(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.

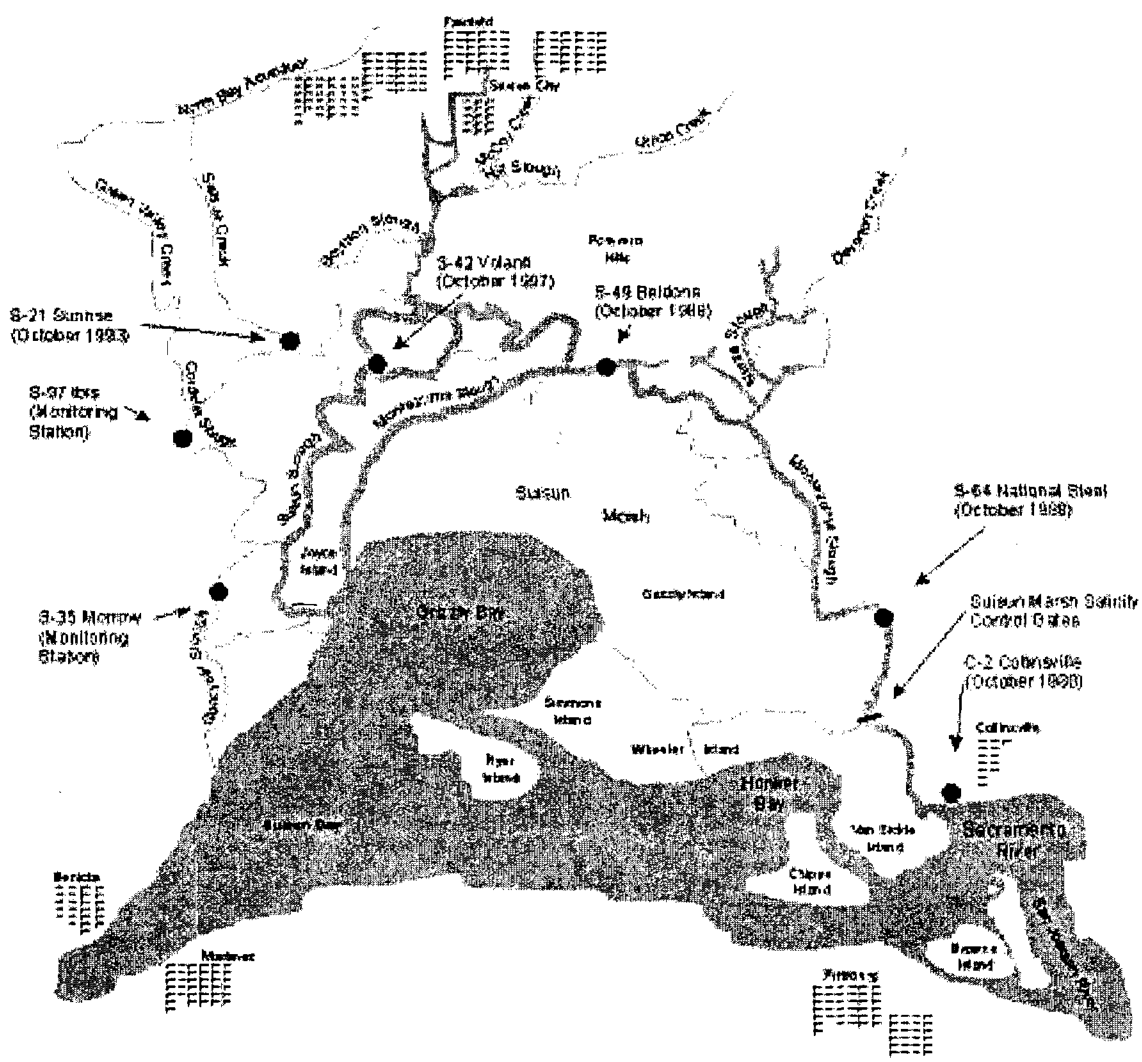

Figure 10 Suisun Bay and Suisun Marsh showing the location of the Suisun Marsh Salinity Control Gates and Salinity Control Stations

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 coōrdinate 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 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.

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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.

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.

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.

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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.

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.
- 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:

- 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 84.

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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)

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.

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).

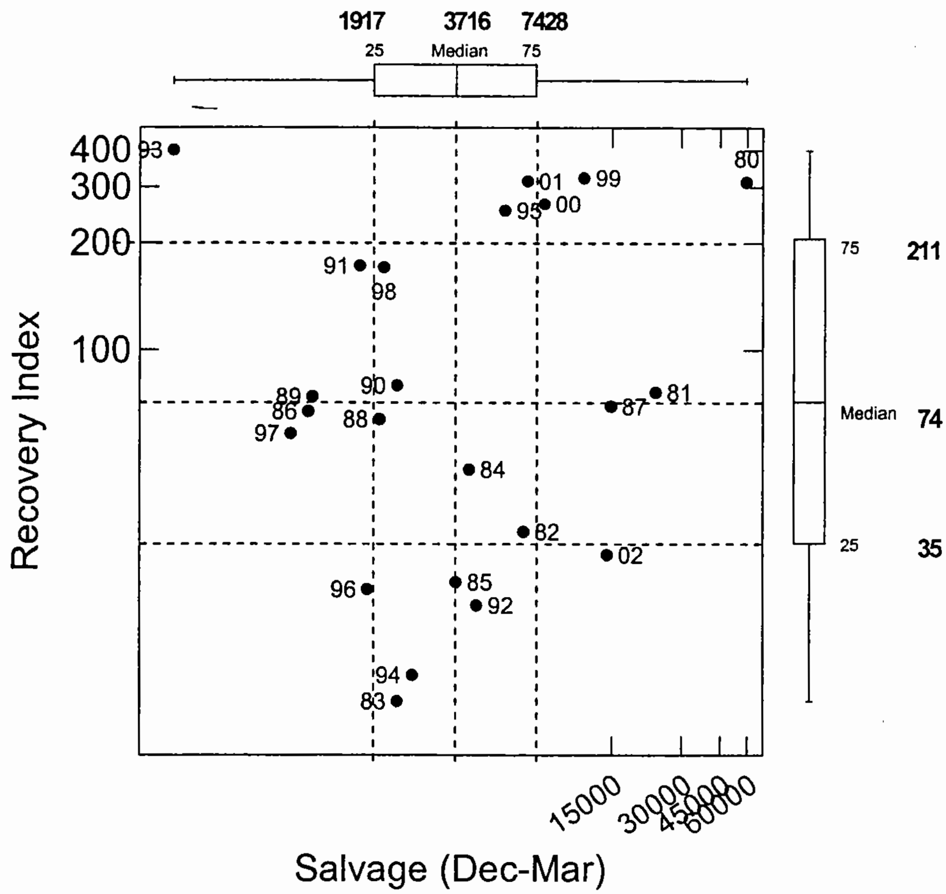
Low juvenile abundance will also be a trigger. When juvenile abundance is low, concern is high. Low abundance is indicated when the total cumulative catch in the 20-mm Survey is less than or equal to the 1995-2003 median value of cumulative 20-mm Survey catch for the same surveys (Table DS5).

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.

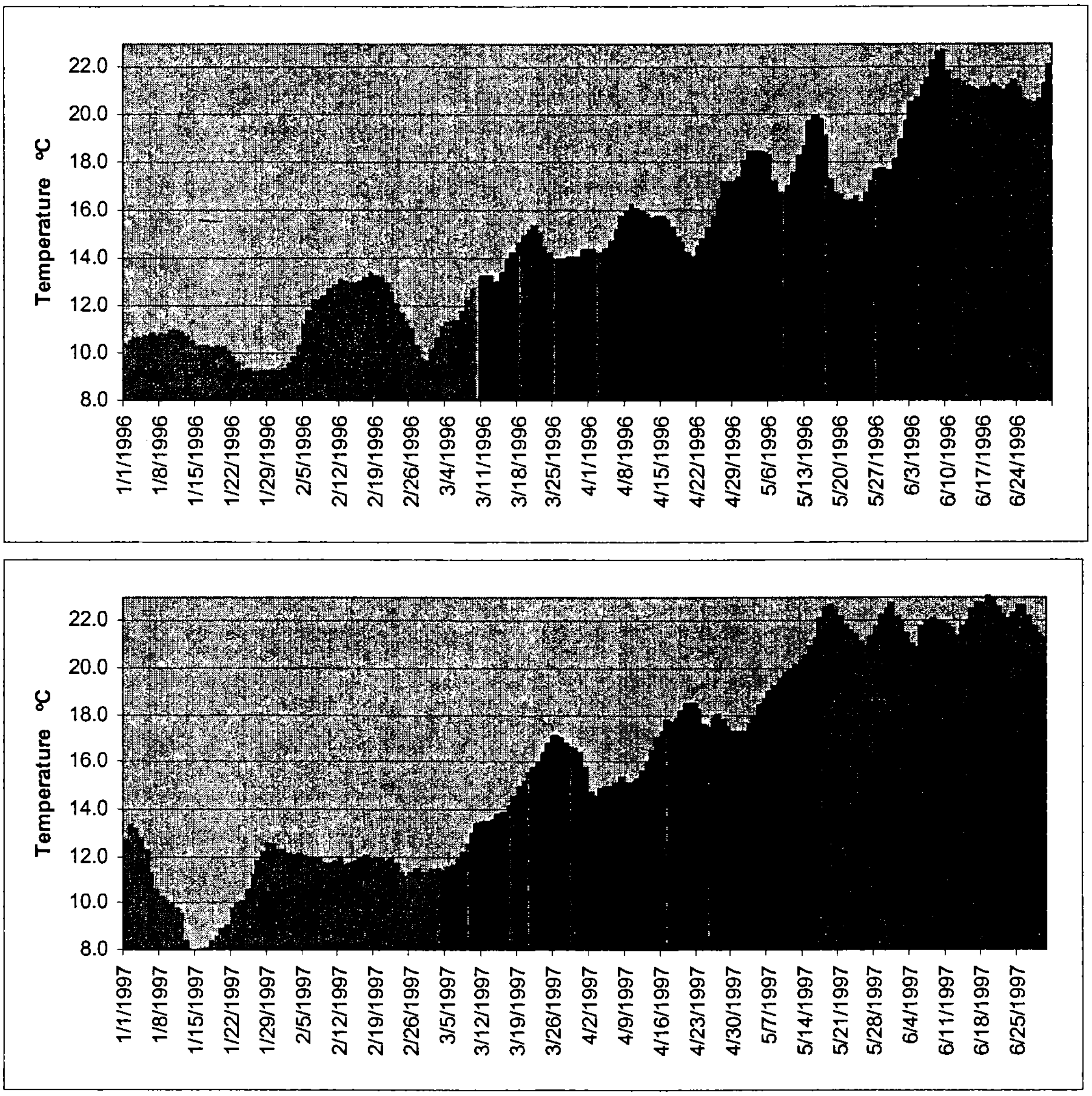


Figure DS2.1 cont.

