SAN JOAQUIN RIVER AGREEMENT

2006 Annual Technical Report

San Joaquin River Group Authority

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Sacramento – San Joaquin Estuary

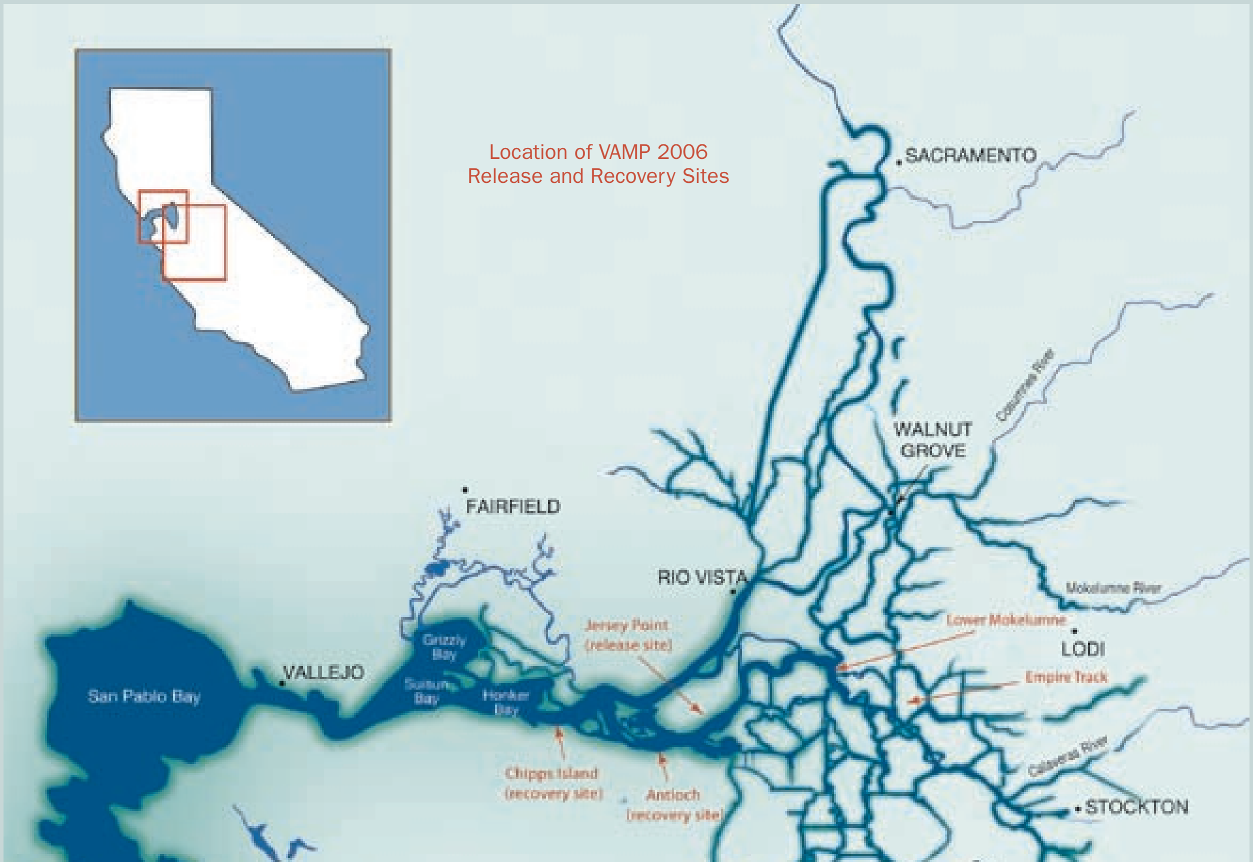

Figure 2-1
Sacramento – San Joaquin Estuary

Executive Summary

The San Joaquin River Agreement (SJRA) and Vernalis Adaptive Management Plan (VAMP) is the cornerstone of a history-making commitment to implement the State Water Resources Control Board (SWRCB) 1995 Water Quality Control Plan (WQCP) for the lower San Joaquin River and the San Francisco Bay-Delta Estuary (Bay-Delta). VAMP, officially initiated in 2000 as part of SWRCB Decision 1641, is a large-scale, long-term (12-year), experimental/management program designed to protect juvenile Chinook salmon migrating from the San Joaquin River through the Sacramento-San Joaquin Delta. VAMP is also a scientific experiment to determine how salmon survival rates change in response to alterations in San Joaquin River flows and State Water Project (SWP)/Central Valley Project (CVP) exports with the installation of the Head of Old River Barrier (HORB).

High spring flows, exceeding the upper target flow objective of 7.000 cfs, prevented installation of the HORB in 2006 In addition low water temperatures at the Merced River Fish Hatchery delayed the growth of the hatchery fish used in the experiment causing the SJRA technical committee to recommend that the VAMP pulse flow period be moved from the default period of April 15 - May 15 to May 1 - May 31. Continued wet hydrologic conditions resulted in flood control releases on both the Tuolumne and Merced rivers; and excess water released from the Friant Dam on the Upper San Joaquin River. These conditions resulted in a gradual increase in Vernalis flow between May 1 and May 31.

The 2006 Annual Technical Report consolidates the annual SJRA Operations and the Vernalis Adaptive Management Plan (VAMP) Monitoring Reports. The VAMP 2006 program represents the seventh year of formal compliance with SWRCB Decision 1641 (D-1641). D-1641 requires the preparation of an annual report documenting the implementation and results of the VAMP program. Specifically, this 2006 report includes the following information on the implementation of the SJRA: the hydrologic chronicle; management of any additional SJRA water; flow and fisheries monitoring in the lower San Joaquin River, Old River, and Delta; results of the juvenile Chinook salmon smolt survival investigations; discussion of complementary investigations; and conclusions and recommendations.

VAMP is intended to employ an adaptive management strategy using current knowledge to protect Chinook salmon as they migrate through the Delta, while gathering information to allow more efficient protection in the future. In addition to providing improved protection for juvenile Chinook salmon emigrating from the San Joaquin River system, specific experimental objectives of VAMP 2006 included:

- Quantification of Chinook salmon smolt survival between Mossdale or Dos Reis, and Jersey Point using recaptures at Antioch and Chipps Island, under conditions of a San Joaquin River flow at Vernalis above 7,000 cfs, without an installed HORB, and SWP/CVP export rates of 1,500 and 6,000 cfs.
- Evaluation of the San Joaquin River – Old River flow split at the Head of Old River under the 2006 flow conditions without the installed HORB.
- Monitoring in Old River to evaluate the movement of salmon smolts into the Old River under the 2006 flow conditions without the installed HORB.
- Health and physiology testing of VAMP fish was conducted at the MRH and at Chipps Island to evaluate the incidence of disease.

The VAMP design provides for a 31-day pulse flow (target flow) in the San Joaquin River at the Vernalis gage along with a corresponding reduction in SWP/CVP exports. The magnitude of the pulse flow is based on an estimated flow that would occur during the pulse period absent the VAMP. As part of the implementation planning, the VAMP hydrology and biology groups meet regularly throughout the year to review current and projected information on hydrologic conditions occurring within the San Joaquin River watershed. This facilitates communication and coordination for both the VAMP Chinook salmon smolt survival experiments and for scheduling streamflow releases on the Tuolumne, Merced, and Stanislaus rivers to facilitate the experimental investigations and protection for juvenile salmon within the tributaries.

In planning for the VAMP the 2006 hydrologic conditions were similar to those of 2005. In the March 23 operation plan the existing a flow was forecasted to be between 6,110 and 6,610 cfs, thereby calling for a VAMP target flow of 7,000 cfs. This early forecast also indicated that the HORB could not safely be installed during 2006 due to flows exceeding 5,000 cfs in the San Joaquin River during the installation period. As wet conditions continued through the spring period, operators for New Don Pedro on the Tuolumne River and Lake McClure on the Merced River were required to initiate flood control operations. Due to continued wet conditions and the forecasted flood control operations on the Tuolumne and Merced rivers the subsequent operations plans forecasted an existing flow at Vernalis in excess of 7,000 cfs. By April 11 forecast of existing flow at Vernalis was projected to be about 25,880 cfs over the period of April 22 through May 22 and expected to increase. Additionally, the California Department of Fish and Game informed SJRA Technical Committee that low water temperatures at the Merced River Fish Hatchery were causing an apparent delay in the maturation of the salmon smolts. The SJRA Technical Committee recommended delaying the start of the VAMP pulse period until May 1 in an effort to provide smolt sized fish for the experiment. Also the study was modified to measure survival between Mossdale and Dos Reis and Jersey Point without a HORB. The release site at Durham Ferry was not used due to the flow being partially diverted into Paradise Cut, an overflow channel that leaves the San Joaquin River downstream of Durham Ferry but upstream of Mossdale.

VAMP experimental test conditions that have occurred over the past seven years are summarized below:

Year	VAMP Period	Average Vernalis Flow (cfs)	Average SWP/CVP Exports (cfs)	Head of Old River Barrier
2000	April 15-May 15	5,869	2,155	Installed
2001	April 20-May 20	4,220	1,420	Installed
2002	April 15-May 15	3,300	1,430	Installed
2003	April 15-May 15	3,235	1,446	Installed
2004	April 15-May 15	3,155	1,331	Installed
2005	May 1-May 31	10,390	2,986	Not Installed
2006	May 1-May 31	26,020	1,559/5,748 (a)	Not Installed

(a) Intended target export rate was 1,500 cfs (May 3-17) and 6,000 cfs (May 18-June 2)

Water temperature data were collected with a series of computerized recorders at the Merced River Fish Facility, in the transport trucks, at the release sites and throughout the lower San Joaquin River and Delta. Overall the average temperature at all sites ranged from 17 to 22 C.

Kodiak trawling was conducted in Old River in 2006, in addition to the usual sampling conducted in the San Joaquin River near Mossdale. Data from the two sites were compared to assess movement into the Old River during the VAMP period when there was no HORB installed. The ratio between the number of unmarked salmon and CWT salmon captured at the two locations was similar. It appears in May 2006, Salmon were diverted down Old River at a higher rate than the water flow. The hydraulic conditions at the San Joaquin/Old River split location may be contributing to a higher proportion of salmon entering the Old River.

In order to further verify the split of salmon at Old River and other South Delta channels, an acoustic telemetry tracking study was conducted in 2006. One hundred salmon smolts, with surgically implanted micro acoustic transmitters, were released and tracked for up to a 10-day period. Results from this effort also showed that in 2006, many of the ultrasonic tagged fish migrated into Old River.

Consistent with the VAMP experimental design, the 2006 effort included two mark-recapture studies performed in early and mid May to provide estimates of salmon survival however in 2006, they were at two different export conditions. The experimental design in past years included multiple release locations at Durham Ferry, Mossdale, and Jersey Point. In 2006, the releases were made at Mossdale and Dos Reis to better assess losses into upper Old River. The multiple recapture locations (Antioch, Chipps Island, SWP and CVP salvage operations, and in the ocean fisheries) were the same in 2006 as they have been in past years. The use of data from multiple release and recapture locations allows for a more thorough evaluation of juvenile Chinook salmon smolt survival as compared to recapture data from only one sampling location and/or one series of releases.

Chinook salmon smolt survival indices were calculated based on the number of marked salmon released and the number recaptured. Releases at Jersey Point serve as controls for releases at Mossdale and Dos Reis. Recapture data from Antioch, Chipps Island (for 2004-2006) and in the ocean fishery (releases made prior to 2004) thereby allowed calculation of survival estimates based on the ratio of recovery rates from marked salmon recaptured from upstream (Durham Ferry and Mossdale/Dos Reis) and downstream (Jersey Point) releases. Use of ratio estimates as part of the VAMP study design factors out the potential differential gear efficiency at Antioch and Chipps Island for each release group catch and differences in Ocean survival when the ocean recovery data is used as part of the ratio. These ratio estimates were used to evaluate relationships between salmon smolt survival and San Joaquin River flow and CVP and SWP exports with and without the HORB in place.

Survival of fish released at Mossdale during the high export period was extremely low and the lowest estimated since 2000.

The health of the CWT fish in 2006 was relatively good and PKD infection did not seem to be a problem as it may have been in 2003-2005. None of the VAMP fish recovered at Chipps Island had evidence of infection in their kidneys by the parasite that causes PKD in 2006.

Survival through the Delta does appear to be related to San Joaquin River flow at Vernalis, especially with the HORB in place. Relationships observed when there was no HORB in place are not clear, especially with the addition of the 2005 and 2006 data. At the high flows observed in 2006, we would have expected higher estimates.

The relationship of survival to exports is still difficult to detect based on the data gathered to date. The escapement data for adult salmon indicate that the flow/export ratio explains more of the variability in adult escapement than flow alone without the HORB, but the smolt survival data is too limited to detect these effects, if they are real. To further refine the relationship between survival and exports without the HORB, the survival experiments need to be conducted at a flow of 7,000 cfs with HORB installed at the two export levels, 1,500 and 3,000 cfs. We have not yet met these experimental conditions.

In addition to this recommendation, each previous technical report contained recommendations for future VAMP implementation. Key conclusions and recommendations resulting from the 2006 VAMP include:

- Survival from Durham Ferry and Mossdale/Dos Reis in 2003, 2004, 2005 and the second release group in 2006, was significantly less then prior years. Continued evaluation of survival rate versus flow and export rate is needed to detect differences in survival tests at extreme target levels (e.g. 7,000 cfs flow and 3,000 or 1,500 cfs exports), or equivalent high flow/export ratios are necessary.
- The flow data collected in 2005 and 2006 at San Joaquin River near Lathrop and the Head of Old River provided a useful evaluation of the flow split at the Head of Old River. Comparison of these 2005/2006 flow data against DWR-DSM2 modeling results should be conducted and may provide useful information.
- The Clifton Court Forebay was treated in early June with the aquatic herbicide Komeen, known to be toxic to salmon. While the treatment likely did not affect test fish, the treatment may have negatively affected natural smolts emigrating from the San Joaquin River in late May and early June.
- The numbers of CWT salmon, from Mossdale releases recovered at the SWP and CVP salvage facilities was less than prior years without an HORB. Only a few Mossdale and Dos Reis fish were recovered at the SWP and CVP salvage facilities in 2006.
- During the second release of experimental fish it was determined that the CWT lots were mixed between the Mossdale lots and Jersey Point lots resulting in not using the data from one tag group of the second Mossdale release and the need to adjust release numbers from the second Jersey Point release.
- The historical data indicates that the reach between Dos Reis and Jersey Point, in years when no HORB is installed, has the highest mortality. The relationship between the survival of the Dos Reis groups relative to the Jersey Point groups indicate that survival will improve as flows increase for smolts that remain within the main stem San Joaquin River when there is no HORB.

VAMP has been designed to evaluate opportunities to adaptively refine the VAMP test implementation conditions to: improve protection for juvenile Chinook salmon migrating from the San Joaquin River, and to improve the ability to detect differences in survival, if they exist, as a function of river flow and SWP/CVP export operations, and optimize the allocation of available water supplies each year.

The VAMP program should continue until smolt survival has been examined in relation to all target flow and export rates with an installed HORB. When completed the VAMP study will demonstrate the value of large-scale, long-duration, interdisciplinary experimental investigations that provide both protection to fishery resources while also providing important information that can be used to evaluate the performance and biological benefits of various management actions.

Chapter 1
Introduction

Actions associated with the Vernalis Adaptive Management Plan (VAMP) were implemented between May 1 and May 31, 2006 to protect juvenile Chinook salmon and evaluate the relationship between San Joaquin River flow and State Water Project (SWP) and federal Central Valley Project (CVP) water project exports on the survival of marked juvenile Chinook salmon migrating through the Sacramento – San Joaquin Delta. Initially the Delta Smelt workgroup recommended not installing the HORB but as the planning progressed the HORB could not be installed for the 2006 VAMP period due to high river flows. The VAMP period was postponed 15 days from previous years in an effort to maintain stable flows and to allow for maturation of the experimental fish. The water districts attempted to maintain stable flow in accordance with the SJRA throughout the May study period, however ongoing flood control activities limited the effort. Studies conducted in 2006, represent the seventh year of the VAMP experiment. Results from previous VAMP experiments are available in San Joaquin River Agreement Technical Reports, for each respective year. Similar experiments were conducted prior to the official implementation of VAMP with results available in South Delta Temporary Barriers Annual Reports (DWR 2001 and DWR 1998). This report will describe the experimental design of VAMP, the hydrologic planning and implementation, the additional water supply arrangements and deliveries, fishery monitoring within the San Joaquin River and Old River in the absence of the Head of Old River Barrier (HORB), the salmon smolt survival investigation and complimentary studies related to VAMP. Conclusions and recommendations for future VAMP studies are also included.

Experimental Design Elements

The VAMP experimental design measures salmon smolt survival through the Delta under six different combinations of flow and export rates. The experimental design includes two mark-recapture studies performed each year during the April-May juvenile salmon outmigration period that provide estimates of salmon survival under each set of conditions. During 2006, a total of 200,000 juvenile Chinook salmon were made available from the Merced River Hatchery (MRH) annual production for the VAMP survival studies. Chinook salmon survival indices under the experimental conditions are calculated based on the number of marked salmon released and the number recaptured. Absolute survival estimates and combined differential recovery rates (CDRR) are also calculated with the CDRR's used in relationships between survival and San Joaquin River flow and CVP and SWP exports.

As described the SJRA and VAMP is an experimental/management program designed to protect juvenile Chinook salmon migrating from the San Joaquin River while at the same time conducting a scientific experiment to determine how salmon survival changes in response to alterations in San Joaquin River flows, SWP/CVP export rates, and the installation of the HORB. 2006 resulted in flow conditions that would not allow the HORB to be installed and made Vernalis flows difficult to control. The SJRA recognizes there may be years when the existing flow would be greater than 7,000 cfs, the HORB could not be in place due to high flows, and it may not be possible to maintain a constant flow rate at Vernalis. In such events of high flows the Technical Committee will develop an alternate plan pursuant to which those studies would be conducted under the SJRA as a VAMP experiment. This annual technical report describes the flow and HORB conditions encountered in 2006, the alternative experimental plan, and the findings.

With the high Vernalis flows and lack of the HORB the SJRA technical committee took advantage of these conditions in recommending two distinct levels of SWP/CVP export rates between the first and second release of test fish. A change in the export rate between the first and second half of the VAMP pulse period provided for the collection of survival estimates under two export/flow ratios without the HORB.

Due to a decline of the delta smelt population in the Bay-Delta estuary the delta Smelt workgroup recommended the HORB not be installed in 2006. Ultimately high flows in the San Joaquin River prohibited installation of the barrier. The 2006 VAMP experimental design included both multiple release locations (Mossdale, Dos Reis and Jersey Point), and multiple recapture locations (Antioch, Chipps Island, SWP and CVP salvage operations, and in the ocean fisheries; Figure 1-1, Inside Front Cover). Since the barrier was not installed Dos Reis was selected as an alternate

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release site immediately downstream of the HOR. The absence of the HORB in 2006 provided the opportunity to conduct Kodiak Trawls in both the San Joaquin River and Old River near the vicinity of the Head of Old River. Data from these fishery surveys has been used to assess the movement of juvenile Chinook salmon from the San Joaquin River (e.g., released upstream of Old River at Mossdale) into Old River when the HORB is not installed.

The use of data from multiple release and recapture locations allows for a more thorough evaluation of juvenile Chinook salmon survival as compared to recapture data from only one sampling location and/or one release location. The VAMP coded-wire tag (CWT) releases (Mossdale, Dos Reis and Jersey Point) and recapture locations (Antioch and Chipps Island, SWP and CVP salvage) are consistent with some previous years, providing a greater opportunity to assess salmon smolt survival over the range of Vernalis flows, SWP/CVP exports, and with and without the presence of the HORB. The recovery of marked fish in the ocean fishery also greatly improves the precision associated with the individual survival estimates, and improves confidence in detecting differences in salmon smolt survival as a function of Vernalis flows and SWP/CVP exports. The survival estimates prior to 2004 used in this report have been calculated based on recoveries at all three locations (Antioch, Chipps Island, and the ocean fishery). Releases at Jersey Point serve as controls for recaptures at Antioch, Chipps Island and the ocean fishery, thereby allowing the calculation of survival estimates based on the ratio of recovery rates from marked salmon recaptured from upstream (e.g., Mossdale and Dos Reis) and downstream (control release at Jersey Point) releases. The use of ratio estimates as part of the VAMP study design factors out the potential differential gear efficiency at Antioch and Chipps Island and ocean survival from ocean recoveries within and among years.

During the 2006 VAMP period an Acoustic Telemetry pilot study was conducted to evaluate the viability of using acoustic tagged fish and acoustic receivers to track San Joaquin River smolts. A total of 100 fish from the MRH were released at Mossdale and Dos Reis over the VAMP period. Five acoustic receivers located along the lower San Joaquin River, Old River, and in south Delta channels were used to track smolt movement throughout the south Delta.

A quality assurance/quality control program has been used as a routine part of VAMP tests, and includes quantifying the number of marked fish successfully clipped and tagged. In addition, the 2006 VAMP program continued use of the net pen studies and physiological testing to assess overall condition and health of marked fish used in VAMP experiments. Improvements were also made in 2006 relative to measuring flow in the San Joaquin River downstream of the confluence with Old River.

Chapter 2

VAMP Hydrologic Planning and Implementation

This section documents the planning and implementation undertaken by the Hydrology Group of the San Joaquin River Technical Committee (SJRTC) for the 2006 VAMP investigations. Implementation of VAMP is guided by the framework provided in the San Joaquin River Agreement (SJRA) and anticipated hydrologic conditions within the watershed. The planning and implementation activities were reduced due to the 2006 wet hydrology requiring no supplemental water to be provided and not allowing DWR to install the HORB

The Hydrology Group was established for the purpose of forecasting hydrologic conditions and for planning, coordinating, scheduling and implementing the flows required to meet the test flow target in the San Joaquin River near Vernalis. The Hydrology Group is also charged with exchanging information relevant to the forecasted flows, and coordinating with others in the SJRTC, in particular the Biology Group, responsible for planning and implementing the salmon smolt survival study.

Participation in the Hydrology Group is open to all interested parties, with the core membership consisting of the designees of the agencies responsible for the water project operations that would be contributing flow to meet the target flow. In 2006, the agencies belonging to the Hydrology Group included: Merced Irrigation District (Merced), Turlock Irrigation District (TID), Modesto Irrigation District (MID), Oakdale Irrigation District (OID), South San Joaquin Irrigation District (SSJID), San Joaquin River Exchange Contractors (SJRECWA), and the U.S. Bureau of Reclamation (USBR). Though not a water provider, the California Department of Water Resources (DWR) was closely involved with the coordination of operations relating to the potential installation of the HORB and the planning of Delta exports consistent with the VAMP.

2006 VAMP Summary

Relatively full reservoirs as a result of wet conditions in 2005 combined with significant precipitation around the first of the year and again throughout March and into early April resulted in very high flow conditions in the San Joaquin River during the Spring of 2006. The mean daily flow in the San Joaquin River below the Stanislaus River exceeded 10,000 cfs in early March, increasing to 15,000 cfs at the end of March and peaking at 34,700 cfs on April 13. The flow remained above 30,000 cfs until the beginning of May, then slowly receded to around 20,000 cfs by the end of May. Since the flow during April and May exceeded the maximum VAMP target flow of 7,000 cfs no supplemental water was provided by the SJRGA agencies. Additionally, the flow in early April was significantly above the allowable installation flow threshold of 5000 cfs, therefore DWR was unable to install the temporary Head of Old River Barrier (HORB).

The planning and implementation process for the VAMP operation remained nearly unchanged from those of prior VAMP years and that outlined in the SJRA. Daily operation plans were updated on a frequent basis to keep the SJRTC informed of changed conditions. Operation conference calls were not conducted during the 2006 VAMP but contact was maintained with the operating entities to track reservoir releases. The Technical Committee placed an added emphasis on analyzing the flow and fish movement into Old River absent the HORB. Monitoring of real-time flow data was maintained throughout the planning and implementation phases.

VAMP Background and Description

This section provides information on the background and description of the water operations and factors to be considered when planning for the VAMP each year. Even with the high flow conditions during 2006 these factors continued to be considered in the planning process and implementation.

Table 2-1
VAMP Vernalis Flow and Delta Export Targets

Forecasted Existing Flow (cfs)	VAMP Target Flow (cfs)	Delta Export Target Rates (cfs)
0 to 1,999	2,000	
2,000 to 3,199	3,200	1,500
3,200 to 4,449	4,450	1,500
4,450 to 5,699	5,700	2,250
5,700 to 7,000	7,000	1,500 or 3,000
Greater than 7,000	Provide stable flow to extent possible	1,500, 2,250 or 3,000*

*Suggested rates

The VAMP provides for a 31-day pulse flow (target flow) at the Vernalis gage on the San Joaquin River (Figure 2-1, inside front cover) during the months of April and May, along with a corresponding reduction in State Water Project (SWP) and Central Valley Project (CVP) Sacramento-San Joaquin Delta exports. The VAMP target flow and reduced Delta export are determined based on a forecast of the San Joaquin River flow that would occur during the pulse flow period absent the VAMP (Existing Flow) as shown in Table 2-1. The Existing Flow is defined in the SJRA as "the forecasted flows in the San Joaquin River at Vernalis during the Pulse Flow Period that would exist absent the VAMP or water acquisitions," including such flows as minimum in-stream flows, water quality or scheduled fishery releases from New Melones Reservoir, flood control releases, uncontrolled reservoir spills, and/or local runoff. Achieving the target flow requires the coordinated operation of the three major San Joaquin River tributaries upstream of Vernalis: the Merced River, the Tuolumne River and the Stanislaus River.

As part of the development of the VAMP experimental design, the VAMP Hydrology and Biology Groups jointly identified a level of variation in San Joaquin River flow and SWP/CVP export rate thought to be within an acceptable range for specific VAMP test conditions. In developing the criteria, the VAMP Hydrology and Biology Groups examined both the ability to effectively monitor and manage flows and exports within various ranges (e.g., the ability to accurately manage and regulate export rates is substantially greater than the ability to manage San Joaquin River flows) and the flow and export differences among VAMP targets (Table 2-1). Through these discussions, the technical committees agreed that SWP/CVP export rates would be managed to a level of plus or minus 2.5% of a given export rate target. Furthermore, the technical committees agreed that, to the extent possible, it would be desirable that exports be allocated approximately evenly between SWP and CVP diversion facilities.

The ability to manage and regulate the San Joaquin River flow near Vernalis is difficult due to uncertainty and variation in unregulated flows, inaccuracy in real-time flows due to changing channel conditions, lags and delays in transit time, and a variety of other factors. Concern was expressed that variation in San Joaquin River flow on the order of plus or minus 10% would potentially result in overlapping flow conditions between two VAMP targets. To minimize the probability of overlapping flow conditions among VAMP targets, the technical committees explored an operational guideline of plus or minus 5% flow variation at the Vernalis gage; however, system operators expressed concern about the ability to maintain flows within this range. As a result of these discussions and analysis, the Hydrology and Biology Groups agreed to a target range variation of plus or minus 7% of the Vernalis flow target. It was recognized by the Hydrology and Biology Groups that these guidelines are not absolute conditions, but is to be used by the VAMP technical committees to evaluate the potential effect of flow and export variation on the ability to detect and assess variation in juvenile Chinook salmon survival.

Under the SJRA, the Merced, OID, SSJID, SJRECWA, MID and TID members of the San Joaquin River Group Authority (SJRGA) agencies have agreed to jointly provide the supplemental water needed to achieve the VAMP target flows, limited to a maximum of 110,000 acre-feet:. The Merced supplemental water would be provided on the Merced River from storage in Lake McClure and would be measured at the Cressey gage on the Merced River. The OID and SSJID supplemental water would be provided on the Stanislaus River through diversion reductions and would be measured below Goodwin Dam. The SJRECWA supplemental water would be provided via Salt Slough, West Delta Drain, Boundary Drain and/or Orestimba Creek. The MID and TID supplemental water would be provided on the Tuolumne River from storage in Don Pedro Lake and would be measured at the Tuolumne River below LaGrange Dam gage.

The target flow of 2,000 cubic feet per second (cfs) shown in Table 2-1 does not represent a VAMP experiment target flow data point, but, rather, is used to define the SJRGA supplemental water obligation limit when Existing Flow is less than 2,000 cfs. In preparation of the conceptual framework for the VAMP it was recognized that in extremely dry conditions the San Joaquin River flow and associated exports would be determined in accordance with the existing biological opinions under the Endangered Species Act and the 1994 Bay-Delta Accord. In consideration of these factors, when the Existing Flow is less than 2000 cfs, the target flow will be 2,000 cfs and the USBR, in accordance with the SJRA, shall act to purchase additional water from willing sellers to fulfill the requirements of existing biological opinions.

When the Existing Flow exceeds 7,000 cfs, as was the case in 2006, the Parties will exert their best efforts to maintain a stable flow during the VAMP pulse flow period to the extent reasonably permitted. Under such conditions the SJRTC shall attempt to develop a plan to carryout the studies pursuant to the SJRA.

Table 2-2
San Joaquin Valley Water Year Hydrologic Year Classifications Used in VAMP

60-20-20 Water Year Classification	VAMP Numerical Indicator
Wet	5
Above Normal	4
Below Normal	3
Dry	2
Critical	1

Based upon hydrologic conditions, the target flow in a given year could either be increased to the next higher value (double-step) or the supplemental water requirement could be eliminated entirely (off-ramp). These potential adjustments to the target flow are dependent on the hydrologic year type as defined by the SWRCB San Joaquin Valley Water Year Hydrologic Classification (60-20-20 classification), which is given a numerical indicator as shown in Table 2-2 to make this determination. A double-step flow year occurs when the sum of the numerical indicators for the previous year's year type and current year's forecasted 90 percent exceedence year type is seven (7) or greater, a general recognition of either abundant reservoir storage levels or a high probability of abundant runoff. An off-ramp year occurs when the sum of the numerical indicators for the two previous years' year types and the current year's forecasted 90 percent exceedence year type is four (4) or less, an indication of extended drought conditions.

Under the SJRA, the maximum amount of supplemental water to be provided to meet VAMP target flows in any given year is 110,000 acre-feet. In a double-step year, the quantity of supplemental water required may be as high as 157,000 acre-feet. In any year in which more than 110,000 acre-feet of supplemental water is needed, the USBR will attempt to acquire the needed additional water on a willing seller basis. In accordance with the SJRA, the SJRGA has agreed to extend a "favored purchaser" offer to the USBR through each current year's VAMP period.

Hydrologic Planning for 2006 VAMP

Hydrology Group Meetings

Beginning in February 2006, and continuing until early April, the Hydrology Group held three planning and coordination meetings (February 21, March 16 and April 11). The March 16 and April 11 meetings were joint meetings of the Hydrology and Biology Groups. At these meetings, forecasts of hydrologic and operational conditions on the San Joaquin River and its tributaries were discussed and refined.

Monthly Operation Forecast

As part of the initial planning efforts in February, a monthly operation forecast was developed by the Hydrology Group to provide an initial estimate of the Existing Flow and VAMP Target Flow. Inflows to the tributary reservoirs used in these forecasts were based on DWR Bulletin 120 runoff forecasts. The monthly operation forecasts used the 90 percent and 50 percent probability of exceedence runoff forecasts to provide a range of estimates. The initial monthly operation forecast was presented at the February 21 Hydrology Group meeting. The 90 percent exceedence forecast was indicating a VAMP target flow of 5,700 cfs and the 50 percent exceedence forecast was indicating a VAMP target flow of 7,000 cfs.

Daily Operation Plan Development

Starting in mid-March, the Hydrology Group began development of a daily operation plan, updating it as hydrologic conditions and operational requirements changed. The purpose of the daily operation plan is to provide a forecast of the Existing Flow which sets the VAMP target flow and to coordinate the tributary operations needed to meet that target. It also provides a forecast of the daily flows expected during the HORB installation period. In years like 2006 where the Existing Flow exceeds the maximum VAMP target flow, the daily operation plan is used to determine to what extent a stable flow can be provided during the VAMP pulse flow period. The daily operation plan calculates an estimated mean daily flow at Vernalis based on estimates of the daily flow at the major tributary control points, estimates of ungaged flow between those control points and Vernalis, and estimates of flow in the San Joaquin River above the major tributaries.

The following travel times for flows from the tributary measurement points and upper San Joaquin River to the Vernalis gage are used in the development of the daily operation plan. Whole day increments are used because the daily operation plan is developed using mean daily flows.

Flow Travel Times

a. Merced River at Cressey to Vernalis ....3 days

b. San Joaquin River above Merced River to Vernalis..2 days

c. Tuolumne River below LaGrange Dam to Vernalis ...2 days

d. Stanislaus River below Goodwin Dam to Vernalis ...2 days

By definition, the ungaged flow at Vernalis is the unmeasured flow entering or leaving the system between the Vernalis gage and the upstream measuring points and is calculated as follows:

Ungaged flow at Vernalis =
$VNS - GDW_{lag} - LGN_{lag} - CRS_{lag} - USJR_{lag}$

Where:

VNS = San Joaquin River near Vernalis

GDW_{lag} = Stanislaus River below Goodwin Dam lagged 2 days

LGN_{lag} = Tuolumne River below LaGrange Dam lagged 2 days

CRS_{lag} = Merced River at Cressey lagged 3 days

$USJR_{lag}$ = San Joaquin River above Merced River lagged 2 days

(USJR is not a gaged flow but is the calculated difference between the gaged flows at the San Joaquin River at Newman (NEW) and the Merced River near Stevinson (MST)).

The forecast of the ungaged flow is the factor with the greatest uncertainty in the development of the daily operation plan. An extensive review of historical ungaged flows has been made to determine if there are any correlations between the ungaged flow and the current hydrologic conditions that could be used to reduce the uncertainty. Unfortunately, no significant correlations were found. However, the review did indicate that the amount of ungaged flow at the beginning of the VAMP pulse flow period is a reasonable estimate of the average ungaged flow for pulse flow period. It is impossible to forecast day-to-day fluctuations of the ungaged flow, so the daily operation plan is developed assuming a constant ungaged flow throughout the pulse flow period essentially equal to the value entering the pulse flow period.

The VAMP 31-day pulse flow period can occur anytime between April 1 and May 31. Factors that are considered in the determination of the timing of the VAMP pulse flow period include installation of HORB, availability of juvenile salmon at the MRH, and manpower and equipment availability for salmon releases and recapture. Until a specific start date is defined, a default pulse flow period of April 15 to May 15 is used for the VAMP operation planning.

As part of the daily operation plan development, the determination must be made on whether the current year is likely to fall into the “off-ramp” or “double-step” category. As noted earlier, an “off-ramp” condition would occur in critically dry periods when the sum of VAMP numerical indicators for the previous two years and the current year is equal to or less than four. The 60-20-20 water year classifications for 2004 and 2005 were “DRY” (VAMP numerical indicator of two) and “WET” (VAMP numerical indicator of five), respectively. Under these conditions there was no possibility of 2006 being an off-ramp year since the off-ramp criterion was already exceeded without including the current year’s numerical indicator. A “double-step” condition would occur if sum of the VAMP numerical indicators for the previous year and current year is equal to or greater than seven, with the current year’s indicator based on the 90% probability of exceedence forecast of the 60-20-20 water year classification. Due to the previous year being a “WET” year and the wet conditions in the current year, in the early planning it looked likely that 2006 would be a “double-step” year.

The initial daily operation plan was prepared on March 23. This daily operation plan looked at four scenarios based on two hydrologic conditions, dry and average, and two pulse flow periods, April 15 to May 15 and April 22 to May 22. These scenarios forecast “existing flows” ranging from 5,960 cfs to 6,610 cfs, all of which indicate a VAMP target flow of 7,000 cfs In this forecast Don Pedro Lake on the Tuolumne River and Lake McClure on the Merced River were expected to be making flood control releases and the Stanislaus River was expected to be at its institutional maximum of 1,500 cfs throughout the VAMP pulse flow period. This forecast also indicated that it was likely that the flow would be too high to allow for the safe installation of the Head of Old River Barrier (HORB). By the end of March it was apparent that the flows would be too great to allow for the installation of the HORB, and in all likelihood would continue to increase such that they would exceed the VAMP target flow of 7,000 cfs. Continually increasing runoff forecasts resulted in continually increasing forecasts

Table 2-3
Summary of Daily Operation Plans

Phase	VAMP Forecast Date	DWR Runoff Forecast Date	VAMP Target Flow Period	Assumed Ungaged Flow at Vernalis (cfs)	Existing Flow (cfs)	VAMP Target Flow (cfs)	Supplemental Water Requirement (acre-feet)
Planning	3/23/06	3/14/06	April 15 - May 15	500	6,110	7,000	54,610
				1,000	6,610	7,000	23,870
			April 22 - May 22	500	5,960	7,000	63,790
				1,000	6,460	7,000	33,050
	3/27/06	3/21/06	April 15 - May 15	500	6,960	7,000	2,370
			April 22 - May 22	500	6,930	7,000	4,610
	4/3/06	3/28/06	April 15 - May 15	1,000	11,470	na	0
			April 22 - May 22	1,000	11,300	na	0
	4/11/06	4/1/06	April 22 - May 22	1,000	25,880	na	0
	4/18/06	4/11/06	April 22 - May 22	2,000	29,240	na	0
			May 1 - May 31	2,000	27,980	na	0
	4/25/06	4/18/06	May 1 - May 31	2,000	30,000	na	0

Table 2-4
Real-time Mean Daily Flow Data Sources

Measurement Location	Data Source
San Joaquin River near Vernalis	USGS, station 11303500 (http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=31&site_no=11303500)
Stanislaus River below Goodwin Dam	USBR, Goodwin Dam Daily Operation Report (http://www.usbr.gov/mp/cvo/vungvari/gdwdop.pdf)
Tuolumne River below LaGrange Dam	USGS, station 11289650 (http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=31&site_no=11289650)
Merced River at Cressey	CDEC, station CRS (http://cdec.water.ca.gov/cgi-progs/queryDgroups?s=fw2)
Merced River near Stevinson	CDEC, station MST (http://cdec.water.ca.gov/cgi-progs/queryDgroups?s=fw2)
San Joaquin River at Newman	USGS, station 11274000 (http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=31&site_no=11274000)

of flood control releases from Don Pedro Lake on the Tuolumne River, Lake McClure on the Merced River and Millerton Lake on the San Joaquin River such that by April 11 the daily operation forecast was looking at an existing flow of approximately 26,000 cfs. Due to the wet conditions and a need for the experiment fish to mature the SJRTC declared a VAMP pulse flow period of May 1 to May 31.

Table 2-3 provides a summary of the daily operation plans developed during the VAMP planning phase. The daily operation plans prepared during the VAMP planning phase are provided in Appendix A-1, Tables 1 through 12.

Tributary Flow Coordination

As previously noted, by early April the forecast existing flow was greater than the maximum VAMP target flow of 7,000 cfs. Under these conditions the tributary operations were coordinated to the degree possible to provide as stable a flow as possible during the VAMP pulse flow period. With this in mind the tributary operations prior to the VAMP were adjusted to the degree possible to maximize the very limited potential operational flexibility during the VAMP pulse flow period.

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Table 2-5
2006 Vernalis Adaptive Management Plan (VAMP)
Final Flows and Accounting of Supplemental Water Contributions
Target flow period: May 1 - May 31 * Target Flow: greater than 7,000 cfs

	Merced R. at Cressey (3 day Travel Time to Vernalis)			Tuolumne R. blw LaGrange Dam (2 day Travel Time to Vernalis)			Stanislaus R. blw Goodwin Dam (2 day Travel Time to Vernalis)			Upper SJR	Vernalis Ungaged	San Joaquin River at Vernalis		
Date	Existing Flow (cfs)	Observed Flow (cfs)	VAMP Supple-mental Water (cfs)	Existing Flow (cfs)	Observed Flow (cfs)	VAMP Supple-mental Water (cfs)	Existing Flow (cfs)	Observed Flow (cfs)	VAMP Supple-mental Water (cfs)	Observed Flow (cfs)	Observed Flow (cfs)	Existing Flow (cfs)	Observed Flow (cfs)	VAMP Supple-mental Water (cfs)
04/01/05	3,130	3,130		6,260	6,260		3,014	3,014		2,580	879	15,000	15,000	
04/02/05	2,980	2,980		6,440	6,440		3,019	3,019		2,680	1,232	16,200	16,200	
04/03/05	3,610	3,610		6,150	6,150		3,039	3,039		2,920	1,866	16,700	16,700	
04/04/05	6,990	6,990		3,650	3,650		3,303	3,303		2,380	1,631	16,900	16,900	
04/05/05	4,910	4,910		4,780	4,780		4,714	4,714		2,156	3,611	18,700	18,700	
04/06/05	4,970	4,970		5,640	5,640		5,776	5,776		8,771	7,757	20,700	20,700	
04/07/05	5,230	5,230		6,660	6,660		6,148	6,148		16,209	3,160	21,800	21,800	
04/08/05	5,190	5,190		7,020	7,020		4,379	4,379		18,238	(1,997)	23,100	23,100	
04/09/05	5,170	5,170		7,010	7,010		3,534	3,534		19,680	(6,587)	27,400	27,400	
04/10/05	5,110	5,110		6,990	6,990		3,504	3,504		19,401	(3,867)	31,000	31,000	
04/11/05	4,630	4,630		7,650	7,650		3,509	3,509		18,763	(3,314)	32,100	32,100	
04/12/05	4,540	4,540		8,100	8,100		3,868	3,868		18,163	(865)	34,200	34,200	
04/13/05	4,490	4,490		8,140	8,140		4,019	4,019		16,756	(332)	34,700	34,700	
04/14/05	4,480	4,480		7,890	7,890		3,995	3,995		15,308	(361)	34,400	34,400	
04/15/05	4,660	4,660		7,780	7,780		4,039	4,039		13,660	145	33,600	33,600	
04/16/05	4,550	4,550		7,740	7,740		4,062	4,062		12,950	1,017	32,700	32,700	
04/17/05	4,170	4,170		7,910	7,910		4,756	4,756		12,930	1,441	31,400	31,400	
04/18/05	4,010	4,010		8,590	8,590		5,495	5,495		12,710	1,088	30,500	30,500	
04/19/05	3,950	3,950		8,630	8,630		5,510	5,510		12,400	454	30,600	30,600	
04/20/05	4,010	4,010		8,820	8,820		5,507	5,507		12,180	(265)	30,700	30,700	
04/21/05	4,030	4,030		8,740	8,740		5,510	5,510		12,060	150	30,700	30,700	
04/22/05	4,010	4,010		8,850	8,850		5,522	5,522		11,980	143	30,600	30,600	
04/23/05	4,000	4,000		8,840	8,840		5,524	5,524		12,000	80	30,400	30,400	
04/24/05	4,000	4,000		8,980	8,980		5,548	5,548		12,060	18	30,400	30,400	
04/25/05	4,000	4,000		9,210	9,210		5,489	5,489		12,250	26	30,400	30,400	
04/26/05	4,170	4,170		9,170	9,170		5,527	5,527		12,210	12	30,600	30,600	
04/27/05	4,180	4,180		9,230	9,230		5,511	5,511		12,080	(49)	30,900	30,900	
04/28/05	4,250	4,250	0	9,180	9,180		5,508	5,508		11,890	93	31,000	31,000	
04/29/05	4,380	4,380	0	9,210	9,210	0	5,513	5,513	0	11,600	9	31,000	31,000	
04/30/05	4,500	4,500	0	9,250	9,250	0	5,514	5,514	0	11,380	42	30,800	30,800	
05/01/05	4,510	4,510	0	9,210	9,210	0	5,161	5,161	0	11,100	27	30,600	30,600	0
05/02/05	4,510	4,510	0	9,190	9,190	0	5,012	5,012	0	10,920	(124)	30,400	30,400	0
05/03/05	4,510	4,510	0	9,220	9,220	0	5,031	5,031	0	10,560	29	30,000	30,000	0
05/04/05	4,500	4,500	0	9,230	9,230	0	4,704	4,704	0	10,340	(32)	29,600	29,600	0
05/05/05	4,270	4,270	0	9,240	9,240	0	4,533	4,533	0	10,110	(221)	29,100	29,100	0
05/06/05	4,040	4,040	0	9,190	9,190	0	4,523	4,523	0	9,950	(284)	28,500	28,500	0
05/07/05	4,020	4,020	0	9,280	9,280	0	4,525	4,525	0	9,750	(383)	28,000	28,000	0
05/08/05	4,010	4,010	0	8,980	8,980	0	4,529	4,529	0	9,530	(333)	27,600	27,600	0
05/09/05	4,170	4,170	0	8,830	8,830	0	5,404	5,404	0	9,400	(395)	27,200	27,200	0
05/10/05	4,170	4,170	0	8,820	8,820	0	4,521	4,521	0	9,370	(259)	26,800	26,800	0
05/11/05	4,160	4,160	0	8,650	8,650	0	4,512	4,512	0	9,240	(1,144)	26,500	26,500	0
05/12/05	4,190	4,190	0	8,530	8,530	0	4,522	4,522	0	9,020	(581)	26,300	26,300	0
05/13/05	4,340	4,340	0	8,890	8,890	0	4,518	4,518	0	8,700	(472)	26,100	26,100	0
05/14/05	4,390	4,390	0	8,980	8,980	0	4,243	4,243	0	8,580	(232)	26,000	26,000	0
05/15/05	4,400	4,400	0	8,900	8,900	0	4,006	4,006	0	8,560	(498)	25,800	25,800	0
05/16/05	4,370	4,370	0	8,660	8,660	0	4,011	4,011	0	8,490	(643)	25,500	25,500	0
05/17/05	4,350	4,350	0	8,650	8,650	0	4,015	4,015	0	8,430	(656)	25,200	25,200	0
05/18/05	4,340	4,340	0	8,520	8,520	0	4,022	4,022	0	8,060	(561)	25,000	25,000	0
05/19/05	4,330	4,330	0	8,550	8,550	0	4,034	4,034	0	7,710	(665)	24,800	24,800	0
05/20/05	4,290	4,290	0	8,300	8,300	0	4,024	4,024	0	7,640	(452)	24,500	24,500	0
05/21/05	4,420	4,420	0	8,120	8,120	0	4,026	4,026	0	7,710	(334)	24,300	24,300	0
05/22/05	4,640	4,640	0	7,880	7,880	0	4,024	4,024	0	8,180	106	24,400	24,400	0
05/23/05	4,540	4,540	0	7,300	7,300	0	3,634	3,634	0	8,650	354	24,500	24,500	0
05/24/05	4,530	4,530	0	7,110	7,110	0	3,406	3,406	0	9,230	96	24,600	24,600	0
05/25/05	4,280	4,280	0	7,120	7,120	0	3,407	3,407	0	9,600	376	24,600	24,600	0
05/26/05	3,530	3,530	0	6,880	6,880	0	3,405	3,405	0	9,810	314	24,600	24,600	0
05/27/05	2,820	2,820	0	6,600	6,600	0	3,404	3,404	0	9,530	143	24,800	24,800	0
05/28/05	2,880	2,880	0	6,260	6,260	0	3,143	3,143	0	8,730	125	24,500	24,500	0
05/29/05	2,870	2,870		5,890	5,890	0	2,907	2,907	0	7,900	536	23,600	23,600	0
05/30/05	2,880	2,880		5,450	5,450	0	2,914	2,914		7,380	1,347	22,300	22,300	0
05/31/05	2,850	2,850		4,930	4,930		2,577	2,577		7,130	1,423	21,000	21,000	0
							VAMP Period							
Average (cfs):	4,210	4,210		8,370	8,370		4,270	4,270		9,280	(110)	26,020	26,020	
Supplemental Water (ac-ft):			0			0			0					0

VAMP Period

Observed Flow Sources

Merced River at Cressey (CA DWR B05155): California DWR, Water Data Library, 9/8/06

Tuolumne River below LaGrange Dam near LaGrange (USGS 11289650): USGS, provisional data as of 9/8/06

Stanislaus River below Goodwin Dam: USBR, Goodwin Reservoir Daily Operations Report - OID/SSJID/Tri-Dams, 5/1/06 (April report) and 6/1/06 (May report)

San Joaquin River near Vernalis (USGS 11303500): USGS, provisional data as of 9/8/06

Delta Exports

The VAMP experimental design does not mandate specific magnitudes of reduced export rates when the existing flow at Vernalis is expected to exceed the maximum VAMP target flow rate of 7,000 cfs, but does provide the following suggested export rates.

Vernalis Flow	Suggested Export Rate
Up to 10,000 cfs	1,500 cfs or 3,000 cfs
Up to 15,000 cfs	2,250 cfs
Over 15,000 cfs	3,000 cfs

On April 25, 2006 the projected VAMP operation plan was discussed with the CalFed Operations Group. On April 28 the CalFed Water Operation Management Team (WOMT), which is made up of representatives from the DWR, USBR, USFWS, CDFG and NMFS, settled on a combined State and Federal export rate of 1,500 cfs for the first half of the VAMP pulse flow period (May 3 to May 17) and 6,000 cfs for the second half of the VAMP pulse flow period (May 18 to June 2). The period of reduced export pumping was slightly offset from the VAMP target flow period of May 1 to May 31 to allow both Mossdale releases a full 14 days to migrate through the system prior to changing the export rate.

Implementation

Operation Conference Calls

Due to the high flows in the San Joaquin River and the fact that the operation was being controlled by flood control considerations and not by the VAMP target flow, no operation conference calls were conducted in 2006.

Operation Monitoring

The planning and implementation of the VAMP spring pulse flow operation was accomplished using the best available real-time data from the sources listed in Table 2-4. The real-time flow data used during the implementation of the VAMP flow have varying degrees of quality. The CDEC real-time data has not been reviewed for accuracy or adjusted for rating shifts, whereas the USGS real-time data has had some preliminary review and adjustment. During the VAMP flow period, the real-time flows at Vernalis and in the San Joaquin River tributaries are continuously monitored. Similarly, the computed ungaged flow at Vernalis and the flow in the San Joaquin River upstream of the Merced River are continuously updated.

Results of Operations

The final accounting for the VAMP operation was accomplished using provisional mean daily flow data available from USGS and DWR as of August 1, 2006. Provisional data is data that has been reviewed and adjusted for rating shifts but is still considered preliminary and subject to change. Plots of the real-time and provisional flows at the primary measuring points are provided in Appendix A-2, Figures 1 through 8, to illustrate the differences between the real-time and the provisional data.

The mean daily flow in the San Joaquin River at the Vernalis gage averaged 26,020 cfs during the VAMP target flow period (May 1 – May 31). The flow showed a steady decline throughout the target flow period, ranging from a high of 30,600 cfs on May 1 to a low of 21,000 cfs on May 31, as shown in Figure 2-2. Figure 2-1 also shows the tributary contributions to the flow at Vernalis. Plots of the flow at the Merced River, Tuolumne River and Stanislaus River measurement points are provided in Figure 2-3. A tabulation of the observed mean daily flows during and around the VAMP target flow period is provided in Table 2-5.

The mean daily ungaged flow at Vernalis averaged -110 cfs during the VAMP target flow period, ranging from a minimum of -1,143 cfs to a maximum of 1,427 cfs. A plot of the ungaged flow is provided in Figure 2-4.

As noted previously, Millerton Lake on the San Joaquin River was making flood control releases during the VAMP target flow period. The Millerton Lake flood control operation resulted in a significant contribution of flow to the lower San Joaquin River as shown in Figure 2-5.

As previously stated, the combined CVP and SWP Delta export rate target was set at 1,500 cfs for the first half of the VAMP target flow period and 6,000 cfs for the second half. The observed exports, shown in Figure 2-6, averaged 1,559 cfs during the first half and 5,748 cfs during the second half.

Hydrologic Impacts

The Merced VAMP supplemental water is provided from storage in Lake McClure on the Merced River and the MID/TID VAMP supplemental water is provided from storage in Don Pedro Lake, thereby resulting in potential impacts on reservoir storage as a result of the VAMP operation. Any storage impacts, though, would be offset by any water conservation measures that have been instituted as a result of the SJRA and that result in a reduced reliance on river diversions. The OID/SSJID VAMP supplemental water is made available from their diversion entitlements and therefore there are no storage impacts in New Melones Reservoir on the Stanislaus River due to the SJRA. Due to the extended nature of the VAMP, a 12-year plan, the storage impacts can potentially carry over from year to year. Reservoir storage impacts are reduced or eliminated when the reservoirs make flood control releases.

Due to the flood control operations in 2005 there were no SJRA storage impacts entering the 2006. No VAMP supplemental water was provided, so the 2006 VAMP operation had no impacts on reservoir storage. With and without SJRA storage and releases in 2006 for Lake McClure and Don Pedro Lake are shown in Figures 2-7 and 2-8, respectively.

Summary of Historical VAMP Operations

2006 marks the seventh year of VAMP operation in compliance with D-1641. A summary of the VAMP target flows for these first seven years is provided in Table 2-6. A summary of the SJRGA supplemental water contributions is provided in Table 2-7. The SJRTC Hydrology Group monitors the cumulative impact of the SJRA on reservoir storage and stream flows. Plots of storage and flow impacts throughout the seven years of VAMP operation are provided in Appendix B-1, Figures 1 through 4.

Over the first seven years of the program considerable variation has occurred in both the flow entering the system upstream of the Merced River and the ungaged flow within the system. With each update of the daily operation plan throughout the planning and implementation phases the upstream and ungaged flows would vary causing the SJRGA to reduce or increase the contribution of supplemental water in order to support the VAMP target flow. Analysis of the variability in the ungaged flow at Vernalis and the San Joaquin River above Merced River flow and how these affect the forecasting of the existing and supplemental flows is ongoing.

Figure 2-2
2006 VAMP: San Joaquin River near Vernalis
With Lagged Contributions from Primary Sources

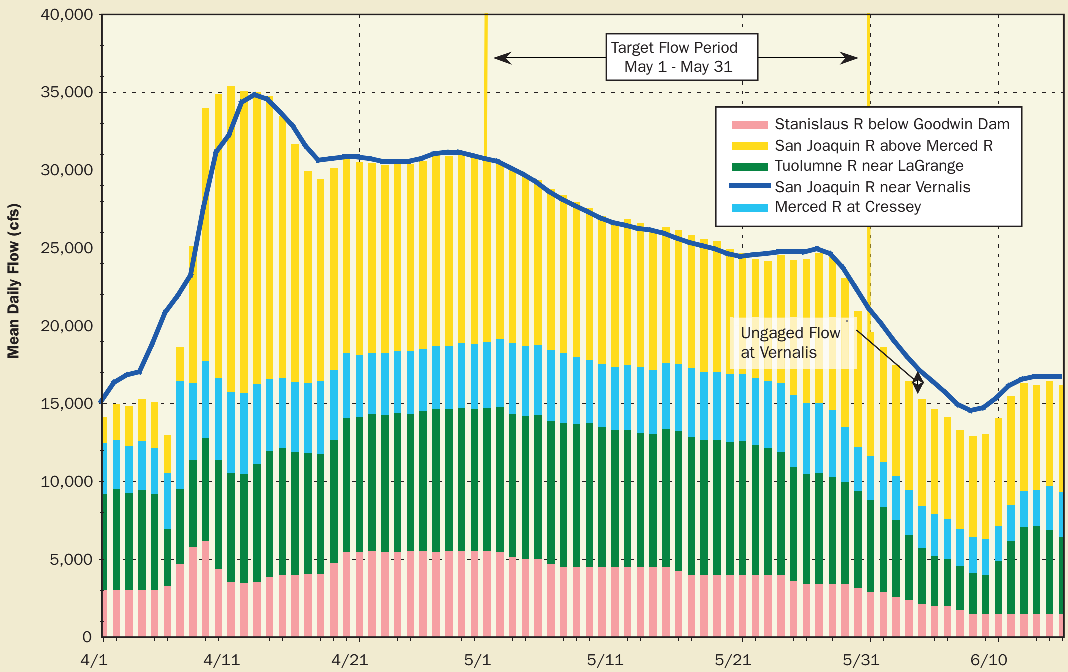


Figure 2-3
2006 VAMP: Flow at Tributary Measurement Points

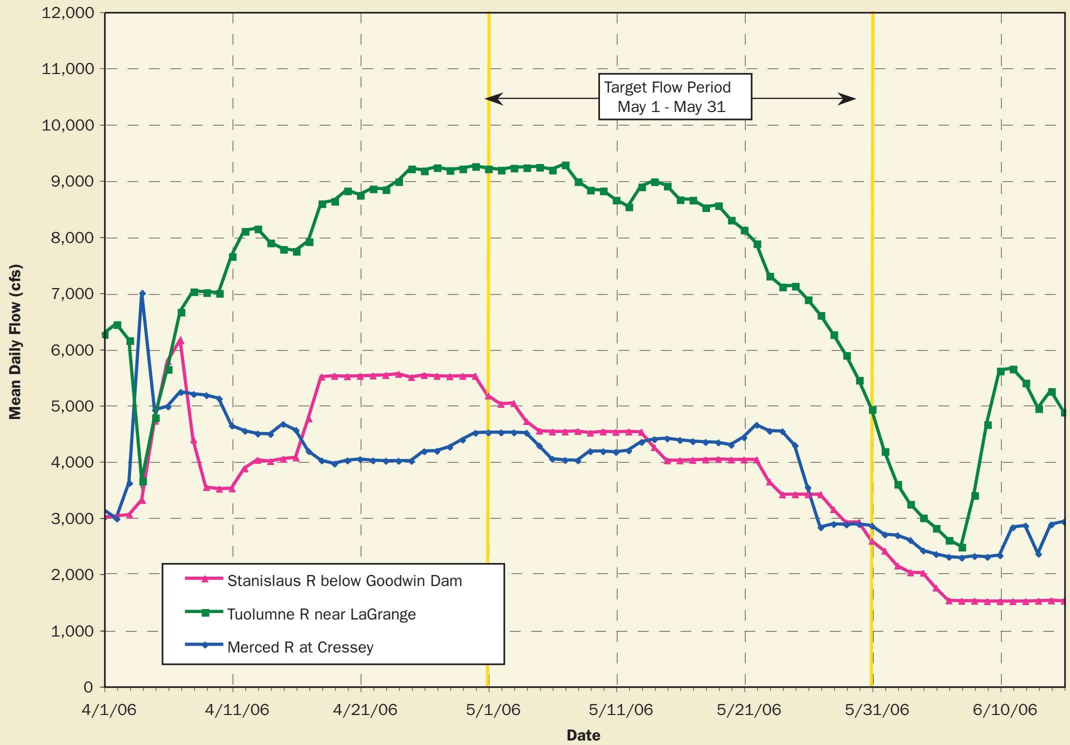


Figure 2-4
2006 VAMP - Ungaged Flow in San Joaquin River at Vernalis

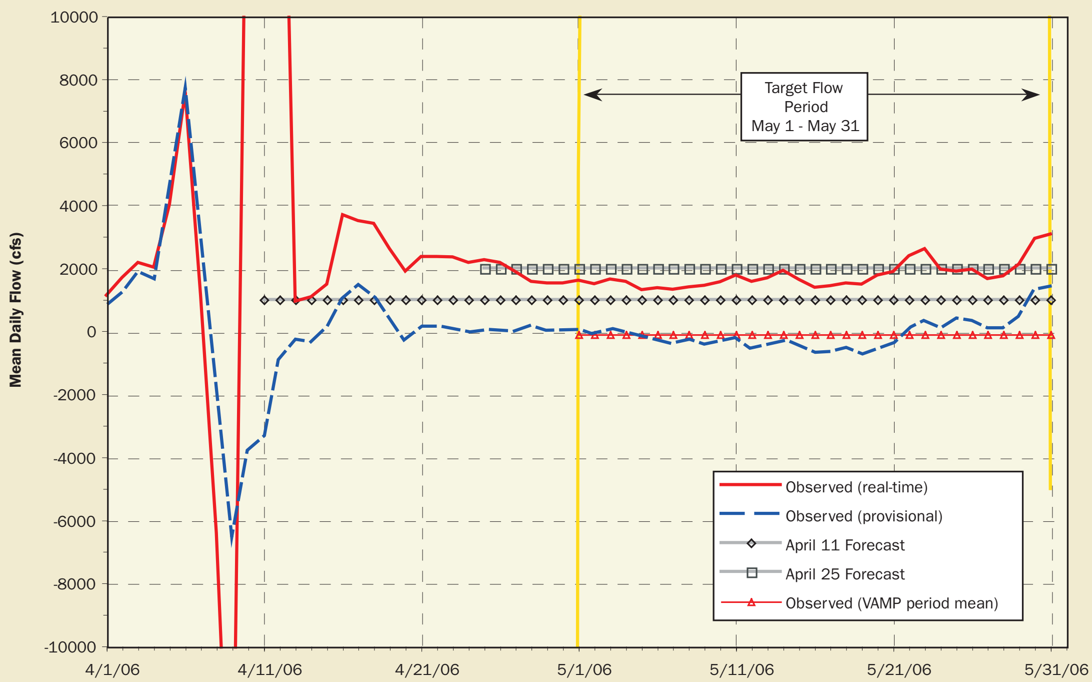


Figure 2-5
2006 VAMP - Upper San Joaquin River Flow

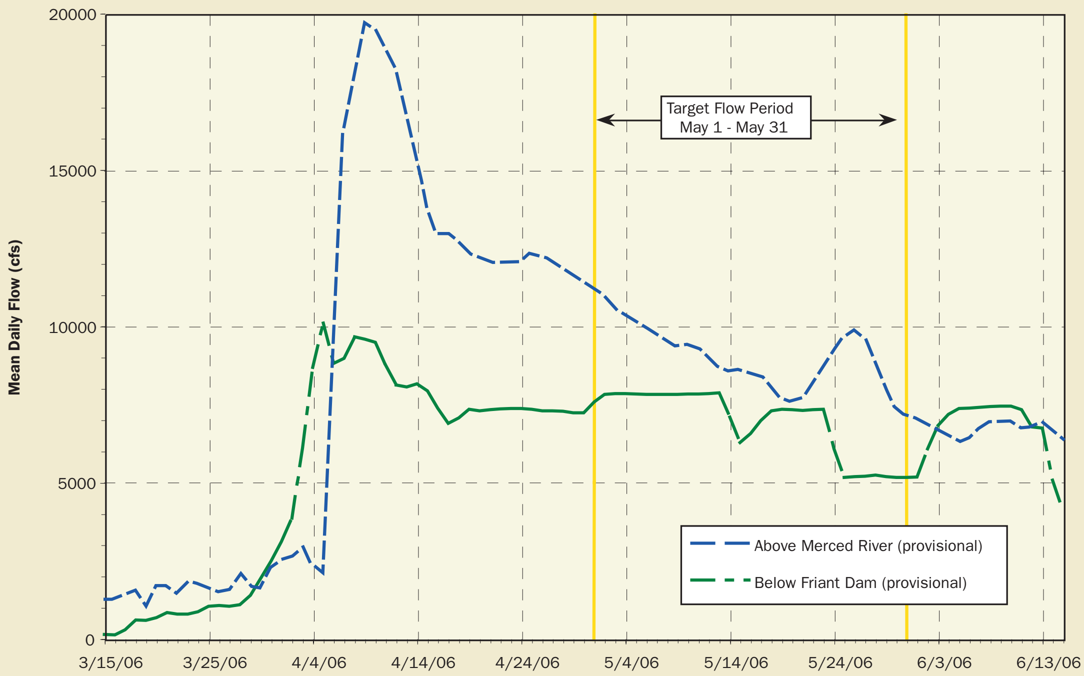


Figure 2-6
2006 VAMP - Federal and State Delta Exports

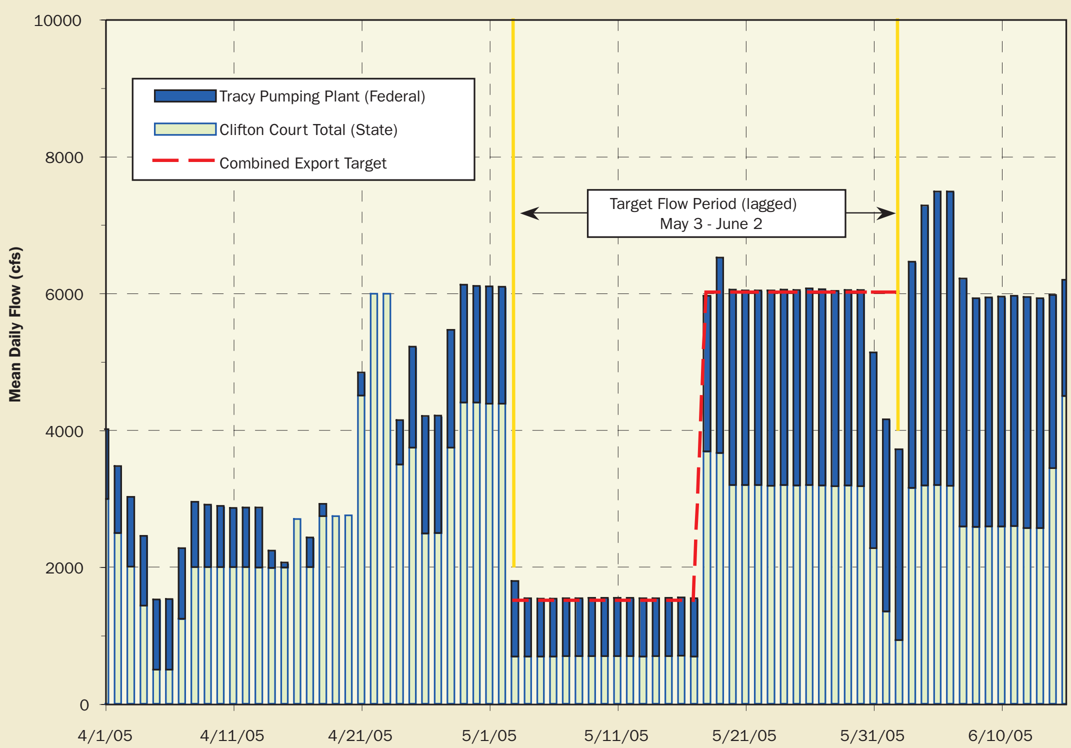


Figure 2-7

San Joaquin River Agreement Storage and Flow Impacts
Merced River - Lake McClure Storage and Release - 2006

