needs of salmon and steelhead trout.

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 previously mentioned in the East Side Division, and is generally consistent with the IPO for New Melones (Reclamation 2004). In-stream fishery management flow volumes on the Stanislaus River, as part of the IPO, are based on the New Melones end-of-February storage plus forecasted March to September inflow as shown in the IPO. The volume determined by the IPO is a combination of fishery flows pursuant to the 1987 DFG Agreement and the Service AFRP in-stream flow goals. The fishery volume is then initially distributed based on modeled fish distributions and patterns used in the IPO.

Actual in-stream fishery management flows below Goodwin Dam will be determined in accordance with the Department of the Interior Decision on Implementation of Section 3406 (b)(2) of the CVPIA (Reclamation 2004). Reclamation and Service have begun a process to develop a long-term operations plan for New Melones. This plan will be coordinated with the Agencies at weekly B2IT meetings, along with the stakeholders and the public before it is finalized.

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

Export curtailments at the CVP Tracy Pumping Plant and increased CVP reservoir releases required to meet D-1641, as well as direct export reductions for fishery management using dedicated (b)(2) water at the CVP Tracy Pumping Plant, will be determined in accordance with the Department of the Interior Decision on Implementation of Section 3406 (b)(2) of the CVPIA (Reclamation 2004). Direct Tracy Pumping Plant export curtailments for fishery management protection will be based on recommendations of the Service, after consultation with Reclamation, DWR, NOAA Fisheries and DFG pursuant to the weekly B2IT coordination meetings. See the Adaptive Management section for the other coordination groups, i.e., DAT, OFF, WOMT and EWAT.

Environmental Water Account Operations in the Delta

As specified in the CALFED ROD (Reclamation 2004), the EWA has been implemented to provide sufficient water, and combined with the Ecosystem Restoration Program (ERP), to address CALFED's fish protection and restoration/recovery needs while enhancing the predictability of CVP and SWP operations and improving the confidence in and reliability of water allocation forecasts. In the Delta environment, EWA resources and operational flexibility are used as both a real time fish management tool to improve the passage and survival of at-risk fish species in the Delta environment and for specific seasonal planned fish protection operations at the CVP and SWP Delta pumps.

The EWA agencies include Reclamation, Service, NOAA Fisheries, DWR, and DFG have established protocols for the expenditure of water resources following the guidance given in the CALFED ROD. EWA resources may be used to temporarily reduce SWP Delta exports at Banks Pumping Plant for fish protection purposes above D-1641 requirements and to coordinate with the implementation of Section 3406(b)(2) fish actions pursuant to the CVPIA. EWA resources also may be used to temporarily reduce CVP Tracy Pumping Plant export for fish protection purposes in addition to the resources available through Section 3406(b)(2) of the CVPIA.

The EWA is a cooperative management program, whose purpose is to provide protection to the at-risk native fish of the Bay-Delta estuary through environmentally beneficial changes in Project operations at no uncompensated water cost to the projects' water users. It is a tool to increase water supply reliability and to protect and recover at-risk fish species.

The EWA described in the CALFED ROD is a 4-year program, which the EWA Agencies have been implementing since 2000. However, the EWA Agencies believe a long-term EWA is critical to meet the CALFED ROD goals of increased water supply reliability to water users, while at the same time assuring the availability of sufficient water to meet fish protection and restoration/recovery needs. Thus, the EWA Agencies envision implementation of a long-term EWA as part of the operation of the Project. However, inclusion of the EWA in this description does not constitute a decision on the future implementation of EWA. Future implementation of a long-term EWA is subject to NEPA and the California Environmental Quality Act (CEQA).

The EWA allows the Projects to take actions to benefit fish. An example action would be curtailing project exports by reducing pumping during times when pumping could be detrimental to at-risk fish species. EWA assets are then used to replace project supplies that would have otherwise been exported, but for the pumping curtailment. Used in this way, the EWA allows the EWA Agencies to take actions to benefit fish without reducing water deliveries to the projects' water users.

The commitment to not reduce project water deliveries resulting from EWA actions to benefit fish is predicated on three tiers of protection, as recognized in the CALFED ROD. These three tiers are described as follows:

- **Tier 1 (Regulatory Baseline)**. Tier 1 is baseline water and consists of currently existing BOs, water right decisions and orders, CVPIA Section 3406(b)(2) water, and other regulatory actions affecting operations of the CVP and SWP. Also included in Tier 1 are other environmental statutory requirements such as Level 2 refuge water supplies.

- **Tier 2 (EWA)**. Tier 2 is the EWA and provides fish protection actions supplemental to the baseline level of protection (Tier 1). Tier 2 consists of EWA assets, which combined with the benefits of CALFED's ERP, will allow water to be provided for fish actions when needed without reducing deliveries to water users. EWA assets will include purchased (fixed) assets, operational (variable) assets, and other water management tools and agreements to provide for specified level of fish protection. Fixed assets are those water supplies that are purchased by the EWA Agencies. These purchased quantities are approximations and subject to some variability. Operational assets are those water supplies made available through CVP and SWP operational flexibility. Some examples include the flexing of the export-to-inflow ratio standard required to for meeting Delta water quality and flows, and ERP water resulting from upstream releases pumped at the SWP Banks Pumping Plant. Water management tools provide the ability to convey, store, and manage water that has been secured through other means. Examples include dedicated pumping capacity, borrowing, banking, and entering into exchange agreements with water contractors. Chapter 8 of this BA contains a more detailed description of EWA operations, as characterized in the CALSIM II modeling for the CVP OCAP.

- **Tier 3 (Additional Assets)**. In the event the EWA Agencies deem Tiers 1 and 2 levels of protection insufficient to protect at-risk fish species in accordance with the Act, Tier 3 would be initiated. Tier 3 sets in motion a process based upon the commitment and ability of the EWA Agencies to make additional water available, should it be needed. This Tier may consist of additional purchased or operational assets, funding to secure additional assets if needed, or project water if funding or assets are unavailable. It is unlikely that protection beyond those described in Tiers 1 and 2 will be needed to meet requirements of the Act. However, Tier 3 assets will be used when Tier 2 assets and water management tools are exhausted, and the EWA Agencies determine that jeopardy to an at-risk fish species is likely to occur due to project operations, unless additional measures are taken. In determining the need for Tier 3 protection, the EWA Agencies would consider the views of an independent science panel.

With these three tiers of protection in place that are subject to changes based on NEPA/CEQA review, or new information developed through the Act/California Endangered Species Act (CESA)/ Natural Community Conservation Planning Act (NCCPA) review or the CALFED Science Program, the EWA Agencies will provide long-term regulatory commitments consistent with the intent set forth in the CALFED ROD. The commitments are intended to protect the CVP and SWP exports at the Tracy and Banks Pumping Plants from reductions in water supplies for fish protection beyond those required in Tier 1.

Water Transfers

California Water Law and the CVPIA promote water transfers as important water resource management measures to address water shortages provided certain protections to source areas and users are incorporated into the water transfer. Water transferees generally acquire water from sellers who have surplus reservoir storage water, sellers who can pump groundwater instead of using surface water, or sellers who will idle crops or substitute a crop that uses less water in order to reduce normal consumptive use of surface diversions.

Water transfers (relevant to this document) occur when a water right holder within the Delta or Sacramento-San Joaquin watershed undertakes actions to make water available for transfer by export from the Delta. Transfers requiring export from the Delta are done at times when pumping and conveyance capacity at the Project export facilities are available to move the water. Additionally, operations to accomplish these transfers must be carried out in coordination with Project operations, such that project purposes and objectives are not diminished or limited in any way.

In particular, parties to the transfer are responsible for providing for any incremental changes in flows required to protect Delta water quality standards. Reclamation and the DWR will work to facilitate transfers and will complete them in accordance with all existing regulations and requirements. This document does not address the upstream operations that may be required to produce water for transfer. Also, this document does not address the impacts of water transfers to terrestrial species. Such effects would require a separate consultation with the Service and NOAA Fisheries under the Act.

Purchasers of water for water transfers may include Reclamation, DWR, SWP contractors, CVP contractors, other State and Federal agencies, or other parties. DWR and Reclamation have operated water acquisition programs to provide water for environmental programs and additional supplies to SWP contractors, CVP contractors, and other parties. The DWR programs include the 1991, 1992, and 1994 Drought Water Banks and Dry Year Programs in 2001 and 2002 (Reclamation 2004).

Reclamation operated a forbearance program in 2001 (Reclamation 2004) by purchasing CVP contractors' water in the Sacramento Valley for CVPIA in-stream flows, and to augment water supplies for CVP contractors south of the Delta and wildlife refuges. DWR, Reclamation, Service, NOAA Fisheries, and DFG cooperatively administer the EWA. Reclamation administers the CVPIA Water Acquisition Program for Refuge Level 4 supplies and fishery in-stream flows. The CALFED ERP will, in the future, acquire water for fishery and ecosystem restoration.

The Sacramento Valley Water Management Agreement (Reclamation 2004) is a water rights settlement among Sacramento Valley water rights holders, Reclamation, DWR, and the Project export water users which establishes a water management program in the Sacramento Valley. This program will provide new water supplies from Sacramento Valley water rights holders (up to 185,000 af per year) for the benefit of the CVP and SWP.

This program has some of the characteristics of a transfer program in that water will be provided upstream of the Delta and increased exports may result. In the past, Project contractors have also independently acquired water in the past and arranged for pumping and conveyance through SWP facilities. State Water Code provisions grant other parties access to unused conveyance capacity, although SWP contractors have priority access to capacity not being used by the DWR to meet SWP contract amounts.

The Project may provide Delta export pumping for transfers using surplus capacity that is available, up to the physical maximums of the pumps, consistent with prevailing operations constraints such as E/I ratio, conveyance or storage capacity, and the protective criteria established that may apply as conditions on such transfers. For example, pumping for transfers may have conditions for protection of Delta water levels, water quality, or fish.

The surplus capacity available for transfers will vary a great deal with hydrologic conditions. In general, as hydrologic conditions get wetter, surplus capacity diminishes because the Projects are more fully using export pumping capacity for Project supplies. CVP has little surplus capacity, except in the drier hydrologic conditions. SWP has the most surplus capacity in critical and some dry years, less or sometimes none in a broad middle range of hydrologic conditions, and some surplus again in some above normal and wet years when demands may be lower because contractors have alternative supplies.

The availability of water for transfer and the demand for transfer water may also vary with hydrologic conditions. Accordingly, since many transfers are negotiated between willing buyers and sellers under prevailing market conditions, price of water also may be a factor determining how much is transferred in any year. This document does not attempt to identify how much of the available and useable surplus export capacity of the Project will actually be used for transfers in a *particular* year, but recent history, the expectations for EWA, and the needs of other transfer programs suggest a growing reliance on transfers.

This project description assumes the majority of transfers would occur during July through September and would increase Delta exports from 200,000-600,000 af in most years, once the 8,500 cfs Banks capacity is operational (see Chapter 8 of the biological assessment - Modeling Results Section subheading Transfers for post-processed results on available capacity at Tracy and Banks). Such future transfers would occur within the Banks 8,500 cfs capacity, and the Tracy 4,600 cfs capacity described in this document, and in no case would transfers require higher rates of pumping than those. The range of 200,000-600,000 af describes the surplus export capacity estimated to be available in July-September (primarily at Banks) in about 80 percent of years when 8,500 cfs Banks is in place.

Under these conditions, transfer capability will often be capacity-limited. In the other 20 percent of years (which are critical and some dry years), both Banks and Tracy have more surplus capacity, so capacity most likely is not limited to transfers. Rather, either supply or demand for transfers may be a limiting factor. In some dry and critical years, water transfers may range as high as 800,000[7]-1,000,000 af depending on the severity of the water supply situation, cross-Delta capacity, and available supplies upstream.

During dry or critical years, low project exports and high demand for water supply could make it possible to transfer larger amounts of water. Low project exports in other months may also make it advantageous to expand the "normal transfer" season. Transfers outside the typical July through September season may be implemented when transferors provide water on a "fish-friendly" pattern. Real-time operations would be implemented as needed to avoid increased incidental take of listed species.

Reclamation and DWR coordinate the implementation of transfers in the B2IT, the EWAT, and WOMT to ensure the required changes in upstream flows and Delta exports are not disruptive to planned fish protection actions. Reclamation and DWR will continue to use these groups for routine coordination of operations with transfers during the July through September season. Reclamation and DWR will also use these groups to help evaluate proposed transfers that would expand the transfer season or involve transfers in amounts significantly greater than the typical range anticipated by this project description, i.e., 200,000-600,000 af per year.

Although supply, demand, and price of water may at times be limiting factors, it would not be unreasonable to assume that in many years, all the available Project capacity to facilitate transfers will be used.

Intertie Proposed Action

The proposed action, known as the DMC and CA Intertie (Intertie), consists of construction and operation of a pumping plant and pipeline connections between the DMC and the CA. The Intertie alignment is proposed for DMC milepost 7.2 where the DMC and the CA are about 500 feet apart.

The Intertie would be used in a number of ways to achieve multiple benefits, including meeting current water supply demands, allowing for the maintenance and repair of the CVP Delta export and conveyance facilities, and providing operational flexibility to respond to emergencies. The Intertie would allow flow in both directions, which would provide additional flexibility to both CVP and SWP operations. The Intertie includes a 400 cfs pumping plant at the DMC that would

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7 DWR's 1991 Drought Water Bank purchased over 800,000 af, and conveyed approximately 470,000 af of purchased water across the Delta.

allow up to 400 cfs to be pumped from the DMC to the CA. Up to 950 cfs flow could be conveyed from the CA to the DMC using gravity flow.

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

Location

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

Operations

The Intertie would be used under three different scenarios:

Up to 400 cfs would be pumped from the DMC to the CA to help meet water supply demands of CVP contractors. This would allow Tracy Pumping Plant to pump to its authorized capacity of 4,600 cfs, subject to all applicable export pumping restrictions for water quality and fishery protections.

Up to 400 cfs would be pumped from the DMC to the CA to minimize impacts to water deliveries due to required reductions in water levels on the lower DMC (south of the Intertie) or the upper CA (north of the Intertie) for system maintenance or due to an emergency shutdown.

Up to 950 cfs would be conveyed from the CA to the DMC using gravity flow to minimize impacts to water deliveries due to required reductions in water levels on the lower CA(south of the Intertie) or the upper DMC (north of the Intertie) for system maintenance or due to an emergency shutdown.

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

Water conveyed at the Intertie to minimize reductions to water deliveries during system maintenance or an emergency shutdown on the DMC or CA could include pumping of CVP water at Banks Pumping Plant or SWP water at Tracy Pumping Plant through use of JPOD. In accordance with COA Articles 10(c) and 10(d) (Reclamation 2004), JPOD may be used to replace conveyance opportunities lost because of scheduled maintenance, or unforeseen outages. Use of JPOD for this purpose could occur under Stage 2 operations defined in SWRCB D-1641, or could occur as a result of a Temporary Urgency request to the SWRCB. Use of JPOD does not result in any net increase in allowed exports at CVP and SWP export facilities.

To help meet water supply demands of the CVP contractors, operation of the Intertie would allow the Tracy Pumping Plant to pump to its full capacity of 4,600 cfs, subject to all applicable export pumping restrictions for water quality and fishery protections. When in use, water within the DMC would be transferred to the CA via the Intertie. Water diverted through the Intertie would be conveyed through the CA to O'Neill Forebay.

Freeport Regional Water Project

Reclamation and the Freeport Regional Water Authority (FRWA) are proposing to construct and operate the FRWP, a water supply project to meet regional water supply needs. FRWA, a joint powers agency formed under State law by the SCWA and EBMUD, is the State lead agency, and Reclamation is the Federal lead agency. A separate BO will be prepared for all other terrestrial and aquatic species related to the construction of the project.

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

The FRWP has a design capacity of 286 cfs (185 millions of gallons per day [mgd]). Up to 132 cfs (85 mgd) would be diverted under Sacramento County's existing Reclamation water service contract (Reclamation 1999) and other anticipated water entitlements and up to 155 cfs (100 mgd) of water would be diverted under EBMUD's amended Reclamation water service contract (Reclamation 2001). Under the terms of its amendatory contract with Reclamation, EBMUD is able to take delivery of Sacramento River water in any year in which EBMUD's March 1 forecast of its October 1 total system storage is less than 500,000 af. When this condition is met, the amendatory contract entitles EBMUD to take up to 133,000 af annually. However, deliveries to EBMUD are subject to curtailment pursuant to CVP shortage conditions and project capacity (100 mgd), and are further limited to no more than 165,000 af in any 3-consecutive-year period that EBMUD's October 1 storage forecast remains below 500,000 af. EBMUD would take delivery of its entitlement at a maximum rate of 100 mgd (112,000 af per year). Deliveries would start at the beginning of the CVP contract year (March 1) or any time afterward. Deliveries would cease when EBMUD's CVP allocation for that year is reached, when the 165,000 af limitation is reached, or when EB MUD no longer needs the water (whichever comes first). Average annual deliveries to EBMUD are approximately 23,000 af. Maximum delivery in any one water year is approximately 99,000 af.

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

SCWA provides water to areas in central Sacramento County

The long-term master plan for Zone 40 (Sacramento County Water Agency 2002) envisions meeting present and future water needs through a program of conjunctive use of groundwater and surface water; or if surface water is not available, through groundwater until surface water becomes available. SCWA presently has a CVP entitlement of 22,000 af through Reclamation. SCWA has subcontracted 7,000 af of this entitlement to the City of Folsom. CVP water for SCWA is currently delivered through the City of Sacramento's intake and treatment facilities based on SCWA need and available city capacity. SCWA's CVP contract also allows it to divert at the location identified as Freeport on the Sacramento River south of downtown Sacramento. SCWA expects to be able to provide additional anticipated surface water entitlements to serve Zone 40 demands, including an assignment of a portion of SMUD existing CVP water supply contract, potential appropriative water rights on the American and Sacramento Rivers, and potential transfers of water from areas within the Sacramento Valley. Total long-term average Zone 40 water demand is estimated to be 109,500 af per year. Long-term average surface water use is expected to be 68,500 af per year.

East Bay Municipal Utility District

EBMUD is a multipurpose regional agency that provides water to more than 1.3 million M&I customers in portions of Contra Costa and Alameda Counties in the region east of San Francisco Bay (East Bay). EBMUD obtains most of its supply from Pardee Reservoir on the Mokelumne River, with the remainder collected from local runoff in East Bay terminal reservoirs.

On July 26, 2001, EBMUD and Reclamation entered into an amendatory CVP contract (Reclamation 2001) that sets forth three potential diversion locations to allow EBMUD to receive its CVP supply. One of these locations is Freeport. EBMUD's CVP supply is 133,000 af in any one year, not to exceed 165,000 af in any consecutive 3-year period of drought when EBMUD total system storage is forecast to be less than 500,000 af. Subject to certain limitation, the contract also provides for a delivery location on the lower American River and EBMUD retains the opportunity to take delivery of water at the FSC should other alternatives prove infeasible. Additional environmental review is required prior to diversion under the contract.

Water supply forecasts are used in the preparation of operation projections. The water supply forecast is a March 1 forecast of EBMUD's October 1 total system storage, as revised monthly through May 1, as more reliable information becomes available. The main parameters considered in the operation projection are the water supply forecast of projected runoff, water demand of other users on the river, water demand of EBMUD customers, and flood control requirements. According to the terms of its CVP contract with Reclamation, these forecasts determine when EBMUD would be able to take delivery of CVP water through the new intake facility near Freeport to supplement its water supplies and retain storage in its Mokelumne River and terminal reservoir systems.

Under the terms of its amendatory contract with Reclamation (Reclamation 2001), EBMUD is able to take delivery of Sacramento River water in any year in which EBMUD's March 1 forecast of its October 1 total system storage is less than 500,000 af. When this condition is met, the amendatory contract entitles EBMUD to take up to 133,000 af annually. However, deliveries to EBMUD are subject to curtailment pursuant to CVP shortage conditions and project capacity (100 mgd), and are further limited to no more than 165,000 af in any 3-consecutive-year period that EBMUD's October 1 storage forecast remains below 500,000 af.

EBMUD would take delivery of its entitlement at a maximum rate of 100 mgd (112,000 af per year). Deliveries would start at the beginning of the CVP contract year (March 1) or any time afterward. Deliveries would cease when EBMUD's CVP allocation for that year is reached, when the 165,000 af limitation is reached, or when EBMUD no longer needs the water (whichever comes first). Average annual deliveries to EBMUD are approximately 23,000 af. In the modeling the maximum delivery in any one water year is approximately 99,000 af. It is possible that they could take their full entitlement if there were not shortages imposed.

The City of Sacramento has joined FRWA as an associate member. The City's main interests lie in the design and construction of FRWA project facilities that may be located in the City or on various City properties on rights-of-way. A City representative sits on the FRWA Board of Directors as a non-voting member.

Water Deliveries Associated With The CCWD Settlement Agreement

Under the CCWD settlement agreement (Reclamation 2004), FRWA and EBMUD agreed to "wheel" 3,200 af per year of water for the CCWD. Wheeling is the transmission of water owned by one entity through the facilities owned by another. In this agreement, CCWD water that is normally diverted from the Delta would be diverted from the Sacramento River and conveyed to CCWD through FRWP facilities, Reclamation's Folsom South Canal, and EBMUD's Mokelumne Aqueduct facilities, at which point CCWD's Los Vaqueros Pipeline intersects the Mokelumne Aqueduct. Unless there are unavoidable conditions that reduce the capacity of the system and prevent function, water would be wheeled to CCWD annually. CCWD would take delivery of a small portion of its CVP supply at the FRWP intake (unlike the past, in which Rock Slough or Old River intakes in the Delta were used).

In the settlement agreement with the Santa Clara Valley Water District (SCVWD) (Reclamation 2004), EBMUD would make 6,500 af of its CVP water allocation available to SCVWD in any drought year in which EBMUD would take delivery of Sacramento River water. If the following year is also a drought year in which EBMUD continues to take delivery of Sacramento River water, SCVWD is obligated to return up to 100 percent of the 6,500 af of water to EBMUD. At EBMUD's discretion, the water may be returned in the following year. If drought conditions do not persist for a second or third year, SCVWD would keep the water and would compensate EBMUD for its Reclamation costs. Since SCVWD would take delivery of the EBMUD CVP water at the Tracy pumping plant, and EBMUD would take delivery of SCVWD's CVP water at

Freeport, no additional facilities would be constructed.

The settlement agreements modify the location of CVP deliveries, while the total quantities delivered remain unchanged. In normal and wet years, Delta inflow would be reduced by 3,200 af. This volume is equal to an average reduction of 4 cfs. During normal and wet years, Sacramento River flow nearly always exceeds 14,000 cfs, and the anticipated average change would be less than 0.03 percent. Delta diversions would be reduced by an identical amount, offsetting the minor change in flow. In the first year of a drought, inflow to the Delta would be increased by a nearly identical amount, and this increase would be offset by an identical increase in Delta pumping, resulting in no substantial change. In the second year of a drought, Delta inflow may be decreased by as much as 13 cfs on the average. This decrease (0.1 percent) remains minor compared to the typical flows of 10,000 cfs in the Sacramento River and is offset by decreased pumping in the Delta. Potential Delta effects associated with changes in pumping location are discussed in Chapter 10.

The Delta Smelt Working Group and the delta smelt risk assessment matrix

The delta smelt risk assessment matrix (DSRAM) consists of month by month criteria which, when exceeded will trigger a meeting of the Delta Smelt Working Group (Working Group). The purpose of the DSRAM is to take actions to protect delta smelt in a proactive manner prior to salvage events. Reclamation and/or DWR are responsible for monitoring the DSRAM criteria and reporting back to the Service and the Working Group. The DSRAM has been modified from the delta smelt decision tree which was peer reviewed and presented in the IEP Newsletter. The DSRAM will be sent out for independent peer review. The DSRAM is an adaptive management tool which may be further modified by the Working Group/WOMT as new information becomes available, without undergoing formal reconsultation. An informative link to an existing website will be developed that compiles monitoring data from IEP and DFG to enable members of the Working Group to easily track the progress of the triggering criteria. Data will be updated at least weekly to determine the need for a meeting.

Should a triggering criterion be met or exceeded, Reclamation and/or DWR will inform the members of the Working Group and the Working Group will determine the need to meet. Any member of the Working Group may set up a meeting of the Working Group at any time. A meeting of the Working Group may consist of an in-person meeting, a conference call, or a discussion by email. If needed, the Working Group will meet prior to the weekly meetings of the DAT and the WOMT and information will be shared with these groups.

Should a meeting of the Working Group prove necessary, the group will decide whether to recommend a change in exports, change in south delta barrier operations, San Joaquin River flows, or a change in delta cross channel operations, and the extent and duration of the potential action. These potential actions are listed in the DSRAM by the months wherein each of these tools generally become available. The group will recommend actions which will be shared with the DAT and forwarded to the WOMT for discussion and potential implementation. This recommendation will include a discussion of the level of concern for delta smelt and will include who participated in the working group discussions. All dissenting opinions and/or discussion points will also be forwarded to the WOMT. The Working Group will meet at least weekly throughout the period in which the triggering criteria are met or exceeded, to determine the need to provide further recommendations to the WOMT.

Notes and findings of Working Group meeting will be submitted to the Service and members of the WOMT for their records. The WOMT will respond to the Working Group's recommendations and the actions taken by the WOMT will be summarized by Reclamation and/or DWR annually and submitted to all WOMT agencies.

If an action is taken, the Working Group will follow up on the action to attempt to ascertain its effectiveness. An assessment of effectiveness will be attached to the notes from the Working Group's discussion concerning the action.

Delta Smelt Risk Assessment Matrix (DSRAM)

Life Stage	Adults	Adults	Adults	Adults and larvae	Adults and larvae	Larvae and juveniles	Larvae and juveniles	Juveniles
Previous Year's Fall Midwater Trawl Recovery Index (1)	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74
Risk of Entrainment (2)				X2 upstream of Chipps Island and temps are ≥ 12°	X2 upstream of Chipps Island and temps are between 12° and 18°C	X2 upstream of Chipps Island and mean delta-wide temps <18°C and south delta temps below 25°C	X2 upstream of Chipps Island and temps are below 25°C	X2 upstream of Chipps Island and temps are below 25°C
Duration of Spawning period (number of days temperatures are between 12 and 18°C) (3)					39 days or less by April 15	50 days or less by May 1		
Spawning Stage as determined by spring Kodiak trawl and/or salvage (4)			Presence of Adults at spawning stage ≥ 4	Adult spawning stage ≥ 4	Adult spawning stage ≥ 4			
smelt distribution (5)	See footnote #5	See footnote #5	See footnote #5	See footnote #5 or negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance
Salvage Trigger (6)	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation		If salvage is above zero	If salvage is above zero	

Tools for Change (7)	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**
Export reduction at one or both facilities	X	X	X	X	X	X	X	X
Change in barrier operations						X	X	X
Change in San Joaquin River flows				X	X	X	X	X
Change position of cross channel gates						X	X	

Delta Smelt Risk Assessment Matrix Footnotes (note: the references for the DSRAM are also included in the literature cited section of the biological opinion)

1 The Recovery index is calculated from a subset of the September and October Fall Midwater Trawl sampling (http://www.delta.dfg.ca.gov/). The number in the matrix, 74, is the median value for the 1980-2002 Recovery Index (Figure DS1)

2 The temperature range of 12 to 18 degrees Celsius is the range in which most successful delta smelt spawning occurs. This has been analyzed by using observed cohorts entering the 20-mm Survey length frequency graphs (1996-2002). Cohorts were defined by having a noticeable peak or signal and occurring over three or more surveys during the rearing season. Back calculations were made using the first survey of that cohort with fish less than 15 mm fork length. Temperature data from IEP's HEC-DSS Time Series Data web site was compiled using three stations representing the south Delta (Mossdale), confluence (Antioch), and north Delta (Rio Vista) and averaged together. Spawning dates for each cohort were back-calculated by applying an average daily growth rate (wild fish) of 0.45 mm/day (Bennett, DFG pers. comm.) and egg incubation period of 8-14 days (Baskerville-Bridges, Lindberg pers. comm.)(Mager et al. 2004) from the median value of the analyzed cohort. Each spawning event was then plotted against temperature over time (Figure DS2.1). While spawning does occur outside of the 12-18 degree range, larval survival is most likely reduced when temperatures are either below (DFG pers. comm.) or above this range (Baskerville-Bridges & DFG pers. comm.).

Critical thermal maxima for delta smelt was reached at 25.4 degrees Celsius in the laboratory (Swanson et al., 2000); and at temperatures above 25.6 degrees Celsius smelt are no longer found in the delta (DFG, pers. comm.).

Websites for the temperature data: http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAN007
http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAN087
http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAC101

Mager RC, Doroshov SI, Van Eenennaam JP, and Brown RL. 2004. Early Life Stages of Delta Smelt. American Fisheries Society Symposium 39:169-180.

Swanson C, Reid T, Young PS, and Cech JJ. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced Wakasagi (*H. nipponensis*) in an altered California estuary. Oecologia 123:384-390.

3 Figure DS3: The working hypothesis for delta smelt is that spawning only occurs when temperatures are suitable during the winter and spring. In years with few days having suitable spawning temperatures, the spawning "window" is limited, so the species produces fewer cohorts of young smelt. When there are fewer cohorts the risk that mortality sources such as entrainment may substantially reduce population size increases. The figures below were used

to help define years when there were relatively few days with suitable temperatures. For April 15 and May 1, the figures show the cumulative spawning days for each year during 1984-2002. The cumulative spawning days for each year were calculated based on the number of days that the mean water temperature for three Delta stations (Antioch; Mossdale and Rio Vista) was in the 12 - 18 C range starting on February 1. The results are plotted in terms of the ranks to identify the lower quartile. In other words, years in the lower quartile represent examples of years with relatively few spawning days.

4 The adult spawning stage is determined by the Spring Kodiak Trawl and/or fish collected at the salvage facilities (http://www.delta.dfg.ca.gov/). A stage greater than or equal to 4 indicates female delta smelt are ripe and ready to spawn or have already spawned (Mager 1996).

Mager RC. 1996. Gametogenesis, Reproduction and Artificial Propogation of Delta Smelt, *Hypomesus transpacificus*. [Dissertation] Davis: University of California, Davis. 115 pages. Published.

5 The spring kodiak trawl will be used to generally evaluate the distribution of adult delta smelt. However, since the spring kodiak trawl is not intended to be a survey for abundance or distribution, no definitive trigger for concern can be determined at this time.
Juveniles (March-July) – distribution of juvenile delta smelt where the centroid is located upstream (negative) or downstream (positive) of the Sacramento-San Joaquin River confluence (Sacramento RKI 81; Figure DS5.1). The 20-mm Survey centroid is calculated by multiplying the observed delta smelt station CPUE (fish/10,000 m3) by a distance parameter in km from Sacramento RKI 81. The summed result (summed over a survey) is divided by the survey CPUE which gives the survey centroid position (Figure DS5.2).

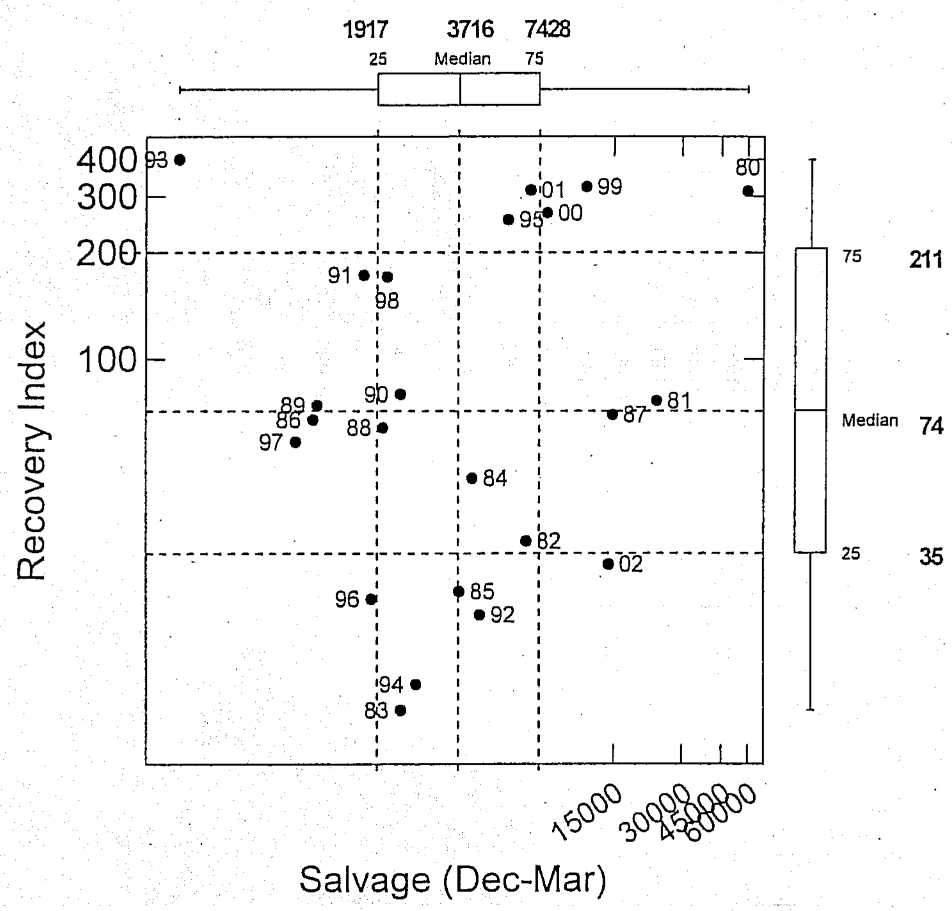
Low juvenile abundance will also be a trigger. When juvenile abundance is low, concern is high. Low abundance is indicated when the total cumulative catch in the 20-mm Survey is less than or equal to the 1995-2003 median value of cumulative 20-mm Survey catch for the same surveys (Table DS5).

6 Adult salvage trigger: the adult delta smelt salvage trigger period is December through March and the trigger is calculated as the ratio of adult delta smelt salvage to the fall MWT index. This ratio will increase as fish are salvaged during the winter months. If the ratio exceeds the median ratio observed during December-March 1980-2002, then the trigger has been met (see Figure DS6 for more explanation of the calculation)

Juvenile salvage trigger: During May and June, if delta smelt salvage at the SWP/CVP facilities is greater than zero, then the working group will meet. This is because May and June are the peak months of delta smelt salvage and salvage densities cannot be predicted. Therefore, during these two months, the delta smelt working group expects to meet regularly to look at relevant information such as salvage, delta temperatures, delta hydrology and delta smelt distribution and decide whether to recommend proactive measures to protect these fish.

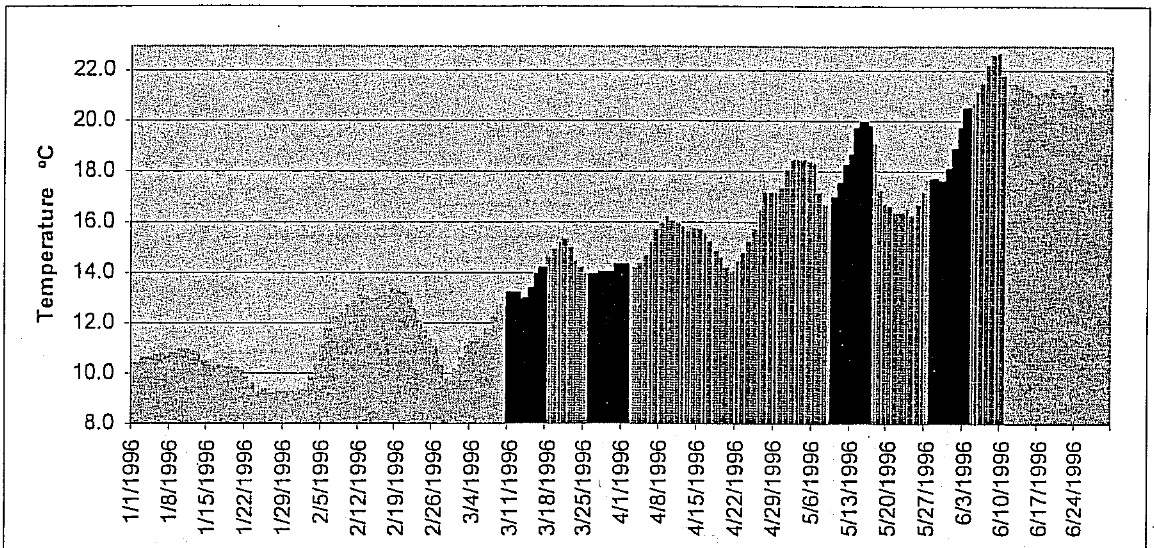
7 The tools for change are actions that the working group can recommend to the WOMT to help protect delta smelt. Exports may be reduced at one or both of the south delta export facilities and a proposed duration of the reduction would be recommended by the working group. Export reductions and changes in San Joaquin River flows may be covered by B(2) or EWA assets. Details of past fish actions can be found at the Calfed Ops website: http://wwwoco.water.ca.gov/calfedops/index.html; >Operations [year]

Figure DS1



Points are labeled with the year representing the recovery index.
The winter salvage for this analysis starts on December 1 of the recovery index year and continues through March 31 of the following year.

Figure DS2.1. Successful delta smelt spawning periods (shaded blue area) and cohorts (black bars) plotted against water temperature (1996-2002). Spawning periods and cohorts were back calculated using 20-mm Survey catch data. Start of spawning season uses an egg incubation period of 14 d and a growth rate of 0.45 mm/day and end of spawning season 8 d with a growth rate of 0.45 mm/day. Black bars represent the range of 8-14 d egg incubation with a growth rate of 0.45 mm/day from laboratory results. Temperature data (°C) was compiled from IEP's HEC-DSS Time Series Data using mean daily temperatures from the confluence (Antioch), south Delta (Mossdale), north Delta (Rio Vista) and averaged together.



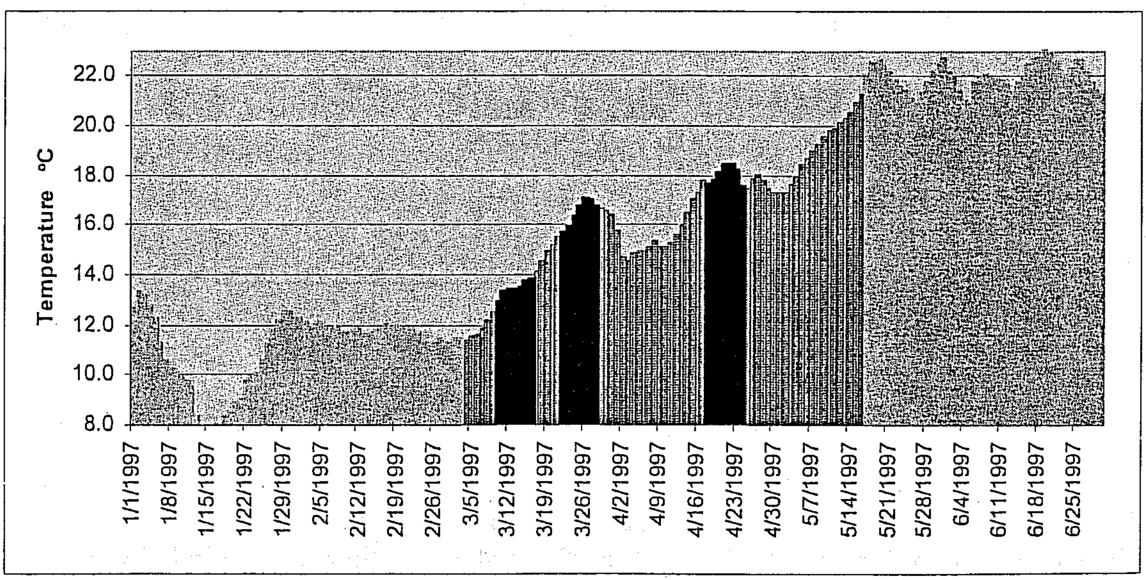


Figure DS2.1 cont.

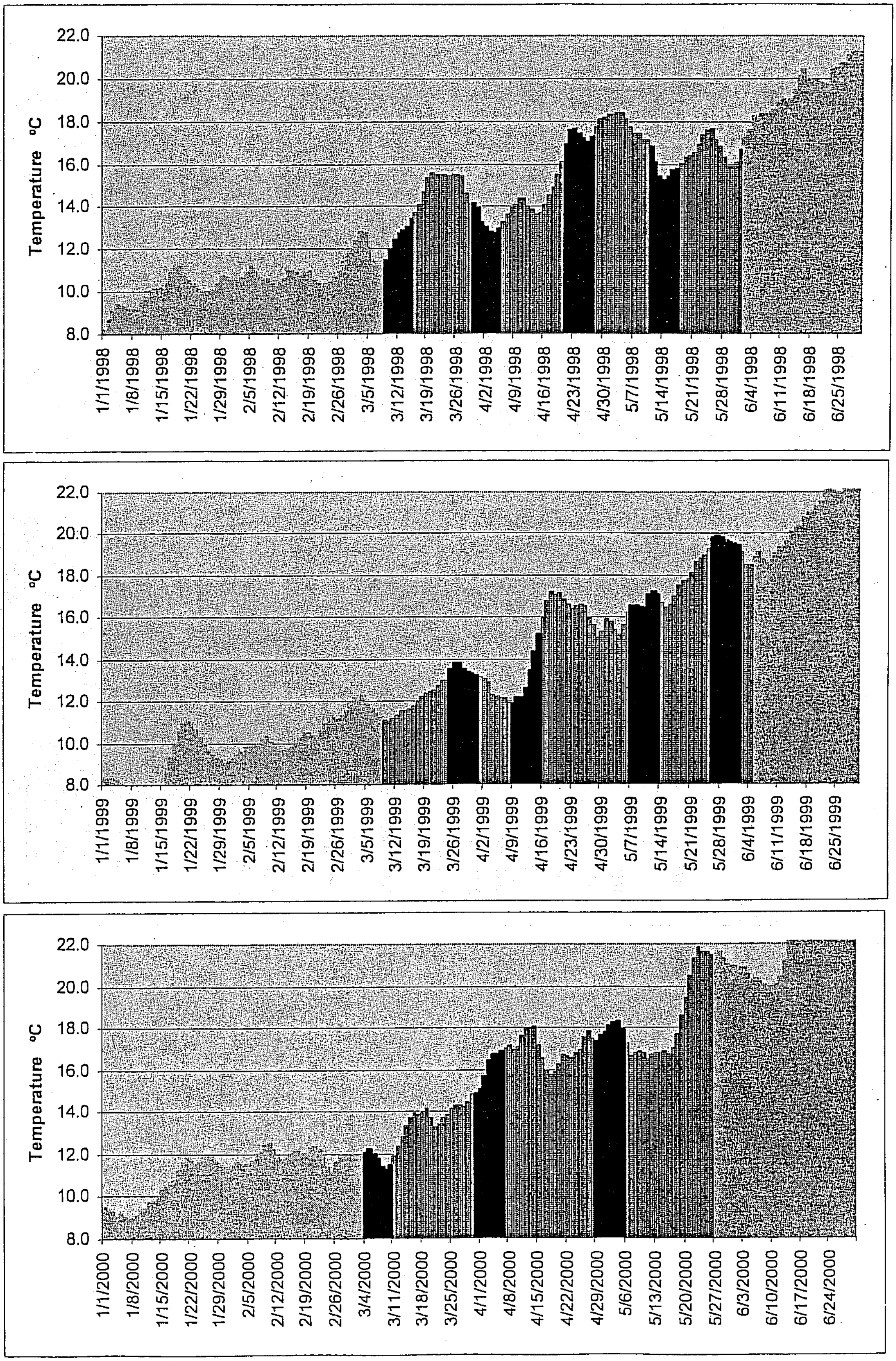
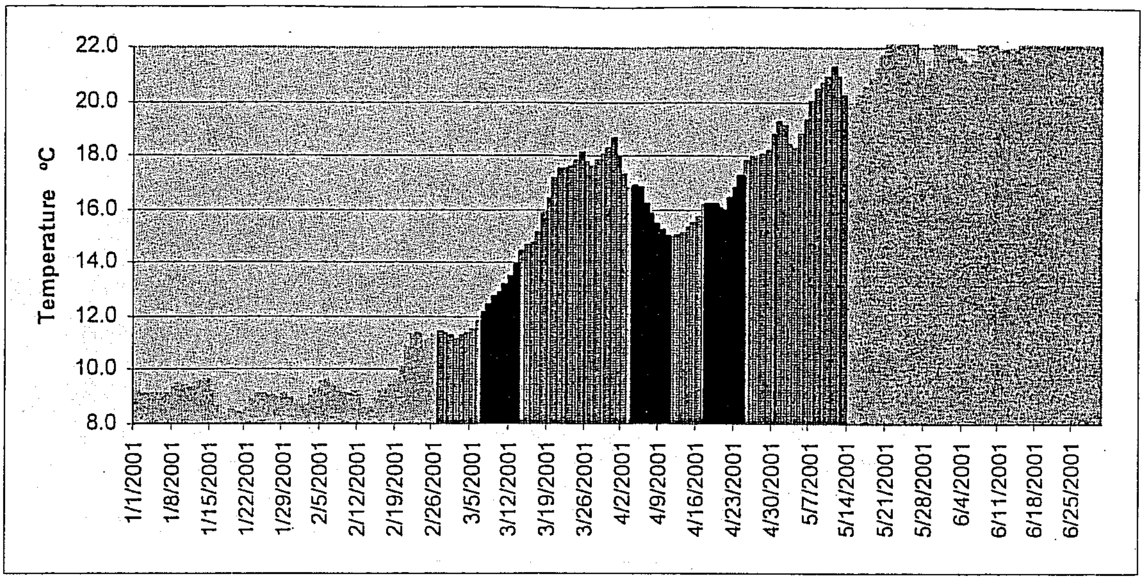


Figure DS2.1 cont.



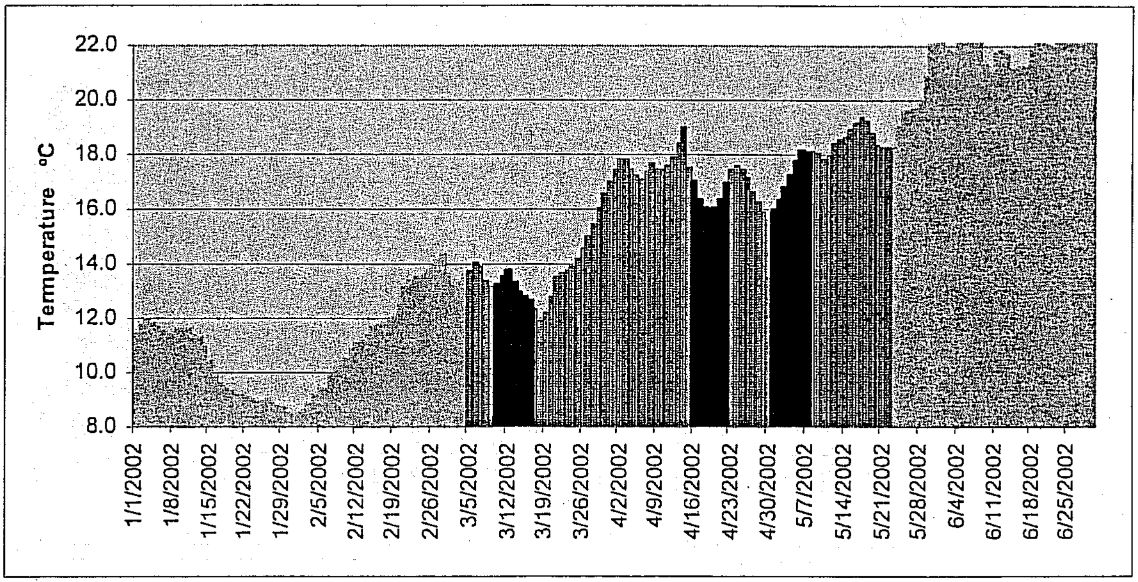
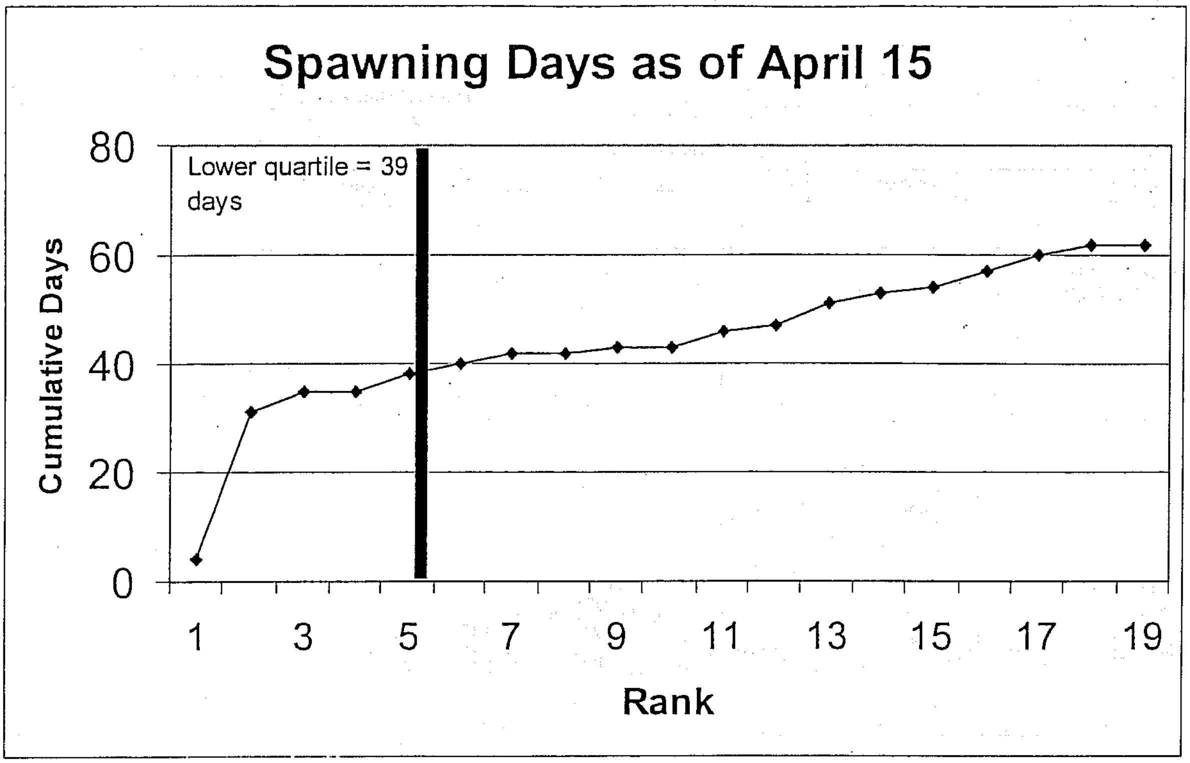


Figure DS3.


Spawning Days as of April 15
Lower quartile = 39 days
Cumulative Days
0
20
40
60
80
1
3
5
7
9
11
13
15
17
19
Rank

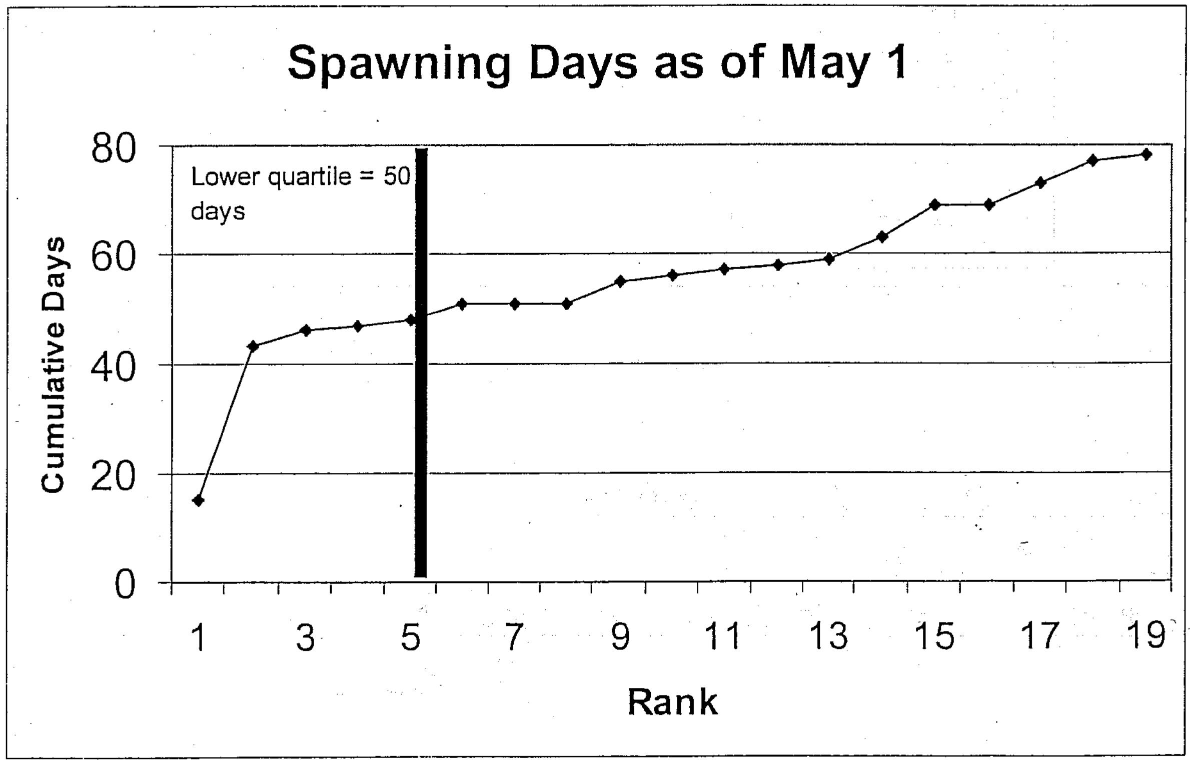

Spawning Days as of May 1
Lower quartile = 50 days
Cumulative Days
0
20
40
60
80
1
3
5
7
9
11
13
15
17
19
Rank

Figure DS5.1. A 20-mm Survey delta smelt bubble plot map with calculated centroid position from the confluence of Sacramento-San Joaquin Rivers with one standard deviation.

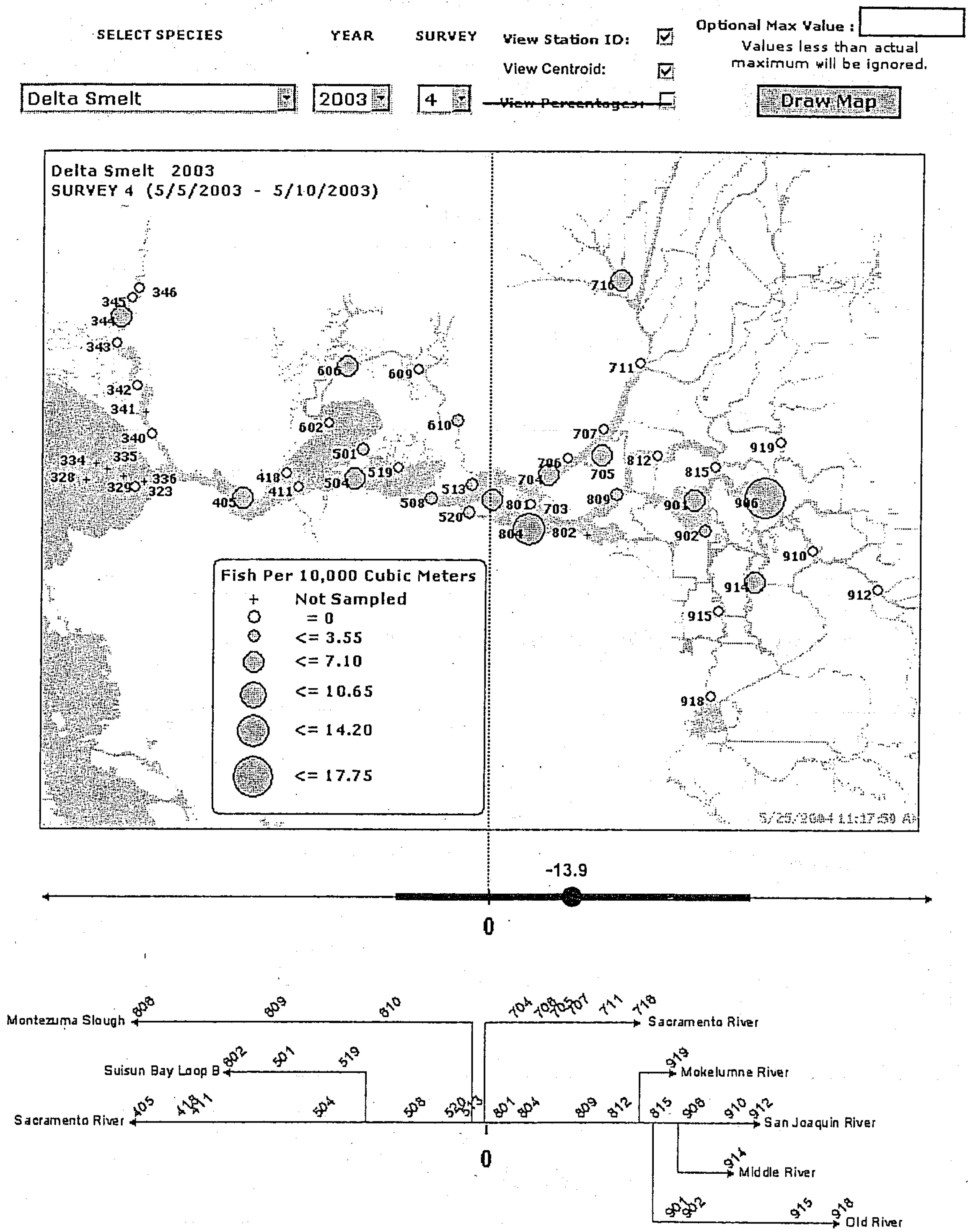


Figure DS5.2. Historic juvenile centroid position (20-mm Survey) with one standard deviation.