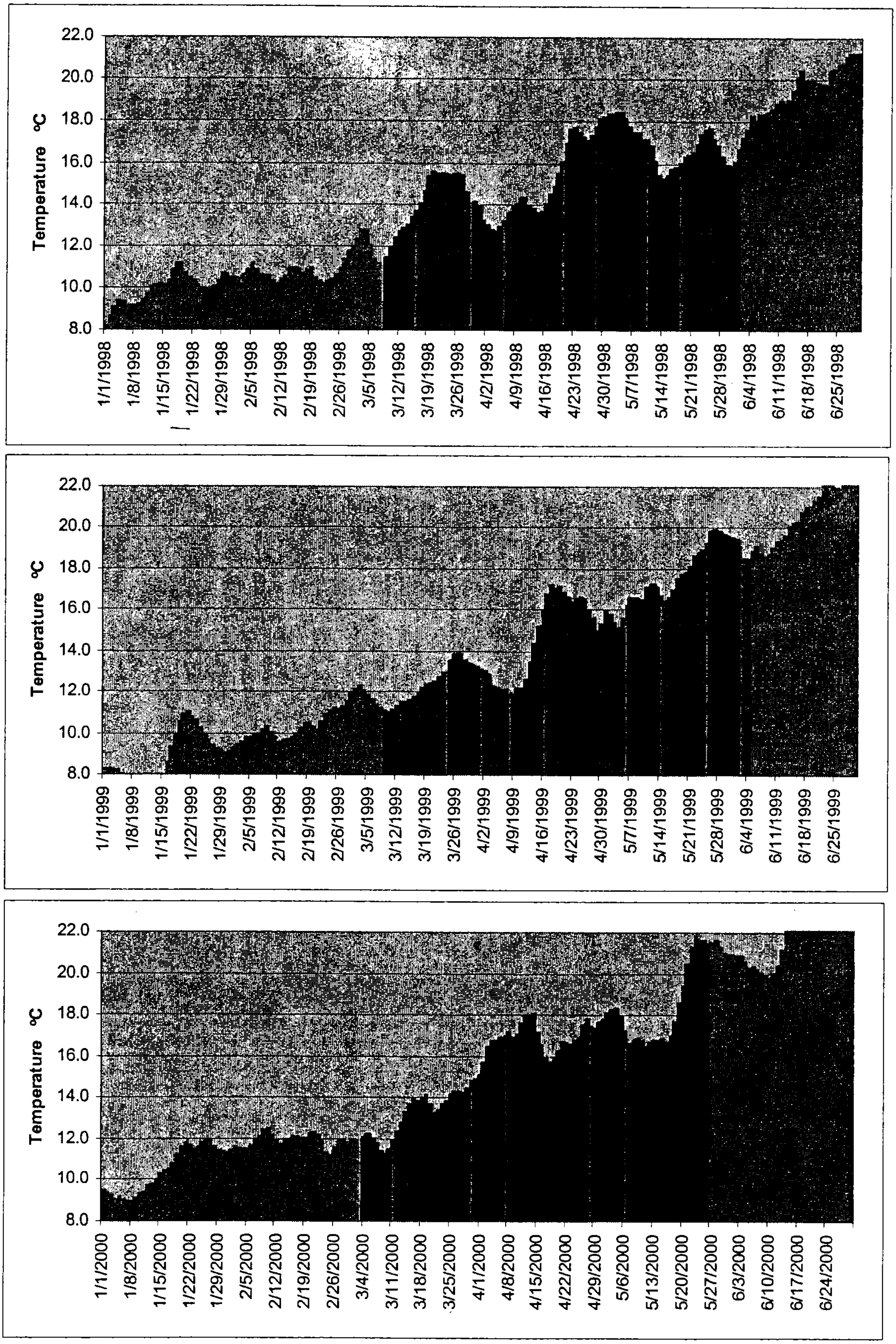
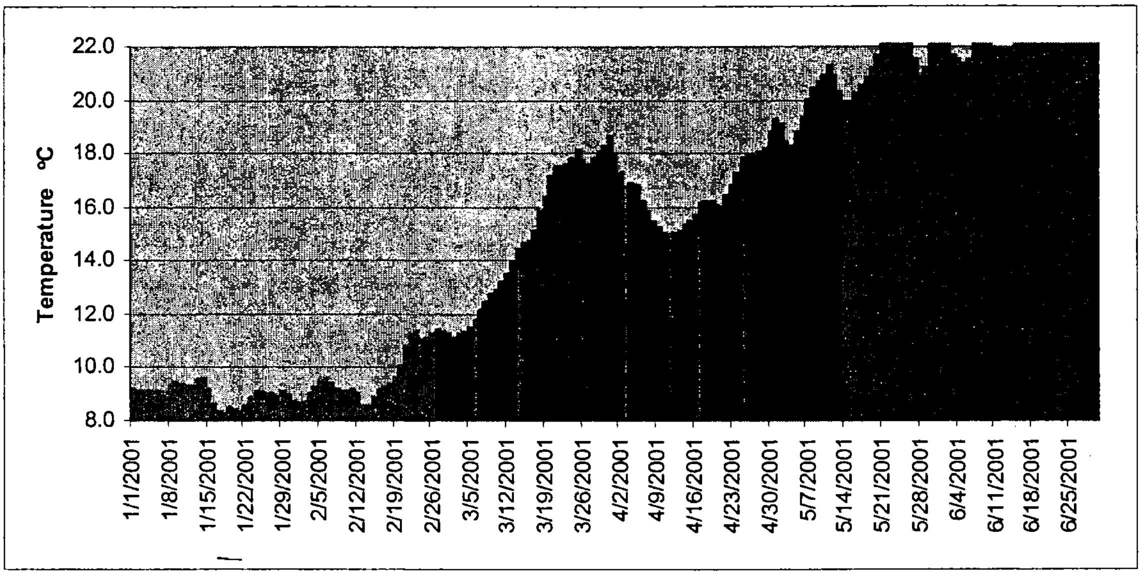


Figure DS2.1 cont.



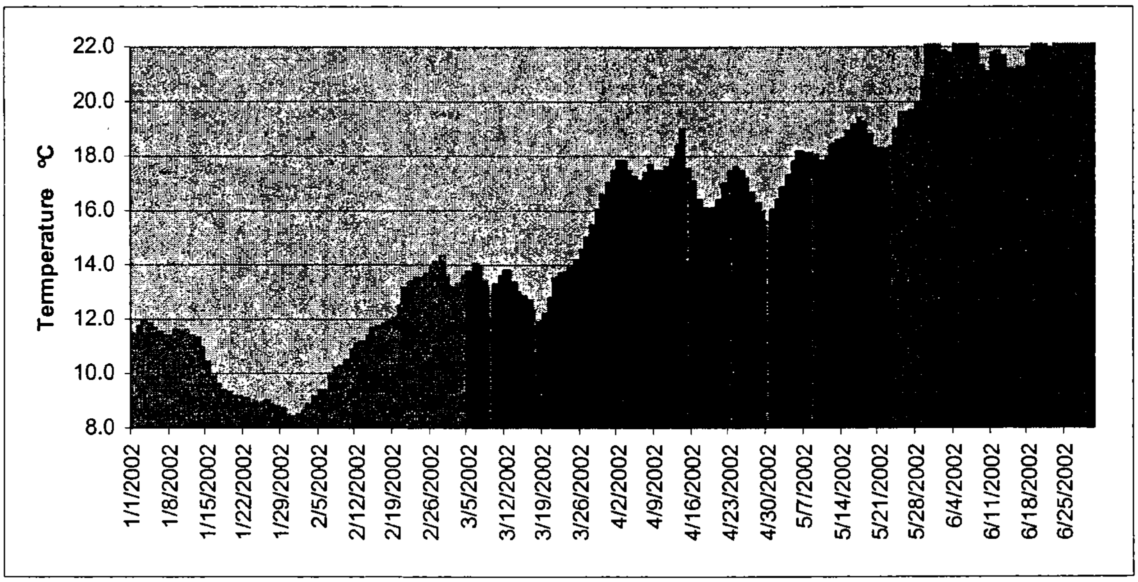
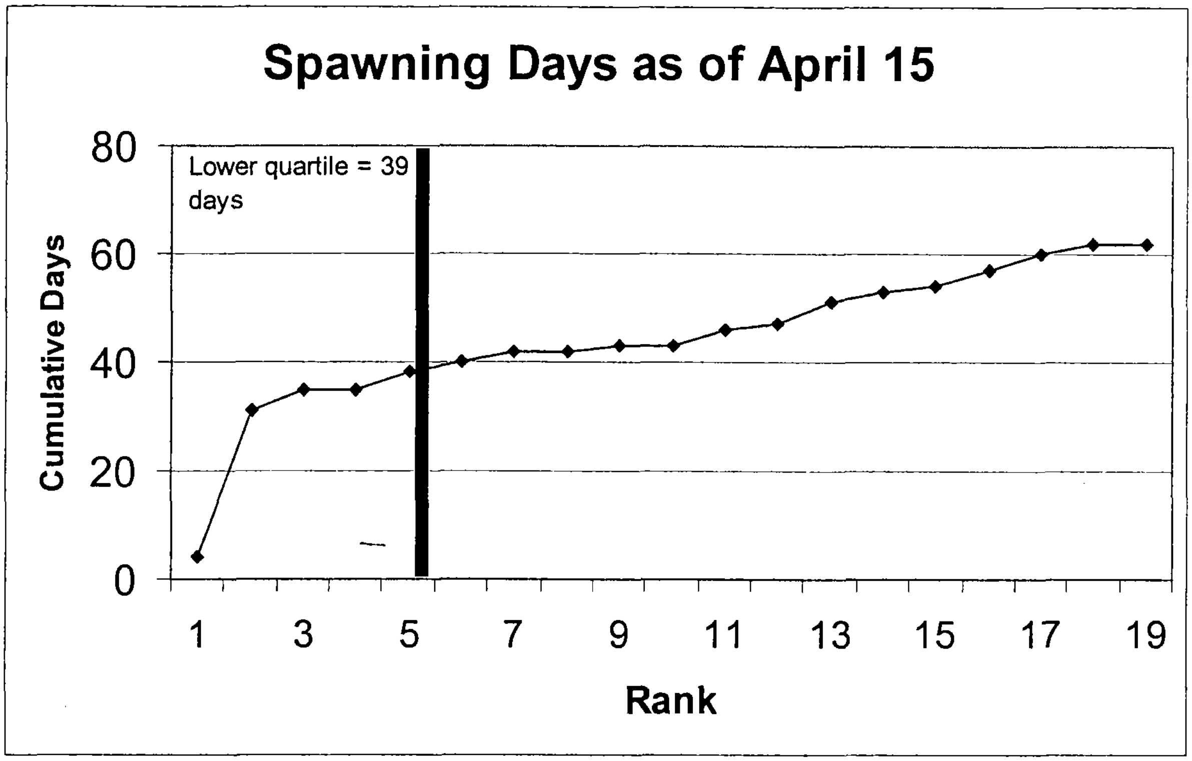


Figure DS3.


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

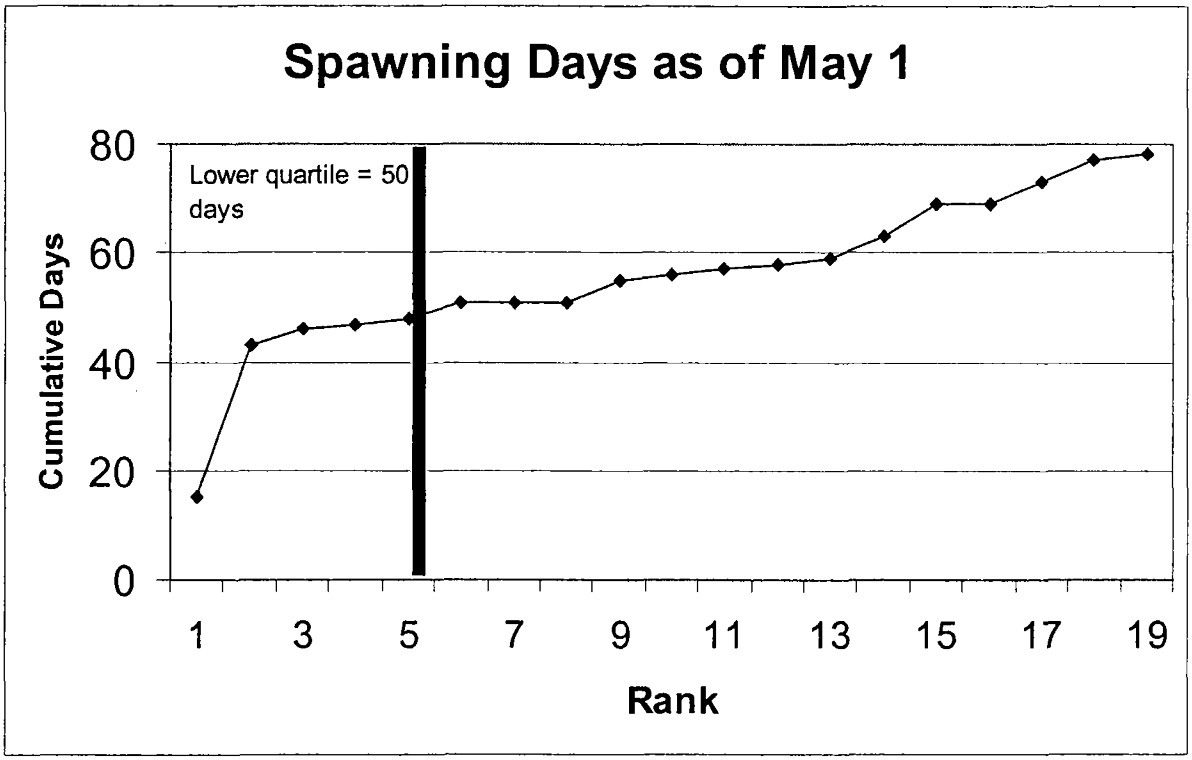

Spawning Days as of May 1
Lower quartile = 50 days
Cumulative Days
0
20
40
60
80
1
3
5
7
9
11
13
15
17
19
Rank

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.