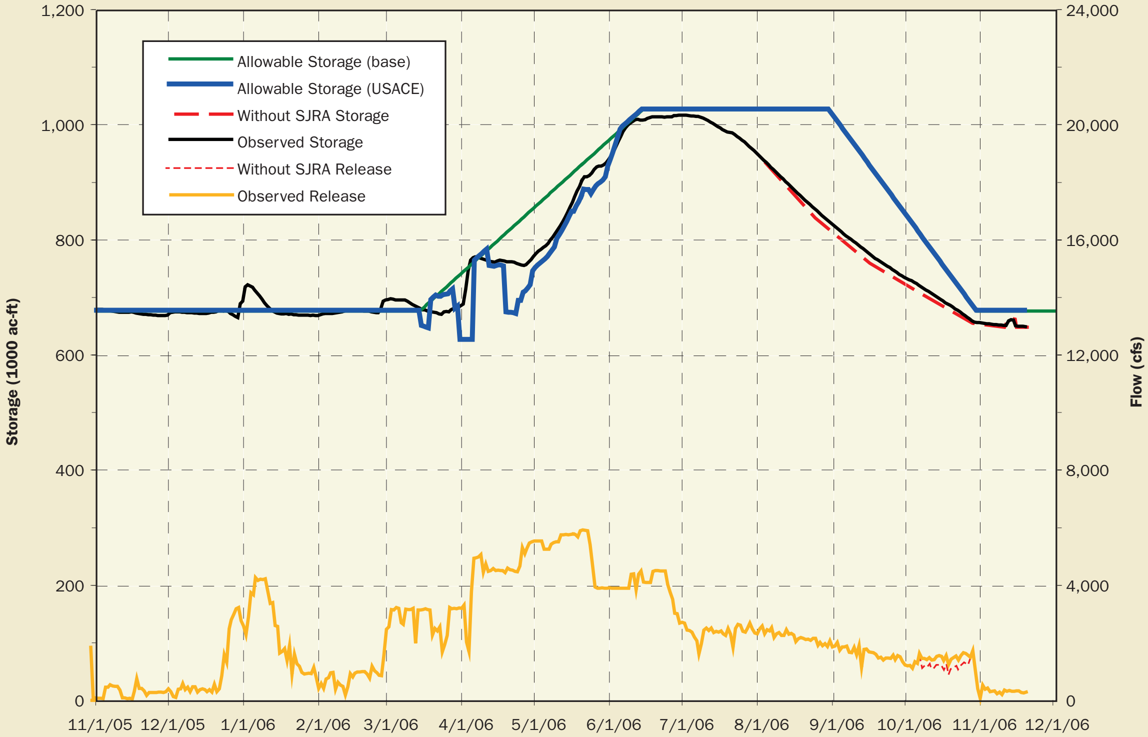


Figure 2-8

San Joaquin River Agreement Storage and Flow Impacts
Tuolumne River - New Don Pedro Reservoir Storage and Release - 2006

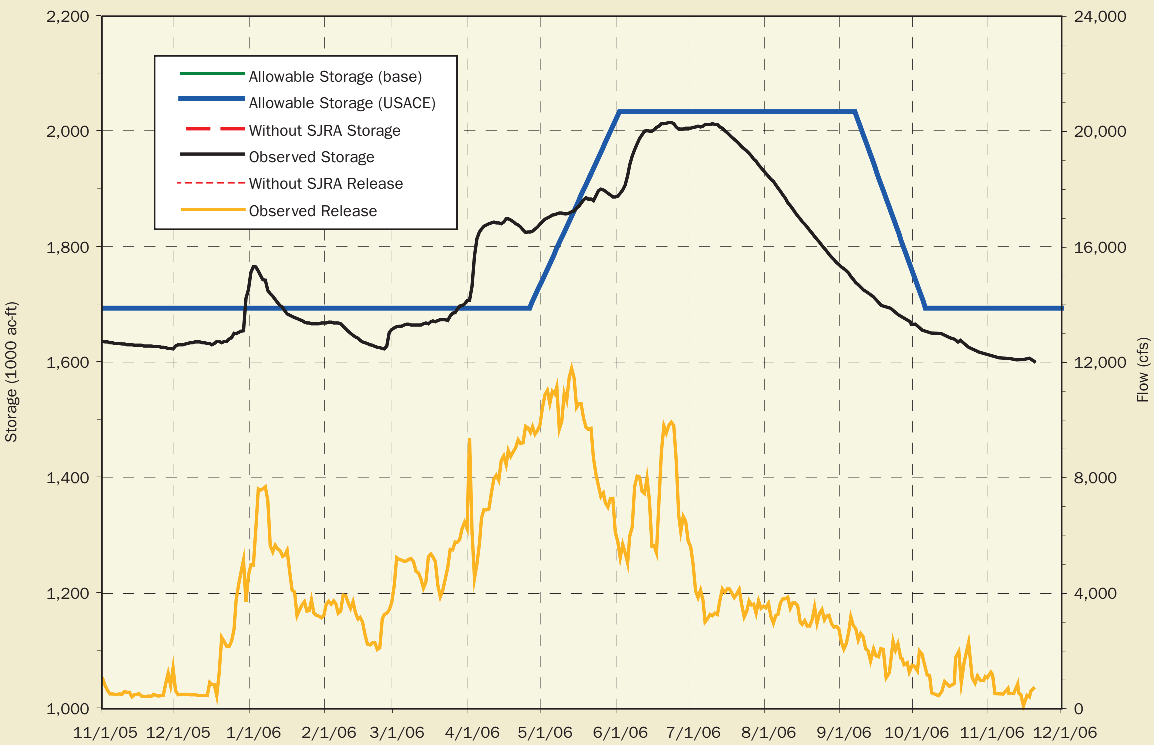


Table 2-6
Summary of VAMP Flows, 2000-2006

Year	60-20-20 Water Year Hydrologic Classification	VAMP Numerical Indicator	VAMP Target Flow (cfs)	Observed VAMP Flow (cfs)	Existing Flow (cfs)	VAMP Supplemental Water (acre-feet)	Delta Export Target (cfs)	Observed Delta Exports (cfs)
2000	Above Normal	4	5,700	5,869	4,800	77,680	2,250	2,155
2001	Dry	2	4,450	4,224	2,909	78,650	1,500	1,420
2002	Dry	2	3,200	3,301	2,757	33,430	1,500	1,430
2003	Below Normal	3	3,200	3,235	2,290	58,065	1,500	1,446
2004	Dry	2	3,200	3,155	2,088	65,591	1,500	1,331
2005	Wet	5	>7,000	10,390	10,390	0	2,250	2,986 [a]
2006	Wet	5	>7,000	26,220/24,262 [b]	26,020	0	1,500/6,000	1,559/5,748 [b]

[a] May 1 through 25 average was 2,260 cfs; exports were increased starting May 26 inconjunction with increasing existing flow; May 26 through 31 average was 6,012 cfs.

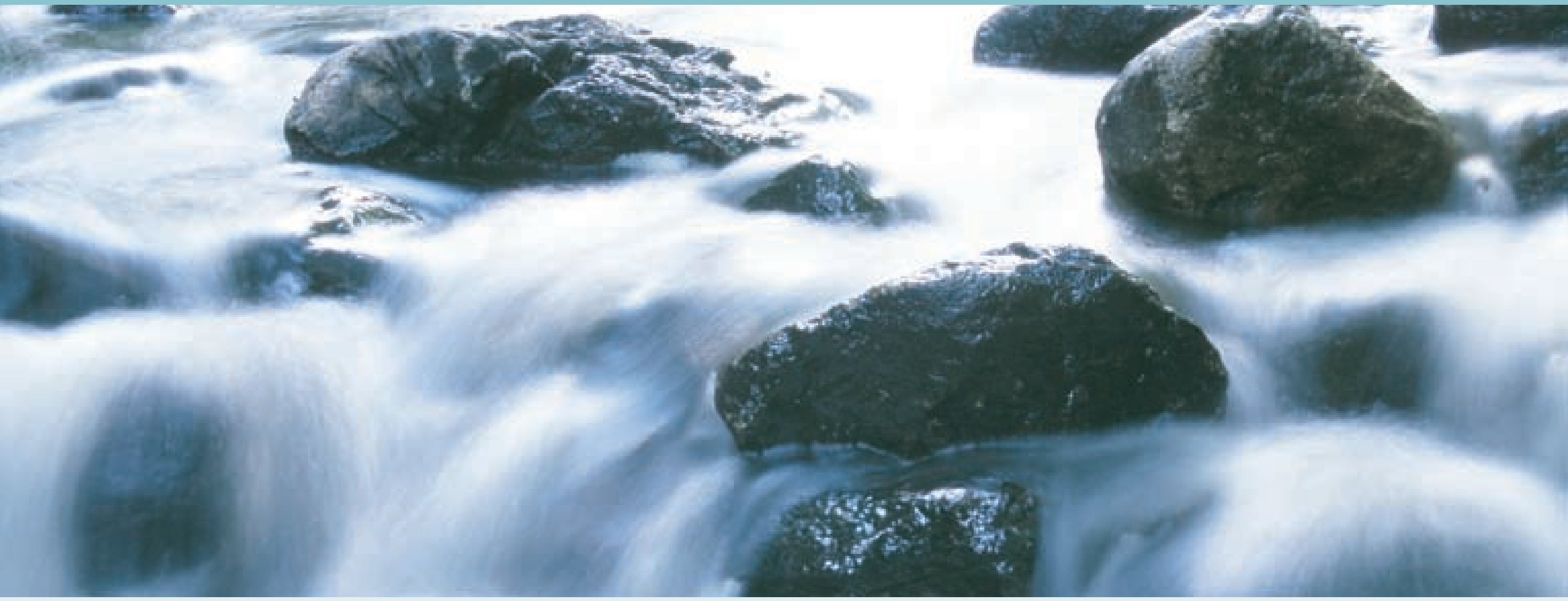
[b] "First fish release-recapture period"/"second fish release-recapture period"

Table 2-7
Summary of VAMP Supplemental Water Contributions, 2000-2006

Year	VAMP Supplemental Water (acre-feet)		Supplemental Water (acre feet) Merced ID	OID	SSJID	SJRECWA	MID	TID
2000	77,680	Observed:	46,750	(a)	(b)	8,280	15,200	7,450
	Division Agreement:	45,160	7,300	7,300	7,300	16,920	8,300	
	Deviation:	+ 1590	0	0	+ 980	- 1,720	- 850	
2001	78,650	Observed:	42,120	7,365	7,365	7,740	7,030	7,030
	Division Agreement:	42,150	7,300	7,300	7,300	7,300	7,300	
	Deviation:	- 30	+ 65	+ 65	+ 440	- 270	- 270	
2002	33,430	Observed:	25,840	3,795	3,795	0	0	0
	Division Agreement:	25,000	4,215	4,215	0	0	0	
	Deviation:	+ 840	- 420	- 420	0	0	0	
2003	58,065	Observed:	38,257	5,039	5,039	(c)	4,864.5	4,864.5
	Division Agreement:	38,065	5,000	5,000	5,000	5,000	5,000	
	Deviation:	+ 192	+ 39	+ 39	0	-135.5	-135.5	
2004	65,591	Observed:	42,680	5,880	5,880	(c)	5,575.5	5,575.5
	Division Agreement:	41,500	7,045.5	7,045.5	5,000	5,000	5,000	
	Deviation:	+ 1,180	- 1165.5	- 1165.5	0	+ 575.5	+ 575.5	
2005	0	Observed:	0	0	0	0	0	0
	Division Agreement:	0	0	0	0	0	0	
	Deviation:	0	0	0	0	0	0	
2006	0	Observed:	0	0	0	0	0	0
	Division Agreement:	0	0	0	0	0	0	
	Deviation:	0	0	0	0	0	0	

Chapter 3

Additional Water Supply Arrangements and Deliveries



The SJRA includes a provision (Paragraph 8.4) stating that "Merced Irrigation District (Merced) shall provide, and the USBR shall purchase 12,500 acre-feet of water…during October of all years." The SJRA also states in Paragraph 8.4.4 that "Water purchased pursuant to Paragraph 8.4 may be scheduled for months other than October provided Merced, DFG and USFWS all agree." Pursuant to Paragraph 8.5 of the SJRA, "Oakdale Irrigation District (OID) shall sell 15,000 acre-feet of water to the USBR in every year of (the) Agreement…In addition to the 15,000 acre-feet, Oakdale will sell the difference between the water made available to VAMP under the SJRGA agreement and 11,000 acre-feet." This water is referred to as the Difference water. The purpose of additional water supply deliveries in the fall months is to provide instream flows to attract and assist adult salmon during spawning.

Merced Irrigation District

The Paragraph 8.4 water is referred to as the Fall SJRA Transfer Water. The daily schedule for the Fall SJRA Transfer Water is developed by the California Department of Fish and Game (DFG), United States Fish and Wildlife Services (USFWS) and Merced ID.

The schedule for the 2006 Fall SJRA Transfer was finalized on September 27, 2006, with the transfer commencing on October 8, 2006. A daily summary table of the Merced 2006 Fall SJRA Transfer is provided as Table 3-1.

Oakdale Irrigation District

The combined Paragraph 8.5 water is referred to as the OID Additional Water.

OID did not provide any supplemental water for the 2006 VAMP operation, therefore the amount of additional water purchased by the USBR from OID was 26,000 acre-feet (15,000 plus 11,000). The OID additional water is made available in New Melones reservoir for use by the USBR for any authorized purpose of the New Melones project.

Due to high storage levels and ongoing operations at New Melones Reservoir at the time of this writing the USBR has not scheduled the release of the 2006 OID additional water.

Table 3-1 2006 Merced Irrigation District SJRA Fall Water Transfer Daily Summary (Final)									
		Scheduled			Observed				
		Transfer Water			Observed Flow			Transfer Water	
Date	Base Flow (cfs) {1}	Daily Flow Rate (cfs) {2}	Cumulative Volume (ac-ft) {3}	Target Flow [1] (cfs) {4} = {1}+{2}	Merced R at Shaffer Bridge [PG&E] (cfs) {5}	Merced R at Cressey [DWR] (cfs) {6}	For Transfer [1] (cfs) {7}	Daily Flow Rate (cfs) {8} = {7}-{1}	Cumulative Volume (ac-ft) {9}
01-Oct-06	550	0	0	550	550	558	558	0	0
02-Oct-06	400	0	0	400	395	546	546	0	0
03-Oct-06	400	0	0	400	395	420	420	0	0
04-Oct-06	400	0	0	400	390	392	392	0	0
05-Oct-06	700	0	0	700	669	380	380	0	0
06-Oct-06	700	0	0	700	674	578	578	0	0
07-Oct-06	700	0	0	700	1,000	604	604	0	0
08-Oct-06	550	274	543	824	932	887	887	337	668
09-Oct-06	550	274	1,087	824	932	819	819	269	1,202
10-Oct-06	550	274	1,630	824	926	799	799	249	1,696
11-Oct-06	550	274	2,174	824	963	791	791	241	2,174
12-Oct-06	550	274	2,717	824	969	828	828	278	2,725
13-Oct-06	550	274	3,261	824	988	841	841	291	3,302
14-Oct-06	550	274	3,804	824	982	859	859	309	3,915
15-Oct-06	550	274	4,348	824	988	862	862	312	4,534
16-Oct-06	550	274	4,891	824	988	856	856	306	5,141
17-Oct-06	550	274	5,435	824	969	861	861	311	5,758
18-Oct-06	550	274	5,978	824	982	849	849	299	6,351
19-Oct-06	550	274	6,522	824	982	854	854	304	6,954
20-Oct-06	550	274	7,065	824	988	863	863	313	7,575
21-Oct-06	550	274	7,609	824	988	870	870	320	8,210
22-Oct-06	550	274	8,152	824	988	879	879	329	8,862
23-Oct-06	550	274	8,696	824	988	878	878	328	9,513
24-Oct-06	550	274	9,239	824	988	888	888	338	10,183
25-Oct-06	550	274	9,782	824	994	896	896	346	10,869
26-Oct-06	550	274	10,326	824	969	910	910	360	11,583
27-Oct-06	550	274	10,869	824	988	903	903	353	12,284
28-Oct-06	550	274	11,413	824	988	923	923	109	12,500
29-Oct-06	550	274	11,956	824	865	929	929		
30-Oct-06	550	185	12,323	735	669	816	816		
31-Oct-06	400	90	12,502	490	380	635	635		

[1]: The Technical Appendix to the San Joaquin River Group Division Agreement states that "[T]he Merced River at Shaffer Bridge…will be used for flows between 0 and 300 cfs. …[F]or the flows above 300 cfs, measurements will be provided at the gage on the Merc

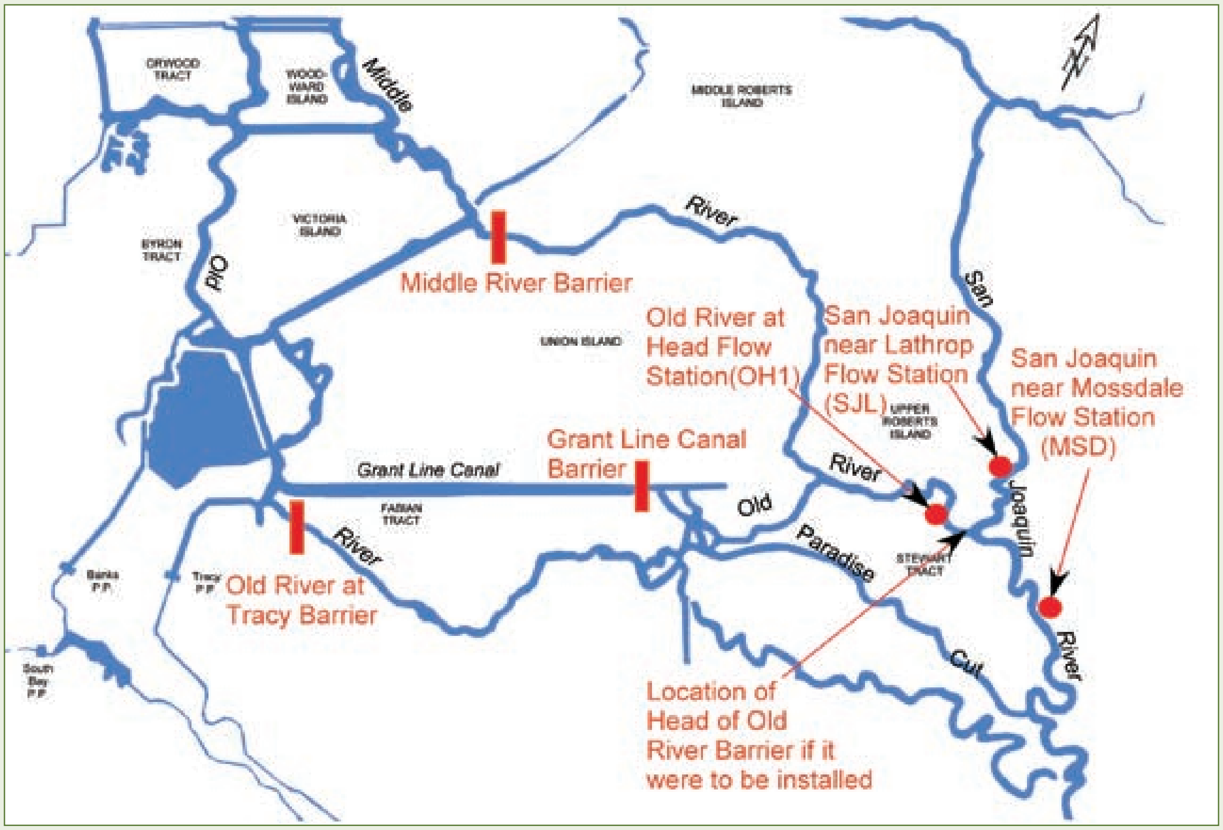
Chapter 4
Head of Old River Barrier

The spring temporary Head of Old River Barrier (HORB) was not installed in 2006 due to high flows in the San Joaquin River, nonetheless, monitoring near the HOR is performed as required by the permitting agencies and is one element of the monitoring program of the south delta Temporary Barriers Project (TBP). The TBP mitigates for low water levels in the south delta and improves water circulation and quality for agricultural purposes. Fishery sampling was conducted during the 2006 VAMP study period to determine the proportion of juvenile Chinook salmon that migrated into Old River in the absence of the HORB. Results of the 2006 monitoring tested the hypothesis that juvenile salmon migrate in direct proportion to a flow split. Results of the 2006 monitoring are briefly discussed below.

Background

The spring HORB was first constructed in 1992. Since then, the barrier has been installed in 1994, 1996, 1997 (w/two culverts), and between 2000 and 2004. In 2000-2004 the barrier was installed with six culverts. The HORB was not installed in 1993, 1995, 1998, 2005, and 2006 due to high San Joaquin River flows. The HORB was not installed in 1999 due to landowner access problems. The HORB, a key component of VAMP, is intended to increase San Joaquin River Chinook salmon smolt survival by preventing them from entering Old River.

Figure 4-1
South Delta Temporary Barriers



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Although the HORB was not installed in 2006, the three agricultural barriers (the Middle River barrier, the Old River near Tracy barrier, and the Grant Line Canal barrier) were installed by July 7, 2006, July 17, 2006, and July 20, 2006 respectively. Removal of the Middle River, Old River near Tracy, and Grant Line barriers was completed by November 18, December 13, and December 10, respectively. The agricultural barriers are installed to mitigate for low water surface elevations in south Delta region. Figure 4-1 shows the locations of the three agricultural barriers and the location of the HORB, if it were to be installed.

Flow Measurements at and Around the Head of Old River

DWR operates two Acoustic Doppler Current Meters (ADCM) in the vicinity of head of Old River, one in the San Joaquin River 1,500 feet downstream of Old River (San Joaquin River below Old River near Lathrop, SJL) and another in Old River 840 feet downstream of the head of Old River (Old River at Head, OH1). This year, a third acoustical Doppler was installed at the abutment of the Rail Road tracks near Mossdale (Figure 4-1). The ADCMs record velocity measurements at a 15 minute interval from which flow values can be determined. Table 4-1 lists the daily minimum, maximum and mean flows for the April 1, 2006 through June 30, 2006 period for the three ADCMs as well as the flow split percentage of the total San Joaquin River flow between stations OH1 and SJL. Figures 4-2, 4-3, and 4-4 show the daily flow range and the mean for the Old River at head gage, the San Joaquin River below Old River gage, and the San Joaquin River at Mossdale gage respectively. The head of Old River gage reported missing data from April 1, 2006 till April 07, 2006 and from April 28, 2006 till May 1, 2006. All missing data are attributed to instrument malfunctioning or the lack of calibration at the site during that period.

At the HOR, during the 2006 VAMP period, an average of 54.3 percent of the flow entered the Old River compared to 51.3 percent during the 2005 VAMP period. However, the flow range at Vernalis in 2006 was 30,600 cfs to 21,000 cfs compared to a range of 7,700 cfs to 15,100 cfs in 2005. As is described below a portion of the higher 2006 flow entered Paradise Cut which was not the case in 2005. Until more data is collected no relationship between San Joaquin River flow and HOR flow can be made.

Table 4-2 shows the mean daily flow for the San Joaquin River gage at Mossdale and the San Joaquin River near Vernalis gage for the duration April 1, 2006 through June 30, 2006. When the flow in the San Joaquin River exceeds 18,000 cfs in the channel stretch between Vernalis and Mossdale; river water starts flowing over a flood-bypass weir (located approximately 12 miles downstream of Vernalis and about five miles upstream of the juncture with the Head of Old River) and into Paradise Cut which is a ditch with a dual purpose; irrigation and flood control-bypass channel conveying water from the San Joaquin River to Old River thereby easing the pressure on the levees located downstream of the weir. Figure 4-5 shows the San Joaquin River flow near Vernalis and at Mossdale as well as an estimation of the flow that was diverted into

Table 4-1
Flows in Old River at Head and San Joaquin River below Old River

Date	Old River at Head (OH1)			San Joaquin River below Old River (SJL)			San Joaquin River at Mossdale (MSD)			Flow Split (% of Total Flow)	
	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	OH1	SJL
4/1/2006				6,170	7,320	6,800	14,230	15,450	14,840		
4/2/2006				6,690	7,600	7,170	14,970	16,650	15,830		
4/3/2006				6,870	8,220	7,530	16,230	17,240	16,740		
4/4/2006				6,980	8,440	7,710	16,270	17,420	16,800		
4/5/2006				7,240	8,360	7,780	16,890	18,950	17,750		
4/6/2006				7,830	9,850	8,620	18,610	20,280	19,260		
4/7/2006	10,180	10,830	10,530	8,310	10,140	9,050	19,650	20,890	20,310	53.8%	46.2%
4/8/2006	10,290	11,330	10,710	8,610	10,440	9,650	20,370	22,390	21,230	52.6%	47.4%
4/9/2006	11,150	12,610	11,740	9,540	11,790	10,690	22,150	24,640	23,040	52.3%	47.7%
4/10/2006	12,210	13,430	12,750	11,360	13,150	12,130	24,190	26,090	25,210	51.2%	48.8%
4/11/2006	12,670	13,400	13,010	11,680	13,290	12,370	24,790	27,560	26,010	51.3%	48.7%
4/12/2006	13,120	14,440	13,770	12,500	15,100	13,710	26,630	28,730	27,700	50.1%	49.9%
4/13/2006	13,930	14,690	14,330	13,030	15,250	14,190	27,770	29,380	28,420	50.2%	49.8%
4/14/2006	13,940	14,790	14,400	12,460	15,190	13,850	27,140	28,900	28,000	51.0%	49.0%
4/15/2006	13,810	14,750	14,320	12,850	14,530	13,650	26,470	28,150	27,410	51.2%	48.8%
4/16/2006	13,460	14,330	13,880	12,220	14,390	13,360	25,770	28,050	26,820	51.0%	49.0%
4/17/2006	13,250	14,120	13,580	11,010	12,720	11,900	25,220	26,960	26,110	53.3%	46.7%
4/18/2006	12,940	13,770	13,320	10,480	12,540	11,460	24,280	25,870	25,200	53.8%	46.2%
4/19/2006	12,760	13,470	13,100	10,490	12,250	11,540	23,840	25,270	24,680	53.2%	46.8%
4/20/2006	12,890	13,750	13,260	11,100	12,070	11,560	23,760	25,670	24,670	53.4%	46.6%
4/21/2006	12,950	13,670	13,340	10,870	12,050	11,530	23,630	25,880	24,670	53.6%	46.4%
4/22/2006	12,830	13,590	13,200	10,930	12,130	11,530	23,520	25,210	24,370	53.4%	46.6%
4/23/2006	13,060	13,610	13,330	10,640	12,100	11,300	23,570	25,110	24,490	54.1%	45.9%
4/24/2006	12,940	13,440	13,220	11,070	12,160	11,640	23,450	25,030	24,260	53.2%	46.8%
4/25/2006	13,000	13,550	13,280	10,880	12,140	11,520	23,260	24,840	24,140	53.5%	46.5%
4/26/2006	12,780	13,630	13,290	10,830	12,240	11,500	23,060	24,840	24,040	53.6%	46.4%
4/27/2006	13,030	13,490	13,310	11,030	12,610	11,900	23,250	25,210	24,180	52.8%	47.2%
4/28/2006				11,310	12,640	11,950	23,660	25,620	24,590		
4/29/2006				11,270	12,680	11,950	23,730	26,110	24,640		
4/30/2006				11,480	12,900	12,050	23,680	25,370	24,520		
5/1/2006	13,050	13,720	13,340	11,590	12,650	12,170	23,570	25,500	24,620	52.3%	47.7%
5/2/2006	13,040	13,800	13,400	11,310	12,610	12,010	23,840	25,700	24,740	52.7%	47.3%
5/3/2006	12,950	13,650	13,340	10,980	12,610	11,850	23,360	25,010	24,140	53.0%	47.0%
5/4/2006	12,820	13,530	13,200	11,080	12,270	11,760	22,720	24,750	23,680	52.9%	47.1%
5/5/2006	12,780	13,430	13,130	10,960	12,360	11,630	22,500	24,030	23,430	53.0%	47.0%
5/6/2006	12,700	13,350	13,040	10,800	12,110	11,250	22,220	23,580	22,900	53.7%	46.3%
5/7/2006	12,380	13,040	12,660	10,670	11,900	11,440	21,490	23,570	22,620	52.5%	47.5%
5/8/2006	12,370	12,890	12,640	10,480	11,800	11,210	21,690	23,120	22,340	53.0%	47.0%
5/9/2006	12,310	12,830	12,550	10,450	11,590	11,030	21,280	23,300	22,320	53.2%	46.8%
5/10/2006	11,980	12,820	12,420	10,530	11,370	10,920	20,910	22,250	21,630	53.2%	46.8%
5/11/2006	11,840	12,700	12,220	9,820	11,190	10,610	20,560	22,620	21,440	53.5%	46.5%
5/12/2006	11,980	12,790	12,290	9,900	10,870	10,510	21,250	22,620	21,960	53.9%	46.1%
5/13/2006	11,990	12,580	12,360	9,860	10,870	10,340	20,990	22,620	21,830	54.4%	45.6%
5/14/2006	11,790	12,610	12,200	9,840	10,820	10,360	20,850	22,250	21,510	54.1%	45.9%
5/15/2006	11,640	12,720	12,200	9,430	11,000	10,190	20,650	22,920	21,650	54.5%	45.5%
5/16/2006	12,040	12,700	12,360	9,590	10,620	10,150	20,670	22,600	21,650	54.9%	45.1%
5/17/2006	11,970	12,500	12,270	9,840	10,800	10,200	20,520	22,340	21,590	54.6%	45.4%
5/18/2006	11,940	12,520	12,220	9,540	10,490	10,060	21,170	22,660	21,920	54.8%	45.2%
5/19/2006	11,600	12,530	12,160	9,460	10,630	10,030	21,240	22,560	21,780	54.8%	45.2%
5/20/2006	11,810	12,330	12,050	9,550	10,310	9,950	20,750	21,980	21,320	54.8%	45.2%
5/21/2006	11,570	12,130	11,870	9,440	10,290	9,900	20,110	21,610	20,840	54.5%	45.5%
5/22/2006	11,820	12,440	12,090	9,350	10,330	9,840	20,400	22,010	21,390	55.1%	44.9%
5/23/2006	11,660	12,420	12,030	9,410	10,360	9,950	20,230	22,260	21,240	54.7%	45.3%
5/24/2006	11,750	12,550	12,150	9,400	10,330	9,910	20,570	22,330	21,480	55.1%	44.9%
5/25/2006	11,980	12,500	12,260	9,140	10,030	9,550	20,750	22,240	21,390	56.2%	43.8%
5/26/2006	11,960	12,570	12,280	9,080	10,000	9,540	20,700	21,970	21,340	56.3%	43.7%
5/27/2006	11,990	12,610	12,270	9,140	10,550	9,750	20,450	22,470	21,610	55.7%	44.3%
5/28/2006	11,760	12,340	12,100	9,240	10,350	9,760	20,960	22,520	21,730	55.4%	44.6%
5/29/2006	11,490	12,230	11,910	8,930	10,130	9,600	20,110	21,980	21,270	55.4%	44.6%
5/30/2006	11,110	11,910	11,470	8,630	9,770	9,180	19,090	21,060	20,190	55.5%	44.5%
5/31/2006	10,790	11,370	11,090	8,010	9,210	8,750	18,250	20,300	19,160	55.9%	44.1%
6/1/2006	10,440	11,260	10,780	7,740	8,880	8,350	17,400	18,930	18,380	56.4%	43.6%
6/2/2006	10,160	10,830	10,530	7,530	8,190	7,860	16,930	18,210	17,510	57.3%	42.7%
6/3/2006	9,490	10,400	9,960	7,040	7,900	7,630	16,170	17,510	16,850	56.6%	43.4%
6/4/2006	9,210	9,950	9,550	6,850	7,440	7,140	15,230	16,530	16,000	57.2%	42.8%
6/5/2006	8,950	9,660	9,250	6,620	7,230	6,900	14,810	15,980	15,400	57.3%	42.7%
6/6/2006	8,640	9,180	8,930	6,160	6,890	6,540	14,070	15,410	14,770	57.7%	42.3%
6/7/2006	8,300	8,910	8,590	5,840	6,420	6,130	13,560	14,720	14,110	58.4%	41.6%
6/8/2006	8,150	8,710	8,390	5,410	6,160	5,850	13,220	13,990	13,590	58.9%	41.1%
6/9/2006	8,110	8,570	8,370	5,320	6,280	5,870	13,180	14,240	13,660	58.8%	41.2%
6/10/2006	8,380	8,880	8,660	5,350	6,420	6,010	13,870	15,300	14,540	59.0%	41.0%
6/11/2006	8,660	9,160	8,950	5,800	6,820	6,340	14,670	15,960	15,360	58.5%	41.5%
6/12/2006	8,930	9,460	9,190	6,010	6,910	6,560	15,100	16,420	15,900	58.3%	41.7%
6/13/2006	9,260	9,860	9,540	6,160	6,970	6,630	15,570	16,930	16,290	59.0%	41.0%
6/14/2006	9,550	10,000	9,790	6,350	7,190	6,730	16,050	17,100	16,440	59.3%	40.7%
6/15/2006	9,280	9,880	9,520	6,300	7,040	6,690	15,810	16,760	16,320	58.7%	41.3%
6/16/2006	9,040	9,530	9,260	6,260	6,990	6,700	15,550	16,740	16,200	58.0%	42.0%
6/17/2006	8,570	9,140	8,910	6,210	6,840	6,570	15,160	16,180	15,730	57.6%	42.4%
6/18/2006	8,230	8,770	8,510	5,870	6,530	6,260	14,890	15,840	15,340	57.6%	42.4%
6/19/2006	7,750	8,530	8,070	5,470	6,400	5,950	13,810	15,140	14,610	57.6%	42.4%
6/20/2006	7,390	7,910	7,600	5,130	5,900	5,540	13,010	14,180	13,610	57.8%	42.2%
6/21/2006	7,130	7,580	7,370	4,870	5,630	5,310	12,740	13,560	13,170	58.1%	41.9%
6/22/2006	7,340	7,910	7,680	4,760	5,690	5,350	12,920	14,310	13,610	58.9%	41.1%
6/23/2006	7,670	8,140	7,900	5,020	5,940	5,510	13,670	14,580	14,170	58.9%	41.1%
6/24/2006	7,740	8,300	7,990	5,170	6,050	5,660	13,940	14,980	14,550	58.5%	41.5%
6/25/2006	7,730	8,350	8,110	5,230	6,330	5,850	14,410	15,690	15,060	58.1%	41.9%
6/26/2006	7,950	8,480	8,290	5,560	6,490	6,060	15,100	16,060	15,560	57.8%	42.2%
6/27/2006	8,160	8,590	8,380	5,860	6,610	6,230	15,170	16,470	15,960	57.4%	42.6%
6/28/2006	7,980	8,550	8,270	5,880	6,600	6,200	15,280	16,250	15,830	57.2%	42.8%
6/29/2006	7,400	8,160	7,780	5,410	6,290	5,900	14,310	15,620	15,030	56.9%	43.1%
6/30/2006	7,220	7,580	7,430	4,930	5,850	5,470	13,510	14,770	14,060	57.6%	42.4%

No Data

Figure 4-2
Daily Flow Range - Old River at Head Gage, 2006

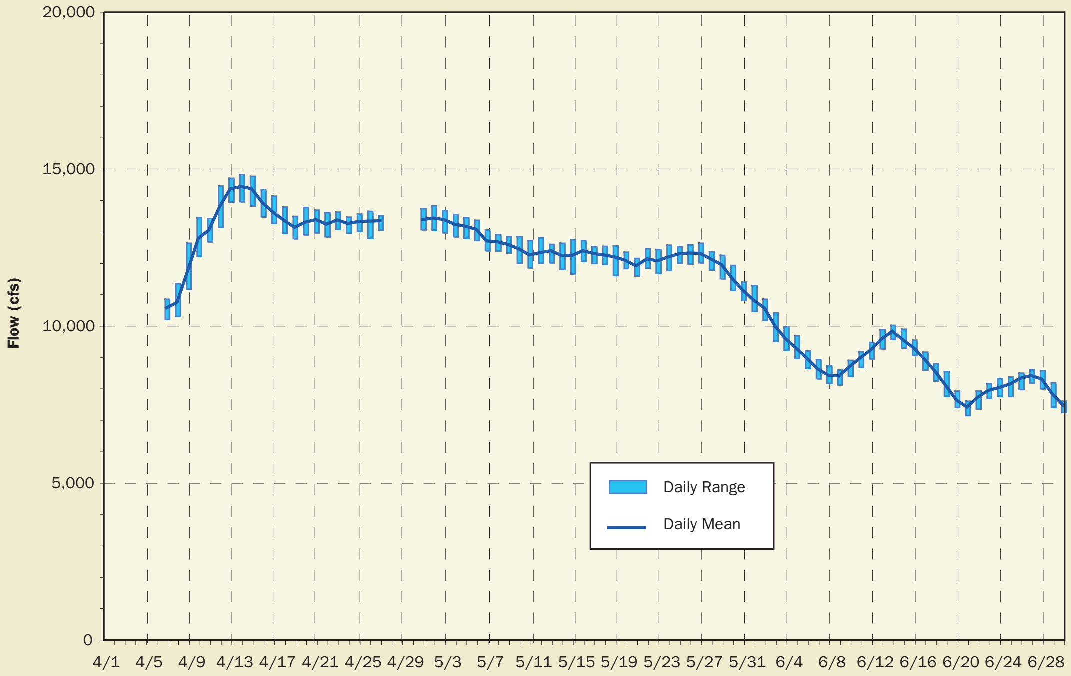
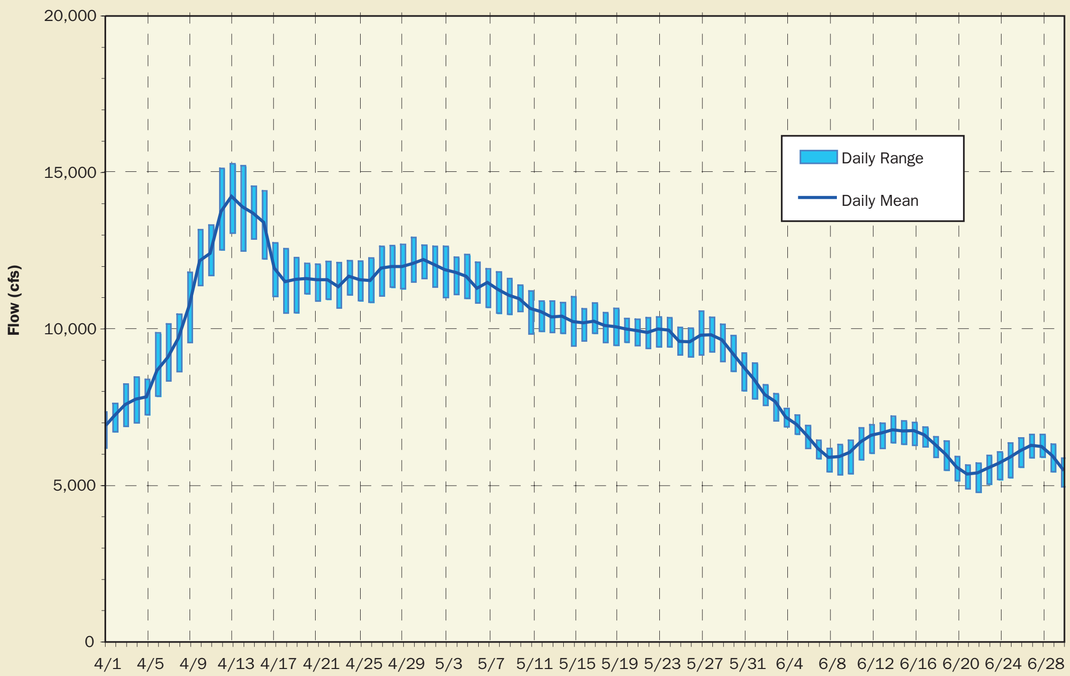


Figure 4-3
Daily Flow Range - San Joaquin River below Old River Gage, 2006



Paradise Cut. Since the test fish were released downstream of this location the flow diverted into Paradise Cut did not confound the analyses of the 2006 survival data.

DWR at the end of each year conducts a Delta Simulation Model 2 (DSM2) modeling run to be included in the yearly published South Delta Temporary Barriers Monitoring Report. As in 2005 data collected from the two ADCMs will be used to verify the flow split of the San Joaquin River and Old River at the confluence against the output generated using the model. In 2005, the flow split observed in the field during the period of April through June was 48.9 percent of the total flow for the San Joaquin River and 51.1 percent for the Old River at head. The output of the DSM2 model revealed a flow split of 47 percent and 53 percent respectively.

Seepage Monitoring

A seepage-monitoring program was initiated in April 2000, to evaluate the effects of HORB operations on seepage and groundwater on Upper Roberts Island. Although the HORB was not installed this year, DWR continued monitoring for seepage. Seepage was observed and recorded in April and May at Upper Roberts Island near and around the monitoring wells. A link to the continuous time series data in the water data library is available on the Internet.

Old and San Joaquin River Kodiak Trawling

As in 2005, the spring Head of Old River Barrier was not constructed in 2006 due to flows in excess of 5,000 cfs on the San Joaquin River. Consequently, there was no fish entrainment monitoring. As an alternative to the entrainment monitoring, the Department of Fish and Game towed a Kodiak trawl in Old River during the VAMP test period. The Old River Kodiak Trawl (ORKT) was conducted in a manner similar to the Mossdale Kodiak Trawl (MKT) which is conducted year-round on the San Joaquin River. Both trawls sampled for juvenile salmon during the first three weeks of May. Comparison of salmon catch between the two trawls may provide insights into salmon migration from the San Joaquin River into Old River.

Methods and Results

The ORKT and MKT used similar sampling gear and protocols. Fish were collected using a Kodiak trawl towed between two boats. Trawling took place in Old River, starting approximately two miles downstream of the head; and in the San Joaquin River, upstream of the head of Old River (Figure 4-6). The beginning of the 2006 ORKT sample site was about 0.8 miles downstream of the end of the 2005 sample site. The Kodiak trawl is 65 feet long, made of variable mesh (ranging from 0.5 inches stretch

Table 4-2
San Joaquin River and Old River Mean Daily Flows

Date	Mean Daily Flow (cfs)		
	San Joaquin River at Mossdale [A]	San Joaquin River near Vernalis [B]	Estimate of Flow Diverted to Paradise Cut [B] - [C]
4/1/06	14,840	15,000	
4/2/06	15,830	16,200	
4/3/06	16,740	16,700	
4/4/06	16,800	16,900	
4/5/06	17,750	18,700	950
4/6/06	19,260	20,700	1,440
4/7/06	20,310	21,800	1,490
4/8/06	21,230	23,100	1,870
4/9/06	23,040	27,400	4,360
4/10/06	25,210	31,000	5,790
4/11/06	26,010	32,100	6,090
4/12/06	27,700	34,200	6,500
4/13/06	28,420	34,700	6,280
4/14/06	28,000	34,400	6,400
4/15/06	27,410	33,600	6,190
4/16/06	26,820	32,700	5,880
4/17/06	26,110	31,400	5,290
4/18/06	25,200	30,500	5,300
4/19/06	24,680	30,600	5,920
4/20/06	24,670	30,700	6,030
4/21/06	24,670	30,700	6,030
4/22/06	24,370	30,600	6,230
4/23/06	24,490	30,400	5,910
4/24/06	24,260	30,400	6,140
4/25/06	24,140	30,400	6,260
4/26/06	24,040	30,600	6,560
4/27/06	24,180	30,900	6,720
4/28/06	24,590	31,000	6,410
4/29/06	24,640	31,000	6,360
4/30/06	24,520	30,800	6,280
5/1/06	24,620	30,600	5,980
5/2/06	24,740	30,400	5,660
5/3/06	24,140	30,000	5,860
5/4/06	23,680	29,600	5,920
5/5/06	23,430	29,100	5,670
5/6/06	22,900	28,500	5,600
5/7/06	22,620	28,000	5,380
5/8/06	22,340	27,600	5,260
5/9/06	22,320	27,200	4,880
5/10/06	21,630	26,800	5,170
5/11/06	21,440	26,500	5,060
5/12/06	21,960	26,300	4,340
5/13/06	21,830	26,100	4,270
5/14/06	21,510	26,000	4,490
5/15/06	21,650	25,800	4,150
5/16/06	21,650	25,500	3,850
5/17/06	21,590	25,200	3,610
5/18/06	21,920	25,000	3,080
5/19/06	21,780	24,800	3,020
5/20/06	21,320	24,500	3,180
5/21/06	20,840	24,300	3,460
5/22/06	21,390	24,400	3,010
5/23/06	21,240	24,500	3,260
5/24/06	21,480	24,600	3,120
5/25/06	21,390	24,600	3,210
5/26/06	21,340	24,600	3,260
5/27/06	21,610	24,800	3,190
5/28/06	21,730	24,500	2,770
5/29/06	21,270	23,600	2,330
5/30/06	20,190	22,300	2,110
5/31/06	19,160	21,000	1,840
6/1/06	18,380	20,000	1,620
6/2/06	17,510	18,900	1,390
6/3/06	16,850	17,900	1,050
6/4/06	16,000	17,000	1,000
6/5/06	15,400	16,300	
6/6/06	14,770	15,600	
6/7/06	14,110	14,800	
6/8/06	13,590	14,400	
6/9/06	13,660	14,600	
6/10/06	14,540	15,200	
6/11/06	15,360	16,000	
6/12/06	15,900	16,400	
6/13/06	16,290	16,600	
6/14/06	16,440	16,600	
6/15/06	16,320	16,600	
6/16/06	16,200	16,500	
6/17/06	15,730	16,000	
6/18/06	15,340	15,400	
6/19/06	14,610	14,700	
6/20/06	13,610	13,800	
6/21/06	13,170	13,400	
6/22/06	13,610	13,900	
6/23/06	14,170	14,300	
6/24/06	14,550	14,600	
6/25/06	15,060	15,000	
6/26/06	15,560	15,400	
6/27/06	15,960	15,800	
6/28/06	15,830	15,500	
6/29/06	15,030	14,400	
6/30/06	14,060	13,600	

Figure 4-4
Daily Flow Range - San Joaquin River at Mossdale, 2006

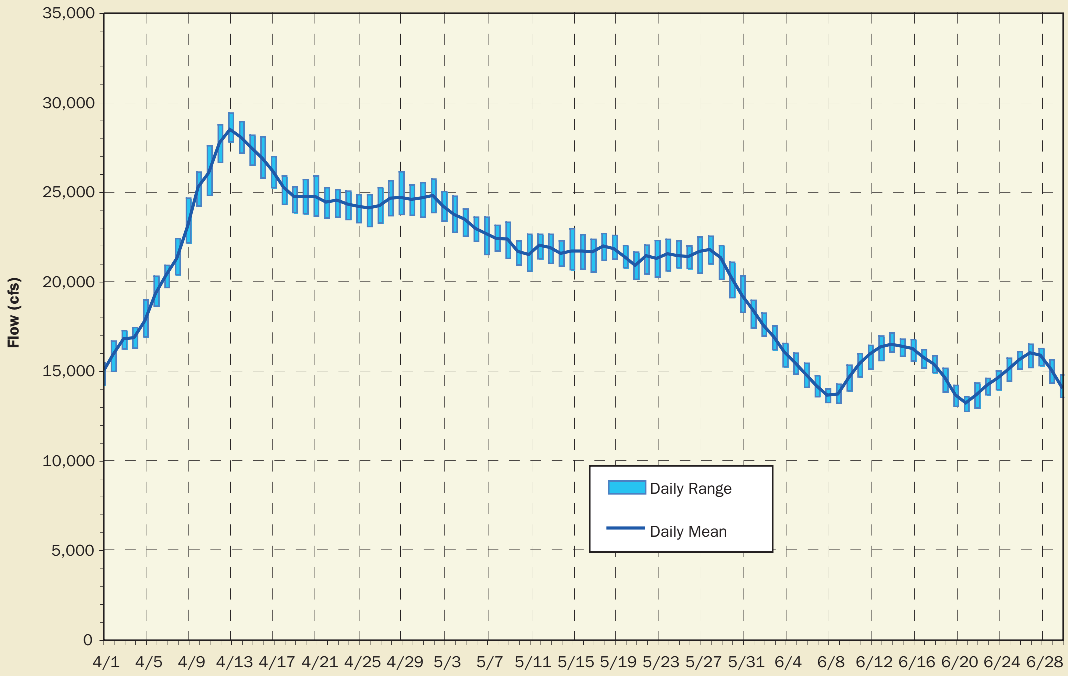
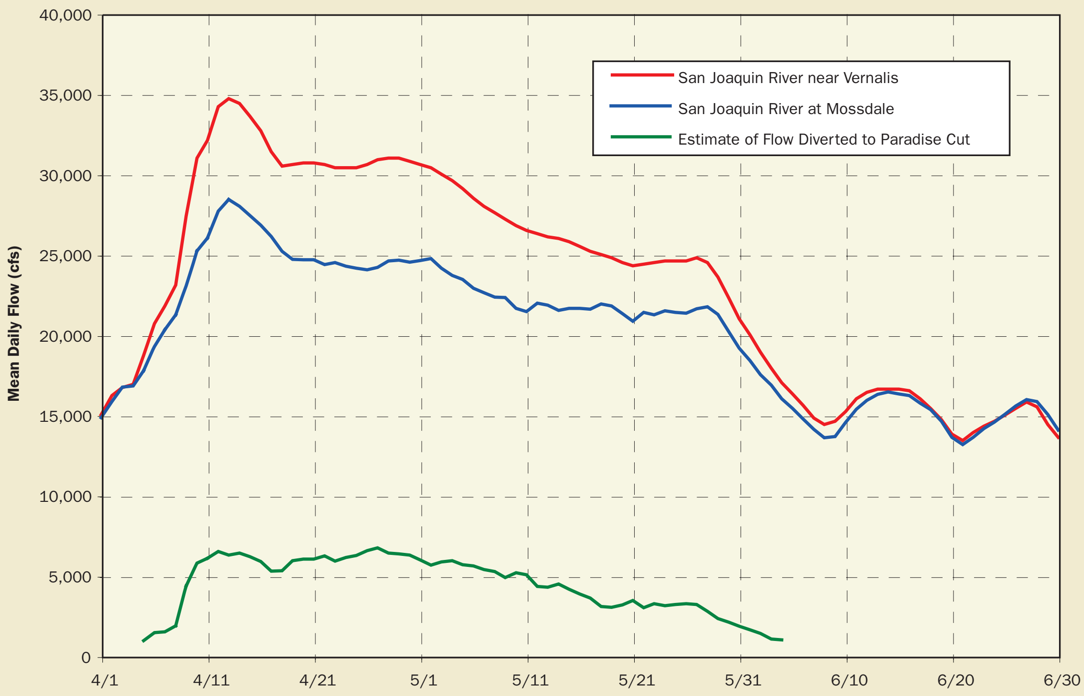


Figure 4-5
San Joaquin River Flow near Vernalis and at Mossdale, 2006



mesh at the cod-end to 2.0 inches mesh at the mouth), and has a mouth opening of 6.0 feet by 25 feet. The effective sampling area of the net was estimated at 134.5 ft^2 (USFWS 2003). All trawling was done during daylight hours, starting around 0800 hrs. Typically, the MKT and ORKT started and ended within a half hour of each other. The Kodiak trawl was towed against the current for 20 minutes. Although the boats and net faced upstream, the high flows carried the boats and net downstream. Due to the extremely high flows, only two tows were completed before the ORKT net was retrieved and reset upstream. For the ORKT, a total of 14 tows per day, five days a week, were conducted from May 3 through May 19. During this same time period, the MKT conducted 15 tows per day, seven days a week.

For the ORKT, all fish were counted and measured (fork length) to the nearest millimeter. All salmon were checked for a clipped adipose fin or spray dyed color-mark. Salmon

Table 4-3.
The raw abundance and composition of fishes caught in the Kodiak trawl in Old River (ORKT) and in the San Joaquin River (MKT) for trawls conducted weekdays, May 3-19, 2006. Chinook salmon catch is divided into CWT salmon, unmarked salmon, and color-marked salmon. Note: ORKT conducted 182 tows and the MKT conducted 196 tows.

Species	ORKT	MKT
Black Crappie	1	
Bluegill	5	
Brown Bullhead	1	
Common Carp	2	14
Goldfish		1
Golden Shiner		1
Inland Silverside		2
Redear Sunfish	1	2
Red Shiner		4
Sacramento Pikeminnow		2
Sacramento Sucker		1
Splittail	1	11
Steelhead	4	2
Threadfin shad	13	61
White Catfish	4	3
Chinook Salmon	**211**	**855**
CWT Salmon	54	238
Unmarked Salmon	130	547
Color-Marked Salmon	27	70
Total	**243**	**959**

with a clipped adipose fin were sacrificed for CWT reading. Although all the CWTs from the ORKT were read, not all the CWTs from the MKT were read and available at the writing of this section. Thus, for this comparison of the MKT and ORKT salmon catch, CWT salmon refers to all salmon with a clipped adipose fin. Because the number of salmon with a clipped adipose fin and no CWT is small, this should not significantly change the results. The unmarked salmon catch represents both hatchery and naturally spawned salmon. A flow meter was used to estimate the volume of water sampled. All sample statistics are reported as the mean ± standard deviation unless otherwise noted. The average volume of water sampled per tow by the MKT (395,969 ± 43,820 ft3) was greater than the ORKT (257,021 ± 32,203 ft3).

The ORKT caught 243 fish, representing 10 species, in 186 tows during 13 days of sampling in Old River. The most abundant species was Chinook salmon (87 %) followed by threadfin shad (Table 4-3). Of the 211 salmon caught, 130 were unmarked, 54 were classified as CWT, and 27 had a color-mark. The MKT caught 959 fish, representing 13 species, in 196 tows during the same 13 days of sampling in the San Joaquin River. The most abundant species caught was Chinook salmon (89 %) followed by threadfin shad (Table 4-3). Of the 855 salmon caught, 547 were unmarked, 238 were classified as CWT, and 70 had a color-mark. A two sample t-test (degrees of freedom (df) = 964, Probability (P) = 0.03, t statistic = 2.17) indicated fork lengths for salmon (unmarked and CWT pooled) were significantly different between the MKT caught salmon (100.8 ± 8.2 mm) and the ORKT caught salmon (102.3 ± 8.0 mm).

As part of the VAMP salmon survival studies, roughly 50,000 CWT salmon were released at Mossdale on May 4 and 75,000 on May 19. On May 5, the ORKT caught four CWT salmon from the May 4 VAMP release. No CWT salmon were caught by the ORKT from the May 19 release. CWT salmon catch was the highest on May 17 in the San Joaquin River (Figure 4-7) and on May 18 in Old River (Figure 4-8). The highest unmarked catch occurred on May 18 in both rivers. To estimate salmon vulnerability to the Kodiak trawl, groups of color-marked salmon were released upstream of the MKT and ORKT on May 4, 11 and 18. On each of these dates, approximately 5,000 fish were released at the Mossdale boat ramp and approximately 2,000 fish were released at the head of Old River. The MKT caught marked fish from all three Mossdale releases while the ORKT only caught marked fish from the first and last Old River releases (Table 4-4).

Daily catch ratios of CWT to unmarked salmon were compared between trawls to determine if CWT salmon were migrating similarly to unmarked salmon into the Old

Figure 4-6
Map of the 2006 Kodiak trawl sample locations on Old and San Joaquin Rivers. The Old River Kodiak trawl sampled between letters A and B, and the Mossdale Kodiak trawl sampled between letters C and D.

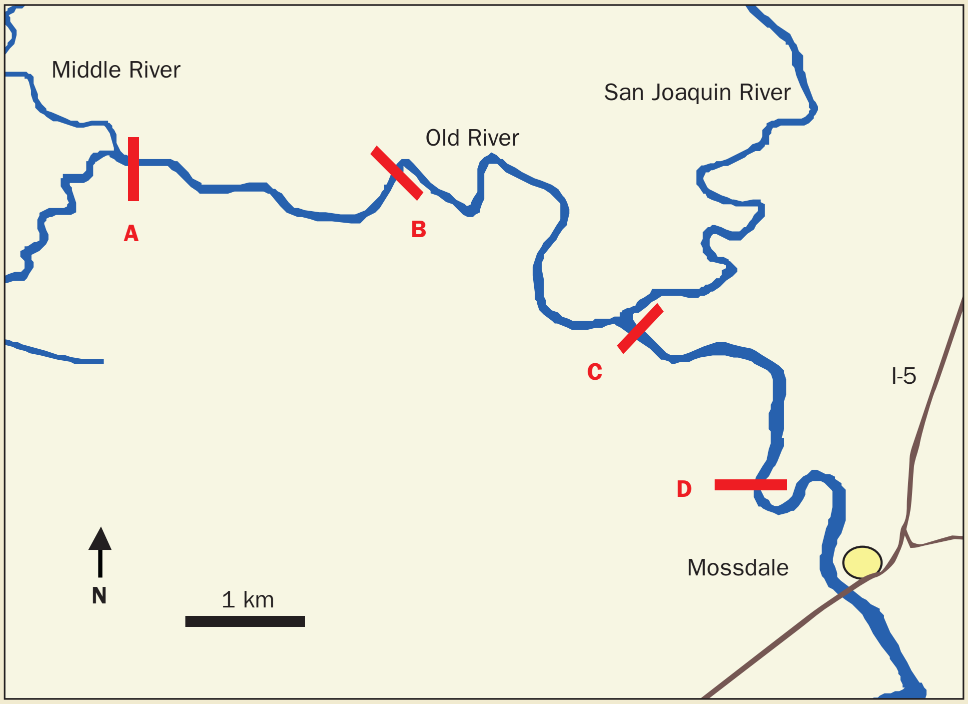


Figure 4-7
The total number of salmon by category (color-marked, coded wire tagged, and unmarked) caught in daily five hour Kodiak trawling sessions (150,000 m^3) in the San Joaquin River, 2006.

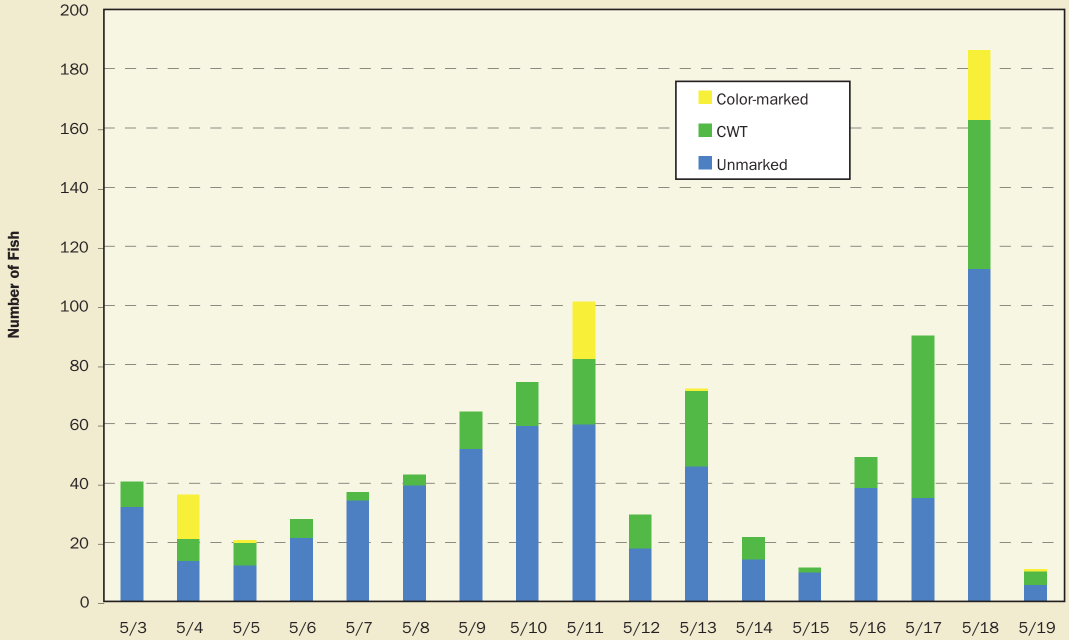


Figure 4-8

The total number of salmon by category (color-marked, coded wire tagged, and unmarked) caught in daily five hour Kodiak trawling sessions (150,000 m^3) in the Old River, 2006. An "X" indicates no samples were collected.

