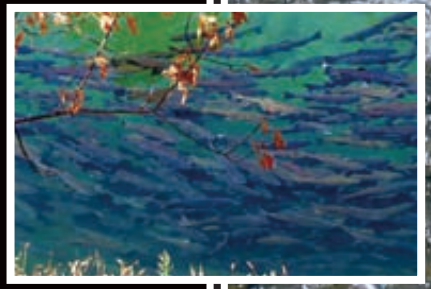
2005 Annual Technical Report

San Joaquin River Agreement



San Joaquin River Group Authority

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).

The VAMP experiment was modified in 2005 because high spring flows exceeded the upper target flow level of 7,000 cfs preventing the installation of the HORB. In addition, the SJRA technical committee recommended that the VAMP pulse flow period be moved from the default period of April 15 - May 15 to May 1 - May 31, when flows were anticipated to be more stable over the 31-day period. A continued wet hydrologic condition 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 2005 Annual Technical Report consolidates the annual SJRA Operations and the Vernalis Adaptive Management Plan (VAMP) Monitoring Reports. The VAMP 2005 program

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represents the sixth 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 2005 report includes the following information on the implementation of the SJRA: the hydrologic chronicle; management of the additional SJRA water; flow and fisheries monitoring in Old River; results of the juvenile Chinook salmon smolt survival investigations; discussion of complementary investigations; and conclusions and recommendations.

VAMP employs an adaptive management strategy to use 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 2005 included:

- Quantification of Chinook salmon smolt survival between Durham Ferry, Dos Reis, and Jersey Point using recapture locations 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 2,250 cfs.
- Evaluation of the San Joaquin River – Old River flow split at the Head of Old River under the 2005 flow conditions without the installed HORB.
- Monitoring in Old River to evaluate the movement of salmon smolts into the Old River under the 2005 flow conditions without the installed HORB.
- Health and physiology testing of VAMP fish over an extended period to evaluate disease, swimming performance, and saltwater adaptation.

VAMP 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 these experimental investigations and protection for juvenile salmon within the tributaries.

In planning for the VAMP, the March 23 operation plan forecasted an existing a flow of about 6,665 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 2005 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. The SJRA Technical Committee recommended delaying the start of the VAMP pulse period from April 15 to May 1 in an effort to provide for increased stability of Vernalis flows. Additionally, the SJRA Technical Committee modified the experimental design to measure survival between Durham Ferry and Dos Reis and Jersey Point without a HORB.

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

Year	VAMP Period	Average Vernalis Flow (cfs)	Average SWP/CVP Exports (cfs)
2000	April 15-May 15	5,869	2,155
2001	April 20-May 20	4,220	1,420
2002	April 15-May 15	3,300	1,430
2003	April 15-May 15	3,235	1,446
2004	April 15-May 15	3,155	1,331
2005[a]	May 1 –May 31	10,390	2,986

[a] HORB not installed.

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Water temperature data were collected with a series of computerized recorders at the Merced River Fish Facility, in the transport trucks, and throughout the lower San Joaquin River and Delta. Overall the average temperature at all sites ranged from 19 to 22 C.

Kodiak trawling was conducted in Old River in 2005, 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 is no HORB installed. The ratio between the number of unmarked salmon and CWT salmon captured at the two locations was similar. A daily average, over a 19 day period, of about 55 percent of the unmarked salmon and 64 percent of the CWT salmon migrated down the Old River. This estimate assumed efficiency of the two trawls was similar. We were not able to determine the relative efficiency between gears at the two locations so the true percentage of fish migrating into each channel is unknown.

Consistent with the VAMP experimental design, the 2005 effort included two mark-recapture studies performed in early May to provide estimates of salmon survival under similar flow and export conditions. The experimental design in past years included multiple release locations

at Durham Ferry, Mossdale, and Jersey Point. In 2005, the releases were made at Dos Reis instead of Mossdale 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 2005 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 numbers of marked salmon released and the number recaptured. Releases at Jersey Point serve as controls for releases at Durham Ferry and Dos Reis. Recapture data from Antioch, Chipps Island and in the ocean fishery thereby allowed calculation of survival estimates based on the ratio of recovery rates or survival indices 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 within and among years. It also factors out ocean survival when using the ocean recovery data. 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.

The estimated survival of coded wire tagged (CWT) salmon released from Durham Ferry and Dos Reis was the third lowest measured since 2000. Samples of CWT salmon from the 2005 VAMP lots were collected and taken to the California-Nevada (CA-NV) Fish Health Center prior to the release dates for rearing and monitoring over an extended period. At the actual time of release the test fish appeared relatively healthy based on results of short-term survival studies and physiological examinations and should have performed adequately for outmigration assessment. However, 27 percent of the test fish held at the Fish

Health Center died due to Proliferative Kidney Disease (PDK) between 36 and 50 days after collection, indicating that survival may have been reduced from the effects of PKD after the fish passed Chipps Island. This reduction would not be reflected in the recapture data from Antioch and Chipps Island, but may be detected in future ocean recovery rates.

In 2005, the HORB was not installed and could have contributed to the low survival observed. Past evaluations have indicated that survival for salmon migrating through the Delta is lower when there is no HORB installed.

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 more variable and not statistically significant, although both the ocean and trawl data show a similar trend of increased survival with increased flows.

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, but the smolt survival data is too limited to detect these effects, if they are real. To further refine the relationship between survival and flow or flow/export ratio, 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.

Conducting experiments when there is no HORB will further define and refine the relationship of survival to exports and flow.

In addition to this recommendation, each previous technical report contained recommendations for future VAMP implementation. Key conclusions and recommendations resulting from the 2005 VAMP include:

- Survival from Durham Ferry and Mossdale/Dos Reis in 2003, 2004, and 2005, 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 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 flow data against DWR-DSM2 modeling results should be conducted and may provide useful information.
- The Clifton Court Forebay was treated with the aquatic herbicide Komeen, known to be toxic to salmon, one day following the Durham Ferry release of test fish. DWR and USBR should coordinate operation and maintenance activities at the SWP and CVP export facilities with the VAMP technical groups.
- VAMP 2005 was the first time a sample of experimental fish were held at the CA-NV Fish Health Center for health evaluation, swimming performance testing, and saltwater adaptation testing. Such testing and evaluation should be continued in future years.
- The numbers of CWT salmon, from Durham Ferry releases recovered at the SWP and CVP salvage facilities were greater than prior years due to the lack of a HORB. Only a few Dos Reis fish were recovered at the SWP and CVP salvage facilities.
- 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 should 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

1 Introduction

Actions associated with the Vernalis Adaptive Management Plan (VAMP) were implemented between May 1 and May 31, 2005 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, with the HORB installed, on the survival of marked juvenile Chinook salmon migrating through the Sacramento – San Joaquin Delta. Due to high river flows the HORB could not be installed for the 2005 VAMP period. The pulse flow period was postponed 15 days from previous years and in accordance with the SJRA the water districts attempted to maintain stable flow throughout the period. Studies conducted in 2005, represent the sixth 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, the Head of Old River Barrier (HORB) background, flow and seepage monitoring, Kodiak trawling in Old River, 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 mid-April to mid-May juvenile salmon outmigration period that provide estimates of salmon survival under each set of conditions. During 2005, a total of 400,000 juvenile Chinook salmon were made available from the Merced River Fish Facility (MRFF) 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 are also calculated and used to assess relationships between survival and San Joaquin River flow and CVP and SWP exports.

Due to high flows in the San Joaquin River the HORB was not installed for the 2005 VAMP. The 2005 VAMP experimental design included both multiple release locations (Durham Ferry, 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). Two releases were made during the 2005 VAMP study at Durham Ferry, Dos Reis, and Jersey Point. Due to no HORB during the pulse flow period the Dos Reis release site was used in lieu of Mossdale to provide a better evaluation of smolt movement into the Old River. 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 (Durham Ferry, Dos Reis, and Jersey Point) and recapture locations (Antioch and Chipps Island) 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 HORB. The recovery of marked fish at both Antioch and Chipps Island also 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. Releases at Jersey Point serve as controls for recaptures at Antioch and Chipps Island, thereby allowing the calculation of survival estimates based on the ratio of survival indices from marked salmon recaptured from upstream (e.g., Durham Ferry and Dos Reis) and downstream (control release at Jersey Point) releases. The combined differential recovery rates are calculated in a similar manner after the number recovered from each trawl location is combined. The use of ratio estimates as part of the VAMP study design factors out the potential differential gear efficiency at Antioch and Chipps Island within and among years.

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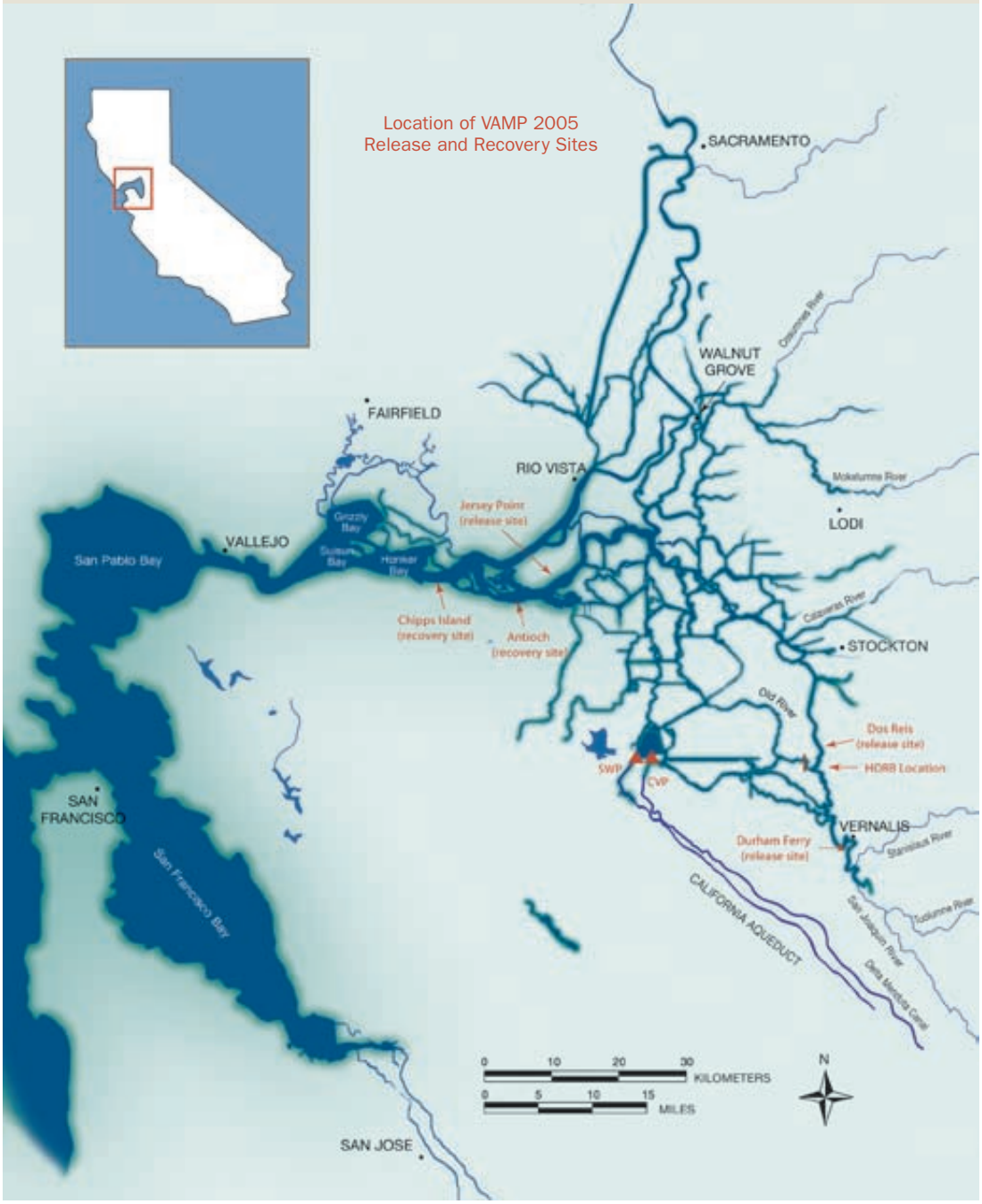
A quality assurance/quality control program has been used as a routine part of VAMP tests, and includes quantifying the number of marked fish successfully clipped and tagged. Coordination with the local landowner to curtail operation of an agricultural diversion pump located immediately downstream of Durham Ferry, coincident with the Durham Ferry release was continued in 2005. In addition, the 2005 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 2005 relative to measuring flow in the San Joaquin River downstream of the confluence with Old River. The absence of the HORB in 2005 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.

Figure 1-1
Sacramento – San Joaquin Estuary



Chapter 2

VAMP Hydrologic Planning & Implementation

This section documents the planning and implementation undertaken by the Hydrology Group of the San Joaquin River Technical Committee (SJRTC) for the 2005 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 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 2005, 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 installation of the HORB and the planning of Delta exports consistent with the VAMP.

2005 VAMP SUMMARY

Generally wet conditions in the San Joaquin River basin and tributary basins resulted in relatively high flow conditions entering the Spring of 2005. Due to these high flows DWR was unable to install the temporary Head of Old River Barrier (HORB). Additionally, the flow in the San Joaquin River at Vernalis exceeded the maximum VAMP target flow of 7,000 cfs during the VAMP pulse flow period, therefore no supplemental water was provided by the SJRGA agencies.

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 2005 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 2005 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	

The VAMP provides for a 31-day pulse flow (target flow) at the Vernalis gage on the San Joaquin River (see 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 are to be used by the VAMP Hydrology and Biology workgroups to evaluate experimental test conditions and the potential effect of flow and export variation on our ability to detect and assess variation in juvenile Chinook salmon survival rates among VAMP test conditions.

Under the SJRA, the following San Joaquin River Group Authority (SJRGA) agencies have agreed to provide the supplemental water needed to achieve the VAMP target flows, limited to a maximum of 110,000 acre-feet: Merced, OID, SSJID, SJRECWA, MID and TID. 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 New Don Pedro Reservoir 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 2005, 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.

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.

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

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 2005 VAMP

Hydrology Group Meetings

Beginning in February 2005, and continuing until early April, the Hydrology Group held three planning and coordination meetings (February 16, March 23 and April 11). The March 23 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 16 Hydrology Group meeting. The 90 percent exceedence forecast was indicating a VAMP target flow of 4,450 cfs and the 50 percent exceedence forecast was indicating a VAMP target flow of 5,700 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 2005 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 MRFF, 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 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 2003 and 2004 were "BELOW NORMAL" (VAMP numerical indicator of three) and "DRY" (VAMP numerical indicator of two), respectively. Under these conditions there was no possibility of 2005 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. This also was not a factor in 2005 since all indications during the planning phase were pointing to a VAMP target flow of 7,000 cfs or greater.

The initial daily operation plan was prepared on March 23. This forecast showed an existing flow of 6,665 cfs, indicating a VAMP target flow of 7,000 cfs. In this forecast New Don Pedro Reservoir 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). Weighing all of these factors the SJRTC determined that delaying the start of the VAMP pulse flow period would increase the chances of installation of the HORB and declared a VAMP pulse flow period of May 1 to May 31. Hydrologic conditions continued to get wetter and by early April the daily operation plan forecasts were

Table 2-3
Summary of Daily Operation Plans

Phase	VAMP Forecast Date	VAMP Target Flow Period	Assumed Ungaged Flow at Vernalis (cfs)	Existing Flow (cfs)	VAMP Target Flow (cfs)	Supplemental Water needed to meet Target Flow (acre-feet)
Planning	March 23, 2005	April 15 - May 15	800	6,665	7,000	20,600
			1,200	7,465	na	0
	March 25, 2005	May 1 - May 31	800	6,811	7,000	11,610
			1,200	7,211	na	0
	April 5, 2005	May 1 - May 31	600	8,839	na	0
			1,200	9,439	na	0
	April 13, 2005	May 1 - May 31	600	6,764	7,000	14,520
			1,200	8,139	na	0
	April 21, 2005	May 1 - May 31	1,000	7,938	na	0
	April 28, 2005	May 1 - May 31	400	7,943	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)

Table 2-5
Summary of USGS Flow Measurements at the San Joaquin River near Vernalis Gage

Date	Gage Height (ft)	Measured Flow (cfs)	Current Rating Shift Flow (cfs)	Percent Difference	Rating Shift Change
4/20/05 (11:30)	15.98	8,410	8,710	-3.4%	no
4/20/05 (12:19)	15.97	8,490	8,700	-2.4%	no
4/27/05 (10:57)	14.65	6,450	6,950	-7.2%	yes
5/3/05 (11:12)	15.71	8,360	7,780	7.5%	yes
5/10/05 (09:02)	16.24	9,000	8,740	3.0%	no
5/17/05 (10:08)	16.18	9,150	8,660	5.7%	yes

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indicating that the possibility of HORB installation had essentially been eliminated. It was also looking more likely that the existing flow would exceed the maximum VAMP target flow of 7,000 cfs. Continually increasing runoff forecasts resulted in continually increasing forecasts of flood control releases on the Tuolumne and Merced Rivers such that by April 28 the daily operation forecast was looking at an existing flow of approximately 8,000 cfs. Table 2-3 summarizes the various iterations of the daily operation plan during the VAMP planning phase, and demonstrates the evolutionary nature, of its development. The daily operation plans prepared during the VAMP planning phase are provided in Appendix A-1, Tables 1 through 10.

Tributary Flow Coordination

As previously noted, by late 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.

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 March 30, April 15 and April 27 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 May and 3,000 cfs for the second half of May. On May 4 the WOMT revised the combined export rate to 2,250 cfs for the VAMP period provided the Vernalis flow stayed in the vicinity of 8,000 cfs, and noted that the export rate reduction would be reassessed if the Vernalis flow increased significantly above 8,000 cfs.

IMPLEMENTATION

Operation Conference Calls

Due to the excess flow conditions and the fact that the operation was being controlled by flood control considerations and not by the VAMP target flow, the operation conference calls that had been conducted in previous years were not conducted in 2005.

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.

Normally, the USGS makes monthly measurements of the flow at Vernalis to check the current rating shift. The real-time flows reported by the USGS and CDEC are dependent on the most current rating shift, therefore a new measurement and shift can result in a sudden and significant change in the reported real-time flow. In order to minimize the potential for these sudden and significant changes, arrangements were made with the USGS to measure the flow at Vernalis on a weekly basis between April 20 and May 17. The results of these measurements are summarized in Table 2-5. There were no significant rating shifts during the 2005 VAMP operation period.

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, 2005. 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 at the Vernalis gage averaged 10,390 cfs during the May 1 – May 31 VAMP pulse flow period. The flow was relatively steady for the first 19 days of the pulse flow period, ranging from 7,500 cfs to 9,200 cfs. For the latter portion of the pulse flow period the flow at Vernalis

Table 2-6
2005 Vernalis Adaptive Management Plan (VAMP)
Final Flows and Accounting of Supplemental Water Contributions
Pulse 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 Supplemental Water (cfs)	Existing Flow (cfs)	Observed Flow (cfs)	VAMP Supplemental Water (cfs)	Existing Flow (cfs)	Observed Flow (cfs)	VAMP Supplemental Water (cfs)	Observed Flow (cfs)	Observed Flow (cfs)	Existing Flow (cfs)	Observed Flow (cfs)	VAMP Supplemental Water (cfs)
04/01/05	4,190	4,190		7,010	7,010		229	229		2,460	500	15,100	15,100	
04/02/05	4,100	4,100		6,670	6,670		229	229		2,230	951	15,000	15,000	
04/03/05	3,810	3,810		6,870	6,870		229	229		2,010	781	15,000	15,000	
04/04/05	3,850	3,850		7,140	7,140		226	226		1,630	1,681	15,000	15,000	
04/05/05	3,600	3,600		6,990	6,990		229	229		1,410	1,491	14,700	14,700	
04/06/05	3,430	3,430		5,490	5,490		229	229		1,290	1,594	14,400	14,400	
04/07/05	3,270	3,270		5,020	5,020		226	226		1,090	921	13,400	13,400	
04/08/05	3,270	3,270		4,570	4,570		227	227		950	1,391	12,000	12,000	
04/09/05	3,240	3,240		4,050	4,050		225	225		910	1,734	11,500	11,500	
04/10/05	3,240	3,240		4,120	4,120		229	229		940	1,683	10,700	10,700	
04/11/05	3,200	3,200		4,830	4,830		232	232		940	1,945	10,400	10,400	
04/12/05	2,740	2,740		4,940	4,940		226	226		1,010	1,771	10,300	10,300	
04/13/05	2,660	2,660		4,010	4,010		227	227		980	1,558	10,800	10,800	
04/14/05	2,700	2,700		4,070	4,070		228	228		860	524	9,900	9,900	
04/15/05	2,720	2,720		3,950	3,950		231	231		770	1,363	9,320	9,320	
04/16/05	2,680	2,680		4,040	4,040		229	229		700	1,262	9,080	9,080	
04/17/05	2,630	2,630		4,050	4,050		342	342		650	1,359	9,010	9,010	
04/18/05	2,570	2,570		4,060	4,060		406	406		620	1,121	8,810	8,810	
04/19/05	2,500	2,500		4,030	4,030		403	403		610	1,028	8,750	8,750	
04/20/05	2,430	2,430		4,000	4,000		400	400		570	944	8,660	8,660	
04/21/05	2,380	2,380		3,980	3,980		404	404		550	767	8,380	8,380	
04/22/05	2,350	2,350		3,840	3,840		401	401		530	540	8,010	8,010	
04/23/05	2,250	2,250		3,520	3,520		402	402		470	366	7,730	7,730	
04/24/05	2,210	2,210		3,290	3,290		409	409		470	339	7,490	7,490	
04/25/05	2,060	2,060		3,020	3,020		414	414		530	448	7,190	7,190	
04/26/05	1,780	1,780		3,220	3,220		401	401		590	331	6,750	6,750	
04/27/05	1,600	1,600		3,680	3,680		405	405		610	316	6,490	6,490	
04/28/05	1,550	1,550		3,750	3,750		401	401		560	449	6,720	6,720	
04/29/05	1,510	1,510		3,760	3,760		1,285	1,285		550	485	6,960	6,960	
04/30/05	1,830	1,830		3,760	3,760		1,504	1,504		480	729	7,040	7,040	
05/01/05	1,980	1,980		3,770	3,770		1,498	1,498		430	375	7,520	7,520	0
05/02/05	1,930	1,930		3,770	3,770		1,504	1,504		440	716	7,970	7,970	0
05/03/05	1,380	1,380		3,750	3,750		1,499	1,499		630	592	8,120	8,120	0
05/04/05	1,340	1,340		3,770	3,770		1,500	1,500		650	166	7,860	7,860	0
05/05/05	1,820	1,820		3,760	3,760		1,519	1,519		520	(139)	7,670	7,670	0
05/06/05	1,970	1,970		3,740	3,740		1,518	1,518		420	610	7,910	7,910	0
05/07/05	1,950	1,950		3,760	3,760		1,505	1,505		570	1,051	8,190	8,190	0
05/08/05	1,960	1,960		3,980	3,980		1,503	1,503		620	912	8,410	8,410	0
05/09/05	2,000	2,000		4,230	4,230		1,507	1,507		680	825	8,630	8,630	0
05/10/05	1,990	1,990		4,220	4,220		1,501	1,501		750	817	8,870	8,870	0
05/11/05	2,000	2,000		4,230	4,230		1,501	1,501		830	553	8,930	8,930	0
05/12/05	1,990	1,990		4,220	4,220		1,507	1,507		970	409	8,880	8,880	0
05/13/05	1,970	1,970		4,230	4,230		1,501	1,501		1,020	389	8,940	8,940	0
05/14/05	2,010	2,010		4,250	4,250		1,501	1,501		970	343	9,040	9,040	0
05/15/05	2,010	2,010		4,250	4,250		1,504	1,504		910	329	9,070	9,070	0
05/16/05	2,040	2,040		4,240	4,240		1,505	1,505		840	239	8,930	8,930	0
05/17/05	2,370	2,370		4,230	4,230		1,500	1,500		870	106	8,780	8,780	0
05/18/05	2,460	2,460		4,510	4,510		1,504	1,504		1,200	175	8,770	8,770	0
05/19/05	2,430	2,430		5,580	5,580		1,506	1,506		1,580	560	9,200	9,200	0
05/20/05	2,410	2,410		6,620	6,620		1,504	1,504		1,890	616	10,200	10,200	0
05/21/05	2,410	2,410		6,580	6,580		1,507	1,507		2,160	274	11,400	11,400	0
05/22/05	2,360	2,360		6,620	6,620		1,503	1,503		2,480	(244)	12,200	12,200	0
05/23/05	2,320	2,320		6,640	6,640		1,505	1,505		2,840	143	12,800	12,800	0
05/24/05	2,690	2,690		6,590	6,590		1,506	1,506		3,140	87	13,100	13,100	0
05/25/05	2,700	2,700		6,180	6,180		1,503	1,503		3,420	155	13,500	13,500	0
05/26/05	2,670	2,670		5,830	5,830		1,506	1,506		3,950	244	13,800	13,800	0
05/27/05	3,050	3,050		5,760	5,760		1,501	1,501		4,450	7	13,800	13,800	0
05/28/05	3,590	3,590		5,640	5,640		1,507	1,507		4,900	214	14,200	14,200	0
05/29/05	3,860	3,860		5,560	5,560		1,504	1,504		5,330	219	14,600	14,600	0
05/30/05	3,940	3,940		5,330	5,330		1,433	1,433		5,820	103	15,200	15,200	0
05/31/05	3,930	3,930		5,070	5,070		1,340	1,340		6,300	(384)	15,600	15,600	0
VAMP Period														
Average (cfs):	2,151	2,151		4,775	4,775		1,497	1,497		1,629	337	10,390	10,390	
Supplemental Water (ac-ft):			0			0			0					0

VAMP Period

Observed Flow Sources:
Merced River at Cressey (CA DWR B05155): California DWR, San Joaquin District, 8/24/05
Tuolumne River below LaGrange Dam near LaGrange (USGS 11289650): USGS, provisional data as of 8/1/05
Stanislaus River below Goodwin Dam: USBR, Goodwin Reservoir Daily Operations Report - OID/SSJID/Tri-Dams, 5/2/05 (April report) and 6/1/05 (May report)
San Joaquin River near Vernalis (USGS 11303500): USGS, provisional data as of 8/1/05

was impacted by flood releases from Friant Dam (Millerton Lake), reaching a VAMP period maximum of 15,600 cfs on May 31 as shown in Figure 2-2. 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 period is provided in Table 2-6.

Near the end of April, just prior to the pulse flow period, the computed ungaged flow had dropped into the range of 400 to 600 cfs, so that a value of 400 cfs was used in the April 28 daily operation plan. The final accounting shows that the average ungaged flow during the VAMP pulse flow period was 284 cfs, with a minimum of -544 cfs and maximum of 741 cfs. A plot of the ungaged flow is provided in Figure 2-4.

Another unknown in the forecast equation similar to the ungaged flow is the flow in the San Joaquin River upstream of the Merced River. This unknown tends not to be as variable as the ungaged flow, but like the ungaged flow, it may be adjusted if the observed flow warrants it. During the 2005 VAMP the greatest uncertainty in regards to the San Joaquin River above Merced River flow was the potential for Friant Dam flood releases which could significantly affect this flow. As can be seen in Figure 2-5, the observed flow was slightly greater than the forecast for the first half of the pulse flow period due to the wet conditions in the basin. In mid-May it became necessary for Friant Dam to make significant flood control releases which resulted in the observed flow in the San Joaquin River above the Merced River significantly exceeding the forecasted flow as shown in Figure 2-5.

As previously stated, the combined CVP and SWP Delta export rate target was set at 2,250 cfs provided the Vernalis flow remained near 8,000 cfs. The export rate was held near the target rate for the first 25 days of the VAMP pulse flow period (see Figure 2-6) with an average of 2,260 cfs. However, due to the significant increase in the flow at Vernalis in the latter part of May, the DWR and USBR increased the combined export rate to between 6,000 and 7,000 cfs for the last five days in May. The resulting average combined export rate for the 31 day VAMP target flow data was 2,986 cfs.

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 New Don Pedro Reservoir. 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.

As of November 1, 2004, following the Fall 2004 SJRA water transfer, the cumulative impact of the SJRA on the storage in Lake McClure was a reduction of 215,197 acre-feet (see Table 2-7), assuming Merced I.D. diversions from the Merced River would have been the same both without and with the SJRA. It should be noted, however, that as a direct result of the SJRA, Merced I.D. has undertaken a number of conservation measures that have resulted

Table 2-7
Storage Impact History, Lake McClure (Merced River)

Calendar Year	VAMP Supplemental Water (acre-feet) [a]	Fall Supplemental Water (acre-feet)	SJRA Storage Impact Replenishment (acre-feet)	End of Year Cumulative Storage Impact (acre-feet)
2000	46,750	12,500	46,750 (May 2000)	-12,500
2001	43,146	12,496	0	-68,142
2002	27,120	12,470	0	-107,732
2003	39,586	12,500	0	-159,818
2004	42,879	12,500	0	-215,197
2005	0	12,500	215,197 (Jan.-Mar. 2005)	0 [b]

[a] Includes ramping flows.
[b] Fall Supplemental Water from re-opened flood-control release, therefore storage was not impacted.

Figure 2-2
2005 VAMP: San Joaquin River near Vernalis
With Lagged Contributions from Primary Sources

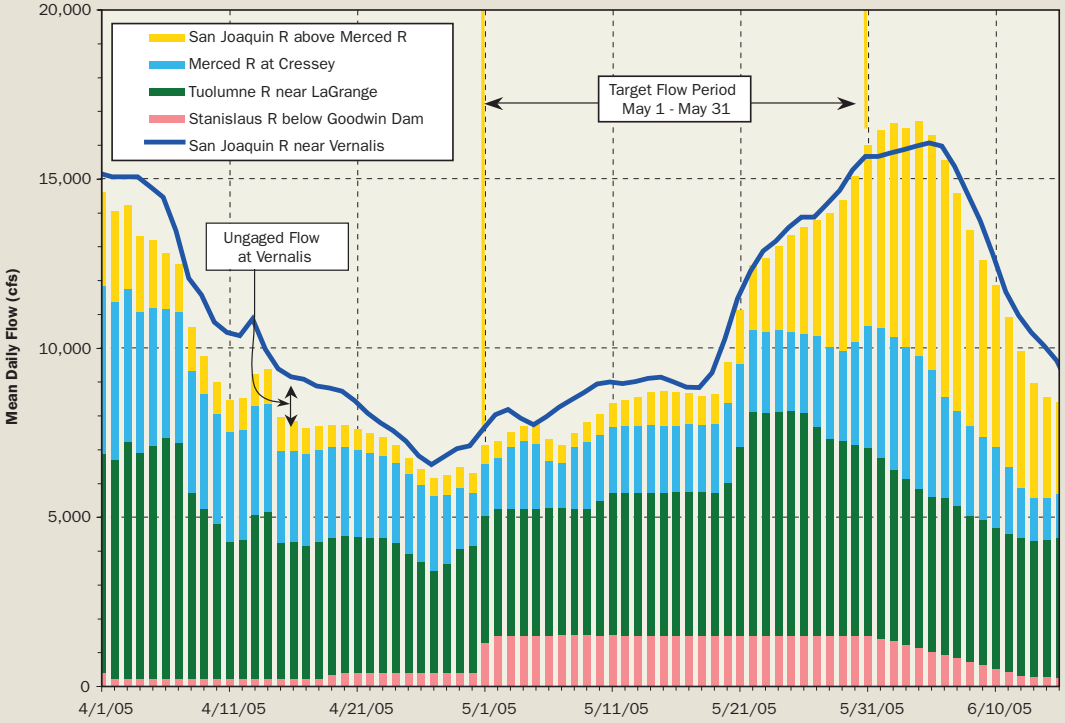


Figure 2-3
2005 VAMP: Flow at Tributary Measurement Points

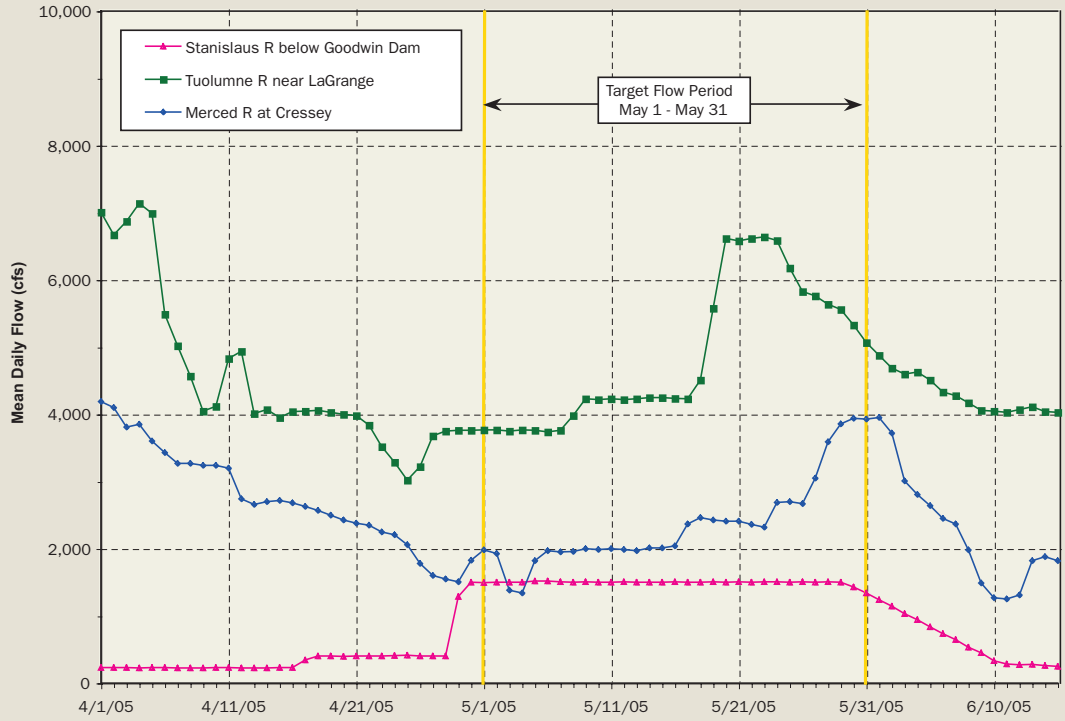


Figure 2-4
2005 VAMP - Ungaged Flow in San Joaquin River at Vernalis
Comparison of Forecasted and Observed

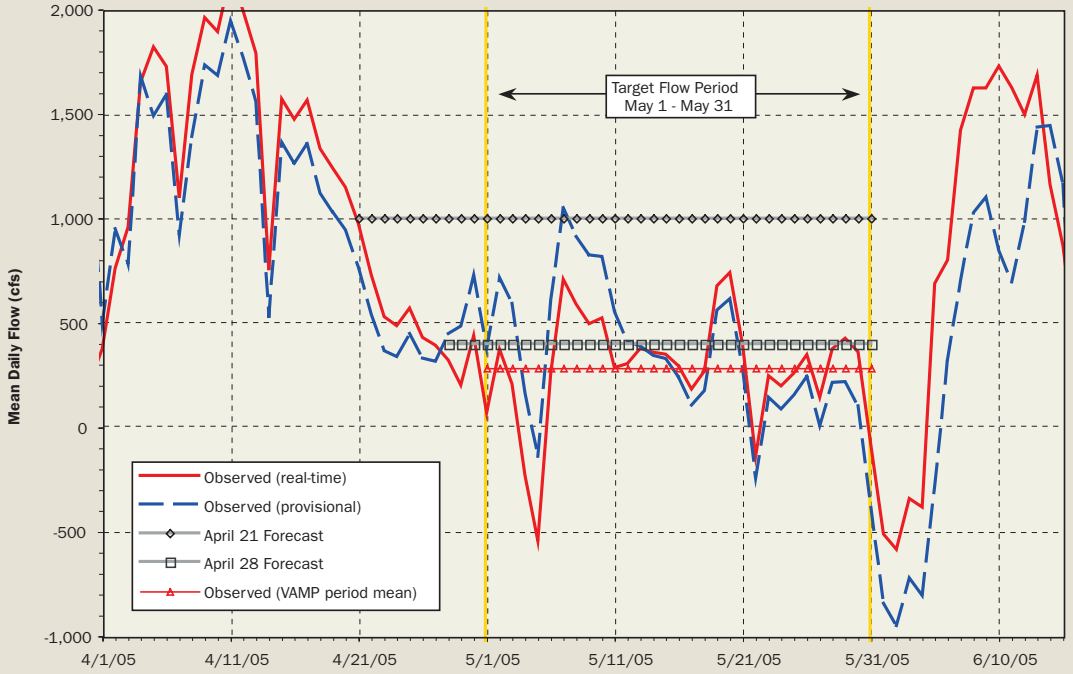


Figure 2-5
2005 VAMP - Upper San Joaquin River Flow
Comparison of Forecasted and Observed

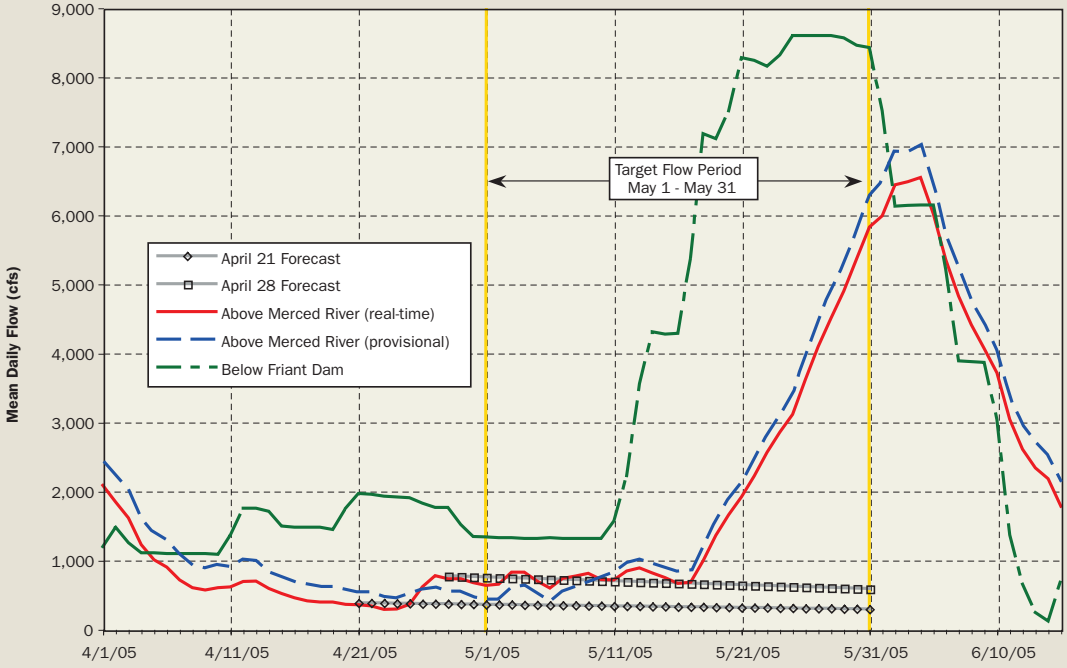


Figure 2-6
2005 VAMP - Federal and State Delta Exports

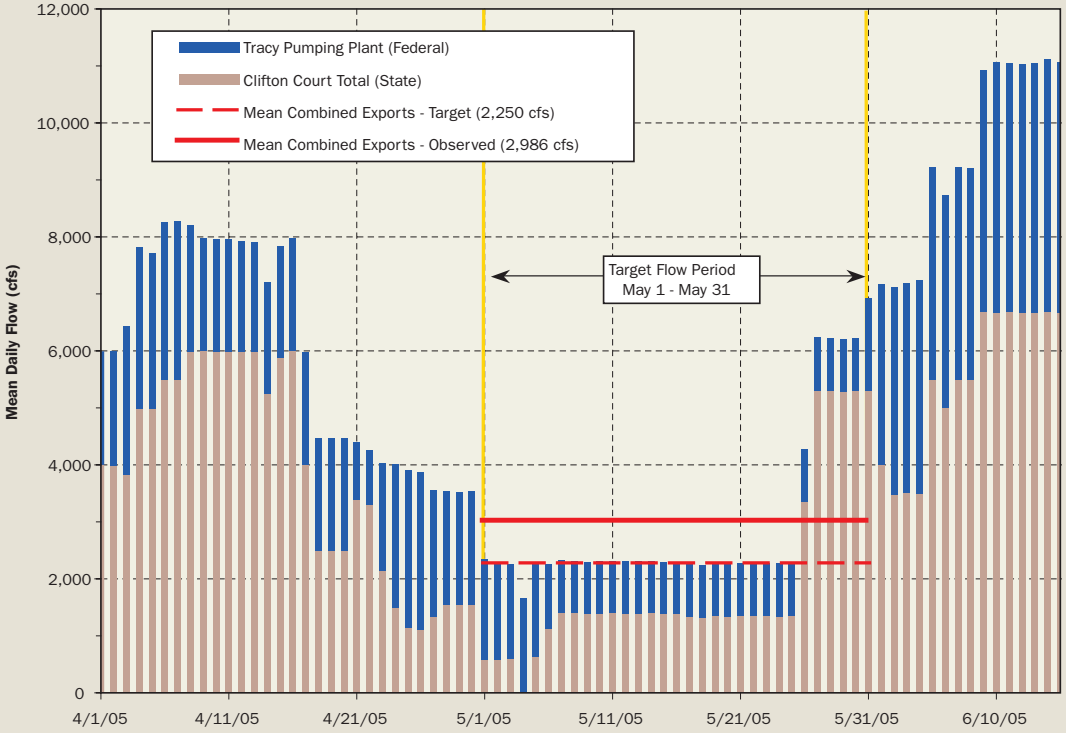
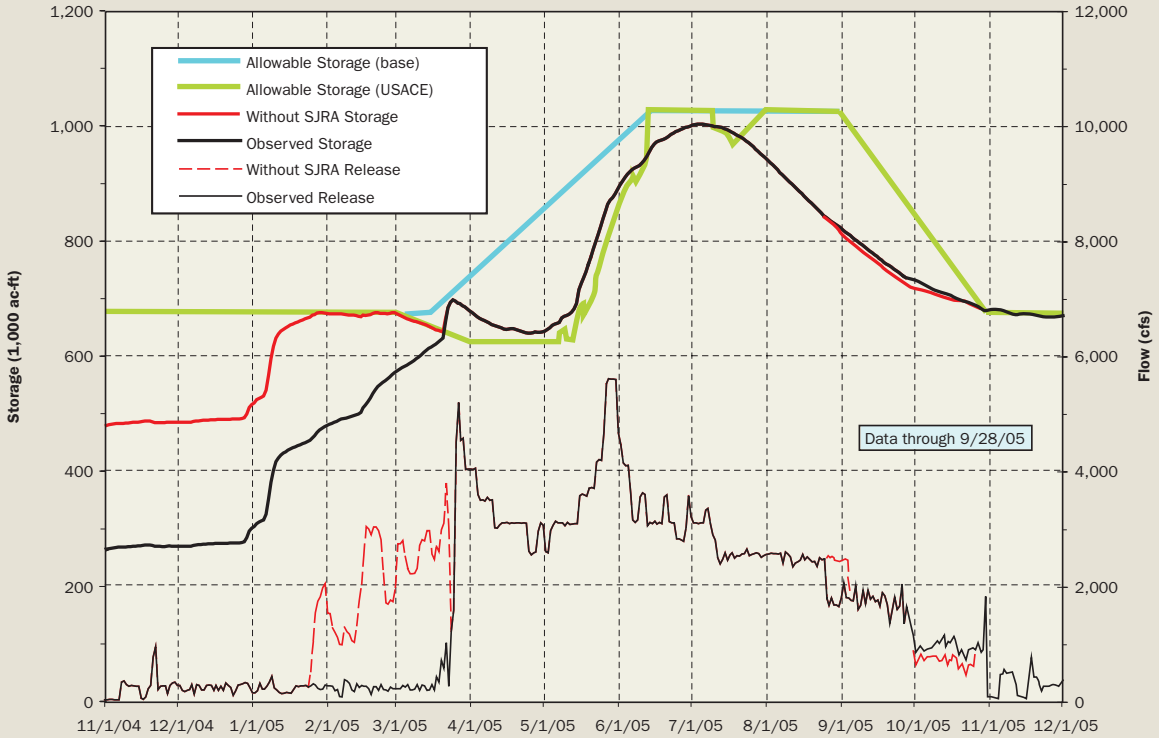


Figure 2-7
San Joaquin River Agreement Storage and Flow Impacts
Merced River - Lake McClure Storage and Release - 2005



in a reduced reliance on Merced River diversions. Any reductions in Merced River diversions would offset the 215,197 acre-foot storage impact. The impact of the conservation measures on Merced River diversions is in the process of being quantified and was not available at the time of publication of this report.

Assuming that the storage impact in Lake McClure was 215,197 acre-feet after the 2004 SJRA operation, the wet conditions in water year 2005 resulted in the complete replenishment of this water between January 25, 2005 and March 23, 2005 as shown in Figure 2-7. In compliance with D-1641, none of the following were in effect when this storage was replenished:

"(T)he USBR is releasing water from New Melones Reservoir for purpose of meeting the Vernalis salinity objective, or…Standard Permit Term 93 is in effect, or…salinity objectives at Vernalis are not being met."

Following the 2004 VAMP operation, the cumulative impact of the SJRA on storage in New Don Pedro Reservoir was a reduction of 11,151 acre-feet (see Table 2-8). This storage deficit was erased as a result of flood control operations in late January and early February 2005 as shown in Figure 2-8. This storage replenishment was also in compliance of the D-1641 terms noted above.

SUMMARY OF HISTORICAL VAMP OPERATIONS

2005 marks the sixth year of VAMP operation in compliance with D-1641. A summary of the VAMP target flows for these first six years is provided in Table 2-9. A summary of the SJRGA supplemental water contributions is provided in Table 2-10. The Hydrology Group monitors the cumulative impact of the SJRA on reservoir storage and stream flows. Plots of storage and flow impacts throughout the five years of VAMP operation are provided in Appendix D-1, Figures 1 through 4.

Over the first six 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.

Table 2-8
Storage Impact History, New Don Pedro Reservoir (Tuolumne River)

Calendar Year	VAMP Supplemental Water (acre-feet)	SJRA Storage Impact Replenishment (acre-feet)	End of Year Cumulative Storage Impact (acre-feet)
2000	22,651	14,955 (Sep.-Oct. 2000)	-7,696
2001	14,061	7,696 (Jan.-Feb. 2001)	-14,061
2002	0	0	-14,061
2003	9,729	0	-23,790
2004	11,151	23,790 (March 2004)	-11,151
2005	0	11,151 (Jan.-Feb. 2005)	0

Figure 2-8
San Joaquin River Agreement Storage and Flow Impacts
Tuolumne River - New Don Pedro Reservoir Storage and Release - 2005

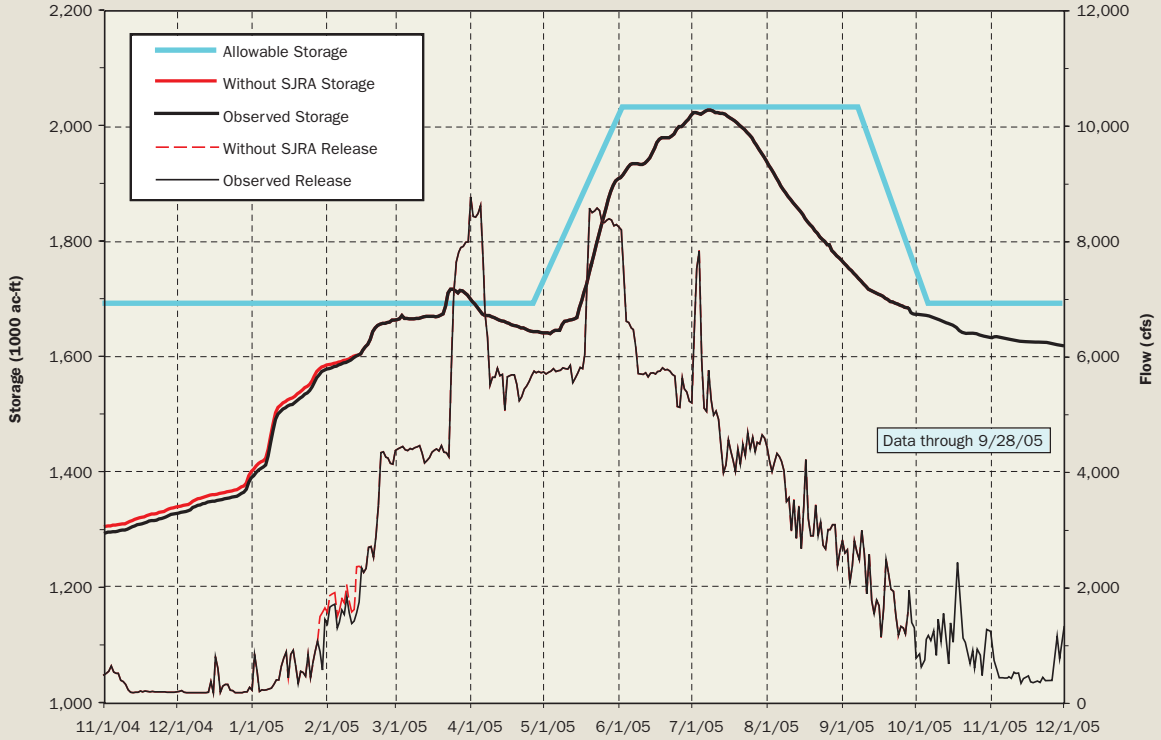


Table 2-9
Summary of VAMP Flows, 2000-2005

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]

[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.

Table 2-10
Summary of VAMP Supplemental Water Contributions, 2000-2004

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

Chapter 3

Additional Water Supply Arrangements & 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

Paragraph 8.4 of the SJRA states 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." This 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 2005 Fall SJRA Transfer was finalized on September 26, 2005, with the transfer commencing on October 1, 2005. A daily summary table of the Merced 2005 Fall SJRA Transfer is provided as Table 3-1.

OAKDALE IRRIGATION DISTRICT

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.

OID did not provide any supplemental water for the 2005 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.

The OID additional water was released from New Melones Reservoir by the USBR October 1, 2005, and December 1, 2005, as shown in Table 3-2.

Table 3-1
2005 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 [A] (cfs) {4} = {1}+{2}	Merced R at Shaffer Bridge [PG&E] (cfs) {5}	Merced R at Cressey [DWR] (cfs) {6}	For Transfer [A] (cfs) {7}	Daily Flow Rate (cfs) {8} = {7}-{1}	Cumulative Volume (ac-ft) {9}
01-Oct-05	30	125	248	155	266	279	266	236	468
02-Oct-05	30	125	496	155	204	202	204	174	813
03-Oct-05	30	125	744	155	190	184	190	160	1,131
04-Oct-05	30	125	992	155	184	176	184	154	1,436
05-Oct-05	30	125	1,240	155	197	190	197	167	1,767
06-Oct-05	30	125	1,488	155	194	193	194	164	2,093
07-Oct-05	30	125	1,736	155	195	196	195	165	2,420
08-Oct-05	30	125	1,983	155	184	191	184	154	2,725
09-Oct-05	30	150	2,281	180	228	230	228	198	3,118
10-Oct-05	30	200	2,678	230	296	287	296	266	3,646
11-Oct-05	30	300	3,273	330	380	350	350	320	4,280
12-Oct-05	30	300	3,868	330	397	370	370	340	4,955
13-Oct-05	30	300	4,463	330	380	360	360	330	5,609
14-Oct-05	30	300	5,058	330	376	356	356	326	6,256
15-Oct-05	30	300	5,653	330	372	354	354	324	6,899
16-Oct-05	85	300	6,248	385	416	387	387	302	7,498
17-Oct-05	85	300	6,843	385	430	404	404	319	8,130
18-Oct-05	85	250	7,339	335	400	381	381	296	8,717
19-Oct-05	85	200	7,736	285	347	343	343	258	9,229
20-Oct-05	85	200	8,132	285	346	332	332	247	9,719
21-Oct-05	85	200	8,529	285	355	339	339	254	10,223
22-Oct-05	85	200	8,926	285	368	351	351	266	10,750
23-Oct-05	85	200	9,322	285	367	357	357	272	11,290
24-Oct-05	85	200	9,719	285	370	349	349	264	11,814
25-Oct-05	85	200	10,116	285	450	410	410	325	12,458
26-Oct-05	85	200	10,512	285	461	428	428	21	12,500
27-Oct-05	85	200	10,909	285	484	443	443		
28-Oct-05	85	200	11,306	285	503	463	463		
29-Oct-05	85	200	11,702	285	490	451	451		
30-Oct-05	85	200	12,099	285	496	455	455		
31-Oct-05	85	200	12,496	285	504	448	448		

[A]: 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 Merced River located near Cressey.