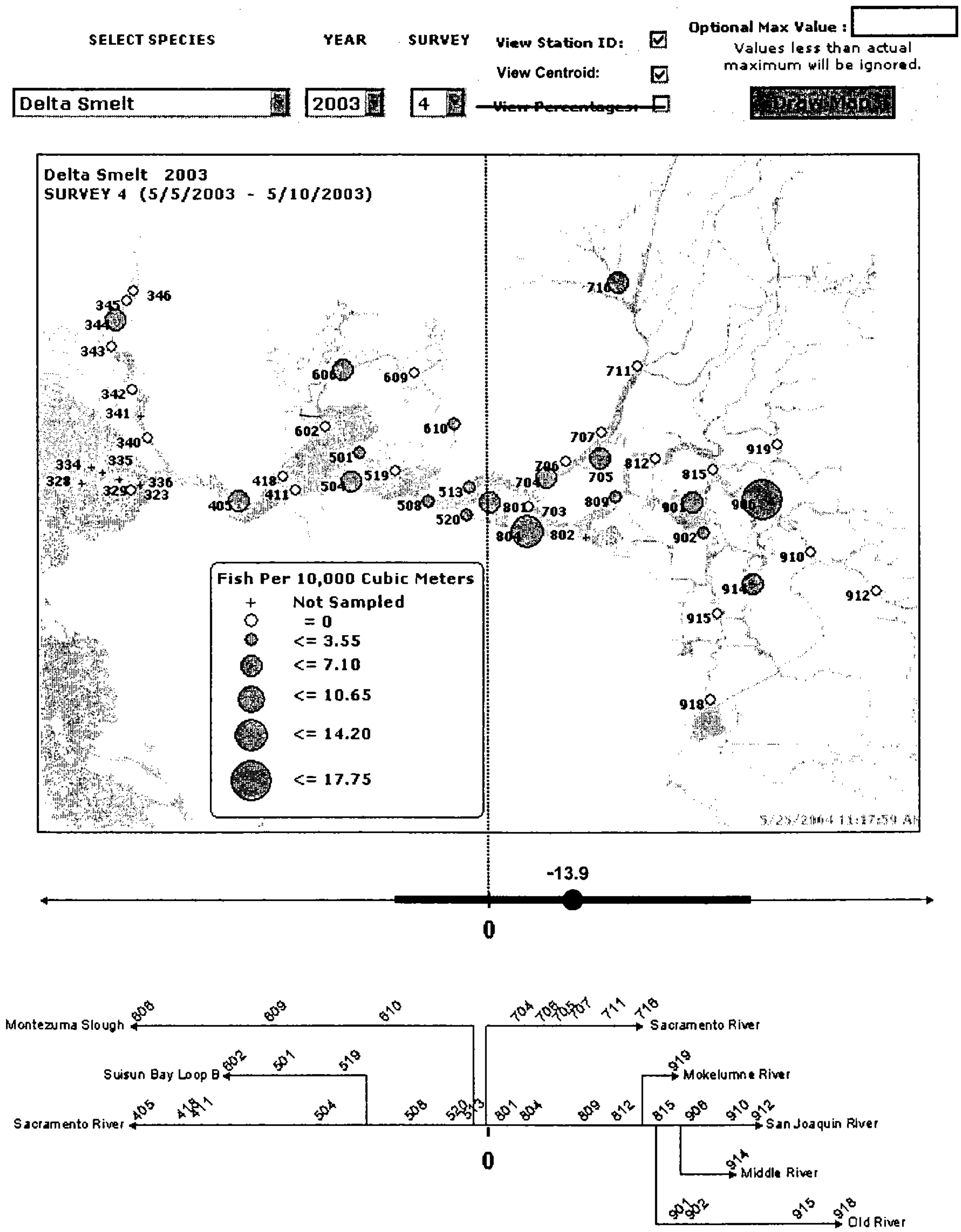


Figure DS5.2. Historic juvenile centroid position (20-mm Survey) with one standard deviation.

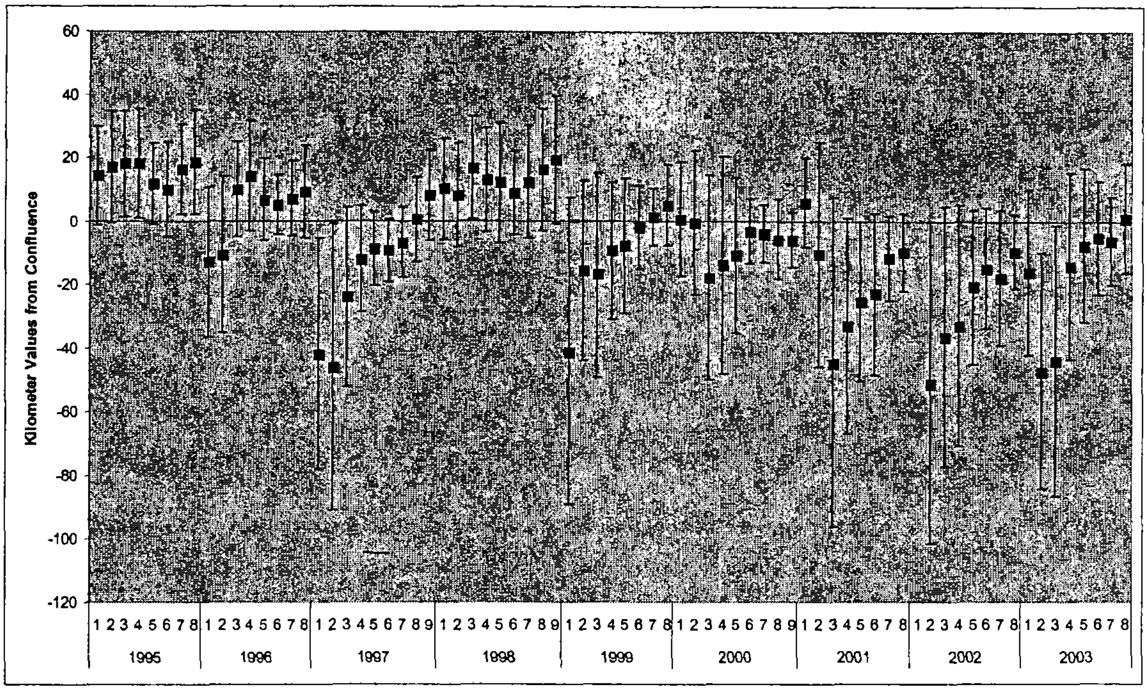


Table DS5. Median values of cumulative catch from the 20-mm Survey. When cumulative catch per survey during a season is at or below the calculated value, concern is high.

	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

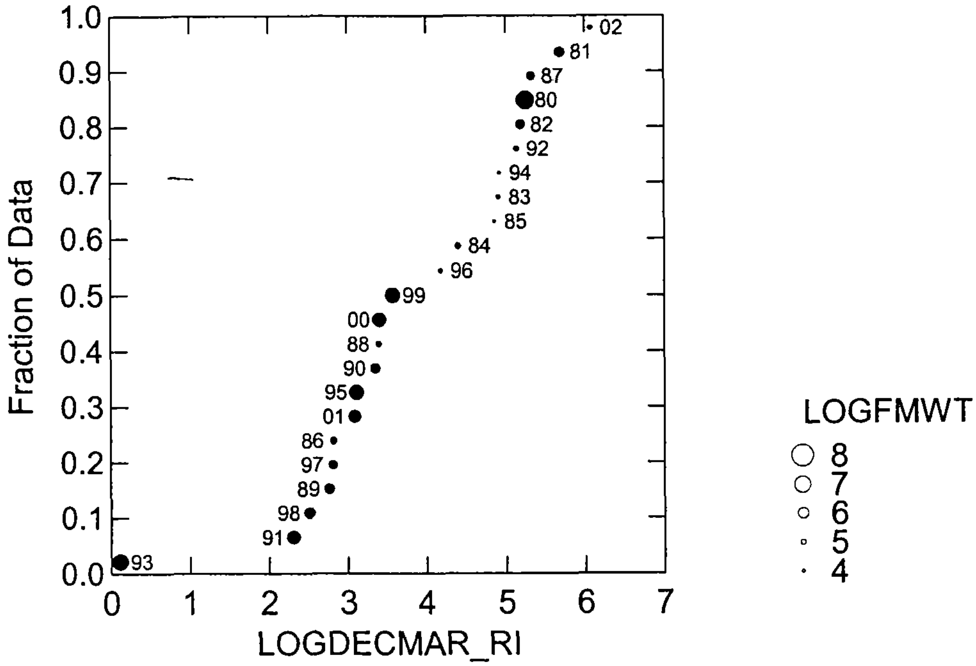
Figure DS6

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 MWT index (ln(winter salvage/MWT 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)* MWT 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.

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 ($<8^{\circ}$ C to $>25^{\circ}$ 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 14°-16° 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 transport larval and juvenile delta smelt 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 to transport smelt larvae 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.

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.

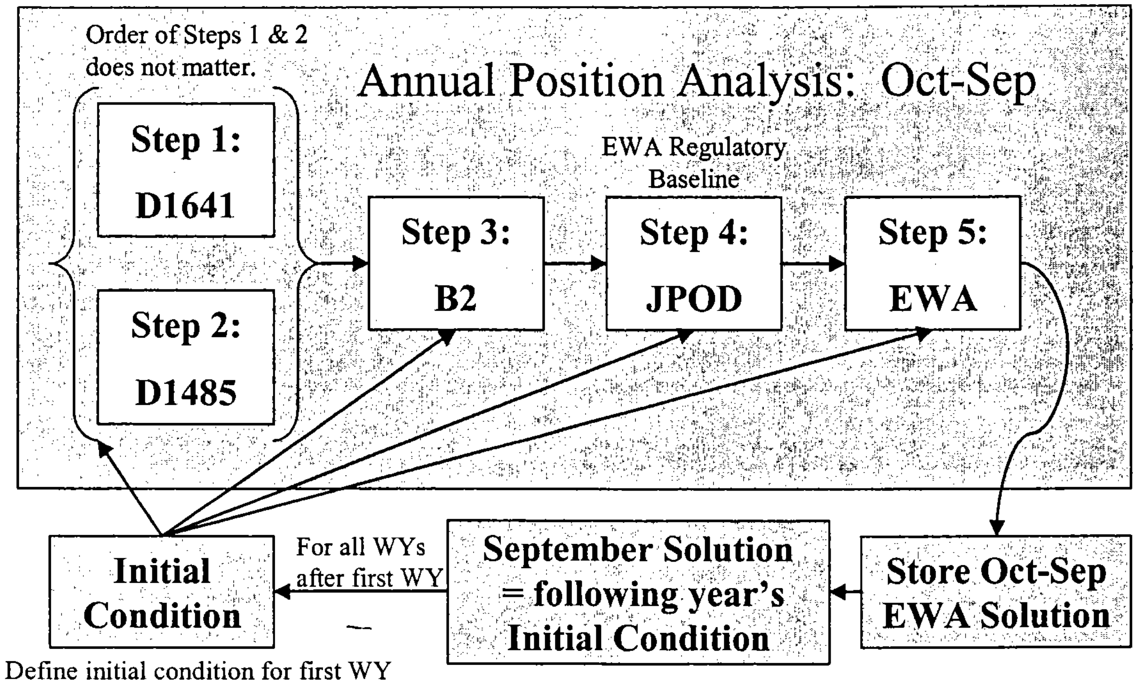


Figure 11. CALSIM II procedure to simulate EWA operations. (Note: Step 4 is named "JPOD" in the OCAP Today Studies and "SDIP" in the OCAP Future Studies.)