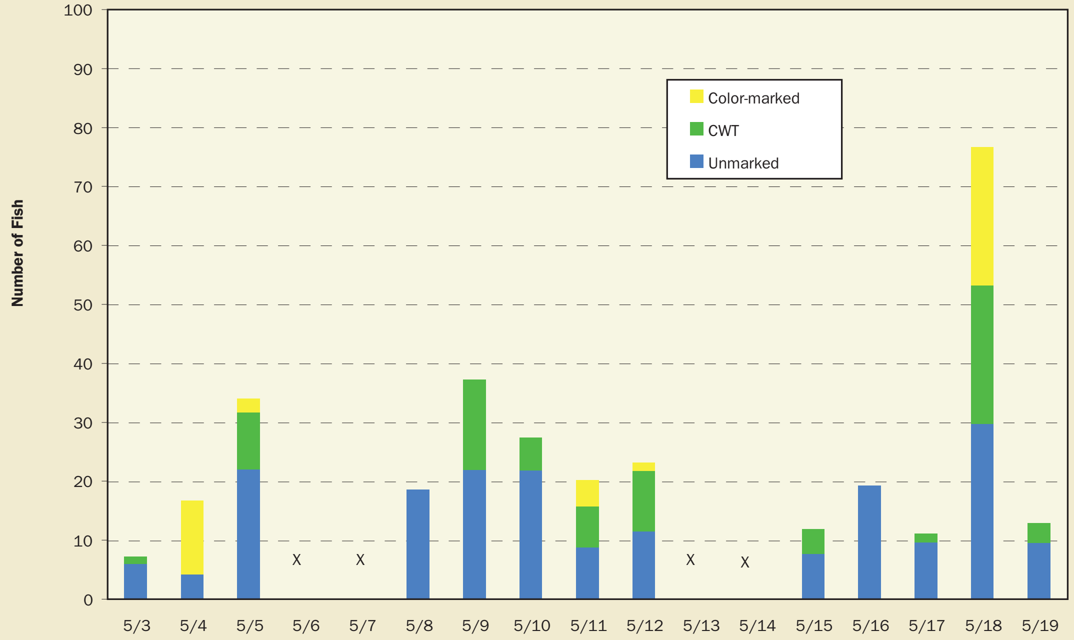
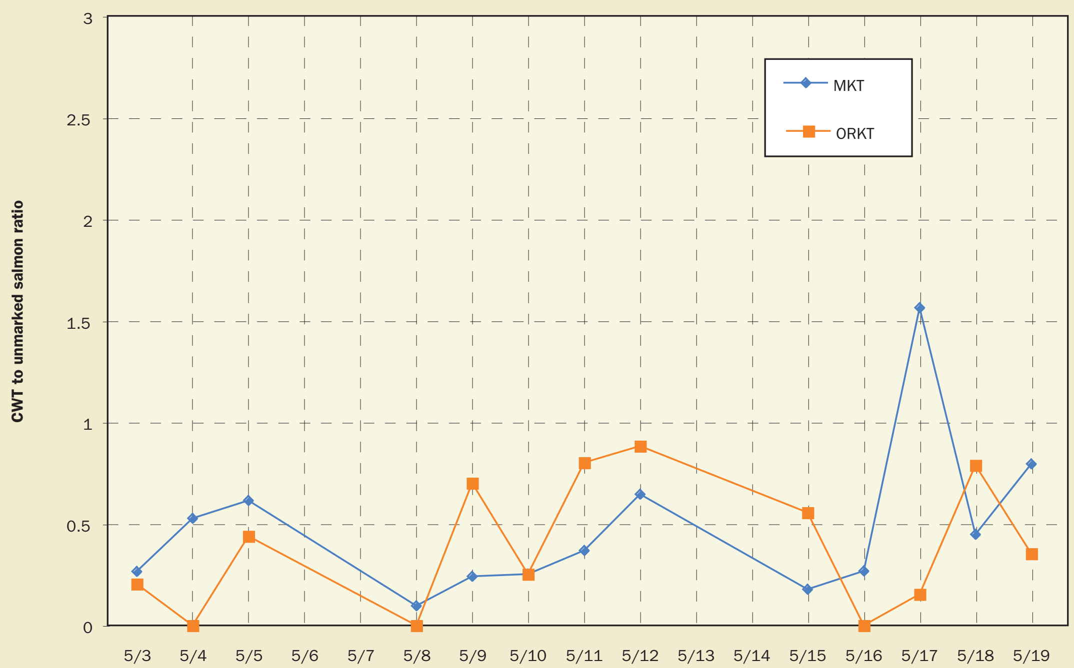


Figure 4-9

The ratio of CWT salmon to unmarked salmon caught in the Old River Kodiak trawl (ORKT) on Old River and the Mossdale Kodiak trawl (MKT) on the San Joaquin River, 2006.



River. The daily ratio of CWT salmon to unmarked salmon was similar between the ORKT and MKT (Figure 4-9). The daily ratios of CWT to unmarked salmon were converted to percentages (percent of the combined CWT and unmarked catch) and arcsine transformed before testing whether there was a significant difference between the ORKT and MKT. A paired two-tailed t-test (df = 12, P = 0.45, t statistic = 0.78) indicates no significant difference between the daily percent of CWT salmon caught in the ORKT and in the MKT.

Two different methods were used to calculate five-hour daily salmon abundance estimates in the San Joaquin River and Old River. These abundance estimates were used to estimate the percent of salmon migrating down Old River from the San Joaquin River. The abundance method based on flow (Af) is calculated by multiplying salmon density, calculated from the Kodiak trawl, by river flow and trawling duration (equation 1). The abundance estimate based on vulnerability (Av) is calculated by dividing the daily catch by the vulnerability estimate and standardizing the tow duration to 20 minutes (equation 2). For both methods, the 5 hour abundance estimates were standardized to 15 tows (5 hours of sampling) before they were compared to one another.

Equation 1:

$$A_f = \sum_{i=1}^{n} D_i * F_i * T_i$$

A_f = Abundance estimate based on flow and density
D = fish density (fish/m^3)
F = river flow (m^3/s) during sampling
T = trawling duration (s)
i = i^{th} tow
n = last tow with fish

Equation 2:

$$A_v = \sum_{i=1}^{n} (C_i/V)/(T_i/20)$$

A_v = Abundance estimate based on vulnerability
C = catch of Chinook salmon
V = vulnerability
T = tow duration (min)
i = i^{th} tow
n = number of tows

where:

$$V = \sum_{i=1}^{N} (Y_i/X_i)/N$$

V = vulnerability
Y = number of color-marked fish recaptured
X = number of color-marked fish released
N = number of releases
i = i^{th} release

The color-mark releases suggest the MKT flow abundance estimates were underestimating salmon abundance by one third and the ORKT flow abundance estimates were underestimating salmon abundance by one sixth (Table 4-4). Overall, the vulnerability abundance estimates were much higher than the flow abundance estimates, especially for Old River. Based on the flow method, on a daily average, 31 ± 29 % of the unmarked salmon, 32 ± 37 % of the CWT salmon, and 21 ± 11 % of the Mossdale released color-marked salmon estimated to be in the San Joaquin River migrated down Old River. Based on the vulnerability method,

Table 4-4
Color-marked salmon vulnerability results for the Mossdale and Old River Kodiak trawls. The catch in parenthesis for the Mossdale releases indicates the number of salmon caught by the ORKT. Abundance is the color-marked salmon abundance estimate based on flow method. Percent is how close the abundance estimate is to the actual number of marked salmon released.

Date	Released	Tows	Minutes	Catch	Vulnerability	Abundance	Percent
Mossdale Kodiak Trawl							
5/4/06	4,998	11	220	17 (3)	0.0034	1,261	25%
5/11/06	4,999	13	260	25 (4)	0.0050	1,529	31%
5/18/06	4,990	4	80	25 (8)	0.0050	1,774	36%
Average	4,996			22 (5)	0.0045	1,521	30%
Old River Kodiak Trawl							
Date	**Released**	**Tows**	**Minutes**	**Catch**	**Vulnerability**	**Abundance**	**Percent**
5/4/06	1,997	7	140	4	0.0020	296	15%
5/11/06	1,978			0		0	
5/18/06	1,989	5	100	5	0.0025	315	16%
Average	1,988			4.5	0.0023	203	15%

85 ± 87 % of the unmarked salmon, 78 ± 94 % of the CWT salmon, and 43 ± 17 % of the Mossdale released color-marked salmon estimated to be in the San Joaquin River migrated down Old River.

Flow data for the head of Old River (OH1) and San Joaquin River below Old River near Lathrop (SJL) was obtained from the California Department of Water Resources. Like last year, estimated flow on the San Joaquin River above Old River was calculated by summing flows from OH1 and SJL. From May 3 through May 19, river flow was slightly higher down Old River than down the San Joaquin River (Figure 4-10). During trawling, the percentage of water flowing down Old River ranged from 51 % (11,596 cfs) to 57 % (13,651 cfs), and averaged 54 % (12,113 cfs) ± 1 % (193 cfs).

Discussion

Despite high flows on Old River, which delayed the initial start date by two weeks, trawling went reasonably well. The delayed start limited our sampling to 13 days. Overall, the ORKT caught fewer fish and fewer fish species than the MKT. For both trawls, salmon were caught throughout the monitoring period and consisted of least 85 % of the total catch. Statistically, salmon caught in the ORKT were on average larger than salmon caught in the MKT; however, the couple of millimeter difference in length is probably not biologically significant and should not affect the catch comparison between trawls. Very few of the VAMP CWT salmon released at Mossdale were caught by either Kodiak trawls. The Mossdale VAMP releases were intentionally delayed to mid afternoon to avoid their capture by the Kodiak trawls. Interestingly, half of the CWT salmon caught by the ORKT were fish released for the Lower Merced River Survival Studies on April 26. These CWT salmon were caught throughout the two and half weeks of sampling in Old River.

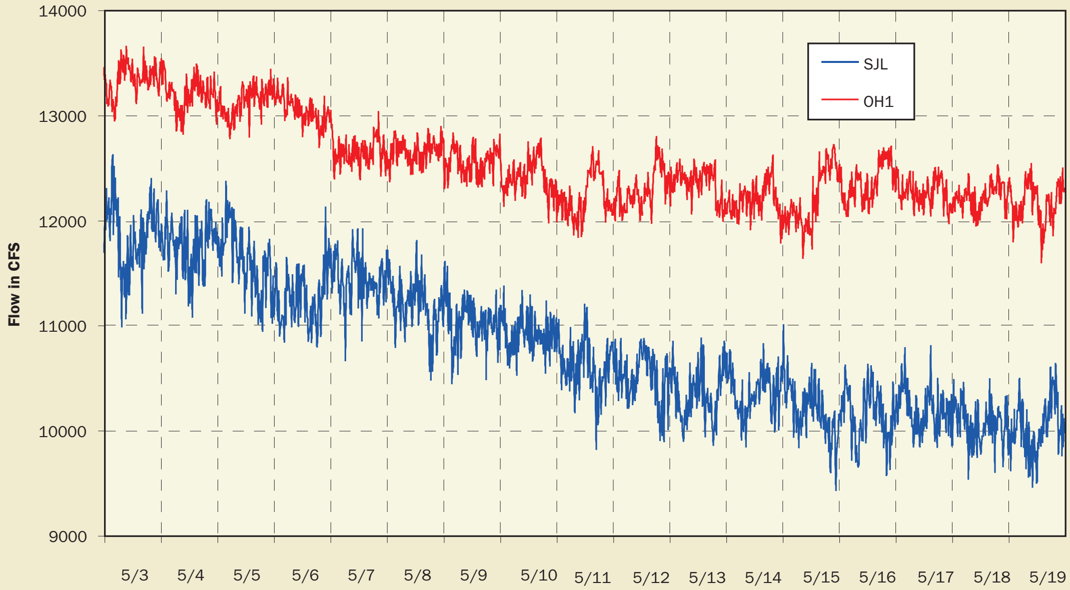
Direct comparisons between ORKT and MKT are difficult for a variety of reasons. Biases that can affect catch include the habitat (channel width, depth, and flow are not the same between and within the sample sites); the sporadic and uneven distribution of migrating salmon; boat and crew differences affecting how the Kodiak net is towed; and MKT and ORKT flow meters might have different calibrations which would effect water volume calculations. Using the ratio of CWT to unmarked salmon in each trawl minimizes some of these biases and other sampling differences. Although abundance estimates are calculated for both the Old and San Joaquin River, they will only be used to provide general insights to salmon migration into Old River.

The daily ratio of CWT to unmarked salmon was similar between the San Joaquin River and Old River. Like last year, CWT and unmarked salmon were migrating proportionally down Old River at the same rate. It appears the marking and subsequent release of CWT salmon in the tributaries does not affect their outmigration relative to the unmarked fish when they reach the Delta. However, there might be a difference for in-Delta releases of color-marked salmon. It appears color-marked salmon migrate down Old River at a lower rate overall than the unmarked and CWT salmon. However, when comparing salmon caught only on the three color-marked release days (May 4,11 and 18), color-marked salmon migrate down Old River at a slightly higher rate than the unmarked and CWT salmon. If color-marked fish

Table 4-5
Salmon abundance estimates in the San Joaquin River and Old River, for a 5 hour period, and the percent migrating down Old River. Abundancde estimates are based on two different methods of calculation: Abundance based on flow (A_f) and abundance based on vulnerability (A_v). Flow is the percent of the San Joaquin River flowing down Old River.

Unmarked Salmon							
	San Joaquin River		Old River		Percent down Old River		
Date	A_f	A_v	A_f	A_v	Flow	A_f	A_v
5/3/06	2,713	8,052	273	1,898	54%	10%	24%
5/4/06	1,163	3,355	189	1,423	53%	16%	42%
5/5/06	1,026	2,684	983	8,601	53%	96%	320%
5/8/06	3,170	9,171	795	6,167	53%	25%	67%
5/9/06	4,124	13,644	931	7,116	53%	23%	52%
5/10/06	4,721	15,433	924	7,591	53%	20%	49%
5/11/06	4,958	15,727	362	2,847	53%	7%	18%
5/12/06	1,385	4,250	480	3,795	54%	35%	89%
5/15/06	737	2,460	312	2,372	54%	42%	96%
5/16/06	2,925	8,947	804	6,167	55%	27%	69%
5/17/06	2,660	9,394	400	2,847	55%	15%	30%
5/18/06	8,450	26,841	1,227	8,065	55%	15%	30%
5/19/06	418	1,342	393	2,847	55%	94%	212%
Average					54%	31%	85%
Std dev					1%	29%	87%
CWT Salmon							
	San Joaquin River		Old River		Percent down Old River		
Date	A_f	A_v	A_f	A_v	Flow	A_f	A_v
5/3/06	724	2,237	56	474	54%	7%	21%
5/4/06	614	1,566	0	0	53%	0%	0%
5/5/06	631	1,789	432	3,345	53%	66%	187%
5/8/06	308	895	0	0	53%	0%	0%
5/9/06	1,001	3,579	652	5,219	53%	63%	146%
5/10/06	1,189	3,802	234	1,898	53%	19%	50%
5/11/06	1,827	5,871	290	2,372	53%	15%	40%
5/12/06	894	2,908	424	3,321	54%	46%	114%
5/15/06	131	447	174	1,423	54%	128%	318%
5/16/06	787	2,460	0	0	55%	0%	0%
5/17/06	4,162	14,539	61	474	55%	1%	3%
5/18/06	3,780	11,631	967	6,167	55%	25%	53%
5/19/06	332	1,118	139	949	55%	40%	85%
Average					54%	32%	78%
Std dev					1%	37%	94%
Color-marked							
	San Joaquin River		Old River		Percent down Old River		
Date	A_f	A_v	A_f	A_v	Flow	A_f	A_v
5/4/06	1,261	3,802	226	1,328	53%	18%	35%
5/11/06	1,529	5,592	173	1,771	53%	11%	32%
5/18/06	1,774	5,592	591	3,542	55%	33%	63%
Average					54%	21%	43%
Std dev					1%	11%	17%

Figure 4-10
Flow at the head of Old River (OH1) and near Lathrop on the San Joaquin River (SJL) during the 2006 Kodiak trawl survey. Flow recorded at 15 minute intervals.



releases were conducted everyday, they would probably show the same range in variability as the unmarked salmon migrating down Old River.

Salmon abundance in the San Joaquin River and Old River was calculated using two different methods. As in 2005, salmon abundance was calculated by multiplying salmon density by river flow and trawling duration. In 2006, abundance estimates were also calculated using the vulnerability results. Salmon abundance estimates for the two different methods gave vastly different results. Therefore, the average daily percentage of salmon calculated to be heading down Old River varied dramatically between the two methods. The color-marked vulnerability studies suggest the ORKT was underestimating salmon abundance to a larger degree than the MKT. The color-marked flow abundance estimates indicate the ORKT was only half as efficient as the MKT in catching juvenile salmon. The flow abundance estimates also tend to underestimate abundance when salmon are not evenly distributed in the water column. The vulnerability estimates likely give a better abundance estimate because they are based on net efficiency and the assumption that color-marked salmon distribute themselves similarly to the unmarked salmon.

The daily percentage of CWT and unmarked salmon heading down Old River is similar on most days. However, there is variability in the percentages among sampling days. Although flow in the San Joaquin River and Old River was relatively constant during the monitoring period, the variability around the mean for salmon migrating down Old River is large. If salmon always migrated in proportion to the flow split, and if we sampled consistently among days, we would expect low variability among the daily percentages of salmon migrating down Old River. The large observed variability could be due to the natural variability in salmon migration compounded by trawling biases and the extrapolated abundance estimate calculations.

As a general insight into salmon migration into Old River, average salmon abundance estimates were compared at different flows for three different years of Kodiak trawling. Based on the 1995, 2005 (San Joaquin River Group Authority 2006) and 2006 salmon abundance estimates for the San Joaquin and Old Rivers, it appears a higher percentage of salmon migrate down Old River at higher flows. When flow on the San Joaquin River upstream of the split was around 8,000 cfs (in 2005), 59 ± 51 % of the salmon went down Old River. At flows around 18,000 cfs (in 1995), 67 ± 13 % of the salmon headed down Old River. At flows around 23,000 cfs (2006), 78 ± 71 % of the salmon went down Old River. It must be noted that there is a lot of variability around the means and the overall relationship is probably not statistically significant. Also, differences in sampling location, sampling procedures and salmon abundance calculations among years contribute additional variability which further confounds the results.

If salmon truly head down Old River at a higher rate at higher flows, then the hydrology in front of the split with Old River might be a contributing factor. At higher flows, it appears the main current in the San Joaquin River is pushed towards the western bank and down Old River. As observational evidence, on May 4, 2006, while trawling in Old River, we noticed a steady ribbon of water hyacinth floating with the current. At the end of the day, on our trip back to the Mossdale boat ramp, we noticed that all the water hyacinth was heading down Old River and nothing was continuing down the San Joaquin River. The continuous ribbon of hyacinth revealed that the bend in the San Joaquin River, just upstream of the head of Old River, pushed the main current to the western side of the river and straight down Old River. Anything floating with the main current or west of the main current went down Old River.

Summary

Salmon were the most abundant species caught during the 13 days of Kodiak trawling in the San Joaquin River and Old River. Five-hour salmon abundance estimates were calculated for each river using two different methods. It appears abundance estimates based on vulnerability gives a better estimate than those based on density and flow. On an average daily basis, it appears about three-quarters of the salmon in the San Joaquin River migrated down Old River. During this time period, a little more than half of the San Joaquin River flow was heading down Old River. Although the daily variability in the data is large, it appears that in May 2006, salmon were going down Old River at a higher rate than water flow. The hydrology at the San Joaquin River and Old River split might be a contributing factor for increased salmon migration down Old River at higher flows. Any salmon following the main current will probably head down Old River. More research into the hydrology of this area will provide better insights into salmon migration down Old River.

Chapter 5
Salmon Smolt Survival Investigations

One of the primary objectives of the VAMP study, in addition to providing enhanced protection of juvenile Chinook salmon emigrating from the San Joaquin River system, is to determine the effects of San Joaquin River flows, SWP and CVP water exports, and HORB placement on survival of Chinook salmon smolts emigrating from the San Joaquin River through the Delta. As mentioned in previous chapters, the HORB was not installed in 2006. Therefore the VAMP study design was modified in 2006 to accommodate this change. This section describes the methods used to conduct the Chinook salmon smolt survival investigations and provides calculated survival indices, absolute survival estimates, and combined differential recovery rates for coded-wire tagged (CWT) Chinook salmon smolts released during the VAMP 2006 test period.

Merced River Fish Hatchery Coded-Wire Tagging

Merced River Fish Hatchery (MRH) supplied 200,000 CWT Chinook salmon smolts for the VAMP 2006 study. This was lower than requested due to lower than average adult returns to the hatchery and use of many of the MRH fish available for tributary studies. Salmon were coded wire tagged and marked with an adipose fin clip by a private contractor in March and April. Groups of fish were generally held separately by tag code, for approximately 27 days before release. Salmon were tagged with one of eight distinct tag codes. MRH examined sub-samples of tagged salmon to obtain estimates of mean size at release and CWT retention rates. CWT retention is typically high and all salmon from the sub-samples without a detected tag were sacrificed to verify the accuracy of the CWT detection process and to determine if these fish contained an undetected, non-magnetized tag. No sub-sampled fish were found to contain non-magnetized tags. Average tag retention documented by MRH was 97% and ranged from 94% to 100% (Table 5-1).

California Department of Fish and Game (Region 4) calculated the effective number released (ER) by tag code by first subtracting the pond loss at the hatchery (HL) from the total number tagged (TM) to obtain the hatchery release number (HR) (Table 5-1). Mortalities from the quality control (QCL), loading (LL) and transporting (TL) processes were then subtracted from the HR to obtain the number released at the site (SR). The number released at the site (SR) was then corrected for the tag retention rate (TRR) to obtain the number of fish with tags released at the site (ST). Finally, the fish with tags in the net pens (PT) that were sacrificed were subtracted from the site release with tags (ST) to obtain the effective release number (ER). The following formula restates how the effective number of fish released in each VAMP group was calculated.

$$HR = TM - HL$$

$$SR = HR - QCL - LL - TL$$

$$ST = SR * TRR$$

$$ER = ST - PT$$

VAMP Fish Releases

CWT salmon were released at three sites on five dates for the 2006 VAMP experiment (Table 5-2). CWT salmon with different tag codes were held separately at the hatchery and trucked in discrete tag lots to each release location. Releases occurred at Mossdale, Dos Reis, and Jersey Point for the first set of releases and at Mossdale and Jersey Point for the second set of releases. Transport and water temperatures at the time of release are listed in Table 5-2. The mean size of the fish released in each of the VAMP groups is also shown in Table 5-2.

Mossdale is located on the San Joaquin River upstream of the Head of the Old River (HOR)(Figure 1-1). For the first release, approximately 50,000 CWT salmon with two different tag codes were released at Mossdale. For the second release approximately 75,000 CWT salmon with three different tag codes were released at Mossdale.

Dos Reis is located downstream of the HOR (Figure 1-1), and was used as a release site in 2006 to help assess the mortality of marked salmon from the Mossdale release diverted into Old River. Just over 25,000 CWT salmon of one tag code were released during the first release. No releases were made at Dos Reis during the second set of releases.

Two releases of approximately 25,000 each were made at Jersey Point with one tag code per release. CWT salmon were released on a flood tide at Jersey Point to increase fish dispersion throughout the channel before they migrated downstream past Antioch and Chipps Island (recovery

Table 5-1
Chinook Salmon Smolt Release Data for VAMP, 2006

Release Site	CWT Code	Release Date	Total Marked TM	Mortalities					# Released at Site (SR)	Retention (TRR)	# Released at Site with tags (ST)	Fish in net pens w/ tags (PT)	Effective Release (ER)
				Hatchery Loss (HL)	Hatchery rel. (HR)	Quality Control (QCL)	Load (LL)	Transport/ Plant (TL)					
Mossdale	06-47-13	5/4/06	25,992	92	25900	32	21	2	25,845	0.97	24,946	243	24,703
Mossdale	06-47-14	5/4/06	25,841	92	25749	34	27	3	25,685	0.96	24,534	219	24,315
Dos Reis	06-47-16	5/5/06	26,018	61	25957	25	27	1	25,904	1.00	25,904	302	25,602
Jersey Point	06-47-15	5/8/06	27,240	90	27150	30	23	3	27,094	0.98	26,417	225	26,192
Mossdale	06-47-21	5/19/06	25,917	49	25868	29	1	1	25,837	0.98	25,320	215	25,105
Mossdale	06-47-22	5/19/06	25,996	58	25938	38	6	1	25,893	0.94	24,225	217	24,008
Mossdale	06-47-23	5/19/06	25,765	43	25722	28	4	2	25,688	0.99	25,303	237	25,066
Jersey Point	06-47-24	5/22/06	25,941	51	25890	26	636	0	25,228	1.00	25,102	197	24,905
									Average	0.97			

Table 5-2
Chinook salmon smolt release data for VAMP 2006.

Release Date	Release Site	Tag Code	Effective Number Released	Size at release (in mm)	Transport Temperature (F)	River Temperature (F)
Release 1						
4-May-06	Mossdale	06-47-13	24703	80	53	64
4-May-06	Mossdale	06-47-14	24315	77	53	64
5-May-06	Dos Reis	06-47-16	25602	79	53	64
8-May-06	Jersey Point	06-47-15	26192	80	53	66
Release 2						
19-May-06	Mossdale	06-47-21	25105	89	55	67
19-May-06	Mossdale	06-47-22	24008	88	55	67
19-May-06	Mossdale	06-47-23	25066	89	55	67
22-May-06	Jersey Point	06-47-24	24905	87	55	67

sampling stations). Releases at other locations did not incorporate the tides for determining release times.

During the VAMP period in 2006, San Joaquin River flows were so high that part of the flow was diverted into Paradise Cut (a flood bypass). Paradise Cut flow leaves the San Joaquin River upstream of Mossdale, but downstream of Durham Ferry. To better compare results to other years, when San Joaquin flow was not diverted into Paradise Cut, the upstream release site was changed from Durham Ferry to Mossdale in 2006.

The study design in 2006 was intended to 1) estimate survival between Mossdale and Jersey Point under two different export levels and 2) determine if there was a difference in survival for smolts released at Mossdale versus those released at Dos Reis. The group released at Mossdale would have some of the group presumably diverted into upper Old River while those released at Dos Reis would generally stay on the mainstem San Joaquin River. Two sets of releases were made at Mossdale and Jersey Point to measure survival through the Delta at two exports levels, under similar and high San Joaquin River flow levels (approximately 25,000 cfs). Average daily exports were targeted to be 1500 cfs for the two weeks following the first release at Mossdale and 6000 cfs during the two weeks following the second Mossdale release. The number released for the first Mossdale group was reduced from 75,000 to 50,000 to provide 25,000 fish to be released at Dos Reis. It was anticipated, even with the low release numbers, that recovery numbers would be sufficient from both Mossdale and Dos Reis since survival has been relatively high in the past during similar high flow years. With the anticipation that survival might be lower under higher exports the Mossdale release numbers were kept at 75,000 for the second Mossdale release resulting in no Dos Reis release during the second set of releases.

Water Temperature Monitoring

Water temperature was monitored during the VAMP 2006 study using individual computerized temperature recorders (e.g., Onset Stowaway Temperature Monitoring/Data Loggers). Water temperatures were measured at locations along the longitudinal gradient of the San Joaquin River and interior Delta channels between Durham Ferry and Chipps Island – locations along the migratory pathway for the juvenile Chinook salmon released as part of these tests (Appendix C-1and C-2). As part of the 2006 VAMP monitoring program additional temperature recorders were deployed in the south and central Delta (Appendix C-1) to provide geographic coverage for characterizing water temperature conditions while juvenile salmon emigrate from the lower San Joaquin River through the Delta.

Water temperature was recorded at 24-minute intervals throughout the period of the VAMP 2006 investigations. Water temperatures were also recorded within the hatchery raceways at the MRH coincident with the period when juvenile Chinook salmon were being tagged and held. These temperature recorders were later transported with the juvenile salmon released at Mossdale (Appendix C-1).

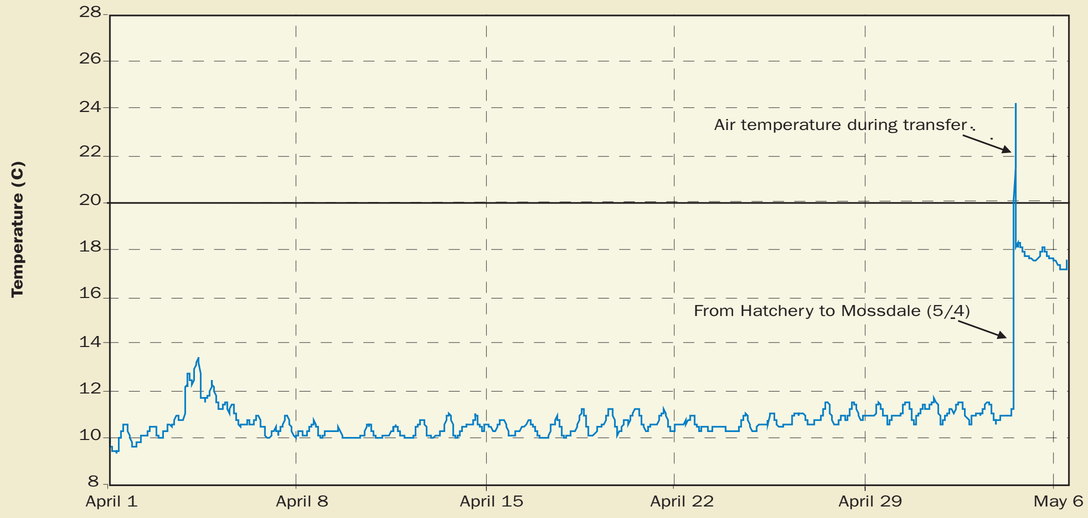
Results of water temperature monitoring within the MRH showed that juvenile Chinook salmon were reared in, and acclimated to, water temperatures of approximately 10°- 12° C (50° - 54° F) prior to release into the lower San Joaquin River (Figures 5-1 and 5-2). Results of water temperature monitoring at Durham Ferry, Dos Reis, and Chipps Island during the April-May fall-run Chinook salmon smolt emigration from the San Joaquin River through the Delta are shown in Figures 5-3, 5-4, and 5-5. The water temperature logger deployed at the Mossdale release site could not be relocated and may have been lost to vandalism. Water temperature monitoring showed that water temperatures throughout the lower San Joaquin River and Delta (Appendix C-2) were higher than those at the hatchery, which is usually always the case. Water temperatures measured within the lower San Joaquin River and Delta (Figures 5-4 and 5-5; Appendix C-2) generally increased over time and may have reduced survival of emigrating juvenile Chinook salmon released as part of the VAMP 2006 investigations.

Short-Term Survival Study

A short term survival study was conducted as part of VAMP to determine if handling, transport, and release affected immediate (short-term) and 48-hour survival and general condition. A subset of approximately 225 CWT salmon were removed from the MRH truck and placed in net pens (volume ~ 1m^3; mesh size ~3 mm) before the remaining fish were released. Samples from each tag group were held in separate net pens.

Once placed into the pens, sub-samples of 25 fish from each pen were examined for swimming vigor then euthanized for measuring and documenting general condition. Each fish was measured (fork length to nearest 1 mm), weighed (to the nearest 0.1 g) and examined qualitatively in the field for percent scale loss, body color, fin hemorrhaging, eye quality, and gill coloration. Table 5-3 identifies the criteria used to define normal and abnormal conditions for these characteristics. Additionally, quality of adipose fin clip was documented. The sub-sampled fish were taken to the U.S. Fish and Wildlife Service, Stockton office (STFWO), for verification of tag code. After 48-hours post release, an additional 25 fish from each pen were measured, weighed, and examined for condition, as

Figure 5-1
Water Temperature Monitoring Merced River Fish Hatchery to Mossdale



5-2
Water Temperature Monitoring Merced River Fish Hatchery to Mossdale

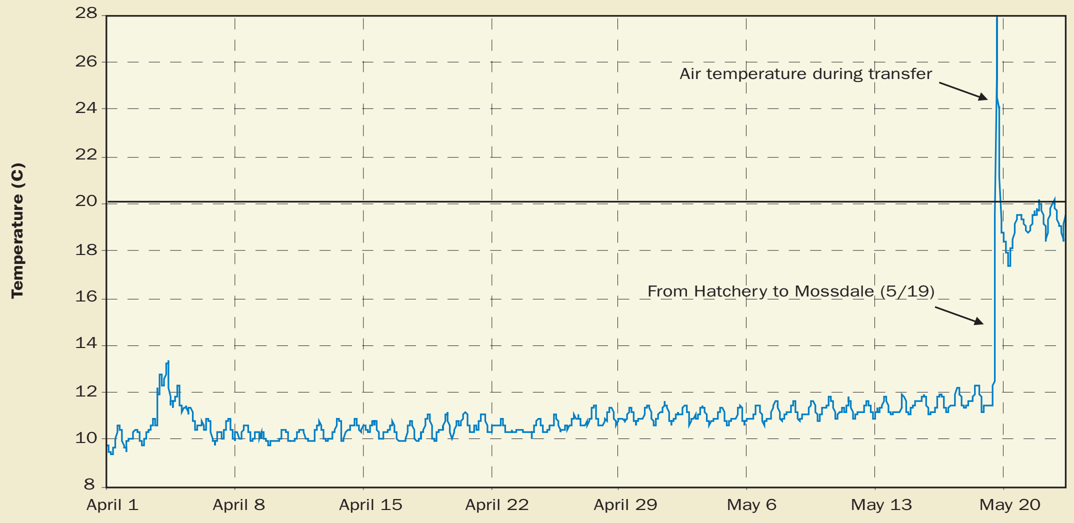


Figure 5-3
Water Temperature Monitoring Site 1 - Durham Ferry

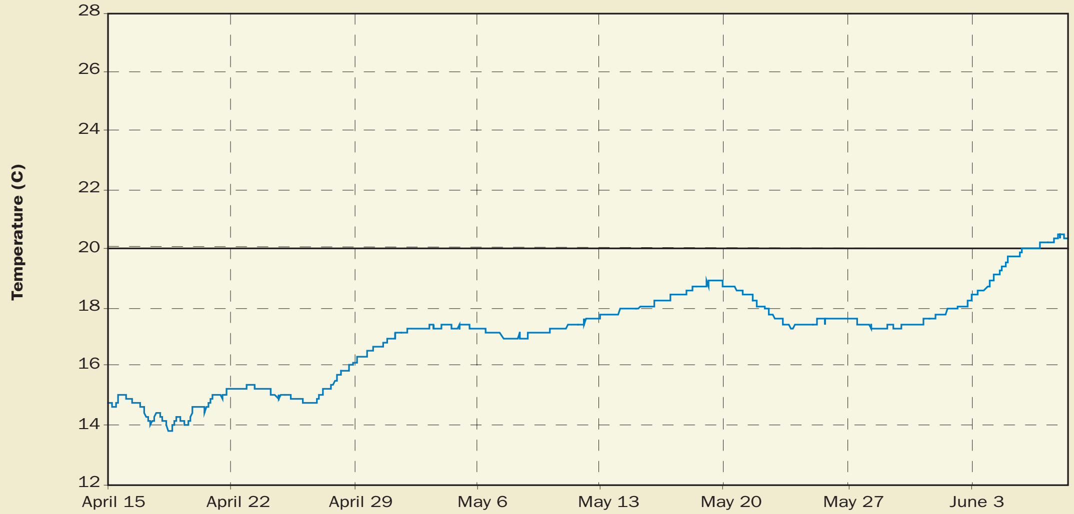


Figure 5-4
Site 3 - Dos Reis Water Temperature Monitoring

Figure 5-5
Site 10 - Chipps Island Water Temperature Monitoring

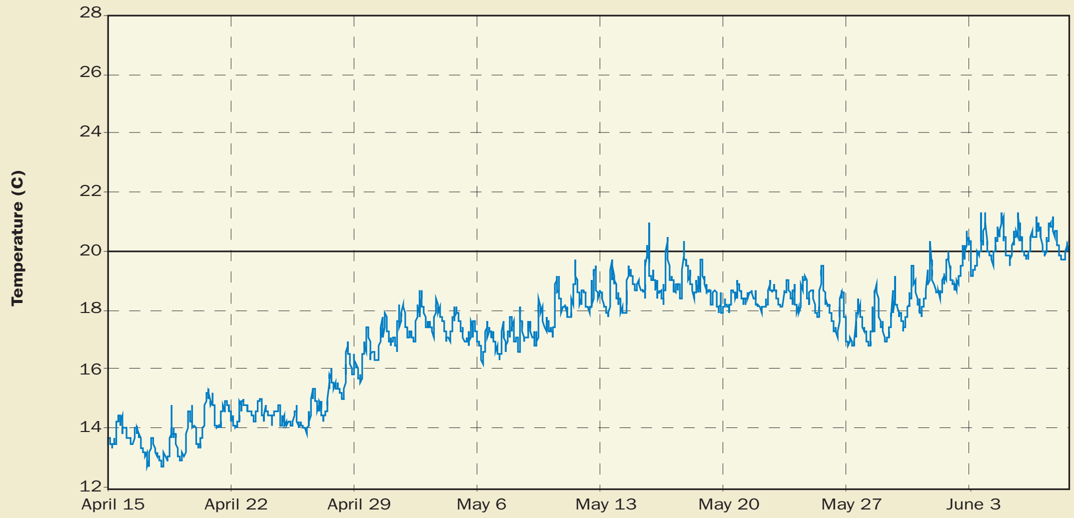


Table 5-3 Characteristics assessed for Chinook salmon smolt condition and short-term survival.		
Character	**Normal**	**Abnormal**
Percent Scale Loss	Lower relative numbers based on 0-100%	Higher relative number based on 0-100%
Body Color	High contrast dark dorsal surface and light sides	Low contrast dorsal surface and sides, coppery color
Fin Hemorrhaging	No bleeding at base of fins	Blood present at base of fins
Eyes	Normally shaped	Bulging or with hemorrhaging
Gill Color	Dark beet red to cherry red colored gill filaments	Gray to light red colored gill filaments
Vigor	Active swimming (prior to anesthesia)	Lethargic or motionless (prior to anesthesia)

described above. The remaining fish from each pen were examined for mortalities, euthanized, counted, measured, weighed, and returned to the STFWO for additional tag code verification.

Sub-samples of fish in the net pens immediately after release were generally in good condition (Appendix C-3a). All fish were swimming vigorously before being euthanized. Mean scale loss ranged from 3% for the second Mossdale release to 7% for the second Jersey Point release (average of all locations = 5.5%). Body color and gill color were normal for all fish examined except the second Jersey Point release. These fish were held for an additional 2 hours in the truck due to a flat tire; subsequently, body and gill color appeared pale. Fin hemorrhaging was observed in 4% of fish from the first Mossdale and second Jersey Point releases. Partial fin clips were observed at all sites and ranged from 8% to 16%.

Short-term survival (48-hours post-transport) was high (100%) within the net pens. Fish retained in the net pens for the 48-hour post release examination were swimming vigorously and generally in good condition (Appendix C-3b). Mean scale loss was (7%) and ranged from 5% to 12.5% after each of the 48-hour trials. Fish from all releases, except the second Jersey Point release had fin hemorrhaging. Fin hemorrhaging ranged from 4% to 16%. Fish from the second Jersey Point release had a high occurrence of abnormal body color (84%). No abnormal eye quality was detected in any fish. Pale gills were detected in 3% of fish from the second Mossdale release and 16% from the second Jersey Point release. No other fish had abnormal gill coloration. These data indicate that the fish used for the VAMP 2006 experiment were in good condition both initially and after 48 hours; and that handling, transport, and release should not have affected their survival.

Tag code discrepancies were found to have occurred between two tag codes used in the second set of releases; one of the mixed tag codes (06-47-23) was from the Mossdale release (May 19th), and the other was from the May 22nd Jersey Point release (06-47-24). The mixing was discovered when one of the 25 fish from the Mossdale net pen had a tag code associated with the Jersey Point release. To further evaluate the extent of the mixing, all fish kept from each of eight net pens were dissected to obtain the tags and identify tag codes. For the one Mossdale net pen, a total of 7 fish out of 212 contained tags with the Jersey Point tag code (06-47-24). For the Jersey Point net pen group, 32 of 222 were found to have a Mossdale tag code (06-47-23). In further discussion with Fish and Game it was determined that the mixing occurred when a screen at the hatchery was changed that separated the tag groups in the raceway. There was no evidence of mixing in the remaining six tag codes.

Health and Physiology

On April 25 2006, a subsample of 60 CWT juvenile Chinook salmon from tagged lots used in the 2006 VAMP study, were brought from the MRH to the U.S. Fish and Wildlife Service California-Nevada Fish Health Center (CA-NA FHC). Kidneys from these fish were collected aseptically for viral assay, culture of systemic bacteria and imprint smears to determine if *Renibacterium salmoninarum* was present. Posterior kidney from 20 salmon was processed to evaluate *Tetracapsuloides bryosalmonae* infection and kidney inflammation. This parasite has been detected in Merced River salmon for several decades (Hederick et al., 1986) and causes Proliferative Kidney Disease (PKD). A total of 14 of 60 kidney imprints contained low numbers of bacteria that resembled *R. salmoninarum*. While the fish were asymptomatic for Bacterial Kidney Disease (BKD), the 23% detection rate indicates that MRH juvenile Chinook contained a high number of *R. salmoninarum* infected fish. *R. salmoninarum* infections have been documented for MRH Chinook juveniles in previous years. It is unclear whether such infection later develops into clinical disease and is a health problem for the population.

In addition to examining MRH 2006 VAMP salmon prior to release, selected salmon recovered at Chipps Island were also examined for the presence of PKD. A subsample of 407 adipose fin clipped Chinook juveniles were collected in the Chipps Island trawl between 5 May and 18 June 2006. Kidney samples were collected from these fish by field personnel from the Stockton Fish and Wildlife Office. Imprints from 66 of these fish, which contained tags with VAMP tag codes, were screened for *T. brysalmonae*. The parasite *T. brysalmonae* was not detected in Chipps Island imprints, however, a number of imprints were observed to have been improperly fixed. If kidney imprints are collected in the future, it may be necessary to use rapid methanol fixation or provide additional training to field personnel. Based on the inability to detect *T. brysalmonae* in both histological and cytological sample types, this strongly suggests that the MRH juvenile Chinook population was not infected in 2006. A full report is available in Foott and Stone (2006).

Release Number Correction

The release number for the 2nd Jersey Point group has been corrected because of the tag code mixing at the hatchery, explained above. Information from the mixed Mossdale tag lot (6-47-23 tag code) has not been used for any analyses in this report. Only the two unmixed Mossdale tag codes were used from the 2nd release. We have corrected the Jersey Point release number based on the assumption that the proportion of those mixed in the total group is the same as the proportion mixed in the net pens. Without this assumption, there is no basis for correcting the release numbers. While this assumption is reasonable, there is no way of testing it.

The number of fish actually released at Jersey Point with a 6-47-24 tag code was estimated by subtracting those with the same tag code that were mistakenly released at Mossdale (925) from the effective release number (Table 5-4). We have assumed that the estimated number of survivors to Jersey Point (19) of the 925 released at Mossdale would have a negligible effect on our estimates of survival or recovery rate. The number of survivors was estimated by multiplying the number estimated to be released at Mossdale (925) by the survival rate to Jersey Point of the other (two unmixed) Mossdale tag groups released on the same day (Table 5-4). The estimated number of 06-47-24 tags released at Mossdale was obtained by multiplying the effective release number of the Jersey Point group (06-47-24) by the proportion of the tag code in the Mossdale net pen relative to the total in both net pens (Jersey Point and the one mixed Mossdale net pen). Numbers were standardized so that equal weight was given to both net pens, although due to rounding this adjustment did not change the number of tags estimated (7) with a 6-47-24 code in the Mossdale net pen. The proportion (0.0371) of 06-47-24 tags in the Mossdale net pen was estimated by dividing the standardized number found in the Mossdale net pen (7) by the standardized total in both net pens (197). The corrected effective release (CER) of the 06-47-24 tag code released at Jersey Point was estimated at 23980.

Coded-Wire Tag Recovery Efforts

Coded-wire tagged salmon were recaptured at Old River, Mossdale, Antioch, Chipps Island, and the Federal (Central Valley Project (CVP)) and State Water Projects (SWP) (Figure 1-1). CWT salmon recovered in California Department of Fish and Game (DFG) Kodiak trawls at Old River and Mossdale are discussed in Chapter 4. Juvenile Chinook salmon with an adipose fin clip caught at Antioch, Chipps Island and at the CVP and SWP fish facilities were sacrificed, labeled, and frozen for CWT processing by staff at Stockton Fish and Wildlife Office. DFG Region 4 staff processed CWT fish from Old River and Mossdale.

Table 5-4
Calculations to correct tag code mixing between 6-47-23 and 6-47-24 for VAMP studies in 2006

Net Pen Location	Net Pen Total	CWT Code 06-47-23	CWT Code 06-47-24	Percentage 6-47-23 in Net Pen at Mossdale
Mossdale	212	205	7	96.70%
Adjusted net pen sample Mossdale	222	215	7	
Jersey Point	222	32	190	
CWT Code	**Number in Tag Code**	**Proportion of Tag Code Released at JP**	**Proportion of Tag Code Released at Moss**	
06-47-24	24905	0.9629	0.0371	
CWT Code	**Estimated Number Released at Mossdale**	**Corrected Number Released at JP CE**	**Estimated Survival Mossdale to JP**	**Mossdale Release Fish Surviving to JP**
06-47-24	925	23980	2%	19

CWT processing consists of dissecting each tagged fish to obtain the 1-mm cylindrical tag from the snout. Tags are then placed under a dissecting microscope and the numbers are read and recorded in a database and archived. All tags were read twice, with any discrepancies resolved by a third reader. It should be noted that many CWT Chinook salmon are captured during the VAMP study; however a portion of these fish have been tagged for other studies and are not affiliated with the VAMP study. In order to identify tags related to VAMP, it is necessary to read all recovered tags.

Antioch Recapture Sampling

Fish sampling was conducted in the vicinity of Antioch on the lower San Joaquin River (Figure 1-1) using a Kodiak trawl, similar to previous years (since 2000). The Kodiak trawl has a graded stretch mesh, from 2-inch mesh at the mouth to 1/2-inch mesh at the cod-end. Its overall length is 65 feet, and the mouth opening is 6 feet deep and 25 feet wide. The net was towed between two skiffs, sampling in an upstream direction. Trawls were performed near the left bank, mid-channel, and right bank to sample CWT salmon emigrating from the San Joaquin River. Each sample was approximately 20 minutes in duration.

All captured fish were transferred immediately from the Kodiak trawl to buckets filled with river water, where they were held for processing. Data collected during each trawl included: species identification and fork length for each fish captured, tow start time and duration, and location in the channel. Any fish mortalities or injuries were documented to comply with the Endangered Species Act permit requirements. Juvenile Chinook salmon with an adipose fin clip were retained for later CWT processing while other fish were released at a location downstream of the sampling site immediately after identification, enumeration, and measurement.

Sampling at Antioch each day between 5:30 a.m. and 9:00 p.m. began May 5 and continued through May 31. In all, 680 Kodiak trawl samples were collected, for a total of 13,520 tow minutes. During sampling, 3,147 unmarked juvenile Chinook salmon were captured; 110 salmon with a coded wire tag were collected: 52 from VAMP releases (Table 5-5) and 57 from other hatchery releases. In addition, 59 delta smelt, 8 unmarked steelhead, and 8 adipose fin clipped steelhead were caught during sampling.

Chipps Island Recapture Sampling

Recovery efforts at Chipps Island were conducted using a mid-water trawl towed at the surface. The trawling net is 82 feet in length and has an opening that is 30 feet wide by 10 feet deep. Mesh size of the net is variable and ranges from 4-inch mesh at the mouth to 5/16-inch mesh at the cod end.

For VAMP 2006 trawling was conducted during two time periods per day, seven days per week from May 5, 2006 through June 17, 2006. Greater recoveries of Chinook salmon smolts have been reported during sunrise and sunset (Hanson Environmental, unpublished data).

Table 5-5
Chinook salmon smolt recovery information at Antioch, Chipps Island, and the fish facilities for VAMP 2006 releases.

				Antioch Recoveries						
Tag Code	Release Site	Release Date	Corrected or Effective Release number	First Day Recovered	Last Day Recovered	Number Recovered	Recovery Effort (minutes sampled)	Percent of Time Sampled	Survival Index	Group index
06-47-13	Mossdale		24,703	5/10/06	5/10/06	5	580	0.403	0.036	
06-47-14	Mossdale		24,315	5/11/06	5/16/06	4	3255	0.377	0.031	
	Total	**5/4/06**	**49,018**	**5/10/06**	**5/16/06**	**9**	**3835**	**0.380**		**0.035**
06-47-16	Dos Reis	5/5/06	25,602	5/10/06	5/12/06	3	1760	0.407	0.021	
06-47-15	Jersey Point	5/8/06	26,192	5/8/06	5/13/06	26	3245	0.376	0.190	
06-47-21	Mossdale		25,105	–	–	0	0	0.000	–	
06-47-22	Mossdale		24,008	–	–	0	0	0.000	–	
~~06-47-23~~	~~Mossdale~~		~~25,066~~	~~5/24/06~~	~~5/24/06~~	~~1~~	~~580~~	~~0.403~~	~~0.007~~	
	Total	**5/19/06**	**49,113**			**0**	**~~580~~**	**~~0.403~~**		**0.000**
06-47-24	Jersey Point	5/22/06	23,980	5/22/06	5/29/06	14	4160	0.363	0.116	

Mossdale group (6-47-23 tag code) not used in the analyses.

Therefore, the first shift began during sunrise and the second shift was completed during sunset in an attempt to increase the recovery of Chinook salmon smolts and reduce the variability in calculated survival indices and recovery rates. Two shifts a day have been conducted during the VAMP period since 1998. Each shift consisted of ten 20-minute tows conducted in the north, middle, and south sections of the channel parallel to the shore. Generally, three tows are conducted in each section of the channel with the section of the channel selected randomly for the last tow. After six weeks, the majority of VAMP Chinook salmon smolts have migrated past Chipps Island, so sampling was subsequently reduced. Ten morning tows were continued seven days per week between June 18 and June 24; and three days per week after June 25.

All fish retained in the cod end of the net were placed in aerated water collected from the sample site. All Chinook salmon smolts with an adipose fin clip were labeled and retained for later CWT processing. All other fish were identified to species, enumerated, and released. The fork length of each individual was measured to the nearest mm. As mentioned previously, some salmon were also processed in the field to determine if *T. bryosalmonae* were present. CWT salmon released for the VAMP 2006 study were recovered from Chipps Island between May 8 and May 29, 2006 (Table 5-5). A total of 53 juvenile Chinook salmon with tag codes used in the VAMP 2006 study were recaptured at Chipps Island; the majority being released at Jersey Point.

During this same time period, the catch included 10,695 unmarked Chinook salmon; 944 CWT Chinook salmon from non-VAMP studies; 179 delta smelt; 80 Sacramento splittail; 6 marked steelhead; and 12 unmarked steelhead.

CVP and SWP Salvage Recapture Sampling

CVP and SWP fish facilities salvage fish on a continuous basis. To estimate the total number of fish salvaged, sub-samples (raw salvage) are collected approximately every two hours. Expanded salvage is a calculated by expanding the raw salvage by the time sampled and provides an estimate of the total number of fish salvaged. Expanded salvage does not take into account the loss of Chinook salmon smolts at the facilities from pre-screen predation, screening, handling, and trucking. Raw and expanded CVP and SWP salvage estimates are reported in Table 5-5.

During VAMP 2006, salvage and expanded salvage was very low. This result is surprising in that the HORB was not installed which has in the past increased the number of CWT salmon observed in salvage (Brandes and McLain, 2001).

Transit Time

Recoveries of VAMP 2006 smolts were made at Antioch between May 10 and May 29 and at Chipps Island between May 8 and May 29 (Appendix C-4). Recoveries were made at the CVP and SWP fish facilities between May 4 and May 19 (Table 5-5); a few days earlier than at the other recovery locations.

Chipps Island Recoveries							Fish Facilities Recoveries Raw Salvage (Expanded Salvage)		
First Day Recovered	**Last Day Recovered**	**Number Recovered**	**Recovery Effort (minutes sampled)**	**Percent of Time Sampled**	**Survival Index**	**Group index**	**CVP**	**SWP**	**Recovery Days**
5/8/06	5/18/06	7	4400	0.278	0.133		0	2 (12)	5/4/06
5/11/06	5/12/06	2	800	0.278	0.038		0	1 (6)	5/4/06
5/8/06	**5/18/06**	**9**	**4400**	**0.278**		**0.086**			**5/4/06 - 5/4/06**
5/10/06	5/15/06	7	2400	0.278	0.128		0	0	–
5/9/06	5/16/06	58	3200	0.278	1.036		0	0	–
5/20/06	5/20/06	2	400	0.278	0.037		1 (12)	0	5/19/06
–	–	0	0	0.000	–		1 (12)	0	5/19/06
~~5/20/06~~	~~5/20/06~~	~~2~~	~~400~~	~~0.278~~	~~0.037~~		~~2 (24)~~	~~0~~	~~5/19/06~~
		2	**400**	**0.278**		**0.019**			**5/19/06 - 5/19/06**
5/23/06	5/28/06	44	2400	0.278	0.859		0	0	–

VAMP Chinook Salmon CWT Survival

Survival Indices

Survival indices were calculated for marked salmon released at Mossdale, Dos Reis and Jersey Point and recovered at Antioch and Chipps Island. Survival indices (SI) were calculated using the formula:

$$SI = (R / (ER*T*W))$$

where: R is the number recovered, ER is the effective number released, T is the fraction of time sampled, and W is the fraction of channel width sampled.

The fraction of the channel width sampled at Chipps Island (0.00769) was calculated by dividing the net width (30 feet) by the estimated channel width (3,900 feet). The fraction of the channel width sampled at Antioch (0.01388) was calculated in the same manner, with the net width being 25 feet and the channel width being 1,800 feet. The fraction of time sampled at both locations was calculated based on the number of minutes sampled between the first and last day of catching each particular tag code or group, divided by the total number of minutes in the time period. The fraction of time sampled for the VAMP 2006 release groups at Chipps Island was about 28%, while at Antioch it was about 40% (Table 5-5).

Survival indices were calculated for each tag code to provide a sense of the variability associated with the group survival index. To generate the group survival index, the recovery numbers and release numbers are combined for the tag codes within a release group.

Sampling at Antioch in 2006 was irregular between days (Appendix C-4) and potentially adds noise in estimating survival using the recoveries at Antioch. For instance, if the majority of the Mossdale group moves past Antioch on a day where more sampling occurs relative to the next day when the majority of Jersey Point fish pass, the Mossdale recovery rate would be potentially biased high relative to the recovery rate of the Jersey Point group. However, the timing of the Mossdale and Jersey Point groups past Antioch appears similar enough over the entire recovery period that there is probably no substantial bias however standardizing sampling effort between days could reduce the noise and variance associated with estimating survival (Appendix C-4). We will evaluate this source of noise in 2007.

Chinook Salmon Survival Estimates, and Differential and Combined Differential Recovery Rates

Survival indices are better put into context by evaluating absolute survival estimates and combined differential recovery rates (CDRR). Absolute survival estimates and CDRRs should be more robust for comparing survival between groups and years, since using ratios between upstream and downstream groups theoretically standardizes for differences in catch efficiency between recovery locations and years. As in past years, estimates of both absolute survival and CDRRs were calculated for CWT releases as part of VAMP 2006. The CDRR is similar to calculating absolute survival estimates, but does not expand estimates based on the fraction of the time and space sampled. The Differential Recovery Rate (DRR) is similar to the CDRR but only uses recoveries from one recovery location.

The CDRR and the absolute survival estimates should not be very different as (1) the fraction of the time sampled is similar between groups within a recovery location and (2) the fraction of space sampled at each recovery location is a constant. Neither would change the relative differences between groups. However, combining the recovery numbers from Antioch, Chipps Island and ocean fishery could result in different survival estimates between the two methods.

Absolute survival estimates (AS_i) are calculated by the formula:

$$AS_i = SI_u / SI_d$$

where: SI_u is the survival index of the upstream group (Mossdale or Dos Reis),

SI_d is the survival index of the downstream group (Jersey Point) and

i is either Antioch or Chipps Island.

Although referred to throughout this document as absolute survival estimates they are more aptly described as standardized or relative survival estimates.

The combined differential recovery rate (CDRR) is calculated by the formula:

$$CDRR = CRR_u / CRR_d$$

where: CRR_u is the combined recovery rate for the upstream group (Mossdale or Dos Reis),

CRR_d is the combined recovery rate for the downstream group (Jersey Point).

and the combined recovery rate (CRR) is estimated by the formula:

$$CRR = R_{C+A+O} / ER$$

where: R_{C+A+O} is the combined recoveries at Antioch, Chipps Island and in the ocean fishery of a CWT group,

and ER is the effective release number.

Recoveries are not available from each recovery location for all years so only those that are available have been used. For data obtained prior to 2000, no Antioch recoveries are available and for releases in 2004, 2005 and 2006 no ocean recoveries are available at this time.

This new approach of combining all recoveries to estimate survival was suggested by Dr. Ken Newman, statistician with the USFWS in Stockton. Since recovery rates in the past have been higher in the ocean fishery than in the Antioch and Chipps Island trawls, inclusion of the expanded ocean recoveries decreases the variance of the point estimates.

Standard errors were calculated for the CDRRs based on the Delta method and other methods developed by Ken Newman (K. Newman, personal communication). Plus or minus two standard errors are roughly equivalent to the 95% confidence intervals around the estimate. In comparing survival between reaches, the confidence intervals were used to determine if CDRRs were significantly different from one other. If the 95% confidence intervals overlapped, CDRRs were not considered statistically different from each other. If the 95% lower confidence level was less than zero it was truncated at zero, except in the case of the 95% confidence level around the difference in two point estimates.

Results:

Individual and group survival indices to Antioch and Chipps Island of the CWT salmon released as part of VAMP 2006 are shown in Table 5-5. Survival indices have been reported to three significant digits, but we realize indices are not likely that precise. Survival indices were not corrected for the number of CWT fish recovered in DFG sampling in Old River. Survival indices estimated for smolts released at Mossdale and Dos Reis were relatively low in 2006, especially for the 2nd group released at Mossdale. Jersey Point survival indices were much higher for estimates based on Chipps Island recoveries (1.04 and 0.86 respectively) whereas they were lower when based on Antioch recoveries (0.19 and 0.12).

As in past years, survival indices were higher using the Chipps Island recoveries than when using the Antioch recoveries. Also as in the past, the raw recovery numbers at Chipps Island and Antioch were similar, but once recoveries were expanded for effort, survival indices were much lower at Antioch, indicating that the greater sampling at Antioch is not translating into additional recoveries.

Survival estimates and CDRR's in 2006 are reported in Table 5-6. Survival was generally high between Mossdale and Dos Reis (Figure 5-6), indicating no difference in survival under the low export condition from part of the group being diverted into upper Old River. Survival from Mossdale to Jersey Point was relatively low for both sets of releases, but lower for the second release when exports were higher (Figure 5-7). However the confidence levels around the difference in the point estimates, under the two different export levels, included zero, indicating the difference was not statistically significant at the $p<0.05$ level. (Figure 5-7). While there is general relative agreement between CDRR point estimates based on Chipps Island and Antioch recoveries versus those using the Chipps Island, Antioch and ocean recoveries (next section), the variance generally lessens once the ocean recoveries are incorporated (Figure 5-8). Thus future recoveries in the ocean fishery may increase the precision of the point estimate of the difference between the two test conditions in 2006 such that the 95% confidence interval would no longer include zero and be statistically significant.

Between the first and second release at Mossdale, temperatures at release increased by 3 degrees F (Table 5-2). This increase in water temperature could account for at least part of the differences observed in survival between the two groups. One additional issue, associated with water temperature was the 2 degrees F difference between the first Mossdale and Jersey Point releases, whereas the water temperature at the two locations for the second release was the same (Table 5-2). The lower temperature may have benefited the first Mossdale group and increased its survival somewhat relative to the Jersey

Table 5-6
Absolute survival and combined differential recovery rates (CDRR) for VAMP 2006 releases.

Survival Reach	Release Date	Antioch Absolute survival	Chipps Island Absolute survival	CDRR
First release				
Mossdale to Dos Reis	4-May-06	1.67	0.67	0.94
Mossdale to Jersey Point	4-May-06	0.18	0.08	0.11
Dos Reis to Jersey Point	5-May-06	0.11	0.12	0.12
Second release				
Mossdale to Jersey Point	19-May-06	0.00	0.03	0.02

Figure 5-6
Combined Differential Recovery Rates (CDRR) (+ / -1 and 2 standard errors) of CWT smolts released at Mossdale (M) and Dos Reis (DR) and relative to those released at Jersey Point (JP) for the Dos Reis (DR/JP) and Mossdale (M/JP) first (1), second (2) release groups in 2006.

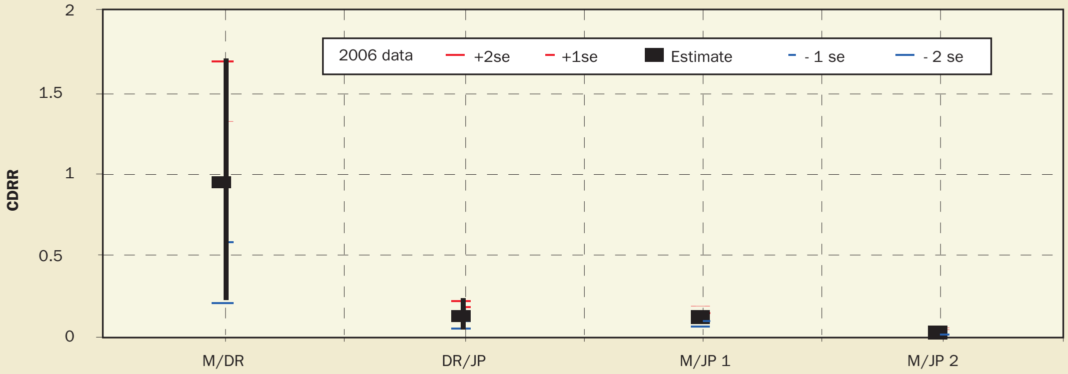


Figure 5-7
Combined Differential Recovery Rates (CDRR) (+ / -1 and 2 standard errors) of CWT smolts released at Mossdale (MD) relative to those released at Jersey Point for the first (1), second (2) release groups and the difference between the 1st and 2nd release groups at Mossdale in 2006.