Table 3-2
USBR Release of Oakdale Irrigation District SJRA Additional Water

Date	OID SJRA Additional Water		Date	OID SJRA Additional Water	
	Flow Rate (cfs)	Cumulative Volume (ac-ft)		Flow Rate (cfs)	Cumulative Volume (ac-ft)
01-Oct-05	125	248	01-Nov-05	125	18,744
02-Oct-05	125	496	02-Nov-05	125	18,992
03-Oct-05	125	744	03-Nov-05	125	19,240
04-Oct-05	125	992	04-Nov-05	125	19,488
05-Oct-05	125	1,240	05-Nov-05	125	19,736
06-Oct-05	125	1,488	06-Nov-05	125	19,983
07-Oct-05	125	1,736	07-Nov-05	125	20,231
08-Oct-05	125	1,983	08-Nov-05	125	20,479
09-Oct-05	125	2,231	09-Nov-05	125	20,727
10-Oct-05	125	2,479	10-Nov-05	125	20,975
11-Oct-05	125	2,727	11-Nov-05	125	21,223
12-Oct-05	125	2,975	12-Nov-05	125	21,471
13-Oct-05	125	3,223	13-Nov-05	125	21,719
14-Oct-05	125	3,471	14-Nov-05	125	21,967
15-Oct-05	125	3,719	15-Nov-05	125	22,215
16-Oct-05	125	3,967	16-Nov-05	125	22,463
17-Oct-05	125	4,215	17-Nov-05	125	22,711
18-Oct-05	375	4,959	18-Nov-05	125	22,959
19-Oct-05	775	6,496	19-Nov-05	125	23,207
20-Oct-05	775	8,033	20-Nov-05	125	23,455
21-Oct-05	775	9,570	21-Nov-05	125	23,702
22-Oct-05	775	11,107	22-Nov-05	125	23,950
23-Oct-05	775	12,645	23-Nov-05	125	24,198
24-Oct-05	775	14,182	24-Nov-05	125	24,446
25-Oct-05	775	15,719	25-Nov-05	125	24,694
26-Oct-05	525	16,760	26-Nov-05	125	24,942
27-Oct-05	275	17,306	27-Nov-05	125	25,190
28-Oct-05	225	17,752	28-Nov-05	125	25,438
29-Oct-05	125	18,000	29-Nov-05	125	25,686
30-Oct-05	125	18,248	30-Nov-05	125	25,934
31-Oct-05	125	18,496	01-Dec-05	50	26,033

4 Head of Old River Barrier

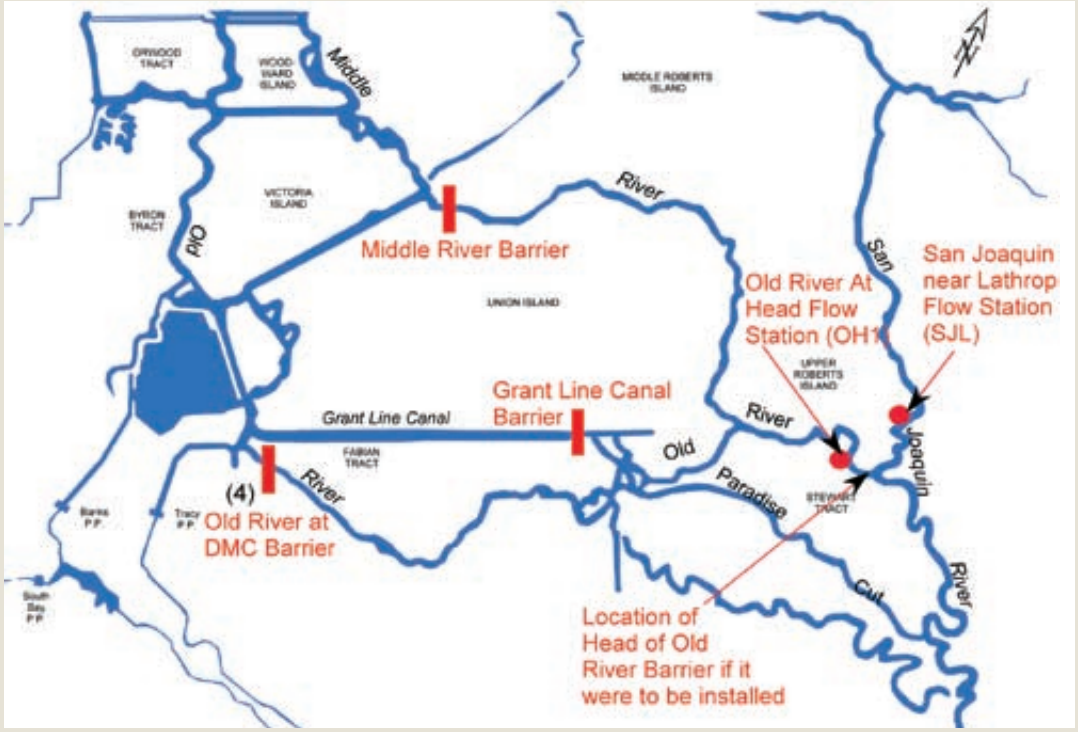
Installation of the spring temporary Head of Old River Barrier (HORB) was not performed in 2005 due to high flows in the San Joaquin River, nonetheless, the spring HORB is a component of the south delta Temporary Barriers Project (TBP). The TBP mitigates for low water levels in the south delta and improves water circulation and quality for agricultural purposes.

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, and 2005 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.

Although the HORB was not installed in 2005, the three agricultural barriers (the Grant Line Canal barrier, the Old River near Tracy barrier, and the Middle River barrier) were installed in mid-April and were removed at end of November 2005. Figure 4-1 shows the locations of the three agricultural barriers and the location of the HORB, if it were to be installed.

Figure 4-1
South Delta Temporary Barriers



SEE USEFUL WEB PAGES

FLOW MEASUREMENTS AT AND AROUND THE HEAD OF OLD RIVER

DWR operates two Acoustic Doppler Current Meters (ADCM) in the vicinity of the 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 one in Old River 840 feet downstream of the head of Old River (Old River at Head, OH1) (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 8, 2005 through June 30, 2005 period for the two ADCMs, along with the percentage of the total San Joaquin River flow at each ADCM. Figures 4-2 and 4-3 show plots of the daily minimum, maximum and mean flows for the two ADCMs. The San Joaquin River below Old River near Lathrop ADCM suffered from a technical glitch with the Handar data logger program resulting in a period of missing data from April 27, 2005 at 12:45 p.m. through April 29, 2005 at 1:45 p.m.

A comparison of the mean daily flow near Vernalis and the mean daily flow at Old River is presented in Table 4-2 and in Figure 4-4.

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. 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 that estimated using the model.

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. In 2005 no seepage was observed at any of the monitoring sites despite the high flows in the San Joaquin River. Currently, DWR is in the process of completing the (2004-2005) seepage report.

SEE USEFUL WEB PAGES

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)			Flow Split (% of Total Flow)	
	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	OH1	SJL
4/1/2005								
4/2/2005								
4/3/2005								
4/4/2005								
4/5/2005								
4/6/2005								
4/7/2005								
4/8/2005	5,538	6,339	5,946	4,753	5,830	5,383	52.5%	47.5%
4/9/2005	5,279	5,822	5,558	4,593	5,525	5,151	51.9%	48.1%
4/10/2005	5,012	5,603	5,295	4,446	5,344	4,908	51.9%	48.1%
4/11/2005	4,732	5,315	5,056	4,119	5,020	4,693	51.9%	48.1%
4/12/2005	4,616	5,212	4,968	4,085	4,931	4,611	51.9%	48.1%
4/13/2005	4,794	5,335	5,119	4,219	5,187	4,766	51.8%	48.2%
4/14/2005	4,570	5,308	4,889	4,213	4,891	4,636	51.3%	48.7%
4/15/2005	4,208	4,828	4,563	3,896	4,579	4,290	51.5%	48.5%
4/16/2005	4,201	4,637	4,446	3,772	4,472	4,127	51.9%	48.1%
4/17/2005	4,044	4,557	4,327	3,617	4,428	4,043	51.7%	48.3%
4/18/2005	3,984	4,518	4,229	3,559	4,340	4,013	51.3%	48.7%
4/19/2005	3,878	4,355	4,146	3,519	4,258	3,918	51.4%	48.6%
4/20/2005	3,809	4,415	4,143	3,333	4,154	3,785	52.3%	47.7%
4/21/2005	3,677	4,311	4,020	3,154	4,105	3,685	52.2%	47.8%
4/22/2005	3,477	4,114	3,882	2,986	4,023	3,557	52.2%	47.8%
4/23/2005	3,287	4,128	3,719	2,763	3,848	3,451	51.9%	48.1%
4/24/2005	3,163	4,083	3,644	2,668	3,806	3,384	51.9%	48.1%
4/25/2005	3,079	4,010	3,550	2,523	3,770	3,300	51.8%	48.2%
4/26/2005	2,838	3,723	3,348	2,229	3,595	3,110	51.8%	48.2%
4/27/2005	2,527	3,623	3,193					
4/28/2005	2,570	3,645	3,199					
4/29/2005	2,870	3,703	3,359					
4/30/2005	2,862	3,702	3,378	2,532	3,781	3,284	50.7%	49.3%
5/1/2005	3,135	3,898	3,517	2,826	3,969	3,434	50.6%	49.4%
5/2/2005	3,352	3,970	3,716	3,156	4,087	3,631	50.6%	49.4%
5/3/2005	3,513	4,075	3,821	3,195	4,092	3,727	50.6%	49.4%
5/4/2005	3,466	4,096	3,768	3,155	4,092	3,712	50.4%	49.6%
5/5/2005	3,259	3,946	3,642	3,041	4,003	3,552	50.6%	49.4%
5/6/2005	3,293	4,047	3,713	2,864	4,043	3,589	50.9%	49.1%
5/7/2005	3,352	4,219	3,838	2,967	4,178	3,713	50.8%	49.2%
5/8/2005	3,442	4,322	3,935	3,115	4,260	3,809	50.8%	49.2%
5/9/2005	3,473	4,381	4,029	3,003	4,421	3,823	51.3%	48.7%
5/10/2005	3,663	4,509	4,165	3,372	4,473	4,008	51.0%	49.0%
5/11/2005	3,761	4,524	4,204	3,535	4,498	4,080	50.7%	49.3%
5/12/2005	3,850	4,523	4,207	3,613	4,549	4,096	50.7%	49.3%
5/13/2005	3,945	4,523	4,252	3,642	4,554	4,125	50.8%	49.2%
5/14/2005	4,038	4,502	4,282	3,735	4,489	4,133	50.9%	49.1%
5/15/2005	4,070	4,442	4,258	3,677	4,476	4,097	51.0%	49.0%
5/16/2005	4,022	4,426	4,237	3,643	4,392	4,097	50.8%	49.2%
5/17/2005	3,928	4,387	4,158	3,535	4,348	4,040	50.7%	49.3%
5/18/2005	3,726	4,289	4,066	3,422	4,314	3,960	50.7%	49.3%
5/19/2005	3,806	4,410	4,220	3,380	4,485	4,084	50.8%	49.2%
5/20/2005	4,220	4,837	4,540	3,652	4,738	4,335	51.2%	48.8%
5/21/2005	4,638	5,387	5,079	4,050	5,192	4,751	51.7%	48.3%
5/22/2005	5,175	5,808	5,528	4,460	5,489	5,096	52.0%	48.0%
5/23/2005	5,421	6,058	5,802	4,739	5,696	5,315	52.2%	47.8%
5/24/2005	5,557	6,231	5,966	4,742	5,800	5,433	52.3%	47.7%
5/25/2005	5,705	6,370	6,086	4,852	5,932	5,570	52.2%	47.8%
5/26/2005	5,770	6,580	6,265	5,009	6,090	5,639	52.6%	47.4%
5/27/2005	6,045	6,549	6,358	5,080	6,101	5,719	52.6%	47.4%
5/28/2005	6,124	6,654	6,401	5,356	6,268	5,865	52.2%	47.8%
5/29/2005	6,345	6,788	6,577	5,619	6,381	5,965	52.4%	47.6%
5/30/2005	6,498	7,027	6,786	5,846	6,420	6,141	52.5%	47.5%
5/31/2005	6,788	7,110	6,931	5,806	6,469	6,204	52.8%	47.2%
6/1/2005	6,755	7,126	6,948	5,830	6,504	6,238	52.7%	47.3%
6/2/2005	6,822	7,198	7,023	5,917	6,611	6,270	52.8%	47.2%
6/3/2005	7,005	7,276	7,160	5,906	6,635	6,297	53.2%	46.8%
6/4/2005	7,076	7,417	7,214	5,944	6,773	6,406	53.0%	47.0%
6/5/2005	7,091	7,427	7,261	5,922	6,969	6,476	52.9%	47.1%
6/6/2005	7,062	7,472	7,255	5,996	6,849	6,469	52.9%	47.1%
6/7/2005	6,812	7,400	7,056	6,092	6,738	6,409	52.4%	47.6%
6/8/2005	6,415	6,961	6,691	5,898	6,583	6,207	51.9%	48.1%
6/9/2005	6,200	6,676	6,399	5,561	6,232	5,931	51.9%	48.1%
6/10/2005	5,777	6,324	5,983	5,222	5,876	5,642	51.5%	48.5%
6/11/2005	5,332	5,897	5,597	4,933	5,581	5,314	51.3%	48.7%
6/12/2005	4,844	5,375	5,105	4,762	5,359	5,050	50.3%	49.7%
6/13/2005	4,689	5,143	4,872	4,566	5,147	4,829	50.2%	49.8%
6/14/2005	4,460	4,898	4,663	4,322	4,899	4,609	50.3%	49.7%
6/15/2005	4,293	4,764	4,520	4,035	4,686	4,445	50.4%	49.6%
6/16/2005	3,877	4,497	4,192	3,727	4,470	4,145	50.3%	49.7%
6/17/2005	3,669	4,290	3,890	3,251	4,269	3,831	50.4%	49.6%
6/18/2005	3,389	4,007	3,704	2,925	4,128	3,616	50.6%	49.4%
6/19/2005	3,196	3,897	3,623	2,607	4,048	3,504	50.8%	49.2%
6/20/2005	3,163	4,024	3,577	2,494	4,029	3,419	51.1%	48.9%
6/21/2005	2,794	3,843	3,294	2,085	3,915	3,241	50.4%	49.6%
6/22/2005	2,617	3,473	3,154	2,054	3,850	3,172	49.9%	50.1%
6/23/2005	2,637	3,616	3,262	1,922	3,791	3,111	51.2%	48.8%
6/24/2005	2,794	3,902	3,299	1,665	3,710	3,001	52.4%	47.6%
6/25/2005	2,499	3,773	3,083	1,587	3,505	2,880	51.7%	48.3%
6/26/2005	2,511	3,518	2,936	1,574	3,377	2,768	51.5%	48.5%
6/27/2005	2,392	3,200	2,804	1,815	3,260	2,688	51.1%	48.9%
6/28/2005	2,371	3,300	2,792	1,443	3,179	2,575	52.0%	48.0%
6/29/2005	2,596	3,296	2,820	1,097	3,114	2,512	52.9%	47.1%
6/30/2005	2,319	3,153	2,790	1,237	3,219	2,559	52.2%	47.8%

Missing Data

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

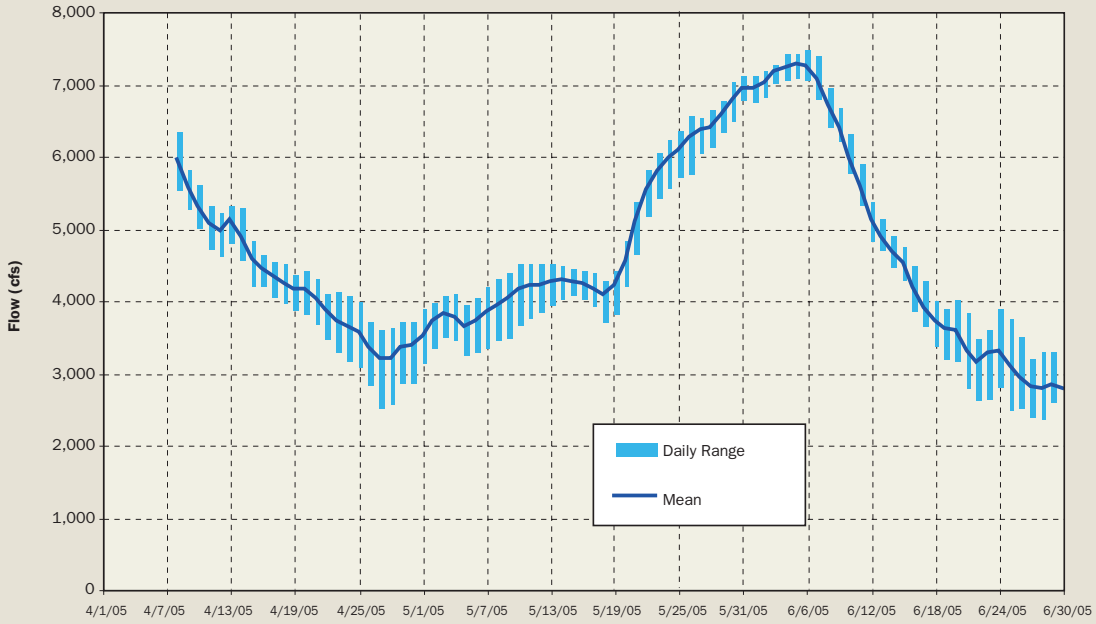


Figure 4-3
Daily Flow Range - San Joaquin River below Old River Gage

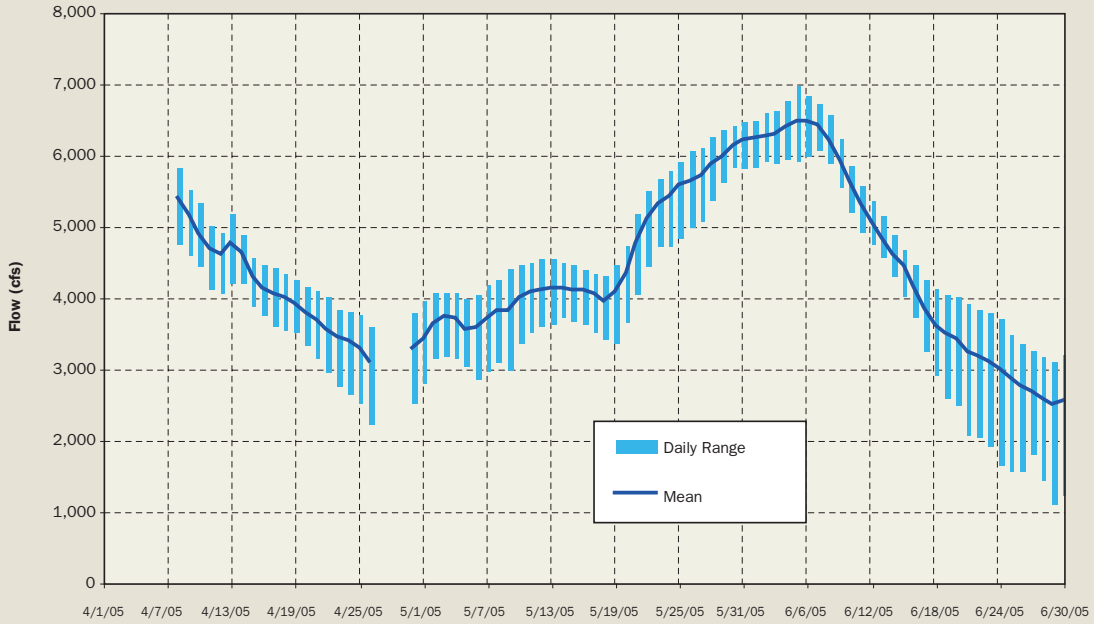


Table 4-2
San Joaquin River and Old River Mean Daily Flows

Date	Mean Daily Flow (cfs)			
	Old River at Head [A]	San Joaquin River below Old River [B]	San Joaquin River at Old River [C]=[A]+[B]	San Joaquin River near Vernalis [D]
4/8/2005	5,946	5,383	11,329	12,000
4/9/2005	5,558	5,151	10,709	11,400
4/10/2005	5,295	4,908	10,203	10,600
4/11/2005	5,056	4,693	9,749	10,200
4/12/2005	4,968	4,611	9,579	10,200
4/13/2005	5,119	4,766	9,886	10,600
4/14/2005	4,889	4,636	9,524	9,690
4/15/2005	4,563	4,290	8,853	9,090
4/16/2005	4,446	4,127	8,573	8,840
4/17/2005	4,327	4,043	8,370	8,740
4/18/2005	4,229	4,013	8,242	8,530
4/19/2005	4,146	3,918	8,064	8,450
4/20/2005	4,143	3,785	7,928	8,360
4/21/2005	4,020	3,685	7,705	8,160
4/22/2005	3,882	3,557	7,439	7,840
4/23/2005	3,719	3,451	7,170	7,620
4/24/2005	3,644	3,384	7,028	7,420
4/25/2005	3,550	3,300	6,850	7,160
4/26/2005	3,348	3,110	6,458	6,730
4/27/2005	3,193			6,500
4/28/2005	3,199			6,800
4/29/2005	3,359			7,090
4/30/2005	3,378	3,284	6,662	7,200
5/1/2005	3,517	3,434	6,951	7,720
5/2/2005	3,716	3,631	7,347	8,180
5/3/2005	3,821	3,727	7,549	8,320
5/4/2005	3,768	3,712	7,480	8,070
5/5/2005	3,642	3,552	7,194	7,890
5/6/2005	3,713	3,589	7,302	8,130
5/7/2005	3,838	3,713	7,551	8,400
5/8/2005	3,935	3,809	7,744	8,610
5/9/2005	4,029	3,823	7,852	8,820
5/10/2005	4,165	4,008	8,173	9,060
5/11/2005	4,204	4,080	8,284	9,110
5/12/2005	4,207	4,096	8,303	9,070
5/13/2005	4,252	4,125	8,377	9,130
5/14/2005	4,282	4,133	8,414	9,220
5/15/2005	4,258	4,097	8,355	9,250
5/16/2005	4,237	4,097	8,334	9,120
5/17/2005	4,158	4,040	8,198	8,970
5/18/2005	4,066	3,960	8,026	8,940
5/19/2005	4,220	4,084	8,305	9,340
5/20/2005	4,540	4,335	8,875	10,200
5/21/2005	5,079	4,751	9,830	11,400
5/22/2005	5,528	5,096	10,624	12,100
5/23/2005	5,802	5,315	11,116	12,600
5/24/2005	5,966	5,433	11,400	13,000
5/25/2005	6,086	5,570	11,656	13,200
5/26/2005	6,265	5,639	11,904	13,500
5/27/2005	6,358	5,719	12,077	13,500
5/28/2005	6,401	5,865	12,267	13,800
5/29/2005	6,577	5,965	12,542	14,200
5/30/2005	6,786	6,141	12,926	14,700
5/31/2005	6,931	6,204	13,136	15,100
6/1/2005	6,948	6,238	13,186	15,000
6/2/2005	7,023	6,270	13,293	15,100
6/3/2005	7,160	6,297	13,458	15,200
6/4/2005	7,214	6,406	13,619	15,300
6/5/2005	7,261	6,476	13,737	15,400
6/6/2005	7,255	6,469	13,724	15,300
6/7/2005	7,056	6,409	13,466	14,700
6/8/2005	6,691	6,207	12,898	13,900
6/9/2005	6,399	5,931	12,330	13,200
6/10/2005	5,983	5,642	11,625	12,200
6/11/2005	5,597	5,314	10,911	11,300
6/12/2005	5,105	5,050	10,155	10,600
6/13/2005	4,872	4,829	9,701	10,100
6/14/2005	4,663	4,609	9,272	9,770
6/15/2005	4,520	4,445	8,964	9,350
6/16/2005	4,192	4,145	8,338	8,640
6/17/2005	3,890	3,831	7,720	8,020
6/18/2005	3,704	3,616	7,320	7,710
6/19/2005	3,623	3,504	7,127	7,540
6/20/2005	3,577	3,419	6,995	7,370
6/21/2005	3,294	3,241	6,535	6,920
6/22/2005	3,154	3,172	6,326	6,720
6/23/2005	3,262	3,111	6,373	6,800
6/24/2005	3,299	3,001	6,300	6,620
6/25/2005	3,083	2,880	5,963	6,270
6/26/2005	2,936	2,768	5,704	6,010
6/27/2005	2,804	2,688	5,492	5,740
6/28/2005	2,792	2,575	5,367	5,560
6/29/2005	2,820	2,512	5,333	5,650
6/30/2005	2,790	2,559	5,349	5,680

Missing data

OLD RIVER AND SAN JOAQUIN RIVER KODIAK TRAWLING

Since the spring HORB was not constructed this year, there was no fish entrainment monitoring at the HORB. As an alternative to the entrainment monitoring, the Department of Fish and Game (DFG) towed a Kodiak trawl in Old River during the VAMP test period. The Old River Kodiak Trawl (ORKT) was conducted in a similar manner to the Mossdale Kodiak Trawl (MKT) which is conducted year-round on the San Joaquin River. Both trawls sampled on a daily basis 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, downstream of the head, and in the San Joaquin River, upstream of the head of Old River (Figure 4-5). The Kodiak trawl is 19.8 m long, made of variable mesh (ranging from 1.27 cm stretch mesh at the cod-end to 5.08 cm mesh at the mouth), and has a mouth opening of 1.83 m by 7.62 m. The effective sampling area of the net was estimated at 12.5 m^2 (USFWS 2003). All trawling occurred during daylight hours, starting around 0800 hrs. Typically, the MKT and ORKT started within a half hour of each other and ended within an 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. Typically, five tows were completed before the ORKT net was retrieved and reset upstream. A total of 15 tows per day, seven days a week, were attempted from May 2 through May 20. Boat troubles and a snagged net resulted in two days with fewer than 15 tows in Old River.

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 with a clipped adipose fin were sacrificed for CWT reading. For this comparison of the MKT and ORKT salmon catch, CWT salmon refers to all salmon with a clipped adipose fin. 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 (10,520 ± 2,216 m^3) was greater than the ORKT (7,224 ± 1,074 m^3). Catch-per-unit-effort (CPUE) for both trawling efforts was standardized to the number of salmon per 10,000 m^3. CPUE was calculated by dividing the catch by the volume (m^3) of water sampled and then multiplying the result by 10,000.

Figure 4-4
San Joaquin River Flow near Vernalis and at Old River

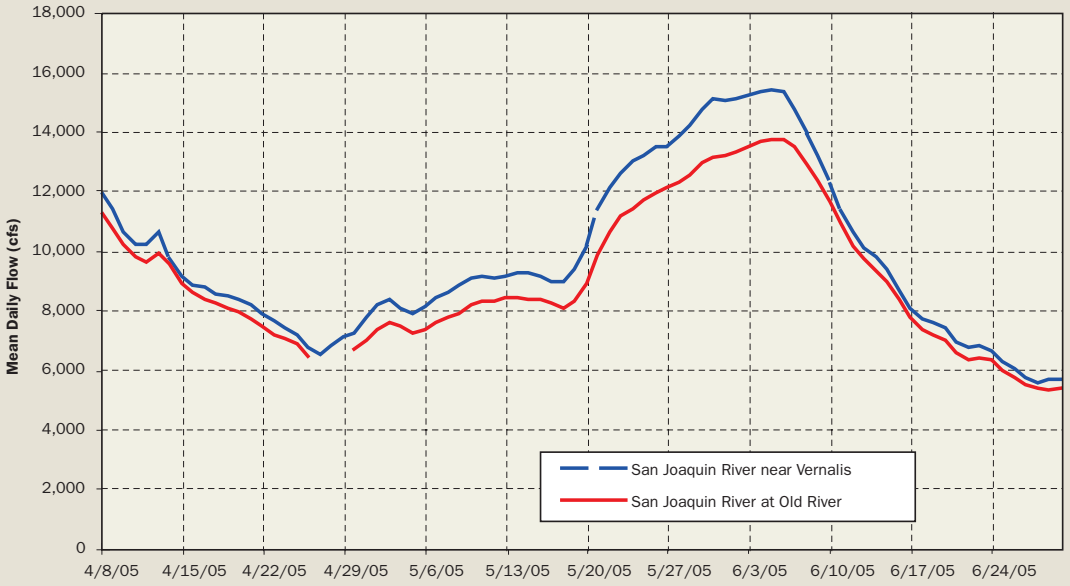
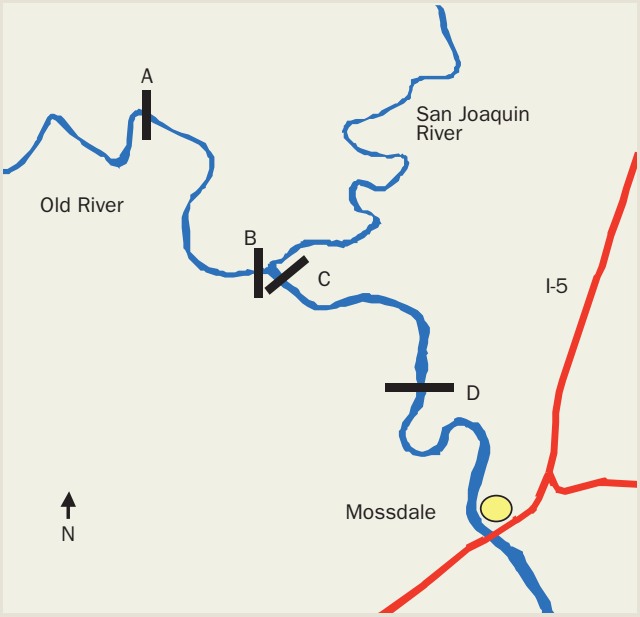


Figure 4-5
Map of the 2005 Kodiak trawl sample locations on Old and San Joaquin Rivers. The Old River Kodiak trawl sampled between letters A and B, and the Mossdale Kodiak trawl sampled between letters C and D.



The ORKT caught approximately 1,000 fish, representing 14 species, in 276 tows during the 19 day sampling period in Old River. The most abundant species was Chinook salmon followed by splittail (*Pogonichthys macrolepidotus*) (Table 4-3). Of the 709 salmon caught, 370 were unmarked, 318 were classified as CWT, and 21 had a color-mark. A two-tailed t-test (degrees of freedom (df) = 686, Probability (P) < 0.01, t statistic = 10.0) indicated fork lengths for unmarked salmon (95 ± 7.9 mm) were significantly larger than CWT salmon fork lengths (89 ± 6.9 mm).

The MKT caught approximately 4,500 fish, representing 17 species, in 285 tows during the same 19 day sampling period in the San Joaquin River. The most abundant species caught was splittail followed by Chinook salmon (Table 4-3).

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 May 2-20, 2005. Chinook salmon catch is divided into CWT salmon, unmarked salmon, and color-marked salmon.

Species	ORKT	MKT
Bigscale Logperch	1	
Black Crappie	1	1
Bluegill	6	1
Carp	11	2
Channel Catfish	2	1
Goldfish		7
Golden Shiner		6
Inland Silverside	1	9
Largemouth Bass		3
Redear Sunfish	2	2
Red Shiner		3
Sacramento Blackfish		2
Sacramento Pikeminnow	1	5
Sacramento Sucker	1	
Splittail	218	2,917
Steelhead	4	4
Striped Bass	3	
Threadfin shad	28	61
White Catfish	27	5
Chinook Salmon	**709**	**1,534**
CWT Salmon	318	466
Unmarked Salmon	370	812
Color-Marked Salmon	21	256
Total	**1,015**	**4,563**

Of the 1,534 salmon caught, 812 were unmarked, 466 were classified as CWT, and 256 had a color-mark. The mean length for unmarked salmon was 95 ± 9.8 mm for the 19 day sampling period. The mean unmarked salmon CPUEs in the MKT, from March through June, were highest during the VAMP period (Figure 4-6).

As part of the VAMP salmon survival studies, roughly 100,000 CWT salmon were released at Durham Ferry on two occasions. The effective number of CWT salmon released was estimated at 93,833 on May 2 and 91,563 on May 9. CWT salmon catch was the highest on May 3 in both Old River (Figure 4-7) and San Joaquin River (Figure 4-8). Overall, ORKT recaptured very few of the Durham Ferry released salmon. More salmon were recaptured from the May 2 release (77 salmon) than from the May 9 release (21 salmon).

To determine if CWT salmon were migrating similarly to unmarked salmon into the Old River, their daily ratios were compared between trawls. The daily ratio of CWT salmon to unmarked salmon was similar between the ORKT and MKT, although CWT salmon were proportionally higher in the ORKT during the VAMP salmon releases (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 = 18, P = 0.13, t statistic = -1.60) indicates no significant difference in the daily percent of CWT salmon caught between the ORKT and MKT.

In order to compare salmon abundance between the San Joaquin River and Old River, salmon densities (calculated from the Kodiak trawls) were expanded by river flow and trawling duration. The following equation was used:

E = estimated number of salmon
D = fish density (fish/m^3)
F = river flow (m^3/s) during sampling
T = trawling time (s)
i = i^{th} tow
n = last tow with fish

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

To determine how well this equation estimates salmon abundance in the San Joaquin River, abundance estimates for color-marked salmon were calculated and compared to the number of color-marked fish released. Eight groups of color-marked fish were released at Mossdale as part of DFG Region IV's MKT vulnerability study (see chapter 6). It was assumed all color-marked fish released upstream of the MKT, at Mossdale, passed the MKT while they were

Figure 4-6
The average daily densities of unmarked salmon caught in the Mossdale Kodiak trawl on the San Joaquin River.

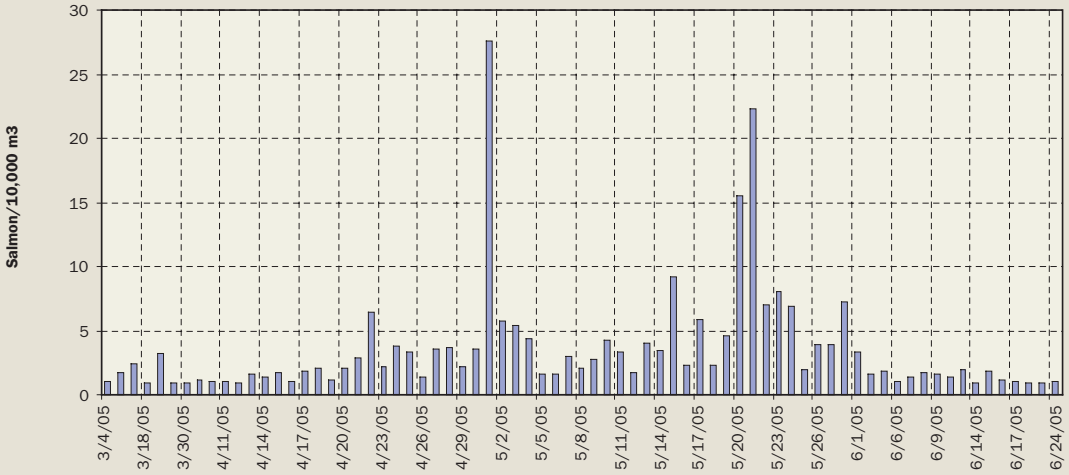


Figure 4-7
The total number of salmon by category (color-marked, coded wire tagged, and unmarked) caught in daily five hour Kodiak trawling sessions (150,000 m^3) in the San Joaquin River.

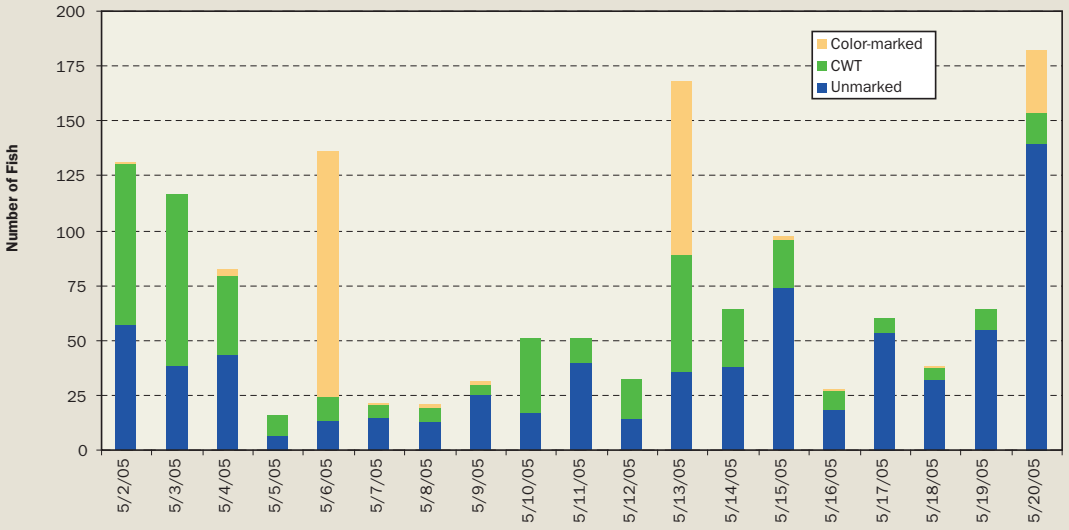


Figure 4-8
The total number of salmon by category (color-marked, coded wire tagged, and unmarked) caught in daily five hour Kodiak trawling sessions (150,000 m^3) in Old River.

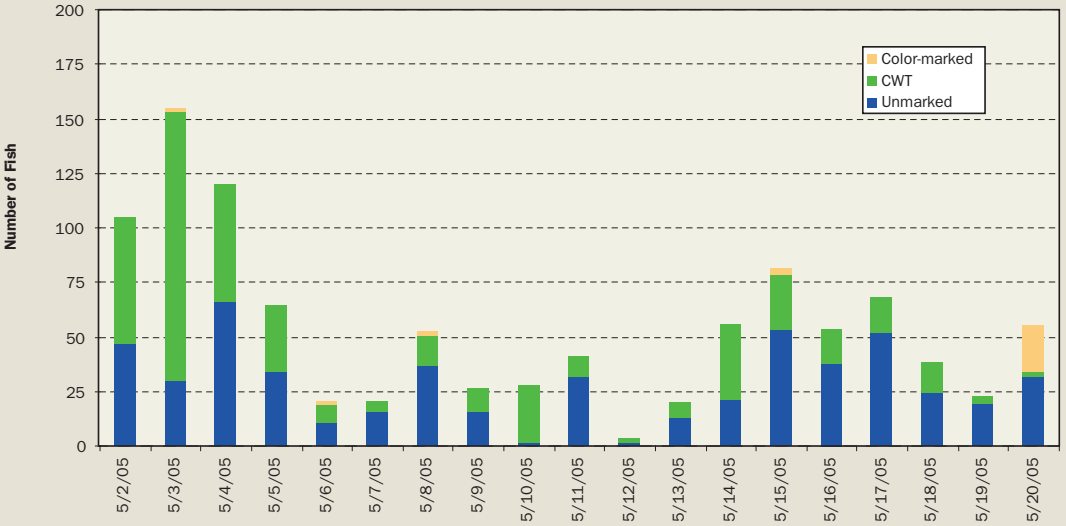
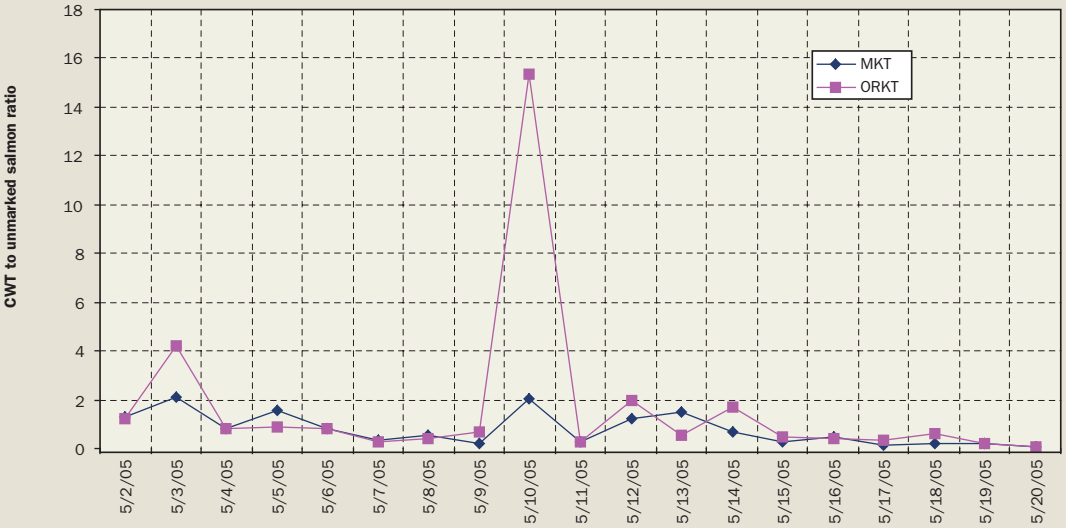


Figure 4-9
The ratio of CWT salmon to unmarked salmon caught in the Old River Kodiak trawl (ORKT) on Old River and the Mossdale Kodiak trawl (MKT) on the San Joaquin River.



trawling. Three of the color-mark groups were released when both MKT and ORKT were sampling. The estimated number of color-marked fish passing the MKT ranged from 6 % to 138 % of the color-marked salmon released upstream of the trawl, and averaged 50 % ± 38 % (Table 4-4). ORKT only caught color-marked salmon from the May 20 release (Table 4-5).

Flow data for the head of Old River (OH1) and San Joaquin River below Old River near Lathrop (SJL) was obtained from the California Data Exchange Center (http://cdec.water.ca.gov). Estimated flow on the San Joaquin River above Old River was calculated by summing flows from OH1 and SJL. The flow was split approximately equally between Old River and the San Joaquin River from May 2 through May 20 (Figure 4-10). The percent of water flowing down Old River ranged from 47 % (3,259 cfs) to 58 % (4,387 cfs), and averaged 51 % (4,060 cfs) ± 2 % (292 cfs).

As a general comparison of flows and fish between Old and San Joaquin Rivers, a daily five hour salmon abundance estimate was calculated for both CWT and unmarked salmon. The salmon abundance estimate was calculated using the previously mentioned equation; however, all daily 20 minute tows (n = 15) were used in the calculation. On a daily average, 55 ± 61 % of the unmarked salmon and 64 ± 43 % of the CWT salmon estimated in the San Joaquin River migrated down Old River (Table 4-6).

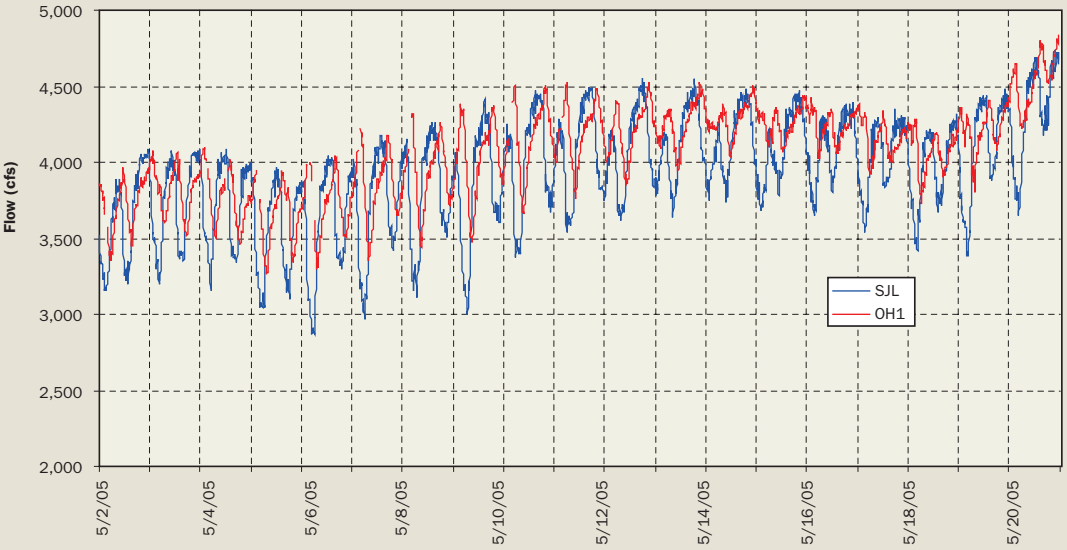
Table 4-4
The estimated number of color-marked salmon passing the Mossdale Kodiak trawl compared to the actual number of color-marked salmon released upstream of the trawl. Estimates based on salmon densities as calculated by the Mossdale Kodiak trawl multiplied by river flow (while trawling) and trawling duration. Percent is how close the estimated number is to the color-marked release number.

Date	Flow (cfs)	Density (salmon/m3)	Estimate	Released	Percent
4/6/05	12,800	0.000100	130	2,036	6%
4/15/05	8,518	0.000767	1,997	5,068	39%
4/22/05	7,077	0.001300	938	2,000	47%
4/29/05	6,337	0.000778	1,507	5,000	30%
5/6/05	7,301	0.003700	2,754	2,003	138%
5/13/05	7,882	0.001580	2,116	5,000	42%
5/20/05	8,910	0.000933	848	2,001	42%
5/27/05	11,576	0.000540	1,062	2,000	53%

Table 4-5
Total raw catch (first nine tows only) in the Mossdale and Old River Kodiak trawls, by tow and time, for three color-marked salmon releases on the San Joaquin River at Mossdale Landing. The asterisk in the Old River column indicates when the net was reset upstream.

	RedUC/Do (5/6/2005)		RedUC (5/13/2005)		RedLC (5/20/2005)	
Tow	Mossdale Catch Time	Old River Catch Time	Mossdale Catch Time	Old River Catch Time	Mossdale Catch Time	Old River Catch Time
1	0 (8:12)	0 (8:04)	0 (8:29)	0 (8:23)	0 (8:08)	0 (7:35)
2	72 (8:35)	0 (8:29)	6 (8:53)	0 (8:47)	0 (8:32)	0 (8:01)
3	59 (8:59)	0 (8:54)	19 (9:17)	0 (9:12)	25 (8:55)	0 (8:26)
4	3 (9:23)	0 (9:18)	53 (9:40)	0 (9:37)	2 (9:17)	0 (8:51)
5	0 (9:46)	0 (9:42)	1 (10:05)	0 (10:02)	2 (9:41)	0 (9:32)*
6	0 (10:10)	0 (10:06)	2 (10:41)	0 (10:55)*	0 (10:04)	12 (9:50)
7	0 (10:33)	0 (10:53)*	0 (11:04)	0 (11:20)	0 (10:28)	0 (10:15)
8	0 (10:57)	0 (11:17)	0 (11:28)	0 (11:45)	0 (10:51)	5 (10:46)
9	0 (11:20)	0 (11:42)	0 (11:51)	0 (12:10)	0 (11:26)	0 (11:26)*
Total catch	134	0	81	0	29	17

Figure 4-10
Flow at the head of Old River (OH1) and near Lathrop on the San Joaquin River (SJL) during the 2005 Kodiak trawl survey.



DISCUSSION

For the most part, trawling went well in Old River. Boat engine problems resulted in eight missed tows on the first day and a snagged net resulted in one missed tow on another day. MKT was able to complete all their tows during this time period.

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, and allows the two rivers to be compared with some certainty. Although direct CPUE comparisons and abundance estimates are presented here, they are to provide general insights to salmon movement and must be viewed with caution.

To determine if marked salmon had a similar migration rate into Old River as unmarked salmon, the daily percent of CWT salmon was compared between the two rivers. Proportionally, CWT and unmarked salmon were migrating down Old River at the same rate. It appears the marking and subsequent release does not affect salmon outmigration relative to the unmarked fish. Although during the Durham Ferry releases, a higher proportion of CWT went down Old River compared to unmarked salmon. There might be some differences for the Durham Ferry released salmon. Once the CWT salmon results from the MKT are available, the Durham Ferry salmon catch can be compared to the other CWT salmon catches to specifically find if there is a migration difference into Old River for in-delta salmon releases.

It is not possible to determine the total number of Durham Ferry released CWT salmon that migrated down Old River. The ORKT caught very few salmon (combined, less than 0.05 %) from the two Durham Ferry releases. The 2002-2004 results from the 24 hour entrainment studies at the HORB indicate salmon released around noon at Durham Ferry start reaching the head of Old River in about 12 hours. Consequently, entrainment of Durham Ferry salmon is highest (63 ± 20 %) during the first night following a fish release. Only 16 ± 15 % of the total Durham Ferry salmon entrainment occurs during the following day. Extrapolating the ORKT day results to include the nighttime period would greatly underestimate the number of Durham Ferry fish migrating down Old River.

ORKT and the MKT salmon abundance estimates were calculated using the same method. Salmon abundance was estimated by multiplying salmon density by river flow and trawling duration. Although the abundance estimates based on the MKT vulnerability study might be more accurate, this method was not used since no vulnerability study was conducted in Old River. However, the color-marked salmon vulnerability study releases were used to provide information on the accuracy of the MKT salmon abundance estimates. The range in the accuracy of the eight estimates (Table 4-4) might be caused by several factors, such as the uneven distribution of salmon as they migrate downstream, the variability in trawling, and the ability to detect the color-mark on recaptured fish. On average, it appeared the MKT underestimated the color-marked fish by half. Thus, a correction factor could be used with these calculations to get a better estimate of outmigrating salmon.

The ORKT would probably have a smaller correction factor compared to the MKT. Since the channel is narrower in Old River than it is in the San Joaquin River, ORKT sampled a larger percentage of the channel width. The resulting calculated fish densities in Old River might be closer to the actual densities than the densities calculated in the San Joaquin River. Consequently, salmon catch in the MKT would be adjusted upward to a greater degree than in the ORKT. Adjusting both the MKT and ORKT for catch efficiencies would probably decrease the daily calculated percentages of salmon heading down Old River that are presented in Table 4-6.

Color-marked salmon released for the MKT vulnerability study were not recaptured by the ORKT on two of the three releases that occurred while ORKT was sampling. The most likely reason for the zero catch is that the net was being moved back upstream while the marked fish were migrating down Old River. Based on the timing of the MKT catch and the time ORKT caught color-marked fish in Old River, the boats trawling in Old River reached the end of the sampling area and picked up the net before the color-marked fish arrived. The net was then reset upstream (around 1100 hrs) after the color-marked fish entered Old River. This means that an approximately 1.5 mile stretch of river is not sampled as the net is moved back upstream. Any fish in this section of the stream will pass by undetected. On May 20, when color-marked fish were caught, the net was reset upstream earlier (0930 hrs). The ORKT was sampling near the head when marked fish entered Old River.

An attempt was made to estimate the number of salmon migrating down Old and San Joaquin River during the trawling periods. For these comparisons, it was assumed catch efficiency was the same between the ORKT and MKT.

Table 4-6
Estimated total number of unmarked and CWT salmon in a section of the San Joaquin upstream of Old River and at the head of Old River, for a 5 hour period per day, and the percent migrating down Old River. Estimates based on salmon densities from the Kodiak trawls multiplied by river flow and trawling duration.

	San Joaquin River		Old River		Percent down Old River		
Date	Unmarked	CWT	Unmarked	CWT	Flow	Unmarked	CWT
5/2/05	1,411	1,811	600	739	52%	43%	41%
5/3/05	994	2,061	390	1,633	51%	39%	79%
5/4/05	1,133	947	862	709	50%	76%	75%
5/5/05	158	244	423	382	49%	267%	157%
5/6/05	340	280	131	111	49%	39%	40%
5/7/05	400	136	201	61	48%	50%	45%
5/8/05	334	186	471	176	48%	141%	95%
5/9/05	670	138	208	137	49%	31%	99%
5/10/05	460	950	23	350	49%	5%	37%
5/11/05	1,095	321	432	132	49%	39%	41%
5/12/05	389	487	17	33	50%	4%	7%
5/13/05	993	1,476	181	100	50%	18%	7%
5/14/05	1,050	738	299	504	51%	29%	68%
5/15/05	2,059	621	765	361	51%	37%	58%
5/16/05	518	233	534	232	51%	103%	100%
5/17/05	1,491	193	738	234	51%	50%	121%
5/18/05	874	169	331	199	50%	38%	118%
5/19/05	1,581	279	275	56	50%	17%	20%
5/20/05	4,292	434	491	29	50%	11%	7%
Mean					50%	55%	64%
Standard Deviation					1%	61%	43%

As previously mentioned, the catch efficiency is probably different between the two trawls. Although we can correct for the MKT estimates based on the color-marked salmon releases, we have no correction for ORKT; thus, neither catch was adjusted. These abundance estimates are probably underestimating, to a different degree, the actual number of salmon in each river. When catch is adjusted for flow, it appears on a daily basis that a little more than half of the salmon in the San Joaquin River turn down Old River. During this time period, half of the San Joaquin River flow was also heading down Old River. In general terms, it appears salmon are going with the flow.

When comparing the ORKT and MKT salmon abundance estimates, the daily percentage of CWT and unmarked salmon heading down Old River is similar on most days. These results are similar to the previously mentioned CWT to unmarked salmon percent analysis. However, there is some variability among sampling days. If salmon always migrated in proportion to the flow split, we would expect low variability among the daily percentages of salmon migrating down Old River. However, the variability around the mean for both unmarked and CWT is large, e.g. ranges from 4 % to 267 % for unmarked salmon. The reason for this variability could be due to the natural variability in salmon migration which might then be compounded by trawling biases.

The 2005 flow-catch results differ from the 1995 Real-Time Monitoring (RTM) Program's Kodiak trawling results on the San Joaquin River at Dos Reis and head of Old River. RTM trawling indicated salmon densities were higher, except on one sampling day, in Old River than in the San Joaquin River (IEP 1996). In order to more accurately compare the 1995 RTM results to the 2005 Kodiak trawl results, the raw data from the 1995 Dos Reis and Old River trawls were obtained from the USFWS. The 1995 data was then analyzed using the same methods that were used on the

2005 data. For the 1995 trawling, it was assumed the catch efficiencies were the same between rivers. River flows at OH1 and SJL during the 1995 Kodiak trawling period (8 days) were estimated by using Vernalis flows and equating it to OH1 and SJL flows through regression analyses. On average, flows at OH1 were calculated at 9,971 ± 462 (95 % confidence interval) cfs and at SJL 8,812 ± 658 (95 % confidence interval) cfs. An estimated 53 % of the San Joaquin River flow went down Old River. When salmon density is expanded by flow, it appears on a daily average, 66 ± 17 % of the unmarked salmon and 70 ± 18 % of the CWT salmon migrated down Old River. These percentages are higher than the 2005 percentages for Old River. This could be due to the higher flows in 1995, compared to 2005, which might change downstream migration routes.

The RTM results also might be affected by the order in which Dos Reis and Old River were sampled. A single crew conducted five tows at Dos Reis and Old River. The Old River site was always sampled first, in the morning, and Dos Reis was sampled afterwards, late morning to midday. The higher 1995 salmon densities in Old River could be due to higher salmon activity and vulnerability in the morning than during midday. The 2005 Kodiak trawl results indicate more salmon are caught in the morning than midday. Salmon (unmarked and CWT combined) were 171 % more numerous in the first five tows than in the next five tows (tows 6 – 10) in the ORKT. In the MKT, salmon were 117 % more numerous in the first five tows than in the next five tows. If a single crew is to sample both rivers, the river sampled first should alternate to overcome any morning sampling bias.