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.

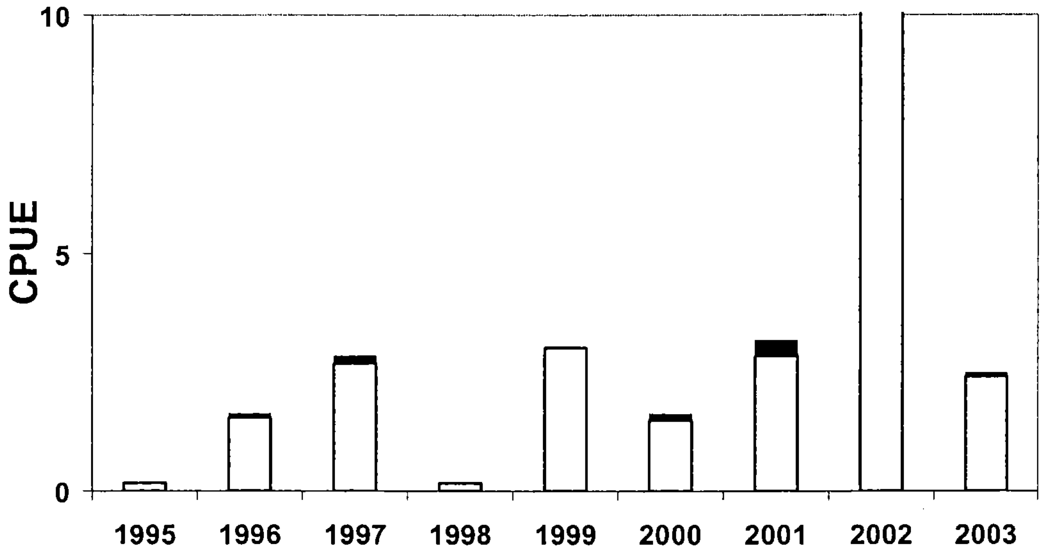


Figure 12 Comparison of delta smelt catch-per-unit-effort (fish/trawl) for NBA monitoring sites in Barker Slough (dark bars) to nearby north Delta sites: Lindsay, Cache and Miner sloughs (white bars). The NBA values are the mean annual CPUE for stations 720, 721, and 727. The nearby North Delta sites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

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.

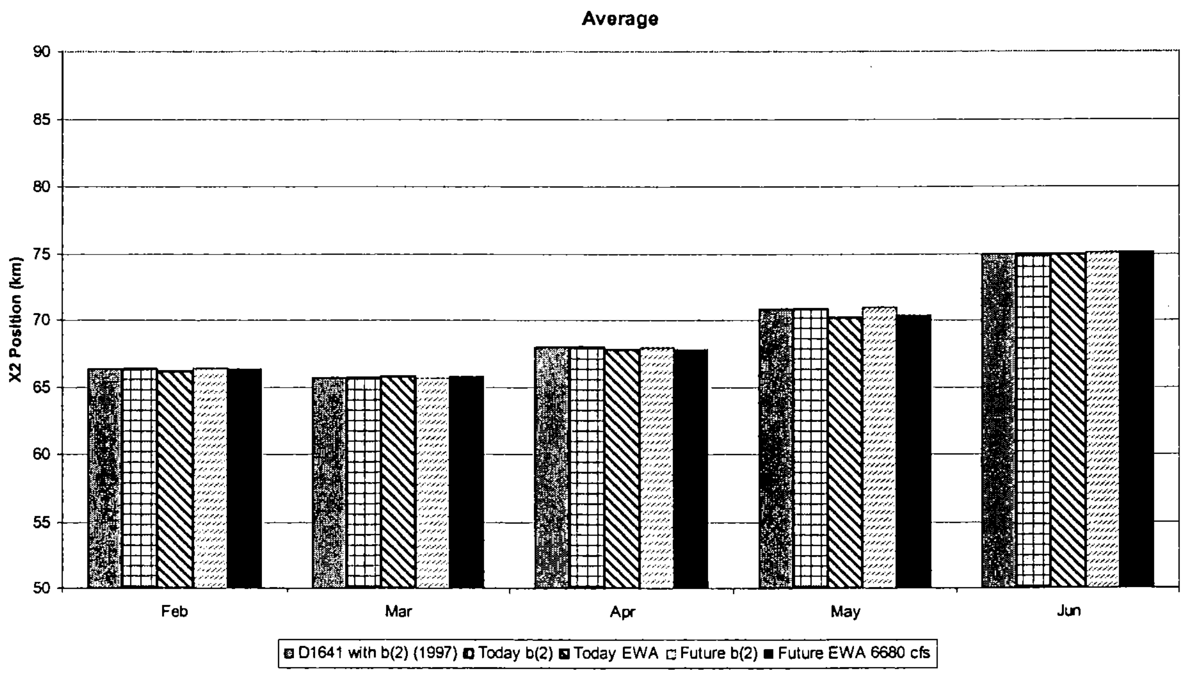


Figure 13 Average Monthly X2 Position

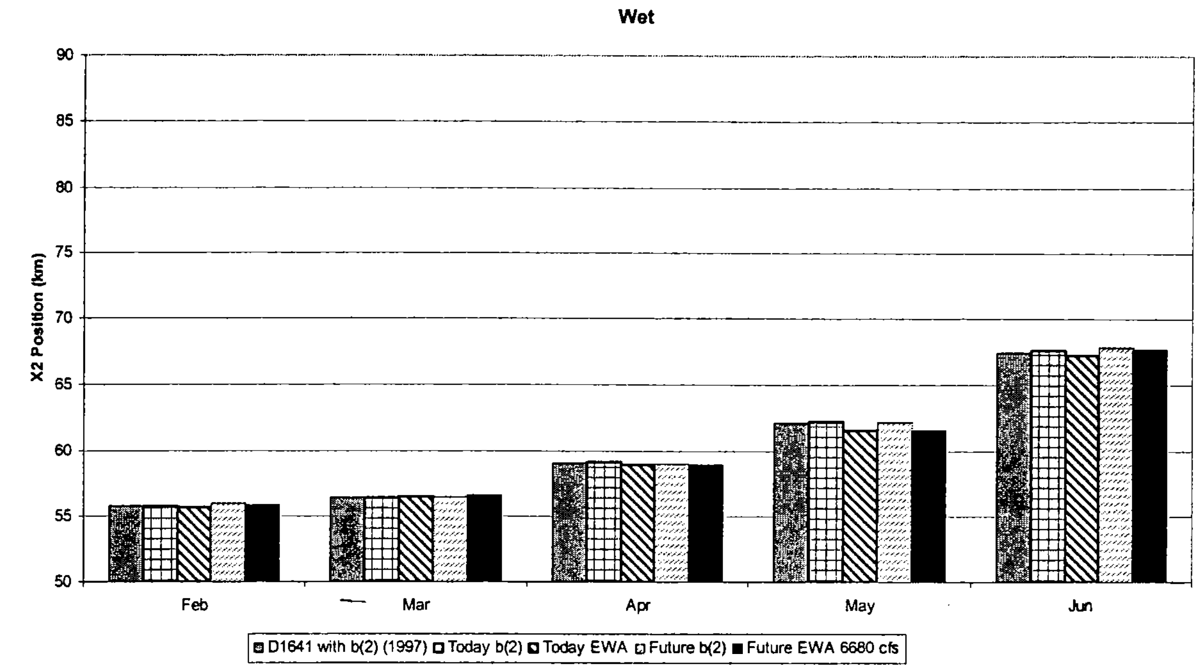


Figure 14 Average wet year (40-30-30 Classification) monthly X2 Position

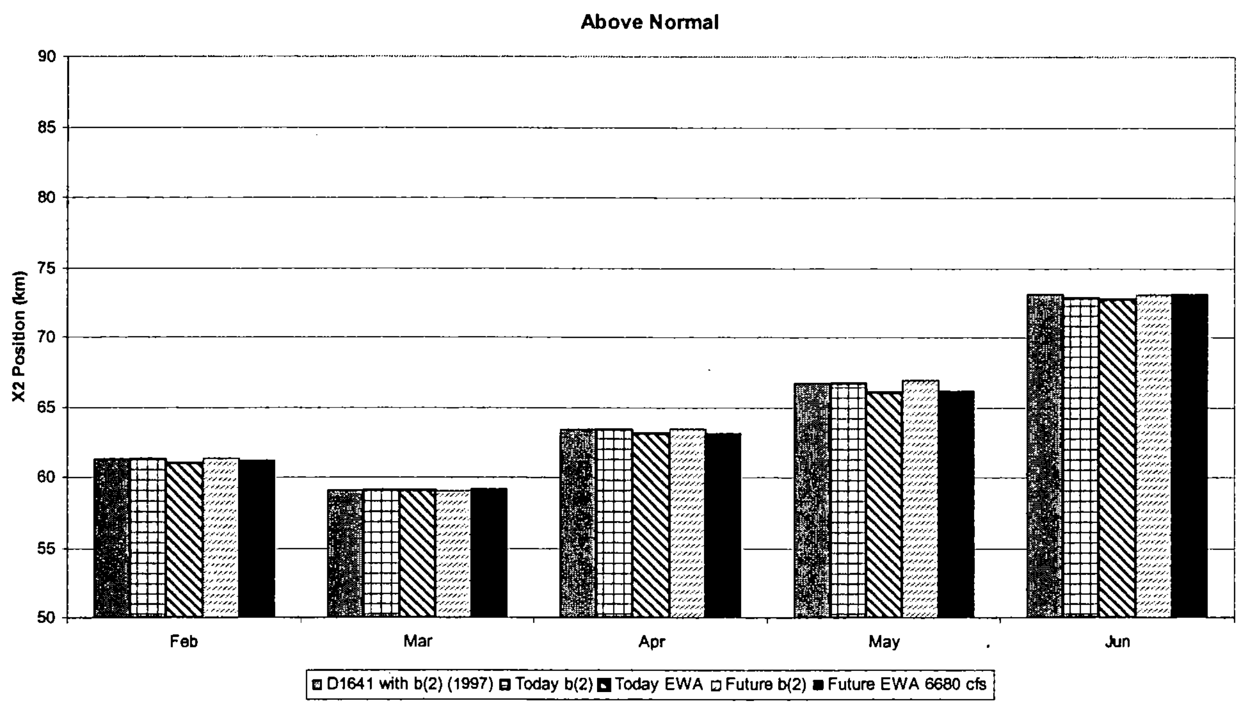


Figure 15 Average above normal year (40-30-30 Classification) monthly X2 Position