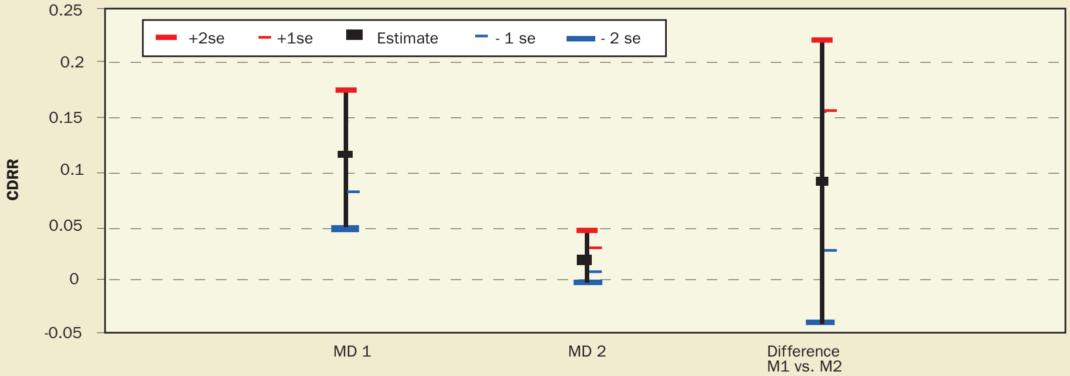
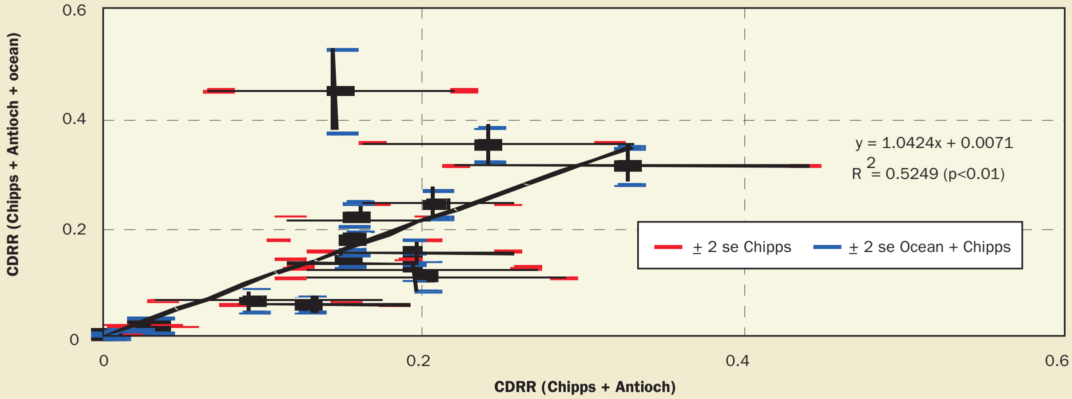


Figure 5-8
CDRR using Chipps Island and Antioch recoveries versus Chipps Island, Antioch and ocean fishery rrecoveries of the Mossdale or Durham Ferry and Jersey Point releases between 2000 and 2003.



Point group. While it is desirable to keep conditions as uniform as possible in these types of experiments, many of the factors are uncontrollable. Switching the export conditions between the two periods (and having the higher export condition first) would help alleviate some of these confounding issues, but due to logistical constraints could not be accommodated during this experiment.

Comparison with Past Years

Ocean Recovery Information

Ocean recovery data of CWT salmon groups can provide an additional source of recoveries for estimating survival through the Delta. The ocean harvest data may be more reliable due to the greater number of CWT recoveries and the extended recovery period.

Adult ocean recovery data are gathered from commercial and sport ocean harvest checked at various ports by DFG. The Pacific States Marine Fisheries Commission database of ocean harvest CWT data was the source of recoveries through 2004. The ocean CWT recovery data accumulate over a one to four year period after the year a study release is made as nearly all of a given year-class of salmon have been either harvested or spawned by age five. Consequently, these data are essentially complete for releases made through 2001 and partially available for CWT releases made from 2002 to 2004. Differential recovery rates (DRR) based on Chipps Island or ocean recoveries and combined differential recovery rates (CDRR) based on both Antioch and Chipps Island recoveries for salmon produced at the MRH are shown in Table 5-7. Absolute survival estimates based on Chipps Island and Antioch survival indices are also included. The earlier releases were made as part of south Delta survival evaluations (1996-1999) with the later releases associated with VAMP (2000-2004). Releases have been made at several locations: Dos Reis, Mossdale, Durham Ferry, and Jersey Point. The Chipps Island and Antioch survival estimates and combined differential (Antioch and Chipps Island recoveries summed) or differential recovery rates (Chipps Island recoveries only) are graphed in relation to the differential recovery rate using the ocean recovery information in Figure 5-9.

Results of this comparative analysis of survival estimates and differential recovery rates for Chinook salmon produced in the MRH show: (1) there is general agreement between survival estimates and differential recovery rates based on juvenile CWT salmon recoveries at Chipps Island and adult recoveries from the ocean fishery (r^2=0.76), (2) there is less agreement with Antioch trawling which has fewer years of data, and (3) additional comparisons need to be made, as more data becomes available from VAMP releases for recoveries at Antioch, Chipps Island, and the ocean fishery.

Survival by Reach

In this section, Chinook salmon smolt survival in different reaches of the San Joaquin River will be evaluated using several years of data. These analyses help our understanding of survival through the south Delta. Initially, survival in the entire reach (Durham Ferry and Mossdale to Jersey Point) will be discussed. The second reach discussed is from Durham Ferry and Mossdale to Dos Reis. And lastly, the reach between Dos Reis and Jersey Point will be discussed. In this section we will only use CDRR's as our estimate of survival. Combined recoveries from Chipps Island and the ocean fishery are available for releases made between 1985 and 1999, combined recoveries from Chipps Island, Antioch and the ocean fishery are available for releases made between 2000 and 2003 and releases made between 2004 and 2006 only have Chipps Island and Antioch recoveries available.

Survival between Durham Ferry or Mossdale and Jersey Point

Smolt survival between Durham Ferry and Mossdale and Jersey Point has been low since 2003 (Figure 5-10). Even the higher flows in 2005 and 2006 did not increase survival to levels we saw in 2000, when flows were 5700 cfs and the barrier was installed. The survival of the first Mossdale and Dos Reis releases in 2006 appeared higher than for the other years since 2003, although it was not always significantly different at the 95% confidence interval.

The health of the CWT fish in 2006 was relatively good and PKD infection did not seem to be a problem as it may have been in 2003-2005. None of the VAMP fish recovered at Chipps Island had evidence of infection in their kidneys by the parasite that causes PKD in 2006. However, kidney imprints detected some (23%) of the VAMP fish at the hatchery were infected with Bacterial Kidney Disease, although they did not show clinical signs of the desease.

Survival between Durham Ferry and Mossdale

No releases were made at Durham Ferry in 2006 thus comparisons of survival rates between Durham Ferry and Mossdale for this year cannot be made. However, survival between Durham Ferry and Mossdale has been measured from 2000 to 2003 and is generally high using the combined Chipps Island, Antioch and ocean recoveries (Table 5-8). Survival was estimated to be high between Durham Ferry and Mossdale in 2004 using Chipps Island and Antioch recoveries alone. Only one release group in 2002 indicated possible mortality between the two locations but confidence intervals around the two point

Table 5-7
Absolute survival estimates and differential recovery rates based on Chipps Island, Antioch, or ocean recoveries of Merced River Hatchery salmon released as part of South Delta studies betweeen 1996 and 2004.

Release Year	San Joaquin River (Merced River Origin) TAG NO.	Release Number	Release Site	Release Date	Chipps Island Recovs.	Antioch Recovs.	Expanded Adult Ocean Recovs. (Age 1+ to 4+) Total	CHIPPS ISLAND	ANTIOCH	DRR or CDRR	OCEAN DRR
		Juvenile Salmon CWT Releases						Absolute Survival Estimates		Differential Recovery Rates	
1996	061110412	22,198	DOS REIS	1-May-96	2		3				
	061110413	25,414	DOS REIS	1-May-96	2		37				
	061110414	16,050	DOS REIS	1-May-96	1		8				
	061110415	31,208	DOS REIS	1-May-96	5		10				
	061110501	46,190	JERSEY PT	3-May-96	39		186				
	Effective Release	94,870	DOS REIS		10		58	0.120		0.125	0.152
	Effective Release	46,190	JERSEY PT		39		186				
1997	062545	48,973	DOS REIS	27-Apr-97	9		180				
	062546	53,483	DOS REIS	27-Apr-97	7		168				
	062547	51,576	JERSEY PT	2-May-97	27		356				
	Effective Release	102,456	DOS REIS		16		348	0.290		0.298	0.492
	Effective Release	51,576	JERSEY PT		27		356				
	062548	46,674	DOS REIS	8-May-97	5		90	0.300		0.283	0.477
	062549	47,534	JERSEY PT	12-May-97	18		192				
1998	61110809	26,465	MOSSDALE	16-Apr-98	25		60				
	61110810	25,264	MOSSDALE	16-Apr-98	31		39				
	61110811	25,926	MOSSDALE	16-Apr-98	32		58				
	61110806	26,215	DOS REIS	17-Apr-98	34		48				
	61110807	26,366	DOS REIS	17-Apr-98	25		35				
	61110808	24,792	DOS REIS	17-Apr-98	34		62				
	61110812	24,598	JERSEY PT	20-Apr-98	87		110				
	61110813	25,673	JERSEY PT	20-Apr-98	100		91				
	Effective Release	77,655	MOSSDALE		88		157	0.300		0.305	0.506
	Effective Release	77,373	DOS REIS		93		145	0.320		0.323	0.469
	Effective Release	50,271	JERSEY PT		187		201				
1999	062642	24,765	MOSSDALE	19-Apr-99	8		128				
	062643	24,773	MOSSDALE	19-Apr-99	15		135				
	062644	25,279	MOSSDALE	19-Apr-99	13		132				
	062645	25,014	DOS REIS	19-Apr-99	20		151				
	062646	24,841	DOS REIS	19-Apr-99	19		225				
	0601110815	25,101	JERSEY PT	21-Apr-99	34		334				
	062647	24,359	JERSEY PT	21-Apr-99	25		387				
	Effective Release	74,817	MOSSDALE		36		395	0.380		0.403	0.362
	Effective Release	49,855	DOS REIS		39		376	0.600		0.656	0.517
	Effective Release	49,460	JERSEY PT		59		721				
2000	06-45-63	24,457	DURHAM FERRY	17-Apr-00	11	11	246				
	06-04-01	23,529	DURHAM FERRY	17-Apr-00	7	6	215				
	06-04-02	24,177	DURHAM FERRY	17-Apr-00	10	10	232				
	06-44-01	23,465	MOSSDALE	18-Apr-00	9	14	207				
	06-44-02	22,784	MOSSDALE	18-Apr-00	9	16	174				
	06-44-03	25,527	JERSEY PT	20-Apr-00	24	50	649				
	06-44-04	25,824	JERSEY PT	20-Apr-00	41	47	704				
	Effective Release	72,163	DURHAM FERRY		28	27	693	0.310	0.190	0.242	0.364
	Effective Release	46,249	MOSSDALE		18	30	381	0.310	0.330	0.329	0.313
	Effective Release	51,351	JERSEY PT		65	97	1353				
	601060914	23,698	DURHAM FERRY	28-Apr-00	7	8	46				
	601060915	26,805	DURHAM FERRY	28-Apr-00	5	15	45				
	0601110814	23,889	DURHAM FERRY	28-Apr-00	10	8	70				
	0601061001	25,572	JERSEY PT	1-May-00	48	76	358				
	0601061002	24,661	JERSEY PT	1-May-00	30	76	230				
	Effective Release	74,392	DURHAM FERRY		22	31	161	0.190	0.140	0.156	0.185
	Effective Release	50,233	JERSEY PT		78	152	588				
2001	06-44-29	23,351	DURHAM FERRY	30-Apr-01	14	28	95				
	06-44-30	22,720	DURHAM FERRY	30-Apr-01	22	30	158				
	06-44-31	22,376	DURHAM FERRY	30-Apr-01	17	18	111				
	06-44-32	23,022	MOSSDALE	1-May-01	17	18	122				
	06-44-33	22,191	MOSSDALE	1-May-01	14	15	106				
	06-44-34	24,444	JERSEY PT	4-May-01	50	156	470				
	06-44-35	24,993	JERSEY PT	4-May-01	61	173	556				
	Effective Release	68,447	DURHAM FERRY		53	76	364	0.340	0.170	0.212	0.256
	Effective Release	45,213	MOSSDALE		31	33	228	0.310	0.110	0.159	0.243
	Effective Release	49,437	JERSEY PT		111	329	1026				
	06-44-36	24,029	DURHAM FERRY	7-May-01	2	8	17				
	06-44-37	23,907	DURHAM FERRY	7-May-01	5	11	45				
	06-44-38	24,054	DURHAM FERRY	7-May-01	2	10	28				
	06-44-39	23,882	MOSSDALE	8-May-01	4	8	25				
	06-44-40	25,310	MOSSDALE	8-May-01	4	11	27				
	06-44-41	25,910	JERSEY PT	11-May-01	17	43	243				
	06-44-42	25,466	JERSEY PT	11-May-01	27	53	335				
	Effective Release	71,990	DURHAM FERRY		9	29	90	0.130	0.200	0.194	0.111
	Effective Release	49,192	MOSSDALE		8	19	52	0.190	0.180	0.201	0.094
	Effective Release	51,376	JERSEY PT		44	96	578				

Note: Ocean recoveries are based on data through 2005

Table 5-7
Absolute survival estimates and differential recovery rates based on Chipps Island, Antioch, or ocean recoveries of Merced River Hatchery salmon released as part of South Delta studies betweeen 1996 and 2004.

Release Year	San Joaquin River (Merced River Origin) TAG NO.	Release Number	Release Site	Release Date	Chipps Island Recovs.	Antioch Recovs.	Expanded Adult Ocean Recovs. (Age 1+ to 4+) Total	CHIPPS ISLAND	ANTIOCH	DRR or CDRR	OCEAN DRR
		Juvenile Salmon CWT Releases						Absolute Survival Estimates		Differential Recovery Rates	
2002	06-44-71	23,920	DURHAM FERRY	18-Apr-02	4	11	33				
	06-44-72	25,176	DURHAM FERRY	18-Apr-02	9	20	96				
	06-44-73	23,872	DURHAM FERRY	18-Apr-02	4	12	74				
	06-44-74	24,747	DURHAM FERRY	18-Apr-02	4	20	67				
	06-44-57	25,515	MOSSDALE	19-Apr-02	6	13	76				
	06-44-58	25,272	MOSSDALE	19-Apr-02	7	29	69				
	06-44-59	24,802	JERSEY PT	22-Apr-02	46	101	494				
	06-44-60	24,128	JERSEY PT	22-Apr-02	37	89	456				
	Effective Release	97,715	DURHAM FERRY		21	63	270	0.130	0.160	0.154	0.142
	Effective Release	50,787	MOSSDALE		13	42	145	0.150	0.210	0.194	0.147
	Effective Release	48,930	JERSEY PT		83	190	950				
	06-44-70	24,680	DURHAM FERRY	25-Apr-02	3	6	23				
	06-44-75	24,659	DURHAM FERRY	25-Apr-02	5	2	21				
	06-44-76	24,783	DURHAM FERRY	25-Apr-02	3	4	7				
	06-44-77	24,381	DURHAM FERRY	25-Apr-02	4	6	6				
	06-44-78	24,519	MOSSDALE	26-Apr-02	2	3	26				
	06-44-79	24,820	MOSSDALE	26-Apr-02	3	4	14				
	06-44-80	24,032	JERSEY PT	30-Apr-02	18	43	307				
	06-44-81	22,880	JERSEY PT	30-Apr-02	28	32	290				
	Effective Release	98,503	DURHAM FERRY		15	18	57	0.160	0.110	0.130	0.045
	Effective Release	49,339	MOSSDALE		5	7	40	0.110	0.090	0.094	0.064
	Effective Release	46,912	JERSEY PT		46	75	597				
2003	06-02-82	24,453	DURHAM FERRY	21-Apr-03	0	1	9				
	06-02-83	25,927	DURHAM FERRY	21-Apr-03	2	4	0				
	06-27-42	24,069	DURHAM FERRY	21-Apr-03	1	1	10				
	06-27-48	24,471	MOSSDALE	22-Apr-03	2	2	3				
	06-27-43	25,212	MOSSDALE	22-Apr-03	3	2	5				
	06-27-44	24,414	JERSEY PT	25-Apr-03	57	71	253				
	Effective Release	74,449	DURHAM FERRY		3	6	19	0.019	0.015	0.023	0.025
	Effective Release	49,683	MOSSDALE		5	4	8	0.048	0.015	0.035	0.016
	Effective Release	24,414	JERSEY PT		57	71	253				
	06-27-45	24,685	DURHAM FERRY	28-Apr-03	0	0	6				
	06-27-46	25,189	DURHAM FERRY	28-Apr-03	0	0	0				
	06-27-47	24,628	DURHAM FERRY	28-Apr-03	0	0	4				
	06-27-49	24,180	MOSSDALE	29-Apr-03	0	0	5				
	06-27-50	24,346	MOSSDALE	29-Apr-03	1	0	0				
	06-27-51	25,692	JERSEY PT	2-May-03	39	35	415				
	Effective Release	74,502	DURHAM FERRY		0	0	10			0.000	0.008
	Effective Release	48,526	MOSSDALE		1	0	5	0.010		0.007	0.006
	Effective Release	25,692	JERSEY PT		39	35	415				
2004	06-27-52	23,440	DURHAM FERRY	22-Apr-04	0	1	0				
	06-27-53	21,714	DURHAM FERRY	22-Apr-04	1	1	0				
	06-27-54	23,328	DURHAM FERRY	22-Apr-04	1	0	0				
	06-27-55	23,783	DURHAM FERRY	22-Apr-04	1	0	0				
	06-46-70	25,319	MOSSDALE	23-Apr-04	0	1	0				
	06-45-82	23,586	MOSSDALE	23-Apr-04	1	0	0				
	06-45-83	24,803	MOSSDALE	23-Apr-04	2	0	0				
	06-45-80	22,911	JERSEY PT	26-Apr-04	25	22	14				
	Effective Release	92,265	DURHAM FERRY		3	2	0	0.030	0.020	0.026	0.000
	Effective Release	73,708	MOSSDALE		3	1	0	0.040	0.010	0.026	0.000
	Effective Release	22,911	JERSEY PT		25	22	14				
2005	06-46-72	23,414	DURHAM FERRY	2-May-05	5	0	0				
	06-46-73	23,193	DURHAM FERRY	2-May-05	2	2	0				
	06-46-74	23,660	DURHAM FERRY	2-May-05	4	3	0				
	06-46-75	23,567	DURHAM FERRY	2-May-05	1	1	0				
	06-46-97	22,302	DOS REIS	3-May-05	1	1	0				
	06-46-98	24,149	DOS REIS	3-May-05	1	3	0				
	06-45-91	22,675	DOS REIS	3-May-05	1	3	0				
	06-45-88	22,767	JERSEY PT	6-May-05	32	31	0				
	Effective Release	93,834	DURHAM FERRY		12	6	0	0.099	0.049	0.069	
	Effective Release	69,126	DOS REIS		3	7	0	0.035	0.110	0.052	
	Effective Release	22,767	JERSEY PT		32	31	0				
	06-45-84	22,777	DURHAM FERRY	9-May-05	2	1	0				
	06-45-85	22,968	DURHAM FERRY	9-May-05	1	1	0				
	06-45-86	23,012	DURHAM FERRY	9-May-05	3	3	0				
	06-45-87	22,806	DURHAM FERRY	9-May-05	0	2	0				
	06-45-89	21,443	DOS REIS	10-May-05	3	5	0				
	06-45-90	23,755	DOS REIS	10-May-05	2	2	0				
	06-46-99	23,448	DOS REIS	10-May-05	1	0	0				
	06-47-00	23,231	JERSEY PT	13-May-05	38	27	0				
	Effective Release	91,563	DURHAM FERRY		6	7	0	0.044	0.094	0.051	
	Effective Release	68,646	DOS REIS		6	7	0	0.058	0.127	0.068	
	Effective Release	23,231	JERSEY PT		38	27	0				

Figure 5-9

Comparison of Antioch and Chipps Island survival estimates and differential or combined differential recovery rates compared to differential ocean recovery rates for 1996-2004.

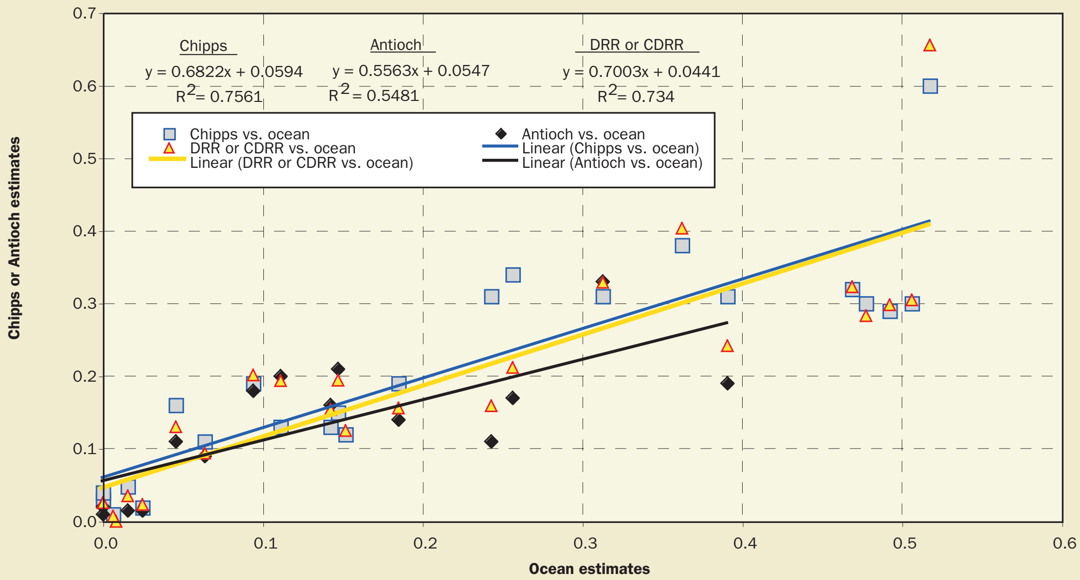
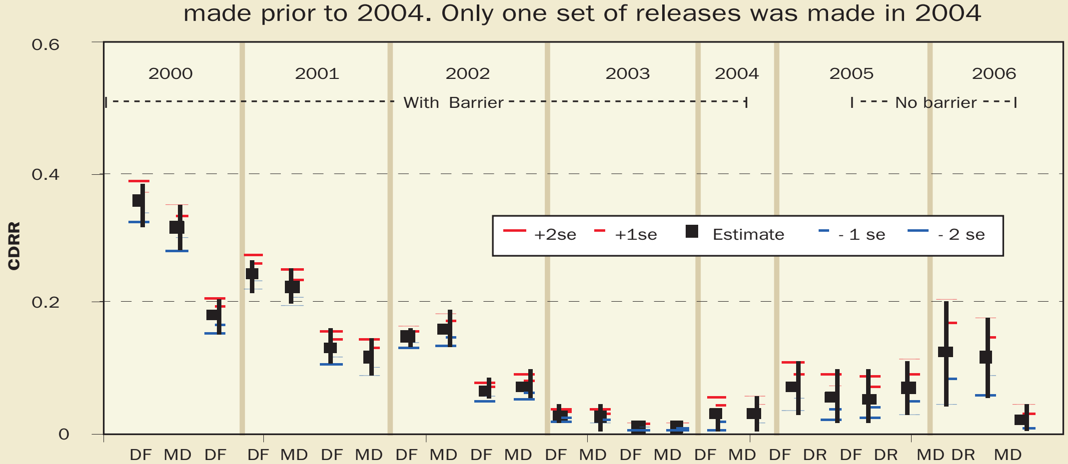


Figure 5-10

Combined Differential Recovery Rates (CDRR) (+/- 1 and 2 standard errors) of CWT smolts released at Durham Ferry (DF), Mossdale (MD) and Dos Reis (DR) relative to those released at Jersey Point for the first and second release groups in 2000- 2006. Recovery rates include recoveries from the ocean fishery for releases made prior to 2004. Only one set of releases was made in 2004



estimates in 2002 did not indicate significant differences at the 95% confidence level even with the ocean recoveries included. Releases of marked fish at both sites will allow detection of mortality between Durham Ferry and Mossdale if mortality becomes great enough to detect in the future.

Survival between Mossdale and Dos Reis

In 2006, releases were made to assess the difference in survival between a group released at Mossdale (which include a portion of the group that migrated down upper Old River) and one group released at Dos Reis (those released on the main-stem San Joaquin River downstream of upper Old River) during the low export condition. Survival between Mossdale and Jersey Point and Dos Reis and Jersey Point was similar for this first set of releases in 2006 (Figure 5-6).

A pilot ultrasonic tagging study (Chapter 6) and trawling in Old River compared to that at Mossdale (Chapter 4) indicated that most salmon migrated through Old River in 2006. If most of the coded wire tagged fish released at Mossdale in 2006 also primarily migrated into Old River under low exports and high flows, survival was similar between the two routes (between Old River and Jersey Point and, between Dos Reis and Jersey Point).

Nine additional paired releases have been made at Mossdale (or Durham Ferry in 2005) and Dos Reis in past years without the HORB in place. Five of these pairs produced ratios of survival between Mossdale and Dos Reis that were significantly less than 1.0 ($p<0.05$), indicating that in some years there was a significant difference in survival between the two groups (Table 5-9). Differences in survival between the two locations could be from a high proportion of the fish entering upper Old River and experiencing higher mortality via that migratory pathway, or from high mortality on the mainstem San Joaquin River between Mossdale and Dos Reis. The average survival between Mossdale or Durham Ferry and Dos Reis without a barrier in place was 0.73 (Table 5-9).

Only once were releases made at Mossdale and Dos Reis with the HORB in place. That was in 1997 and the point estimate of survival between the two locations was 1.29 using combined Chipps Island and ocean recoveries. These data reinforce that the temporary HORB on average provides protection to juvenile salmon migrating from the San Joaquin basin by reducing or preventing these fish from being drawn into upper Old River. It also indicates there was no detectable loss between Mossdale and Dos Reis with the barrier in place. If there truly is substantial mortality occurring now from predation in a hole on the San Joaquin River just downstream of upper Old River, as the ultrasonic data suggests in Chapter 6, we may consider releasing fish at Dos Reis and Mossdale when the barrier is in place in the future to assess this potential mortality source.

Survival between Dos Reis and Jersey Point

Survival in the reach from Dos Reis to Jersey Point in 2006 was much lower than survival from Mossdale to Dos Reis and similar to that between Mossdale and Jersey Point. This indicated that most of the mortality of the coded wire tagged salmon released at Mossdale occurred downstream of Dos Reis in 2006.

There have been 16 experiments where releases have been made at Dos Reis and Jersey Point, with three of these

Table 5-8
Combined differential recovery rates (CDRR) with recoveries from Antioch, Chipps Island, and in the ocean fishery for VAMP fish released at Durham Ferry and Mossdale between 2000 and 2004. Survival is between Durham Ferry and Mossdale. Ocean recoveries are not yet available for the release made in 2004.

YEAR	CDRR		Standard Error + / - 2 SE
	Antioch +Chipps Island +Ocean Recovery	Antioch +Chipps Island	
2000	1.15		
2001	1.11		
2001	1.10		
2002	0.92		
2002	0.65		0.58 - 1.19
2003	1.09		
2003	1.08		
2004		1.00	

made in 1997 with the HORB in place. The remaining data was gathered without the barrier in place between 1989 and 1991, 1995 and 1999 and during 2005 and 2006. CDRRs ranged between 0.05 and 0.79 and averaged 0.28 (Table 5-10). These historical data also indicate that the reach between Dos Reis and Jersey Point has the highest mortality. Additional data obtained in 1991, indicated that the highest salmon smolt mortality (lowest survival per mile) on the San Joaquin River between Dos Reis and Jersey Point occurred between Empire Tract (Figure 1-1) and the mouth of the Mokelumne River, although mortality between Dos Reis and Stockton, and between Stockton and Empire Tract was also high (Figure 1-1), (Brandes and McLain, 2001).

Survival between Old River and Jersey Point

No data has been gathered since 1990 to assess the differential survival for smolts migrating through upper Old River compared to those migrating on the mainstem San Joaquin River and released at Dos Reis. It has previously been published that survival appeared to be about twice that for smolts migrating down the mainstem San Joaquin versus those migrating down upper Old River, however differences were not statistically significant (Brandes and McLain, 2001).

In reanalyzing the data, using CDRR's, four of the seven years tested showed the 95% confidence interval around the ratio was significantly greater than 1.0 indicating the survival for smolts released at Dos Reis in those years was higher than for those released in upper Old River. (Table 5-11). The average ratio (Dos Reis to upper Old River) obtained by combining Chipps Island and ocean recoveries was similar to that reported in the past at 2.2 (Table 5-11). Confidence intervals around the mean of the ratio also indicated that the mean was significantly greater than 1.0, and survival was on average significantly higher for smolts released at Dos Reis compared to those released into upper Old River.

The Role of Flow, Exports and the Head of Old River Barrier on Smolt Survival Through the Delta

San Joaquin River flow and flow relative to exports between April 15 and June 15 was correlated to adult escapement in the San Joaquin basin 2 1/2 years later (SJRG 2003). Both relationships were statistically significant ($p<0.01$) with the ratio of flow to exports accounting for slightly more of the variability in escapement than flow alone ($r^2 = 0.58$ versus $r^2= 0.42$; SJRG 2003). These relationships were updated, refined to only include escapement from the San Joaquin tributaries and split between HORB and non-HORB years (SJRG, 2006) and still suggest that adult escapement in the San Joaquin basin is affected by flow in

Table 5-9
Combined Differential recovery rates (CDRR) for experimental fish released at Mossdale or Durham Ferry and Dos Reis between 1995 - 1999 and 2005 - 2006.
1995 - 1999 do not have Antioch recoveries. 2005 and 2006 do not have ocean recovery data available.
Survival reach is between Durham Ferry or Mossdale and Dos Reis
Those shaded are significantly different (95% confidence interval) from 1.0.

Year	Date	Release site	Chipps + ocean CDRR	Chipps + Antioch CDRR	
1995	17-Apr	Mossdale	0.99		
1995	5-May	Mossdale	0.31		
1995	17-May	Mossdale	0.44		
1996	30-Apr	Mossdale	0.37		
1998	16-Apr	Mossdale	1.05		
1998	23-Apr	Mossdale	0.42		
1999	19-Apr	Mossdale	0.69		
2005	2-May	Durham Ferry		1.32	
2005	9-May	Durham Ferry		0.75	
2006	4-May	Mossdale		0.94	
Average for all years					0.73

Table 5-10
Combined differential recovery rates (CDRR) using recoveries from Chipps Island and the ocean fishery or Chipps Island and Antioch to estimate survial between Dos Reis and Jersey Point between 1989 and 2005. Stock is either Feather River (FR) or Merced River (MR). The barrier was usually not installed (n) except in 1997(y).

Year	Date	Fish Stock	Barrier	CDRR Ocean + Chipps	CDRR Chipps + Antioch	
1989	20-Apr	FR	n	0.19		
1990	16-Apr	FR	n	0.05		
1990	2-May	FR	n	0.07		
1991	15-Apr	FR	n	0.12		
1995	17-Apr	FR	n	0.79		
1996	1-May	FR	n	0.11		
1996	1-May	MR	n	0.15		
1998	17-Apr	MR	n	0.40		
1998	24-Apr	FR	n	0.54		
1999	19-Apr	MR	n	0.53		
1997	29-Apr	FR	y	0.36		
1997	29-Apr	MR	y	0.48		
1997	8-May	MR	y	0.47		
2005	3-May	MR	n		0.05	
2005	10-May	MR	n		0.06	
2006	5-May	MR	n		0.12	
Average all years						0.28

Table 5-11
Ratio between CDRR of marked smolts released at Dos Reis (DR) and Upper Old River (UOR) between 1985 and 1990.

Year		Ratio	SE	+ 2 SE	- 2 SE
1985		0.99	0.01	1.00	0.97
1986		1.90	0.07	2.04	1.76
1987		2.48	0.13	2.74	2.22
1989		0.96	0.21	1.37	0.54
1989		4.35	1.08	6.50	2.20
1990		1.70	0.53	2.77	0.63
1990		3.17	1.05	5.28	1.07
	Mean	2.22		2.68	1.76

the San Joaquin River at Vernalis and flow relative to CVP and SWP exports during the spring months when juveniles migrate through the river and Delta to the ocean. These relationships serve as conceptual models of how smolt survival could vary with flows and exports.

VAMP was designed to further define these relationships by testing how San Joaquin River flows (7,000 cfs or less) at Vernalis and exports (1,500 to 3,000 cfs) at the SWP and CVP, with the HORB, affect smolt survival through the Delta. The HORB is assumed to improve survival based on studies conducted between 1985 and 1990 (Brandes and McLain, 2001) and discussed previously. The HORB barrier could not be installed during the VAMP in 2005 and 2006 as San Joaquin River flows exceeded 5,000 cfs during the scheduled installation period. Flows also exceeded maximum levels for operation of the HORB (7,000 cfs) in 2005 and 2006.

Survival of juvenile Chinook salmon emigrating from the San Joaquin River system has been evaluated within the framework established by the VAMP since the spring of 2000. The installation of the HORB is part of the VAMP experimental design when flows do not exceed 7,000 cfs. This year was the second year since 2000 that the HORB has not been installed and operated during the VAMP experiment, due to high flows. However, similar survival tests both with and without the HORB were conducted prior to 2000. The results of these earlier tests were also used to help define the relationships between flow and exports on smolt survival with and without the HORB in place.

Role of flow on salmon survival

To assess the relationship between San Joaquin River flows at Vernalis and smolt survival with and without the HORB survival (CDRRs), using recoveries from Chipps Island, Antioch and the ocean (if they were available), between Durham Ferry and/or Mossdale and Jersey Point from 1994- 2006 were plotted against San Joaquin River flows at Vernalis. Flows at Vernalis were 10 day averages for each release starting on the day of the Mossdale release or the day after the Durham Ferry release. Ten day averages were used to represent the flow variable since after 10 days most of the fish are far enough downstream (with some already recovered) that the flow at Vernalis is probably no longer important for that particular group migrating to Chipps Island. Flow data was obtained through DWR's DAYFLOW for past years (updated January 2004). San Joaquin flows downstream of Old River (SRL) between 1995 and 2004 were obtained from DWR from a model that simulated historical flows using DSM2 (T. Smith, DWR Personal Communication). SRL flow for 1994 was based on subtracting estimates of average daily flow in upper Old River from flow at Mossdale to obtain San Joaquin flows downstream of upper Old River. Average flows downstream of Dos Reis were for the 10 days starting on the day after the Dos Reis release. SRL and other flow and export data for 2005 and 2006 was obtained from Chapters 2 and 4 of this and last years (SJRG, 2006) annual report.

Role of flow with HORB on Salmon Survival

In the 2005 VAMP report (SJRG, 2006), it was reported that the CDRRs using the Chipps Island and Antioch recoveries of the Mossdale and Durham Ferry groups relative to the Jersey Point groups did increase with Vernalis flow with the HORB in place ($p<0.01$) (SJRG, 2006). It was also reported that the relationship between Vernalis flow and DRR using the ocean data with the HORB was also positive and statistically significant ($p<0.01$) (SJRG, 2006). The ocean data had fewer data points because recoveries were not yet available for the 2003-2005 releases.

For this year's evaluation, we have combined recoveries from Antioch, Chipps Island and in the ocean fishery to obtain one point estimate based on recoveries made to date from all three recovery locations. The relationship between these point estimates and San Joaquin River flow at Vernalis with the HORB in place is statistically significant ($p<0.01$) with flow accounting for 73% of the variability in survival (Figure 5 - 11).

Role of flow without HORB on Salmon Survival

Without the HORB in place, there was no clear relationship between the DRR/CDRR's and flow using the Chipps Island, Antioch and ocean recoveries for the Mossdale and Durham Ferry releases relative to the Jersey Point releases (Figure 5-12). The 2005 and 2006 data were much lower than what previous results had been at similar flow levels. It is not surprising that more variability is associated with smolt survival at any given flow at Vernalis without the HORB since the flow and proportion of marked fish moving into HOR varies more without the HORB.

To explore this issue further, we evaluated a group of test fish that were released on the mainstem San Joaquin River downstream of the head of Old River. The CDRR's of smolts released at Dos Reis relative to those released at Jersey Point were compared to estimates of San Joaquin flow downstream of the HOR. Most of the data were gathered when there was no HORB, but three data points (obtained in 1997) were gathered when the HORB was operating. The data indicated a weak relationship between survival and flow, but 2005 and 2006 were potential outliers (Figure 5-13). The relationship without these two years of data was highly significant and showed that survival from Dos Reis to Jersey Point did increase with San Joaquin River

Figure 5-11
CDRR (point estimates of survival) plus and minus 2 standard errors using Chipps Island, Antioch and ocean recoveries, for groups released at Mossdale or Durham Ferry and Jersey Point in 1994, 1997, 2000-2004 and average flow at Vernalis in cfs for 10 days starting the day of the Mossdale release or the day after the Durham Ferry release with HORB in place. Ocean recoveries are not yet available for 2004 releases.

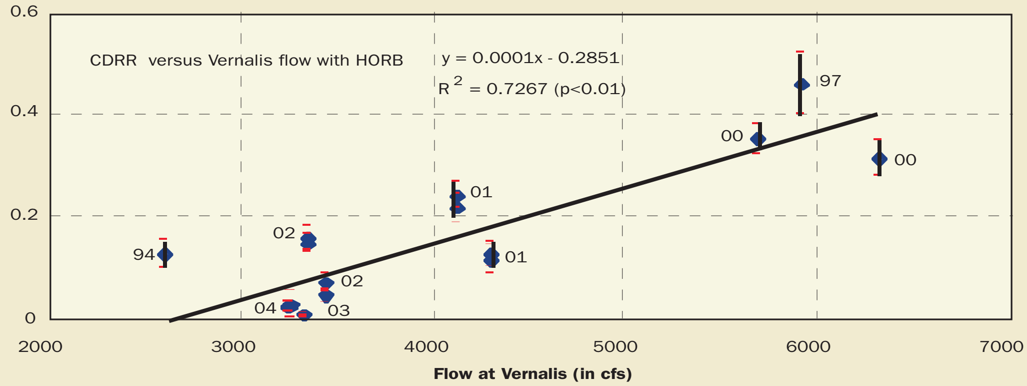


Figure 5-12
CDRR using combined Chipps Island, Antioch and ocean recoveries between Mossdale or Durham Ferry and Jersey Point and average flow at Vernalis in cfs for 10 days starting the day of the Mossdale release or the day after the Durham Ferry release without the HORB in place. Data in 2005 and 2006 only include recoveries from Antioch and Chipps Island.

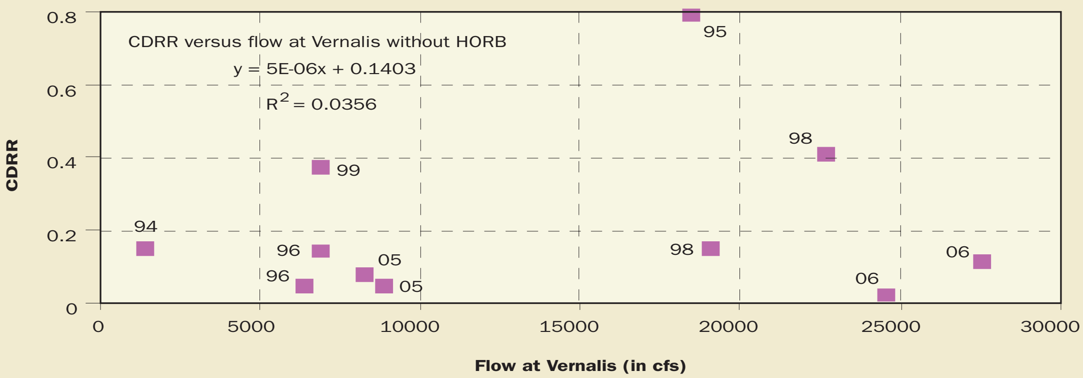
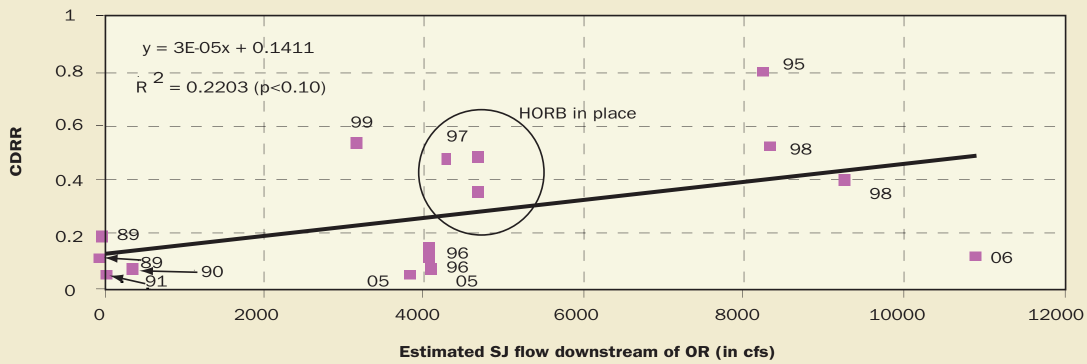


Figure 5-13
Survival between Dos Reis and Jersey Point (with recoveries at Chipps Island and the ocean fishery) with and without the HORB and estimated/modeled San Joaquin flows downstream of Old River between 1989 - 1991, 1995, - 1999, 2005 and 2006. 1997 data was gathered with the HORB in place. 2005 and 2006 data only has Chipps Island and Antioch recoveries available at this time.



flows downstream of the HOR ($p<0.01$ level) (Figure 5-14). It is unclear why 2005 and 2006 experiments resulted in such low survival compared to that observed in the past, although survival has been extremely low and lower than expected since 2003. It appears this trend has continued in 2005 and 2006 without the HORB in place, even though flows were higher.

The Role of Exports on Survival

Another goal of the VAMP program is to identify the role of exports on juvenile salmon survival through the Delta. VAMP limits CVP+SWP exports to between 1,500 and 3,000 cfs depending on the flow target, because of its dual protective purpose for naturally spawned juvenile salmon and to meet the terms of the delta smelt biological opinion. Prior to 1994, exports were generally much greater during this period. The VAMP design includes examining the role of exports with the HORB at flows of 7,000 cfs by experimenting at exports of 1,500 and 3,000 cfs. As conditions have not yet provided a 7,000 cfs flow with a HORB to test either export level, assessing the role of exports with a HORB is limited at this time.

In years when the HORB could not be installed it was recommended in the VAMP framework agreement to limit exports to either 1,500 or 3,000 cfs to make better comparisons with and without the HORB. In 2005, there was an attempt to measure survival with combined SWP/CVP pumping at 1,500 cfs for two weeks and then measure survival again at 3,000 cfs, but it was not implemented as one of the parties did not initially adjust pumping as proposed. In 2006, export levels were 1500 and 6000 cfs at high San Joaquin River flows (~25,000 cfs) for the two sets of VAMP releases. We were able to recommend such an experimental design because flows were deemed high enough to provide adequate protection for delta smelt even with the 6000 cfs exports. Results suggest the higher exports resulted in lower salmon smolt survival, but additional tests, especially with the higher export period, are needed to confirm this apparent benefit. Additional tests of this type may help us better identify the role of exports on smolt survival without the HORB in place.

Role of exports with HORB

The San Joaquin River flow relative to exports does not appear to explain the variability in smolt survival as well as flow alone from data obtained with the HORB in 1994, 1997 and between 2000 and 2004 (Figure 5-15). The flow/export variable is the 10-day mean for the ratio. Previous reports (SJRG 2006) have represented the ratio as the 10-day average of flow divided by the 10-day average of the export rate. One potential explanation for these results is that level of exports were low and did not vary enough during these experiments to provide a sufficient difference to be detected in our measurements of smolt survival. Exports ranged between 1,450 and 2,350 cfs during these experiments which is much lower than those incorporated into the adult escapement relationships. Another complication is that exports and San Joaquin River flows were correlated with higher exports observed during times of higher flows (Figure 5-16). It is also likely the relationship of exports to smolt survival is different with the HORB in place than when it is absent. While some of the juveniles that contributed to adult escapement may have benefited from the HORB in a few of the years, the HORB was not installed during the majority of the years incorporated into the adult relationships.

The next step would be to conduct a survival experiment at flows of 7,000 cfs with the HORB and vary exports (1,500 and 3,000 cfs) to better define the export effect on smolt survival with the HORB in place. Experimenting at flows of 7000 with a 1500 exports would help decouple the effects of flows and exports with the HORB in place (Figure 5-16).

Role of exports without HORB

The role of exports on smolt survival without the HORB in place is also difficult to identify at this time. As mentioned earlier, there was not a clear relationship between smolt survival and flow without the HORB (Figure 5-12). Regressions between the CDRR from Mossdale and Durham Ferry to Jersey Point using Chipps Island, Antioch and ocean recoveries also do not show a clear relationship with flow/export ratios (Figure 5-17). This is counter to our conceptual model based on the better relationship of flow/exports and San Joaquin basin escapement 2 1/2 years later than that when using flow alone. Similar limitations, to those with HORB, occur with this data. Exports have been limited to between 1400 and 3700 cfs, with the exception of 6000 cfs for the second experiment conducted in 2006. Conducting experiments as we did in 2006, where exports varied and flows were relatively constant may help us sort out the role of exports when the HORB is absent.

The Role of the HORB on survival through the Delta

One obvious result of the HORB on survival through the Delta has been the lower rate of salvage (and direct loss) for fish released at Durham Ferry and Mossdale when the HORB is installed. If one assumes densities are equal, direct loss should increase as exports increase. In 2006 very few individuals from either Mossdale group were salvaged in 2006. This could be a result of the extremely

Figure 5-14
Survival between Dos Reis and Jersey Point (with recoveries at Chipps Island and the ocean fishery) with and without the HORB and estimated/modeled San Joaquing flows downstream of Old River between 1989 - 1991, 1995 - 1999, 2005 and 2006. 1997 data was gathered with the HORB in place. 2005 and 2006 data has not been included.

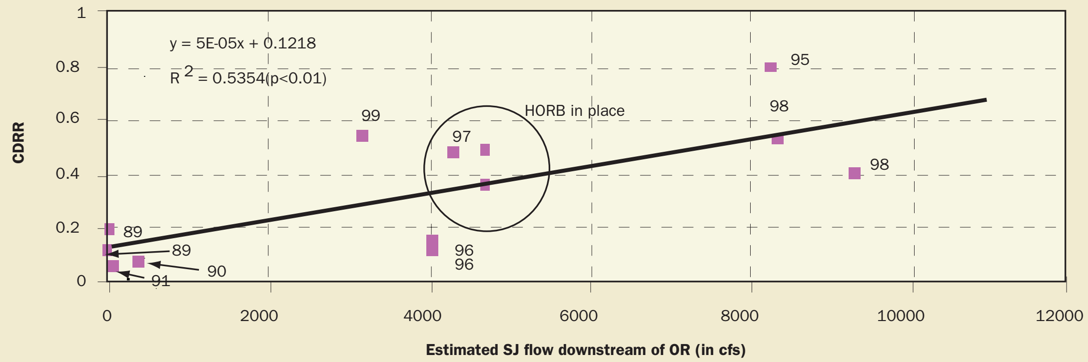


Figure 5-15
CDRR using Chipps Island, Antioch (2000 - 2004 only) and ocean recoveries (1994, 1997, 2000 - 2003), for groups released at Mossdale or Durham Ferry and Jersey Point and average flow at Vernalis/Exports in cfs for 10 days starting the day of the Mossdale release or the day after the Durham Ferry release with the HORB in place.

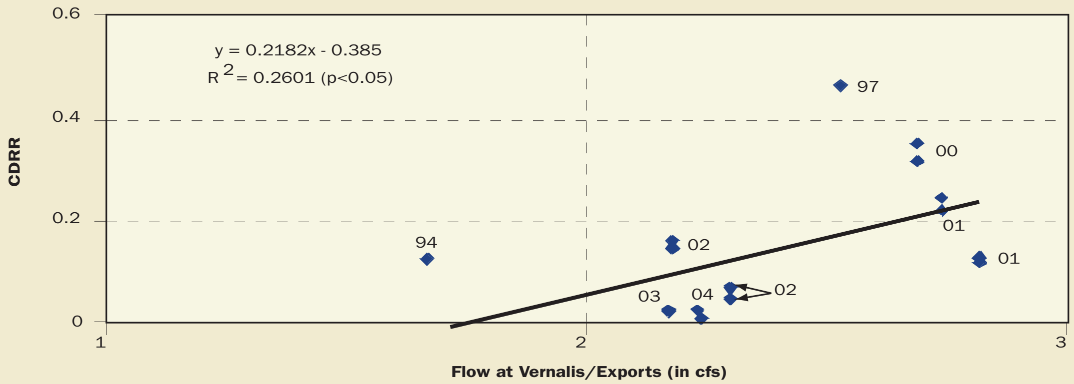


Figure 5-16
The relationship between flow and exports during VAMP tests with the HORB in place.

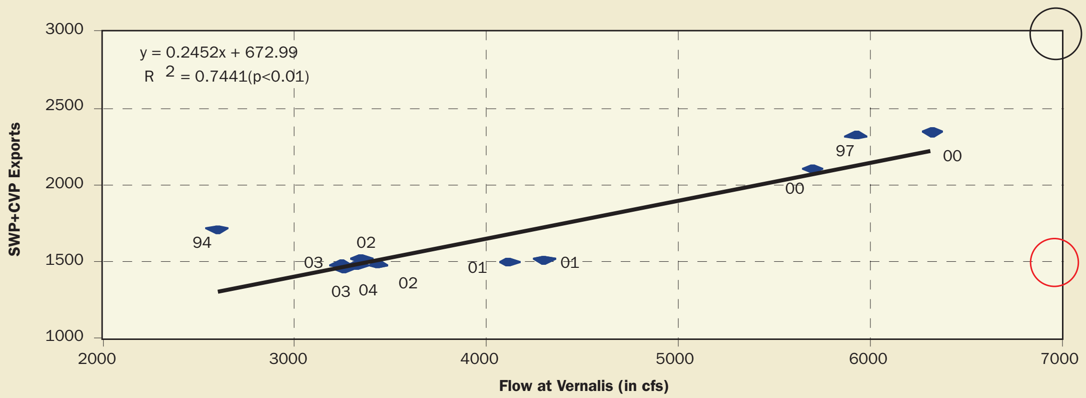


Figure 5-17
CDRR for fish released at Mossdale and Durham Ferry relative to Jersey Point between 1994 - 1996, 1998, 1999, 2005 and 2006 versus the mean Vernalis Flow/Export ratio for the 10 days after release without the HOR barrier.

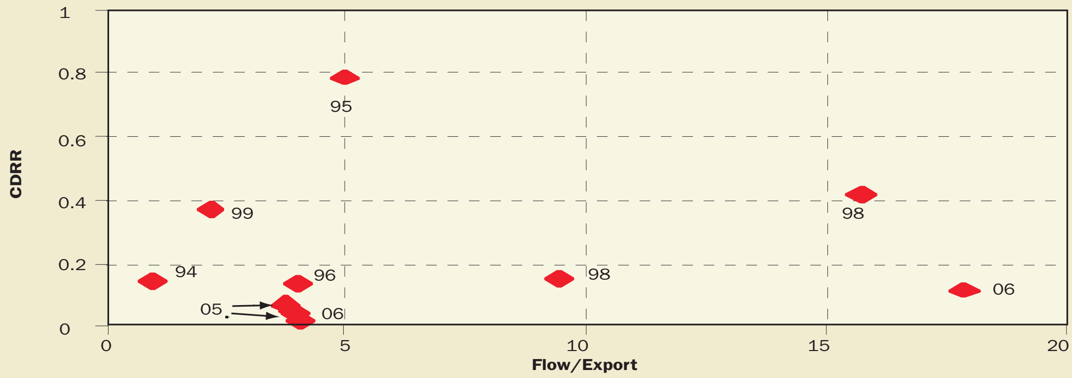


Figure 5-18
CDRR using combined Chipps Island,Antioch and ocean recoveries between Mossdale or Durham Ferry and Jersey Point and average flow at Vernalis in cfs for 10 days starting the day of the Mossdale release or the day after the Durham Ferry release with and without the HORB in place between 1994-2006. Data in 2004,2005 and 2006 only include recoveries from Antioch and Chipps Island.

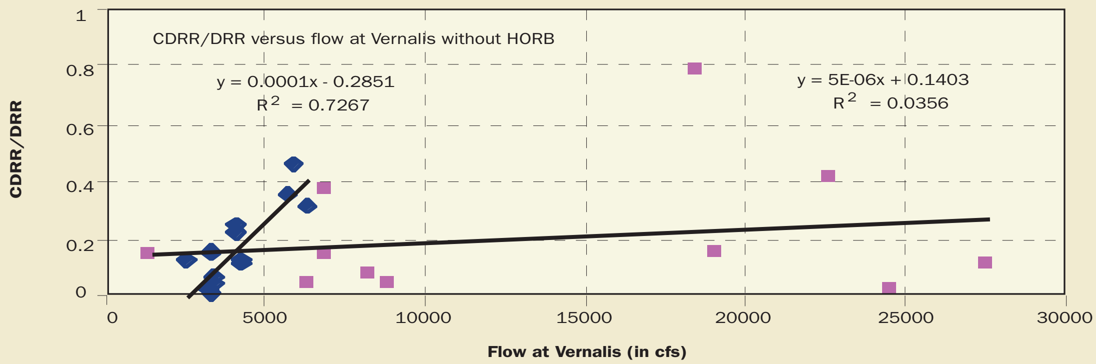
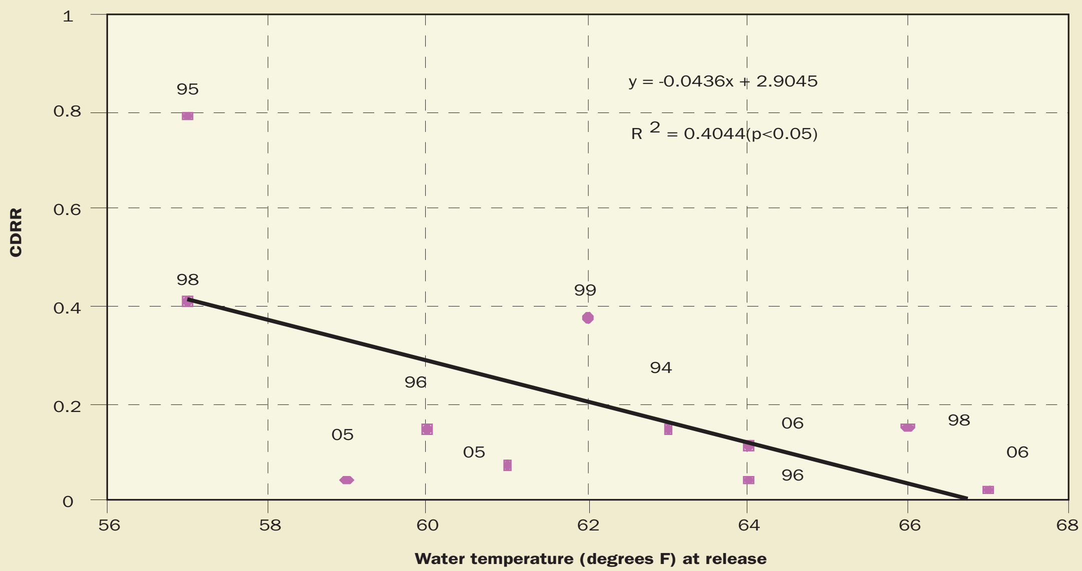


Figure 5-19
Combined Differential Recovery Rate (CDRR) for smolts released at Durham Ferry and Mossdale relative to those released at Jersey Point without the HORB versus water temperature at release site for smolts released at Durham Ferry and Mossdale.



high flows present in 2006. In contrast, several hundred of the Durham Ferry group, were salvaged in 2005 indicating a higher direct loss in 2005 compared to that in 2006.

Comparing the CDRRs with and without HORB data using the recoveries from Chipps Island, Antioch, and the ocean fishery, appears to indicate that there may be on average value in installing the HORB at flows between about 4,000 and 7,000 cfs (Figure 5-18).

The role of temperature on smolt survival

One parameter that appears to be confounding identification of the role of exports and flow is water temperature. Without the HORB, survival from Mossdale or Durham Ferry to Jersey Point was highest in the years that had the lowest temperature at release (Figure 5- 19). Water temperature at release was highest for the second group released in 2006 (Figure 5-19). Water temperature at release has also been shown to be an important factor in survival for smolts migrating through the Delta from the Sacramento basin (Newman, 2003).

Relationship of flow and exports to adult escapement 2 1/2 years later

The relationships between flow and flow/export ratio to escapement 2 1/2 years later have been shown in previous reports (SJRG, 2003 and SJRG, 2006). These data have been updated to include the most recent escapement (to 2005) and flow (to 2003) data (Figure 5-20 and 5-21). These revised and updated escapement data were obtained from the USFWS Anadromous Fish Restoration Program's website at http://www.delta.dfg.ca.gov/afrp. The flow/export variable was also modified to reflect the mean of the daily ratios between April 15 and June 15. The previous relationship (SJRG, 2006) was based on the ratio of the average flow and export values for the two month period.

In determining whether flow or flow/exports was better at predicting escapement 2 1/2 years later, Ken Newman conducted a K-fold cross validation where K=5. Essentially this analysis breaks the data down into five random groups and uses data not used to fit the model to validate the model. In this analysis, Ken found that the total absolute prediction error was about 15% less using the model that incorporated the flow/export variable, indicating that it better predicts the data than the model using flow alone.

The benefit of examining these adult relationships is that there are more data gathered over a broader range of conditions than with smolt survival under the VAMP framework. These adult relationships would indicate that as you increase flows and decrease exports relative to flows there should be corresponding increases in smolt survival and adult escapement 2 1/2 years later. It is not surprising that there is some uncertainty and noise in these relationships because the escapement data does not incorporate the varying age classes within annual escapement, the impact of declining ocean harvest in recent years and the imprecision in the escapement estimates.

Summary

The smolt survival data obtained without the HORB do not show a clear relationship to flow, especially with the 2005 and 2006 data included. With the HORB in place we have demonstrated statistically significant relationships between smolt survival and flow at Vernalis and flow/exports, although exports are correlated to flow. The relationship between the survival of the Dos Reis groups relative to the Jersey Point groups indicate that survival will improve generally as flows increase for smolts migrating downstream on the main stem San Joaquin River. The role of exports on smolt survival within the VAMP (with HORB) and without a HORB is more difficult to define based on the limited data. To identify the role of exports with a HORB it is imperative that we measure survival with export rates at 1,500 and 3,000 cfs with San Joaquin River flows of 7,000 cfs. Experiments like those conducted in 2006 can help assess the role of exports without the HORB. It is unclear why smolt survival between 2003 and 2006 has been so low.

San Joaquin River Salmon Protection

One of the VAMP objectives is to provide improved conditions to increase the survival of juvenile Chinook salmon smolts produced in the San Joaquin River tributaries during their downstream migration through the lower river and Delta. It is hypothesized that these actions to improve conditions for the juveniles will translate into greater adult abundance and escapement in future years than would otherwise occur without the actions.

To determine if VAMP has been successful in targeting the migration period of naturally produced juvenile salmon, catches of unmarked salmon at Mossdale and in salvage at the CVP and SWP facilities were compared prior to and during the VAMP period.

Unmarked Salmon Recovered at Mossdale

The typical time period for VAMP (April 15 to May 15) was chosen based on historical data that indicated a high percentage of the juvenile salmon emigrating from the San Joaquin tributaries passed into the Delta at Mossdale during that time. In 2006, the VAMP period was delayed until May 1 due to flood conditions. The average catch per 10,000 cubic meters per day of unmarked juvenile salmon caught in Kodiak trawling at Mossdale during January through June is shown in Figure 5-22. Unmarked salmon do not have an adipose clip and can be juveniles from natural spawning or unmarked hatchery fish from the MRH. Unmarked smolt releases in 2006 at MRH were as follows: 65,000 on May 26, 75,000 on June 2, and 60,000 on June 4. There were less unmarked juvenile salmon passing Mossdale during the low export period than during the higher export period of VAMP (Figure 5-22). If results from this years VAMP are representative of survival for unmarked fish migrating through the Delta from Mossdale, those migrating during the latter half of May may have survived at a lower rate than those migrating earlier in the month. The size of the juvenile salmon captured in the Mossdale trawl during January through June is shown in Figure 5-23.

Salmon Salvage and Losses at Delta Export Pumps

Fish salvage operations at the CVP and SWP export facilities capture juvenile salmon and transport them by tanker truck to release sites in the western Sacramento-San Joaquin Delta. The untagged salmon are potentially from any source in the Central Valley. It is not certain which unmarked salmon recovered are of San Joaquin basin origin, although the timing of salvage and fish size can be compared with Mossdale trawl data and CWT recovery data for MRH smolts at the salvage facilities to provide some general indications as to the origin of the unmarked fish. However, 2006 had extended San Joaquin River flood conditions and no temporary spring barriers. It was estimated by DWR that nearly all water in the Clifton Court Forebay (CCF) of the SWP during mid-March through June was from the San Joaquin River (SJR); SJR water was also predominant in CCF during January to mid-March (based on Real Time Data and Forecasting Project Water Quality Weekly Reports from DWR Office of Water Quality). It may be assumed that CVP water sources were similar in 2006.

The estimated salmon losses at the CVP and SWP are based on expanded salvage and an estimate of screen efficiency and survival through the facility and salvage process. The CVP pumps divert directly from the Old River channel and direct losses are estimated to range from about 50 to 80% of the number salvaged. Four to five salmon are estimated to be lost per salvaged salmon at the SWP because of high predation rates in Clifton Court Forebay. The SWP losses are therefore about six to eight times higher, per salvaged salmon, than for the CVP. The loss estimates do not include any indirect mortality in the Delta due to water export operations or additional mortality associated with post-release predation.

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Figure 5-20
Vernalis flows (April 15 - June 15) versus escapement 2 1/2 years later in years with and without the HORB between 1951 and 2003.

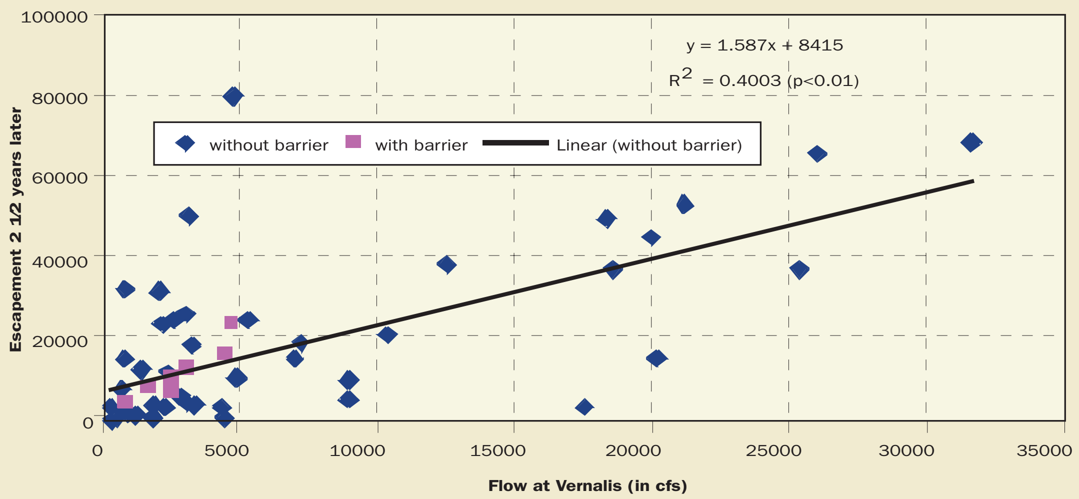


Figure 5-21
Vernalis flow/export ratio versus adult escpement 2 1/2 years later in years with and without the HORB in place between 1951 and 2003.