In conclusion, direct comparisons of expanded salmon abundance estimates between the ORKT and MKT were difficult due to the unknown catch efficiency of the ORKT. Although the catch efficiencies between the ORKT and MKT are probably different, they were assumed to be similar for some of the analyses. Thus, some of these results must be viewed with caution. Proportionally, there is no statistical difference on a daily basis between CWT and unmarked salmon heading down Old River. CWT and unmarked salmon are moving into Old River at a similar rate. The flow split between the San Joaquin River and Old River was 50-50. It appears juvenile salmon migrate down Old River in proportion to the flow: about half of the flow and roughly half of the salmon went down Old River. However, there was a lot of variability among the daily percentages of salmon heading down Old River. This variability might be due to natural variability in salmon migration patterns which are magnified by sampling biases and the subsequent abundance calculations. Salmon migration down Old River might also change at different river flows and pumping rates at the state and federal water projects. More data is needed to elucidate the relationship between flow and catch in Old and San Joaquin rivers.

If Kodiak trawling is conducted in future years, due to no HORB installation, VAMP should release some of their fish at Mossdale. Salmon released at Mossdale, in the morning, would pass the Kodiak trawls in larger numbers than

salmon released at Durham Ferry. This would substantially increase the CWT salmon catch in the ORKT and MKT, and might make comparisons between the two rivers a little easier. The ability to adjust catch in the ORKT based on salmon vulnerability (catch efficiency) would improve the estimate and comparison of salmon abundance to the San Joaquin River. In order for any vulnerability studies to be conducted for the ORKT, the sample site would have to be moved at least two miles downstream, and likely three to four miles, to find a suitable trawling reach. A sample site further downstream would allow time for color-marked salmon released near the head to adjust to Old River flows.

5 Salmon Smolt Survival Investigations

A primary objective of the VAMP study is to determine the effects of San Joaquin River flows, SWP and CVP water exports, and HORB installation on survival of juvenile Chinook salmon smolts emigrating from the San Joaquin River through the Delta. As mentioned in previous chapters, the HORB was not installed in 2005. Therefore the VAMP study was modified to accommodate these differences from past studies. This section describes the methods used to conduct the Chinook salmon smolt survival investigations and estimates survival indices, absolute survival estimates, and combined differential recovery rates for coded-wire tagged (CWT) juvenile Chinook salmon smolts released during the VAMP 2005 test period. The information gathered in 2005 was used in conjunction with past data to assess the relationships between smolt survival, river flow and CVP/SWP exports with and without the HORB. Relationships using escapement (adult salmon returning to the rivers to spawn) are also discussed.

MERCED RIVER FISH FACILITY CODED-WIRE TAGGING

Merced River Fish Facility (MRFF) supplied over 400,000 CWT Chinook salmon smolts for the VAMP 2005 study. Salmon were CWT and marked with an adipose fin clip by MRFF personnel between late March and mid-April 2005 and were generally held for approximately 27 days before release. Salmon were tagged with one of 16 distinct tag codes, depending upon where the fish were to be released. MRFF examined sub-samples of tagged salmon to estimate CWT retention rates. Average tag retention documented by MRFF was 92% and ranged from 86% to 95%. CWT detection 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.

To better estimate juvenile salmon survival through the Delta, survival estimates incorporate a measure of the VAMP Effective Number (ER) of fish that were tagged and released which accounts for tag retention rate and fish mortalities. The ER was calculated by multiplying the mortalities from the estimated number of fish transported by the tag retention rate which was then subtracted from the Hatchery Effective Number (Table 5-1).

ER = H - (M * TR) where:

H = Hatchery Effective Number of CWT salmon transported. This value incorporates mortalities at the hatchery and during release and the MRFF tag retention rate.

M = number of fish sacrificed for the short-term survival studies. For the Durham Ferry and Dos Reis releases, the total numbers of fish sacrificed were divided among the tag codes based on the proportion of hatchery effective number.

TR = CWT retention rate determined at the MRFF.

VAMP FISH RELEASES

Two sets (Release 1 and Release 2) of CWT salmon were released at three sites on six dates for the 2005 VAMP experiment (Table 5-1). Releases occurred at Durham Ferry, Dos Reis, and Jersey Point. Transport and water temperatures at the time of release are listed in Table 5-2.

Durham Ferry is located on the San Joaquin River upstream of the Head of the Old River (HOR). Due to high water and poor road condition, releases were made at the top of the levee at Durham Ferry. Over 90,000 CWT salmon with four different codes were released on each occasion at Durham Ferry.

Table 5-1
Chinook Salmon Smolt Release Data for VAMP 2005

Release Date	Release Site	Tag Code	Hatchery Effective Number	Fish Sacrificed for Short-Term Survival Exp.	Tag Retention Rate	Effective Number of Fish Sacrificed for Short-Term	VAMP Effective Number Released
Release 1							
2-May-05	Durham Ferry	06-46-72	23,533	127	0.94	119	23,414
2-May-05	Durham Ferry	06-46-73	23,311	126	0.94	118	23,193
2-May-05	Durham Ferry	06-46-74	23,780	128	0.94	120	23,660
2-May-05	Durham Ferry	06-46-75	23,687	128	0.94	120	23,567
Summary			**94,311**	**508**	**0.94**	**478**	**93,833**
3-May-05	Dos Reis	06-45-91	22,823	163	0.91	148	22,675
3-May-05	Dos Reis	06-46-97	22,444	160	0.89	142	22,302
3-May-05	Dos Reis	06-46-98	24,310	173	0.93	161	24,149
Summary			**69,577**	**496**		**452**	**69,125**
6-May-05	Jersey Point	06-45-88	**23,186**	**450**	**0.93**	**419**	**22,767**
Release 2							
9-May-05	Durham Ferry	06-45-84	22,874	107	0.91	97	22,777
9-May-05	Durham Ferry	06-45-85	23,066	108	0.91	98	22,968
9-May-05	Durham Ferry	06-45-86	23,110	108	0.91	98	23,012
9-May-05	Durham Ferry	06-45-87	22,903	107	0.91	97	22,806
Summary			**91,953**	**429**	**0.91**	**390**	**91,563**
10-May-05	Dos Reis	06-45-89	21,574	152	0.86	131	**21,443**
10-May-05	Dos Reis	06-45-90	23,913	169	0.94	158	**23,755**
10-May-05	Dos Reis	06-46-99	23,602	167	0.93	154	**23,448**
Summary			**69,089**	**488**		**443**	**68,646**
13-May-05	Jersey Point	06-47-00	**23,562**	**348**	**0.95**	**331**	**23,231**

Table 5-2
Water Temperature During Transport and Release

Release Site	Release Date	Transport Temperature (F)	River Temperature (F)
Durham Ferry	2-May-05	52	60
Dos Reis	3-May-05	55	63
Jersey Point	6-May-05	52	64
Durham Ferry	9-May-05	52	59
Dos Reis	10-May-05	52	59
Jersey Point	13-May-05	55	66

Dos Reis is located on the San Joaquin River downstream of the HOR, and was used as a release site, in lieu of Mossdale (which is upstream of HOR) in 2005 to assess the mortality of marked salmon diverted in HOR. Additionally, the release at Dos Reis was made on an ebb tide to reduce the likelihood of salmon being pushed upstream into HOR. Just fewer than 70,000 CWT salmon of three tag codes were released on each occasion at Dos Reis.

Jersey Point serves as a "control site" to standardize survival rates since fish released at Jersey Point do not migrate through the Delta and they are released just upstream of the Antioch and Chipps Island revocery locations. CWT salmon were released on a flood tide at Jersey Point to increase fish dispersion throughout the channel before reaching Antioch and Chipps Island (recovery sampling stations). CWT salmon from one tag code were released on each occasion (22,767 and 23,231 CWT salmon, respectively) at Jersey Point.

During the 2005 VAMP study, CWT salmon with different tag codes were held separately at the hatchery except for the fish released at Durham Ferry. During transport it was necessary to combine tag codes from the Dos Reis release, as well. Once the hatchery truck arrived at a release site, approximately 450 salmon were removed for the short-term survival study (see below). The remaining fish were then immediately released.

WATER TEMPERATURE MONITORING

Water temperature was monitored during the VAMP 2005 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 smolts released as part of these tests (Appendix C-1). Water temperature was recorded at 24-minute intervals throughout the period of the VAMP 2005 investigations. Water temperatures were also recorded within the hatchery raceways at the MRFF 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 Durham Ferry.

Results of water temperature monitoring within the Merced River Fish Facility showed that juvenile Chinook salmon were reared in, and acclimated to, water temperatures of approximately 9.7°- 11.8° C (49.5° - 53.2° F) prior to release into the lower San Joaquin River (Figures 5-1 and 5-2). Results of water temperature monitoring at Durham Ferry and Jersey Point following the VAMP 2005 releases are shown in Figures 5-3 and 5-4. This water temperature monitoring showed that water temperatures at the release locations and throughout the lower San Joaquin River and Delta (Appendix C-2) were higher than those at the hatchery, which is generally the case. Water temperatures measured within the lower San Joaquin River and Delta (Figures 5-3 and 5-4) were within a range considered to be suitable (< 20 C; 68 F) for Chinook salmon smolts and would not be expected to result in adverse effects or reduced survival of emigrating juvenile Chinook salmon released as part of the VAMP 2005 investigations.

SHORT-TERM SURVIVAL STUDY

Two groups of CWT salmon were removed from the MRFF fish transport truck before each release to determine if handling, transport, and release affected short-term, 48-hour survival and general condition. The goal was to place 225 CWT fish into each of 2 net pens (volume ~ $1m^3$; mesh size ~3 mm); however, all numbers were approximated when the fish were removed from the MRFF truck in an attempt to reduce handling stress. As mentioned previously, tag codes were mixed during transport and therefore fish were not kept in separate net pens by distinct tag codes.

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 of transported fish. Each fish was measured for fork length (to nearest 1 mm), weighed (to the nearest 0.1 g) and examined qualitatively for percent scale loss, body color, fin hemorrhaging, eye quality, and gill coloration. For the purposes of the 2005 VAMP study, Table 5-3 defines 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, an additional 25 fish from each pen were measured, weighed, and examined for condition, as described above. The remaining fish from each pen were examined for mortalities, euthanized, counted, measured, weighed, and returned to STFWO for later tag code verification, if necessary.

Post transport fish were generally in good condition (Appendix C-3a). All fish were swimming vigorously before being euthanized. Mean scale loss ranged from 2% at the second Jersey Point release up to 12% at the second Durham Ferry release (average of all locations = 5%). Body color and gill color were normal for all fish examined. No fin hemorrhaging was detected in any of the fish. Only one salmon (2%) from the first Jersey Point release had eye

Figure 5-1
Merced River Fish Hatchery to Durham Ferry

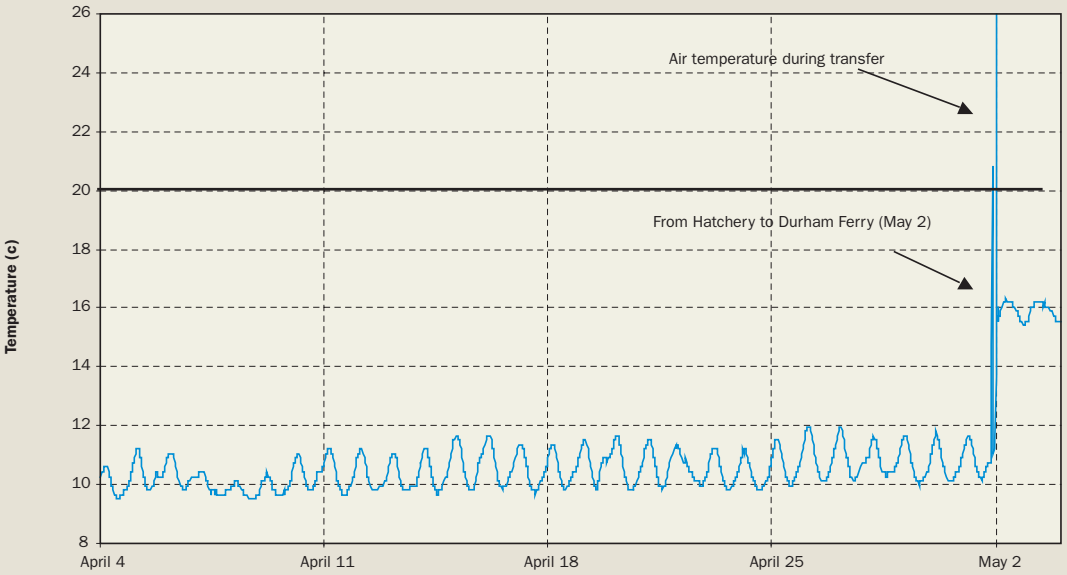


Figure 5-2
Merced River Fish Hatchery to Durham Ferry

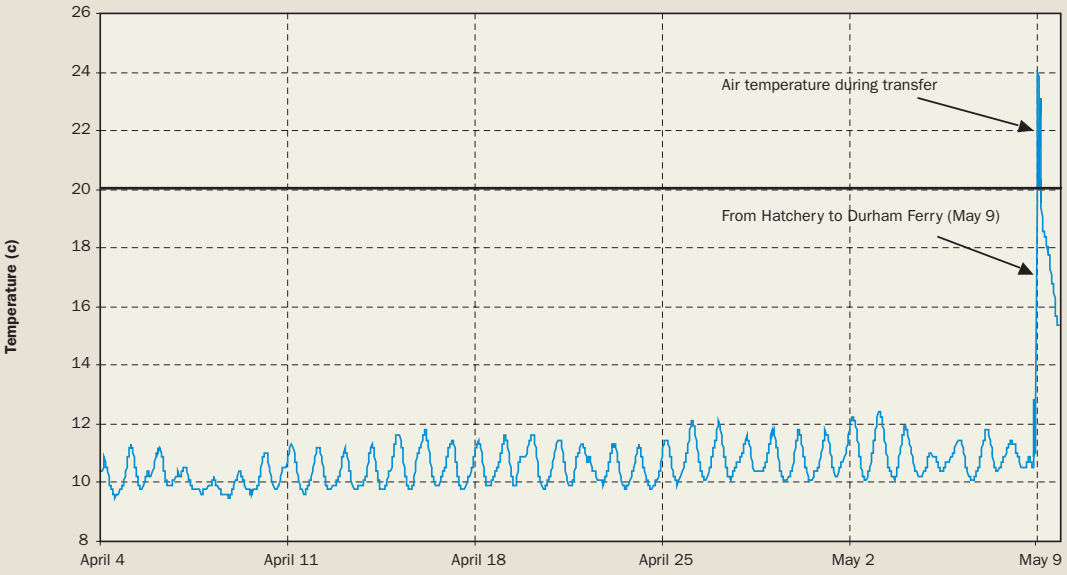
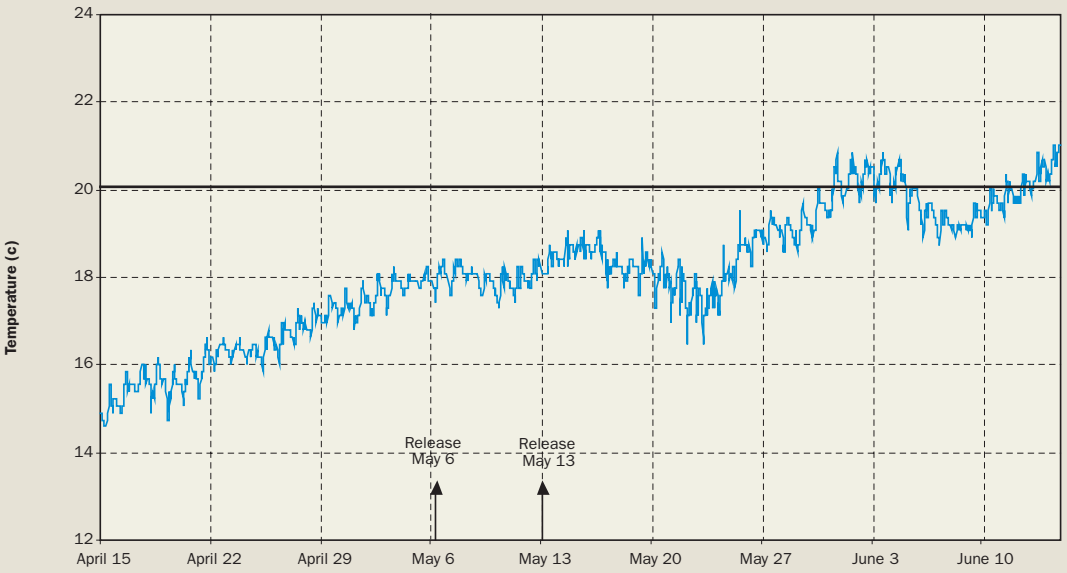


Figure 5-3
Site 1 - Durham Ferry

Figure 5-4
Site 9 - USGS Gauging Station at Jersey Point - Top



hemorrhaging. No errant CWT codes were detected in the 2005 VAMP salmon sub-samples, therefore no additional CWT verification was completed. Adipose fins were completely removed from an average of 85% (range of 74% to 94%) of the CWT salmon.

Short-term survival (48-hours post-transport) was high (99.9%) with only three mortalities (all from the first release at Durham Ferry) 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 (6%) at each site and ranged from 3% to 9% after each of the 48-hour trials. Few fish from the first set of releases had abnormal body color: 4 % from Durham Ferry, 2% from Dos Reis, and 2% from Jersey Point. Abnormal body color was not detected for any of the salmon from the second set of releases. Only 2% of the fish from the first Jersey Point release had fin hemorrhaging. Abnormal eye quality was detected in 4% of the Dos Reis and 2% of the Jersey Point fish from the first release. Abnormal eye quality was detected in 2% of the fish from each of the second releases at Durham Ferry and Dos Reis. Pale gills were detected in 2% of the fish from the second Dos Reis release. No other fish had abnormal gill coloration. These data indicate that the fish used for the 2005 VAMP experiment were in good general condition initially and after 48 hours, and that handling, transport, and release should not have affected their survival.

HEALTH AND PHYSIOLOGY

Juvenile Chinook salmon from tagged lots used in the 2005 VAMP study, were brought from the MRFF to the U.S. Fish and Wildlife Service California-Nevada Fish Health Center (CA/NA FHC) six days prior to the first VAMP release and reared for 50 days at water temperatures similar to the San Joaquin River (14.5 to 19.6 C). At the time of transport, a fish health inspection showed that the population was generally healthy but had a low prevalence of an early stage infection by the myxosporean parasite, *Tetracapsula bryosalmonae*. This parasite has been detected in Merced River salmon for several decades (Hederick et al., 1986) and causes Proliferative Kidney Disease (PKD). The level of clinical PKD, as demonstrated by a combined kidney lesion and anemia score, markedly increased starting at 29 days post-exposure (dpe). A total of 76 study salmon (27% cumulative mortality) died due to PKD beginning at 36 dpe through the final sample at 50 dpe. Time post-exposure and disease state correlated with a decline in both hematocrit and plasma magnesium as well as an elevation in circulating white blood cell number and plasma protein concentration. There was no observed PKD effect on time to exhaustion during a 120-minute swim challenge until 50 dpe. Smolt development measurements indicated that the study fish were in an advanced stage of smoltification. Similar to swim performance, saltwater adaptation was not impaired until 50 dpe.

In addition to examining 2005/VAMP salmon maintained at the CA/NV FHC, selected salmon recovered at Chipps Island were also examined for the presence of PKD. While in the field, CWT salmon were dissected to remove the kidney and make kidney imprints on glass slides. *Tetracapsula bryosalmonae* was observed in 40% (17 of 43) of the kidney imprints collected from VAMP salmon recovered in the Chipps Island trawl. From the laboratory experiments, severe disease was not detected until 29 dpe which was chronologically after the last VAMP coded wire tag recovery at Chipps Island on 27 May 2005. These results indicate that while PKD was prevalent in VAMP out-migrating salmon, it may not have reduced VAMP recoveries. However PKD could be a significant mortality factor for VAMP salmon smolts during their early seaward entry phase (past all VAMP recovery stations). A full report is available in Foott et al.,(2005).

Table 5-3
Smolt Condition Characteristics Assessed for Short Term Survival Studies

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)

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 not discussed in this chapter. Juvenile Chinook salmon with an adipose fin clip caught at all of the sampling locations (except Old River and Mossdale) were sacrificed, labeled, and frozen for CWT processing by staff at STFWO. DFG Region 4 staff processed CWT fish from Old River and Mossdale.

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

Table 5-4
Recovery information at Antioch, Chipps Island, and the fish facilities for VAMP releases in 2005.

			Antioch Recoveries							
Tag Code	Release Site	Release Date	Effective Number Released	First Day Recovered	Last Day Recovered	Number Recovered	Recovery Effort (minutes sampled)	Percent of Channel Sampled	Survival Index	Group Index
06-46-72	Durham Ferry		23,414	–	–	0	–	–	–	
06-46-73	Durham Ferry		23,193	5/5/05	5/7/05	2	1,555	0.360	0.016	
06-46-74	Durham Ferry		23,660	5/5/05	5/24/05	3	10,283	0.357	0.024	
06-46-75	Durham Ferry		23,567	5/10/05	5/10/05	1	555	0.385	0.007	
	Total	**5/2/05**	**93,833**	**5/5/05**	**5/24/05**	**6**	**10,283**	**0.357**		**0.013**
06-45-91	Dos Reis		22,675	5/9/05	5/13/05	3	2,423	0.337	0.026	
06-46-97	Dos Reis		22,302	5/17/05	5/17/05	1	580	0.403	0.007	
06-46-98	Dos Reis		24,149	5/10/05	5/11/05	3	953	0.331	0.025	
	Total	**5/3/05**	**69,125**	**5/9/05**	**5/17/05**	**7**	**3,332**	**0.257**		**0.028**
06-45-88	Jersey Point	5/6/05	22,767	5/7/05	5/12/05	31	2,874	0.333	0.263	
06-45-84	Durham Ferry		22,777	5/15/05	5/15/05	1	500	0.347	0.008	
06-45-85	Durham Ferry		22,968	5/17/05	5/17/05	1	580	0.403	0.007	
06-45-86	Durham Ferry		23,012	5/14/05	5/16/05	3	1,420	0.329	0.026	
06-45-87	Durham Ferry		22,806	5/19/05	5/20/05	2	1,154	0.401	0.014	
	Total	**5/9/05**	**91,563**	**5/14/05**	**5/20/05**	**7**	**2,772**	**0.275**		**0.020**
06-45-89	Dos Reis		21,443	5/16/05	5/19/05	5	2,100	0.365	0.039	
06-45-90	Dos Reis		23,755	5/15/05	5/18/05	2	2,020	0.351	0.016	
06-46-99	Dos Reis		23,448	–	–	0	–	–	–	
	Total	**5/10/05**	**68,646**	**5/15/05**	**5/19/05**	**7**	**1,972**	**0.274**		**0.027**
06-47-00	Jersey Point	5/13/05	23,231	5/14/05	5/19/05	27	3,140	0.363	0.212	

* One fish was excluded due to inaccurate data.

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. 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, within the mid-channel, and near the right bank to sample for 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 began May 4 and continued through May 31. Each day between 5:30 a.m. and 9:00 p.m., anywhere from 6 to 30 tows were conducted. In all, 633 Kodiak trawl samples were collected, for a total of 12,528

Chipps Island Recoveries							Fish Facilities Recoveries Raw Salvage (Expanded Salvage)		
First Day Recovered	Last Day Recovered	Number Recovered	Recovery Effort (minutes sampled)	Percent of Channel Sampled	Survival Index	Group Index	CVP	SWP	Recovery Days
5/5/05	5/11/05	5	2,608	0.259	0.099		38 (456)	5 (27)	
5/10/05	5/12/05	2	1,152	0.267	0.038		25 (300)	2 (9)	
5/9/05	5/19/05	4	4,132	0.261	0.079		37 (444)	7 (39)	
5/7/05	5/7/05	1	400	0.278	0.018		19 (228)	4 (24)	
5/5/05	**5/19/05**	**12**	**5,732**	**0.265**		**0.058**			**05/3 - 05/24**
5/11/05	5/11/05	1	400	0.278	0.019		0	0	
5/11/05	5/11/05	1	400	0.278	0.018		0*	1 (6)	
5/12/05	5/12/05	1	352	0.244	0.020		0	0	
5/11/05	**5/12/05**	**3**	**752**	**0.261**		**0.019**			**05/15**
5/8/05	5/15/05	32	2,960	0.257	0.634		0	0	–
5/15/05	5/26/05	2	4,772	0.276	0.037		16 (192)	19 (102)	
5/12/05	5/12/05	1	352	0.244	0.021		6 (72)	15 (84)	
5/15/05	5/27/05	3	5,172	0.276	0.056		14 (168)	17 (93)	
–	–	0	–	–	–		7 (84)	9 (48)	
5/12/05	**5/27/05**	**6**	**6,324**	**0.274**		**0.028**			**05/10 - 05/31**
5/14/05	5/16/05	3	1,200	0.278	0.055		0	1 (6)	
5/17/05	5/18/05	2	772	0.268	0.038		0	0	
5/17/05	5/17/05	1	372	0.258	0.020		0	0	
5/14/05	**5/18/05**	**6**	**1,972**	**0.274**		**0.037**			**05/17**
5/14/05	5/20/05	38	2,772	0.275	0.711		0	0	–

tow minutes. During sampling, 5,127 unmarked juvenile Chinook salmon were captured; 248 salmon with a coded wire tag were collected, 97 from VAMP releases (Table 5-4) and 151 from other hatchery releases. In addition, 363 delta smelt, 12 unmarked steelhead, and 6 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. To keep the mouth of the net open, the net has floating aluminum hydrofoils on the top bridles and has steel depressors and a weighted lead line attached to the bottom bridles.

For VAMP 2005 trawling was conducted twice per day, seven days per week from May 3, 2005 through June 11, 2005. In past studies, greater recoveries of juvenile Chinook salmon smolts have been reported during sunrise and sunset (Hanson Environmental, unpublished data), therefore, the first shift began during sunrise and the second shift was completed during sunset in an attempt to increase the recovery of juvenile Chinook salmon smolts and reduce the variability in survival indices. Each shift consisted of ten 20-minutes tows conducted in the north, middle, and south sections of the channel parallel to the shore. After six weeks the majority of VAMP juvenile Chinook salmon smolts had migrated past Chipps Island, so sampling was subsequently reduced. Ten morning tows were continued seven days per week between June 12 and June 19; five days per week between June 20 and July 1; and three days per week after July 5.

All fish retained in the cod end of the net are placed in aerated water collected from the sample site. All juvenile Chinook salmon smolts with an adipose fin clip were labeled and retained for later CWT processing. All other fish were identified to species, and enumerated, and released. The fork length of each individual was measured to the nearest mm for most of the catch. As mentioned previously, some salmon were also processed in the field to determine if *T. bryosalmonae* were present. A total of 59 juvenile Chinook salmon with tag codes used in the VAMP 2005 study were recaptured at Chipps Island, with the majority having been released at Jersey Point. During this same time period, the catch included 11,111 unmarked Chinook salmon; 628 CWT Chinook salmon from non-VAMP studies; 101 Delta smelt; 130 Sacramento splittail; 23 marked steelhead; and 21 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. The number of marked salmon collected during the sub-sampling (raw salvage) is reported in Table 5-4. Expanded salvage is a calculation based on the raw salvage

collected and the time sampled and provides an estimate of the total number of fish salvaged. Expanded salvage does not take into account the indirect loss of juvenile salmon smolts at the facilities as it does not include any loss associated with pre-screening predation, screening, handling, and trucking. Expanded CVP and SWP salvage estimates are also reported in Table 5-4.

During VAMP 2005, expanded salvage was greater than salvage from releases at Durham Ferry in 2004 (CVP = 84; SWP = 12). The increase in salvage for VAMP 2005 was not surprising since the HORB was not installed. The installation of HORB reduces the number of fish observed at the fish facilities. Only a few juvenile salmon smolts that were released at Dos Reis and no smolts released at Jersey Point were observed in the raw salvage. The low salvage of smolts released at Dos Reis was anticipated as these fish are released downstream of the Head of Old River on an outgoing tide and would not be expected to be drawn through Old River into the fish facilities. The Jersey Point releases are downstream of all connections to Old River, but are released on an ebb tide to facilitate disbursement. Though in past years a few salmon released at Jersey Point have been observed, they are generally not expected at the salvage facilities.

TRANSIT TIME

The recoveries of the VAMP smolts collected in 2005 were made at Antioch between May 5 and May 24 and over a similar time period at Chipps Island between May 5 and May 27 (Appendix C-4). Recoveries were made at the CVP and SWP fish facilities between May 3 and May 31 (Table 5-4), a few days earlier and later than at the other recovery locations. All recoveries were made prior to the end of the VAMP period.

VAMP CHINOOK SALMON CWT SURVIVAL

Survival Indices

Survival indices were calculated to estimate survival to Antioch and Chipps Island for marked salmon released at Durham Ferry, Dos Reis and Jersey Point. 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 2005 release groups at Chipps Island was about 28%, while at Antioch it was about 37% (Table 5-4).

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.

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

Survival is further put into context by estimating absolute survival estimates and combined differential recovery rates (CDRR). Absolute survival estimates and CDRRs should be more robust for comparing survival between groups, recovery locations, 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, both estimates of absolute survival and CDRRs were calculated for CWT releases as part of VAMP 2005. An additional estimate of survival, differential recovery rates (DRR) was also used for recoveries made in the ocean fishery, two to four years following release, for groups released in past years. DRR are also used when only the Chipps Island recovery location was used, as was the case prior to 2000.

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 (Durham Ferry 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 recovery rate (CRR) is estimated by the formula:

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

where: R_{C+A} is the combined recoveries at Antioch and Chipps Island of a CWT group, and ER is the effective release number.

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 (Durham Ferry, Mossdale or Dos Reis), and CRR_d is the combined recovery rate for the downstream group (Jersey Point).

The CDRR and DRR are other ways to estimate survival between the upstream and downstream release locations. It is similar to calculating absolute survival estimates, but does not expand estimates based on the fraction of the time and space sampled.

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 and Chipps Island could result in different survival estimates between the two methods.

Variance and standard errors were calculated for the CDRR and DRRs based on the Delta method recommended by Dr. Ken Newman. Plus or minus two standard errors are roughly equivalent to the 95% confidence intervals around the estimate. Plus or minus one standard error equates to roughly the 68% confidence intervals for normally distributed data (Ken Newman, University of St. Andrews, Scotland, personal communication). In comparing survival between reaches, the confidence intervals were used to determine if CDRRs were significantly different from each other. If the 95% confidence intervals overlapped, CDRRs were not considered statistically different from each other. Confidence intervals using the lower level of confidence (68%) are also included.

Results:

Individual and group survival indices to Antioch and Chipps Island of the CWT salmon released as part of VAMP 2005 are shown in Table 5-4. 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 at Mossdale or in Old River.

The survival indices were low and ranged between 0.013 and 0.063 for the Durham Ferry and Dos Reis groups using either recoveries at Antioch or Chipps Island. We would have expected the Dos Reis survival indices to be greater than those for the Durham Ferry groups, but this was not the case for the first group recovered at Chipps Island (Table 5-4). The group survival index to Chipps Island for the first Durham Ferry group was 0.063 and for the first Dos Reis group was 0.022. This result could be due to the low recovery numbers and inherent variability in the survival indices.

One compounding factor experienced in 2005, was the application of Komeen in Clifton Court Forebay on May 3, a day after our first Durham Ferry release. Komeen is a chemical herbicide containing copper that is known to be toxic to salmon (J. Stuart, NOAA Fisheries, personal communication). During the application period there were no flows into or out of Clifton Court Forebay for 48 hours (DWR, Delta Field Division, personal communication). The SWP exports directly out of Clifton Court Forebay. The first Durham Ferry released fish was observed at the CVP on May 3, indicating that some of the CWT fish released at Durham Ferry may have been diverted into Clifton Court Forebay before the gates were closed on May 3rd which in turn could have reduced their survival. The first Durham Ferry fish was not observed at the SWP until May 8th. Although the first group released at Durham Ferry did not have consistently lower survival indices, than the second Durham Ferry release, to Antioch and Chipps Island, it is uncertain whether this treatment lessened the survival of the first group released at Durham Ferry. We have requested further communication from DWR regarding the timing of when these herbicide applications are scheduled to avoid this potential problem in the future.

The control groups released at Jersey Point had greater survival than those fish released at Durham Ferry or Dos Reis. The survival index of the first Jersey Point group was 0.263 at Antioch and 0.634 at Chipps Island. The second Jersey Point release had survival indices of 0.212 at Antioch and 0.711 at Chipps Island.

In general, higher survival indices were estimated using the Chipps Island recoveries. As in past years, the raw recovery rate at Chipps Island and Antioch was similar, but once recoveries were expanded for effort, indices indicated that recoveries were much lower at Antioch, indicating that the greater sampling at Antioch is not translating into additional recoveries.

Survival indices for releases made at Durham Ferry and Dos Reis were low relative to releases made at Jersey Point

Table 5-5
Absolute survival and Combined Differential Recovery Rates (CDRR) for VAMP releases in 2005

Survival Reach	Release Date	Antioch Absolute Survival	Chipps Island Absolute Survival	CDRR
First release				
Durham Ferry to Jersey Point	2-May-05	0.049	0.099	0.069
Dos Reis to Jersey Point	3-May-05	0.11	0.035	0.052
Second release				
Durham Ferry to Jersey Point	9-May-05	0.094	0.044	0.051
Dos Reis to Jersey Point	10-May-05	0.127	0.058	0.068

using either set of recovery numbers (Table 5-4). This is especially clear when looking at absolute survival rates and CDRR's (Table 5-5).

The CDRR's for the Durham Ferry groups relative to the Jersey Point groups were 0.069 and 0.051 for the first and second releases, respectively. The Dos Reis to Jersey Point CDRR estimates were 0.052 for the first and 0.068 for the second release (Table 5-5). Confidence intervals around each of the estimates suggested estimates were not significantly different for the two groups even though fish released at Durham Ferry are thought to incur additional mortality since it is roughly 15 miles farther upstream than Dos Reis and there was no HORB (Figure 5-5).

The pooled CDRRs of the two Dos Reis groups was 0.060. The pooled CDRR of the Durham Ferry groups was also 0.060. Further pooling of both sets resulted in the CDRR being 0.060. Plus and minus one and two standard errors of the estimates were also calculated and are shown in Figure 5-5.

COMPARISON WITH PAST YEARS

Ocean Recovery Information

Ocean recovery data of CWT salmon groups can provide another independent estimate of the ratio of recovery rate of an upstream release group relative to a downstream release group. Differential recovery rates using ocean recovery information can be compared with absolute survival estimates based on survival indices and the differential **(DRR)** or combined differential recovery rates **(CDRR)** of juvenile salmon recovered at Chipps Island and Chipps Island and Antioch, respectively. The ocean data may be more reliable due to the 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 2000 and partially available for CWT releases made from 2001 to 2003.

Differential recovery rates based on ocean recoveries, Chipps Island recoveries or combined Antioch and Chipps Island recoveries for salmon produced at the MRFF are shown in Table 5-6. 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 (2000-2003). Releases have been made at several locations: Durham Ferry, Mossdale, Dos Reis, and Jersey Point. The Chipps Island and Antioch survival estimates and CDRR (Antioch and Chipps Island recoveries summed) or DRR (Chipps Island recoveries only) are graphed in relation to the differential recovery rate using the ocean recovery information in Figure 5-6.

Results of this comparative analysis of survival estimates and differential recovery rates for Chinook salmon produced in the MRFF show: (1) there is general agreement between absolute survival estimates based on juvenile CWT salmon recoveries at Chipps Island and the DRR or CDRR using recoveries at Chipps Island or Chipps Island and Antioch and the DRR using adult recoveries from the ocean fishery (r^2=0.71 and r^2 = 0.67), (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.

Figure 5-5
Combined Differential Recovery Rates (CDRR) (+/- 1 and 2 standard errors) of CWT smolts released at Durham Ferry (DF/JP) and Dos Reis (DR/JP) relative to those released at Jersey Point for the first (1), second (2) and combined release groups (1&2) in 2005.

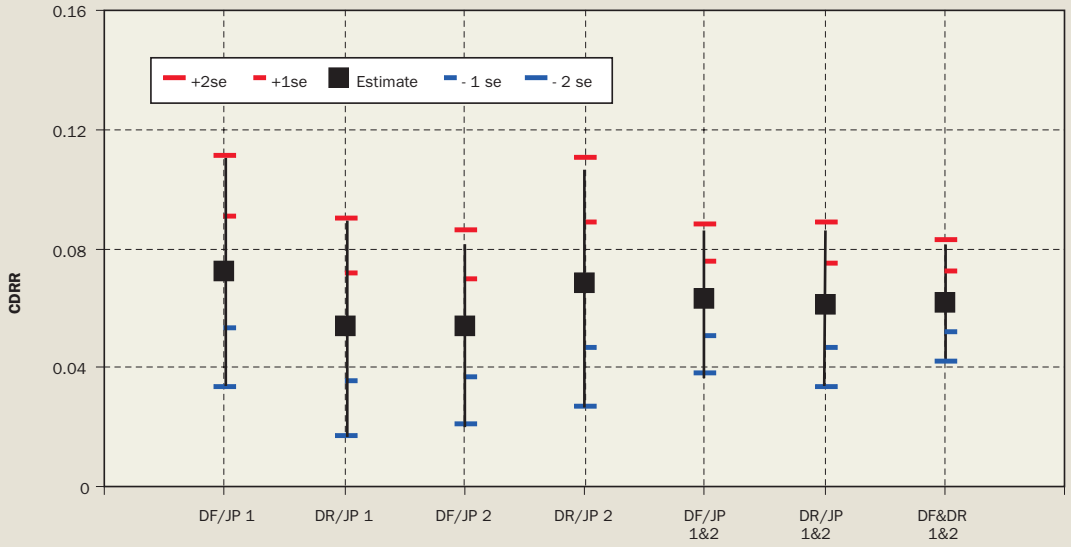


Figure 5-6
Comparison of Antioch and Chipps Island absolute survival estimates and differential or combined differential recovery rates compared to differential ocean recovery rates for 1996-2003.

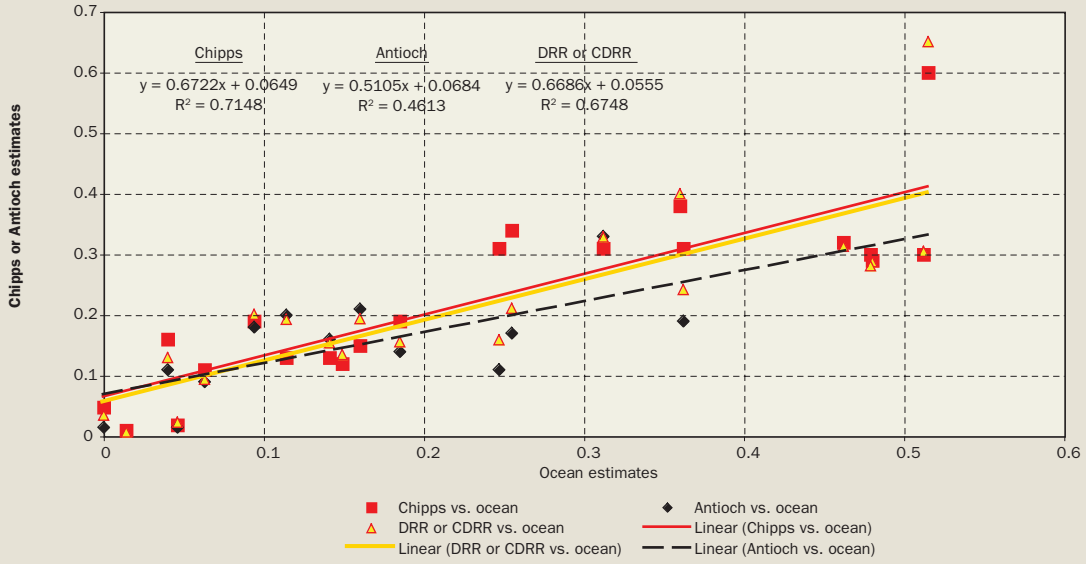


Table 5-6
Survival indices based on Chipps Island, Antioch, and ocean recoveries of Merced River Fish Facility salmon released as part of South Delta studies (1996 - 1999) and VAMP (2000 - 2003).

Release Year	San Joaquin River (Merced River origin) Tag Number	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 Catch
		Juvenile Salmon CWT Releases						Absolute Survival Estimates		Differential Recovery Rates	
1996	H61110412	25,633	DOS REIS	01MAY96	2		3				
	H61110413	28,192	DOS REIS	01MAY96	3		37				
	H61110414	18,533	DOS REIS	01MAY96	1		8				
	H61110415	36,037	DOS REIS	01MAY96	5		10				
	H61110501	53,337	JERSEY PT	03MAY96	39		187				
	Effective Release	107,961	DOS REIS		11		58	0.120		0.135	0.149
	Effective Release	51,737	JERSEY PT		39		187				
1997	H62545	50,695	DOS REIS	29APR97	9		183				
	H62546	55,315	DOS REIS	29APR97	7		167				
	H62547	51,588	JERSEY PT	02MAY97	27		355				
	Effective Release	106,010	DOS REIS		16		350	0.290		0.288	0.480
	Effective Release	51,588	JERSEY PT		27		355				
	H62548	46,728	DOS REIS	08MAY97	5		91	0.300		0.281	0.479
	H62549	47,254	JERSEY PT	12MAY97	18		192				
1998	61110809	26,465	MOSSDALE	16APR98	25		61				
	61110810	25,264	MOSSDALE	16APR98	31		40				
	61110811	25,926	MOSSDALE	16APR98	32		58				
	61110806	26,215	DOS REIS	17APR98	33		47				
	61110807	26,366	DOS REIS	17APR98	23		35				
	61110808	24,792	DOS REIS	17APR98	34		61				
	61110812	24,598	JERSEY PT	20APR98	87		110				
	61110813	25,673	JERSEY PT	20APR98	100		91				
	Effective Release	77,655	MOSSDALE		88		159	0.300		0.305	0.512
	Effective Release	77,373	DOS REIS		90		143	0.320		0.313	0.462
	Effective Release	50,271	JERSEY PT		187		201				
1999	062642	24,715	MOSSDALE	19APR99	8		128				
	062643	24,725	MOSSDALE	19APR99	15		134				
	062644	25,433	MOSSDALE	19APR99	13		132				
	062645	25,014	DOS REIS	19APR99	20		151				
	062646	24,841	DOS REIS	19APR99	19		225				
	0601110815	24,927	JERSEY PT	21APR99	34		338				
	062647	24,193	JERSEY PT	21APR99	25		381				
	Effective Release	74,873	MOSSDALE		36		394	0.380		0.400	0.360
	Effective Release	49,855	DOS REIS		39		376	0.600		0.651	0.515
	Effective Release	49,120	JERSEY PT		59		719				
2000	06-45-63	24,457	DURHAM FERRY	17-Apr-00	11	11	245				
	06-04-01	23,529	DURHAM FERRY	17-Apr-00	7	6	214				
	06-04-02	24,177	DURHAM FERRY	17-Apr-00	10	10	229				
	06-44-01	23,465	MOSSDALE	18-Apr-00	9	14	206				
	06-44-02	22,784	MOSSDALE	18-Apr-00	9	16	174				
	06-44-03	25,527	JERSEY PT	20-Apr-00	24	50	646				
	06-44-04	25,824	JERSEY PT	20-Apr-00	41	47	706				
	Effective Release	72,163	DURHAM FERRY		28	27	688	0.310	0.190	0.242	0.362
	Effective Release	46,249	MOSSDALE		18	30	380	0.310	0.330	0.329	0.312
	Effective Release	51,351	JERSEY PT		65	97	1352				
	601060914	23,698	DURHAM FERRY	28-Apr-00	7	8	46				
	601060915	26,805	DURHAM FERRY	28-Apr-00	5	15	44				
	0601110814	23,889	DURHAM FERRY	28-Apr-00	10	8	70				
	0601061001	25,572	JERSEY PT	1-May-00	48	76	356				
	0601061002	24,661	JERSEY PT	1-May-00	30	76	228				
	Effective Release	74,392	DURHAM FERRY		22	31	160	0.190	0.140	0.156	0.185
	Effective Release	50,233	JERSEY PT		78	152	584				
2001	06-44-29	23,354	DURHAM FERRY	30-Apr-01	14	28	95				
	06-44-30	22,837	DURHAM FERRY	30-Apr-01	22	30	155				
	06-44-31	22,491	DURHAM FERRY	30-Apr-01	17	18	110				
	06-44-32	23,000	MOSSDALE	1-May-01	17	18	123				
	06-44-33	22,177	MOSSDALE	1-May-01	14	15	107				
	06-44-34	24,443	JERSEY PT	4-May-01	50	156	464				
	06-44-35	24,992	JERSEY PT	4-May-01	61	173	553				
	Effective Release	68,682	DURHAM FERRY		53	76	360	0.340	0.170	0.211	0.255
	Effective Release	45,177	MOSSDALE		31	33	230	0.310	0.110	0.159	0.247

Table 5-6
Survival indices based on Chipps Island, Antioch, and ocean recoveries of Merced River Fish Facility salmon released as part of South Delta studies (1996 - 1999) and VAMP (2000 - 2003).

Release Year	San Joaquin River (Merced River origin) Tag Number	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 Catch
		Juvenile Salmon CWT Releases						Absolute Survival Estimates		Differential Recovery Rates	
	Effective Release	49,435	JERSEY PT		111	329	1017				
	06-44-36	24,025	DURHAM FERRY	7-May-01	2	8	17				
	06-44-37	24,029	DURHAM FERRY	7-May-01	5	11	47				
	06-44-38	24,177	DURHAM FERRY	7-May-01	2	10	28				
	06-44-39	23,878	MOSSDALE	8-May-01	4	8	25				
	06-44-40	25,308	MOSSDALE	8-May-01	4	11	27				
	06-44-41	25,909	JERSEY PT	11-May-01	17	43	243				
	06-44-42	25,465	JERSEY PT	11-May-01	27	53	332				
	Effective Release	72,231	DURHAM FERRY		9	29	92	0.130	0.200	0.193	0.114
	Effective Release	49,186	MOSSDALE		8	19	52	0.190	0.180	0.201	0.094
	Effective Release	51,374	JERSEY PT		44	96	575				
2002	06-44-71	23,920	DURHAM FERRY	18-Apr-02	4	11	30				
	06-44-72	25,176	DURHAM FERRY	18-Apr-02	9	20	84				
	06-44-73	23,872	DURHAM FERRY	18-Apr-02	4	12	65				
	06-44-74	24,747	DURHAM FERRY	18-Apr-02	4	20	61				
	06-44-57	25,515	MOSSDALE	19-Apr-02	6	13	72				
	06-44-58	25,272	MOSSDALE	19-Apr-02	7	29	70				
	06-44-59	24,802	JERSEY PT	22-Apr-02	46	101	461				
	06-44-60	24,128	JERSEY PT	22-Apr-02	37	89	394				
	Effective Release	97,715	DURHAM FERRY		21	63	240	0.130	0.160	0.154	0.141
	Effective Release	50,787	MOSSDALE		13	42	142	0.150	0.210	0.194	0.160
	Effective Release	48,930	JERSEY PT		83	190	855				
2002	06-44-70	24,680	DURHAM FERRY	25-Apr-02	3	6	18				
	06-44-75	24,659	DURHAM FERRY	25-Apr-02	5	2	17				
	06-44-76	24,783	DURHAM FERRY	25-Apr-02	3	4	8				
	06-44-77	24,381	DURHAM FERRY	25-Apr-02	4	6	4				
	06-44-78	24,519	MOSSDALE	26-Apr-02	2	3	23				
	06-44-79	24,820	MOSSDALE	26-Apr-02	3	4	14				
	06-44-80	24,032	JERSEY PT	30-Apr-02	18	43	282				
	06-44-81	22,880	JERSEY PT	30-Apr-02	28	32	278				
	Effective Release	98,503	DURHAM FERRY		15	18	47	0.160	0.110	0.130	0.040
	Effective Release	49,339	MOSSDALE		5	7	37	0.110	0.090	0.094	0.063
	Effective Release	46,912	JERSEY PT		46	75	560				
2003	06-02-82	24,563	DURHAM FERRY	21-Apr-03	0	1	5				
	06-02-83	26,036	DURHAM FERRY	21-Apr-03	2	4	0				
	06-27-42	24,179	DURHAM FERRY	21-Apr-03	1	1	8				
	06-27-48	24,706	MOSSDALE	22-Apr-03	2	2	0				
	06-27-43	25,480	MOSSDALE	22-Apr-03	3	2	0				
	06-27-44	24,649	JERSEY PT	25-Apr-03	57	71	93				
	Effective Release	74,778	DURHAM FERRY		3	6	13	0.019	0.015	0.023	0.046
	Effective Release	50,186	MOSSDALE		5	4	0	0.048	0.015	0.035	0.000
	Effective Release	24,649	JERSEY PT		57	71	93				
2003	06-27-45	24,815	DURHAM FERRY	28-Apr-03	0	0	0				
	06-27-46	25,319	DURHAM FERRY	28-Apr-03	0	0	0				
	06-27-47	24,758	DURHAM FERRY	28-Apr-03	0	0	0				
	06-27-49	24,219	MOSSDALE	29-Apr-03	0	0	3				
	06-27-50	24,505	MOSSDALE	29-Apr-03	1	0	0				
	06-27-51	25,950	JERSEY PT	2-May-03	39	36	115				
	Effective Release	74,892	DURHAM FERRY		0	0	0			0.000	0.000
	Effective Release	48,724	MOSSDALE		1	0	3	0.010		0.007	0.014
	Effective Release	25,950	JERSEY PT		39	36	115				

Note: Ocean recoveries are based on data through 2004.

Survival by Reach

In this section, Chinook salmon smolt survival in different reaches of the San Joaquin River will be evaluated between years. These analyses help our understanding of survival through the Delta for VAMP. Initially, survival in the entire reach (Durham Ferry or Mossdale to Jersey Point) will be discussed. Then the entire reach will be broken down by section and discussed further. The second reach discussed will be between Durham Ferry and Mossdale. The third reach is between Durham Ferry (or Mossdale) and Dos Reis. And lastly, the reach between Dos Reis and Jersey Point will be discussed. In this section we will only use CDRR or DRR as our estimate of survival. Data gathered prior to 2000 do not have any Antioch recoveries thus DRR's have been calculated using Chipps Island recoveries alone.

Survival between Durham Ferry or Mossdale and Jersey Point

Smolt survival between Durham Ferry and Jersey Point was low in 2005, as it was in 2003 and 2004. The 2005 survival estimates (0.07 and 0.05) were higher than those obtained in 2003 (0.023, and 0.0) and 2004 (0.026), but still low. The confidence intervals indicate that pooled survival between 2005 and 2004 was not significantly different (Figure 5-7). The pooled estimate in 2003 was the lowest measured to date with a HORB in place. Both the 2003 and 2004 data were much lower than other VAMP years (with the HORB in place) which started in 2000 (Table 5-7). The 2005 data was greater than that gathered in 1994 (0.0) when the HORB was not installed.

Table 5-7
Pooled, Combined Differential Recovery Rate (CDRR) and standard errors for CWT salmon released at Mossdale, Dos Reis and Durham Ferry in relation to those released at Jersey Point between 2000 and 2005.

Year	CDRR	Standard Error
2000	0.187	0.019
2001	0.191	0.014
2002	0.151	0.013
2003	0.019	0.005
2004	0.026	0.010
2005	0.060	0.010

The health of the CWT fish in 2005 may account for some of the low survival observed in 2005. While the fish appeared healthy at the hatchery prior to release, they had a low level of PKD infection. The disease progressed in test fish taken back to the CA/NV Fish Health Center, with severe occurrence observed after 29 days. Forty percent of the VAMP fish recovered at Chipps Island had evidence of infection in their kidneys by the parasite that causes PKD. It is not clear whether these levels of low initial infection rates may have affected our survival estimates to Antioch and Chipps Island in 2005. The CA/NV Fish Health Center concluded that while PKD in the VAMP fish may not have affected their survival to Chipps Island it may affect their long-term survival.

In 2003 and 2004, VAMP experimental fish also had PKD. We hypothesized that the PKD alone did not cause the higher mortality since infection and severe infection rates were not as high as they had been in 2001 when survival was greater (SJRG, 2005). However, the high level of PKD infection in combination with the lower flows in 2003 and 2004 may have differentially increased the mortality of upstream released VAMP fish since Jersey Point groups also had PKD but survived at a higher rate. This hypotheses seems supported by the work conducted by the CA/NV FHC in 2005, that indicated that PKD infection and its effects get worse over time and that a longer migration period (due to the lower flows and further distance than those released at Jersey Point) could have resulted in less smolts surviving to Chipps Island in 2003 and 2004.

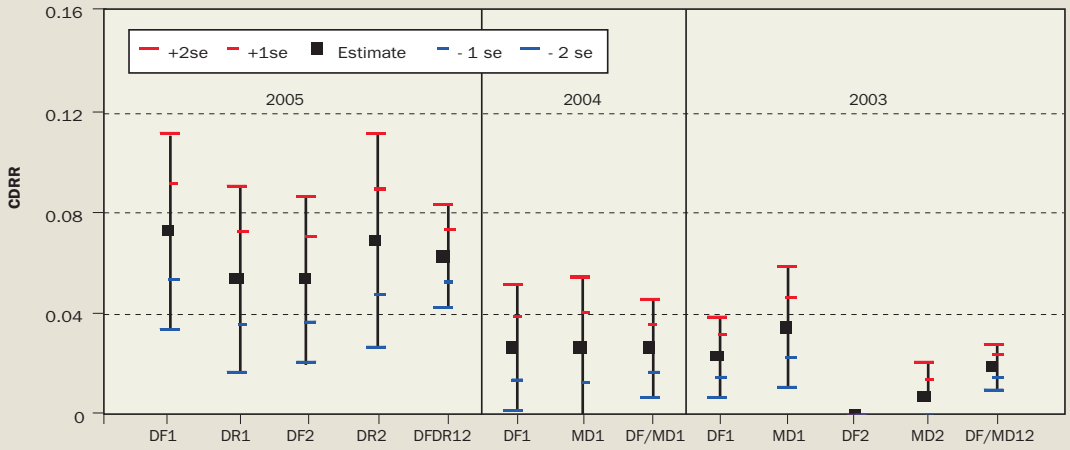
Survival between Durham Ferry and Mossdale

No releases were made at Mossdale in 2005 thus comparisons of survival rates between Durham Ferry and Mossdale cannot be made. However, survival between Durham Ferry and Mossdale between 2000 and 2004 has been generally high using both the Chipps Island and Antioch recoveries as well as the ocean recoveries (Table 5-8). 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.