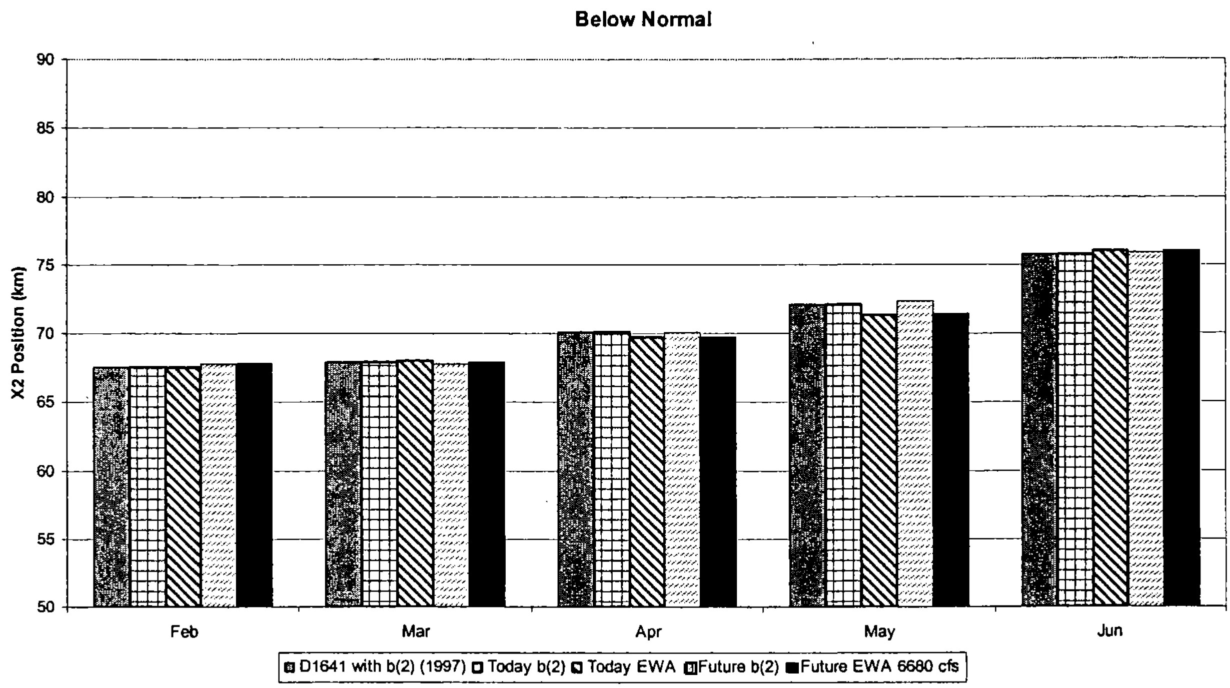


Figure 16 Average below normal year (40-30-30 Classification) monthly X2 Position