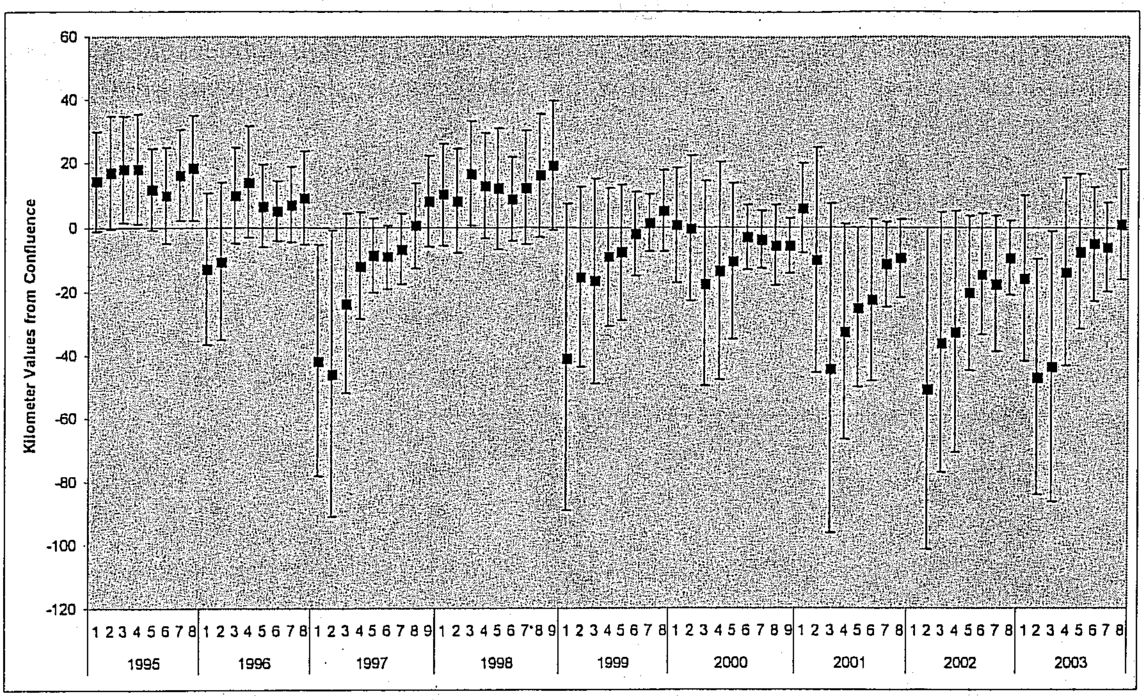


Table DS5. Median values of cumulative catch from the 20-mm Survey. When cumulative catch per survey during a season is at or below the calculated value, concern is high.

	survey 1	survey 2	survey 3	survey 4	survey 5	survey 6	survey 7	survey 8
Median Value	12	40	144	188	346	500	924	1019

Figure DS6

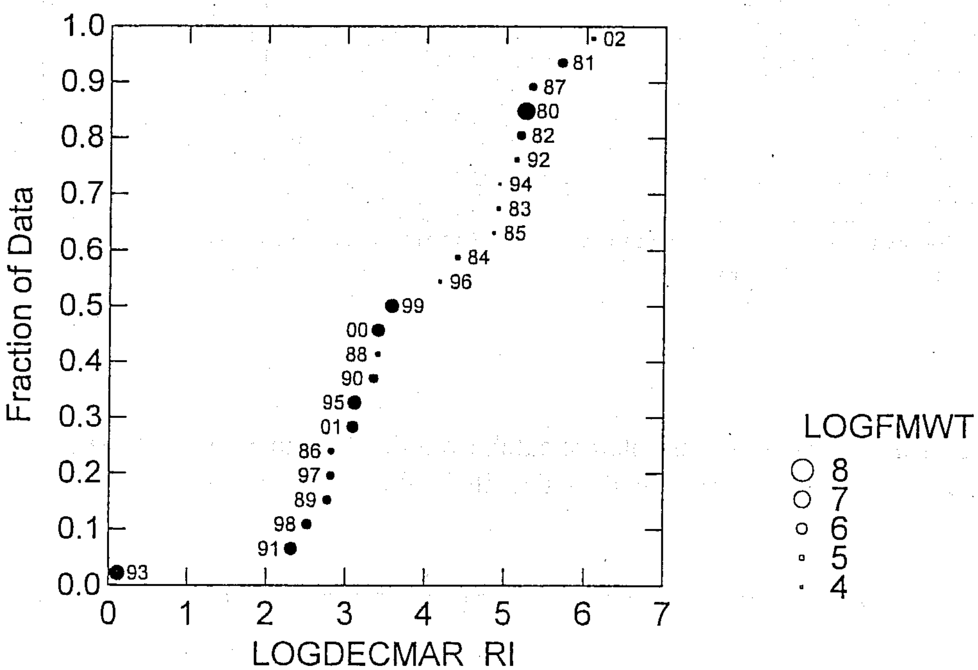
The objective is to quantify a level of concern for adult delta smelt during the winter that is based upon the number of fish salvaged and the overall abundance of delta smelt. Our trigger reflects that when abundance is low and salvage is high concern is high, and conversely when abundance is high and salvage is low that concern is low.

Below is a Quantile plot of the ratio of winter salvage to the MWT recovery index (ln(winter salvage/recovery index)). Winter salvage is defined as the total salvage from December through March. In the figure below, the size of the bubbles is proportional to the log of the fall midwater trawl to demonstrate that concern may be high in years of high or low fall abundance. The resulting quartiles of the ratio are as follows: 25% =: 2.950; 50%= 3.575; 75% 5.029.

Using this approach to calculate winter concern levels, all years above the 1999 point in the graph would have been years of concern. In other words, these are the years in which we may have recommended some protection. Comparing it to the protection afforded adult delta smelt in the winter by the 1995 Biological Opinion: "red light" was, or would have been, reached in fewer winters (1980, 1981, 1982, 1984 and 1999) .

The median was selected as the measure of concern and will be calculated by:

concern level = anti ln(3.575)* Recovery index



The goal for the DSRAM is to avoid the upper quartile of the above graph, which the Working Group thinks will avoid salvage events that are high relative to fall abundance. Actions may be taken prior to major salvage events.

Items for Early Consultation

There are some items that are part of the early consultation, Operation of Components of the South Delta, CVP/SWP Integration and the long-term EWA.

Operation of Components of the South Delta Improvement Project

Introduction

DWR and Reclamation have agreed to jointly pursue the development of the SDIP to address regional and local water supply needs, as well as the needs of the aquatic environment. Overall, the SDIP components are intended to meet the project purpose and objectives by balancing the need to increase the current regulatory limit on inflow to the CCF with the need to improve local agricultural diversions and migratory conditions for Central Valley fall and late fall-run Chinook salmon in the San Joaquin River. Two key operational features of the SDIP are included as part of this project description.[8]

8500 cfs Operational Criteria

From March 16 through December 14—the maximum allowable daily diversion rate into CCF shall meet the following criteria: (1) the 3-day running average diversion rate shall not exceed 9,000 cfs, (2) the 7-day running average diversion rate shall not exceed 8,500 cfs, and (3) the monthly average diversion rate shall not exceed 8,500 cfs.

From December 15 through March 15—the maximum allowable daily diversion rate into CCF shall meet the following criteria: (1) the 7-day running average shall not exceed 8,500 cfs or 6,680 cfs plus one-third of the 7-day running average flow of the San Joaquin River at Vernalis when the flow exceeds 1,000 cfs (whichever is greater), and (2) the monthly average diversion rate shall not exceed 8,500 cfs.

Permanent Barrier Operations

Head of Old River

Barrier operation (closing the barrier) would begin at the start of the VAMP spring pulse flow period, which typically begins around April 15. Operation is expected to continue for 31 consecutive days following the start of the VAMP.

If, in the view of the Service, NOAA Fisheries, and DFG, the barrier needs to be operated at a different time or for a longer period, it may be operated provided the following criteria are met:

- It is estimated that such operation would not increase take of threatened or endangered species in excess of the take authorized by the OCAP biological opinion.

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

- The San Joaquin River flow at Vernalis is less than 10,000 cfs.
- There is a verified presence of out-migrating salmon or steelhead in the San Joaquin River.
- South Delta Water Agency agricultural diverters are able to divert water of adequate quality and quantity.

During the fall months of October and November, the barrier would be operated to improve flow in the San Joaquin River, thus assisting in avoiding historically present hypoxia conditions in the lower San Joaquin River near Stockton. Barrier operation during this period would be conducted at the joint request of DFG, NOAA Fisheries and the Service.

The Head of Old River Barriers (HORB) may be operated at other times provided that the following criteria are met:

- The Service and NOAA Fisheries will determine in coordination with DFG that such operation would not increase take of threatened or endangered species in excess of the take authorized by the OCAP biological opinion.
- The San Joaquin River flow at Vernalis is not above 5,000 cfs.
- The Service and NOAA Fisheries will determine in coordination with DFG that any impacts associated with barrier operation during this period will not result in additional impacts to threatened and endangered (T&E) species that are outside the scope of impacts analyzed by the BO for OCAP.

Middle River, Old River near the DMC and Grant Line Canal

From April 15 through November 30, barriers on the Middle River and Old River near the DMC and Grant Line Canal would be operated (closed) on an as needed basis to protect water quality9 and stage10 for south Delta agricultural diverters . However, if the Service and NOAA Fisheries in coordination with DFG determine there are fishery concerns with the operating the barriers, the matter will be brought to the WOMT.

From December 1 through April 15 the barriers may only be operated with permission from the Service, NOAA Fisheries, and DFG if the following criteria are met:

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9 Minimum Water Quality goals, 30-day running average electrical conductivity (EC) at San Joaquin River at Brandt Bridge, Old River near Middle River and Old River at Tracy Road Bridge would not exceed 0.7 mmhos/cm, April – August; and 1.0 mmhos/cm, September – March.

10 Minimum water levels goals in Middle River, Old River and Grant Line Canal would not drop below 0.0 mean sea level (MSL) - Based on the 1929 National Geodetic Vertical Datum (NGVD)

- The Service and NOAA Fisheries, in coordination with DFG, will determine that such operation would not increase take of species in excess of the take authorized by the BO for OCAP.

- The San Joaquin River flow at Vernalis is not above 5,000 cfs.

- The Service and NOAA Fisheries, in coordination with DFG, will determine that any impacts associated with barrier operation during this period will not result in additional impacts to T&E species that are outside the scope of impacts analyzed by the BO for OCAP.

The barriers on the Middle River and Old River near the DMC and Grant Line Canal may need to be operated (closed) to protect water quality[1] and stage[2] for south Delta agricultural diverters. DWR is also investigating whether the use of low head pumps at barrier locations can further improve water quality at Brandt Bridge. The amount of pumping and the precise location of the pumps have not been determined, nor has the benefit that might be realized by low head pumps been quantified. If DWR concludes there is a benefit to operating low head pumps, it will incorporate the proposed action into the SDIP Action Specific Implementation Plan (ASIP) process. Such an inclusion will require re-initiation of consultation with the Service and NOAA regarding potential effects on listed species. Thus, low head pumps will not be included in the OCAP project description.

Long-Term EWA

There is an assumption in the future studies of an EWA similar to the today level studies (see Chapter 8 of the BA). Purchase assets are the same in the today and future, variable assets may differ under the future proposed actions. Refer to the previous discussion of EWA beginning on page 89.

Transfers

The capability to facilitate transfers is expanded by the implementation of the 8,500 Banks capacity. Available surplus capacity for transfers will increase in most years. The early consultation includes the increased use of the SWP Delta export facilities for transfers that will derive from the increase in surplus capacity associated with implementation of the 8,500 Banks. As mentioned in the project description under the heading Water Transfers, in all but the driest 20 percent of water years, surplus capacity during the typical transfer season of July through September is usually a factor limiting the amount of transfers that can be accomplished. With the 8,500 Banks, the range of surplus capacity available for transfers (in the wetter 80 percent of years) increases from approximately 60,000-460,000 af per year, to 200,000-600,000 af per year. Transfers in the drier 20 percent of years are not limited by available capacity, but rather by either supply or demand. In those years, transfers could still range up to 800,000-1,000,000 af per year, either with or without the 8,500 Banks. Refer to the Water Transfers section for additional discussion.

Reclamation and DWR have agreed to share water provided by Sacramento Valley interests to alleviate in-basin requirements. The Sacramento Valley Water Management Agreement water (Reclamation 2004) will be split 60 percent for the SWP and 40 percent for the CVP. Refer to the previous discussion of Water Transfers.

CVP and SWP Operational Integration

For many years, Reclamation and DWR have considered and attempted to increase the level of operational coordination and integration. Such coordination allows one project to utilize the other's resources to improve water supply reliability and reduce cost. As such, Reclamation and DWR plan to integrate the strengths of the CVP and SWP (storage and conveyance, respectively) to maximize water supplies for the benefit of both CVP and SWP contractors that rely on water delivered from the Delta in a manner that will not impair in-Delta uses, and will be consistent with fishery, water quality, and other flow and operational requirements imposed under the Clean Water Act (CWA) and the Act. The Project Agencies have agreed to pursue the following actions:

- Convey water for Reclamation at the SWP. Upon implementation of the increase to 8,500 cfs at Banks, DWR will divert and pump 100,000 af of Reclamation's Level 2 refuge water before September 1. This commitment will allow Reclamation to commit up to 100,000 af of conveyance capacity at Tracy Pumping Plant, formally reserved for wheeling refuge supplies, for CVP supplies.

- Adjust in-basin obligations. Upon implementation of the increase to 8,500 cfs at Banks, Reclamation will supply up to 75,000 af from its upstream reservoirs to alleviate a portion of the SWP's in-basin obligation.

- Prior to implementation of the increase to 8,500 cfs at Banks, DWR will provide up to 50,000 af of pumping and conveyance of Reclamation's Level 2 refuge water. Likewise, Reclamation will supply up to 37,500 acre feet from its upstream storage to alleviate a portion of the SWP's obligation to meet in-basin uses. It should be noted that the biological effects analyzed in this document are for the full 100,000 acre feet of conveyance and up to 75,000 acre feet of storage, as may occur when the 8,500 Banks is operational. The biological effects of the 50,000 acre feet of conveyance and up to 37,500 acre feet of storage which may occur at the existing permitted Banks capacity, are not analyzed separately, since it is assumed that those effects are encompassed by the analysis of the larger amounts and capacities that may occur when the 8,500 Banks is operational.

- Upstream Reservoir Coordination. Under certain limited hydrologic and storage conditions, when water supply is relatively abundant in Shasta, yet relatively adverse in Oroville, SWP may rely on Shasta storage to support February allocations based on 90 percent exceedance projections, subject to the following conditions. When the CVP's and the SWP's February 90 percent exceedance forecasts project September 30 SWP storage in Oroville Reservoir to be less than 1.5 maf, and CVP storage in Shasta Reservoir to be greater than approximately 2.4 maf, the SWP may, in order to provide allocations based on a 90 percent exceedance forecast, rely on water stored in Shasta Reservoir.
  - Should the actual hydrology be drier than the February 90 percent exceedance forecast, the SWP may borrow from Shasta storage an amount of water equal to the amount needed to maintain the allocation made under the 90 percent exceedance forecast, not to exceed 200,000 af.

- Storage borrowing will be requested by April 1. Upon the request to borrow storage, Reclamation and DWR will develop a plan within 15 days to accomplish the potential storage borrowing. The plan will identify the amounts, timing, and any limitation or risk to implementation and will comply with conditions on Shasta Reservoir and Sacramento River operations imposed by applicable biological opinions. Water borrowed by the SWP shall be provided by adjustments in Article 6 accounting of responsibilities in the COA.

- Maximize use of San Luis Reservoir storage. DWR, in coordination with Reclamation and their respective contractors, will develop an annual contingency plan to ensure San Luis Reservoir storage remains at adequate levels to avoid water quality problems for CVP contractors diverting directly from the reservoir. The plan will identify actions and triggers to provide up to 200,000 af of source shifting, allowing Reclamation to utilize the CVP share of San Luis Reservoir more effectively to increase CVP allocations.

Additionally, a solution to the San Luis Reservoir low point problem is also in the long-term operation of the Project, and is also part of this consultation. Solving the low-point problem in San Luis Reservoir was identified in the August 28, 2000, CALFED ROD (Reclamation 2004) as a complementary action that would avoid water quality problems associated with the low point and increase the effective storage capacity in San Luis Reservoir up to 200,000 af. This action, while not implemented at present, is part of the future proposed action on which Reclamation is consulting. All site-specific and localized actions of implementing a solution to the San Luis Reservoir low point problem, such as construction of any physical facilities in or around San Luis Reservoir and any other site-specific effects, will be addressed in a separate consultation.

Status of the Species

Delta smelt

Delta smelt was federally listed as a threatened species on March 5, 1993, (58 **FR** 12854) (Service 1993a). Critical habitat for delta smelt was designated on December 19, 1994 (59 FR 65256) (Service 1994b). The Sacramento-San Joaquin Delta Native Fishes Recovery Plan was completed in 1996 (Service 1996). The Five Year Status Review for the delta smelt was completed on March 31, 2004 (Service 2004).

Description: Delta smelt are slender-bodied fish that typically reach 60-70 mm standard length (measured from tip of the snout to origin of the caudal fin), although a few may reach 120 mm standard length. The mouth is small, with a maxilla that does not extend past the midpoint of the eye. The eyes are relatively large, with the orbit width contained approximately 3.5-4 times in the head length. Small, pointed teeth are present on the upper and lower jaws. The first gill arch has 27-33 gill rakers and there are 7 branchiostegal rays (paired structures on either side and below the jaw that protect the gills). Counts of branchiostegal rays are used by taxonomists to identify fish. The pectoral fins reach less than two-thirds of the way to the bases of the pelvic fins. There are 9-10 dorsal fin rays, 8 pelvic fin rays, 10-12 pectoral fin rays, and 15-17 anal fin rays. The lateral line is incomplete and has 53-60 scales along it. There are 4-5 pyloric caeca. Live fish are nearly translucent and have a steely-blue sheen to their sides. Occasionally there may be one chromatophore (cellular organelle containing pigment) between the mandibles, but usually there is none. Delta smelt belong to the family Osmeridae, a more ancestral member of the order Salmoniformes which also includes the family Salmonidae (salmon, trout, whitefish, and graylings) (Molye and Cech 1988).

Distribution: Delta smelt are endemic to the upper Sacramento-San Joaquin estuary. They occur in the Delta primarily below Isleton on the Sacramento River, below Mossdale on the San Joaquin River, and in Suisun Bay. They move into freshwater when spawning (ranging from January to July) and can occur in: (1) the Sacramento River as high as Sacramento, (2) the Mokelumne River system, (3) the Cache Slough region, (4) the Delta, and, (5) Montezuma Slough, (6) Suisun Bay, (7) Suisun Marsh, (8) Carquinez Strait, (9) Napa River, and (10) San Pablo Bay. It is not known if delta smelt in San Pablo Bay are a permanent population or if they are washed into the Bay during high outflow periods. Since 1982, the center of delta smelt abundance has been the northwestern Delta in the channel of the Sacramento River. In any month, two or more life stages (adult, larvae, and juveniles) of delta smelt have the potential to be present in Suisun Bay (Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation) 1994; Molye 1976; and Wang 1991). Delta smelt are also captured seasonally in Suisun Marsh.

Habitat Requirements: Delta smelt are euryhaline (a species that tolerates a wide range of salinities) fish that generally occur in water with less than 10-12 parts per thousand (ppt) salinity. However, delta smelt have been collected in the Carquinez Strait at 13.8 ppt and in San Pablo Bay at 18.5 ppt (DFG 2000). In recent history, they have been most abundant in shallow areas where early spring salinities are around 2 ppt. However, prior to the 1800's before the construction of levees that created the Delta Islands, a vast fluvial marsh existed in the Delta and the delta smelt probably reared in these upstream areas. During the recent drought (1987-92), delta smelt were concentrated in deep areas in the lower Sacramento River near Emmaton, where average salinity ranged from 0.36 to 3.6 ppt for much of the year (DWR and Reclamation 1994). During years with wet springs (such as 1993), delta smelt may continue to be abundant in Suisun Bay during summer even after the 2 ppt isohaline (an artificial line denoting changes in salinity in a body of water) has retreated upstream (Sweetnam and Stevens 1993). Fall abundance of delta smelt is generally highest in years when salinities of 2 ppt are in the shallows of Suisun Bay during the preceding spring ($p < 0.05$, $r = 0.50$) (Herbold 1994) (p is a statistical abbreviation for the probability of an analysis showing differences between variables, r is a statistical abbreviation for the correlation coefficient, a measure of the linear relationship of two variables). Herbold (1994) found a significant relationship between number of days when 2 parts per thousand was in Suisun Bay during April with subsequent delta smelt abundance ($p < 0.05$, $r = 0.49$), but noted that autocorrelations (interactions among measurements that make relationships between measurements difficult to understand) in time and space reduce the reliability of any analysis that compares parts of years or small geographical areas. It should also be noted that the point in the estuary where the 2 ppt isohaline is located (X2) does not necessarily regulate delta smelt distribution in all years. In wet years, when abundance levels are high, their distribution is normally very broad. In late 1993 and early 1994, delta smelt were found in Suisun Bay region despite the fact that X2 was located far upstream. In this case, food availability may have influenced delta smelt distribution, as evidenced by the *Eurytemora* found in this area by DFG. In Suisun Marsh, delta smelt larvae occur in both large sloughs and small dead end sloughs. New studies are under way to test the hypothesis that adult fall abundance is dependent upon geographic distribution of juvenile delta smelt.

Critical thermal maxima for delta smelt was reached at 25.4 degrees Celsius in the laboratory (Swanson et al., 2000); and at water temperatures above 25 degrees Celsius delta smelt are no longer found in the delta (DFG, pers. comm.).

Life History: Wang (1986) reported spawning taking place in fresh water at temperatures of about 7º-15º Celsius (C). However, ripe delta smelt and recently hatched larvae have been collected in recent years at temperatures of 15º-22º C, so it is likely that spawning can take place over the entire 7º-22º C range. Temperatures that are optimal for survival of embryos and larvae have not yet been determined, although R. Mager, UCD, (unpublished data) found low hatching success and embryo survival from spawns of captive fish collected at higher temperatures. Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures relatively cool, usually less than 20º-22º C in summer. When not spawning, they tend to be concentrated near the zone where incoming salt water and out flowing freshwater mix (mixing zone). This area has the highest primary productivity and is where zooplankton populations (on which delta smelt feed) are usually most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). At all life stages delta smelt are found in greatest abundance in the top 2 m of the water column and usually not in close association with the shoreline.

Delta smelt inhabit open, surface waters of the Delta and Suisun Bay, where they presumably school. In most years, spawning occurs in shallow water habitats in the Delta. Shortly before spawning, adult smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966; Moyle 1976, 2002; Wang 1991). Migrating adults with nearly mature eggs were taken at the Central Valley Projects's (CVP) Tracy Pumping Plant, located in the south Delta, from late December 1990 to April 1991 (Wang 1991). In February 2000, gravid adults were found at both CVP and the State Water Projects' (SWP) fish facilities in the south Delta. Spawning locations appear to vary widely from year to year (DWR and Reclamation 1993). Sampling of larval smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone between Frank's and Webb tracts, and possibly other areas (Wang 1991). In years of moderate to high Delta outflow, smelt larvae are often most abundant in Suisun Bay and sloughs of Suisun Marsh, but it is not clear the degree to which these larvae are produced by locally spawning fish and the degree to which they originate upstream and are transported by river currents to the bay and marsh. Some spawning probably occurs in shallow water habitats in Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999 and Wang 1991). Spawning has also been recorded in Montezuma Slough near Suisun Bay (Wang 1986) and also may occur in Suisun Slough in Suisun Marsh (P. Moyle, UCD, unpublished data).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Pre-spawning adults are found in Suisun Bay and the western delta as early as September (DWR and Reclamation 1994). Moyle (1976, 2002) collected gravid adults from December to April, although ripe delta smelt were common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1993 as cited in Water Resources and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a University of California at Davis (UCD) study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976, 2002; Wang 1986, 1991; Moyle *et al.* 1992). Although delta smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), some researchers believe the adhesive, demersal eggs attach to substrates such as cattails, tules, tree roots, and submerged branches in shallow waters (Moyle 1976, 2002; Wang 1991).

Laboratory observations have indicated that delta smelt are broadcast spawners (DWR and Reclamation 1994) and eggs are demersal (sinks to the bottom) and adhesive, sticking to hard substrates such as: rock, gravel, tree roots or submerged branches, and submerged vegetation (Moyle 1976, 2002; Wang 1986). At 14º-16º C, embryonic development to hatching takes 9 -14 days and feeding begins 4-5 days later (R. Mager, UCD, unpublished data). Newly hatched delta smelt have a large oil globule that makes them semi-buoyant, allowing them to maintain themselves just off the bottom (R. Mager, UCD, unpublished data), where they feed on rotifers (microscopic crustaceans used by fish for food) and other microscopic prey. Once the swimbladder (a gas-filled organ that allows fish to maintain neutral buoyancy) develops, larvae become more buoyant and rise up higher into the water column. At this stage, 16-18 mm total length, most are presumably washed downstream until they reach the mixing zone or the area immediately upstream of it. Growth is rapid and juvenile fish are 40-50 mm long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). By this time, young-of-year fish dominate trawl catches of delta smelt, and adults become rare. Delta smelt reach 55-70 mm standard length in 7-9 months (Moyle 1976, 2002). Growth during the next 3 months slows down considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966). There is no correlation between size and fecundity, and females between 59-70 mm standard lengths lay 1,200 to 2,600 eggs (Moyle *et al.* 1992). The abrupt change from a single-age, adult cohort during spawning in spring to a population dominated by juveniles in summer suggests strongly that most adults die after they spawn (Radtke 1966 and Moyle 1976, 2002). However, in El Nino years when temperatures rise above 18º C before all adults have spawned, some fraction of the unspawned population may also hold over as two-year-old fish and spawn in the subsequent year. These two-year-old adults may enhance reproductive success in years following El Nino events.

In a near-annual fish like delta smelt, a strong relationship would be expected between number of spawners present in one year and number of recruits to the population the following year. Instead, the stock-recruit relationship for delta smelt is weak, accounting for about a quarter of the variability in recruitment (Sweetnam and Stevens 1993). This relationship does indicate, however, that factors affecting numbers of spawning adults (*e.g.*, entrainment, toxics, and predation) can have an effect on delta smelt numbers the following year.

Delta smelt feed primarily on (1) planktonic copepods (small crustaceans used by fish for food), (2) cladocerans (small crustaceans used by fish for food), (3) amphipods (small crustaceans used by fish for food) and, to a lesser extent, (4) on insect larvae. Larger fish may also feed on the opossum shrimp, *Neomysis mercedis.* The most important food organism for all sizes seems to be the euryhaline copepod, *Eurytemora affinis*, although in recent years the exotic species, *Pseudodiaptomus forbesi*, has become a major part of the diet (Moyle *et al.* 1992). Delta smelt are a minor prey item of juvenile and subadult striped bass, *Morone saxatilis*, in the Sacramento-San Joaquin Delta (Stevens 1966). They also have been reported from the stomach contents of white catfish, *Ameiurus catus,* (Turner 1966 *in* Turner and Kelley (eds) 1966) and black crappie, *Pomoxis nigromaculatus*, (Turner 1966 *in* Turner and Kelley 1966) in the Delta.

Abundance: The smelt is endemic to Suisun Bay upstream of San Francisco Bay and throughout the Delta, in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties, California. Historically, the smelt is thought to have occurred from Suisun Bay and Montezuma Slough, upstream to at least Verona on the Sacramento River, and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993).

Since the 1850s, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to an increase in siltation and the alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94% of the Estuary's tidal marshes. (Nichols *et al.* 1986, Monroe and Kelly 1992). The extensive levee system in the Delta has led to a loss of seasonally flooded habitat and significantly changed the hydrology of the Delta ecosystem, restricting the ability of suitable habitat substrates to re-vegetate.

Delta smelt were once one of the most common pelagic (living in open water away from the bottom) fish in the upper Sacramento-San Joaquin estuary, as indicated by its abundance in DFG trawl catches (Erkkila *et al.* 1950; Radtke 1966; Stevens and Miller 1983). Delta smelt abundance from year to year has fluctuated greatly in the past, but between 1982 and 1992 their population was consistently low. The decline became precipitous in 1982 and 1983 due to extremely high outflows and continued through the drought years 1987-1992 (Moyle *et al.* 1992). In 1993, numbers increased considerably, apparently in response to a wet winter and spring. During the period 1982-1992, most of the population was confined to the Sacramento River channel between Collinsville and Rio Vista (D. Sweetnam, DFG unpublished data). This was still an area of high abundance in 1993, but delta smelt were also abundant in Suisun Bay. The actual size of the delta smelt population is not known. However, the pelagic life style of delta smelt, short life span, spawning habits, and relatively low fecundity indicate that a fairly substantial population probably is necessary to keep the species from becoming extinct.

Recreation in the Delta has resulted in the presence and propagation of predatory non-native fish such as striped bass (*Morone saxatilis*). Additionally, recreational boat traffic has led to a loss of habitat from the building of docks and an increase in the rate of erosion resulting from boat wakes. In addition to the loss of habitat, erosion reduces the water quality and retards the production of phytoplankton in the Delta.

In addition to the degradation and loss of estuarine habitat, delta smelt have been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of the steadily increasing proportion of river flow being diverted from the Delta by the Projects, and occasional droughts (Monroe and Kelly 1992).

Reduced water quality from agricultural runoff, effluent discharge and boat effluent has the potential to harm the pelagic larvae and reduce the availability of the planktonic food source. When the mixing zone is located in Suisun Bay where there is extensive shallow water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). The introduction of the Asian clam (*Potamocorbula amurensis)*, a highly efficient filter feeder, presently reduces the concentration of phytoplankton in this area.

According to seven abundance indices which provide information on the status of the delta smelt, this species was consistently at low population levels through the 1980's (Stevens *et al.* 1990). These same indices also showed a pronounced decline from historical levels of abundance (Stevens *et al.* 1990).

For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone, where the salinity is approximately 2 ppt. (also described as X2) (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993). The relationship between the portion of the smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988, indicates the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cubic feet per second, placing X2 between Chipps and Roe islands (DWR and Reclamation 1994).

Specifically, the summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959) (DFG 2001). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species (DFG 2001). Since 1983, (except for 1986, 1993, and 1994), this index has remained at consistently lower levels than previously found (DFG 2001). These consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the confluence (DFG 2001).

The final summer townet index for 2000 was 8.0, a decline from the 11.9 index for the 1999 summer townet. Both of these indices represent an increase from the 1998 index of 3.3. These higher townet indices were followed by the 2001 (3.5), 2002 (4.7), and 2003 (1.6) indices which were well below the pre-decline average of 20.4 (1959-1981, no sampling in 1966-68).

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990, DFG 1999). The FMWT indicates the abundance of the adult population just prior to upstream spawning migration (DFG 1999). The index calculated from the FMWT uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled (DFG 1999). Until recently, except for 1991, this index has declined irregularly over the past 20 years (DFG 1999). Since 1983, the delta smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded (DFG 1999). The 1994 FMWT index of 101.2 was a continuation of this trend (DFG 1999). This occurred despite the high 1994 summer townet index for reasons unknown (DFG 1999). The low 1995 summer townet index value of 3.3 was followed by a high FMWT index of 839 reflecting the benefits of higher flows due to an extremely wet year (DFG 1999, 2001).

The 1999 FMWT index of 717, which is an increase from 1998's index (417.6), is the third highest since the start of decline of delta smelt abundance in 1982 (DFG 1999). The FMWT abundance index (127) for 1996 represented the fourth lowest on record (DFG 1999). The 1997 abundance index (360.8) almost tripled since the 1996 survey, despite the low summer townet index (4.0) (DFG 1999, 2001).

Both 2001 TNS and FMWT abundance indices for delta smelt decreased from 2000 (Souza and Bryant 2002, DFG 1999 and 2001). The 2001 TNS delta smelt index (3.5) is less than 1999 (11.9) and 2000 (8.0) but comparable to recent years (1995, 1997, and 1998) when the index ranged from 3.2 to 4.0 (Souza and Bryant 2002, DFG 2001). The 2001 FMWT delta smelt index (603) decreased by 20% from 2000 (756) (Souza and Bryant 2002, DFG 2001). Both surveys exhibited an overall trend of decline in the last three years, but this decline seems more pronounced in the TNS where the 2001 delta smelt index is 95% lower than the greatest index of record (62.5) in 1978 (Souza and Bryant 2002, DFG 2001). The 2002 TNS was 4.7 and then dropped to 1.6 in 2003. The 2002 FWTR index (139) was the fifth lowest on record and the 2003 index was 210.

Swimming Behavior: Observations of delta smelt swimming in a swimming flume and in a large tank show that these fish are unsteady, intermittent, slow speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<3 body lengths per second), and during spontaneous, unrestricted swimming in a 1 m tank, smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50% for "stroke and glide" swimming compared to steady swimming. However, the maximum speed smelt are able to achieve using this mode of swimming is less than 3 body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Although juvenile delta smelt appear to be stronger swimmers than adults, forced swimming at 3 body lengths per second in a swimming flume was apparently stressful; the smelt were prone to swimming failure and extremely vulnerable to impingement (Swanson and Cech 1995). Delta smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints (Brett 1976).

Summary of the Five Year Review: In summary, the threats of the destruction, modification, or curtailment of its habitat or range resulting from extreme outflow conditions, the operations of the State and Federal water projects, and other water diversions as described in the original listing remain. The only new information concerning the delta smelt's population size and extinction probability indicates that the population is at risk of falling below an effective population size and therefore in danger of becoming extinct. Although VAMP and Environmental Water Account have helped to ameliorate these threats, it is unclear how effective these will continue to be over time based on available funding and future demands for water. In addition, there are increased water demands outside the CVP and the SWP, which could also impact delta smelt. The increases in water demands are likely to result in less suitable rearing conditions for delta smelt, increased vulnerability to entrainment, and less water available for maintaining the position of X2. The importance of exposure to toxic chemicals on the population of delta smelt is highly uncertain. Therefore, a recommendation to delist the delta smelt is inappropriate.

In addition, many potential threats have not been sufficiently studied to determine their effects, such as predation, disease, competition, and hybridization. Therefore, a recommendation of a change in classification to endangered is premature.

In his August 24, 2003, letter, the foremost delta smelt expert, Dr. Peter B. Moyle, stated that the delta smelt should continue to be listed as a threatened species (Moyle 2003). In addition, in their January 23, 2004, letter, DFG fully supported that the delta smelt should retain its threatened status under the Act (DFG 2004).

Delta Smelt Critical Habitat

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR §424.12(b)).

The Service is required to list the known primary constituent elements together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. space for individual and population growth, and for normal behavior;

2. food, water, air, light, minerals, or other nutritional or physiological requirements;

3. cover or shelter;

4. sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and

5. generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

Larval and juvenile transport. Adequate river flow is necessary to allow larvae from upstream spawning areas to move to rearing habitat in Suisun Bay and to ensure that rearing habitat is maintained in Suisun Bay. To ensure this, X2 must be located westward of the confluence of the Sacramento-San Joaquin Rivers, located near Collinsville (Confluence), during the period when larvae or juveniles are being transported, according to historical salinity conditions. X2 is important because the "entrapment zone" or zone where particles, nutrients, and plankton are "trapped," leading to an area of high productivity, is associated with its location. Habitat conditions suitable for transport of larvae and juveniles may be needed by the species as early as February 1 and as late as August 31, because the spawning season varies from year to year and may start as early as December and extend until July.

Rearing habitat. An area extending eastward from Carquinez Strait, including Suisun, Grizzly, and Honker bays, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of historical tidal incursion. Rearing habitat is vulnerable to impacts of export pumping and salinity intrusion from the beginning of February to the end of August.

Adult migration. Adequate flow and suitable water quality is needed to attract migrating adults in the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas are vulnerable to physical disturbance and flow disruption during migratory periods.

The Service's 1994 and 1995 biological opinions on the operations of the CVP and SWP provided for adequate larval and juvenile transport flows, rearing habitat, and protection from entrainment for upstream migrating adults (Service 1994c, 1995). Please refer to 59 FR 65255 for additional information on delta smelt critical habitat.

Environmental Baseline

Delta Smelt

Adult delta smelt spawn in central Delta sloughs from February through August in shallow water areas having submersed aquatic plants and other suitable substrates and refugia. These shallow water areas have been identified in the Delta Native Fishes Recovery Plan (Recovery Plan) (Service 1996) as essential to the long-term survival and recovery of delta smelt and other resident fish. A no net loss strategy of delta smelt population and habitat is proposed in this Recovery Plan.

The delta smelt is adapted to living in the highly productive Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively consistent spring transport flows that moved delta smelt juveniles and larvae downstream to the mixing zone (Peter Moyle, U.C. Davis pers. comm.). Since the 1850's, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San

Joaquin rivers led to increased siltation and alteration of the circulation patterns of the Estuary (Nichols et al. 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94 percent of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992).

In addition to the degradation and loss of estuarine habitat, the delta smelt has been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle et al. 1992). These adverse conditions are primarily a result of drought and the steadily increasing proportion of river flow being diverted from the Delta by the CVP and SWP (Monroe and Kelly 1992). The relationship between the portion of the delta smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988 (Department and Reclamation 1994). This relationship indicates that the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cfs which placed X2 between Chipps and Roe islands. Placement of X2 downstream of the Confluence, Chipps and Roe islands provides delta smelt with low salinity and protection from entrainment, allowing for productive rearing habitat that increases both smelt abundance and distribution.

The results of seven surveys conducted by the Interagency Ecological Program (IEP) corroborate the dramatic decline in delta smelt. Existing baseline conditions, as mandated for delta smelt under the Service's consultations on CVP operations (Service 1994c, 1995), provide sufficient Delta outflows from February 1 through June 30 to allow larval and juvenile delta smelt to move out of the "zone of influence" of the CVP and SWP pumps, and provide them low salinity, productive rearing habitat. This zone of influence has been delineated by DWR's Particle Tracking Model and expands or contracts with CVP and SWP combined pumping increases or decreases, respectively (Department and Reclamation 1993). With tidal effects contributing additional movement, the influence of the pumps may entrain larvae and juveniles as far west as the Confluence.

According to seven abundance indices designed to record trends in the status of the delta smelt, this species was consistently at low population levels during the last ten years (Stevens *et al.* 1990). These same indices also show a pronounced decline from historical levels of abundance (Stevens *et al.* 1990). The summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species. Except for three years since 1983 (1986, 1993, and 1994), this index has remained at consistently lower levels than experienced previously. As indicated, these consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the Confluence, Chipps and Roe islands.

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990). The fall midwater trawl provides an indication of the abundance of the adult population just prior to upstream spawning migration. The index that is calculated from the FMWT survey uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled. Until recently, except for 1991, this index has declined irregularly over the past 20 years. Since 1983, the delta smelt population has exhibited more low fall midwater trawl abundance indices, for more consecutive years, than previously recorded. The 1994 FMWT index of 101.7 is a continuation of this trend. This occurred despite the high 1994 summer townet index for reasons unknown. The 1995 summer townet was a low index value of 319 but resulted in a high FMWT index of 898.7 reflecting the benefits of large transport and habitat maintenance flows with the Bay-Delta Accord in place and a wet year. The abundance index of 128.3 for 1996 represented the fourth lowest on record. The abundance index of 305.6 for 1997 demonstrated that the relative abundance of delta smelt almost tripled over last years results, and delta smelt abundance continued to rise, peaking in 1999 to an abundance index of 863, only to fall back down to the low abundance indexes of 139 for 2002 and 213 for 2003.

Delta Smelt Critical Habitat

Delta smelt critical habitat has been affected by activities that destroy spawning and refugial areas and change hydrology patterns in Delta waterways. Critical habitat also has been affected by diversions that have shifted the position of X2 upstream of the confluence of the Sacramento and San Joaquin rivers. This shift has caused a decreased abundance of smelt. Existing baseline conditions and implementation of the Service's 1994 and 1995 biological opinions concerning the operation of the Central Valley Project and the State Water Project, provide a substantial part of the necessary positive riverine flows and estuarine outflows that allow smelt larvae to move downstream to suitable rearing habitat in Suisun Bay outside the influence of marinas, agricultural diversions, and Federal and State pumping plants.

The demands on surface water resources in the Central Valley have increased. The proposed Freeport Regional Water Project would divert up to 185,000 acre-feet(af)/year of water from a point of diversion north of the delta at Freeport (Freeport Regional Water Authority 2003). The proposed expansion of Los Vaqueros Reservoir would entail an additional 400,000 af of off-stream storage, diverted from the delta using existing facilities as well as new facilities located at Old River and/or Middle River (CALFED 2003a and Reclamation 2003). Reclamation and DWR have proposed to increase pumping capacity at the SWP Banks pumping plant from 6,680 cubic feet per second (cfs) to 8,500 cfs and eventually to 10,300 cfs (CALFED 2002, 2003b). Reclamation and CDWR have also proposed construction of a 400 cfs intertie connecting their aqueducts, which would allow Reclamation to increase the pumping at their Tracy Pumping Plant from 4,200 cfs to 4,600 cfs. The CALFED Bay-Delta Program proposes to expand surface water storage capacity at existing reservoirs and strategically located off-stream sites by 3.5 million af (including the 400,000 af at Los Vaqueros) by: 1) north of the delta off stream storage; 2) Shasta enlargement; 3) Los Vaqueros Expansion; 4) in-delta storage; and 5) additional storage in the Upper San Joaquin (Friant) (CALFED 2002 and Reclamation 2003). Finally, the City of Stockton proposes to construct a new intake at the southwestern tip of Empire Tract on the San Joaquin River with an ultimate diversion capacity of 371 cfs (Environmental Science Associates 2003). The diversions would likely result in lower delta outflows and increased entrainment. However, these projects have not altered critical habitat's conservation function for the delta smelt, and the smelt's primary constituent elements essential to the conservation of the species still function.

EFFECTS OF THE PROPOSED ACTION

Introduction

There are two separate effects sections in this biological opinion, one for Formal Consultation and one for Early Consultation. The "Formal Consultation" effects described in this biological opinion includes the proposed 2020 operations of the CVP including the ROD flows on the Trinity River, the increased water demands on the American River, the Freeport Diversion, water transfers, the Tracy Fish Facilities, and the SWP-CVP intertie. The effects of operations of the SWP are also included in this opinion and include the operations of the North Bay Aqueduct, water transfers, the Suisun Marsh Salinity Control Gates and the Skinner Fish Facilities.

The "Early Consultation" effects described in this biological opinion includes the proposed operations of components of the South Delta Improvement Program. These operations include pumping of 8500 cfs at the SWP, permanent barrier operations in the south Delta, the long term EWA, water transfers, and CVP and SWP operational integration.

The CALSIM II analyses done for the proposed action are not detailed enough to separate out the individual effects of increased Trinity River flows, increased American River demands, and the other project elements. The effects of the project elements are combined in the modeling and post-process analysis. More details on the limitations of CALSIM II are described below and in the biological assessment.

Baseline Conditions

CVPIA (b)(2)

According to the 1992 CVPIA the Central Valley Project must "dedicate and manage annually 800,000 acre-feet of Central Valley Project yield for the primary purpose of implementing the fish, wildlife, and habitat restoration purposes and measures authorized by this title; to assist the State of California in its efforts to protect the waters of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; and to help to meet such obligations as may be legally imposed upon the Central Valley Project under State or Federal law following the date of enactment of this title, including but not limited to additional obligations under the Federal Endangered Species Act." This dedicated and managed water or (b)(2) water, as it is called, is water the Service in consultation with Reclamation and other agencies (see the project description of B2IT in Adaptive Management) has at its disposal to use to meet the CVP's Water Quality Control Plan (WQCP) obligations and meet any requirements imposed after 1992. CVPIA 3406 (b)(2) water may be used to augment river flows and also to curtail pumping in the Delta to supplement the WQCP requirements. For example, (b)(2) water has been used to maintain flows on Clear Creek to provide adequate spawning and rearing habitat for Chinook salmon. Water exports at the CVP have also been reduced using (b)(2) water to reduce entrainment of salmon or delta smelt at the salvage facilities. This ongoing action provides a benefit to delta smelt in most years.

SWRCB D-1641

The California State Water Resources Control Board's (SWRCB) Water Rights Decision 1641 (adopted in 1999) sets flow and water quality objectives for the Projects to assure protection of beneficial uses in the Delta. D-1641 includes 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. D-1641 obligates the SWP and CVP to comply with the objectives in the 1995 Bay-Delta Plan. The Service issued a biological opinion on the Bay-Delta plan to the Environmental Protection Agency on November 2, 1994. The water quality objectives in the 1995 Bay-Delta Plan and in D-1641 are designed to protect in-Delta agricultural, municipal and industrial, and fishery uses and vary throughout the year and by water year type (see more detail in the project description section). D-1641 will also protect delta smelt by providing transport, habitat and attraction flows (Service 1994).

VAMP

The Vernalis Adaptive Management Plan (VAMP) is a 12-year experimental program, that provides flows on the San Joaquin River and export curtailments at the CVP and SWP. VAMP was included in D-1641 and was in its fifth year in 2004. These activities run for 31 days in April and May for fall-run Chinook salmon and delta smelt. VAMP's purpose is to provide pulse flows on the San Joaquin River and improve habitat conditions in the delta by reducing exports at the CVP and SWP. Currently, (b)(2) water can be used to reduce exports at the CVP. These export reductions are taken and (b)(2) water is used to account for the reduction. The EWA can reduce exports at the SWP or the CVP. If export reductions are taken, the EWA transfers water in the summer to make up for the earlier export reductions. The reductions in exports and the pulse flows down the San Joaquin River during VAMP allow larval and juvenile smelt to avoid becoming entrained at the export facilities and to move downstream to Suisun Bay.

EWA

The Environmental Water Account (EWA), as described in the CALFED ROD is a key component of CALFED's water management strategy. Created to address the problems of declining fish populations and water supply reliability, the EWA is an adaptive management tool that aims to protect both fish and water users as it modifies water project operations in the Bay-Delta. The EWA provides water for the protection and recovery of fish beyond that which would be available through the existing baseline of regulatory protection related to project operations. The EWA buys water from willing sellers or diverts surplus water when safe for fish, then banks, stores, transfers and releases it as needed to protect fish and compensate water users for deferred diversions (EWA 2003).

To date, EWA actions taken to benefit delta smelt consist of Project export pumping curtailments, which directly reduce incidental take at the CVP and SWP pumps in the South Delta. Pumping curtailments from January through March minimize take of pre-spawning and spawning adult delta smelt, which are considered the most critical life-stage, since in an annual species they represent the individuals who have successfully avoided risk occurring at earlier life stages to achieve reproductive maturity (Poage in prep 2004). Actions taken in April through June minimize take of late-spawning adults or larvae and juveniles (EWA 2003). The EWA can also be used to increase in-stream flows or increased outflows in the Delta. Increased outflows, in particular, would benefit delta smelt.

CALSIM II Modeling

The CALSIM II monthly model results were one of the tools used to analyze effects of proposed CVP and SWP operations on steelhead, coho salmon, delta smelt, winter-run and spring-run Chinook salmon. The major changes in operations since the 1995 biological opinion relative to current assumptions that are expected to impact the CVP and SWP are:

- Lewiston releases on the Trinity River (340,000 AF, ranging between 368,600 to 452,600 AF and 368,600 to 815,000 AF annually)
- Freeport project
- Level of Development
- CVP/SWP Integration Agreement (100,000 AF dedicated CVP Refuge Level 2 Pumping at Banks and 75,000 AF of CVP releases for SWP COA requirements)
- The Intertie
- South Delta Improvement Project (increase Banks pumping capacity from 6,680 cfs to 8,500 cfs)

CALSIM II for the OCAP BA studies has the most current assumptions of the (b)(2) policy, May 2003. Studies 3, 5, and 5a have the most current assumptions for the EWA program as agreed to in October 2003. Table 10 shows the seven studies developed for OCAP and how the previously mentioned changes in operations are incorporated into them.

Table 10. Summary of Assumptions in the OCAP CALSIM II runs

	Trinity Min Flows	CVPIA 3406 (b)(2)	Level of Development	EWA	SDIP	CVP/SWP Integration	Freeport	Intertie
Study 1 D1641 with b(2) (1997)	340,000 af/yr	May 2003	2001					
Study 2 Today b(2)	368,600-452,600 af/yr	Same as above	Same as above					
Study 3 Today EWA	Same as above	Same as above	Same as above	X				
Study 4 Future SDIP	368,600-815,000 af/yr	Same as above	2020		X	X	X	X
Study 4a Future b(2)	Same as above	Same as above	Same as above				X	X
Study 5 Future EWA	Same as above	Same as above	Same as above	X	X	X	X	X
Study 5a Future EWA 6680	Same as above	Same as above	Same as above	X			X	X

CALSIM II replaces both the DWRSIM and PROSIM as the CVP-SWP simulation models developed and used by the California Department of Water Resources and the Bureau of Reclamation respectively. CALSIM II represents the best available planning model for the CVP-SWP system. As quoted in the April 9th 2004, Draft Response Plan from the CALFED Science Program Peer Review of CALSIM II: "*As the official model of those projects, Calsim II is the default system model for any inter-regional or statewide analysis of water in the Central Valley...California needs a large-scale relatively versatile inter-regional operations planning model and Calsim II serves that purpose reasonably well.*"

The two Benchmark Studies (2001 and 2020 Level of Development) have been developed by staff from both DWR and Reclamation for the purpose of creating a CALSIM II study that is to be used as a basis in comparing project alternatives. Because CALSIM II uses generalized rules to operate the CVP and SWP systems the results are an estimate and may not reflect how actual operations would occur. CALSIM II should only be used as a comparative tool to reflect how changes in facilities and operations may affect the CVP-SWP system.

Hydrologic Modeling Methods

The DWR/Reclamation Joint CALSIM II planning model was used to simulate the CVP and SWP water operations on a monthly time step from water year 1922 to 1994. The hydrology in CALSIM II was developed jointly by DWR and Reclamation. Water diversion requirements (demands), stream accretions and depletions, rim basin inflows, irrigation efficiency, return flows, nonrecoverable losses, and groundwater operation are components that make up the hydrology used in CALSIM II. Sacramento Valley and tributary basin hydrologies are developed using a process designed to adjust the historical sequence of monthly stream flows to represent a sequence of flows at a future level of development. Adjustments to historic water supplies are determined by imposing future level land use on historical meteorological and hydrologic conditions. San Joaquin River basin hydrology is developed using fixed annual demands and regression analysis to develop accretions and depletions. The resulting hydrology represents the water supply available from Central Valley streams to the CVP and SWP at a future level of development (Reclamation 2004).

CALSIM II uses DWR's Artificial Neural Network (ANN) model to simulate the flow-salinity relationships for the Delta. The ANN model correlates DSM2 model-generated salinity at key locations in the Delta with Delta inflows, Delta exports, and DCC operations. The ANN flow-salinity model estimates electrical conductivity at the following four locations for the purpose of modeling Delta water quality standards: Old River at Rock Slough, San Joaquin River at Jersey Point, Sacramento River at Emmaton, and Sacramento River at Collinsville. In its estimates, the ANN model considers antecedent conditions up to 148 days, and considers a "carriage-water" type of effect associated with Delta exports (Reclamation 2004).

CALSIM II uses logic for determining deliveries to North-of-Delta (NOD), and South-of-Delta (SOD) CVP and SWP contractors. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as water supply parameters (i.e., runoff forecasts) become more certain. The SOD SWP delivery is determined based upon water supply parameters and operational constraints. The CVP system wide delivery and SOD delivery are determined similarly upon water supply parameters and operational constraints with specific consideration for export constraints (DWR 2002). More details on the CALSIM II logic can be found in chapter 8 of the biological assessment.

CVPIA 3406 (b)(2) and Environmental Water Account Modeling

CALSIM II dynamically models CVPIA 3406(b)(2) and the Environmental Water Account (EWA). (b)(2) accounting procedures in CALSIM II are based on system conditions under operations associated with SWRCB D-1485 and D-1641 regulatory requirements (Reclamation 2004). Similarly, the operating guidelines for selecting actions and allocating assets under the EWA are based on system conditions under operations associated with a Regulatory Baseline as defined by the CALFED ROD, which includes SWRCB D-1641 and (b)(2) among other elements. Given the task of simulating dynamic EWA operations, and the reality of interdependent operational baselines embedded in EWA's Regulatory Baseline, a modeling analysis has been developed to dynamically integrate five operational baselines for each water year of the hydrologic sequence. These five steps constitute a position analysis with five Studies linked to different regulatory regimes: D1485, D1641, (b)(2), JPOD, and EWA. The results from the final case of the position analysis (EWA) is accepted as the end-of-year system state, and serve as the initial conditions for each of the five cases in the following year's position analysis. The general modeling procedure is shown in Figure 11.

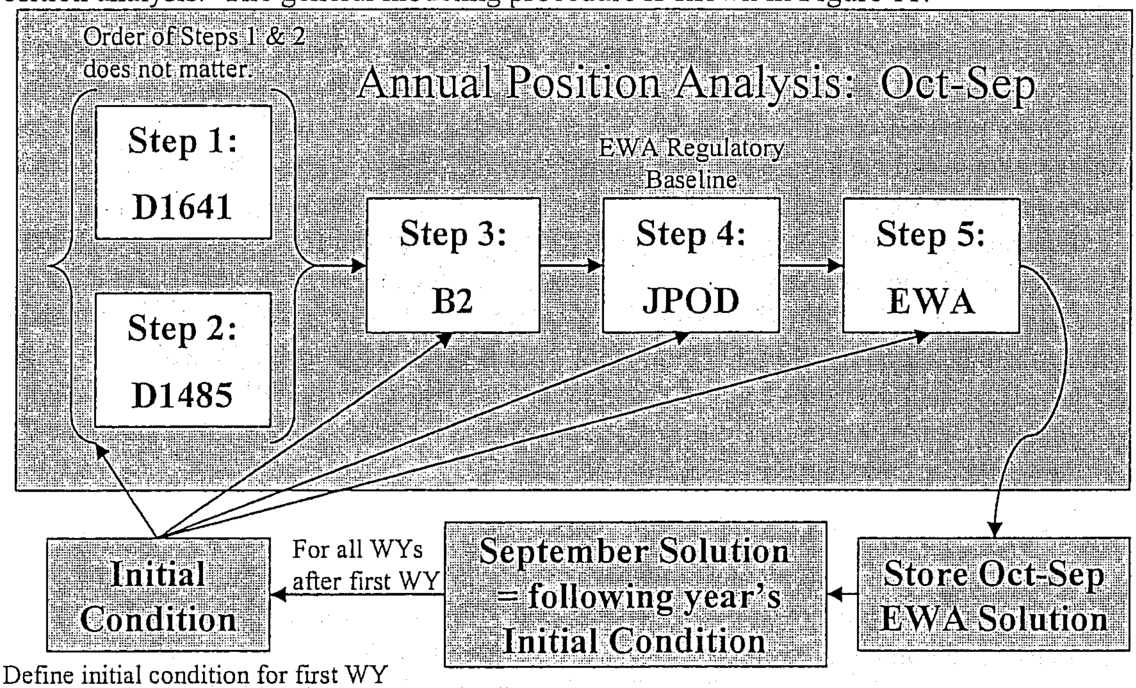


Figure 11. CALSIM II procedure to simulate EWA operations. (Note: Step 4 is named "JPOD" in the OCAP Today Studies and "SDIP" in the OCAP Future Studies.)

CVPIA (b)(2)

The following assumptions were used to model the May 2003 3406 (b)(2) Dept. of the Interior decision:

Allocation of (b)(2) water is 800,000 af/yr, 700,000 af/yr in 40-30-30 Dry Years, and 600,000 af/yr in 40-30-30 Critical years

Upstream flow metrics are calculated at Clear Creek, Keswick, Nimbus and Goodwin Reservoirs where (b)(2) water can be used to increase flow for fishery purposes.

More details on the (b)(2) assumptions can be found in the biological assessment.

Environmental Water Account

Three Management Agencies (Service, NOAA Fisheries, and DFG) and two Project Agencies (Reclamation and DWR) share responsibility in the implementation and management of the Environmental Water Account (EWA). The Management Agencies manage the EWA assets and exercise the biological judgment to recommend operation changes in the CVP and SWP that are beneficial to the Bay-Delta system. Together, the Management and Project Agencies form an EWA Team, or EWAT (see more details in the project description).

The objective of simulating EWA for OCAP modeling is to represent the functionality of the program in three ways: as it was designed in the CALFED ROD, as it has been implemented by EWAT during Water Years 2001-2004, and as it is foreseen to be implemented in coming years by CALFED Operations. The EWA representation in CALSIM II simulates not a prescription for operations; but a representation of the following EWA operating functions.

The following actions are simulated in the OCAP modeling for EWA fishery purposes:

Winter-period Export Reduction (December–February):

Definition: "Asset spending goal" where a constraint is imposed on total Delta exports that equals 50,000 af less per month relative to the amount of export under the Regulatory Baseline. This is modeled as a monthly action and conceptually represents EWAT implementation of multiple several-day actions during the month.

Trigger: All years for December and January; also in February if the hydrologic year-type is assessed to be Above Normal and Wet according to the Sac 40-30-30 Index.

Pre-VAMP "Shoulder-period" Export Reduction (April –April 15):

Definition: Extend the target-restriction level applied for VAMP-period into the April 1-April 15 period.

Trigger: Never. It was not simulated to occur based on actions implemented by EWAT from WY2001–2003 and in the foreseeable future.

VAMP-period Export Reduction (April 15–May 15):

Definition: Reduce exports to a target-restriction level during the VAMP-period, regardless of the export level under the Regulatory Baseline; target depends on San Joaquin River flow conditions.

Trigger: All years. Taking action during the VAMP period has been an EWAT high priority in 2001–2003, and is therefore modeled as a high priority.

Post-VAMP "Shoulder-period" Export Reduction (May 16–May 31):

Definition: Extend the target-restriction level applied for VAMP-period into the May 16-May 31 period.

Trigger: In any May if collateral exceeds debt at the start of May.

June Export Reduction:

Definition: Steadily relieve the constraint on exports from the target-restriction level of the Post-VAMP period to the June Export-to-Inflow constraint level. Complete this steady relief on constraint during a 7-day period.

Trigger: If the Post-VAMP "Shoulder-period" Export Reduction was implemented and if collateral exceeds debt at the start of June.

The following assets are included in the OCAP modeling:

Allowance for Carryover Debt (Replacing "One-Time Acquisition of Stored-Water Equivalent" defined in the CALFED ROD)
Water Purchases, North and South of Delta
50 percent Gain of SWP Pumping of (b)(2)/ERP Upstream Releases
50 percent Dedication of SWP Excess Pumping Capacity (i.e., JPOD)
July-September Dedicated Export Capacity at Banks

The role of these fixed and operational assets in mitigating the effects of EWA actions is dependent upon operational conditions and is ascertained dynamically during the simulation. On the issue of the one-time acquisition of stored-water equivalent, the CALFED ROD specified the acquisition of initial and annual assets dedicated to the EWA, and EWA was to be guaranteed 200,000 acre-feet of stored water south of Delta.

CALSIM II Modeling Studies

The two Benchmark Studies (2001 and 2020 Level of Development) were developed by staff from both DWR and Reclamation for the purpose of creating a CALSIM II study that is to be used as a basis in comparing project alternatives. From the Benchmark Studies seven studies have been developed to evaluate the impacts of changes in operations for the Trinity River, Freeport Project, Intertie, Level of Development, CVP/SWP Project Integrations and SDIP.

Study 1 is used to evaluate how the operations and regulations have been impacted since the delta smelt biological opinion with (b)(2) operations acting as a surrogate for the 2:1 VAMP restrictions. Studies 2, 4, and 4a are to evaluate the CALFED Tier 1 environmental regulatory effects that are mandated by law. Studies 3, 5, and 5a were run to evaluate the EWA costs as the modeling can best simulate the current actions taken by the EWA program. The current EWA program may be regarded as representative of foreseeable future EWA operations. However, it is noted that the EWA has not been finalized with a long-term plan of operations. In this biological opinion, study 1 represents the baseline conditions (the 1995 OCAP conditions), study 5a represents the formal consultation simulations, and study 5 represents the early consultation simulations. Studies 4 and 4a were also analyzed in order to understand the beneficial effects of EWA.

Post-Processed EWA Results

The results in this section are from the EWA spreadsheet model developed by the DWR Transfers Section. The model accounts for assets that CALSIM II does not represent (i.e., E/I Relaxation, Exchanges, Source-Shifting; see Figure 8-17 of the BA for assets modeled). Like CALSIM II, the model can be used to describe annual EWA operations. However, the model provides many more assumptions on asset source and availability, and includes a financial cost module for analyzing asset-acquisition strategies. It is structured to accept output from CALSIM II runs and other computations to allow testing and analysis of how the EWA would fare if the 73-year hydrologic record were to be repeated. The DWR Transfers Section uses this model to test the ability of various tools and management options to meet annual targets for fish actions. Like CALSIM II, this model assumes that actions are implemented as Delta pumping curtailments. However, this model employs much simpler assumptions on action costs, assuming that they vary only with year-type. The annual average action costs by water-year type can be seen in Table 10.

Figure 8-18 of the BA shows the time series of annual debt status for the 73-year analysis. Simulated EWA operations led to accumulating assets during the long-term drought periods and accumulating debt during wet periods. Maximum debt accumulation happens in 1970 and is a little over 400 TAF. Figure 8-19 of the BA shows annual pumping expenditures. Figure 8-20 of the BA shows the annual costs in dollars for the EWA program. For more detailed results and assumption about the model see the EWA Model for OCAP appendix in the biological assessment.