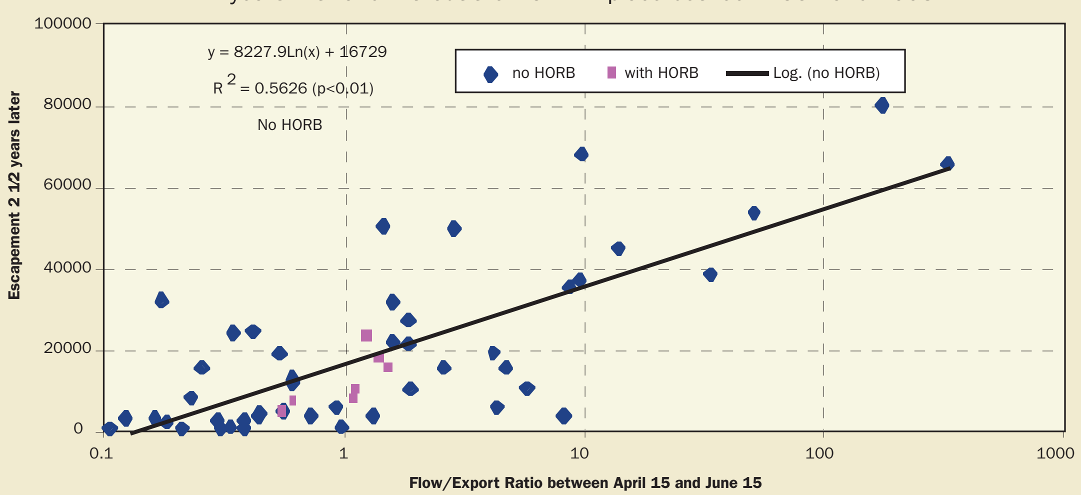


Figure 5-22
Average daily densities of unmarked salmon caught in the Mossdale Kodiak trawl.

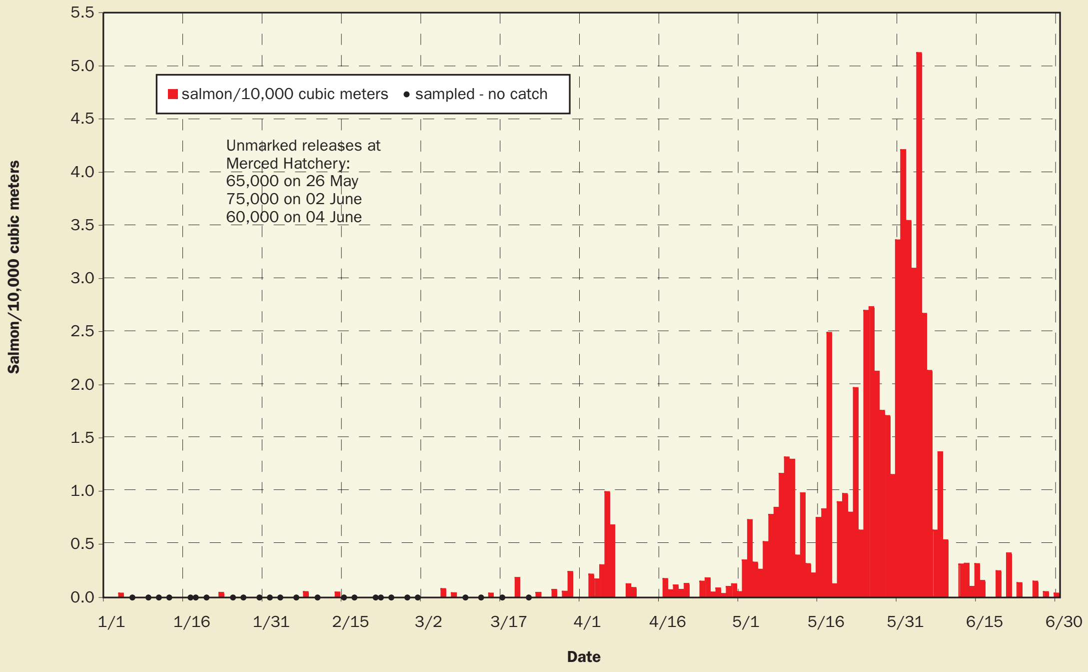


Figure 5-23
Mossdale Kodiak trawl individual daily forklengths of unmarked juvenile Chinook salmon, January through June 2006

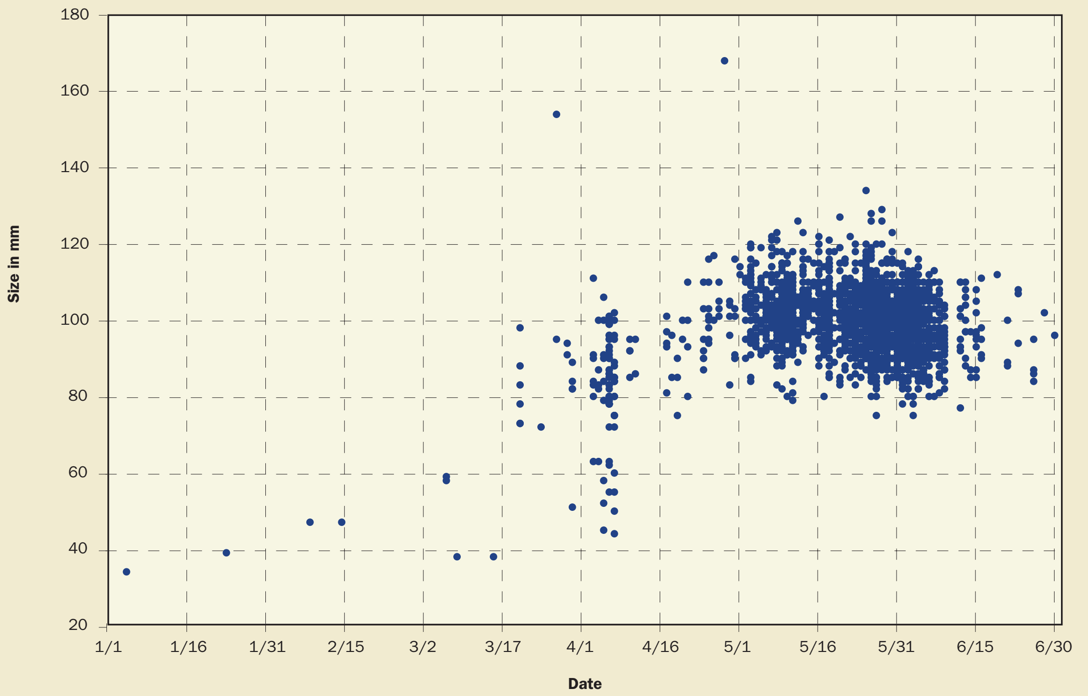


Figure 5-24
2006 CVP estimated salmon salvage and loss

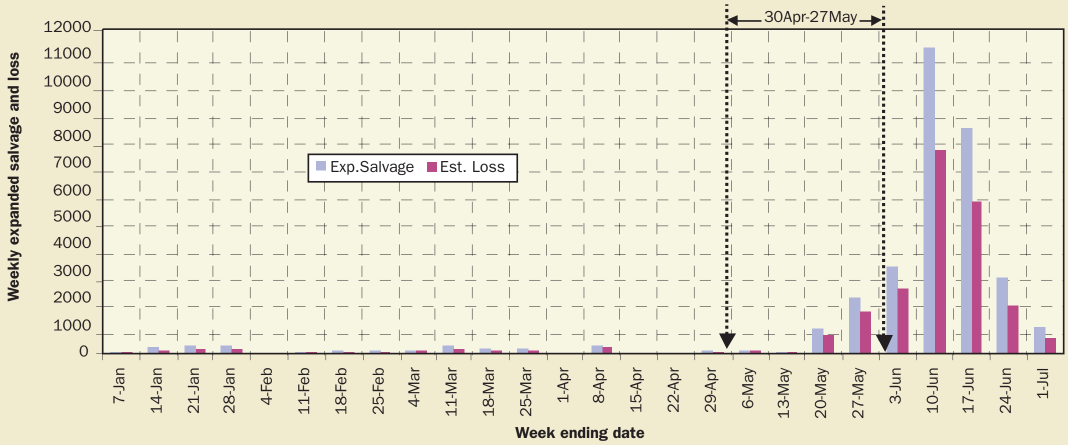


Figure 5-25
2006 SWP estimated salmon salvage and loss

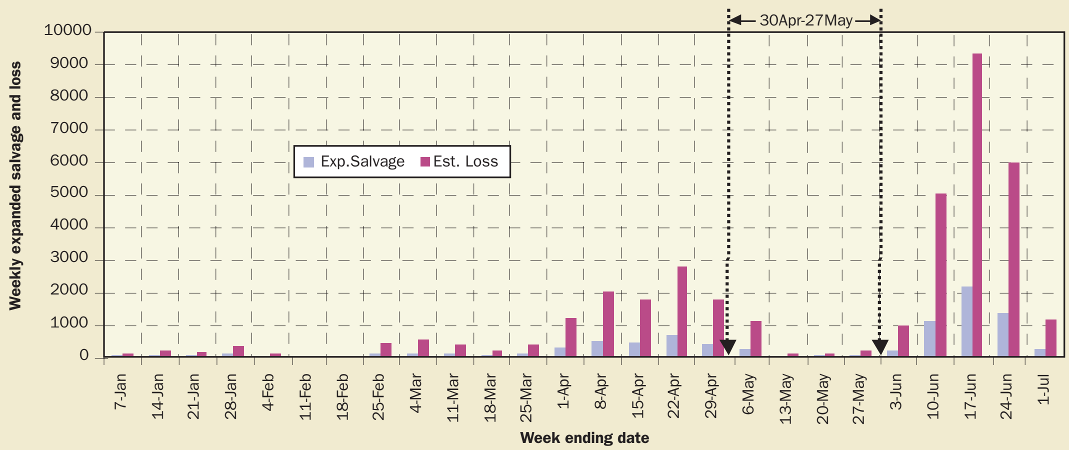
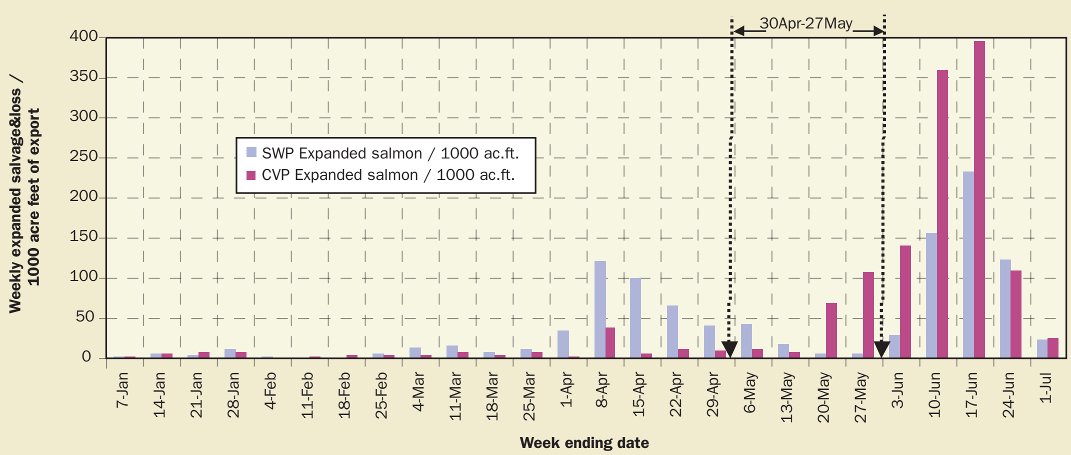


Figure 5-26
2006 SWP & CVP Combined salvage and loss density



Density of salmon encountering both of the export and fish salvage facilities off Old River is represented by the combined salvage and loss estimated per acre-foot of water pumped. The DFG and DWR maintain a database of daily, weekly, and monthly salvage data.

The number and density of juvenile salmon that migrated through the system, the placement of the HORB, and the amount of water pumped by each facility are some of the factors that influence the number of juvenile salmon salvaged and lost. Density is an indicator of when concentrations of juvenile salmon may be more susceptible to the export facilities and salvage system. Additionally, salvage efficiency is lower for smaller-sized salmon (fry and pre-smolts), so their salvage numbers and estimated losses are underrepresented.

The weekly data covering the period of April 30 to May 27 approximated the 2006 VAMP period. A review of weekly data for January through June indicates that the highest CVP salvage and losses occurred in June, with the last half of May having increasing values (Figure 5-24). Highest SWP salvage and losses were also in June with a lesser peak from late March to early May (Figure 5-25). Salmon densities based on combined salvage and loss estimates at both facilities were highest in June, with an earlier peak from late March to early May, mainly at the SWP (Figure 5-26). CVP densities were also relatively high in the second half of May (Figure 5-26). The June CVP and SWP peaks occurred during a period of declining flow at Vernalis (Figure 5-27).

The size distribution of unmarked salmon during January through June in the Mossdale trawl (Figure 5-23) generally overlaps withthe size distribution of those salvaged at the fish facilities (Figure 5-28, Source E. Chappell, DWR). Based on comparisons with Mossdale data , it appears that some salmon salvaged prior to VAMP could have been from the San Joaquin basin (Figure 5-22).

Results of these analyses showed that the 2006 VAMP test period coincided with part of the peak period of San Joaquin River salmon smolt emigration. The largest daily peak of the production passing Mossdale occurred after VAMP ended (June 3).

Summary and Recommendations

The CDRRs measured for the first group released in 2006, under low exports, appeared higher than those obtained in 2003 – 2005 and for the 2006 group released under higher exports and higher temperature.

The health of the fish used in 2006 was generally good, but it is uncertain whether detection of Bacterial Kidney Disease (BKD) in a proportion of the fish may have affected their survival through the Delta.

There are significant relationships between smolt survival and San Joaquin River flow at Vernalis and flow/exports with the HORB, although exports and flows are correlated in the data. These relationships are found when combining all of the recoveries available (Chipps Island, Antioch and ocean fishery) for the Durham Ferry and Mossdale groups relative to the Jersey Point groups. There does not appear to be a clear relationship to flow when the HORB is absent. There is however, a statistically significant relationship between SJR flow/exports and adult escapement 2 1/2 years later.

To better determine relationships of smolt survival to exports and flow, certain conditions should be targeted during the remaining years of VAMP and in years when the HORB cannot be installed. Two of the conditions that need to be tested with the HORB are at exports at 1500 and 3000 cfs with San Joaquin River flows at 7000 cfs. In addition, the 7000 cfs flow and the 1500 export condition would be especially valuable in decoupling the effects of flow and exports with the HORB in place. More experiments, like those in 2006, should be conducted when the HORB cannot be installed to further refine and define the survival relationships to flow and exports without the HORB in place. If exports are to vary within a year, further consideration should be given to doing the high export rate with low temperatures first, to decouple the trend of higher flows, low exports and low temperatures for the first release and lower flows, higher exports and higher temperatures for the second release. Conducting field experiments where many parameters vary together, make isolating the role of a single variable more difficult.

Figure 5-27
2006 weekly export rates and Vernalis flow

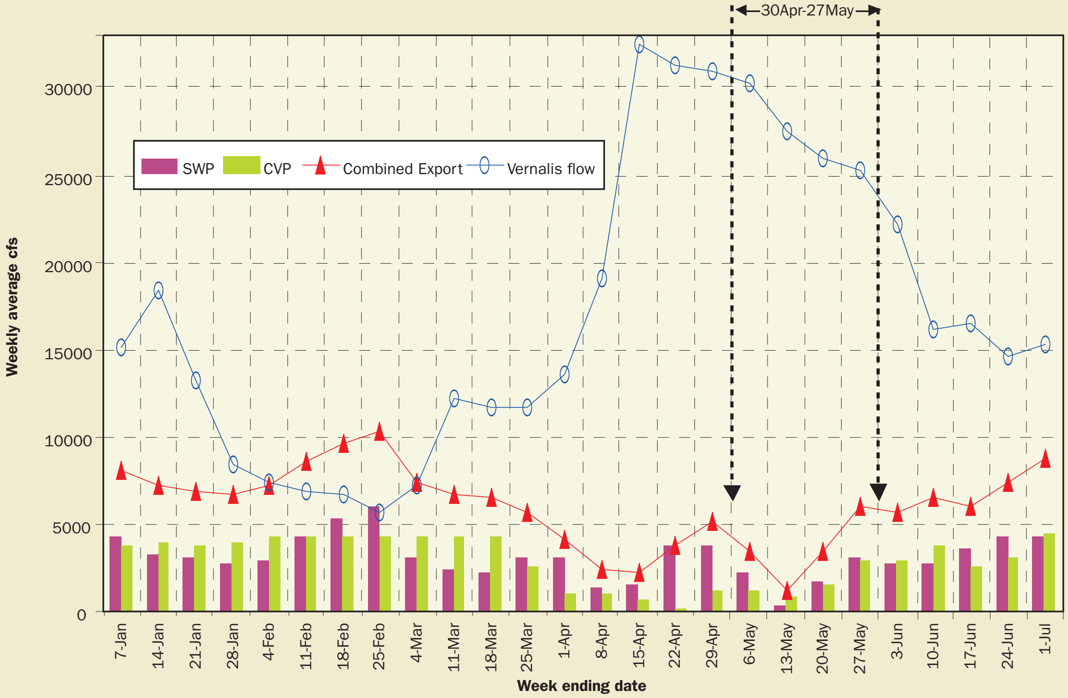
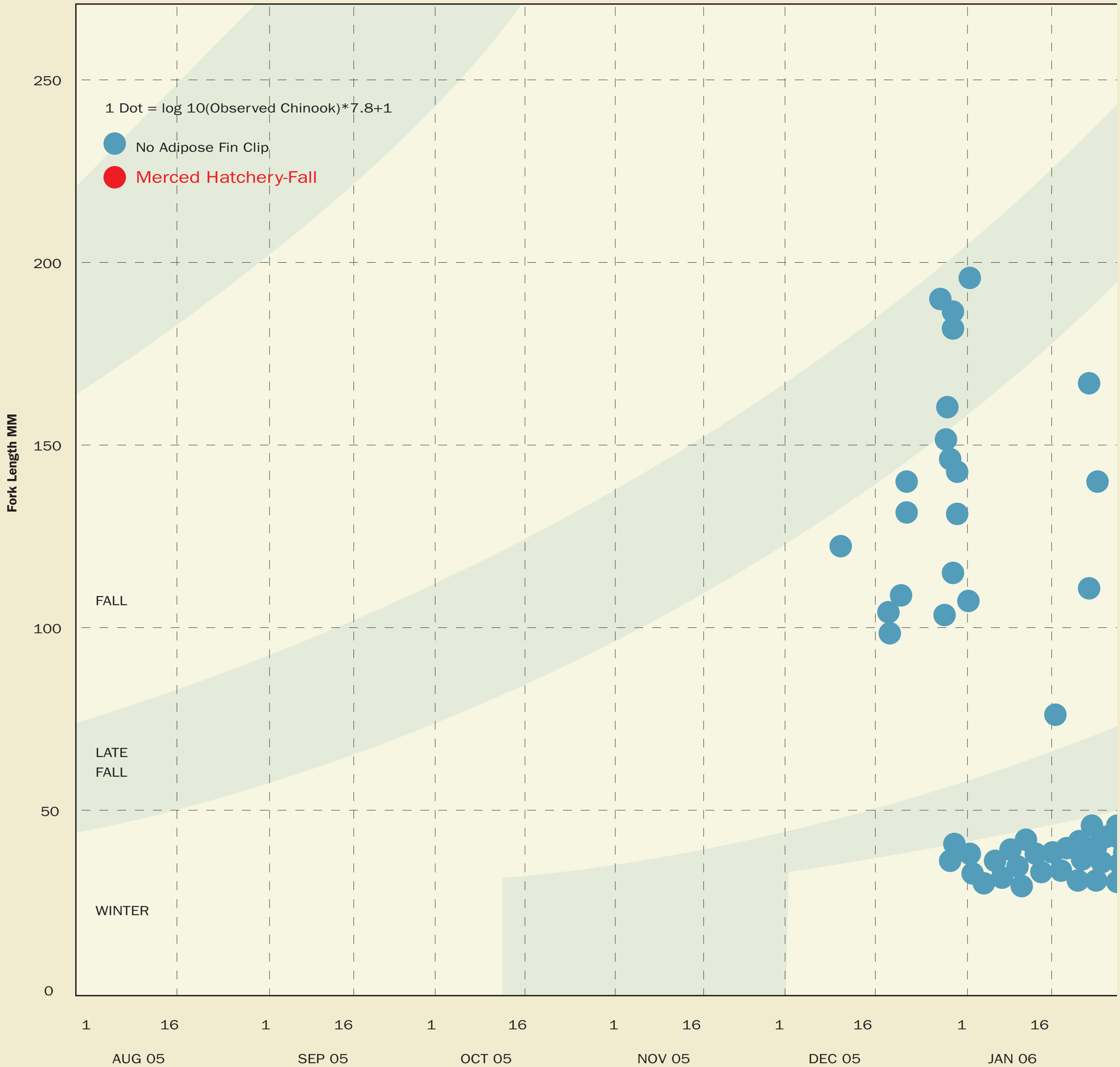
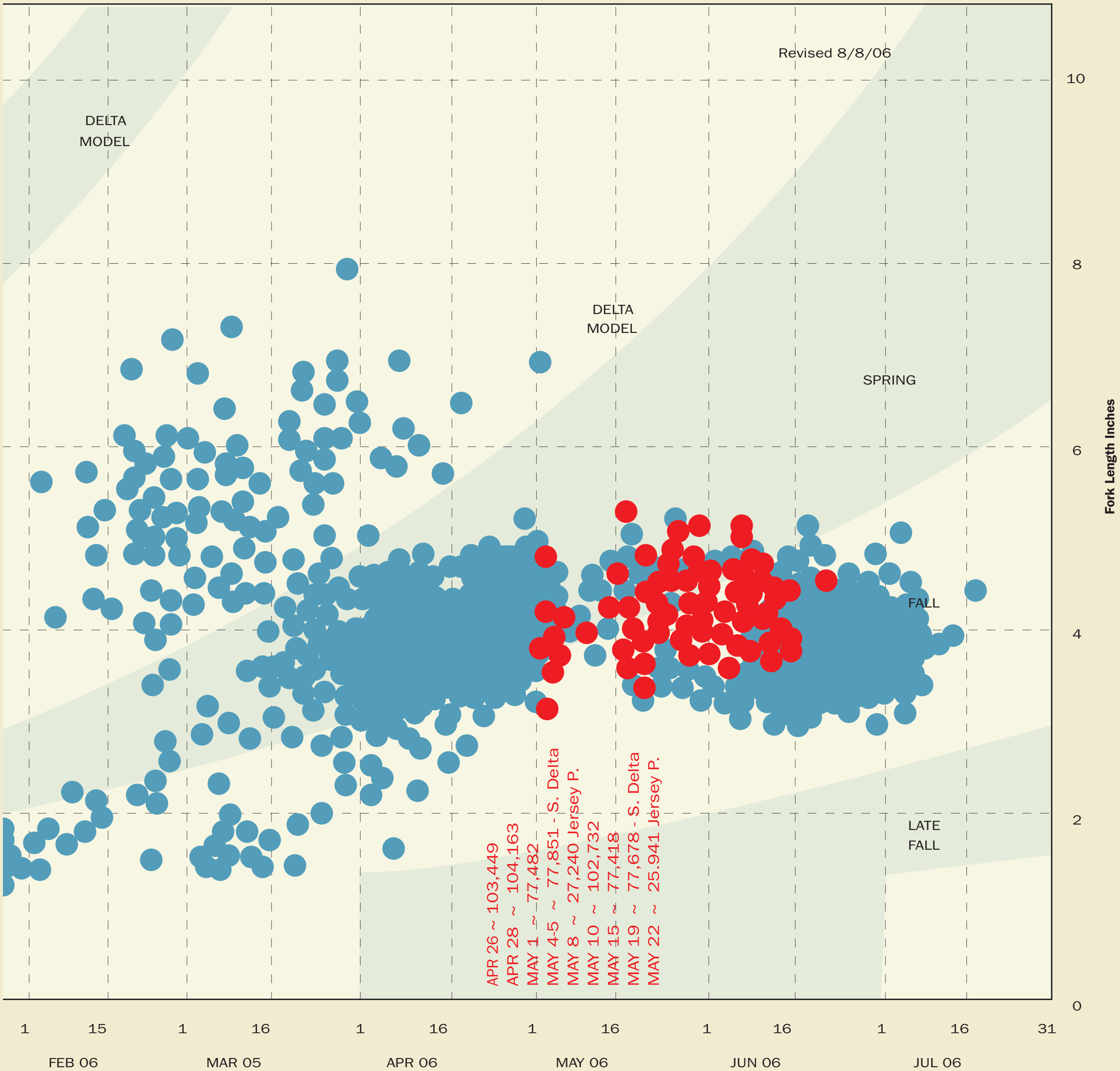


Figure 5-27
Observed Chinook salvage at the SWP and CVP
Delta Fish Facilities, August 2005 through July 2006.





Revised 8/8/06
DELTA
MODEL
DELTA
MODEL
SPRING
FALL
LATE
FALL
APR 26 ~ 103,449
APR 28 ~ 104,163
MAY 1 ~ 77,482
MAY 4-5 ~ 77,851 - S. Delta
MAY 8 ~ 27,240 Jersey P.
MAY 10 ~ 102,732
MAY 15 ~ 77,418
MAY 19 ~ 77,678 - S. Delta
MAY 22 ~ 25.941 Jersey P.
10
8
6
4
2
0
Fork Length Inches
1
15
1
16
1
16
1
16
1
16
1
16
31
FEB 06
MAR 05
APR 06
MAY 06
JUN 06
JUL 06

Chapter 6

Complimentary Studies Related to the VAMP

Throughout 2006 several fishery studies were conducted that were considered to be important to the overall understanding of the abundance and survival of juvenile salmon in the San Joaquin River basin. These are presented below to provide the reader with summary information on each study. More information can be obtained from each study manager or report author.

Review of Juvenile Salmon Data from the San Joaquin River Tributaries to the South Delta During January to Mid-July, 2006

Contributed by Tim Ford, Turlock and Modesto Irrigation Districts, and Andrea Fuller, FISHBIO Environmental

The VAMP includes protective measures for San Joaquin River (SJR) smolts during a 31-day period in April and May, and evaluations are conducted annually to determine how these measures (i.e., river flow and exports) relate to delta survival. However, juvenile salmon from the spawning areas of the Stanislaus, Tuolumne, and Merced rivers (referred to here as tributaries) can migrate to the SJR and delta over a longer season that may range from January to June. Their migration and rearing patterns vary among tributaries and among years in response to flow releases, runoff events, turbidity, and other factors.

During 2006, rotary screw trapping was conducted near the confluences of the Stanislaus and Tuolumne Rivers with the San Joaquin River - no comparable monitoring occurred on the Merced River. Seining was also done in the SJR from below the HOR to upstream of the Tuolumne River confluence. This review presents data from those rotary screw traps (RST) and seining to identify the presence and movement of juvenile salmon from the tributaries into the mainstem San Joaquin River relative to observations at the Mossdale Trawl and in CVP and SWP salvage facilities. Stanislaus River RST monitoring was conducted at River Mile (RM) 9 (Caswell site) during 07 Mar – 14 Jul; and Tuolumne River RST monitoring was conducted at RM 5 (Grayson site) during 26 Jan – 22 Jun. Weekly seining during Jan-June was done at up to 8 sites from River Mile 51 (Dos Reis) to River Mile 83 (North of Tuolumne River) and 2 other sites were seined every 2 weeks from mid-January to mid-June at River Mile 78 and 90. Trawling was conducted in the San Joaquin River at Mossdale near RM 54 (downstream of the tributaries, and just upstream of the Head of Old River) during 03 Jan – 29 June (daily, except only 3 days/week prior to April). Although salvage data of unmarked salmon does not distinguish which salmon originate from the San Joaquin tributaries, they can be compared to timing, abundance, and size of salmon collected in the San Joaquin basin monitoring. Flow and rainfall patterns in the basin are shown in Figure 6-1; flow at the Modesto gage was estimated by the sum of flow at La Grange the prior day and the flow of Dry Creek at Modesto and some flows at Merced River at Stevinson were estimated as the difference in flow between San Joaquin River at Newman and Fremont Ford Bridge.

Seasonal peaks in catch of fry in the Tuolumne River RST (Figure 6-2) occurred on January 28 and March 1. The first peak followed a decrease in flood releases and was very near the start of sampling, which could have missed an earlier peak. The peak during March coincided with a large rain event and increasing flood releases. However, similar to 2005, relatively few early fish were observed at the Mossdale trawl (Figure 6-3), and in the CVP (Figure 5-24) and SWP (Figure 5-25) salvage operations. Seasonal peak catch occurred at Mossdale during early June, coincident with peak smolt catches on the Tuolumne and Stanislaus (Figure 6-4) rivers and prior to the peak densities recorded at the salvage facilities (Fig. 5-26). Figure 6-5 shows that most fish observed prior to mid-March averaged <50 mm fork length (FL). Both the trawl and salvage are relatively less effective at capture of fry (salmon less than 50 mm long).

Average size in RST and trawl catch and salvage increased by late April to >80 mm FL at all locations (Figure 6-5). Migrants captured during the first half of June at Mossdale and in the salvage were on average approximately 10 mm larger than Stanislaus River smolts. By late June, all sampling in the tributaries and at Mossdale indicated very low abundance of juvenile salmon. Seining in the SJR only captured salmon prior to VAMP, with salmon <50 mm in fork length being present through March (Figure 6-6), with the highest densities recorded at Mossdale and/or Dos Reis in early March and early April. (Figure 6-7)

Figure 6-1
San Joaquin Basin Flows and Rainfall

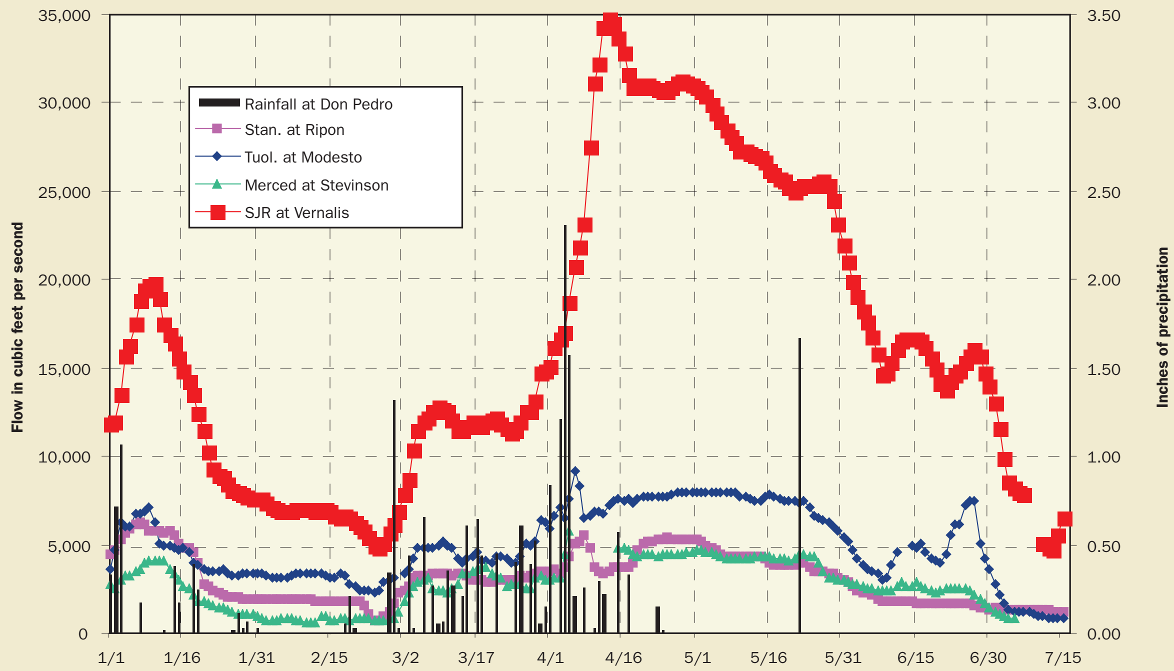


Figure 6-2
Tuolumne screw trap catch of unmarked juvenile Chinook salmon

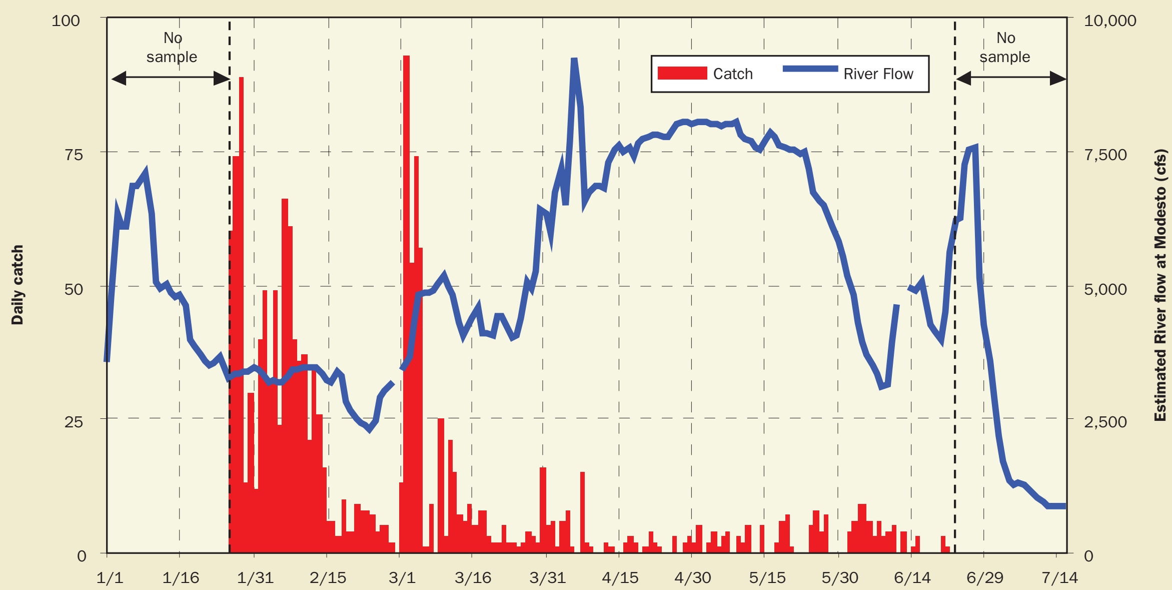


Figure 6-3
Mossdale kodiak trawl catch of unmarked juvenile Chinook salmon

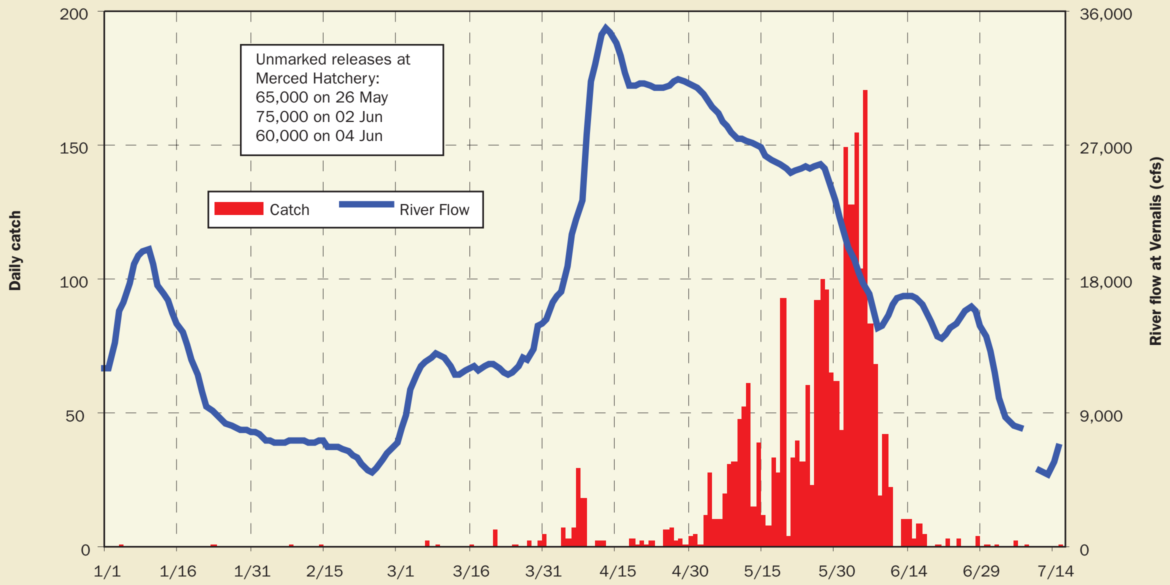
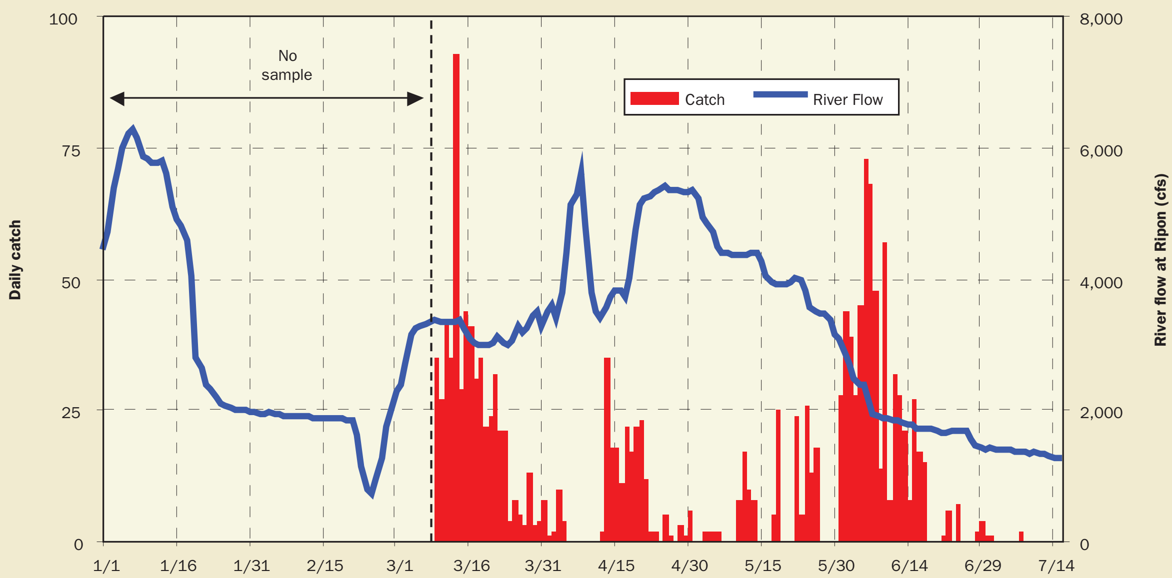


Figure 6-4
Stanislaus screw trap catch of unmarked juvenile Chinook salmon



It is apparent that much of the Tuolumne River juvenile salmon population migrated into the SJR during January to March as fry and pre-smolts. Although sampling did not occur near the mouth of the Stanislaus River prior to early March, many fry and pre-smolts outmigrated during the portion of March that was monitored. With early flood flows similar to the Tuolumne, it is also likely that much of the Stanislaus River juvenile population emigrated as fry and pre-smolts prior to the initiation of sampling as has been recorded during January and February of previous sampling years when flood releases occurred. Early migrants were not captured in high numbers at Mossdale or in the salvage, indicating that the juveniles may have remained in the lower San Joaquin above Mossdale and/or that relative efficiency of the trawl and salvage facilities for fry-sized salmon is less than for the RST. However, high densities have been recorded early in the season at those sites in other years (SJRGA, 2005); differences in density at Mossdale and salvage between years may also be influenced by the overall abundance of juveniles migrating from the tributaries as a result of varying parent runs.

To obtain more information on fry movement into the Delta, additional monitoring at the lower end of each of the three San Joaquin tributaries for the entire season (January through June) would be a high priority. Further evaluation of the trawl and salvage efficiency on smaller juvenile salmon is necessary. These data would help to refine existing protective measures for smolts, if warranted, and to identify alternative strategies that may protect a larger proportion of the juvenile salmon population migrating from the San Joaquin tributaries.

2006 Mossdale Trawl Summary

Contributed by Jason Guignard,
California Department of Fish and Game

Introduction

Monitoring for the fall-run chinook salmon smolt out-migrant population, in the San Joaquin drainage, is conducted two miles downstream of Mossdale Landing, Country Park (river mile 56), and upstream of the Old River confluence (Figure 6-8). The measurement of timing and production (indices and estimates) for the out-migrating fall-run Chinook salmon smolts have been monitored at this location since 1987 to:

1) Determine annual salmon smolt production in the San Joaquin Basin,

2) Develop smolt production trend information,

3) Determine timing and magnitude of smolt out-migration into the Delta from the San Joaquin tributaries.

Methods:

Sampling is performed with a 6 x 25 foot (1.87m x 7.6m) Kodiak trawl net. The Kodiak trawl uses two boats to pull a net equipped with spreader bars, wings, and a "belly" in the throat of the net (to improve capture vulnerability). The cod end of the trawl net is secured using a rope. The sampling intensity was 5 days a week from April 3 to April 21, and then increased into 7 days a week from April 24 to May 28. The sampling effort was reduced to 5 days a week during May 29 to June 16. The entire sampling period was from April 3 to June 16, 2006 with a total of 62 sample days out of the study period of 75 days. All trawling occurred during daylight hours, starting around 0800 hours. A sampling day usually consisted of 15 tows at 20 minutes per tow, although the first three weeks and last two weeks of sampling had 10 tows per day. Due to high river level conditions, sampling was not performed between April 12-14. Sampling is also conducted 3 days per week between mid- June and April by the USFWS in Stockton.

Water temperature, turbidity, weather, beginning tow time and velocity were recorded for each tow. Velocity was recorded by using a digital flow meter model 2030R that is made by General Oceanics Inc. A Garmin GPSMap 172c was used to map the location of all sampling tows. This mapping was done in an attempt evaluate differences in catch rate throughout the sampling area (Figure 6-9). The mean daily river flow data that is used in this report were taken from the U.S. Geological Survey mean daily stream flow gauge at Vernalis as well as the California Department of Water Resources gauge at Mossdale.

All fish were identified to species and enumerated. The first 20 per tow of all species, except Chinook salmon, were also measured. Chinook salmon were checked for a clipped adipose fin and/or dye mark. All non-marked Chinook salmon were considered "natural" for the purpose of this study. All Chinook salmon were measured (fork length, mm). Chinook salmon that had a clipped adipose fin was measured, individually bagged, and labeled and saved for coded wire tag processing.

Flows averaging over 20,000 cfs in the spring of 2006 resulted in the daily operation of the trawl beginning at the upstream end of the sampling area. Although the boats and net faced upstream, the high flows carried the boats and net downstream. Typically, three tows were completed before the net was retrieved and reset upstream. The marked fish associated with the weekly vulnerability tests were released at the Mossdale boat ramp and coincided with the first tow of the day. Fish were released over a two hour period to allow the group to disperse through the reach.

Figure 6-5
Daily average forklength of unmarked juvenile Chinook salmon

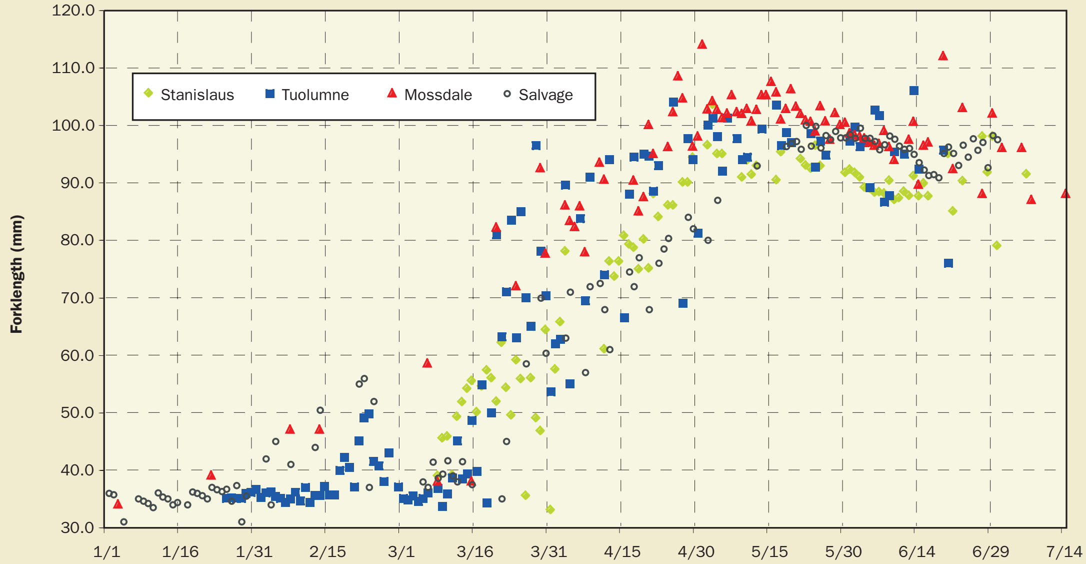


Figure 6-6
San Joaquin River salmon catch in 2006 seining by USFWS and TID/MID from River Mile 51 (Dos Reis) to RM 90 (Laird)

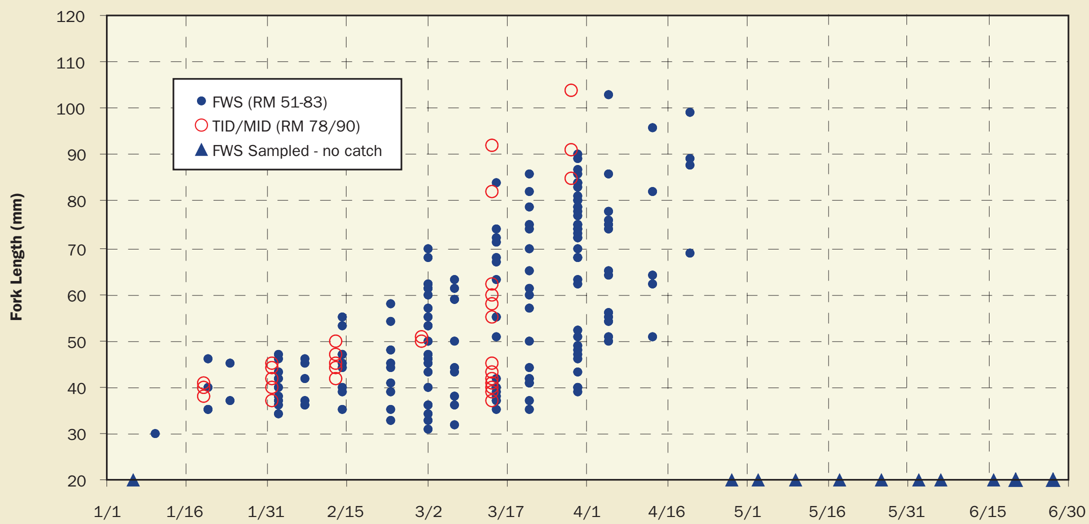


Figure 6-7
Salmon density in San Joaquin River seining from River Mile 51 (Dos Reis) to RM 90 (Laird) during January to June, 2006 - no catch in May and June.

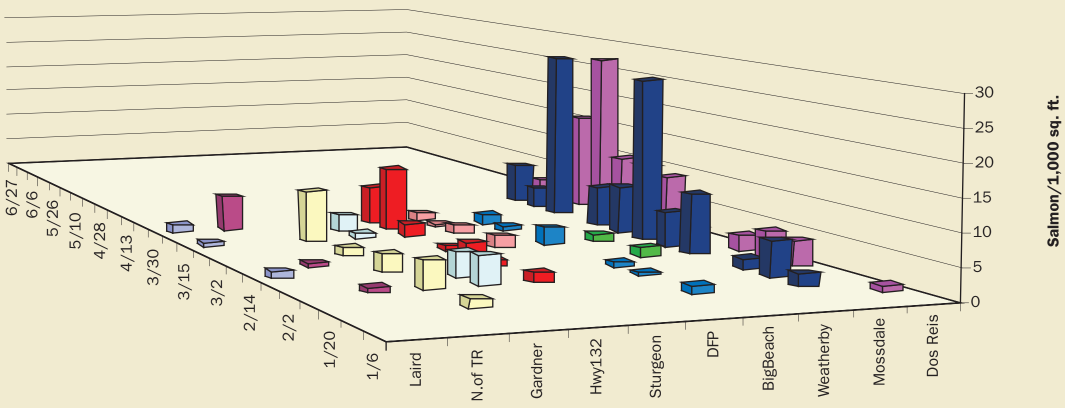


Figure 6-8
San Joaquin River and Delta.

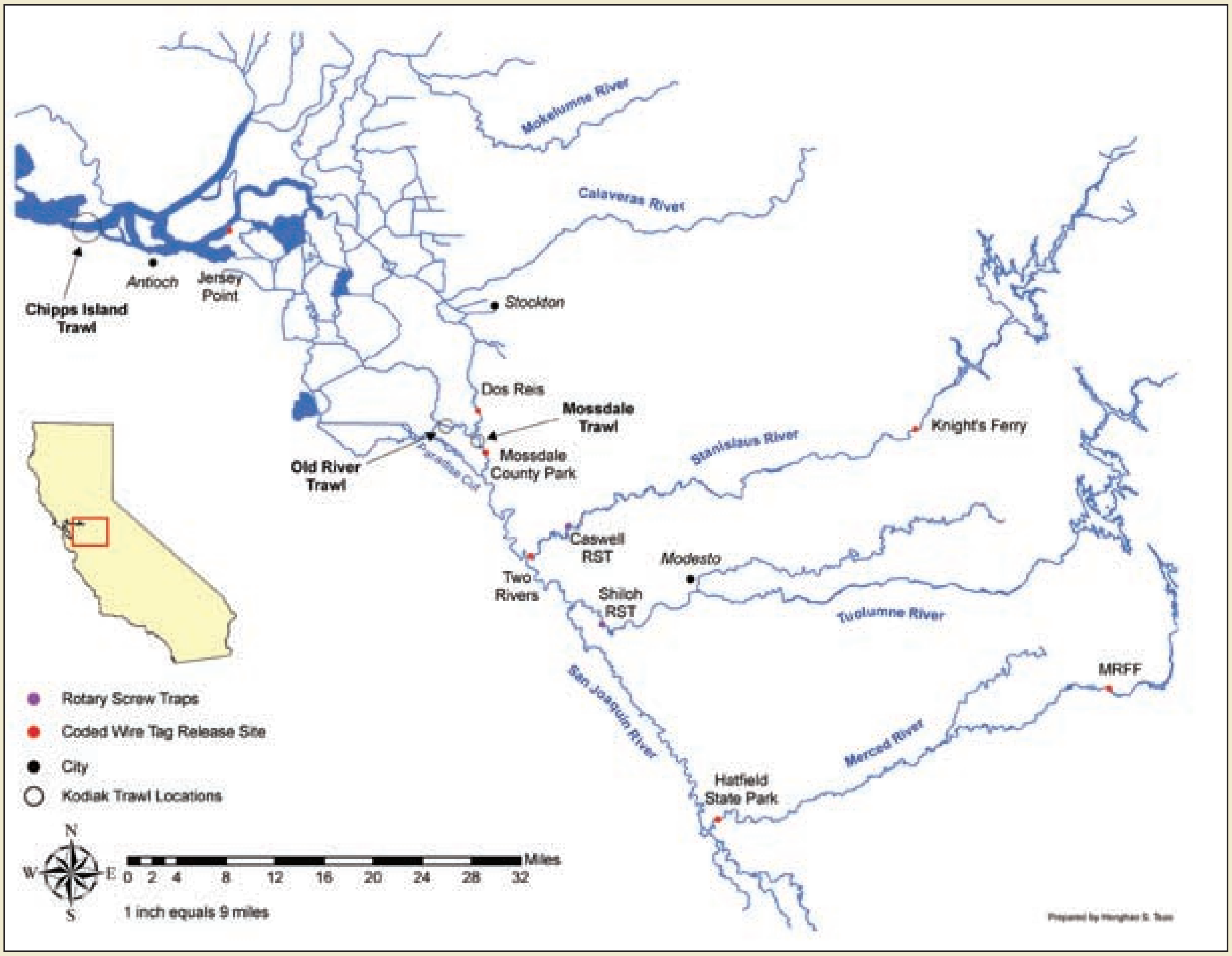


Figure 6-9
GPS tracks of all sampling tows and the corresponding catch of Chinook.

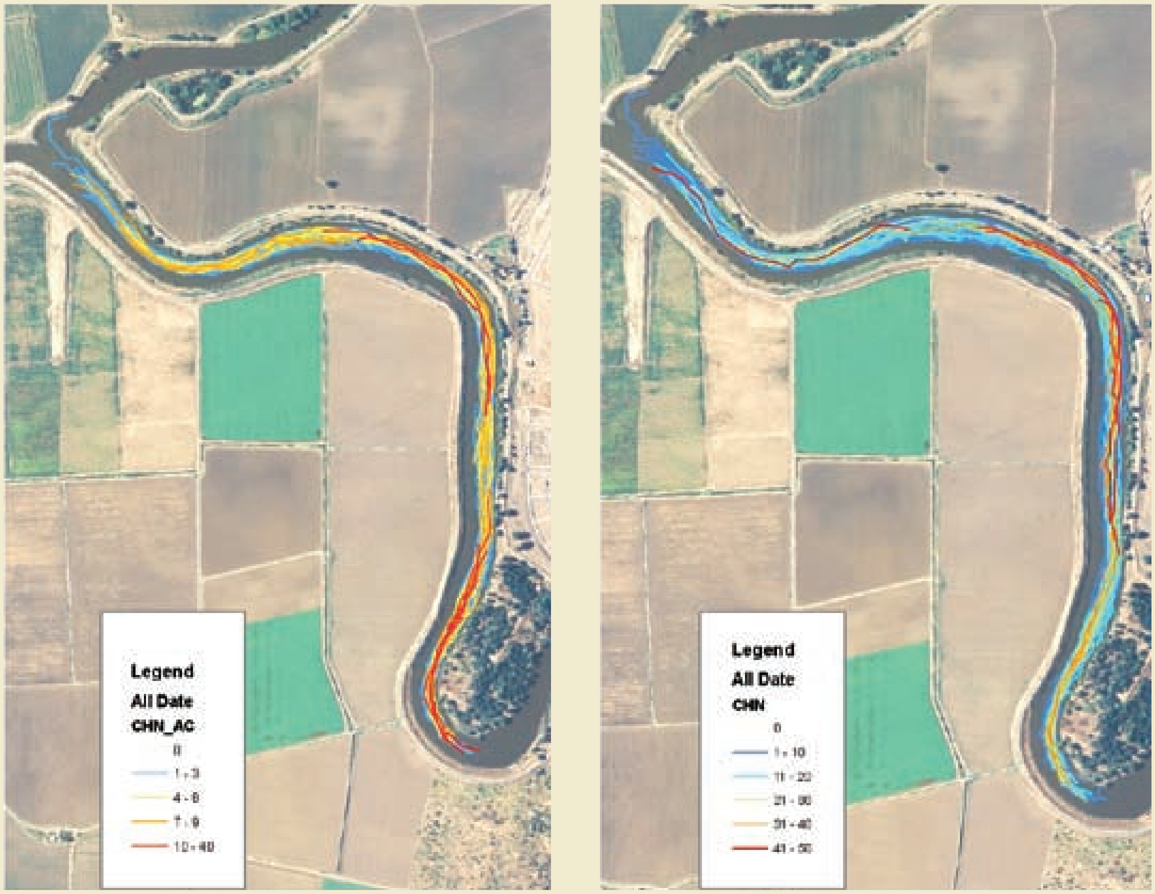
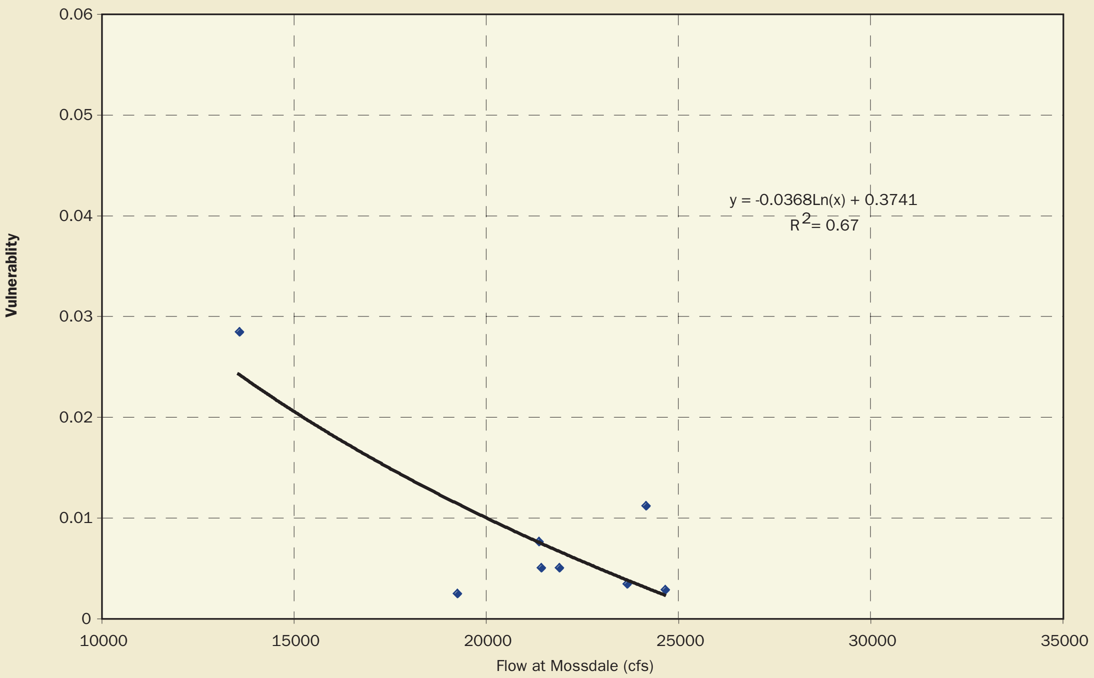


Figure 6-10
Natural Log of 2006 vulnerability tests vs. flow at Mossdale



High river flows resulted in some water being routed around Mossdale into Old River through Paradise Cut (Figure 6-8). Average mean daily flow through Paradise Cut between 4/1/2006 and 5/31/2006 was 5300 cfs.

The 2006 natural smolt production from the San Joaquin drainage was estimated by two different methods. The first method (smolt/ac-ft method) involves taking the actual number of non-marked Chinook salmon and dividing by the actual volume sampled to get Chinook/ac-ft. This number is then expanded by the daily mean flow recorded at Mossdale for a 5-hour index and expanded again for a 24-hour daily estimate. These daily average smolt densities were then expanded by multiplying by the daily mean flow recorded at Mossdale. Production for days not sampled within the study period were estimated by averaging smolt/ac-ft for the 2 days before and 2 days after the non-sampled period. Past smolt production estimates have been based on flows at Vernalis. Due to the flows through Paradise Cut, the 2006 production estimate utilized mean daily flow at Mossdale.

The second estimate (population ratio method), which we believe to be a more accurate estimate, due to the uneven distribution of smolts in the channel, was determined using the 8 dye marked vulnerability release groups (Table 6-1 and Figure 6-10). Production for days not sampled within the study period were estimated by averaging smolt catch and minutes towed for the 2 days before and 2 days after the non-sampled period.

Smolt Production Index Calculation (Smolt/ac-ft Method):

The natural smolt index estimates (E_I) are calculated as follow:

$$E_I = \sum_{i=1}^{n=75}\left[\left(\frac{C_i}{V_{Ti}}\right)\left(V_{Pi}\right)\left(\frac{24}{5}\right)\right]$$

Where:

n = days in the index period

C = daily non-marked Chinook catch

V_T = daily volume of trawl sampled

V_P = daily 5-hour volume of water passing Mossdale

i = i^{th} Day

The 95% confidence interval around this index was calculated as +1.96 x the Standard Deviation of the mean smolt density (smolt/ac-ft) in the trawl catch over the 75 days.

Table 6-1
Dye marked smolt releases from Merced River Hatchery for vulnerability studies (released 975 meters upstream of the Kodiak trawl) in the san Joaquin River at Mossdale Landing, April through May, 2006.

Release Date/Time	Water Temp. (°C) Truck/River	Effective # Released	Number Recovered	Streamflow (cfs) at Mossdale	Beginning and Ending Recovery Time
6-Apr-06	10/ 13	2,056	5	19,263	10:31
9:18					11:50
20-Apr-06	10/ 14	4,986	14	24,672	9:50
9:03					11:08
27-Apr-06	11/ 15	5,027	56	24,177	9:27
8:35					11:40
4-May-06	11/ 16	4,998	17	23,679	8:26
7:32					12:58
11-May-06	12/ 17	4,999	25	21,445	8:52
8:00					14:14
18-May-06	12/ 19	4,990	25	21,919	8:31
7:34					9:48
25-May-06	12/ 17	4,994	38	21,388	8:42
7:51					10:43
*01-Jun-06	12/ 18.5	4,999	12	18,379	8:21
7:55					10:06
8-Jun-06	12/ 20	4,998	142	13,595	8:15
7:45					9:09

* Vulnerability test ommitted due to problems with trawl net

Kodiak Trawl Vulnerability Estimates (Population Ratio Method):

The vulnerability expansion production estimate (E_V) was used for 2001-2006 estimates, and is calculated as follow:

$$E_V = \sum_{i=1}^{N=75} \left\{ \left[\frac{(C_i/r)}{(T_i/300)} \right] \left(\frac{24}{5} \right) \right\}$$

Where:

r = population ratio

C = Daily non-marked Chinook catch

T = Tow Duration

i = i^{th} Day

N = number of days sampled

The population ratio (r) is calculated as follow:

$$r = \frac{\sum_{i=1}^{n} y}{\sum_{i=1}^{n} x} = \frac{\bar{y}}{\bar{x}}$$

Where:

n = number of vulnerability test groups

y = number of marked fish captured

x = number of marked fish released (effective release)

i = i^{th} Day

Estimated variance ( ) of r:

$$\hat{V}(r) = \hat{V}\left(\frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} x_i} \right) = \left(\frac{N-n}{nN} \right) \left(\frac{1}{\mu_x^2} \right) s.d._r^2$$

N = number of days sampled

n = number of vulnerability test groups

y = number of marked fish captured

x = number of marked fish released (effective release)

i = i^{th} Day day

u_ = average of effective release

s.d. = standard deviation

The 95% confidence interval around this estimate was calculated as $r \pm 1.96\sqrt{\hat{V}(r)}$

The 1989-2000 estimates, are based on the number of actual non-adipose clipped Chinook salmon caught per tow and expanded by the natural log of all vulnerability tests (1989-2005). This number is then extrapolated out to a 5-hour index and a 24- hour seasonal estimate.

For the purpose of analysis, vulnerability to the trawl was assumed from the beginning of the first tow detected to the end of the last tow detected on the day of release. Detection of marked fish subsequent to day of release was not used in the analysis (this was less than 5 fish total for all releases). Travel time (from release point to trawl), time vulnerable to the trawl and the percent vulnerability as related to flow were determined for each test group.

Results

Between April 3 and June 16, 2006 2,743 non-marked Chinook salmon smolts were captured in the Mossdale trawl. Daily capture of non-marked salmon ranged from 0 – 176 individuals with an average of 43. Average forklength of non-marked Chinook was 99.5 millimeters (mm) and ranged from 44 – 134 mm. A total of 543 adipose fin clipped Chinook were captured between May 3 and June 14, 2006. The average forklength of marked Chinook was 99.6 mm and ranged from 71 – 126 mm.

Smolt production estimates for the San Joaquin basin ranged between 848,394 using the smolt/ac-ft estimate and 1,808,143 using the trawl vulnerability estimate (Table 6-2). The trawl vulnerability extimate is thought to be more accurate than the smolt density index method because it should account for an uneven distribution of migrating smolts in the river channel. Trawl vulnerabilities were obtained by conducting mark-recapture tests each week. Release groups ranged from 2,056 – 5,027 dye marked juveniles. Juveniles were obtained from the Merced River Hatchery and were selected by size to match as closely as possible the size of wild fish being observed in the river at that time. The production estimate had a 95% confidence range of (1,749,531 – 1,866,755).

Eleven steelhead/ rainbow trout (RBT) were captured during the 2006 sampling period. All RBTs were measured and returned to the river. Average forklength was 271 mm, and all samples exhibited advanced stages of the smoltification process. Figure 6-12 shows the total number and average forklength of RBTs captured by the Mossdale Trawl from 1988 to 2006.

Figure 6-11
Expanded daily catch of non-marked Chinnok based on vulnerability estimates and flow at Mossdale, 2006

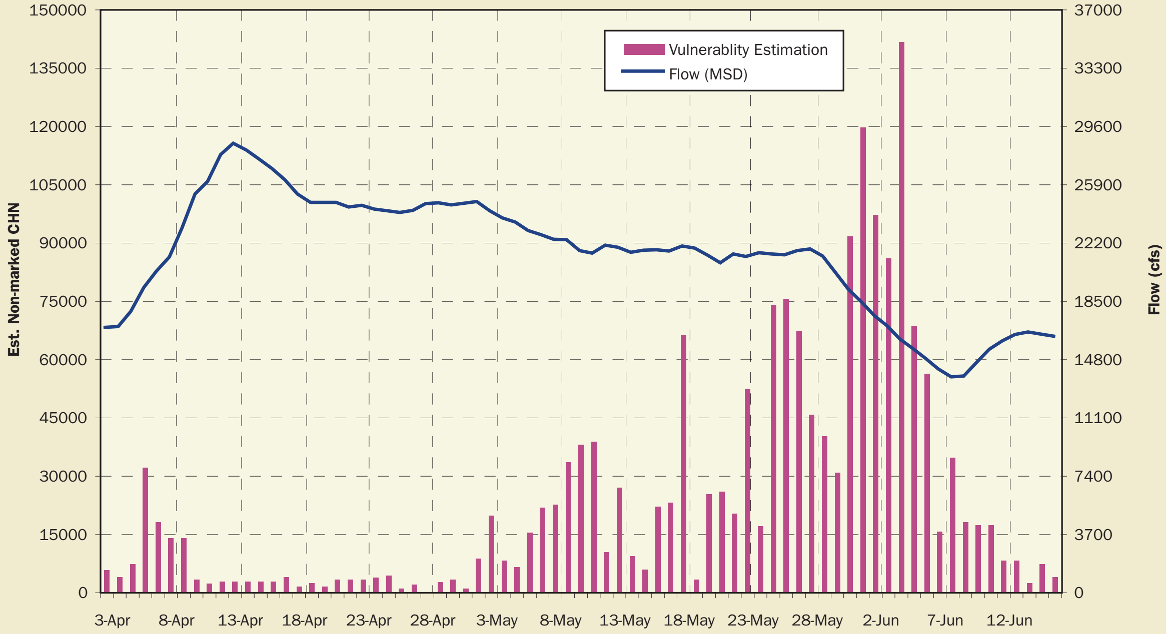


Figure 6-12
Annual rainbow trout/steelhead catch and average forklength at Mossdale

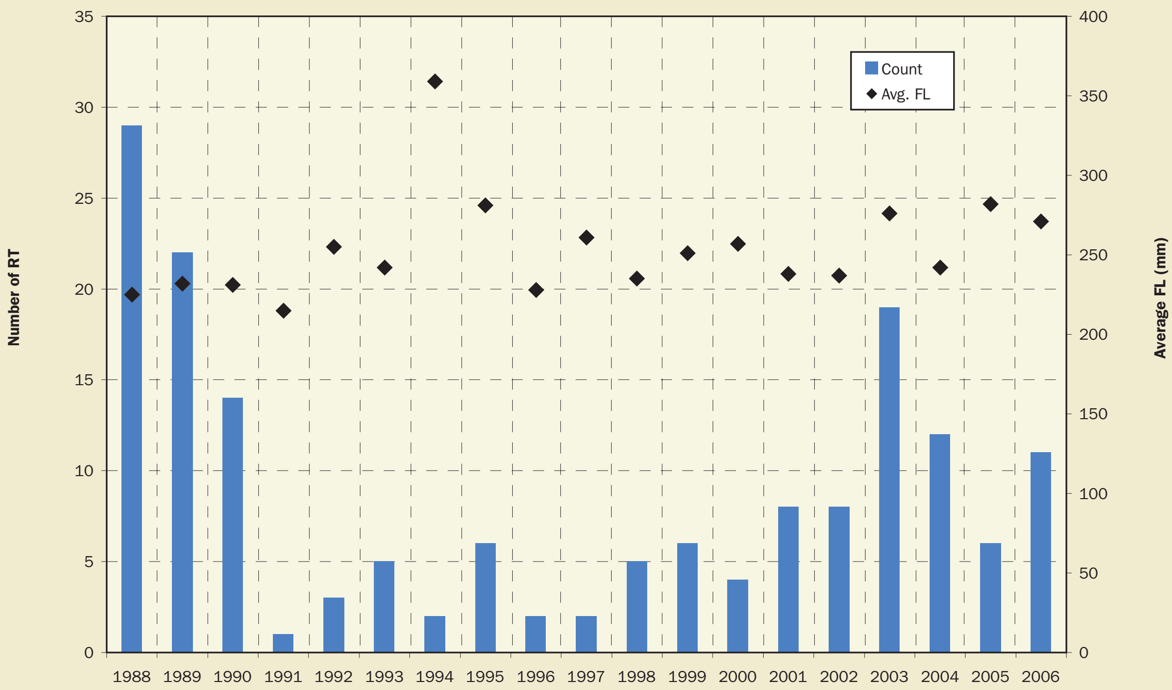


Table 6-2 Smolt Production seasonal estimates and sampling period for the duration of the study.				
Year	**Sampling Period (Days)**	**Percentage of Day Sampled (%)**	**Smolt/ac-ft Estimate**	**Vulnerability Smolt Production Seasonal Estimate** (95% confidence range)**
2006	75	85.3	848,394 + 12,888	1,808,143 : (1,749,531-1,866,755)
2005	89	80.9	363,800 + 14,700	621,403 : (388,884-1,119,550)
2004	61	88.5	92,500 + 66,500	297,348 : (191,222- 665,160)
2003	88	80.7	107,500 + 60,300	368,424 : (277,626- 545,121)
2002	74	87.8	229,100 + 557,100	2,254,647 : (1,455,066-5,179,591)
2001	103	78.6	279,800 + 286,000	928,996 : (586,790-2,228,789)
2000	88	81.8	211,100 + 181,900	484,703
1999	119	71.4	146,900 + 63,500	438,979
1998	99	67.7	1,075,000 + 562,800	2,844,637
1997	92	69.6	168,600 + 89,400	635,517
1996	89	85.4	381,900 + 626,900	1,155,319
1995	60	78.3	1,108,900 + 2,640,000	3,361,384
1994	63	73	67,500 + 62,200	453,245
1993	83	61.4	54,200 + 21,800	269,035
1992	72	44.4	23,600 + 6,300	280,395
1991	59	66.1	*	538,005
1990	82	69.5	*	263,932
1989	54	100	*	4,241,862

* Data is currently being reevaluated.

** 2001-2006 production estimates based on the annual population ratio method, 1989-2000 estimates based on the natural log of all vulnerability tests (1989-2005).

2006 VAMP Pilot Study to Monitor the Migration of Juvenile Chinook Salmon Using Acoustic Telemetry

Contributed by Dave Vogel, Natural Resource Scientists, Inc.

Introduction

During the 2006 Vernalis Adaptive Management Program (VAMP), a pilot study was initiated to monitor the migration of juvenile Chinook salmon using acoustic telemetry. The study was prompted by interest from VAMP participants to determine if the applied technology would provide detailed information about the movements of juvenile salmon through the Delta. In particular, there was need to evaluate how lack of a barrier at the Old River/San Joaquin River flow split may affect juvenile salmon and determine migration pathways used by salmon at other locations further downstream in the San Joaquin River. The project was conducted as a short-term, small-scale pilot effort to evaluate if the equipment, techniques, and results would be valuable toward supplementing existing VAMP studies in future years. The following section provides a brief description of the results of the 2006 pilot study. Additional details will be provided in a separate technical report.

Summary of 2006 Pilot Study

The pilot study was conducted from May 8 through May 19, 2006, during high flow conditions. One hundred Merced Hatchery juvenile fall-run Chinook were used for the study. A request was made to the California Department of Fish and Game to include wild fish captured in the Merced River but was not approved. Miniature acoustic transmitters (0.8 grams) (Figure 6-13) were surgically implanted (Figure 6-14) inside the hatchery fish. Each transmitter was programmed to be individually identifiable based on sound transmission pulse width and repetition rate.

Acoustic receivers (Figure 6-15) capable of recording each acoustic-tagged salmon were deployed off the levee banks (Figure 6-16) or from California Department of Water Resources tide gauging stations to detect fish passing each site. The receivers electronically record the time when each fish is detected.

The acoustic-tagged salmon were released at Mossdale and Dos Reis in the lower San Joaquin and monitored with acoustic receivers placed at five locations shown in Figure 6-17.

Only five acoustic receivers were available for this pilot study and, therefore, data collection was limited by coverage in only some of the Delta channels where fish may migrate. Other important areas could not be included in the study (e.g., south Delta export facilities).

An initial release of 32 acoustic-tagged salmon was made at Mossdale on May 8, 2006. Originally, it was planned to release 100 fish on that date, but the remaining fish at the hatchery were slightly smaller than required for tag implantation. Therefore, the remaining fish were kept at the hatchery to acquire additional growth for tagging, then subsequently released on May 15, 2006.

First Fish Release (May 8, 2006) (Low Export Rate)

Of the 32 fish released at Mossdale on May 8, 2006, 25 fish (78%) were detected to have been diverted into Old River and 5 fish (16%) were detected to have migrated down the lower San Joaquin past the Brandt gauge. The fate of the remaining 2 fish is unknown, but, given the caveats

Figure 6-13
An acoustic transmitter

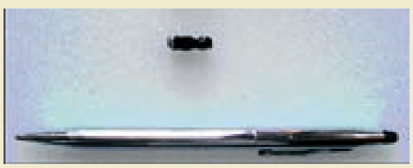


Figure 6-14
A juvenile Chinook salmon with a surgically implanted acoustic tag.

Figure 6-15
An acoustic (hydrophone) receiver, connection cable, output extender box, and 12-VDC marine batter.

Figure 6-16
Deployment of an acoustic receiver from a Delta levee.

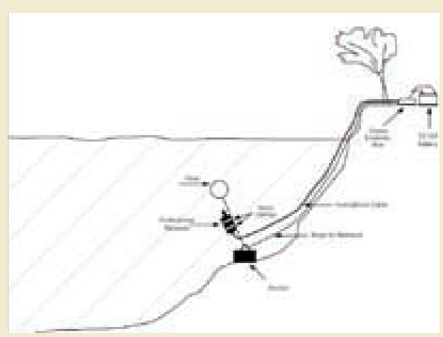
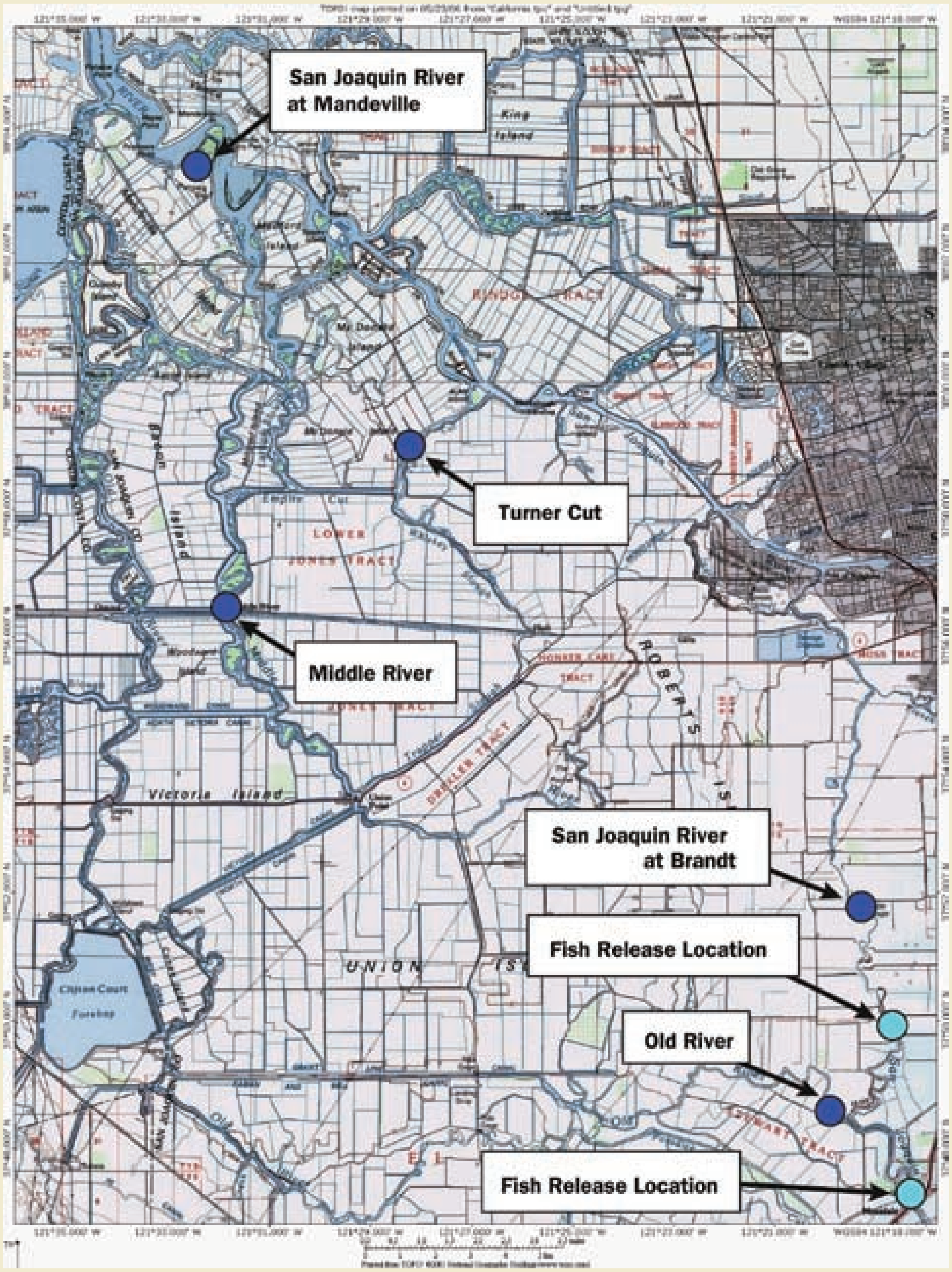


Figure 6-17
Release locations of acoustic-tagged juvenile salmon and deployment locations of acoustic receivers during May 2006.



described below, the fish were presumed to have been preyed upon because the transmitters were not detected at any receivers during the study period.

The proportionally high rate of fish diverted into Old River could not be explained by proportion of flow diverted. Based on preliminary flow data, Old River was diverting approximately 53% of the mainstem San Joaquin flow at the time the fish approached the flow split, but at least 78% of the fish were diverted into Old River. (Table 6-3)

Table 6-4
Acoustic tag detections following a release of 32 fish at Mossdale on May 8, 2006

# Detected in Old River	# Detected in San Joaquin River at Brandt Gauge	# Assumed Lost Due to Predation
25* (78%)	5 (16%)	2 (6%)

* Three of these fish were subsequently detected in Middle River

Second Fish Release (May 15, 2006)

Because such an unexpectedly high proportion of the fish were diverted into Old River during the first fish release, the second release was modified by releasing 35 fish at Mossdale and 33 fish at Dos Reis on May 15, 2006. Based on preliminary flow data, approximately 51% of the mainstem San Joaquin flow was diverted into Old River at the time fish approached the flow split, with 40% of fish released at Mossdale entering Old River (Table 6-4). Of the 33 fish release at Dos Reis, only 14 (42%) passed the first downstream receiver at the Brandt gauge (Table 6-5). The fate of the remaining 19 fish (58%) is unknown but the fish

Table 6-5
Acoustic tag detections following a release of 35 fish at Mossdale on May 15, 2006

# Detected in Old River	# Detected in San Joaquin River at Brandt Gauge	# Assumed Lost Due to Predation
14 * (40%)	11 (31%)	10 (29%)

* One of these fish was subsequently detected in Middle River and two of these fish were subsequently detected by mobile telemetry and assumed preyed upon.

Table 6-6
Acoustic tag detections following a release of 33 fish at Dos Reis on May 15, 2006

# Detected in San Joaquin River at Brandt Gauge	# Assumed Lost Due to Predations
14 (42%)	19 (58%)

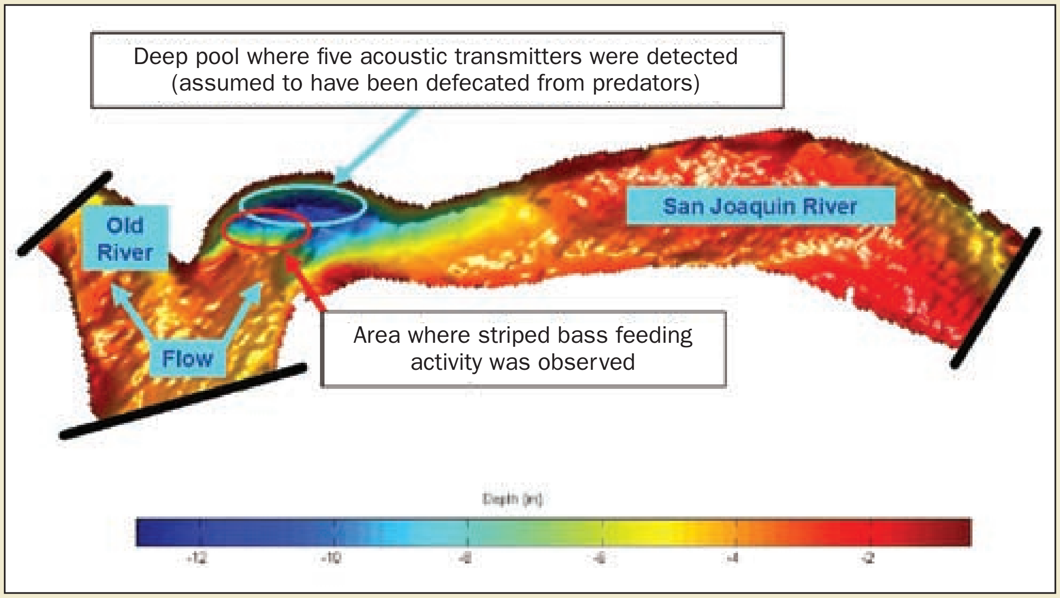
were assumed to be consumed by predators because the transmitters were not detected by any fixed-station receiver during the study period.

No fish were detected in Turner Cut or the lower San Joaquin River at Mandeville Island. The Turner Cut acoustic receiver had complete coverage of the cross-section of the river channel so no acoustic-tagged fish passing the site could have escaped detection. The Mandeville Island receiver had coverage of the majority of flow passing the site. Some flow passing around a side channel at the site could not be covered by the receiver and, therefore, it is possible some fish may have escaped detection. However, that circumstance is probably not likely based on fish behavior derived from extensive fish radio-telemetry in that region during prior studies. If those fish passing the Brandt gauge receiver took a long time (e.g., a week) to reach Turner Cut or Mandeville Island, it is also possible that the transmitter battery reached its useful life, estimated at about 10 days. However, based on past radio-telemetry studies on juvenile salmon in that region, fish movements past the area would be expected to be only several days.

Because of the limited number of acoustic receivers available for this pilot study, no data could be collected upstream of the two fish release sites. Therefore, it is possible (but not probable) that some acoustic-tagged salmon could have swam upstream during the period of study. It is more likely that some salmon were consumed by predatory fish that swam upstream escaping detection from any receiver. Notably, May is the peak upstream spawning migration period for striped bass spawning.

The fate of fish after diversion into Old River could not be determined from this study due to the limited number of acoustic receivers. However, four of the fish diverted into Old River were subsequently detected in Middle River

Figure 6-18
Plan-view, bathymetry of the Old River/San Joaquin River flow split (bathymetry graphic courtesy of Jon Burau and Aaron Blake, USGS).



near Bacon Island. Because of the small amount of flow diverted at the Old River/Middle River flow split, it is likely those fish moved west via Grant Line Canal or Fabian and Bell Canal, then north (past the south Delta export facilities) and subsequently moved across to Middle River through one of several interior Delta channels (e.g., Victoria Canal, Woodward Canal). A prior radio-telemetry study on juvenile salmon in this region demonstrated such migration pathways north of the export facilities.

On May 19, 2006, all five receivers were removed from Delta channels. One receiver was utilized as a "mobile" receiver in an attempt to locate transmitters that were not detected at either the Old River or lower San Joaquin River (Brandt) receiver sites. This was accomplished by hanging the receiver submerged off a boat and drifting the distance from just upstream of the Mossdale bridges to downstream of the location where the lower San Joaquin receiver had been deployed at the Brandt gauge. During this final mobile survey, 13 acoustic transmitters were located within the surveyed reach. Five transmitters were detected in a large, deep hole in the San Joaquin River adjacent to the Old River flow split (Figure 6-18). At that location, numerous striped bass were observed feeding. Eight additional transmitters were located further downstream near pump station structures in the river channel. All 13 transmitters were assumed to have been defecated from predatory fish that had consumed acoustic-tagged juvenile salmon, although this could not be confirmed.

Conclusions from the 2006 Pilot Study

- The equipment and techniques worked well, but the study was limited by the number of available acoustic receivers; additional receivers deployed at other locations throughout the Delta would maximize collection of data useful to determine the fate of salmon migrating through the Delta.
- A higher than anticipated number of fish were diverted into Old River; the proportion of fish diverted into Old River was higher than the proportion of flow diverted.
- Study results suggested a high rate of predation; future use of a mobile receiver would locate areas of predation.

Survival Estimated for CWT Releases Made in the San Joaquin Tributaries

Contributed by Pat Brandes, U.S. Fish and Wildlife Service

Coded wire tagged salmon from the MRH were released in the Merced and Stanislaus Rivers between April 26 and May 15, 2006 as part of independent (complimentary to VAMP) fishery investigations. Releases were made in the upper and lower reaches of the Merced (Merced River Hatchery and Hatfield State Park, respectively) and Stanislaus (Knights Ferry and Two Rivers) Rivers.

Survival indices to Antioch and Chipps Island of lower Merced releases made at Hatfield State Park and lower Stanislaus releases at Two Rivers include mortality down the mainstem San Joaquin River, as well as, through the Delta (Figure 6-8). Chipps Island survival indices of the lower Merced River and Two Rivers groups were comparable to survival indices from the 2006 VAMP releases made at Mossdale and Dos Reis. Only recoveries from a few of the upstream groups were made at Antioch. Survival indices using Chipps Island recoveries ranged between 0.019 – 0.077 (Table 6-7), while those for VAMP fish released at Mossdale and Dos Reis ranged from 0.019 to 0.128 (Table 5-5).

These data indicate that the low survival observed from the Mossdale and Dos Reis groups was common to those released upstream. It is also interesting to note that the first groups released on the Merced River had higher survival indices to Chipps Island than the 2nd group released later. This difference in survival could be related to the different export rates (and temperatures) during the two periods as was shown for the Mossdale groups and discussed in Chapter 5.

Survival indices were also generated for groups released on the upper Merced (MRH) and Stanislaus Rivers. Comparison of survival indices of groups released upstream and

Table 6-7
Smolt survial indcies for smolts released in the upper and lower reaches of the Merced and Stanislaus Rivers in 2006

							Antioch				
TagCode	Release Site/Stock	Date	Truck Temp (F)	Release Temp (F)	Number Released	Average Size (mm)	First Day Recovered	Last Day Recovered	Number Recovered	Minutes Fished	Percent Sampled
6-46-94	MRH		52	52	25533	87	–	–	0	–	–
6-46-95	MRH		52	52	26120	87	–	–	0	–	–
6-47-01	MRH		52	52	25382	87	5/6/06	5/6/06	1	200	0.139
6-47-02	MRH		52	52	26289	87	–	–	0	–	–
	Total	**4/26/06**			**103324**		**5/6/06**	**5/6/06**	**1**	**200**	**0.139**
6-47-03	Hatfield State Park		53.6	60.8	17645	88	5/7/06	5/10/06	2	2065	0.359
06-47-04	Hatfield State Park		52.7	57.2	17615	88	5/8/06	5/14/06	2	3760	0.373
06-47-05	Hatfield State Park		52.7	57.2	17684	88	5/11/06	5/17/06	4	3775	0.375
	Total	**5/1/06**			**52944**		**5/7/06**	**5/17/06**	**8**	**5840**	**0.369**
6-47-09	MRH		54	54	23433	81	–	–	0	–	–
6-47-10	MRH		54	54	23500	81	–	–	0	–	–
6-47-11	MRH		54	54	23255	81	–	–	0	–	–
06-47-12	MRH		54	54	23295	81	–	–	0	–	–
	Total	**5/10/06**			**93483**		**–**	**–**	**0**	**–**	**–**
06-47-06	Hatfield State Park		55.4	60.8	24700	87	–	–	0	–	–
06-47-07	Hatfield State Park		55.4	60.8	24232	87	5/24/06	5/24/06	1	580	0.403
06-47-08	Hatfield State Park		56.3	62.6	24181	87	–	–	0	–	–
	Total	**5/15/06**			**73113**		**5/24/06**	**5/24/06**	**1**	**580**	**0.403**
06-47-17	Knights Ferry		51.8	53.6	26089	73	–	–	0	–	–
06-47-18	Knights Ferry		51.8	53.6	25577	75	–	–	0	–	–
06-47-19	Knights Ferry		55.4	53.6	24575	75	–	–	0	–	–
	Total	**4/28/06**			**76241**		**–**	**–**	**0**	**–**	**–**
06-47-20	Two Rivers	5/2/06	52.7	57.2	24411	75	5/30/06	5/30/06	1	560	0.389

downstream and recovered at Chipps Island provides an estimate of survival through the Merced and Stanislaus Rivers. This is accomplished by dividing the upstream group survival index by the downstream survival index. For the two sets released on the Merced River, survival was estimated to range from 0.39 and 1.05, indicating survival down the Merced River was relatively high (Table 6-8). Survival through the Stanislaus River was lower and estimated at 0.23. (Table 6-8). These comparisons likely do not provide precise estimates of survival through the Merced and Stanislaus Rivers, but may be useful for distinguishing between high and low tributary survival. Ocean recoveries will be available for these groups in future years and will provide an additional source of recoveries of which to use to estimate survival through each tributary. It is also clear that in 2006, survival through the Delta was much lower between Mossdale and Jersey Point for the first and second groups (0.12 and 0.02, respectively) than it was down the Merced or Stanislaus rivers.

More of the CWT fish released in the San Joaquin tributaries were recovered at the CVP and SWP fish facilities than for the VAMP groups (Table 6-7). It also appeared there were more salvaged at the CVP during the later releases although unexpanded salvage was still generally low.

Table 6-8
Estmates of tributary survial in the Merced and Stanislaus Rivers in 2006

Release site	Release Date	Survival index	Tributary survival
Upper Merced	4/26/06	0.41	0.39
Hatfield State Park	5/1/06	0.106	
Upper Merced	5/10/06	0.02	1.05
Hatfield State Park	5/15/06	0.019	
Knights Ferry	4/28/06	0.018	0.23
Two Rivers	5/2/06	0.077	

		Chipps							CVP and SWP Salvage			
									Observed (unexpanded) salvage		Expanded salvage	
Survival Index	Group Index	First Day Recovered	Last Day Recovered	Number Recovered	Minutes Fished	Percent Sampled	Survival Index	Group Index	SWP	CVP	SWP	CVP
–		5/6/06	5/17/06	4	4800	0.278	0.073		0	3	0	60
–		–	–	0	–	–	–		2	1	12	12
0.020		5/27/06	5/27/06	1	400	0.278	0.071		0	2	0	24
–		5/15/06	5/31/06	4	6802	0.278	0.071		0	4	0	48
	0.005	**5/6/06**	**5/31/06**	**9**	**10402**	**0.278**		**0.041**				
0.023		5/8/06	5/14/06	3	2800	0.278	0.080		1	4	6	48
0.022		5/6/06	5/15/06	7	4000	0.278	0.186		2	2	9	24
0.044		5/7/06	5/24/06	2	7202	0.278	0.053		1	1	6	12
	0.030	**5/6/06**	**5/24/06**	**12**	**7602**	**0.278**		**0.106**				
–		6/1/06	6/1/06	1	400	0.278	0.020		1	6	12	72
–		5/31/06	5/31/06	1	400	0.278	0.020		0	5	0	96
–		6/1/06	6/1/06	1	400	0.278	0.020		1	3	12	48
–		6/1/06	6/1/06	1	400	0.278	0.020		1	4	12	72
	–	**5/31/06**	**6/1/06**	**4**	**800**	**0.278**		**0.020**				
–		5/29/06	5/29/06	1	400	0.278	0.019		2	8	12	108
0.007		5/29/06	6/1/06	2	1600	0.278	0.039		0	11	0	156
–		–	–	0	–	–	–		1	8	6	108
	0.002	**5/29/06**	**6/1/06**	**3**	**1600**	**0.278**		**0.019**				
–		–	–	0	–				0	11	0	219
–		5/30/06	5/30/06	1	400	0.278	0.018		0	9	0	252
–		5/28/06	6/11/06	2	5986	0.277	0.038		5	12	45	216
	–	**5/28/06**	**6/11/06**	**3**	**5986**	**0.277**		**0.018**				
0.008		5/10/06	6/6/06	4	11188	0.277	0.077		0	10	0	112

Comparison of VAMP Releases with Sacramento River Delta Releases

Contributed by Pat Brandes, U.S. Fish and Wildlife Service

As in previous years, marked fish from the Feather River were released on the Sacramento River near West Sacramento. Three groups were released to index survival through the Delta for juvenile salmon originating in the Sacramento basin. Comparison of survival between the Sacramento released fish and those released at Mossdale and Dos Reis provide insight on the variation in survival between basins. The average survival index in 2006 for the three separate groups of Feather River Hatchery smolts released on April 18, May 1, and May 17 was 0.53 similar to that measured in 2003 (0.51) and 2005 (0.46) and greater than that measured in 2004 (0.19). VAMP survival indices to Chipps Island for groups released at Mossdale and Dos Reis for the first release in 2006 were 0.086 and 0.128 respectively. The second release group, released at Mossdale under higher exports in 2006, had a survival index of 0.019. Survival indices for Durham Ferry, Mossdale and or Dos Reis were low for all three years between 2003 and 2005 and were estimated at about 0.05. These data indicate survival was lowest in both basins in 2004. Delta smolt survival in 2003, 2005 and 2006 for the Sacramento basin was similar between these years and much higher than for the VAMP fish released in the same years. Survival for the VAMP fish was low for all of these years, with the exception of some apparent improvement in 2006 under the low export condition.

Survival indices are typically higher for smolts migrating through the Delta from Sacramento than for smolts emigrating past Mossdale. It is unclear why this is the case although smolts entering the Delta from Mossdale are generally exposed to lower river flows than on the Sacramento River and smolts from the San Joaquin basin migrate in closer proximity to the CVP and SWP pumping plants. In 2006, San Joaquin stocks did not have PKD as they have had in the recent past, which may have decreased survival in some of the previous years. All of these factors and others may result in the lower survival detected through the Delta for juvenile salmon originating from the San Joaquin basin.

Chapter 7
Conclusions and Recommendations

The 2006 VAMP was implemented without the installation of the HORB due to high flow conditions described in Chapter 2. The start of the VAMP pulse flow period was delayed until May 1, with a resulting average flow between May 1 and May 31 of 26,020 cfs. Exports were separated in two rates of 1,559 cfs and 5,748 cfs for the period May 3 -17 and May 18 – June 2. Flow monitoring was conducted in the San Joaquin River downstream of the HOR and in the Old River. Kodiak trawling was again conducted in Old River in 2006, and compared with the regularly conducted sampling on the San Joaquin River at Mossdale. Estimates of juvenile Chinook salmon smolt survival were calculated based upon recoveries of CWT juvenile salmon produced in the MRH and released at Mossdale, Dos Reis, and Jersey Point. Marked salmon were recaptured in sampling at Mossdale, in Old River, at the SWP and CVP fish facilities, and at Antioch and Chipps Island. Based upon the data and experience gained during the VAMP 2006 investigations, conclusions and recommendations have been developed, and summarized in Table 7-1. The conclusions and recommendations include both technical and policy/ management issues that will affect the implementation of future VAMP operations and investigations.

Smolt survival in 2006 was low as it has been the past three years. There were greater flows in 2006 then in 2005 and we would have anticipated survival should have improved. Survival in 2006 for the first group releases (at low exports) was somewhat better than in 2005 although the second group released in 2006 (at high exports) was lower than in 2005 and more similar to that observed in 2003. The relationship of salmon survival to San Joaquin River flow has shown that survival increases as flows increase, with the HORB in place. This relationship is statistically significant when recovery from all available sources (Antioch, Chipps Island, and ocean fishery) are combined. The relationships are more variable comparing survival to flow without the HORB especially when including data from 2005 and 2006. Relationships of flow to adult escapement 2 1/2 years later, indicates these relationships are likely real and that survival is improved as flows and flows relative to exports increase.

The role of exports has been difficult to identify. During the 2006 test two distinct export rates were evaluated to collect more useful data. The role of exports will not be established with the HORB until at least two VAMP targets of 7,000 cfs flow with a HORB are obtained so that survival can be measured with exports at 1,500 and 3,000 cfs. The VAMP program provides increased flows at a wide range of flow and likely increases the survival of unmarked juvenile salmon migrating through the Delta during the VAMP period.

Table 7-1
Summary of VAMP 2006 conclusions and recommendations

CONCLUSIONS	RECOMMENDATIONS FOR 2007
Observed ungaged flows (accretions, depletions) between upstream measurement points and Vernalis varied significantly from those forecasted resulting in differences in forecasted and required supplemental flows.	Hydrology committee to continue refining estimates of ungaged flow and develop a management scheme to accommodate variability.
The flow data collected in 2006 at San Joaquin River near Lathrop and the Old River at Head provided useful information on the flow split at the Head of Old River	The 2005 and 2006 flow data should be compared against DWR-DSM2 modeling results. Continue to calibrate the stage and flow monitoring at the San Joaquin River near Lathrop station.
Short-term survival (48-hours post-transport) was high (99.9%) indicating that handling, transport, and release likely had no affect on short-term smolt survival.	Continue net pen studies and fish health inspections.
Some test fish obtained from Chipps Island Trawl to detect the presence of PKD were improperly fixed.	Recommend additional training of staff or different process for fixing of tissues used to detect presence of PKD.
The number of CWT salmon from Mossdale releases recovered at the SWP and CVP salvage facilities were much less than in prior years when there was no HORB.	Continue salvage monitoring to document direct losses at SWP/ CVP export facilities.
VAMP has been designed to adaptively change within a few weeks, the VAMP test period each year	Continue to identify opportunities when it would be beneficial to delay the VAMP period to stabilize VAMP test conditions and to increase protection for juvenile Chinook salmon outmigrating from the San Joaquin basin.
Survival from Mossdale and Dos Reis in 2006 was lower with higher exports without the HORB installed.	It is anticipated that due to the decline in delta smelt the HORB will not be installed in the future. Continue to measure survival when there is no HORB to compare to past years and to better understand the role of flow and exports on survival without the HORB in place. The VAMP tests should be continued.
Further evaluation of survival rate versus export rate is needed. The VAMP is limited by lack of data at the target conditions of 7000 cfs flow with a HORB with exports at 1500 or 3000 cfs.	Evaluate the possibility of amending the San Joaquin River Agreement to achieve needed test conditions of 7000 cfs flow with a HORB at exports of 1500 or 3000 cfs. Prescribing target conditions will allow the most critical data to be obtained quickly so that the role of exports can be identified in the most efficient manner.
HOR Kodiak trawl, when the HORB is not installed, is an important component to understanding the distribution of out migrating salmon in the southern Delta.	Implement the HOR trawl during the spring out migration when the HORB is not installed.
Mossdale Kodiak trawl is an important component in determining distribution of juvenile salmon out migration from the San Joaquin basin.	Maintain the Mossdale Kodiak trawl at existing or higher level of effort throughout year.
During 2006 two CWT lots were mixed at MRH resulting in the need to correct release numbers to estimate survival.	Merced River Hatchery should safeguard against the mixing of CWT lots.
An Acoustic Telemetry pilot study was conducted in 2006 to determine the suitability to track the movement of out migrating salmon in the Lower San Joaquin River and southern Delta.	Implement a full-scale Acoustic Telemetry study to better understand the movement and survival of out migrating salmon from the San Joaquin River basin.
Complimentary studies to evaluate mechanisms affecting survival of fish from tributaries and across the Delta were conducted.	Encourage an expansion of complementary studies to provide additional information on factors and mechanisms affecting salmon survival.

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SAN JOAQUIN RIVER GROUP AUTHORITY

*San Joaquin River Group Authority Members

2006 Useful Web Pages

Page 3 San Joaquin River Agreement
www.sjrg.org/agreement.htm

Page 3 SWRCB Decision 1641
www.waterrights.ca.gov/hearings/Decisions.htm

Page 8 VAMP Annual Technical Reports

www.sjrg.org

Page 8 VAMP Experimental Design

www.sjrg.org/agreement.htm

Page 14 San Joaquin River nr.Vernalis, USGS Daily
http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=1&site_no=11303500

San Joaquin River nr. Newman, USGS Daily
http://waterdata.usgs.gov/ca/nwis/dv?format=pre&period=31&site_no=11274000

Tuolumne River nr. LaGrange, USGS Daily
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Stanislaus River below Goodwin, USBR Daily
www.usbr.gov/mp/cvo/vungvari/gdwdop.pdf

Merced River at Cressey, CDEC Daily
http://cdec.water.ca.gov/cgi-progs/queryDgroups?s=fw2

Merced River nr. Stevinson, CDEC Daily
http://cdec.water.ca.gov/cgi-progs/queryDgroups?s=fw2

Page 24 Temporary Barrier Program
http://sdelta.water.ca.gov/web_pg/tempmesr.html

Page 28 Reclamation District 544 Seepage Monitoring Study
http://wdl.water.ca.gov/hydstra/index.cfm#GW

Page 64 CVP and SWP Salvage Data
www.iep.ca.gov

USFWS Stockton
www.delta.dfg.ca.gov/data/salvage

Regional Mark Information System
www.rmis.org

Page 63 U.S. Fish and Wildlife Service

Anadromous Fish Restoration Program
www.delta.dfg.ca.gov/afrp

Common Acronyms and Abbreviations

ADCP	Acoustic Doppler Current Profiler
Bay-Delta	Sacramento and San Joaquin Rivers San Francisco Bay Delta
CDEC	California Data Exchange Center
CDRR	Combined Differential Recovery Rate
CFS	Cubic Feet Per Second
CPUE	Catch Per Unit Effort
CRR	Combined Recovery Rate
CVP	Central Valley Project
CWT	Coded-Wire Tagged
D-1641	Water Rights Decision 1641 of the SWRCB
DFG	California Department of Fish and Game
DWR	California Department of Water Resources
GLC	Grant Line Canal
HOR	Head of Old River
HORB	Head of Old River Barrier
Merced	Merced Irrigation District
MID	Modesto Irrigation District
MR	Middle River
MRH	Merced River Hatchery
MSL	Mean Sea Level
NOAA	National Oceanic and Atmospheric Administration Fisheries
OID	Oakdale Irrigation District
ORT	Old River at Tracy
PKD	Proliferative Kidney Disease
SDWA	South Delta Water Agency
SJRA	San Joaquin River Agreement
SJRECWA	San Joaquin River Exchange Contractors Water Authority
SJRGA	San Joaquin River Group Authority
SJRTC	San Joaquin River Technical Committee
SSJID	South San Joaquin Irrigation District
SWP	State Water Project
SWRCB	State Water Resources Control Board
TBP	Temporary Barriers Project
TID	Turlock Irrigation District
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
VAMP	Vernalis Adaptive Management Plan
WQCP	Water Quality Control Plan for the Bay-Delta Estuary

Appendix

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Appendix A

Hydrology and Operation Plans

Appendix A-1, Table 1

2006 VAMP DAILY OPERATION PLAN
March 23, 2006 (A) • LOW
Target Flow Period: April 15 - May 15 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow- reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	**1,583**	**966**	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	**1,698**	**936**	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	**1,792**	**612**	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	**1,716**	**550**	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	**2,454**	**630**	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	**2,223**	**811**	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	**1,986**	**505**	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	**2,178**	**352**	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06								2,000			2,000										
24-Mar-06								2,000			2,000										
25-Mar-06								2,000			2,000										
26-Mar-06								1,500			1,500										
27-Mar-06								1,500			1,500										
28-Mar-06								1,500			1,500										
29-Mar-06								1,000			1,000										
30-Mar-06						779		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
31-Mar-06						774		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
01-Apr-06	7,899				7,899	769	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
02-Apr-06	7,894				7,894	764	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
03-Apr-06	7,619				7,619	759	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
04-Apr-06	7,464				7,464	754	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
05-Apr-06	7,459				7,459	748	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
06-Apr-06	7,454				7,454	742	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
07-Apr-06	7,448				7,448	736	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
08-Apr-06	7,442				7,442	730	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
09-Apr-06	7,436				7,436	724	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
10-Apr-06	7,430				7,430	718	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
11-Apr-06	7,424				7,424	712	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
12-Apr-06	7,418				7,418	706	500	850	419	81	1,350	2,850	2,850		2,850	2,500	2,500			2,500	
13-Apr-06	7,412	0			7,412	700	500	850	419	81	1,350	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
14-Apr-06	7,406	0			7,406	695	500	850	419	81	1,350	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
15-Apr-06	6,400	610	0	1.21	7,010	690	500	850	419	81	1,350	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
16-Apr-06	6,395	610	0	2.42	7,005	684	500	850	419	81	1,350	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
17-Apr-06	6,390	610	0	3.63	7,000	679	500	850	449	81	1,380	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
18-Apr-06	6,384	610	0	4.84	6,994	674	500	850	449	81	1,380	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
19-Apr-06	6,379	610	0	6.05	6,989	669	500	850	449	81	1,380	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
20-Apr-06	6,374	640	0	7.32	7,014	663	500	850	449	81	1,380	2,850	2,850	110	2,960	1,500	1,500	0	0	1,500	
21-Apr-06	6,369	640	0	8.59	7,009	658	500	850	449	81	1,380	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
22-Apr-06	6,363	640	0	9.86	7,003	653	500	850	449	81	1,380	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
23-Apr-06	6,358	650	0	11.15	7,008	648	500	850	449	81	1,380	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
24-Apr-06	6,353	650	0	12.44	7,003	642	500	850	479	81	1,410	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
25-Apr-06	6,348	650	0	13.73	6,998	637	500	850	479	81	1,410	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
26-Apr-06	6,342	650	0	15.01	6,992	632	500	850	479	81	1,410	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
27-Apr-06	6,337	680	0	16.36	7,017	627	500	850	479	81	1,410	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
28-Apr-06	6,332	680	0	17.71	7,012	622	500	850	479	81	1,410	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
29-Apr-06	6,327	680	0	19.06	7,007	616	500	850	479	81	1,410	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
30-Apr-06	6,322	680	0	20.41	7,002	611	500	850	509	81	1,440	2,850	2,850	120	2,970	1,500	1,500	0	0	1,500	
01-May-06	6,316	680	0	21.76	6,996	606	500	850	509	81	1,440	2,350	2,350	620	2,970	1,500	1,500	0	0	1,500	
02-May-06	6,311	680	0	23.11	6,991	601	500	850	509	81	1,440	2,350	2,350	620	2,970	1,500	1,500	0	0	1,500	
03-May-06	5,806	1,210	0	25.51	7,016	595	500	850	509	81	1,440	2,350	2,350	620	2,970	1,500	1,500	0	0	1,500	
04-May-06	5,801	1,210	0	27.91	7,011	590	500	850	509	81	1,440	2,350	2,350	620	2,970	1,500	1,500	0	0	1,500	
05-May-06	5,795	1,210	0	30.31	7,005	585	500	850	509	81	1,440	2,350	2,350	620	2,970	1,500	1,500	0	0	1,500	
06-May-06	5,790	1,210	0	32.71	7,000	580	500	850	539	81	1,470	2,350	2,350	620	2,970	1,500	1,500	0	0	1,500	
07-May-06	5,785	1,210	0	35.11	6,995	574	500	850	539	81	1,470	2,350	2,350	620	2,970	1,500	1,500	0	0	1,500	
08-May-06	5,780	1,210	0	37.51	6,990	569	500	850	539	81	1,470	2,350	2,350	615	2,965	1,500	1,500	0	0	1,500	
09-May-06	5,774	1,240	0	39.97	7,014	564	500	850	539	81	1,470	2,350	2,350	610	2,960	1,500	1,500	0	0	1,500	
10-May-06	5,769	1,235	0	42.42	7,004	559	500	850	539	81	1,470	2,350	2,350	610	2,960	1,500	1,500	0	0	1,500	
11-May-06	5,764	1,230	0	44.86	6,994	553	500	850	539	81	1,470	2,350	2,350	610	2,960	1,500	1,500	0	0	1,500	
12-May-06	5,759	1,230	0	47.30	6,989	548	500	850	539	81	1,470	2,350	2,350	610	2,960	1,500	1,500	0	0	1,500	
13-May-06	5,753	1,230	0	49.74	6,983	543	500	850			850	2,350	2,350	610	2,960	1,500	1,500	0	0	1,500	
14-May-06	5,748	1,230	0	52.18	6,978	538	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
15-May-06	5,743	1,230	0	54.61	6,973	533	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
16-May-06	5,738	0	0		5,738	528	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
17-May-06	5,733	0	0		5,733	523	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
18-May-06	5,728	0	0		5,728	518	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
19-May-06	5,723	0	0		5,723	513	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
20-May-06	5,718	0	0		5,718	508	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
21-May-06	5,713	0	0		5,713	503	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
22-May-06	5,708	0	0		5,708	498	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
23-May-06	5,703	0	0		5,703	493	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
24-May-06	5,698	0	0		5,698	488	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
25-May-06	5,693	0	0		5,693	483	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
26-May-06	5,688	0	0		5,688	478	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
27-May-06	5,683	0	0		5,683	473	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
28-May-06	5,678	0	0		5,678	468	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
29-May-06	5,673	0	0		5,673	463	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
30-May-06	5,668	0	0		5,668	458	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
31-May-06	5,663	0	0		5,663	453	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
VAMP Period																					
Avg. (cfs):	6,112	888			7,000	622	500	850	482	81	1,413	2,640	2,640	325	2,966	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				54.61							29.63	4.98				20.00				0.00	

VAMP flow operation period

Appendix A-1, Table 2

2006 VAMP DAILY OPERATION PLAN
March 23, 2006 (B) • HIGH
Target Flow Period: April 15 - May 15 • Flow Target: greater than 7,000 cfs
Bold Numbers: observed real-time mean daily flows

Date	San Joaquin River near Vernalis: Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Merced River at Cressey: Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Tuolumne River at LaGrange: Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Stanislaus R blw Goodwin: Existing Flow - Base	Existing Flow- reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	**1,583**	**966**	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	**1,698**	**936**	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	**1,792**	**612**	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	**1,716**	**550**	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	**2,454**	**630**	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	**2,223**	**811**	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	**1,986**	**505**	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	**2,178**	**352**	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06								2,000			2,000										
24-Mar-06								2,000			2,000										
25-Mar-06								2,000			2,000										
26-Mar-06								1,500			1,500										
27-Mar-06								1,500			1,500										
28-Mar-06								1,500			1,500										
29-Mar-06								1,000			1,000										
30-Mar-06						779		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
31-Mar-06						774		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
01-Apr-06	8,399				8,399	769	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
02-Apr-06	8,394				8,394	764	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
03-Apr-06	8,119				8,119	759	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
04-Apr-06	7,964				7,964	754	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
05-Apr-06	7,959				7,959	748	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
06-Apr-06	7,954				7,954	742	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
07-Apr-06	7,948				7,948	736	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
08-Apr-06	7,942				7,942	730	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
09-Apr-06	7,936				7,936	724	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
10-Apr-06	7,930				7,930	718	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
11-Apr-06	7,924				7,924	712	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
12-Apr-06	7,918				7,918	706	1,000	850	100	0	950	2,850	2,850		2,850	2,500	2,500			2,500	
13-Apr-06	7,912	0			7,912	700	1,000	850	100	0	950	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
14-Apr-06	7,906	0			7,906	695	1,000	850	100	0	950	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
15-Apr-06	6,900	100	0	0.20	7,000	690	1,000	850	100	0	950	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
16-Apr-06	6,895	100	0	0.40	6,995	684	1,000	850	100	0	950	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
17-Apr-06	6,890	100	0	0.60	6,990	679	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
18-Apr-06	6,884	100	0	0.79	6,984	674	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
19-Apr-06	6,879	100	0	0.99	6,979	669	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
20-Apr-06	6,874	150	0	1.29	7,024	663	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
21-Apr-06	6,869	150	0	1.59	7,019	658	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
22-Apr-06	6,863	150	0	1.88	7,013	653	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
23-Apr-06	6,858	150	0	2.18	7,008	648	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
24-Apr-06	6,853	150	0	2.48	7,003	642	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
25-Apr-06	6,848	150	0	2.78	6,998	637	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
26-Apr-06	6,842	150	0	3.07	6,992	632	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
27-Apr-06	6,837	150	0	3.37	6,987	627	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
28-Apr-06	6,832	150	0	3.67	6,982	622	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
29-Apr-06	6,827	150	0	3.97	6,977	616	1,000	850	200	0	1,050	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
30-Apr-06	6,822	150	0	4.26	6,972	611	1,000	850	700	0	1,550	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
01-May-06	6,816	150	0	4.56	6,966	606	1,000	850	700	0	1,550	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
02-May-06	6,811	200	0	4.96	7,011	601	1,000	850	700	0	1,550	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
03-May-06	6,306	700	0	6.35	7,006	595	1,000	850	700	0	1,550	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
04-May-06	6,301	700	0	7.74	7,001	590	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
05-May-06	6,295	700	0	9.12	6,995	585	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
06-May-06	6,290	700	0	10.51	6,990	580	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
07-May-06	6,285	750	0	12.00	7,035	574	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
08-May-06	6,280	750	0	13.49	7,030	569	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
09-May-06	6,274	750	0	14.98	7,024	564	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
10-May-06	6,269	750	0	16.46	7,019	559	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
11-May-06	6,264	750	0	17.95	7,014	553	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
12-May-06	6,259	750	0	19.44	7,009	548	1,000	850	750	0	1,600	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
13-May-06	6,253	750	0	20.93	7,003	543	1,000	850			850	2,350	2,350	0	2,350	1,500	1,500	0	0	1,500	
14-May-06	6,248	750	0	22.41	6,998	538	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
15-May-06	6,243	750	0	23.90	6,993	533	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
16-May-06	6,238	0	0		6,238	528	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
17-May-06	6,233	0	0		6,233	523	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
18-May-06	6,228	0	0		6,228	518	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
19-May-06	6,223	0	0		6,223	513	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
20-May-06	6,218	0	0		6,218	508	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
21-May-06	6,213	0	0		6,213	503	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
22-May-06	6,208	0	0		6,208	498	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
23-May-06	6,203	0	0		6,203	493	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
24-May-06	6,198	0	0		6,198	488	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
25-May-06	6,193	0	0		6,193	483	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
26-May-06	6,188	0	0		6,188	478	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
27-May-06	6,183	0	0		6,183	473	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
28-May-06	6,178	0	0		6,178	468	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
29-May-06	6,173	0	0		6,173	463	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
30-May-06	6,168	0	0		6,168	458	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
31-May-06	6,163	0	0		6,163	453	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
18-May-05	6,217	0	0		6,217	605	1,200	650			650	3,400	3,400		3,400	352	352			352	
VAMP Period																					
Avg. (cfs):	6,612	389			7,001	622	1,000	850	389	0	1,239	2,640	2,640	0	2,640	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				23.90							23.90	0.00				0.00				0.00	

VAMP flow operation period

Appendix A-1, Table 3

2006 VAMP DAILY OPERATION PLAN
March 23, 2006 (C) • LOW
Target Flow Period: April 22 - May 22 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow-reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	1,583	966	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	1,698	936	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	1,792	612	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	1,716	550	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	2,454	630	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	2,223	811	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	1,986	505	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	2,178	352	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06								2,000			2,000										
24-Mar-06								2,000			2,000										
25-Mar-06								2,000			2,000										
26-Mar-06								1,500			1,500										
27-Mar-06								1,500			1,500										
28-Mar-06								1,500			1,500										
29-Mar-06								1,000			1,000										
30-Mar-06						779		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
31-Mar-06						774		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
01-Apr-06	7,899				7,899	769	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
02-Apr-06	7,894				7,894	764	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
03-Apr-06	7,619				7,619	759	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
04-Apr-06	7,464				7,464	754	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
05-Apr-06	7,459				7,459	748	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
06-Apr-06	7,454				7,454	742	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
07-Apr-06	7,448				7,448	736	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
08-Apr-06	7,442				7,442	730	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
09-Apr-06	7,436				7,436	724	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
10-Apr-06	7,430				7,430	718	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
11-Apr-06	7,424				7,424	712	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
12-Apr-06	7,418				7,418	706	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
13-Apr-06	7,412	0			7,412	700	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
14-Apr-06	7,406	0			7,406	695	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
15-Apr-06	7,400	0			7,400	690	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
16-Apr-06	7,395	0			7,395	684	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
17-Apr-06	7,390	0			7,390	679	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
18-Apr-06	7,384	0			7,384	674	500	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
19-Apr-06	7,379	0			7,379	669	500	850	579	81	1,510	2,850	2,850		2,850	2,500	2,500			2,500	
20-Apr-06	7,374	0			7,374	663	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
21-Apr-06	7,369	0			7,369	658	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
22-Apr-06	6,363	660	0	1.31	7,023	653	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
23-Apr-06	6,358	660	0	2.62	7,018	648	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
24-Apr-06	6,353	660	0	3.93	7,013	642	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
25-Apr-06	6,348	660	0	5.24	7,008	637	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
26-Apr-06	6,342	660	0	6.55	7,002	632	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
27-Apr-06	6,337	660	0	7.85	6,997	627	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
28-Apr-06	6,332	660	0	9.16	6,992	622	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
29-Apr-06	6,327	660	0	10.47	6,987	616	500	850	579	81	1,510	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
30-Apr-06	6,322	660	0	11.78	6,982	611	500	850	579	81	1,510	2,850	2,850	40	2,890	1,500	1,500	0	0	1,500	
01-May-06	6,316	660	0	13.09	6,976	606	500	850	579	81	1,510	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
02-May-06	6,311	700	0	14.48	7,011	601	500	850	579	81	1,510	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
03-May-06	5,806	1,220	0	16.90	7,026	595	500	850	579	81	1,510	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
04-May-06	5,801	1,220	0	19.32	7,021	590	500	850	579	81	1,510	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
05-May-06	5,795	1,220	0	21.74	7,015	585	500	850	579	81	1,510	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
06-May-06	5,790	1,220	0	24.16	7,010	580	500	850	584	81	1,515	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
07-May-06	5,785	1,220	0	26.58	7,005	574	500	850	589	81	1,520	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
08-May-06	5,780	1,220	0	29.00	7,000	569	500	850	589	81	1,520	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
09-May-06	5,774	1,225	0	31.43	6,999	564	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
10-May-06	5,769	1,230	0	33.87	6,999	559	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
11-May-06	5,764	1,230	0	36.31	6,994	553	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
12-May-06	5,759	1,260	0	38.81	7,019	548	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
13-May-06	5,753	1,260	0	41.31	7,013	543	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
14-May-06	5,748	1,260	0	43.80	7,008	538	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
15-May-06	5,743	1,260	0	46.30	7,003	533	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
16-May-06	5,738	1,260	0	48.80	6,998	528	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
17-May-06	5,733	1,260	0	51.30	6,993	523	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
18-May-06	5,728	1,260	0	53.80	6,988	518	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
19-May-06	5,723	1,260	0	56.30	6,983	513	500	850	619	81	1,550	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
20-May-06	5,718	1,260	0	58.80	6,978	508	500	850			850	2,350	2,350	560	2,910	1,500	1,500	0	0	1,500	
21-May-06	5,713	1,260	0	61.30	6,973	503	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
22-May-06	5,708	1,260	0	63.80	6,968	498	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
23-May-06	5,703	0	0		5,703	493	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
24-May-06	5,698	0	0		5,698	488	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
25-May-06	5,693	0	0		5,693	483	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
26-May-06	5,688	0	0		5,688	478	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
27-May-06	5,683	0	0		5,683	473	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
28-May-06	5,678	0	0		5,678	468	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
29-May-06	5,673	0	0		5,673	463	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
30-May-06	5,668	0	0		5,668	458	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
31-May-06	5,663	0	0		5,663	453	500	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
VAMP Period																					
Avg. (cfs):	5,962	1,038			7,000	585	500	850	594	81	1,525	2,527	2,527	363	2,890	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				63.80							36.52	4.98				22.29				0.00	

VAMP flow operation period

Appendix A-1, Table 4
2006 VAMP DAILY OPERATION PLAN
March 23, 2006 (D) • HIGH
Target Flow Period: April 22 - May 22 • Flow Target: greater than 7,000 cfs
Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow-reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	**1,583**	**966**	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	**1,698**	**936**	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	**1,792**	**612**	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	**1,716**	**550**	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	**2,454**	**630**	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	**2,223**	**811**	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	**1,986**	**505**	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	**2,178**	**352**	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06								2,000			2,000										
24-Mar-06								2,000			2,000										
25-Mar-06								2,000			2,000										
26-Mar-06								1,500			1,500										
27-Mar-06								1,500			1,500										
28-Mar-06								1,500			1,500										
29-Mar-06								1,000			1,000										
30-Mar-06						779		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
31-Mar-06						774		1,000			1,000	3,120	3,120		3,120	2,500	2,500			2,500	
01-Apr-06	8,399				8,399	769	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
02-Apr-06	8,394				8,394	764	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
03-Apr-06	8,119				8,119	759	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
04-Apr-06	7,964				7,964	754	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
05-Apr-06	7,959				7,959	748	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
06-Apr-06	7,954				7,954	742	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
07-Apr-06	7,948				7,948	736	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
08-Apr-06	7,942				7,942	730	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
09-Apr-06	7,936				7,936	724	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
10-Apr-06	7,930				7,930	718	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
11-Apr-06	7,924				7,924	712	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
12-Apr-06	7,918				7,918	706	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
13-Apr-06	7,912	0			7,912	700	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
14-Apr-06	7,906	0			7,906	695	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
15-Apr-06	7,900	0			7,900	690	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
16-Apr-06	7,895	0			7,895	684	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
17-Apr-06	7,890	0			7,890	679	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
18-Apr-06	7,884	0			7,884	674	1,000	850			850	2,850	2,850		2,850	2,500	2,500			2,500	
19-Apr-06	7,879	0			7,879	669	1,000	850	150	0	1,000	2,850	2,850		2,850	2,500	2,500			2,500	
20-Apr-06	7,874	0			7,874	663	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
21-Apr-06	7,869	0			7,869	658	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
22-Apr-06	6,863	150	0	0.30	7,013	653	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
23-Apr-06	6,858	150	0	0.60	7,008	648	1,000	850	150	0	1,000	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
24-Apr-06	6,853	150	0	0.89	7,003	642	1,000	850	155	0	1,005	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
25-Apr-06	6,848	150	0	1.19	6,998	637	1,000	850	200	0	1,050	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
26-Apr-06	6,842	150	0	1.49	6,992	632	1,000	850	200	0	1,050	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
27-Apr-06	6,837	155	0	1.80	6,992	627	1,000	850	200	0	1,050	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
28-Apr-06	6,832	200	0	2.19	7,032	622	1,000	850	200	0	1,050	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
29-Apr-06	6,827	200	0	2.59	7,027	616	1,000	850	200	0	1,050	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
30-Apr-06	6,822	200	0	2.99	7,022	611	1,000	850	500	0	1,350	2,850	2,850	0	2,850	1,500	1,500	0	0	1,500	
01-May-06	6,816	200	0	3.38	7,016	606	1,000	850	500	0	1,350	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
02-May-06	6,811	200	0	3.78	7,011	601	1,000	850	500	0	1,350	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
03-May-06	6,306	703	0	5.17	7,009	595	1,000	850	500	0	1,350	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
04-May-06	6,301	703	0	6.57	7,004	590	1,000	850	500	0	1,350	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
05-May-06	6,295	703	0	7.96	6,998	585	1,000	850	500	0	1,350	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
06-May-06	6,290	703	0	9.36	6,993	580	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
07-May-06	6,285	703	0	10.75	6,988	574	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
08-May-06	6,280	703	0	12.14	6,983	569	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
09-May-06	6,274	753	0	13.64	7,027	564	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
10-May-06	6,269	753	0	15.13	7,022	559	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
11-May-06	6,264	753	0	16.63	7,017	553	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
12-May-06	6,259	753	0	18.12	7,012	548	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
13-May-06	6,253	753	0	19.61	7,006	543	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
14-May-06	6,248	753	0	21.11	7,001	538	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
15-May-06	6,243	753	0	22.60	6,996	533	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
16-May-06	6,238	753	0	24.09	6,991	528	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
17-May-06	6,233	753	0	25.59	6,986	523	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
18-May-06	6,228	753	0	27.08	6,981	518	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
19-May-06	6,223	753	0	28.57	6,976	513	1,000	850	550	0	1,400	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
20-May-06	6,218	753	0	30.07	6,971	508	1,000	850			850	2,350	2,350	203	2,553	1,500	1,500	0	0	1,500	
21-May-06	6,213	753	0	31.56	6,966	503	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
22-May-06	6,208	753	0	33.05	6,961	498	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
23-May-06	6,203	0	0		6,203	493	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
24-May-06	6,198	0	0		6,198	488	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
25-May-06	6,193	0	0		6,193	483	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
26-May-06	6,188	0	0		6,188	478	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
27-May-06	6,183	0	0		6,183	473	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
28-May-06	6,178	0	0		6,178	468	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
29-May-06	6,173	0	0		6,173	463	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
30-May-06	6,168	0	0		6,168	458	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
31-May-06	6,163	0	0		6,163	453	1,000	850			850	2,350	2,350		2,350	1,500	1,500			1,500	
VAMP Period																					
Avg. (cfs):	6,462	538			7,000	585	1,000	850	407	0	1,257	2,527	2,527	131	2,658	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				33.05							25.00	0.00				8.05				0.00	

VAMP flow operation period

Appendix A-1, Table 5

2006 VAMP DAILY OPERATION PLAN
March 27, 2006 (A)
Target Flow Period: April 15 - May 15 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow-reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	1,583	966	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	1,698	936	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	1,792	612	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	1,716	550	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	2,454	630	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	2,223	811	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	1,986	505	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	2,178	352	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06	**11,600**				**11,600**	2,129	175	**2,115**			**2,115**	**3,670**	**3,670**		**3,670**	**3,008**	**3,008**			**3,008**	
24-Mar-06	**11,400**				**11,400**	2,177	380	**2,080**			**2,080**	**3,910**	**3,910**		**3,910**	**3,005**	**3,005**			**3,005**	
25-Mar-06	**11,500**				**11,500**	2,063	450	**2,035**			**2,035**	**4,590**	**4,590**		**4,590**	**3,013**	**3,013**			**3,013**	
26-Mar-06	**12,000**				**12,000**	2,097	522	**1,867**			**1,867**	**4,580**	**4,580**		**4,580**	**3,009**	**3,009**			**3,009**	
27-Mar-06								1,500			1,500										
28-Mar-06								1,500			1,500										
29-Mar-06								1,000			1,000										
30-Mar-06						779		1,000			1,000	3,400	3,400		3,400	2,500	2,500			2,500	
31-Mar-06						774		1,000			1,000	3,400	3,400		3,400	2,500	2,500			2,500	
01-Apr-06	8,179				8,179	769	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
02-Apr-06	8,174				8,174	764	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
03-Apr-06	8,169				8,169	759	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
04-Apr-06	8,104				8,104	754	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
05-Apr-06	8,099				8,099	748	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
06-Apr-06	8,094				8,094	742	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
07-Apr-06	8,088				8,088	736	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
08-Apr-06	8,082				8,082	730	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
09-Apr-06	8,076				8,076	724	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
10-Apr-06	8,070				8,070	718	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
11-Apr-06	8,064				8,064	712	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
12-Apr-06	8,058				8,058	706	500	940	0	0	940	3,400	3,400		3,400	2,500	2,500			2,500	
13-Apr-06	8,052	0			8,052	700	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
14-Apr-06	8,046	0			8,046	695	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
15-Apr-06	7,040	0	0	0.00	7,040	690	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
16-Apr-06	7,035	0	0	0.00	7,035	684	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
17-Apr-06	7,030	0	0	0.00	7,030	679	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
18-Apr-06	7,024	0	0	0.00	7,024	674	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
19-Apr-06	7,019	0	0	0.00	7,019	669	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
20-Apr-06	7,014	0	0	0.00	7,014	663	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
21-Apr-06	7,009	0	0	0.00	7,009	658	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
22-Apr-06	7,003	0	0	0.00	7,003	653	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
23-Apr-06	6,998	0	0	0.00	6,998	648	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
24-Apr-06	6,993	0	0	0.00	6,993	642	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
25-Apr-06	6,988	0	0	0.00	6,988	637	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
26-Apr-06	6,982	0	0	0.00	6,982	632	500	940	0	0	940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
27-Apr-06	6,977	0	0	0.00	6,977	627	500	940	50	0	990	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
28-Apr-06	6,972	0	0	0.00	6,972	622	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
29-Apr-06	6,967	0	0	0.00	6,967	616	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
30-Apr-06	6,962	50	0	0.10	7,012	611	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
01-May-06	6,956	60	0	0.22	7,016	606	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
02-May-06	6,951	60	0	0.34	7,011	601	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
03-May-06	6,946	60	0	0.46	7,006	595	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
04-May-06	6,941	60	0	0.58	7,001	590	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
05-May-06	6,935	60	0	0.69	6,995	585	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
06-May-06	6,930	60	0	0.81	6,990	580	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
07-May-06	6,925	60	0	0.93	6,985	574	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
08-May-06	6,920	60	0	1.05	6,980	569	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
09-May-06	6,914	60	0	1.17	6,974	564	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
10-May-06	6,909	60	0	1.29	6,969	559	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
11-May-06	6,904	110	0	1.51	7,014	553	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
12-May-06	6,899	110	0	1.73	7,009	548	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
13-May-06	6,893	110	0	1.94	7,003	543	500	940			940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
14-May-06	6,888	110	0	2.16	6,998	538	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
15-May-06	6,883	110	0	2.38	6,993	533	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
16-May-06	6,878	0	0		6,878	528	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
17-May-06	6,873	0	0		6,873	523	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
18-May-06	6,868	0	0		6,868	518	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
19-May-06	6,863	0	0		6,863	513	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
20-May-06	6,858	0	0		6,858	508	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
21-May-06	6,853	0	0		6,853	503	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
22-May-06	6,848	0	0		6,848	498	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
23-May-06	6,843	0	0		6,843	493	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
24-May-06	6,838	0	0		6,838	488	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
25-May-06	6,833	0	0		6,833	483	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
26-May-06	6,828	0	0		6,828	478	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
27-May-06	6,823	0	0		6,823	473	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
28-May-06	6,818	0	0		6,818	468	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
29-May-06	6,813	0	0		6,813	463	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
30-May-06	6,808	0	0		6,808	458	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
31-May-06	6,803	0	0		6,803	453	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
VAMP Period																					
Avg. (cfs):	6,962	39			7,000	622	500	940	39	0	979	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				2.38							2.38	0.00				0.00				0.00	

VAMP flow operation period

Appendix A-1, Table 6

2006 VAMP DAILY OPERATION PLAN
March 27, 2006 (B)
Target Flow Period: April 22 - May 22 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow- reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	**1,583**	**966**	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	**1,698**	**936**	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	**1,792**	**612**	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	**1,716**	**550**	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	**2,454**	**630**	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	**2,223**	**811**	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	**1,986**	**505**	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	**2,178**	**352**	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06	**11,600**				**11,600**	**2,129**	**175**	**2,115**			**2,115**	**3,670**	**3,670**		**3,670**	**3,008**	**3,008**			**3,008**	
24-Mar-06	**11,400**				**11,400**	**2,177**	**380**	**2,080**			**2,080**	**3,910**	**3,910**		**3,910**	**3,005**	**3,005**			**3,005**	
25-Mar-06	**11,500**				**11,500**	**2,063**	**450**	**2,035**			**2,035**	**4,590**	**4,590**		**4,590**	**3,013**	**3,013**			**3,013**	
26-Mar-06	**12,000**				**12,000**	**2,097**	**522**	**1,867**			**1,867**	**4,580**	**4,580**		**4,580**	**3,009**	**3,009**			**3,009**	
27-Mar-06								1,500			1,500										
28-Mar-06								1,500			1,500										
29-Mar-06								1,000			1,000										
30-Mar-06						779		1,000			1,000	3,400	3,400		3,400	2,500	2,500			2,500	
31-Mar-06						774		1,000			1,000	3,400	3,400		3,400	2,500	2,500			2,500	
01-Apr-06	8,179				8,179	769	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
02-Apr-06	8,174				8,174	764	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
03-Apr-06	8,169				8,169	759	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
04-Apr-06	8,104				8,104	754	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
05-Apr-06	8,099				8,099	748	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
06-Apr-06	8,094				8,094	742	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
07-Apr-06	8,088				8,088	736	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
08-Apr-06	8,082				8,082	730	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
09-Apr-06	8,076				8,076	724	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
10-Apr-06	8,070				8,070	718	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
11-Apr-06	8,064				8,064	712	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
12-Apr-06	8,058				8,058	706	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
13-Apr-06	8,052	0			8,052	700	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
14-Apr-06	8,046	0			8,046	695	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
15-Apr-06	8,040	0			8,040	690	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
16-Apr-06	8,035	0			8,035	684	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
17-Apr-06	8,030	0			8,030	679	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
18-Apr-06	8,024	0			8,024	674	500	940			940	3,400	3,400		3,400	2,500	2,500			2,500	
19-Apr-06	8,019	0			8,019	669	500	940	10	0	950	3,400	3,400		3,400	2,500	2,500			2,500	
20-Apr-06	8,014	0			8,014	663	500	940	10	0	950	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
21-Apr-06	8,009	0			8,009	658	500	940	10	0	950	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
22-Apr-06	7,003	10	0	0.02	7,013	653	500	940	10	0	950	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
23-Apr-06	6,998	10	0	0.04	7,008	648	500	940	10	0	950	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
24-Apr-06	6,993	10	0	0.06	7,003	642	500	940	10	0	950	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
25-Apr-06	6,988	10	0	0.08	6,998	637	500	940	10	0	950	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
26-Apr-06	6,982	10	0	0.10	6,992	632	500	940	30	0	970	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
27-Apr-06	6,977	10	0	0.12	6,987	627	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
28-Apr-06	6,972	10	0	0.14	6,982	622	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
29-Apr-06	6,967	30	0	0.20	6,997	616	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
30-Apr-06	6,962	60	0	0.32	7,022	611	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
01-May-06	6,956	60	0	0.44	7,016	606	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
02-May-06	6,951	60	0	0.56	7,011	601	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
03-May-06	6,946	60	0	0.67	7,006	595	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
04-May-06	6,941	60	0	0.79	7,001	590	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
05-May-06	6,935	60	0	0.91	6,995	585	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
06-May-06	6,930	60	0	1.03	6,990	580	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
07-May-06	6,925	60	0	1.15	6,985	574	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
08-May-06	6,920	60	0	1.27	6,980	569	500	940	60	0	1,000	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
09-May-06	6,914	60	0	1.39	6,974	564	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
10-May-06	6,909	60	0	1.51	6,969	559	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
11-May-06	6,904	60	0	1.63	6,964	553	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
12-May-06	6,899	110	0	1.84	7,009	548	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
13-May-06	6,893	110	0	2.06	7,003	543	500	940	110	0	1,050	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
14-May-06	6,888	110	0	2.28	6,998	538	500	940	160	0	1,100	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
15-May-06	6,883	110	0	2.50	6,993	533	500	940	160	0	1,100	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
16-May-06	6,878	110	0	2.72	6,988	528	500	940	160	0	1,100	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
17-May-06	6,873	160	0	3.03	7,033	523	500	940	160	0	1,100	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
18-May-06	6,868	160	0	3.35	7,028	518	500	940	160	0	1,100	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
19-May-06	6,863	160	0	3.67	7,023	513	500	940	160	0	1,100	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
20-May-06	6,858	160	0	3.99	7,018	508	500	940			940	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
21-May-06	6,853	160	0	4.30	7,013	503	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
22-May-06	6,848	160	0	4.62	7,008	498	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
23-May-06	6,843	0	0		6,843	493	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
24-May-06	6,838	0	0		6,838	488	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
25-May-06	6,833	0	0		6,833	483	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
26-May-06	6,828	0	0		6,828	478	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
27-May-06	6,823	0	0		6,823	473	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
28-May-06	6,818	0	0		6,818	468	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
29-May-06	6,813	0	0		6,813	463	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
30-May-06	6,808	0	0		6,808	458	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
31-May-06	6,803	0	0		6,803	453	500	940			940	3,400	3,400		3,400	1,500	1,500			1,500	
VAMP Period																					
Avg. (cfs):	6,925	75			7,000	585	500	940	75	0	1,015	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				4.62							4.62	0.00				0.00				0.00	

VAMP flow operation period

Appendix A-1, Table 7

2006 VAMP DAILY OPERATION PLAN
April 3, 2006 (A)
Target Flow Period: April 15 - May 15 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow-reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	**1,583**	**966**	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	**1,698**	**936**	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	**1,792**	**612**	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	**1,716**	**550**	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	**2,454**	**630**	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	**2,223**	**811**	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	**1,986**	**505**	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	**2,178**	**352**	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06	**11,600**				**11,600**	**2,129**	**175**	**2,115**			**2,115**	**3,670**	**3,670**		**3,670**	**3,008**	**3,008**			**3,008**	
24-Mar-06	**11,400**				**11,400**	**2,177**	**380**	**2,080**			**2,080**	**3,910**	**3,910**		**3,910**	**3,005**	**3,005**			**3,005**	
25-Mar-06	**11,500**				**11,500**	**2,063**	**450**	**2,035**			**2,035**	**4,590**	**4,590**		**4,590**	**3,013**	**3,013**			**3,013**	
26-Mar-06	**12,000**				**12,000**	**2,097**	**522**	**1,867**			**1,867**	**4,580**	**4,580**		**4,580**	**3,009**	**3,009**			**3,009**	
27-Mar-06	**12,600**				**12,600**	**2,243**	**758**	**1,583**			**1,583**	**5,070**	**5,070**		**5,070**	**3,025**	**3,025**			**3,025**	
28-Mar-06	**12,500**				**12,500**	**1,595**	**876**	**2,584**			**2,584**	**5,070**	**5,070**		**5,070**	**3,043**	**3,043**			**3,043**	
29-Mar-06	**13,200**				**13,200**	**1,887**	**1,661**	**3,033**			**3,033**	**5,420**	**5,420**		**5,420**	**3,026**	**3,026**			**3,026**	
30-Mar-06	**14,700**				**14,700**	**1,855**	**1,728**	**2,877**			**2,877**	**6,050**	**6,050**		**6,050**	**3,014**	**3,014**			**3,014**	
31-Mar-06	**14,800**				**14,800**	**2,311**	**2,096**	**2,790**			**2,790**	**6,340**	**6,340**		**6,340**	**3,014**	**3,014**			**3,014**	
01-Apr-06	**15,100**				**15,100**	**2,574**	**2,147**	**2,972**			**2,972**	**6,110**	**6,110**		**6,110**	**3,014**	**3,014**			**3,014**	
02-Apr-06	**16,200**				**16,200**	**2,678**	**1,563**	**2,847**			**2,847**	**6,270**	**6,270**		**6,270**	**3,019**	**3,019**			**3,019**	
03-Apr-06	15,488				15,488	2,498	1,000	3,200			3,200	6,200	6,200		6,200	3,000	3,000			3,000	
04-Apr-06	15,939				15,939	2,318	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
05-Apr-06	15,545				15,545	2,139	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
06-Apr-06	14,918				14,918	1,959	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
07-Apr-06	14,739				14,739	1,779	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
08-Apr-06	14,559				14,559	1,599	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
09-Apr-06	14,379				14,379	1,419	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
10-Apr-06	14,199				14,199	1,239	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
11-Apr-06	14,019				14,019	1,060	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
12-Apr-06	13,839				13,839	880	1,000	3,200	0	0	3,200	5,400	5,400		5,400	3,000	3,000			3,000	
13-Apr-06	13,660	0			13,660	700	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
14-Apr-06	13,480	0			13,480	695	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
15-Apr-06	11,800	0	0	0.00	11,800	690	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
16-Apr-06	11,795	0	0	0.00	11,795	684	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
17-Apr-06	11,790	0	0	0.00	11,790	679	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
18-Apr-06	11,784	0	0	0.00	11,784	674	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
19-Apr-06	11,779	0	0	0.00	11,779	669	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
20-Apr-06	11,774	0	0	0.00	11,774	663	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
21-Apr-06	11,769	0	0	0.00	11,769	658	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
22-Apr-06	11,763	0	0	0.00	11,763	653	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
23-Apr-06	11,758	0	0	0.00	11,758	648	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
24-Apr-06	11,753	0	0	0.00	11,753	642	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
25-Apr-06	11,748	0	0	0.00	11,748	637	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
26-Apr-06	11,742	0	0	0.00	11,742	632	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
27-Apr-06	11,737	0	0	0.00	11,737	627	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
28-Apr-06	11,732	0	0	0.00	11,732	622	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
29-Apr-06	11,727	0	0	0.00	11,727	616	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
30-Apr-06	11,722	0	0	0.00	11,722	611	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
01-May-06	11,716	0	0	0.00	11,716	606	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
02-May-06	11,711	0	0	0.00	11,711	601	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
03-May-06	11,106	0	0	0.00	11,106	595	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
04-May-06	11,101	0	0	0.00	11,101	590	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
05-May-06	11,095	0	0	0.00	11,095	585	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
06-May-06	11,090	0	0	0.00	11,090	580	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
07-May-06	11,085	0	0	0.00	11,085	574	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
08-May-06	11,080	0	0	0.00	11,080	569	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
09-May-06	11,074	0	0	0.00	11,074	564	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
10-May-06	11,069	0	0	0.00	11,069	559	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
11-May-06	11,064	0	0	0.00	11,064	553	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
12-May-06	11,059	0	0	0.00	11,059	548	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
13-May-06	11,053	0	0	0.00	11,053	543	1,000	3,200			3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
14-May-06	11,048	0	0	0.00	11,048	538	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
15-May-06	11,043	0	0	0.00	11,043	533	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
16-May-06	11,038	0	0		11,038	528	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
17-May-06	11,033	0	0		11,033	523	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
18-May-06	11,028	0	0		11,028	518	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
19-May-06	11,023	0	0		11,023	513	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
20-May-06	11,018	0	0		11,018	508	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
21-May-06	11,013	0	0		11,013	503	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
22-May-06	11,008	0	0		11,008	498	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
23-May-06	11,003	0	0		11,003	493	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
24-May-06	10,998	0	0		10,998	488	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
25-May-06	10,993	0	0		10,993	483	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
26-May-06	10,988	0	0		10,988	478	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
27-May-06	10,983	0	0		10,983	473	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
28-May-06	10,978	0	0		10,978	468	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
29-May-06	10,973	0	0		10,973	463	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
30-May-06	10,968	0	0		10,968	458	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
31-May-06	10,963	0	0		10,963	453	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
VAMP Period																					
Avg. (cfs):	11,470	0			11,470	622	1,000	3,200	0	0	3,200	5,148	5,148	0	5,148	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				0.00							0.00	0.00				0.00				0.00	

VAMP flow operation period

Appendix A-1, Table 8
2006 VAMP DAILY OPERATION PLAN
April 3, 2006 (B)
Target Flow Period: April 22 - May 22 • Flow Target: greater than 7,000 cfs
Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow- reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	11,700				11,700	1,583	966	2,849			2,849	4,060	4,060		4,060	3,005	3,005			3,005	
16-Mar-06	11,900				11,900	1,698	936	2,843			2,843	3,700	3,700		3,700	3,002	3,002			3,002	
17-Mar-06	12,000				12,000	1,792	612	2,939			2,939	3,380	3,380		3,380	3,009	3,009			3,009	
18-Mar-06	11,700				11,700	1,716	550	3,309			3,309	3,340	3,340		3,340	3,000	3,000			3,000	
19-Mar-06	11,900				11,900	2,454	630	2,409			2,409	3,900	3,900		3,900	3,004	3,004			3,004	
20-Mar-06	12,100				12,100	2,223	811	2,285			2,285	3,840	3,840		3,840	3,010	3,010			3,010	
21-Mar-06	12,200				12,200	1,986	505	2,407			2,407	3,740	3,740		3,740	3,014	3,014			3,014	
22-Mar-06	11,900				11,900	2,178	352	2,066			2,066	3,660	3,660		3,660	3,008	3,008			3,008	
23-Mar-06	11,600				11,600	2,129	175	2,115			2,115	3,670	3,670		3,670	3,008	3,008			3,008	
24-Mar-06	11,400				11,400	2,177	380	2,080			2,080	3,910	3,910		3,910	3,005	3,005			3,005	
25-Mar-06	11,500				11,500	2,063	450	2,035			2,035	4,590	4,590		4,590	3,013	3,013			3,013	
26-Mar-06	12,000				12,000	2,097	522	1,867			1,867	4,580	4,580		4,580	3,009	3,009			3,009	
27-Mar-06	12,600				12,600	2,243	758	1,583			1,583	5,070	5,070		5,070	3,025	3,025			3,025	
28-Mar-06	12,500				12,500	1,595	876	2,584			2,584	5,070	5,070		5,070	3,043	3,043			3,043	
29-Mar-06	13,200				13,200	1,887	1,661	3,033			3,033	5,420	5,420		5,420	3,026	3,026			3,026	
30-Mar-06	14,700				14,700	1,855	1,728	2,877			2,877	6,050	6,050		6,050	3,014	3,014			3,014	
31-Mar-06	14,800				14,800	2,311	2,096	2,790			1,000	6,340	6,340		6,340	3,014	3,014			3,014	
01-Apr-06	15,100				15,100	2,574	2,147	2,972			2,972	6,110	6,110		6,110	3,014	3,014			3,014	
02-Apr-06	16,200				16,200	2,678	1,563	2,847			2,847	6,270	6,270		6,270	3,019	3,019			3,019	
03-Apr-06	15,488				13,698	2,498	1,000	3,200			3,200	6,200	6,200		6,200	3,000	3,000			3,000	
04-Apr-06	15,939				15,939	2,318	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
05-Apr-06	15,545				15,545	2,139	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
06-Apr-06	14,918				14,918	1,959	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
07-Apr-06	14,739				14,739	1,779	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
08-Apr-06	14,559				14,559	1,599	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
09-Apr-06	14,379				14,379	1,419	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
10-Apr-06	14,199				14,199	1,239	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
11-Apr-06	14,019				14,019	1,060	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
12-Apr-06	13,839				13,839	880	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
13-Apr-06	13,660				13,660	700	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
14-Apr-06	13,480				13,480	695	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
15-Apr-06	13,300				13,300	690	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
16-Apr-06	13,295				13,295	684	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
17-Apr-06	13,290				13,290	679	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
18-Apr-06	13,284				13,284	674	1,000	3,200			3,200	5,400	5,400		5,400	3,000	3,000			3,000	
19-Apr-06	13,279				13,279	669	1,000	3,200	0	0	3,200	5,400	5,400		5,400	3,000	3,000			3,000	
20-Apr-06	13,274				13,274	663	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
21-Apr-06	13,269				13,269	658	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
22-Apr-06	11,763	0	0	0.00	11,763	653	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
23-Apr-06	11,758	0	0	0.00	11,758	648	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
24-Apr-06	11,753	0	0	0.00	11,753	642	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
25-Apr-06	11,748	0	0	0.00	11,748	637	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
26-Apr-06	11,742	0	0	0.00	11,742	632	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
27-Apr-06	11,737	0	0	0.00	11,737	627	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
28-Apr-06	11,732	0	0	0.00	11,732	622	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
29-Apr-06	11,727	0	0	0.00	11,727	616	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
30-Apr-06	11,722	0	0	0.00	11,722	611	1,000	3,200	0	0	3,200	5,400	5,400	0	5,400	1,500	1,500	0	0	1,500	
01-May-06	11,716	0	0	0.00	11,716	606	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
02-May-06	11,711	0	0	0.00	11,711	601	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
03-May-06	11,106	0	0	0.00	11,106	595	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
04-May-06	11,101	0	0	0.00	11,101	590	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
05-May-06	11,095	0	0	0.00	11,095	585	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
06-May-06	11,090	0	0	0.00	11,090	580	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
07-May-06	11,085	0	0	0.00	11,085	574	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
08-May-06	11,080	0	0	0.00	11,080	569	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
09-May-06	11,074	0	0	0.00	11,074	564	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
10-May-06	11,069	0	0	0.00	11,069	559	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
11-May-06	11,064	0	0	0.00	11,064	553	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
12-May-06	11,059	0	0	0.00	11,059	548	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
13-May-06	11,053	0	0	0.00	11,053	543	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
14-May-06	11,048	0	0	0.00	11,048	538	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
15-May-06	11,043	0	0	0.00	11,043	533	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
16-May-06	11,038	0	0	0.00	11,038	528	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
17-May-06	11,033	0	0	0.00	11,033	523	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
18-May-06	11,028	0	0	0.00	11,028	518	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
19-May-06	11,023	0	0	0.00	11,023	513	1,000	3,200	0	0	3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
20-May-06	11,018	0	0	0.00	11,018	508	1,000	3,200			3,200	4,800	4,800	0	4,800	1,500	1,500	0	0	1,500	
21-May-06	11,013	0	0	0.00	11,013	503	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
22-May-06	11,008	0	0	0.00	11,008	498	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
23-May-06	11,003	0	0		11,003	493	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
24-May-06	10,998	0	0		10,998	488	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
25-May-06	10,993	0	0		10,993	483	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
26-May-06	10,988	0	0		10,988	478	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
27-May-06	10,983	0	0		10,983	473	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
28-May-06	10,978	0	0		10,978	468	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
29-May-06	10,973	0	0		10,973	463	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
30-May-06	10,968	0	0		10,968	458	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
31-May-06	10,963	0	0		10,963	453	1,000	3,200			3,200	4,800	4,800		4,800	1,500	1,500			1,500	
VAMP Period																					
Avg. (cfs):	11,298	0			11,298	585	1,000	3,200	0	0	3,200	5,013	5,013	0	5,013	1,500	1,500	0	0	1,500	
Supplemental Water (TAF):				0.00							0.00	0.00				0.00				0.00	

VAMP flow operation period

Appendix A-1, Table 9

2006 VAMP DAILY OPERATION PLAN
April 11, 2006
Target Flow Period: April 22 - May 22 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow-reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	**11,700**				**11,700**	**1,352**	**638**	**2,849**			**2,849**	**4,060**	**4,060**		**4,060**	**3,005**	**3,005**			**3,005**	
16-Mar-06	**11,900**				**11,900**	**1,407**	**956**	**2,843**			**2,843**	**3,700**	**3,700**		**3,700**	**3,002**	**3,002**			**3,002**	
17-Mar-06	**12,000**				**12,000**	**1,573**	**794**	**2,939**			**2,939**	**3,380**	**3,380**		**3,380**	**3,009**	**3,009**			**3,009**	
18-Mar-06	**11,700**				**11,700**	**1,684**	**742**	**3,309**			**3,309**	**3,340**	**3,340**		**3,340**	**3,000**	**3,000**			**3,000**	
19-Mar-06	**11,900**				**11,900**	**1,364**	**1,095**	**2,409**			**2,409**	**3,900**	**3,900**		**3,900**	**3,004**	**3,004**			**3,004**	
20-Mar-06	**12,100**				**12,100**	**1,892**	**1,137**	**2,285**			**2,285**	**3,840**	**3,840**		**3,840**	**3,010**	**3,010**			**3,010**	
21-Mar-06	**12,200**				**12,200**	**1,866**	**623**	**2,407**			**2,407**	**3,740**	**3,740**		**3,740**	**3,014**	**3,014**			**3,014**	
22-Mar-06	**11,900**				**11,900**	**1,674**	**749**	**2,066**			**2,066**	**3,660**	**3,660**		**3,660**	**3,008**	**3,008**			**3,008**	
23-Mar-06	**11,600**				**11,600**	**1,978**	**695**	**2,115**			**2,115**	**3,670**	**3,670**		**3,670**	**3,008**	**3,008**			**3,008**	
24-Mar-06	**11,400**				**11,400**	**1,952**	**651**	**2,080**			**2,080**	**3,910**	**3,910**		**3,910**	**3,005**	**3,005**			**3,005**	
25-Mar-06	**11,500**				**11,500**	**1,835**	**778**	**2,035**			**2,035**	**4,590**	**4,590**		**4,590**	**3,013**	**3,013**			**3,013**	
26-Mar-06	**12,000**				**12,000**	**1,776**	**1,018**	**1,867**			**1,867**	**4,580**	**4,580**		**4,580**	**3,009**	**3,009**			**3,009**	
27-Mar-06	**12,600**				**12,600**	**1,851**	**1,082**	**1,583**			**1,583**	**5,070**	**5,070**		**5,070**	**3,025**	**3,025**			**3,025**	
28-Mar-06	**12,500**				**12,500**	**2,262**	**1,100**	**2,584**			**2,584**	**5,070**	**5,070**		**5,070**	**3,043**	**3,043**			**3,043**	
29-Mar-06	**13,200**				**13,200**	**1,971**	**1,387**	**3,033**			**3,033**	**5,420**	**5,420**		**5,420**	**3,026**	**3,026**			**3,026**	
30-Mar-06	**14,700**				**14,700**	**1,795**	**2,742**	**2,877**			**2,877**	**6,050**	**6,050**		**6,050**	**3,014**	**3,014**			**3,014**	
31-Mar-06	**14,800**				**14,800**	**2,211**	**1,799**	**2,790**			**1,000**	**6,340**	**6,340**		**6,340**	**3,014**	**3,014**			**3,014**	
01-Apr-06	**15,100**				**15,100**	**2,444**	**1,208**	**2,972**			**2,972**	**6,110**	**6,110**		**6,110**	**3,014**	**3,014**			**3,014**	
02-Apr-06	**16,200**				**16,200**	**2,518**	**1,734**	**2,847**			**2,847**	**6,270**	**6,270**		**6,270**	**3,019**	**3,019**			**3,019**	
03-Apr-06	**16,700**				**16,700**	**2,733**	**2,342**	**3,513**			**3,513**	**6,020**	**6,020**		**6,020**	**3,039**	**3,039**			**3,039**	
04-Apr-06	**17,000**				**17,000**	**2,233**	**2,221**	**6,838**			**6,838**	**3,740**	**3,740**		**3,740**	**3,303**	**3,303**			**3,303**	
05-Apr-06	**18,700**				**18,700**	**2,796**	**4,061**	**4,830**			**4,830**	**4,800**	**4,800**		**4,800**	**4,714**	**4,714**			**4,714**	
06-Apr-06	**20,800**				**20,800**	**8,724**	**8,011**	**4,937**			**4,937**	**5,580**	**5,580**		**5,580**	**5,776**	**5,776**			**5,776**	
07-Apr-06	**21,900**				**21,900**	**15,426**	**2,752**	**5,219**			**5,219**	**6,470**	**6,470**		**6,470**	**6,148**	**6,148**			**6,148**	
08-Apr-06	**23,100**				**23,100**	**17,466**	**-1,810**	**5,183**			**5,183**	**6,790**	**6,790**		**6,790**	**4,379**	**4,379**			**4,379**	
09-Apr-06	**27,400**				**27,400**	**19,099**	**-5,581**	**5,157**			**5,157**	**6,780**	**6,780**		**6,780**	**3,534**	**3,534**			**3,534**	
10-Apr-06	**31,100**				**31,100**	**18,623**	**-2,754**	**5,102**			**5,102**	**6,760**	**6,760**		**6,760**	**3,504**	**3,504**			**3,504**	
11-Apr-06	32,000				32,000	17,174	-2,596	5,000			5,000	6,700	6,700		6,700	3,500	3,500			3,500	
12-Apr-06	32,000				32,000	16,000	-2,044	4,500			4,500	6,600	6,600		6,600	3,500	3,500			3,500	
13-Apr-06	32,476				32,476	15,500	0	4,500			4,500	6,600	6,600		6,600	3,500	3,500			3,500	
14-Apr-06	32,100				32,100	15,000	1,000	4,500			4,500	6,600	6,600		6,600	3,500	3,500			3,500	
15-Apr-06	31,100				31,100	14,500	1,000	4,500			4,500	6,600	6,600		6,600	3,500	3,500			3,500	
16-Apr-06	30,600				30,600	14,000	1,000	3,870			3,870	6,600	6,600		6,600	3,500	3,500			3,500	
17-Apr-06	30,100				30,100	13,500	1,000	3,820			3,820	6,600	6,600		6,600	5,500	5,500			5,500	
18-Apr-06	29,600				29,600	13,000	1,000	3,820			3,820	6,600	6,600		6,600	5,500	5,500			5,500	
19-Apr-06	30,470				30,470	12,500	1,000	3,810	0	0	3,810	6,600	6,600		6,600	5,500	5,500			5,500	
20-Apr-06	29,920				29,920	12,000	1,000	3,790	0	0	3,790	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
21-Apr-06	29,420				29,420	11,867	1,000	3,790	0	0	3,790	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
22-Apr-06	28,910	0	0	0.00	28,910	11,733	1,000	3,670	0	0	3,670	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
23-Apr-06	28,757	0	0	0.00	28,757	11,600	1,000	3,650	0	0	3,650	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
24-Apr-06	28,623	0	0	0.00	28,623	11,467	1,000	3,520	0	0	3,520	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
25-Apr-06	28,370	0	0	0.00	28,370	11,333	1,000	3,570	0	0	3,570	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
26-Apr-06	28,217	0	0	0.00	28,217	11,200	1,000	3,630	0	0	3,630	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
27-Apr-06	27,953	0	0	0.00	27,953	11,067	1,000	3,620	0	0	3,620	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
28-Apr-06	27,870	0	0	0.00	27,870	10,933	1,000	3,620	0	0	3,620	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
29-Apr-06	27,797	0	0	0.00	27,797	10,800	1,000	3,620	0	0	3,620	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
30-Apr-06	27,653	0	0	0.00	27,653	10,667	1,000	3,620	0	0	3,620	6,600	6,600	0	6,600	5,500	5,500	0	0	5,500	
01-May-06	27,520	0	0	0.00	27,520	10,533	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
02-May-06	27,387	0	0	0.00	27,387	10,400	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
03-May-06	26,653	0	0	0.00	26,653	10,267	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
04-May-06	25,750	0	0	0.00	25,750	10,133	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
05-May-06	25,617	0	0	0.00	25,617	10,000	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
06-May-06	25,483	0	0	0.00	25,483	9,867	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
07-May-06	25,350	0	0	0.00	25,350	9,733	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
08-May-06	25,217	0	0	0.00	25,217	9,600	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
09-May-06	25,083	0	0	0.00	25,083	9,467	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
10-May-06	24,950	0	0	0.00	24,950	9,333	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
11-May-06	24,817	0	0	0.00	24,817	9,200	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
12-May-06	24,683	0	0	0.00	24,683	9,067	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
13-May-06	24,550	0	0	0.00	24,550	8,933	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
14-May-06	24,417	0	0	0.00	24,417	8,800	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
15-May-06	24,283	0	0	0.00	24,283	8,667	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
16-May-06	24,150	0	0	0.00	24,150	8,533	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
17-May-06	24,017	0	0	0.00	24,017	8,400	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
18-May-06	23,883	0	0	0.00	23,883	8,267	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
19-May-06	23,750	0	0	0.00	23,750	8,133	1,000	2,850	0	0	2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
20-May-06	23,617	0	0	0.00	23,617	8,000	1,000	2,850			2,850	6,000	6,000	0	6,000	5,500	5,500	0	0	5,500	
21-May-06	23,483	0	0	0.00	23,483	7,850	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
22-May-06	23,350	0	0	0.00	23,350	7,700	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
23-May-06	23,200	0	0		23,200	7,550	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
24-May-06	23,050	0	0		23,050	7,400	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
25-May-06	22,900	0	0		22,900	7,250	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
26-May-06	22,750	0	0		22,750	7,100	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
27-May-06	22,600	0	0		22,600	6,950	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
28-May-06	22,450	0	0		22,450	6,800	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
29-May-06	22,300	0	0		22,300	6,650	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
30-May-06	22,150	0	0		22,150	6,500	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
31-May-06	22,000	0	0		22,000	6,350	1,000	2,850			2,850	6,000	6,000		6,000	5,500	5,500			5,500	
VAMP Period																					
Avg. (cfs):	25,876	0			25,876	10,000	1,000	3,163	0	0	3,163	6,213	6,213	0	6,213	5,500	5,500	0	0	5,500	
Supplemental Water (TAF):				0.00							0.00	0.00				0.00				0.00	

VAMP flow operation period (shaded)

Appendix A-1, Table 10

2006 VAMP DAILY OPERATION PLAN
April 18, 2006 (A)
Target Flow Period: April 22 - May 22 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow- reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	11,700				11,700	1,583	966	2,849			2,849	4,060	4,060		4,060	3,005	3,005			3,005	
16-Mar-06	11,900				11,900	1,698	936	2,843			2,843	3,700	3,700		3,700	3,002	3,002			3,002	
17-Mar-06	12,000				12,000	1,792	612	2,939			2,939	3,380	3,380		3,380	3,009	3,009			3,009	
18-Mar-06	11,700				11,700	1,716	550	3,309			3,309	3,340	3,340		3,340	3,000	3,000			3,000	
19-Mar-06	11,900				11,900	2,454	630	2,409			2,409	3,900	3,900		3,900	3,004	3,004			3,004	
20-Mar-06	12,100				12,100	2,223	811	2,285			2,285	3,840	3,840		3,840	3,010	3,010			3,010	
21-Mar-06	12,200				12,200	1,986	505	2,407			2,407	3,740	3,740		3,740	3,014	3,014			3,014	
22-Mar-06	11,900				11,900	2,178	352	2,066			2,066	3,660	3,660		3,660	3,008	3,008			3,008	
23-Mar-06	11,600				11,600	2,129	175	2,115			2,115	3,670	3,670		3,670	3,008	3,008			3,008	
24-Mar-06	11,400				11,400	2,177	380	2,080			2,080	3,910	3,910		3,910	3,005	3,005			3,005	
25-Mar-06	11,500				11,500	2,063	450	2,035			2,035	4,590	4,590		4,590	3,013	3,013			3,013	
26-Mar-06	12,000				12,000	2,097	522	1,867			1,867	4,580	4,580		4,580	3,009	3,009			3,009	
27-Mar-06	12,600				12,600	2,243	758	1,583			1,583	5,070	5,070		5,070	3,025	3,025			3,025	
28-Mar-06	12,500				12,500	1,595	876	2,584			2,584	5,070	5,070		5,070	3,043	3,043			3,043	
29-Mar-06	13,200				13,200	1,887	1,661	3,033			3,033	5,420	5,420		5,420	3,026	3,026			3,026	
30-Mar-06	14,700				14,700	1,855	1,728	2,877			2,877	6,050	6,050		6,050	3,014	3,014			3,014	
31-Mar-06	14,800				14,800	2,311	2,096	2,790			1,000	6,340	6,340		6,340	3,014	3,014			3,014	
01-Apr-06	15,100				15,100	2,444	1,208	2,972			2,972	6,110	6,110		6,110	3,014	3,014			3,014	
02-Apr-06	16,200				16,200	2,518	1,734	2,847			2,847	6,270	6,270		6,270	3,019	3,019			3,019	
03-Apr-06	16,700				16,700	2,733	2,342	3,513			3,513	6,020	6,020		6,020	3,039	3,039			3,039	
04-Apr-06	17,000				17,000	2,233	2,221	6,838			6,838	3,740	3,740		3,740	3,303	3,303			3,303	
05-Apr-06	18,700				18,700	2,796	4,061	4,830			4,830	4,800	4,800		4,800	4,714	4,714			4,714	
06-Apr-06	20,800				20,800	8,724	8,011	4,937			4,937	5,580	5,580		5,580	5,776	5,776			5,776	
07-Apr-06	21,900				21,900	15,426	2,752	5,219			5,219	6,470	6,470		6,470	6,148	6,148			6,148	
08-Apr-06	23,100				23,100	17,466	-1,810	5,183			5,183	6,790	6,790		6,790	4,379	4,379			4,379	
09-Apr-06	27,400				27,400	19,099	-5,581	5,157			5,157	6,780	6,780		6,780	3,534	3,534			3,534	
10-Apr-06	31,100				31,100	18,623	-2,754	5,102			5,102	6,760	6,760		6,760	3,504	3,504			3,504	
11-Apr-06	32,200				32,200	17,974	-2,396	4,618			4,618	7,340	7,340		7,340	3,509	3,509			3,509	
12-Apr-06	34,300				34,300	17,219	256	4,518			4,518	7,730	7,730		7,730	3,868	3,868			3,868	
13-Apr-06	34,800				34,800	15,911	875	4,465			4,465	7,770	7,770		7,770	4,019	4,019			4,019	
14-Apr-06	34,500				34,500	13,300	1,065	4,446			4,446	7,550	7,550		7,550	3,995	3,995			3,995	
15-Apr-06	33,700				33,700	12,160	1,482	4,619			4,619	7,450	7,450		7,450	4,039	4,039			4,039	
16-Apr-06	32,900				32,900	11,538	3,590	4,511			4,511	7,420	7,420		7,420	4,062	4,062			4,062	
17-Apr-06	31,700				31,700	11,520	3,605	4,130			4,130	7,600	7,600		7,600	4,756	4,756			4,756	
18-Apr-06	30,639				30,639	11,330	3,000	4,000			4,000	8,500	8,500		8,500	5,500	5,500			5,500	
19-Apr-06	30,387				30,387	11,226	2,000	4,000	0	0	4,000	8,600	8,600		8,600	5,500	5,500			5,500	
20-Apr-06	31,460				31,460	11,122	2,000	4,000	0	0	4,000	8,700	8,700	0	8,700	5,500	5,500	0	0	5,500	
21-Apr-06	31,326				31,326	11,018	2,000	4,000	0	0	4,000	8,800	8,800	0	8,800	5,500	5,500	0	0	5,500	
22-Apr-06	31,322	0	0	0.00	31,322	10,914	2,000	4,000	0	0	4,000	8,900	8,900	0	8,900	5,500	5,500	0	0	5,500	
23-Apr-06	31,318	0	0	0.00	31,318	10,810	2,000	3,650	0	0	3,650	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
24-Apr-06	31,314	0	0	0.00	31,314	10,706	2,000	3,520	0	0	3,520	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
25-Apr-06	31,310	0	0	0.00	31,310	10,601	2,000	3,570	0	0	3,570	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
26-Apr-06	30,856	0	0	0.00	30,856	10,497	2,000	3,630	0	0	3,630	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
27-Apr-06	30,621	0	0	0.00	30,621	10,393	2,000	3,620	0	0	3,620	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
28-Apr-06	30,568	0	0	0.00	30,568	10,289	2,000	3,620	0	0	3,620	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
29-Apr-06	30,523	0	0	0.00	30,523	10,185	2,000	3,620	0	0	3,620	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
30-Apr-06	30,409	0	0	0.00	30,409	10,081	2,000	3,620	0	0	3,620	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
01-May-06	30,305	0	0	0.00	30,305	9,977	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
02-May-06	30,201	0	0	0.00	30,201	9,873	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
03-May-06	30,097	0	0	0.00	30,097	9,769	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
04-May-06	29,223	0	0	0.00	29,223	9,665	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
05-May-06	29,119	0	0	0.00	29,119	9,561	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
06-May-06	29,015	0	0	0.00	29,015	9,457	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
07-May-06	28,911	0	0	0.00	28,911	9,353	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
08-May-06	28,807	0	0	0.00	28,807	9,249	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
09-May-06	28,703	0	0	0.00	28,703	9,145	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
10-May-06	28,599	0	0	0.00	28,599	9,041	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
11-May-06	28,495	0	0	0.00	28,495	8,937	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
12-May-06	28,391	0	0	0.00	28,391	8,832	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
13-May-06	28,287	0	0	0.00	28,287	8,728	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
14-May-06	28,182	0	0	0.00	28,182	8,624	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
15-May-06	28,078	0	0	0.00	28,078	8,520	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
16-May-06	27,974	0	0	0.00	27,974	8,416	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
17-May-06	27,870	0	0	0.00	27,870	8,312	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
18-May-06	27,766	0	0	0.00	27,766	8,208	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
19-May-06	27,662	0	0	0.00	27,662	8,104	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
20-May-06	27,558	0	0	0.00	27,558	8,000	2,000	2,850			2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
21-May-06	27,454	0	0	0.00	27,454	7,850	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
22-May-06	27,350	0	0	0.00	27,350	7,700	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
23-May-06	27,200	0	0		27,200	7,550	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
24-May-06	27,050	0	0		27,050	7,400	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
25-May-06	26,900	0	0		26,900	7,250	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
26-May-06	26,750	0	0		26,750	7,100	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
27-May-06	26,600	0	0		26,600	6,950	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
28-May-06	26,450	0	0		26,450	6,800	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
29-May-06	26,300	0	0		26,300	6,650	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
30-May-06	26,150	0	0		26,150	6,500	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
31-May-06	26,000	0	0		26,000	6,350	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
VAMP Period																					
Avg. (cfs):	29,235	0			29,235	9,561	2,000	3,194	0	0	3,194	8,981	8,981	0	8,981	5,500	5,500	0	0	5,500	
Supplemental Water (TAF):				0.00							0.00	0.00				0.00				0.00	

VAMP flow operation period

Appendix A-1, Table 11

2006 VAMP DAILY OPERATION PLAN

April 18, 2006 (B)

Target Flow Period: May 1 - May 31 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow- reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	11,700				11,700	1,583	966	2,849			2,849	4,060	4,060		4,060	3,005	3,005			3,005	
16-Mar-06	11,900				11,900	1,698	936	2,843			2,843	3,700	3,700		3,700	3,002	3,002			3,002	
17-Mar-06	12,000				12,000	1,792	612	2,939			2,939	3,380	3,380		3,380	3,009	3,009			3,009	
18-Mar-06	11,700				11,700	1,716	550	3,309			3,309	3,340	3,340		3,340	3,000	3,000			3,000	
19-Mar-06	11,900				11,900	2,454	630	2,409			2,409	3,900	3,900		3,900	3,004	3,004			3,004	
20-Mar-06	12,100				12,100	2,223	811	2,285			2,285	3,840	3,840		3,840	3,010	3,010			3,010	
21-Mar-06	12,200				12,200	1,986	505	2,407			2,407	3,740	3,740		3,740	3,014	3,014			3,014	
22-Mar-06	11,900				11,900	2,178	352	2,066			2,066	3,660	3,660		3,660	3,008	3,008			3,008	
23-Mar-06	11,600				11,600	2,129	175	2,115			2,115	3,670	3,670		3,670	3,008	3,008			3,008	
24-Mar-06	11,400				11,400	2,177	380	2,080			2,080	3,910	3,910		3,910	3,005	3,005			3,005	
25-Mar-06	11,500				11,500	2,063	450	2,035			2,035	4,590	4,590		4,590	3,013	3,013			3,013	
26-Mar-06	12,000				12,000	2,097	522	1,867			1,867	4,580	4,580		4,580	3,009	3,009			3,009	
27-Mar-06	12,600				12,600	2,243	758	1,583			1,583	5,070	5,070		5,070	3,025	3,025			3,025	
28-Mar-06	12,500				12,500	1,595	876	2,584			2,584	5,070	5,070		5,070	3,043	3,043			3,043	
29-Mar-06	13,200				13,200	1,887	1,661	3,033			3,033	5,420	5,420		5,420	3,026	3,026			3,026	
30-Mar-06	14,700				14,700	1,855	1,728	2,877			2,877	6,050	6,050		6,050	3,014	3,014			3,014	
31-Mar-06	14,800				14,800	2,311	2,096	2,790			2,790	6,340	6,340		6,340	3,014	3,014			3,014	
01-Apr-06	15,100				15,100	2,444	1,208	2,972			2,972	6,110	6,110		6,110	3,014	3,014			3,014	
02-Apr-06	16,200				16,200	2,518	1,734	2,847			2,847	6,270	6,270		6,270	3,019	3,019			3,019	
03-Apr-06	16,700				16,700	2,733	2,342	3,513			3,513	6,020	6,020		6,020	3,039	3,039			3,039	
04-Apr-06	17,000				17,000	2,233	2,221	6,838			6,838	3,740	3,740		3,740	3,303	3,303			3,303	
05-Apr-06	18,700				18,700	2,796	4,061	4,830			4,830	4,800	4,800		4,800	4,714	4,714			4,714	
06-Apr-06	20,800				20,800	8,724	8,011	4,937			4,937	5,580	5,580		5,580	5,776	5,776			5,776	
07-Apr-06	21,900				21,900	15,426	2,752	5,219			5,219	6,470	6,470		6,470	6,148	6,148			6,148	
08-Apr-06	23,100				23,100	17,466	-1,810	5,183			5,183	6,790	6,790		6,790	4,379	4,379			4,379	
09-Apr-06	27,400				27,400	19,099	-5,581	5,157			5,157	6,780	6,780		6,780	3,534	3,534			3,534	
10-Apr-06	31,100				31,100	18,623	-2,754	5,102			5,102	6,760	6,760		6,760	3,504	3,504			3,504	
11-Apr-06	32,200				32,200	17,974	-2,396	4,618			4,618	7,340	7,340		7,340	3,509	3,509			3,509	
12-Apr-06	34,300				34,300	17,219	256	4,518			4,518	7,730	7,730		7,730	3,868	3,868			3,868	
13-Apr-06	34,800				34,800	15,911	875	4,465			4,465	7,770	7,770		7,770	4,019	4,019			4,019	
14-Apr-06	34,500				34,500	13,300	1,065	4,446			4,446	7,550	7,550		7,550	3,995	3,995			3,995	
15-Apr-06	33,700				33,700	12,160	1,482	4,619			4,619	7,450	7,450		7,450	4,039	4,039			4,039	
16-Apr-06	32,900				32,900	11,538	3,590	4,511			4,511	7,420	7,420		7,420	4,062	4,062			4,062	
17-Apr-06	31,700				31,700	11,520	3,605	4,130			4,130	7,600	7,600		7,600	4,756	4,756			4,756	
18-Apr-06	30,639				30,639	11,330	3,000	4,000			4,000	8,500	8,500		8,500	5,500	5,500			5,500	
19-Apr-06	30,387				30,387	11,226	2,000	4,000			4,000	8,600	8,600		8,600	5,500	5,500			5,500	
20-Apr-06	31,460				31,460	11,122	2,000	4,000			4,000	8,700	8,700		8,700	5,500	5,500			5,500	
21-Apr-06	31,326				31,326	11,018	2,000	4,000			4,000	8,800	8,800		8,800	5,500	5,500			5,500	
22-Apr-06	31,322				31,322	10,914	2,000	4,000			4,000	8,900	8,900		8,900	5,500	5,500			5,500	
23-Apr-06	31,318				31,318	10,810	2,000	3,650			3,650	9,000	9,000		9,000	5,500	5,500			5,500	
24-Apr-06	31,314				31,314	10,706	2,000	3,520			3,520	9,000	9,000		9,000	5,500	5,500			5,500	
25-Apr-06	31,310				31,310	10,601	2,000	3,570			3,570	9,000	9,000		9,000	5,500	5,500			5,500	
26-Apr-06	30,856				30,856	10,497	2,000	3,630			3,630	9,000	9,000		9,000	5,500	5,500			5,500	
27-Apr-06	30,621				30,621	10,393	2,000	3,620			3,620	9,000	9,000		9,000	5,500	5,500			5,500	
28-Apr-06	30,568				30,568	10,289	2,000	3,620	0	0	3,620	9,000	9,000		9,000	5,500	5,500			5,500	
29-Apr-06	30,523				30,523	10,185	2,000	3,620	0	0	3,620	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
30-Apr-06	30,409	0	0		30,409	10,081	2,000	3,620	0	0	3,620	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
01-May-06	30,305	0	0	0.00	30,305	9,977	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
02-May-06	30,201	0	0	0.00	30,201	9,873	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
03-May-06	30,097	0	0	0.00	30,097	9,769	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
04-May-06	29,223	0	0	0.00	29,223	9,665	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
05-May-06	29,119	0	0	0.00	29,119	9,561	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
06-May-06	29,015	0	0	0.00	29,015	9,457	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
07-May-06	28,911	0	0	0.00	28,911	9,353	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
08-May-06	28,807	0	0	0.00	28,807	9,249	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
09-May-06	28,703	0	0	0.00	28,703	9,145	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
10-May-06	28,599	0	0	0.00	28,599	9,041	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
11-May-06	28,495	0	0	0.00	28,495	8,937	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
12-May-06	28,391	0	0	0.00	28,391	8,832	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
13-May-06	28,287	0	0	0.00	28,287	8,728	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
14-May-06	28,182	0	0	0.00	28,182	8,624	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
15-May-06	28,078	0	0	0.00	28,078	8,520	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
16-May-06	27,974	0	0	0.00	27,974	8,416	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
17-May-06	27,870	0	0	0.00	27,870	8,312	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
18-May-06	27,766	0	0	0.00	27,766	8,208	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
19-May-06	27,662	0	0	0.00	27,662	8,104	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
20-May-06	27,558	0	0	0.00	27,558	8,000	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
21-May-06	27,454	0	0	0.00	27,454	7,850	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
22-May-06	27,350	0	0	0.00	27,350	7,700	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
23-May-06	27,200	0	0	0.00	27,200	7,550	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
24-May-06	27,050	0	0	0.00	27,050	7,400	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
25-May-06	26,900	0	0	0.00	26,900	7,250	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
26-May-06	26,750	0	0	0.00	26,750	7,100	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
27-May-06	26,600	0	0	0.00	26,600	6,950	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
28-May-06	26,450	0	0	0.00	26,450	6,800	2,000	2,850	0	0	2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
29-May-06	26,300	0	0	0.00	26,300	6,650	2,000	2,850			2,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
30-May-06	26,150	0	0	0.00	26,150	6,500	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
31-May-06	26,000	0	0	0.00	26,000	6,350	2,000	2,850			2,850	9,000	9,000		9,000	5,500	5,500			5,500	
VAMP Period																					
Avg. (cfs):	27,982	0			27,982	8,558	2,000	2,925	0	0	2,925	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
Supplemental Water (TAF):				0.00							0.00	0.00				0.00				0.00	

VAMP flow operation period

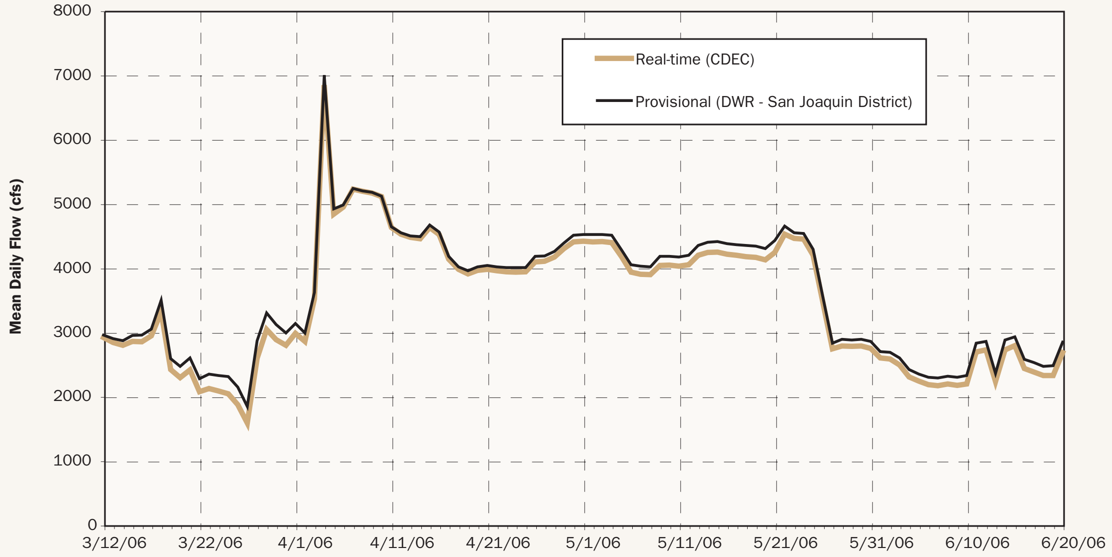
Appendix A-1, Table 12

2006 VAMP DAILY OPERATION PLAN
April 25, 2006
Target Flow Period: May 1 - May 31 • Flow Target: greater than 7,000 cfs
Bold Numbers: observed real-time mean daily flows

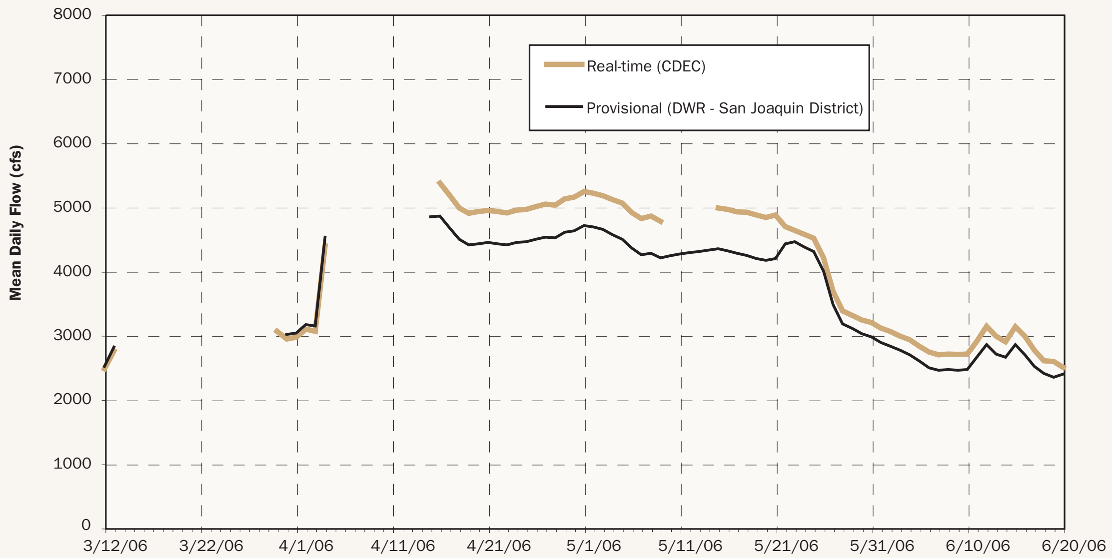
	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existing Flow-reshaped	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
15-Mar-06	11,700				11,700	1,583	966	2,849			2,849	4,060	4,060		4,060	3,005	3,005			3,005	
16-Mar-06	11,900				11,900	1,698	936	2,843			2,843	3,700	3,700		3,700	3,002	3,002			3,002	
17-Mar-06	12,000				12,000	1,792	612	2,939			2,939	3,380	3,380		3,380	3,009	3,009			3,009	
18-Mar-06	11,700				11,700	1,716	550	3,309			3,309	3,340	3,340		3,340	3,000	3,000			3,000	
19-Mar-06	11,900				11,900	2,454	630	2,409			2,409	3,900	3,900		3,900	3,004	3,004			3,004	
20-Mar-06	12,100				12,100	2,223	811	2,285			2,285	3,840	3,840		3,840	3,010	3,010			3,010	
21-Mar-06	12,200				12,200	1,986	505	2,407			2,407	3,740	3,740		3,740	3,014	3,014			3,014	
22-Mar-06	11,900				11,900	2,178	352	2,066			2,066	3,660	3,660		3,660	3,008	3,008			3,008	
23-Mar-06	11,600				11,600	2,129	175	2,115			2,115	3,670	3,670		3,670	3,008	3,008			3,008	
24-Mar-06	11,400				11,400	2,177	380	2,080			2,080	3,910	3,910		3,910	3,005	3,005			3,005	
25-Mar-06	11,500				11,500	2,063	450	2,035			2,035	4,590	4,590		4,590	3,013	3,013			3,013	
26-Mar-06	12,000				12,000	2,097	522	1,867			1,867	4,580	4,580		4,580	3,009	3,009			3,009	
27-Mar-06	12,600				12,600	2,243	758	1,583			1,583	5,070	5,070		5,070	3,025	3,025			3,025	
28-Mar-06	12,500				12,500	1,595	876	2,584			2,584	5,070	5,070		5,070	3,043	3,043			3,043	
29-Mar-06	13,200				13,200	1,887	1,661	3,033			3,033	5,420	5,420		5,420	3,026	3,026			3,026	
30-Mar-06	14,700				14,700	1,855	1,728	2,877			2,877	6,050	6,050		6,050	3,014	3,014			3,014	
31-Mar-06	14,800				14,800	2,311	2,096	2,790			2,790	6,340	6,340		6,340	3,014	3,014			3,014	
01-Apr-06	15,100				15,100	2,444	1,208	2,972			2,972	6,110	6,110		6,110	3,014	3,014			3,014	
02-Apr-06	16,200				16,200	2,518	1,734	2,847			2,847	6,270	6,270		6,270	3,019	3,019			3,019	
03-Apr-06	16,700				16,700	2,733	2,342	3,513			3,513	6,020	6,020		6,020	3,039	3,039			3,039	
04-Apr-06	17,000				17,000	2,233	2,221	6,838			6,838	3,740	3,740		3,740	3,303	3,303			3,303	
05-Apr-06	18,700				18,700	2,796	4,061	4,830			4,830	4,800	4,800		4,800	4,714	4,714			4,714	
06-Apr-06	20,800				20,800	8,724	8,011	4,937			4,937	5,580	5,580		5,580	5,776	5,776			5,776	
07-Apr-06	21,900				21,900	15,426	2,752	5,219			5,219	6,470	6,470		6,470	6,148	6,148			6,148	
08-Apr-06	23,100				23,100	17,466	-1,810	5,183			5,183	6,790	6,790		6,790	4,379	4,379			4,379	
09-Apr-06	27,400				27,400	19,099	-5,581	5,157			5,157	6,780	6,780		6,780	3,534	3,534			3,534	
10-Apr-06	31,100				31,100	18,623	-2,754	5,102			5,102	6,760	6,760		6,760	3,504	3,504			3,504	
11-Apr-06	32,200				32,200	17,974	-2,396	4,618			4,618	7,340	7,340		7,340	3,509	3,509			3,509	
12-Apr-06	34,300				34,300	17,219	256	4,518			4,518	7,730	7,730		7,730	3,868	3,868			3,868	
13-Apr-06	34,800				34,800	15,911	875	4,465			4,465	7,770	7,770		7,770	4,019	4,019			4,019	
14-Apr-06	34,500				34,500	13,300	1,065	4,446			4,446	7,550	7,550		7,550	3,995	3,995			3,995	
15-Apr-06	33,700				33,700	12,160	1,482	4,619			4,619	7,450	7,450		7,450	4,039	4,039			4,039	
16-Apr-06	32,900				32,900	11,538	3,590	4,511			4,511	7,420	7,420		7,420	4,062	4,062			4,062	
17-Apr-06	31,700				31,700	11,420	3,605	4,130			4,130	7,580	7,580		7,580	4,756	4,756			4,756	
18-Apr-06	30,900				30,900	11,322	3,261	3,970			3,970	8,190	8,190		8,190	5,495	5,495			5,495	
19-Apr-06	30,900				30,900	10,905	2,633	3,900			3,900	8,240	8,240		8,240	5,510	5,510			5,510	
20-Apr-06	31,000				31,000	10,679	1,863	3,955			3,955	8,420	8,420		8,420	5,507	5,507			5,507	
21-Apr-06	31,000				31,000	10,660	2,375	3,970			3,970	8,340	8,340		8,340	5,510	5,510			5,510	
22-Apr-06	30,900				30,900	10,580	2,394	3,948			3,948	8,440	8,440		8,440	5,522	5,522			5,522	
23-Apr-06	30,700				30,700	10,600	2,235	3,933			3,933	8,430	8,430		8,430	5,524	5,524			5,524	
24-Apr-06	30,700				30,700	10,655	2,188	3,927			3,927	8,560	8,560		8,560	5,548	5,548			5,548	
25-Apr-06	30,502				30,502	10,605	2,000	3,850			3,850	8,700	8,700		8,700	5,500	5,500			5,500	
26-Apr-06	30,696				30,696	10,555	2,000	3,850			3,850	9,000	9,000		9,000	5,500	5,500			5,500	
27-Apr-06	30,732				30,732	10,505	2,000	3,850			3,850	9,000	9,000		9,000	5,500	5,500			5,500	
28-Apr-06	30,905				30,905	10,454	2,000	3,850	0	0	3,850	9,000	9,000		9,000	5,500	5,500			5,500	
29-Apr-06	30,855				30,855	10,404	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
30-Apr-06	30,804				30,804	10,354	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
01-May-06	30,754	0	0	0.00	30,754	10,304	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
02-May-06	30,704	0	0	0.00	30,704	10,254	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
03-May-06	30,654	0	0	0.00	30,654	10,204	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
04-May-06	30,604	0	0	0.00	30,604	10,154	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
05-May-06	30,554	0	0	0.00	30,554	10,104	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
06-May-06	30,504	0	0	0.00	30,504	10,053	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
07-May-06	30,454	0	0	0.00	30,454	10,003	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
08-May-06	30,403	0	0	0.00	30,403	9,953	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
09-May-06	30,353	0	0	0.00	30,353	9,903	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
10-May-06	30,303	0	0	0.00	30,303	9,853	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
11-May-06	30,253	0	0	0.00	30,253	9,803	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
12-May-06	30,203	0	0	0.00	30,203	9,753	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
13-May-06	30,153	0	0	0.00	30,153	9,702	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
14-May-06	30,103	0	0	0.00	30,103	9,652	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
15-May-06	30,052	0	0	0.00	30,052	9,602	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
16-May-06	30,002	0	0	0.00	30,002	9,552	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
17-May-06	29,952	0	0	0.00	29,952	9,502	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
18-May-06	29,902	0	0	0.00	29,902	9,452	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
19-May-06	29,852	0	0	0.00	29,852	9,402	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
20-May-06	29,802	0	0	0.00	29,802	9,351	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
21-May-06	29,752	0	0	0.00	29,752	9,301	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
22-May-06	29,701	0	0	0.00	29,701	9,251	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
23-May-06	29,651	0	0	0.00	29,651	9,201	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
24-May-06	29,601	0	0	0.00	29,601	9,151	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
25-May-06	29,551	0	0	0.00	29,551	9,101	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
26-May-06	29,501	0	0	0.00	29,501	9,051	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
27-May-06	29,451	0	0	0.00	29,451	9,001	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
28-May-06	29,401	0	0	0.00	29,401	8,950	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
29-May-06	29,351	0	0	0.00	29,351	8,900	2,000	3,850			3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
30-May-06	29,300	0	0	0.00	29,300	8,850	2,000	3,850			3,850	9,000	9,000		9,000	5,500	5,500			5,500	
31-May-06	29,250	0	0	0.00	29,250	8,800	2,000	3,850			3,850	9,000	9,000		9,000	5,500	5,500			5,500	
VAMP Period																					
Avg. (cfs):	30,002	0			30,002	9,652	2,000	3,850	0	0	3,850	9,000	9,000	0	9,000	5,500	5,500	0	0	5,500	
Supplemental Water (TAF):				0.00							0.00	0.00				0.00				0.00	

VAMP flow operation period

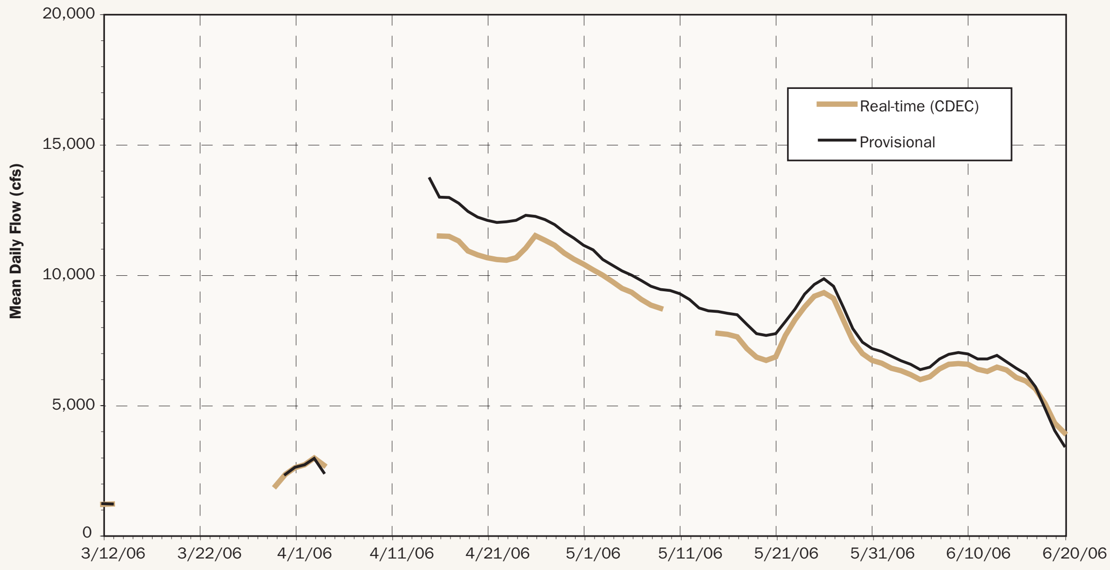
Appendix A-2, Figure 1
Merced River at Cressey



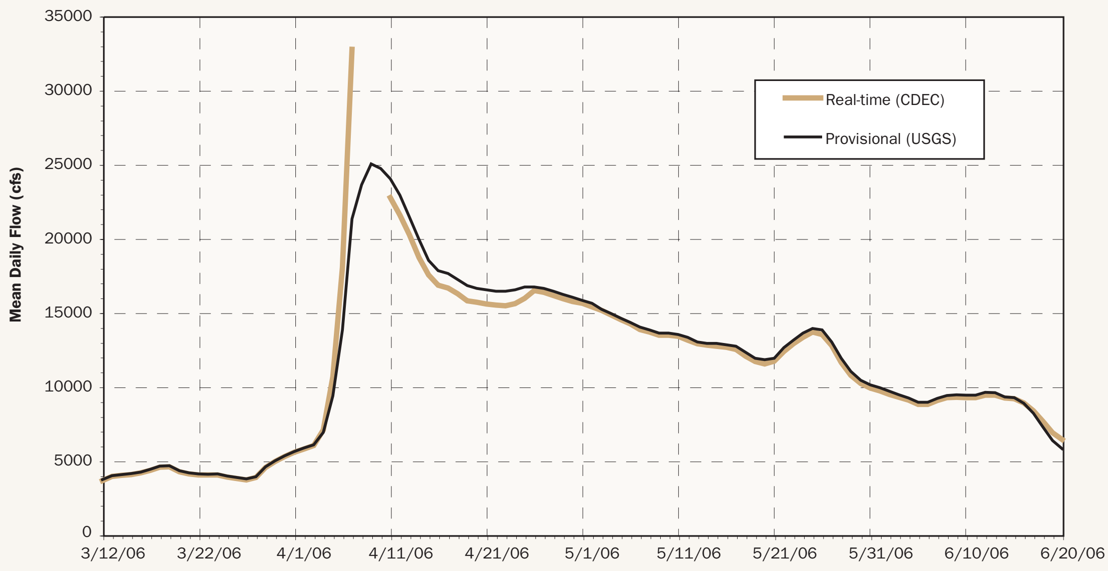
Appendix A-2, Figure 2
Merced River near Stevinson



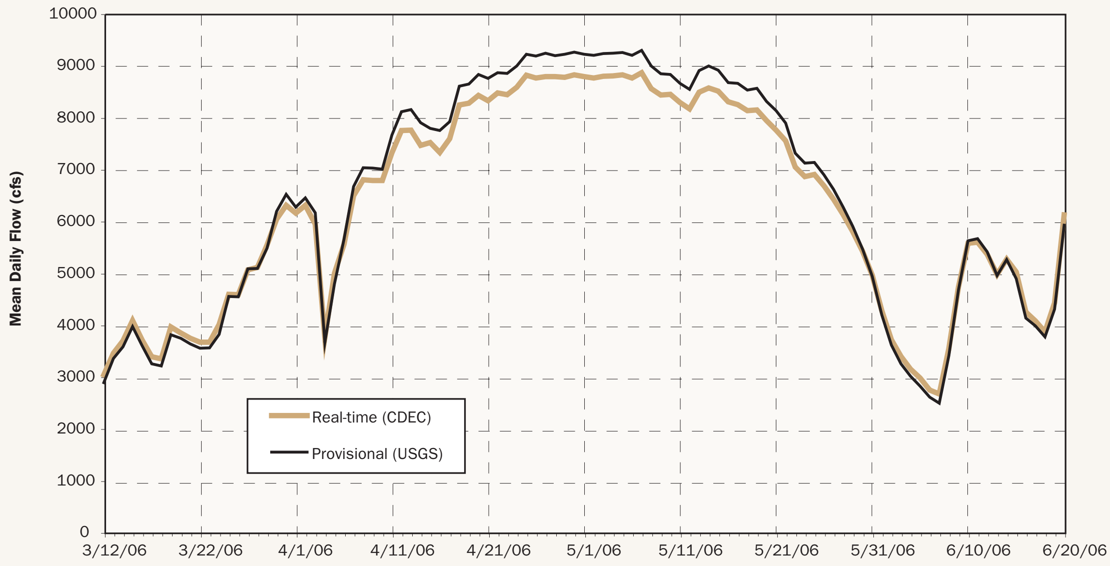
Appendix A-2, Figure 3
San Joaquin River above Merced River



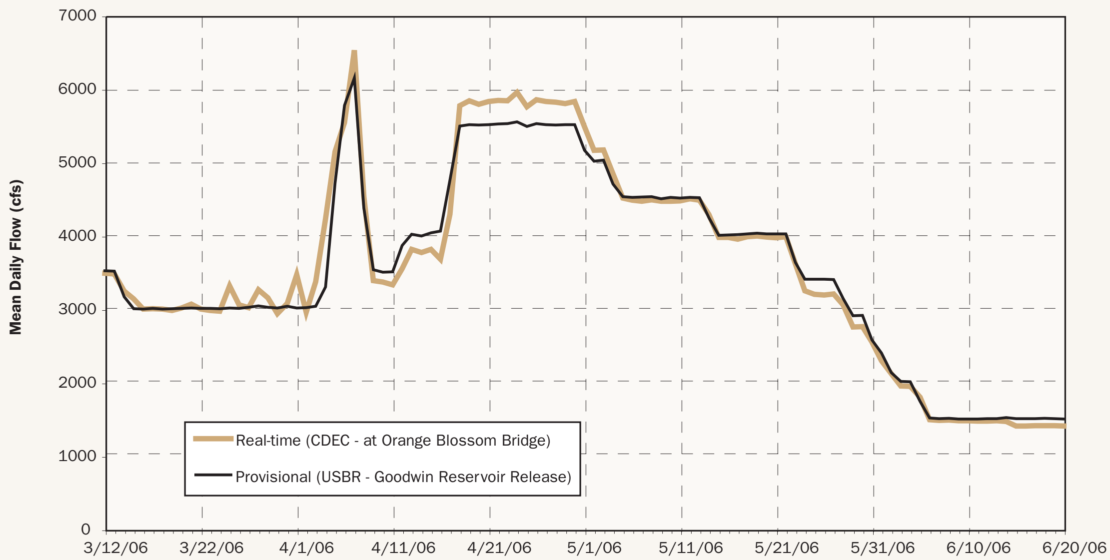
Appendix A-2, Figure 4
San Joaquin River near Newman



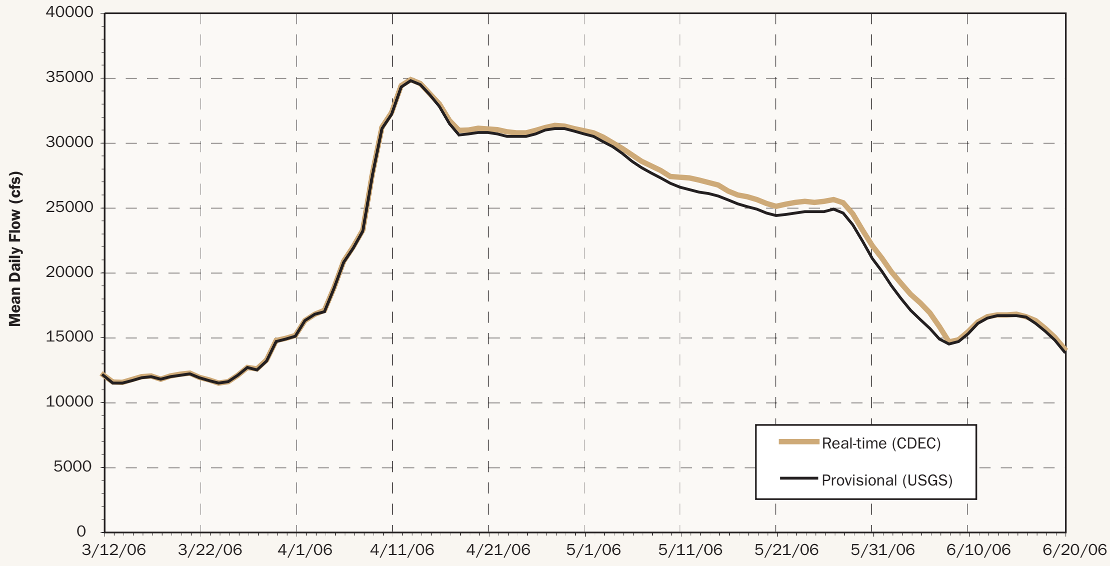
Appendix A-2, Figure 5
Tuolumne River below LaGrange Dam



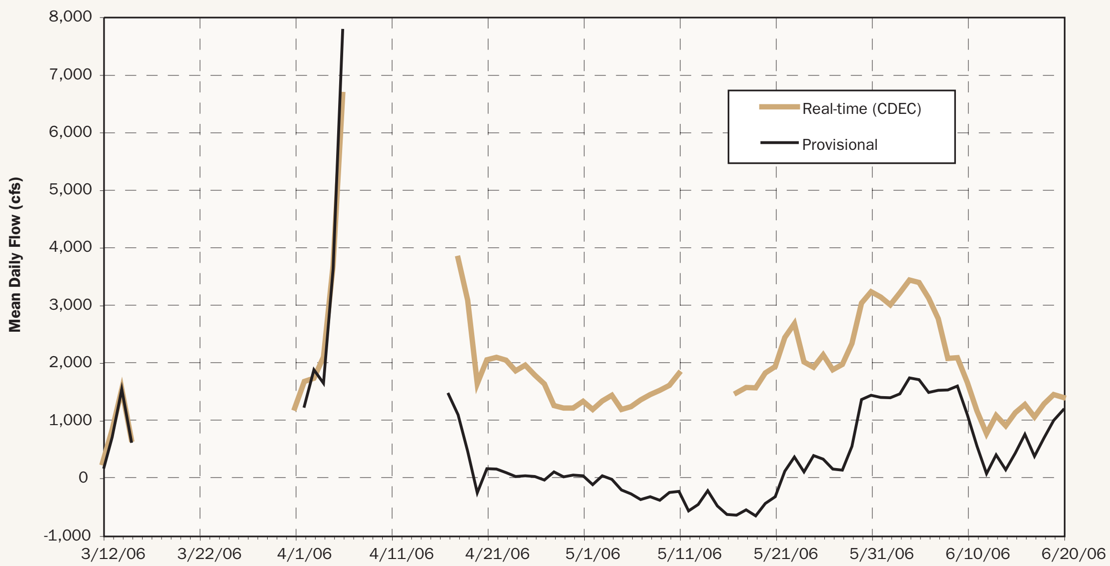
Appendix A-2, Figure 6
Stanislaus River below Goodwin Dam



Appendix A-2, Figure 7
San Joaquin River near Vernalis

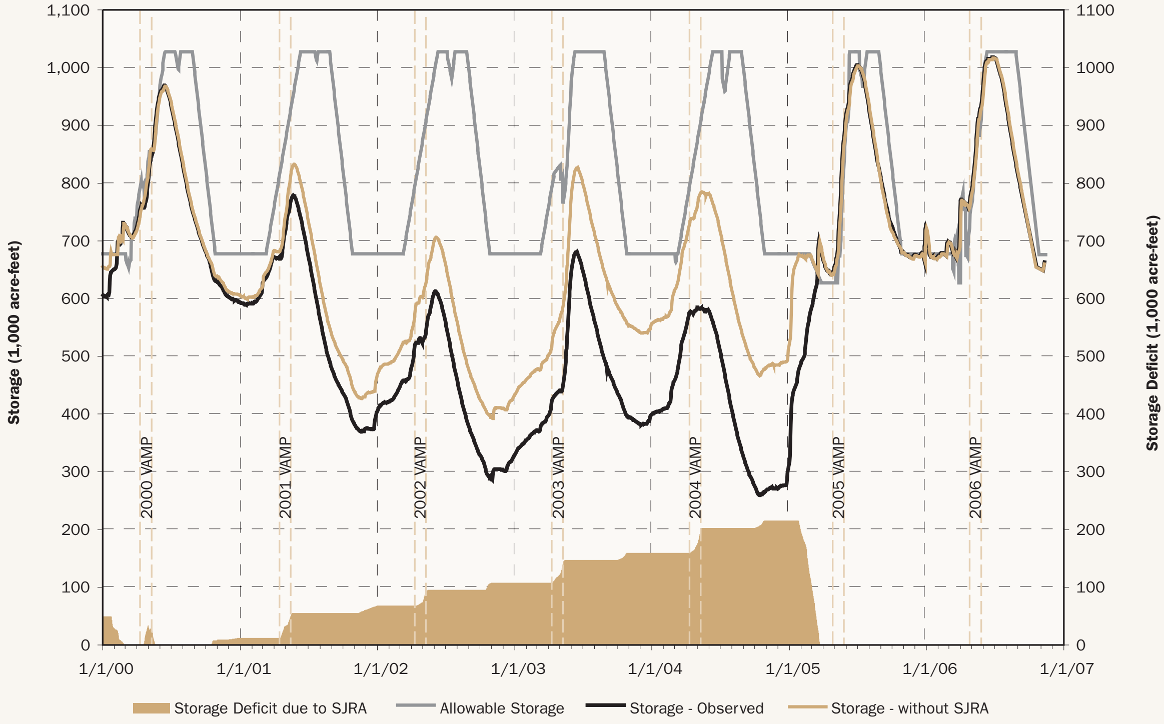


Appendix A-2, Figure 8
Ungaged Flow in San Joaquin River near Vernalis

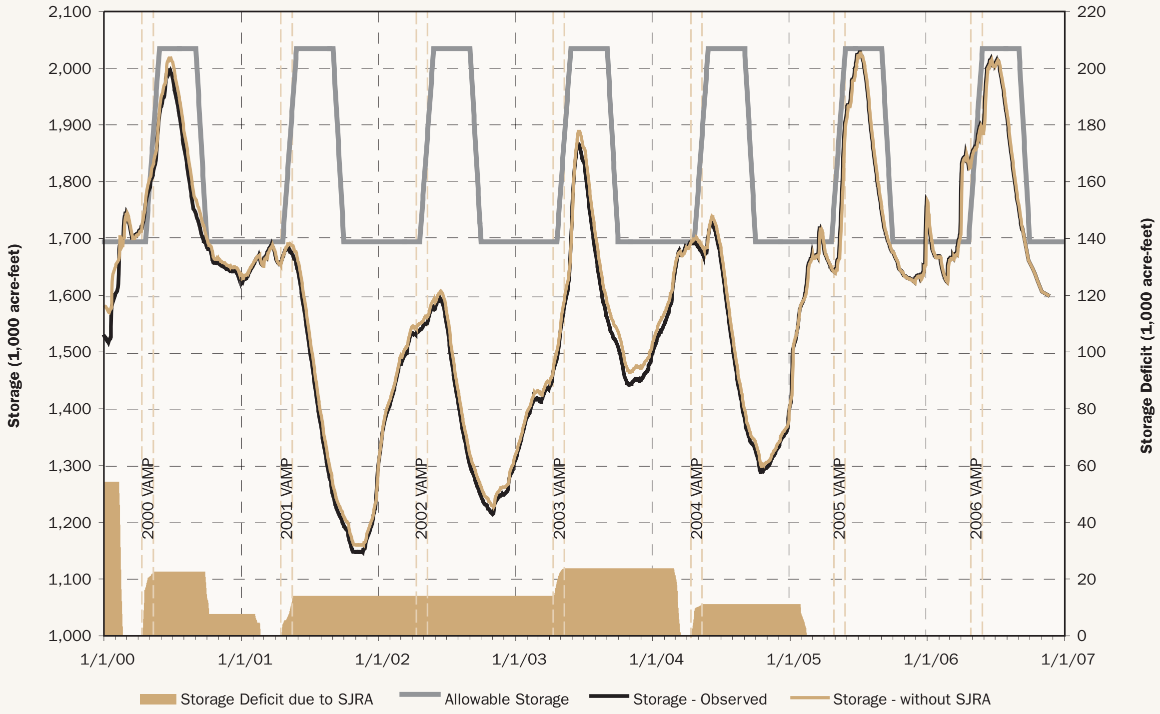


Appendix B
Historical Data

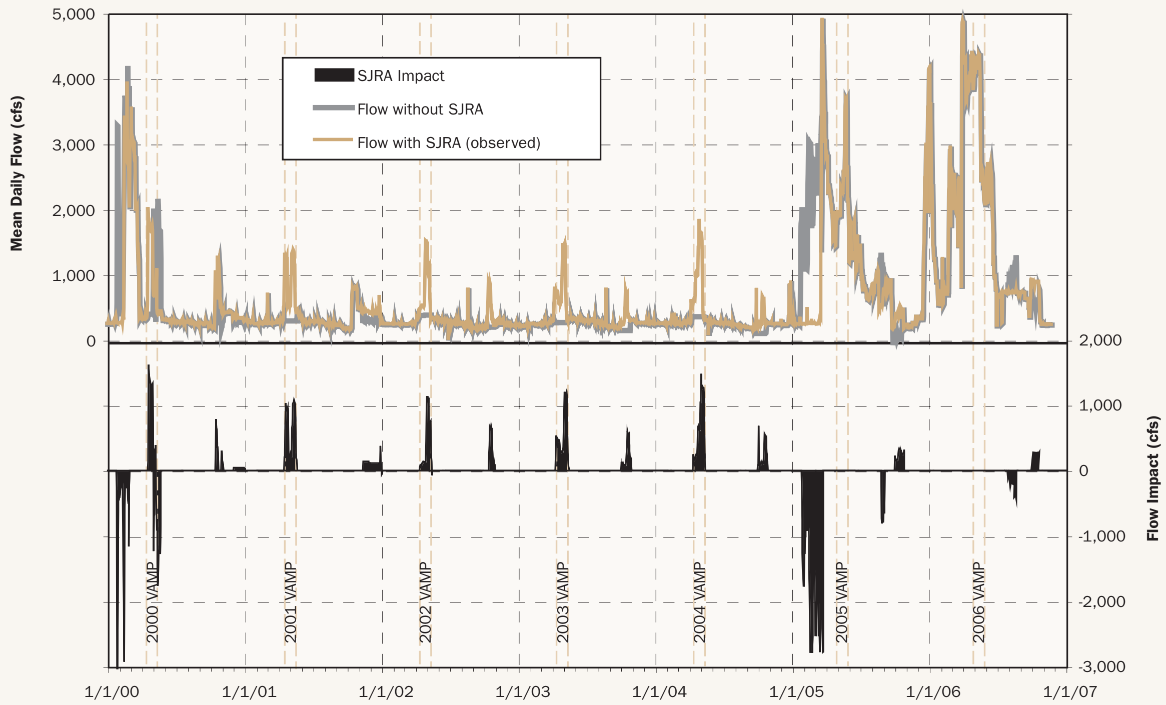
Appendix B-1, Figure 1
SJRA Storage Impacts, 2000-2006
Lake McClure (Merced River)



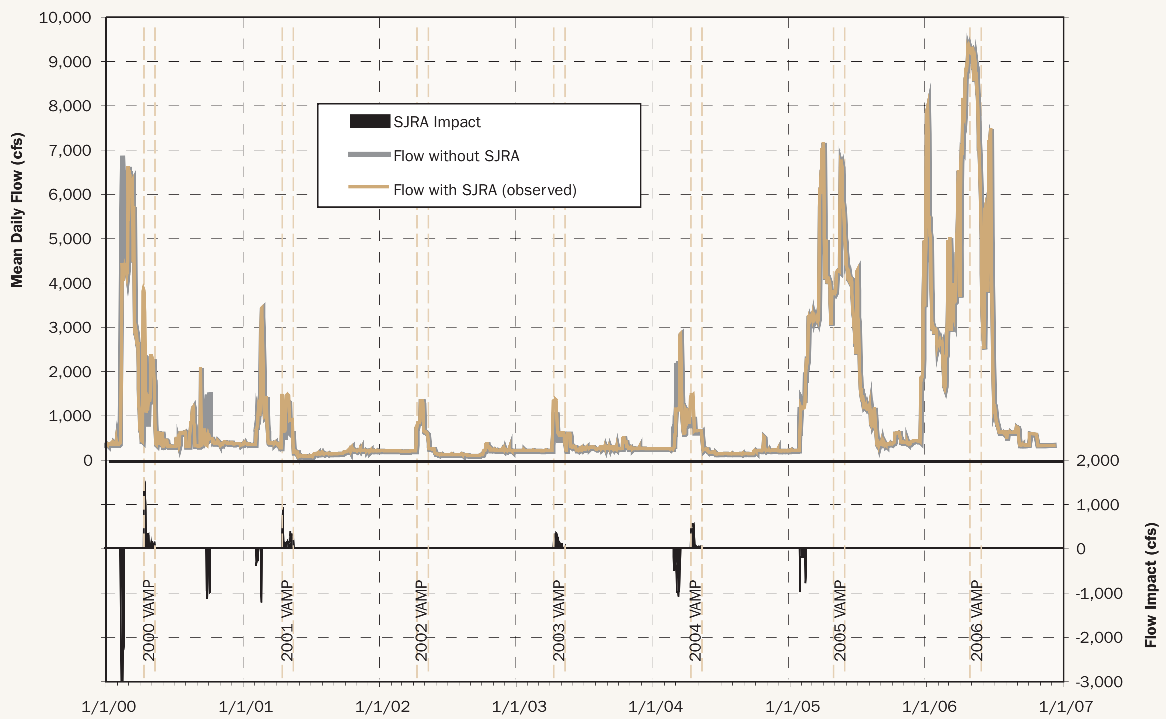
Appendix B-1, Figure 2
SJRA Storage Impacts, 2000-2006
New Don Pedro Reservoir (Tuolumne River)



Appendix B-1, Figure 3
Merced River below Crocker-Huffman Dam
2000-2006



Appendix B-1, Figure 4
Tuolumne River below LaGrange Dam
2000-2006

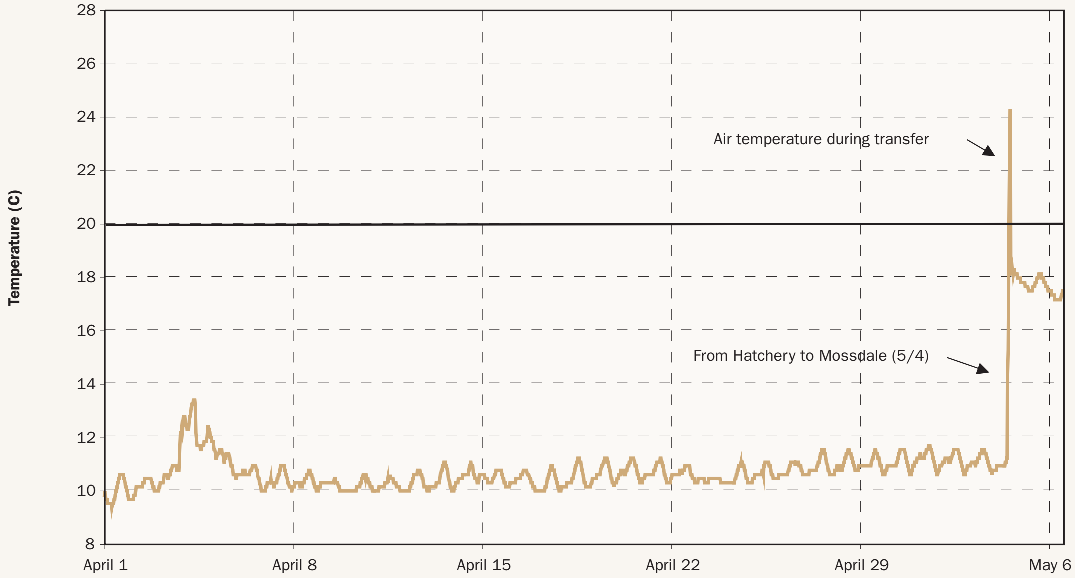


Appendix C
Chinook Salmon Survival Investigations

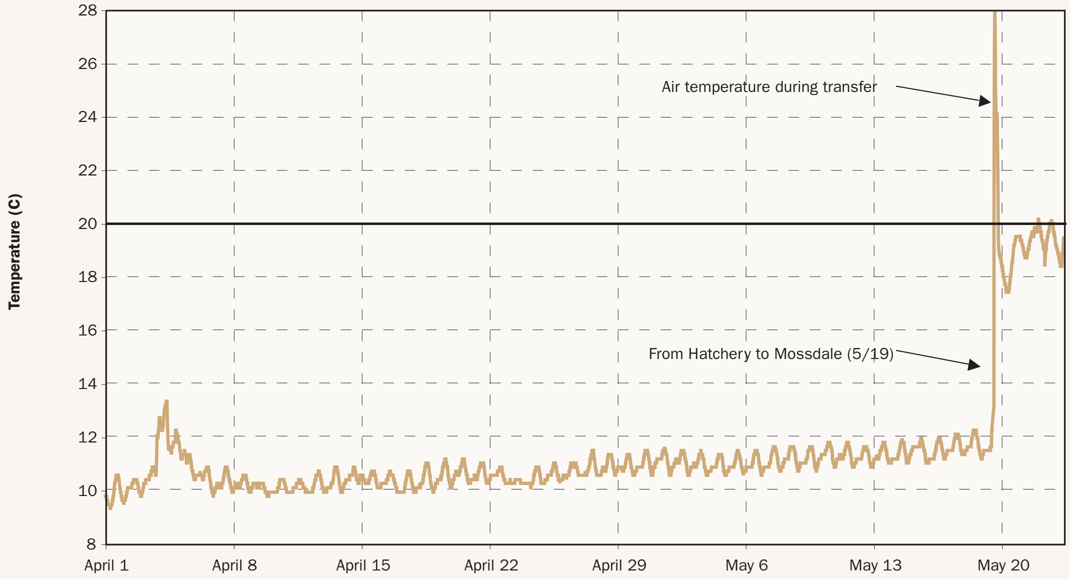
Appendix C-1
Water Temperature Monitoring Locations

Appendix C-1 VAMP 2005 Water Temperature Monitoring								
Site #	**Logger Number**	**Temperature Monitoring Location**	**Lat**	**Long**	**Distance from Durham Ferry**	**Date Deployed**	**Date Retrieved**	**Notes**
	551654	Merced River Hatcher - 1			n/a	3/27/06	5/23/06	
	562570	Merced River Hatcher - 2			n/a	3/27/06	5/23/06	
1	877664	Durham Ferry	N 37 41.381	W 121 15.657	n/a	4/4/06	6/8/06	
2	900627	Mossdale	N 37 47.180	W 121 18.425	11	4/4/06	6/8/06	Logger Lost
3	900626	Dos Reis	N 37 49.808	W 121 18.665	16	4/4/06	6/8/06	
4	900625	DWR Monitoring Station	N 37 51.869	W 121 19.376	19	4/4/06	6/8/06	
5a	900624	Confluence – Top	N 37 56.818	W 121 20.285	27	4/4/06	6/8/06	
5b	900615	Confluence- Bottom	N 37 56.818	W 121 20.285	27	4/4/06	6/8/06	
6	900616	Downstream of Channel Marker 30	N 37 59.776	W 121 25.569	33	4/4/06	6/8/06	
7	900617	"Q" Piling 1/2 mile upstream of channel marker 13	N 38 01.940	W 121 28.769	37	4/4/06	6/8/06	
8	877663	All Pro abandoned boat	N 38 04.522	W 121 34.413	45	4/4/06	6/8/06	Logger malfunction - no data
9	877667	Jersey Point USGS Gauging Station	N 38 03.172	W121 41.637	56	4/4/06	6/8/06	Logger Lost
10	877668	Chipps Island	N 38 03.084	W 121 55.463	72	4/4/06	6/8/06	
11	877666	Mokelumne River- Lighthouse Marina	N 38 06.334	W 121 34.213	40	na	6/8/06	Not deployed this year due to no Mokelumne releases
12	877669	Old River at HORB	N 37 48.457	W 121 19.872	13	4/4/06	6/8/06	
13	900619	Antioch Marina	N 38 01.147	W121 48.829	53	4/4/06	6/8/06	
14	900620	Turner Cut	N 37 59.468	W121 27.267	40	4/4/06	6/5/06	Logger Semi-Dewatered: Lying in very shallow water (2-3 inches)
15	877666	Holland Riverside Marina	N 37 58.323	W 121 34.887	42	4/18/06	6/5/06	
16	900618	Old River / Indian Slough Confluence	N 37 54.954	W 121 33.949	34	4/18/06	6/5/06	
17	900622	CCF Radial Gates	N 37 49.773	W 121 33.096	26	4/18/06	6/6/06	Fisher man said has been periodically dewatered by curious people.
18	822253	Grant Line Canal at Travy Blvd Bridge	N 37 49.143	W 121 27.026	21	4/18/06	6/6/06	Casing smashed, but logger present. Dewatered at somepoint.
19	900621	Middle River at Victoria Canal Confluence	N37 53.323	W121 29.334	32	4/18/06	6/6/06	
20	877665	Werner Cut: Channel above Woodward Isle	N 37 56.319	W 121 30.584	40	4/18/06	6/6/06	

Appendix C-2
Water Temperature Monitoring
Merced River Fish Hatchery to Mossdale



Appendix C-2
Water Temperature Monitoring
Merced River Fish Hatchery to Mossdale



Appendix C-2
Water Temperature Monitoring
Site 1 - Durham Ferry

Appendix C-2
Water Temperature Monitoring
Site 3 - Dos Reis

Appendix C-2
Water Temperature Monitoring
Site 4 - DWR Monitoring Station

Appendix C-2
Water Temperature Monitoring
Site 5a - Confluence - Top

Appendix C-2
Water Temperature Monitoring
Site 5b - Confluence - Bottom

Appendix C-2
Water Temperature Monitoring
Site 6 - Downstream of Channel Marker 30

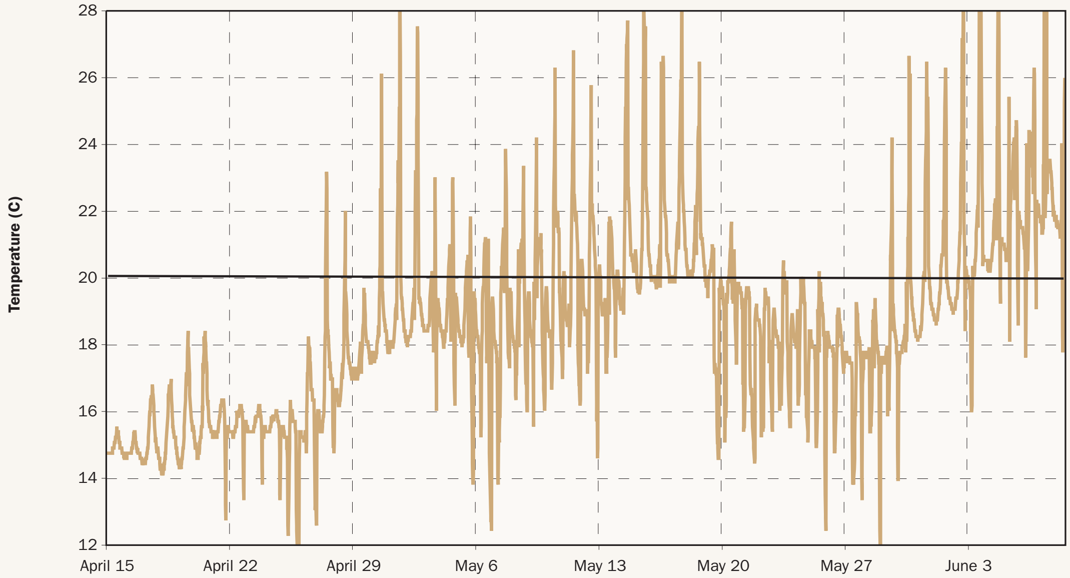
Appendix C-2
Water Temperature Monitoring
Site 7 - Upsteam of Channel Marker 13

Appendix C-2
Water Temperature Monitoring
Site 10 - Chipps Island

Appendix C-2
Water Temperature Monitoring
Site 12 - Old River at Head of Old River Barrier

Appendix C-2
Water Temperature Monitoring
Site 13 - Antioch Marina

Appendix C-2
Water Temperature Monitoring
Site 14 - Turner Cut



Appendix C-2
Water Temperature Monitoring
Site 15 - Holland Riverside Marina

Appendix C-2
Water Temperature Monitoring
Site 16 - Old River at Confluence with Indian Slough

Appendix C-2
Water Temperature Monitoring
Site 17 - CCF Radial Gates

Appendix C-2
Water Temperature Monitoring
Site 18 - Grant Line Canal At Tracy Blvd. Bridge

Appendix C-2
Water Temperature Monitoring
Site 19 - Middle River at the Confluence with Victoria Canal

Appendix C-2
Water Temperature Monitoring
Site 20 - Werner Cut; Channel above Woodward Isle

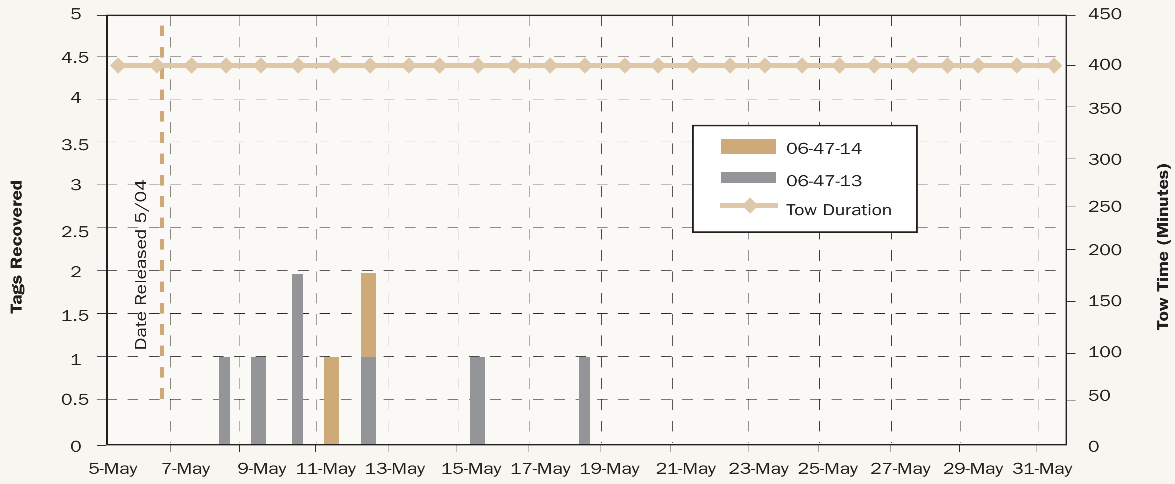
C-3a Chinook salmon smolt condition post-transport, immediately after VAMP 2006 releases.										
Release Site	Examination Date	Mean Fork Length (mm)	Mean Weight (g)	Vigor (%)	Mean Scale Loss (%)	Normal Body Color (%)	Fin Hemorrhaging (%)	Normal Eye Quality (%)	Normal Gill Color %	Complete Adclip (%)
Mossdale	5/4/06	85	7	100	6	100	2	100	100	88
Dos Reis	5/5/06	81	6	100	6	100	0	100	100	84
Jersey Point	5/8/06	86	7	100	5	100	0	100	100	92
Mossdale	5/19/06	92	9	100	5	100	12	100	100	87
Jersey Point	5/22/06	89	8	100	5	100	8	100	100	100

* % correct tag code of those that retained tags.

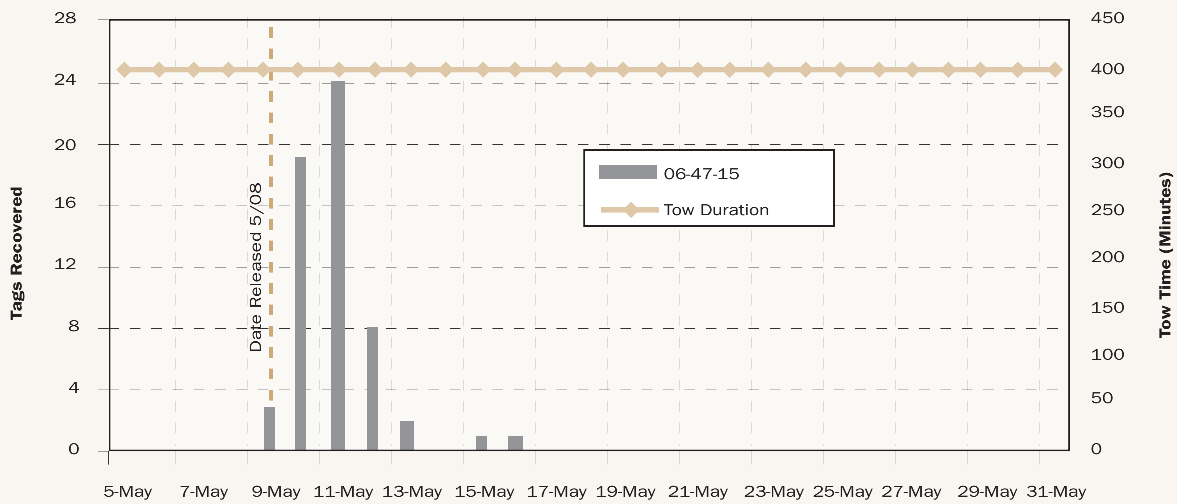
C-3b Chinook salmon smolt condition 48-hours post-release.											
Release Site	Examination Date	Mean Fork Length (mm)	Mean Weight (g)	Vigor (%)	Net Pen Mortalities	Mean Scale Loss (%)	Normal Body Color (%)	Fin Hemorrhaging (%)	Normal Eye Quality (%)	Normal Gill Color %	Complete Adclip (%)
Mossdale	5/6/06	86	7	100	0	8	100	0	100	100	86
Dos Reis	5/7/06	81	6	100	0	8	100	0	100	100	80
Jersey Point	5/10/06	86	7	100	0	6	100	12		100	92
Mossdale	5/21/06	93	9	100	0	7	100	16	100	97	95
Jersey Point	5/24/06	92	8	16**	0	7	16**	0	100	84	100

** Transport truck delayed for 2 1/2 hours due to flat tire; fish very pale (color, gills), vigor deminished.

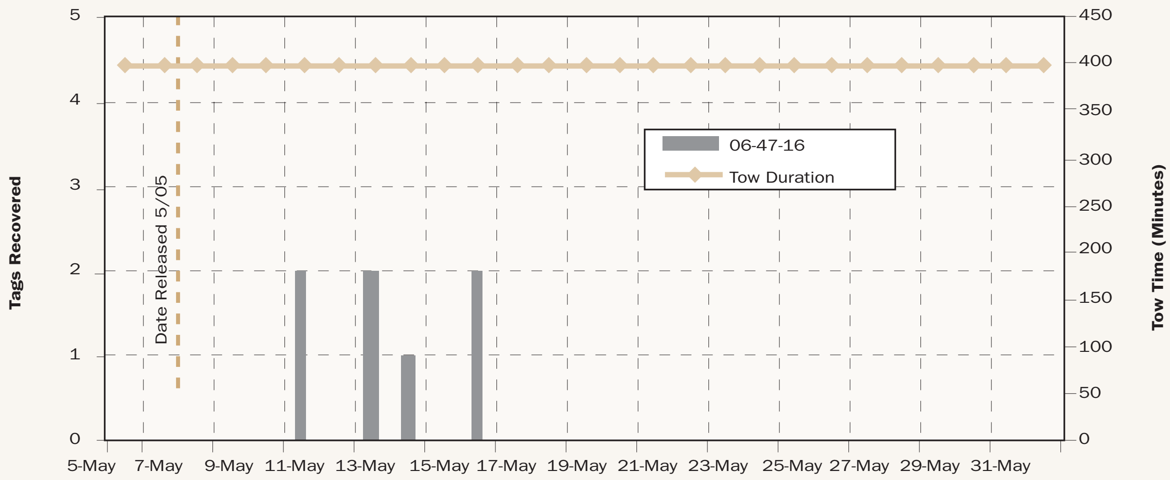
Appendix C-4, Figure 1
Chipps Island/Mossdale 1



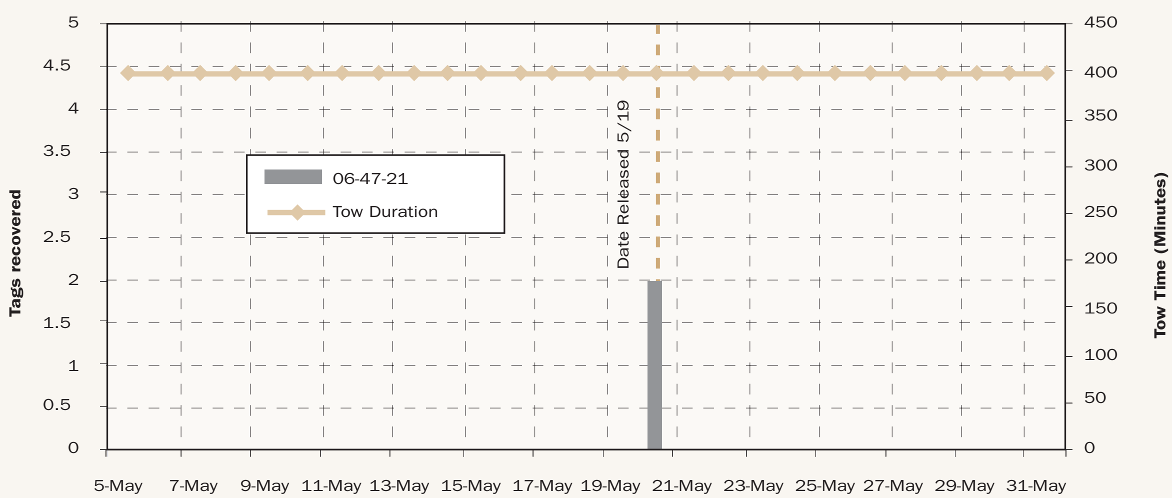
Appendix C-4, Figure 2
Chipps Island/Jersey Point 1



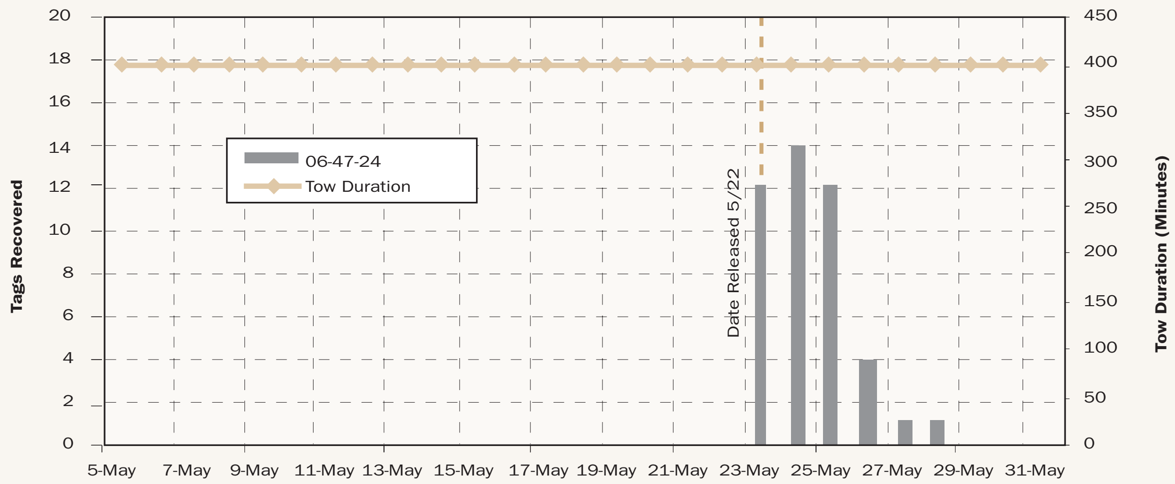
Appendix C-4, Figure 3
Chipps Island/Dos Reis 1



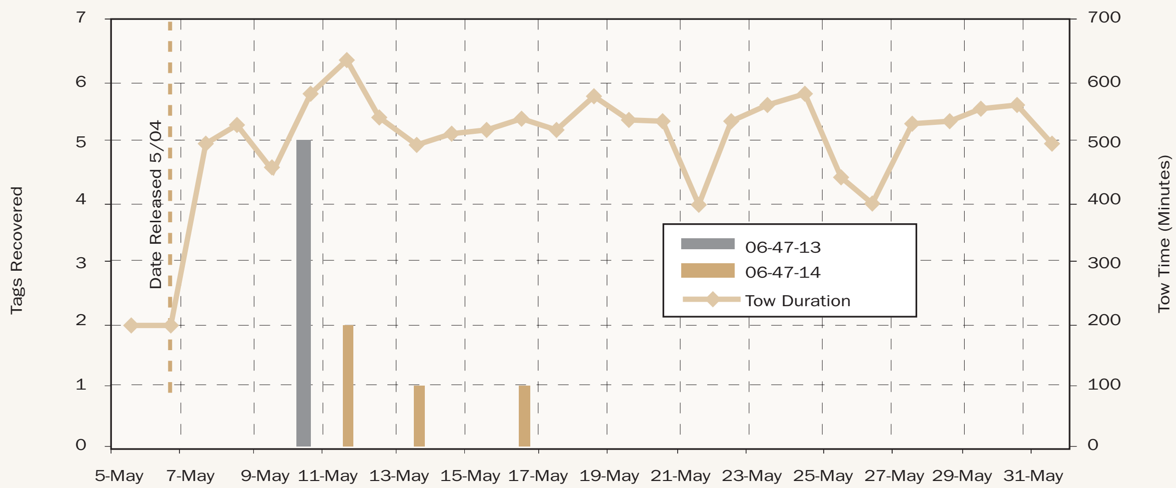
Appendix C-4, Figure 4
Chipps Island/Mossdale 2



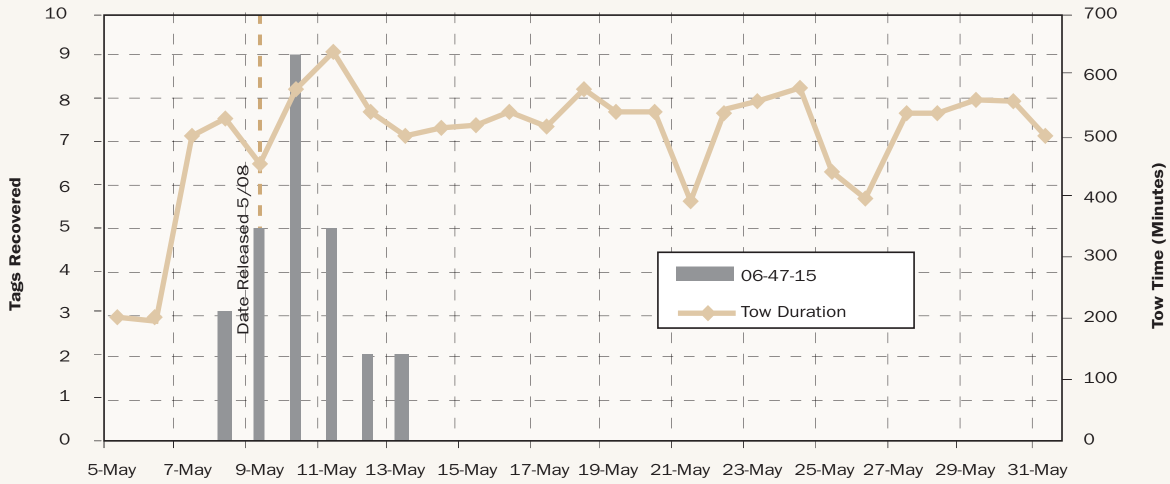
Apendix C-4, Figure 5
Chipps Island/Jersey Point 2



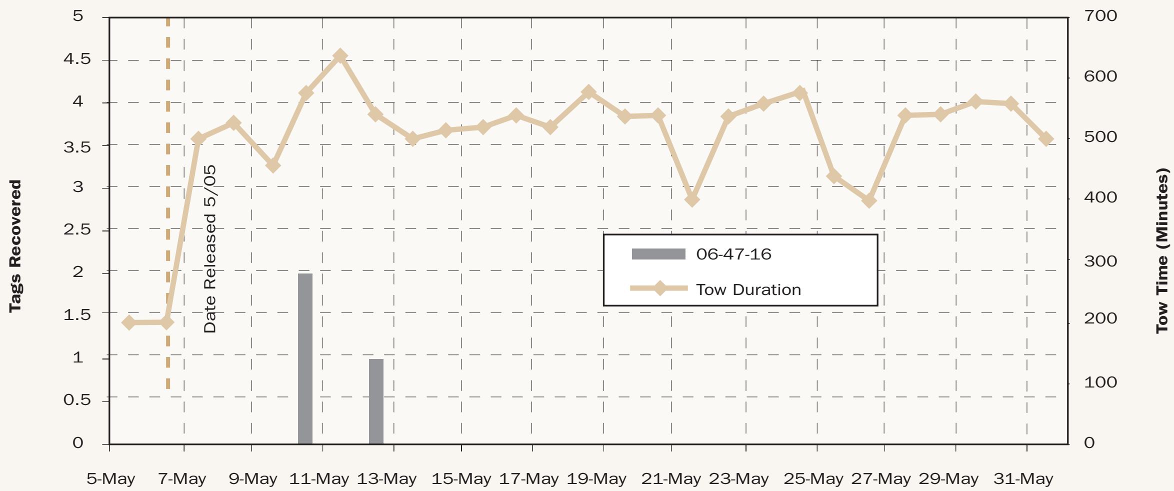
Appendix C-4, Figure 6
Antioch/Mossdale 1



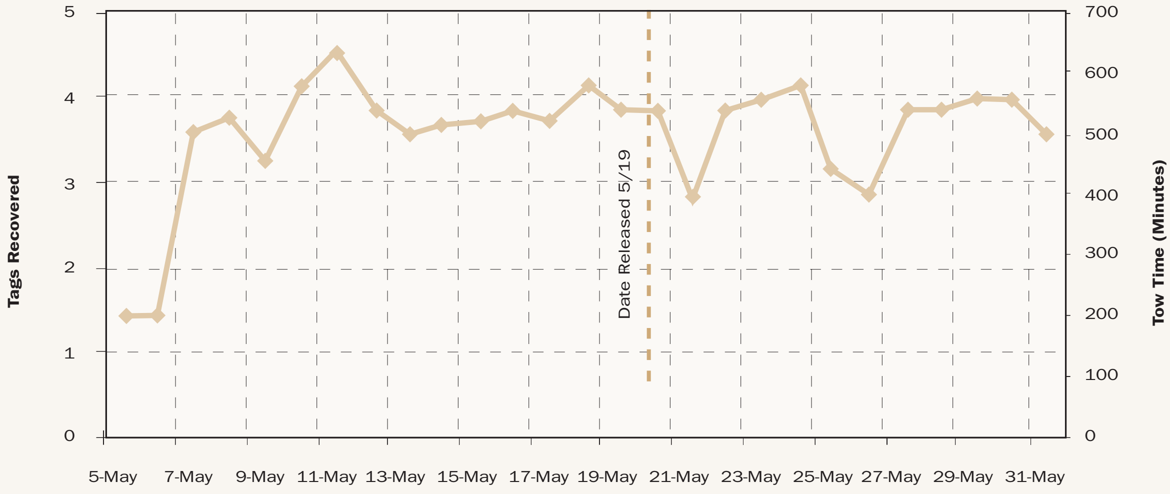
Appendix C-4, Figure 7
Antioch/Jersey Point 1



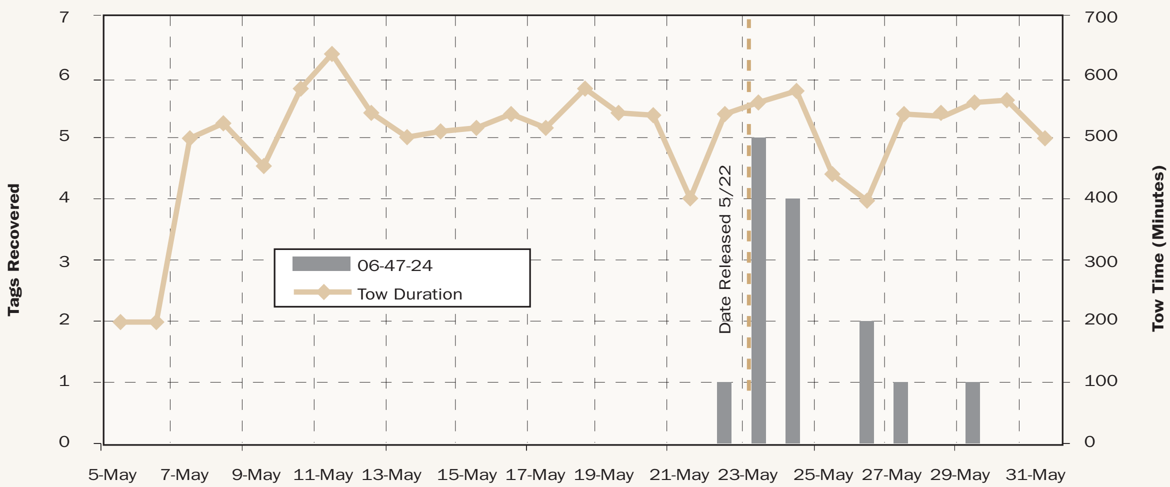
Appendix C-4. Figure 8
Antioch/Dos Reis 1



Appendix C-4, Figure 9
Antioch/Mossdale 2

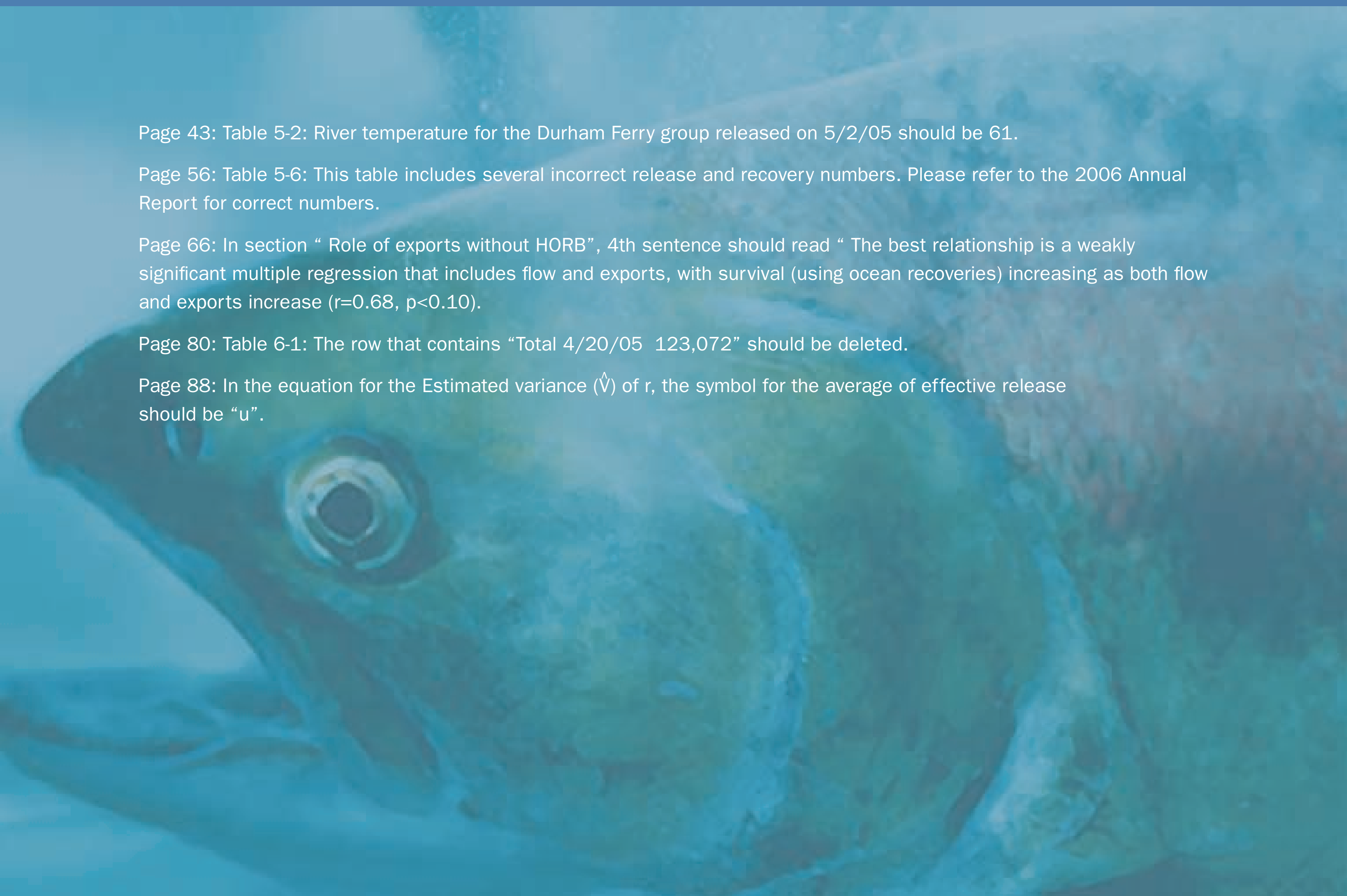


Appendix C-4, Figure 10
Antioch/Jersey Point 2



Appendix Q

Errata for the Year 2005 Annual Technical Report



Page 43: Table 5-2: River temperature for the Durham Ferry group released on 5/2/05 should be 61.

Page 56: Table 5-6: This table includes several incorrect release and recovery numbers. Please refer to the 2006 Annual Report for correct numbers.

Page 66: In section " Role of exports without HORB", 4th sentence should read " The best relationship is a weakly significant multiple regression that includes flow and exports, with survival (using ocean recoveries) increasing as both flow and exports increase ($r=0.68$, $p<0.10$).

Page 80: Table 6-1: The row that contains "Total 4/20/05 123,072" should be deleted.

Page 88: In the equation for the Estimated variance ($\hat{V}$) of r, the symbol for the average of effective release should be "u".

San Joaquin River Group Authority

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Modesto Irrigation District

Turlock Irrigation District

Oakdale Irrigation District

Merced Irrigation District

Friant Water Users Authority

City and County of San Francisco

South San Joaquin Irrigation District

San Joaquin River Exchange Contractors