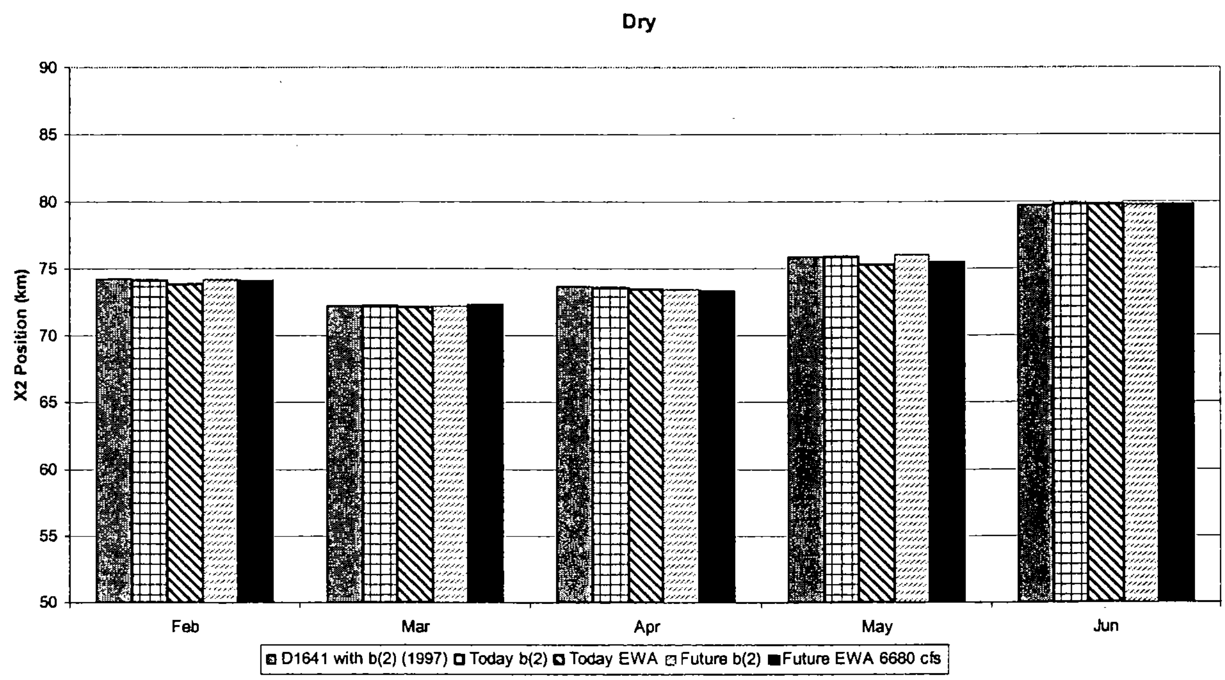


Figure 17 Average dry year (40-30-30 Classification) monthly X2 Position

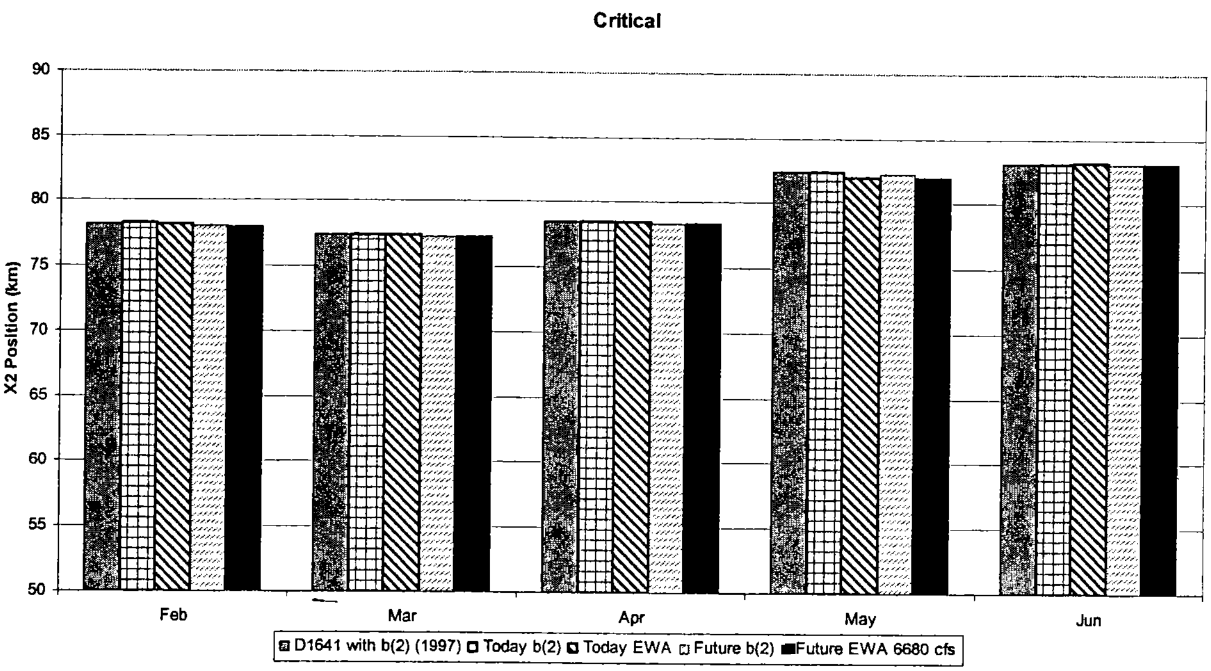


Figure 18 Average critical year (40-30-30 Classification) monthly X2 Position

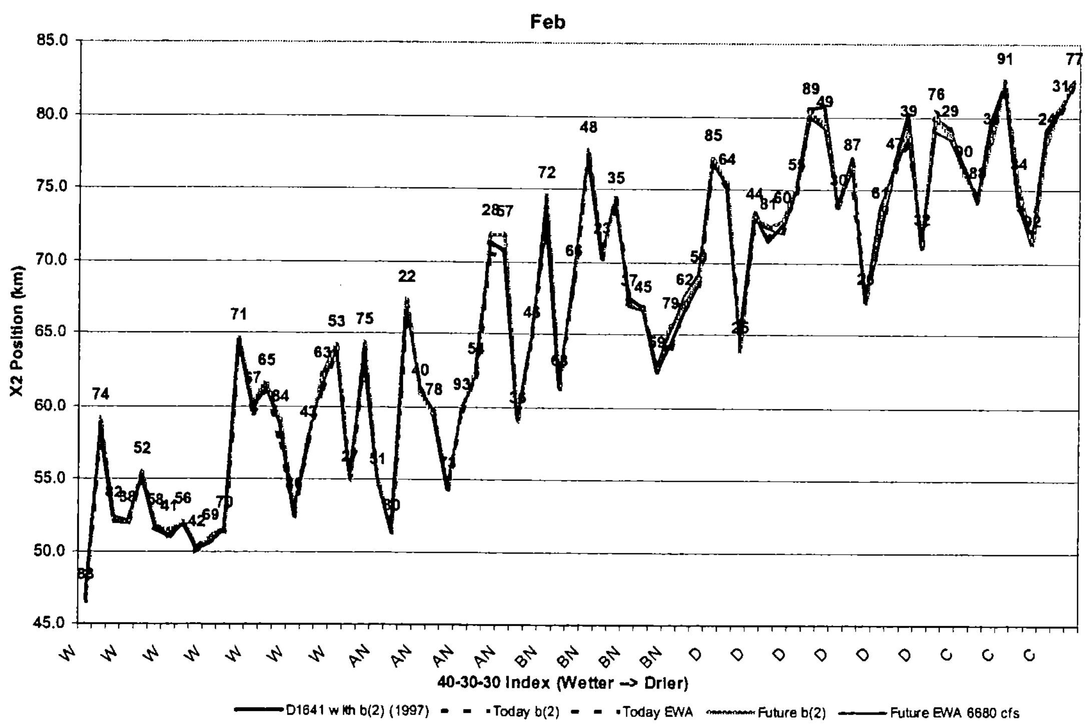


Figure 19 February X2 Position sorted by 40-30-30 Index

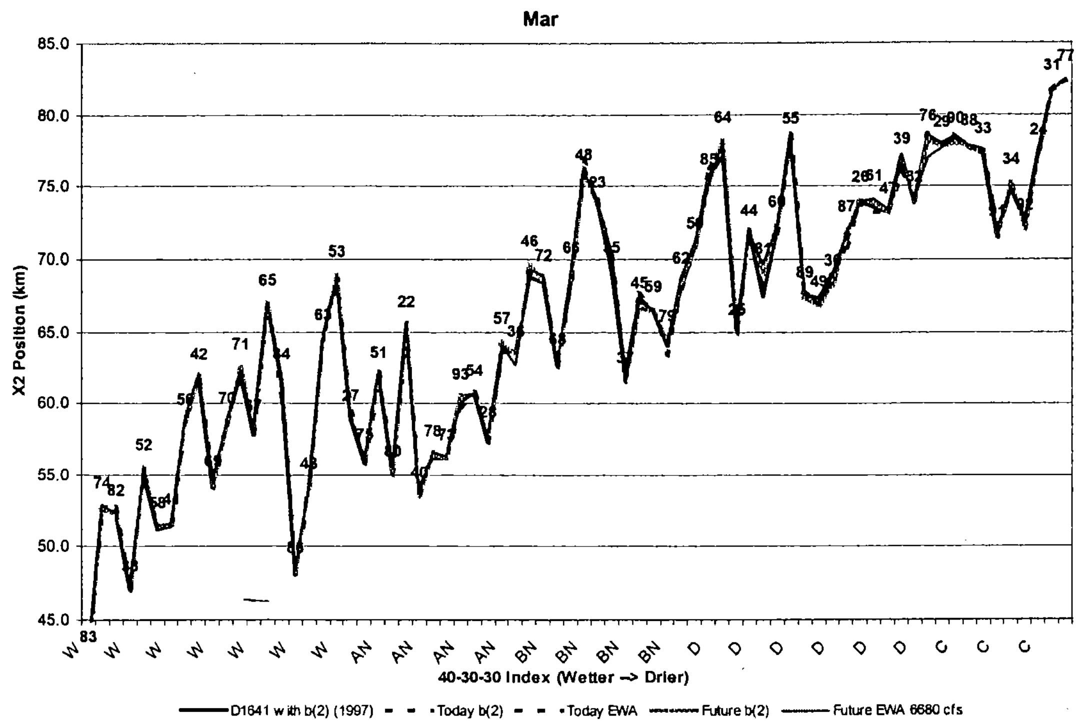


Figure 20 March X2 Position sorted by 40-30-30 Index

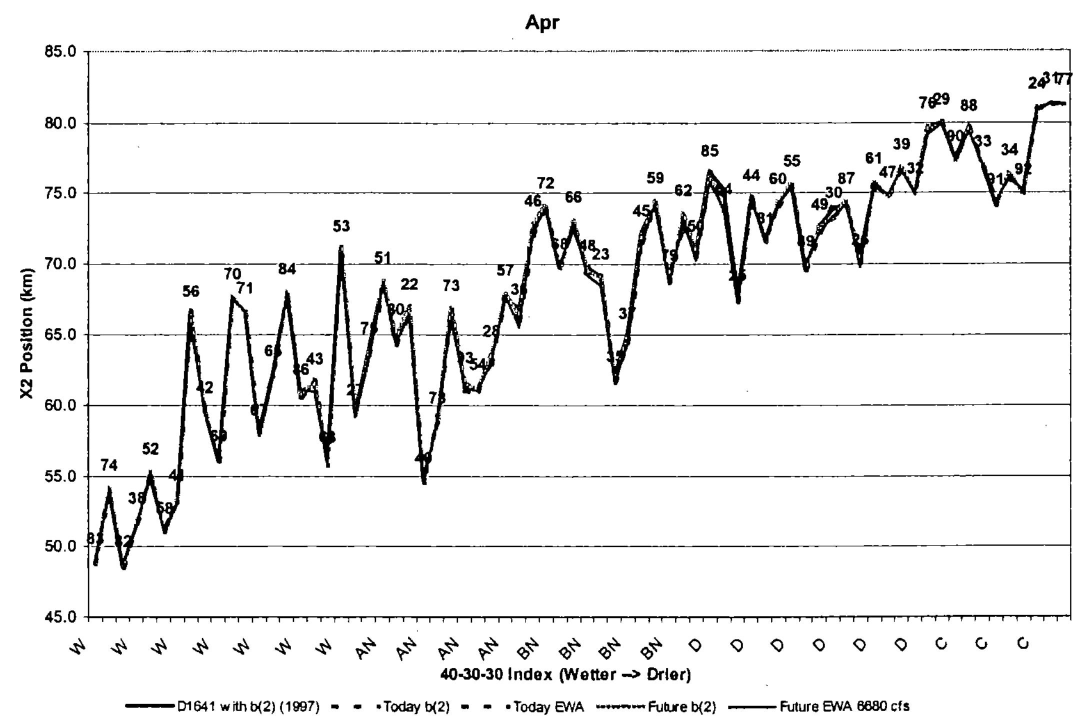


Figure 21 April X2 Position sorted by 40-30-30 Index

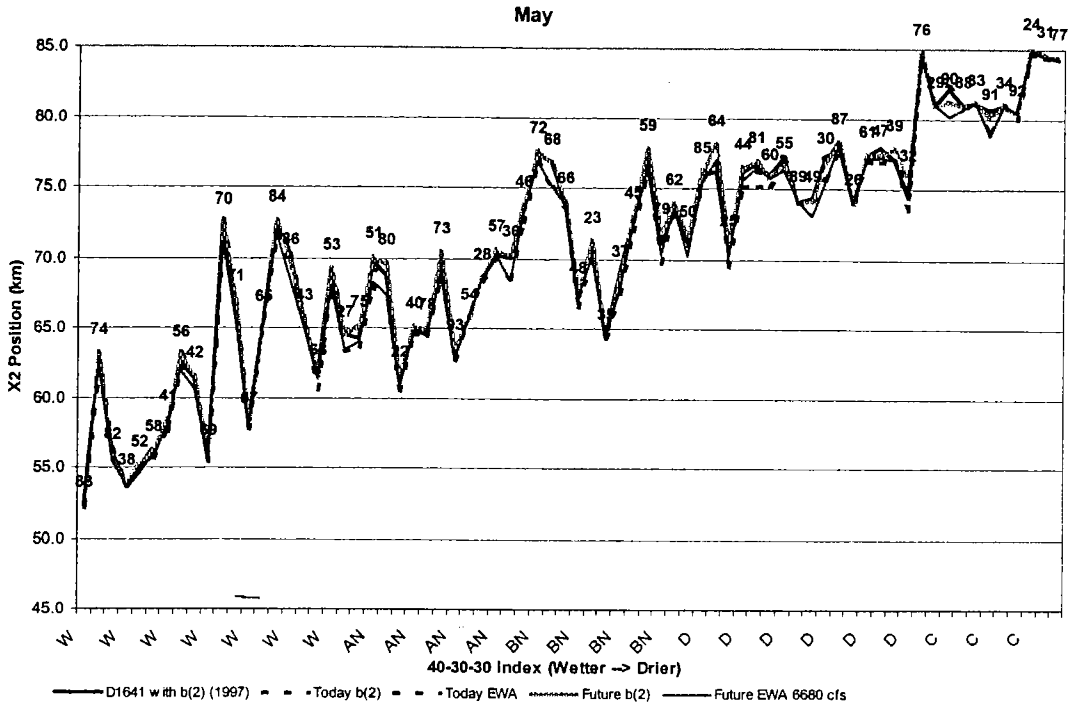


Figure 22 May X2 Position sorted by 40-30-30 Index

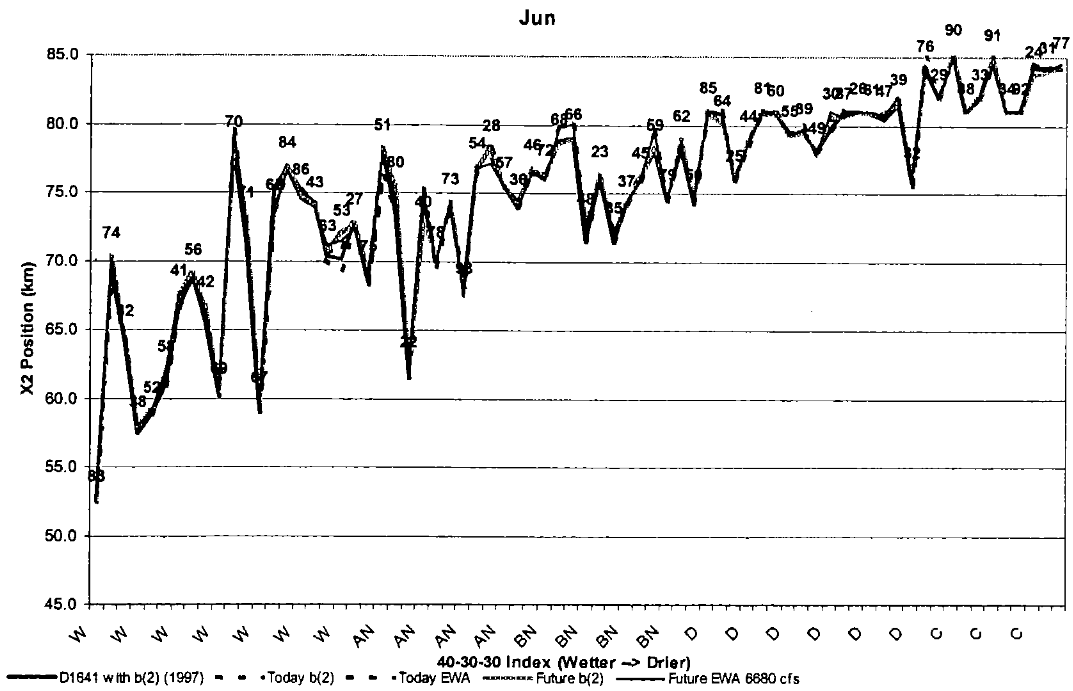


Figure 23 June X2 Position sorted by 40-30-30 Index

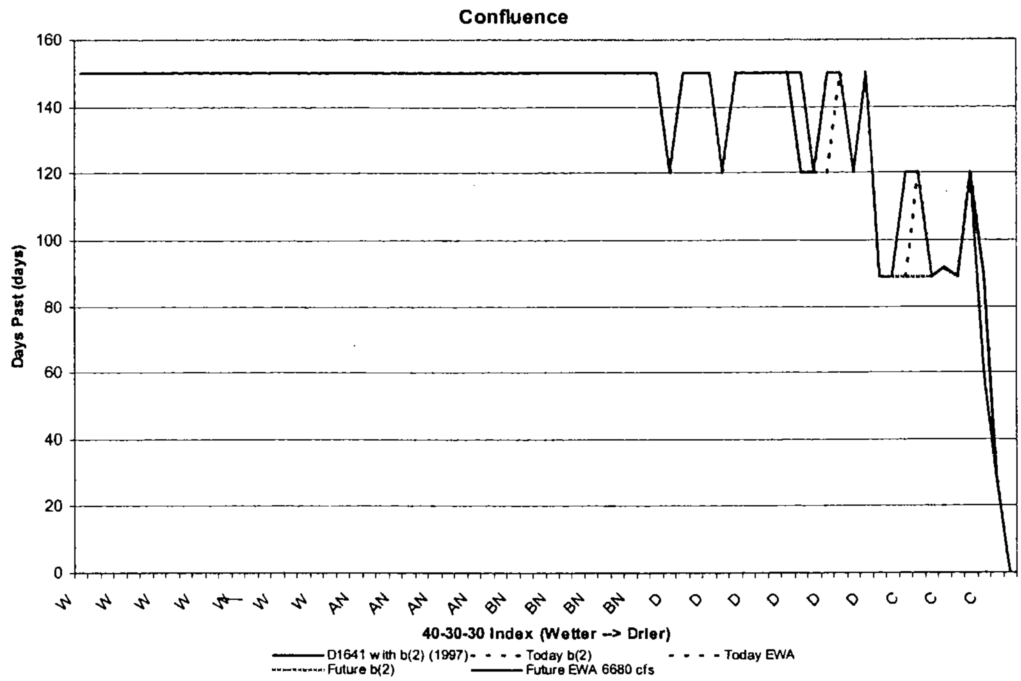


Figure 24 Total number of days average monthly X2 position is past the Confluence 40-30-30 Index (Note: that the total days for a month are assigned if the average X2 position is past the confluence)

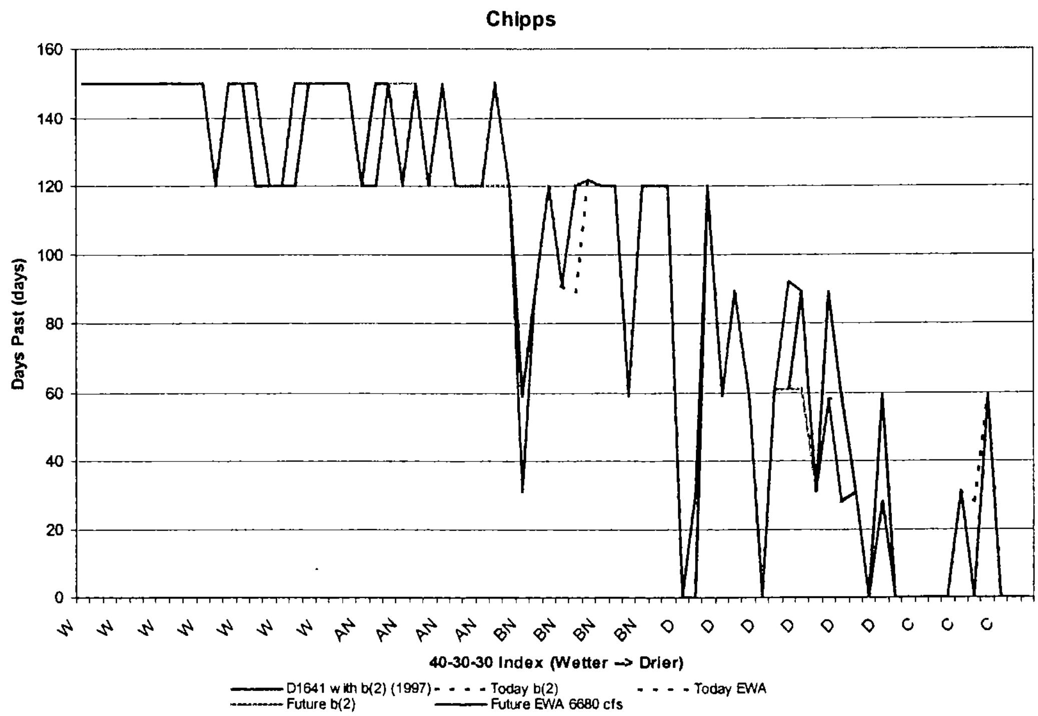


Figure 25 Total number of days average monthly X2 position is past the Chipps Island 40-30-30 Index (Note: that the total days for a month are assigned if the average X2 position is past the Chipps Island)