Table 10. Annual EWA Expenditures Targets by Water Year Type

40-30-30 Index	Annual Cost
Wet	430,000 AF
Above Normal	490,000 AF
Below Normal	400,000 AF
Dry	300,000 AF
Critical	250,000 AF

CALSIM II Limitations

The main limitation of CALSIM II and the temperature models used in the study is the time-step. Mean monthly flows and temperatures do not define daily variations that could occur in the rivers due to dynamic flow and climatic conditions. However, monthly results are still useful for general comparison of alternatives.

CALSIM II cannot completely capture the policy-oriented operation and coordination the 800,000 af of dedicated CVPIA 3406 (b)(2) water and the CALFED EWA. Because the model is set up to run each step of the 3406(b)(2) on an annual basis and because the WQCP and Act actions are set on a priority basis that can trigger actions using 3406(b)(2) water or EWA assets, the model will exceed the dedicated amount of 3406(b)(2) water that is available. Moreover, the 3406(b)(2) and EWA operations in CALSIM II are just one set of plausible actions aggregated to a monthly representation and modulated by year type. However, they do not fully account for the potential weighing of assets versus cost or the dynamic influence of biological factors on the timing of actions. The monthly time-step of CALSIM II also requires day-weighted monthly averaging to simulate minimum in-stream flow levels, VAMP actions, export reductions, and X2-based operations that occur within a month. This averaging can either under- or over-estimate the amount of water needed for these actions.

Since CALSIM II uses fixed rules and guidelines results from extended drought periods might not reflect how the SWP and CVP would operate through these times. The allocation process in the modeling is conservative in that it is weighted heavily on storage conditions and inflow to the reservoirs that are fed into the curves mentioned previously in the Hydrologic Modeling Methods section beginning on page 8-2 of the BA and does not project inflow from contributing streams when making an allocation. This curve-based approach does cause some variation in results between studies that would be closer with a more robust approach to the allocation process.

CALSIM II Conclusions

The main reduction in Shasta Reservoir Storage is due to the decrease in imports from the Trinity through Spring Creek and Clear Creek Tunnels, which is caused from increased flow targets for the Trinity River. Trinity Reservoir storage decreases are due to increased flow targets for the Trinity River.

Decreases in Folsom Lake storage levels are due to increased demands associated with changes in the Level of Development along the American River. Level of Development would include buildout of the water rights and water service contracts. The operation of the American River, specifically operations for the in-stream flows and the demands for the Future simulations reflect operations specific to OCAP modeling and may be different than the agreement between Reclamation and the Lower American River Water Forum.

Impact differences between the five studies on the Feather River system are minimal and shift releases to either earlier or later in the year. The change in timing of releases has more to do with the EWA reduction than with increases in demands south of the Delta. Oroville does have reduced carryover storage in the Wet through Below Normal years due to a more aggressive allocation curve and increased demands south of the Delta but is less aggressive in the drier years due to reduced carryover storage.

The Stanislaus River shows no major impacts between the five studies because Interim Operations Plan elements are implemented in each of the studies. Assumptions associated with the Future condition studies do not seem to affect operational conditions as simulated under Today conditions.

The increase in export capacity with the intertie at Tracy and the ability to pump up to 8,500 cfs at Banks allows for more outflow to be pumped from the Delta. The upstream reservoirs show marginal extra releases for exports as a result of the increased capacity at the pumps.

October to January costs of operations for CVPIA Section 3406 (b)(2) increase in the future and limit the ability of (b)(2) to cover export restrictions. The over- and under-spending of allocated (b)(2) water shows the following:

The inability of CALSIM II to completely capture the adaptive management process that occurs on at least a weekly basis in the B2IT Meetings.

Over-spending demonstrates a need for CALSIM II to have improved forecasting of annual (b)(2) costs.

Under-spending shows that the current implementation needs a forecasting tool to allow for additional actions to be taken in Wet to Below Normal water years.

This representation shows just one set of actions that can be taken under CVPIA, and are not the actual operations. The CALSIM II representation of (b)(2) is meant to be used as a planning tool for grossly evaluating (b)(2) costs under various operating scenarios.

The simulated operations of EWA actions and assets in both the Today EWA and Future EWA studies seem to be somewhat in balance. It is noted that simulated EWA operations are based on assumptions that do not perfectly map to the considerations affecting real EWA operations:

CALSIM II must simulate EWA operations on a monthly time step with relatively inflexible rules that must apply for a wide variety of simulation years (according to hydrology and operational conditions); EWA assets are utilized on a day-to-day basis through a flexible, adaptive management process.

CALSIM II employs an annual position analysis paradigm to track multiple operational baselines, which necessitates split accounting for new and carryover debt; EWAT's procedures for tracking multiple operational baselines does not get interrupted annually as does CALSIM II, and therefore describes debt without the split accounting.

CALSIM II represents action possibilities (especially during Winter and June) as a monthly representation of many different action possibilities; expenditure of EWA assets is flexible and selects among many combinations of multi-day actions during Winter and/or June.

To reiterate, the CALSIM II representation of EWA operations is a simplified representation that reflects an adaptive management program and does not represent the true operational flexibility of the EWA. The CALSIM II model is meant to capture a reasonable representation of EWA's current and foreseeable operations.

Overall CVP/SWP Effects-Formal Consultation

Effects of the re-operation of the Trinity River

Although the proposed changes in CVP operations resulting from implementation of the Trinity River

Fishery Restoration Program will result in decreased flow down the Sacramento River, this change in flows is anticipated to result in minimal effects to delta smelt and delta smelt habitat. Flows to the Sacramento River will be reduced (see figure 9-6 of the biological assessment) and the timing of water movement into and through the Sacramento watershed would change as a result of these changes in CVP operations. The reduction in flows could have an additional small effect on the location on X2, which in turn could affect delta smelt. Smelt are usually distributed around the location of X2 from February through June. An upstream movement of X2 could cause smelt to be distributed further upstream into the east and south Delta, where they could be more susceptible to entrainment at the export facilities and at local diversions in the Delta, and increased mortality due to high temperatures or predation.

The CH2MHill Trinity analysis (dated November 5, 2003) mapped X2 location outputs from CALSIM II modeling. This analysis included only the effects of the Trinity River added to the "today" Study. The outputs showed that upstream movements of X2 greater than 0.5 km due to increased flows in the Trinity River occurred in a total of 26 months. The Service then analyzed the upstream movements of X2 and eliminated upstream movements in X2 in the 73 year record in wet years or in dry years. In wet years, X2 is located in Suisun Bay, which provides a shallow, protective, food-rich environment for delta smelt. An upstream movement of 0.5 km in wet years would result in an X2 location that would still be located in Suisun Bay, which would not be significant for delta smelt since substantial high quality habitat would still be available. In dry years, X2 is located upstream of the confluence of the Sacramento and San Joaquin Rivers and the habitat available to smelt is poor and the upstream movement does not result in any substantial additional loss of habitat or increase in adverse effects. When X2 is located upstream of Chipps Island, smelt would already be susceptible to entrainment or mortality due to high temperatures. The critical thermal maximum for delta smelt was experimentally determined to be 25.4 degrees Celsius in the laboratory (Swanson et al., 2000); and at temperatures above 25.6 degrees Celsius smelt are no longer found in the Delta (DFG, pers. comm.). By ruling out wet and dry years, the Service determined that there were 2 months (out of a possible 355 months) where the upstream movement of X2 could result in a loss of habitat for delta smelt. The delta smelt risk assessment matrix (DSRAM, see project description) includes a trigger for the delta smelt working group to meet when X2 is upstream of Chipps Island during the period from February to June. If this trigger is met, the delta smelt working group may recommend an action to be taken to minimize effects to delta smelt (see delta smelt risk assessment matrix process discussion in the project description). Use of the DSRAM and subsequent implementation of recommendations made by the delta smelt working group, where practicable, will minimize the effects of movement of X2 on delta smelt resulting from the reduction of Trinity River water diverted down the Sacramento River. Therefore, the Service has determined it is not necessary to provide specific reasonable and prudent measures to reduce effects to delta smelt from the proposed changes in CVP operations resulting from implementation of the Trinity River Fishery Restoration Program.

Effects of Increased Level of Development on the American River

The greatest impact to the American River is the increases in demands from the 2001 (Today) to the 2020 (Future) Level of Development (LOD). The actual deliveries, based on long-term average, increase from a total of 251,000 af in the 2001 LOD to 561,000 af in the 2020 LOD. The ability to fill Folsom Reservoir in May is reduced from 50 % of the time to 40 % of the time between the Today and

Future runs (see Figure 9-47 of the BA). Carryover September storage in Folsom Reservoir is reduced by 30,000 to 45,000 af on a long-term average basis from the Today to the Future Study.

Effects to delta smelt from these lower amounts of water from the American River cannot be specifically determined from the CALSIM II modeling. Generally, a higher American River LOD will not result in an overall change of delta smelt habitat through a change in outflows or the location of X2 since more water would be released from Shasta if needed to make up for the reduction in American River water. Less American River water may reduce flexibility for Reclamation and DWR to meet WQCP requirements and may contribute to lower Reservoir storages elsewhere in the system.

Effects of the Freeport Diversion

The Freeport Regional Water Authority (FRWA) has a design capacity of 287 cfs (185 million gallons per day). Up to 132 cfs would be diverted under Sacramento County's existing Reclamation water service contract and other anticipated water entitlements and up to 155 cfs of water would be diverted under EBMUD's amended Reclamation water service contract. Under the terms of its amendatory contract with Reclamation, EBMUD is able to take delivery of Sacramento River water in any year in which EBMUD's March 1 forecast of its October 1 total system storage is less than 500,000 af. Additionally, EBMUD can only take 133,000 af in any one year, not to exceed 165,000 af in any consecutive 3-year drought period. Modeling shows that EBMUD takes an annual max of 94,000 af five times in the 73 years that are analyzed (1939, 1959, 1962, 1968 and 1987). The 165,000 af limit is reached in two consecutive years 3 times (1929-1930, 1959-1960, and 1987-1988) and in three consecutive years 4 times (1962-1964, 1976-1978, 1977-1979 and 1990-1992). Table 9-55 in the biological assessment shows the average annual Freeport diversions by water year type.

Effects to delta smelt from water diversions at Freeport would be similar to the increased American River demands in that the specific effects of the Freeport diversions cannot be determined from the CALSIM II analysis. Again, losses of water in the Sacramento River due to higher demands on the American River would be made up with additional water from other parts of the system and outflows and X2 are not likely to be affected by the Freeport diversions. This consultation does not authorize the construction activities required for the Freeport diversion.

Suisun Marsh Salinity Control Gates

The Suisun Marsh Salinity Control Gates impair free movement of delta smelt into or out of Montezuma Slough. Smelt in Montezuma Slough when the gates are down may be subject to entrainment due to private and state-owned diversions. Smelt may also be subject to increased predation at the gates by predatory fish.

Effects of Diversions in Barker Slough/North Bay Aqueduct

Analysis of the effects of the North Bay Aqueduct is based on monitoring required under the March 6, 1995 OCAP Biological Opinion. Specifically, the 1995 Biological Opinion required the Department of Water Resources (DWR) to monitor larval delta smelt in Barker Slough, from which the North Bay Aqueduct (NBA) diverts its water. Since then, monitoring has been required every other day at three sites from mid-February through mid-July, when delta smelt may be present. As part of the Interagency Ecological Program, DWR has contracted with the Department of Fish and Game to conduct the required monitoring each year since the Biological Opinion was issued.

Data from the past 9 years of monitoring show that catch of delta smelt in Barker Slough has been consistently very low, an average of just five percent of the values for nearby north Delta stations (Cache, Miner and Lindsay sloughs) (Figure 12). In other words, sampling over the past decade indicates that a relatively small portion of the delta smelt population in this region is typically susceptible to NBA diversions. Moreover, recent research by the Interagency Ecological Program indicates that well-designed positive barrier fish screens (such as those used by NBA) effectively limit smelt entrainment. These results are consistent with Nobriga et. al. (2004), who found that a small diversion with a positive barrier screen resulted in no entrainment of delta smelt, despite the fact that the diversion was located in a region of high smelt density.

In summary, NBA diversions do not appear to have had a substantial effect on delta smelt. The proposed operations are sufficiently similar to indicate that the effect of NBA on smelt will continue to be relatively low.

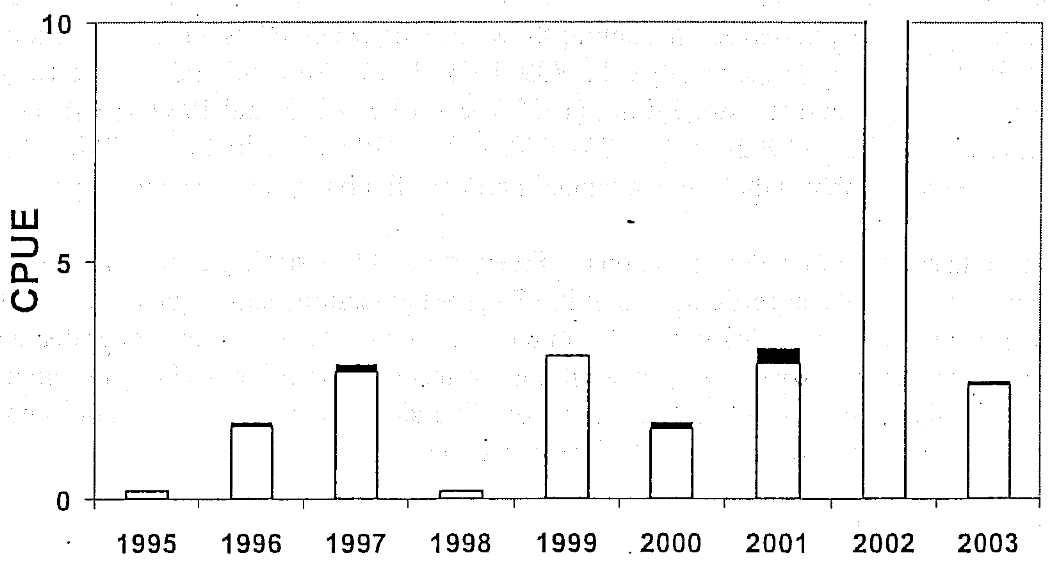


Figure 12 Comparison of delta smelt catch-per-unit-effort (fish/trawl) for NBA monitoring sites in Barker Slough (dark bars) to nearby north Delta sites: Lindsay, Cache and Miner sloughs (white bars). The NBA values are the mean annual CPUE for stations 720, 721, and 727. The nearby North Delta sites represent the mean annual CPUE for stations 718, 722, 723, 724, and 726

Based on these findings, the Delta Smelt Working Group (Working Group) has recommended a broader regional survey during the primary period when delta smelt are most vulnerable to water project diversions. An alternative sampling approach would be conducted as a 1-2 year pilot effort in association with the Department of Fish and Game's existing 20-mm survey (http://www.delta.dfg.ca.gov/data/20mm). The survey would cover all existing 20-mm stations, but would have an earlier seasonal start and stop date to focus on the presence of larvae in the Delta. The proposed gear type is a surface boom tow, as opposed to oblique sled tows that have traditionally been used to sample larval fishes in the San Francisco Estuary. Under the proposed work plan, the Working Group will evaluate utility of the study and effectiveness of the gear in each year of the pilot work. This new monitoring effort may give a better understanding of the abundance and distribution of larval delta smelt and may help the Working Group in its recommendations to WOMT to change project operations to protect smelt. This monitoring study may result in the harm, or harassment of delta smelt. Incidental take associated with this study is included in the incidental take in this biological opinion.

Effects of Rock Slough and other CCWD Diversions

The Contra Costa Water District (CCWD) diverts CVP water from the Delta for irrigation and M&I uses. The Rock Slough diversion can divert up to 350 cfs and is not currently screened for delta smelt. CCWD's biological opinion for the Los Vaqueros Reservoir required the Rock Slough diversion to be screened for delta smelt. Reclamation requested an extension to the screening requirement until 2008, when the use of Rock Slough will be determined by the proposed Los Vaqueros expansion project. The Service granted this request in a letter dated December 10, 2003 (Service File #1-1-04-F-0034). Effects due to entrainment of delta smelt will be offset by the purchase of compensation habitat for delta smelt as long as the facility remains unscreened. No additional water is proposed to be diverted from the Rock Slough diversion as a part of this project.

Contra Costa Water District also operates diversions that are screened for delta smelt at Mallard Slough and on Old River. These diversions are not expected to change as part of the proposed project and their effects are covered in separate Section 7 consultations with the Service.

Effects of Changes in X2 Location

The X2 standards in SWRCB D-1641 were intended to provide adequate transport flows to move delta smelt away from the influence of the CVP/SWP water diversion facilities into low-salinity rearing habitat in Suisun Bay and the lower Sacramento River. This is based on previous research showing the longitudinal distribution of delta smelt during its larval and juvenile stages is related to flow magnitude and its correlate, X2 position (Sweetnam and Stevens 1993; Dege and Brown 2004). Therefore, during the larval and juvenile phases, river flows of sufficient magnitude and duration facilitate down-estuary movement from spawning habitats in the delta to rearing habitats.

Young delta smelt are usually distributed upstream of X2 (Sweetnam 1999; Dege and Brown 2004). A recent study showed that since the sudden population decline in the early 1980s, upstream placement of X2 during spring is associated with low delta smelt abundance in the DFG Tow-net Survey (Kimmerer, 2002). Prior to 1982, the opposite was true: delta smelt abundance was highest when X2 was in or near the Delta. Currently, the central and south Delta are generally no longer suitable habitat for post-larval delta smelt due to entrainment losses and/or altered habitat conditions. Thus, D-1641 requires the X2 location to meet certain requirements from February through June, as described in the project description. The CALSIM II modeling considers the D-1641 standards to be the baseline condition. However, in certain years, hydrologic conditions may result in the X2 standard not being met for as many days as in the baseline. Even if D-1641 X2 standard continues to be met, there could be adverse effects to delta smelt if X2 moves upstream of Chipps Island in the future Study (as modeled in the BA). Since delta smelt generally move with X2, a further upstream location of X2 near Chipps Island in the future Study could result in a distribution pattern wherein more delta smelt would be susceptible to entrainment and elevated mortality in the Central and South Delta due to high temperatures or predation. The critical thermal maximum for delta smelt under laboratory conditions is 25.4 degrees Celsius (Swanson et al., 2000); and at temperatures above 25 degrees Celsius smelt are no longer found in the Delta (DFG, pers. comm.). South Delta temperatures can approach 25 degrees Celsius in May and June, and exceed 25 Celsius during summer months. The future Study could result in an upstream movement of X2 due to increased pumping at the CVP, increased American River demands, the Freeport diversion, and less water from the Trinity River.

Two analyses were done to assess the effects of the proposed project on the movement of X2 and subsequent effects to delta smelt: an analysis using CALSIM II modeling and a graphical analysis by CH2MHill. The CALSIM modeling results were done by Reclamation and used a 1 kilometer change in X2 location as a criterion and are presented in the biological assessment. The CH2MHill analysis used a half kilometer change in the location of X2 as a criterion and is presented in Appendix L of the biological assessment.

CALSIM II Analysis
The X2 position in CALSIM II represents where the 2 ppt isohaline lies, as calculated from the monthly average Net Delta Outflow (NDO). Since the model represents the end of month X2 position, the day-to-day effects of CVP/SWP operations are not shown in the CALSIM II representation.

The monthly average X2 position based on long-term and water year type-dependent averages are shown in Figures 13 to18. The six Figures generally depict the same trend from February to June with regard to the average X2 position as it moves more upstream into the Delta. In the months of Februrary, April, May, and June the X2 position shifts slightly downstream in the formal consultation Study (Study 5a) when compared to the other Studies which were modeled. This means that overall outflow conditions for delta smelt may be improved slightly in the formal consultation Study. However, sporadic upstream movements of X2 may have adverse effects.

Figures 19 to 23 show the X2 position sorted from wettest to driest years, according to the 40-30-30 Index, and show the variability within a particular group of water years. These results show that X2 moves upstream as the water years get drier. Figures 24 to 26 show the total number of days where the X2 position is downstream of one of the three compliance points (Confluence, Chipps Island and Roe Island) varies annually. These latter results represent gross approximations because CALSIM II must estimate "the total number of days" values based on monthly, rather than daily, simulation results. These graphs indicate that average changes to X2 under the proposed actions for formal consultation are minor (i.e., within the measurement error of X2 position). For further definition of the modeled CALSIM II studies, see Table 10 in the beginning of the effects section.

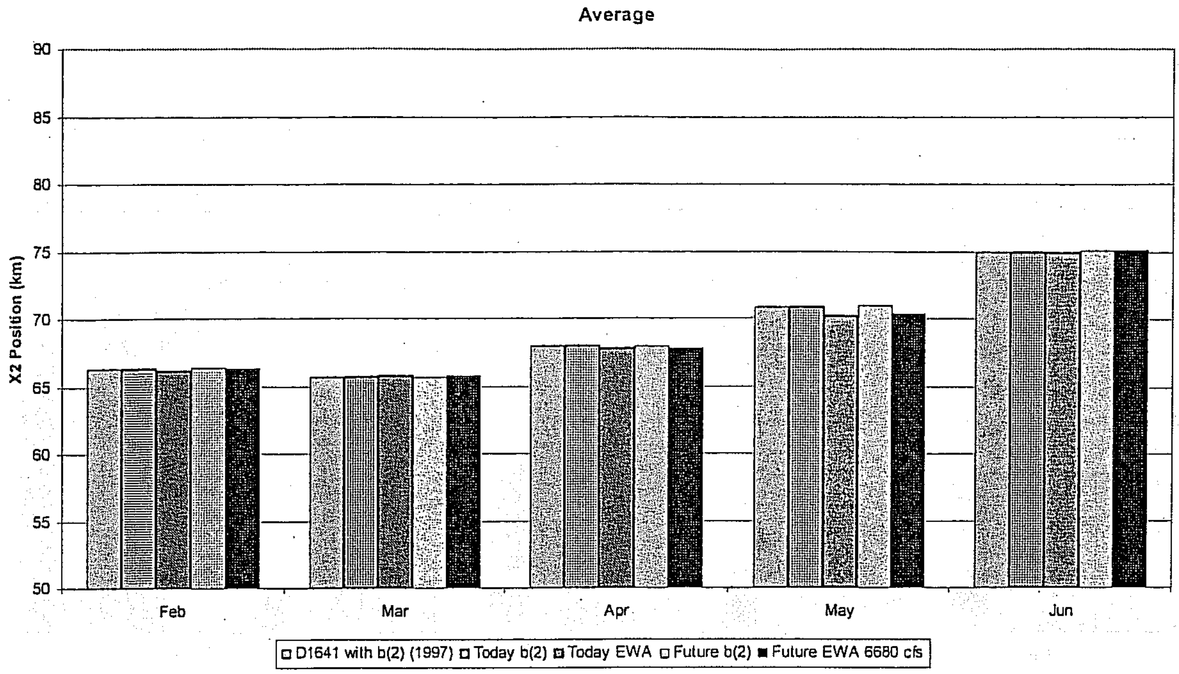


Figure 13 Average Monthly X2 Position

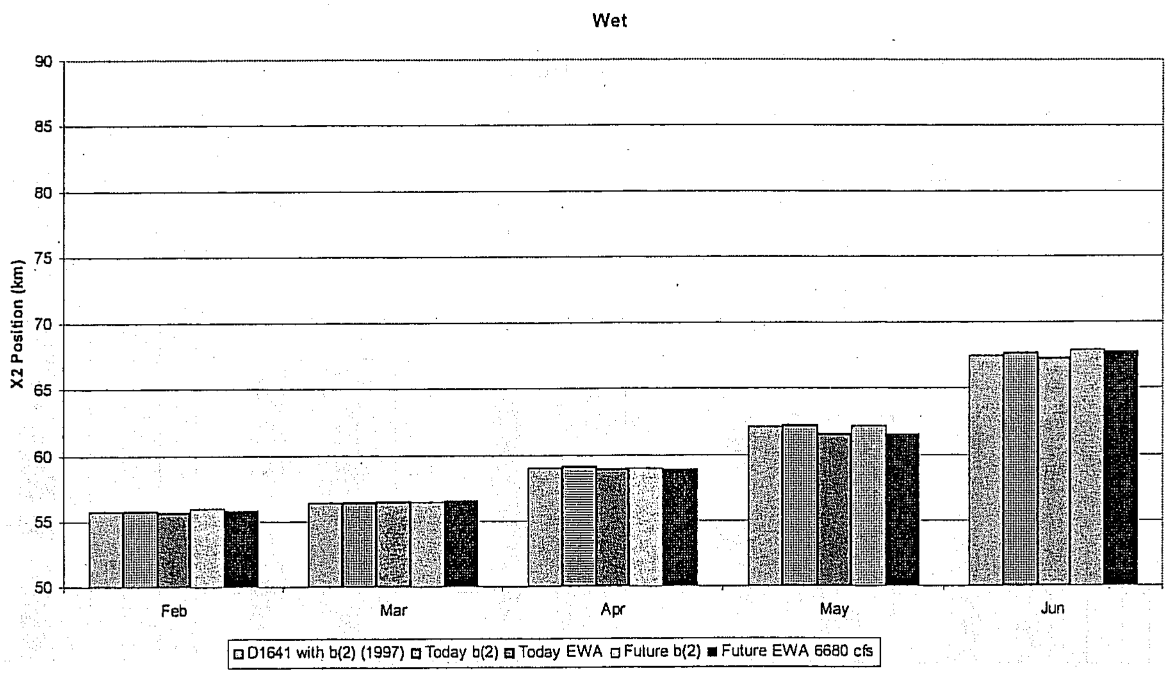


Figure 14 Average wet year (40-30-30 Classification) monthly X2 Position

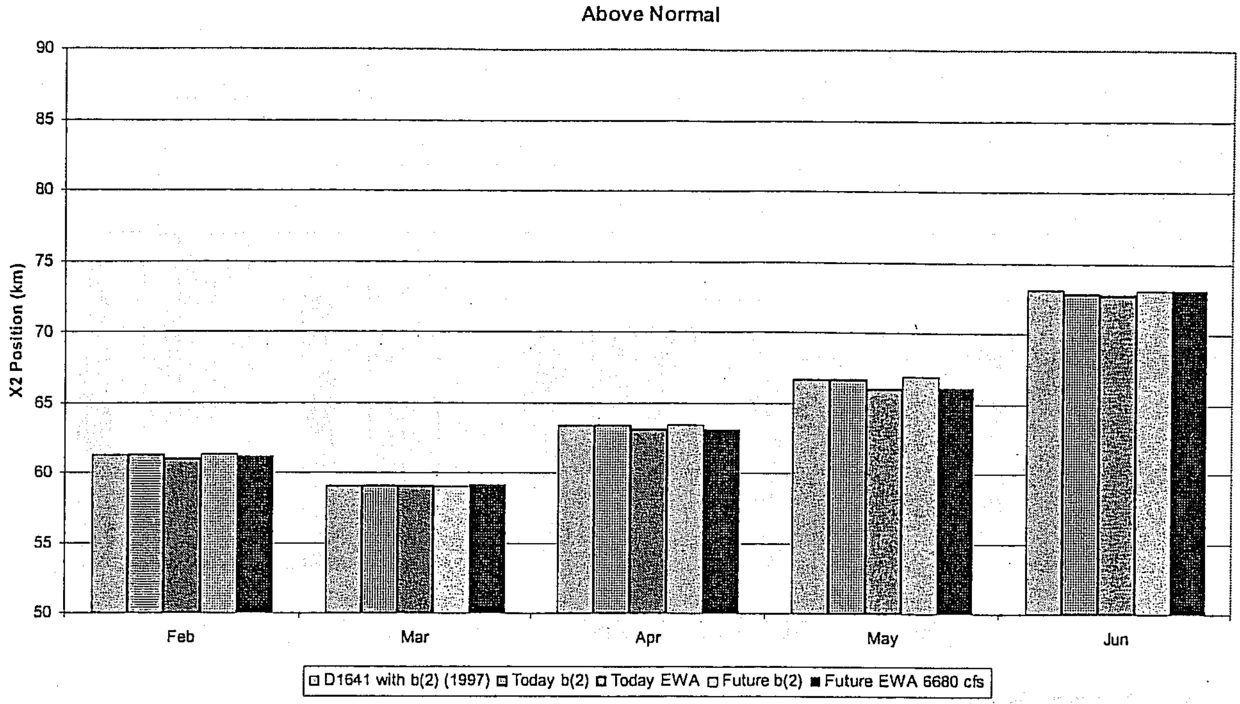


Figure 15 Average above normal year (40-30-30 Classification) monthly X2 Position

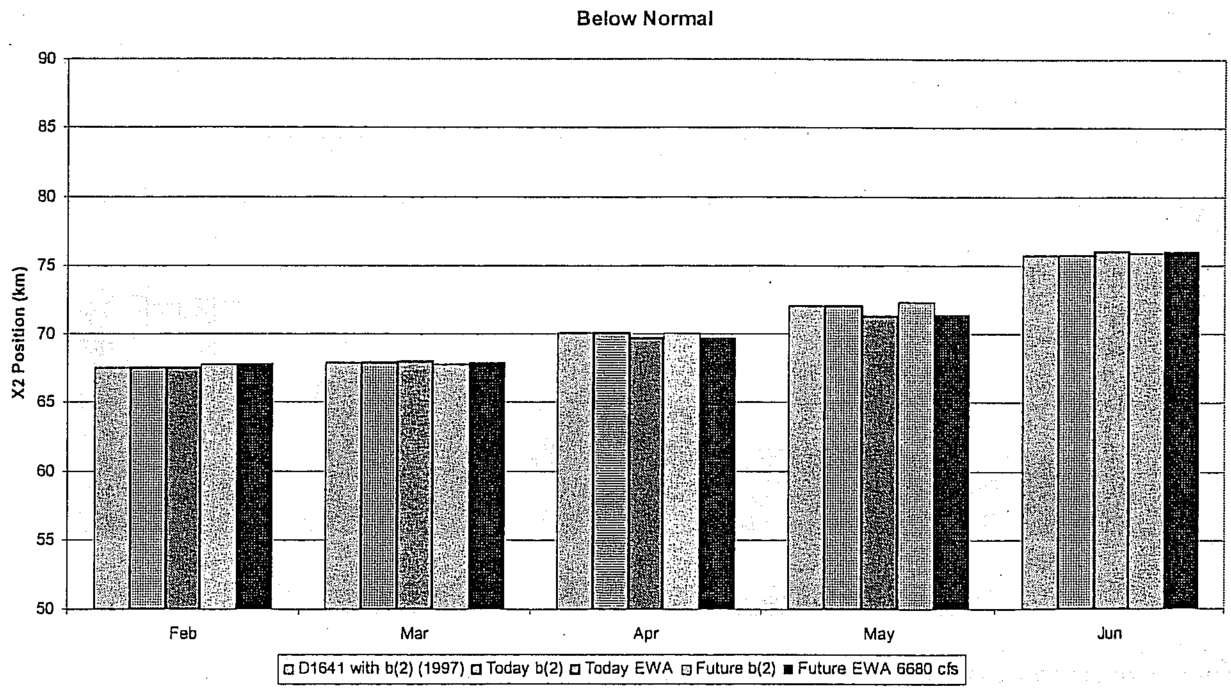


Figure 16 Average below normal year (40-30-30 Classification) monthly X2 Position

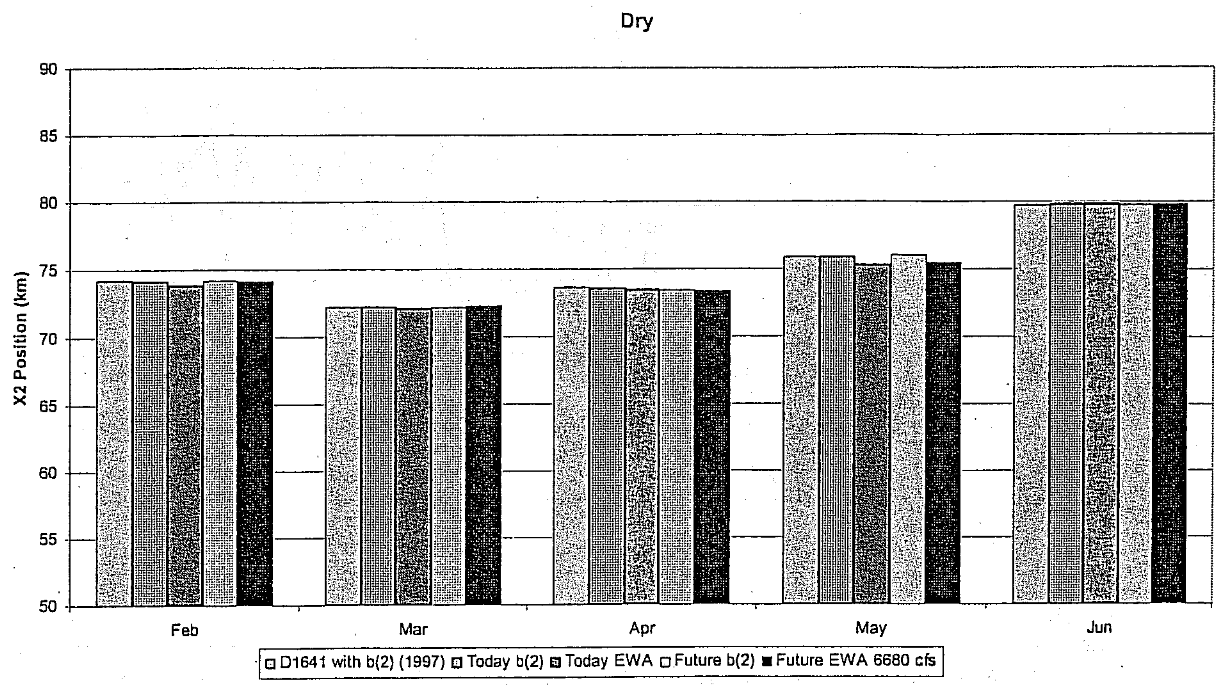


Figure 17 Average dry year (40-30-30 Classification) monthly X2 Position

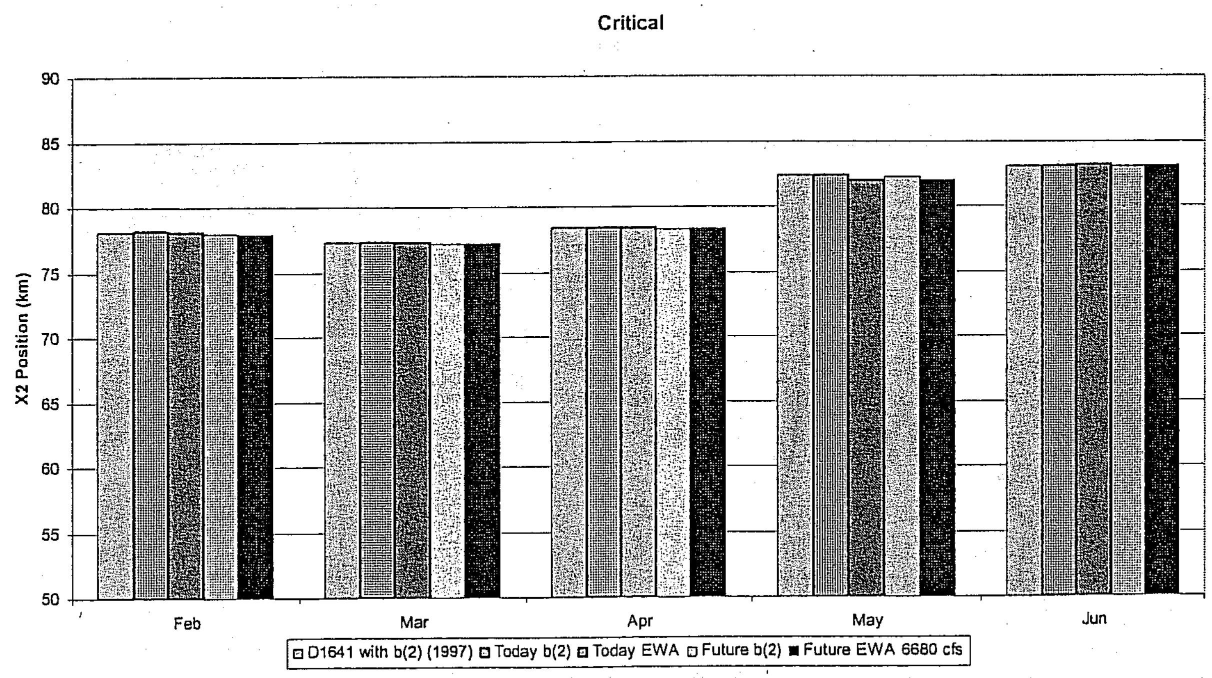


Figure 18 Average critical year (40-30-30 Classification) monthly X2 Position

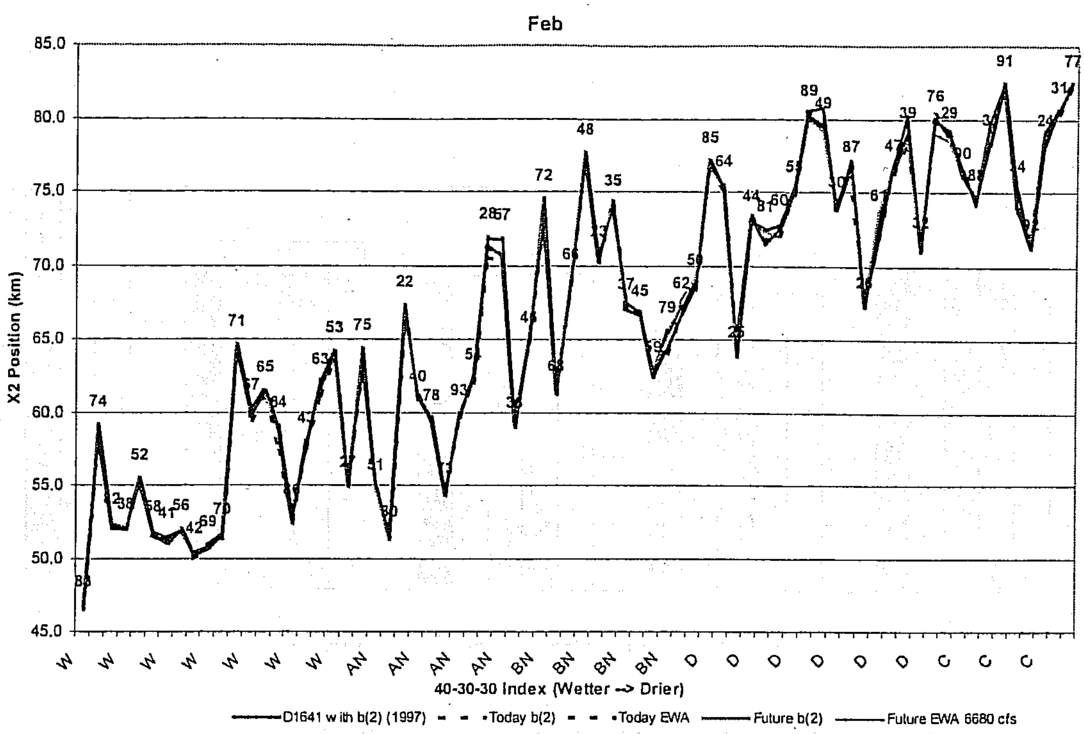


Figure 19 February X2 Position sorted by 40-30-30 Index

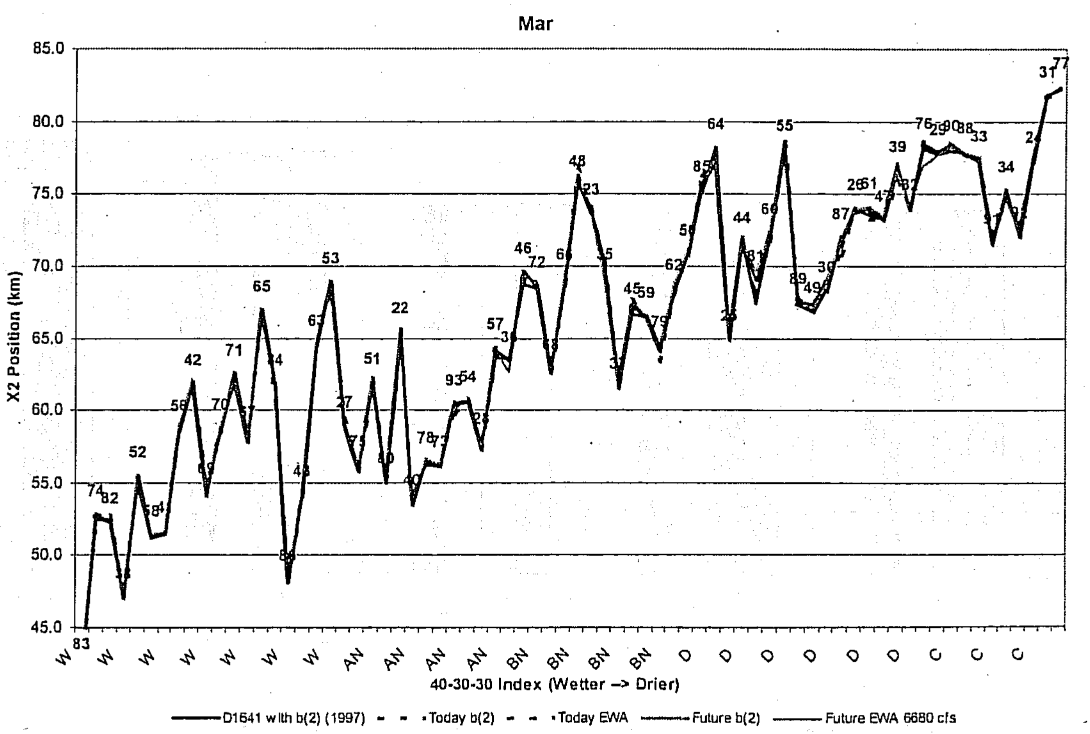


Figure 20 March X2 Position sorted by 40-30-30 Index

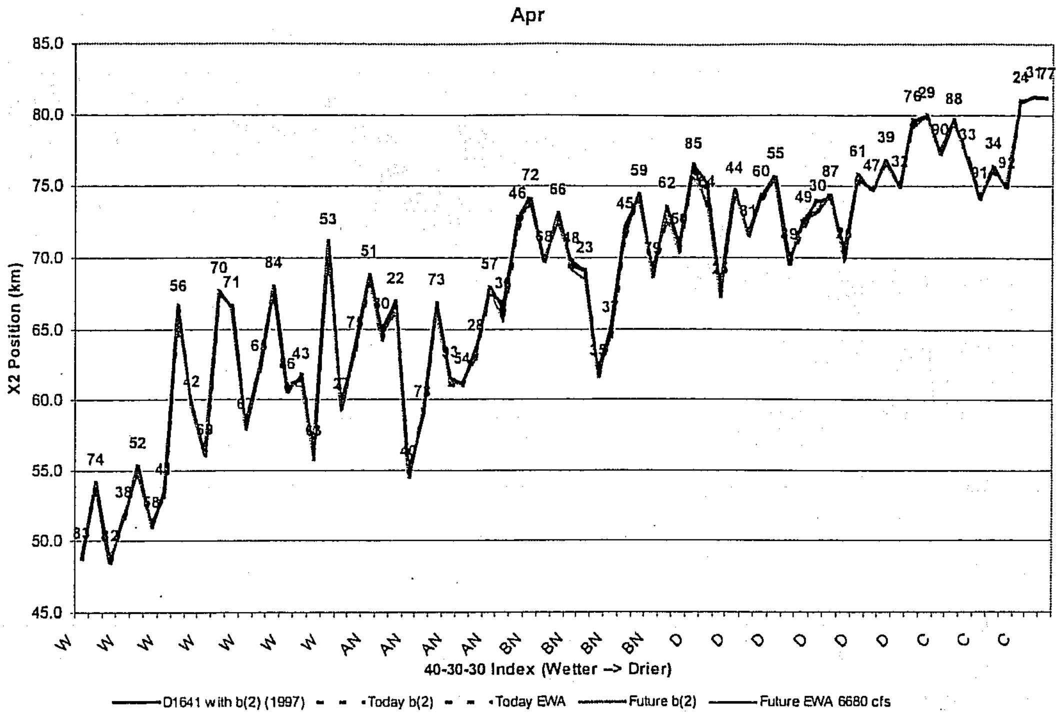


Figure 21 April X2 Position sorted by 40-30-30 Index

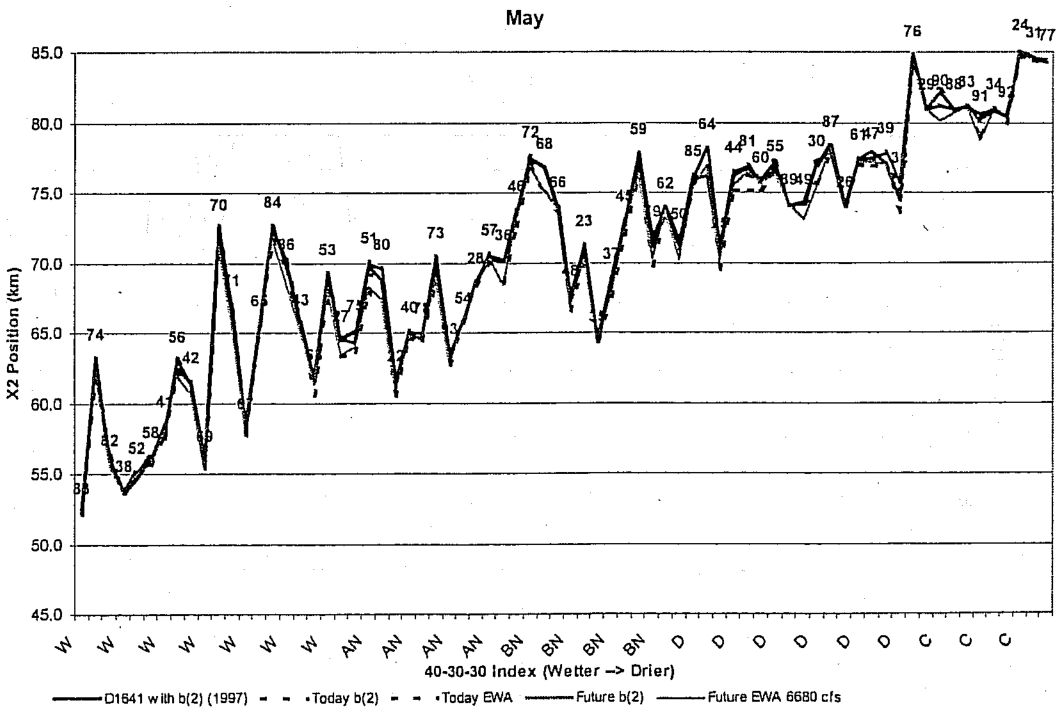


Figure 22 May X2 Position sorted by 40-30-30 Index

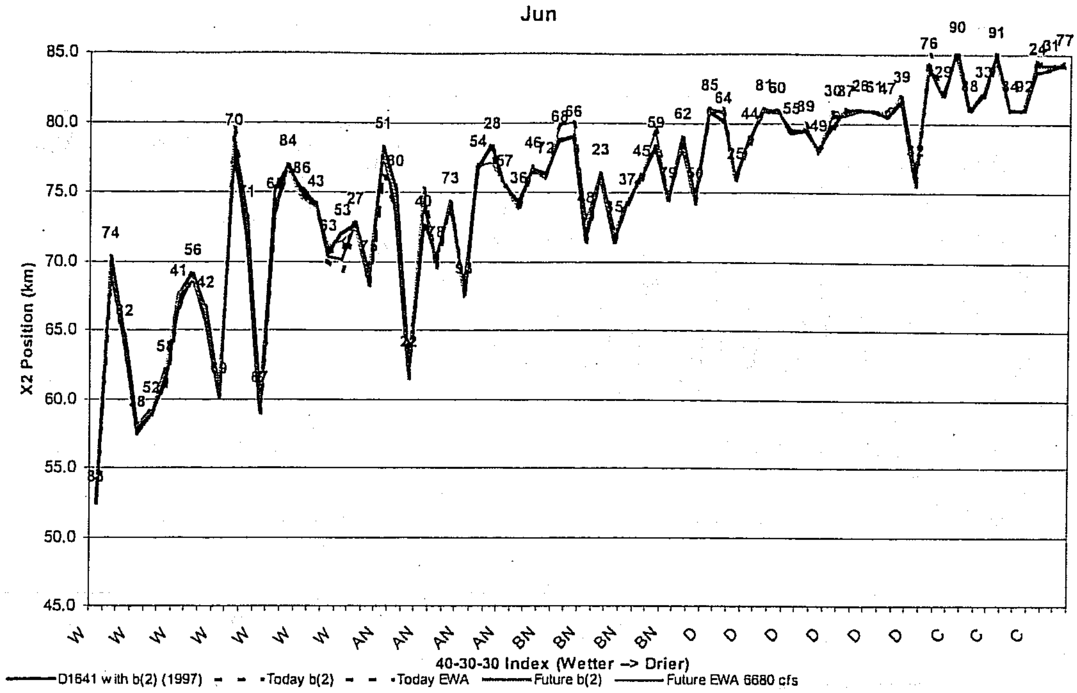


Figure 23 June X2 Position sorted by 40-30-30 Index

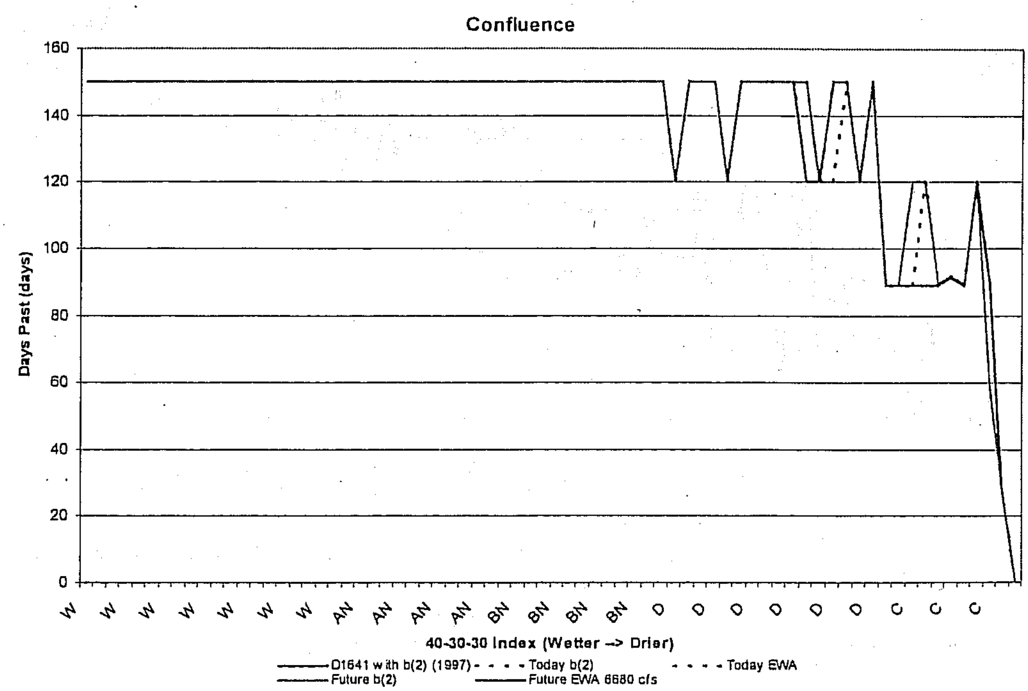


Figure 24 Total number of days average monthly X2 position is past the Confluence 40-30-30 Index (Note: that the total days for a month are assigned if the average X2 position is past the confluence)

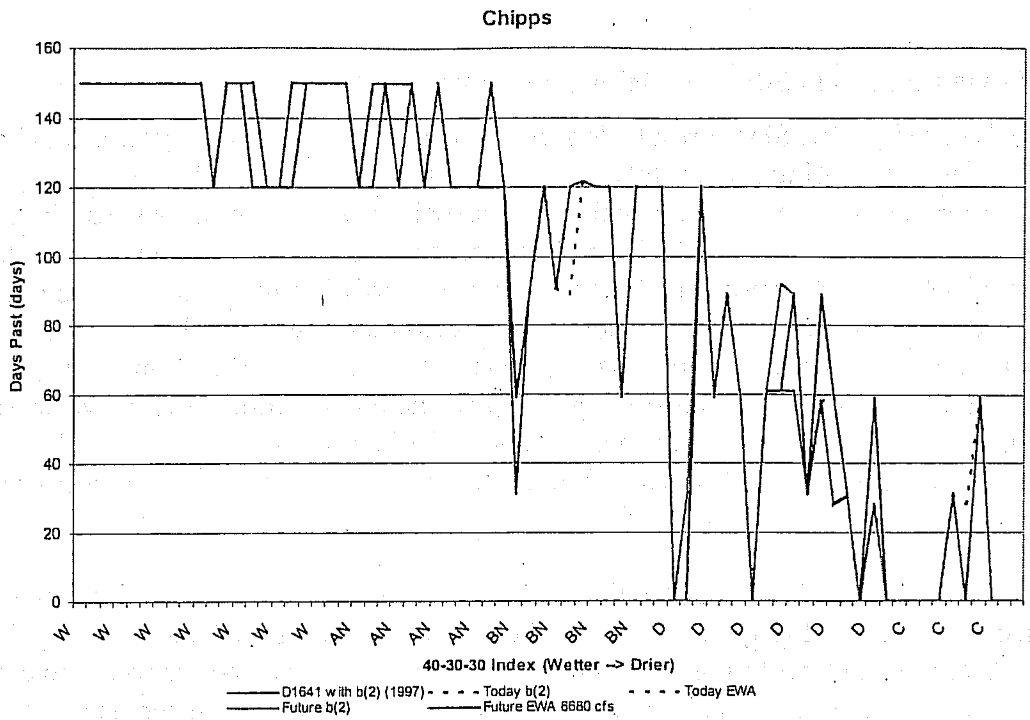


Figure 25 Total number of days average monthly X2 position is past the Chipps Island 40-30-30 Index (Note: that the total days for a month are assigned if the average X2 position is past the Chipps Island)

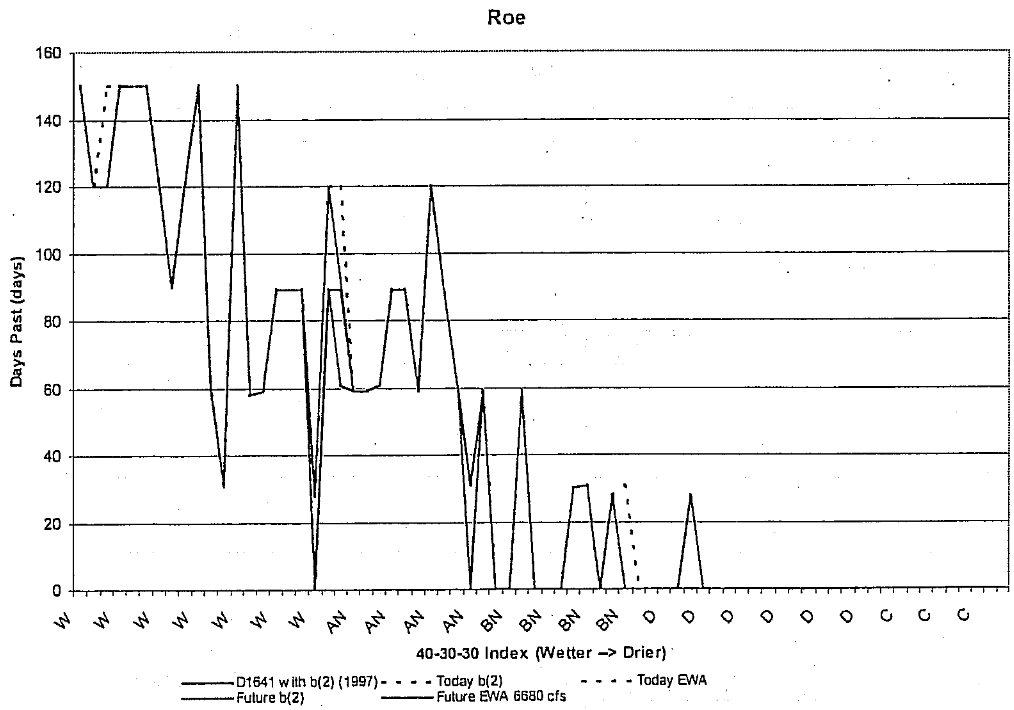
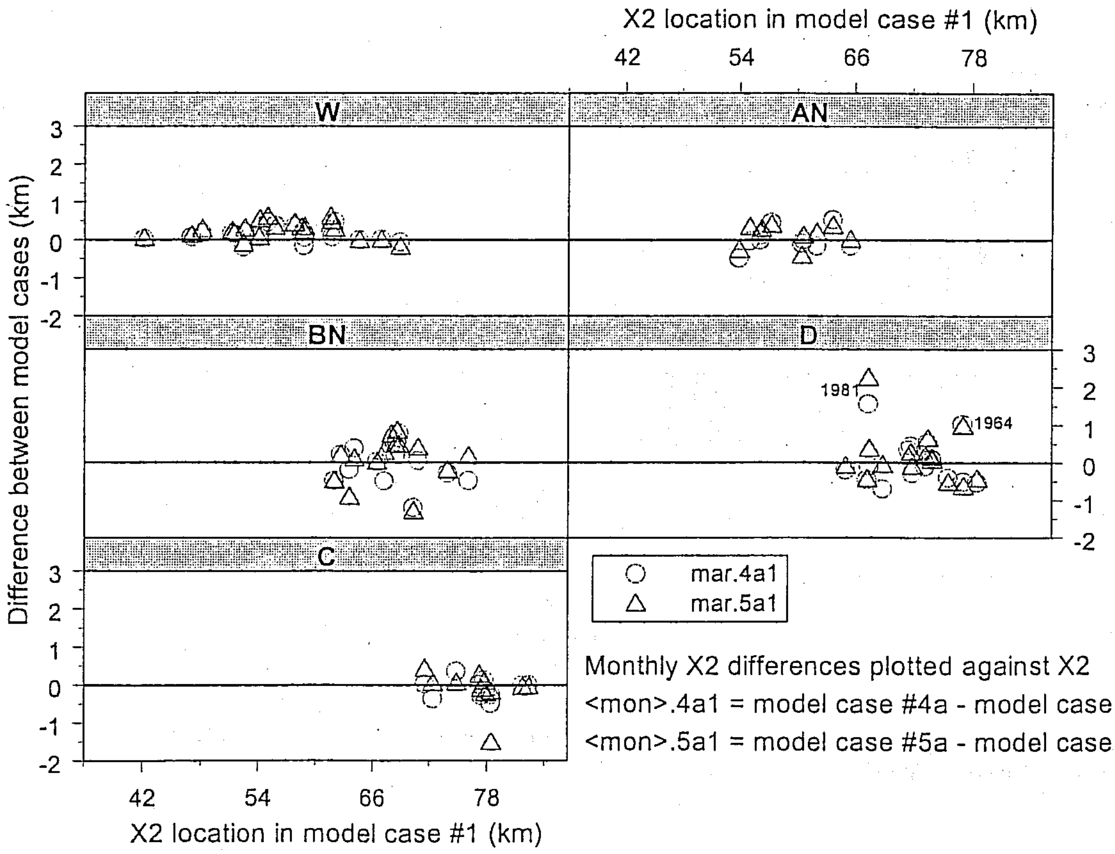


Figure 26 Total number of days average monthly X2 position is past the Roe Island 40-30-30 Index (Note: that the total days for a month are assigned if the average X2 position is past the Roe Island)

Changes in Habitat Availability for Delta Smelt Based on X2 Movement

Another analysis using CALSIM II results looked at changes in X2 by water year and month. The average position of X2 during March–July of each year differed very little between Study #1 and either #4a or #5a. However, a review of the monthly data revealed that there were isolated differences that were larger than most others during the March–July months. Concern arises with regard to upstream movements of X2 during the spring and early summer primarily because smelt tend to aggregate in a region defined by low salinity, and movement of that region upstream moves those aggregations closer to the export pumps. Upstream movements of X2 can cause smelt to become more susceptible to entrainment in the south Delta (March-July) and expose them to potentially lethal water temperatures (June-July). Because there is presently no known basis for identifying a particular value as the critical one separating a detrimental X2 difference from an innocuous one, one kilometer was selected as a conservative (protective) criterion for review.

The differences between X2 in CALSIM II Study #4a and #5a and Study #1 (as described in Table 10) were plotted against X2 in Study #1 for each of the months March through July (Figure 27 to 31). In each figure, five panels representing each of the Sacramento River water-year types are presented. Positive differences represent movement of X2 upstream. In each figure, difference values larger than one kilometer in Below Normal, Dry, and Critically Dry years have been labeled with the years they represent.



Monthly X2 differences plotted against X2
<mon>.4a1 = model case #4a - model case #1
<mon>.5a1 = model case #5a - model case #1

Figure 27 Differences in X2 under Studies #4 and #5 in March. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

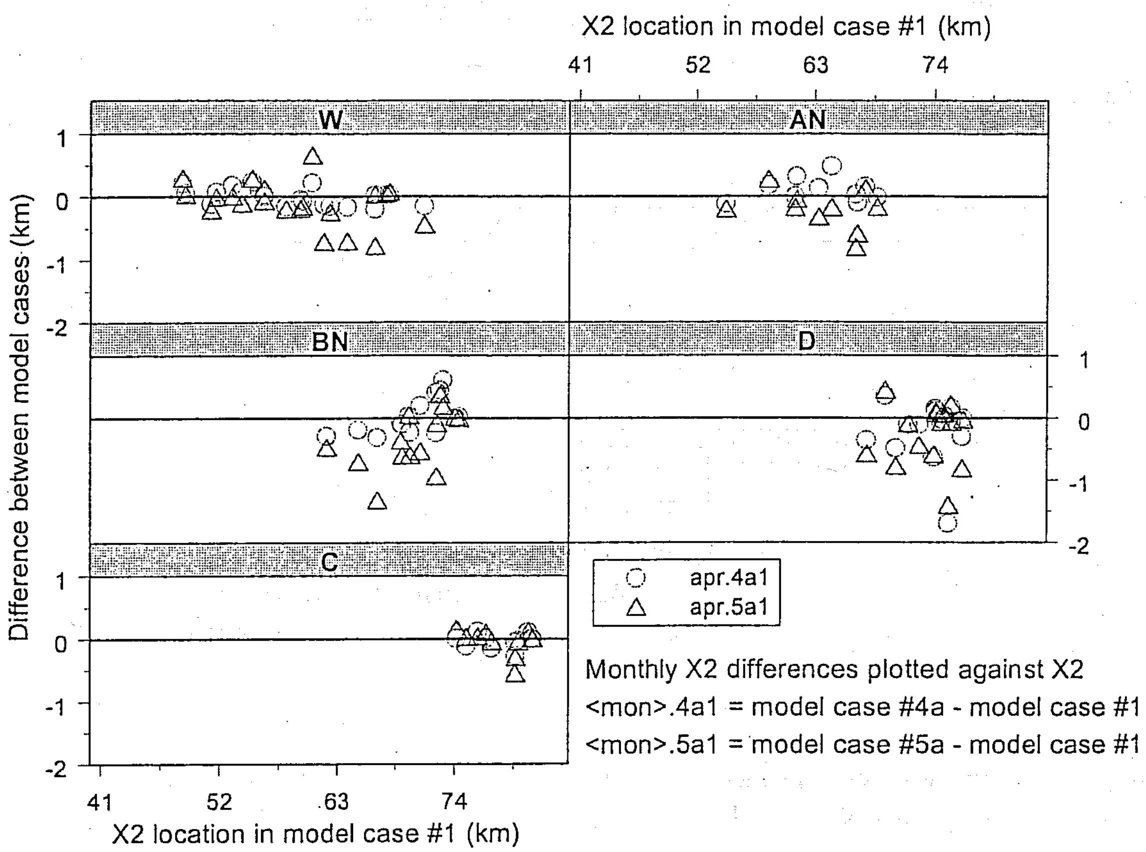


Figure 28 Differences in X2 under Studies #4 and #5 in April. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

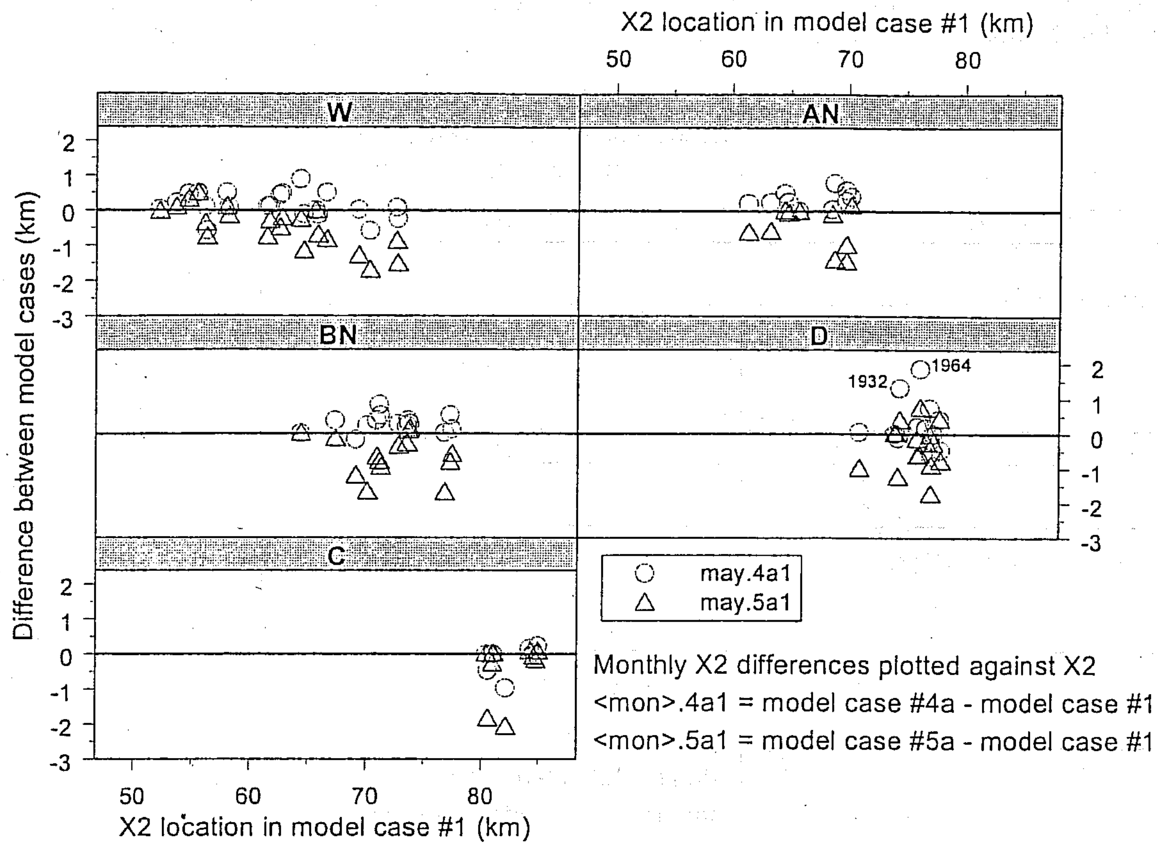


Figure 29 Differences in X2 under Studies #4 and #5 in May. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

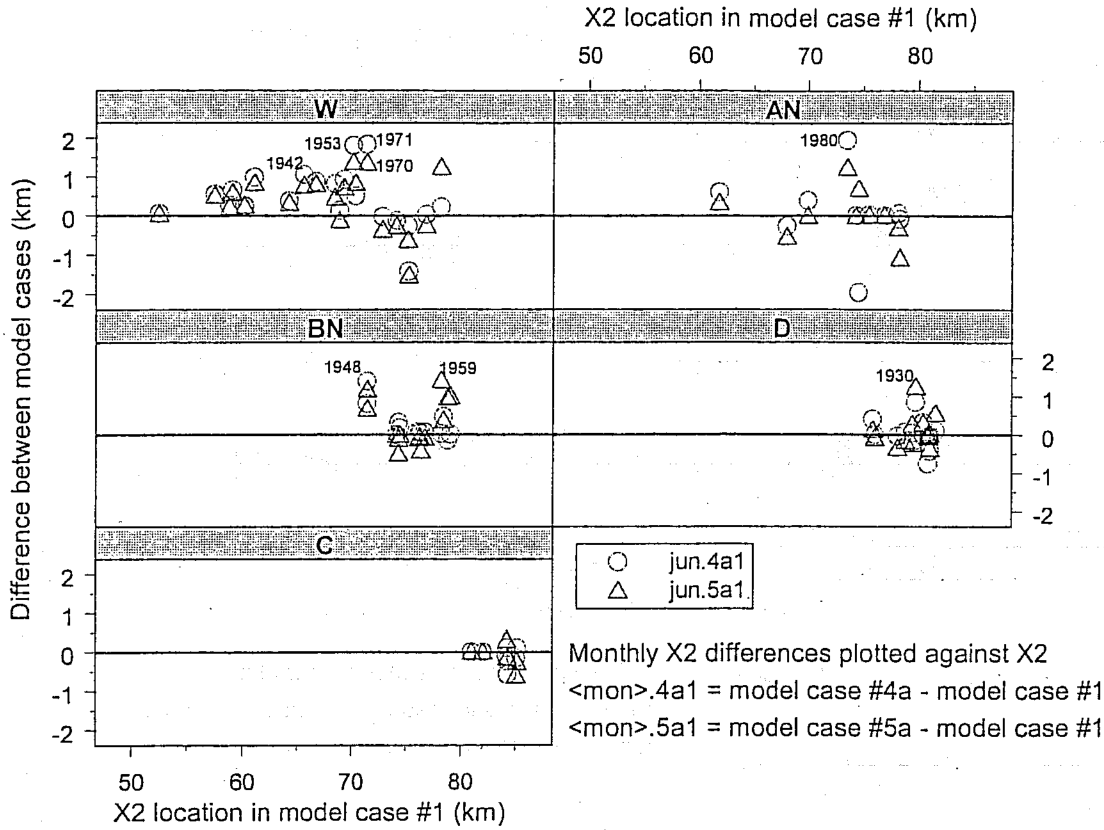


Figure 30 Differences in X2 under Studies #4 and #5 in June. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

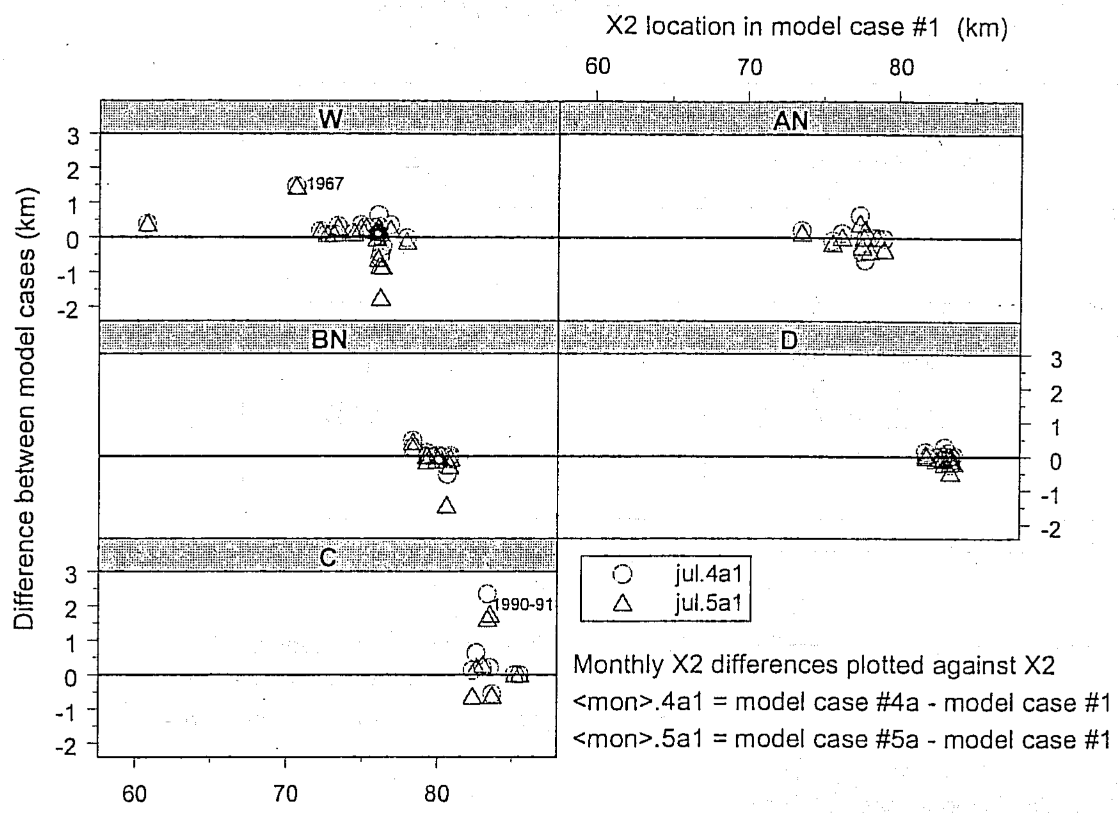


Figure 31 Differences in X2 under Studies #4 and #5 in July. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

Results

March

Relative to Study #1, there were two detectible upstream shifts of X2 of at least one kilometer in Dry years in Scenario #4a (1964:1.0 km; 1981: 1.5 km) and one in #5a (1981: 2.2km). Neither Study involves a movement past Chipps Island. In all three Studies the shift in the following month was downstream of the value predicted in Study #1. Most differences that occurred in March in this comparison involved a movement of X2 downstream in the future scenario.

April

There were no detectible differences larger than one kilometer in April.

May

There were two detectible differences of at least one kilometer shift upstream in Study #4a during May in Dry years (1932:1.3 km; 1964: 1.8 km). There was no occurrence in Study #5a. In Study #4a, the 1932 positive May value was followed by a smaller (0.4 km) upstream movement in June; the 1964 upstream movement in May was followed by a downstream movement in June (-0.8). The 1.3 km 1932 shift in Study #4a appears to pass Chipps Island.

June

In June there were three differences of at least a kilometer in Study #4a in Wet years (1942: 1.1 km; 1953: 1.8 km; 1971: 1.8 km), one in an Above Normal year (1980: 2.0 km), and one in a Below Normal year (1948: 1.4 km). All of these except 1971 was followed by a smaller upstream movement in July. In Study #5a there were three in Wet years (1953: 1.4 km; 1970: 1.2 km; 1971: 1.4 km), one in an Above Normal year (1980: 1.2 km), two in Below Normal years (1948: 1.2 km; 1959: 1.4 km), and one in a Dry year (1930: 1.2 km). Four of these seven were followed by downstream movements in July. In none of these Studies does X2 appear to move past Chipps Island.

July

In Study #4a, the criterion was reached in one Wet year (1967: 1.5 km) and one Critically Dry year (1990, 2.3 km). The Critically Dry year occurrence was followed by a small downstream difference in August; the Wet year occurrence was followed by an even larger (1.8 km) upstream difference in August. In Study #5a, the criterion was reached in 1967 (1.4 km), 1990 (1.6 km), and 1991 (a Critically Dry year, 1.7 km). The two Critically Dry year occurrences were followed by negative differences in August, while the Wet year occurrence was followed by a larger upstream movement (1.8 km) in August. None of these Studies involved a shift past Chipps Island.

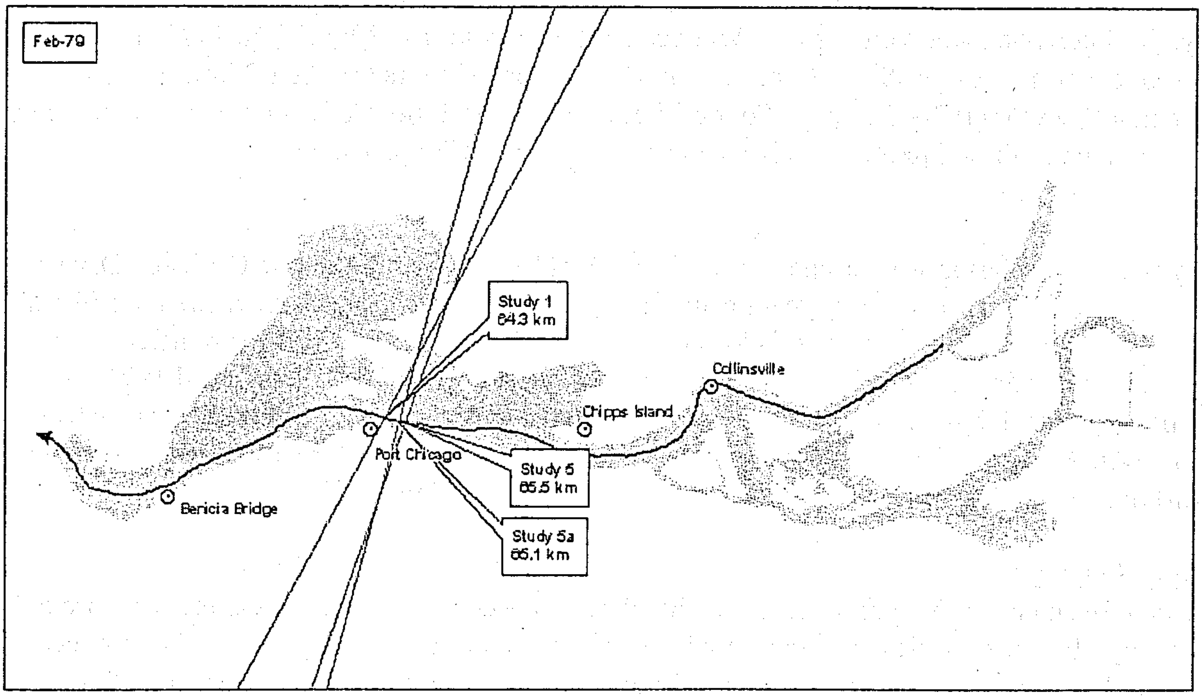
Modeling Summary

Upstream movements of X2 predicted in the future model Studies reach one kilometer or more only occasionally. In some Studies upstream movements observed in Study #4a are erased or reduced in Study #5a. In a few Studies the upstream movement is larger in Study #5a. There were a few movements from the west to the east side of Chipps Island, but these were of small magnitude.

CH2MHill Analysis

The CH2MHill analysis, as shown in Appendix L of the BA compared the location of X2 for February through June for the future Study as compared to the base Study (study 5A vs. study 1). The monthly X2 location was taken from the CALSIM II modeling studies. X2 locations from study 5A and study 1 were then mapped (see figure 31 for an example) to show how far X2 moved upstream. In wet years, X2 is located in Suisun Bay throughout the modeled period. An upstream movement of 0.5 km in wet years would not significantly reduce habitat quality or quantity for delta smelt. In drier years, X2 is located upstream of the confluence of the Sacramento and San Joaquin Rivers and the amount of quality habitat available to delta smelt is minimal and adult abundance is low (Bennett 2003). When X2 is located this far upstream, delta smelt would already be susceptible to increased mortality due to high temperatures, predation and entrainment. An upstream movement of X2 of 0.5 km would not be significant when it is located upstream of the confluence because smelt habitat is already poor and the upstream movement does not result in any substantial additional loss of habitat or increase in adverse effects. This analysis showed that there were 28 months (out of a possible 360 months) where X2 moved upstream more than 0.5 km. By ruling out the wet and dry years described above, the Service determined that there were 5 months out of the 28 months where the upstream movement of X2 could result in a substantial loss of habitat for delta smelt.

Figure 32



Therefore, in order to protect smelt from detrimental effects when X2 is upstream of Chipps Island, the DSRAM will be used to determine whether actions are necessary to protect delta smelt. The DSRAM and a description of it is located in Appendix A. The DSRAM has a number of triggers that determine when the Delta Smelt Working Group meets. One of the triggers calls for the Delta Smelt Working Group to meet if X2 is upstream of Chipps Island and temperatures are between 12 and 18 degrees Celsius, the approximate range of spawning temperatures for delta smelt. If this trigger is met, the Working Group will meet to evaluate whether to a change in operations such as a change in exports, San Joaquin River flows, barrier operations or cross channel gates might help protect smelt. The Working Group's recommendation will then be sent to the WOMT for consideration of implementation. Through these actions, potentially detrimental effects to delta smelt due to an upstream movement of X2 will be avoided or ameliorated.

Pumping at the CVP and SWP Facilities

Tracy Pumping

The Tracy Pumping Plant in Studies 4a and 5a the intertie allows pumping to increase to the facility design capacity of 4600 cfs (from its current pumping rate of 4200 cfs). Figure 33 shows the percentile values for monthly pumping at Tracy. November through February are the months when Tracy most frequently pumps at 4600 cfs. Tracy can better utilize the 4600 cfs pumping in wet years in Study 4a and Study 5a. As shown in Figure 33, from December through February the pumping is decreased in Study 5a by the 25 TAF/month placeholder for the EWA program. April, May and June show reductions compared to other months because of the VAMP restrictions, and May shows further reductions due to EWA spending some assets to implement the May Shoulder pumping reduction. July through September show pumping increases generally for irrigation deliveries.

Figures 34 to 39 show similar trends in monthly average exports by year type, with pumping being greatest December through February and July through September. The exception is in the Critical year (Figure 39) when the pumping stays between 1000 cfs and 1500 cfs through August due to reduced storage and water quality (salinity) in the Delta. In general, pumping at Tracy will increase in Study 5a and may increase the number of delta smelt entrained, but these increases in entrainment would be minimized by implementation of the DSRAM and use of EWA water to reduce exports.

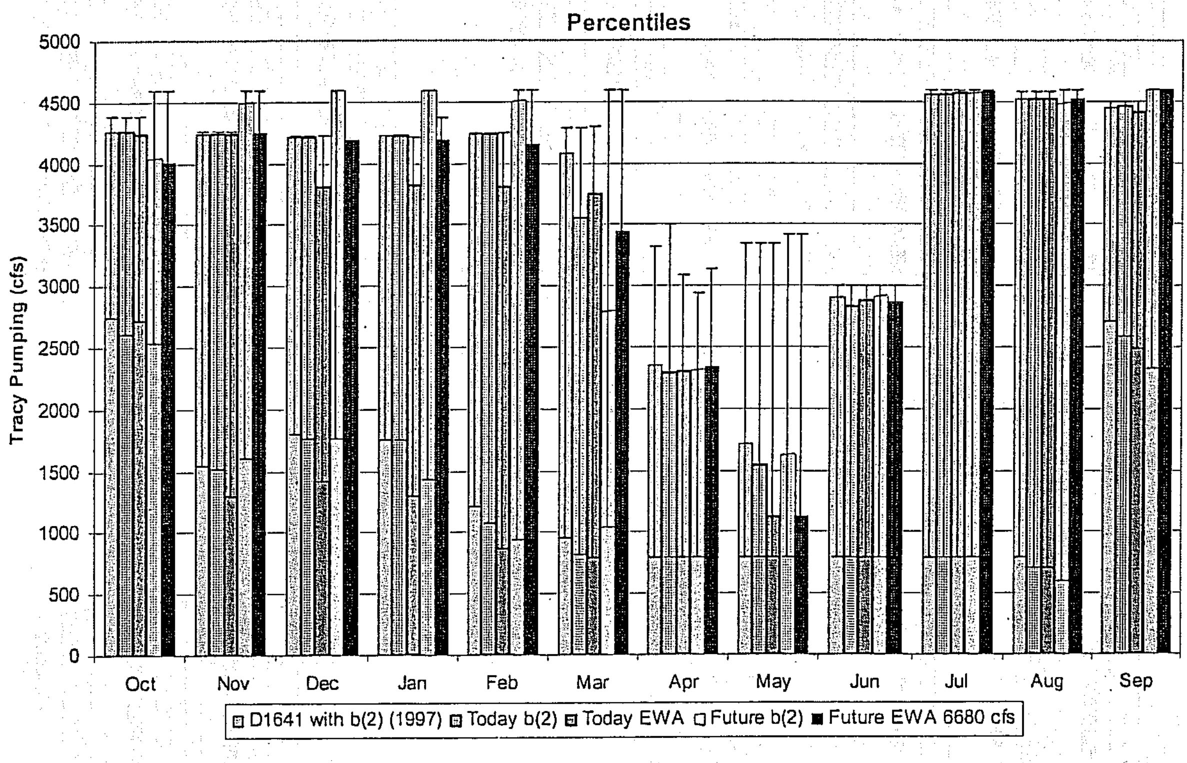


Figure 33 Tracy Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

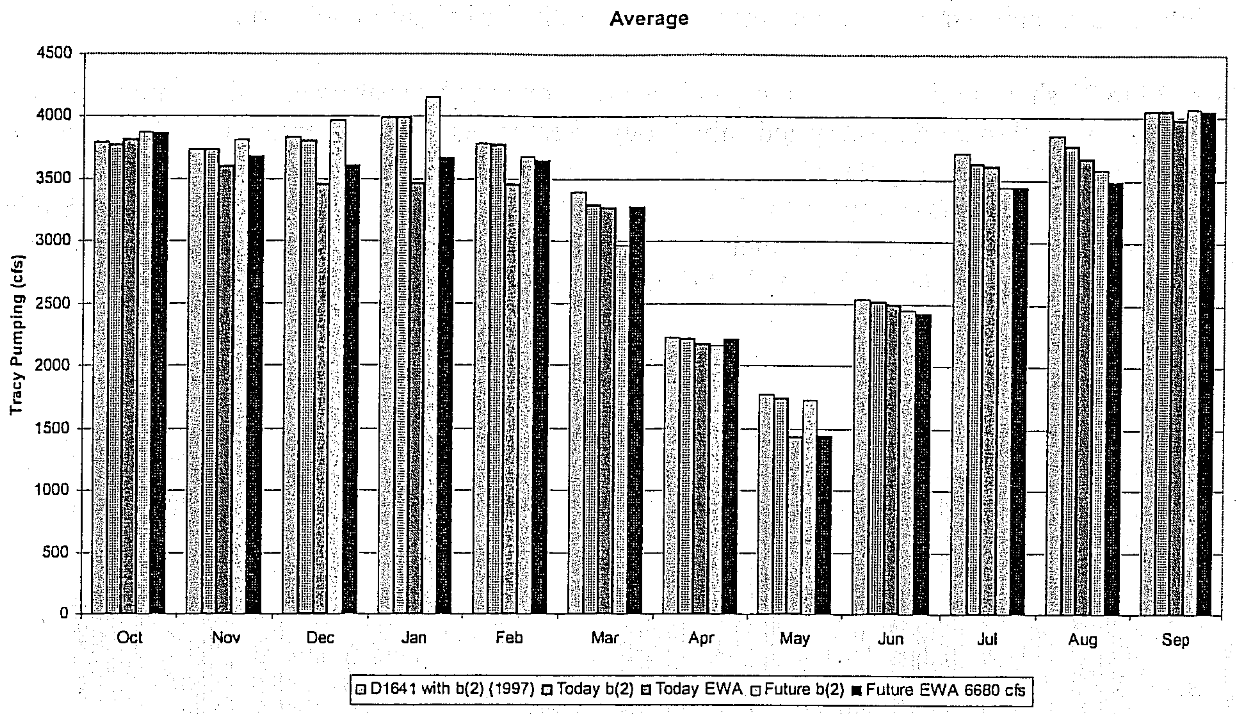


Figure 34 Average Monthly Tracy Pumping

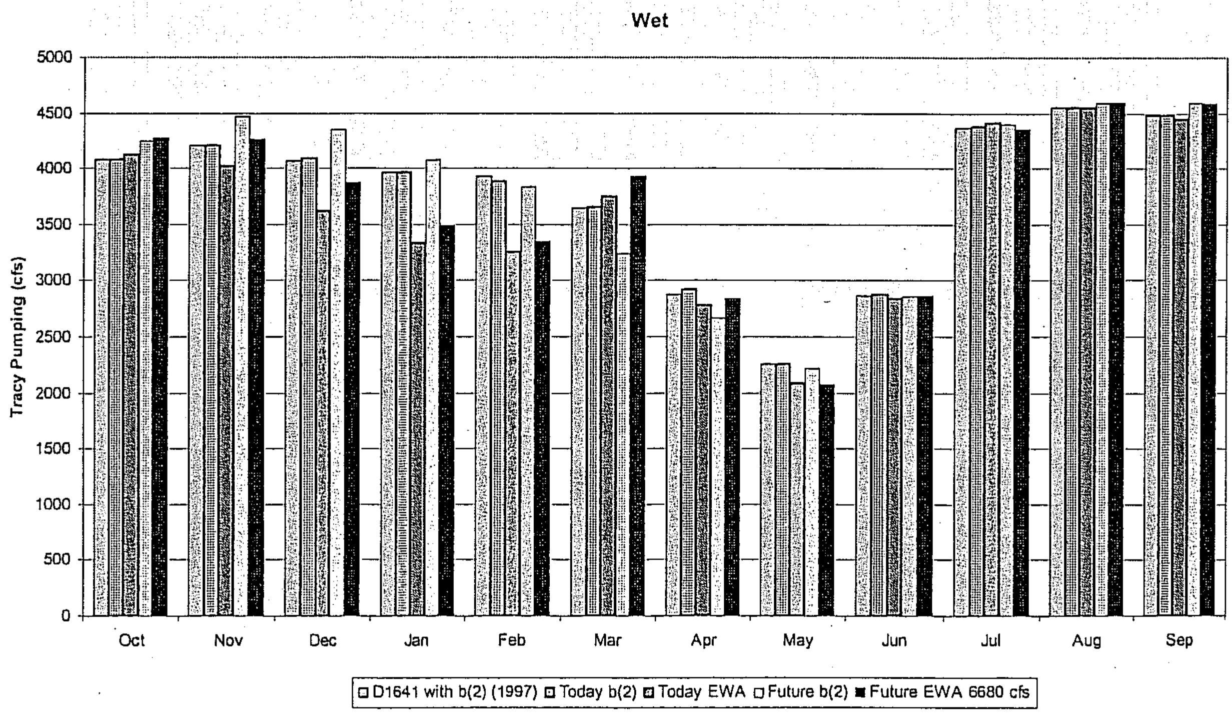


Figure 35 Average wet year (40-30-30 Classification) monthly Tracy Pumping

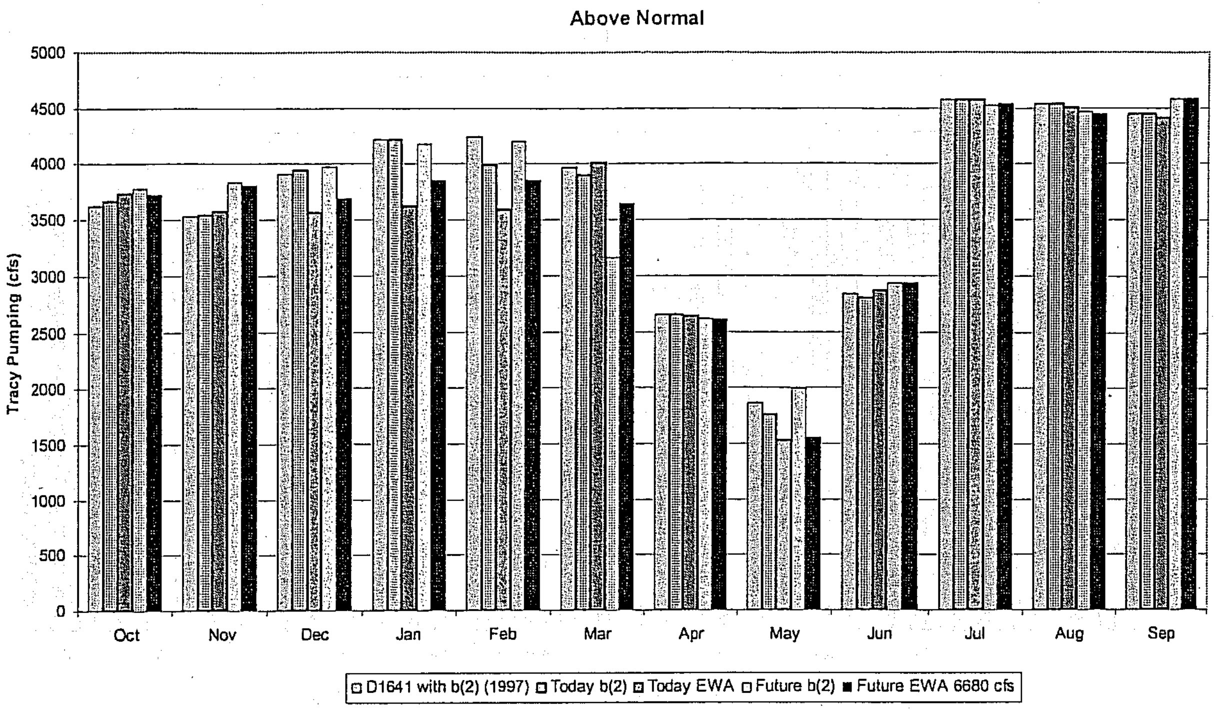


Figure 36 Average above normal year (40-30-30 Classification) monthly Tracy Pumping

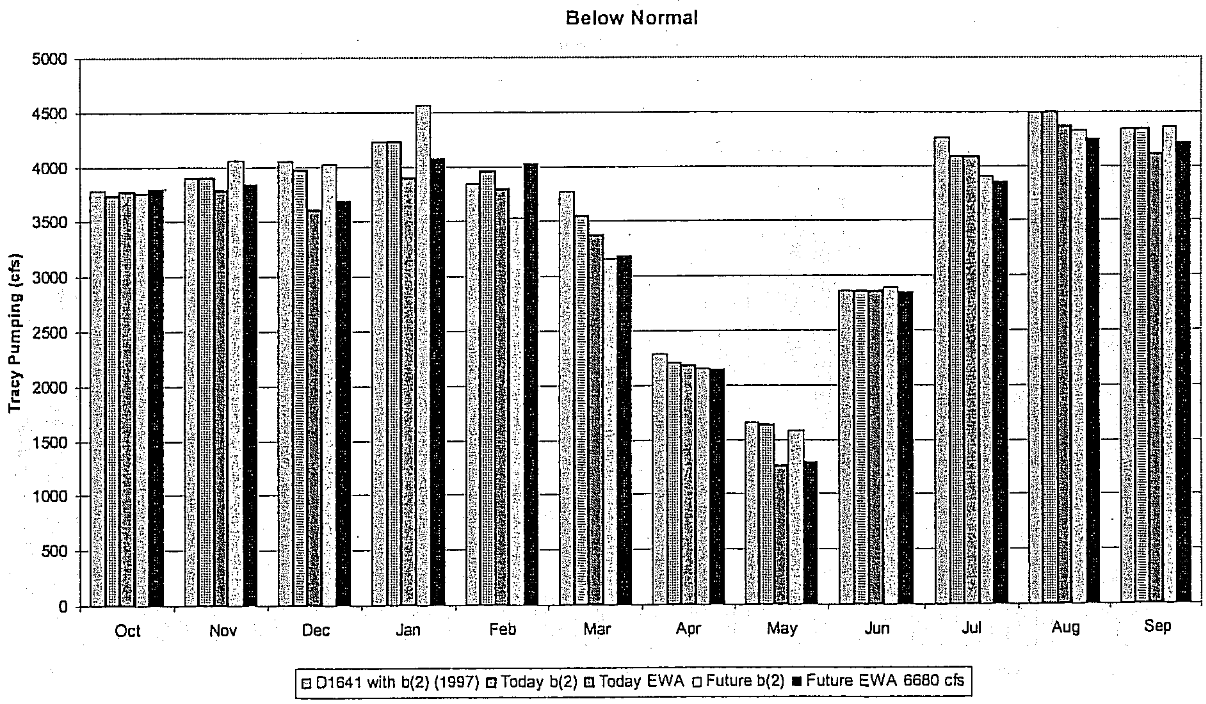


Figure 37 Average below normal year (40-30-30 Classification) monthly Tracy Pumping

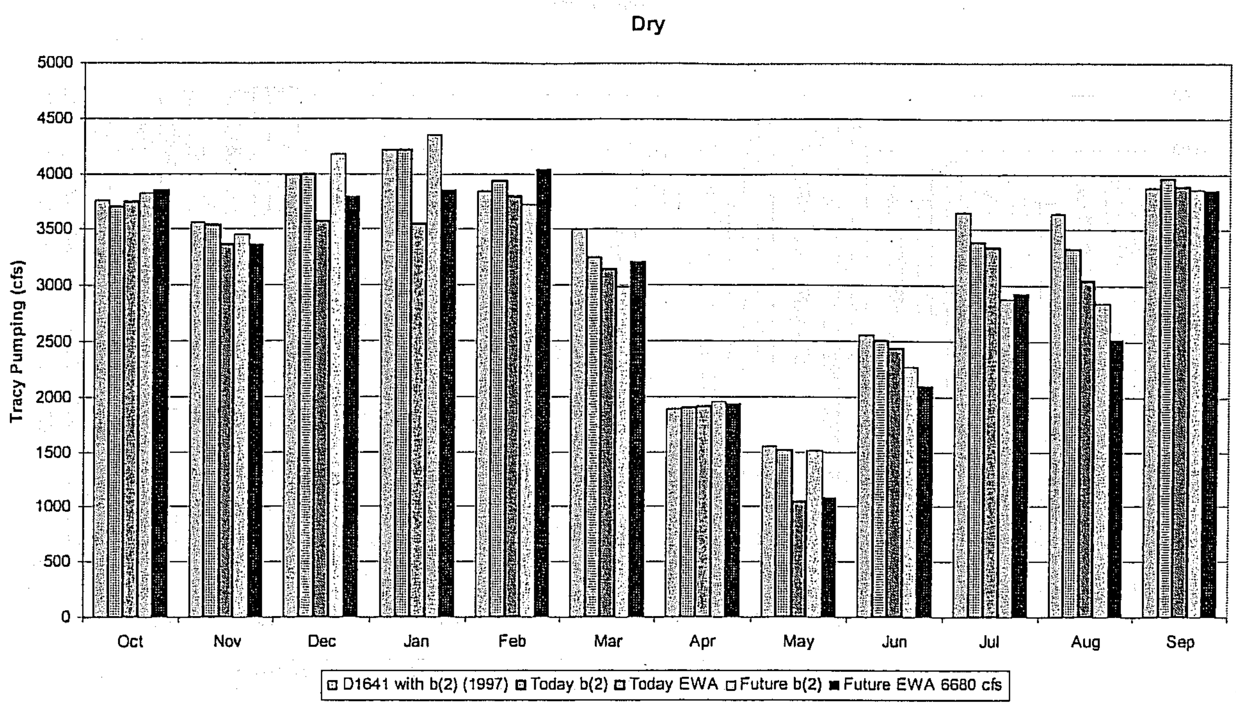


Figure 38 Average dry year (40-30-30 Classification) monthly Tracy Pumping

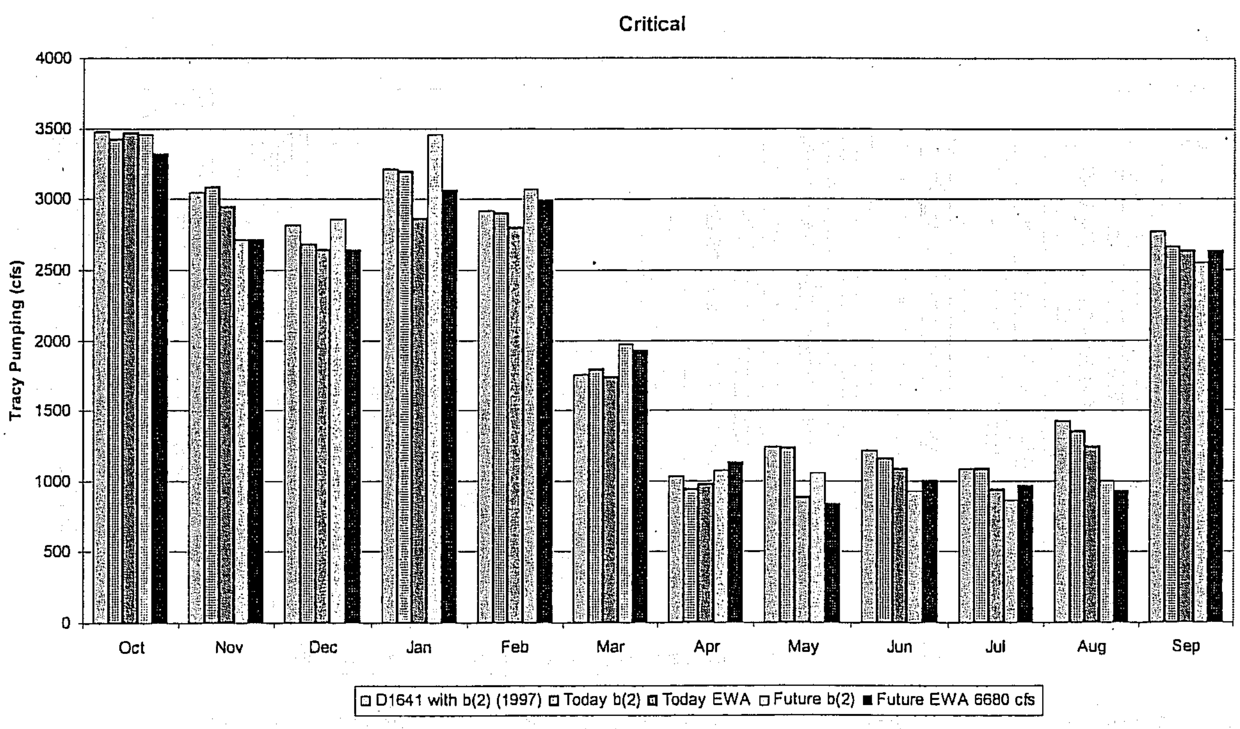


Figure 39 Average critical year (40-30-30 Classification) monthly Tracy Pumping

Banks Pumping

Figures 40 through 46 represent simulated total Banks exports for the five studies. Figure 40 shows that export levels in Studies 4a and 5a are greater export levels than Study 1.. The Future export levels are higher most months except for April and May.

While EWA and (b)(2) implementation in Study 5a results in higher export levels in all months except for April and May, the percentage of the summer time increases vary as a function of year type (Figure 41 to 46). In general, the dryer the water year, the less pumping occurs.

Most of the time EWA exports are increased primarily during the summertime to make up for reduced exports due to EWA export reductions in April and May. In general, the pumping increases in Study 5a may increase the number of delta smelt entrained, but these increases in entrainment would be minimized by implementation of the DSRAM and use of EWA water to reduce exports.

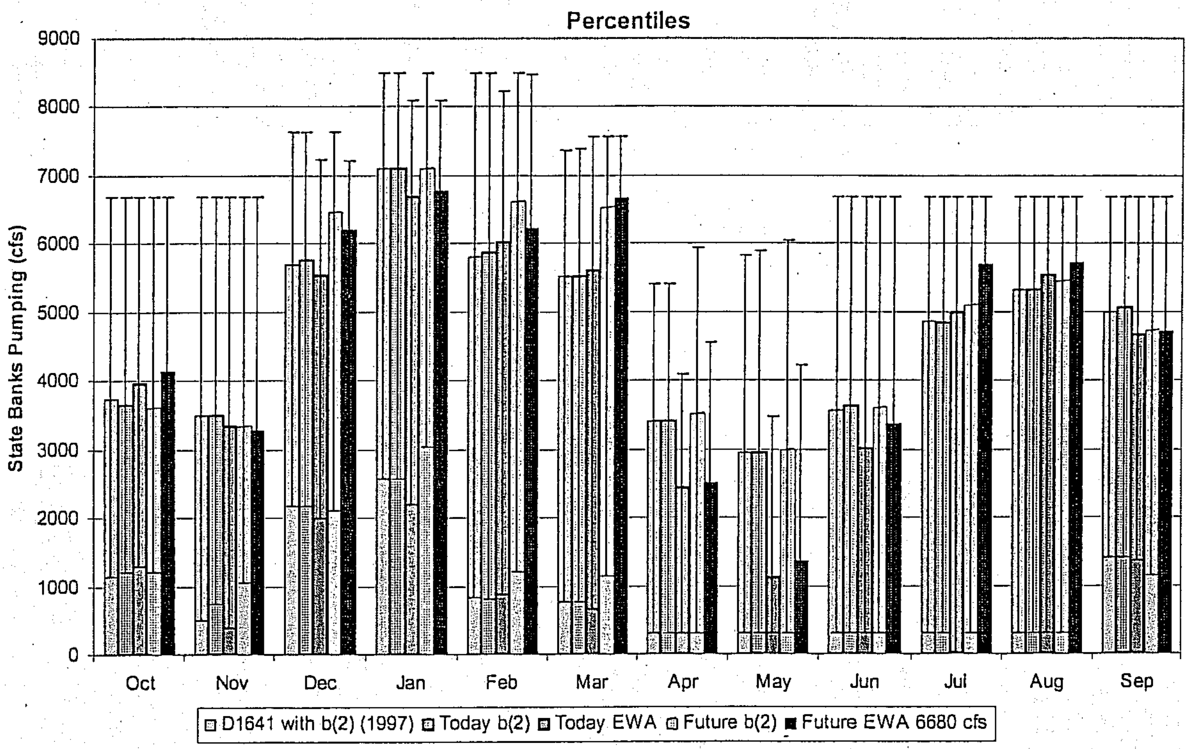


Figure 40 Banks Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

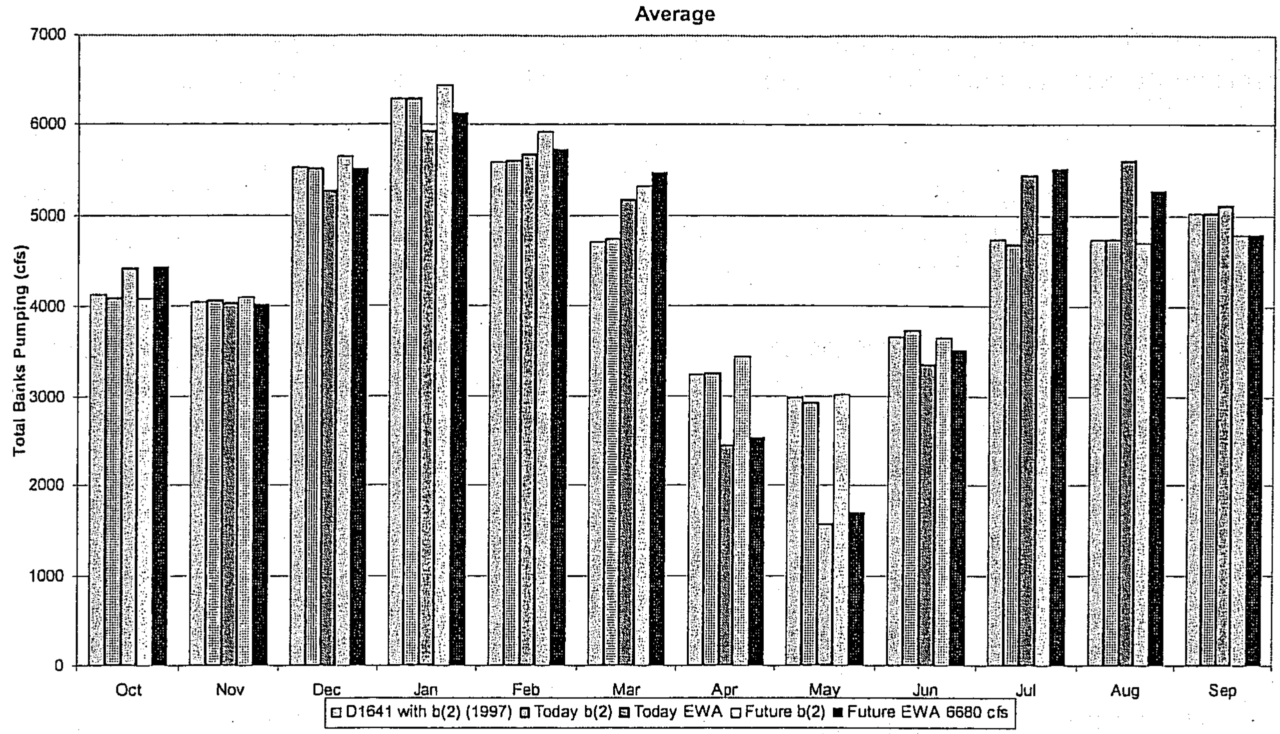


Figure 41 Average Monthly Banks Pumping

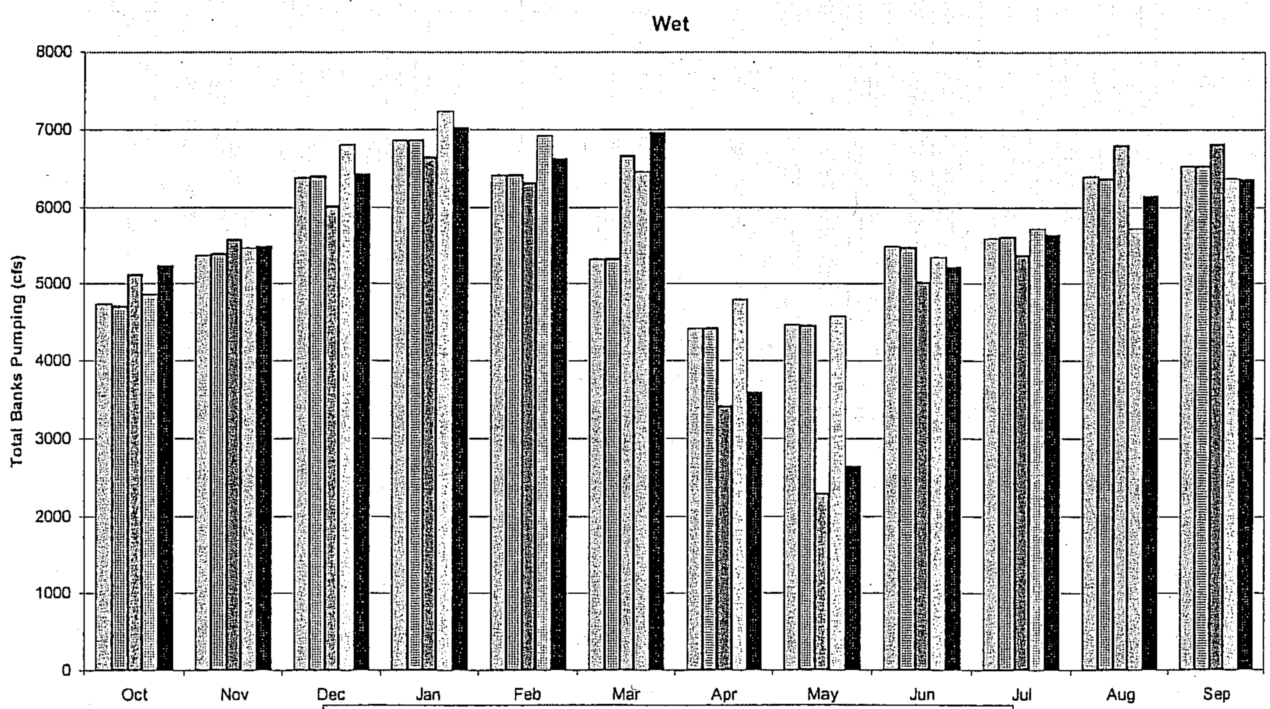


Figure 42 Average wet year (40-30-30 Classification) monthly Banks Pumping

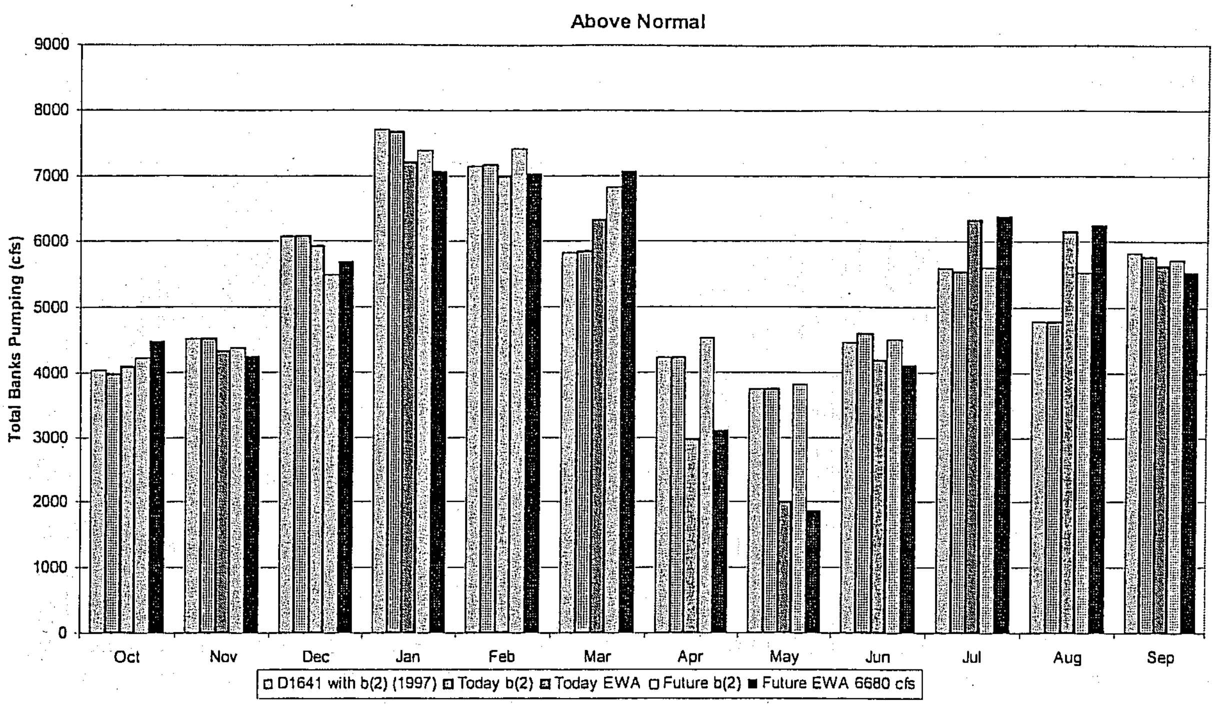


Figure 43 Average above normal year (40-30-30 Classification) monthly Banks Pumping

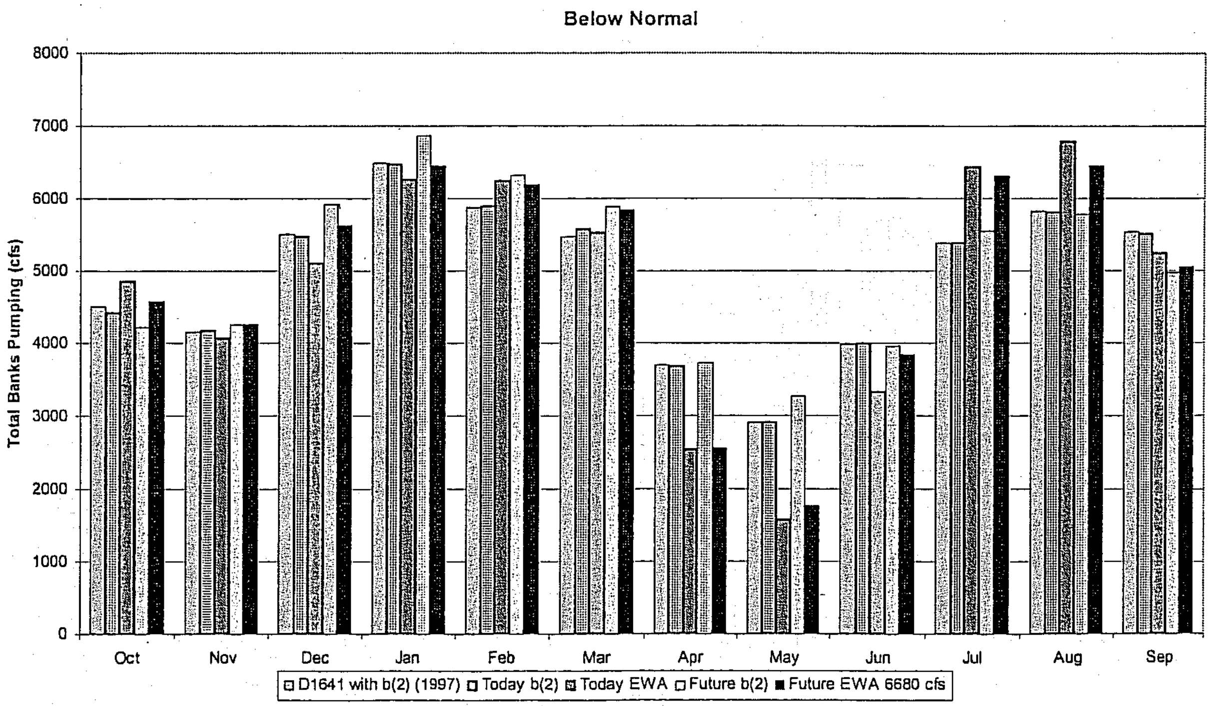


Figure 44 Average below normal year (40-30-30 Classification) monthly Banks Pumping

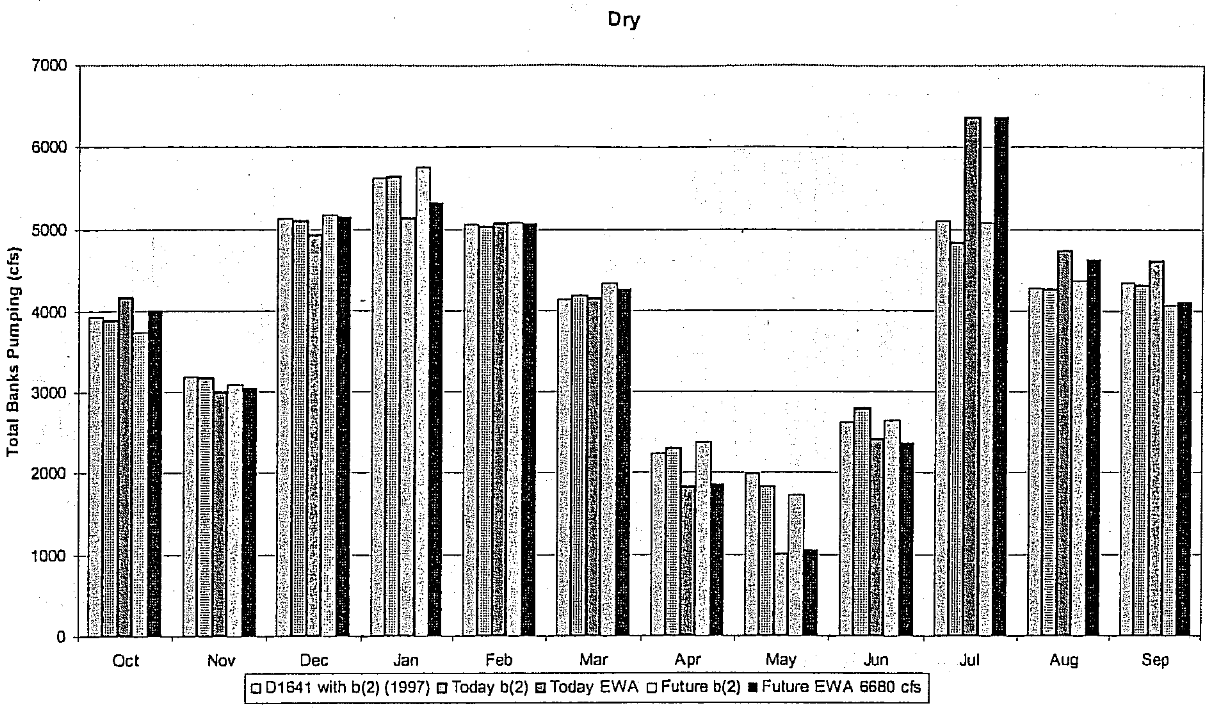


Figure 45 Average dry year (40-30-30 Classification) monthly Banks Pumping

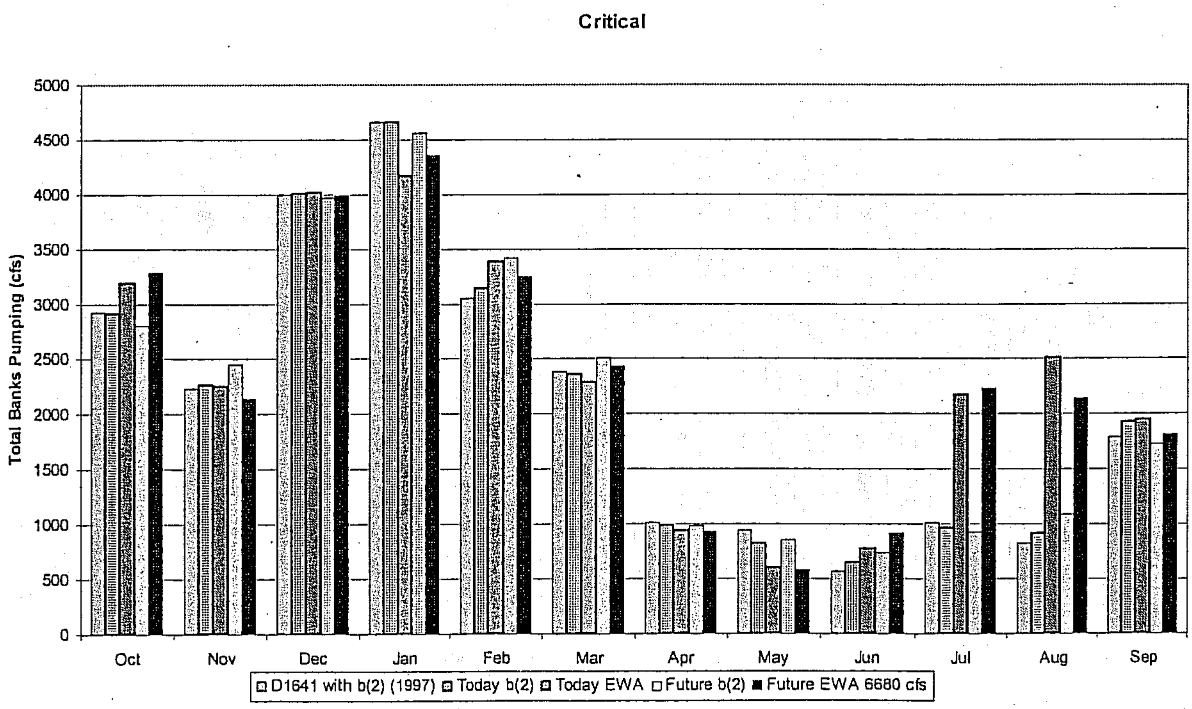


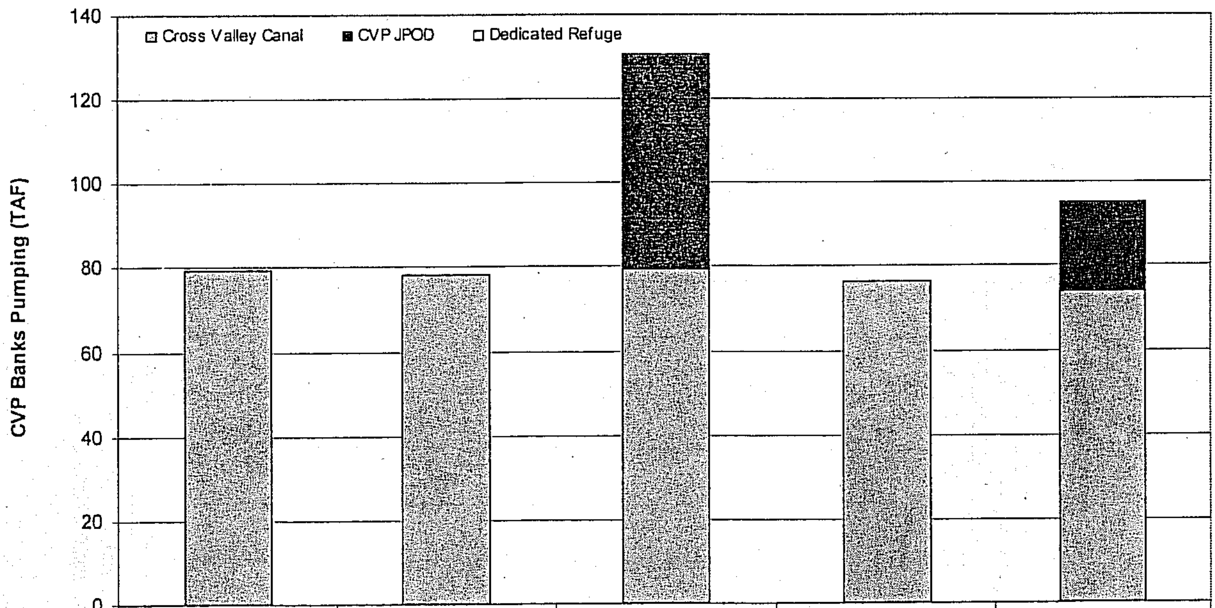
Figure 46 Average critical year (40-30-30 Classification) monthly Banks Pumping

Federal Pumping at Banks Pumping Plant (Joint Point of Diversion)

Federal pumping at Banks Pumping Plant generally occurs in the late summer, see Figure 48. Some Federal pumping occurs during October through March for Cross Valley Contractors. Joint Point of Diversion (JPOD) pumping is generally higher in Studies 3 and 5a due to CVP having the capacity to export half of the JPOD availability above the CVC pumping. Most JPOD opportunities occur in wet years with pumping averages decreasing as the years get drier.

Figure 47 shows the annual average use of Banks pumping for the CVP by study. The average JPOD pumping between the Today EWA to the Future EWA 6680 was reduced due to loss of export capacity to higher State deliveries. The Future studies do not include the dedicated 100,000 af/yr of dedicated refuge level 2 capacity at Banks. Pumping for Cross Valley Canal (Tier 1 JPOD pumping) ranges from 74 TAF to 79 TAF between the studies.

These Figures (49 to 54) show that most JPOD pumping occurs in the summer and fall, when delta smelt are not likely to be present in the south Delta. Smelt entrainment at the export facilities is not likely to increase as a result of the JPOD pumping. Since JPOD pumping also benefits the EWA, it can be considered a beneficial action when smelt are not present in the south Delta. JPOD pumping will not occur until the Management Agencies (and the Working Group, as necessary) through the WOMT determine that fish in the Delta would not be harmed.



	D1641 with b(2) (1997)	Today b(2)	Today EWA	Future b(2)	Future EWA 6680 cfs
Dedicated Refuge	0	0	0	0	0
CVP JPOD	0	0	52	0	22
Cross Valley Canal	79	78	79	76	74

Figure 47 Average use of Banks pumping for the CVP

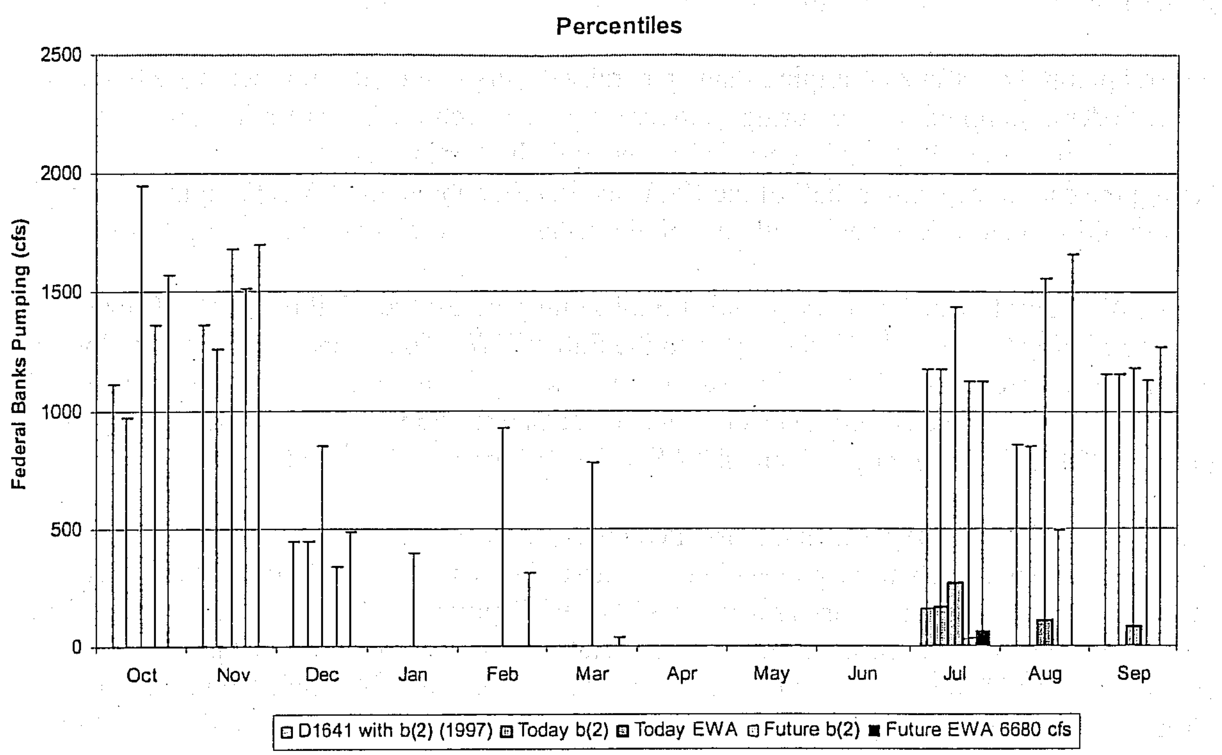


Figure 48 Federal Banks Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

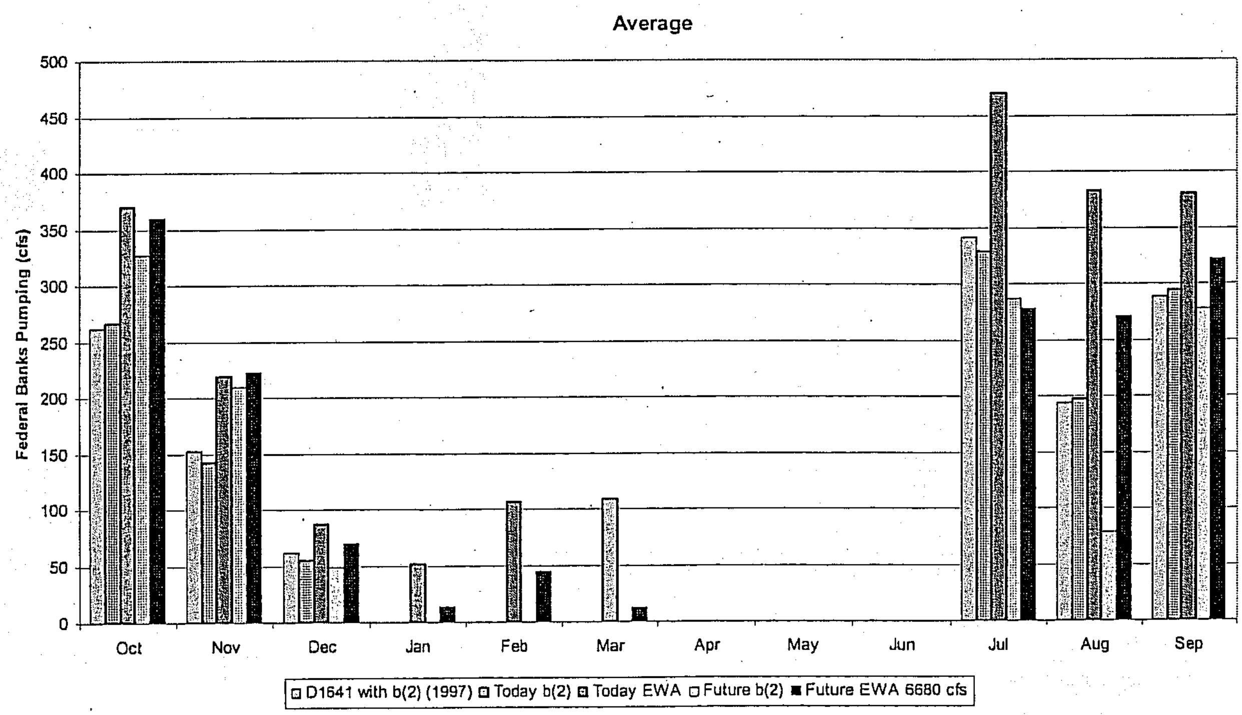


Figure 49 Average Monthly Federal Banks Pumping

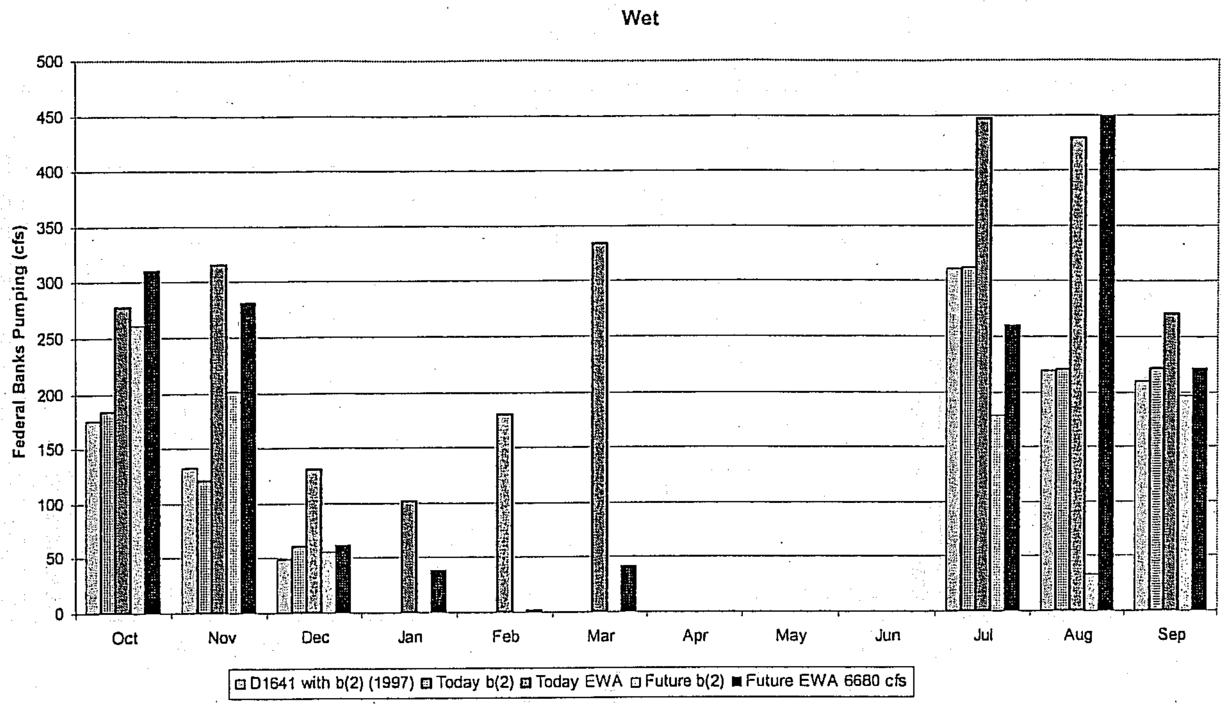


Figure 50 Average wet year (40-30-30 Classification) monthly Federal Banks Pumping

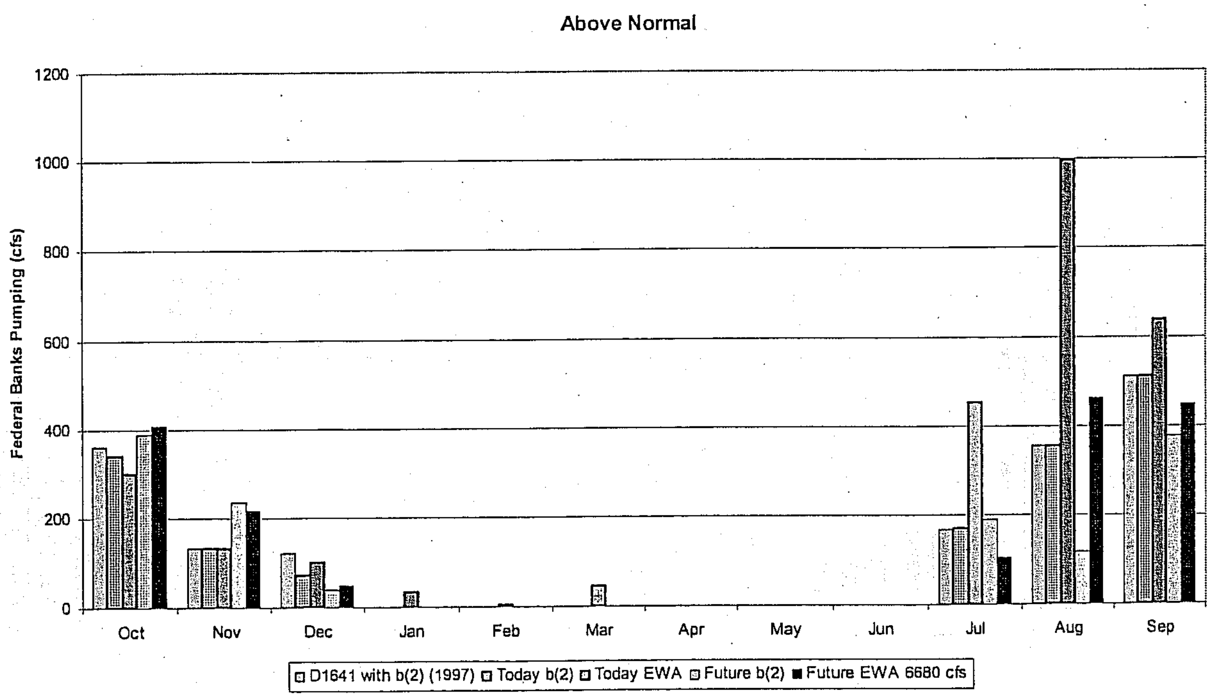


Figure 51 Average above normal year (40-30-30 Classification) monthly Federal Banks Pumping

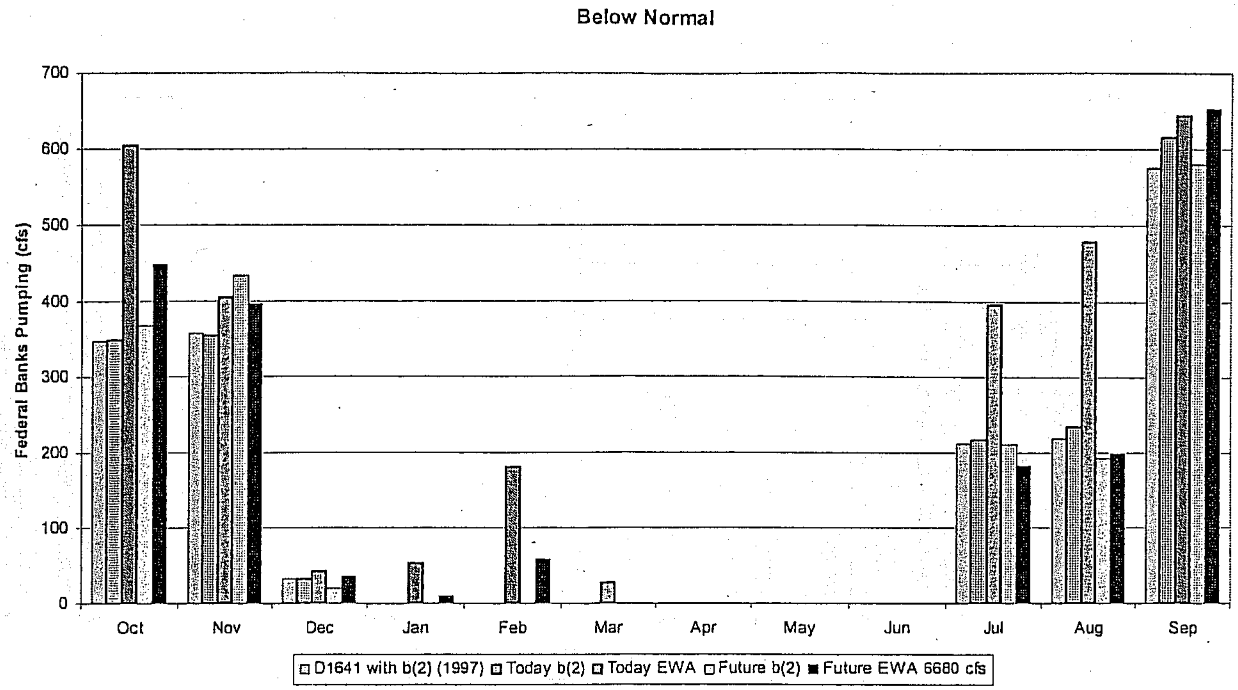


Figure 52 Average below normal year (40-30-30 Classification) monthly Federal Banks Pumping

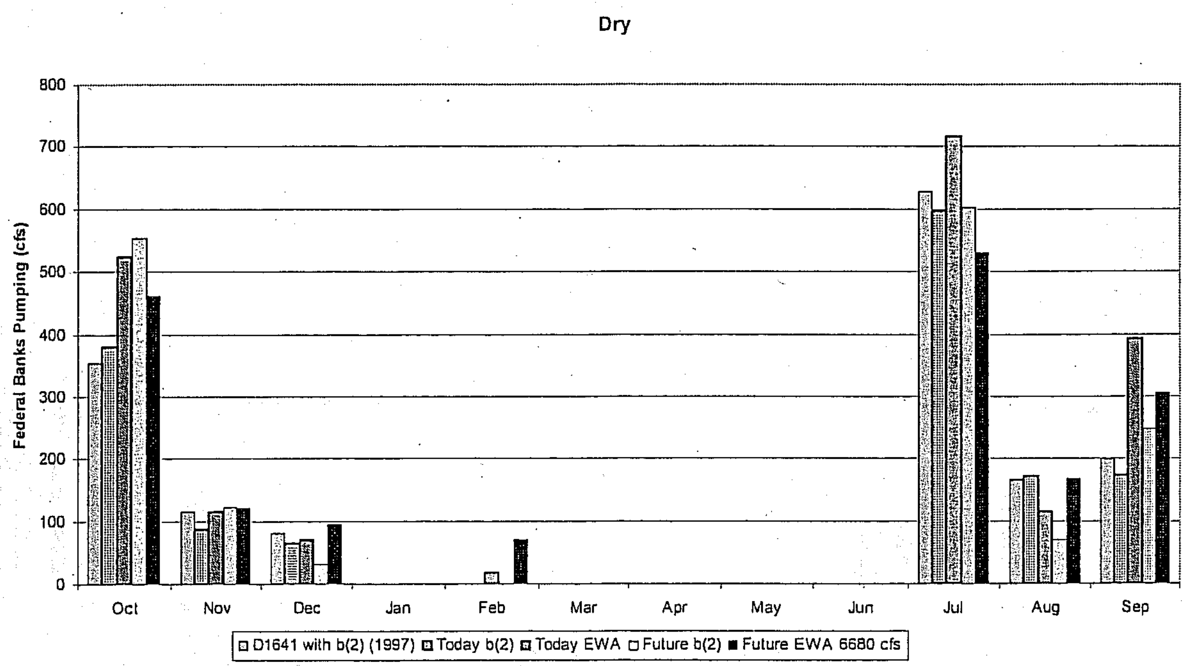


Figure 53 Average dry year (40-30-30 Classification) monthly Federal Banks Pumping

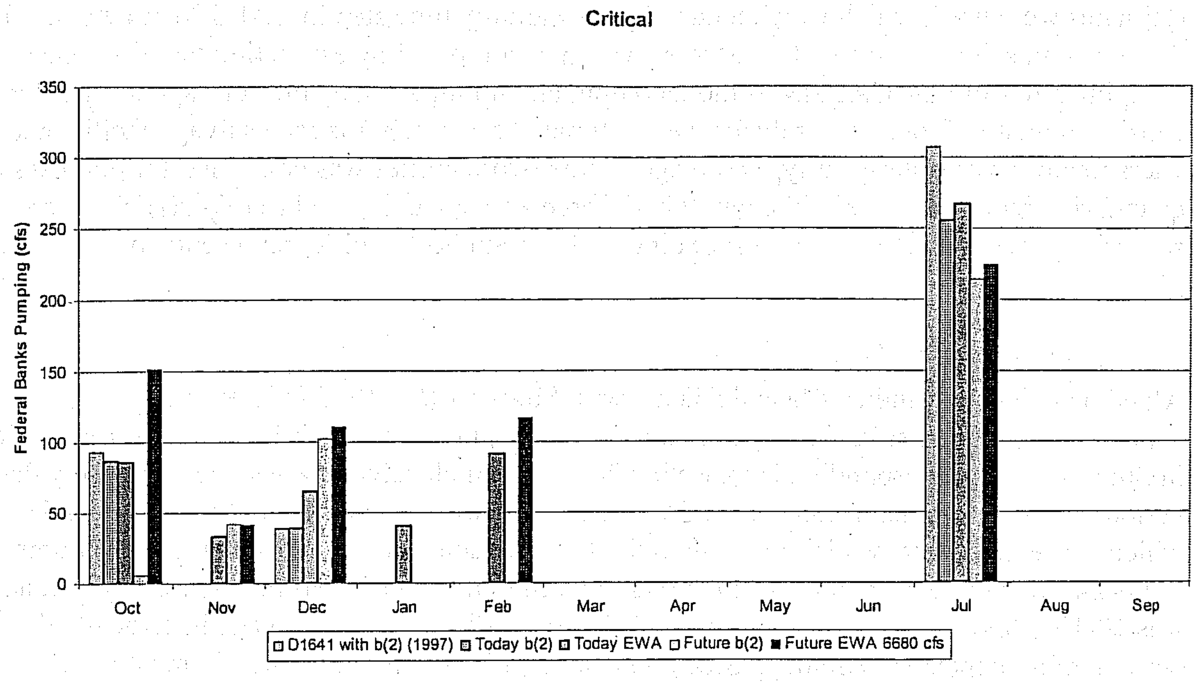


Figure 54 Average critical year (40-30-30 Classification) monthly Federal Banks Pumping

Salvage and loss (direct and indirect) at the CVP and SWP

Direct losses to entrainment by CVP and SWP export facilities

Annually, thousands of delta smelt are entrained by the Projects and unknown percentages of the entrained fish are observed and counted in fish salvage operations. Although both the CVP and SWP have fish salvage facilities, delta smelt do not survive the salvage process, either due to stress and injury from handling, trucking and release, or from predation in or near the salvage facilities, the release sites, or in Clifton Court Forebay (DFG unpublished data). Delta smelt entrainment is highly seasonal. Adult delta smelt may be present in the south Delta and vulnerable to entrainment from about December through April; larvae and juveniles are likely to be present and vulnerable during March through early July.

Delta smelt entrainment is presently estimated (or indexed) by extrapolating catch data from periodic samples of salvaged fish (≥ 20 mm). A sub-sample of water from the facility holding tanks is extrapolated based on the volume of water diverted during collection of that sample to estimate the number of fish entrained into the facilities during the sampling interval. Intervals typically range from 1-24 hours depending on time of year, debris loads, etc. To simplify predictions of the difference in salvage (and by extension entrainment) between model scenarios, it was assumed that salvage density (fish per volume of water diverted) was independent of the pumping rate. Because salvage density also varies considerably among seasons and years, salvage density was estimated for wet and dry water year types from historical data representing the period 1993–2002. There were too few years of most water-year types to reasonably estimate salvage density for each type, so data from wet (Wet and Above Normal) and dry (Below Normal, Dry, and Critically Dry) types were pooled. Note that monthly mean salvage density estimates were used, which were dictated by the monthly time step in CALSIM II outputs. The difference in salvage between two Studies was then computed by estimating the difference in pumping rate from the CALSIM II model output and multiplying by the corresponding salvage density estimate. Changes in salvage were estimated separately for each salvage facility and Sacramento River water-year type (salvage for the two facilities was combined for purposes of quantifying incidental take). The monthly differences were computed as $(X_y - X_1)/X_1$ where the subscript y is either 4a or 5a (corresponding to those Studies), and X_1 represents the base Study (#1).

Salvage of adult delta smelt

All comparisons of Studies #4a and #5a are with Study #1 (the 1995 OCAP conditions). In general, there were median increases of 6-9% in CVP pumping during December through March in Study #4a. A corresponding increase in adult delta smelt salvage was expected during that period. There is a general decrease in CVP pumping during the same months in Study #5a, which was expected to result in correspondingly lower adult salvage. Median SWP pumping in Study #4a was up to 7.7% higher in February and March in Below Normal and Dry years, and was 10-13% higher in Critically Dry years. Correspondingly higher salvage in critically dry years was therefore expected. Although Study #5a was similar to the base Study in most months, median SWP pumping was up to 25% higher during March.

Table 11 CVP salvage in Wet years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	4222	+8.9%	–0.7%	0.010	+9	–1
January	4226	+8.8%	–0.8%	0.095	+140	–13
February	4243	+8.2%	–2.3%	0.151	+116	–33
March	4273	–9.0%	+7.5%	0.159	–35	+29
Largely Juveniles						
April	2747	0.0%	0.0%	0.206	0	0
May	2274	0.0%	0.0%	7.430	0	0
June	3000	0.0%	0.0%	2.017	0	0
July	4588	0.0%	0.0%	0.036	0	0
Net: December – March					+230	–17
Net: April – July					0	0

[a] Average delta smelt salvage density (fishes $c.f.s.^{-1}$ $month^{-1}$) estimated from pooled Above Normal and Wet years 1995-2000.

[b] Predicted median difference has unit: fishes $month^{-1}$. See text for explanation of calculation.

Table 12 CVP salvage in Above Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	4221	+8.9%	–0.7%	0.010	+9	–1
January	4225	+8.9%	–0.8%	0.095	+144	–13
February	4242	+8.4%	–2.0%	0.151	+151	–36
March	4262	–22.9%	–9.9%	0.159	–91	–40
Largely Juveniles						
April	2742	0.0%	0.0%	0.206	0	0
May	1911	0.0%	0.0%	7.430	0	0
June	2920	0.0%	0.0%	2.017	0	0
July	4580	+0.2%	+0.3%	0.036	+8	+11
Net: December – March					+212	–89
Net: April – July					+8	+11

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Above Normal and Wet years 1995-2000.

[b] Predicted median difference has unit: fishes month^{-1}. See text for explanation of calculation.

Table 13 CVP salvage in Below Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	4221	+7.3%	–0.9%	0.067	+22	–3
January	4225	+8.9%	–0.8%	0.180	+133	–12
February	4241	–3.8%	+8.1%	0.235	–30	+63
March	4235	–6.7%	–8.2%	0.201	–68	–83
Largely Juveniles						
April	2321	0.0%	–1.2%	0.259	0	–16
May	1911	0.0%	–9.3%	11.93	0	–9017
June	3000	0.0%	0.0%	1.584	0	0
July	4554	+0.4%	0.3%	0.005	+9	+7
Net: December – March					+57	–35
Net: April – July					+9	–9025

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from Dry and Critically Dry years 1994 and 2001-2

[b] Predicted median difference has unit: fishes month^{-1}. See text for explanation of calculation.

Table 14 CVP salvage in Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	4220	+7.8%	–1.3%	0.067	+21	–3
January	4225	+8.8%	–0.8%	0.180	+105	–10
February	4235	+8.3%	+8.4%	0.235	+59	–60
March	4208	–9.5%	–2.4%	0.201	–75	–19
Largely Juveniles						
April	1808	+0.8%	+0.6%	0.259	+6	+5
May	1720	0.0%	–23.0%	11.93	0	–14469
June	2874	–4.1%	–14.7%	1.584	–812	–2910
July	4421	–7.5%	–3.2%	0.005	–175	–74
Net: December – March					+110	+28
Net: April – July					–980	–17448

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from Dry and Critically Dry years 1994 and 2001-2

[b] Predicted median difference has unit: fishes month^{-1}. See text for explanation of calculation.

Table 15 CVP salvage in Critically Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	2897	–0.4%	–19.3%	0.067	–1	–41
January	4218	+6.0%	–9.6%	0.180	+61	–98
February	3979	+8.5%	+2.1%	0.235	+36	+9
March	1247	+6.8%	+0.2%	0.201	+25	+1
Largely Juveniles						
April	800	0.0%	0.0%	0.259	0	0
May	1189	0.0%	–32.7%	11.93	0	–11652
June	953	0.0%	0.0%	1.584	0	0
July	800	0.0%	0.0%	0.005	0	0
Net: December – March					+121	–130
Net: April – July					0	–11652

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2

[b] Predicted median difference has unit: fishes month^{-1}. See text for explanation of calculation.

Table 16 SWP salvage in Wet years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	7033	0.0%	–5.6%	0.015	0	–6
January	7408	0.0%	–4.8%	0.214	0	–76
February	5848	0.1%	+6.1%	0.242	+1	+86
March	5653	+16.4%	+25.0%	0.069	+64	+98
Largely Juveniles						
April	4830	+4.4%	–21.5%	0.058	+12	–60
May	4660	0.0%	–46.6%	12.52	0	–27188
June	5925	–0.2%	–1.7%	10.9	–129	–1098
July	6680	0.0%	0.0%	0.611	0	0
Net: December – March					+65	+102
Net: April – July					–117	–28346

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Above Normal and Wet years 1993 and 1995-2000.

[b] Predicted median difference has unit: fishes month^{-1}. See text for explanation of calculation.

Table 17 SWP salvage in Above Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	6484	0.0%	–5.7%	0.015	0	–6
January	7548	0.0%	–5.4%	0.214	0	–87
February	7451	0.0%	–5.2%	0.242	0	–94
March	5784	+21.9%	+22.9%	0.069	+87	+91
Largely Juveniles						
April	4508	–0.3%	–29.6%	0.058	–1	–77
May	3596	+0.9%	–57.6%	12.52	+405	–25933
June	3942	+0.8%	–0.3%	10.9	+344	–129
July	6157	0.0%	+7.5%	0.611	0	+282
Net: December – March					+87	–95
Net: April – July					+748	–25857

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Above Normal and Wet years 1993 and 1995-2000.

[b] Predicted median difference has unit: fishes month^{-1}. See text for explanation of calculation.

Table 18 SWP salvage in Below Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	5938	0.0%	–5.4%	0.050	0	–16
January	7172	0.0%	–5.5%	0.209	0	–82
February	5850	+4.4%	0.0%	0.134	+34	0
March	5713	+7.7%	+6.2%	0.178	+78	63
Largely Juveniles						
April	3548	–0.3%	–27.2%	0.369	–4	–356
May	3235	+3.5%	–32.1%	29.97	+3393	–31122
June	3977	+0.3%	–0.2%	6.706	+80	–53
July	5320	0.0%	+13.4%	0.446	0	+318
Net: December – March					+113	–35
Net: April – July					+3469	–31213

[a] Average delta smelt salvage density (fishes $c.f.s.^{-1}$ $month^{-1}$) estimated from pooled Dry and Critically Dry years 1994 and 2001-2

[b] Predicted median difference has unit: fishes $month^{-1}$. See text for explanation of calculation.

Table 19 SWP salvage in Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	5358	0.0%	–5.6%	0.050	0	–15
January	5717	0.0%	–7.3%	0.209	0	–87
February	5303	+2.2%	0.0%	0.134	+16	0
March	4413	0.0%	0.0%	0.178	0	0
Largely Juveniles						
April	2168	+0.1%	–18.1%	0.369	+1	–144
May	2099	–3.0%	–51.0%	29.97	–1887	–32083
June	2952	–0.7%	–6.4%	6.706	–139	–1267
July	5217	–0.1%	+21.2%	0.446	–2	+493
Net: December – March					+16	–102
Net: April – July					–2027	–33000

[a] Average delta smelt salvage density (fishes $c.f.s.^{-1}$ $month^{-1}$) estimated from pooled Dry and Critically Dry years 1994 and 2001-2

[b] Predicted median difference has unit: fishes $month^{-1}$. See text for explanation of calculation.

Table 20 SWP salvage in Critically Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4a	Median change in Study 5a	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4a – 1	5a – 1
Adults						
December	4267	+8.2%	–5.3%	0.050	+17	–11
January	4891	–0.1%	–10.2%	0.209	–1	–104
February	3198	+13.1%	+12.0%	0.134	+56	+51
March	2030	+10.1%	+0.6%	0.178	+36	+2
Largely Juveniles						
April	1197	0.0%	0.0%	0.369	0	0
May	1189	0.0%	–20.4%	29.97	0	–7269
June	300	0.0%	0.0%	6.706	0	0
July	553	+2.9%	+70.8%	0.446	+7	+175
Net: December – March					+109	–62
Net: April – July					+7	–7095

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2

[b] Predicted median difference has unit: fishes month^{-1}. See text for explanation of calculation.

These tables show that under study 4a, an increase in the salvage of delta smelt occurs over the number of smelt salvaged in study 1 (see the second column from the right in the tables above). When the EWA is added in study 5a, the increases in salvage are reversed and take is reduced in study 1 (see the far right column in the tables above). It should be noted that the EWA as modeled only uses placeholders that reduce exports in a regular pattern during the spring and summer, and these actions do not correlate to actual salvage events at the fish facilities. In actual operations and by using the DSRAM, more informed use of the EWA actions in a proactive manner will likely reduce salvage even further.

Salvage of Juvenile Delta Smelt

Export Rates at both the CVP and SWP facilities is generally flat or declining under both #4a and #5a, with corresponding reductions in predicted salvage of juvenile smelt similar to those described for Studies #4 and #5 above. The only exceptions are SWP pumping in July of Dry and Critically Dry years, with median increases of 21.2% and 13.4%, respectively. We expect corresponding increases in salvage, however, salvage is typically near zero in July of most years, presumably because water temperatures in the south Delta are too warm for successful rearing.

It should be noted that although salvage is used to index delta smelt take, it does not reliably index delta smelt entrainment. Furthermore, delta smelt salvage is highly variable at all time scales, because they are patchily distributed, spawn at different times and places from year to year and larval dispersal is influenced by hydrodynamic conditions operating on tidal time scales. Salvage efficiencies also vary daily and seasonally due to changes in operations, size of the fish, and presumably metabolic demands of predators hunting within the facilities. Consequently, while this analysis credibly predicts what might happen in typical years, there will (even under the "baseline" Study 1 scenario) certainly be a small percentage of future years in which the confluence of natural and anthropogenic circumstances cause large delta smelt entrainment episodes. Delta smelt typically spend more time closer to the export facilities under low-flow conditions and in relatively cool years with low to intermediate flows, making these episodes more likely under those conditions. Because an analysis of the likelihood of these events would require modeling delta smelt movement using detailed historical distributional data that does not exist, we cannot determine whether the frequency of large entrainment events would be different from Study #1 under Study #4 or #5. More sophisticated models and shorter time-scale monitoring of young smelt distribution may provide a means to resolve this question in the future. (BA 2004)

Salvaged numbers of delta smelt do not adequately reflect the actual number of smelt that are lost at the CVP and SWP. The current salvage facilities use a louver system that is efficient for salmon and striped bass, but has unknown efficiency for delta smelt. Predation on delta smelt in Clifton Court Forebay also affects the salvage efficiency at the SWP. The collection, handling and transport studies (CHTR) currently underway propose to evaluate methods to improve handling, such that some delta smelt may survive the salvage process. In addition, a more complete understanding of the salvage efficiencies at the projects would improve estimates of the number of delta smelt entrained.

Article 21 Effects

The assumptions in CALSIM II for the demands that drives Banks Pumping varies by month with some variation across years. The demand for Article 21 water is one component of this total demand. In general, the assumed demand December through March for Article 21 water in CALSIM II is 134 taf per month–the assumed demand December through March Article 21 accounts for 90 percent of the annual total. With this assumed demand, 400 taf or more of Article 21 water is diverted 10 percent of the time (see Figure 10-46 of the BA).

It is likely that if the demand is assumed higher in these months, more may be diverted. To test this sensitivity DWR staff conducted an auxiliary simulation based on Study 2 with a demand set at 203 taf January through March (in the original Study 2, demand is never fully met in December) and with a demand of 300 taf January through March. With these higher demands 400 taf or more of Article 21 water is delivered 26 percent of the time. One other result worth noting is that based on Study 4 (a future conditions study with the same Article 21 demands as Study 2), there is an 8 percent chance of delivering 400 taf or more Article 21 water between December and March in any given year.

These differences are appropriately illustrated in the larger context of total SWP diversions from the South Delta in Figure 10-47 of the BA. For example, there is a 32 percent chance that Banks Pumping will total 1600 taf or more December through March assuming an Article 21 demand of 134 taf/month; the chances increase to 36 percent assuming an Article 21 demand of 203 taf/month and 41 percent assuming an Article 21 demand of 300 taf/month. These differences are best characterized with the probabilistic exceedance plots. Nevertheless, a similar characterization is illustrated in Figure 10-48 of the BA, which depicts the total Banks diversions with the different Article 21 demands averaged by water year type. A corollary look at the effects on the position of X2 is presented in Figure 10-49 of the BA.

The effects of Article 21 pumping on delta smelt are not expected to be very significant. The most pumping of Article 21 water occurs during above normal or wet water years, when delta smelt are not likely to be near the projects. Also, outflows and X2 requirements will continue to be met during Article 21 pumping, so delta smelt habitat is not likely to be significantly affected by the pumping of Article 21 water. An increase in smelt take at the TFCF or at the Skinner Fish Facilities could occur as a result of Article 21 pumping if delta smelt are present in the south Delta at the time of the pumping.

Intertie Effects

The DMC and CA Intertie (Intertie) consists of construction and operation of a pumping plant and pipeline connections between the Delta Mendota Canal and the California Aqueduct. The Intertie would include a 400 cfs pumping plant to allow up to 400 cfs to be pumped from the DMC to the CA. Up to 950 cfs could be conveyed from the CA to the DMC using gravity.

The Intertie would allow the Tracy pumping plant to export to its authorized capacity of 4,600 cfs (currently 4,200 cfs), subject to all applicable export pumping restrictions for fishery protections and water quality. These increased export amounts were modeled in the CALSIM II modeling and salvage is expected to increase as a result of the increase in maximum pumping at Tracy up to 4,600 cfs. The effects of the increase in the number of delta smelt salvaged at the Tracy fish facilities is described in the Salvage and Loss section of the Effects section.

Water Transfers Effects

Water transfers would increase Delta exports from 200,000-600,000 AF in about 80% of years. Most transfers would occur during July through September. Delta smelt are not likely to be present in the south Delta during this time (DFG unpublished data). However, delta smelt may still inhabit parts of the Delta in the zone of influence in July of some years. Water transfers may also occur outside of the July through September period and would be subject to all current water quality and pumping restrictions. As described in the project description, transfers will take place at times when delta smelt will not be adversely affected by the transfer and Reclamation and DWR will coordinate these transfers through the B2IT, EWAT and WOMT. The effects of transferring the water for terrestrial species would need to be handled in a separate Section 7 consultation.

Conservation Measures

A number of conservation measures are expected to continue in the future as part of the proposed project. These measures provide protection for delta smelt and/or their habitats and it is important to continue these protections to maintain or improve delta smelt populations that use the Delta. These baseline conditions will continue in the future as part of the project description and will help provide protection to delta smelt throughout its life cycle. These measures are further described in the Project Description.

Water Rights Decision 1641

Under the Water Quality Control Plan, flows and water quality objectives help maintain delta smelt habitat quality during their early life stages. In particular, X2 and E:I ratio requirements to reduce delta smelt entrainment risk (for more details see the X2 effects section).

VAMP

The Vernalis Adaptive Management Plan provides pulse flows in the San Joaquin River and lower Delta exports during April and May which is thought to improve transport and habitat conditions for delta smelt.

EWA

The Environmental Water Account, as modeled, reduces exports during periods considered critical to delta smelt. Primarily via export reductions, it helps reduce salvage at the CVP and SWP. It provides an important adaptive management mechanism to benefit delta smelt.

CVPIA (b)(2)

Water that is part of the CVPIA (b)(2) account can be used to reduce exports at the SWP and CVP. These reductions help reduce entrainment of smelt in the same way that EWA does.

Adaptive Management process

The Adaptive Management section of the Project Description describes a number of groups and teams which meet to discuss potential operational actions to be taken to benefit delta smelt. These groups use the salmon decision tree and the DSRAM to determine a concern level and which actions are appropriate to protect fish. The delta smelt working group uses the DSRAM to determine if the level of concern is sufficient to recommend an action to be taken to protect smelt. By using the various groups and teams, proactive actions may help avoid high salvage events and improve habitat conditions.

Summary of Effects

In summary, the operations of the Projects under formal consultation as described in the Project Description will result in adverse effects to delta smelt through entrainment at the CVP and SWP and by drawing delta smelt into poorer quality habitat in the south delta. However, with the inclusion of the conservation measures described above and the implementation of the DSRAM, these adverse effects would be avoided or minimized. With these conservation measures in place, the re-operation of the Trinity River, the increased level of development on the American

River, the Freeport Diversion, the Suisun Marsh Salinity Control Gates, the Barker Slough Diversion, or due to changes to X2, as described in the Project Description, are not expected to result in adverse effects delta smelt.

Critical Habitat Effects

Critical habitat is not likely to be adversely modified or destroyed as a result of the formal consultation proposed project. The primary constituent elements essential to the conservation of the species will not be affected by the proposed project. Pumping at the CVP and SWP pumping facilities as a result of the proposed project will not result in a loss of physical habitat in the delta. River flows and water in the delta will continue to be adequate to provide spawning, rearing and foraging habitat for the smelt. The salinity of the delta will not be modified beyond the normal fluctuations as a result of this project, as the location of X2 during February through June will not change significantly as a result of this project. No breeding habitat will be affected by the proposed project, and the sustainability of the food base for delta smelt will not be changed by the proposed project. In addition, adequate flows and reduced exports during the delta smelt spawning and rearing seasons will protect delta smelt and these protections will remain in place as long as the WQCP 1641 requirements continue to be met.

Overall CVP/SWP Effects-Early Consultation

The "Early Consultation" effects described in this biological opinion includes the proposed operations of components of the South Delta Improvement Program. These operations include pumping of 8500 cfs at the SWP, permanent barrier operations in the south Delta, the long term EWA, water transfers, and CVP and SWP operational integration. (See Table 21).

Table 21 Summary of formal and early consultation assumption differences

	Early Consultation	Formal Consultation
South Delta Improvement Plan	X	
DMC Intertie	X	X
CVP/SWP Project Integration	X	
Freeport	X	X

Effects of the re-operation of Trinity Reservoir

Trinity effects as part of early consultation are the same as for formal consultation. Therefore, the effects to smelt from operations on the Trinity River are expected to be same for early consultation.

Although the proposed changes in CVP operations resulting from implementation of the Trinity River Fishery Restoration Program will result in decreased flow down the Sacramento River, this change in flows is anticipated to result in minimal effects to delta smelt and delta smelt habitat. Flows to the Sacramento River will be reduced (see figure 9-6 of the biological assessment) and the timing of water movement into and through the Sacramento watershed would change as a result of these changes in CVP operations. The reduction in flows could have an additional small effect on the location on X2, which in turn could affect delta smelt. Smelt are usually distributed around the location of X2 from February through June. An upstream movement of X2 could cause smelt to be distributed further upstream into the east and south delta, where they could be more susceptible to entrainment at the export facilities and at local diversions in the Delta and increased mortality due to high temperatures or predation.

The CH2MHill Trinity analysis (dated November 5, 2003) mapped X2 location outputs from CALSIM II modeling. This analysis included only the effects of the Trinity River added to the "today" Study. The outputs showed that upstream movements of X2 greater than 0.5 km due to increased flows in the Trinity River occurred in a total of 26 months. The Service then analyzed the upstream movements of X2 and eliminated upstream movements in X2 in the 73 year record in wet years or in dry years. In wet years, X2 is located in Suisun Bay, which provides a shallow, protective, food-rich environment for delta smelt. An upstream movement of 0.5 km in wet years would result in an X2 location that would still be located in Suisun Bay, which would not be significant for delta smelt since substantial high quality habitat would still be available. In dry years, X2 is located upstream of the confluence of the Sacramento and San Joaquin Rivers and the habitat available to smelt is poor and the upstream movement does not result in any substantial additional loss of habitat or increase in adverse effects. When X2 is located upstream of Chipps Island, smelt would already be susceptible to entrainment or mortality due to high temperatures. The critical thermal maximum for delta smelt was experimentally determined to be 25.4 degrees Celsius in the laboratory (Swanson et al., 2000); and at temperatures above 25.6 degrees Celsius smelt are no longer found in the Delta (DFG, pers. comm.). By ruling out wet and dry years, the Service determined that there were 2 months (out of a possible 355 months) where the upstream movement of X2 could result in a substantial loss of habitat for delta smelt. The delta smelt risk assessment matrix (DSRAM, see project description) includes a trigger for the delta smelt working group to meet when X2 is upstream of Chipps Island during the period from February to June. If this trigger is met, the delta smelt working group may recommend an action to be taken to minimize effects to delta smelt (see DSRAM process discussion in the project description). Use of the DSRAM and subsequent implementation of recommendations made by the delta smelt working group, where practicable, will minimize the effects of movement of X2 on delta smelt resulting from the reduction of Trinity River water diverted down the Sacramento River. Therefore, the Service has determined it is not necessary to provide specific reasonable and prudent measures to reduce effects to delta smelt from the proposed changes in CVP operations resulting from implementation of the Trinity River Fishery Restoration Program.

Effects of Increased Level of Development on the American River

American River effects for the early consultation are the same as under the formal consultation.

The greatest impact to the American River is the increases in demands from the 2001 (Today) to the 2020 (Future) Level of Development (LOD). The actual deliveries, based on long-term average, increase from a total of 251,000 af in the 2001 LOD to 561,000 af in the 2020 LOD. The ability to fill Folsom Reservoir in May is reduced from 50 % of the time to 40 % of the time between the Today and Future runs (see Figure 9-47 of the BA). Carryover September storage in Folsom Reservoir is reduced by 30,000 to 45,000 af on a long-term average basis from the Today to the Future Study.

Effects to delta smelt from these lower amounts of water from the American River cannot be specifically determined from the CALSIM II modeling. Generally, a higher American River LOD will not result in an overall change of delta smelt habitat through a change in outflows or the location of X2 since more water would be released from Shasta if needed to make up for the reduction in American River water. Less American River water may reduce flexibility for Reclamation and DWR to meet WQCP requirements and may contribute to lower Reservoir storages else ware in the system.

Effects of the Freeport Diversion

Effects from the Freeport Diversion for the early consultation are the same as under the formal consultation.

The Freeport Regional Water Authority (FRWA) has a design capacity of 287 cfs (185 million gallons per day). Up to 132 cfs would be diverted under Sacramento County's existing Reclamation water service contract and other anticipated water entitlements and up to 155 cfs of water would be diverted under EBMUD's amended Reclamation water service contract. Under the terms of its amendatory contract with Reclamation, EBMUD is able to take delivery of Sacramento River water in any year in which EBMUD's March 1 forecast of its October 1 total system storage is less than 500,000 af. Additionally, EBMUD can only take 133,000 af in any one year, not to exceed 165,000 af in any consecutive 3-year drought period. Modeling shows that EBMUD takes an annual max of 94,000 af five times in the 73 years that are analyzed (1939, 1959, 1962, 1968 and 1987). The 165,000 af limit is reached in two consecutive years 3 times (1929-1930, 1959-1960, and 1987-1988) and in three consecutive years 4 times (1962-1964, 1976-1978, 1977-1979 and 1990-1992). Table 9-55 in the biological assessment shows the average annual Freeport diversions by water year type.

Effects to delta smelt from water diversions at Freeport would be similar to the increased American River demands in that the specific effects of the Freeport diversions cannot be determined from the CALSIM II analysis. Again, losses of water in the Sacramento River due to higher demands on the American River would be made up with additional water from other parts of the system and outflows and X2 are not likely to be affected by the Freeport diversions. This consultation does not authorize the construction activities required for the Freeport diversion.

Suisun Marsh Salinity Control Gates

Effects from the Suisun Marsh Salinity Control Gates are the same as under the formal consultation. The Suisun Marsh Salinity Control Gates impair free movement of delta smelt into or out of Montezuma Slough. Smelt in Montezuma Slough when the gates are down may be subject to entrainment due to private and state-owned diversions. Smelt may also be subject to increased predation at the gates by predatory fish.

Effects of Diversions in Barker Slough/North Bay Aqueduct

The effects from Barker Slough/North Bay Aqueduct under early consultation would be the same as the formal consultation effects.

Analysis of the effects of the North Bay Aqueduct is based on monitoring required under the March 6, 1995 OCAP Biological Opinion. Specifically, the 1995 Biological Opinion required the Department of Water Resources (DWR) to monitor larval delta smelt in Barker Slough, from which the North Bay Aqueduct (NBA) diverts its water. Since then, monitoring has been required every other day at three sites from mid-February through mid-July, when delta smelt may be present. As part of the Interagency Ecological Program, DWR has contracted with the Department of Fish and Game to conduct the required monitoring each year since the Biological Opinion was issued.

Data from the past 9 years of monitoring show that catch of delta smelt in Barker Slough has been consistently very low, an average of just five percent of the values for nearby north Delta stations (Cache, Miner and Lindsay sloughs) (Figure 55). In other words, sampling over the past decade indicates that a relatively small portion of the delta smelt population in this region is typically susceptible to NBA diversions. Moreover, recent research by the Interagency Ecological Program indicates that well-designed positive barrier fish screens (such as those used by NBA) effectively limit smelt entrainment. These results are consistent with Nobriga et al. (2004), who found that a small diversion with a positive barrier screen resulted in no entrainment of delta smelt, despite the fact that the diversion was located in a region of high delta smelt density.

In summary, NBA diversions do not appear to have had a substantial effect on delta smelt. The proposed operations are sufficiently similar to indicate that the effect of NBA on smelt will continue to be relatively low.

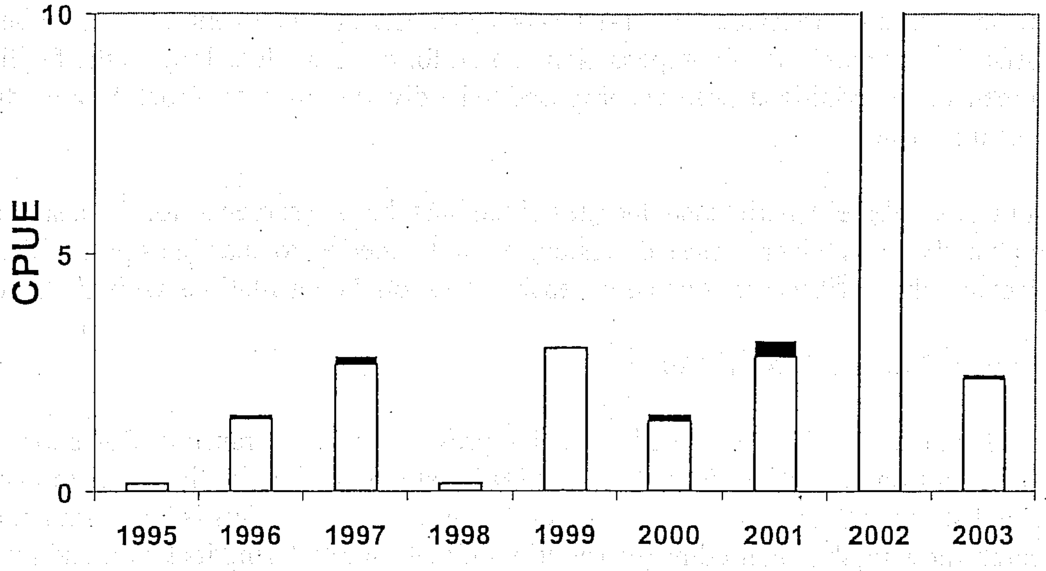


Figure 55 Comparison of delta smelt catch-per-unit-effort (fish/trawl) for NBA monitoring sites in Barker Slough (dark bars) to nearby north Delta sites: Lindsay, Cache and Miner sloughs (white bars). The NBA values are the mean annual CPUE for stations 720, 721, and 727. The nearby North Delta sites represent the mean annual CPUE for stations 718, 722, 723, 724, and 726

Based on these findings, the Delta Smelt Working Group (Working Group) has recommended a broader regional survey during the primary period when delta smelt are most vulnerable to water project diversions. An alternative sampling approach would be conducted as a 1-2 year pilot effort in association with the DFG's existing 20-mm survey (http://www.delta.dfg.ca.gov/data/20mm). The survey would cover all existing 20-mm stations, but would have an earlier seasonal start and stop date to focus on the presence of larvae in the Delta. The proposed gear type is a surface boom tow, as opposed to oblique sled tows that have traditionally been used to sample larval fishes in the San Francisco Estuary. Under the proposed work plan, the Working Group will evaluate utility of the study and effectiveness of the gear in each year of the pilot work. This new monitoring effort may give a better understanding of the abundance and distribution of larval delta smelt and may help the Working Group in its recommendations to WOMT to change project operations to protect smelt. This monitoring study may result in the harm, or harassment of delta smelt. Incidental take associated with this study is included in the incidental take in this biological opinion.

Effects of Rock Slough and other CCWD Diversions

The effects from the Rock Slough and other CCWD diversions are the same as under the formal consultation. The Contra Costa Water District (CCWD) diverts CVP water from the Delta for irrigation and M&I uses. The Rock Slough diversion can divert up to 350 cfs and is not currently screened for delta smelt. CCWD's biological opinion for the Los Vaqueros Reservoir required the Rock Slough diversion to be screened for delta smelt. Reclamation requested an extension to the screening requirement until 2008, when the use of Rock Slough will be determined by the proposed Los Vaqueros expansion project. The Service granted this request in a letter dated

December 10, 2003 (Service File #1-1-04-F-0034). Effects due to entrainment of delta smelt will be offset by the purchase of compensation habitat for delta smelt as long as the facility remains unscreened. No additional water is proposed to be diverted from the Rock Slough diversion as a part of this project.

Contra Costa Water District also operates diversions that are screened for delta smelt at Mallard Slough and on Old River. These diversions are not expected to change as part of the proposed project and their effects are covered in separate Section 7 consultations with the Service.

Effects of Changes in X2 Location

The X2 standards in D-1641 were intended to provide adequate transport flows to move delta smelt away from the influence of the CVP/SWP water diversion facilities into low-salinity rearing habitat in Suisun Bay and the lower Sacramento River. This is based on previous research showing the longitudinal distribution of delta smelt during its larval and juvenile stages is related to flow magnitude and its correlate, X2 position (Sweetnam and Stevens 1993; Dege and Brown 2004). Therefore, during the larval and juvenile phases, river flows of sufficient magnitude and duration facilitate down-estuary movement from spawning habitats in the delta to rearing habitats.

Young delta smelt are usually distributed upstream of X2 (Sweetnam 1999; Dege and Brown 2004). A recent study showed that since the sudden population decline in the early 1980s, upstream placement of X2 during spring is associated with low delta smelt abundance in the DFG Tow-net Survey (Kimmerer, 2002). Prior to the 1982, the opposite was true: delta smelt abundance was highest when X2 was in or near the delta. Currently, the central and south delta are generally no longer suitable habitat for post-larval delta smelt due to entrainment losses and/or altered habitat conditions. Thus, D-1641 requires the X2 location to meet certain requirements from February through June, as described in the project description. The CALSIM II modeling considers the D-1641 standard to be the baseline condition. However, in certain years, hydrologic conditions may result in the X2 standard not being met for as many days as in the baseline. Even if D-1641 X2 standard continues to be met, there could be adverse effects to delta smelt if X2 moves upstream of Chipps Island in the future Study. Since delta smelt generally move with X2, a further upstream location of X2 near Chipps Island in the future Study could result in a distribution pattern wherein more delta smelt would be susceptible to entrainment and elevated mortality in the Central and South Delta due to high temperatures or predation. The critical thermal maximum for delta smelt under laboratory conditions is 25.4 degrees Celsius (Swanson et al., 2000); and at temperatures above 25 degrees Celsius smelt are no longer found in the Delta (DFG, pers. comm.). South delta temperatures can approach 25 degrees Celsius in May and June, and exceed 25 Celsius during summer months. The future Study could result in an upstream movement of X2 due to increased pumping at the CVP, increased American River demands, the Freeport diversion, and less water from the Trinity River.

Two analyses were done to assess the effects of the proposed project on the movement of X2 and subsequent effects to delta smelt: an analysis using CALSIM II modeling and a graphical analysis by CH2MHill. The CALSIM modeling results was done by Reclamation and used a 1 kilometer change in X2 location as a criterion and are presented in the biological assessment. The CH2MHill analysis used a half kilometer change in the location of X2 as a criterion and is presented in Appendix L of the biological assessment.

CALSIM II Analysis
The X2 position in CALSIM II represents where the 2 ppt isohaline lies, as calculated from the monthly average Net Delta Outflow (NDO). Since the model represents the end of month X2 position, the day-to-day effects of CVP/SWP operations are not shown in the CALSIM II representation.

Figure 56 shows the exceedance plot for monthly differences in X2 position between the Studies for all February to June values simulated. Operational changes in Study 2 – Study 1 have minor influence on the X2 position. Operational changes in Study 3 have a greater effect than those in Study 2 due to EWA effects on pumping operations. The largest effect on X2 is in Study 5 compared to Study 1 this comparison shows the cumulative effect on X2 with 0.5 km shifts occurring about equal on either side of the curve.

The monthly average X2 position based on long-term and water year type-dependent averages are shown in Figures 57 to 62. The six Figures generally indicate the same trend from February to June in the X2 position on average as it moves more upstream into the Delta. Also in the months February, April, May, and June the X2 position shifts slightly downstream in the early consultation study when compared to the other Studies which were modeled. However, sporadic upstream movements of X2 may have adverse effects.

Figure 63 to 67 show the X2 position sorted from wettest to driest 40-30-30 Index and show the variability within a particular group of water years. These results show that X2 moves upstream as the water years get drier. Figure Figures 68 to 70 show the total number of days that the X2 position is downstream of one of the three compliance points (Confluence, Chipps Island and Roe Island) varies annually. These latter results represent gross approximations because CALSIM II must estimate "the total number of days" values based on monthly, rather than daily, simulation results. These graphs indicate that average changes to X2 under the proposed actions for formal consultation are minor (i.e. within the measurement error of X2 position). For further definition of the modeled CALSIM II studies, see Table 10 in the beginning of the effects section.

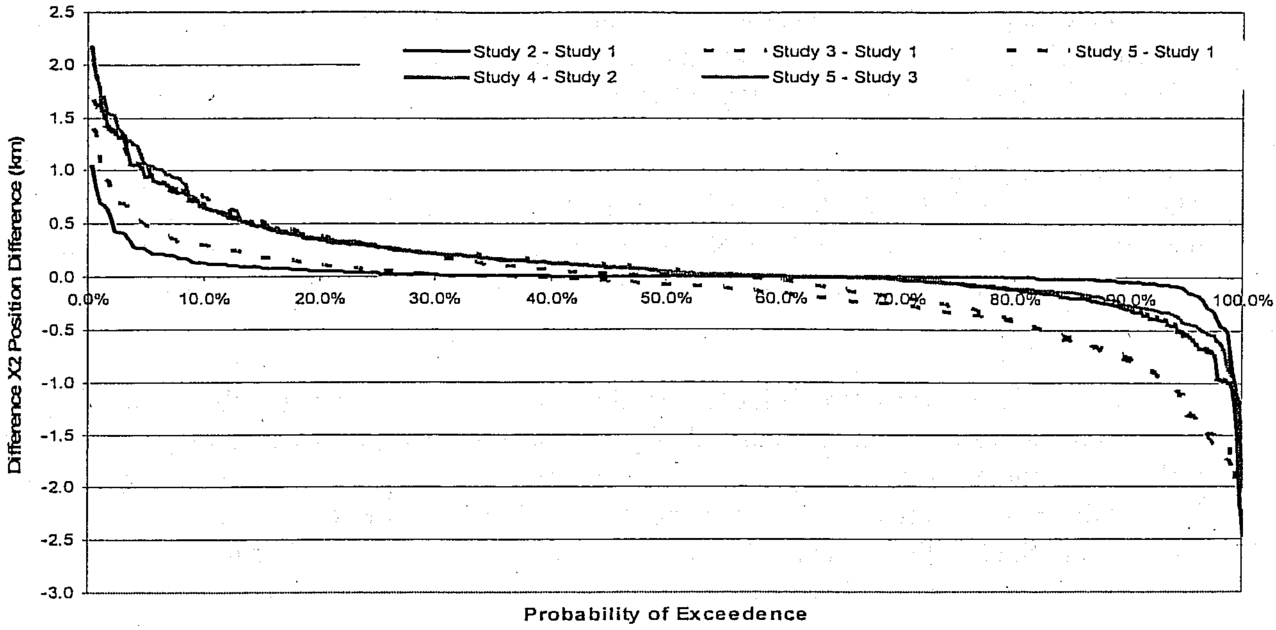


Figure 56 Probability of Exceedance for Monthly Shifts in X2 Position for the Feb – June Period

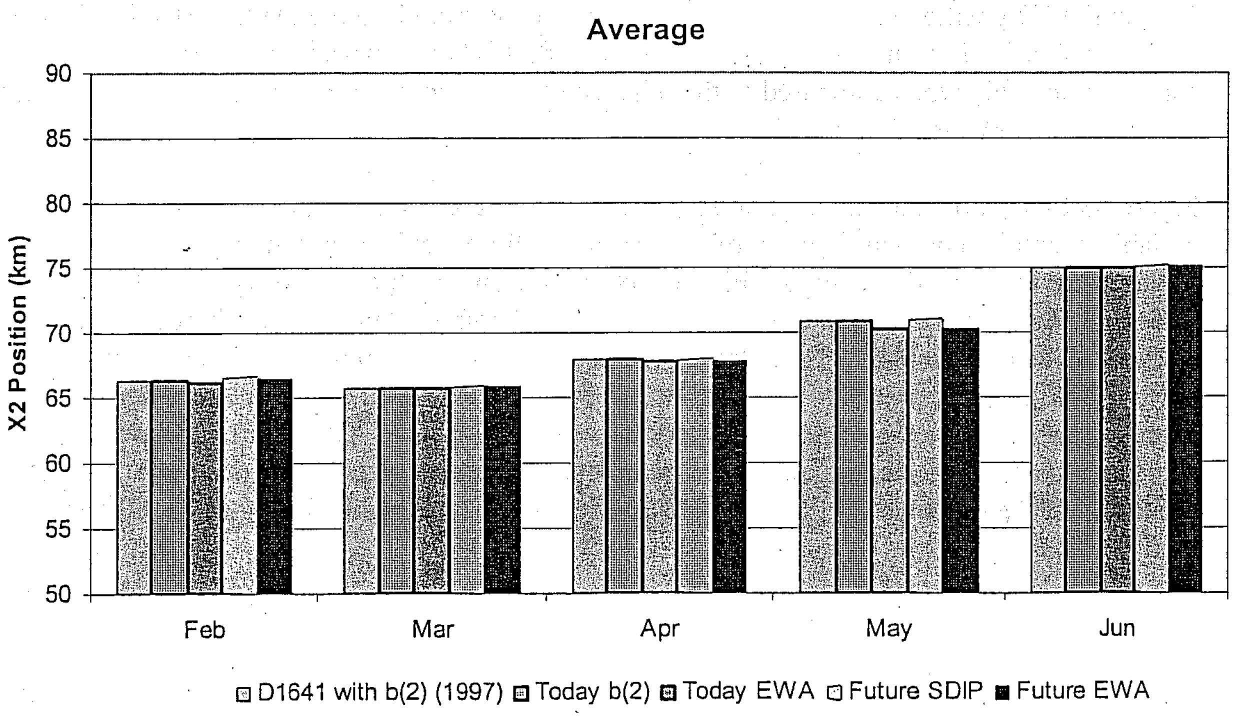


Figure 57 Average Monthly X2 Position

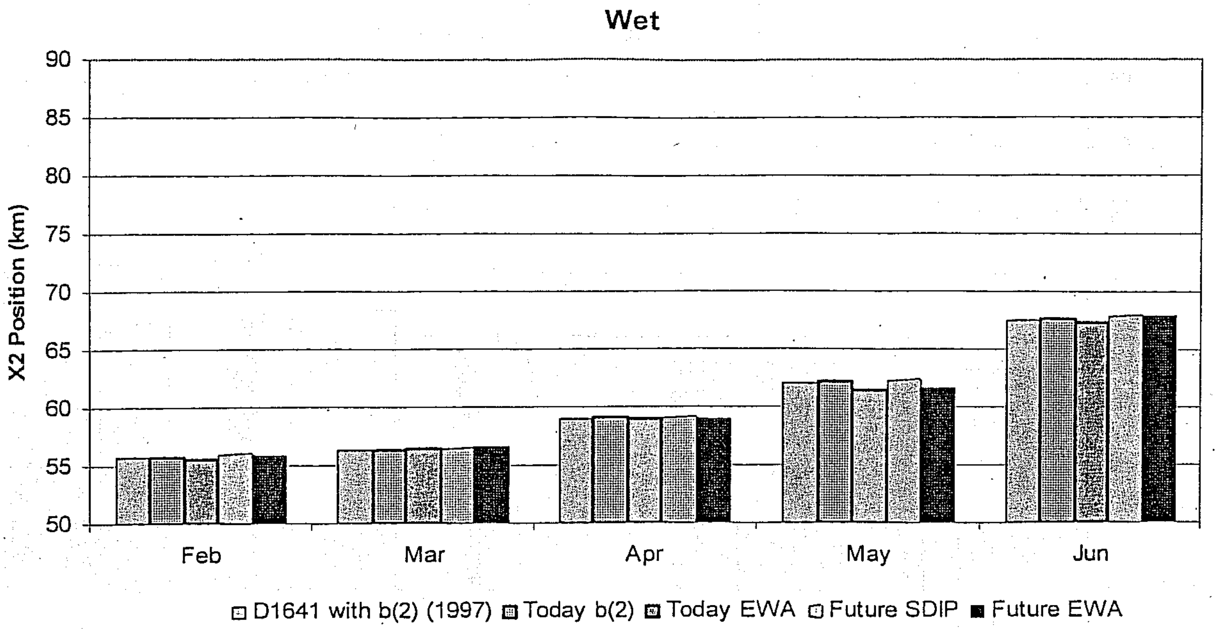


Figure 58 Average wet year (40-30-30 Classification) monthly X2 Position

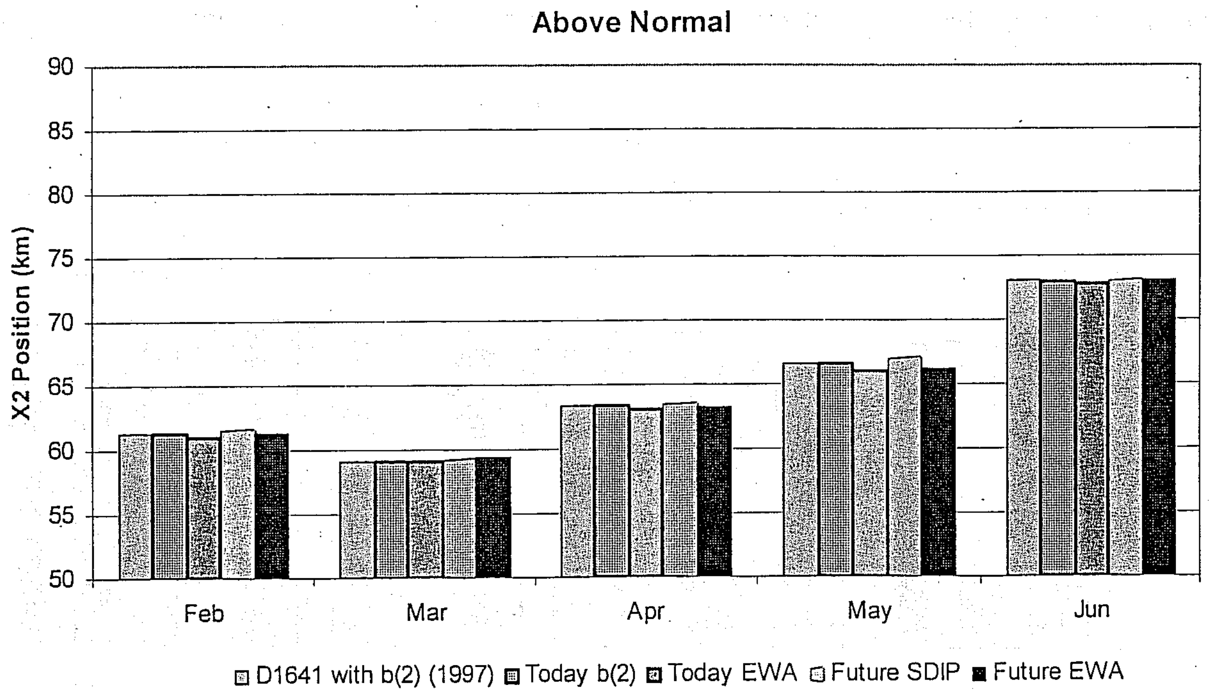


Figure 59 Average above normal year (40-30-30 Classification) monthly X2 Position

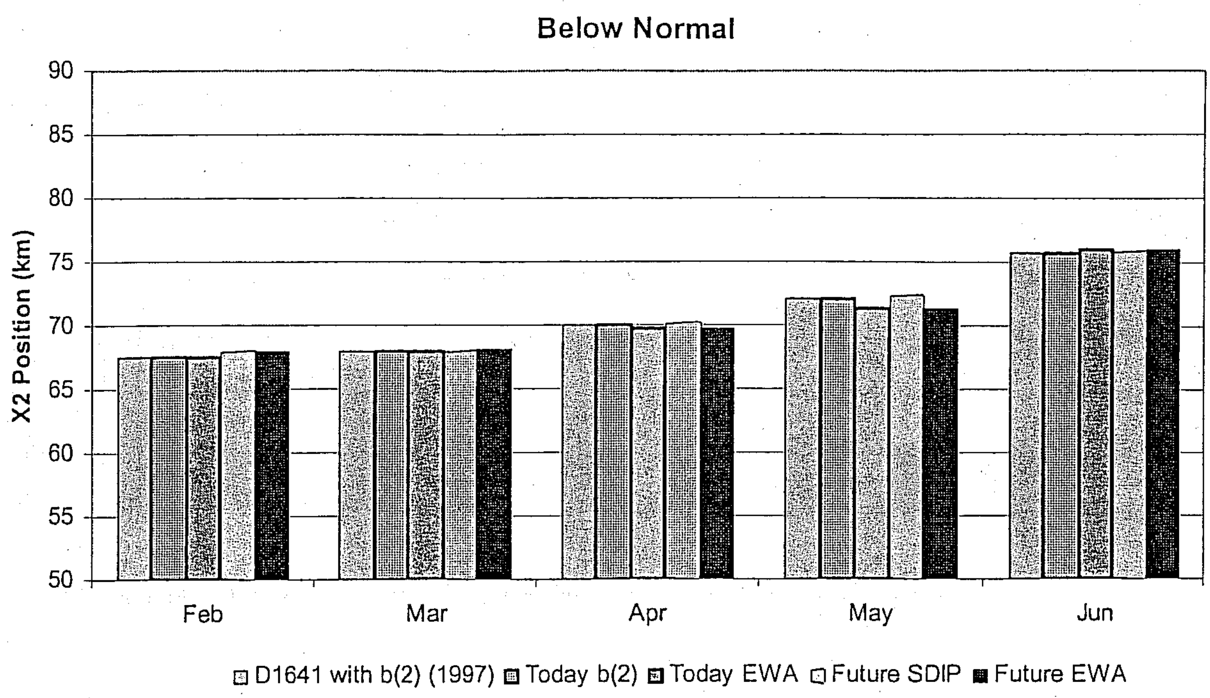


Figure 60 Average below normal year (40-30-30 Classification) monthly X2 Position

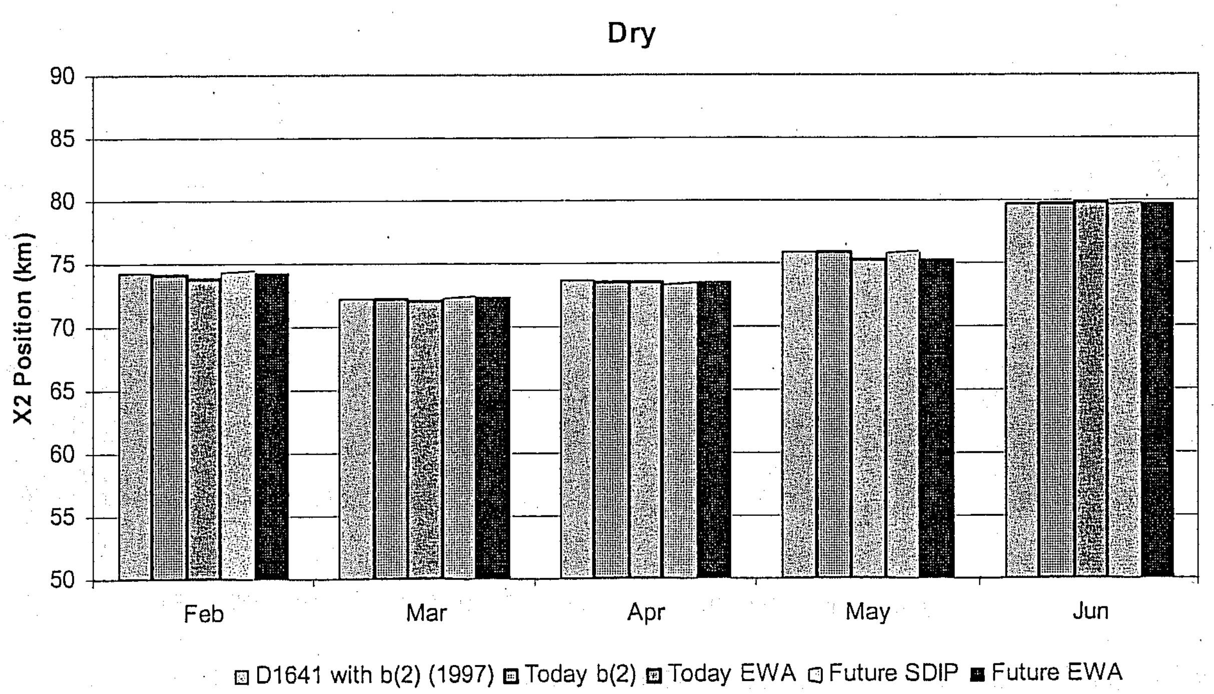


Figure 61 Average dry year (40-30-30 Classification) monthly X2 Position

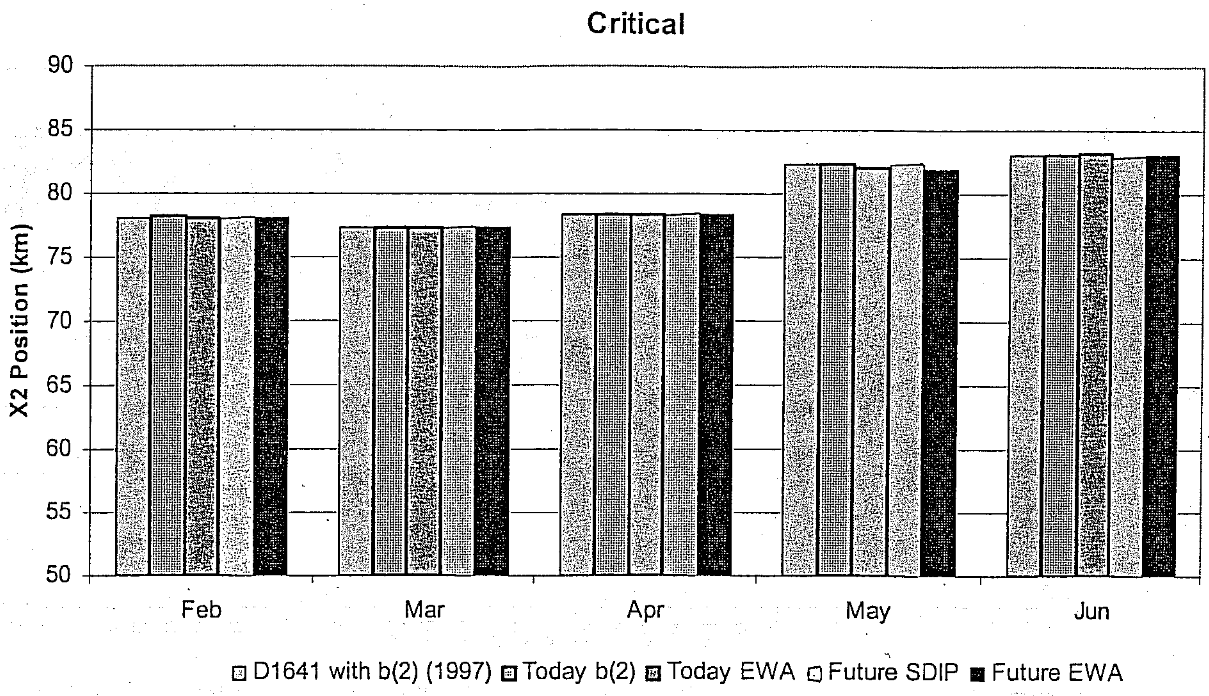


Figure 62 Average critical year (40-30-30 Classification) monthly X2 Position

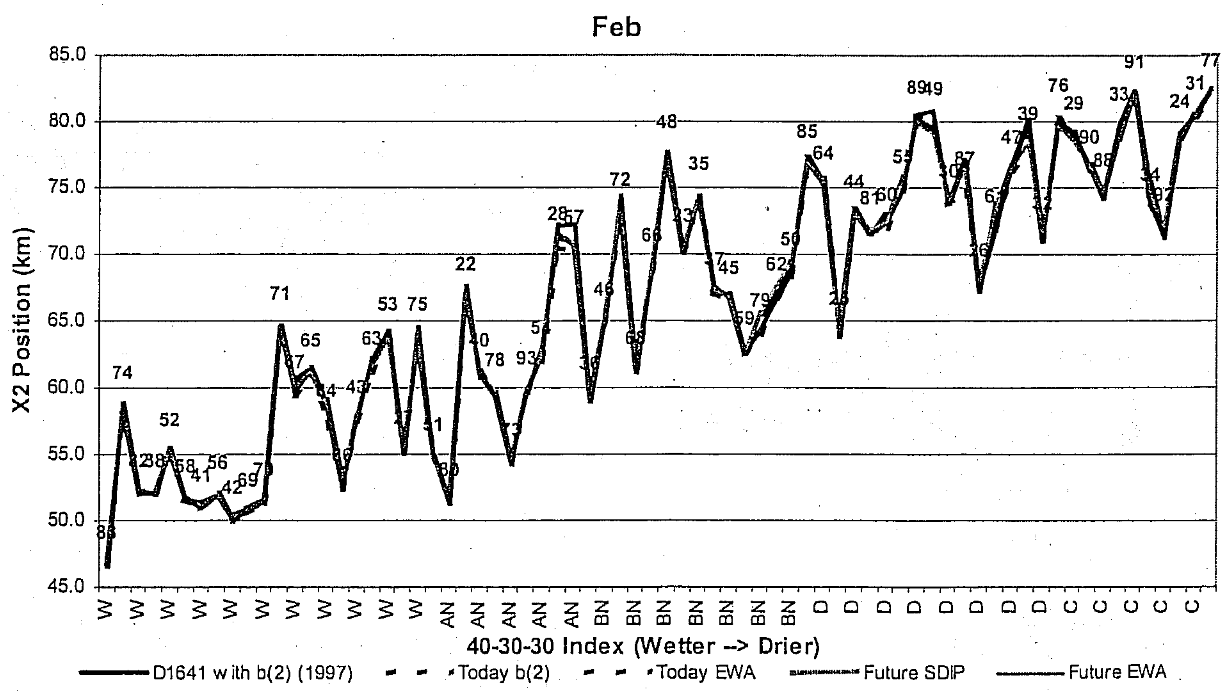


Figure 63 February X2 Position sorted by 40-30-30 Index

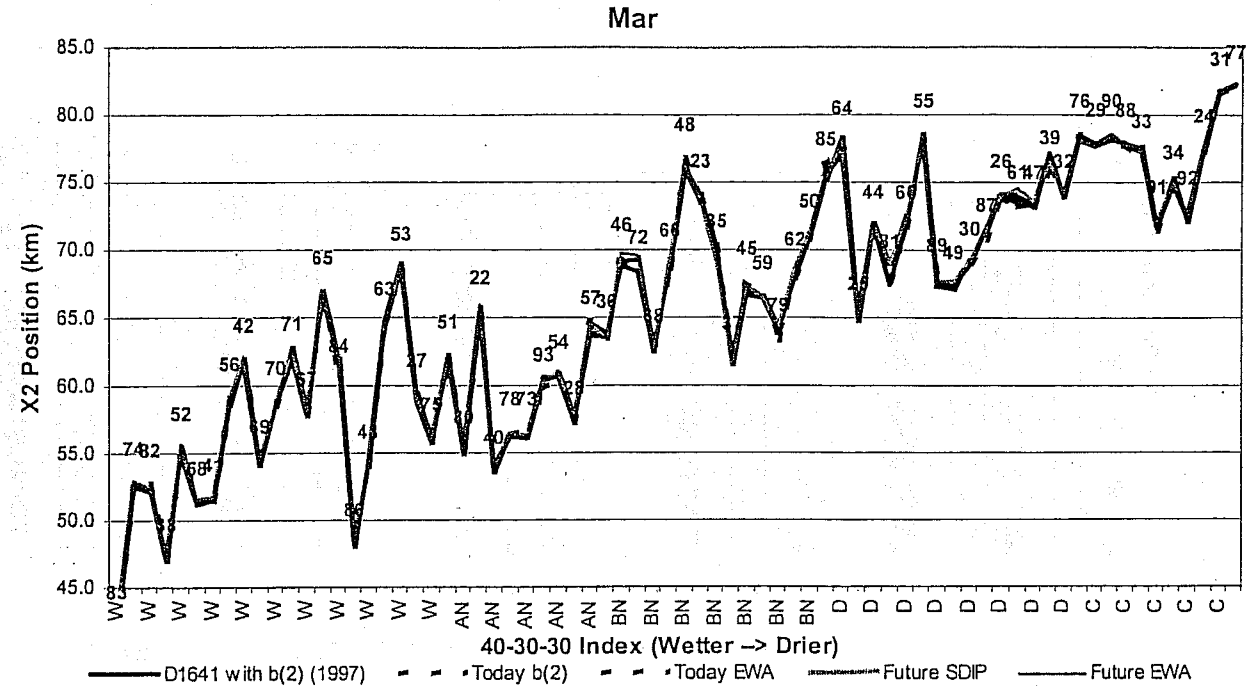


Figure 64 March X2 Position sorted by 40-30-30 Index

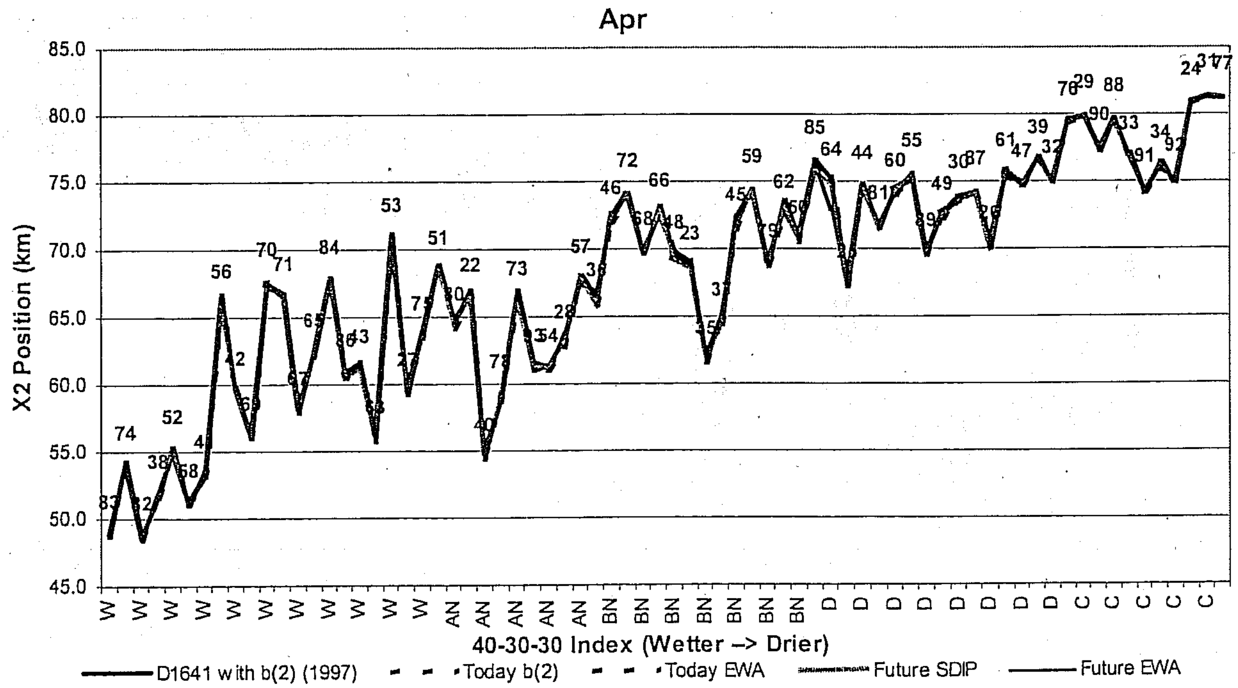


Figure 65 April X2 Position sorted by 40-30-30 Index

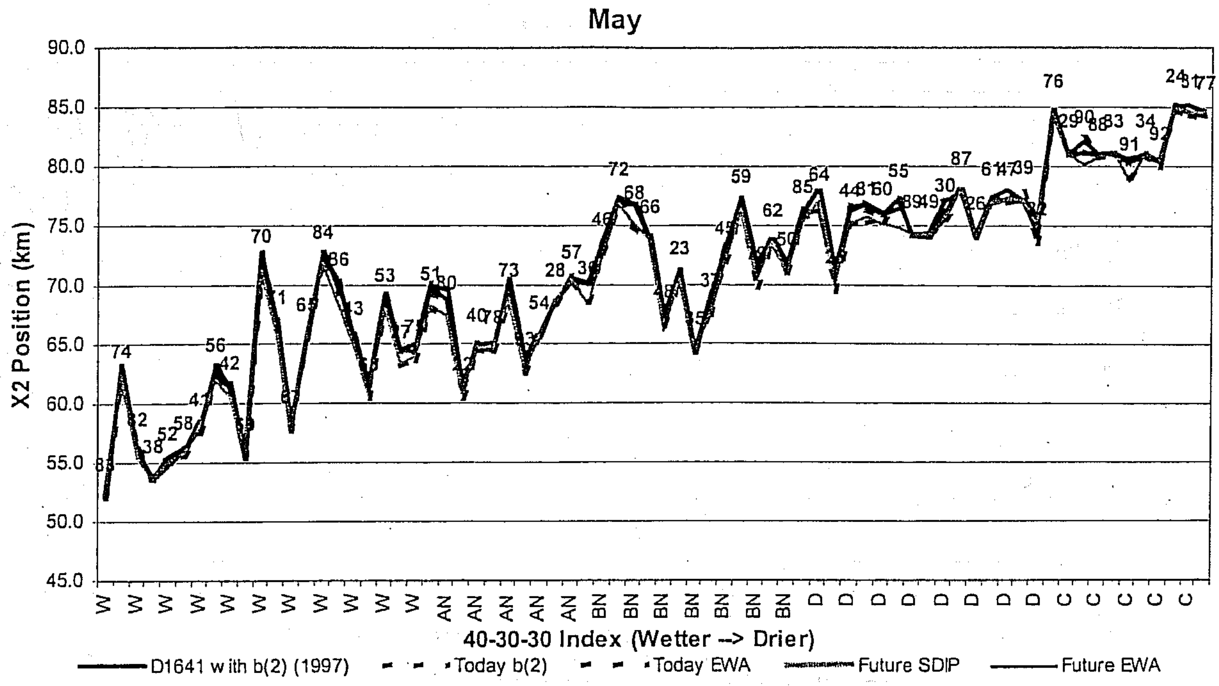


Figure 66 May X2 Position sorted by 40-30-30 Index

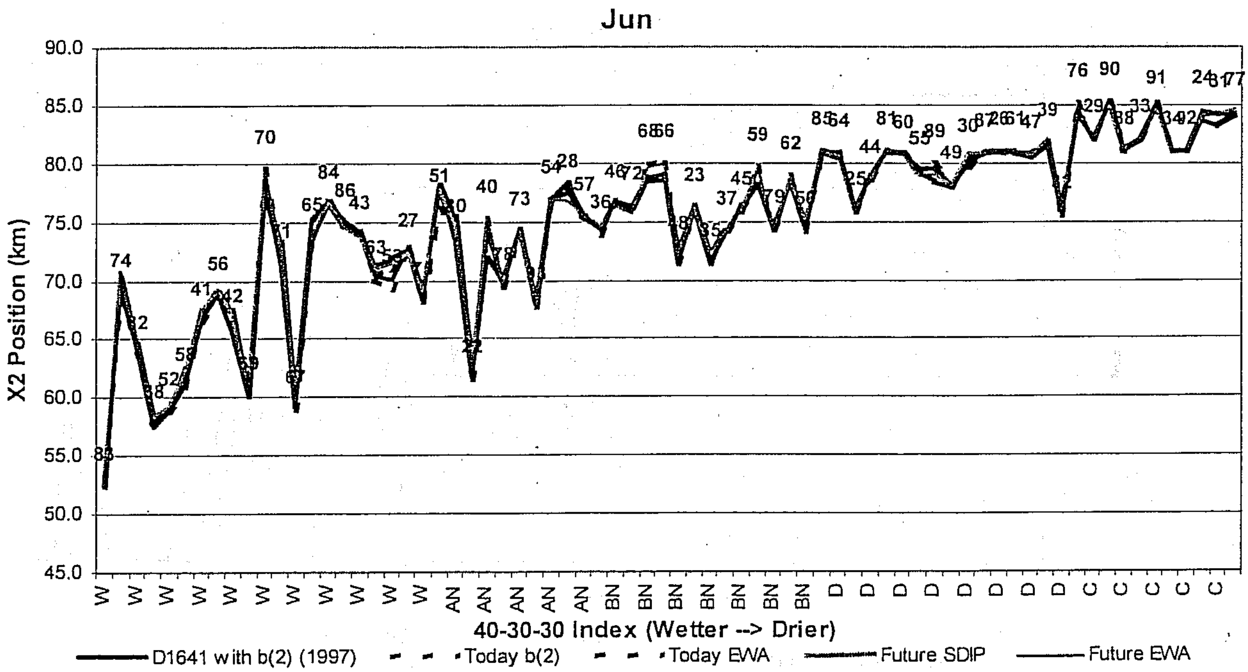


Figure 67 June X2 Position sorted by 40-30-30 Index

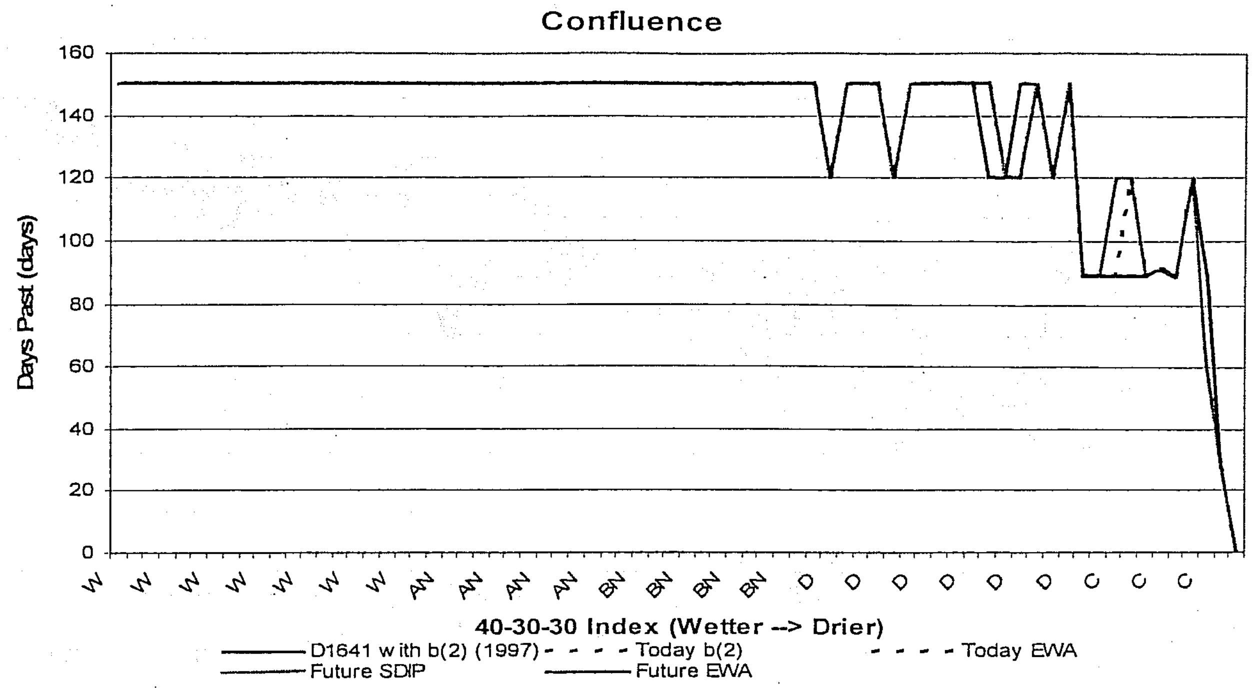


Figure 68 Total number of days average monthly X2 position is past the Confluence 40-30-30 Index
(Note: that the total days for a month are assigned if the average X2 position is past the confluence)

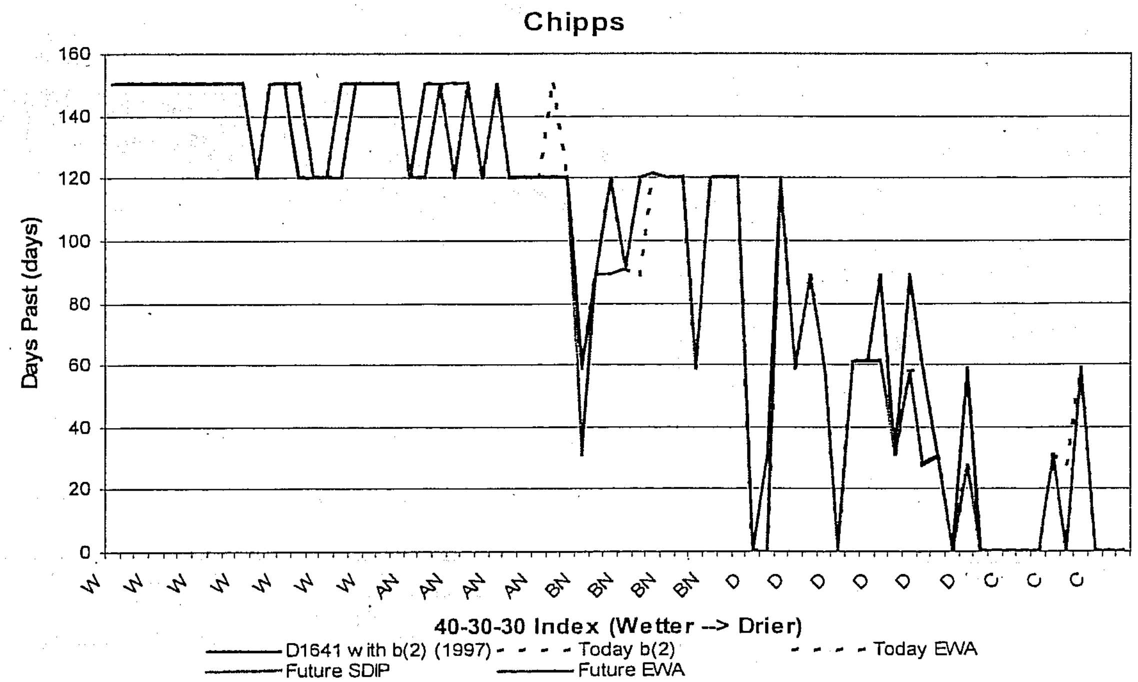


Figure 69 Total number of days average monthly X2 position is past the Chipps Island 40-30-30 Index **(Note: that the total days for a month are assigned if the average X2 position is past the Chipps Island)**

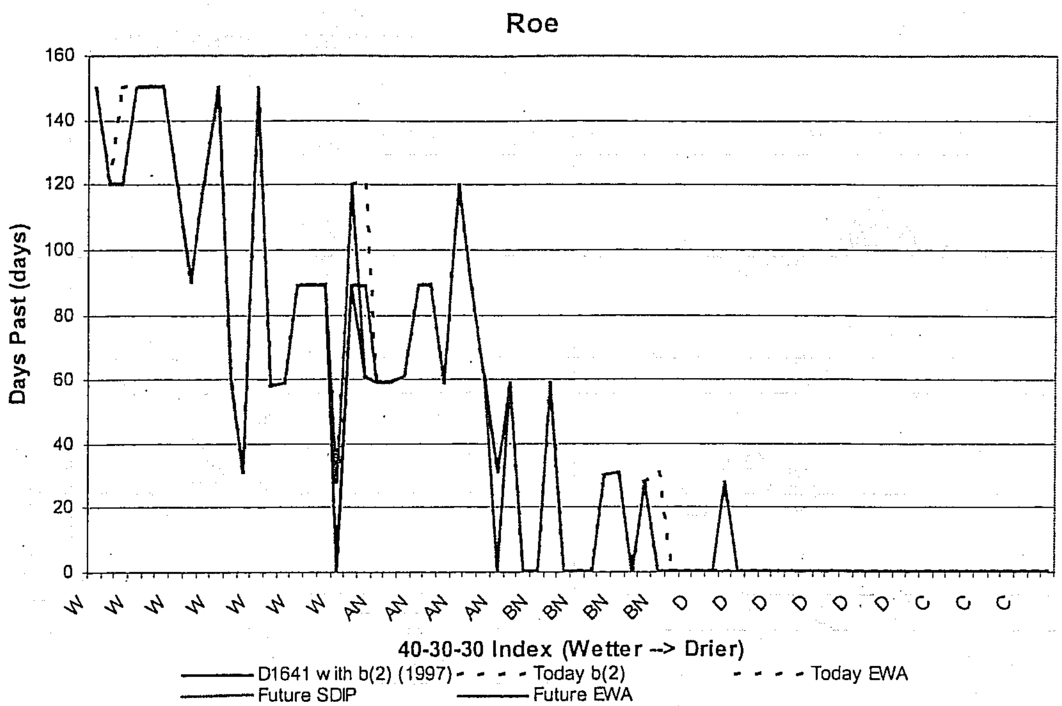


Figure 70 Total number of days average monthly X2 position is past the Roe Island 40-30-30 Index
(Note: that the total days for a month are assigned if the average X2 position is past the Roe Island)

Changes in Habitat Availability for Delta Smelt Based on X2 Movement

Another analysis using CALSIM II results looked at changes in X2 by water year and month. The average position of X2 during March–July of each year differed very little between model Study #1 and either #4 or #5 (refer to Table 10 for the Study descriptions). Concern arises with regard to upstream movements of X2 during the spring and early summer primarily because smelt tend to aggregate in a region defined by low salinity, and movement of that region upstream moves those aggregations closer to the export pumps. Upstream movements of X2 can cause smelt to become more susceptible to entrainment in the south Delta (March-July) and expose them to potentially lethal water temperatures (June-July). Because there is no basis for identifying a particular value as the critical one that separates a detrimental X2 difference from an innocuous one, one kilometer was selected as the criterion for review.

The difference between X2 in CALSIM II Studies #4 and #5 and Study #1 were plotted against X2 in Study #1 for each of the months March through July (Figures 71 to 75). In each figure, five panels representing each of the Sacramento River water-year types are presented. Positive differences represent movement of X2 upstream. In each figure, difference values larger than one kilometer in Below Normal, Dry, and Critically Dry years have been labeled with the years they represent.

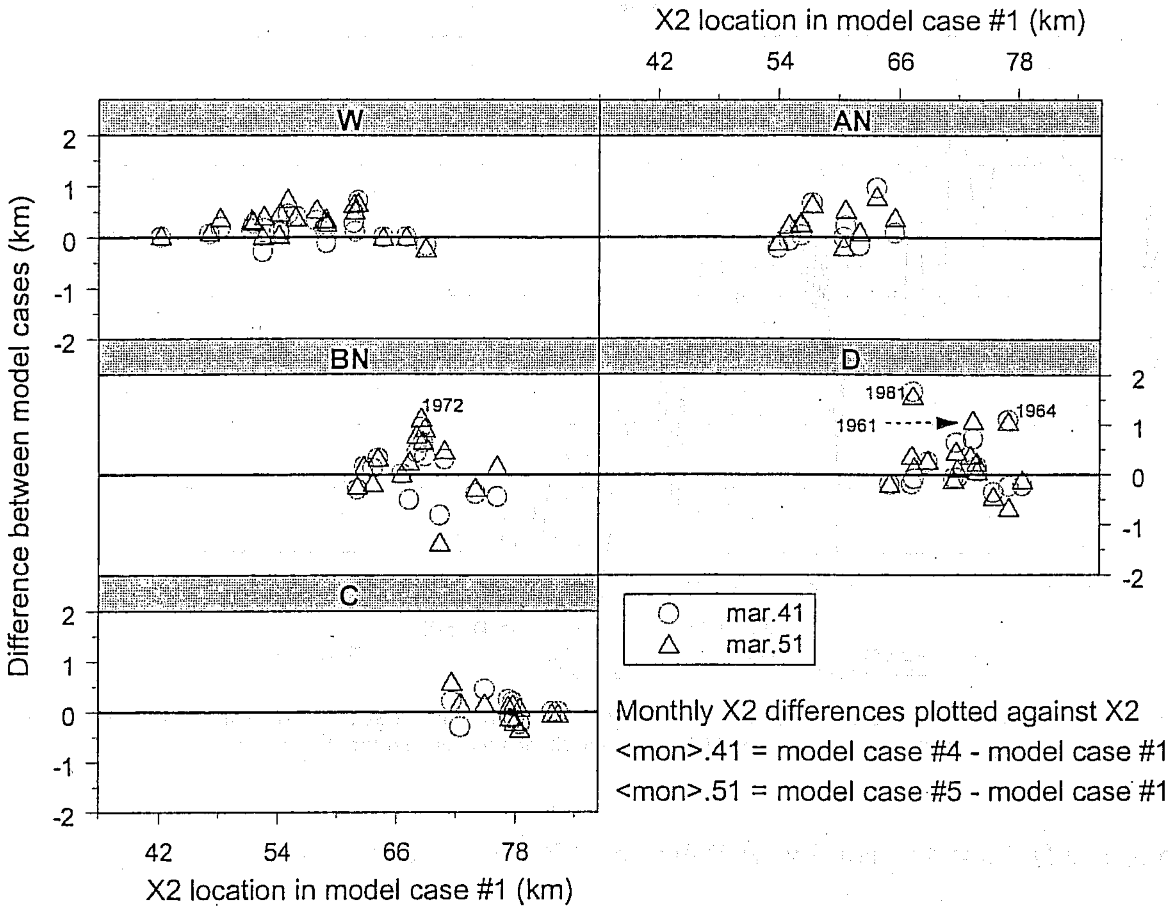


Figure 71 Differences in X2 under Studies #4 and #5 in March. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

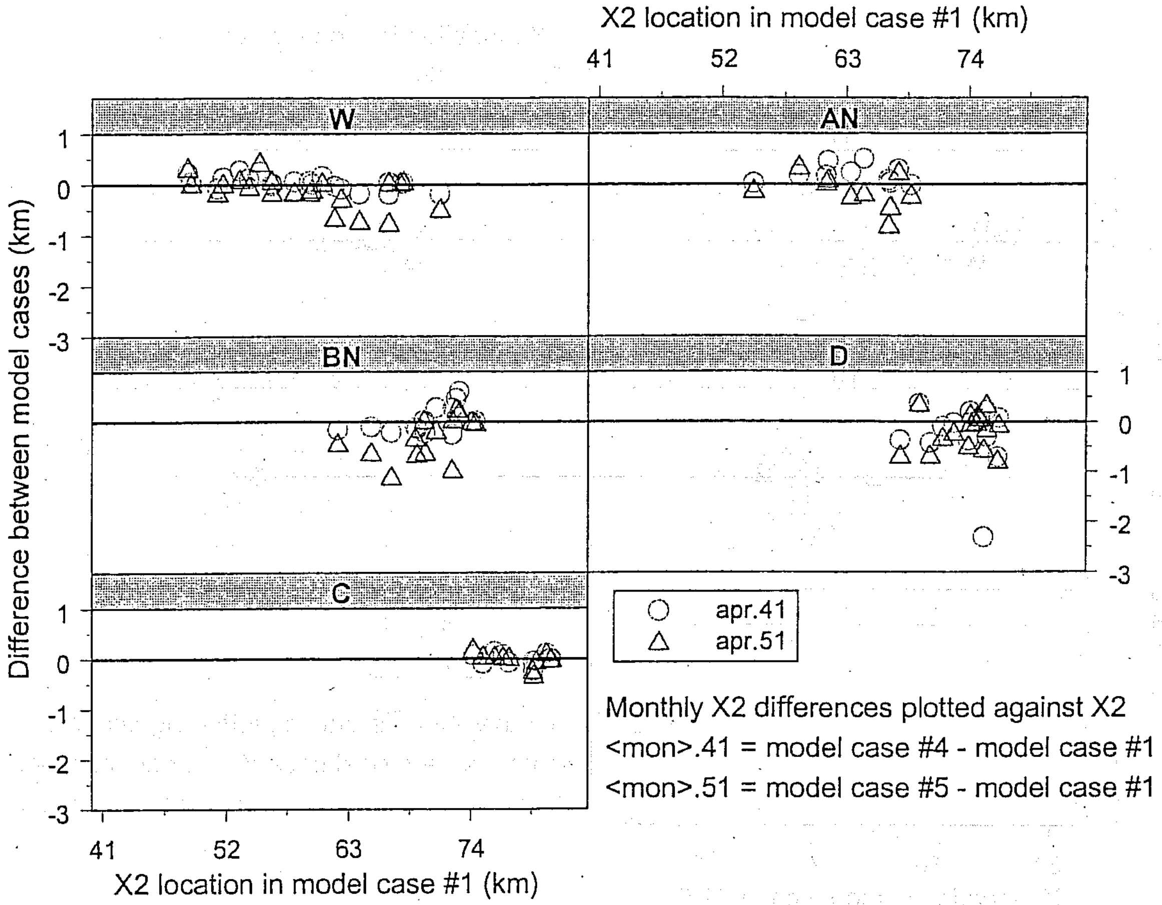


Figure 72 Differences in X2 under Studies #4 and #5 in April. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

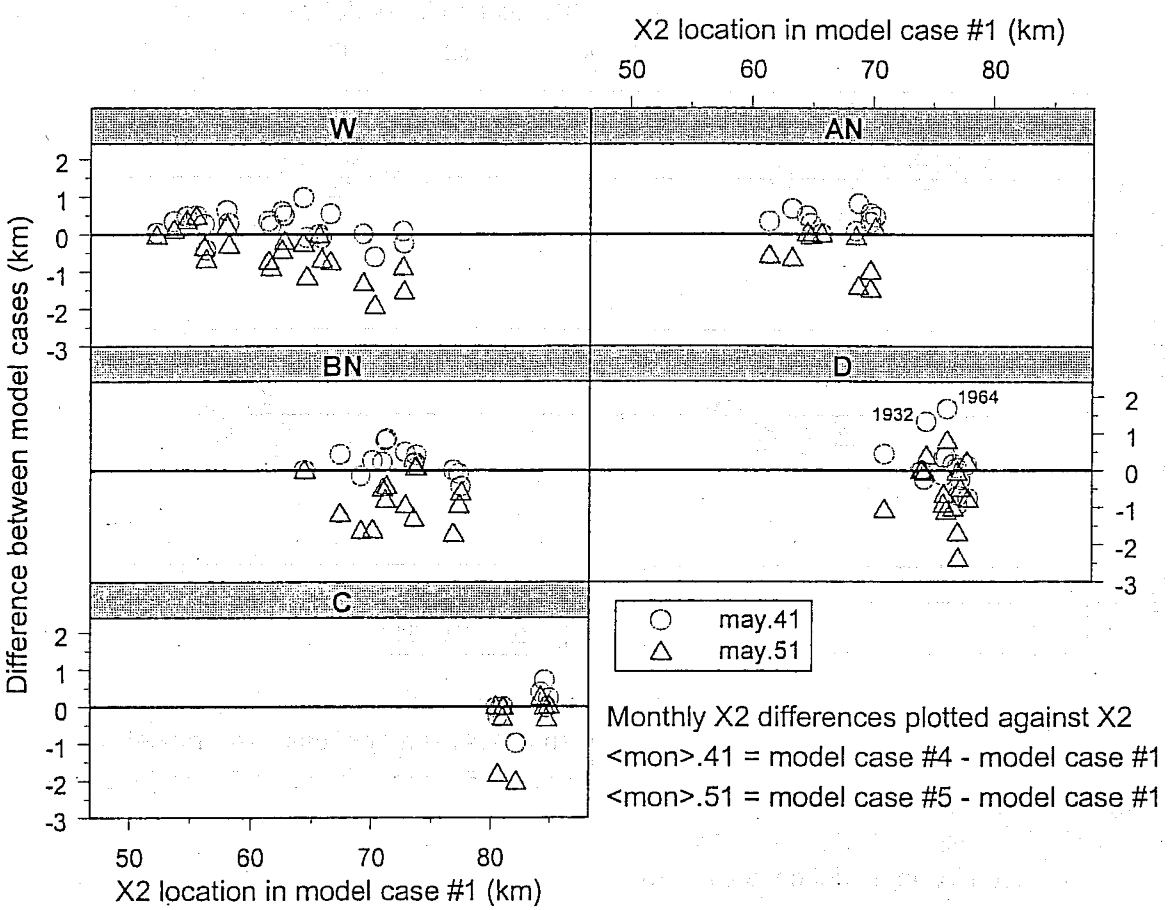


Figure 73 Differences in X2 under Studies #4 and #5 in May. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

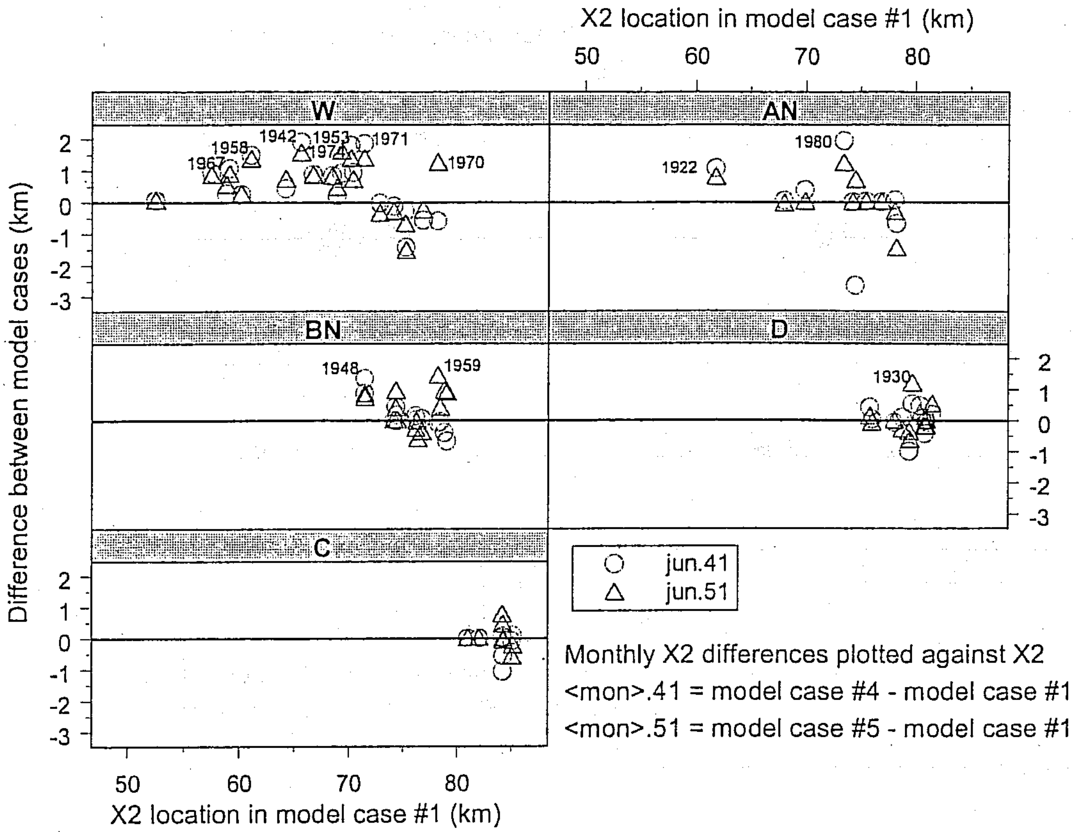


Figure 74 Differences in X2 under Studies #4 and #5 in June. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

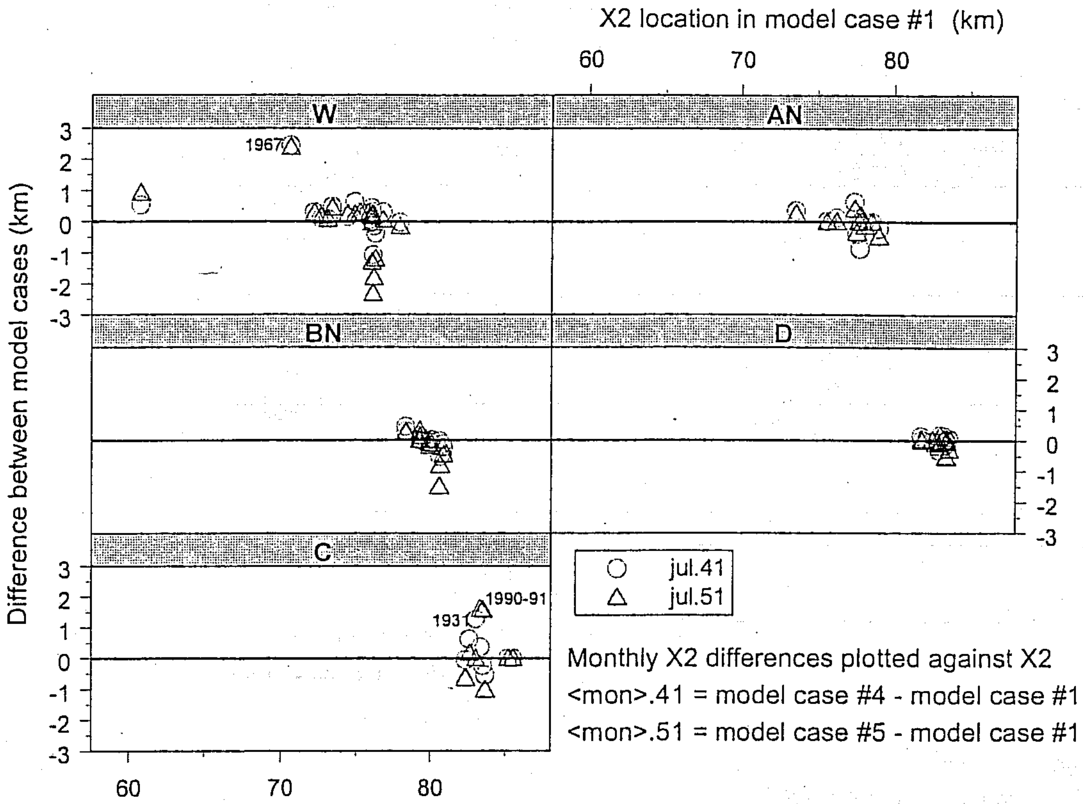


Figure 75 Differences in X2 under Studies #4 and #5 in July. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

Results

<u>March</u>

There was one detectable difference of at least one kilometer in in two Dry years (1964: 1.1 km; 1981: 1.7 km). In Study #5 it was achieved in three Dry years (1961: 1.1 km; 1964: 1.0 km; 1981: 1.6 km), and one Below Normal Year (1972: 1.1 km). None of these larger differences was followed by an April X2 difference larger than 0.34 km; indeed, all but two of the April differences were downstream movements and another was zero. It did not appear that X2 passed Chipps Island in any of these examples.

<u>April</u>

There were no detectable differences larger than one kilometer in April.

<u>May</u>

Study #4 during May in Dry years (1932: 1.3 km; 1964: 1.7 km). In both Studies (1932 and 1964), the differences were greatly reduced (1.3 km vs. 0.4 km in 1932 and 1.67 vs. 0.8 km in 1964) by the addition of EWA actions in model Study #5, resulting in Study #5 not reaching the criterion in any month. In the 1932 Study there was an upstream movement (0.4 km) in the following month, while in the 1964 Study there was a downstream movement (-0.4 km) in June. In the 1932 Study, X2 moved past Chipps Island (from 74.5 km in Study #1 to 75.8 km in Study #4).

June
In Study #4 X2 moved upstream one kilometer five times in Wet years (1942: 1.9 km; 1953: 1.8 km; 1958: 1.5 km; 1967: 1.1 km; 1971: 1.9 km), twice in Above Normal years (1922: 1.1 km; 1980: 2.0 km), and once in a Below Normal year (1948: 1.3 km). In Study #5 X2 moved upstream one kilometer six times in Wet years (1942: 1.6 km; 1953: 1.4 km; 1958: 1.4 km; 1970: 1.2 km; 1971: 1.4 km; 1974: 1.6 km), once in an Above Normal year (1980: 1.2 km), once in a Below Normal year (1.4 km), and once in a Dry year (1930: 1.2 km). In all of these instances save 1967 in Study #4a the X2 difference in the following month was much smaller or moved downstream. None of these Studies appears to involve a movement of X2 past Chipps Island.

July
In Study #4 X2 moved upstream more than 1 km once in a Wet year (1967: 2.5 km) and once in a Critically Dry year (1931: 1.3 km). In #5 X2 moved upstream more than 1 km in 1967 (2.4 km) and twice in Critically Dry years (1990: 1.6 km; 1991: 1.6 km). In all Studies except #4 in 1967, there was a downstream shift from Study #1 in the following month. None of these Studies involved a shift of X2 east past Chipps Island.

Modeling Summary
Upstream movements of X2 predicted in the future Studies reach one kilometer or more only occasionally. In some Studies upstream movements observed in Study #4 were reduced or erased in Study #5. In a few Studies the upstream movement is larger in Studies #5 and #5a. There were a few movements from the west to the east side of Chipps Island, but these were of small magnitude.

CH2MHill Analysis
The CH2MHill analysis, as shown in Appendix L of the BA compared the location of X2 for February through June for the future Study as compared to the base Study (study 5A vs. study 1). The monthly X2 location was taken from the CALSIM II modeling studies. X2 locations from study 5A and study 1 were then mapped (see Figure 32 for an example) to show how far X2 moved upstream. In wet years, X2 is located in Suisun Bay throughout the modeled period. An upstream movement of 0.5 km in wet years would not significantly reduce habitat quality or quantity for delta smelt. In drier years, X2 is located upstream of the confluence of the Sacramento and San Joaquin Rivers and the amount of quality habitat available to delta smelt is minimal and adult abundance is low (Bennett 2003). When X2 is located this far upstream, smelt would already be susceptible to increased mortality due to high temperatures, predation and entrainment. An upstream movement of X2 of 0.5 km would not be significant when it is located upstream of the confluence because delta smelt habitat is already poor and the upstream movement does not result in any substantial additional loss of habitat or increase in adverse effects. This analysis showed that there were 37 months (out of a possible 360 months) where X2 moved upstream more than 0.5 km. By ruling out the wet and dry years described above, the Service determined that there were 6 months out of the 37 months where the upstream movement

of X2 could result in a substantial loss of habitat for delta smelt.

Therefore, in order to protect smelt from detrimental effects when X2 is upstream of Chipps Island, the DSRAM will be used to determine whether actions are necessary to protect delta smelt. The DSRAM and a description of it is located in Appendix A. The DSRAM has a number of triggers that determine when the Delta Smelt Working Group meets. One of the triggers calls for the Delta Smelt Working Group to meet if X2 is upstream of Chipps Island and temperatures are between 12 and 18 degrees Celsius, the approximate range of spawning temperatures for delta smelt. If this trigger is met, the Working Group will meet to evaluate whether to a change in operations such as a change in exports, San Joaquin River flows, barrier operations or cross channel gates might help protect smelt. The Working Group's recommendation will then be sent to the WOMT for consideration of implementation. Through these actions, potentially detrimental effects to delta smelt due to an upstream movement of X2 will be avoided or ameliorated.

Pumping at the CVP and SWP Facilities

Tracy Pumping

The Tracy Pumping Plant in Studies 4 and 5 the intertie allows pumping to increase to the facility design capacity of 4600 cfs (from its current pumping rate of 4200 cfs). Figure 76 shows the percentile values for monthly pumping at Tracy. November through February are the months when Tracy most frequently pumps at 4600 cfs. Tracy can better utilitze the 4600 cfs pumping in wet years in Study 4 and Study 5 (Figure 78).

From Figure 76, the pumping is decreased in December through February in Studies 3 and 5 by the 25 TAF/month placeholder for the EWA program. April, May and June show reductions compared to other months because of the VAMP restrictions, and May shows further reductions due to EWA spending some assets to implement the May Shoulder pumping redcution. July through September show pumping increases generally for irrigation deliveries.

Figures 77 to 82 show similar trends in monthly average exports by year type with pumping being greatest December through February and July through September. The exception is in the Critical year (Figure 82) when the pumping stays between 1000 cfs and 1500 cfs through August due to reduced storage and water qaulity (salinity) in the Delta. In general, pumping at Tracy will increase in Study 5a and may increase the number of delta smelt entrained, but these increases in entrainment are likely to be avoided by the DSRAM and use of EWA water to reduce exports.

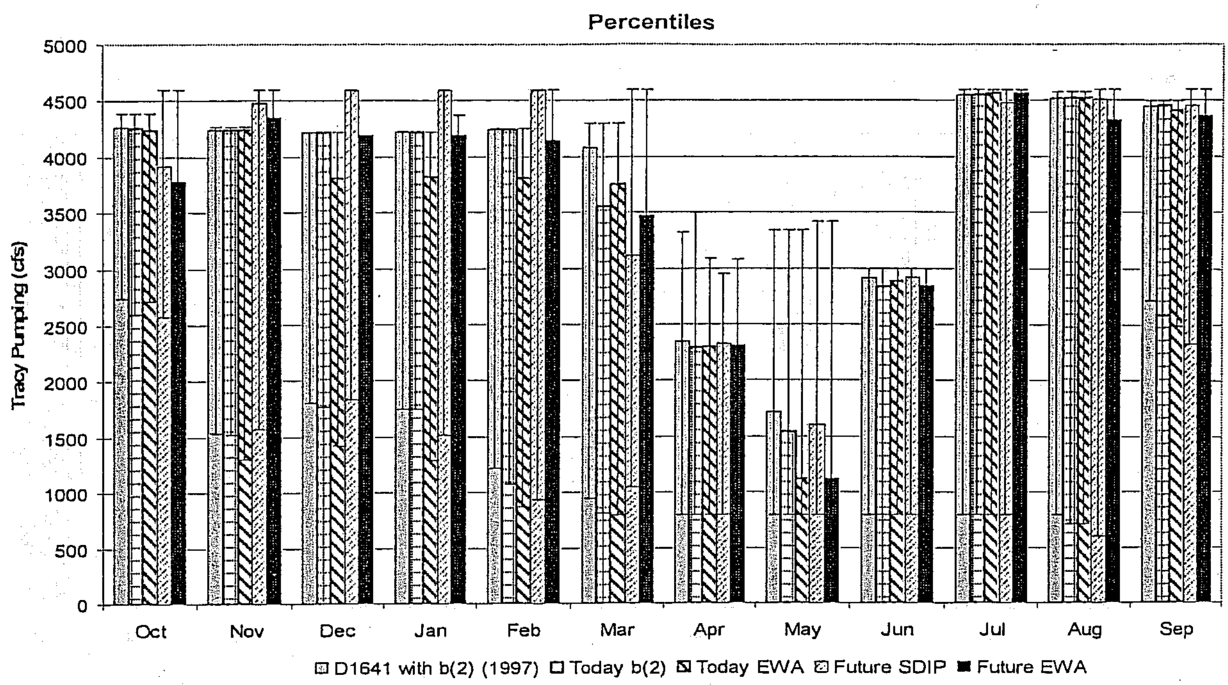


Figure 76 Tracy Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

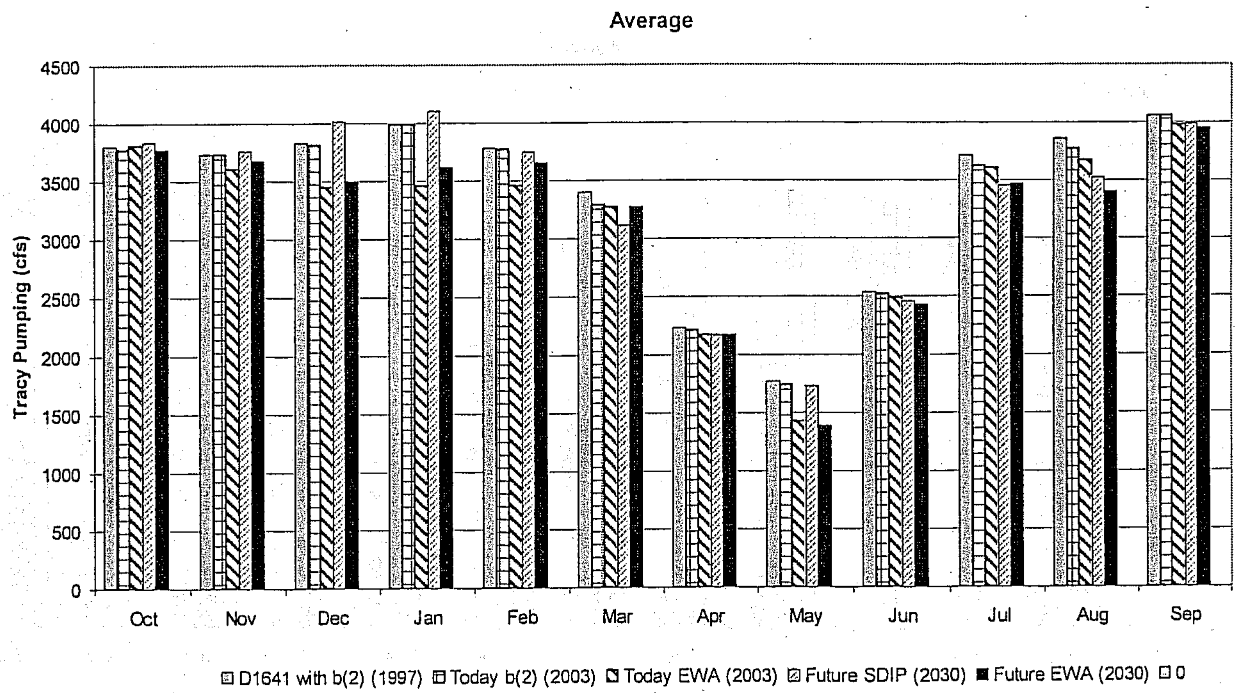


Figure 77 Average Monthly Tracy Pumping

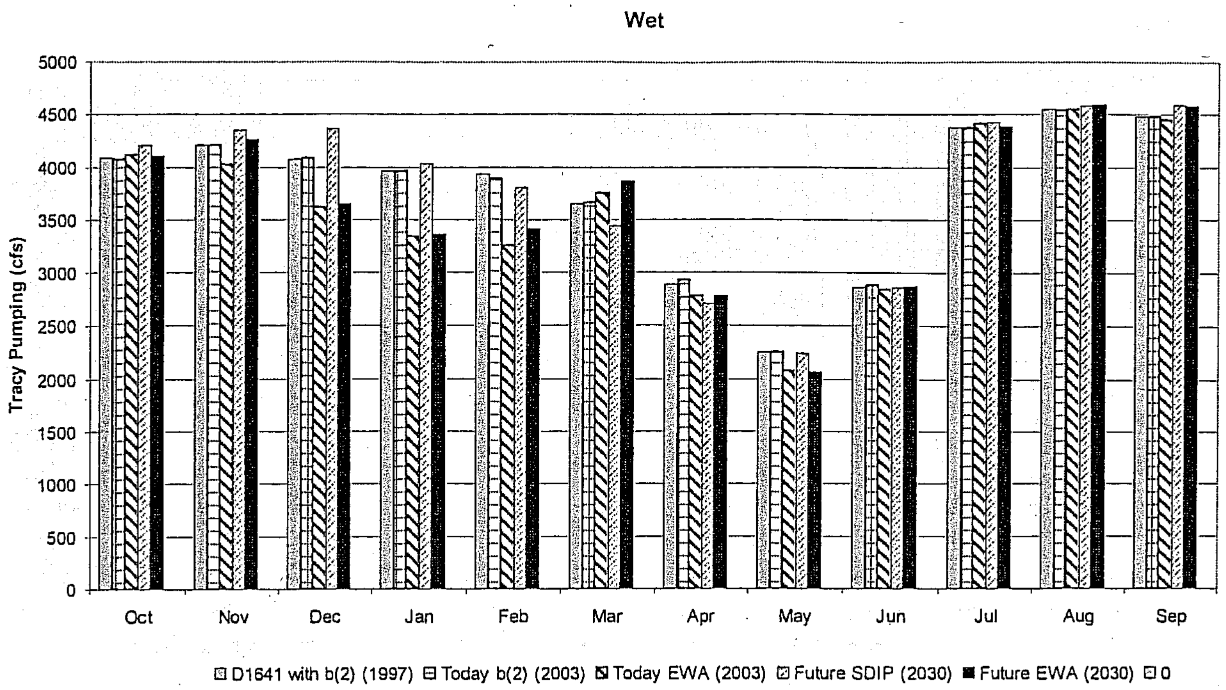


Figure 78 Average wet year (40-30-30 Classification) monthly Tracy Pumping

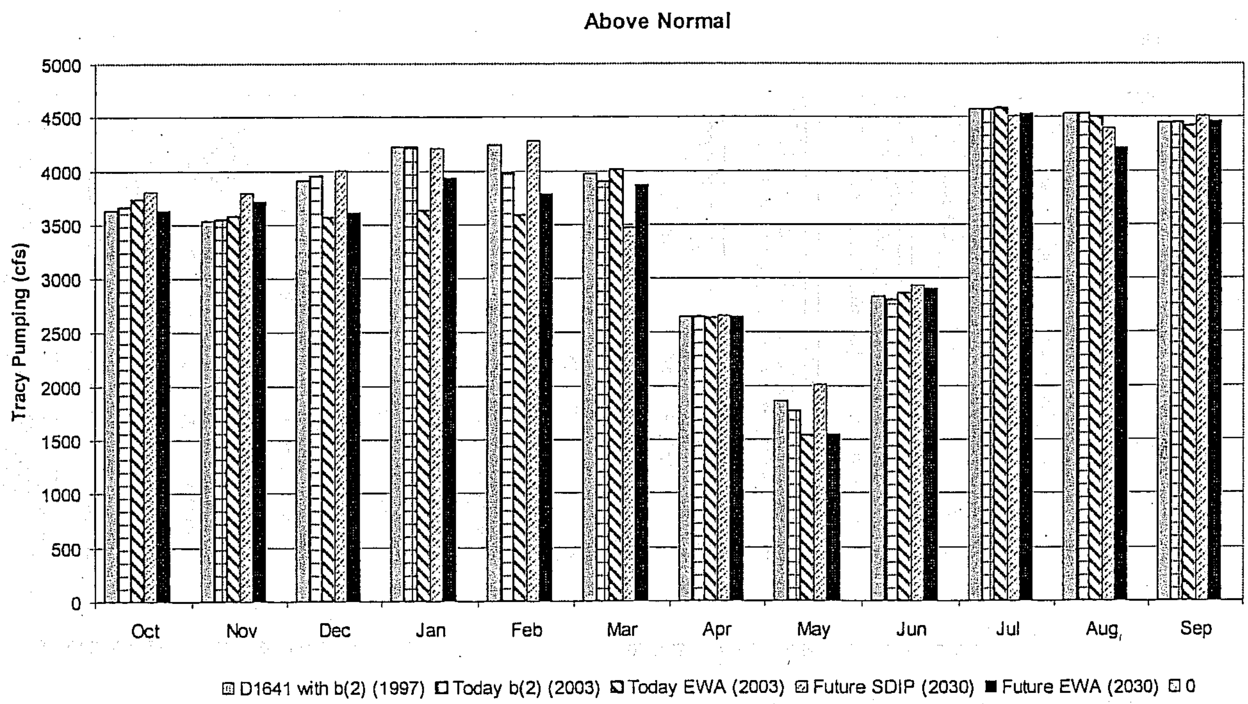


Figure 79 Average above normal year (40-30-30 Classification) monthly Tracy Pumping

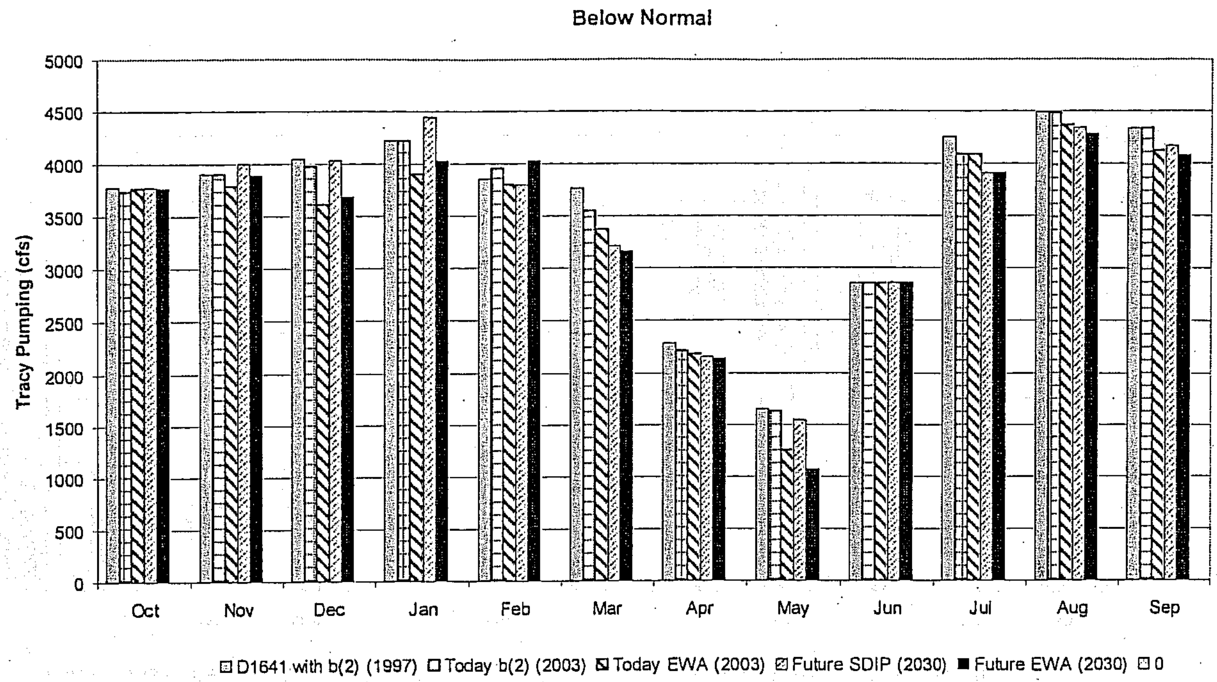


Figure 80 Average below normal year (40-30-30 Classification) monthly Tracy Pumping

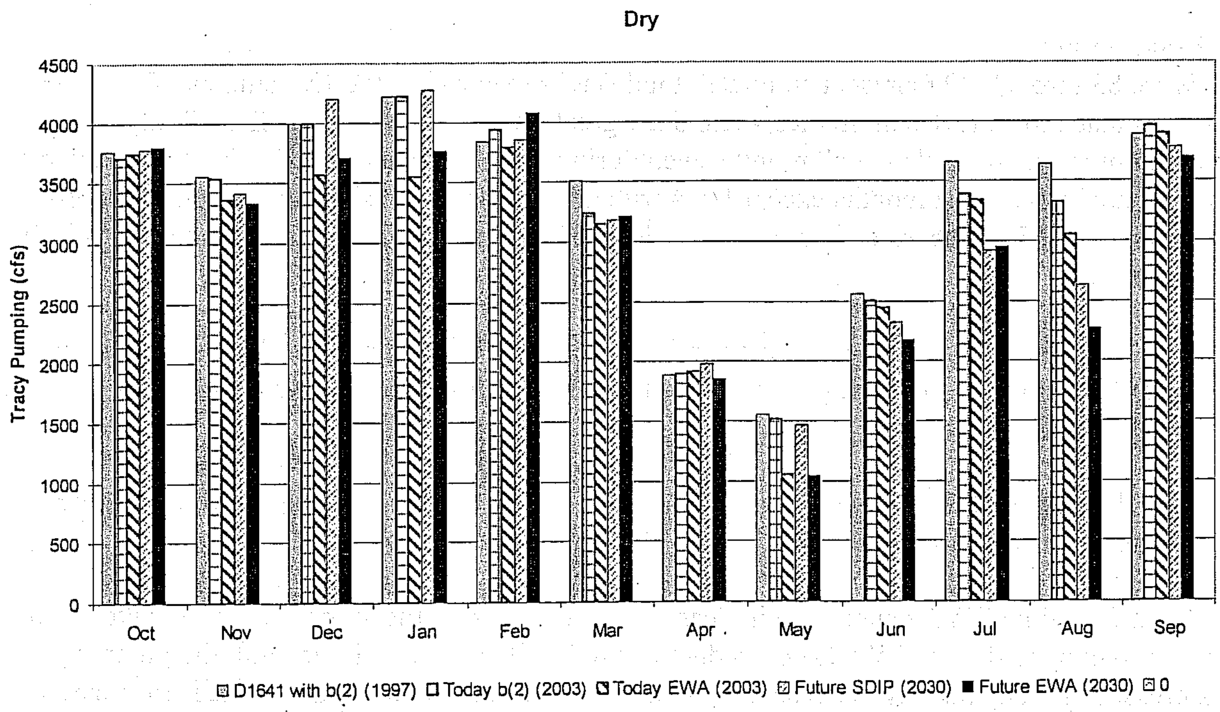


Figure 81 Average dry year (40-30-30 Classification) monthly Tracy Pumping

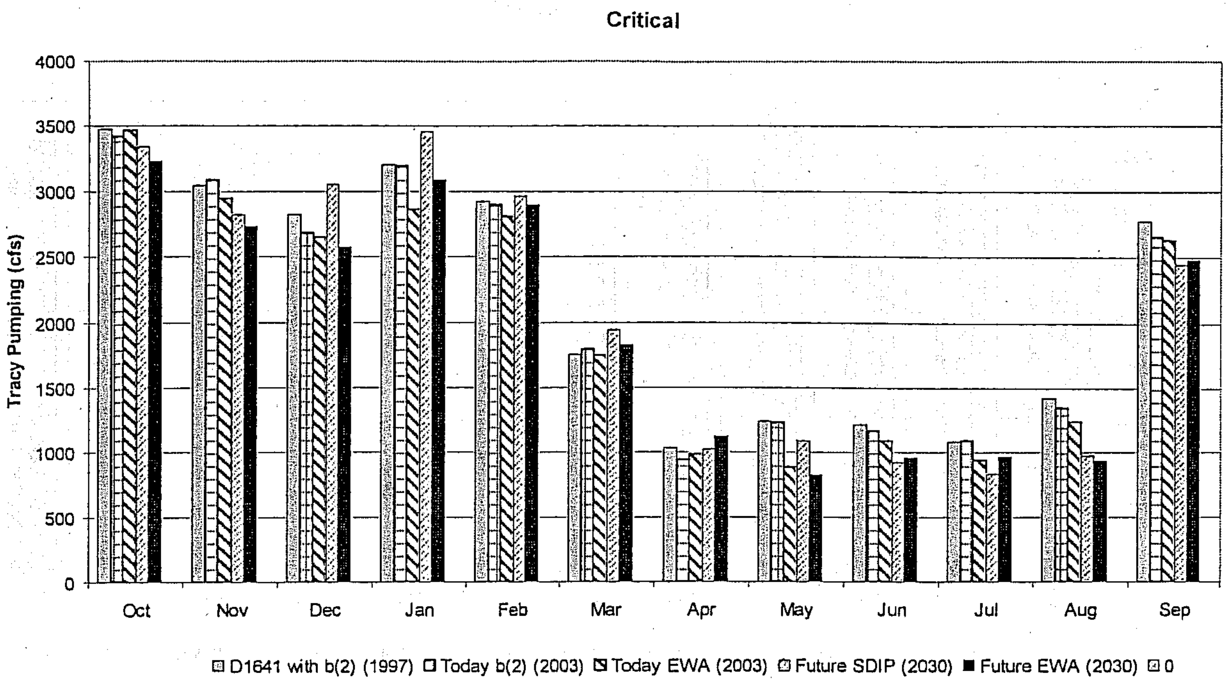


Figure 82 Average critical year (40-30-30 Classification) monthly Tracy Pumping

Banks Pumping

Figure 83 through 89 represent simulated total Banks exports for the five studies. Figure 92 shows that export levels in Studies 4 and 5 are greater than Study 1. The SDIP Study shows higher pumping over almost all months even during the April-May period. The Future export levels are higher most months except for April and May. The whisker plot (Figure 83) also shows that a 8500 export level is reached at least 5% of the time in the SDIP and the EWA future Studies

While EWA and SDIP implementation in Study 5 results in higher export levels in all months except for April and May, the percentage of the summer time increases vary as a function of year type (Figure 84 to 89).

In the driest years EWA related exports more than double the July, August, and September exports when compared to Study 1.

Most of the time EWA exports are increased primarily during the summertime to make up for reduced exports due to EWA export reductions in April and May. In general, the pumping increases in Study 5a may increase the number of delta smelt entrained, but these increases in entrainment are likely to be avoided by the DSRAM and use of EWA water to reduce exports.

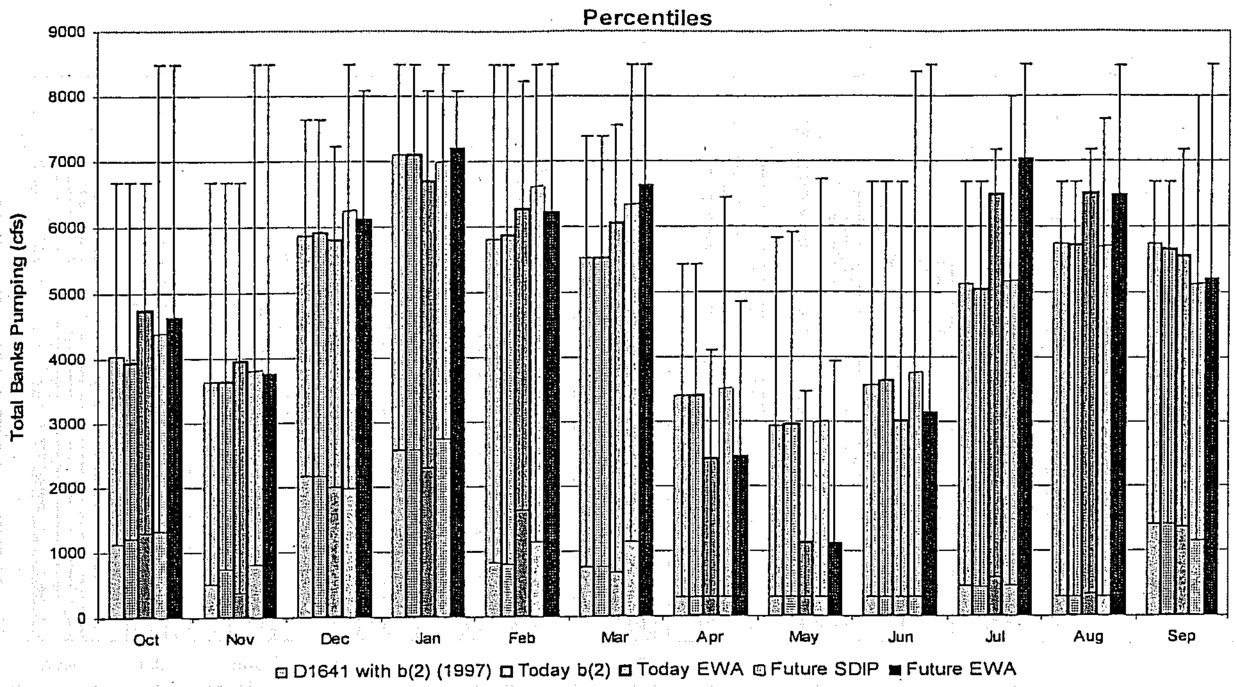


Figure 83 Banks Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

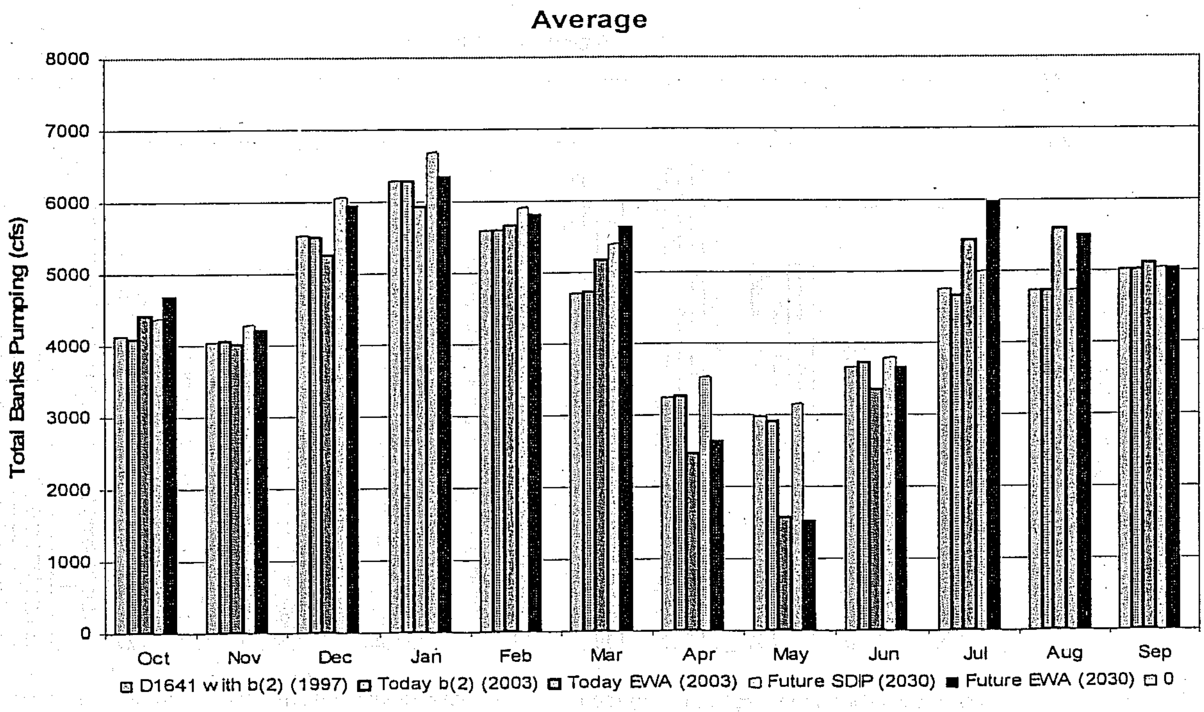


Figure 84 Average Monthly Banks Pumping

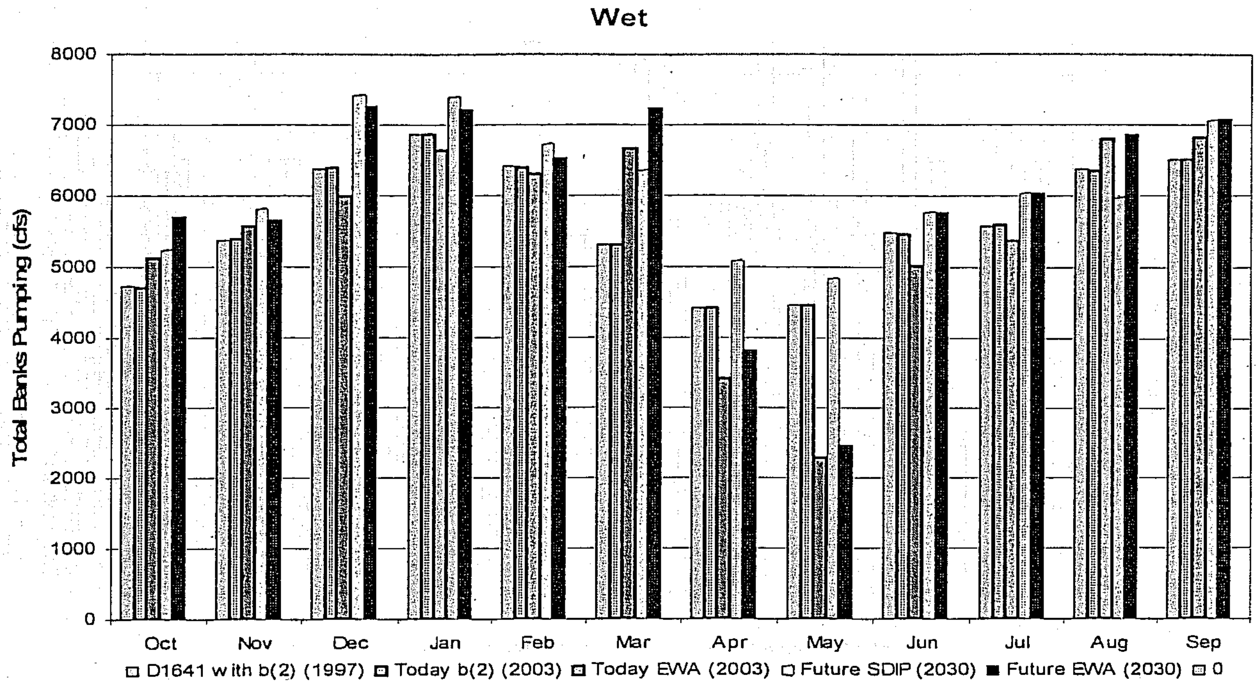


Figure 85 Average wet year (40-30-30 Classification) monthly Banks Pumping

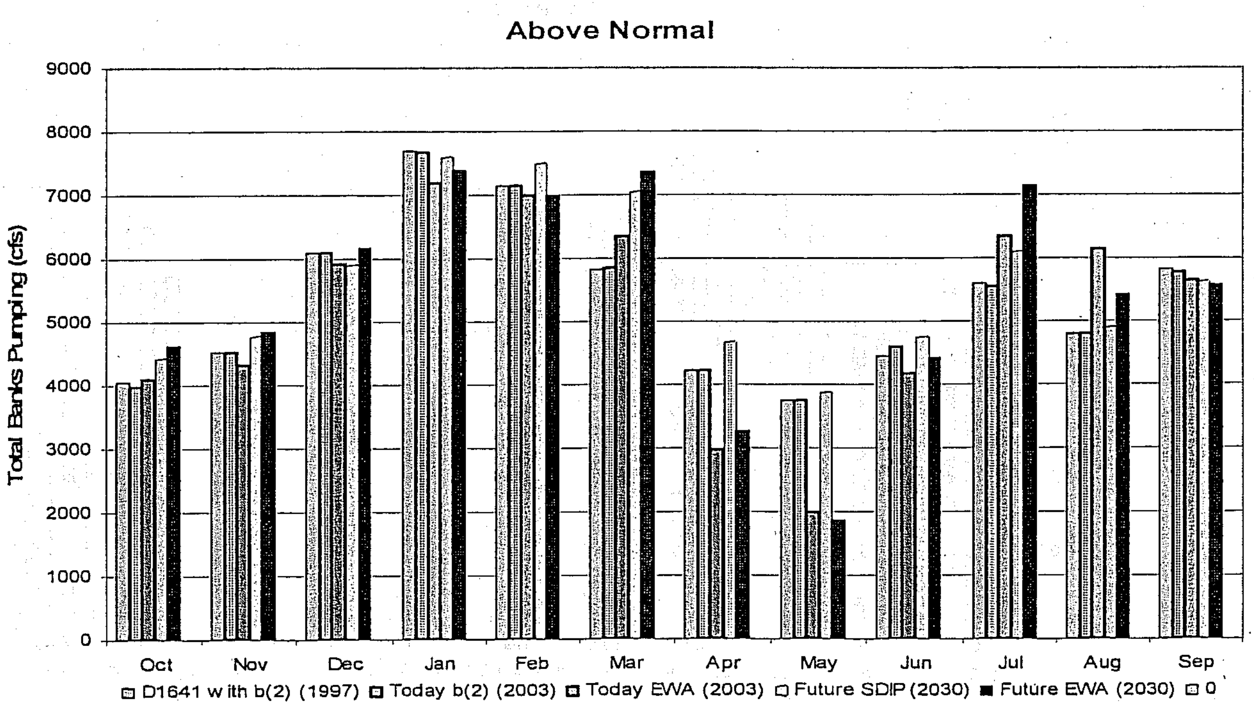


Figure 86 Average above normal year (40-30-30 Classification) monthly Banks Pumping

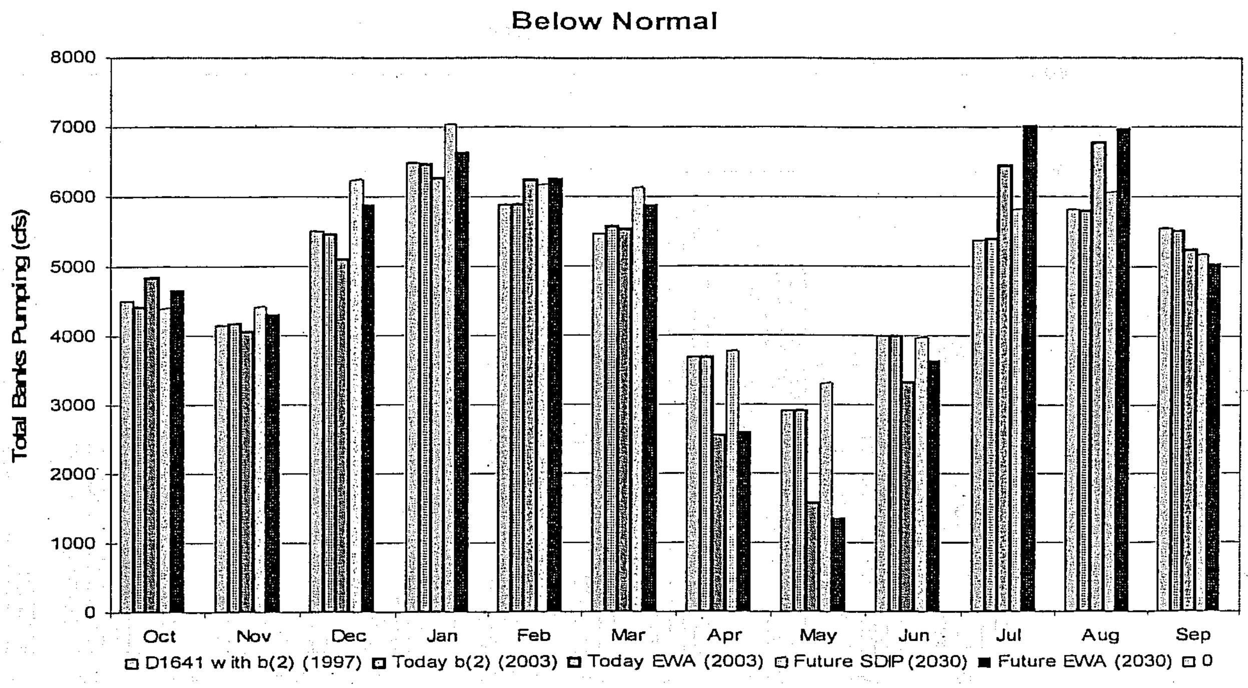


Figure 87 Average below normal year (40-30-30 Classification) monthly Banks Pumping

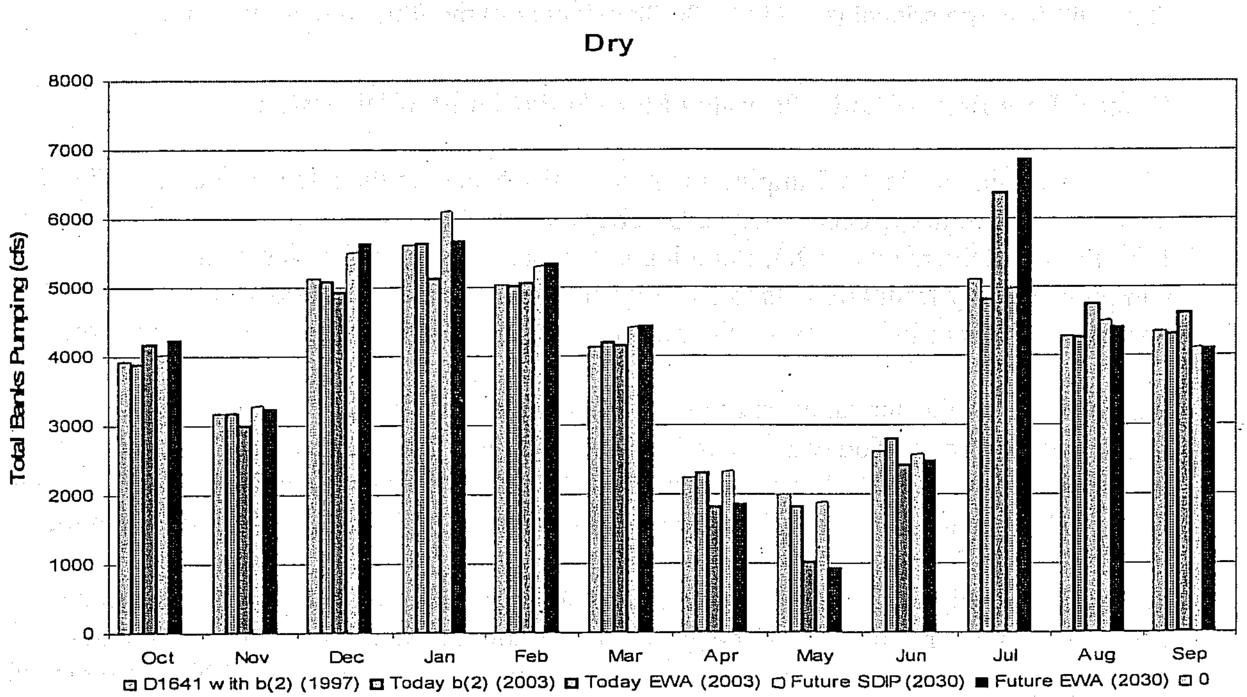


Figure 88 Average dry year (40-30-30 Classification) monthly Banks Pumping

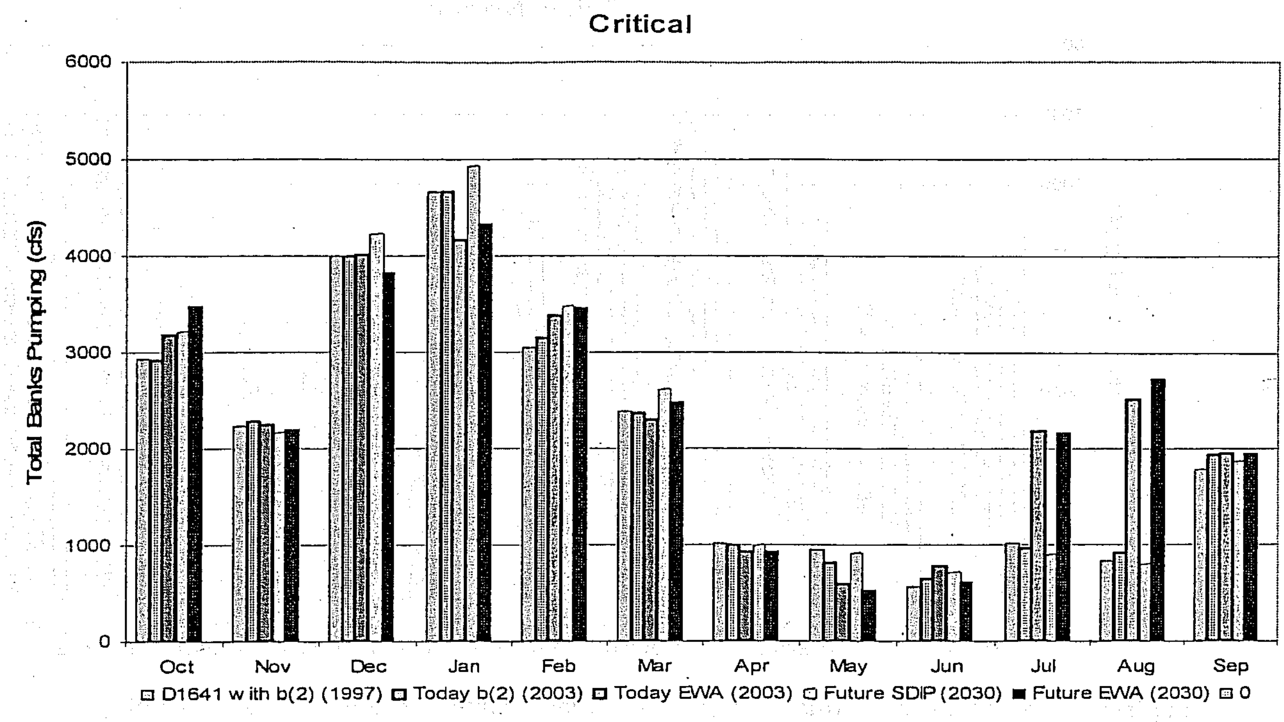


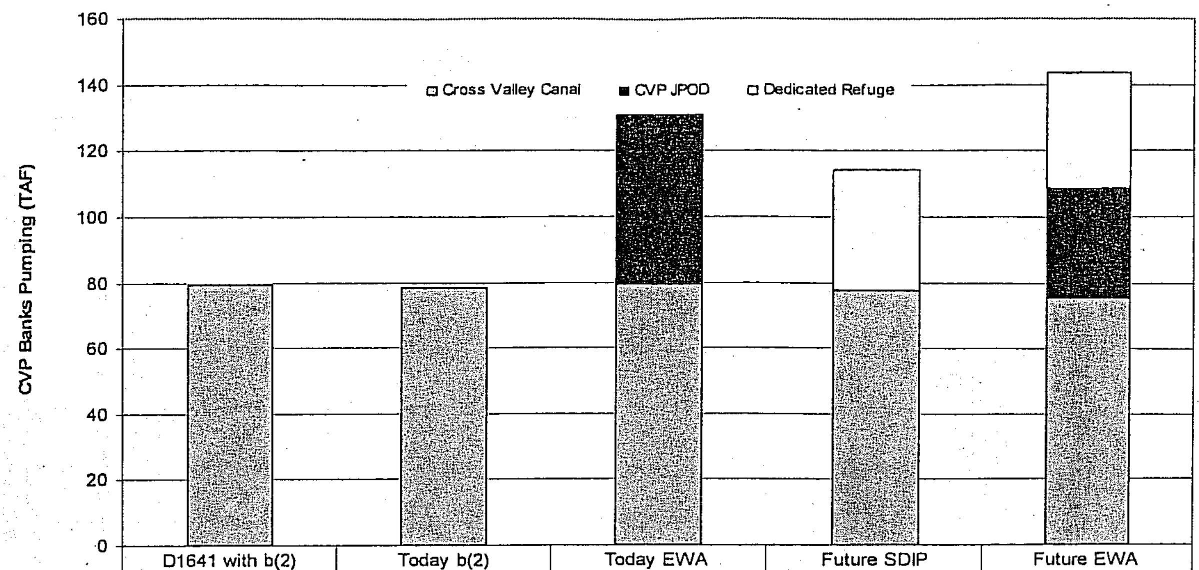
Figure 89 Average critical year (40-30-30 Classification) monthly Banks Pumping

Federal Pumping at Banks Pumping Plant (Joint Point of Diversion)

Federal pumping at Banks Pumping Plant generally occurs in the late summer, see Figure 91. Some Federal pumping occurs during October through March for Cross Valley Contractors. Joint Point of Diversion (JPOD) Pumping is generally higher in Studies 4 and 5 due to increased pumping capacity from 6680 cfs to 8500 cfs and the dedicated 100,000 af/Yr. Most JPOD opportunities occur in wet years, with pumping averages decreasing as the years get drier.

Figure 90 shows the annual average use of Banks pumping for the CVP by study. The average JPOD pumping in the Today EWA and Future EWA was 52 TAF and 33 TAF respectively. If the Future EWA JPOD includes the dedicated 100,000 af/yr the number is 68 TAF. Pumping for Cross Valley Canal (Tier 1 JPOD pumping) ranges from 75 TAF to 79 TAF between the studies.

These Figures (Figures 92 to 97) show that most JPOD pumping occurs in the summer and fall, when delta smelt are not likely to be present in the south Delta. Smelt entrainment at the export facilities is not likely to increase as a result of the JPOD pumping. Since JPOD pumping also benefits the EWA, it can be considered a beneficial action when smelt are not present in the south Delta. JPOD pumping will not occur until the Management Agencies (and the Working Group, as necessary) through the WOMT determine that fish in the Delta would not be harmed.



	D1641 with b(2)	Today b(2)	Today EWA	Future SDIP	Future EWA
Dedicated Refuge	0	0	0	37	35
CVP JPOD	0	0	52	0	33
Cross Valley Canal	79	78	79	78	75

Figure 90 Average use of Banks pumping for the CVP

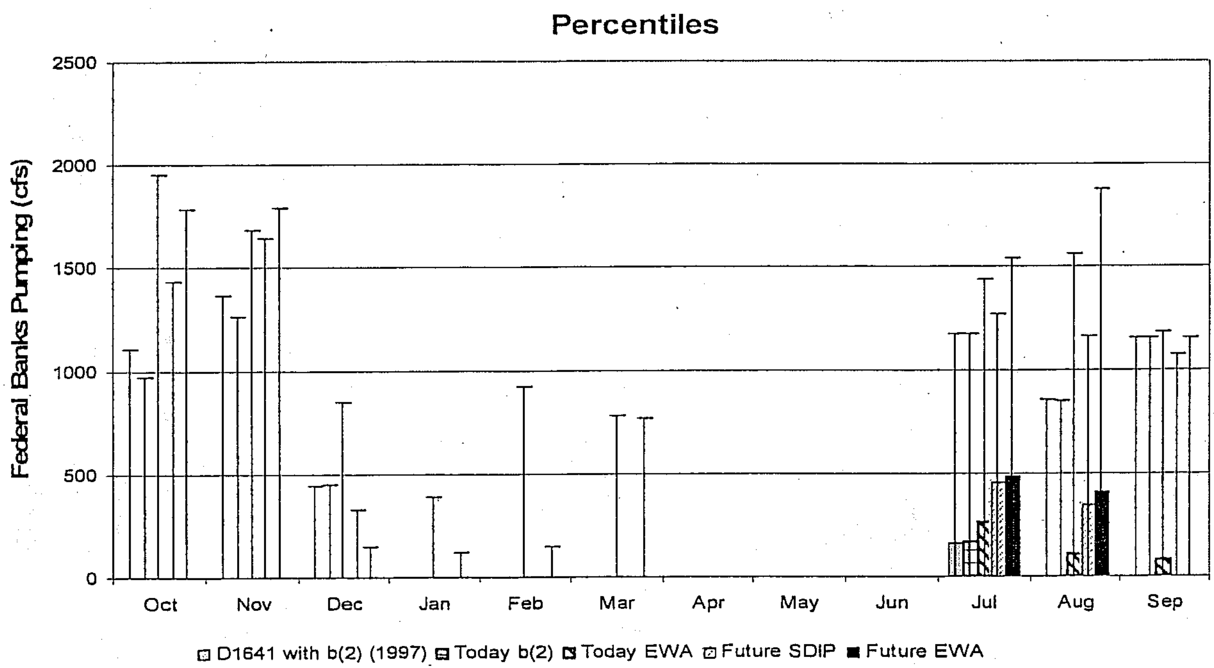


Figure 91 Federal Banks Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

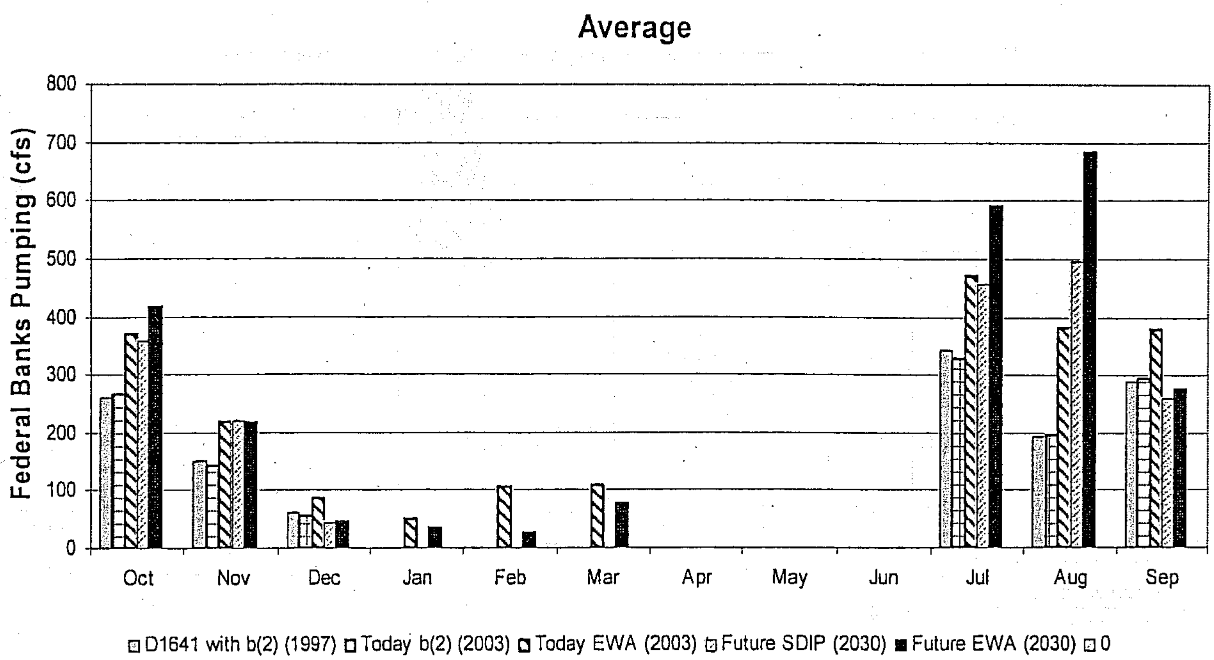


Figure 92 Average Monthly Federal Banks Pumping

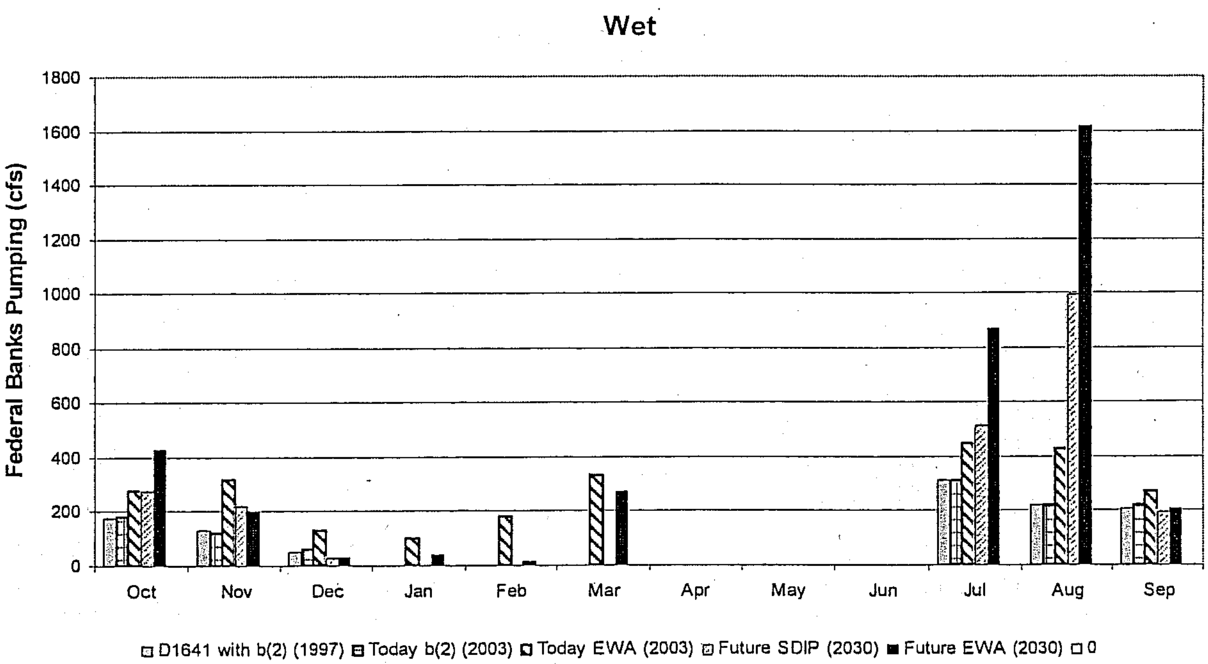


Figure 93 Average wet year (40-30-30 Classification) monthly Federal Banks Pumping

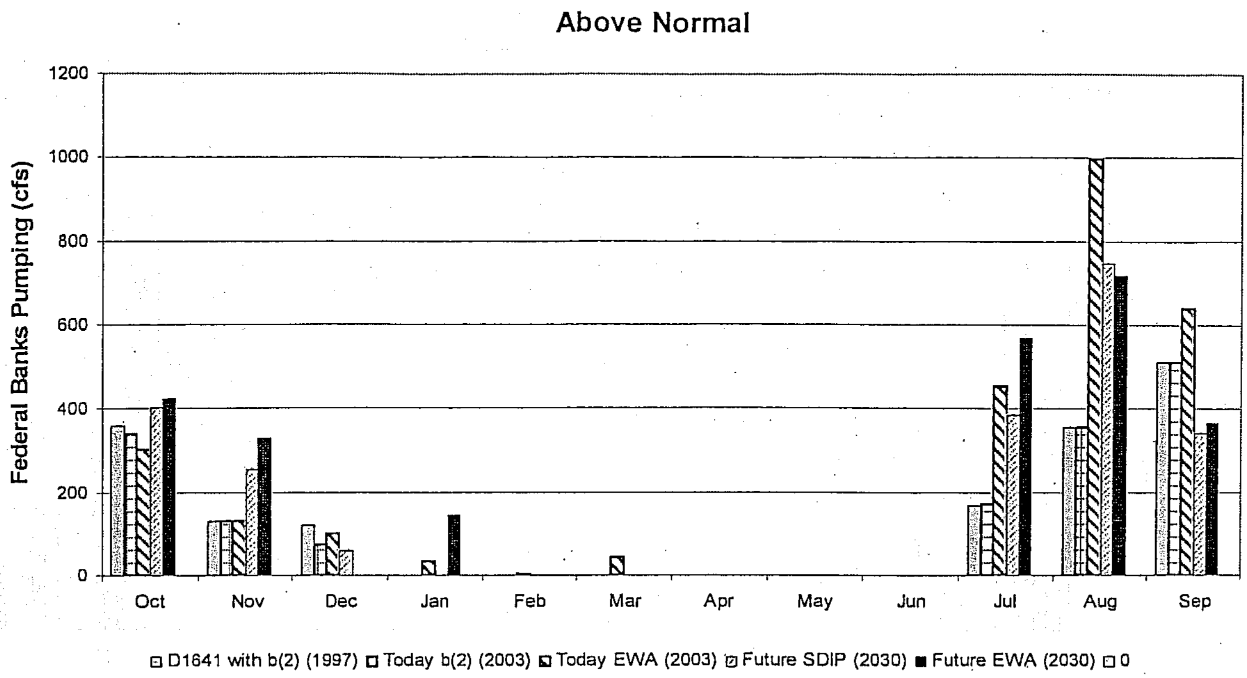


Figure 94 Average above normal year (40-30-30 Classification) monthly Federal Banks Pumping

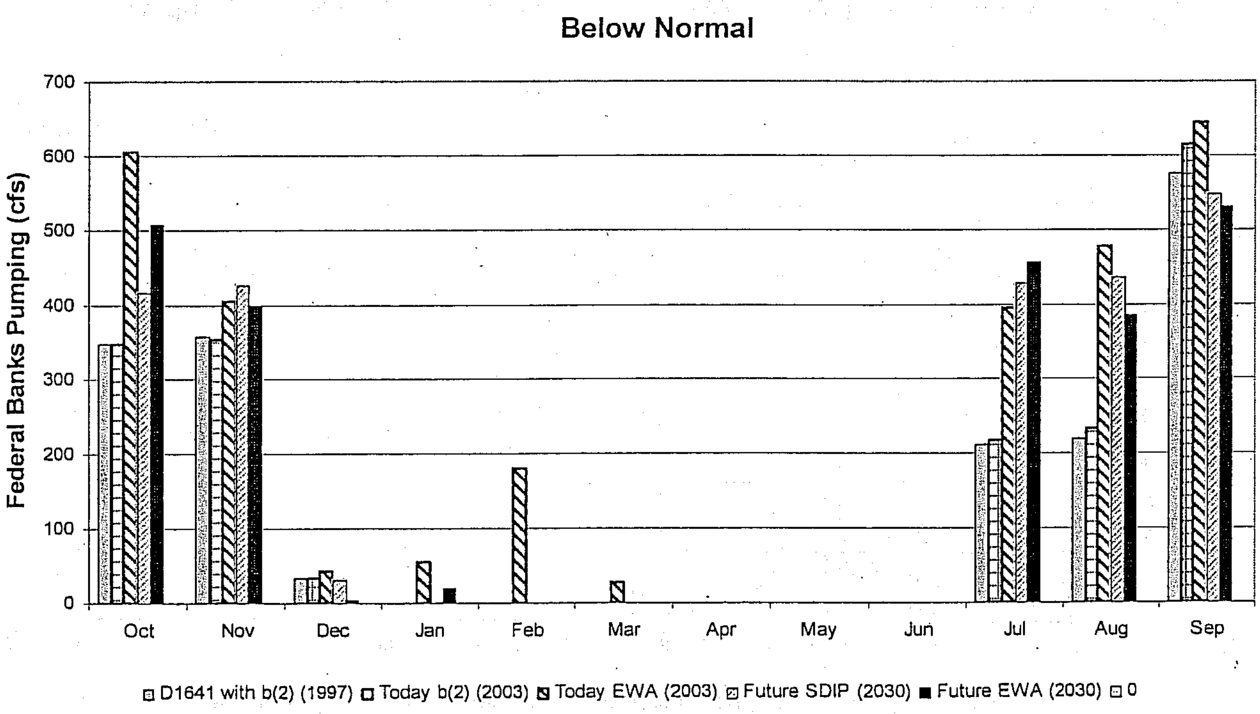


Figure 95 Average below normal year (40-30-30 Classification) monthly Federal Banks Pumping

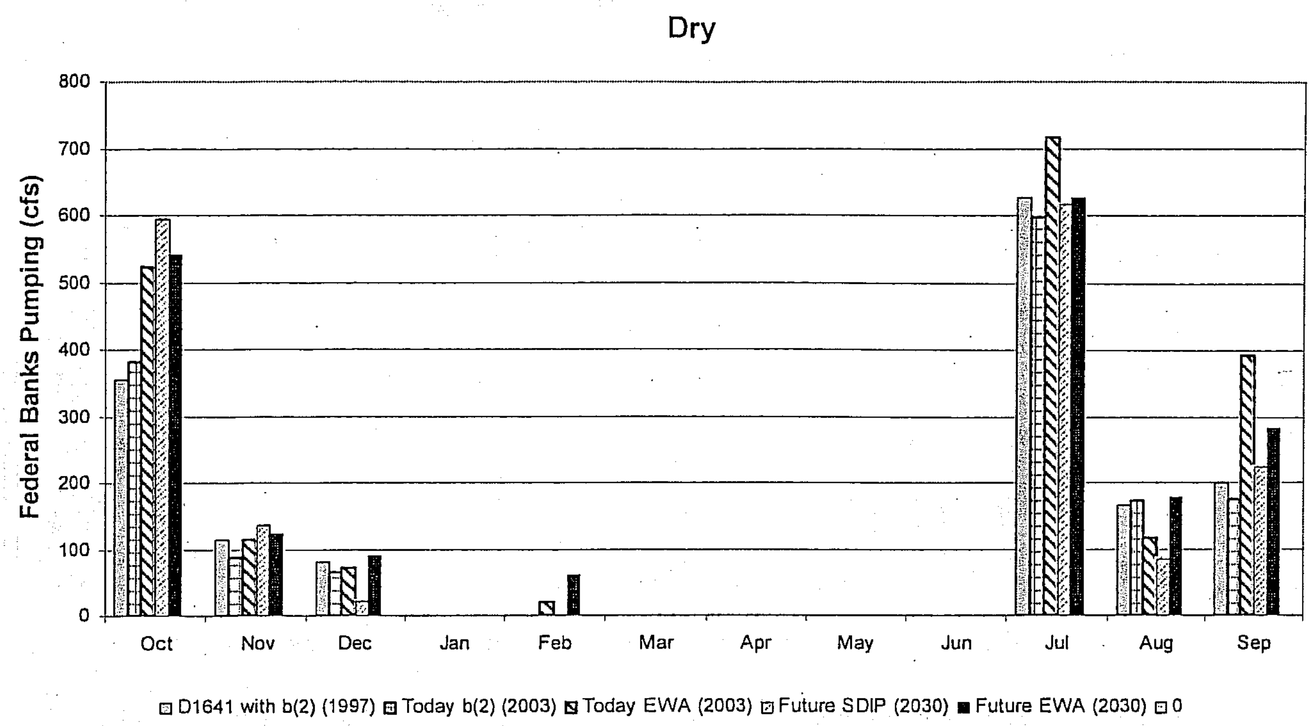


Figure 96 Average dry year (40-30-30 Classification) monthly Federal Banks Pumping

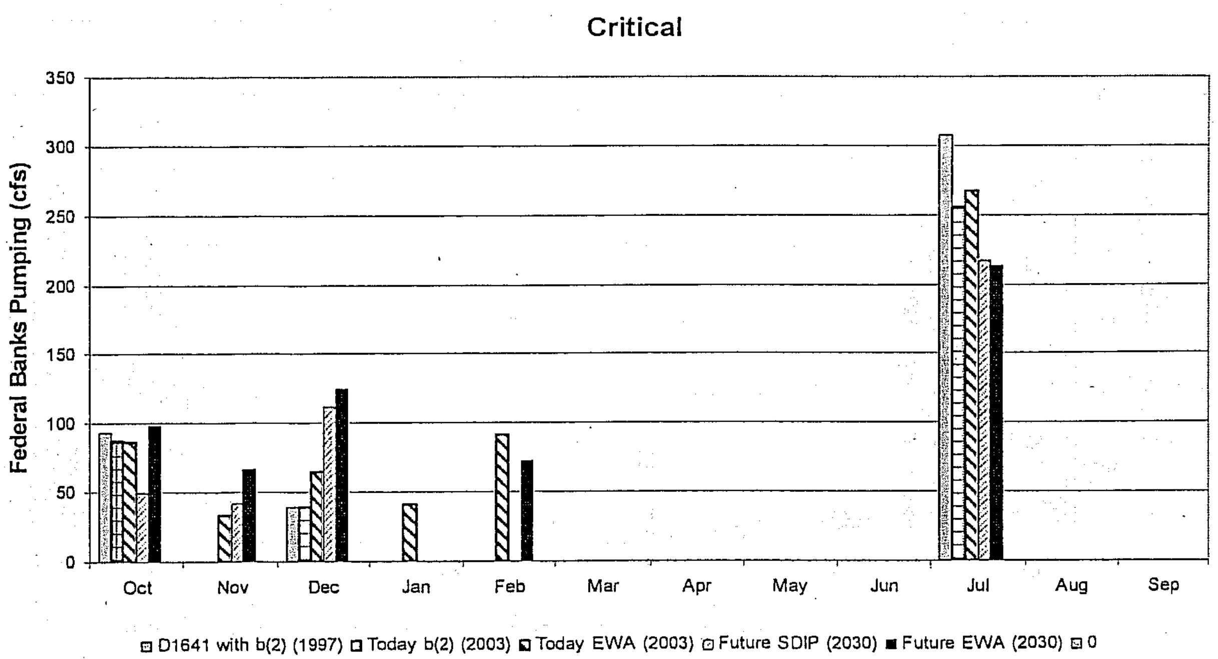


Figure 97 Average critical year (40-30-30 Classification) monthly Federal Banks Pumping

Salvage and Loss (direct and indirect) at the CVP and SWP

Direct losses to entrainment by CVP and SWP export facilities
Annually, thousands of delta smelt are entrained by the Projects and unknown percentages of the entrained fish are observed and counted in fish salvage operations. Although both the CVP and SWP have fish salvage facilities, delta smelt do not survive the salvage process, either due to stress and injury from handling, trucking and release, or from predation in or near the salvage facilities, the release sites, or in Clifton Court Forebay (DFG unpublished data). Delta smelt entrainment is highly seasonal. Adult delta smelt may be present in the south Delta and vulnerable to entrainment from about December through April; larvae and juveniles are likely to be present and vulnerable during March through early July.

Delta smelt entrainment is presently estimated (or indexed) by extrapolating catch data from periodic samples of salvaged fish ($\geq$ 20 mm). A sub-sample of water from the facility holding tanks is extrapolated based on the volume of water diverted during collection of that sample to estimate the number of fish entrained into the facilities during the sampling interval. Intervals typically range from 1-24 hours depending on time of year, debris loads, etc. To simplify predictions of the difference in salvage (and by extension entrainment) between model scenarios, it was assumed that salvage density (fish per volume of water diverted) was independent of the pumping rate. Because salvage density also varies considerably among seasons and years, salvage density was estimated for wet and dry water year types from historical data representing the period 1993–2002. There were too few years of most water-year types to reasonably estimate salvage density for each type, so data from wet (Wet and Above Normal) and dry (Below Normal, Dry, and Critically Dry) types were pooled. Note that monthly mean salvage density estimates were used, which were dictated by the monthly time step in CALSIM II outputs. The difference in salvage between two model Studies was then computed by estimating the difference in pumping rate from the CALSIM II model output and multiplying by the corresponding salvage density estimate. Changes in salvage were estimated separately for each salvage facility and Sacramento River water-year type (salvage for the two facilities was combined for purposes of quantifying incidental take). The monthly differences were computed as $(X_y - X_1)/X_1$ where the subscript y is either 4a or 5a (corresponding to those model Studies), and X_1 represents the base Study (#1).

Salvage of adult delta smelt
In general, there is a 7 to10 percent increase in median pumping in typical years at the CVP in Study #4, while there is either no change or a trivial decrease when EWA actions are included in Study #5 (Table 22 through 31). There are smaller increases of 1.9 to 8.9 percent at the CVP in Critically Dry years in #4; the corresponding months in #5 feature either reductions in pumping relative to the base Study or no change. March is exceptional in #4, with up to a 10.8 percent decrease in pumping (relative to #1) in the wetter months.

At the SWP facility, median pumping winter pumping rate changes in wetter years ranged as high as +18 percent in December in #4 and +24.8 percent in March in #5, though most of the other wetter-year changes are +10 percent or less. In drier years median changes varied between zero and +14.4 percent, with several values above +10 percent.

In all, predicted adult salvage at the CVP differs very little in #4 and #5 from #1, and there are consistent increases of up to a few hundred individuals under both #4 and #5 at the SWP.

Table 22 CVP salvage in Wet years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	4222	+8.9%	–0.7%	0.010	+4	0
January	4226	+8.8%	–0.8%	0.095	+35	–3
February	4243	+8.3%	–2.2%	0.151	+53	–14
March	4273	–2.9%	+7.0%	0.159	–19	+47
Largely Juveniles						
April	2747	0	0	0.206	0	0
May	2274	0	0	7.430	0	0
June	3000	0	0	2.017	0	0
July	4588	+0.3%	0	0.036	0	0
Net: December – March					+73	+30
Net: April – July					0	0

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Above Normal and Wet years 1995-2000.
[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 23 CVP salvage in Above Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	4221	+8.9%	–0.7%	0.010	+4	0
January	4225	+8.9%	–0.8%	0.095	+36	–3
February	4242	+8.4%	–2.2%	0.151	+54	–14
March	4262	–14.3%	+0.3%	0.159	–73	–45
Largely Juveniles						
April	2742	0	0	0.206	0	0
May	1911	0	0	7.430	0	0
June	2920	0	0	2.017	0	0
July	4580	+0.1%	+0.2%	0.036	0	+1
Net: December – March					+20	–62
Net: April – July					0	+1

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Above Normal and Wet years 1995-2000.
[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 24 CVP salvage in Below Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	4221	+7.3%	–3.5%	0.067	+21	–10
January	4225	+8.9%	–0.7%	0.180	+68	–6
February	4241	+8.1%	+8.2%	0.235	+81	+82
March	4235	–3.8%	–4.8%	0.201	–32	–41
Largely Juveniles						
April	2321	0	–1.1%	0.259	0	–7
May	1911	0	–34.0%	11.93	0	–7761
June	3000	0	0	1.584	0	0
July	4554	+0.3%	+0.2%	0.005	0	0
Net: December – March					+137	+26
Net: April – July					0	–7768

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 25 CVP salvage in Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	4220	+8.9%	–0.7%	0.067		
January	4225	+8.8%	–0.8%	0.180		
February	4235	+8.4%	+8.4%	0.235		
March	4208	+1.4%	–0.8%	0.201		
Largely Juveniles						
April	1808	+0.7%	+0.9%	0.259		
May	1720	0	–38.1%	11.93		
June	2874	0	–8.9%	1.584		
July	4421	–0.3%	–5.7%	0.005		
Net: December – March						
Net: April – July						

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 26 CVP salvage in Critically Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Tracy[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	2897	+4.8%	–19.1%	0.067	+9	–37
January	4218	+8.9%	–9.7%	0.180	+67	–73
February	3979	+1.9%	–0.1%	0.235	+18	0
March	1247	+2.9%	0	0.201	+7	0
Largely Juveniles						
April	800	0	0	0.259	0	0
May	1189	0	–32.6%	11.93	0	–4638
June	953	–1.1%	0	1.584	–17	0
July	800	–1.5%	0	0.005	0	0
Net: December – March					+102	–110
Net: April – July					–17	–4638

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 27 SWP salvage in Wet years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Banks[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	7033	+18.0%	+13.7%	0.015	+19	+14
January	7408	+9.5%	+8.4%	0.214	+151	+133
February	5848	+2.4%	+4.1%	0.242	+34	+58
March	5653	+17.2%	+24.8%	0.069	+67	+97
Largely Juveniles						
April	4830	+8.7%	–19.2%	0.058	+24	–54
May	4660	+5.8%	–48.4%	12.52	+3366	–28216
June	5925	–0.1%	+7.0%	10.90	–229	+4547
July	6680	+12.7%	+17.4%	0.611	+520	+711
Net: December – March					+270	+302
Net: April – July					+3682	–23011

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Above Normal and Wet years 1993 and 1995-2000.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 28 SWP salvage in Above Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Banks[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	6484	+9.3%	+4.8%	0.015	+8	+6
January	7548	0	–4.8%	0.214	0	–7
February	7451	+2.1%	–3.1%	0.242	+62	+103
March	5784	+14.3%	+26.6%	0.069	+60	+36
Largely Juveniles						
April	4508	+7.4%	–23.5%	0.058	+22	–66
May	3596	+2.3%	–58.3%	12.52	+1540	–22496
June	3942	+3.5%	+0.6%	10.90	+1268	–1099
July	6157	+7.7%	+27.0%	0.611	+372	+869
Net: December – March					+130	+137
Net: April – July					+3201	–22792

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Above Normal and Wet years 1993 and 1995-2000.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 29 SWP salvage in Below Normal years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Banks[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	5938	+11.2%	+6.0%	0.050	+33	+18
January	7172	+7.5%	–0.4%	0.209	+113	–7
February	5850	+2.1%	+5.7%	0.134	+17	+45
March	5713	+12.4%	+8.9%	0.178	+126	+90
Largely Juveniles						
April	3548	+1.0%	–25.2%	0.369	+13	–330
May	3235	+3.9%	–50.0%	29.97	+3792	–48444
June	3977	–0.2%	–2.6%	6.706	–50	–682
July	5320	+4.0%	+23.1%	0.446	+94	+548
Net: December – March					+289	+146
Net: April – July					+3849	–48908

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 30 SWP salvage in Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Banks[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	5358	+9.5%	+9.5%	0.050	+25	+26
January	5717	+10.0%	–8.6%	0.209	+119	–103
February	5303	+7.2%	+9.5%	0.134	+51	+67
March	4413	–0.1%	–0.1%	0.178	0	0
Largely Juveniles						
April	2168	+0.1%	–18.1%	0.369	+1	–145
May	2099	–1.8%	–58.1%	29.97	–1111	–36577
June	2952	–0.8%	–6.7%	6.706	–155	–1330
July	5217	+0.1%	+29.2%	0.446	+1	+679
Net: December – March					+196	–10
Net: April – July					–1265	–37373

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

Table 31 SWP salvage in Critically Dry years

Month	Median model Study 1 pumping (c.f.s.)	Median change in Study 4	Median change in Study 5	Density of delta smelt at Banks[a]	Predicted median difference in salvage[b]	
					4 – 1	5 – 1
Adults						
December	4267	+6.0%	–5.9%	0.050	+13	–12
January	4891	+6.2%	–13.2%	0.209	+63	–135
February	3198	+13.4%	+14.4%	0.134	+58	+62
March	2030	+14.2%	+0.3%	0.178	+51	+1
Largely Juveniles						
April	1197	0	0	0.369	0	0
May	1189	0	–32.7%	29.97	0	–11652
June	300	0	0	6.706	0	0
July	553	–1.1%	+53.5%	0.446	–3	+132
Net: December – March					+185	–84
Net: April – July					–3	–11521

[a] Average delta smelt salvage density (fishes c.f.s.$^{-1}$ month^{-1}) estimated from pooled Dry and Critically Dry years 1994 and 2001-2.

[b] Predicted median difference has unit: fishes month.$^{-1}$. See text for explanation of calculation.

These tables show that under study 4, an increase in the salvage of delta smelt occurs over the number of smelt salvaged in study 1 (see the second column from the right in the tables above). When the EWA is added in study 5, the increases in salvage are reversed and take is reduced in study 1 (see the far right column in the tables above). It should be noted that the EWA as modeled only uses placeholders that reduce exports in a regular pattern during the spring and summer, and these actions do not correlate to actual salvage events at the fish facilities. In actual operations and by using the DSRAM, more informed use of the EWA actions in a proactive manner will likely reduce salvage even further.

Salvage of Juvenile Delta Smelt

All comparisons of Studies #4 and #5 are with Study #1. There are only small changes in juvenile salvage at the CVP facility under both Study #4 and Study #5. Changes at Banks under Study #4 are also small. There are substantial median reductions in Banks pumping in April and May when EWA actions are added in Study #5. These would result in reductions in juvenile smelt salvage during those months that might benefit the species in some years, particularly those in which high entrainment episodes would otherwise occur during that period (particularly in May).

It should be noted that although salvage is used to index delta smelt take, it does not reliably index delta smelt entrainment. Furthermore, delta smelt salvage is highly variable at all time scales, because they are patchily distributed, spawn at different times and places from year to year, and larval dispersal is influenced by hydrodynamic conditions operating on tidal time scales. Salvage efficiencies also vary daily and seasonally due to changes in operations, size of the fish, and presumably metabolic demands of predators hunting within the facilities. Consequently, while this analysis credibly predicts what might happen in typical years, there will – even under the "baseline" Study 1 scenario – certainly be a small percentage of future years in which the confluence of natural and anthropogenic circumstances cause large delta smelt entrainment episodes. Delta smelt typically spend more time closer to the export facilities under low-flow conditions and in relatively cool years with low to intermediate flows, making these episodes more likely under those conditions. Because an analysis of the likelihood of these events would require modeling delta smelt movement using detailed historical distributional data that does not exist, we cannot determine whether the frequency of large entrainment events would be different from Study #1 under Studies #4 or #5. More sophisticated models and shorter time-scale monitoring of young smelt distribution may provide a means to resolve this question in the future. (BA 2004)

Salvaged numbers of delta smelt do not adequately reflect the actual number of smelt that are lost at the CVP and SWP. The current salvage facilities use a louver system that is efficient for salmon and striped bass, but has unknown efficiency for delta smelt. Predation on delta smelt in Clifton Court Forebay also affects the salvage efficiency at the SWP. The collection, handling and transport studies (CHTR) currently underway propose to evaluate methods to improve handling, such that some delta smelt may survive the salvage process. In addition, a more complete understanding of the salvage efficiencies at the projects would improve estimates of the number of delta smelt entrained.

Article 21 Effects
The assumptions in CALSIM II for the demands that drives Banks Pumping varies by month with some variation across years. The demand for Article 21 water is one component of this total demand. In general, the assumed demand December through March for Article 21 water in CALSIM II is 134 taf per month–the assumed demand December through March Article 21 accounts for 90 percent of the annual total. With this assumed demand, 400 taf or more of Article 21 water is diverted 10 percent of the time (see Figure 10-46 of the BA).

It is likely that if the demand is assumed higher in these months, more may be diverted. To test this sensitivity DWR staff conducted an auxiliary simulation based on Study 2 with a demand set at 203 taf January through March (in the original Study 2, demand is never fully met in December) and with a demand of 300 taf January through March. With these higher demands 400 taf or more of Article 21 water is delivered 26 percent of the time. One other result worth noting is that based on Study 4 (a future conditions study with the same Article 21 demands as Study 2), there is an 8 percent chance of delivering 400 taf or more Article 21 water between December and March in any given year.

These differences are appropriately illustrated in the larger context of total SWP diversions from the South Delta in Figure 10-47 of the BA. For example, there is a 32 percent chance that Banks Pumping will total 1600 taf or more December through March assuming an Article 21 demand of 134 taf/month; the chances increase to 36 percent assuming an Article 21 demand of 203 taf/month and 41 percent assuming an Article 21 demand of 300 taf/month. These differences are best characterized with the probabilistic exceedance plots. Nevertheless, a similar characterization is illustrated in Figure 10-48 of the BA, which depicts the total Banks diversions with the different Article 21 demands averaged by water year type. A corollary look at the effects on the position of X2 is presented in Figure 10-49 of the BA.

The effects of Article 21 pumping on delta smelt are not expected to be very significant. The most pumping of Article 21 water occurs during above normal or wet water years, when delta smelt are not likely to be near the projects. Also, outflows and X2 requirements will continue to be met during Article 21 pumping, so delta smelt habitat is not likely to be significantly affected by the pumping of Article 21 water. An increase in smelt take at the TFCF or at the Skinner Fish Facilities could occur as a result of Article 21 pumping if delta smelt are present in the south Delta at the time of the pumping.

Intertie Effects
The DMC and CA Intertie (Intertie) consists of consruction and operation of a pumping plant and pipeline connections between the Delta Mendota Canal and the California Aqueduct. The Intertie would include a 400 cfs pumping plant to allow up to 400 cfs to be pumped from the DMC to the CA. Up to 950 cfs could be conveyed from the CA to the DMC using gravity.

The Intertie would allow the Tracy pumping plant to export to its authorized capacity of 4,600 cfs (currently 4,200 cfs), subject to all applicable export pumping restrictions for fishery protections and water quality. These increased export amounts were modeled in the CALSIM II modeling and the salvage of delta smelt is expected to increase as a result of the increase in maximum pumping at Tracy up to 4,600 cfs. The effects of the increase in the number of salvaged delta smelt at the Tracy fish facilities is described in the Salvage and Loss section of the Effects section.

Water Transfers Effects

Water transfers would increase Delta exports from 200,000-600,000 AF in about 80% of years. Most transfers would occur during July through September. Delta smelt are not likely to be present in the south Delta during this time (DFG unpublished data). However, delta smelt may still inhabit parts of the Delta in the zone of influence in July of some years. Water transfers may also occur outside of the July through September period and would be subject to all current water quality and pumping restrictions. As described in the project description, transfers will take place at times when delta smelt will not be adversely affected by the transfer and Reclamation and DWR will coordinate these transfers through the B2IT, EWAT and WOMT. The effects of transferring the water for terrestrial species would need to be handled in a separate Section 7 consultation.

Effects of Operation of Permanent Barriers

The effects of the permanent barriers are presumed to be similar to the temporary barriers since the permanent barriers would be closed (operated) in a similar manner to the temporary barriers. The effects of construction of the permanent barriers and any associated dredging will be covered in a separate consultation.

Head of Old River Barrier

Under the project description, the Head of Old River barrier (HORB) would be closed at the start of VAMP, which starts approximately around the middle of April and will remain closed for 31 days. The barrier will also be closed in the fall during October and November. There are additional conditions under which the fishery agencies may request that the barrier be closed (see the Project Description for more detail).

Agricultural Barriers

Under the project description, from April 15 through November 30, the agricultural barriers on Middle River, Old River and on Grant Line Canal would be operated with the permission of the Service and NOAA Fisheries on an as-needed basis to protect water quality and stage in the south Delta. From December 1 through April 15, the barriers on Middle River, Old River and Grant Line Canal would be closed to protect water quality and stage only if the Service, NOAA Fisheries and DFG determined that no increase in take would occur from the barrier closure.

The closures of the barriers in the south Delta impose a number of adverse effects on the delta smelt. The closure of the HORB in the spring could change the hydrology of the south and central Delta and may cause smelt to move towards the south Delta export facilities rather than out to Suisun Bay. The HORB closure could also degrade central Delta water quality by directing poorer quality San Joaquin River water to the central Delta. The closure of the agricultural barriers could prevent flow cues in the Delta upon which adult delta smelt may rely. These flows cues may be important from December through March, and closure of the barriers during this time may interfere with upstream and downstream migrations of smelt. Additionally, the closure of the barriers could decrease water quality and increase water temperatures behind the barriers. Smelt could also be subjected to higher entrainment in agricultural diversions behind the barriers as well as increased predation.

However, since all the permanent South Delta barriers are operable, the Service or the delta smelt working group may recommend that any barrier be opened to help protect delta smelt from entrainment, high water temperatures or other adverse conditions. These openings may help to allow juvenile delta smelt to move from the south and central Delta to Suisun Bay. The proposed barrier operations should be an improvement over the temporary barriers since the permanent barriers will be operated more precisely to close the barriers the minimum amount required to maintain water levels. This will allow smelt to have the ability to pass the barriers for the few hours when the barriers are open. The Service may request that the barriers remain open for longer periods if smelt distributions are a concern.

CVP and SWP Coordination items effects

San Luis Low Point

Since the effects to delta smelt are not clear, prior to the implementation of the San Luis low point as described in the project description, the Service, NOAA Fisheries and DFG will be notified to determine if the proposed San Luis operations will adversely affect delta smelt.

Upstream Reservoir Coordination

After reviewing the Future modeling the times when Oroville storage is less than 1,500,000 af and Shasta is over 2,400,000 af only occurs twice (1961 and 1962). Since this happens in only about 3% of the years covered by the available data, the conditions seem rare for this to happen more frequently. Prior to implementation of this action, Reclamation will notify the Service, NOAA Fisheries, and DFG to determine if delta smelt will be harmed as a result of this action.

Conservation Measures

A number of conservation measures are expected to continue in the future as part of the proposed action. These measures provide protection for delta smelt and/or their habitats and it is important to continue these protections in the future to maintain or improve delta smelt populations in the Delta. These baseline conditions will continue in the future as part of the project description and will help provide protection to delta smelt throughout their life cycle. These measures are further described in the Project Description.

Water Rights Decision 1641

Under the Water Quality Control Plan, flows and water quality objectives help maintain delta smelt habitat quality during their early life stages. In particular, X2 and E:I ratio requirements to reduce delta smelt entrainment risk (for more details see the X2 effects section).

VAMP

The Vernalis Adaptive Management Plan provides pulse flows in the San Joaquin River and lower Delta exports during April and May which is thought to improve transport and habitat conditions for delta smelt.

EWA

The Environmental Water Account, as modeled, reduces exports during periods considered critical to delta smelt. Primarily via export reductions, it helps reduce salvage at the CVP and SWP. It provides an important adaptive management mechanism to benefit delta smelt.

CVPIA (b)(2)

Water that is part of the CVPIA (b)(2) account can be used to reduce exports at the SWP and CVP. These reductions help reduce entrainment of smelt in the same way that EWA does.

Adaptive Management process

The Adaptive Management section of the Project Description describes a number of groups and teams which meet to discuss potential operational actions to be taken to benefit delta smelt. These groups use the salmon decision tree and the DSRAM to determine a concern level and which actions are appropriate to protect fish. The delta smelt working group uses the DSRAM to determine if the level of concern is sufficient to recommend an action to be taken to protect smelt. By using the various groups and teams, proactive actions may help avoid high salvage events and improve habitat conditions.

Summary of Effects

In summary, the operations of the Projects under formal consultation as described in the Project Description will result in adverse effects to delta smelt through entrainment at the CVP and SWP and by drawing delta smelt into poorer quality habitat in the south delta. However, with the inclusion of the conservation measures described above and the implementation of the DSRAM, these adverse effects would be avoided or minimized. With these conservation measures in place, the re-operation of the Trinity River, the increased level of development on the American River, the Freeport Diversion, the Suisun Marsh Salinity Control Gates, the Barker Slough Diversion, or due to changes to X2, as described in the Project Description, are not expected to result in adverse effects delta smelt

Critical Habitat Effects

Critical habitat is not likely to be adversely modified or destroyed as a result of the early consultation proposed project. The primary constituent elements essential to the conservation of the species will not be affected by the proposed project. Pumping at the CVP and SWP pumping facilities as a result of the proposed project will not result in a loss of physical habitat in the delta. River flows and water in the delta will continue to be adequate to provide spawning, rearing and foraging habitat for the smelt. The salinity of the delta will not be modified beyond the normal fluctuations as a result of this project, as the location of X2 during February through June will not change significantly as a result of this project. Breeding habitat will not be substantially affected by the proposed project, and the sustainability of the food base for delta smelt will not be changed by the proposed project. In addition, adequate flows and reduced exports during the delta smelt spawning and rearing seasons will protect delta smelt and these protections will remain in place as long as the WQCP 1641 requirements continue to be met.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions affecting listed species that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions not related to this proposed action are not considered in determining the cumulative effects, but are subject to separate consultation requirements pursuant to section 7 of the Act.

Any continuing or future non-Federal diversions of water that may entrain adult or larval fish would have cumulative effects to the smelt. Water diversions through intakes serving numerous small, private agricultural lands contribute to these cumulative effects. These diversions also include municipal and industrial uses. State or local levee maintenance may also destroy or adversely modify spawning or rearing habitat and interfere with natural long term habitat-maintaining processes.

Additional cumulative effects result from the impacts of point and non-point source chemical contaminant discharges. These contaminants include but are not limited to selenium and numerous pesticides and herbicides as well as oil and gasoline products associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for smelt, these contaminants may adversely affect fish reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants, used a substrates for adhesive egg attachment, are lost due to toxic substances.

Other cumulative effects could include: the dumping of domestic and industrial garbage may present hazards to the fish because they could become trapped in the debris, injure themselves, or ingest the debris; golf courses reduce habitat and introduce pesticides and herbicides into the environment; oil and gas development and production remove habitat and may introduce pollutants into the water; agricultural uses on levees reduce riparian and wetland habitats; and grazing activities may degrade or reduce suitable habitat, which could reduce vegetation in or near waterways.

The cumulative effects of the proposed action is not expected to alter the magnitude of cumulative effects on the above described actions upon the critical habitat's conservation function for the smelt

Conclusion

After reviewing the current status of the smelt, environmental baseline for the species, the effects of the proposed project, and the cumulative effects on these species, it is the Service's biological opinion that the proposed project, as described herein, is not likely to jeopardize the continued existence of the smelt because of the DSRAM, D-1641, EWA and other conservation measures.

In evaluating the Status of the Species for critical habitat and the Environmental Baseline, while there are current actions that result in adverse effects to delta smelt critical habitat, the primary constituent elements continue to remain functional for the smelt. In the effects section, the Service determined that the primary constituent elements of delta smelt critical habitat would not be affected by the proposed project since there will not be a loss of physical habitat in the delta, river flows will continue to provide habitat, salinity will not be affected by the proposed project, and no breeding habitat will be affected and the sustainability of the food base will not be affected. In the cumulative effects section, we determined that the cumulative effects of the proposed action are not expected to alter the magnitude of future actions' effects on critical habitat's conservation function for the smelt. Based on the analysis in these four areas, it is our conclusion that Critical habitat is not likely to be adversely modified or destroyed as a result of implementing the proposed project.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with this Incidental Take Statement.

The reasonable and prudent measures described below are nondiscretionary and must be implemented by Reclamation and DWR so they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. Reclamation and DWR have a continuing duty to regulate the activity that is covered by this incidental take statement. If the Federal agency (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take-Formal Consultation

The Service anticipates that incidental take of delta smelt will occur in the form of harassment and mortality by operating the CVP and SWP. The Service also anticipates that incidental take of delta smelt will occur at the Barker Slough intake at the NBA and through studies done to determine screening criteria and improve delta smelt handling and survival in the salvage process. Take for these studies and for take at the Barker Slough intake is allowed. However, the Service anticipates that any take of delta smelt at the Skinner and TFCF will be difficult to detect and quantify for a number of reasons: they have a relatively small body size; they are relatively secretive; their presence in the Delta coincides with relatively turbid conditions, which makes their detection difficult, their presence in aquatic vegetation makes them difficult to detect, the species is wide-ranging and its distribution varies from one year to the next, the level of predation is unknown, and losses of the species may be masked by seasonal fluctuations in numbers. Therefore, it is not possible to provide precise numbers of delta smelt that could be injured, harassed, harmed, or killed from the long-term operation of the CVP and SWP.

This take statement was developed by projecting the total number of smelt salvaged at both salvage facilities if the export facilities are operated as modeled in the CALSIM II studies. Delta smelt salvage densities (numbers of fishes per unit water exported) were estimated for each month from historical (1993-2003) data. Because wet-year salvage has historically differed from dry-year salvage, separate estimates were computed for wet (Wet and Above Normal) years and dry (Below Normal, Dry, and Critically Dry) years. To project future salvage, we multiplied the monthly export pumping reported by CALSIM II by the corresponding estimated monthly salvage density appropriate for that month and water year type. From these data we computed the median predicted salvage for each month in wet and dry years.

The delta smelt salvage density estimates employed to develop this incidental take statement were computed from the eleven years from 1993 through 2003. Of those years only three were classified as dry or critical year types. The rest were above normal or wet. Because of the limited number of drier year-types, it would be most prudent statistically to aggregate the year types into wetter years (above normal and wet) and drier years (critical, dry, and below normal). Because we have developed these estimates from few data, however, they are uncertain. Total annual salvage has varied widely in the past, and this will probably continue.

Furthermore, there is greater practicality with the implementation of just two year types. Because the classification of a year can change from month to month depending on hydrology and because this change doesn't occur until the eighth of each month January through May, it is impractical to use a take statement for each month based on the particular year type. However, year types changes when they do occur typically only change from one year type to the next, such as dry to below normal. Rarely does a year type change in the extreme such as dry to wet. Therefore using just wetter or drier year types should prove manageable for the project operators and the use of the Delta Smelt workgroup.

Salvage rates do not necessarily index how facility operations affect the delta smelt population. In years when delta smelt are numerous and widely distributed, high salvage rates may not be of great concern. Conversely, in years when there are few delta smelt and they are distributed in areas vulnerable to entrainment at the export facilities, even low salvage rates may be of great concern. Entrainment of prespawning adults is of greater concern than entrainment of juveniles, as prespawning adults are individually more important to the perpetuation of the species. The DSRAM incorporates this information and identifies variables that the Working Group will examine to decide whether action should be taken to try to reduce salvage. However, the DSRAM was not included among the assumptions of the CALSIM II modeling and its effectiveness is as-yet unknown. This analysis and information is described in the effects section of the biological opinion.

To ensure that the Working Group closely monitors the effects of salvage on the delta smelt population, we have chosen the median predicted salvage, as described above, as a trigger for the Working Group to meet. While we are confident that use of the DSRAM will reduce the frequency with which actual salvage exceeds the median predicted salvage, the exceedence frequency could be as high as 50%. When incidental take is exceeded, the Working Group will convene a meeting to determine and recommend: 1) the actions, if any, that should be taken to reduce salvage and, 2) if the Service should consider reinitiation of consultation. Should the Working Group recommend reinitiation of consultation, the Service will determine if the reinitiation of consultation is warranted.

The incidental take by water year type is as follows:

		Water Year Type	
	Month	**Wet or Above Normal**	**Below Normal, Dry, or Critical**
Monthly incidental take	**October**	100	100
	November	100	100
	December	700	400
	January	3000	1900
	February	2300	1700
	March	1300	1300
	April	1000	1100
	May	37800	30500
	June	45300	31700
	July	3500	2500
	August	100	100
	September	100	100

The Water year is based on the 90 % exceedance forecast, which is updated monthly throughout the water year. The amount of combined salvage was determined using historical delta smelt densities from 1993 through 2003 and future exports from CALSIM II study #5a. The WQCP, B2, and EWA are included in CALSIM II Study #5a, and anticipated take can best be determined from the modeling done for Study 5a.

In the months of December through April, primarily adult delta smelt are salvaged, while from May through July mostly juvenile delta smelt are salvaged. These numbers have been rounded to the nearest 100. From August through November very few delta smelt are in the Delta. For those four months, the Service set a take level of 100. Incidental take of delta smelt from the pilot larval delta smelt monitoring and future larval delta smelt monitoring is included in the above expected take table.

Upon implementation of the following reasonable and prudent measures, Reclamation and DWR will become exempt from the prohibitions described under section 9 of the Act for incidental take associated with the long-term operation of the Central Valley Project and the State Water project in the form of harm, harassment, injury, or mortality to delta smelt.

Preliminary Amount or Extent of Take-Early Consultation

The Service anticipates that incidental take of delta smelt will occur in the form of harassment and mortality by operating the CVP and SWP. The Service anticipates that incidental take of delta smelt will occur at the Barker Slough intake at the NBA, through the operations of the permanent barriers, and through studies done to determine screening criteria and improve delta smelt handling and survival in the salvage process. Take for these studies and for take at the Barker Slough intake and the operations of the permanent barriers is allowed. However, the Service anticipates that any take of delta smelt at the Skinner and TFCF will be difficult to detect and quantify for a number of reasons: they have a relatively small body size; they are relatively secretive; their presence in the Delta coincides with relatively turbid conditions, which makes their detection difficult, their presence in aquatic vegetation makes them difficult to detect, the species is wide-ranging and its distribution varies from one year to the next, the level of predation is unknown, and losses of the species may be masked by seasonal fluctuations in numbers. Therefore, it is not possible to provide precise numbers of delta smelt that could be injured, harassed, harmed, or killed from the long-term operation of the CVP and SWP.
This take statement was developed by projecting the total number of smelt salvaged at both salvage facilities if the export facilities are operated as modeled in the CALSIM II studies. Delta smelt salvage densities (numbers of fishes per unit water exported) were estimated for each month from historical (1993-2003) data. Because wet-year salvage has historically differed from dry-year salvage, separate estimates were computed for wet (Wet and Above Normal) years and dry (Below Normal, Dry, and Critically Dry) years. To project future salvage, we multiplied the monthly export pumping reported by CALSIM II by the corresponding estimated monthly salvage density appropriate for that month and water year type. From these data we computed the median predicted salvage for each month in wet and dry years.

The delta smelt salvage density estimates employed to develop this incidental take statement were computed from the eleven years from 1993 through 2003. Of those years only three were classified as dry or critical year types. The rest were above normal or wet. Because of the limited number of drier year-types, it would be most prudent statistically to aggregate the year types into wetter years (above normal and wet) and drier years (critical, dry, and below normal). Because we have developed these estimates from few data, however, they are uncertain. Total annual salvage has varied widely in the past, and this will probably continue.

Furthermore, there is greater practicality with the implementation of just two year types. Because the classification of a year can change from month to month depending on hydrology and because this change doesn't occur until the eighth of each month January through May it is impractical to use a take statement for each month based on the particular year type. However, year types changes when they do occur typically only change from one year type to the next, such as dry to below normal. Rarely does a year type change in the extreme such as dry to wet. Therefore using just wetter or drier year types should prove manageable for the project operators and the use of the Delta Smelt workgroup.

Salvage rates do not necessarily index how facility operations affect the delta smelt population. In years when delta smelt are numerous and widely distributed, high salvage rates may not be of great concern. Conversely, in years when there are few delta smelt and they are distributed in areas vulnerable to entrainment at the export facilities, even low salvage rates may be of great concern. Entrainment of prespawning adults is of greater concern than entrainment of juveniles, as prespawning adults are individually more important to the perpetuation of the species. The DSRAM incorporates this information and identifies variables that the Working Group will examine to decide whether action should be taken to try to reduce salvage. However, the DSRAM was not included among the assumptions of the CALSIM II modeling and its effectiveness is as-yet unknown. This analysis and information is described in the effects section of the biological opinion.

To ensure that the Working Group closely monitors the effects of salvage on the delta smelt population, we have chosen the median predicted salvage, as described above, as a trigger for the Working Group to meet. While we are confident that use of the DSRAM will reduce the frequency with which actual salvage exceeds the median predicted salvage, the exceedence frequency could be as high as 50%. When incidental take is exceeded, the Working Group will convene a meeting to determine and recommend: 1) the actions, if any, that should be taken to reduce salvage and, 2) if the Service should consider reinitiation of consultation. Should the Working Group recommend reinitiation of consultation, the Service will determine if the reinitiation of consultation is warranted.

The preliminary incidental take by water year type is as follows:

		Water Year Type	
	Month	**Wet or Above Normal**	**Below Normal, Dry, or Critical**
Monthly incidental take	**October**	100	100
	November	100	100
	December	900	400
	January	3400	1900
	February	2400	1700
	March	1300	1300
	April	1000	1100
	May	28700	30500
	June	44800	33200
	July	3900	2500
	August	100	100
	September	100	100

The Water year is based on the 90 % exceedance forecast, which is updated monthly throughout the water year. The amount of combined salvage was determined using historical delta smelt densities from 1993 through 2003 and future exports from CALSIM II study #5. The WQCP, B2, and EWA are included in CALSIM II Study #5a, and anticipated take can best be determined from the modeling done for Study 5.

In the months of December through April, primarily adult delta smelt are salvaged, while from May through July mostly juvenile delta smelt are salvaged. These numbers have been rounded to the nearest 100. From August through November very few delta smelt are in the Delta. For those four months, the Service set a take level of 100. Incidental take of delta smelt from the pilot larval delta smelt monitoring and future larval delta smelt monitoring is included in the above expected take table.

Take associated with the construction of the permanent south Delta barriers is not authorized as a part of this biological opinion. Take for the operations of the permanent south Delta barriers is minimized by the proposed operations in the project description. The barriers would be closed mostly during the summer months, when delta smelt effects are smaller and the barriers would also be able to be opened when the Service or the delta smelt working group determine that delta smelt are being harmed by closed barriers.

Because the early consultation project elements are likely to result in the taking of listed species incidental to those actions, the Service has included an incidental take statement pursuant to section 7(b)(4) of the Act. However, because this is an early consultation on the prospective action, this incidental take statement does not eliminate Reclamation's liability under the taking prohibitions of section 9 of the Act.

Instead, this statement provides your agency and the applicant with foreknowledge of the anticipated incidental take that will occur if this prospective application is filed with your agency. The incidental take statement for the early consultation will become effective only after the Service confirms the preliminary biological opinion on the prospective action.

Effect of the Take

The Service has determined that this level of anticipated take for the formal consultation is not likely to result in jeopardy to the smelt because this level of take is at or below historical levels of take.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of listed species:

1. Minimize the potential for harassment, harm, injury and mortality to the smelt.

2. Continue to monitor delta smelt throughout their life history

Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary:

The following terms and conditions implement the reasonable and prudent measure #1 (*Minimize the potential for harassment, harm, injury and mortality to the smelt.*):

A. The Project shall be implemented as described.

B. All cultured delta smelt that are used for experiments or studies at the fish facilities will not be allowed to be released into the wild. These fish will be retained in captivity after these studies conclude.

The following term and condition implements the reasonable and prudent measure #2 (*Continue to monitor delta smelt throughout their life history*):

A. The following surveys will continue to be conducted to determine abundance and distribution of delta smelt: Spring Kodiak trawl, 20mm survey, summer townet survey, and fall midwater trawl survey. Any changes to these surveys would be subject to Service (as part of WOMT) approval.

Reporting Requirements

The Service should be notified in writing within three (3) working days of the finding of any dead or injured smelt associated with the proposed project. Notification should include the date, time, and location of the incident or of the finding of a dead or injured animal plus any other pertinent information. The Service contact for this information is Jan C. Knight, Chief of the Endangered Species Division at (916) 414-6620.

Any killed specimens of fish have been taken should be properly preserved in accordance with Natural History Museum of Los Angeles County policy of accessioning (10% formalin in quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, the water temperature and outflow/tide conditions, and any other relevant information should be written on 100% rag content paper with permanent ink and included in the container with the specimen. Preserved specimens shall be delivered to the Service's Division of Law Enforcement at 2800 Cottage Way, Room W-2928 Sacramento, California 95825, phone (916) 414-6660.

The U.S. Fish and Wildlife Service Regional Office in Portland, Oregon, must be notified immediately if any dead or sick listed wildlife species is found in or adjacent to pesticide-treated areas (including fungicide, herbicide, bird or animal control treatments). Cause of death or illness, if known, also should be conveyed to this office. The appropriate contact is Richard Hill at (503) 231-6241.

Delta smelt salvage information will be reported to the Service in an annual report which will be submitted to the Service by February 28 of the following year. An annual report of the studies conducted at the CVP or SWP fish facilities will also be submitted to the Service.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

1. The Service recommends that Reclamation develop and implement restoration measures in areas designated in the Delta Fishes Recovery Plan (USFWS 1996).

2. The Service recommends that Reclamation help improve population estimates of delta smelt and pumping impacts to the population.

3. The Service recommends Reclamation improve delta smelt survival and impacts of predation at Clifton Court Forebay and at the CVP and SWP salvage facilities.

4. The Service recommends that Reclamation, in conjunction with the Service, DWR and DFG pursue new methods for determining incidental take at the CVP and SWP.

To be kept informed of actions minimizing or avoiding adverse effects or benefiting listed and proposed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation with Reclamation on the proposed coordinated operations of the CVP and SWP and the OCAP in California. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

This concludes early consultation for the coordinated operations of the CVP and SWP and the OCAP in California. You may ask the Service to confirm this preliminary biological opinion as a final biological opinion on the prospective action. The request must be in writing. If the

Service reviews the proposed action and finds that there are no significant changes in the action as planned or in the information used during the early consultation, it will confirm the preliminary biological opinion as a final biological opinion on the project and no further section 7 consultation will be necessary except when one of the following criteria for reinitiation is met: 1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

If the Service does not confirm this preliminary biological opinion as a final biological opinion on the prospective action, Reclamation is required to initiate formal consultation with the Service.

If you have any questions regarding this biological opinion on the coordinated operations of the CVP and SWP and the OCAP in California, please contact Ryan Olah or Cay Goude of the Sacramento Fish and Wildlife Office at (916) 414-6625.

cc:
ARD (ES), Portland, OR
National Marine Fisheries Service, Sacramento, CA (Attn.: Michael Aceituno)
California Department of Fish and Game, Sacramento, CA
California Department of Water Resources, Sacramento, CA

Literature Cited

Aceituno ME. 1993. The relationship between instream flow and physical habitat availability for chinook salmon in the Stanislaus River, California. USFWS Ecological Services, Sacramento Field Office. 71 p.

Arthur, J.F. and M.D. Ball 1978. Entrapment of suspended materials in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Bureau of Reclamation, Sacramento, California.

______. 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 *in* T.J. Conomos, editor. Pacific Division, Amer. Assoc. Advance. Sci., San Francisco, California

______. 1980. The significance of the entrapment zone location to the phytoplankton standing crop in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Water and Power Resources Service.

Bennett, William A. 2003. The Population Ecology of Delta Smelt in the San Francisco Estuary. 44 pp.

Brett, J.R. 1976. Scope for metabolism and growth of sockeye salmon *Oncorhynchus nerka*, and some related energetics. Journal of the Fisheries Research Board of Canada 33:307-313.

Bureau of Reclamation. 2003. Notice of Initiation of Federal Feasibility Studies. Mid-Pacific Regional Office, Sacramento California.

CALFED Bay Delta Program. 2002. Annual Report 2002. Sacramento, California. 80 pp.

______. 2003a. CALFED Los Vaqueros Reservoir Studies [database on the internet]. Updated on May 27, 2003. Available from http://www.lvstudies.com/default.asp. Accessed on October 10, 2003.

______. 2003b. CALFED Implementation: The Role of the Napa Proposal. Powerpoint Presentation. Sacramento, California.

[Corps] (U.S. Army Corps of Engineers). 1987. Folsom Dam and Lake, American River, California. Water Control Manual. Appendix VIII to Master Water Control Manual Sacramento River Basin, California.

Dege, M., and L.R. Brown. 2004. Effect of outflow on spring and summer distribution and abundance of larval and juvenile fishes in the upper San Francisco Estuary. Pages 49-65 in F. Feyrer, L.R. Brown, R.L. Brown, and J.J. Orsi, editors. Early Life History of Fishes in the San Francisco Estuary and Watershed. American Fisheries Society, Symposium 39, Bethesda, Maryland.

Department of Fish and Game. 1999. Fall Midwater Trawl [database on the internet]. Available from http://www.delta.ca.gov/data/mwt99/index.html. Accessed on September 18, 2002.

______ 2000. 20mm Survey [database on the internet]. Available from http://www.delta.ca.gov/data/20mm/2000/. Accessed on September 18, 2002.

______ 2001. 2001 Summer Townet Survey [database on the internet]. Available from http://www.delta.dfg.ca.gov/data/skt/skt2002/index.html. Accessed on September 18, 2002.

______. 2004. Comment Letter on the Five Year Status Review of the Delta Smelt. 2 pp.

Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1993. Effects of the Central Valley Project and State Water Project on delta smelt. Sacramento County, California. 134 pp.

______ and U.S. Bureau of Reclamation, Mid-Pacific Region 1994. Effects of the Central Valley Project and State Water Project on delta smelt and Sacramento splittail. Sacramento, California. 230 pp.

Environmental Science Associates. 2003. Stockton Delta Water Supply Project. 25 pp.

Environmental Water Account. 2003. Draft Environmental Impact Statement/Environmental Impact Report Volume III: Action Specific Implementation Plan.

Erkkila, L.F., J.F. Moffett, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin Delta fishery resources: effects of Tracy pumping plant and delta cross channel. U.S. Fish and Wildlife Services Special Report. Fisheries 56. 109 pp.

Freeport Regional Water Authority. 2003. Draft Environmental Impact Report/Environmental Impact Statement.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pp.64-94 in D.W. Kelley, ed.: Ecological studies of the Sacramento-San Joaquin Estuary, Part 1. Calif. Dept. Fish and Game, Fish Bulletin No. 133.

Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Ecological Studies Program Newsletter, Winter 1994. California Department of Water Resources, Sacramento, California.

Kimmerer, WJ. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? Marine Ecology Progress Serires 243:39-55.

Knutson, A.C., Jr. and J.J. Orsi. 1983. Factors regulating abundance and distribution of the shrimp *Neomysis mercedis* in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society 112:476-485.

Mager RC. 1996. Gametogenesis, Reproduction and Artificial Propogation of Delta Smelt, *Hypomesus transpacificus.* [Dissertation] Davis: University of California, Davis. 115 pages. Published.

Mager RC, Doroshov SI, Van Eenennaam JP, and Brown RL. 2004. Early Life Stages of Delta Smelt. American Fisheries Society Symposium 39:169-180.

Monroe, M.W. and J. Kelly 1992. State of the Estuary: A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Estuary Project, Oakland, California.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley, California. 405 pp.

Molye, Peter B. 2002. Inland Fishes of California. University of California Press. 576 pp.

Moyle, Peter B. 2003. Comment Letter on the Five Year Status Review of the Delta Smelt. 4pp.

Moyle, P. B. and J. Cech, Jr. 1988. Fishes: An Introduction to Ichthyology. Prentice Hall, Englewood Cliffs, New Jersey. 559 pages.

Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Trans. Am. Fish. Soc.121:67-77.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson 1986. The modification of an Estuary. Science 231:567-573.

Nobriga, Matthew L, , Z Matica, and Z.P. Hymanson 2004. Evaluating Entrainment Vulnerability to Agricultural Irrigaion Diversions: A Comparision among Open-Water Fishes. Pages 281-295 in F. Feyrer, L.R. Brown, R.L. Brown, and J.J. Orsi, editors. Early Life History of Fishes in the San Francisco Estuary and Watershed. American Fisheries Society, Symposium 39, Bethesda, Maryland.

Orsi, J.J. and W.L. Mecum. 1986. Zooplankton distribution and abundance in the Sacramento-San Joaquin Delta in relation to certain environmental factors. Estuaries 9(4B):326-339.

Poage, V. in prep 2004. Why We Do a "Post-VAMP Shoulder" for Delta Smelt. 9 pp.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta. Pp. 115-119 in J. L. Turner and D. W. Kelley, eds.: Ecological studies of the Sacramento-San Joaquin Estuary, Part 2. California Department of Fish and Game Fish Bulletin No. 136.

Reclamation 1999. Contract Between the United States and Sacramento County Water Agency Providing for Project Water Service.

______.2001 Amendatory Contract Between the United States and East Bay Municipal Utility District Providing for Project Water Service From the American River Division.

______.2004. Long-Term Central Valley Project and State Water Project Operations Criteria and Plan Biological Assessment.

Sacramento County Water Agency 2002. Sacramento County Water Agency Zone 40 Water Supply Master Plan.

Souza, K. and M. Bryant. 2002. Townet Survey and Fall Midwater Trawl. Interagency Ecological Program for the San Francisco Estuary. Newsletter 15(2):21-24.

Stevens, D. E. 1996. Distribution and food habits of American Shad (*Alosa sapidissima*) in the Sacramento-San Joaquin Delta. Pp. 97-107. *In*: J.L. Turner and D.W. Kelley (Eds.). Ecological studies of the San Francisco Bay Estuary. California Fish and Game Bulletin No. 136.

Stevens, D. E. and S. W. Miller. 1983. Effects of river flow on abundance of young chinook salmon, American shad, longfin smelt, and Delta smelt in the Sacramento-San Joaquin river system. North American Journal of Fisheries Management 3:425-437.

Stevens, D. E., S. W. Miller, and B. C. Bolster 1990. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. California Department of Fish and Game Candidate Species Status Rept. 90-2. 149 pages.

Swanson, C. And J. J. Cech, Jr. 1995. Environmental tolerances and requirements of the delta smelt, Hypomesus transpacificus. Final Report. Davis, California. 77 pp.

Swanson C, Reid T, Young PS, and Cech JJ. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced Wakasagi (*H. nipponensis*) in an altered California estuary. Oecologia 123:384- 390.

Sweetnam, D.A. 1999. Status of delta smelt in the Sacramento-San Joaquin Estuary. California Fish and Game 85(1):22-27.

Sweetnam, D.A. and D.E. Stevens 1993. Report to the Fish and Game Commission: A status review of the delta smelt (Hypomesus transpacificus) in California. Candidate Species Status Report 93-DS. Sacramento, California. 98 pages plus appendices.

Turner, J.L. and D.W. Kelly. 1966. Ecological studies of the Sacramento-San Joaquin Delta. Calif. Dept. of Fish and Game Bulletin No. 136.

U.S. Fish and Wildlife Service. 1993a. Endangered and threatened wildlife and plants: Determination of threatened status for the delta smelt. March 5, 1993. Federal Register 58(42):12854-12864.

_______. 1993b. Formal Consultation on Effects of the Proposed Los Vaqueros Reservoir Project on Delta Smelt, Contra Costa County, California

_______. 1994a. Formal Endangered Species Consultation on the Environmental Protection Agency's proposed Water Quality Standards for the San Francisco Bay/Sacramento-San Joaquin Rivers and Delta.

_______. 1994b. Endangered and threatened wildlife and plants: Critical habitat determination for the delta smelt. December 19, 1994. Federal Register 59(242): 65256-65279.

_______. 1994c. Formal consultation on the 1994 operation of the Central Valley Project and State Water Project: Effects on delta smelt. Sacramento, California. 34 pages, plus figures.

_______. 1995. Formal consultation and conference on the effects of long-term operation of the Central Valley Project and State Water Project on the threatened delta smelt, delta smelt critical habitat, and proposed threatened Sacramento splittail. Sacramento, California.52 pages, plus figures and attachment.

_______. 1996. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. Portland, Oregon.

_______. 2000. Biological Opinion on Implementation of the CVPIA and Continued Operations and Maintenance of the CVP. Sacramento, California.

_______. 2004. Five Year Status Review for the Delta Smelt. Sacramento, California. 50 pp.

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Sacramento, California. Technical Report 9.

Wang, J.C.S. 1991. Early life stages and early life history of the delta smelt, *Hypomesus* *transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Sacramento, California.Technical Report 28.

Weihs, D. 1974. Energetic advantages of burst swimming of fish. J. Theor. Bio. 48:215-229.