Table 5-8
Combined Differential Recovery Rates and Differential Recovery Rates for recoveries at Chipps and Antioch and in the ocean fishery for VAMP fish released at Durham Ferry and Mossdale between 2000 and 2004.

Year	CDRR Chipps and Antioch	DRR Ocean
2000	0.733	1.17
2001	1.325	1.04
2001	0.958	1.19
2002	0.794	0.93
2002	1.377	0.65
2003	0.667	
2003	0	
2004	0.998	

Figure 5-7
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 (1), second (2) and combined release groups in 2003, 2004 and 2005. Only one set of releases was made in 2004.



Survival between Durham Ferry (or Mossdale) and Dos Reis

In 2005, releases were made at Durham Ferry and Dos Reis. However, the differences in survival between the two sites and Jersey Point in 2005 were not consistently or significantly different from each other (Figure 5-5). In past years, releases have also been made at Dos Reis and prior to 2005, were paired with comparable releases at Mossdale without the HORB in place. Average survival between Mossdale or Durham Ferry and Dos Reis was 0.71 using the Chipps Island recoveries (and Antioch recoveries in 2005) whereas it was 0.65 using the ocean recoveries (Table 5-9). However, there were two out of the nine instances using the Chipps Island recoveries and one instance using the ocean recoveries where the Mossdale or Durham Ferry groups survived at a higher rate than the Dos Reis groups. Low recovery rates, especially at Chipps Island and Antioch, may hinder our ability to consistently see differences even if they do exist.

Table 5-9
Differential Recovery Rates (and Combined Differential Recovery Rates in 2005) for experimental fish released at Mossdale (or Durham Ferry) and Dos Reis between 1995 and 2005.

MD/DF- DR	Release Date	CI	Ocean
1995	17-Apr	1.26	0.99
1995	5-May	0.31	0.51
1995	17-May	0.44	0.71
1996	30-Apr	0.33	0.38
1998	16-Apr	0.94	1.07
1998	23-Apr	0.4	0.22
1999	19-Apr	0.62	0.7
2005	2-May	1.36	
2005	9-May	0.76	
Average		0.71	0.65

Only once were releases made at Mossdale and Dos Reis with the HORB in place. That was in 1997 and estimates of survival between the two locations were 1.02 using Chipps Island recoveries and 1.29 using ocean recoveries. These data further reinforce that the temporary HORB provides protection to juvenile salmon migrating from the San Joaquin basin by reducing or preventing these fish from being drawn into upper Old River.

Survival between Dos Reis and Jersey Point

Survival in the reach from Dos Reis to Jersey Point in 2005, was much lower than survival from Durham Ferry to Dos Reis. This indicates that most of the juvenile salmon mortality occurs in the lower reach of the Delta. This finding is consistent in all years.

There have been 15 experiments where releases have been made at Dos Reis and Jersey Point, with three of these made in 1997 with the HORB in place. Data was gathered in the spring between 1989 and 1991, 1995 and 1999 and during 2005 without the HORB in place. Survival for the non-HORB years, using CDRR or DRR at Chipps Island (and Antioch recoveries in 2005) ranged between 0.03 and 0.66 and averaged 0.20. For ocean recoveries the DRR ranged between 0.05 and 0.83 and averaged 0.36 (Table 5-10). These data indicate that survival from Dos Reis to Jersey Point is generally low but has been relatively high some years. The highest survival was observed in 1995, 1997, 1998 and 1999.

Table 5-10
CDRR and DRR for survvial between Dos Reis (DR) and Jersey Point (JP) between 1989 and 2005. Stock is either Feather River (FR) or Merced River (MR). The HORB was usually not installed (n) except in 1997 (y).

Year	Release Date	CI DRR or CI and Antioch CDRR	Stock	HORB	DRR Ocean
1989	20-Apr	0.16	FR	n	0.2
1990	16-Apr	0.06	FR	n	0.05
1990	2-May	0.03	FR	n	0.08
1991	15-Apr	0.09	FR	n	0.13
1995	17-Apr	0.31	FR	n	0.83
1996	1-May	0.06	FR	n	0.11
1996	1-May	0.12	MR	n	0.15
1998	17-Apr	0.32	MR	n	0.47
1998	24-Apr	0.28	FR	n	0.77
1999	19-Apr	0.66	MR	n	0.52
1997	29-Apr	0.18	FR	y	0.37
1997	29-Apr	0.3	MR	y	0.492
1997	8-May	0.28	MR	y	0.485
2005	3-May	0.05	MR	n	
2005	10-May	0.07	MR	n	
Average		0.20			0.36

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 suggest that adult escapement in the San Joaquin basin is affected by flow in the San Joaquin River at Vernalis and exports by the CVP and SWP 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 would 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 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). These studies indicated that smolts released on the San Joaquin River downstream of the HOR survived at about twice the rate of those released in the Old River. And while those data were not statistically significant, placing a temporary barrier at the Head of Old River appeared to be a management action that would improve survival through the Delta for smolts originating from the San Joaquin basin. The HORB barrier cannot be installed when the San Joaquin River flows exceed 5,000 cfs during the scheduled installation period, and would potentially need to be removed if the San Joaquin River flows were to exceed 7,000 cfs.

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 assumed as part of the VAMP experimental design. This year was the first year since 2000 that the HORB has not been in place during the VAMP experiment. 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, CDRRs using recoveries at Chipps Island and Antioch as our estimate of survival between Durham Ferry and Mossdale and Jersey Point data from 1994- 2005 were plotted. In the past the CDRRs of all Durham Ferry and Mossdale releases within a year were pooled, as they were not significantly different from each other at the 95% confidence level. To increase our sample size, each separate estimate was used in this year's evaluation. Prior to combining the data from both locations, regression lines comparing the CDRR/DRR's to Vernalis flow were evaluated from both locations independently. The results indicated that the variances and the regression lines from the two locations were not statistically different. Thus the CDRR/DRR data from both Mossdale and Durham Ferry releases were plotted together in the various relationships discussed below.

Flows at Vernalis were 10 day averages for each release starting on the day of the Mossdale release (in previous years) 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 prior to 2005 were obtained from DWR from a model that simulated historical flows using DSM2 (T. Smith, DWR Personal Communication). Flow data for 2005 was obtained from Chapters 2 and 4 of this report. A request has been made to DWR to compare measured flows to those predicted by the model for the spring of 2005.

Role of flow with HORB on Salmon Survival

The CDRR/DRRs 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 ($p<0.01$; Figure 5-8).

The relationship between Vernalis flow and DRR using the ocean data with the HORB was also positive and statistically significant ($p<0.01$; Figure 5-9). The ocean data has fewer data points because recoveries are not yet available for the 2004 and 2005 releases.

Figure 5-8
CDRR or DRR using Chipps Island and Antioch recoveries between Mossdale or Durham Ferry and Jersey Point with the HORB in place 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.

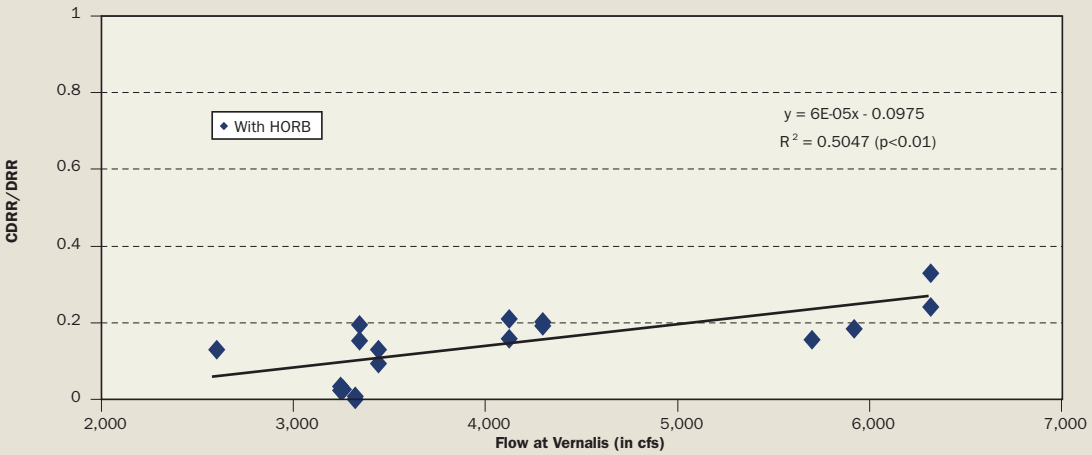


Figure 5-9
DRR using ocean recoveries, between Mossdale or Durham Ferry and Jersey Point and average flow at Vernalis in cfs for 10 days starting the day of the Mossdale release or the day after the Durham Ferry release with the HORB in place.

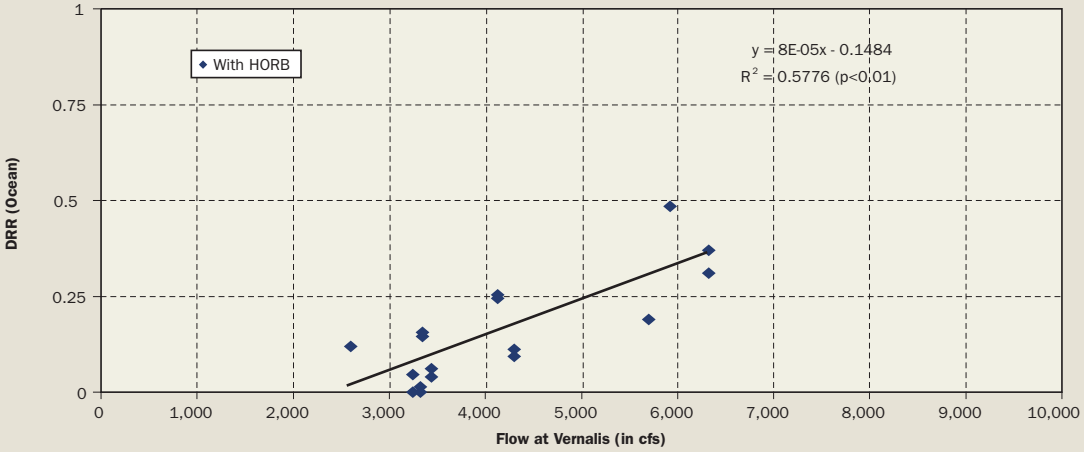
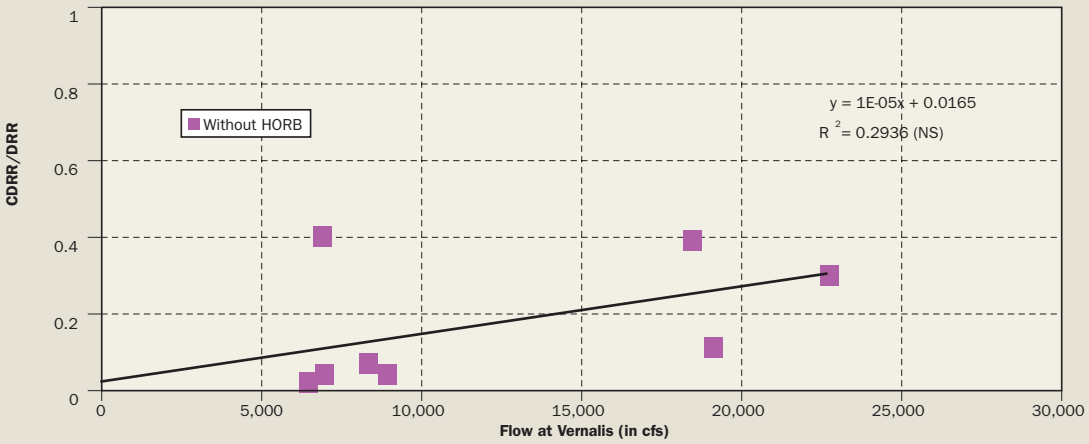


Figure 5-10
CDRR or DRR using Chipps Island and Antioch recoveries between Mossdale or Durham Ferry and Jersey Point and average flow at Vernalis in cfs for 10 days starting the day of the Mossdale release or the day after the Durham Ferry release without the HORB in place.



Role of flow without HORB on Salmon Survival

Without the HORB in place, the regression line of the DRR/CDRR's using the Chipps Island and Antioch recoveries of the Mossdale and Durham Ferry to Jersey Point survival increased with flow, but the relationship was not statistically significant (Figure 5-10).

The relationship using the ocean data without the HORB had a higher r^2 value than the one obtained using the Chipps Island and Antioch data, but was still not statistically significant (Figure 5-11). The two relationships were similar indicating that increasing flow may improve survival of the Mossdale and Durham Ferry groups relative to the Jersey Point groups without the HORB in place.

It is not surprising that there is more variability 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 "stayed" on the mainstem San Joaquin River and were not diverted into upper Old River. The CDRR/DRR's of smolts released at Dos Reis relative to those released at Jersey Point were compared to modeled San Joaquin flow downstream of the HOR. Three data points were gathered when the HORB was installed in 1997. The Chipps Island/Antioch data indicated a possible relationship between survival and flow, but one year (1999) was an obvious outlier (Figure 5-12). The relationship using the ocean recovery data showed that survival from Dos Reis to Jersey Point did increase with San Joaquin flows downstream of the HOR and it was statistically significant at the $p<0.01$ level (Figure 5-13). The 1999 data was no longer an outlier indicating that perhaps the Jersey Point group was biased low due to some missed sampling at Chipps Island that spring, as hypothesized in an earlier report (Brandes, 2000). This relationship indicated that survival is increased as flow increases on the mainstem San Joaquin River downstream of Old River, for the fish staying on the mainstem San Joaquin River when there is no HORB in place.

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. Historically, exports were generally much greater during this period. The VAMP design was intended to identify the role of exports with the HORB at flows of 7,000 cfs by experimenting at exports of 1,500 and 3,000 cfs. Conditions have not provided a 7,000 cfs flow with a HORB to test either export level. These limitations have made assessing the role of exports using the VAMP data difficult 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, an agreement to have combined SWP/CVP pumping at 1,500 cfs for two weeks and then 3,000 cfs for the following two weeks was established and fish releases were to be made at each export level. However this agreement was not implemented as one of the parties did not initially adjust pumping as proposed. The failure to adjust pumping rates resulted in a combined pumping of approximately 2,250 cfs when marked fish were first released. A resolution was then implemented to maintain pumping at this rate for the full VAMP period. Pumping was approximately 2,250 cfs for the first 26 days of the 31 day VAMP period. Starting on May 26, exports increased gradually because the continued implementation of the reduced export level was increasing the costs (Environmental Water Account debt) to levels unacceptable to the implementing agencies.

Role of exports with HORB

Exports do not appear to explain additional variability in smolt survival over that using flow alone, in data obtained with the HORB in 1994, 1997 and between 2000 and 2004. 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 between 1951 and 2002 than that when using flow alone. In the recovery data from Chipps Island and Antioch (CDRR and DRR) with the HORB installed, regression analyses did show a relationship between the Durham Ferry and Mossdale data and flow/export ratios (Figure 5-14). However, the p value (0.02) indicated lower significance than the regression using flow alone ($p <0.01$) (Figure 5-8).

The ocean recovery data, while only available for releases prior to 2002, does show a trend of increasing survival with higher flow/export ratios but the relationship is not as statistically significant ($p<0.10$; Figure 5-15). Again, the relationship using flow alone was stronger (Figure 5-9).

One limitation in these experiments is the extremely narrow range of exports (1,450 to 2,350 cfs) during these smolt survival experiments with the HORB – a narrower range than in the VAMP design and much more narrow than the range of export levels observed since 1951 used in the adult escapement relationships. This narrow range may be why we can not detect a better smolt survival relationship using the flow/export ratio variable than when using flow alone with the HORB in place.

Figure 5-11
DRR using 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.

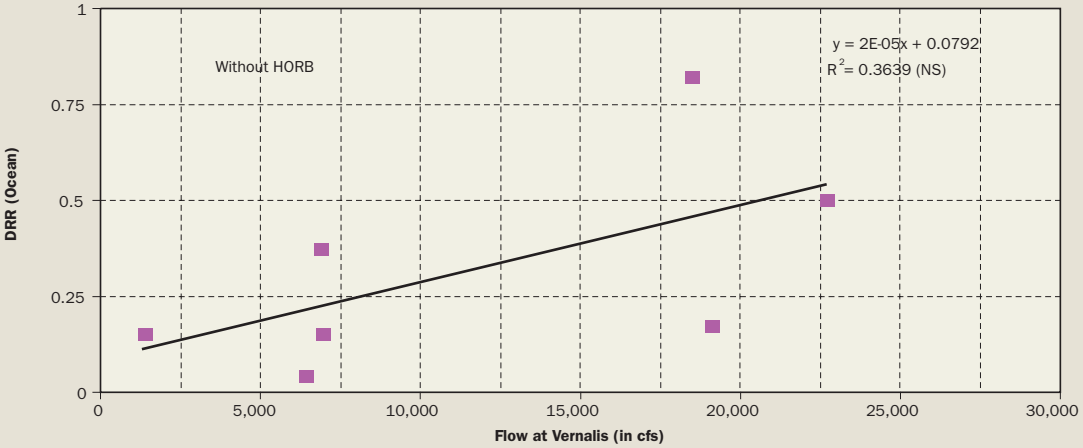


Figure 5-12
Survival between Dos Reis and Jersey Point (using recoveries at Chipps or Chipps and Antioch) with and without the HORB and modeled San Joaquin flows downstream of Old River. 1997 data was gathered with the HORB in place.

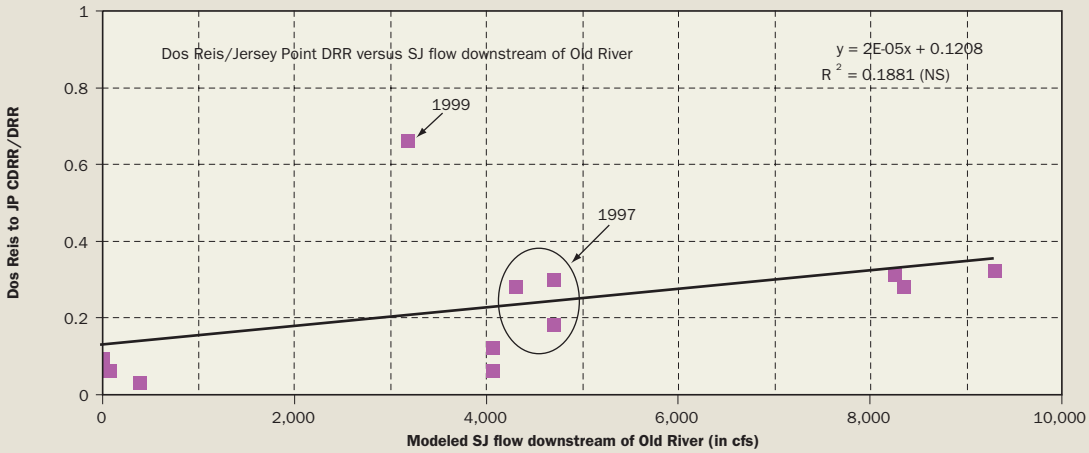


Figure 5-13
Ocean DRR of survival between Dos Reis and Jersey Point with and without a HORB and San Joaquin flows downstream of Old River. 1997 data was gathered with the HORB in place.

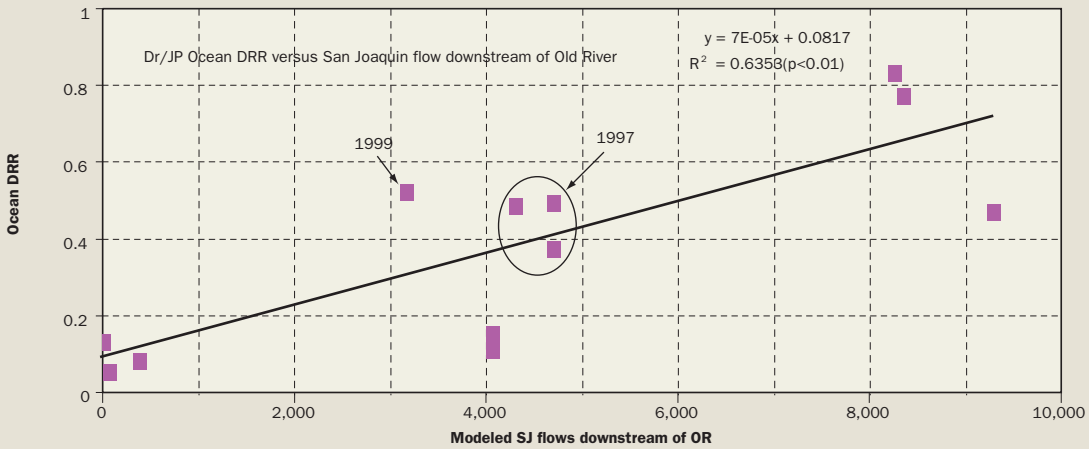


Figure 5-14
The survival between Durham Ferry or Mossdale and Jersey Point (CDRR/DRR) using Antioch and or Chipps Island recoveries and the Vernalis flow/export ratio for the 10 days after the Mossdale release. The data is gathered in years when there was a HORB in place.

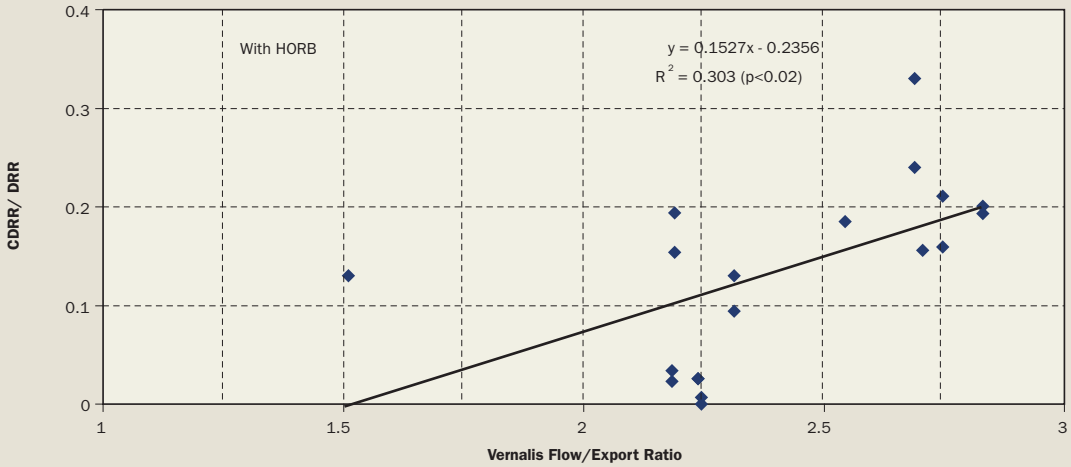


Figure 5-15
Ocean DRR of fish released at Durham Ferry or Mossdale and Jersey Point versus mean Vernalis flow/export ratio 10 days after release with the HORB in place.

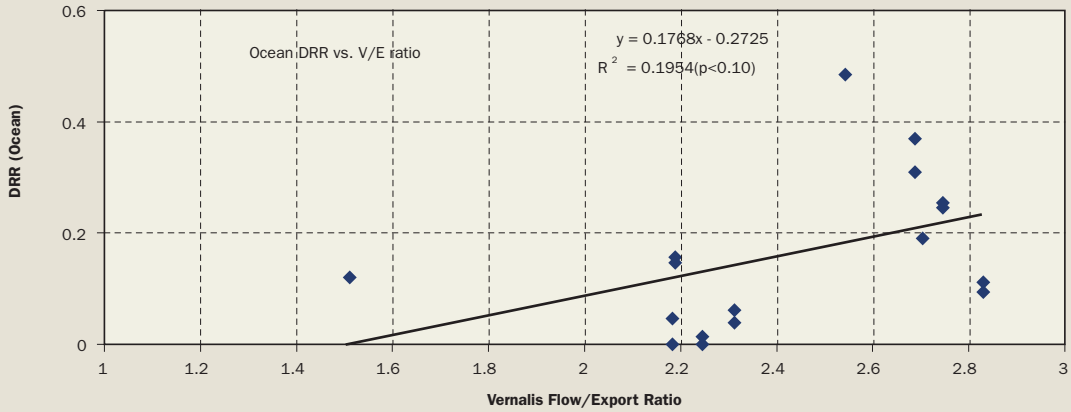
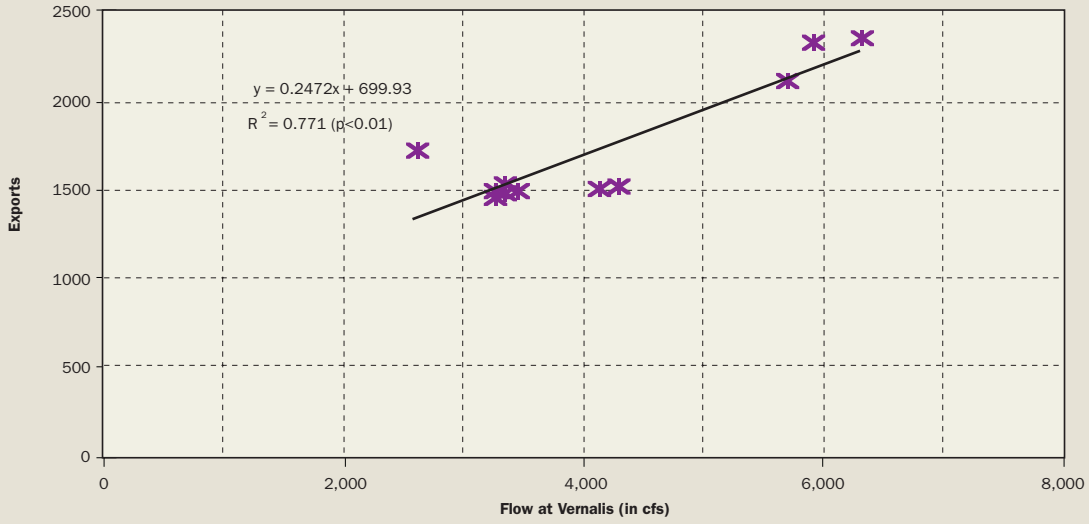


Figure 5-16
The relationship between San Joaquin River flows at Vernalis and CVP+SWP Exports during VAMP smolt survival tests conducted with the HORB in years between 1994 and 2004.



Additional analyses by Dean Marston of California Deparment of Fish and Game found that the CDRR and DRR's increased as exports increased in simple linear regressions (r^2 = 0.47 – Chipps and Anitoch recoveries, and r^2 = 0.69 – ocean recoveries) of the Mossdale groups relative to the Jersey Point groups, using both Antioch and Chipps Island and ocean recoveries. But when the exports and flow values used in these regressions were regressed against each other, there was a strong relationship between flow and exports (r^2 = 0.77) indicating that in general the experiments conducted with the HORB at the lower flows had lower exports and experiments at the higher flows had higher exports (Figure 5-16). It is problematic to identify the respective roles of each variable when the two variables tested are linked in this way.

Our next step is to experiment at flows of 7,000 cfs with the HORB and vary exports (1,500 and 3,000 cfs) to better define the export affect, independent of flow, on smolt survival.

Role of exports without HORB

The role of exports on smolt survival without the HORB in place is even more difficult to identify at this time. As mentioned earlier, relationships of smolt survival without the HORB with flow alone were not statistically significant (Figures 5-10 and 5-11). Regressions of exports to smolt survival without the HORB were weakly or not statistically significant (Figure 5-17) using both the Chipps Island and Antioch and ocean recoveries, but both relationships indicated survival increased as exports increased. 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 ($p<0.68$, $p<0.10$). In these data flows and exports were not correlated to each other (r^2 =0.0142), but the export range was limited to between 1400 and 3700 cfs. It is possible that increasing exports in this range decreases residence time in Old river such that survival for those smolts moving into Old River have higher survival. These findings are counter to our hypothesis that survival decreases as exports increase relative to flow.

Regressions between the DRR from Mossdale and Durham Ferry using Chipps Island and Antioch and ocean recoveries did not show a relationship with flow/export ratios (Figure 5-18) – but again these data are limited in the range of export values tested. The adult escapement data which incorporates a larger range in export values indicates a positive and strongly statistically significant relationship ($p<0.01$) with flow/exports without the HORB but we are not able to detect this same relationship with the smolt survival data we have gathered to date. As in the with HORB data, it will be important to continue these experiments in the future and to measure survival at different export levels at the same flows without the HORB.

The Role of the HORB on survival through the Delta

One obvious result of the HORB on survival through the Delta is the lower salvage (and direct loss) for fish released at Durham Ferry and Mossdale when the HORB is installed. In 2005, several hundred of the Durham Ferry group, were salvaged indicating a higher loss compared to previous years because the HORB was not in place.

Comparing the with and without HORB data, using the Chipps Island and Antioch data, appears to indicate that there is value in installing the HORB at flows between about 3,000 and 6,000 cfs (Figure 5-19a). The benefit, using the ocean data, seems less apparent but may improve survival between flows of 4,000 and 6,000 cfs (Figure 5-19b).

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

The relationships between flow and flow/exports to escapement (all year classes) 2 1/2 years later have been shown in previous reports (SJRGA, 2003). In this section of the report, we will present revised escapement data (includes all age classes) which only includes escapement from the Stanislaus, Tuolumne and Merced rivers. Previous estimates included escapement in the Mokelumne, Calaveras and Consumnes rivers as well. In addition, the data has been updated to include the most recent escapement (to 2004) and flow (to 2002) data. 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/index/asp.

These updated escapement data for the years of 1953 to 2004 was divided into two groups: the first group includes data gathered in those years when the HORB was in place for at least 2 weeks during the smolt out-migration period (April 15 to June 15) 2 1/2 years earlier and the second group includes escapement data for those years when there was no HORB. These relationships using both sets of data continue to show that escapement is significantly ($p<0.01$) correlated to Vernalis flows (Figure 5-20) and Vernalis flows/CVP+SWP exports continues to explain more of the variability in adult escapement than when using flow alone when there was no HORB in place (Figure 5-21). In addition, escapement was significantly correlated to Vernalis flows minus exports (Figure 5-22). The highest r^2 value for the years when there was a HORB in place was for the relationship between adult escapement and flow. This may reflect the relatively low exports in the years the HORB has

Figure 5-17
Chipps Island DRR or Chipps Island and Antioch DRR and ocean DRR for CWT smolts released at Mossdale or Durham Ferry relative to those released at Jersey Point versus combined SWP+CVP mean exports for the 10 days after release in years between 1994 and 2005 when there was no HORB in place.

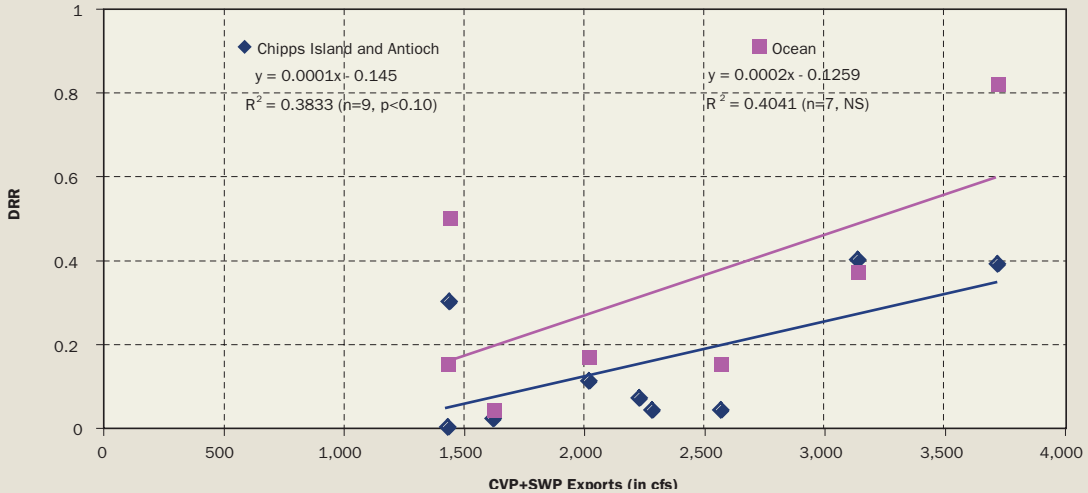


Figure 5-18
Ocean DRR's and Antioch and/or Chipps Island CDRR's or DRR's for fish released at Mossdale and Jersey Point versus the mean Flow/Export ratio for the 10 days after release without the HOR barrier.

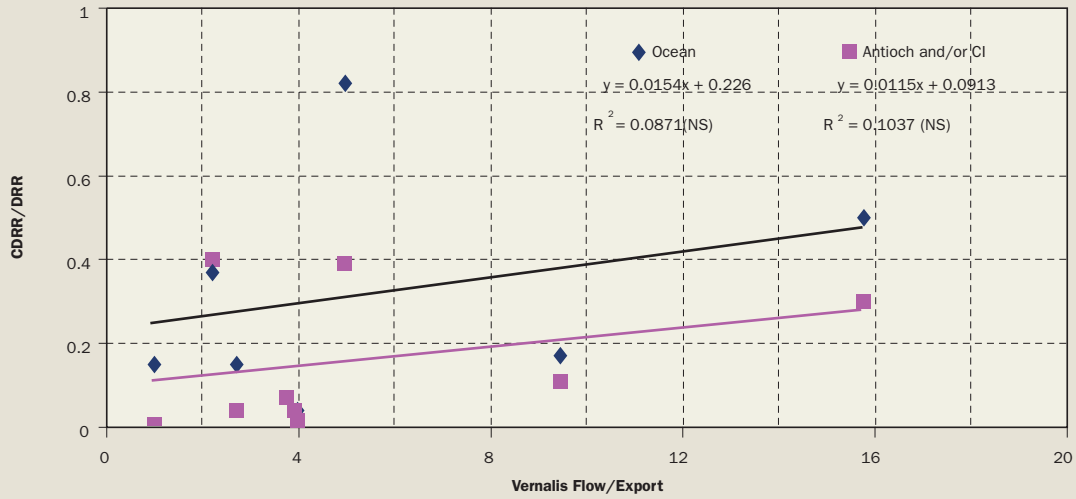


Figure 5-19
CDRR or DRR using Chipps Island and Antioch recoveries between Mossdale or Durham Ferry and Jersey Point and average flow at Vernalis in cfs.

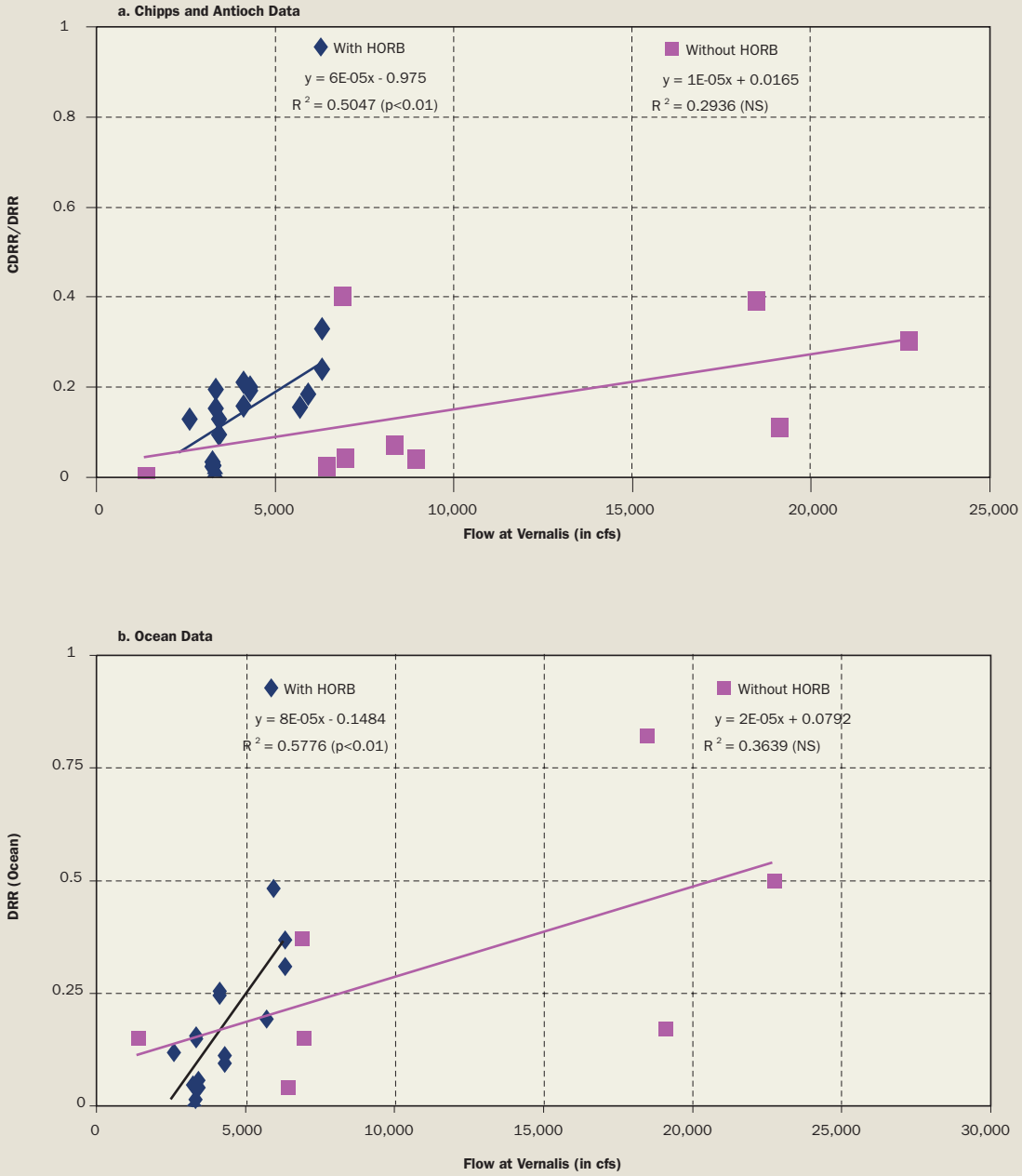


Figure 5-20
Vernalis flows versus escapement 2 1/2 years later in years with and without the HORB.

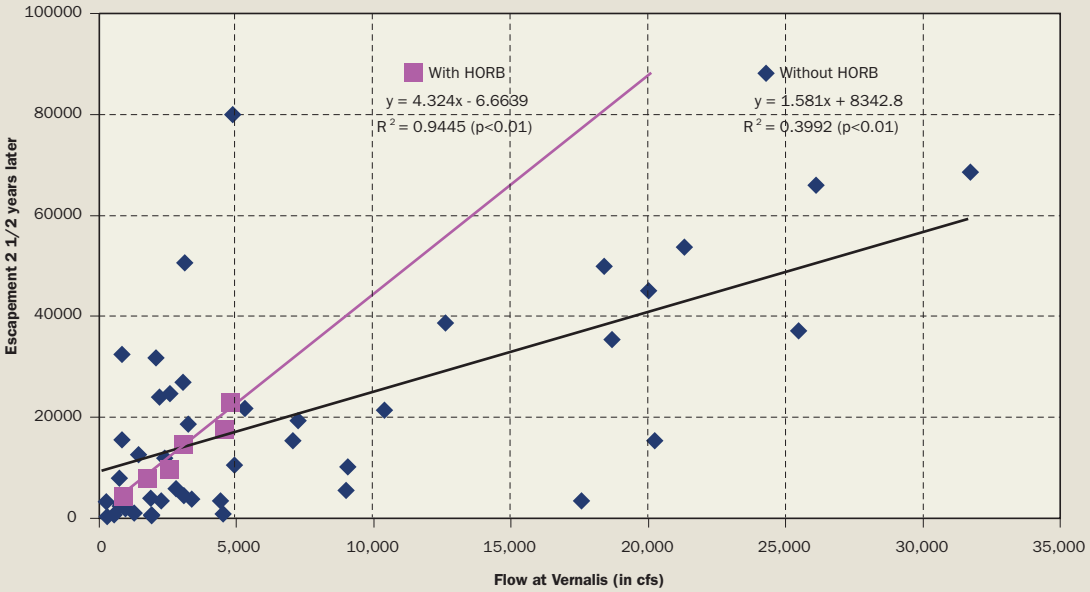
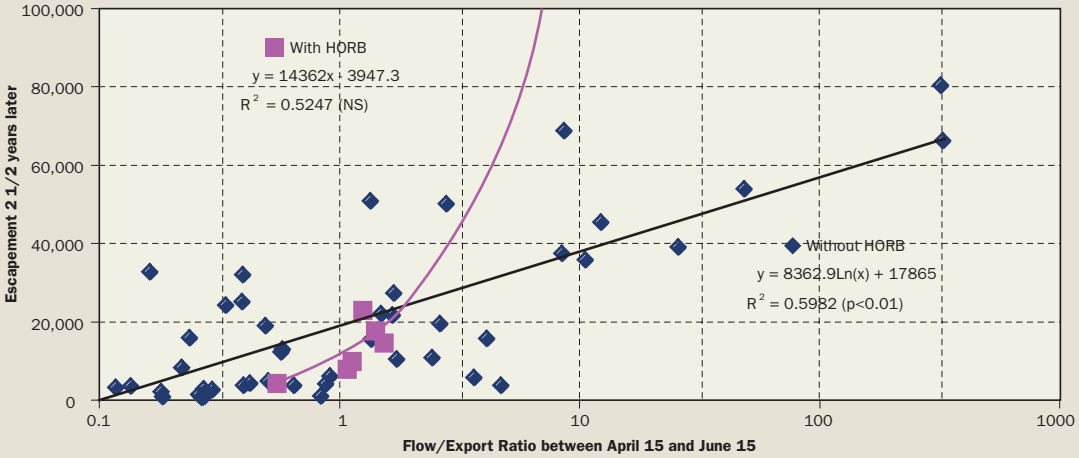


Figure 5-21
Vernalis flow/export ratio versus adult escapement 2 1/2 years later in years with and without the HORB in place.



been in place and the greater effect over a broader range of flow relative to exports on escapement when there wasn't a HORB.

In a multiple regression correlating escapement to flows and exports, exports did not provide any additional predictive power to the model than using flow alone. It is not clear why escapement without the HORB is better predicted using the flow/export ratio than flow alone in simple linear regressions, but in a multiple regression, exports do not explain any additional variability in escapement in all years between 1953 and 2004 over that of flow alone. The with and without HORB data was not partitioned in the multiple regression analyses and may explain some of these differences.

In addition, the ratio of exports to flow (opposite of the flow to export ratio) has been used in the past to estimate the amount of flow diverted into HOR when there is no HORB installed (Jim Snow, DWR, personal communication). It is likely the amount of flow diverted affects the proportion of smolts diverted into HOR. The smolts diverted into HOR would likely be more affected by project exports which in turn would affect their overall smolt survival through the Delta and sequential adult returns 2 1/2 years later. This relationship between the ratio of exports/flow and the proportion of flow diverted into Old River may help explain why we see relationships with the flow/export ratio to adult escapement but do not find that exports account for any additional variability in a multiple regression analyses with flow.

The benefit of examining these adult relationships is that there is more data gathered over a broader range than for 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. So while we cannot yet see a significant relationship of flow/exports to smolt survival with the limited data gathered to date, these data would suggest there is a relationship and it predicts adult escapement better than flow alone when there is no HORB. The relationship of flow alone to data gathered with the HORB may reflect the lack of variability in exports with the HORB in place during these experiments as mentioned previously.

When comparing the relationships of escapement and flow with and without the HORB we find that the HORB may have increased escapement between average flows of about 3,000 to 5,000 cfs (Figures 5-20). However, it is not clear that the with and without HORB regression lines are different from one another. Using the relationships of escapement, to evaluate the benefits of the HORB, are imprecise because the HORB wasn't in place for the entire migration period of the juvenile salmon that returned to spawn 2 1/2 years later. This is only one of the sources of noise in the escapement data. Additional data are needed to confirm this apparent benefit. Returns based on cohort estimates (specific year classes) would provide an important refinement to this assessment, as the assumption that the majority of spawners are 3-year old fish is known to be inaccurate.

Summary

With the HORB in place we have established statistically significant relationships between smolt survival and flow at Vernalis. These relationships are found using the Chipps Island and Antioch smolt recovery data and the ocean recovery data. The smolt survival data obtained without the HORB show a trend of increasing survival as flows increase but relationships are weaker and not statistically significant. The relationship between ocean recovery rates of the Dos Reis groups relative to the Jersey Point groups indicate that survival improves as flows increase for smolts that remain within the mainstem San Joaquin River when there is no HORB. 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. It is imperative that we measure the two export rate conditions (1,500 and 3,000 cfs) at flows of 7,000 cfs with a HORB in place so that the uncertainty can be resolved. Additional data should also be gathered without the HORB. Finally, the relationships with adult escapement infer that survival through the Delta can be improved with 1) increased flow when there is a HORB, 2) increased flow/export ratios when HORB is not installed, and 3) with a HORB at flows between 3,000 and 5,000 cfs.

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.

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

Figure 5-22
Relationship between San Joaquin flow minus exports between April 15 and June 15 and adult escapement 2 1/2 years later with and without the HORB in place.

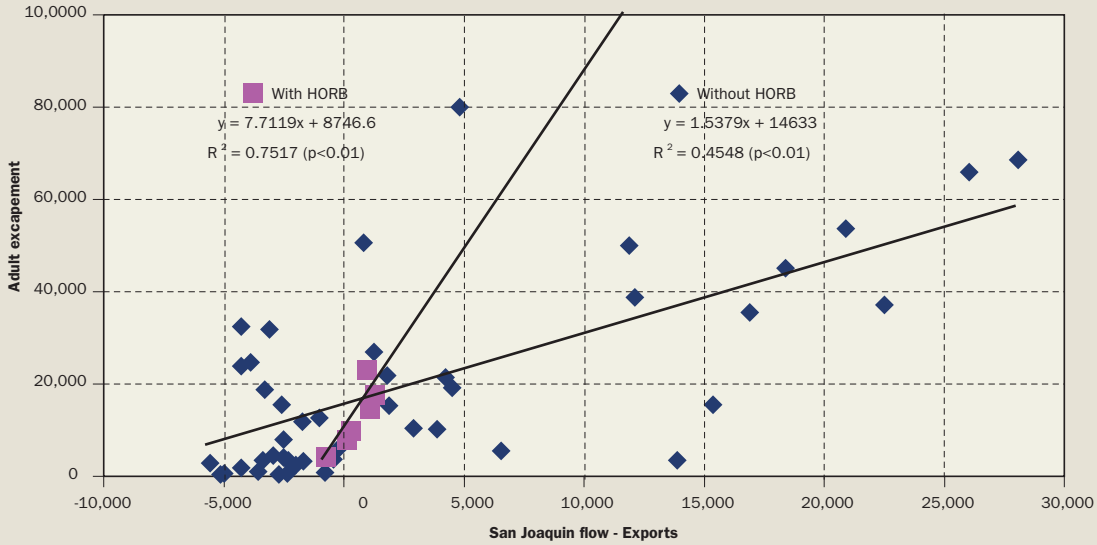


Figure 5-23
The average daily densities of unmarked salmon caught in the Mossdale Kodiak trawl on the San Joaquin River and the percent of smolts protected during the pre-VAMP and VAMP periods.

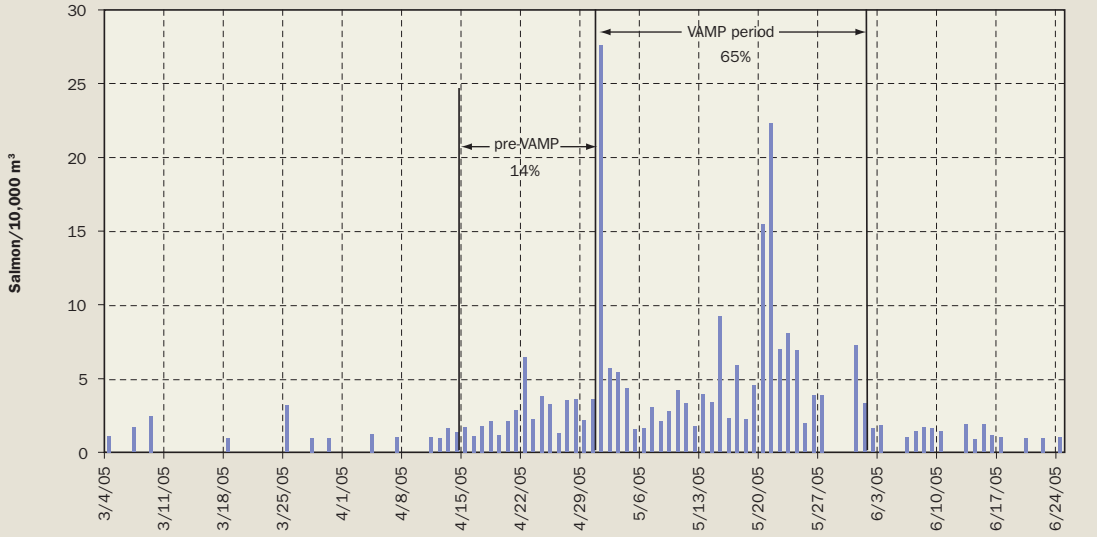


Figure 5-24
Mossdale Kodiak trawl individual daily forklengths of all unmarked juvenile Chinook salmon, March 15 through June 30, 2005.

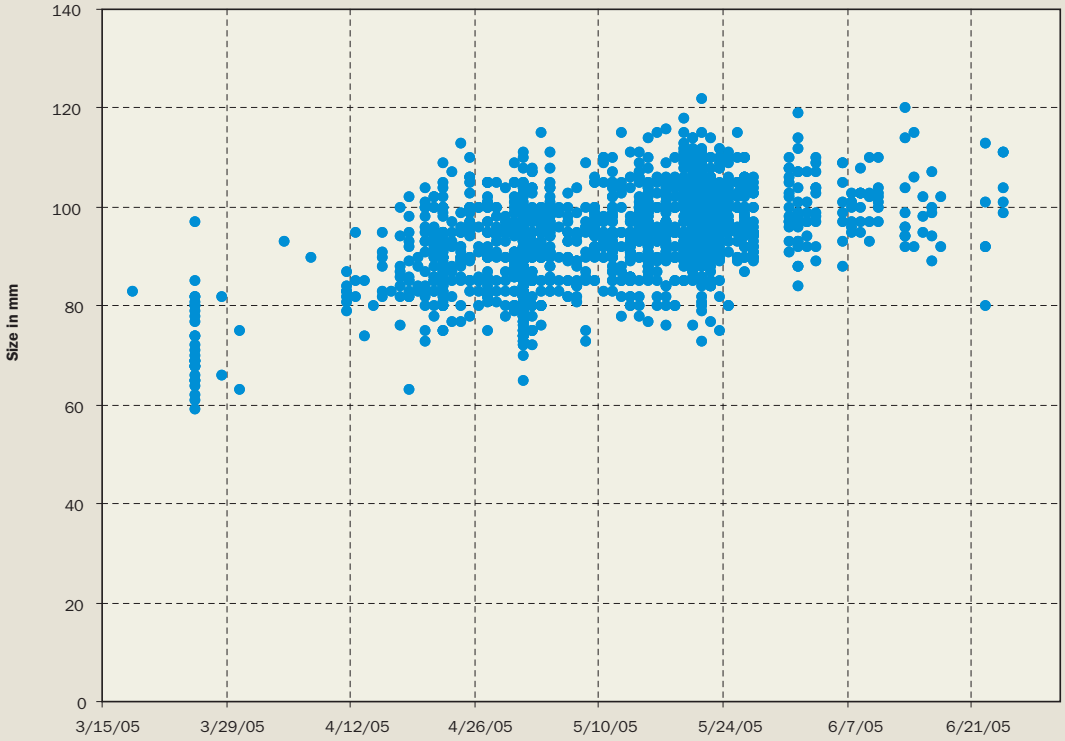
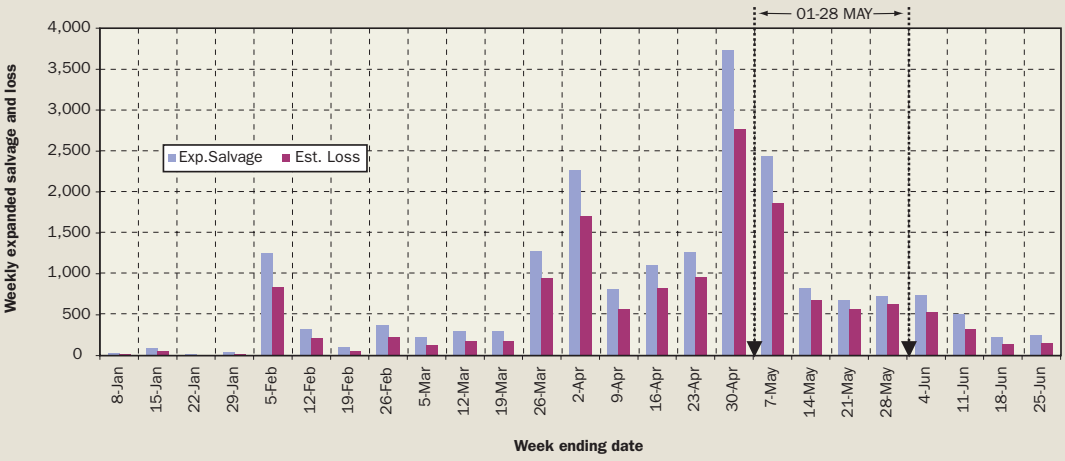


Figure 5-25
2005 CVP Estimated Salmon Salvage and Loss



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 smolts emigrating from the San Joaquin tributaries passed into the Delta at Mossdale during that time. In 2005, the VAMP period was delayed until May 1 with the intent of providing more stability in the river flows at Vernalis. The average catch per 10,000 cubic meters per day of unmarked juvenile salmon caught in Kodiak trawling at Mossdale between March 15 and June 30, 2005 is shown in Figure 4-6. Unmarked salmon do not have an adipose clip and could be juveniles from natural spawning or unmarked fish released from the MRFF.

Approximately 65% of the unmarked catch that passed Mossdale between March 15 and June 30 passed during this years VAMP period (May 1 – June 1) (Figure 5-23). The range has varied between 31 and 76% in the pervious VAMP years since 2000 (SJRG, 2005). The pre- VAMP shoulder on VAMP that restricted exports between April 18 and May 1 provided protection to an additional 14% of the population in 2005 (Figure 5- 23). The size of the juvenile salmon migrating past Mossdale between March 15 and June 30, 2005 is shown in Figure 5-24.

Salmon Salvage and Losses at Delta Export Pumps

Fish salvage operations at the CVP and SWP export facilities capture unmarked salmon and transport them by tanker truck for release 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 MRFF smolts at the salvage facilities to provide some general indications as to the origin of the unmarked fish.

The 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 CVP losses are about six to eight times less, per salvaged salmon, than for the SWP. The loss estimates do not include any indirect mortality in the Delta due to water export operations, or any additional mortality associated with trucking and handling, or post-release predation.

Density of salmon at the fish facilities is represented by the combined number of salvage and losses estimated per acre-foot of water pumped. This approach provides more comparable densities at each facility than density values based only on salvage estimates that were used previously, due to the different calculation of associated losses at each location. 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.

The weekly data covering the period of May 1 to May 28 approximated the 2005 VAMP period. A review of weekly data for January through June indicates that the highest CVP salvage and loss occurred from late April to early May. Lesser peaks occurred between late March and early April and in early February (Figure 5-25). Highest SWP salvage and loss were in late April with a sustained broad peak from mid-May to mid-June (Figure 5-26). The primary CVP and SWP peaks occurred during an extended period of late March to mid-June when combined CVP and SWP weekly export rates were equal to, or exceeded by Vernalis flow (Figure 5-27).

Salmon densities at the CVP facilities were highest in late April to early May, with an earlier peak in late March (Figure 5-28). Densities at the SWP facilities were highest in the second half of May and were elevated from mid-April through early June (Figure 5-28).

The size distribution of unmarked salmon during mid-March through May in the Mossdale trawl (Figure 5-24) was a subset of the size distribution of those salvaged at the fish facilities (Figure 5-29, Source E. Chappell, DWR). Based on comparisons with Mossdale data (Table 4-2), it appears that some salmon salvaged prior to VAMP could have been from the San Joaquin basin.

Results of these analyses showed that the 2005 VAMP test period and the pre-VAMP curtailment in exports for Delta smelt coincided with much of the peak period of San Joaquin River salmon smolt emigration. Reductions in SWP and CVP exports and increased San Joaquin River flow likely provided improved conditions for salmon survival through the Delta.

SUMMARY AND RECOMMENDATIONS

The survival estimates and CDRRs measured in 2005 were low and similar to those estimated in 2003 and 2004. One of the reasons 2005 survival was low was due to the fact that there was no HORB installed. We would have predicted higher survival if the HORB had been installed.

The health of the fish used in 2005 was again somewhat suspect and improving their condition should be discussed with those responsible for fish production in the basin. Specifically, factors that could reduce the incidence of the parasite that causes PKD should be identified. The CA/NV FHC has shown PKD is also in the wild population in the San Joaquin basin. The survival indices were consistently low for all of the marked fish released from MRFF, with the exception of those released at Jersey Point. However, the survival of fish released at Jersey Point may have been reduced after they passed Chipps Island because they also had PKD but in general were recovered sooner then those released upstream.

There are statistically significant relationships of smolt survival and flow with the HORB. These relationships are found using the Chipps Island and Antioch recoveries of the Durham Ferry and Mossdale groups relative to the Jersey Point groups and when using ocean recoveries. Escapement 2 1/2 years later was also significantly ($p<0.01$) correlated to San Joaquin River flow at Vernalis with a HORB.

There is also a trend of increasing smolt survival with San Joaquin River flow without the HORB but the relationships are not statistically significant. There is however, a statistically significant relationship between spring flows without a HORB and adult escapement 2 1/2 years later. Without a HORB the best predictor of escapement is the flow/export ratio.

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 are at exports at 1,500 and 3,000 cfs with San Joaquin River flows at 7,000 cfs with the HORB in place. In addition, the 7,000 cfs flow and the 1,500 export condition would achieve the highest inflow to export ratio (4.7) within the VAMP design and provide a larger ratio to test. Unless these extremes are tested soon, the length of the study may need to be extended. Furthermore, more data should be obtained when the HORB cannot be installed to further refine and define the survival relationships to flow and exports without the HORB in place.

Figure 5-26
2005 SWP Estimated Salmon Salvage and Loss

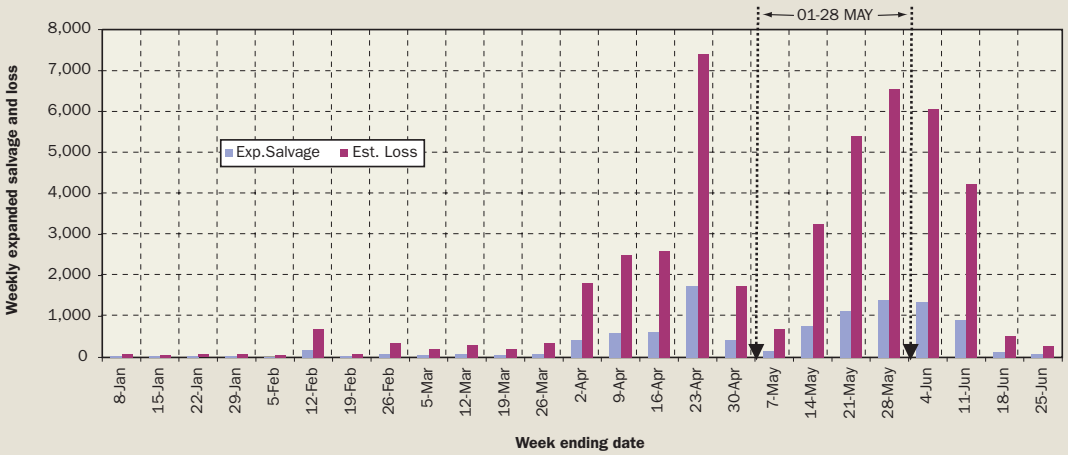


Figure 5-27
2005 Weekly Export Rates and Vernalis Flow

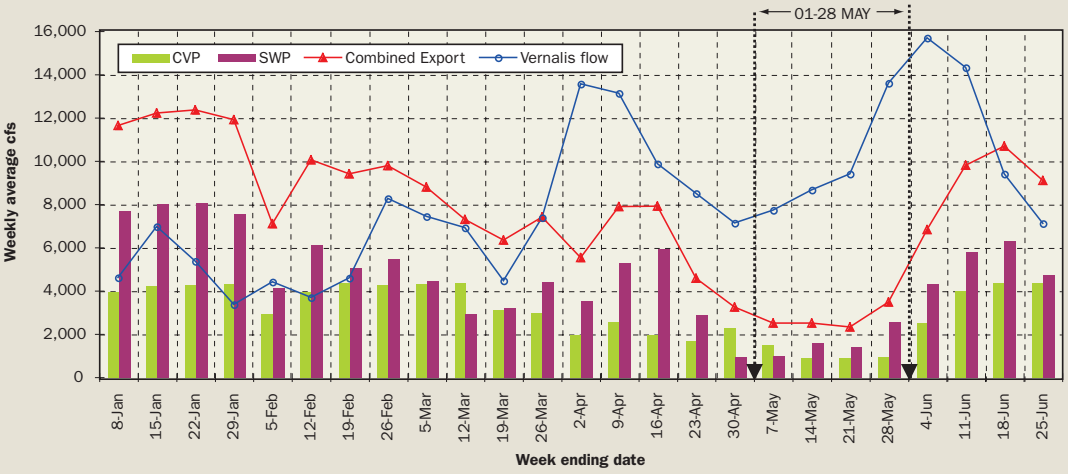


Figure 5-28
2005 CVP & SWP Combined Salvage and Loss Density

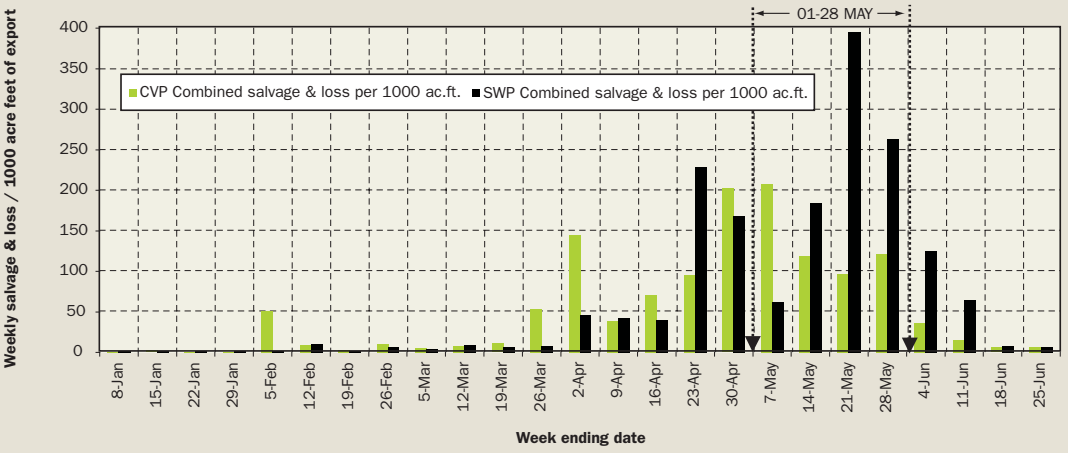
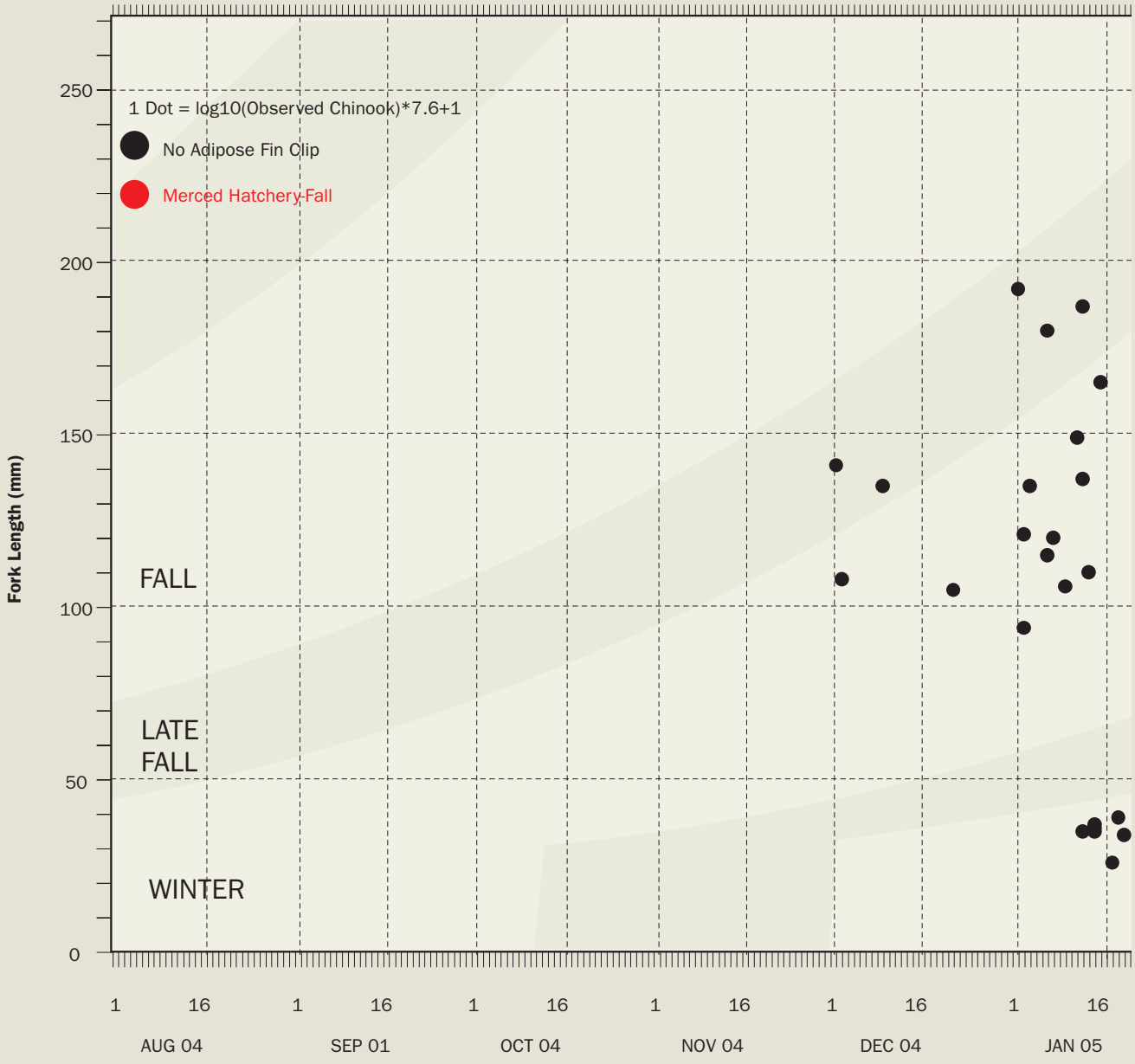
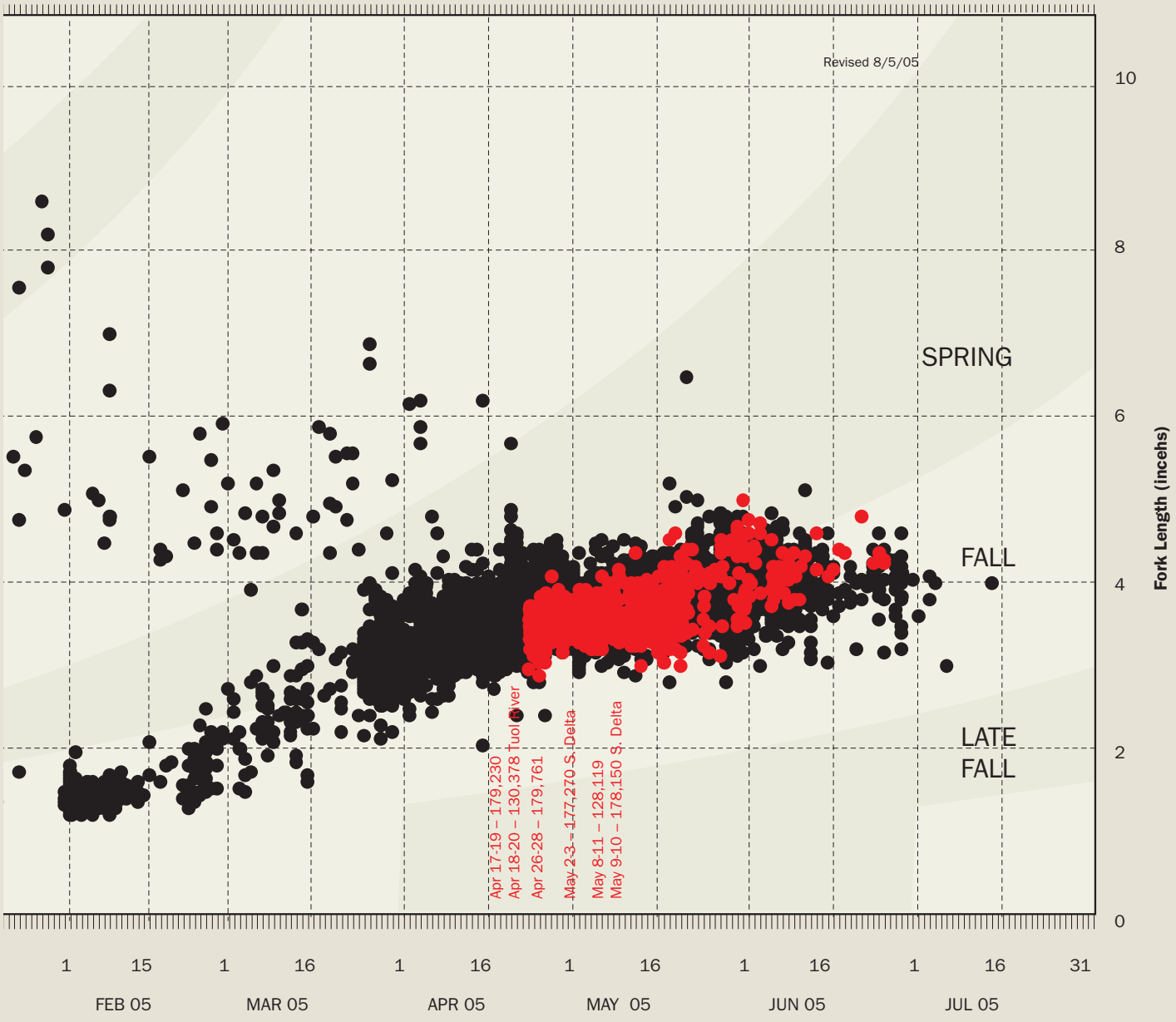


Figure 5-29
Observed Chinoook Salvate at SWP & CVP
Delta Fish Facilities 8/1/04 Through 7/31/05




Revised 8/5/05
SPRING
FALL
LATE
FALL
Apr 17-19 – 179,230
Apr 18-20 – 130,378 Tuolumne River
Apr 26-28 – 179,761
May 2-3 – 177,270 S. Delta
May 8-11 – 128,119
May 9-10 – 178,150 S. Delta
Fork Length (inches)
0
2
4
6
8
10
1
15
1
16
1
16
1
16
1
16
1
16
31
FEB 05
MAR 05
APR 05
MAY 05
JUN 05
JUL 05

6 Complimentary Studies Related to the VAMP

Throughout 2005 several fishery studies were conducted that were considered to be important to the overall understanding of the abundance and survival 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.

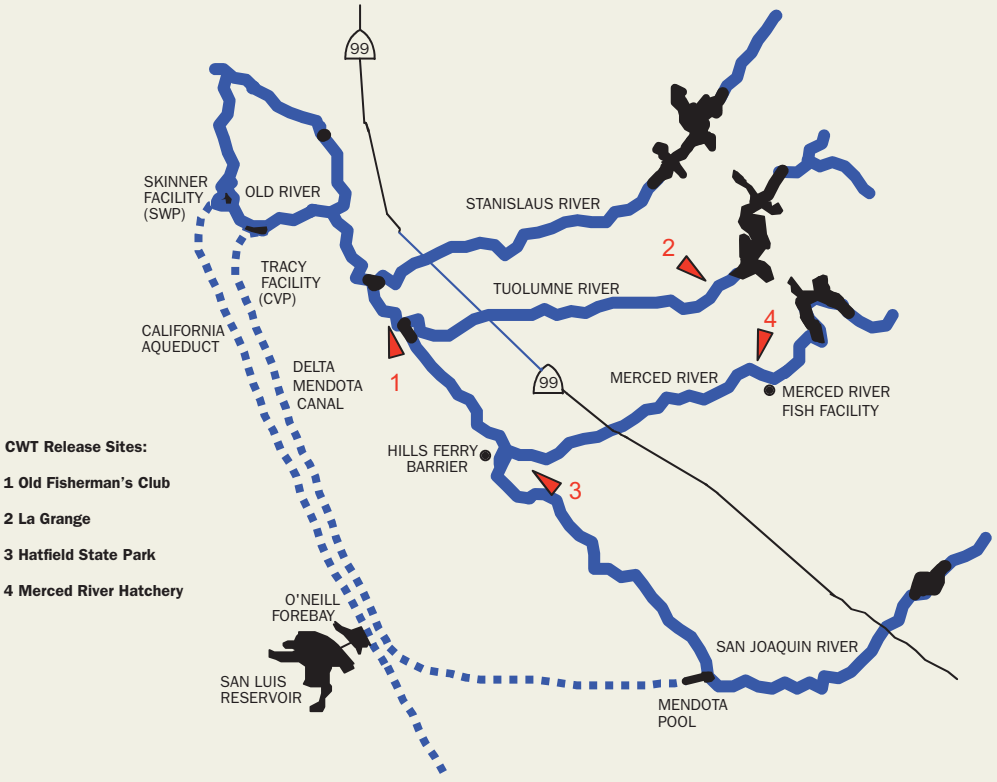
SURVIVAL ESTIMATED FOR CWT RELEASES MADE IN THE SAN JOAQUIN TRIBUTARIES

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

Coded wire tagged salmon from the MRFF were released in the Merced River between April 17 and May 11, 2005 as part of an independent (complimentary to VAMP) fishery investigation. Releases were made in the upper and lower reaches of the Merced River (Merced Hatchery and Hatfield State Park, respectively). One set was also released in the Tuolumne (La Grange) and in the mainstem San Joaquin River just downstream of the confluence with the Tuolumne River (Old Fisherman's Club) (Figure 6-1).

Survival indices to Antioch and Chipps Island of lower Merced releases made at Hatfield State Park and San Joaquin River releases (Old Fisherman's Club) include

Figure 6-1
CWT release sites for releases made in the Merced, Tuolumne and San Joaquin Rivers in 2005



mortality down the mainstem San Joaquin River, as well as through the Delta. Chipps Island survival indices of the lower Merced River and Old Fisherman's Club groups were comparable to survival indices from the 2005 VAMP releases made at Durham Ferry and Dos Reis. Survival indices using Chipps Island recoveries ranged between 0.010 – 0.077 (Table 6-1), while those for VAMP fish released at Dos Reis and Durham Ferry ranged from 0.022 to 0.063 (Table 5-4). No recoveries were made at Antioch.

These data would indicate that the variables that affected the survival of Durham Ferry and Dos Reis released VAMP fish in 2005 also affected survival of the lower Merced River and Old Fisherman's Club release groups. Mortality was not as great for the Jersey Point groups. This same pattern was also detected in 2003 and 2004 (SJRG, 2004).

Survival indices were also generated for the upstream Merced River releases (MRFF) and for those groups released in the upper Tuolumne. Comparison of survival indices to Chipps Island of groups released upstream and downstream provides an estimate of survival through the tributary. This is accomplished by dividing the Chipps Island upstream group survival index by the downstream survival index. For the three sets released on the Merced River, survival was estimated to range from 0.42 to 1.2, indicating survival through the tributary was high (Table 6-2). Survival through the Tuolumne River was also high and was calculated to be 1.2 (Table 6-2). Estimates of over one are likely due to the variance associated with low recoveries of both the upper and lower release groups. These comparisons likely do not provide precise estimates of survival through the Merced and Tuolumne rivers, but may be useful for distinguishing between high and low survival. Ocean recoveries will be available for these groups in future years and will provide an additional means to estimate survival through each tributary.

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 Sacramento (Figure 1-1). Three groups were released to index survival through the Delta for juvenile salmon originating in the Sacramento basin. Comparison of these groups to VAMP releases tell us how survival has varied between basins. The average survival index in 2005 for the three separate groups of Feather River Hatchery smolts released on April 15, April 29 and May 16 was 0.46, similar to that measured in 2003 (0.51) and greater than that measured in 2004 (0.19). VAMP survival for groups released at Durham Ferry, Mossdale and Dos Reis were low for all three years and was estimated to be less than about 0.05. From a relative scale survival was lower through the Sacramento River delta in 2004 than in 2005 or 2003, whereas with the VAMP fish survival was low for all three years. This indicates that perhaps different variables are controlling survival in the two basins since relative survival between years within each of the basins do not follow similar patterns.

Survival indices are typically higher for smolts migrating through the Delta from Sacramento than for smolts migrating from Mossdale. It is unclear why this is the case, although smolts entering the Delta from Mossdale are exposed to lower river flows and higher temperatures than on the Sacramento River. Smolts from the San Joaquin basin migrate in closer proximity to the CVP and SWP pumping plants, and are more subjected to subsequent altered Delta flow patterns. Sacramento stocks also do not have PKD. All of these factors and others probably result in the lower survival through the Delta for juvenile salmon originating from the San Joaquin basin.

2005 MOSSDALE TRAWL SUMMARY

Contributed by Tim Heyne,
California Department of Fish and Game

Introduction

Monitoring for the fall-run Chinook salmon smolt out-migrant population in the San Joaquin drainage is located two miles downstream of Mossdale Landing Country Park (river mile 56), and upstream of the Old River confluence (Figure 6-1). The timing and measurement of out-migrant production (indices and estimates) of fall-run Chinook salmon smolts have been monitored at Mossdale on the San Joaquin River since 1987 to:

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

2) Develop smolt production trend information,

3) Determine the 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

Table 6-1
Chipps Island VAMP Tag Summary, Survival Calculations and Expanded Fish Facility Recoveries for Tagged Fish

							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
06-46-76	Merced Hatchery (MRFF)		N/P	N/P	25,067	N/P	–	–	0	–	–
06-46-77	Merced Hatchery (MRFF)		N/P	N/P	25,141	N/P	–	–	0	–	–
06-46-78	Merced Hatchery (MRFF)		N/P	N/P	24,384	N/P	–	–	0	–	–
06-46-79	Merced Hatchery (MRFF)		N/P	N/P	24,996	N/P	–	–	0	–	–
	Total	**04/17/05**			**99,558**				**0**		
06-46-80	Hatfield (MRFF)		N/P	N/P	24,278	N/P	–	–	0	–	–
06-46-81	Hatfield (MRFF)		N/P	N/P	23,647	N/P	5/8/05	5/8/05	1	471	0.3271
06-46-82	Hatfield (MRFF)		N/P	N/P	23,733	N/P	–	–	0	–	–
	Total	**04/19/05**			**71,658**		**5/8/05**	**5/8/05**	**1**	**471**	**0.327**
05-51-36	La Grange (MRFF)	04/18/05	N/P	N/P	75,696	N/P	5/5/05	5/23/05	5	9,743	0.3561
05-11-69	Old Fisherman's Cl (MRFF)	04/20/05	N/P	N/P	47,376	N/P	5/5/05	5/9/05	2	2,416	0.3356
	Total	**04/20/05**			**123,072**						
06-46-83	Merced Hatchery (MRFF)		N/P	N/P	25,157	N/P	–	–	0	–	–
06-46-84	Merced Hatchery (MRFF)		N/P	N/P	25,029	N/P	–	–	0	–	–
06-46-85	Merced Hatchery (MRFF)		N/P	N/P	25,107	N/P	–	–	0	–	–
06-46-86	Merced Hatchery (MRFF)		N/P	N/P	24,553	N/P	5/21/05	5/21/05	1	560	0.3889
	Total	**04/26/05**			**99,846**		**5/21/05**	**5/21/05**	**1**	**560**	**0.389**
06-46-87	Hatfield (MRFF)		N/P	N/P	23,345	N/P	5/7/05	5/7/05	1	540	0.375
06-46-88	Hatfield (MRFF)		N/P	N/P	24,315	N/P	5/5/05	5/20/05	2	8,163	0.3543
06-46-89	Hatfield (MRFF)		N/P	N/P	23,338	N/P	5/10/05	5/16/05	2	3,453	0.3426
	Total	**04/28/05**			**70,998**		**5/5/05**	**5/20/05**	**5**	**8,163**	**0.3543**
06-46-92	Merced Hatchery (MRFF)		N/P	N/P	25,029	N/P	–	–	0	–	–
06-46-93	Merced Hatchery (MRFF)		N/P	N/P	25,009	N/P	–	–	0	–	–
06-46-96	Merced Hatchery (MRFF)		N/P	N/P	25,312	N/P	–	–	0	–	–
	Total	**05/08/05**			**75,350**				**0**		
06-46-90	Hatfield (MRFF)		N/P	N/P	22,868	N/P	5/18/05	5/18/05	1	560	0.3889
06-46-91	Hatfield (MRFF)		N/P	N/P	22,739	N/P	–	–	0	–	–
	Total	**05/11/05**			**45,607**		**5/18/05**	**5/18/05**	**1**	**560**	**0.389**

Table 6-2
Absolute survival estimates based on survival indices to Chipps Island for survival through the Merced and Tuolumne Rivers in 2005.

Date	Merced	Hatfield	Tributary Survival
4/17-4/19/2005	0.032	0.077	0.42
4/26-4/28/2005	0.024	0.071	0.33
5/8-5/11/2005	0.012	0.010	1.2
Date	**La Grange**	**Old Fishermans Club**	**Tributary Survival**
4/18-4/20/2005	0.047	0.038	1.2

intensity was 5 days a week from April 4 to April 10, and then increased into 7 days a week from April 11 to May 27. The sampling effort was reduced to 5 days a week during May 28 to June 17, and then to 3 days a week during the last 2 weeks. The entire sampling period was from April 4 to July 1, 2005 with a total of 72 sample days out of study period of 89 days. A sampling day usually consisted of 15 tows at 20 minutes per tow, although the first two weeks and last five weeks of sampling had 10 tows per day. Due to hazardous weather conditions, there were only 7 tows on

		Chipps Island										
Survival Index	Group Index	First Day Recovered	Last Day Recovered	Number Recovered	Minutes Fished	Percent Sampled	Survival Index	Group Index	Salvage CVP	Numbers SWP	Expanded CVP	Expanded SWP
–		04/26/05	05/28/05	2	11,532	0.243	0.041		11	7	132	27
–		05/10/05	05/10/05	1	400	0.278	0.018		19	6	228	24
–		–	–	0	–	–	–		12	6	144	24
–		04/29/05	04/30/05	3	400	0.139	0.108		9	6	108	27
		04/26/05	**05/28/05**	**6**	**11,532**	**0.243**		**0.032**				
–		04/30/05	05/05/05	3	1,800	0.208	0.073		19	7	228	42
0.009		04/26/05	05/05/05	2	2,600	0.181	0.057		9	5	108	21
–		05/06/05	05/06/05	1	400	0.278	0.019		11	5	132	27
	0.004	**04/26/05**	**05/06/05**	**6**	**3,000**	**0.189**		**0.077**				
0.013		04/27/05	05/26/05	7	10,532	0.244	0.047		29	39	349	210
0.008		05/03/05	05/17/05	4	5,732	0.265	0.038		37	29	444	141
–		–	–	0	–	–	–		5	1	60	3
–		05/03/05	05/23/05	2	8,132	0.269	0.038		5	8	60	36
–		05/06/05	05/25/05	3	7,732	0.268	0.056		1	4	12	24
0.007				0					4	8	48	36
	0.002	**05/03/05**	**05/25/05**	**5**	**8,932**	**0.27**		**0.024**				
0.008		05/07/05	05/07/05	1	400	0.278	0.018		9	1	108	6
0.015		05/02/05	05/26/05	4	9,532	0.265	0.074		11	0	132	0
0.017		05/03/05	05/16/05	3	5,360	0.266	0.058		9	1	108	6
	0.013	**05/02/05**	**05/26/05**	**8**	**9,532**	**0.265**		**0.071**				
–		06/07/05	06/07/05	1	400	0.278	0.018		2	12	24	63
–		06/05/05	06/05/05	1	400	0.278	0.018		5	9	60	48
–		–	–	0	–	–	–		1	16	12	90
		06/05/05	**06/07/05**	**2**	**1,200**	**0.278**		**0.012**				
0.007		05/24/05	05/24/05	1	400	0.278	0.018		7	10	86	54
–		–	–	0	–	–	–		5	6	61	33
	0.004	**05/24/05**	**05/24/05**	**1**	**400**	**0.278**		**0.010**				

April 8, 2005. Sampling is also conducted 3 days per week between July 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. The daily river flow data that is used in this report had been measured by U.S. Geological Survey mean daily stream flow gauge at Vernalis. All fish were identified to species and enumerated. The first 30 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. The first 50 natural and dye mark Chinook salmon, for each tow, were measured (fork length, mm) and the excess tallied without measurement. Every Chinook salmon that had a clipped adipose fin was measured, individually bagged, and labeled and saved for coded wire tag processing.

Flows averaging over 10,000 cfs in the spring of 2005 resulted in the daily operation of the trawl beginning at the upstream end of the sampling area. The weekly vulnerability tests released at the Mossdale boat ramp were done to coincide with the first tow of the day. The first vulnerability test conducted on April 6 was not used in the analysis due to problems with the net.

The 2005 natural smolt production from the San Joaquin drainage was estimated by two different methods. The first 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 Vernalis for a 5-hour index and expanded again for a 24-hour daily estimate. These daily average smolt densities were then expanded by multiplying with the daily mean flow recorded at Vernalis. Production estimates for days not sampled within the study period were assigned by averaging smolt/ac-ft for the days before and after the day not sampled.

The second estimate, 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 6-3 and Figure 6-2). Production estimates for days not sampled within the study period were assigned by averaging smolt caught and minutes towed for the days before and after the day not sampled.

Smolt Production Index Calculation:

The natural smolt index estimates (EI) is calculated as follow:

$$E_I = \sum_{i=1}^{n=89} \left[\left(\frac{C_i}{V_{Ti}} \right) \left(V_{Pi} \right) \left(\frac{24}{5} \right) \right]$$

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 89 days.

Table 6-3
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, 2005.

Release Date/Time	Water Temp. (°C) Truck/River	Effective # Released	Number Recovered	Streamflow (cfs)	Beginning And Ending Recovery Time
*06APR05 08:20	-/-	2,031	3	13,700	09:54 10:41
15APR05 09:15	9.5/14	5,060	71	9,242	09:48 13:10
22APR05 08:11	10.5/14	1,975	47	8,163	09:16 10:04
29APR05 07:59	11/14	4,988	64	6,882	09:41 12:49
06MAY05 08:00	11/14.5	1,997	134	7,847	08:35 09:23
13MAY05 08:20	11/15	4,999	79	8,744	08:53 09:17
20MAY05 07:57	11.5/15	2,001	29	10,190	08:55 09:14
27MAY05 08:07	13/15	1,948	28	14,062	08:37 11:08

*Vulnerability test omitted due to problems with trawl net.

Kodiak Trawl Vulnerability Estimates:

The vulnerability expansion production estimates (EV) is calculated as follow:

$$E_V = \sum_{i=1}^{N=89} \left\{ \left[\frac{(C_i/r)}{(T_i/300)} \right] \left(\frac{24}{5} \right) \right\}$$

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 ($\hat{V}$) of r:

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

Where:

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

_ = average of effective release

s.d. = standard deviation

Standard deviation (s.d.) is calculated as follow:

$$s.d._r = \sqrt{\frac{\sum_{i=1}^{n} (y_i - r x_i)^2}{n-1}}$$

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

95% Confidence Interval (C.I.) is calculated as follow:

$$C.I. = r \pm 1.96\sqrt{\hat{V}(r)}$$

Where:

r = population ratio of what?

(r) = variance of population ratio

For the purpose of analysis, vulnerability to the trawl calculations was limited to 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 in all releases). Travel time (from release point to trawl), time vulnerable to trawl and percent vulnerability as related to flow were determined for each test group.

Results

Between April 4 and July 1, 2005 2,294 non-marked Chinook salmon smolts were captured in the Mossdale trawl. Daily capture of non-marked salmon ranged from 0 – 363 individuals with an average of 32.

Smolt production estimates for the San Joaquin basin ranged between 363,800 using method 1 and 621,403 using method 2 (Table 6-4). The first method used a smolt density index to expand daily catch. The standard deviation using this method was +/-_14,700.

The second method used trawl efficiency (vulnerability) to expand daily catch (Figure 6-3). This method 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 1,948 – 5,060 dye

Figure 6.2
Vulnerability of Test Group vs. Flow

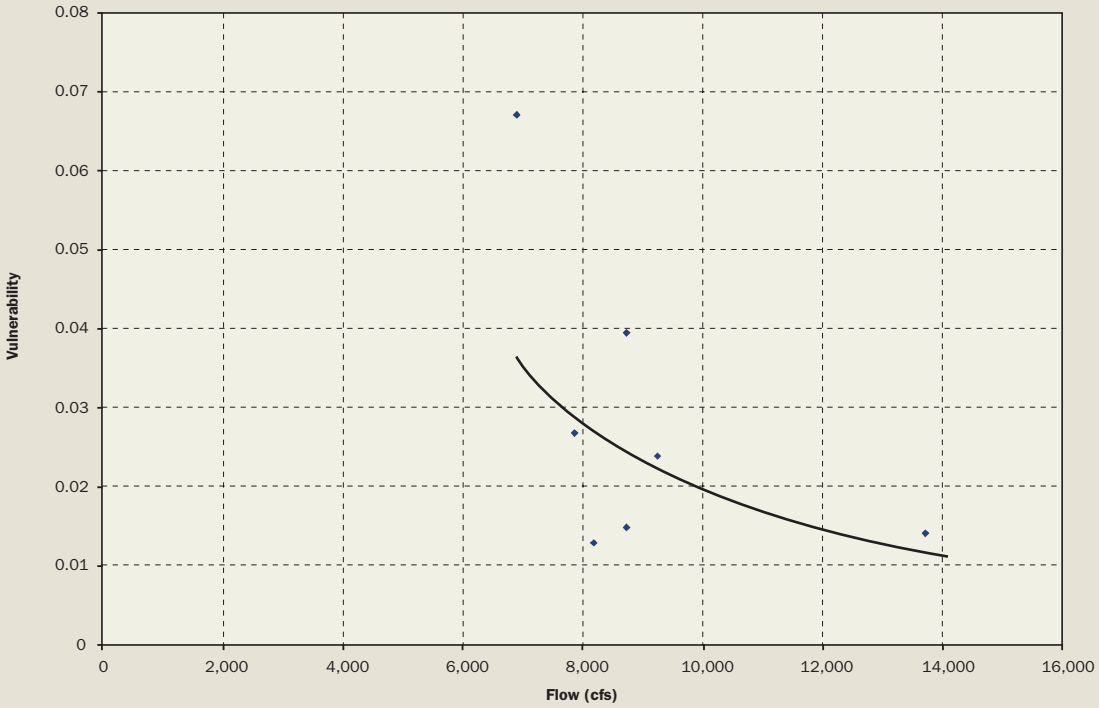
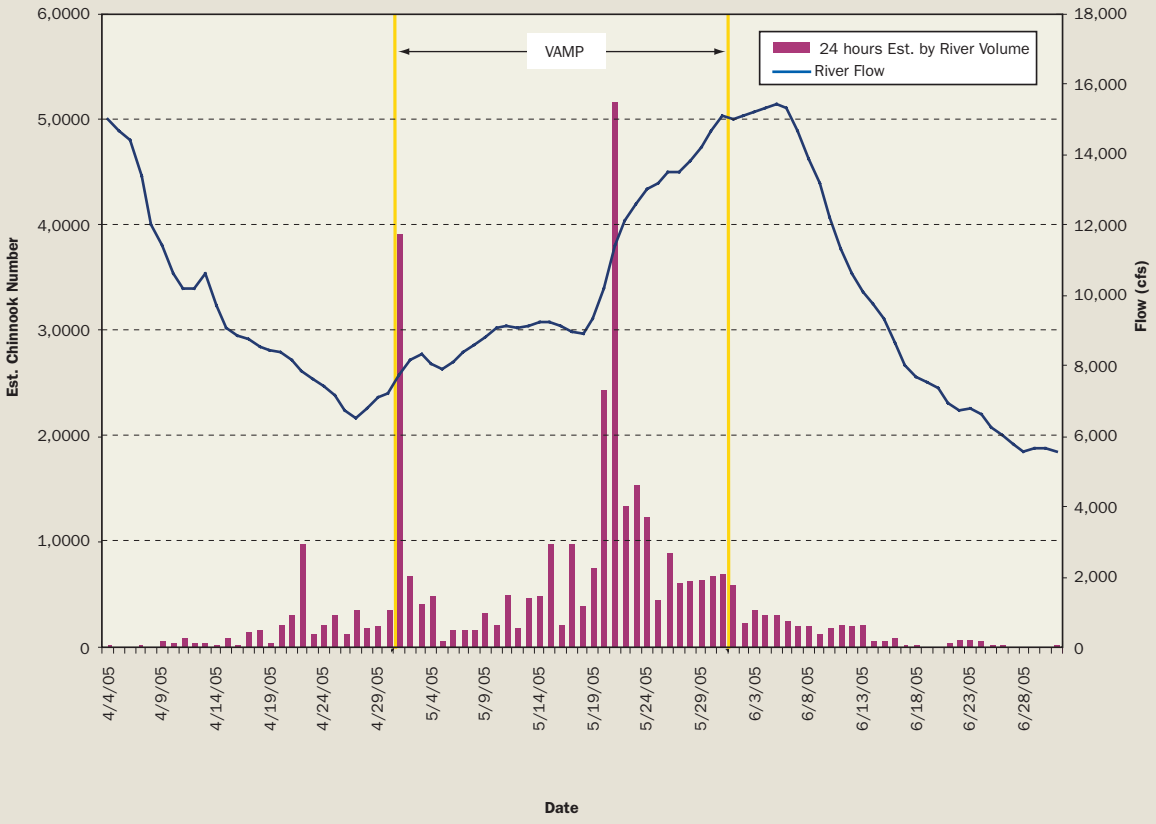


Figure 6.3
Daily Production Estimates (expanded using vulnerability testing) vs. Flow



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 388,884 – 1,119,550). Production of San Joaquin River basin smolts in 2005 was roughly twice that of the production in 2004.

This doubling in production occurred in spite of the number of spawning salmon the fall before being roughly equivalent in both years (~10,000). The main difference between the two years was a more than doubled spring outflow.

REVIEW OF JUVENILE SALMON DATA FROM THE SAN JOAQUIN RIVER TRIBUTARIES TO THE SOUTH DELTA DURING JANUARY TO JUNE, 2005

Contributed by Tim Ford, Turlock and Modesto Irrigation Districts, and Andrea Fuller, S. P. Cramer and Associates

The VAMP includes protective measures for San Joaquin River (SJR) smolts during a 31 day window 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

Table 6-4
Smolt production seasonal estimates with corresponding smolt/ac-ft. estimates and sampling period for the duration of the study.

Year	Sampling Period (Days)	Smolt/ac-ft Estimate 1=1,000	Vulnerability Smolt Production Seasonal Estimate (95% confidence range)
2005	89	363,800 + 14,700	621,403 : (388,884-1,119,550)**
2004	61	92,500 + 66,500	333,080
2003	88	107,500 + 60,300	550,446
2002	75	229,100. + 557,100	733,839
2001	*	*	848,488
2000	72	211,100 + 181,900	484,703
1999	86	*	438,979
1998	80	*	2,844,637
1997	67	*	635,517
1996	75	*	1,155,319
1995	46	*	3,361,384
1994	48	*	453,245
1993	51	*	269,035
1992	33	*	280,395
1991	39	*	538,005
1990	55	*	263,932
1989	50	*	4,241,862

Note: Data from 1989 – 2004 is cited from Annual Performance Report Federal Aid in Sport Fish Restoration Act. Project No. 26, Job No. 4, Table 1.

*Estimates are currently being analyzed.

**Analysis of 2005 production estimate was performed by the method described in the body of the report. All previous years have a production estimate that is based on a regressive relation of flow and vulnerability that uses data from all test years except 2005. Confidence limits are currently being developed for those estimates.

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 2005, rotary screw trapping was conducted on the Stanislaus River to document juvenile outmigration throughout the season; on the Tuolumne River during roughly half of the outmigration season; and no monitoring occurred on the Merced River. This review briefly presents data from the rotary screw traps fished in the Stanislaus and Tuolumne rivers during 2005 to identify the movement of juvenile salmon from the tributaries into the mainstem San Joaquin River relative to observations at the Mossdale Trawl and in salvage.

Stanislaus River rotary screw trap (RST) monitoring was conducted at River Mile (RM) 9 (Caswell site) during 05 Jan - 16 Jun; and Tuolumne River RST monitoring was conducted at RM 5 (Grayson site) during 01 Apr - 16 Jun. Trawling was conducted in the San Joaquin River at Mossdale near RM 54 (downstream of the tributaries, and 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.

Several local runoff events between January and March were associated with significant rainfall periods (Figure 6-4). The seasonal peak catch of fry in the Stanislaus River RST (Figure 6-5) followed a late January storm event. However, relatively few early fish were observed at the Mossdale trawl (Figure 6-6), and SWP (Figure 5-24) salvage operations; more were found in the CVP salvage (Figures 5-23 and 5-26). Figure 6-7 shows that most fish observed prior to mid-February averaged <40 mm fork length (FL). Average size increased by mid- April to >80 mm FL in all areas (Figure 6-7), coincident to increased daily catch on the Tuolumne River (Figure 6-8) and also the highest densities observed at Mossdale (Figure 6-6) and the CVP/SWP (Figure 5-26). By mid-June, all sampling indicated very low abundance of juvenile salmon marking the end of the 2005 outmigration season.

It appears from the Stanislaus data that in 2005, much of juvenile salmon population migrated into the SJR, as fry and pre-smolts, between January to April. These early migrants were not captured in high densities at Mossdale but appear to have arrived in the CVP salvage, indicating that at least some fry moved into the Delta; relative efficiency of the trawl and salvage facilities for fry size salmon may be less than for the RST. However, even though fry were not observed at Mossdale in high densities during 2005, high densities have been recorded early in the season at this site in other years (SJRGA, 2005); and differences in density at Mossdale between years may also be influenced by the overall abundance of juveniles migrating from the tributaries as a result of fluctuating escapement.

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 efficiency on different sized juvenile salmon might also be useful. These data would help to refine existing protective measures, if warranted, and to identify potential needs for additional protective measures targeting a larger proportion of the juvenile salmon population migrating from the San Joaquin tributaries.

FLORIDONE EXPOSURE TO EMIGRATING JUVENILE FALL RUN CHINOOK SALMON

Contributed by Jeff Stuart, National Marine Fisheries Service

In April 2005, the California Department of Boating and Waterways (DBW) in conjunction with the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) applied the herbicide fluridone to waters of the Delta for the control of the non-native invasive weed *Egeria densa*. The National Marine Fisheries Service (NMFS) permitted this early season application of herbicide to the waters of Franks Tract, Sandmound Slough, and Disappointment Slough under the authority of their Section 7 Biological Opinion for the *Egeria densa* Control Program. Applications to these restricted areas were determined by NMFS to present a reduced level of exposure to juvenile salmonids during their spring emigration through the Delta. As part of the terms and conditions for this early season application, NMFS required DBW and the USDA-ARS to examine the level of fluridone exposure to emigrating juvenile fall-run Chinook salmon through the levels of fluridone found in their body tissues.

NMFS, in cooperation with the U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Game (DFG), and the Vernalis Adaptive Management Plan (VAMP) stakeholders, gathered coded wire tagged (CWT) fall-run Chinook salmon from monitoring trawls at Chipps Island, Antioch, Mossdale, and Sherwood Harbor to look for exposure to the fluridone herbicide during their downstream migration. The reading of the CWTs allow for the direct measurement of time spent in the water since release, the location of release, and the origins of these fish. These fish

Figure 6-4
San Joaquin Basin Flows and Rainfall

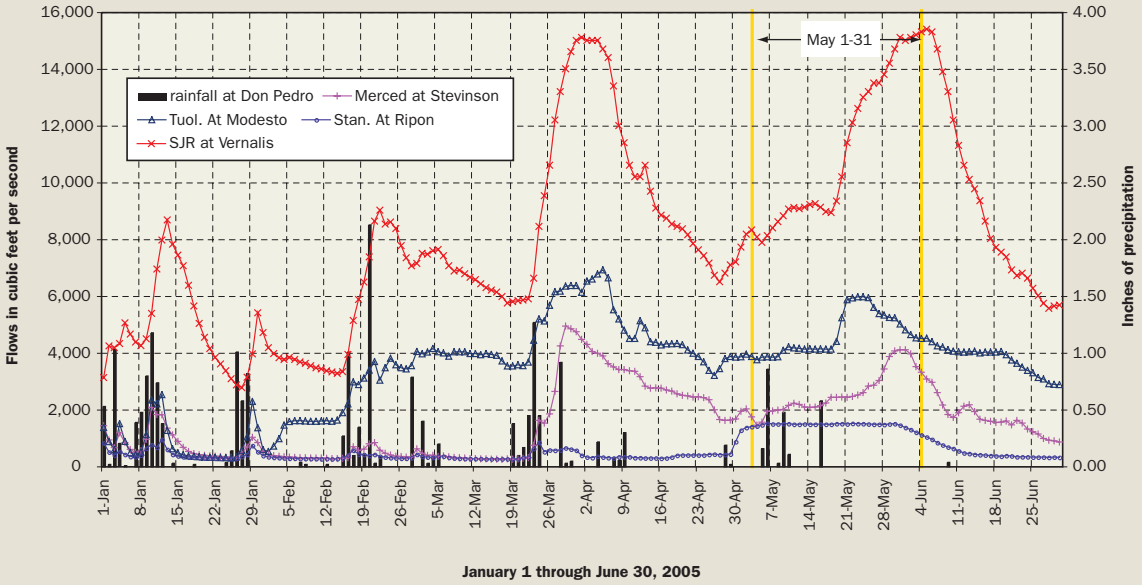


Figure 6-5
Stanislaus rotary screw trap daily catch of all unmarked juvenile Chinook salmon.

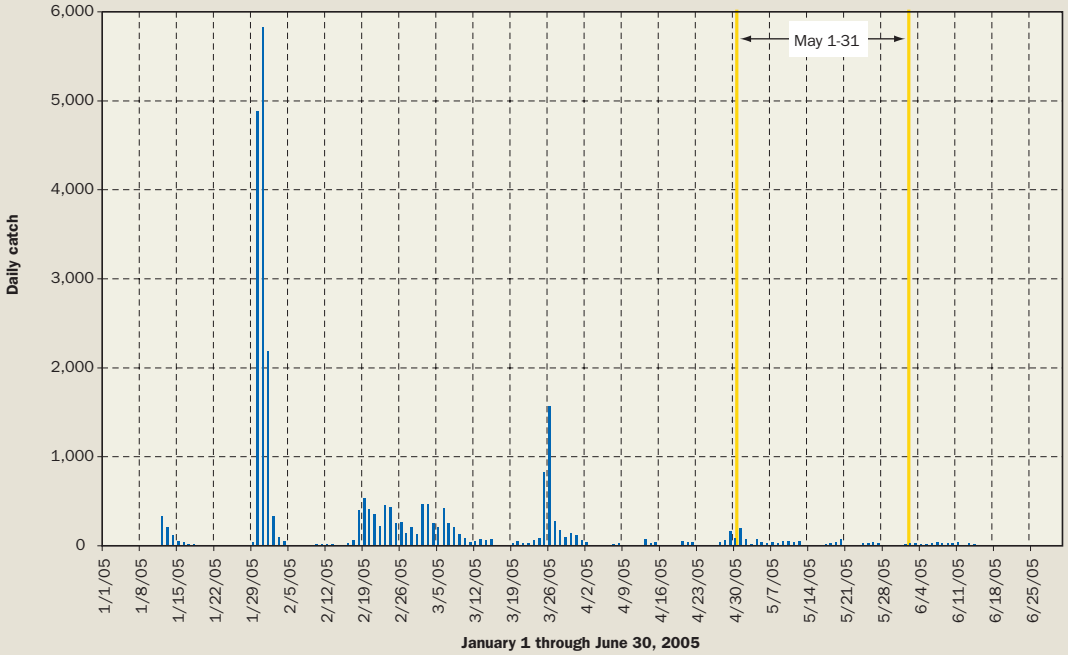


Figure 6-6
Mossdale Kodiak trawl mean daily catch per minute of all unmarked juvenile Chinook salmon.

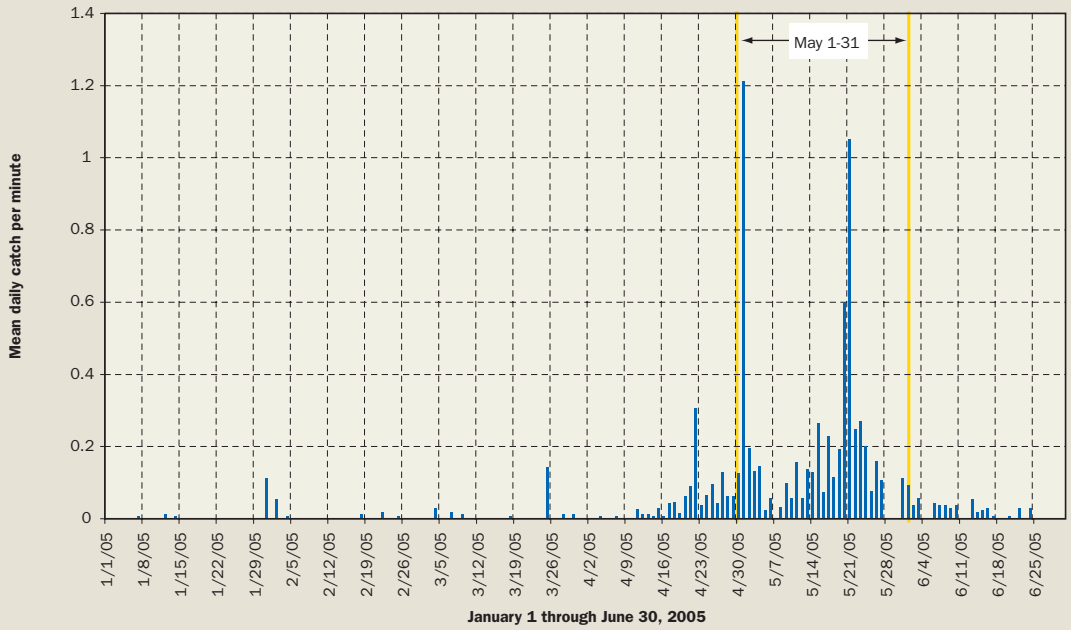


Figure 6-7
Daily average forklength of unmarked juvenile Chinook salmon.

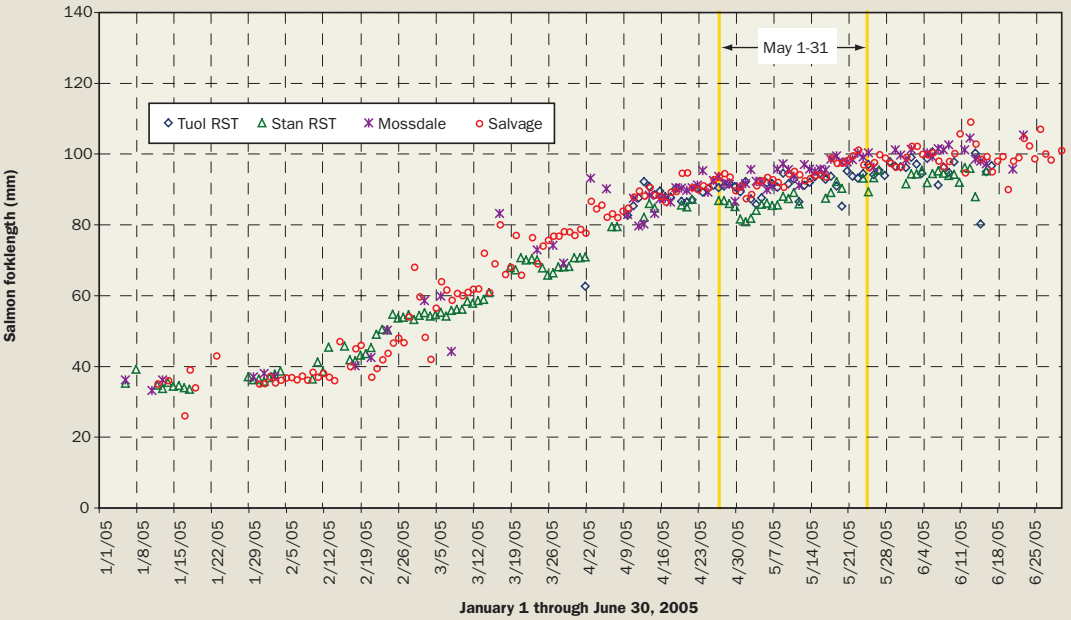
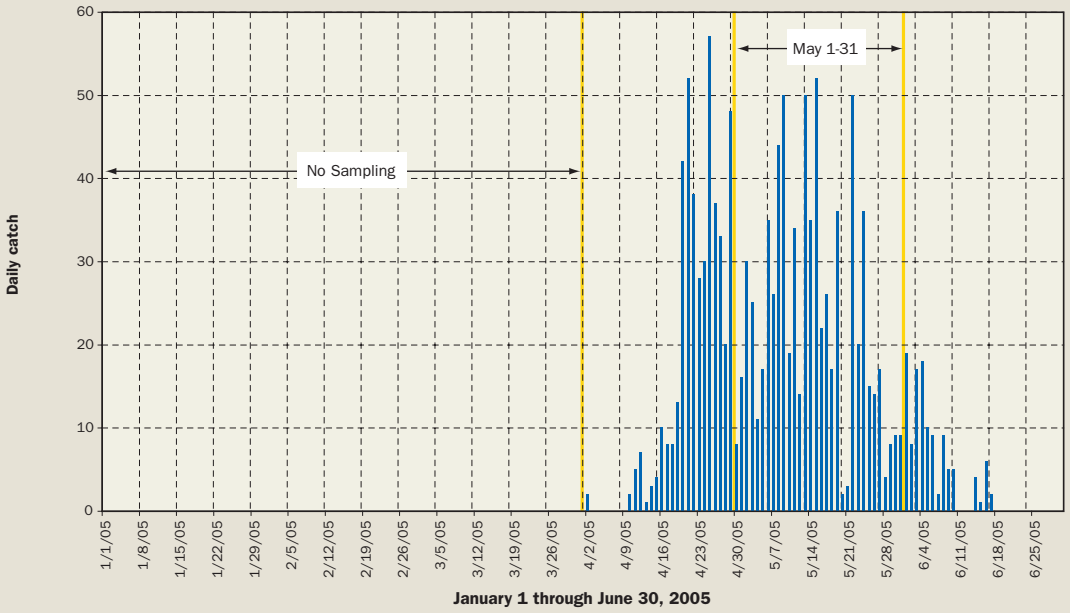


Figure 6-8
Tuolumne rotary screw trap daily catch of all unmarked juvenile Chinook salmon.



will be processed and whole body homogenates analyzed by DFG staff at the Water Pollution Control Laboratory for residues of the parent fluridone compound and the daughter metabolite compound, hydroxyl-fluridone. NMFS hypothesizes that fish migrating through the San Joaquin River system have a higher likelihood of encountering the fluridone compound than those which migrate down the Sacramento River system. Prior to entrance into the Delta from the San Joaquin River, fish should not have had any exposure history to the fluridone compound. Fish sampled at Mossdale should therefore not have any fluridone residues in their body, while those fish from the Merced Hatchery recovered at Antioch and Chipps Island should at least have the potential to have fluridone residues in their body, based on their predicted migration path through the Delta. Samples which are found to have residues of fluridone or its daughter metabolite indicate that the fish have moved through areas being treated for *Egeria densa*. Chinook salmon recovered at Sherwood Harbor on the Sacramento River have not yet entered the Delta, and like fish from Mossdale, should not have any fluridone residues in their body tissues. Fish recovered at Chipps Island were predominantly from the Sacramento River basin (Feather River hatchery). NMFS hypothesizes that most of these fish should migrate down the Sacramento River channel to Chipps Island before capture in the monitoring trawls and should therefore not have any fluridone or its metabolite in their body tissues. Should these Sacramento River origin fish show fluridone residues, then their migration path would necessitate that they moved through the Central Delta and into the San Joaquin River system prior to their capture at Chipps Island.

NMFS will use the fluridone body tissue burdens in their future analysis of exposure risks to emigrating salmonids in the Delta. The results of the data will facilitate developing future application windows to reduce or eliminate exposure risk to listed salmonids in the Delta from weed control programs.

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SOUTH SAN JOAQUIN IRRIGATION DISTRICT*

MODESTO IRRIGATION DISTRICT*

TURLOCK IRRIGATION DISCTICT*

MERCED IRRIGATION DISTRICT*

SAN JOAQUIN RIVER EXCHANGE CONTRACTORS WATER AUTHORITY*

Central California Irrigation District

Firebaugh Canal Water District

Columbia Canal Company

Sal Luis Canal Company

FRIANT WATER USERS AUTHORITY*

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SAN JOAQUIN RIVER GROUP AUTHORITY

*San Joaquin River Group Authority Members

2005 Useful Web Pages

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

Page 4 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 Operation Monitoring, CDEC Hourly
http://cdec.water.ca.gov/cgi-progs/queryGroup?s=fw1

Operation Monitoring, CDEC Daily
http://cdec.water.ca.gov/cgi-progs/queryDgroups?s=fw2

Vernalis USGS Real-Time
http://waterdata.usgs.gov/nwis/uv?format=pre&period=1&site_no=11303500

Vernalis, USGS Daily
http://waterdata.usgs.gov/nwis/uv?format=pre&period=1&site_no=11303500

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

LaGrange, USGS Daily
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www.usbr.gov/mp/cvo/vungvari/gdwdop.pdf

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

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

Page 28 Temporary Barrier Program
http://sdelta.water.ca.gov/web_pg/tempmesr.html

Page 29 Reclamation District 544 Seepage Monitoring Study
http://sdelta.water.ca.gov/web_pg/tempmesr.html

Page 63 CVP and SWP Salvage Data
www.iep.ca.gov

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

Pacifica States Marine Fisheries Commission Regional Mark Information System
www.rmis.org

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
MRFF	Merced River Fish Facility
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

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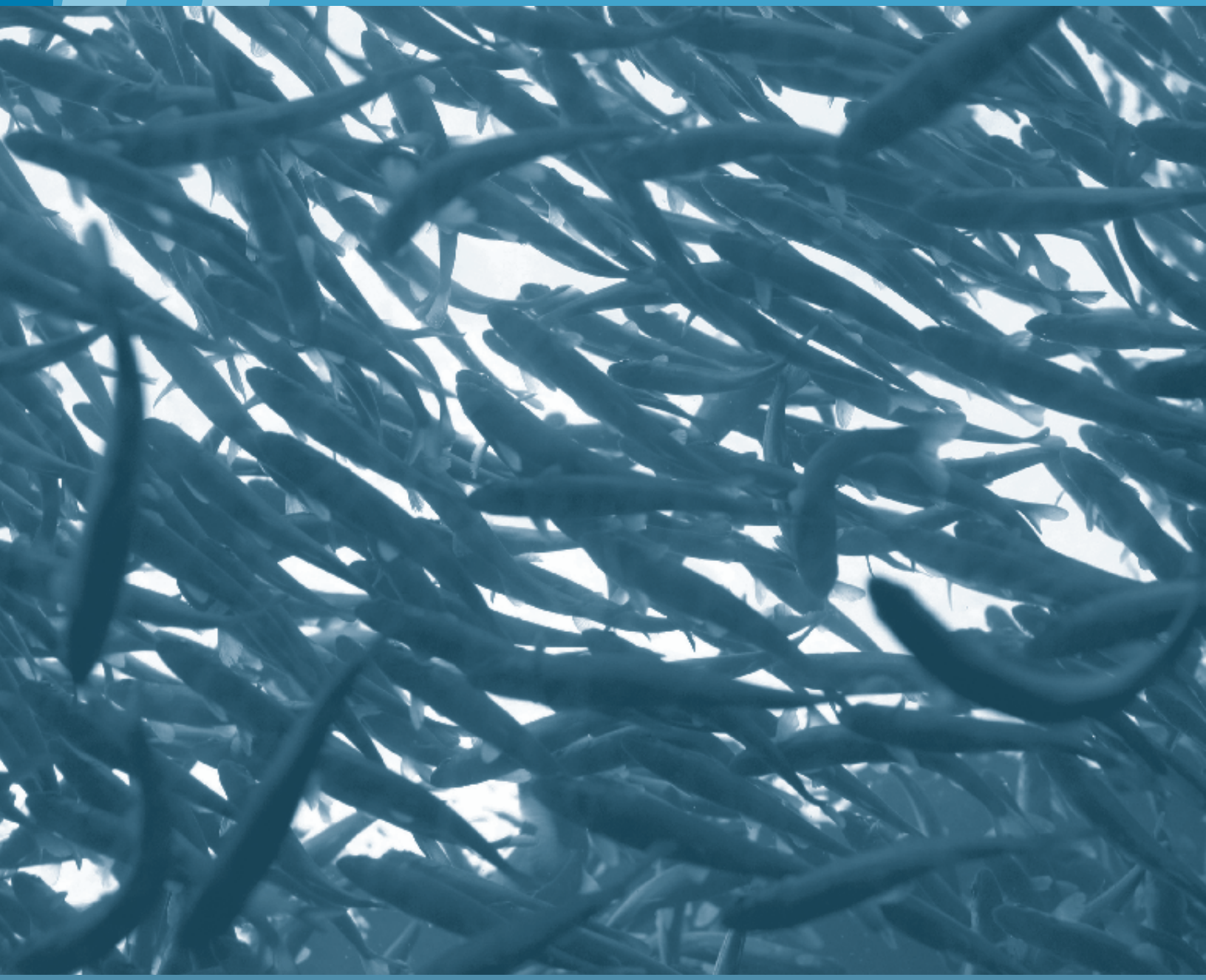
APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

Appendix A
Hydrology and Operation Plans



Appendix A-1, Table 1

2005 VAMP DAILY OPERATION PLAN
March 23, 2005 (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-05	**6,260**				**6,260**	**1,278**	**1,183**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,234**	**1,201**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,181**	**1,110**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,820**				**5,820**	**1,163**	**932**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,163**	**995**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,750**				**5,750**	**1,151**	**932**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,246**	**995**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,880**				**5,880**	**1,535**	**1,041**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05																					
24-Mar-05																					
25-Mar-05																					
26-Mar-05																					
27-Mar-05																					
28-Mar-05								650													
29-Mar-05								650													
30-Mar-05						879		650				3,000	3,000			225	225				
31-Mar-05						874		650				3,000	3,000			225	225				
01-Apr-05	5,554					869	800	650			650	3,000	3,000		3,000	225	225			225	
02-Apr-05	5,549					864	800	650			650	3,000	3,000		3,000	225	225			225	
03-Apr-05	5,544					859	800	650			650	3,000	3,000		3,000	225	225			225	
04-Apr-05	5,539				5,539	854	800	650			650	3,000	3,000		3,000	225	225			225	
05-Apr-05	5,534				5,534	848	800	650			650	3,000	3,000		3,000	225	225			225	
06-Apr-05	5,529				5,529	842	800	650			650	3,000	3,000		3,000	225	225			225	
07-Apr-05	5,523				5,523	836	800	650			650	3,000	3,000		3,000	225	225			225	
08-Apr-05	5,517				5,517	830	800	650			650	3,000	3,000		3,000	225	225			225	
09-Apr-05	5,511				5,511	824	800	650			650	3,000	3,000		3,000	225	225			225	
10-Apr-05	5,505				5,505	818	800	650			650	3,000	3,000		3,000	225	225			225	
11-Apr-05	5,499				5,499	812	800	650			650	3,000	3,000		3,000	225	225			225	
12-Apr-05	5,493				5,493	806	800	650	270	0	920	3,000	3,000		3,000	225	225			225	
13-Apr-05	5,487	0			5,487	800	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
14-Apr-05	5,481	0			5,481	794	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
15-Apr-05	6,750	270	0	0.54	7,020	789	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
16-Apr-05	6,744	270	0	1.07	7,014	783	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
17-Apr-05	6,739	270	0	1.61	7,009	777	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
18-Apr-05	6,733	270	0	2.14	7,003	772	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
19-Apr-05	6,727	270	0	2.68	6,997	766	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
20-Apr-05	6,722	270	0	3.21	6,992	760	800	650	270	0	920	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
21-Apr-05	6,716	270	0	3.75	6,986	755	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
22-Apr-05	6,710	270	0	4.28	6,980	749	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
23-Apr-05	6,705	270	0	4.82	6,975	743	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
24-Apr-05	6,699	320	0	5.45	7,019	738	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
25-Apr-05	6,693	320	0	6.09	7,013	732	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
26-Apr-05	6,688	320	0	6.72	7,008	726	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
27-Apr-05	6,682	320	0	7.36	7,002	721	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
28-Apr-05	6,676	320	0	7.99	6,996	715	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
29-Apr-05	6,671	320	0	8.63	6,991	709	800	650	320	0	970	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
30-Apr-05	6,665	320	0	9.26	6,985	704	800	650	370	0	1,020	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
01-May-05	6,659	320	0	9.90	6,979	698	800	650	370	0	1,020	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
02-May-05	6,654	320	0	10.53	6,974	692	800	650	370	0	1,020	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
03-May-05	6,648	370	0	11.27	7,018	687	800	650	370	0	1,020	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
04-May-05	6,642	370	0	12.00	7,012	681	800	650	370	0	1,020	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
05-May-05	6,637	370	0	12.73	7,007	675	800	650	370	0	1,020	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
06-May-05	6,631	370	0	13.47	7,001	670	800	650	410	0	1,060	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
07-May-05	6,625	370	0	14.20	6,995	664	800	650	410	0	1,060	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
08-May-05	6,620	370	0	14.94	6,990	658	800	650	410	0	1,060	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
09-May-05	6,614	410	0	15.75	7,024	653	800	650	410	0	1,060	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
10-May-05	6,608	410	0	16.56	7,018	647	800	650	410	0	1,060	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
11-May-05	6,603	410	0	17.38	7,013	641	800	650	410	0	1,060	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
12-May-05	6,597	410	0	18.19	7,007	636	800	650	395	0	1,045	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
13-May-05	6,591	410	0	19.00	7,001	630	800	650			650	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
14-May-05	6,586	410	0	19.81	6,996	625	800	650			650	3,000	3,000		3,000	352	352			352	
15-May-05	6,580	395	0	20.60	6,975	620	800	650			650	3,000	3,000		3,000	352	352			352	
16-May-05	5,427	0	0		5,427	615	800	650			650	3,000	3,000		3,000	352	352			352	
17-May-05	5,422	0	0		5,422	610	800	650			650	3,000	3,000		3,000	352	352			352	
18-May-05	5,417	0	0		5,417	605	800	650			650	3,000	3,000		3,000	352	352			352	
										VAMP Period											
Avg. (cfs):	6,665	335			7,000	715	800	650	335	0	985	3,000	3,000	0	3,000	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		20.60							20.60	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 2

2005 VAMP DAILY OPERATION PLAN
March 23, 2005 (B) • High
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-05	**6,260**				**6,260**	**1,278**	**1,183**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,234**	**1,201**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,181**	**1,110**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,820**				**5,820**	**1,163**	**932**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,163**	**995**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,750**				**5,750**	**1,151**	**932**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,246**	**995**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,880**				**5,880**	**1,535**	**1,041**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05																					
24-Mar-05																					
25-Mar-05																					
26-Mar-05																					
27-Mar-05																					
28-Mar-05																					
29-Mar-05								650													
30-Mar-05						879		650				3,400	3,400			225	225				
31-Mar-05						874		650				3,400	3,400			225	225				
01-Apr-05	6,354					869	1,200	650			650	3,400	3,400		3,400	225	225			225	
02-Apr-05	6,349					864	1,200	650			650	3,400	3,400		3,400	225	225			225	
03-Apr-05	6,344					859	1,200	650			650	3,400	3,400		3,400	225	225			225	
04-Apr-05	6,339				6,339	854	1,200	650			650	3,400	3,400		3,400	225	225			225	
05-Apr-05	6,334				6,334	848	1,200	650			650	3,400	3,400		3,400	225	225			225	
06-Apr-05	6,329				6,329	842	1,200	650			650	3,400	3,400		3,400	225	225			225	
07-Apr-05	6,323				6,323	836	1,200	650			650	3,400	3,400		3,400	225	225			225	
08-Apr-05	6,317				6,317	830	1,200	650			650	3,400	3,400		3,400	225	225			225	
09-Apr-05	6,311				6,311	824	1,200	650			650	3,400	3,400		3,400	225	225			225	
10-Apr-05	6,305				6,305	818	1,200	650			650	3,400	3,400		3,400	225	225			225	
11-Apr-05	6,299				6,299	812	1,200	650			650	3,400	3,400		3,400	225	225			225	
12-Apr-05	6,293				6,293	806	1,200	650	0	0	650	3,400	3,400		3,400	225	225			225	
13-Apr-05	6,287	0			6,287	800	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
14-Apr-05	6,281	0			6,281	794	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
15-Apr-05	7,550	0	0	0.00	7,550	789	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
16-Apr-05	7,544	0	0	0.00	7,544	783	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
17-Apr-05	7,539	0	0	0.00	7,539	777	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
18-Apr-05	7,533	0	0	0.00	7,533	772	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
19-Apr-05	7,527	0	0	0.00	7,527	766	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
20-Apr-05	7,522	0	0	0.00	7,522	760	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
21-Apr-05	7,516	0	0	0.00	7,516	755	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
22-Apr-05	7,510	0	0	0.00	7,510	749	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
23-Apr-05	7,505	0	0	0.00	7,505	743	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
24-Apr-05	7,499	0	0	0.00	7,499	738	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
25-Apr-05	7,493	0	0	0.00	7,493	732	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
26-Apr-05	7,488	0	0	0.00	7,488	726	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
27-Apr-05	7,482	0	0	0.00	7,482	721	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
28-Apr-05	7,476	0	0	0.00	7,476	715	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
29-Apr-05	7,471	0	0	0.00	7,471	709	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
30-Apr-05	7,465	0	0	0.00	7,465	704	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
01-May-05	7,459	0	0	0.00	7,459	698	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
02-May-05	7,454	0	0	0.00	7,454	692	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
03-May-05	7,448	0	0	0.00	7,448	687	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
04-May-05	7,442	0	0	0.00	7,442	681	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
05-May-05	7,437	0	0	0.00	7,437	675	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
06-May-05	7,431	0	0	0.00	7,431	670	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
07-May-05	7,425	0	0	0.00	7,425	664	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
08-May-05	7,420	0	0	0.00	7,420	658	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
09-May-05	7,414	0	0	0.00	7,414	653	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
10-May-05	7,408	0	0	0.00	7,408	647	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
11-May-05	7,403	0	0	0.00	7,403	641	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
12-May-05	7,397	0	0	0.00	7,397	636	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
13-May-05	7,391	0	0	0.00	7,391	630	1,200	650			650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
14-May-05	7,386	0	0	0.00	7,386	625	1,200	650			650	3,400	3,400		3,400	352	352			352	
15-May-05	7,380	0	0	0.00	7,380	620	1,200	650			650	3,400	3,400		3,400	352	352			352	
16-May-05	6,227	0	0		6,227	615	1,200	650			650	3,400	3,400		3,400	352	352			352	
17-May-05	6,222	0	0		6,222	610	1,200	650			650	3,400	3,400		3,400	352	352			352	
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):	7,465	0			7,465	715	1,200	650	0	0	650	3,400	3,400	0	3,400	1,500	1,500	0	0	1,500	
Supp. Water (TAF):		0.00							0.00	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 3

2005 VAMP DAILY OPERATION PLAN
March 25, 2005 (A) • Low
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-05	**6,260**				**6,260**	**1,278**	**1,183**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,234**	**1,201**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,181**	**1,110**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,820**				**5,820**	**1,163**	**932**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,163**	**995**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,750**				**5,750**	**1,151**	**932**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,246**	**995**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,880**				**5,880**	**1,535**	**1,041**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	**6,540**				**6,540**	**1,502**	**1,586**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	**8,230**				**8,230**	**1,789**	**2,995**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05																					
26-Mar-05																					
27-Mar-05																					
28-Mar-05																					
29-Mar-05																					
30-Mar-05																					
31-Mar-05																					
01-Apr-05						869	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
02-Apr-05						864	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
03-Apr-05						859	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
04-Apr-05	6,509				6,509	854	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
05-Apr-05	6,504				6,504	848	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
06-Apr-05	6,499				6,499	842	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
07-Apr-05	6,493				6,493	836	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
08-Apr-05	6,487				6,487	830	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
09-Apr-05	6,481				6,481	824	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
10-Apr-05	6,475				6,475	818	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
11-Apr-05	6,469				6,469	812	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
12-Apr-05	6,463				6,463	806	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
13-Apr-05	6,457				6,457	800	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
14-Apr-05	6,451				6,451	794	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
15-Apr-05	6,445				6,445	789	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
16-Apr-05	6,439				6,439	783	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
17-Apr-05	6,434				6,434	777	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
18-Apr-05	6,428				6,428	772	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
19-Apr-05	6,422				6,422	766	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
20-Apr-05	6,417				6,417	760	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
21-Apr-05	6,411				6,411	755	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
22-Apr-05	6,405				6,405	749	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
23-Apr-05	6,400				6,400	743	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
24-Apr-05	6,394				6,394	738	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
25-Apr-05	6,388				6,388	732	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
26-Apr-05	6,383				6,383	726	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
27-Apr-05	6,377				6,377	721	800	1,220			1,220	3,400	3,400		3,400	225	225			225	
28-Apr-05	6,371				6,371	715	800	1,220	120	0	1,340	3,400	3,400		3,400	225	225			225	
29-Apr-05	6,366				6,366	709	800	1,220	120	0	1,340	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
30-Apr-05	6,360				6,360	704	800	1,220	120	0	1,340	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
01-May-05	6,929	120	0	0.24	7,049	698	800	1,180	120	0	1,300	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
02-May-05	6,924	120	0	0.48	7,044	692	800	1,180	120	0	1,300	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
03-May-05	6,918	120	0	0.71	7,038	687	800	1,180	160	0	1,340	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
04-May-05	6,872	120	0	0.95	6,992	681	800	1,180	160	0	1,340	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
05-May-05	6,867	120	0	1.19	6,987	675	800	1,180	160	0	1,340	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
06-May-05	6,861	160	0	1.51	7,021	670	800	1,180	160	0	1,340	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
07-May-05	6,855	160	0	1.82	7,015	664	800	1,180	160	0	1,340	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
08-May-05	6,850	160	0	2.14	7,010	658	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
09-May-05	6,844	160	0	2.46	7,004	653	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
10-May-05	6,838	160	0	2.78	6,998	647	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
11-May-05	6,833	200	0	3.17	7,033	641	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
12-May-05	6,827	200	0	3.57	7,027	636	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
13-May-05	6,821	200	0	3.97	7,021	630	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
14-May-05	6,816	200	0	4.36	7,016	625	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
15-May-05	6,810	200	0	4.76	7,010	620	800	1,180	200	0	1,380	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
16-May-05	6,805	200	0	5.16	7,005	615	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
17-May-05	6,800	200	0	5.55	7,000	610	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
18-May-05	6,795	200	0	5.95	6,995	605	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
19-May-05	6,790	220	0	6.39	7,010	600	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
20-May-05	6,785	220	0	6.82	7,005	595	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
21-May-05	6,780	220	0	7.26	7,000	590	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
22-May-05	6,775	220	0	7.70	6,995	585	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
23-May-05	6,770	220	0	8.13	6,990	580	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
24-May-05	6,765	220	0	8.57	6,985	575	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
25-May-05	6,760	220	0	9.00	6,980	570	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
26-May-05	6,755	220	0	9.44	6,975	565	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
27-May-05	6,750	220	0	9.88	6,970	560	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
28-May-05	6,745	220	0	10.31	6,965	555	800	1,180	220	0	1,400	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
29-May-05	6,740	220	0	10.75	6,960	550	800	1,180			1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
30-May-05	6,735	220	0	11.19	6,955	545	800	1,180			1,180	2,700	2,700		2,700	352	352			352	
31-May-05	6,730	220	0	11.62	6,950	540	800	1,180			1,180	2,700	2,700		2,700	352	352			352	
VAMP Period																					
Avg. (cfs):	6,811	189			7,000	627	800	1,184	189	0	1,373	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		11.62							11.62	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 4

2005 VAMP DAILY OPERATION PLAN
March 25, 2005 (B) • High
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-05	**6,260**				**6,260**	**1,278**	**1,183**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,234**	**1,201**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,181**	**1,110**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,820**				**5,820**	**1,163**	**932**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,163**	**995**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,750**				**5,750**	**1,151**	**932**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,246**	**995**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,880**				**5,880**	**1,535**	**1,041**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	**6,540**				**6,540**	**1,502**	**1,586**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	**8,230**				**8,230**	**1,789**	**2,995**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05																					
26-Mar-05																					
27-Mar-05																					
28-Mar-05																					
29-Mar-05																					
30-Mar-05																					
31-Mar-05																					
01-Apr-05						869	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
02-Apr-05						864	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
03-Apr-05						859	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
04-Apr-05	6,909				6,909	854	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
05-Apr-05	6,904				6,904	848	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
06-Apr-05	6,899				6,899	842	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
07-Apr-05	6,893				6,893	836	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
08-Apr-05	6,887				6,887	830	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
09-Apr-05	6,881				6,881	824	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
10-Apr-05	6,875				6,875	818	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
11-Apr-05	6,869				6,869	812	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
12-Apr-05	6,863				6,863	806	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
13-Apr-05	6,857				6,857	800	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
14-Apr-05	6,851				6,851	794	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
15-Apr-05	6,845				6,845	789	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
16-Apr-05	6,839				6,839	783	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
17-Apr-05	6,834				6,834	777	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
18-Apr-05	6,828				6,828	772	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
19-Apr-05	6,822				6,822	766	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
20-Apr-05	6,817				6,817	760	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
21-Apr-05	6,811				6,811	755	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
22-Apr-05	6,805				6,805	749	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
23-Apr-05	6,800				6,800	743	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
24-Apr-05	6,794				6,794	738	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
25-Apr-05	6,788				6,788	732	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
26-Apr-05	6,783				6,783	726	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
27-Apr-05	6,777				6,777	721	1,200	1,220			1,220	3,400	3,400		3,400	225	225			225	
28-Apr-05	6,771				6,771	715	1,200	1,220	0	0	1,220	3,400	3,400		3,400	225	225			225	
29-Apr-05	6,766				6,766	709	1,200	1,220	0	0	1,220	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
30-Apr-05	6,760				6,760	704	1,200	1,220	0	0	1,220	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
01-May-05	7,329	0	0	0.00	7,329	698	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
02-May-05	7,324	0	0	0.00	7,324	692	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
03-May-05	7,318	0	0	0.00	7,318	687	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
04-May-05	7,272	0	0	0.00	7,272	681	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
05-May-05	7,267	0	0	0.00	7,267	675	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
06-May-05	7,261	0	0	0.00	7,261	670	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
07-May-05	7,255	0	0	0.00	7,255	664	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
08-May-05	7,250	0	0	0.00	7,250	658	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
09-May-05	7,244	0	0	0.00	7,244	653	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
10-May-05	7,238	0	0	0.00	7,238	647	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
11-May-05	7,233	0	0	0.00	7,233	641	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
12-May-05	7,227	0	0	0.00	7,227	636	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
13-May-05	7,221	0	0	0.00	7,221	630	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
14-May-05	7,216	0	0	0.00	7,216	625	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
15-May-05	7,210	0	0	0.00	7,210	620	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
16-May-05	7,205	0	0	0.00	7,205	615	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
17-May-05	7,200	0	0	0.00	7,200	610	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
18-May-05	7,195	0	0	0.00	7,195	605	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
19-May-05	7,190	0	0	0.00	7,190	600	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
20-May-05	7,185	0	0	0.00	7,185	595	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
21-May-05	7,180	0	0	0.00	7,180	590	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
22-May-05	7,175	0	0	0.00	7,175	585	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
23-May-05	7,170	0	0	0.00	7,170	580	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
24-May-05	7,165	0	0	0.00	7,165	575	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
25-May-05	7,160	0	0	0.00	7,160	570	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
26-May-05	7,155	0	0	0.00	7,155	565	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
27-May-05	7,150	0	0	0.00	7,150	560	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
28-May-05	7,145	0	0	0.00	7,145	555	1,200	1,180	0	0	1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
29-May-05	7,140	0	0	0.00	7,140	550	1,200	1,180			1,180	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
30-May-05	7,135	0	0	0.00	7,135	545	1,200	1,180			1,180	2,700	2,700		2,700	352	352			352	
31-May-05	7,130	0	0	0.00	7,130	540	1,200	1,180			1,180	2,700	2,700		2,700	352	352			352	
VAMP Period																					
Avg. (cfs):	7,211	0			7,211	627	1,200	1,184	0	0	1,184	2,700	2,700	0	2,700	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		0.00							0.00	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 5

2005 VAMP DAILY OPERATION PLAN
April 5, 2005 (A) • Low
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-05	**6,260**				**6,260**	**1,278**	**1,183**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,234**	**1,201**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,181**	**1,110**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,820**				**5,820**	**1,163**	**932**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,163**	**995**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,830**				**5,830**	**1,151**	**1,012**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,246**	**995**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,880**				**5,880**	**1,535**	**1,041**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	**6,540**				**6,540**	**1,502**	**1,586**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	**8,230**				**8,230**	**1,789**	**2,995**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05	**9,220**				**9,220**	**2,881**	**3,960**	**1,532**			**1,532**	**5,810**	**5,810**		**5,810**	**611**	**611**			**611**	
26-Mar-05	**10,200**				**10,200**	**3,265**	**2,106**	**2,147**			**2,147**	**6,230**	**6,230**		**6,230**	**607**	**607**			**607**	
27-Mar-05	**11,700**				**11,700**	**3,095**	**629**	**4,145**			**4,145**	**6,240**	**6,240**		**6,240**	**610**	**610**			**610**	
28-Mar-05	**12,700**				**12,700**	**2,371**	**1,066**	**5,695**			**5,695**	**6,120**	**6,120**		**6,120**	**604**	**604**			**604**	
29-Mar-05	**13,500**				**13,500**	**2,364**	**1,408**	**5,451**			**5,451**	**6,440**	**6,440**		**6,440**	**603**	**603**			**603**	
30-Mar-05	**14,000**				**14,000**	**2,513**	**760**	**5,232**			**5,232**	**6,660**	**6,660**		**6,660**	**400**	**400**			**400**	
31-Mar-05	**14,300**				**14,300**	**2,378**	**-802**	**4,717**			**4,717**	**6,660**	**6,660**		**6,660**	**229**	**229**			**229**	
01-Apr-05	**14,400**				**14,400**	**2,156**	**-624**	**4,604**			**4,604**	**7,230**	**7,230**		**7,230**	**229**	**229**			**229**	
02-Apr-05	**14,300**				**14,300**	**1,906**	**-199**	**4,164**			**4,164**	**6,860**	**6,860**		**6,860**	**229**	**229**			**229**	
03-Apr-05	**14,400**				**14,400**	**1,676**	**68**	**4,076**			**4,076**	**7,070**	**7,070**		**7,070**	**229**	**229**			**229**	
04-Apr-05	**14,300**				**14,300**	**1,282**	**701**	**4,074**			**4,074**	**7,360**	**7,360**		**7,360**	**226**	**226**			**226**	
05-Apr-05	14,139				14,139	1,217	1,000	3,700			3,700	7,200	7,200		7,200	225	225			225	
06-Apr-05	13,744				13,744	1,153	800	3,200			3,200	6,500	6,500		6,500	225	225			225	
07-Apr-05	13,316				13,316	1,088	600	2,500			2,500	5,000	5,000		5,000	225	225			225	
08-Apr-05	12,178				12,178	1,023	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
09-Apr-05	10,113				10,113	959	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
10-Apr-05	8,348				8,348	894	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
11-Apr-05	8,284				8,284	829	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
12-Apr-05	8,219				8,219	765	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
13-Apr-05	8,154				8,154	700	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
14-Apr-05	8,090				8,090	695	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
15-Apr-05	8,025				8,025	690	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
16-Apr-05	8,020				8,020	684	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
17-Apr-05	8,015				8,015	679	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
18-Apr-05	8,009				8,009	674	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
19-Apr-05	8,004				8,004	669	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
20-Apr-05	7,999				7,999	663	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
21-Apr-05	7,994				7,994	658	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
22-Apr-05	7,988				7,988	653	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
23-Apr-05	7,983				7,983	648	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
24-Apr-05	7,978				7,978	642	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
25-Apr-05	7,973				7,973	637	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
26-Apr-05	7,967				7,967	632	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
27-Apr-05	7,962				7,962	627	600	2,500			2,500	4,000	4,000		4,000	225	225			225	
28-Apr-05	7,957				7,957	622	600	2,500	0	0	2,500	4,000	4,000		4,000	225	225			225	
29-Apr-05	7,952				7,952	616	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
30-Apr-05	7,947				7,947	611	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
01-May-05	8,916	0	0	0.00	8,916	606	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
02-May-05	8,911	0	0	0.00	8,911	601	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
03-May-05	8,906	0	0	0.00	8,906	595	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
04-May-05	8,901	0	0	0.00	8,901	590	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
05-May-05	8,895	0	0	0.00	8,895	585	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
06-May-05	8,890	0	0	0.00	8,890	580	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
07-May-05	8,885	0	0	0.00	8,885	574	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
08-May-05	8,880	0	0	0.00	8,880	569	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
09-May-05	8,874	0	0	0.00	8,874	564	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
10-May-05	8,869	0	0	0.00	8,869	559	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
11-May-05	8,864	0	0	0.00	8,864	553	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
12-May-05	8,859	0	0	0.00	8,859	548	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
13-May-05	8,853	0	0	0.00	8,853	543	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
14-May-05	8,848	0	0	0.00	8,848	538	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
15-May-05	8,843	0	0	0.00	8,843	533	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
16-May-05	8,838	0	0	0.00	8,838	528	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
17-May-05	8,833	0	0	0.00	8,833	523	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
18-May-05	8,828	0	0	0.00	8,828	518	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
19-May-05	8,823	0	0	0.00	8,823	513	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
20-May-05	8,818	0	0	0.00	8,818	508	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
21-May-05	8,813	0	0	0.00	8,813	503	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
22-May-05	8,808	0	0	0.00	8,808	498	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
23-May-05	8,803	0	0	0.00	8,803	493	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
24-May-05	8,798	0	0	0.00	8,798	488	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
25-May-05	8,793	0	0	0.00	8,793	483	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
26-May-05	8,788	0	0	0.00	8,788	478	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
27-May-05	8,783	0	0	0.00	8,783	473	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
28-May-05	8,778	0	0	0.00	8,778	468	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
29-May-05	8,773	0	0	0.00	8,773	463	600	2,500			2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
30-May-05	8,768	0	0	0.00	8,768	458	600	2,500			2,500	3,700	3,700		3,700	352	352			352	
31-May-05	8,763	0	0	0.00	8,763	453	600	2,500			2,500	3,700	3,700		3,700	352	352			352	
VAMP Period																					
Avg. (cfs):	8,839	0			8,839	539	600	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		0.00							0.00	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 6

2005 VAMP DAILY OPERATION PLAN
April 5, 2005 (B) • High
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-05	**6,260**				**6,260**	**1,278**	**1,183**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,234**	**1,201**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,181**	**1,110**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,820**				**5,820**	**1,163**	**932**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,163**	**995**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,830**				**5,830**	**1,151**	**1,012**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,246**	**995**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,880**				**5,880**	**1,535**	**1,041**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	**6,540**				**6,540**	**1,502**	**1,586**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	**8,230**				**8,230**	**1,789**	**2,995**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05	**9,220**				**9,220**	**2,881**	**3,960**	**1,532**			**1,532**	**5,810**	**5,810**		**5,810**	**611**	**611**			**611**	
26-Mar-05	**10,200**				**10,200**	**3,265**	**2,106**	**2,147**			**2,147**	**6,230**	**6,230**		**6,230**	**607**	**607**			**607**	
27-Mar-05	**11,700**				**11,700**	**3,095**	**629**	**4,145**			**4,145**	**6,240**	**6,240**		**6,240**	**610**	**610**			**610**	
28-Mar-05	**12,700**				**12,700**	**2,371**	**1,066**	**5,695**			**5,695**	**6,120**	**6,120**		**6,120**	**604**	**604**			**604**	
29-Mar-05	**13,500**				**13,500**	**2,364**	**1,408**	**5,451**			**5,451**	**6,440**	**6,440**		**6,440**	**603**	**603**			**603**	
30-Mar-05	**14,000**				**14,000**	**2,513**	**760**	**5,232**			**5,232**	**6,660**	**6,660**		**6,660**	**400**	**400**			**400**	
31-Mar-05	**14,300**				**14,300**	**2,378**	**-802**	**4,717**			**4,717**	**6,660**	**6,660**		**6,660**	**229**	**229**			**229**	
01-Apr-05	**14,400**				**14,400**	**2,156**	**-624**	**4,604**			**4,604**	**7,230**	**7,230**		**7,230**	**229**	**229**			**229**	
02-Apr-05	**14,300**				**14,300**	**1,906**	**-199**	**4,164**			**4,164**	**6,860**	**6,860**		**6,860**	**229**	**229**			**229**	
03-Apr-05	**14,400**				**14,400**	**1,676**	**68**	**4,076**			**4,076**	**7,070**	**7,070**		**7,070**	**229**	**229**			**229**	
04-Apr-05	**14,300**				**14,300**	**1,282**	**701**	**4,074**			**4,074**	**7,360**	**7,360**		**7,360**	**226**	**226**			**226**	
05-Apr-05	14,139				14,139	1,217	1,000	3,700			3,700	7,200	7,200		7,200	225	225			225	
06-Apr-05	14,144				14,144	1,153	1,200	3,200			3,200	6,500	6,500		6,500	225	225			225	
07-Apr-05	13,916				13,916	1,088	1,200	2,500			2,500	5,000	5,000		5,000	225	225			225	
08-Apr-05	12,778				12,778	1,023	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
09-Apr-05	10,713				10,713	959	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
10-Apr-05	8,948				8,948	894	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
11-Apr-05	8,884				8,884	829	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
12-Apr-05	8,819				8,819	765	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
13-Apr-05	8,754				8,754	700	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
14-Apr-05	8,690				8,690	695	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
15-Apr-05	8,625				8,625	690	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
16-Apr-05	8,620				8,620	684	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
17-Apr-05	8,615				8,615	679	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
18-Apr-05	8,609				8,609	674	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
19-Apr-05	8,604				8,604	669	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
20-Apr-05	8,599				8,599	663	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
21-Apr-05	8,594				8,594	658	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
22-Apr-05	8,588				8,588	653	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
23-Apr-05	8,583				8,583	648	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
24-Apr-05	8,578				8,578	642	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
25-Apr-05	8,573				8,573	637	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
26-Apr-05	8,567				8,567	632	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
27-Apr-05	8,562				8,562	627	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
28-Apr-05	8,557				8,557	622	1,200	2,500	0	0	2,500	4,000	4,000		4,000	225	225			225	
29-Apr-05	8,552				8,552	616	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
30-Apr-05	8,547				8,547	611	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
01-May-05	9,516	0	0	0.00	9,516	606	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
02-May-05	9,511	0	0	0.00	9,511	601	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
03-May-05	9,506	0	0	0.00	9,506	595	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
04-May-05	9,501	0	0	0.00	9,501	590	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
05-May-05	9,495	0	0	0.00	9,495	585	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
06-May-05	9,490	0	0	0.00	9,490	580	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
07-May-05	9,485	0	0	0.00	9,485	574	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
08-May-05	9,480	0	0	0.00	9,480	569	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
09-May-05	9,474	0	0	0.00	9,474	564	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
10-May-05	9,469	0	0	0.00	9,469	559	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
11-May-05	9,464	0	0	0.00	9,464	553	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
12-May-05	9,459	0	0	0.00	9,459	548	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
13-May-05	9,453	0	0	0.00	9,453	543	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
14-May-05	9,448	0	0	0.00	9,448	538	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
15-May-05	9,443	0	0	0.00	9,443	533	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
16-May-05	9,438	0	0	0.00	9,438	528	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
17-May-05	9,433	0	0	0.00	9,433	523	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
18-May-05	9,428	0	0	0.00	9,428	518	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
19-May-05	9,423	0	0	0.00	9,423	513	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
20-May-05	9,418	0	0	0.00	9,418	508	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
21-May-05	9,413	0	0	0.00	9,413	503	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
22-May-05	9,408	0	0	0.00	9,408	498	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
23-May-05	9,403	0	0	0.00	9,403	493	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
24-May-05	9,398	0	0	0.00	9,398	488	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
25-May-05	9,393	0	0	0.00	9,393	483	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
26-May-05	9,388	0	0	0.00	9,388	478	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
27-May-05	9,383	0	0	0.00	9,383	473	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
28-May-05	9,378	0	0	0.00	9,378	468	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
29-May-05	9,373	0	0	0.00	9,373	463	1,200	2,500			2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
30-May-05	9,368	0	0	0.00	9,368	458	1,200	2,500			2,500	3,700	3,700		3,700	352	352			352	
31-May-05	9,363	0	0	0.00	9,363	453	1,200	2,500			2,500	3,700	3,700		3,700	352	352			352	
VAMP Period																					
Avg. (cfs):	9,439	0			9,439	539	1,200	2,500	0	0	2,500	3,700	3,700	0	3,700	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		0.00							0.00	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 7

2005 VAMP DAILY OPERATION PLAN

April 13, 2005 (A) • Low

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-05	**6,260**				**6,260**	**1,238**	**1,223**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,194**	**1,241**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,020**	**1,141**	**1,130**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,790**				**5,790**	**1,123**	**942**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,123**	**1,035**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,830**				**5,830**	**1,111**	**1,052**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,206**	**1,035**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,850**				**5,850**	**1,495**	**1,051**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	**6,570**				**6,570**	**1,452**	**1,656**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	**8,390**				**8,390**	**1,729**	**3,195**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05	**9,460**				**9,460**	**2,811**	**4,250**	**1,532**			**1,532**	**5,810**	**5,810**		**5,810**	**611**	**611**			**611**	
26-Mar-05	**10,500**				**10,500**	**3,185**	**2,466**	**2,147**			**2,147**	**6,230**	**6,230**		**6,230**	**607**	**607**			**607**	
27-Mar-05	**12,100**				**12,100**	**3,005**	**1,099**	**4,145**			**4,145**	**6,240**	**6,240**		**6,240**	**610**	**610**			**610**	
28-Mar-05	**13,300**				**13,300**	**2,261**	**1,746**	**5,695**			**5,695**	**6,120**	**6,120**		**6,120**	**604**	**604**			**604**	
29-Mar-05	**14,100**				**14,100**	**2,224**	**2,098**	**5,451**			**5,451**	**6,440**	**6,440**		**6,440**	**603**	**603**			**603**	
30-Mar-05	**14,600**				**14,600**	**2,393**	**1,470**	**5,232**			**5,232**	**6,660**	**6,660**		**6,660**	**400**	**400**			**400**	
31-Mar-05	**15,000**				**15,000**	**2,298**	**38**	**4,717**			**4,717**	**6,660**	**6,660**		**6,660**	**229**	**229**			**229**	
01-Apr-05	**15,100**				**15,100**	**2,086**	**196**	**4,604**			**4,604**	**7,230**	**7,230**		**7,230**	**229**	**229**			**229**	
02-Apr-05	**15,000**				**15,000**	**1,846**	**581**	**4,164**			**4,164**	**6,860**	**6,860**		**6,860**	**229**	**229**			**229**	
03-Apr-05	**15,000**				**15,000**	**1,616**	**738**	**4,076**			**4,076**	**7,070**	**7,070**		**7,070**	**229**	**229**			**229**	
04-Apr-05	**15,000**				**15,000**	**1,232**	**1,461**	**4,074**			**4,074**	**7,360**	**7,360**		**7,360**	**226**	**226**			**226**	
05-Apr-05	**14,700**				**14,700**	**1,009**	**1,621**	**3,690**			**3,690**	**7,200**	**7,200**		**7,200**	**229**	**229**			**229**	
06-Apr-05	**14,300**				**14,300**	**904**	**1,406**	**3,575**			**3,575**	**5,600**	**5,600**		**5,600**	**229**	**229**			**229**	
07-Apr-05	**13,400**				**13,400**	**719**	**888**	**3,404**			**3,404**	**5,110**	**5,110**		**5,110**	**226**	**226**			**226**	
08-Apr-05	**12,000**				**12,000**	**616**	**1,577**	**3,385**			**3,385**	**4,630**	**4,630**		**4,630**	**227**	**227**			**227**	
09-Apr-05	**11,400**				**11,400**	**582**	**1,770**	**3,349**			**3,349**	**4,090**	**4,090**		**4,090**	**225**	**225**			**225**	
10-Apr-05	**10,700**				**10,700**	**618**	**1,823**	**3,332**			**3,332**	**4,160**	**4,160**		**4,160**	**229**	**229**			**229**	
11-Apr-05	**10,300**				**10,300**	**615**	**2,018**	**3,286**			**3,286**	**4,910**	**4,910**		**4,910**	**232**	**232**			**232**	
12-Apr-05	**10,300**				**10,300**	**697**	**1,944**	**2,807**			**2,807**	**5,020**	**5,020**		**5,020**	**226**	**226**			**226**	
13-Apr-05	10,789				10,789	700	1,700	2,500			2,500	4,000	4,000		4,000	225	225			225	
14-Apr-05	10,429				10,429	695	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
15-Apr-05	8,632				8,632	690	900	2,500			2,500	4,000	4,000		4,000	225	225			225	
16-Apr-05	8,020				8,020	684	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
17-Apr-05	8,015				8,015	679	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
18-Apr-05	7,609				7,609	674	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
19-Apr-05	7,604				7,604	669	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
20-Apr-05	7,599				7,599	663	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
21-Apr-05	7,594				7,594	658	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
22-Apr-05	7,588				7,588	653	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
23-Apr-05	7,583				7,583	648	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
24-Apr-05	7,578				7,578	642	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
25-Apr-05	7,573				7,573	637	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
26-Apr-05	7,567				7,567	632	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
27-Apr-05	7,562				7,562	627	600	2,500			2,500	3,600	3,600		3,600	225	225			225	
28-Apr-05	7,557				7,557	622	600	1,625	220	0	1,845	3,000	3,000		3,000	225	225			225	
29-Apr-05	7,552				7,552	616	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
30-Apr-05	6,947				6,947	611	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
01-May-05	6,841	220	0	0.44	7,061	606	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
02-May-05	6,836	220	0	0.87	7,056	601	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
03-May-05	6,831	220	0	1.31	7,051	595	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
04-May-05	6,826	220	0	1.75	7,046	590	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
05-May-05	6,820	220	0	2.18	7,040	585	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
06-May-05	6,815	220	0	2.62	7,035	580	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
07-May-05	6,810	220	0	3.05	7,030	574	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
08-May-05	6,805	220	0	3.49	7,025	569	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
09-May-05	6,799	220	0	3.93	7,019	564	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
10-May-05	6,794	220	0	4.36	7,014	559	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
11-May-05	6,789	220	0	4.80	7,009	553	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
12-May-05	6,784	220	0	5.24	7,004	548	600	1,625	220	0	1,845	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
13-May-05	6,778	220	0	5.67	6,998	543	600	1,625	230	0	1,855	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
14-May-05	6,773	220	0	6.11	6,993	538	600	1,625	230	0	1,855	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
15-May-05	6,768	220	0	6.55	6,988	533	600	1,625	230	0	1,855	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
16-May-05	6,763	230	0	7.00	6,993	528	600	1,625	230	0	1,855	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
17-May-05	6,758	230	0	7.46	6,988	523	600	1,625	240	0	1,865	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
18-May-05	6,753	230	0	7.91	6,983	518	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
19-May-05	6,748	230	0	8.37	6,978	513	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
20-May-05	6,743	240	0	8.85	6,983	508	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
21-May-05	6,738	260	0	9.36	6,998	503	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
22-May-05	6,733	260	0	9.88	6,993	498	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
23-May-05	6,728	260	0	10.39	6,988	493	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
24-May-05	6,723	260	0	10.91	6,983	488	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
25-May-05	6,718	260	0	11.42	6,978	483	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
26-May-05	6,713	260	0	11.94	6,973	478	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
27-May-05	6,708	260	0	12.46	6,968	473	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
28-May-05	6,703	260	0	12.97	6,963	468	600	1,625	260	0	1,885	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
29-May-05	6,698	260	0	13.49	6,958	463	600	1,625			1,625	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
30-May-05	6,693	260	0	14.00	6,953	458	600	1,625			1,625	2,500	2,500		2,500	352	352			352	
31-May-05	6,688	260	0	14.52	6,948	453	600	1,625			1,625	2,500	2,500		2,500	352	352			352	
VAMP Period																					
Avg. (cfs):	6,764	236			7,000	539	600	1,625	236	0	1,861	2,500	2,500	0	2,500	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		14.52							14.52	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 8

2005 VAMP DAILY OPERATION PLAN
April 13, 2005 • High
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-05	6,260				**6,260**	**1,238**	**1,223**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	6,180				**6,180**	**1,194**	**1,241**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	6,040				**6,040**	**1,141**	**1,130**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	5,790				**5,820**	**1,123**	**942**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	5,800				**5,800**	**1,123**	**1,035**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	5,830				**5,830**	**1,111**	**1,052**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	5,850				**5,850**	**1,206**	**1,035**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	5,850				**5,880**	**1,495**	**1,051**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	6,570				**6,540**	**1,452**	**1,656**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	8,390				**8,230**	**1,729**	**3,195**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05	9,460				**9,220**	**2,811**	**4,250**	**1,532**			**1,532**	**5,810**	**5,810**		**5,810**	**611**	**611**			**611**	
26-Mar-05	10,500				**10,200**	**3,185**	**2,466**	**2,147**			**2,147**	**6,230**	**6,230**		**6,230**	**607**	**607**			**607**	
27-Mar-05	12,100				**11,700**	**3,005**	**1,099**	**4,145**			**4,145**	**6,240**	**6,240**		**6,240**	**610**	**610**			**610**	
28-Mar-05	**13,300**				**12,700**	**2,261**	**1,746**	**5,695**			**5,695**	**6,120**	**6,120**		**6,120**	**604**	**604**			**604**	
29-Mar-05	**14,100**				**13,500**	**2,224**	**2,098**	**5,451**			**5,451**	**6,440**	**6,440**		**6,440**	**603**	**603**			**603**	
30-Mar-05	**14,600**				**14,000**	**2,393**	**1,470**	**5,232**			**5,232**	**6,660**	**6,660**		**6,660**	**400**	**400**			**400**	
31-Mar-05	**15,000**				**14,300**	**2,298**	**38**	**4,717**			**4,717**	**6,660**	**6,660**		**6,660**	**229**	**229**			**229**	
01-Apr-05	**15,100**				**14,400**	**2,086**	**196**	**4,604**			**4,604**	**7,230**	**7,230**		**7,230**	**229**	**229**			**229**	
02-Apr-05	**15,000**				**14,300**	**1,846**	**581**	**4,164**			**4,164**	**6,860**	**6,860**		**6,860**	**229**	**229**			**229**	
03-Apr-05	**15,000**				**14,400**	**1,616**	**738**	**4,076**			**4,076**	**7,070**	**7,070**		**7,070**	**229**	**229**			**229**	
04-Apr-05	**15,000**				**14,300**	**1,232**	**1,461**	**4,074**			**4,074**	**7,360**	**7,360**		**7,360**	**226**	**226**			**226**	
05-Apr-05	**14,700**				**14,100**	**1,009**	**1,621**	**3,690**			**3,690**	**7,200**	**7,200**		**7,200**	**229**	**229**			**229**	
06-Apr-05	**14,300**				**13,700**	**904**	**1,406**	**3,575**			**3,575**	**5,600**	**5,600**		**5,600**	**229**	**229**			**229**	
07-Apr-05	**13,400**				**12,800**	**719**	**888**	**3,404**			**3,404**	**5,110**	**5,110**		**5,110**	**226**	**226**			**226**	
08-Apr-05	**12,000**				**12,000**	**616**	**1,577**	**3,385**			**3,385**	**4,630**	**4,630**		**4,630**	**227**	**227**			**227**	
09-Apr-05	**11,400**				**11,400**	**582**	**1,770**	**3,349**			**3,349**	**4,090**	**4,090**		**4,090**	**225**	**225**			**225**	
10-Apr-05	**10,700**				**10,700**	**618**	**1,823**	**3,332**			**3,332**	**4,160**	**4,160**		**4,160**	**229**	**229**			**229**	
11-Apr-05	**10,300**				**10,300**	**615**	**2,018**	**3,286**			**3,286**	**4,910**	**4,910**		**4,910**	**232**	**232**			**232**	
12-Apr-05	**10,300**				**10,300**	**697**	**1,944**	**2,807**			**2,807**	**5,020**	**5,020**		**5,020**	**226**	**226**			**226**	
13-Apr-05	10,789				10,789	700	1,700	2,500			2,500	4,000	4,000		4,000	225	225			225	
14-Apr-05	10,429				10,429	695	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
15-Apr-05	8,932				8,932	690	1,200	2,500			2,500	4,000	4,000		4,000	225	225			225	
16-Apr-05	8,620				8,620	684	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
17-Apr-05	8,615				8,615	679	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
18-Apr-05	8,209				8,209	674	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
19-Apr-05	8,204				8,204	669	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
20-Apr-05	8,199				8,199	663	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
21-Apr-05	8,194				8,194	658	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
22-Apr-05	8,188				8,188	653	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
23-Apr-05	8,183				8,183	648	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
24-Apr-05	8,178				8,178	642	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
25-Apr-05	8,173				8,173	637	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
26-Apr-05	8,167				8,167	632	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
27-Apr-05	8,162				8,162	627	1,200	2,500			2,500	3,600	3,600		3,600	225	225			225	
28-Apr-05	8,157				8,157	622	1,200	1,800	0	0	1,800	3,600	3,600		3,600	225	225			225	
29-Apr-05	8,152				8,152	616	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
30-Apr-05	8,147				8,147	611	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
01-May-05	8,216	0	0	0.00	8,216	606	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
02-May-05	8,211	0	0	0.00	8,211	601	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
03-May-05	8,206	0	0	0.00	8,206	595	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
04-May-05	8,201	0	0	0.00	8,201	590	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
05-May-05	8,195	0	0	0.00	8,195	585	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
06-May-05	8,190	0	0	0.00	8,190	580	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
07-May-05	8,185	0	0	0.00	8,185	574	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
08-May-05	8,180	0	0	0.00	8,180	569	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
09-May-05	8,174	0	0	0.00	8,174	564	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
10-May-05	8,169	0	0	0.00	8,169	559	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
11-May-05	8,164	0	0	0.00	8,164	553	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
12-May-05	8,159	0	0	0.00	8,159	548	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
13-May-05	8,153	0	0	0.00	8,153	543	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
14-May-05	8,148	0	0	0.00	8,148	538	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
15-May-05	8,143	0	0	0.00	8,143	533	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
16-May-05	8,138	0	0	0.00	8,138	528	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
17-May-05	8,133	0	0	0.00	8,133	523	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
18-May-05	8,128	0	0	0.00	8,128	518	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
19-May-05	8,123	0	0	0.00	8,123	513	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
20-May-05	8,118	0	0	0.00	8,118	508	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
21-May-05	8,113	0	0	0.00	8,113	503	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
22-May-05	8,108	0	0	0.00	8,108	498	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
23-May-05	8,103	0	0	0.00	8,103	493	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
24-May-05	8,098	0	0	0.00	8,098	488	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
25-May-05	8,093	0	0	0.00	8,093	483	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
26-May-05	8,088	0	0	0.00	8,088	478	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
27-May-05	8,083	0	0	0.00	8,083	473	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
28-May-05	8,078	0	0	0.00	8,078	468	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
29-May-05	8,073	0	0	0.00	8,073	463	1,200	1,800			1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
30-May-05	8,068	0	0	0.00	8,068	458	1,200	1,800			1,800	3,100	3,100		3,100	352	352			352	
31-May-05	8,063	0	0	0.00	8,063	453	1,200	1,800			1,800	3,100	3,100		3,100	352	352			352	
VAMP Period																					
Avg. (cfs):	8,139	0			8,139	539	1,200	1,800	0	0	1,800	3,100	3,100	0	3,100	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		0.00							0.00	0.00				0.00				0.00			

VAMP flow operation period

Appendix A-1, Table 9

2005 VAMP DAILY OPERATION PLAN
April 21, 2005
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-05	**6,260**				**6,260**	**1,238**	**1,223**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,194**	**1,241**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,141**	**1,130**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,790**				**5,820**	**1,123**	**942**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,123**	**1,035**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,830**				**5,830**	**1,111**	**1,052**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,206**	**1,035**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,850**				**5,880**	**1,495**	**1,051**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	**6,570**				**6,540**	**1,452**	**1,656**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	**8,390**				**8,230**	**1,729**	**3,195**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05	**9,460**				**9,220**	**2,811**	**4,250**	**1,532**			**1,532**	**5,810**	**5,810**		**5,810**	**611**	**611**			**611**	
26-Mar-05	**10,500**				**10,200**	**3,185**	**2,466**	**2,147**			**2,147**	**6,230**	**6,230**		**6,230**	**607**	**607**			**607**	
27-Mar-05	**12,100**				**11,700**	**3,005**	**1,099**	**4,145**			**4,145**	**6,240**	**6,240**		**6,240**	**610**	**610**			**610**	
28-Mar-05	**13,300**				**12,700**	**2,261**	**1,746**	**5,695**			**5,695**	**6,120**	**6,120**		**6,120**	**604**	**604**			**604**	
29-Mar-05	**14,100**				**13,500**	**2,224**	**2,098**	**5,451**			**5,451**	**6,440**	**6,440**		**6,440**	**603**	**603**			**603**	
30-Mar-05	**14,600**				**14,000**	**2,393**	**1,470**	**5,232**			**5,232**	**6,660**	**6,660**		**6,660**	**400**	**400**			**400**	
31-Mar-05	**15,000**				**14,300**	**2,298**	**38**	**4,717**			**4,717**	**6,660**	**6,660**		**6,660**	**229**	**229**			**229**	
01-Apr-05	**15,100**				**14,400**	**2,086**	**196**	**4,604**			**4,604**	**7,230**	**7,230**		**7,230**	**229**	**229**			**229**	
02-Apr-05	**15,000**				**14,300**	**1,846**	**581**	**4,164**			**4,164**	**6,860**	**6,860**		**6,860**	**229**	**229**			**229**	
03-Apr-05	**15,000**				**14,400**	**1,616**	**738**	**4,076**			**4,076**	**7,070**	**7,070**		**7,070**	**229**	**229**			**229**	
04-Apr-05	**15,000**				**14,300**	**1,232**	**1,461**	**4,074**			**4,074**	**7,360**	**7,360**		**7,360**	**226**	**226**			**226**	
05-Apr-05	**14,700**				**14,100**	**1,009**	**1,621**	**3,690**			**3,690**	**7,200**	**7,200**		**7,200**	**229**	**229**			**229**	
06-Apr-05	**14,300**				**13,700**	**904**	**1,406**	**3,575**			**3,575**	**5,600**	**5,600**		**5,600**	**229**	**229**			**229**	
07-Apr-05	**13,400**				**12,800**	**719**	**888**	**3,404**			**3,404**	**5,110**	**5,110**		**5,110**	**226**	**226**			**226**	
08-Apr-05	**12,000**				**12,000**	**616**	**1,577**	**3,385**			**3,385**	**4,630**	**4,630**		**4,630**	**227**	**227**			**227**	
09-Apr-05	**11,400**				**11,400**	**582**	**1,770**	**3,349**			**3,349**	**4,090**	**4,090**		**4,090**	**225**	**225**			**225**	
10-Apr-05	**10,700**				**10,700**	**618**	**1,823**	**3,332**			**3,332**	**4,160**	**4,160**		**4,160**	**229**	**229**			**229**	
11-Apr-05	**10,300**				**10,300**	**615**	**2,018**	**3,286**			**3,286**	**4,910**	**4,910**		**4,910**	**232**	**232**			**232**	
12-Apr-05	**10,300**				**10,300**	**697**	**1,944**	**2,807**			**2,807**	**5,020**	**5,020**		**5,020**	**226**	**226**			**226**	
13-Apr-05	**10,700**				**10,700**	**704**	**1,611**	**2,713**			**2,713**	**4,040**	**4,040**		**4,040**	**227**	**227**			**227**	
14-Apr-05	**9,840**				**9,840**	**595**	**611**	**2,742**			**2,742**	**4,100**	**4,100**		**4,100**	**228**	**228**			**228**	
15-Apr-05	**9,250**				**9,250**	**532**	**1,472**	**2,750**			**2,750**	**3,980**	**3,980**		**3,980**	**231**	**231**			**231**	
16-Apr-05	**9,010**				**9,010**	**458**	**1,374**	**2,702**			**2,702**	**4,070**	**4,070**		**4,070**	**229**	**229**			**229**	
17-Apr-05	**8,930**				**8,930**	**418**	**1,445**	**2,645**			**2,645**	**4,080**	**4,080**		**4,080**	**342**	**342**			**342**	
18-Apr-05	**8,740**				**8,740**	**400**	**1,233**	**2,577**			**2,577**	**4,100**	**4,100**		**4,100**	**406**	**406**			**406**	
19-Apr-05	**8,670**				**8,670**	**396**	**1,128**	**2,515**			**2,515**	**4,060**	**4,060**		**4,060**	**403**	**403**			**403**	
20-Apr-05	**8,580**				**8,580**	**375**	**1,029**	**2,460**			**2,460**	**4,030**	**4,030**		**4,030**	**400**	**400**			**400**	
21-Apr-05	8,436				8,436	390	1,000	2,500			2,500	3,600	3,600		3,600	400	400			400	
22-Apr-05	8,320				8,320	388	1,000	2,500			2,500	3,600	3,600		3,600	400	400			400	
23-Apr-05	7,850				7,850	385	1,000	2,500			2,500	3,600	3,600		3,600	400	400			400	
24-Apr-05	7,888				7,888	383	1,000	2,500			2,500	3,600	3,600		3,600	400	400			400	
25-Apr-05	7,885				7,885	381	1,000	2,500			2,500	3,600	3,600		3,600	400	400			400	
26-Apr-05	7,883				7,883	379	1,000	2,500			2,500	3,600	3,600		3,600	400	400			400	
27-Apr-05	7,881				7,881	376	1,000	2,500			2,500	3,600	3,600		3,600	400	400			400	
28-Apr-05	7,879				7,879	374	1,000	1,800	0	0	1,800	3,600	3,600		3,600	400	400			400	
29-Apr-05	7,876				7,876	372	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
30-Apr-05	7,874				7,874	370	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
01-May-05	7,972	0	0	0.00	7,972	367	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
02-May-05	7,970	0	0	0.00	7,970	365	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
03-May-05	7,967	0	0	0.00	7,967	363	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
04-May-05	7,965	0	0	0.00	7,965	361	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
05-May-05	7,963	0	0	0.00	7,963	358	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
06-May-05	7,961	0	0	0.00	7,961	356	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
07-May-05	7,958	0	0	0.00	7,958	354	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
08-May-05	7,956	0	0	0.00	7,956	352	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
09-May-05	7,954	0	0	0.00	7,954	349	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
10-May-05	7,952	0	0	0.00	7,952	347	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
11-May-05	7,949	0	0	0.00	7,949	345	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
12-May-05	7,947	0	0	0.00	7,947	343	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
13-May-05	7,945	0	0	0.00	7,945	340	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
14-May-05	7,943	0	0	0.00	7,943	338	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
15-May-05	7,940	0	0	0.00	7,940	336	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
16-May-05	7,938	0	0	0.00	7,938	334	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
17-May-05	7,936	0	0	0.00	7,936	331	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
18-May-05	7,934	0	0	0.00	7,934	329	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
19-May-05	7,931	0	0	0.00	7,931	327	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
20-May-05	7,929	0	0	0.00	7,929	325	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
21-May-05	7,927	0	0	0.00	7,927	322	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
22-May-05	7,925	0	0	0.00	7,925	320	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
23-May-05	7,922	0	0	0.00	7,922	318	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
24-May-05	7,920	0	0	0.00	7,920	316	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
25-May-05	7,918	0	0	0.00	7,918	313	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
26-May-05	7,916	0	0	0.00	7,916	311	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
27-May-05	7,913	0	0	0.00	7,913	309	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
28-May-05	7,911	0	0	0.00	7,911	307	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
29-May-05	7,909	0	0	0.00	7,909	304	1,000	1,800			1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
30-May-05	7,907	0	0	0.00	7,907	302	1,000	1,800			1,800	3,300	3,300		3,300	352	352			352	
31-May-05	7,904	0	0	0.00	7,904	300	1,000	1,800			1,800	3,300	3,300		3,300	352	352			352	
VAMP Period																					
Avg. (cfs):	7,938	0			7,938	338	1,000	1,800	0	0	1,800	3,300	3,300	0	3,300	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):			0.00							0.00	0.00				0.00				0.00		

VAMP flow operation period

Appendix A-1, Table 10

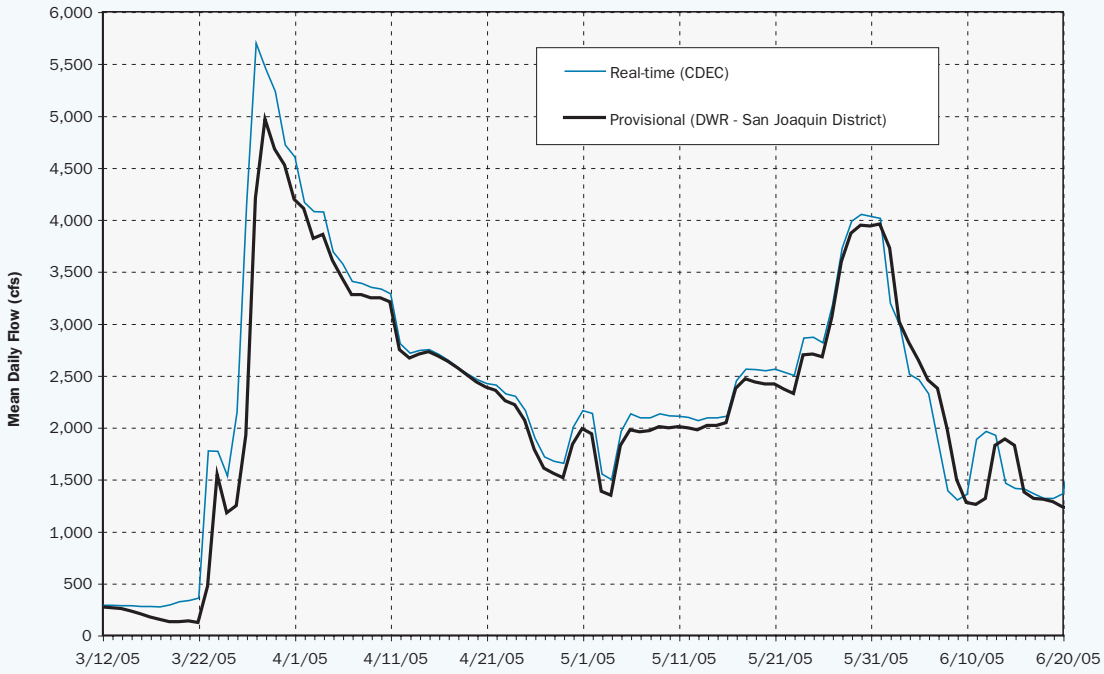
2005 VAMP DAILY OPERATION PLAN
April 28, 2005
Target Flow Period: May 1 - May 31 • Flow Target: greater than 7,000 cfs

Bold Numbers: observed real-time mean daily flows

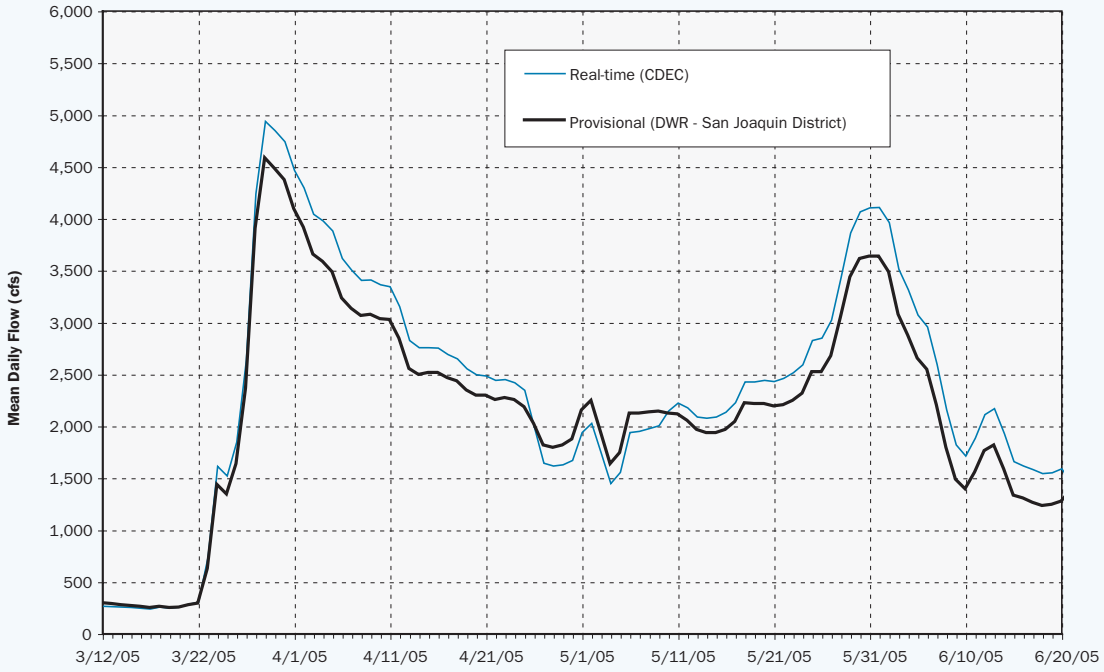
	San Joaquin River near Vernalis							Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin					
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. 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-05	**6,260**				**6,260**	**1,238**	**1,223**	**285**			**285**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
16-Mar-05	**6,180**				**6,180**	**1,194**	**1,241**	**275**			**275**	**3,140**	**3,140**		**3,140**	**229**	**229**			**229**	
17-Mar-05	**6,040**				**6,040**	**1,141**	**1,140**	**276**			**276**	**3,120**	**3,120**		**3,120**	**229**	**229**			**229**	
18-Mar-05	**5,790**				**5,820**	**1,123**	**942**	**274**			**274**	**3,150**	**3,150**		**3,150**	**229**	**229**			**229**	
19-Mar-05	**5,800**				**5,800**	**1,123**	**1,035**	**292**			**292**	**3,190**	**3,190**		**3,190**	**228**	**228**			**228**	
20-Mar-05	**5,830**				**5,830**	**1,111**	**1,052**	**322**			**322**	**3,170**	**3,170**		**3,170**	**226**	**226**			**226**	
21-Mar-05	**5,850**				**5,850**	**1,206**	**1,035**	**335**			**335**	**3,160**	**3,160**		**3,160**	**226**	**226**			**226**	
22-Mar-05	**5,860**				**5,880**	**1,495**	**1,061**	**356**			**356**	**3,120**	**3,120**		**3,120**	**245**	**245**			**245**	
23-Mar-05	**6,570**				**6,540**	**1,452**	**1,656**	**1,774**			**1,774**	**3,170**	**3,170**		**3,170**	**232**	**232**			**232**	
24-Mar-05	**8,390**				**8,230**	**1,729**	**3,195**	**1,769**			**1,769**	**4,230**	**4,230**		**4,230**	**301**	**301**			**301**	
25-Mar-05	**9,470**				**9,220**	**2,811**	**4,260**	**1,532**			**1,532**	**5,810**	**5,810**		**5,810**	**611**	**611**			**611**	
26-Mar-05	**10,500**				**10,200**	**3,185**	**2,466**	**2,147**			**2,147**	**6,230**	**6,230**		**6,230**	**607**	**607**			**607**	
27-Mar-05	**12,100**				**11,700**	**3,005**	**1,099**	**4,145**			**4,145**	**6,240**	**6,240**		**6,240**	**610**	**610**			**610**	
28-Mar-05	**13,300**				**12,700**	**2,261**	**1,746**	**5,695**			**5,695**	**6,120**	**6,120**		**6,120**	**604**	**604**			**604**	
29-Mar-05	**14,100**				**13,500**	**2,224**	**2,098**	**5,451**			**5,451**	**6,440**	**6,440**		**6,440**	**603**	**603**			**603**	
30-Mar-05	**14,600**				**14,000**	**2,393**	**1,470**	**5,232**			**5,232**	**6,660**	**6,660**		**6,660**	**400**	**400**			**400**	
31-Mar-05	**15,000**				**14,300**	**2,298**	**38**	**4,717**			**4,717**	**6,660**	**6,660**		**6,660**	**229**	**229**			**229**	
01-Apr-05	**15,100**				**14,400**	**2,086**	**196**	**4,604**			**4,604**	**7,230**	**7,230**		**7,230**	**229**	**229**			**229**	
02-Apr-05	**15,000**				**14,300**	**1,846**	**581**	**4,164**			**4,164**	**6,860**	**6,860**		**6,860**	**229**	**229**			**229**	
03-Apr-05	**15,000**				**14,400**	**1,616**	**738**	**4,076**			**4,076**	**7,070**	**7,070**		**7,070**	**229**	**229**			**229**	
04-Apr-05	**15,000**				**14,300**	**1,232**	**1,461**	**4,074**			**4,074**	**7,360**	**7,360**		**7,360**	**226**	**226**			**226**	
05-Apr-05	**14,700**				**14,100**	**1,009**	**1,621**	**3,690**			**3,690**	**7,200**	**7,200**		**7,200**	**229**	**229**			**229**	
06-Apr-05	**14,400**				**13,700**	**904**	**1,506**	**3,575**			**3,575**	**5,600**	**5,600**		**5,600**	**229**	**229**			**229**	
07-Apr-05	**13,400**				**12,800**	**719**	**888**	**3,404**			**3,404**	**5,110**	**5,110**		**5,110**	**226**	**226**			**226**	
08-Apr-05	**12,000**				**12,000**	**616**	**1,577**	**3,385**			**3,385**	**4,630**	**4,630**		**4,630**	**227**	**227**			**227**	
09-Apr-05	**11,500**				**11,500**	**582**	**1,870**	**3,349**			**3,349**	**4,090**	**4,090**		**4,090**	**225**	**225**			**225**	
10-Apr-05	**10,700**				**10,700**	**618**	**1,823**	**3,332**			**3,332**	**4,160**	**4,160**		**4,160**	**229**	**229**			**229**	
11-Apr-05	**10,400**				**10,400**	**615**	**2,118**	**3,286**			**3,286**	**4,910**	**4,910**		**4,910**	**232**	**232**			**232**	
12-Apr-05	**10,300**				**10,300**	**697**	**1,944**	**2,807**			**2,807**	**5,020**	**5,020**		**5,020**	**226**	**226**			**226**	
13-Apr-05	**10,800**				**10,800**	**704**	**1,711**	**2,713**			**2,713**	**4,040**	**4,040**		**4,040**	**227**	**227**			**227**	
14-Apr-05	**9,900**				**9,900**	**595**	**671**	**2,742**			**2,742**	**4,100**	**4,100**		**4,100**	**228**	**228**			**228**	
15-Apr-05	**9,320**				**9,320**	**532**	**1,542**	**2,750**			**2,750**	**3,980**	**3,980**		**3,980**	**231**	**231**			**231**	
16-Apr-05	**9,080**				**9,080**	**458**	**1,444**	**2,702**			**2,702**	**4,070**	**4,070**		**4,070**	**229**	**229**			**229**	
17-Apr-05	**9,010**				**9,010**	**418**	**1,525**	**2,645**			**2,645**	**4,080**	**4,080**		**4,080**	**342**	**342**			**342**	
18-Apr-05	**8,810**				**8,810**	**400**	**1,303**	**2,577**			**2,577**	**4,100**	**4,100**		**4,100**	**406**	**406**			**406**	
19-Apr-05	**8,750**				**8,750**	**396**	**1,208**	**2,515**			**2,515**	**4,060**	**4,060**		**4,060**	**403**	**403**			**403**	
20-Apr-05	**8,660**				**8,660**	**375**	**1,109**	**2,460**			**2,460**	**4,030**	**4,030**		**4,030**	**400**	**400**			**400**	
21-Apr-05	**8,380**				**8,380**	**367**	**944**	**2,423**			**2,423**	**4,010**	**4,010**		**4,010**	**404**	**404**			**404**	
22-Apr-05	**8,010**				**8,010**	**340**	**690**	**2,406**			**2,406**	**3,860**	**3,860**		**3,860**	**401**	**401**			**401**	
23-Apr-05	**7,730**				**7,730**	**292**	**489**	**2,321**			**2,321**	**3,530**	**3,530**		**3,530**	**402**	**402**			**402**	
24-Apr-05	**7,490**				**7,490**	**310**	**466**	**2,301**			**2,301**	**3,280**	**3,280**		**3,280**	**409**	**409**			**409**	
25-Apr-05	**7,190**				**7,190**	**373**	**560**	**2,161**			**2,161**	**3,010**	**3,010**		**3,010**	**414**	**414**			**414**	
26-Apr-05	**6,750**				**6,750**	**626**	**430**	**1,800**			**1,800**	**3,210**	**3,210**		**3,210**	**401**	**401**			**401**	
27-Apr-05	**6,490**				**6,490**	**788**	**392**	**1,600**			**1,600**	**3,700**	**3,700**		**3,700**	**405**	**405**			**405**	
28-Apr-05	6,798				6,798	782	400	1,600	0	0	1,600	3,750	3,750		3,750	400	400			400	
29-Apr-05	7,093				7,093	777	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
30-Apr-05	6,932				6,932	771	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
01-May-05	8,027	0	0	0.00	8,027	766	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
02-May-05	8,021	0	0	0.00	8,021	760	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
03-May-05	8,016	0	0	0.00	8,016	754	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
04-May-05	8,010	0	0	0.00	8,010	749	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
05-May-05	8,004	0	0	0.00	8,004	743	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
06-May-05	7,999	0	0	0.00	7,999	738	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
07-May-05	7,993	0	0	0.00	7,993	732	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
08-May-05	7,988	0	0	0.00	7,988	726	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
09-May-05	7,982	0	0	0.00	7,982	721	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
10-May-05	7,976	0	0	0.00	7,976	715	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
11-May-05	7,971	0	0	0.00	7,971	710	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
12-May-05	7,965	0	0	0.00	7,965	704	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
13-May-05	7,960	0	0	0.00	7,960	698	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
14-May-05	7,954	0	0	0.00	7,954	693	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
15-May-05	7,948	0	0	0.00	7,948	687	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
16-May-05	7,943	0	0	0.00	7,943	682	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
17-May-05	7,937	0	0	0.00	7,937	676	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
18-May-05	7,932	0	0	0.00	7,932	670	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
19-May-05	7,926	0	0	0.00	7,926	665	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
20-May-05	7,920	0	0	0.00	7,920	659	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
21-May-05	7,915	0	0	0.00	7,915	654	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
22-May-05	7,909	0	0	0.00	7,909	648	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
23-May-05	7,904	0	0	0.00	7,904	642	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
24-May-05	7,898	0	0	0.00	7,898	637	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
25-May-05	7,892	0	0	0.00	7,892	631	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
26-May-05	7,887	0	0	0.00	7,887	626	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
27-May-05	7,881	0	0	0.00	7,881	620	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
28-May-05	7,876	0	0	0.00	7,876	614	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
29-May-05	7,870	0	0	0.00	7,870	608	400	1,600			1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
30-May-05	7,864	0	0	0.00	7,864	602	400	1,600			1,600	3,750	3,750		3,750	352	352			352	
31-May-05	7,858	0	0	0.00	7,858	596	400	1,600			1,600	3,750	3,750		3,750	352	352			352	
VAMP Period																					
Avg. (cfs):	7,943	0			7,943	693	400	1,600	0	0	1,600	3,750	3,750	0	3,750	1,500	1,500	0	0	1,500	
Suppl. Water (TAF):		0.00							0.00	0.00				0.00				0.00			

VAMP flow operation period

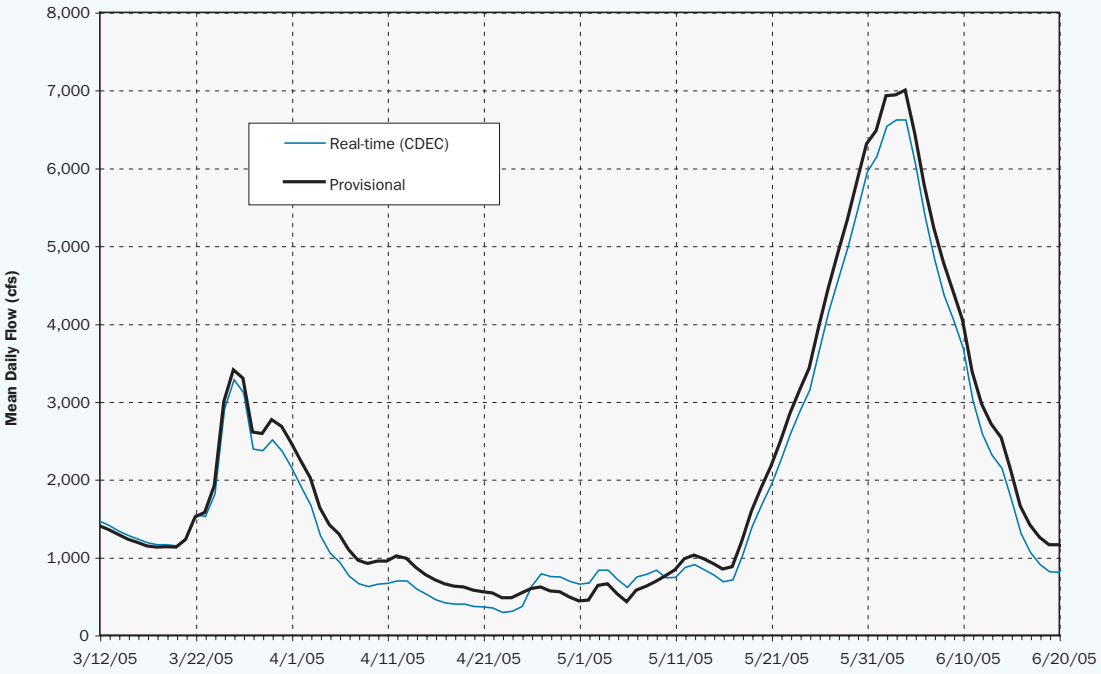
Appendix A-2, Figure 1
Merced River at Cressey



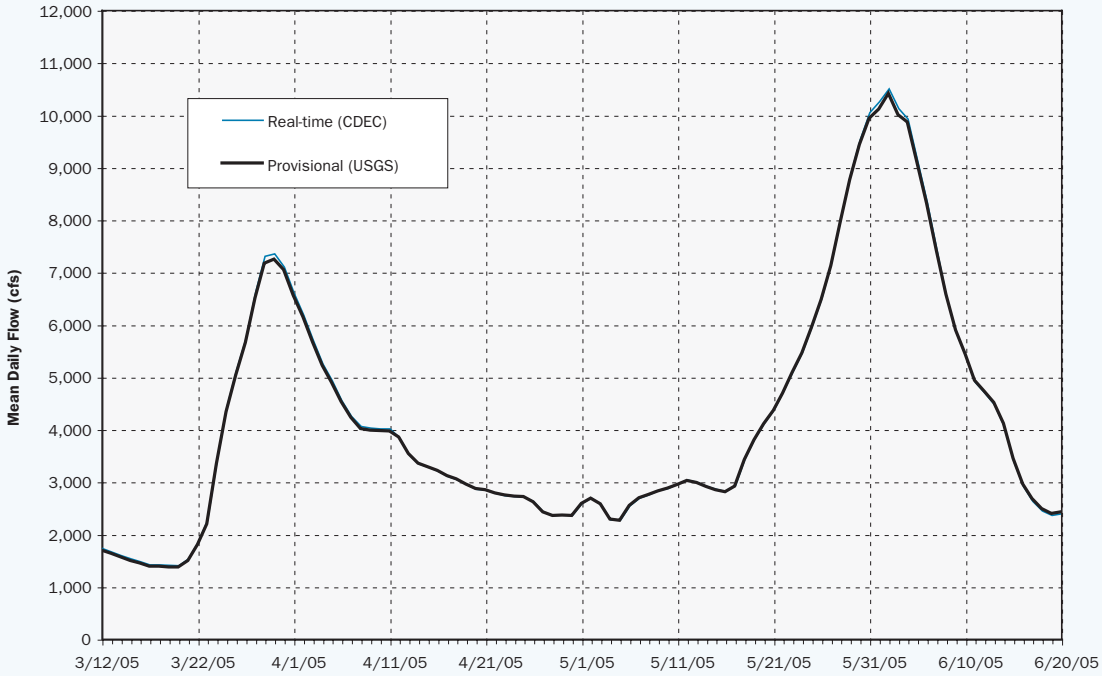
Appendix A-2, Figure 2
Merced River near Stevinson



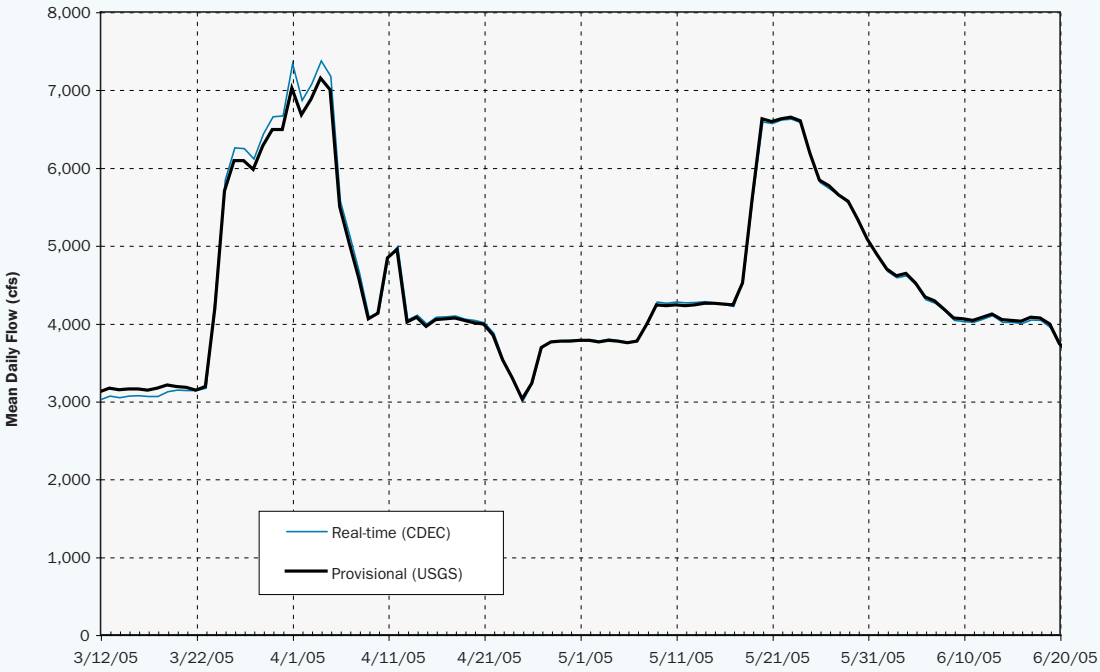
Appendix A-2, Figure 3
San Joaquin River above Merced River



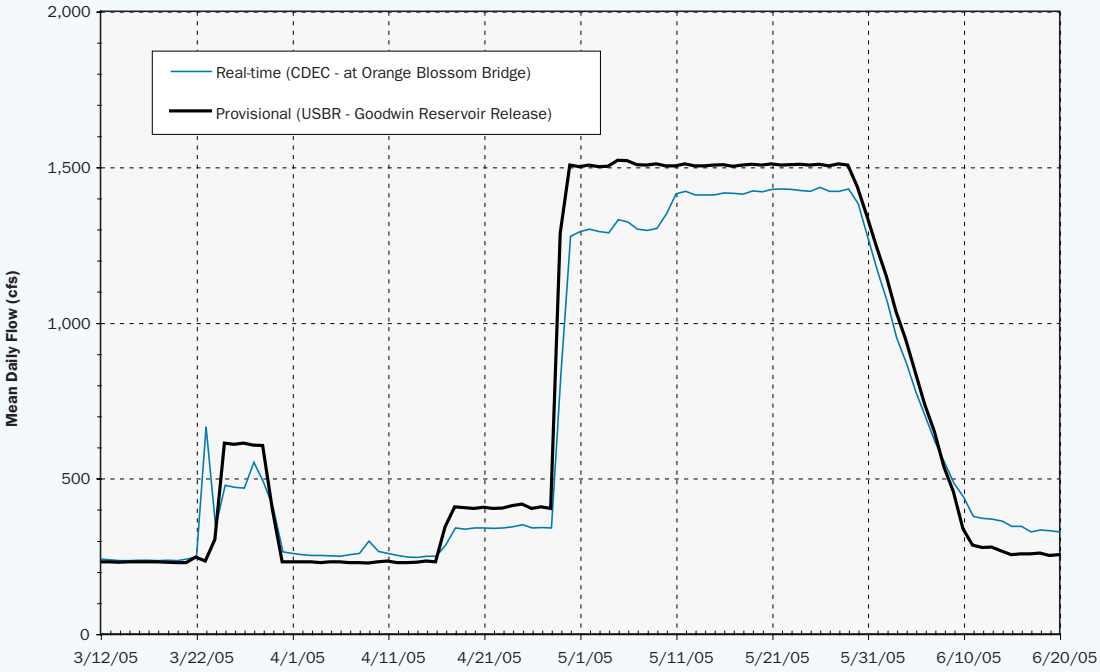
Appendix A-2, Figure 4
San Joaquin River near Newman



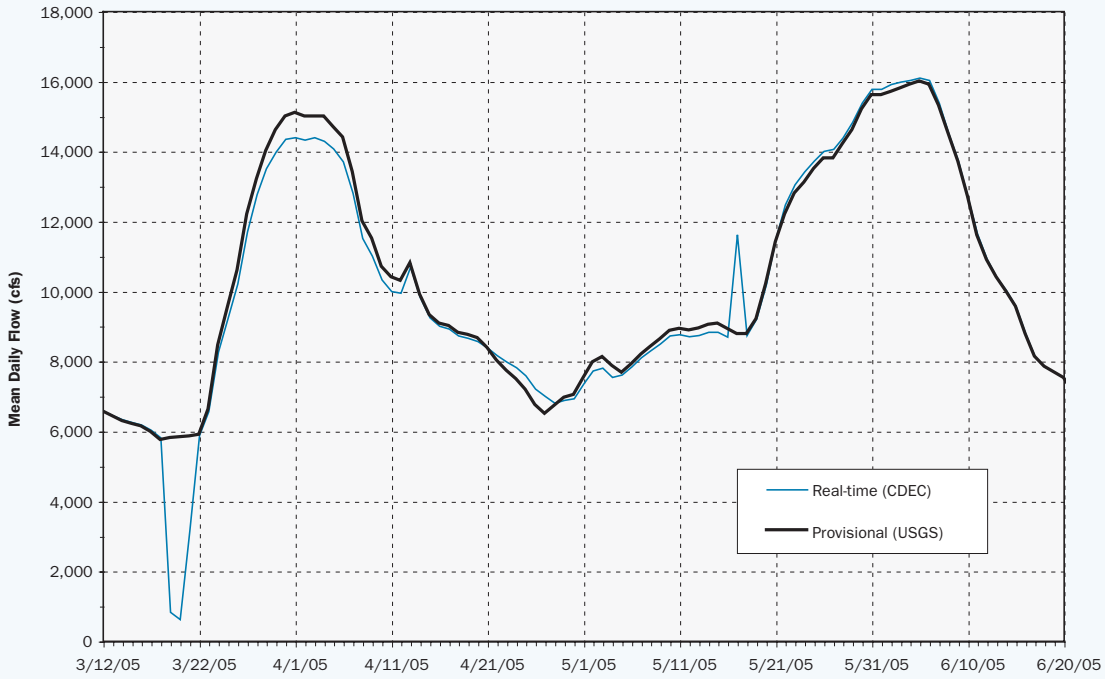
Appendix A-2, Figure 5
Tuolumne River below LaGrange Dam



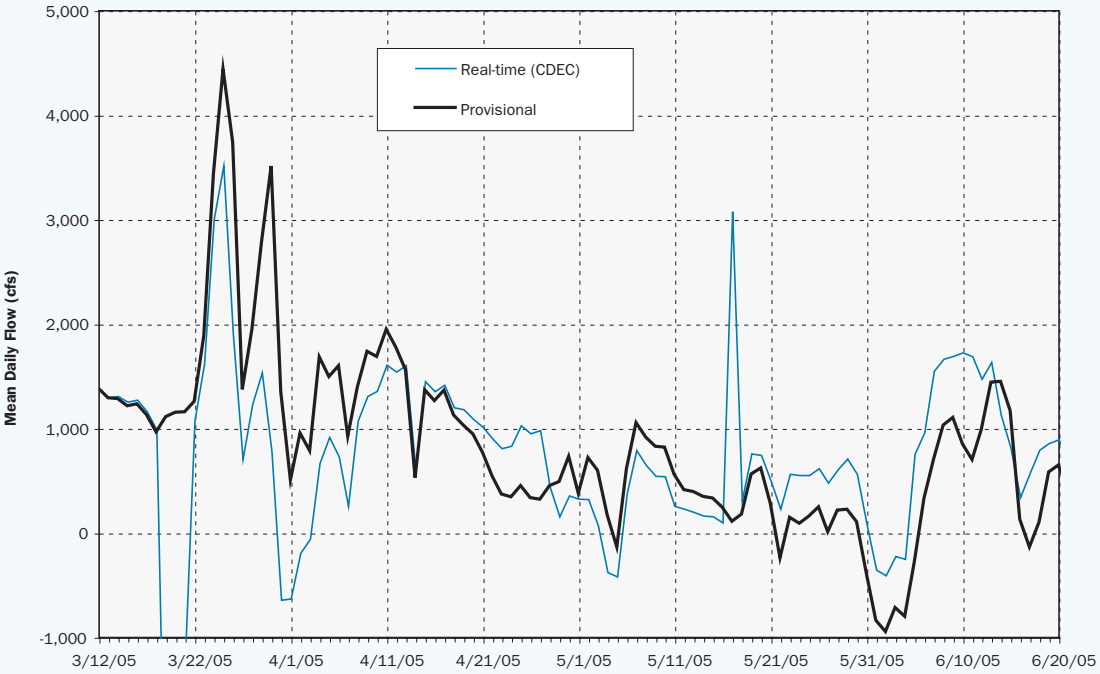
Appendix A-2, Figure 6
Stanislaus River below Goodwin Dam



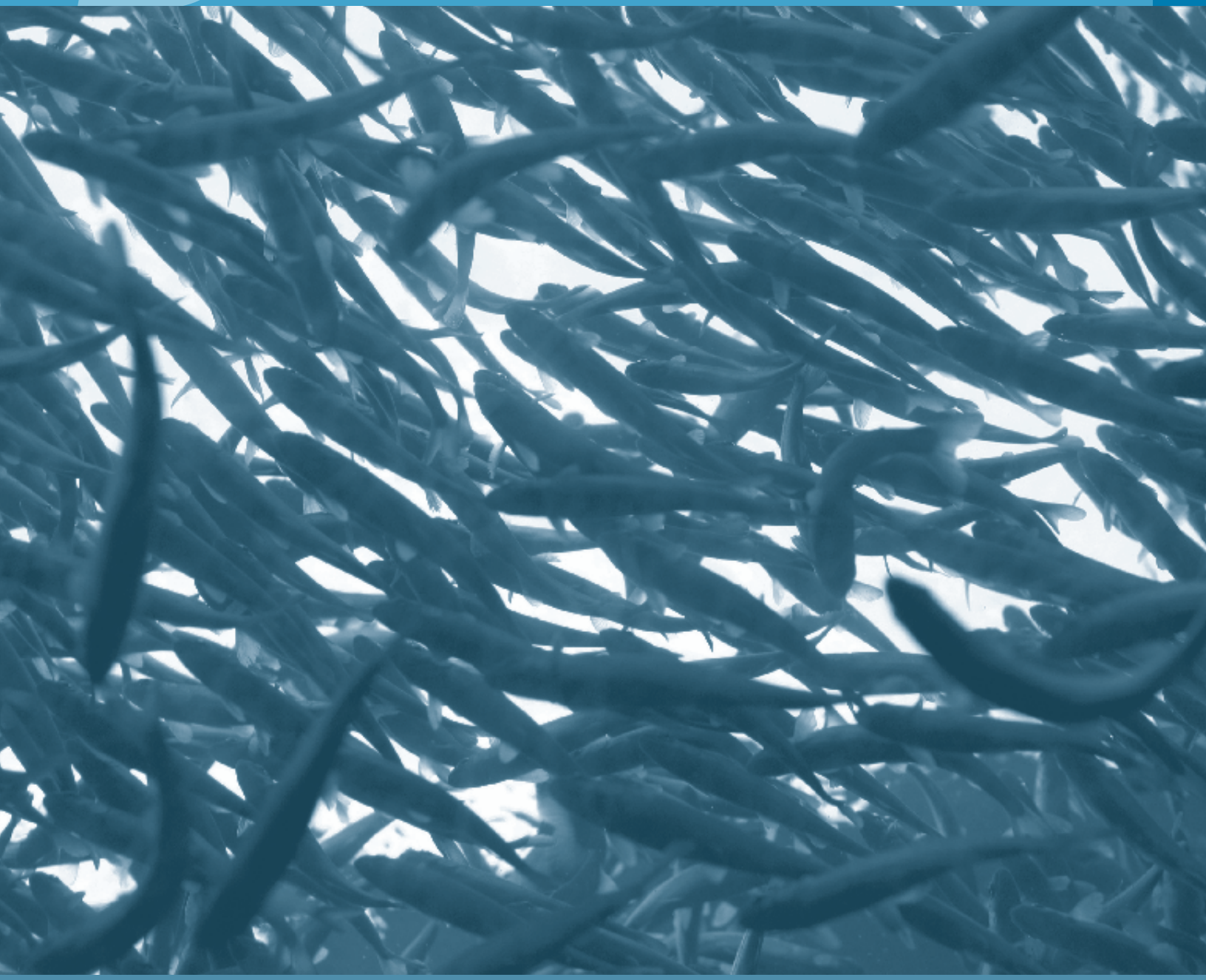
Appendix A-2, Figure 7
San Joaquin River near Vernalis



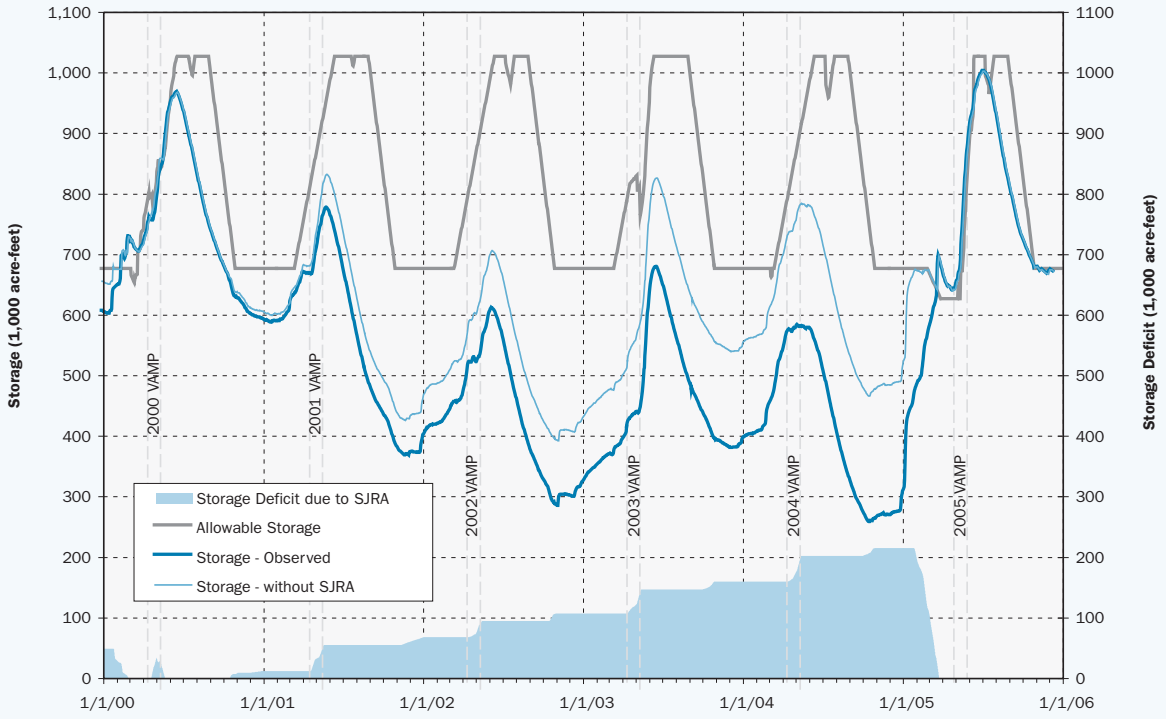
Appendix A-2, Figure 8
Ungaged Flow in San Joaquin River near Vernalis



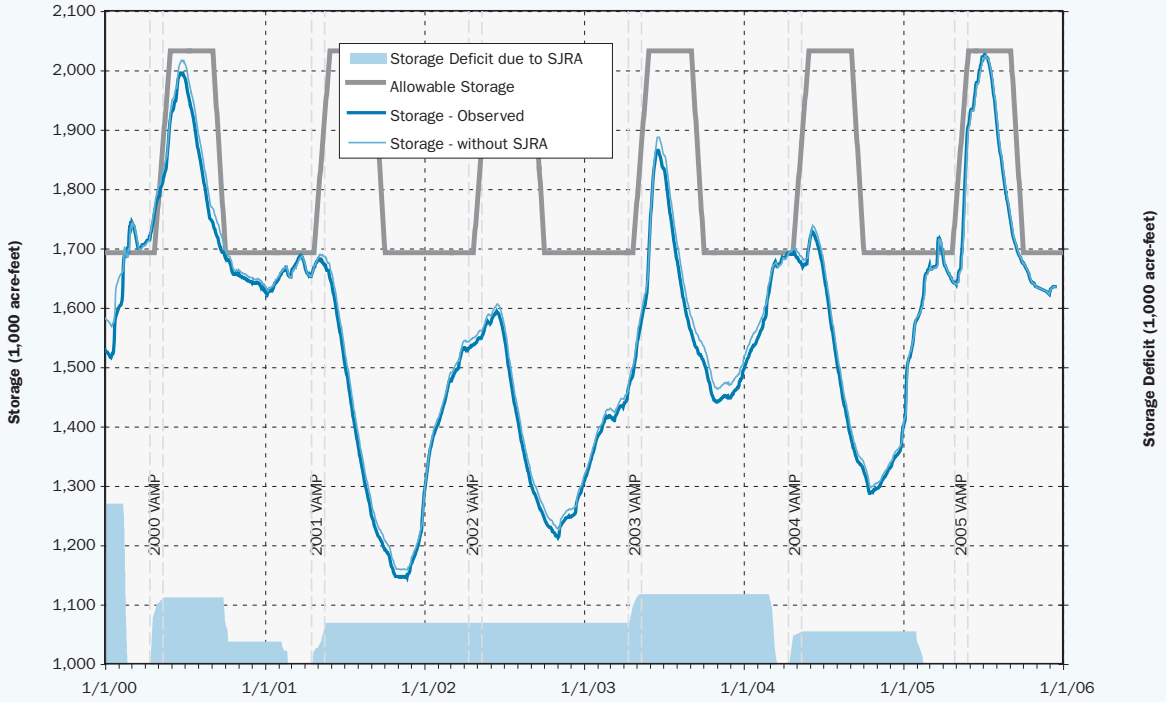
Appendix B
Historic Data



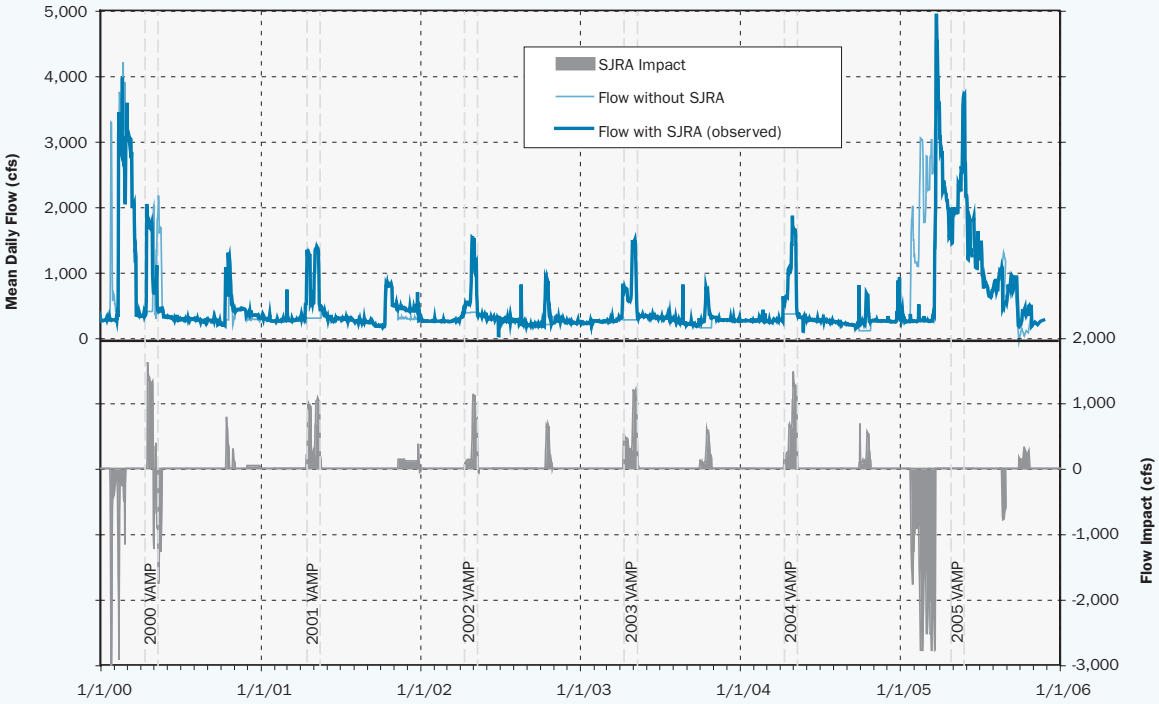
Appendix B-1, Figure 1
SJRA Storage Impacts, 2000-2005
Lake McClure (Merced River)



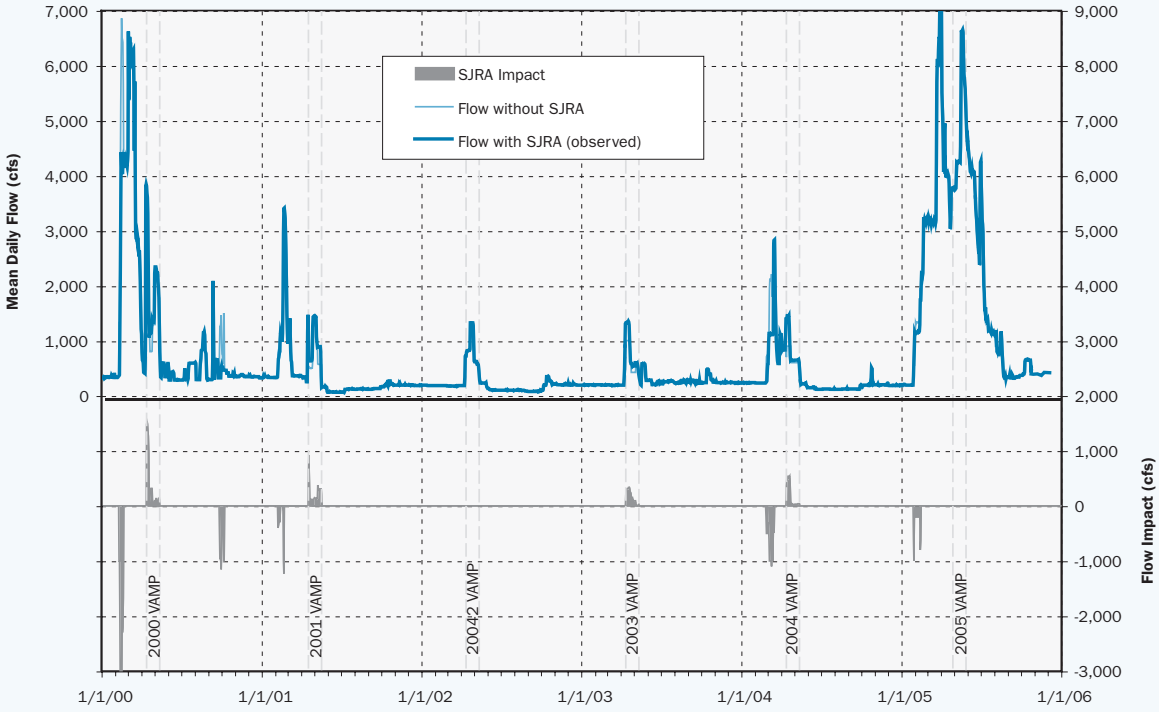
Appendix B-1, Figure 2
SJRA Storage Impacts, 2000-2005
New Don Pedro Reservoir (Tuolumne River)



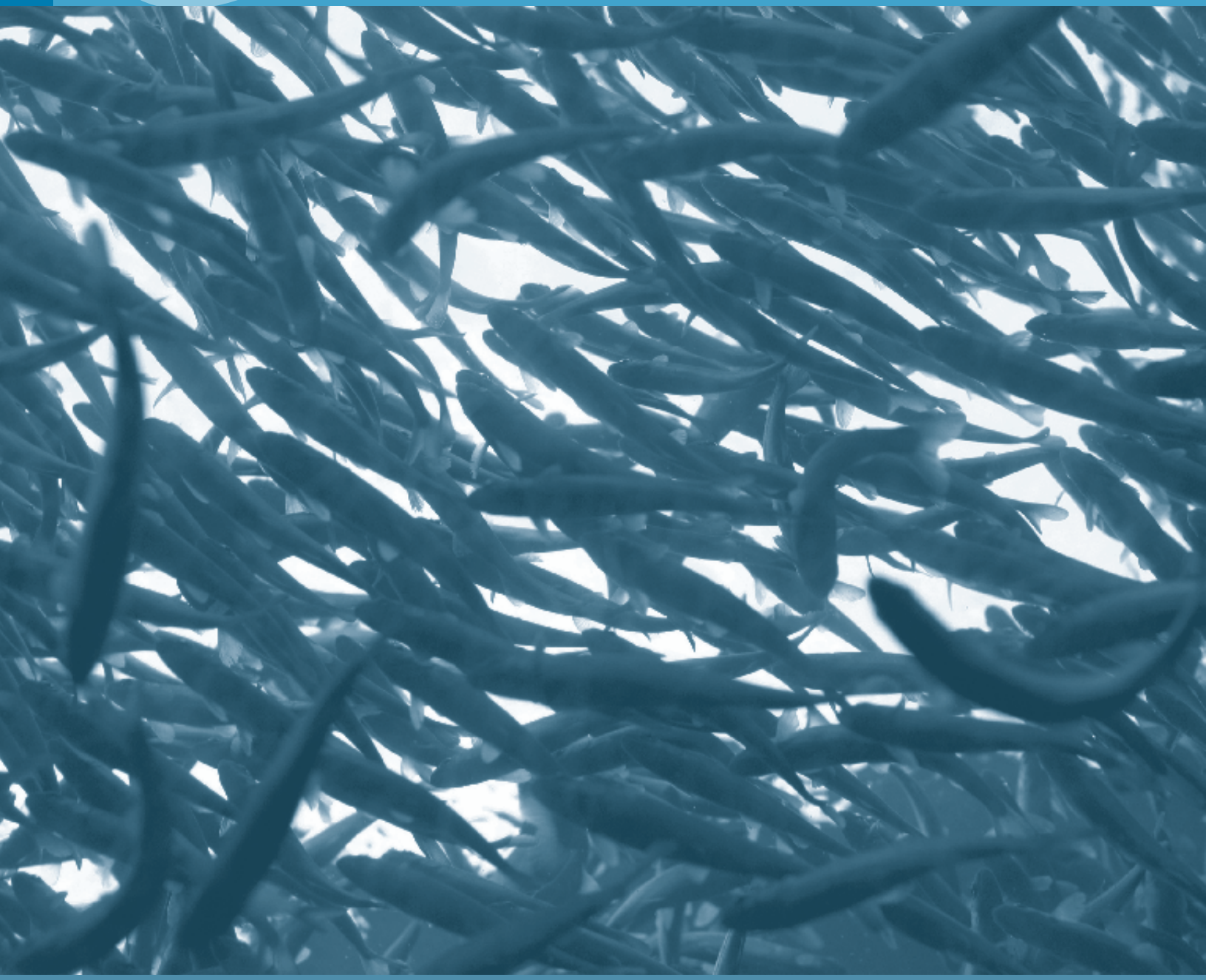
Appendix B-1, Figure 3
Merced River below Crocker-Huffman Dam
2000-2005



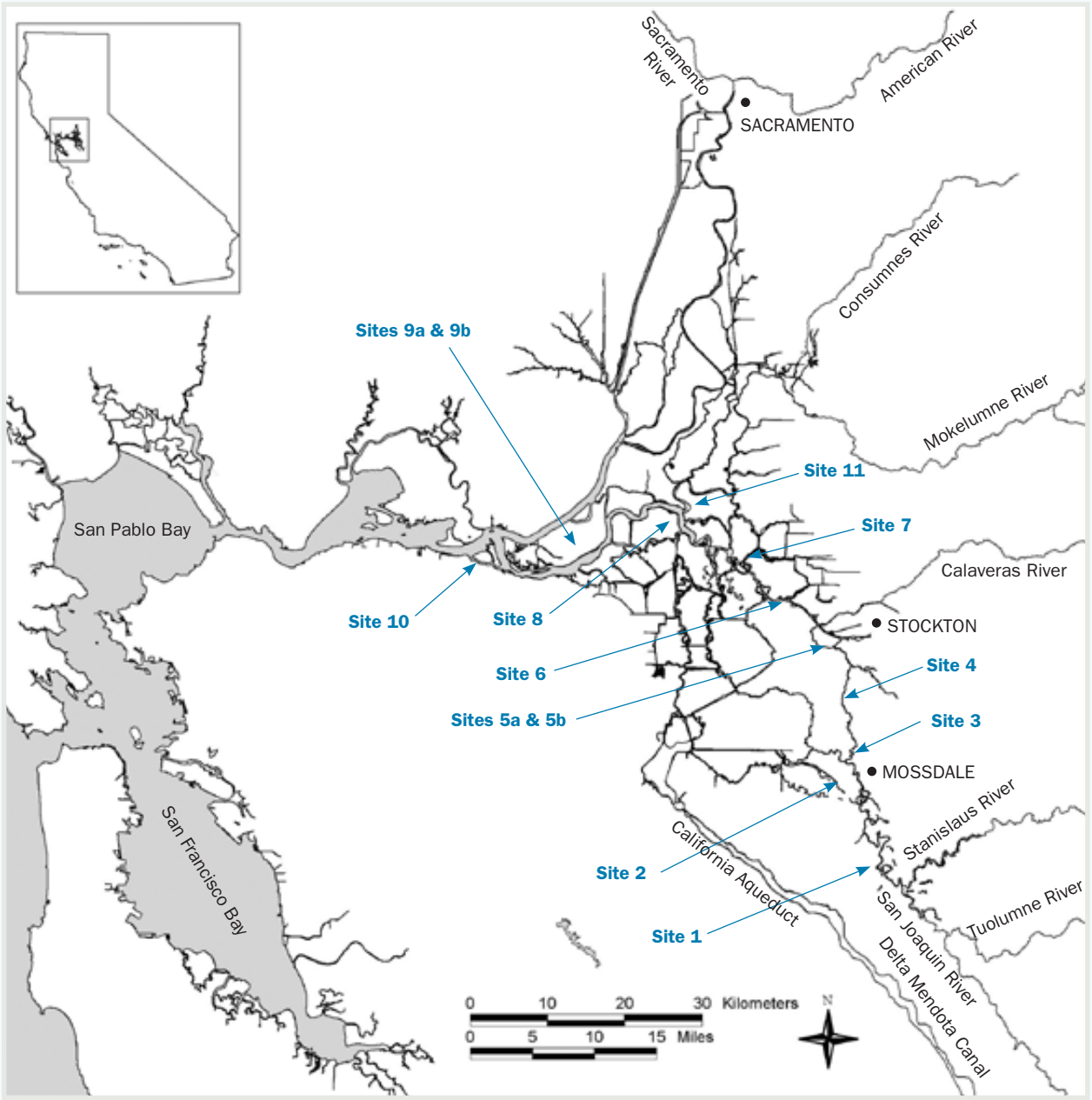
Appendix B-1, Figure 4
Tuolumne River below LaGrange Dam
2000-2005



Appendix C
Chinook Salmon Survival Investigations



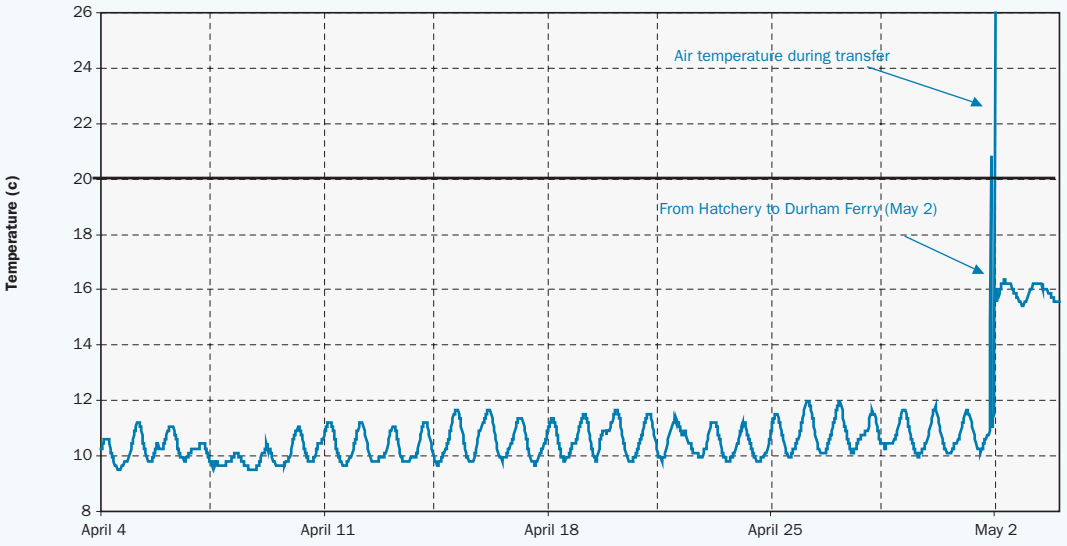
Appendix C-1
Water Temperature Monitoring Locations



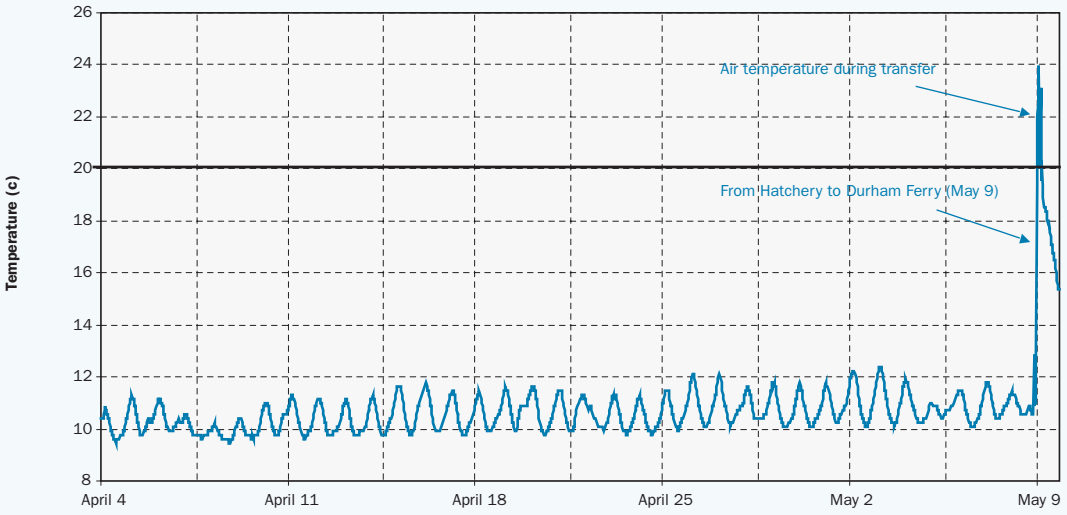
Appendix C-1
VAMP 2005 Water Temperature Monitoring

Site #	Temperature Monitoring Location	Latitude	Longitude	Distance from Durham Ferry (mi)	Date Deployed	Date Retreived	Notes
	Merced River Hatchery - 1			n/a	April 4	May 4	In river May 2 at Durham Ferry
	Merced River Hatchery - 2			n/a	April 4	May 11	In river May 9 at Durham Ferry
1	Durham Ferry	N 37 41.381	W 121 15.657	n/a	April 15	June 15	3 foot depth
2	Mossdale	N 37 47.180	W 121 18.425	11.2	April 15	June 15	3 foot depth
3	Dos Reis	N 37 49.808	W 121 18.665	16.4	April 15	-	Unable to locate logger
4	DWR Monitoring Station	N 37 51.869	W 121 19.376	19.4	April 15	-	Unable to locate logger
5a	Confluence – Top	N 37 56.818	W 121 20.285	26.5	April 15	June 15	Logger was dewatered – unable to use data
5b	Confluence- Bottom	N 37 56.818	W 121 20.285	26.5	April 15	June 15	Logger located on bottom.
6	Downstream of Channel Marker 30	N 37 59.776	W 121 25.569	33.3	April 15	June 15	3 foot depth
7	1/2 mile Upstream of Channel Marker 13	N 38 01.940	W 121 28.769	37.3	April 15	June 15	3 foot depth
8	Downstream of Channel Marker 36	N 38 04.522	W 121 34.413	44.7	April 15	June 15	3 foot depth
9	Jersey Point USGS Gauging Station - Top	N 38 03.172	W121 41.637	56.0	April 15	June 15	3 foot depth
10	Chipps Island	N 38 03.084	W 121 55.463	71.5	April 15	-	Unable to locate logger
11	Mokelumne River-Lighthouse Marina	N 38 06.334	W 121 34.213	40.0	April 15	June 15	3 foot depth

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



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

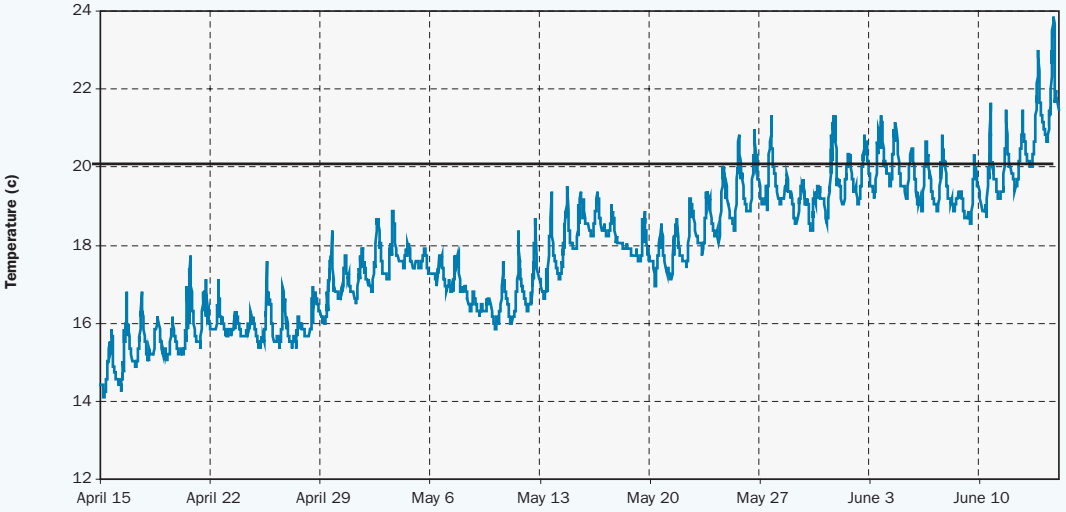


Appendix C-2
Water Temperature Monitoring
Site 1 Durham Ferry

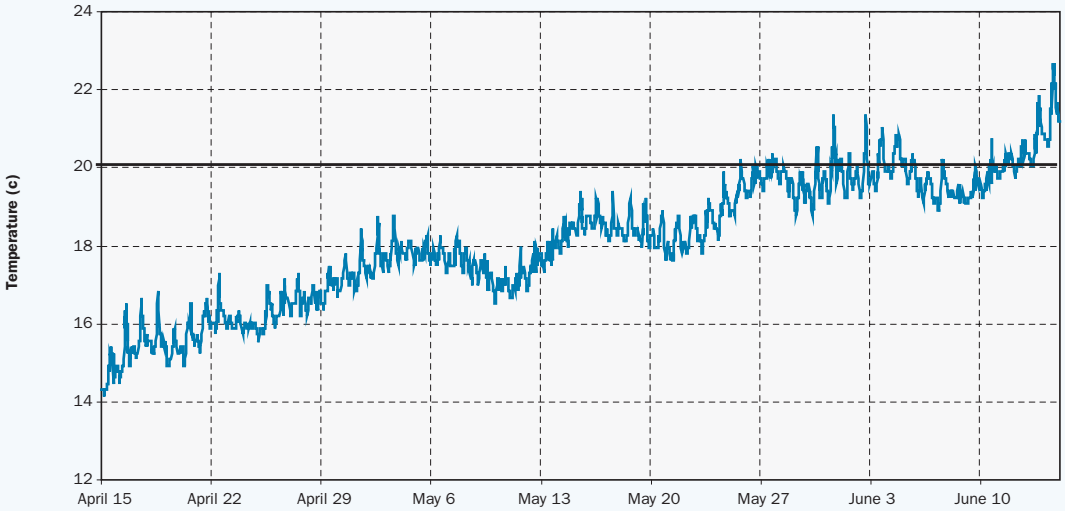
Appendix C-2
Water Temperature Monitoring
Site 2 - Mossdale

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

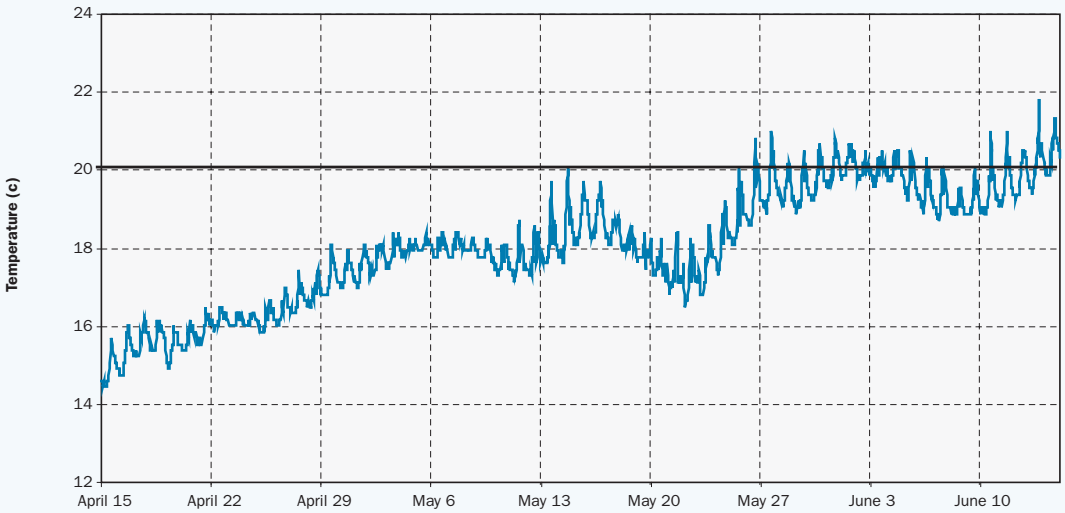
Appendix C-2
Water Temperature Monitoring
Site 6 - Downstream of Channel Marker 30



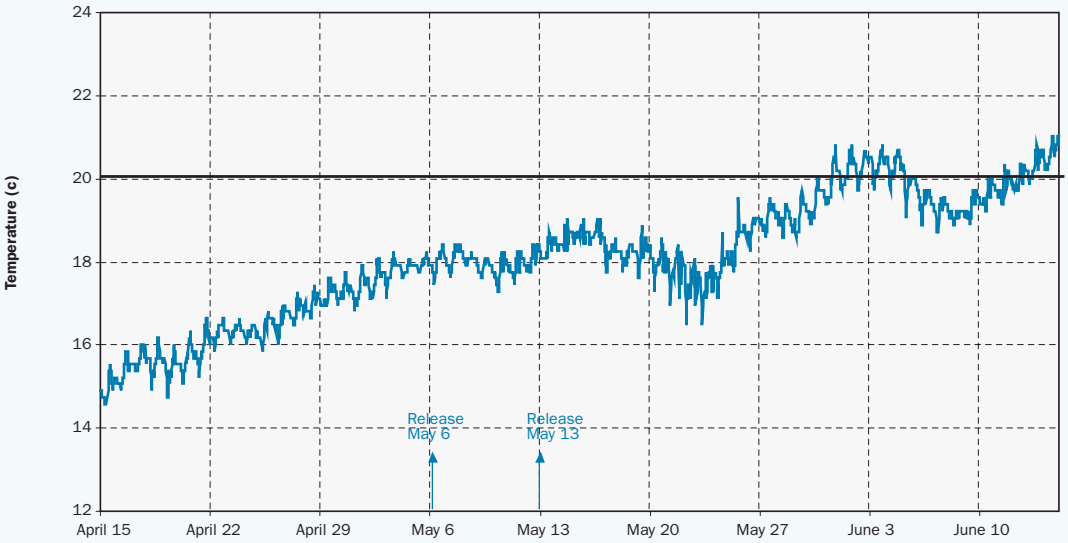
Appendix C-2
Water Temperature Monitoring
Site 7 - 1/2 Mile Upstream of Channel Marker 13



Appendix C-2
Water Temperature Monitoring
Site 8 - Downstream of Channel Marker 36



Appendix C-2
Water Temperature Monitoring
Site 9 - USGS Gauging Station at Jersey Point - Top



Appendix C-2
Water Temperature Monitoring
Site 11 - Mokelumne River - Lighthouse Marina

Appendix C-3a
Salmon Smolt Condition Post Transport, Immediately After Release

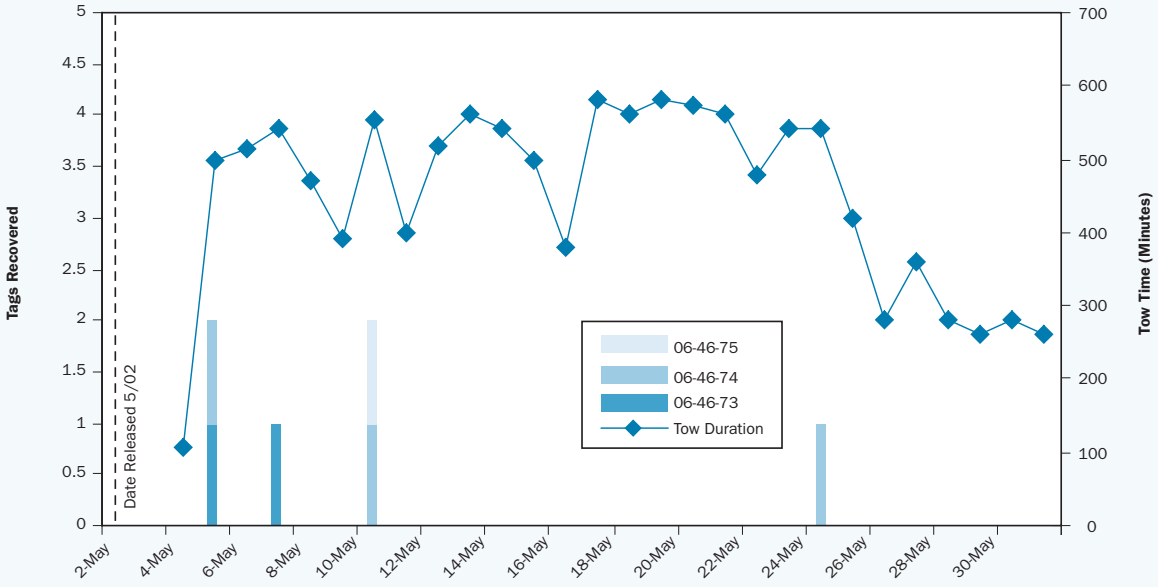
Release Site	Examination Date	Mean Fork Length (mm)	Mean Weight (g)	Vigor (%)	Mean Scale Loss (%)	Normal Body Color (%)	Fin Hemorrhaging (%)	Normal Eye Quality (%)	Normal Gill Color %	Complete Adclip (%)	% Correct Tag Code*
Durham Ferry	5/2/05	85	7	100	3	100	0	100	100	90	100
Dos Reis	5/3/05	86	7	100	3	100	0	100	100	88	100
Jersey Point	5/6/05	83	7	100	3	100	0	98	100	90	100
Durham Ferry	5/9/05	83	10	100	12	100	0	100	100	94	100
Dos Reis	5/10/05	87	7	100	6	100	0	100	100	76	100
Jersey Point	5/13/05	85	7	100	2	100	0	100	100	74	100

* % correct tag code of those that retained tags.

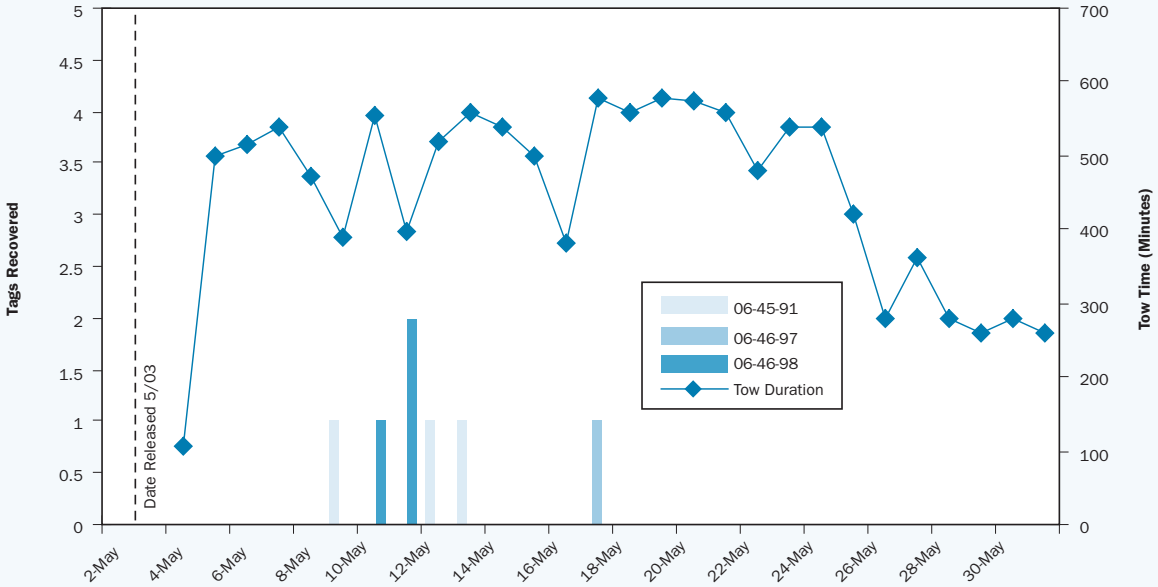
Appendix C-3b
Salmon Smolt Condition 48-hours Post Release

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 (%)
Durham Ferry	5/4/05	84	7	100	9	96	0	100	100	74
Dos Reis	5/5/05	85	7	100	8	98	0	96	100	78
Jersey Point	5/8/05	86	7	100	7	98	2	98	100	84
Durham Ferry	5/11/05	84	6	100	7	100	0	98	100	68
Dos Reis	5/12/05	85	7	100	3	100	0	98	98	76
Jersey Point	5/15/05	87	7	100	3	100	0	100	100	70

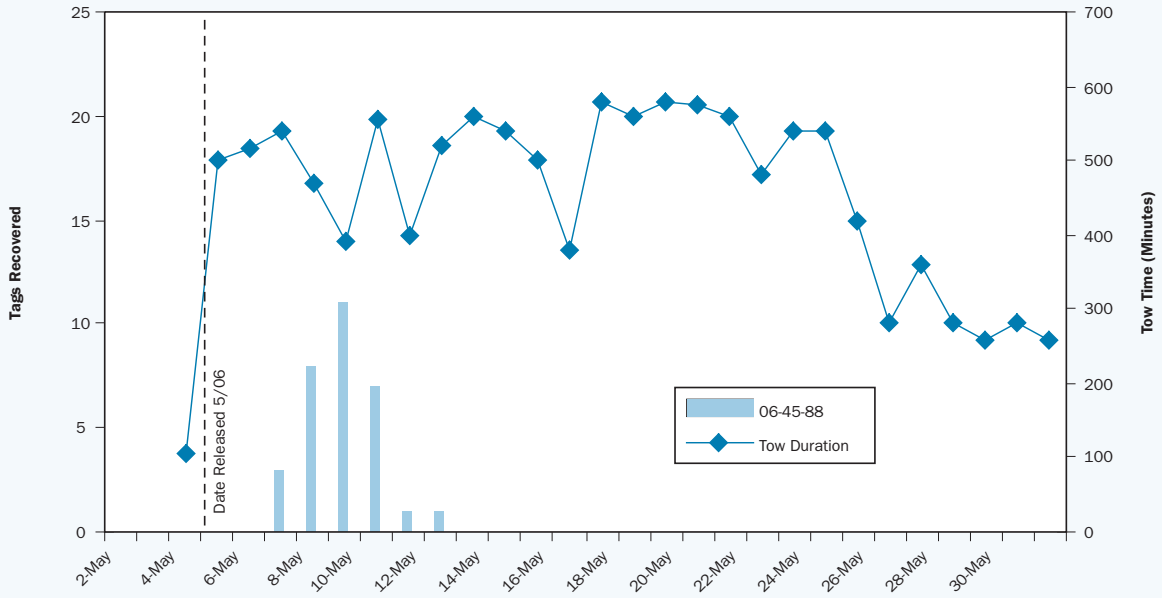
Appendix C-4, Figure 1
Antioch/Durham Ferry 1



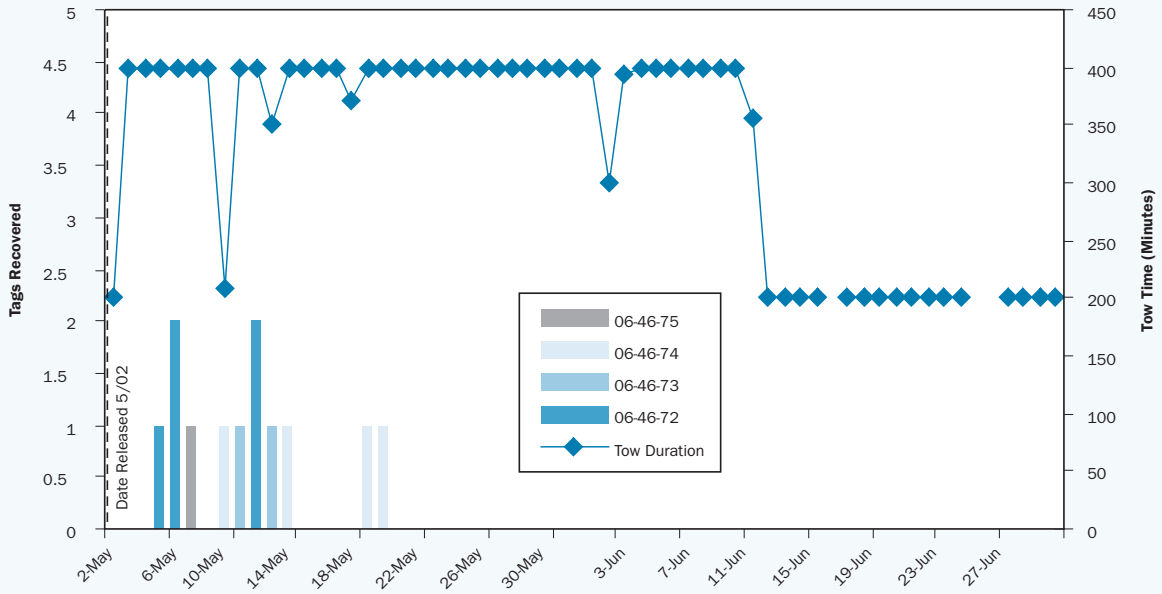
Appendix C-4, Figure 2
Antioch/Dos Reis 1



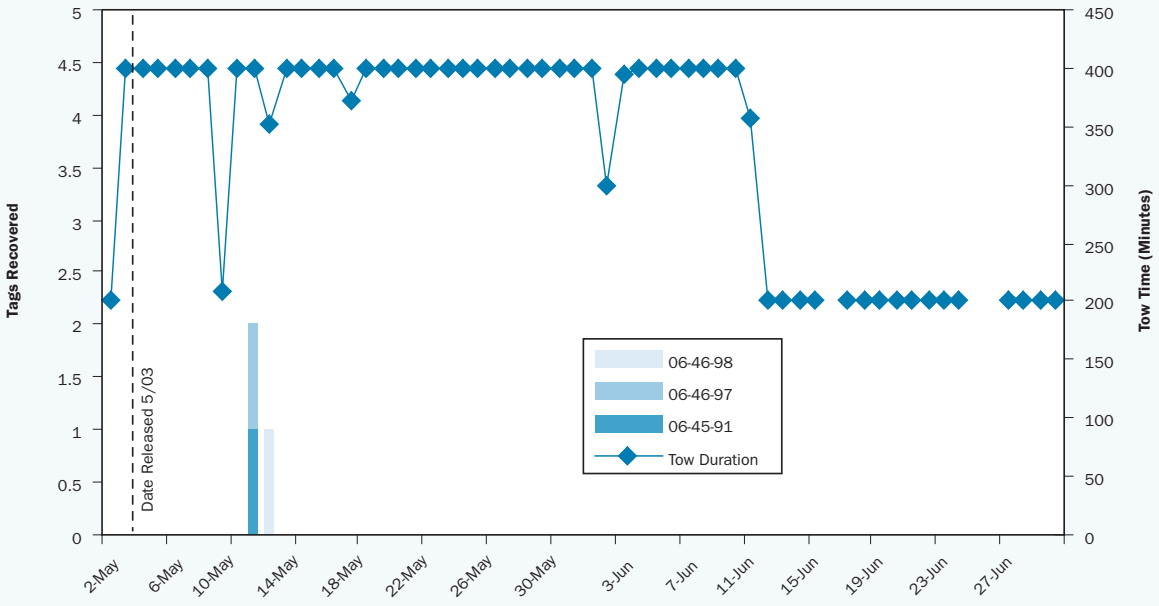
Appendix C-4, Figure 3
Antioch/Jersey Point 1



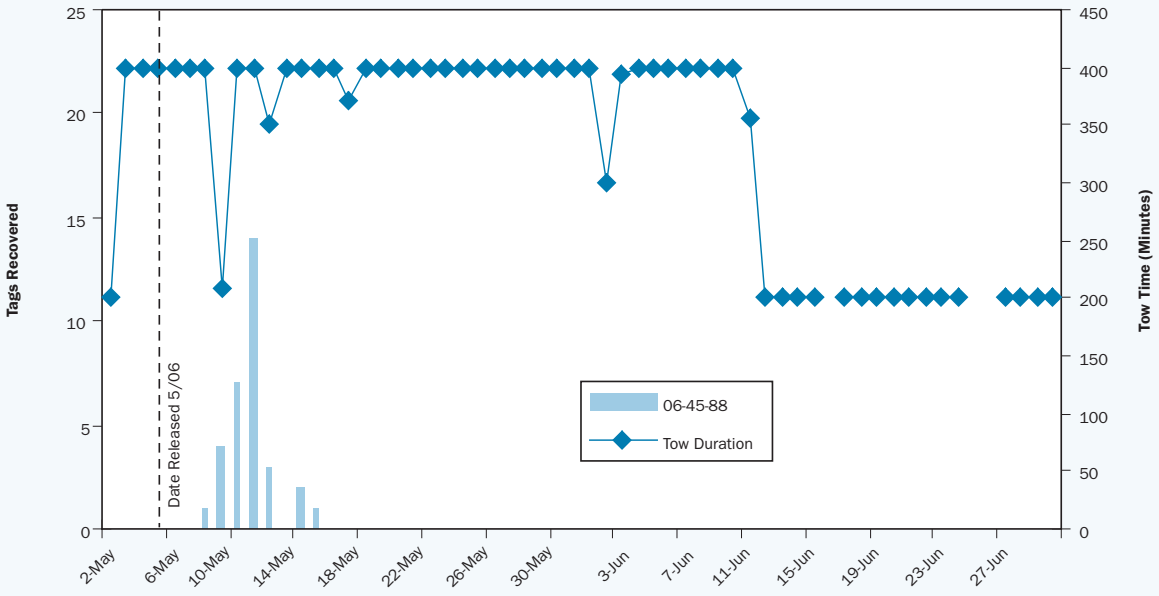
Appendix C-4, Figure 4
Chipps Island/Durham Ferry 1



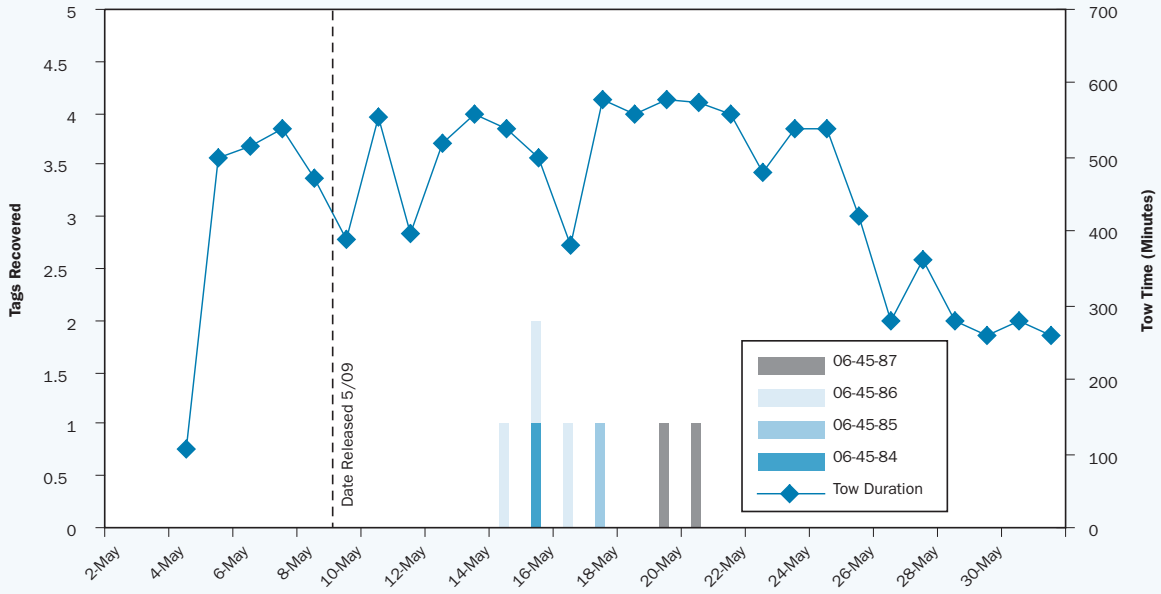
Appendix C-4, Figure 5
Chipps Island/Dos Reis 1



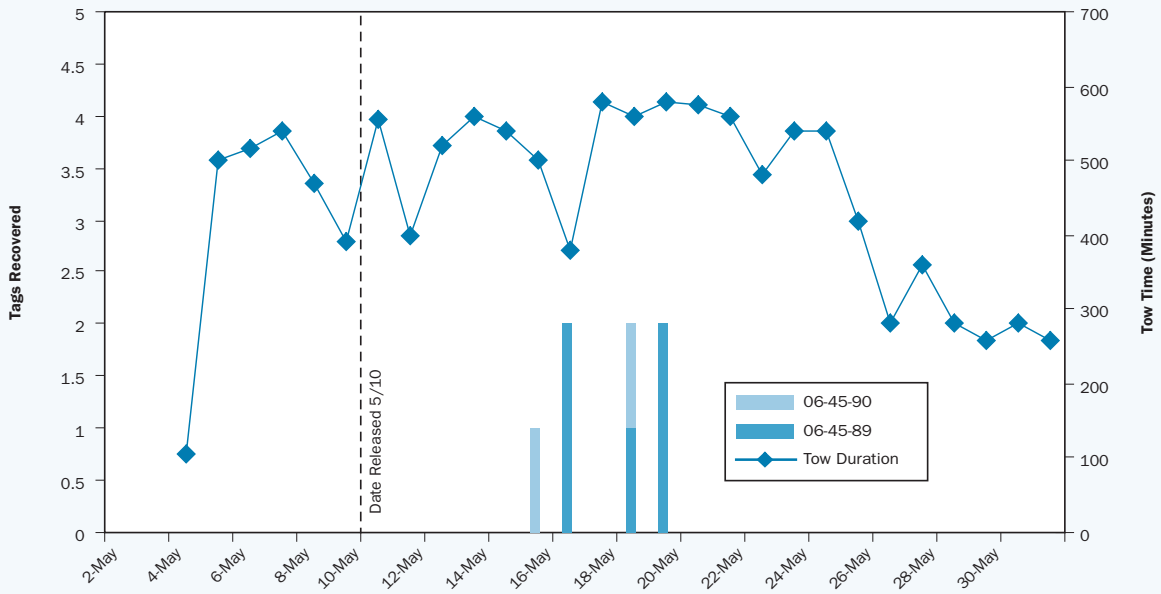
Appendix C-4, Figure 6
Chipps Island/Jersey Point 1



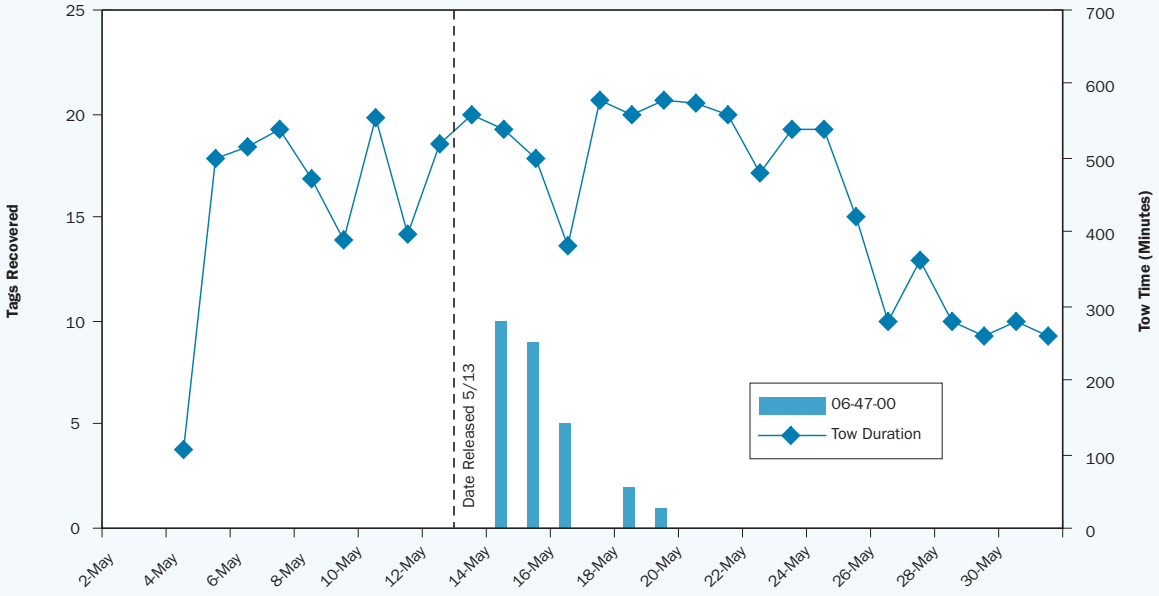
Appendix C-4, Figure 7
Antioch/Durham Ferry 2



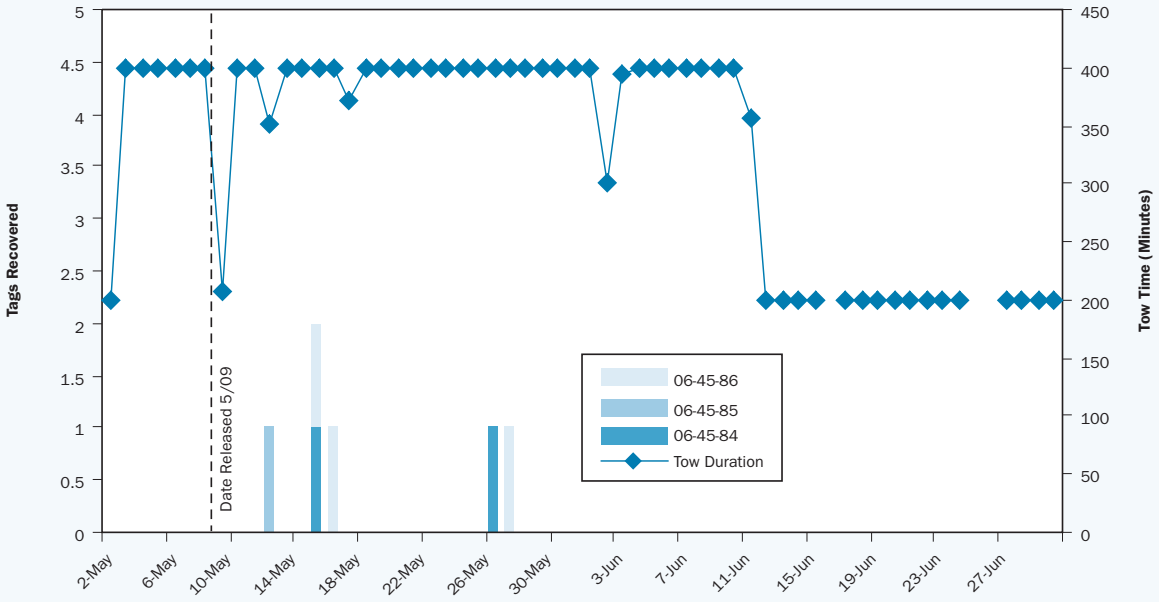
Appendix C-4, Figure 8
Antioch/Dos Reis 2



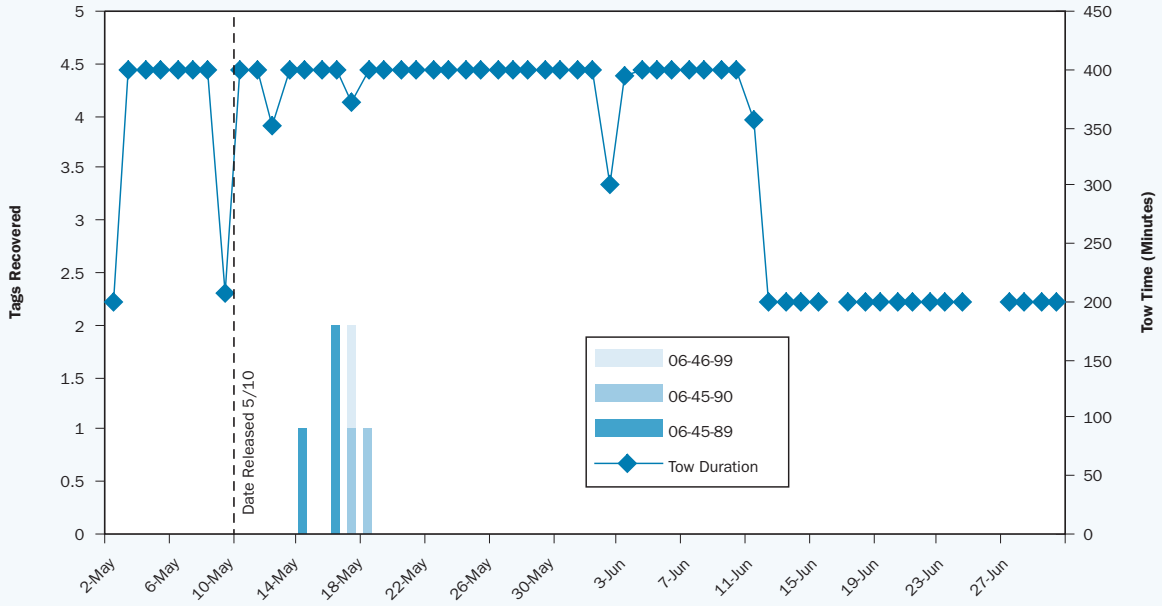
Appendix C-4, Figure 9
Antioch/Jersey Point 2



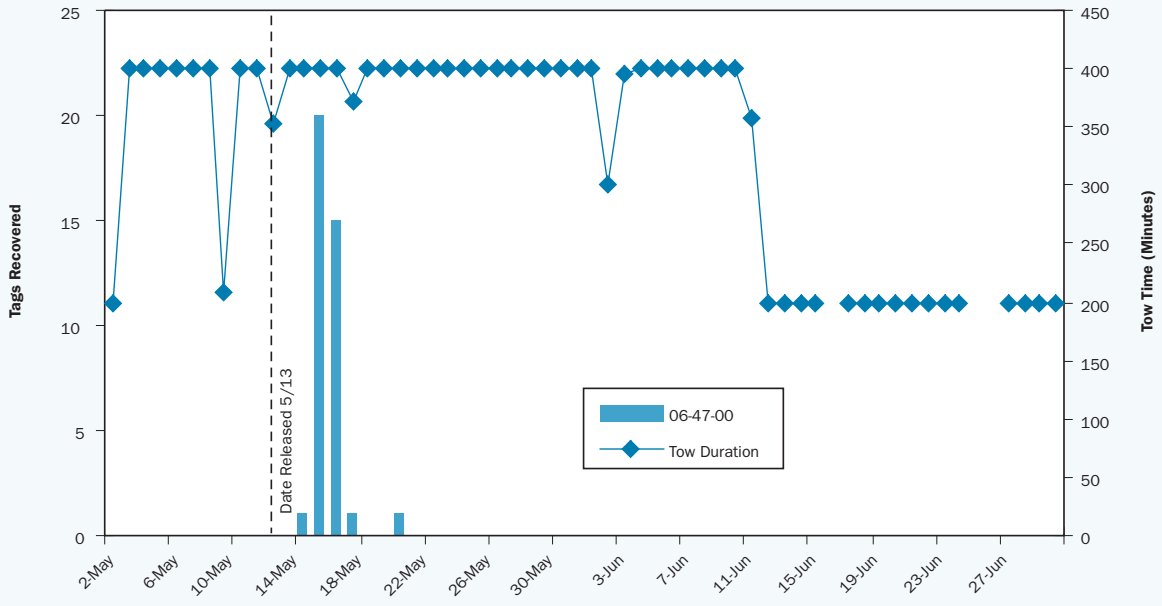
Appendix C-4, Figure 10
Chipps Island/Durham Ferry 2



Appendix C-4, Figure 11
Chipps Island/Dos Reis 2



Appendix C-4, Figure 12
Chipps Island/Jersey Point 2



Appendix D
Errata for the Year 2004 Annual Technical Report

Errata for 2004 Annual Technical Report on Implementaitn and Monitoring of the San Joaquin River Agreement and the Vernalis Adaptive Management Plan. January 2005 San Joaquin River Group Authority

Page 54 under Transit Time: The last sentence should read. "Transit times for marked salmon were estimated from the release day to the first and last day of recovery during VAMP 2004 which is included in Table 5-4.

Page 58: under Figure 5-9 Legend. " +/- 1 and 2 Standard Errors" should be deleted from the legend text.

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