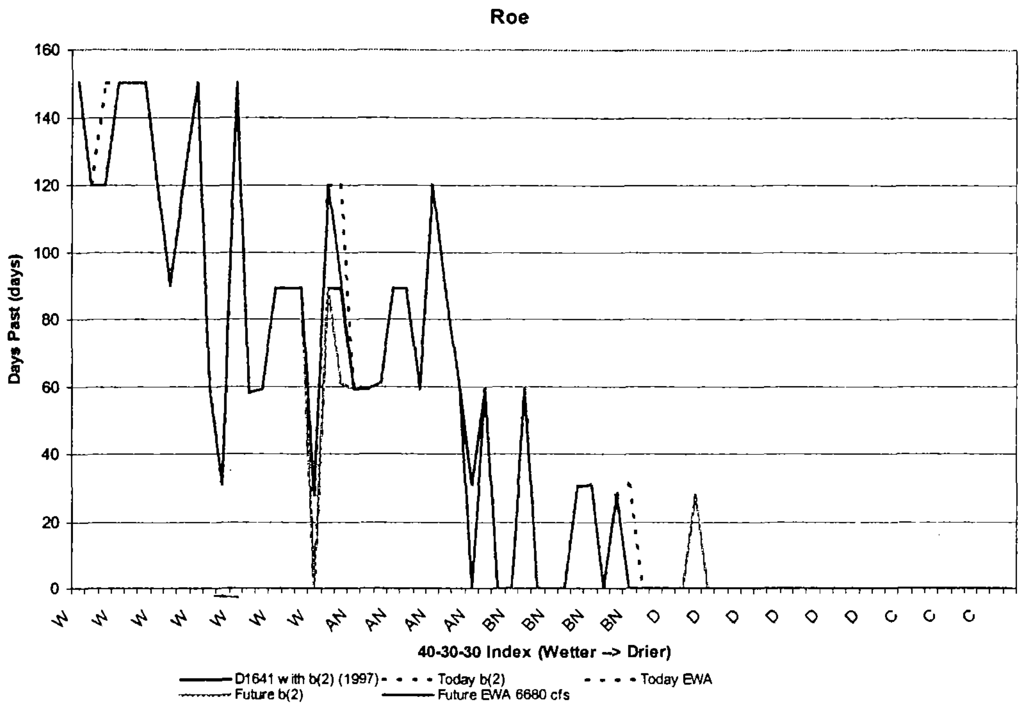


Figure 26 Total number of days average monthly X2 position is past the Roe Island 40-30-30 Index **(Note: that the total days for a month are assigned if the average X2 position is past the Roe Island)**

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.

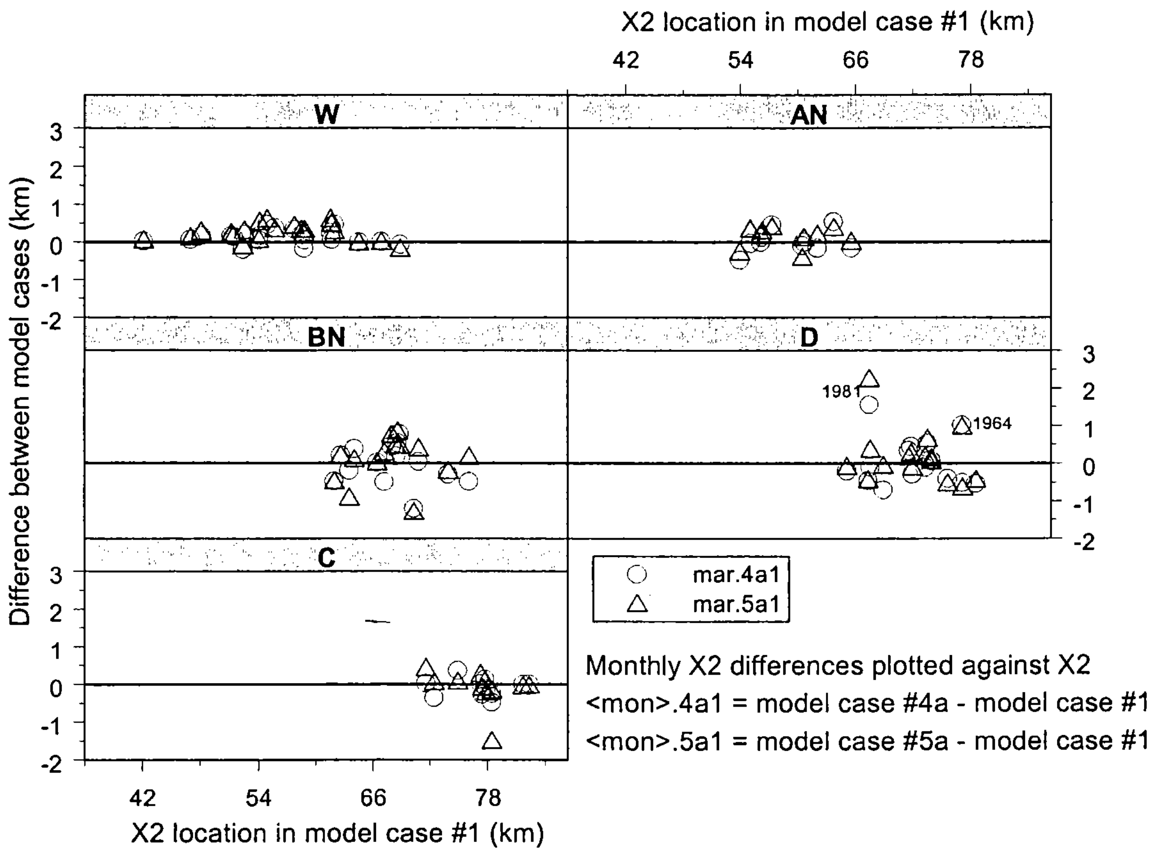


Figure 27 Differences in X2 under Studies #4 and #5 in March. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

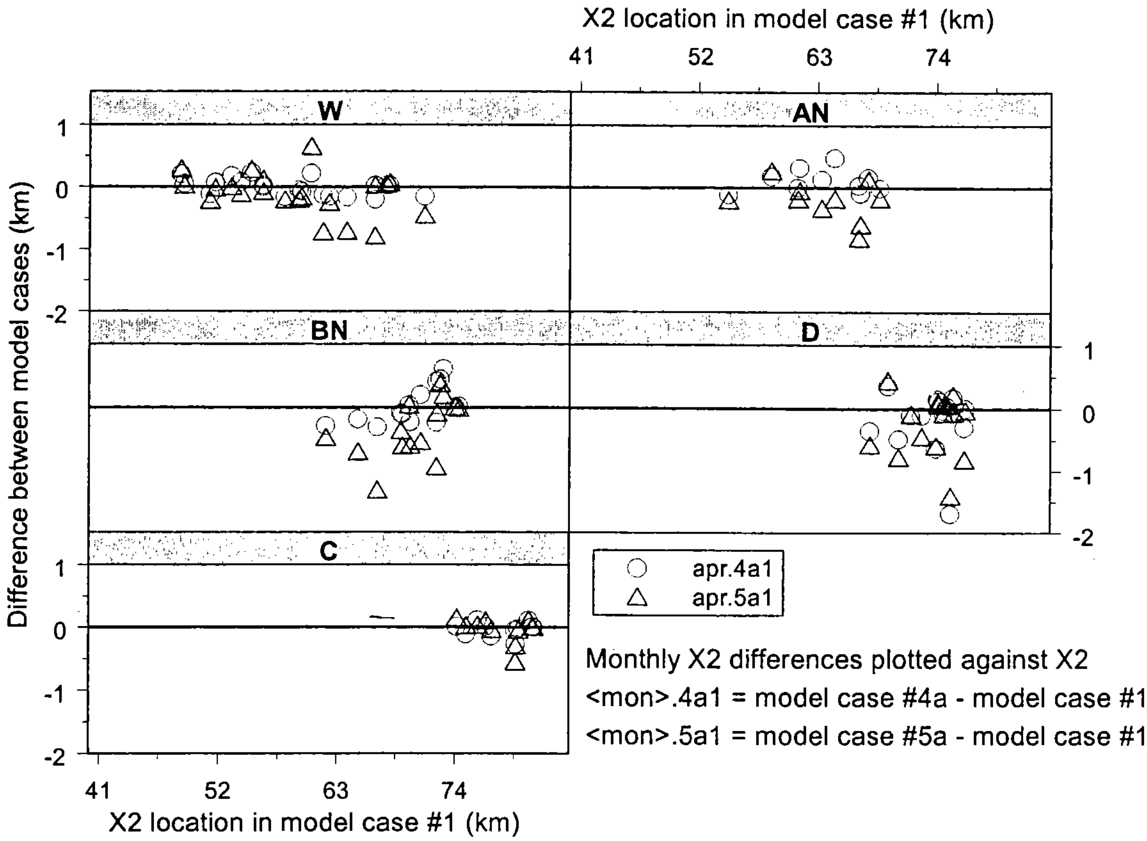


Figure 28 Differences in X2 under Studies #4 and #5 in April. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

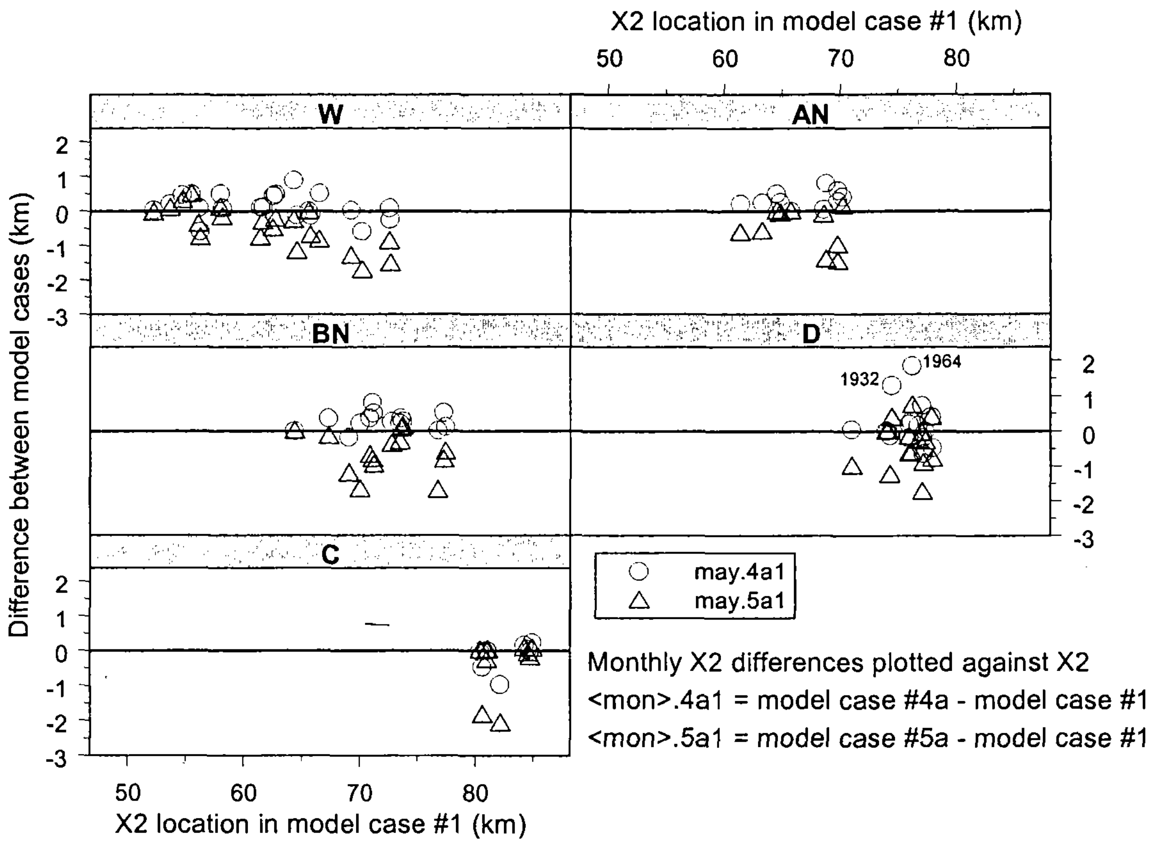


Figure 29 Differences in X2 under Studies #4 and #5 in May. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

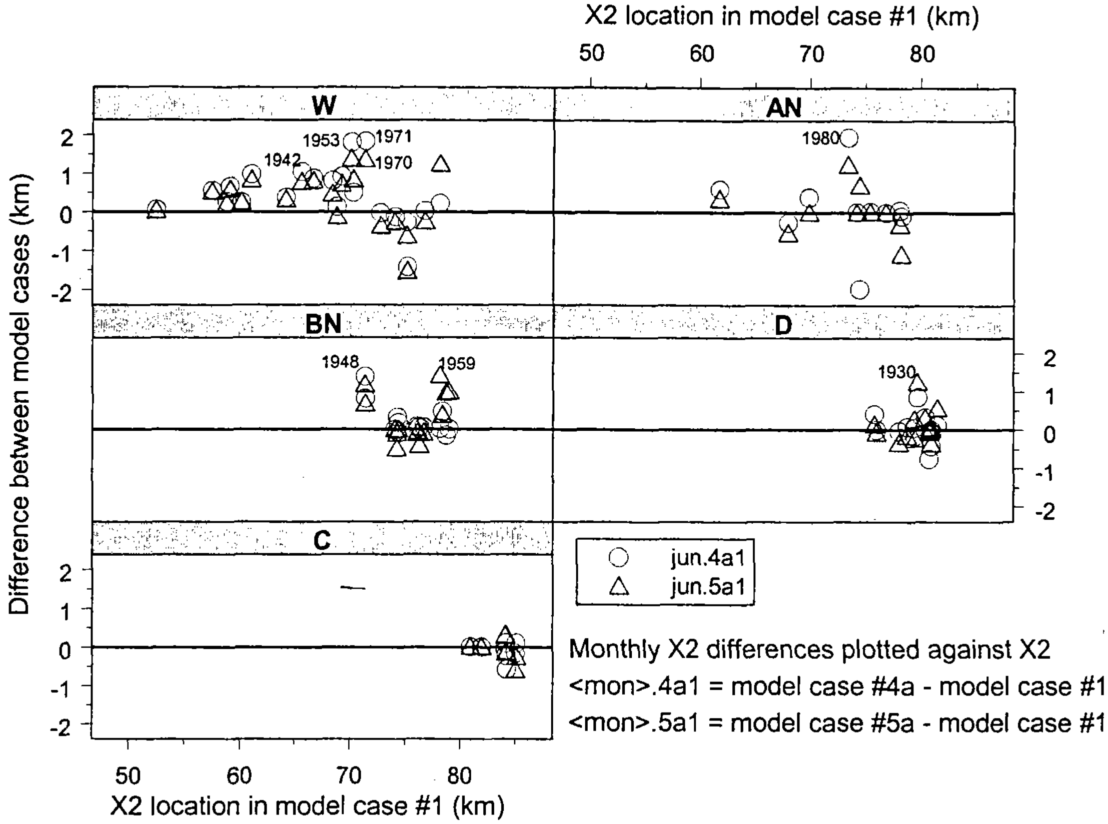


Figure 30 Differences in X2 under Studies #4 and #5 in June. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

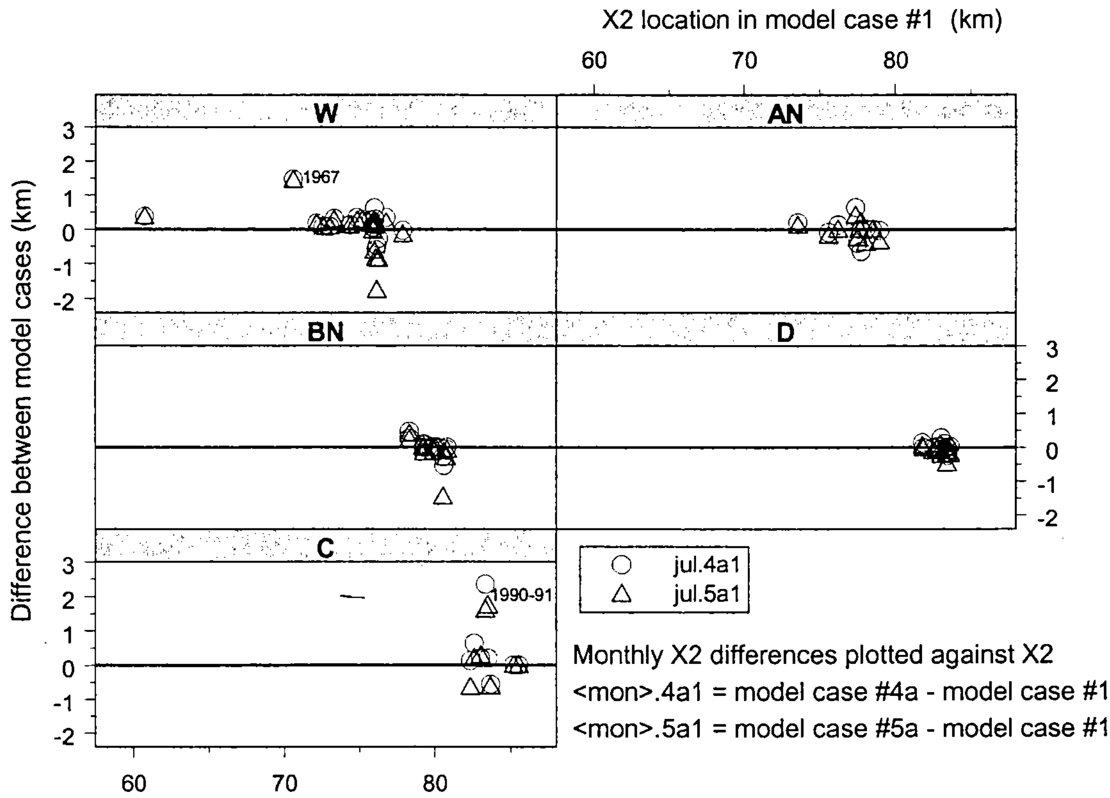


Figure 31 Differences in X2 under Studies #4 and #5 in July. Water year types: W=Wet, AN=Above Normal, BN=Below Normal, D=Dry, C=Critically Dry

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.

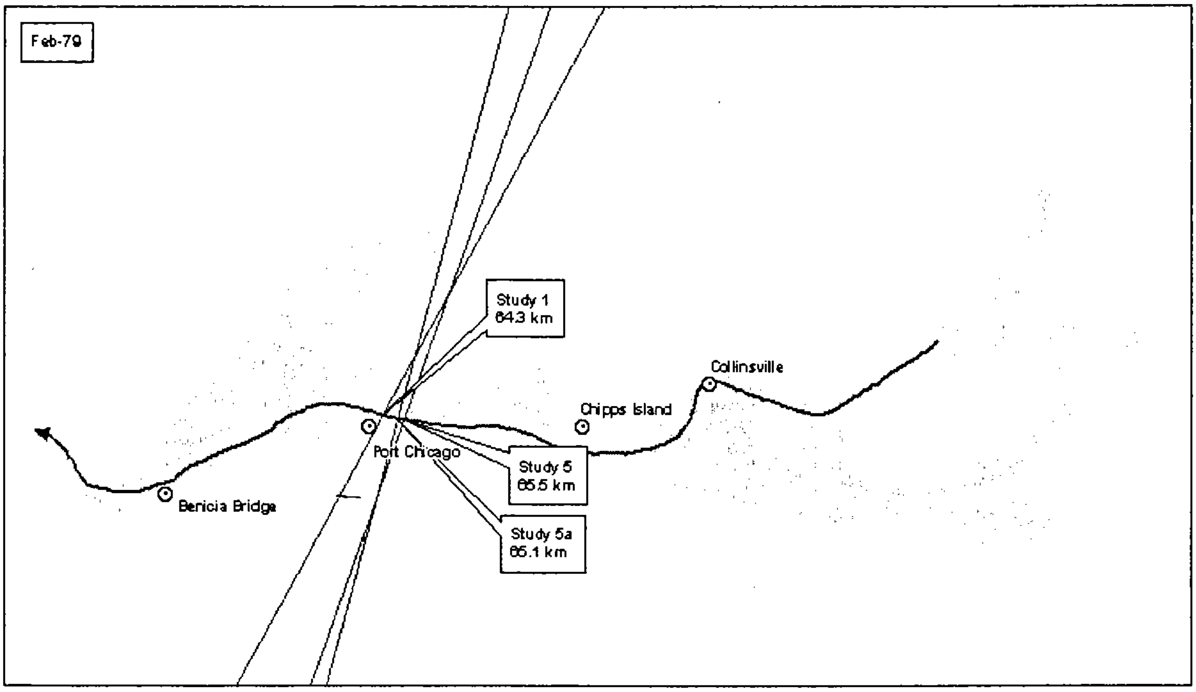
Modeling Summary

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.

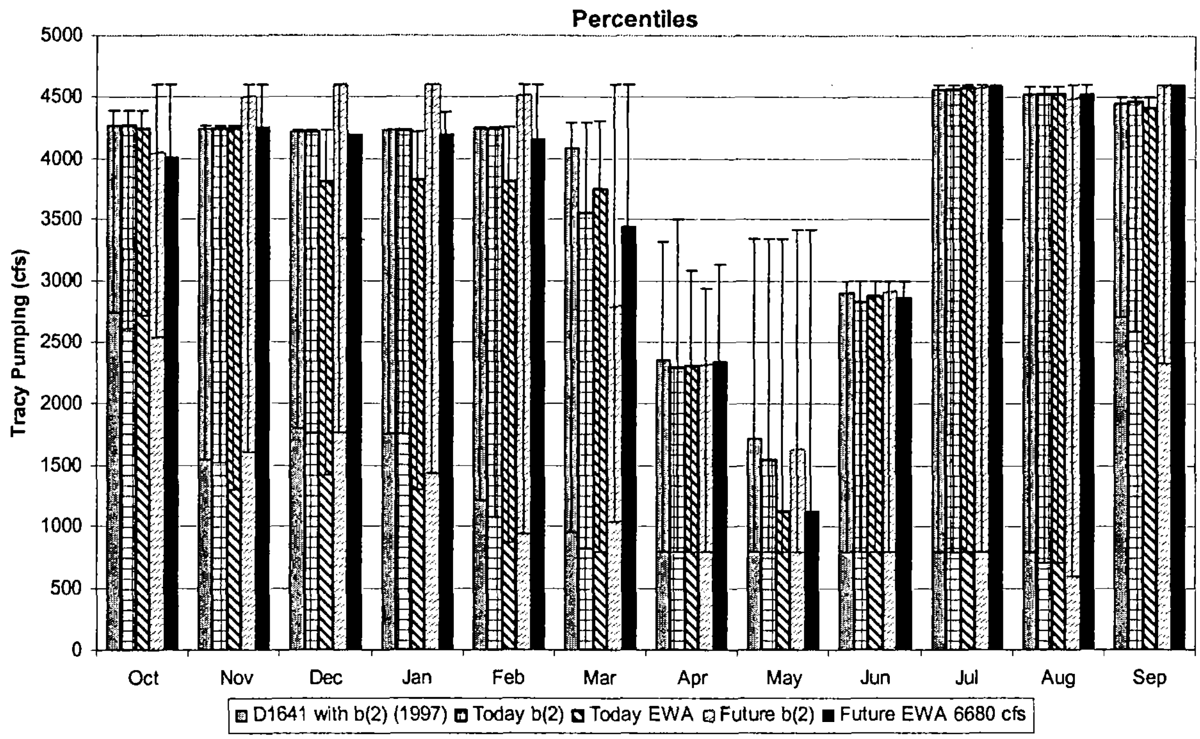


Figure 33 Tracy Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars