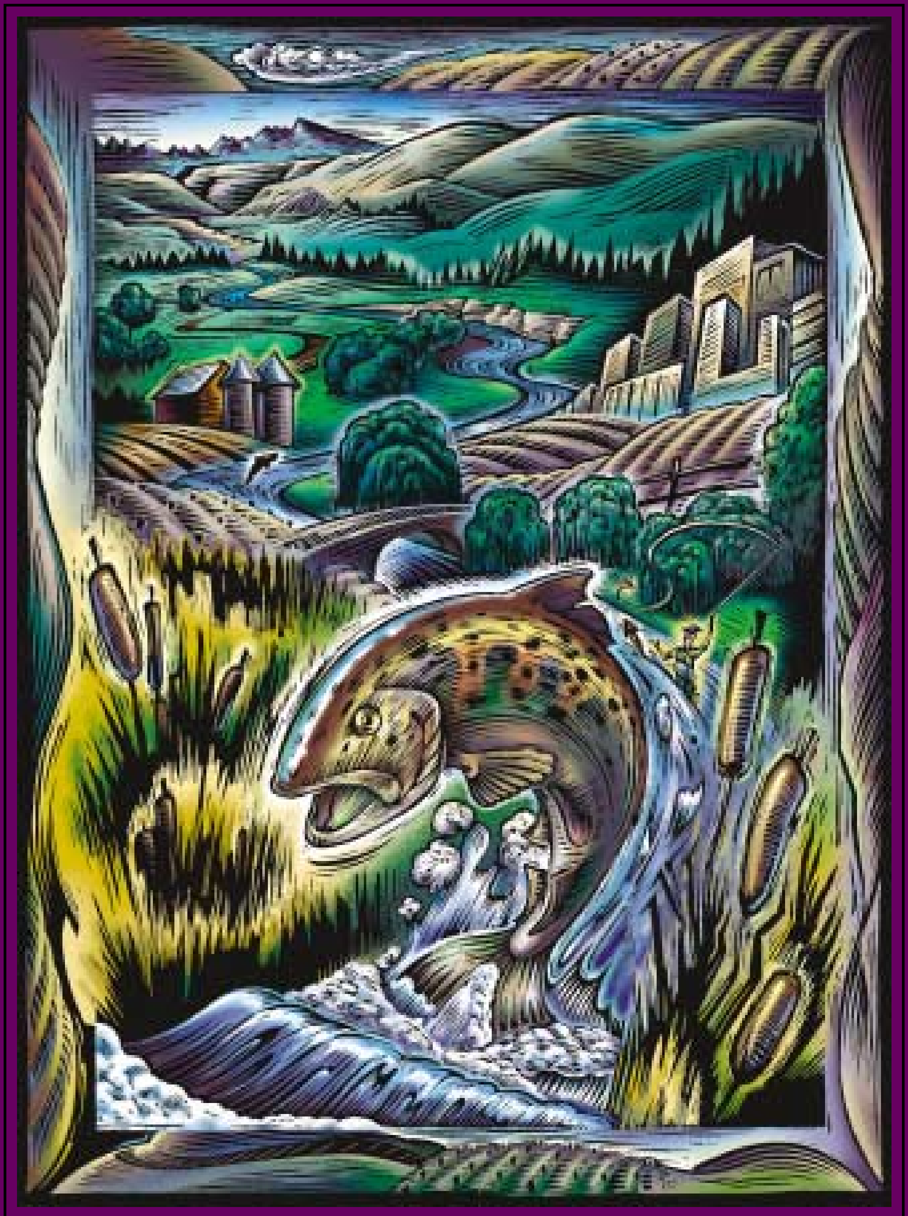
2001 ANNUAL TECHNICAL REPORT



SAN JOAQUIN RIVER GROUP AUTHORITY

Head of Old River Barrier

2001 ANNUAL TECHNICAL REPORT

On Implementation and Monitoring of the San Joaquin River Agreement and the Vernalis Adaptive Management Plan

Prepared by

San Joaquin River Group Authority

Prepared for the

California

State Water Resources Control Board

In Compliance with D-1641

January 2002

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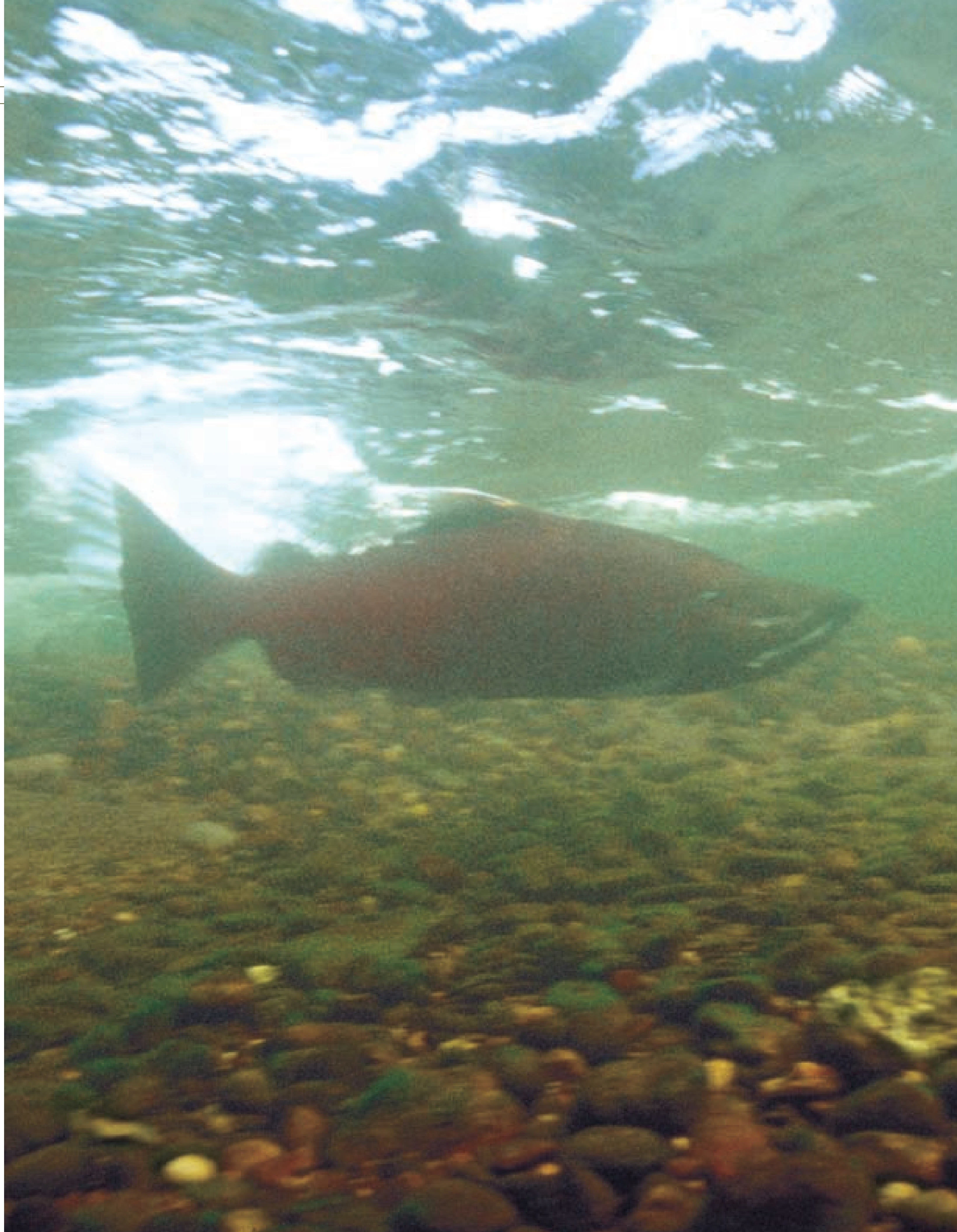

EXECUTIVE SUMMARY

The San Joaquin River Agreement (SJRA) 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). Using a consensus-based approach, the SJRA united a large and diverse group of agricultural, urban, environmental and governmental interests.

The 2001 Annual Technical Report comprises the consolidated annual SJRA Operations Report and Vernalis Adaptive Management Plan (VAMP) Monitoring Report. The VAMP 2001 program represents the second 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 report includes the following information on the implementation of the SJRA: the hydrologic chronicle; management of the additional SJRA water; installation, operation, and monitoring of the Head of Old River Barrier (HORB); results of the juvenile Chinook salmon smolt survival investigations; discussion of complementary investigations; and, conclusions and recommendations. Condition 4.b of D-1641 directs the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR) to send the Executive Director of the State Board the results of the fishery monitoring studies on an annual basis and Condition 7 of D-1641 directs Merced, Modesto, Turlock, South San Joaquin and Oakdale irrigation districts to submit a report detailing district operations as a result of the SJRA. By letter dated September 8, 2000, the SWRCB approved combining these two reports into a single comprehensive report due to the SWRCB on January 31 of each year.

A key part of this landmark agreement is the VAMP. VAMP is designed to protect juvenile Chinook salmon migrating from the San Joaquin River through the Sacramento-San Joaquin Delta.

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VAMP is also a scientifically recognized 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 and the operation of the HORB.

VAMP employs an adaptive management strategy to use current knowledge of hydrology and environmental conditions to protect Chinook salmon smolt passage, 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 2001 included:

- Quantification of Chinook salmon smolt survival between Durham Ferry and Jersey Point using recapture locations at Antioch and Chipps Island, under target conditions of a San Joaquin River flow at Vernalis of 4,450 cfs, with an installed HORB, and SWP/CVP export rates of 1,500 cfs; and
- Comparison of juvenile Chinook salmon survival between Durham Ferry and Mossdale for use in comparing results of VAMP 2001 with results from earlier survival studies where coded-wire tagged salmon releases occurred at Mossdale.

Based on data gathered during the experimental mark-recapture studies that occurred over a 31-day period in April and May 2001, a set of conclusions and recommendations has been developed. These conclusions and recommendations provide guidance and a foundation for design and implementation of future VAMP operations. Key conclusions and recommendations derived from VAMP 2001 include:

- VAMP 2001 is the second year of full implementation of the program. Average Vernalis flow during the VAMP period was 4,420 cfs. SWP and CVP export rates averaged 1,420 cfs. The VAMP period was between April 20 and May 20, 2001.
- Survival estimates between Durham Ferry and Jersey Point using recaptures at Antioch indicated that was no difference between the two replicates conducted in 2001. Survival estimates using the Chipps Island information indicated the first replicate survived at a higher rate than the second.
- The proportion of CWT salmon released and recaptured from the combined Durham Ferry and Mossdale groups relative to the proportion of CWT salmon released and recaptured from the Jersey Point (control) releases showed that the relative proportions during 2001 (target flow 4,450 cfs and 1,500 cfs exports) were not significantly different than the proportions from the VAMP 2000 study (target flow 5,700 cfs and 2,250 cfs exports).
- No conclusions on the relative roles of San Joaquin River flow and SWP/CVP exports on juvenile Chinook salmon smolt survival can be made with these two years of data. The report recommends that the VAMP experimental test program be continued.
- The quality of the real-time flow data at Vernalis were improved by weekly measurements; however, estimation of ungauged flow (accretions and depletions) requires further investigation for use in establishing annual VAMP target flows. Alternative methods of measuring flow at Vernalis and/or alternative measurement locations should also be investigated.
- Delays in permitting and construction of the HORB delayed implementation of the VAMP 2001 studies, contributed to the second salmon release group being exposed to elevated water temperatures, and may have adversely affected their survival. Due to the high risk of losing major salmon protection benefits and biasing experimental conditions, it is strongly recommended that permitting and construction of the HORB be completed to avoid delays in implementing survival investigations. It is also recommended that modifications be made to the barrier design to avoid debris accumulation on trash racks, facilitate routine maintenance, facilitate fisheries sampling, and provide measurements of flow diverted through each culvert.
- Exposure of juvenile Chinook salmon during the second release to elevated water temperatures within the lower San Joaquin River and Delta and evidence of increased disease were identified as factors potentially affecting salmon smolt survival and the validity of the second VAMP test release in 2001. The proportion of marked salmon recaptured from all release locations was found to be significantly lower during the second VAMP release when compared to the first survival study conducted in 2001. The second set of VAMP 2001 releases may not be comparable to other VAMP data and survival results should be interpreted with caution.
- The variability inherent in conducting salmon smolt survival studies in the lower San Joaquin River and Delta makes it difficult to detect statistically significant differences in salmon survival between VAMP flow and export target conditions, which are relatively similar. It is strongly recommended that, when possible, target flow and export conditions be selected to conduct survival tests at VAMP flow and export extremes to improve the ability to detect potential differences in salmon smolt survival among test conditions.
- Approximately 65 percent of the unmarked salmon migrating past Mossdale in 2001 migrated during the VAMP period (April 20 through May 20) and were, therefore protected by increased San Joaquin River flow, installation of the HORB and decreased export pumping.
- Hydrologic conditions during VAMP 2001 were found to be close to the threshold separating two alternative San Joaquin River flow targets. If hydrologic conditions are close to a decision threshold in the future, it is recommended that target flows be selected representing new VAMP test conditions rather than repeating a previously tested flow/export case.
- The selection and management of VAMP flow conditions should, if possible, minimize or avoid requiring upstream tributary flows that adversely affect potential habitat quality or survival of natural salmon produced within the tributaries. It is therefore recommended that upstream tributary and VAMP studies be coordinated as much as possible.

INTRODUCTION

The Vernalis Adaptive Management Plan (VAMP) was implemented during the spring 2001 to protect juvenile Chinook salmon and evaluate the relationship between San Joaquin River flow and state (SWP) and federal (CVP) water project exports on survival of juvenile Chinook salmon migrating through the Sacramento–San Joaquin Delta. This represents the second official year of the VAMP experiment.

EXPERIMENTAL DESIGN ELEMENTS

The VAMP experimental design measures salmon smolt survival rates 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 outmigration period that provide estimates of salmon survival under each set of conditions. Chinook salmon survival indices under each of the experimental conditions are then calculated based on the numbers of marked salmon released and the number recaptured.

The VAMP 2001 experimental design included both multiple release locations (Durham Ferry, Mossdale, and Jersey Point), and multiple recapture locations (Antioch, Chipps Island, SWP and CVP salvage operations, and in the ocean fishery; (Figure 1-1). Two sets of releases were made at Durham Ferry, Mossdale, and Jersey Point. 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 series of releases. The VAMP releases (Durham Ferry and Jersey Point) and recapture locations (Antioch and Chipps Island) will be consistent from one year to the next, providing a greater opportunity to assess salmon smolt survival over a range of Vernalis flows, SWP/CVP exports, and with and without the presence of the Head of Old River Barrier (HORB). 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 downstream (control release at Jersey Point) release locations. The use of ratio estimates as part of the VAMP study design substantially reduces the bias associated with differential gear collection efficiency within and among years, 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.

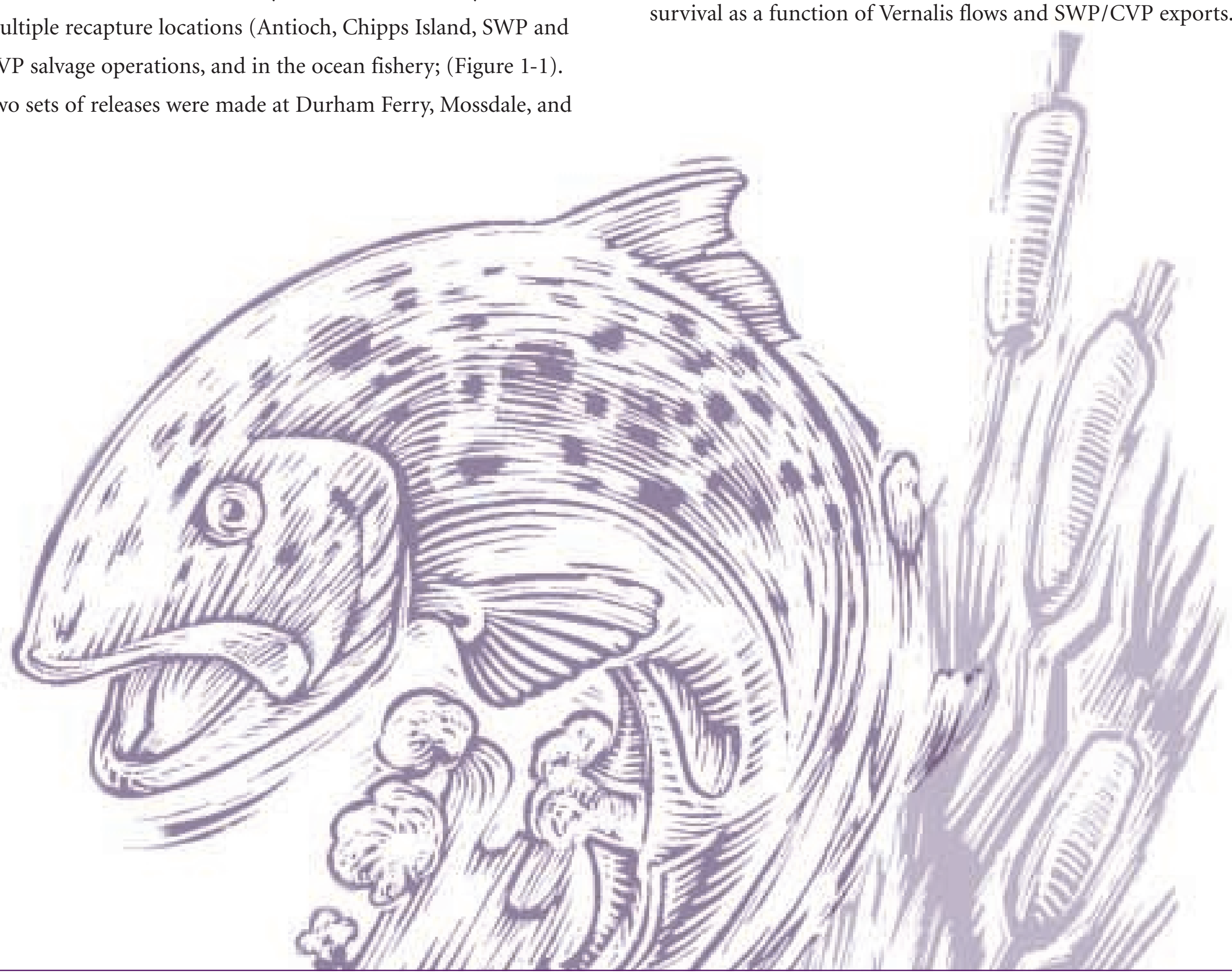


FIGURE 1-1
Sacramento–San Joaquin Estuary

Location of VAMP 2001 release sites (Durham Ferry, Mossdale and Jersey Point), recovery locations (Antioch and Chipps Island), and Head of Old River Barrier location within the Sacramento-San Joaquin River Delta/Estuary.

CHAPTER 2

VAMP HYDROLOGIC PLANNING AND IMPLEMENTATION

This section documents the planning and implementation undertaken by the Hydrology Group of the San Joaquin River Technical Committee (SJRTC) for the 2001 VAMP investigations. Implementation of VAMP is guided by the framework provided in the 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 2001, 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 (Exchange Contractors), 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.

VAMP FLOW AND SWP/CVP EXPORTS

The VAMP investigations are designed to collect data and information on the impacts of San Joaquin River flow and Delta exports (SWP and CVP pumping at the Banks and Tracy pumping plants respectively) on the survival rates of juvenile Chinook salmon emigrating from the San Joaquin River system. The VAMP provides for a 31-day pulse flow at the Vernalis gauge during the months of April and May, along with a corresponding reduction in SWP/CVP exports, as shown in Table 2-1. The magnitude of the pulse flow is based on San Joaquin River flow that would occur during the pulse period absent the VAMP, referred to as the existing flow.

TABLE 2-1
VAMP Vernalis Flow and Delta Export Targets

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
4,500 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 the extent possible	

Based upon hydrologic conditions, the target flow in a given year could either be increased to the next highest value ("double-step") or the supplemental water requirement could be eliminated entirely. A numerical procedure has been established in the SJRA to determine the target flow. The State Board San Joaquin Valley Water Year Hydrologic Classification ("60-20-20" classification) is given a numerical indicator as shown in Table 2-2.

"Double-step" flow years occur when the sum of last year's numerical indicator and the 90 percent exceedence forecast of the current year's numerical indicator is seven (7) or greater.

If the sum of the two previous years' numerical indicators and the 90 percent exceedence forecast of the current year's numerical indicator is four (4) or less, indicative of an extended dry period, the San Joaquin River Group Authority (SJRG) members are not required to provide water above the existing flow. The USBR, however, has a continuing obligation to meet San Joaquin River flows pursuant to the March 6, 1995 Delta Smelt Biological Opinion.

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. Based on the targets outlined in Table 2-1, in a double-step year up to 157,000 acre-feet of supplemental water may be required. If the VAMP target flow requires more than 110,000 acre-feet of supplemental water, then additional water may be acquired on a willing seller basis.

VAMP 2001 HYDROLOGIC PLANNING

Hydrology Group Meetings

Beginning in February 2001, and continuing until early April, the Hydrology Group held five planning and coordination meetings (February 13; March 14 and 29; and April 4 and 11). At these meetings, forecasts of hydrologic and operational conditions on the San Joaquin River and its tributaries were discussed and refined.

Monthly Operation Forecasts

As part of the early planning efforts, monthly operation forecasts were developed by the Hydrology Group to estimate the existing flow at Vernalis. 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. The initial monthly operation forecast was prepared in early February and presented at the February 13 Hydrology Group meeting. The 90 percent exceedence forecast called for a VAMP target flow of 3,200 cfs with a need for 73,000 acre-feet of supplemental water; the 50 percent exceedence forecast called for a VAMP target flow of 4,450 cfs with a need for 59,000 acre-feet of supplemental water. Hydrologic projections and planning were subsequently refined as additional information became available in March and April.

Daily Operation Plan

Starting in mid-March, the Hydrology Group began development of a daily operation plan, updating it as hydrologic conditions and operational requirements changed. The daily operation plan calculated an estimated mean daily flow at Vernalis based on estimates of the daily flow at the major tributary control points, estimates of ungauged flow between those control points and Vernalis, and estimates of flow in the San Joaquin River above the major tributaries. The following key assumptions were used in the development of the daily operation plan:

(1) The travel times for flows from the tributary measurement points and upper San Joaquin River to the Vernalis gauge are assumed as follows:

a. Merced River at Cressey to Vernalis — 3 days
b. San Joaquin River above Merced River to Vernalis — 2 days
c. Tuolumne River at LaGrange to Vernalis — 2 days
d. Stanislaus River below Goodwin Dam to Vernalis — 2 days

(2) Based upon a review of the historical flow record, the ungauged flow at Vernalis was assumed to be constant throughout the VAMP period and equal to the trending value entering the period. By definition, the ungauged flow is that unmeasured flow entering the system between Vernalis and the upstream measuring points and is calculated as follows:

Vernalis Ungauged =

VNS - GDWlag - LGNlag - CRSlag - USJRlag

where:

VNS = San Joaquin River near Vernalis
GDWlag = Stanislaus River below Goodwin Dam lagged 2 days
LGNlag = Tuolumne River below LaGrange Dam lagged 2 days
CRSlag = Merced River at Cressey lagged 3 days
USJRlag = San Joaquin River above Merced River lagged 2 days (USJR is not a gauged flow but is the calculated difference between the gauged flows at the San Joaquin River at Newman (NEW) and the Merced River near Stevinson (MST)).

By definition, the VAMP 31-day pulse flow period can occur anytime between April 1 and May 31. Until the VAMP flow period is specifically defined, it is assumed for the purposes of planning to be April 15 through May 15. Flexibility of the VAMP flow period exists so that it can coincide with the period of peak salmon out-migration. Other factors, including installation of HORB, availability of juvenile salmon at the hatchery, and manpower and equipment availability for salmon releases and recapture need to be considered in determining the timing of the VAMP period.

The 60-20-20 classification for water year 2000 was "above normal", giving it a VAMP numerical indicator of 4. If the 90 percent exceedence forecast on April 1 defined water year 2001 as a "below normal" or wetter year, with a VAMP numerical indicator equal to or greater than 3, then the 2001 VAMP would follow the "double-step" criteria. Early forecasts were pointing towards 2001 being a "dry" year (VAMP numerical indicator of 2), therefore all planning efforts were made using the "single step" criteria. In fact, the 90 percent exceedence forecast on April 1 for the San Joaquin Valley was for a "critical" year, resulting in the 2001 VAMP following the "single step" criteria.

Table 2-3 summarizes the various iterations of and demonstrates the evolutionary nature of the daily operation plan. Copies of the daily operation plans are provided in Appendix A.

As noted previously, initial planning efforts assume a VAMP period from April 15 through May 15. At the April 4 Hydrology Group meeting it was apparent that installation of the HORB would not be completed by April 15, therefore the VAMP period would need to begin at a later date. The planning effort preceded using start dates of April 17 and April 19. At the combined meeting of the Hydrology and Biology Groups on April 11, the decision was made to set the VAMP 2001 period at April 20 through May 20.

The greatest uncertainty in the development of the daily operation plan is the assumed ungauged flows between the upstream control points and Vernalis. Analysis of historical data indicates that a reasonable estimate of the ungauged flow for the VAMP period is the ungauged flow at the start of the VAMP period. As a result of rain on April 7 and 8, the ungauged flow, which had been running around 400 cfs, increased to 735 cfs on April 9. Therefore the planning at this point in time was done using assumed ungauged flows of 500 and 800 cfs. By April 12, refinements had been made to the ungauged flow calculations indicating that the ungauged flow prior to the rain of April 7 and 8 had been running around 600 cfs and peaked around 1,000 cfs on April 8, dropping to 832 cfs on April 11. With this information, the Hydrology Group prepared a daily operation plan on April 12 assuming ungauged flow of 650 cfs. As shown in Table 2-3, this operation plan resulted in an existing flow of 3,216 cfs, essentially on the breakpoint between target flows of 3,200 cfs and 4,450 cfs. The computed ungauged flow for April 12 was 771 cfs and still receding from the effects of the early April rain. Uncertain as to whether the ungauged flow would stabilize around the estimate of 650 cfs or continue receding, the Hydrology Group, on April 13, decided to initiate scheduling assuming a 3,200 cfs target flow with the understanding that if the ungauged flow did not recede significantly then the operation would be adjusted to a VAMP target flow of 4,450 cfs. On April 16, the ungauged flow for April 15 was computed to be 730 cfs with a slowing rate of recession, therefore the decision was made to use a target flow of 4,450 cfs, as shown in the daily operation plan of April 16.

Normally, the USGS measures the flow at Vernalis to check the current rating shift on a monthly basis. 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 March 21 and May 4. The results of these measurements are summarized in Table 2-4. As can be seen in Table 2-4, even with these precautions, the measurement on May 3 resulted in a sudden decrease in the real-time reported flow of just over 300 cfs, the impacts of which will be discussed in a following section.

VAMP 2001 IMPLEMENTATION

Operation Conference Calls

During implementation of the VAMP pulse flow, conference calls were conducted on a regular basis to discuss the status of the pulse flow and to make changes to the operation plan if needed. The calls were held at 6:30 a.m. so that potential operational changes could be implemented on that day. The first call was held on April 19. Starting on April 20 and ending on May 14, the calls were held every Monday, Wednesday and Friday.

Operation Monitoring

During the VAMP flow period, flows at Vernalis and in the San Joaquin River tributaries were continuously monitored using the available real-time data. Similarly, the computed ungauged flow at Vernalis and the flow in the San Joaquin River upstream of the Merced River were continuously updated. The available real-time data sources are summarized in Table 2-5. The monitoring was necessary to verify that supplemental water deliveries were adhering

TABLE 2-3
Summary of 2001 VAMP Daily Operation Plans Prepared During Planning Phase

VAMP FORECAST DATE	PULSE PERIOD	ASSUMED UNGAUGED FLOW AT VERNALIS (CSF)	EXISTING FLOW (CSF)	VAMP TARGET FLOW (CFS)	SUPPLEMENTAL WATER NEEDED TO MEET TARGET FLOW (1,000 AF)
March 14	4/15–5/15	700 1,000	3,943 4,246	4,450 4,450	31.17 12.52
March 20	4/15–5/15	700 1,000	2,833 3,133	4,450 4,450	22.57 4.13
March 23	4/15–5/15	500	2,633	3,200	34.87
April 3	4/15–5/15 4/17–5/17	500 1,000 500 1,000	2,636 3,136 2,628 3,128	3,200 3,200 3,200 3,200	34.66 3.91 35.15 4.40
April 10	4/19–5/19	500 800 500	2,920 3,221 2,594	3,200 4,450 3,600[1]	17.19 75.55 15.13
April 12	4/20–5/20	650	3,216	4,450	57.72
April 16	4/20–5/20	650	3,216	4,450	73.09

[1] Assumes "other supplemental water" is in addition to VAMP supplemental water.

TABLE 2-4
Summary of USGS Flow Measurements at the San Joaquin River

DATE	MEASURED FLOW (CFS)	REPORTED REAL-TIME FLOW (CFS)	PERCENT DIFFERENCE	SHIFT
March 6 at 10:05	5,330	4,570	16.6%	Yes
March 20 at 8:20	2,550	2,970	-14.1%	Yes
March 27 at 10:25	2,210	2,170	1.8%	No
April 3 at 9:40	2,240	2,180	2.8%	No
April 10 at 9:34	2,580	2,430	6.2%	Yes
April 18 at 9:45	2,090	2,140	-2.3%	No
April 25 at 8:42	4,400	4,620	-4.8%	No
May 3 at 10:45	4,220	4,540	-7.0%	Yes
May 8 at 09:45	4,170	4,170	0.0%	No

TABLE 2-5
Real-time Flow Data and Sources

MEASUREMENT LOCATION	REAL-TIME DATA SOURCE
San Joaquin River near Vernalis	USGS
Stanislaus River below Goodwin Dam	USBR Goodwin Dam daily operation report
Tuolumne River below LaGrange Dam (LGN)	CDEC
Merced River at Cressey (CRS)	CDEC
Merced River near Stevinson (MST)	CDEC
San Joaquin River at Newman (NEW)	CDEC

to tributary allocations contained in the SJRA to the extent possible, as well as to determine if changes in hydrologic conditions would require changes to the operation plan.

The daily operation plan was updated throughout the VAMP flow period. A summary of the updated daily operation plans is provided in Table 2-6. Copies of the updated daily operation plans are provided in Appendix A

Operational Highlights

As noted previously, the 2001 VAMP operation started with the uncertainty of whether the target flow would be 3,200 cfs or 4,450 cfs. The final determination was made on April 16 that the target flow would be 4,450 cfs. On April 19 and 20 a significant rain storm passed through the San Joaquin basin, resulting in an apparent peak flow at Vernalis of 4,890 cfs early in the morning of April 22. By the time of the April 23 operation conference call the apparent flow at Vernalis had receded to 4,740 cfs. Since the flow was within the desired operation bounds of plus or minus 7%, no action was taken. An updated daily operation plan was prepared on April 23 to reflect the measured flows to date. The effects of the rain had dissipated by April 26, and the flow at Vernalis appeared to stabilize within a range of plus or minus 100 cfs from the target flow (within 2% of the target). No operation changes were made through May 2 and an updated daily operation plan was prepared to reflect measured flows to date.

Things changed on May 4. The results of the May 3 USGS measurement of the flow at Vernalis indicated that the actual flow was about 300 cfs less than that in the real-time data report (Table 2-4). That is, rather than the reported flow of 4,520 cfs, the flow at Vernalis was actually 4,220 cfs, as illustrated in Figure 2-1. As a result of this news, there was a need to increase the amount of supplemental water being provided. In accordance with the Division Agreement, the additional supplemental water was the responsibility of Merced ID. The disadvantage of this was that with regulatory requirements and travel time, the soonest the increases from the Merced River would be seen at Vernalis would be in about six days. The only other alternative for getting water to Vernalis sooner would have been from the Tuolumne River, but that would have run the risk of disrupting fishery experiments on the Tuolumne as well as causing considerable deviation from the Division Agreement allotments. Since the flow at Vernalis was barely outside of the desired plus or minus 7% range, it was felt that the proper action was to increase the supplemental water contribution on the Merced River. Due to operational constraints and travel time requirements, the mean daily flow at Vernalis went as low as 4,010 cfs (almost 10% below the target) on May 10, before recovering to 4,320 cfs on May 13 and 4,520 cfs on May 14. No other operation changes were made for the duration of the 2001 VAMP period.

TABLE 2-6
Summary of 2001 VAMP Daily Operation Plans Prepared During Implementation Phase

VAMP FORECAST DATE	VAMP PERIOD	ASSUMED UNGAUGED FLOW AT VERNALIS (CFS)	EXISTING FLOW (CFS)	VAMP TARGET FLOW (CFS)	SUPPLEMENTAL WATER NEEDED TO MEET TARGET FLOW (1,000 AF)
April 23	4/20–5/20	650	3,232	4,450	72.15
May 2	4/20–5/20	650	3,211	4,450	73.39
May 4 [1]	4/20–5/20	500	3,026	4,450	86.14
May 7	4/20–5/20	500	3,004	4,450	86.11
May 14	4/20–5/20	500	2,950	4,450	89.48

[1] Rating shift at Vernalis gauge on May 3 resulted in reduced estimate of ungauged flow.

FIGURE 2-1
San Joaquin River Near Vernalis Effects of May 3rd Flow Measurement and Rating Shift

FIGURE 2-2
San Joaquin River Near Vernalis—With and Without VAMP

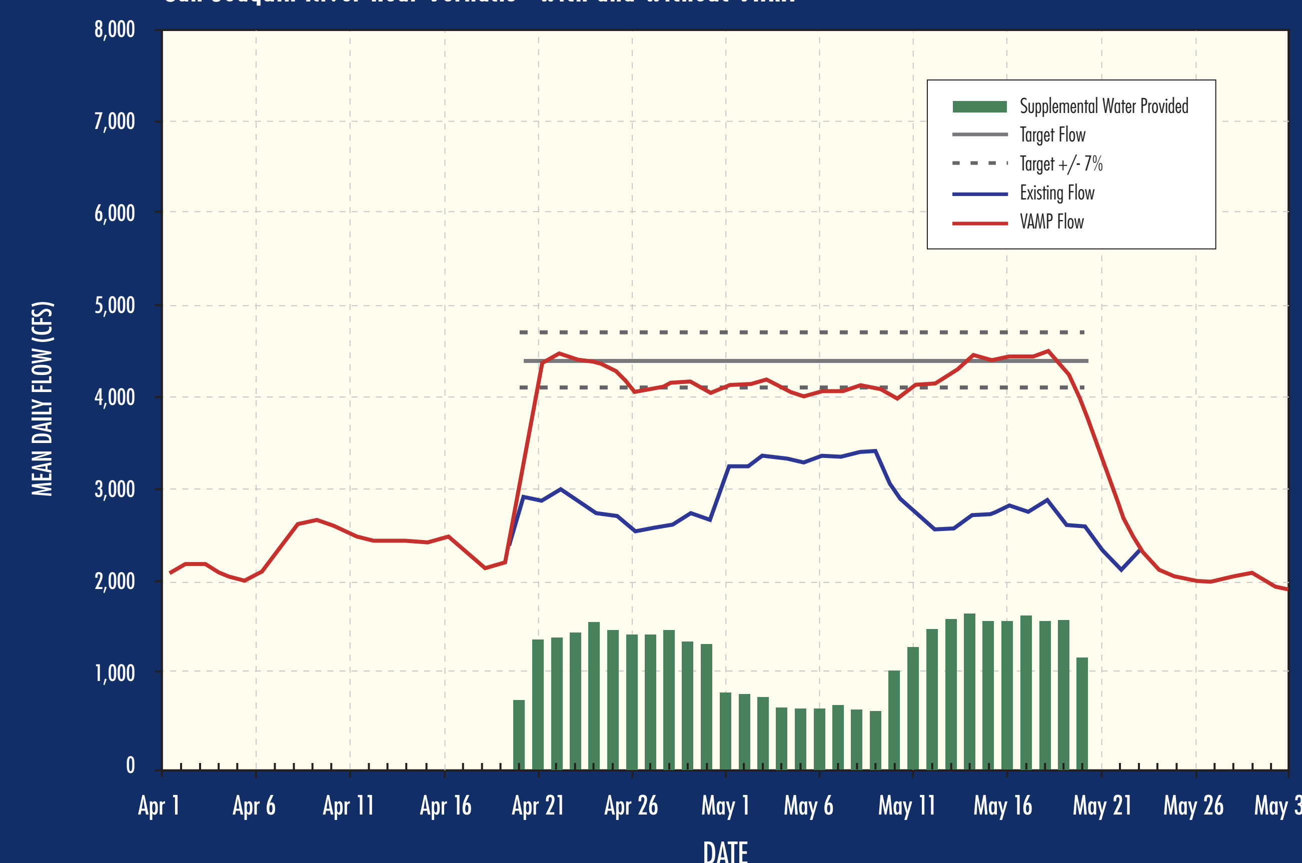


FIGURE 2-3

2001 VAMP—San Joaquin River Near Vernalis With Lagged Contributions From Primary Sources

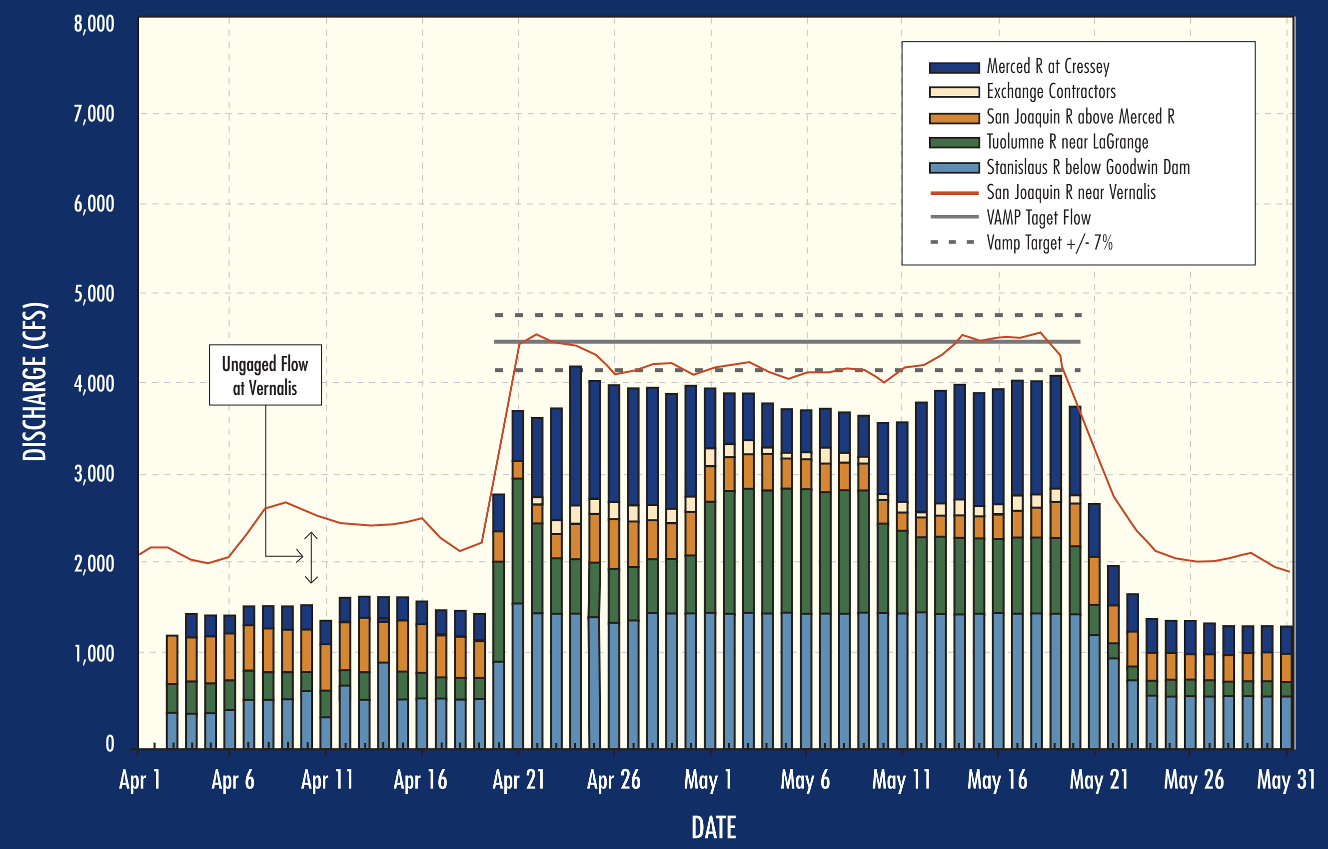
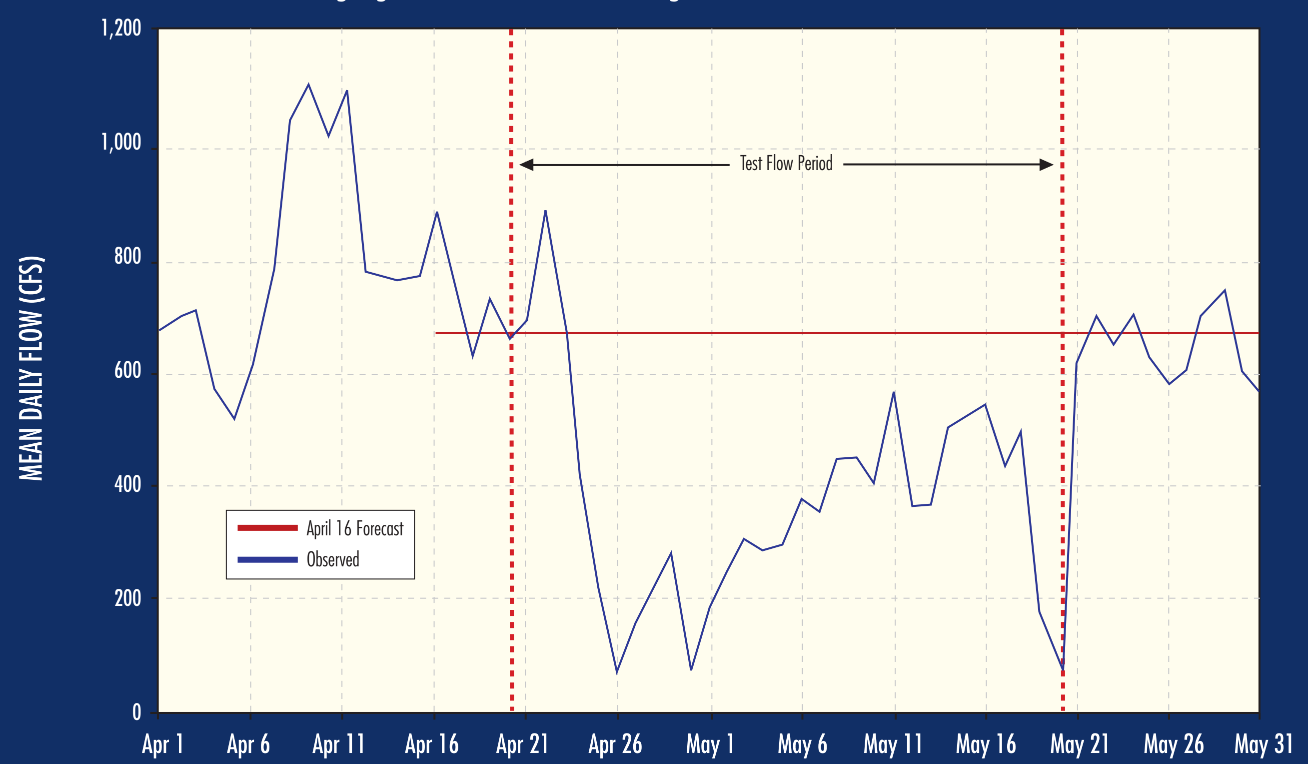


FIGURE 2-4

2001 VAMP—Ungauged Flow at Vernalis During VAMP Flow Period



RESULTS OF VAMP 2001 OPERATIONS

Planning and implementation of the VAMP spring pulse flow operation was accomplished using the best available real-time data, which has not been reviewed for accuracy or adjusted for rating shifts. The final accounting for the VAMP operation is accomplished using provisional mean daily flow data available from USGS and DWR. The provisional data, which is considered to be the best available information, has been reviewed and adjusted for rating shifts but is still considered preliminary and subject to change. To illustrate the differences between the real-time and the provisional data, plots of the real-time and provisional flows at the primary measuring points are provided in Appendix A.

The mean daily flow at the Vernalis gauge averaged 4,220 cfs during the VAMP test flow period, with a maximum of 4,560 cfs and a minimum of 3,450 cfs. The average flow for the test flow period absent the VAMP supplemental water was estimated to be 2,920 cfs. The VAMP operation resulted in a 45 percent increase in flow at Vernalis during the target flow period. Figure 2-2 shows the flow at Vernalis with and without the VAMP pulse flow. Figure 2-3 shows the sources of the flow at Vernalis. A total of 78,650 acre-feet of supplemental water was provided to meet the VAMP target flow. A daily summary of VAMP operations, along with supporting data, is provided in Appendix A.

The combined CVP and SWP export rate averaged 1,420 cfs during the 31-day period, about 5 percent below the target of 1,500 cfs.

As noted earlier, in planning for the VAMP operation the ungauged flow at Vernalis is the most difficult factor to forecast for the test flow period. Currently, estimates are made based on a review of historical data. The sensitivity of the VAMP planning and operation to the estimated ungauged flow was demonstrated this year. On April 16 the predicted ungauged flow was 650 cfs, resulting in an estimated existing flow at Vernalis of 3,216 cfs and a corresponding VAMP target flow of 4,450 cfs. The ungauged flow actually averaged 370 cfs during the test flow period, resulting in an estimated existing flow at Vernalis of 2,920 cfs, which would require a VAMP target flow of 3,200 cfs. In reviewing the data for this year's operation it appears that there may be a factor affecting the ungauged flow that is not accounted for through the use of the historical record, and that is the effects of the pulse flow itself on the ungauged flow. Figure 2-4 shows the ungauged flow during the test flow period and shows a correlation of reduced ungauged flow with the pulse flow. If this effect on the ungauged flow is due to the pulse flow operation, then some of the questions that need to be answered are whether this effect can be quantified, and whether the effect is dependent on the magnitude of the base flow in the San Joaquin River.

The combined CVP and SWP export rate averaged 1,420 cfs during the 31-day period, about 5 percent below the target of 1,500 cfs. The daily SWP and CVP exports during the VAMP test period are shown in Figure 2-5.

SJRG member agencies have entered into the Division Agreement, which allocates responsibility of the members for providing VAMP supplemental water. The distribution of supplemental water for the 2001 VAMP operation, compared to the distribution called for under the Division Agreement, is summarized in Table 2-7.

Storage Impacts

The VAMP supplemental water contributions, with the exception of that provided by the Exchange Contractors, are supplied from reservoir storage: Lake McClure on the Merced River, New Don Pedro Reservoir on the Tuolumne River and New Melones Reservoir on the Stanislaus River. Therefore, the impacts of VAMP operations can be seen directly as changes in reservoir storage. 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.

The storage impacts of the 2000 VAMP operation on Lake McClure were eliminated in May 2000 due to required flood control releases. As per the SJRA, Merced I.D. provided 12,500 acre-feet of

TABLE 2-7

2001 VAMP—Distribution of Supplemental Water

AGENCY	DIVISION AGREEMENT DISTRIBUTION (ACRE-FEET)	SUPPLEMENTAL WATER PROVIDED (ACRE-FEET)	DEVIATION FROM DIVISION AGREEMENT (ACRE-FEET)
Merced I.D.	42,150	42,120	-30
Oakdale I.D./ South San Joaquin I.D.	14,600	14,730	+130
Exchange Contractors	7,300	7,740	+440
Modesto I.D./Turlock I.D.	14,600	14,060	-540

supplemental water in the Fall of 2000. Therefore, prior to the 2001 VAMP operation, the storage impact on Lake McClure due to the SJRA was 12,500 acre-feet. With the 42,120 acre-feet of supplemental water provided for the 2001 VAMP operation along with 1,030 acre-feet of operational ramp-down water, the current impact of the SJRA on Lake McClure storage is 55,650 acre-feet. Figure 2-6 shows Lake McClure storage with and without the SJRA for the period of October 2000 through December 2001.

On the Tuolumne River, the storage impact from previous SJRA operations carried over into water year 2001 was 7,700 acre-feet. However, in late February 2001 precautionary flood control releases were made in excess of 7,700 acre-feet, thereby eliminating the SJRA storage impact. As a result of the 2001 VAMP operation, the current impact of the SJRA on New Don Pedro storage is 14,060 acre-feet. Figure 2-7 shows New Don Pedro Reservoir storage with and without the SJRA for the period of October 2000 through December 2001.

As part of the SJRA, 18,785 acre-feet of "additional" water was purchased from OID by Reclamation and released from New Melones Reservoir between October 17, 2000 and December 10, 2000, thereby resulting in an impact to New Melones storage of 18,785 acre-feet. This impact was carried over into 2001. The impact of the 2001 VAMP operation on New Melones storage was 16,890 acre-feet, of which 14,730 acre-feet was 2001 VAMP supplemental water and 2,160 acre-feet was 2001 VAMP operational ramp-down water. Therefore, the impact of the SJRA to New Melones storage following the 2001 VAMP operation was 35,675 acre-feet. As described in Chapter 3 of this report, Reclamation purchased and released 18,635 acre-feet of "additional" water, bringing the total current SJRA storage impact on New Melones Reservoir to 54,210 acre-feet. Figure 2-8 shows New Melones storage with and without the SJRA for the period of October 2000 through December 2001.

FIGURE 2-5

2001 VAMP – Federal and State Exports

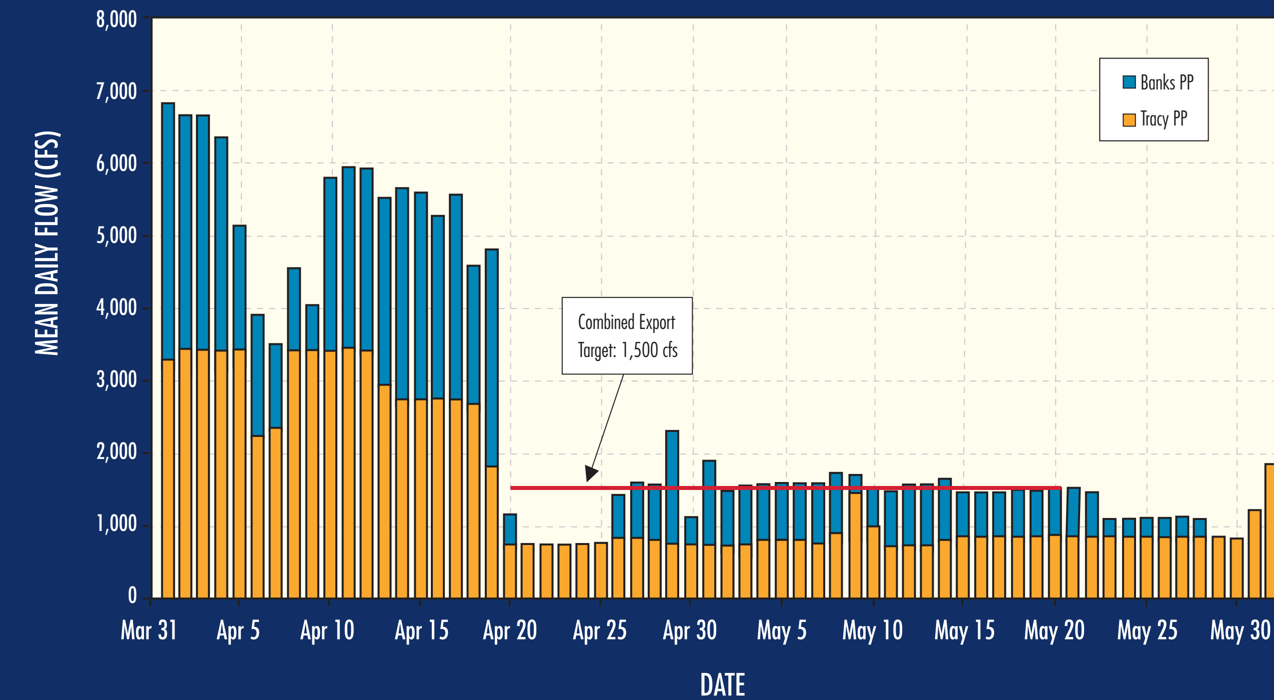


FIGURE 2-6

SJRA Storage Impacts – Lake McClure (Merced River) October 2000 Through December 2001

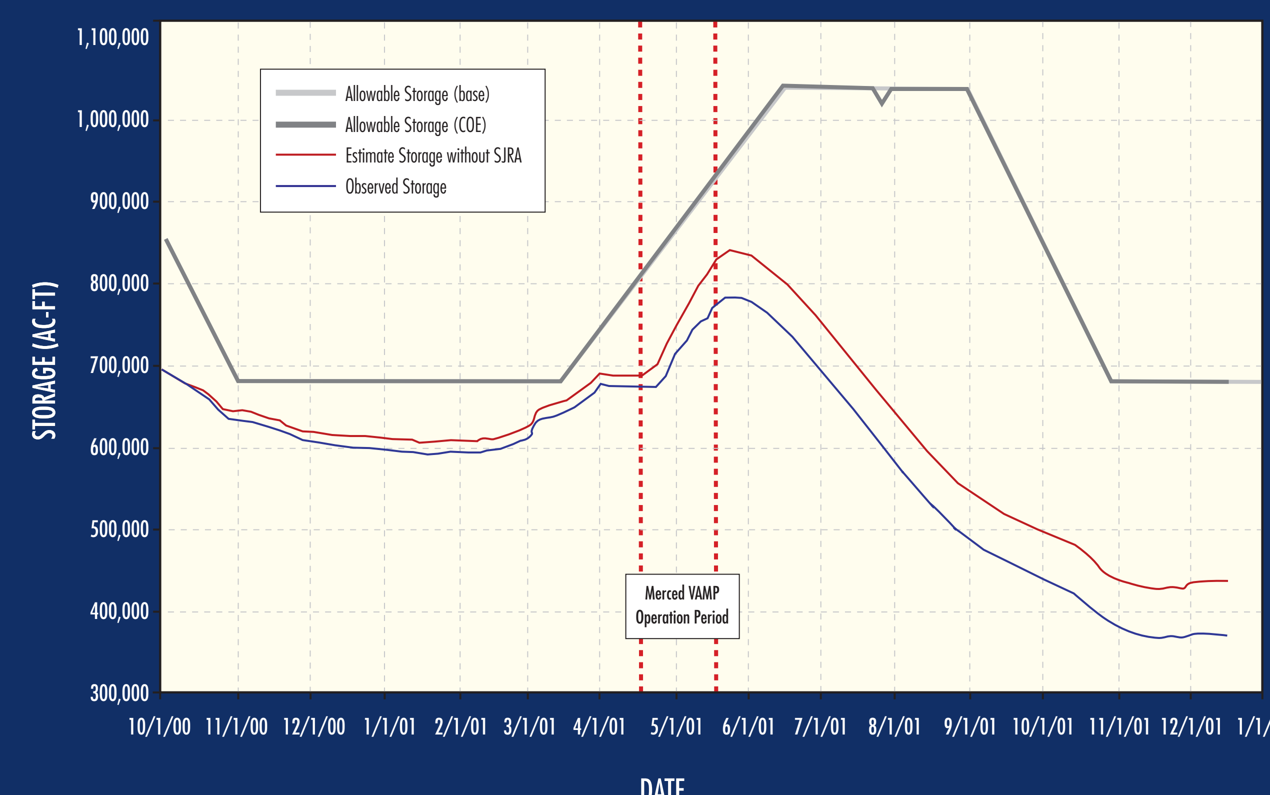


FIGURE 2-7

SJRA Storage Impacts–New Don Pedro Reservoir (Tuolumne River) October 2000 Through December 2001

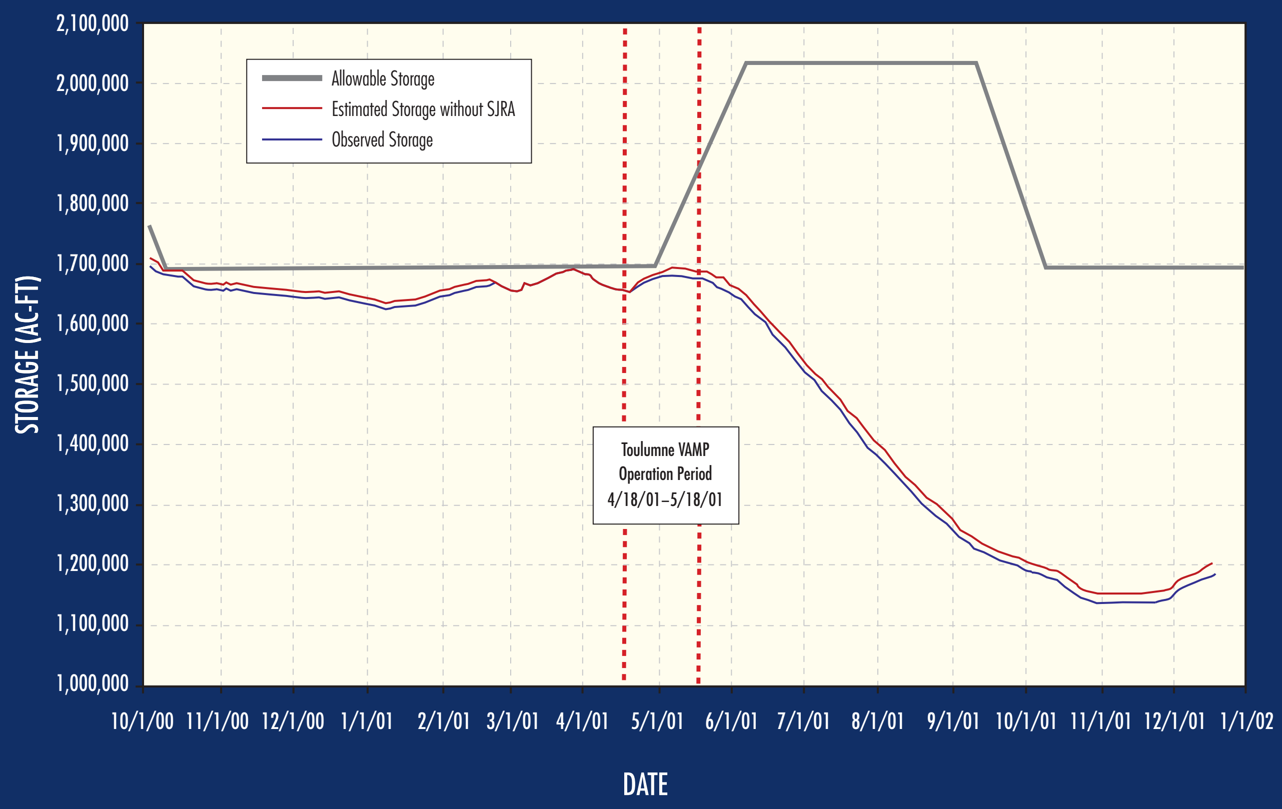
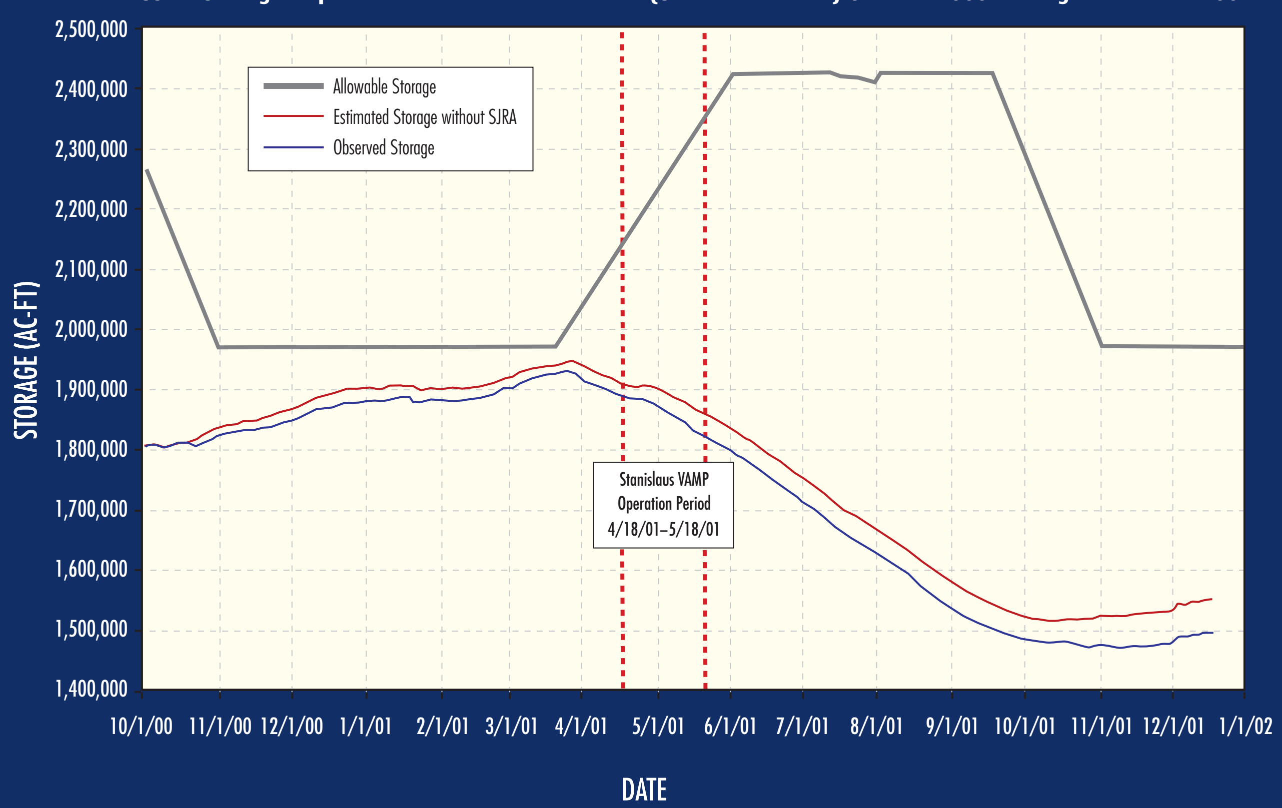


FIGURE 2-8

SJRA Storage Impacts–New Melones Reservoir (Stanislaus River) October 2000 Through December 2001



ADDITIONAL WATER SUPPLY ARRANGEMENTS & DELIVERIES

MERCED IRRIGATION DISTRICT

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

In addition to providing water in the fall of 2001 pursuant to the SJRA, Merced entered into a contract with DWR to transfer up to 25,000 acre-feet of water to the CALFED Environmental Water Account (EWA). This additional water transfer is referred to as the EWA Transfer. The EWA Transfer water was to be delivered south of the Delta via the SWP, using available excess pumping capacity at the Banks Pumping Plant. Since the likelihood of having excess pumping capacity decreases near the end of the year, the desire in the initial planning for the Fall water transfers was to transfer the EWA Transfer water first and use the Fall SJRA Transfer Water to supplement flows in November and December. A tabulation and plot of the initial daily flow schedule for the Fall water transfers is provided in Appendix B.

In October DWR installs a temporary barrier at the head of Old River. As part of the land use agreement allowing for the construction of the barrier, DWR has agreed to remove it if the flow in the San Joaquin River, as measured at the Vernalis gauge, exceeds 4,500 cfs. The expected flows on the Stanislaus River and Tuolumne River were taken into consideration during the Merced River Fall water transfer schedule development to minimize the risk of the San Joaquin River flow at Vernalis exceeding 4,500 cfs while the barrier was in place.

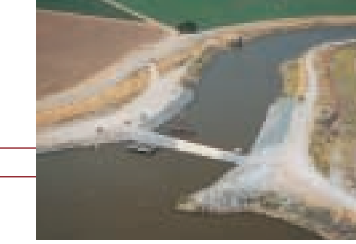
A table summarizing the preliminary data for the observed Merced ID Fall 2001 transferred water is provided in Appendix B. Also provided in Appendix B are the final data for the year 2000 Fall transferred water.

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 provided 7,365 acre-feet of supplemental water for the year 2001 VAMP, resulting in 3,635 acre-feet of Difference water. Therefore, pursuant to Paragraph 8.5 of the Agreement, OID sold a total of 18,635 acre-feet of water to the USBR in 2001.

Release of the OID additional water by the USBR began on October 20, 2001, and was completed on November 21, 2001. A daily tabulation of the OID additional water release is provided in Appendix B.



HEAD OF OLD RIVER BARRIER

BARRIER DESIGN, INSTALLATION AND OPERATION

In 2001, DWR successfully installed and operated the temporary Head of Old River Barrier (HORB) following six months of intense negotiations with regulatory agencies to obtain the necessary permits for this barrier and the three agricultural barriers in the south Delta. 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. The HORB, as currently configured, is now fully permitted though 2005.

The spring HORB was first constructed in 1992 and again in 1994, 1996, 1997 (w/two culverts), 2000 (w/six culverts) and 2001 (w/six culverts). The HORB was not installed in 1993, 1995 and 1998 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.

The HORB was originally designed to withstand a San Joaquin River flow of about 3,000 cfs. Through the years, the design and installation of the HORB has been revised on several occasions to accommodate different needs. For 2001 and future years, the barrier design includes two versions. A "low-flow" barrier when San Joaquin River target flows are below 7,000 cfs would be built to a height of ten feet mean sea level (MSL). A "high-flow" barrier for target flows of 7,000 cfs and above would be built to a height of 11 feet MSL and additional material would be placed to raise the abutments to 13 feet MSL. Both barrier versions are equipped with six 48-inch diameter operable culverts and an overflow weir back-filled with clay. In 2001, the low-flow version was installed.

The dimensions of the 2001 HORB (Figure 4-1) were similar to the 2000 HORB, but considerably larger than those constructed in past years. The base width of the HORB in 2000 and 2001 was 100 feet and the crest elevation was ten feet MSL. The top of HORB was constructed with a 75-foot wide notch, protected with concrete grid mats and back-filled with clay. This larger HORB was designed to safely operate with flows corresponding to stages up to 8.5 feet MSL.

To help mitigate anticipated low water levels in the south Delta (downstream of the HORB) caused by the operation of the HORB, two open culverts were installed in the barrier in 1997, and six operable culverts were installed beginning in 2000. Operation of the culverts was controlled by a slide gate control structure located on the upstream side of HORB. DWR relied on daily modeling and field data collection to monitor water levels at three locations within the south Delta to determine when and how long to operate the culverts. Generally, the model forecasts would tend to forecast low-low water levels lower than what was occurring in the field. Consequently, DWR would make decisions regarding the culvert operations that would take this into consideration. It is expected that refinements to the model over time will provide modeling results that correspond more closely with field measurements.

The downstream outlet of each culvert was designed so fyke nets could be attached to evaluate fish passage. DFG staff conducted a fishery-monitoring program as part of the 2001 HORB operations.

The downstream outlet of each culvert was designed so fyke nets could be attached to evaluate fish passage.

Barrier Operations and Monitoring Plan

DWR obtained new permits from the Corps of Engineers and the DFG to install and operate the HORB with six 48-inch diameter culverts. The culverts permitted flow through the HORB on an as-needed basis.

A barrier operations and monitoring plan was developed based on forecasting and monitoring of tidal conditions. DWR determined the number of culverts to be opened at the HORB so that water levels at Old River near Tracy Road Bridge, Middle River near Howard Road and Grant Line Canal near Tracy Road Bridge would remain above 0.0 feet MSL. Based on modeling results and/or field monitoring of water levels in the south Delta, all six culvert slide gates remained open from April 26 to May 26 when the HORB was removed.

The average daily flow through the culverts varied in response to tidal and San Joaquin River flow conditions. The characteristics of the flow through the culverts are complicated in that the flow rate is influenced by many variables, including the culvert inlet geometry, slope, size, culvert roughness, and approach and tail water conditions. An approximation of the combined net flow through the culverts, including any seepage through the barrier, was accomplished by measuring the flow in Old River just downstream of the HORB using Acoustic Doppler technology. A fixed Acoustic Doppler Current Meter was installed approximately 840 feet downstream of the HORB which recorded velocity measurements every 15 minutes during the period the HORB was operated (April 26 through May 26, 2001). The flow in Old River was then calculated using the known cross-sectional area of the channel as a function of the stage elevation at that location.

In addition, a boat mounted Acoustic Doppler Current Profiler (ADCP) was used to initially calibrate the fixed Doppler system and then recalibrate it periodically during the barrier operational period. The ACDP measured real time flow by performing several transects across the channel. The channel velocity was then calculated and used to adjust the index velocities that were measured by the fixed Doppler system.

The mean daily flow measured in Old River during the operation of the HORB ranged from 75 to 692 cfs as shown in Table 4-1. On May 26, the barrier was breached, which accounts for the maximum flow of 1,450 cfs shown in Table 4-1. The negative flows listed indicate the channel below the HORB was filling on a flood tide, however, this does not mean that flows through the culverts were negative. As long at the river stages on the upstream side of the barrier remain higher than the downstream side, flows through the culverts will always be positive.

Barrier Emergency Response Plan

In addition to the operation and monitoring plan, DWR implemented an updated 2001 "Emergency Operations Plan for the Spring HORB." The plan provided that if the daily measured or forecasted flow at Vernalis exceeded a flow that would correspond to stage at the HORB of 10.0 feet MSL, and the stage was likely to exceed 11.0 feet MSL (the height of the barrier under the "high-flow" target), the barrier would be removed. Operation of the HORB was uneventful this year. Vernalis flows and stages at the barrier were not high enough in 2001 to warrant action under the emergency operations plan. The barrier remained in place until May 26.

Seepage Monitoring

A seepage-monitoring program was initiated in April 2000 and continued this year, to evaluate the effects of HORB operations on seepage and groundwater on Upper Roberts Island.

Three seepage monitoring well sites were chosen in 2000 on Upper Roberts Island. Each site had two shallow wells, positioned 10 feet and 100 feet from the toe of the levee to monitor seepage gradient to and from the San Joaquin River. In addition, a deeper well was drilled at Site 1 (near the Head of Old River) to determine vertical gradients.

In addition to the groundwater monitoring wells, a temporary gauge was installed in April 2000 to record water surface elevations in the San Joaquin River, about 1,500 feet downstream of the HORB. Installation of a permanent tide gauge is expected in the fall 2001.

FIGURE 4-1
Head of Old River Barrier (HORB)

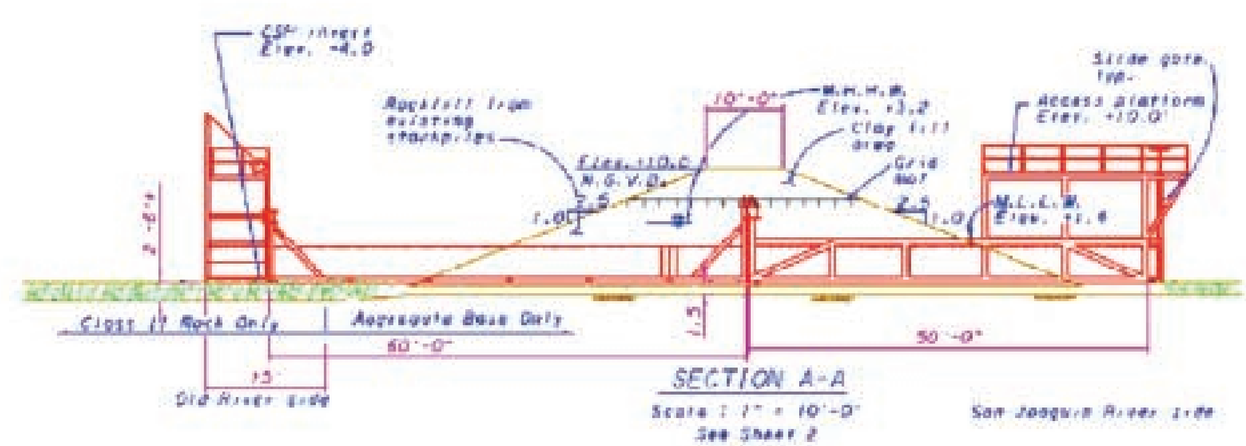


TABLE 4-1
Flow on Old River Downstream of the Head of Old River Barrier–2001

DATE	MEAN DAILY FLOW (CFS)	DAILY MAX FLOW (CFS)	DAILY MIN FLOW (CFS)	DATE	MEAN DAILY FLOW (CFS)	DAILY MAX FLOW (CFS)	DAILY MIN FLOW (CFS)
4/26/01	692	1,033	174	5/14/01	112	434	-130
4/27/01	661	1,053	-186	5/15/01	173	392	-94
4/28/01	675	1,002	346	5/16/01	186	455	-91
4/29/01	530	940	0	5/17/01	112	349	-99
4/30/01	285	821	-463	5/18/01	227	839	-117
5/1/01	331	896	-147	5/19/01	523	817	149
5/2/01	126	673	-565	5/20/01	511	758	267
5/7/01	292	644	-210	5/21/01	360	672	10
5/8/01	321	688	-71	5/22/01	217	527	-79
5/9/01	223	604	-303	5/23/01	216	460	0
5/10/01	221	582	-186	5/24/01	220	542	59
5/11/01	91	474	-246	5/25/01	263	492	31
5/12/01	75	485	-207	5/26/01	533	1,450	62
5/13/01	153	441	-133				

The water surface elevations in the San Joaquin River are compared to groundwater levels on Upper Roberts Island to determine how groundwater levels change relative to changing water level conditions in the river.

In July 2001, DWR completed a "Reclamation District 544 Seepage Monitoring Study". This report documents the seepage monitoring results from Upper Robert Island. (Copies of the report are available from DWR). The report concluded that San Joaquin River stage influences groundwater levels on Upper Roberts Island. When stage increases in the river, groundwater levels will rise toward the land surface, but not as rapidly as the river stage rises. However, over the monitoring period, river stage did not reach levels sufficient to raise groundwater levels to the point where seepage into crop root zones might occur.

Given the results of the seepage monitoring since April 2000, DWR expects that if a VAMP target flow of 7,000 cfs was implemented, stages near the HORB would rise to about 7.5 to 8 feet MSL. This would translate to groundwater levels in the monitoring well closest to the levee of about 6.5 to 7 feet MSL. Because the ground surface elevation is 13 feet MSL near site 1, DWR concludes that seepage should not impact the root zone of crops that could be planted in this area.

It is recommended that the monitoring program be continued in order to gather more data, particularly during high flow periods in the spring.

FISHERY MONITORING AT THE HEAD OF OLD RIVER BARRIER

As mentioned in the previous section, the temporary barrier installed at the HORB in 2001 was equipped with six operable culverts. During the VAMP 2001 test period all six of the culverts were open and diverted water from the San Joaquin River to maintain water quality and water levels within Old River. Juvenile Chinook salmon and other fish species were vulnerable to being entrained into the spring HORB culverts. A fisheries monitoring program was designed and implemented by DFG to evaluate and quantify fish entrainment at the HORB. The specific objectives of the investigation included:

• Determine the total number of juvenile Chinook salmon and other fish species entrained through the culverts at the HORB (entrainment monitoring);

• Determine percentage of coded-wire tagged (CWT) salmon released at Mossdale and Durham Ferry entrained into Old River (entrainment monitoring);

• Determine the effect of tidal stage and day/night conditions on juvenile Chinook salmon entrainment (entrainment special study); and

• Determine migration routes of CWT salmon released at the HORB and recovered at temporary barrier locations in Old River, Middle River, and Grant Line Canal (migration study).

Results of these investigations were intended, in part, to provide information useful in the design and operation of a permanent operable barrier at the Head of Old River in the future.

Materials and Methods

Ten fyke nets were ordered to monitor fish entrainment into the HORB culverts. Due to the delay in the production and delivery of these nets we had to repair three fyke nets from last year's study and borrow three fyke nets to begin this year's study. We replaced these nets as the new fyke nets arrived. The various fyke nets used in the monitoring were (1) 60 feet in length, with ¼-inch braided mesh tapering from a 48-inch cylindrical mouth opening to a 1-foot square cod end; (2) 30 feet in length, made of ¼-inch braided mesh tapering from a 48-inch square mouth opening to a 1-foot square cod end; and (3) 35 feet in length, made of ⅛-inch braided inch, tapering from a 48-inch square mouth opening to a 1-foot square foot cod end. Each of the fyke nets was equipped with a live-box (15.5 x 19.5 x 36 inches), constructed of perforated aluminum sheet metal. Each of the live-boxes included an aluminum baffle designed to reduce water velocities within the live car and improve survival of captured fish.

Operation of all six culverts at the HORB began April 30. The culverts were numbered one through six with one located next to the shoreline and six located mid-channel (Figure 4-2). Only five out of the six culverts had fyke nets attached because one culvert (no. 4) was jammed by debris and could not be closed to allow attachment of a fyke net. Fyke nets were attached to the culverts by connecting the net to the live-box, closing the culvert slide gate, strapping the fyke nets over a 48-inch diameter opening on the tracks, lowering the net over the culvert out-fall, and opening the culvert slide gate. Rubber flaps were used to seal the spaces between the culvert and the net opening to prevent fish loss. The culverts were twisted during construction of the HORB. As a result, the alignment between the net mouth opening and culvert was not exact causing the leakage of some water (and potentially fish) past the net mouth opening. By May 2 the slide gate on a second culvert (no. 2) was jammed by debris and could not be closed. Consequently, the fyke net was removed and sampling was continued on only four of the six culverts. On May 5, all fyke nets were removed to allow work to be done on the San Joaquin River side of the HORB because the trash

FIGURE 4-2
Culvert Numbers for HORB 2001

screens, part of the modifications for 2001, were becoming clogged by debris. However, only culverts two and four, which could no longer be closed due to the blockage of the slide gates, were cleared of debris. Beginning May 7, all six culverts were "operational" and all six fyke nets were re-attached. Sampling continued through May 18. After the 18-day sampling period was completed, the fyke nets were removed, inspected and found to have only minor holes in them.

During monitoring, entrained fish were removed from the live-boxes by closing the culvert slide gate for a period of 30 to 45 minutes with no more than two culverts being closed at one time. During this time the live-boxes were removed from the water, placed onto a boat, and the net and live-boxes checked thoroughly. Once all the nets had been checked and reset the fish that were collected and held in containers were processed. Data recorded for each sample consisted of date, time, water temperature, tidal stage, culvert number, fish species, and species count. Each Chinook salmon collected was measured, categorized as marked (CWT present based on an adipose fin clip), unmarked (natural), or color-dyed, and categorized as dead or alive. All CWT Chinook salmon were retained so tags could be processed; all other fish were released in Old River, downstream of the fyke nets.

Fyke nets were checked routinely on every high and low tide with high tide defined as the time period encompassing the flood and low tide defined as the time period encompassing the ebb. However, starting May 12, all night checks were cancelled due to the low number of Chinook salmon smolts collected. Starting May 15, fyke nets were checked once daily.

Entrainment Monitoring

Loss indices for the CWT salmon released as part of the VAMP survival studies at Durham Ferry and Mossdale were calculated based on data collected from April 30 to May 18. The loss index represents the percentage of CWT salmon entrained into the HORB culverts and is determined by the equation:

$$I = (TC/TR)(TT/ST)$$

Where:

TC = Total number of CWT salmon collected in culvert fyke nets
TR = Total number of CWT released
TT = Total time (hours) during the test period
ST = Total time (hours) sampled at HORB during the test period

Catch-Per-Unit-Effort (CPUE) for unmarked Chinook salmon was calculated as the number collected per hour. The CPUE for salmon collected from each culvert was analyzed using a single factor ANOVA with logarithmic transformation of the data (X` = log (X+1)). CPUE was further analyzed to determine differences between all possible pairs of means using the Tukey multiple comparison test.

Entrainment Special Study:
Eight individually marked (color coded) groups of juvenile Chinook salmon from the Merced River Hatchery were released in the San Joaquin River with respect to the following variables: release site, tidal cycle, and day/night. The first release site was directly in front of the HORB, consisting of approximately 500 juvenile salmon per release group. The second release site located nearly one mile upstream of the HORB consisted of about 3000 juvenile salmon per release group.

Juvenile Chinook salmon used in these tests were color-marked at the hatchery with photonic fluorescent microspheres. The salmon were then transported from the hatchery to the San Joaquin River and placed in 4x10x4 foot live cages lined with 3/16-inch mesh netting. The test fish were held in the live-cages for ten or more hours to reduce handling stress and observe any pre-release mortality. Night releases during high and low tidal cycles were made during the evening of April 30 and early morning of May 1. Though six culverts were in operation during this release, only five fyke nets could be attached for sampling. Day releases for both tidal cycles were made during the morning and afternoon of May 10. All six culverts were in operation for this release and all six fyke nets were attached for sampling.

The percentage of color-marked salmon recovered in the fyke nets compared to the total number released was used as an index of entrainment vulnerability at the HORB.

Migration Study
A pilot study was conducted to determine the migration routes through the south Delta of juvenile Chinook salmon entrained by the HORB. A total of 25,000 CWT Merced River Hatchery juvenile Chinook salmon were released May 12 (0930 hours) into Old River downstream of the HORB. Kodiak trawling was conducted daily over the next seven days upstream and downstream of the Grant Line Canal Barrier (GLCB) and the Old River Barrier near Tracy (OLDRB)(Figure 4-3). Kodiak trawl sampling could not be performed at the Middle River Barrier (MIDRB) because of shallow water depth.

In addition to Kodiak trawl sampling, marked salmon were also recovered in sampling at Chipps Island, Antioch, and at the SWP and CVP fish salvage facilities.

RESULTS AND DISCUSSION

Entrainment Monitoring
Throughout the April 30 to May 18 study period, the number of culverts operated at the HORB and the number of fyke nets sampled varied (Table 4-2). During the sampling period, the six culverts were in operation approximately 2,596 hours. Total sampling time for all fyke nets combined was 2,092 hours. During the entrainment monitoring period, sampling was performed approximately 81% of the time that the culverts were in operation.

Thirty-two fish species were collected in the fyke nets during entrainment monitoring (Table 4-3). Chinook salmon (2,888) and white catfish (2,677) were the two most abundant species collected. No Delta smelt, one splittail, and two steelhead were collected. Of the 2,888 Juvenile Chinook salmon collected in the fyke nets at the culverts:

TABLE 4-2
Culvert and Fyke Net Operations

DATES OF CULVERT OPERATION	NUMBER OF CULVERTS OPERATED	NUMBER OF FYKE NETS SAMPLED
4/30/01–5/2/01	6	5
5/2/01–5/5/01	6	4
5/5/01–5/7/01	6	0
5/7/01–5/8/01	6	4
5/8/01–5/18/01	6	6

FIGURE 4-3
Location of Temporary Barriers Throughout the Southern Delta

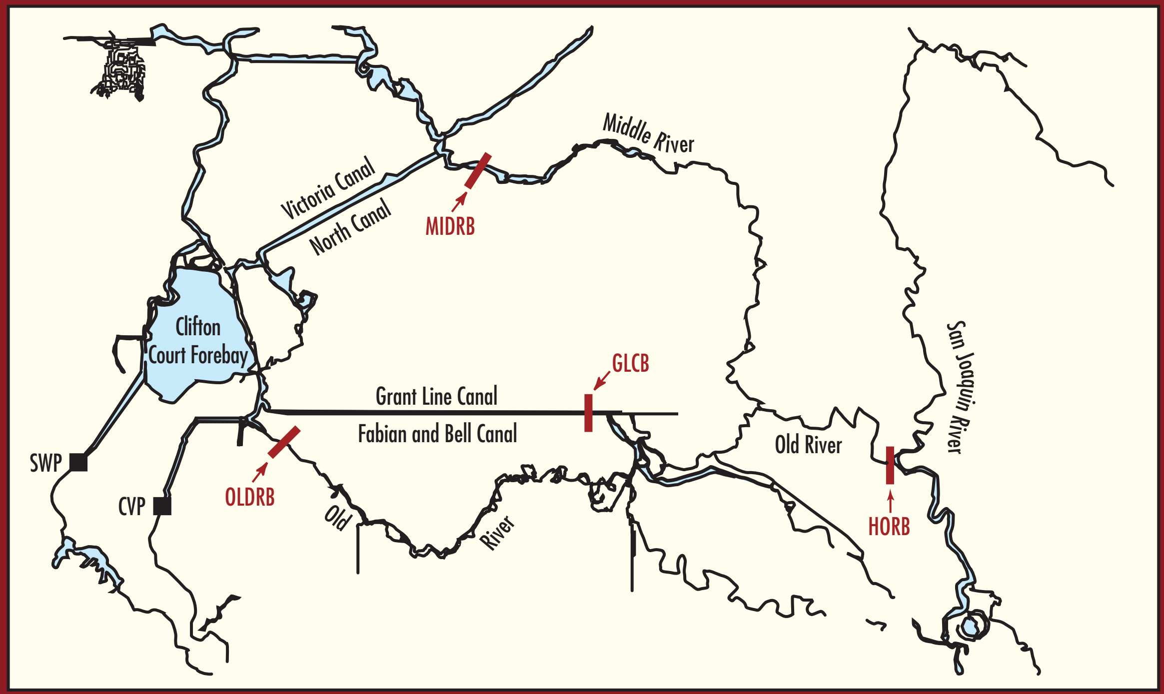
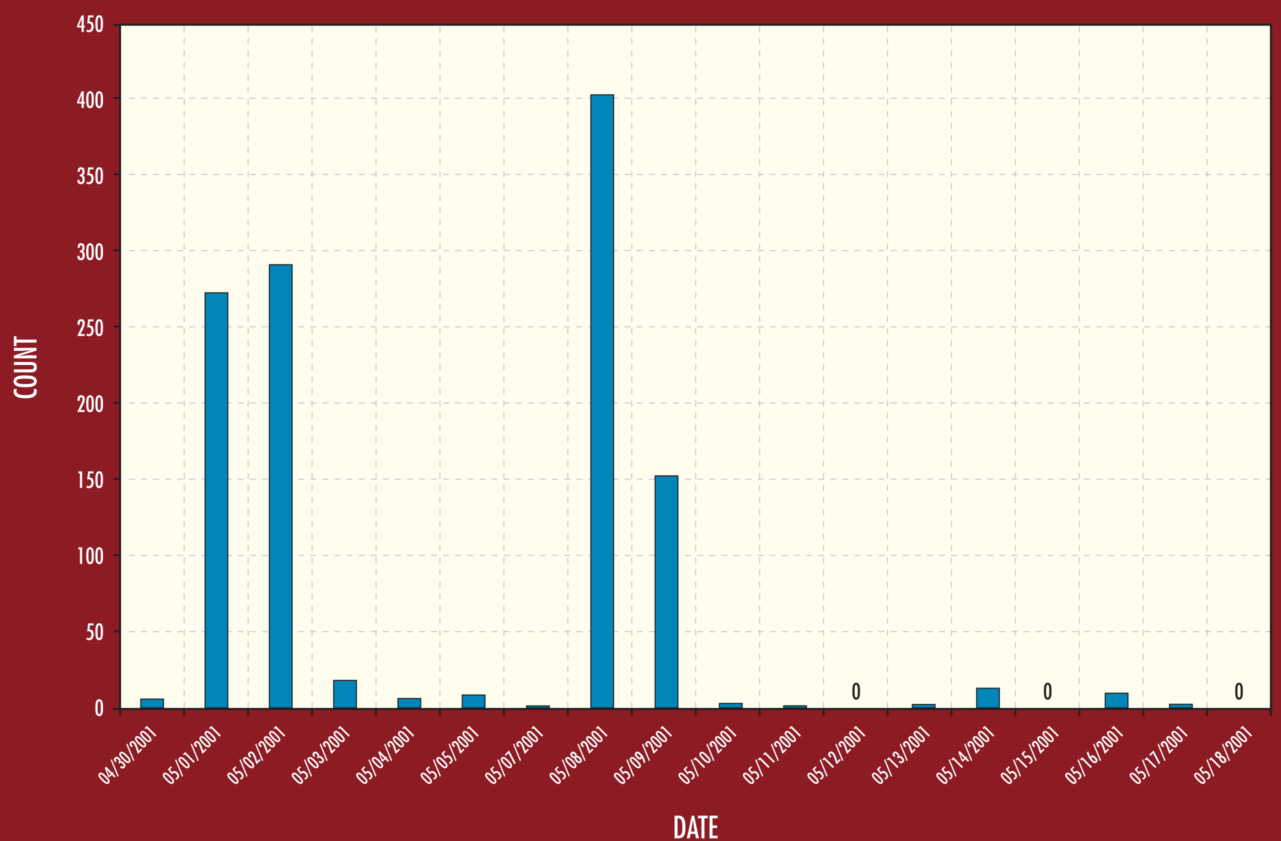


FIGURE 4-4
Number of CWT Chinook Salmon Entrained Per Day From April 30 to May 18, 2001 at HORB



• 1,268 were CWT Chinook salmon (including 92 salmon released on the Merced River, and 21 salmon released on the Tuolumne River);

• 1,014 were unmarked Chinook salmon;

• 475 were color-marked Chinook salmon (Entrainment special study); and

• 131 were mutilated Chinook salmon.

The mutilated salmon smolts observed this year could have come from various sources. The smolts could have died on the San Joaquin side of the HORB and then been diverted through the culverts. In addition, the smolts could have been regurgitated from the many catfish entrained in the fyke nets. The HORB design in 2001 included trash screens placed in front of the culvert openings. Over time, the debris accumulated on the trash screens could have acted like a filter and increased mutilation of entrained salmon.

The entrainment loss index for CWT Chinook salmon released as part of the VAMP 2001 averaged 0.54 percent. The entrainment loss index for releases at Mossdale averaged 0.49 percent (May 1 release entrainment index was 0.61 percent; May 8 release entrainment index was 0.37 percent). The entrainment loss index for releases at Durham Ferry averaged 0.58 percent (April 30 release entrainment index was 0.54 percent; May 7 release entrainment index was 0.62 percent). This year's average entrainment loss index was slightly lower than the previous years (0.75 percent in 2000 and 0.6 percent in 1997). The debris that accumulated on the trash screens, in front of the culvert openings, could have contributed to this lower entrainment loss index. The temporal pattern of CWT salmon collected in entrainment monitoring (Figure 4-4) reflects releases of salmon as part of the VAMP studies at both Durham Ferry and Mossdale. No consistent pattern in entrainment of CWT salmon was apparent under low and high tidal stages (Figure 4-5) and an obvious pattern of entrainment was apparent under day/night (Figure 4-6) with more salmon entrained at night than during the day. However, the tidal cycle did have an effect on CPUE and is represented when only one category (day or night) in Figure 4-6 is singled out and related to the same information (data bars) in Figure 4-5, showing that more salmon were entrained during low tides than high tides. The reason that tidal cycle seems to show no pattern is because day/night is a much stronger influence than tides and therefore hides the tidal cycles' smaller influence. Also, since both factors influence CPUE, they are considered additive influences, meaning a low tide occurring at night will increase the chance of Chinook salmon smolt entrainment as compared to a high tide occurring during the day.

The CPUE for unmarked Chinook salmon ranged from 0.0 to 6.7 fish per net per hour, averaging 0.5 fish per hour. This year's CPUE is approximately three times smaller than last year's estimate (1.7 fish per hour in 2000) and may again be a result of the debris blocking the culvert openings. However, this could also be indicative of a smaller population passing the barrier in 2001 relative to 2000.

Statistical analysis of CPUE for unmarked Chinook salmon showed that entrainment rates among the six culverts were significantly different ($P < 0.002$). Results of the Tukey multiple comparison test showed that CPUE among all six culverts were significantly different from one another ($P < 0.005$) except culverts four and five. Position of the culverts relative to the shoreline, culvert maintenance, eddies and turbulence, and variation in hydraulics and velocities may all be factors contributing to the observed differences in entrainment between culverts.

CPUE for both CWT and unmarked Chinook salmon showed an increasing trend from culvert one to culvert six (Figure 4-7) using data obtained between May 8 and May 18 when all six culverts were sampled. CPUE for CWT and unmarked Chinook salmon are similar for each culvert. Although CPUE was similar between CWT and unmarked salmon, examination of sampling data showed that CWT salmon were collected within two days of release at Durham Ferry and Mossdale. Unmarked salmon were collected throughout the entrainment monitoring period.

Results of entrainment monitoring indicated that day/night and tides might influence Chinook salmon entrainment at the HORB. However, day/night may be a stronger influence than tides. When both influences are occurring simultaneously, the data suggests there is an additive effect. The results also suggest that flow rates through the culverts are not equal and may increase the farther the culvert is from the shoreline.

Entrainment Special Study

Release and recapture information for the entrainment special study is summarized in Table 4-4. The percentage of color-marked salmon collected in each test was extrapolated to account for the number of nets sampled and culverts operated. The percentage of color-marked Chinook salmon recovered was highest for the salmon released adjacent to the HORB and those released during the low tide.

It is evident that the salmon smolts released immediately in front of the HORB were more vulnerable to entrainment than those released further upstream. Therefore, entrainment vulnerability at the HORB for natural or CWT salmon migrating downstream in the San Joaquin River is probably better represented by salmon released upstream of the HORB resulting in greater dispersal and lower percent recoveries.

Furthermore, the finding that the percentage of marked salmon recovered was highest for all release groups during the low tide shows that tidal cycle effects salmon smolt entrainment at the

TABLE 4-3
Species Composition and Number of Fish Species Collected in Fyke Nets From 30 April Through 18 May, 2001.

Mosquitofish	1
Golden Shiner	1
Red Shiner	1
Redear Sunfish	1
Splittail	**1**
White Crappie	1
Yellow Bullhead	1
Yellowfin Goby	1
Black Bullhead	2
Centrarchidae	2
lamprey	2
Steelhead	**2**
Black Crappie	3
Green Sunfish	3
Striped Bass	3
Tule Perch	3
Warmouth Bass	3
Brown Bullhead	5
Goldfish	7
Inland Silverside	7
Sacramento Blackfish	7
Squawfish	17
Log Perch	22
Largemouth Bass	38
American Shad	41
Bluegill	54
Sacramento Sucker	54
Carp	82
Threadfin Shad	105
Channel Catfish	267
White Catfish	2,677
Total Chinook Salmon	**2,888**
CWT Chinook Salmon	1,268
Unmarked Chinook Salmon	1,014
Color-Marked Chinook Salmon	475
Mutilated Chinook Salmon	131
Total	6,302

TABLE 4-4
Number of Color-Marked Chinook Salmon Released During the Entrainment Special Study and Percent Recovered During the Evening (30 April, 1 May) and Day (10 May, 2001).

RELEASE LOCATION	NUMBER OF FISH RELEASED	TIDE	NUMBER COLLECTED	PERCENT RECOVERED	EXTRAPOLATED PERCENT RECOVERED
Night Release (30 April, 1 May)					
Upstream	3,010	High	21	0.70%	0.84%
	3,000	Low	50	1.67%	2.00%
Adjacent	500	High	48	9.60%	11.52%
	502	Low	297	59.16%	71.00%
Day Release (10 May)					
Upstream	3,008	High	2	0.07%	0.07%
	3,024	Low	21	0.69%	0.69%
Adjacent	515	High	4	0.78%	0.78%
	521	Low	15	2.88%	2.88%

TABLE 4-5
Number of CWT Chinook Salmon Released and Recaptured During the 2001 Migration Study.

RELEASE LOCATION	DATE	NUMBER	TIDE
Release Location			
Old River, downstream of HORB	5/12/01	24,398	flood
Recapture Location			
Grant Line Canal Barrier, upstream	5/13	16	ebb
Grant Line Canal Barrier, downstream	5/13	5	ebb
Old River Barrier, upstream	5/14	2	flood
Grant Line Canal Barrier, upstream	5/16	1	ebb
Grant Line Canal Barrier, downstream	5/16	1	ebb
Old River Barrier, upstream	5/17	4	ebb
Chipps Island	5/14 5/16 5/17	2 1 1	
Antioch	5/16	1	
CVP	5/14–5/18	390*	
SWP		0	

*390 is expanded value, 33 is raw value

FIGURE 4-5
CPUE of CWT Chinook Salmon Per Tidal Cycle From April 30 to May 11, 2001 at HORB

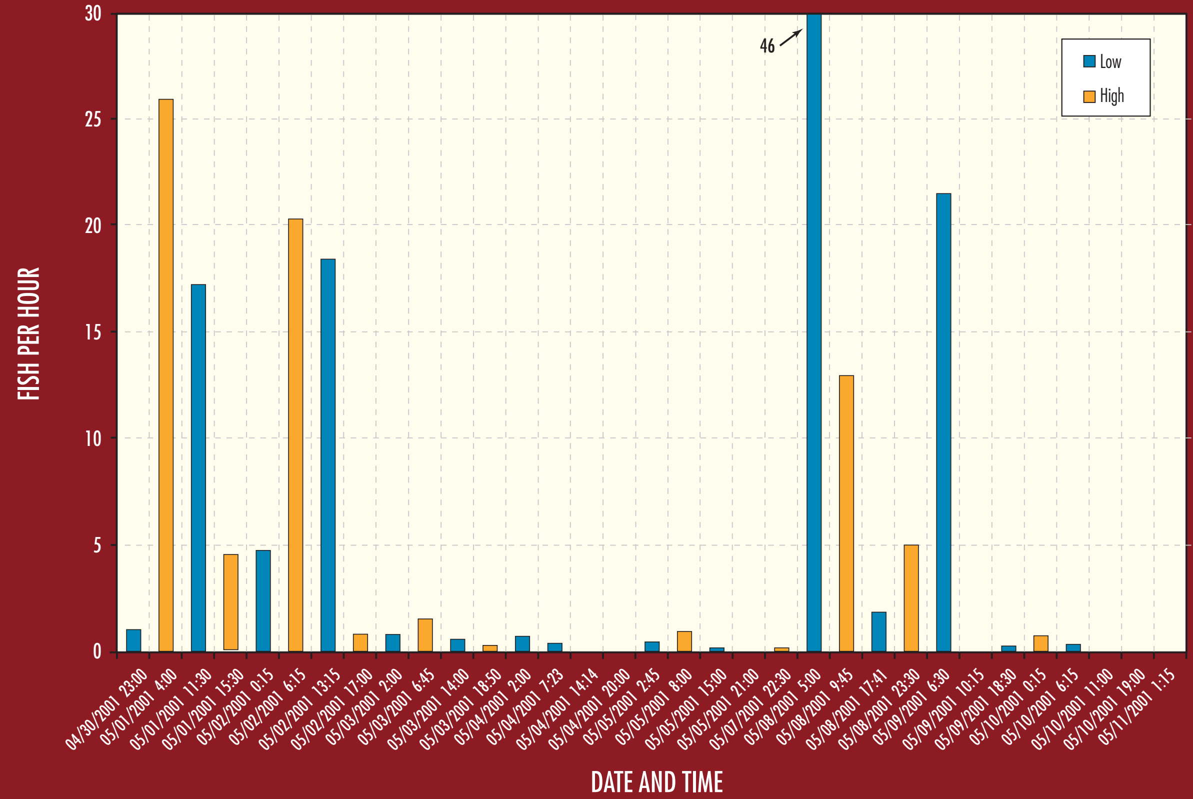


FIGURE 4-6
CPUE of CWT Chinook Salmon Per Day/Night From April 30 to May 11, 2001 at HORB

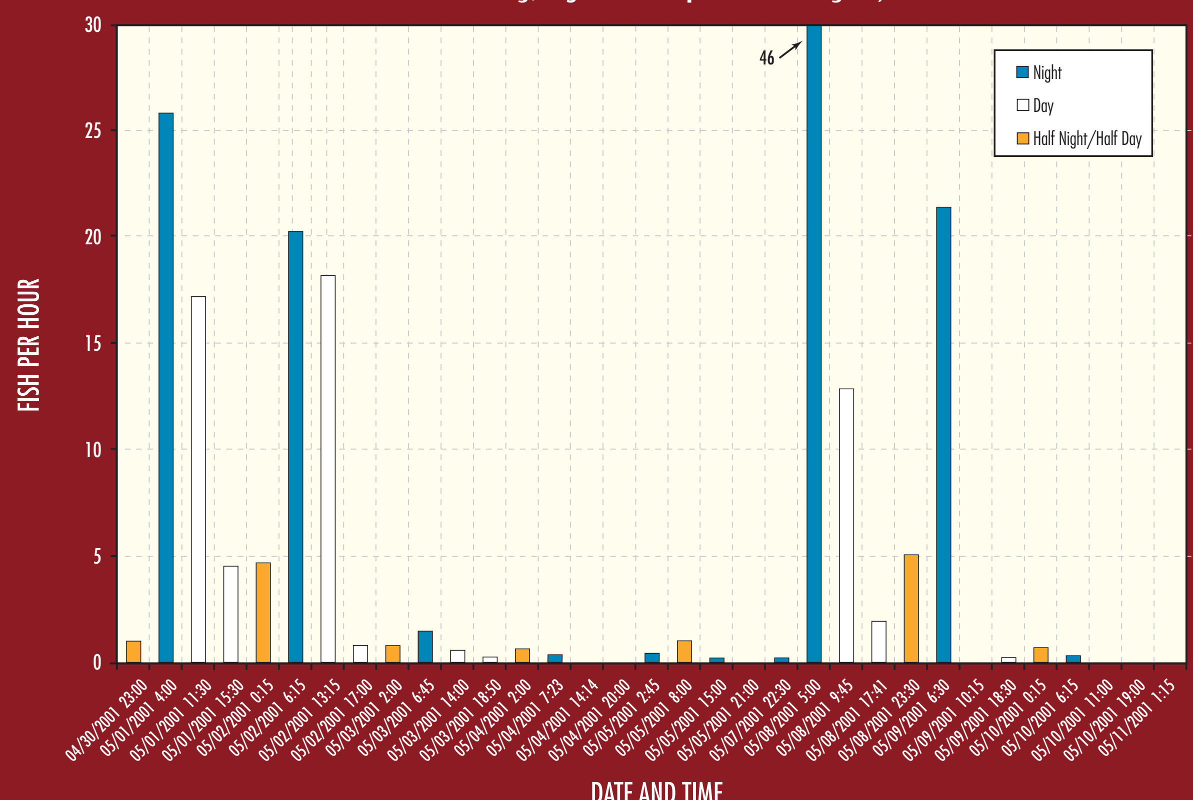
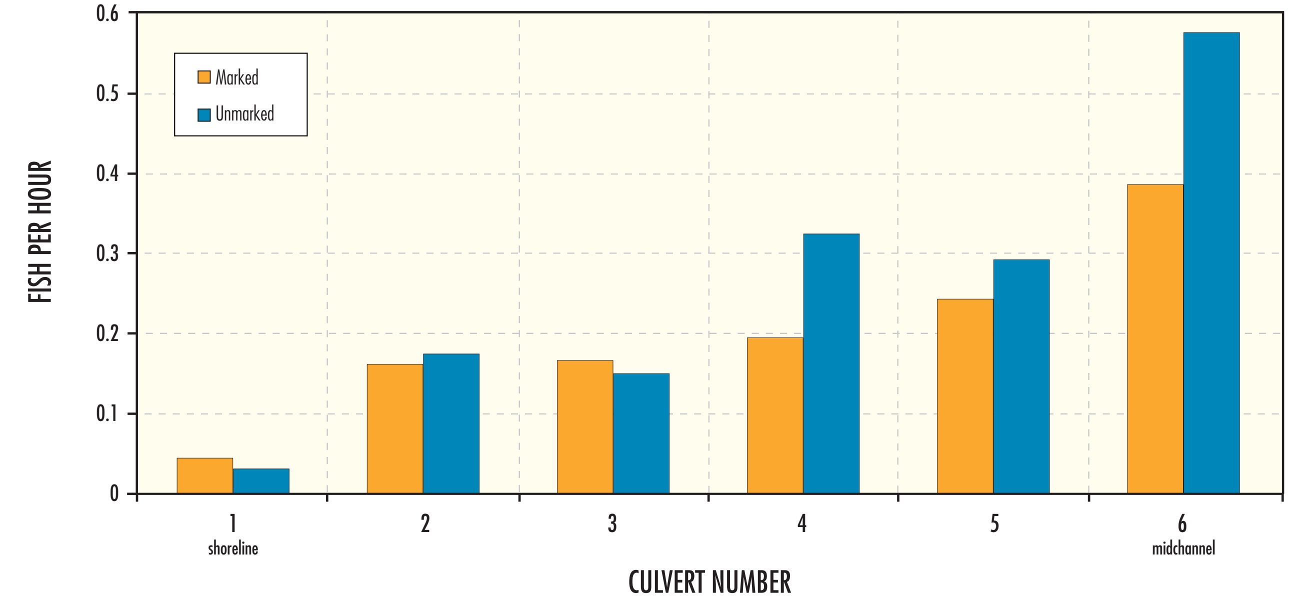


FIGURE 4-7
CPUE of Marked and Unmarked Chinook Salmon From May 8 to May 18, 2001 at HORB



HORB. Low tide creates higher entrainment vulnerability than high tide. Changes in hydraulic characteristics and approach velocities between high and low tidal stages are thought to be factors contributing to the observed entrainment patterns.

Results of the entrainment special study indicated that tides and release location might influence Chinook salmon entrainment at the HORB. Furthermore, the day/night variable could not be examined with confidence due to the nine-day interval between release groups. During this time debris built up on the culvert trash screens possibly effecting entrainment vulnerability.

Migration Study

Release and recapture information for the migration study is summarized in Table 4-5. The majority of the recovered salmon smolts were collected at the CVP fish salvage facilities. No CWT salmon released as part of this test were recaptured at the SWP fish salvage facility. CWT salmon were recaptured at Chipps Island and Antioch, suggesting that a portion of juvenile Chinook salmon entrained into the HORB culverts may successfully emigrate through the south Delta. The survival rate of these fish was not, however, quantified because of the low number of fish released and recaptured. CWT salmon were also recovered upstream and downstream of the GLCB and only upstream of the OLDRB (Figure 4-3). No statistical analysis was performed on the migration data because of the low numbers of fish recaptured at various sampling sites.

Results of the migration study show that a portion of salmon smolts entrained into the south Delta through the HORB can successfully reach Chipps Island. Whether these CWT salmon arrived at Chipps Island on their own or were salvaged at the CVP export facilities, trucked, and released is unknown. The fact is that salmon smolts traveling down Grant Line Canal were able to pass the GLCB. The salmon smolts traveling down Old River were only detected above the OLDRB so it is still unknown whether they are able to pass the OLDRB. Salmon also may have traversed down Middle River, which was not sampled. The factors contributing to the differences in recoveries between the CVP and SWP were not evaluated.

Recommendations

A similar study is planned for 2002 to further evaluate entrainment at the HORB. Modifications to the study design include measurement of flow through each culvert during each sampling event. This will help determine the relationship between flow rates through the culverts and entrainment rates for juvenile salmon and other species. Data that can be statistically analyzed would be beneficial in evaluating factors influencing entrainment rates, including both day/night and tidal effects. If trash screens on the culverts are utilized next year, these screens should be cleaned at regular intervals or constructed so that debris does not block the culverts. Finally, if the migration study is included in next year's plan, the study design and sampling program should be modified to provide statistically reliable data for use in evaluating migration and survival of juvenile salmon released into Old River.

SALMON SMOLT SURVIVAL INVESTIGATION

One of the primary objectives of the VAMP program is to identify the respective roles of San Joaquin River flow, and SWP and CVP export rates with the HORB in place on the survival of juvenile Chinook salmon emigrating from San Joaquin River tributaries. This section describes the methods used in conducting the VAMP 2001 Chinook salmon smolt survival investigations, and presents results of the calculated survival indices and absolute survival estimates for juvenile Chinook salmon during the VAMP 2001 test period. Additional data and information related to the salmon survival investigations are presented in Appendix C.

CODED-WIRE TAGGING

Merced River Hatchery Chinook salmon smolts, released as part of VAMP 2001, were coded-wire tagged (CWT) between March and early April. After the salmon were tagged, they were held in the hatchery for up to 21 days before being released. A sub-sample of the salmon were measured for length and checked for retention of the CWTs a day or two prior to release. The sub-sample was typically comprised of 100 to 300 salmon collected from the top, middle, and bottom of the release group's raceway. Each tag code within a release group was held separately at the hatchery with the exception of the two Durham Ferry releases. Each of these releases were made up of three tag codes that were held together in one section of the raceway.

Although tag retention is usually quite high, as a double check on the tag detector, all salmon from the sub-sample that had no tag detected were sacrificed. These sacrificed salmon were dissected to determine whether they contained an unmagnetized tag. A separate sub-sample of 25 salmon was sacrificed from each release group; the tags were removed and read to detect any incorrect tag codes in the raceways. Table 5-1 summarizes results of the CWT retention rate and the estimate of the effective numbers of salmon released to calculate survival indices. Tag retention rates were determined to be similar to last year, with an overall loss rate of 9.5% among all VAMP groups. The tag retention loss rates varied from 0.5% to 15%. It is recommended that this loss rate be reduced for future VAMP studies.

TABLE 5-1
Coded Wire Tag Retention Rates and Effective Release Numbers for Juvenile Salmon Released as Part of VAMP 2001

RELEASE DATE	CWT CODE	RELEASE SITE	AVERAGE FL(mm)	NUMBER TAGGED	POND LOSS	EFFECTIVE MARKED	TAG RETENTION RATE	EFFECTIVE NUMBER RELEASED
30-Apr	06-44-29	Durham Ferry	88	25,899	97	25,802	90.55%	23,363
	06-44-30	Durham Ferry	88	25,202	97	25,105	91.00%	22,846
	06-44-31	Durham Ferry	88	24,822	97	24,725	91.00%	22,500
1-May	06-44-32	Mossdale	89	25,928	90	25,838	89.05%	23,010
	06-44-33	Mossdale	88	26,199	92	26,107	85.00%	22,191
4-May	06-44-34	Jersey Point	89	25,761	30	25,731	95.00%	24,444
	06-44-35	Jersey Point	88	25,792	26	25,766	97.00%	24,993
7-May	06-44-36	Durham Ferry	87	25,516	88	25,428	94.50%	24,029
	06-44-37	Durham Ferry	87	25,386	88	25,298	95.00%	24,033
	06-44-38	Durham Ferry	87	25,542	88	25,454	95.00%	24,181
8-May	06-44-39	Mossdale	89	25,602	60	25,542	93.50%	23,882
	06-44-40	Mossdale	89	25,768	73	25,695	98.50%	25,310
11-May	06-44-41	Jersey Point	88	26,102	62	26,040	99.50%	25,910
	06-44-42	Jersey Point	88	25,760	37	25,723	99.00%	25,466

CWT RELEASES

Two sets of CWT salmon releases were made as part of the 2001 VAMP experiment. The first set occurred on April 30 at Durham Ferry, May 1 at Mossdale and May 4 at Jersey Point. The second set of releases was made at Durham Ferry on May 7, at Mossdale on May 8, and at Jersey Point on May 11.

Approximately 75,000 salmon, in three distinct tag lots of about 25,000 fish, were released at Durham Ferry, while approximately 50,000 fish, in two tag lots, were used at each Mossdale and Jersey Point release (Table 5-1). Prior to VAMP 2000, each release was made such that all tag lots were trucked from the hatchery mixed and released as a single group. However, during VAMP 2000 and VAMP 2001, a new transport trailer with three tanks allowed each separate CWT lot to be transported to its release site in a separate tank and distinctly released. As mentioned earlier, the three tag lots comprising each of the groups released at Durham Ferry on April 30 and May 7 were already mixed at the hatchery and thus not transported separately by tag lot. Due to logistical difficulties getting the transport truck up the gravel road leading away from the Durham Ferry site, the May 7 release was made from the top of the levee using a combination of flexible aluminum pipe and vinyl hose. The issue of consistently releasing the Durham Ferry group from the top of the levee or near the river needs to be resolved prior to releasing groups in 2002. It is also of note that a nearby agricultural diversion was in operation during the May 7 Durham Ferry release.

In order to test the effectiveness of hydro-acoustic technology for monitoring movement of juvenile Chinook salmon past HORB, the releases at Mossdale were performed over a 12 hour period which was different than had occurred in past years. First, an alternate release site was chosen for delivery of the fish because it had more security and better facilities for watching the fish over the 12-hour period during release. This new site was a boat ramp at the Mossdale Trailer Park, approximately ½-mile upstream and on the opposite bank (west side) from the public ramp traditionally used at the Mossdale County Park. Prior to release, each 25,000 tag lot was taken from the transport truck via dip net and distributed into two large net pens (4' x 4' x 8'). When unloading was complete there were 4 large net pens, each with approximately 12,500 fish. These fish were then held for a few hours and allowed to acclimate to river conditions. Then, on specific points of the tidal cycle, a pen was floated downstream via a small boat, and the fish were freed into the river at approximately mid-channel near the historical release site at the Mossdale public boat ramp. Each group of approximately 12,500 salmon was released approximately 3 hours apart in a similar manner, in an attempt to time the arrival of each group at the HORB on a specific point on the tidal cycle (Table 5-2). These releases were also meant to help determine any day/night release time survival differences. Unfortunately, due to the number of agencies and individuals involved with the Mossdale release strategy, the information on the tag codes for each release time was not retained.

TABLE 5-2
Times of Release at Mossdale on 5/1 and 5/8 for the Four Groups (2 tag codes) Released.

MOSSDALE TIDAL RELEASES					
First Replicate			Second Replicate		
5/1/01	4:15 PM	Day	5/8/01	5:53	Day
	8:35 PM	Night		8:56 PM	Night
5/2/01	2:12 AM	Night	5/9/01	2:00 AM	Night
	7:00 AM	Day		7:12 AM	Day

The release processes at Durham Ferry and Jersey Point were not changed from past years. Releases at Jersey Point were made at the beginning of the flood tide to increase dispersion of the tagged fish before they passed Antioch and Chipps Island. Releases at Mossdale and Durham Ferry were not made on any specific tidal condition.

The water temperature both in the hatchery truck and in the receiving waters was measured at the release site immediately prior to release. These, as well as additional release and recovery data, are provided in Table 5-3.

WATER TEMPERATURE MONITORING

The water temperature was monitored during the VAMP 2001 study using individual computerized temperature recorders (e.g., Onset Stowaway Temperature Monitoring/Data Loggers). The water temperature was measured at locations along the longitudinal gradient of the San Joaquin River and interior Delta channels between Durham Ferry and Jersey Point-locations along the migratory pathways for the juvenile Chinook salmon released as

TABLE 5-3

Release and Recovery Information for Coded Wire Tag Groups Released as Part of VAMP in 2001.

CWT CODE	RELEASE SITE	RELEASE DATE	TRUCK TEMP C°	RELEASE TEMP C°	NUMBER RELEASED	AVERAGE FORK LENGTH (mm)	NUMBER RECOVERED AT ANTIOCH	PERCENT SAMPLED AT ANTIOCH	SURVIVAL INDEX AT ANTIOCH	GROUP SURVIVAL AT ANTIOCH	NUMBER RECOVERED AT CHIPPS	PERCENT SAMPLED AT CHIPPS	SURVIVAL INDEX AT CHIPPS	GROUP SURVIVAL AT CHIPPS	EXPANDED SALVAGE CVP	EXPANDED SALVAGE SWP	ABSOLUTE SURVIVAL ANTIOCH	ABSOLUTE SURVIVAL CHIPPS ISLAND
06-44-29			14.5	21.5	23,354	89	28	0.39	0.22		14	0.28	0.28		12			
06-44-30	Durham Ferry		14.5	21.5	22,837	89	30	0.39	0.24		22	0.28	0.45		24			
06-44-31			14.5	21.5	22,491	89	18	0.39	0.15		17	0.28	0.36		48			
Total		30-Apr			68,682		76	0.39		0.20	53	0.28		0.36			0.17	0.34
06-44-32	Mossdale		15	19.5	23,000	91	18	0.39	0.14		17	0.28	0.35		24	12		
06-44-33	Mossdale		15	19.5	22,177	91	15	0.39	0.13		14	0.28	0.30		12			
Total		1-May			45,177		33	0.39		0.13	31	0.28		0.32			0.11	0.31
06-44-34	Jersey Point		15	20	24,443	88	156	0.39	1.18		50	0.28	0.96					
06-44-35	Jersey Point		15	20	24,992	88	173	0.39	1.27		61	0.28	1.15					
Total		4-May			49,435		329	0.39		1.23	111	0.28		1.06				
06-44-36			14.5	19	24,025	85	8	0.40	0.06		2	0.28	0.04		12	9		
06-44-37	Durham Ferry		14.5	19	24,029	85	11	0.38	0.09		4	0.28	0.08					
06-44-38			14.5	19	24,177	85	10	0.36	0.08		2	0.28	0.04		12	6		
Total		7-May			72,231		29	0.37		0.08	8	0.28		0.05			0.20	0.14
06-44-39	Mossdale		15.5	21	23,878	89	8	0.40	0.06		4	0.28	0.08		12			
06-44-40	Mossdale		15.5	21	25,308	88	11	0.41	0.08		4	0.28	0.07		12	12		
Total		8-May			49,186		19	0.40		0.07	8	0.28		0.08			0.18	0.19
06-44-41	Jersey Point		16	22.5	25,909	88	43	0.40	0.30		17	0.28	0.31					
06-44-42	Jersey Point		16	22.5	25,465	87	53	0.35	0.43		27	0.28	0.50					
Total		11-May			51,374		96	0.35		0.38	44	0.28		0.40				

*** For tag code, 06-44-37, one tag was found to be recovered at Chipps Island on May 9th, only two days after release. The tag was removed from the data set prior to calculating survival and is not included in this table or Appendix C-4.*

TABLE 5-4

Description of the Six Parameters Used to Assess Overall Condition of the Various Tag Groups Released as Part of VAMP in 2001.

	NORMAL	ABNORMAL
Eyes	Normally shaped	Bulging
Color	High contrast dark dorsal surface and light sides	Low contrast dorsal surface and sides, coppery color
Fin Hemorrhaging	No blood ore red at base of fins	Blood at base of fins
Percent Scale Loss	Lower relative numbers better based on 0-100% scale loss	Higher relative numbers worse based on 0-100% scale loss
Gill Color	Dark beet red to cherry red gill filaments	Light red to gray gill filaments
Vigor	Active swimming (prior to anesthesia)	Lethargic or motionless (prior to anesthesia)

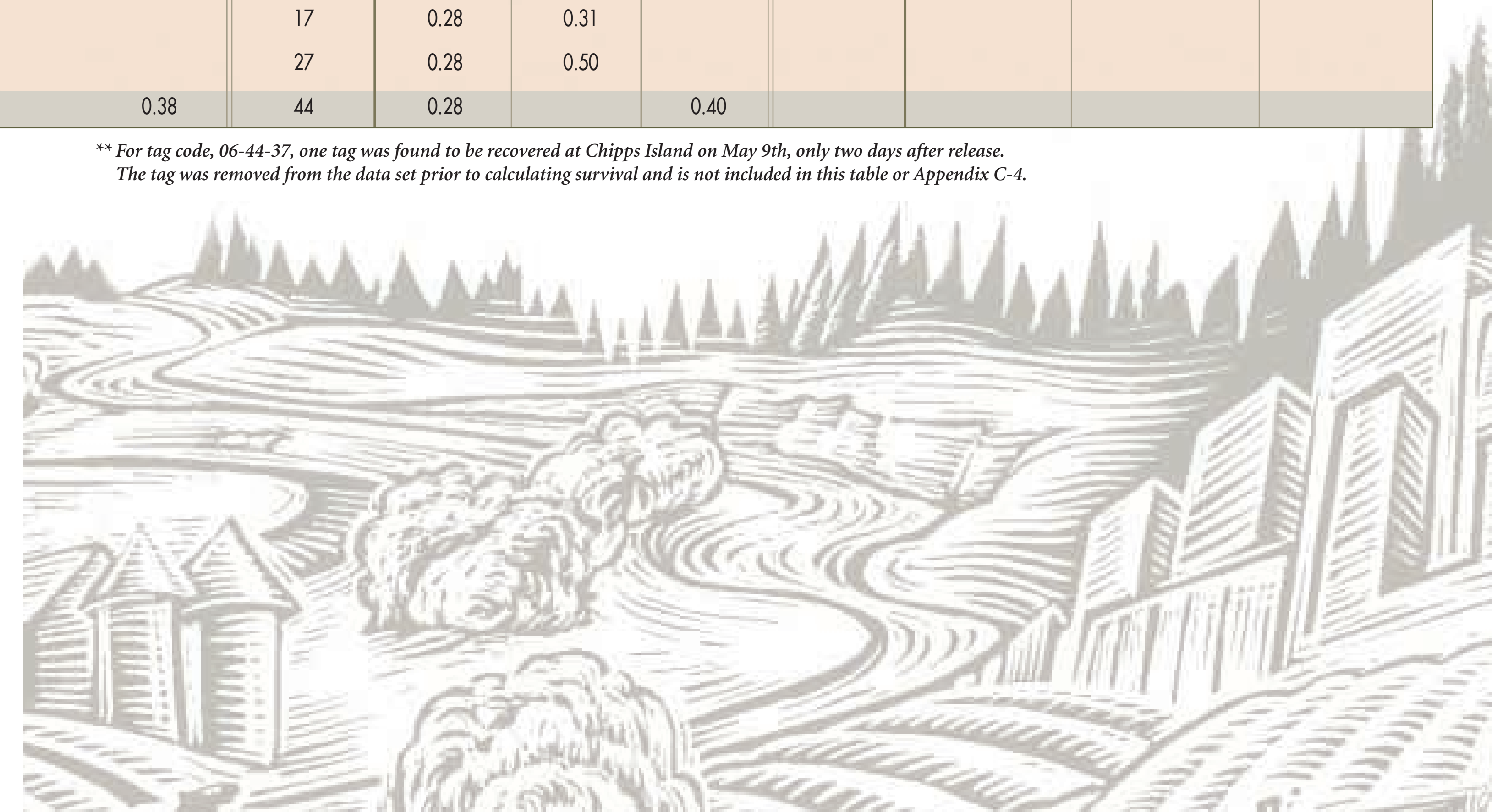


FIGURE 5-1

Results of Water Temperature Monitoring at the Merced River Fish Hatchery.

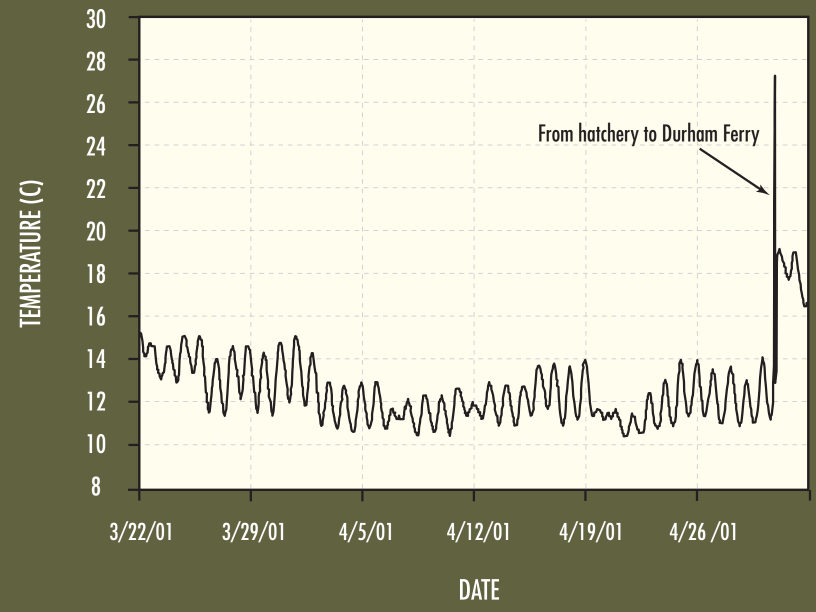


FIGURE 5-2

Water Temperature Measured at Durham Ferry Immediately Following VAMP 2001 Release.

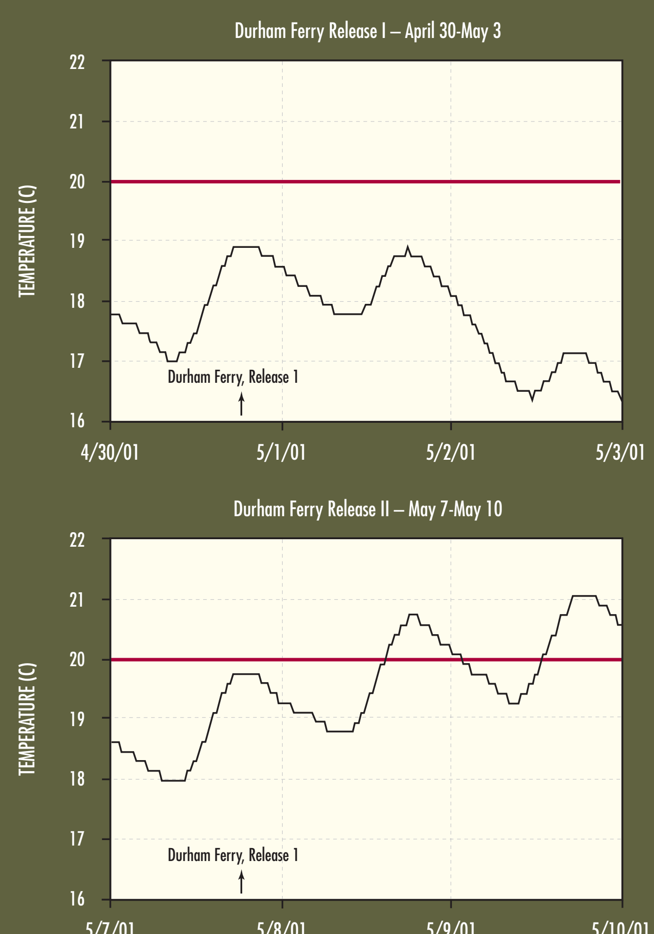
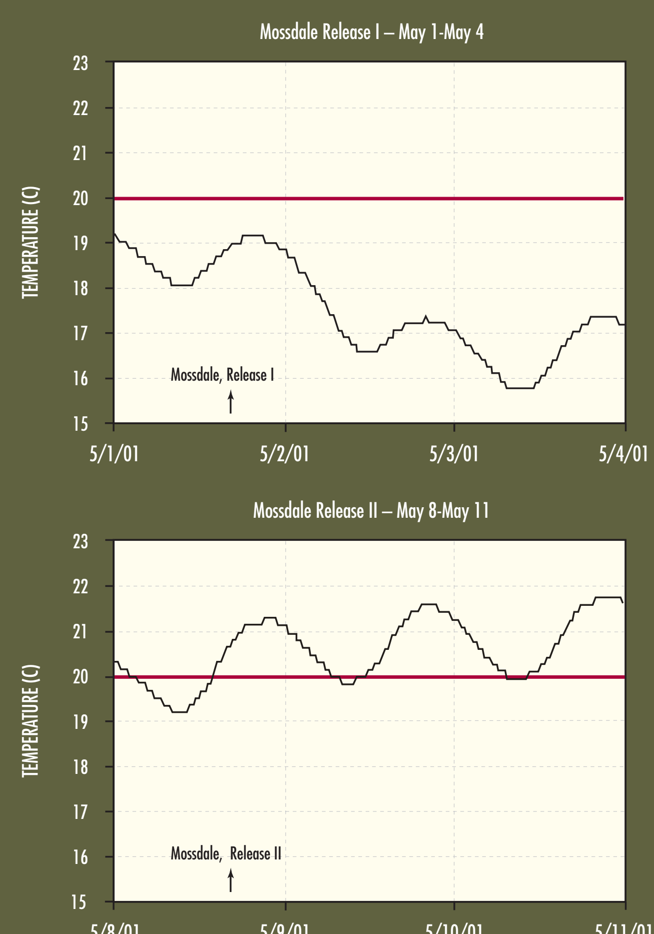


FIGURE 5-3

Water Temperature Measured at Mossdale Immediately Following VAMP 2001 Release.



part of these tests (Appendix C-1). Water temperature was recorded at 24-minute intervals throughout the period of the VAMP 2001 investigations. Water temperature was also recorded within the hatchery raceways at the Merced River Hatchery coincident with the period when juvenile Chinook salmon were being tagged.

Results of water temperature monitoring within the Merced River Hatchery showed that juvenile Chinook salmon were reared in and acclimated to water temperatures of approximately 11.1–13.9 C (52-57 F) prior to release into the lower San Joaquin River (Figure 5-1). Results of water temperature monitoring at Durham Ferry, Mossdale, and Jersey Point following the first and second sets of VAMP 2001 releases are compared in Figures 5-2, 5-3 and 5-4. Results of 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. Water temperatures at the release locations and throughout the lower San Joaquin River and Delta also showed water temperatures were greater coincident with the second VAMP 2001 release, which may have adversely affected juvenile Chinook salmon survival. Within the lower San Joaquin River and Delta, water temperatures during the second VAMP 2001 release and emigration period consistently exceeded 20 C (68 F). High temperatures were identified during the design of the VAMP experiment as an indicator of potential thermal stress adversely affecting juvenile Chinook salmon survival. These high temperatures during the second set of releases in 2001 could affect the interpretation of the flow-export relationship.

POST-RELEASE LIVE-CAR STUDIES

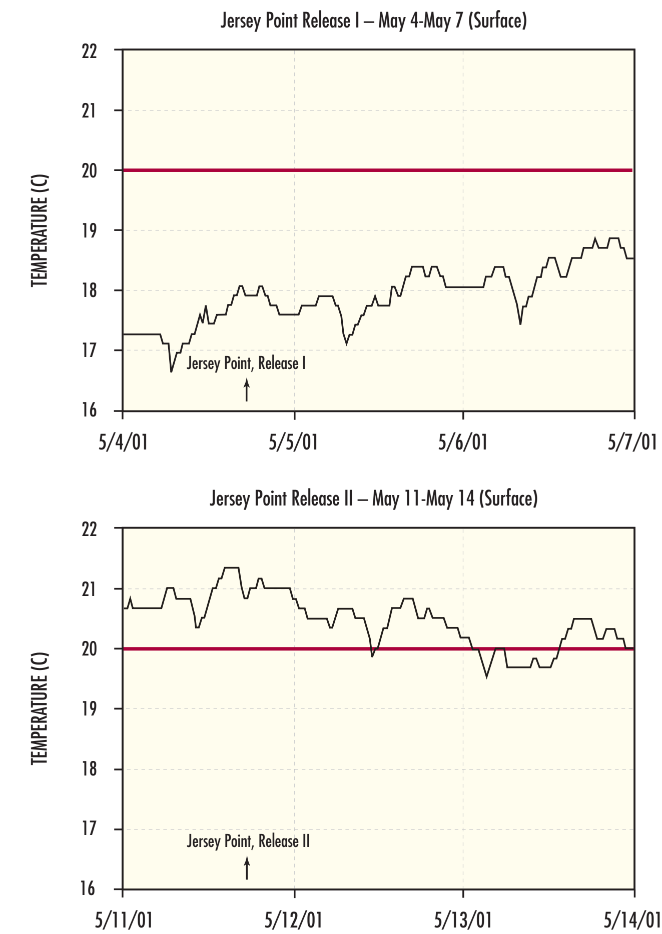
Survival and Condition

The post-release survival and condition of marked salmon was evaluated as part of the VAMP program using sub-samples of marked salmon from each release group. Approximately 200 salmon from each group were held at the respective release site in net pens for 48 hours after release and were evaluated for general condition and short-term mortality which might be associated with the handling, transport and release process. In addition to the 200 salmon held for 48 hours, 25 salmon from each tag group were evaluated for general condition immediately after release and another 25 salmon were held and similarly evaluated after the 48-hour holding period. To assess overall condition, fork length in millimeters, weight in grams, and six other characteristics were examined (Table 5-4). Obvious abnormalities or deformities were also noted.

Results of the evaluations of marked fish in the net pens, both immediately after release and 48 hours later, showed few abnormalities in the condition assessed characteristics which are

FIGURE 5-4

Water Temperature Measured at Jersey Point Immediately Following VAMP 2001 Releases.



shown in Appendix C-3. Scale loss ranged from 1-20%. All fish examined were noted to have normal coloration and normal eye characteristics. One fish from the May 8 Mossdale release had signs of fin hemorrhaging and 55 fish showed abnormally pale gills. Of the 1,433 salmon assessed, four (0.3%) were found to have a poor or incomplete fin clip. A total of three fish had some type of deformity, two of which had eroded pectoral fins (not uncommon for hatchery raised fish) and one that had a partial operculum. The percentage of salmon deformed within the sample group (0.2%) was within the normal range for hatchery-raised fish (S. Foott, Pers. com.).

A total of 19 mortalities were observed throughout the net pen experiments. Ten of these mortalities were observed in the pens immediately after the second Jersey Point release and were removed from the pens to avoid any possible contamination. The remaining nine mortalities were observed at the end of the 48-hour holding period, four at the first Durham release, one mortality at the first Jersey Point release, three at the second Durham release, and one at the second Mossdale release. There were no additional mortalities observed at the end of the 48-hour period at the second Jersey Point release. The higher incidence of pale gills and the observation of a few mortalities may indicate the juvenile salmon used as part of the VAMP experiments were under some level of stress.

Comparison of Release Groups

Results of previous salmon smolt survival studies have demonstrated a positive relationship between the length and condition of juvenile salmon and their survival. One of the underlying assumptions of the VAMP experimental design is that the length and condition of juvenile Chinook salmon released as part of the survival studies are comparable for fish released at Durham Ferry (treatment) and at Jersey Point (control). The experimental design also assumes that juvenile salmon released during the first set of studies each year are comparable in length and condition to the juvenile Chinook salmon in the second release group. Data on length, weight, and condition factor (length-weight relationship) developed from the sub-sample of fish collected for use in the net pen studies were used to test these underlying assumptions. For purposes of these statistical tests, data were selected from the sub-sample of fish measured at the time of release at both Durham Ferry and Jersey Point. If data was normally distributed, a t-test was used to determine if differences in sub-samples were significantly different. If data was not normally distributed, the non-parameter Mann-Whitney rank sum test was used. Results of these statistical comparisons of salmon released as part of the VAMP 2001 survival tests are summarized in Table 5-5.

Results of these tests showed statistically significant differences in both weight and condition factor in the first set of releases at Durham Ferry and Jersey Point. These statistically significant differences were also detected in the length of juvenile salmon released at Durham Ferry and Jersey Point during the second set of VAMP 2001 tests. Significant differences were also detected in both the length and weight of juvenile salmon released at Durham Ferry between the first and second release groups. Salmon were found to be significantly smaller (both length and weight) in the second set of VAMP 2001 releases at Durham Ferry. These statistical differences in size and condition among various test groups of salmon may or may not influence ultimate smolt survival to any meaningful degree. Future analysis of VAMP survival study results should take into account the potential affect of varying sizes of fish at the time of release at both Durham Ferry and Jersey Point as part of the overall analysis of survival study results.

TABLE 5-5

Statistical Analysis of the Size and Condition (Length-Weight Relationship) for Juvenile Chinook Salmon Released as Part of the VAMP 2001

	DURHAM FERRY RELEASE 1 **MEAN**	JERSEY POINT RELEASE 1 **MEAN**	STATISTICAL TEST	PROBABILITY (P)	SIGNIFICANT DIFFERENCE
Length (mm)	88.7	90.4	t-test	0.13	No
Weight (g)	7.3	7.9	t-test	0.03	Yes
Condition factor	2.6	2.1	Mann-Whitney	0.02	Yes
	DURHAM FERRY RELEASE 2 MEAN	**JERSEY POINT RELEASE 2 MEAN**	**STATISTICAL TEST**	**PROBABILITY (P)**	**SIGNIFICANT DIFFERENCE**
Length (mm)	84.6	87.8	t-test	0.03	Yes
Weight (g)	6.4	7.3	t-test	0.08	No
Condition factor	3.4	2.8	t-test	0.15	No
	DURHAM FERRY RELEASE 1 MEAN	**DURHAM FERRY RELEASE 2 MEAN**	**STATISTICAL TEST**	**PROBABILITY (P)**	**SIGNIFICANT DIFFERENCE**
Length (mm)	88.7	84.6	t-test	0.01	Yes
Weight* (g)	7.3	6.4	t-test	0.03	Yes
Condition factor*	2.6	3.4	t-test	0.08	No

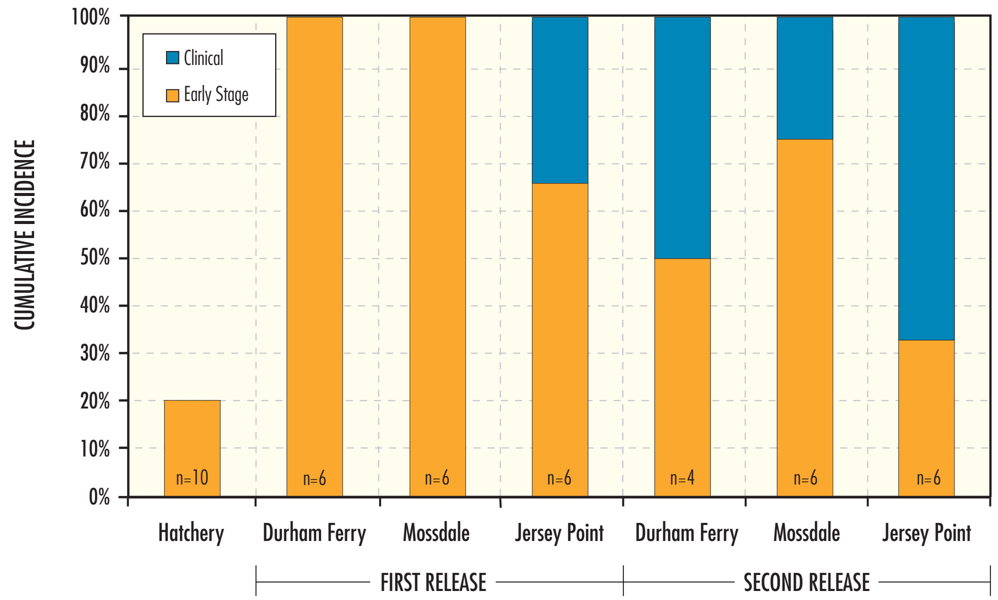
NOTE:
Analyses are based on measurements from net pen studies immediately following each release.

*Weight and condition factor were obtained on only 11 of 25 fish.

FIGURE 5-5

Incidence of Early Stage PKX infection (Early Stage) and Clinical Proliferative Kidney Disease (Clinical) in Posterior Kidney Samples.

Early Stage indicates light presence of parasite, but no associated lesion. Clinical indicates presence of parasite with associated lesion likely impairing kidney function.



Tag Quality Control

The subset of 25 salmon from each tag group (a total of 25 from each of the Durham Ferry releases) evaluated for condition as described above were sacrificed to verify purity of tag codes. The additional 200+ fish from each release that were held for condition and survival evaluations were archived in a freezer. Though rare, on few occasions in the past, salmon from different release groups have been mixed at some point prior to release. While performing quality control checks on the May 8 Mossdale releases, two errant tag codes were discovered. The remaining 210 tags were read to verify tag code purity. After reading all tags, it was determined that neither code was tainted. Upon further review, it appears that the original errant tag codes were the result of tags being lost and found, and not reported as lost, in the lab.

Physiology

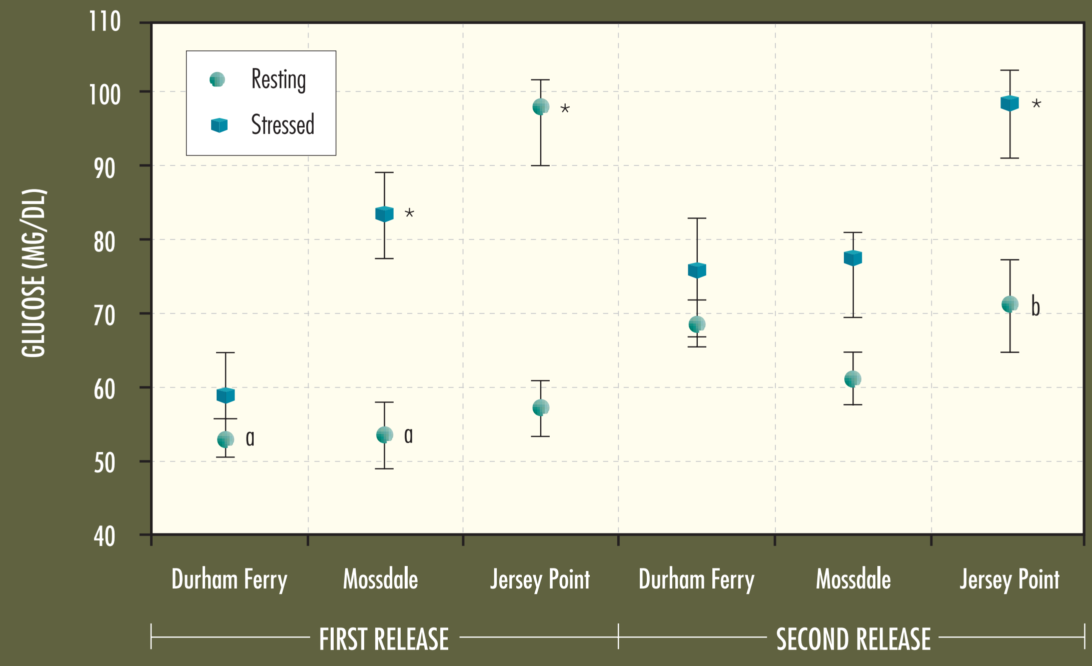
Physiological studies were conducted on a subset of the juvenile salmon used in the VAMP study by the USFWS California-Nevada Fish Health Center (Nichols et al. 2001). The results are briefly summarized below.

Physiological tests were conducted on a subset of the smolts released at Durham Ferry, Mossdale and Jersey Point after they had been held in the live cars for approximately 24 hours. Between 30 and 38 fish were sampled at each site. The fish were euthanized by an overdose of tricaine methane sulfonate (MS222), measured and assessed for external/internal abnormalities. Tissue samples were collected for pathogen and physiological assays. Kidney tissue was checked for bacterial pathogens. Internal organs were examined for parasites and abnormalities. Gill tissue was assayed for gill Na+, K+ - ATPase levels as an indicator of saltwater readiness (smolting). Plasma glucose and chloride levels were used to determine the ability of the fish to adapt to stress. Measurements were made with stressed and unstressed fish. The "unstressed" fish were removed from the net pen as quickly as possible and immediately euthanized. The stressed fish were held out of the water for 30 seconds, and sampled after they were allowed to recover for 30 minutes. To help establish baseline physiological conditions, sixty fish were sampled at random on April 9 from the Merced River Hatchery population. These fish were evaluated in terms of organosomatic analysis, ATPase levels, histology, bacteriology and virology. No stress physiology evaluation was conducted on the Merced River Hatchery fish. Results from the physiological tests indicated that the health of the release groups was poor and declined over time. No bacterial or viral pathogens were detected but infections of the PKX myxosporean parasite (the causative agent of Proliferative Kidney Disease) in the kidney were observed in 20% of Merced River Hatchery samples and 100% of all release groups (Figure 5-5). Infections had progressed to clinical disease in the first Jersey Point and all of the second set of release groups (Figure 5-5). Clinical signs of disease were evident during necropsy in 0-3% of the first release groups and 11-22% of the second release groups. Clinical signs of disease included pale gills, swollen kidney, and swollen spleen.

FIGURE 5-6

Resting and Stressed Plasma Glucose Concentrations in VAMP 2001 Release Groups.

Data given as Mean ± SE. Sample number is 12 for all groups except first Durham Ferry Resting (n=11).

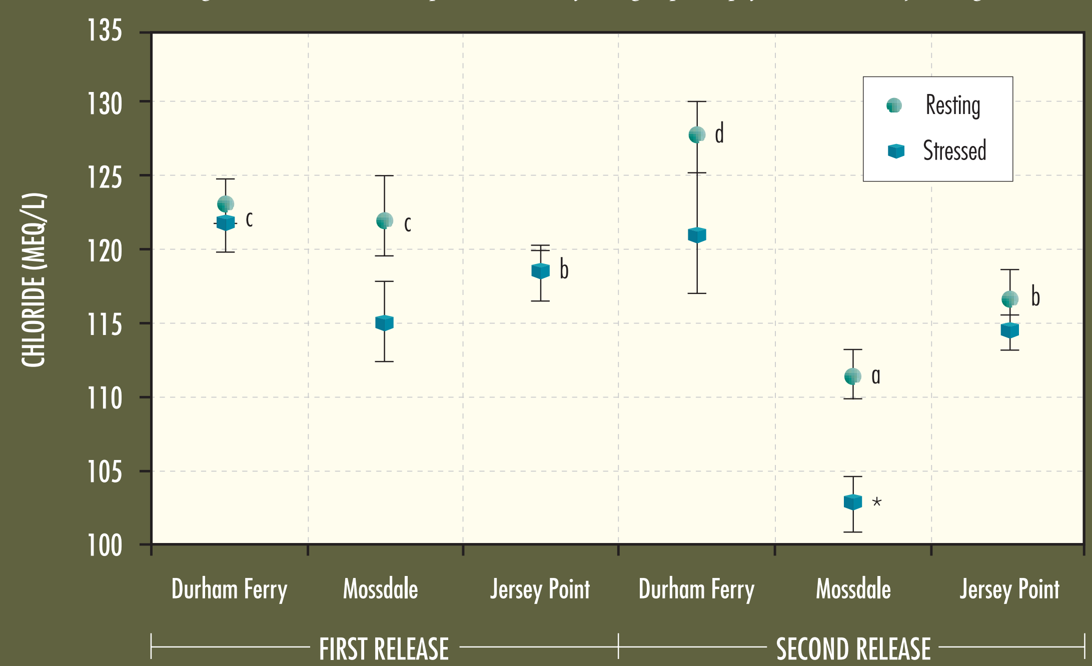


NOTES: * = difference between Resting and Stressed (P<0.05, t-test)
Resting levels labeled a are significantly lower than those labeled b (P<0.05, ANOVA)

FIGURE 5-7

Resting and Stressed Plasma Chloride Concentrations in VAMP 2001 Release Groups.

Data given as Mean += SE. Sample number is 12 for all groups except first Durham Ferry Resting (n=11).



NOTES: * = difference between Resting and Stressed (P<0.05, t-test)
Resting levels labeled a are significantly lower than those labeled c or d (P<0.05)
Resting levels labeled b are significantly lower than those labeled d (P<0.05, ANOVA)

Stress treatments demonstrated healthy energy reserves in half of the release groups (Figure 5-6). Both Durham Ferry and the latter Mossdale groups either did not exhibit a significant glucose stress response or the stress treatment did not allow adequate time for the response to occur. The second Mossdale release demonstrated poor ion balance with low chloride values prior to stress and perilously low values following stress (Figure 5-7). Stress responses of fish from both Jersey Point releases were consistently different from the other groups. This difference was likely due to site conditions, and it was not evident if these differences would lead to increased or decreased survival.

In summary, all test groups showed signs of disease (not just infection) with the second set of release groups having a higher incidence of kidney disease. Stress response was not always healthy, but could have been due to holding conditions. Poor stress tolerance is also typical of PKX infections (Lom and Dyková 1995). Chronic PKX infection could desensitize the stress response of the fish making them more susceptible to the stress of transport and holding conditions.

It is possible that reduced health of the juvenile salmon used in the VAMP 2001 reduced their survival through the Delta. Possible bias in survival results due to reduced fish health was greater in the second set of releases and may be further confounded by exposure of these release groups to elevated water temperatures.

CWT RECOVERY EFFORTS

CWT salmon were recaptured at Antioch and Chipps Island, at CVP and SWP fish salvage facilities and during sampling in upper Old River near the barrier (See Figure 1-1). CWT salmon released upstream of, and at, Mossdale were also recovered in DFG Kodiak trawls at Mossdale but are not discussed in this report. Juvenile Chinook salmon with an adipose fin clip (which identifies CWT salmon) caught at any of these sampling locations were sacrificed, labeled, and frozen pending CWT processing. Coded-wire tag processing was done by USFWS (Stockton) for fish recovered at Chipps Island, HORB, Antioch, and SWP/CVP salvage facilities.

Coded wire tag processing entails dissecting each tagged fish to obtain the half (0.5 millimeters) or full (1 millimeter) cylindrical tag from the snout. Most coded wire tags in 2001 were the newer generation decimal tags, which have the code imprinted several times on each tag, but the print is so small that the reading must be done under a microscope. Tags were read twice, with any discrepancies resolved by a third reader. All tags are archived for future reference. It should be noted that many tags recovered at Chipps Island, Antioch, SWP/CVP salvage, and other locations are from coded wire tag releases not affiliated with VAMP. Since the origin of the tag is unknown until after reading the tag, all tags recovered are read in order to identify the tag recoveries related to VAMP.

SWP/CVP Salvage Recapture Sampling

Sampling at the CVP and SWP fish salvage facilities was conducted approximately every two hours. The number of marked salmon collected (raw salvage) was "expanded" based on the number of minutes sampled during each two hour time period. The estimated expanded total number of CWT salmon, from each release group, was obtained by adding together the expanded number of each tag group for all time periods. Only the CWT salmon recovered in the raw salvage collections were sacrificed for tag decoding. Expanded salvage is only a portion of the direct loss experienced by juvenile salmon at the facilities as it does not include losses prior to, and associated with, pre-screen predation, screening, handling and trucking.

Expanded CVP and SWP salvage estimates of marked salmon released as part of the VAMP 2001 studies are shown in Table 5-3. Salvage numbers were low at both the SWP and CVP. These results are consistent with earlier studies showing that the HORB reduces the number of coded wire tagged salmon entrained at the fish facilities. It is interesting to note that 390 of the 25,000 coded wire tagged smolts released into upper Old River, were estimated to have been salvaged at the CVP. This is a much higher rate of salvage than for smolts released at Mossdale or Durham Ferry. It is likely that most of the salmon smolts released at Durham Ferry and Mossdale that were diverted into upper Old River were recovered and sacrificed in the fyke net sampling at the barrier. It is possible that a few of the recoveries at the CVP and SWP from the Durham Ferry and Mossdale releases could have been from smolts that migrated into upper Old River via the culverts that did not always have a fyke net attached (See Chapter 4).

Once in upper Old River these fish could have migrated downstream to the facilities. It is also possible that the smolts migrated back to the CVP and SWP via Turner or Columbia Cuts or river junctions off the San Joaquin River further downstream.

Antioch Recapture Sampling

Fishery sampling was conducted in the vicinity of Antioch on the lower San Joaquin River using a Kodiak trawl. The Kodiak trawl has a graded stretch mesh, from 2-inch mesh at the mouth to ½-inch mesh at the cod-end. Its overall length is 65 feet, and the mouth opening is six feet deep and 25 feet wide. The net was towed between two skiffs, sampling in an upstream direction. Trawls were performed parallel to the left bank, mid-channel, and right bank to sample CWT salmon emigrating from the San Joaquin River. Each sample was approximately 20 minutes in duration.

All fish collected were transferred immediately from the Kodiak trawl to buckets filled with river water, where the fish were held during processing. Data collected during each trawl included identification and measuring the fork length of fish collected, tow start time and duration and location in the channel. Mortality and damage to fish collected was 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 unmarked salmon, steelhead, Delta smelt, splittail, and other fish were released at a location downstream of the sampling site immediately after identification, enumeration and measurement.

Sampling at Antioch was initiated May 1 and continued through May 25. Each day between 5:00 a.m. and 9:00 p.m., anywhere from 13 to 30, 20-minute tows were conducted. All told, 580 Kodiak trawl samples were collected, representing a total sampling duration of 11,545 minutes. During the sampling, a total of 6,373 unmarked juvenile Chinook salmon and 1,285 salmon with an adipose fin clip (CWT) were collected. In addition, 821 Delta smelt, 188 splittail, and 28 steelhead were caught in the sampling.

Chipps Island Recapture Sampling

As part of VAMP recovery efforts at Chipps Island, trawling was conducted daily between April 30 and June 19. This included at a minimum, a regular schedule of ten, 20-minute tows beginning at about 7:00 am each day, and ending about noon. Between May 3 and June 2, the effort was increased by adding a second shift of trawling in the afternoon/evening, bringing the trawling effort up to twenty, 20-minute tows per day. On these days the first shift was begun at dawn, while the second shift ended at or after sunset, to incorporate the crepuscular periods of Chinook movement. It is hypothesized, based on an analysis of salmon smolts caught during twenty-four hour sampling at Jersey Point in 1997, that a greater number of salmon would be caught around dawn and dusk. Both targeting this crepuscular period and doubling the total trawl effort at Chipps Island were intended to increase the numbers of CWT salmon recaptured and reduce the variability in VAMP survival indices. This second shift was also conducted in 1998, 1999, and 2000.

The trawl at Chipps Island was towed at the surface using a net with a mouth opening 10 feet deep by 30 feet wide, with a total net length of 82 feet. Aluminum hydrofoils were used on the top bridles and steel depressors along with a weighted lead line were used on the bottom bridles to keep the mouth of the net open. The net was variable mesh net starting with 4-inch mesh at the mouth and ending with a ¼-inch cod end.

To sample across the channel, trawling at Chipps Island was conducted in three distinct lanes, one each in the north, south and middle of the channel. Each lane was generally sampled at least three times per shift, with one lane sampled a fourth time during each shift. This lane was chosen at random or selected by the boat operator based on flow conditions.

Coded wire tagged salmon released as part of the VAMP program were recovered at Chipps Island between May 3 and June 2. A total of 256 CWT salmon were recovered at Chipps Island from the VAMP study. During the May 3 through June 2 VAMP recovery period, a total of 7,592 unmarked salmon, 574 CWT salmon from other non VAMP experiments, 165 Delta smelt, 360 Sacramento splittail, 4 clipped steelhead and 14 non-clipped steelhead were also collected at Chipps Island.

VAMP CHINOOK SALMON CWT SURVIVAL INDICES

Survival indices were calculated for marked salmon released at Durham Ferry, Mossdale, and Jersey Point and recovered at Antioch and Chipps Island. Survival indices were calculated by dividing the number of CWT salmon recovered by the effective number released and the fraction of time and channel width sampled. The fraction of the channel width sampled at Chipps Island (0.00769) was the net width (30 feet) divided by an estimate of the channel width (3900 feet). The fraction of the channel width sampled at Antioch (0.01388) was based on the net width (25 feet) used there and an estimate of the channel width (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 percent of time sampled for the VAMP 2001 release groups at Chipps Island was about 28 percent, while at Antioch it ranged between 35 and 40 percent.

Survival indices were calculated for each separate tag code to provide a sense of the variability associated with the overall 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. This results in a slightly different index than would be generated by taking the mean of the survival indices of the individual tag codes within a group.

The individual and group survival indices to Antioch and Chipps Island of the CWT salmon released as part of VAMP 2001 are shown in Table 5-3. As in 2000, survival indices from the release locations to Antioch were sometimes lower than those at Chipps Island. It is expected that indices to Antioch would be greater than those to Chipps Island since Antioch is closer to the release locations than Chipps Island. Lower survival indices to Antioch may be a result of the marked salmon not being equally distributed or vulnerable to the trawls throughout the 24-hour period and the expansions for effort may be biasing the Chipps Island estimates high.

Differences between release groups were also evaluated statistically by comparing the recapture rates (the number recaptured divided by the number released) at Antioch or Chipps Island.

The first and second Durham Ferry releases had survival indices to Antioch of 0.20 and 0.08, respectively. Survival indices to Chipps Island were 0.36 and 0.06. The individual tag code survival indices at Antioch and Chipps Island did not overlap and there appeared to be a difference in survival between the first and second Durham Ferry groups. Results of statistical analysis of the Durham Ferry data showed that the proportion of CWT salmon recaptured from the second group was significantly lower ($P < 0.05$) than the proportion recovered from the first release group using the recovery information at both Antioch and Chipps Island.

The two Mossdale releases showed similar differences between the first and second releases. The first releases had survival indices to Antioch of 0.13 and 0.07 respectively and 0.32 and 0.08 to Chipps Island. Again none of the individual tag code survival indices overlapped between groups indicating a real difference between the two groups. Differences in the proportion of CWT salmon recaptured were statistically significant ($P < 0.05$) based on sampling at Chipps Island. Differences in the proportion recaptured based on sampling at Antioch were not significantly different between the first and second releases.

Similarly, the two Jersey Point groups also appeared to survive at different rates; with the first group surviving at a higher rate than the second. The first group released on May 4 had a survival index to Antioch of 1.23. The second group released on May 11 had an index to Antioch of 0.38. Chipps Island recoveries demonstrated the same apparent difference between groups with the first group having an index of 1.06 and the second group having an index of 0.40. Differences in proportion of CWT salmon recaptured were statistically significant at both recapture locations.

Why survival was so much lower for the second group (releases at Durham Ferry, Mossdale, and Jersey Point), relative to the first group is unknown. Flow and export conditions were similar for both groups. Water temperatures increased for some of the releases in the second group and likely contributed to the lower survival. A higher prevalence of PKD (Proliferative Kidney Disease) was also observed in the second set of releases in the physiological studies. Results of the net pen studies indicated a low level of mortality for all release groups, however it was not apparent that the second group had higher mortality in the net pens than the first group.

As part of the VAMP 2001 experimental design, releases were made at both Mossdale and Durham Ferry to determine how survival differed between these two locations. Results of the releases at Durham Ferry on April 30 and May 7 and Mossdale on May 1 and May 8, indicated survival from Durham Ferry and Mossdale was similar in 2001 even though Durham Ferry is 11 miles further upstream than Mossdale. Although the Durham Ferry group may have survived slightly better, indices were variable enough such that there was likely no real difference between the groups. No statistically significant ($P > 0.05$) difference in the proportion of CWT salmon recaptured was detected among salmon released at Durham Ferry and Mossdale based on recaptures at both Antioch and Chipps Island.

More important than the relative survival indices between locations are comparisons of survival indices within the same recovery location and the trends between the groups using the two recovery locations. The use of absolute survival estimates, where the survival index of the upstream release group is divided by the survival index of the downstream group (recovered at the same location), is most useful for within and between recovery locations and year comparisons.

ABSOLUTE CHINOOK SALMON SURVIVAL ESTIMATES

Absolute survival rates were estimated using the ratio of the survival indices of smolts released at Durham Ferry and Mossdale in relation to those released at Jersey Point. These absolute survival estimates are more powerful for use in comparing survival rates, since the use of ratios between upstream and downstream groups theoretically standardizes for differences in catch efficiency between recovery locations and years. Two independent estimates of absolute survival have been calculated for the VAMP 2001 releases using recoveries at both Antioch and Chipps Island. An additional estimate of absolute survival will be possible from recoveries in the ocean fishery, 2 to 4 years following release. Absolute survival estimates for VAMP 2001 are shown in Table 5-3.

Statistical differences between groups, was also assessed based upon the ratio of CWT salmon released and recaptured from Durham Ferry and Mossdale relative to the proportion of CWT salmon released and recaptured from the downstream Jersey Point (control) releases.

Although the relative survival indices indicated that the first groups released survived at a higher rate than the second group, the absolute estimates of survival appear to give conflicting results. Survival between Durham Ferry and Mossdale and Jersey Point for the first group, was higher than the second group using Chipps Island recovery information. It was similar between the first and second releases using the Antioch recovery information. Differences in the proportions of recovery rates among the two test groups from Durham Ferry relative to Jersey Point groups were not found to be statistically significant based on sampling at Antioch. However, there was a statistically significant difference between the proportions of the two Durham Ferry releases relative to the Jersey Point controls using Chipps Island recovery information.

Differences in the proportion recovered of the combined Durham Ferry releases and the combined Mossdale releases were not found to be statistically significant ($p>0.05$) with recoveries from either sampling location.

Survival estimates in 2000 did appear less for the Durham Ferry group than the Mossdale group using recovery information at Antioch. This difference led to the recommendation of making releases at both Durham Ferry and Mossdale in 2001. Additional releases may be needed to fully understand if differences between these two groups are meaningful.

An alternative method for estimating survival from Durham Ferry to Mossdale and Mossdale to Jersey Point was developed by Dr. Ken Newman (See Chapter 6) based on the ratio of marked salmon recaptured from upstream and downstream release sites. Using this alternative calculation method, survival between Durham Ferry and Mossdale was 1.33 and 0.96 for the first and second groups, respectively. Since it is impossible to have over 100% survival between Durham Ferry and Mossdale, these data appear to show that survival was either very high between the two locations, or that the first group of smolts released at Durham Ferry survived at a higher rate than the first group released at Mossdale for some unknown reason. Survival between Mossdale and Jersey Point was 0.16 and 0.20 for the first and second groups released, respectively.

Variance and standard errors were also calculated based on the Delta method provided by Dr. Newman. The estimates of survival, plus or minus two standard errors, is roughly equivalent to the 95% confidence intervals. These confidence intervals are provided in Table 5-6 showing that there is a substantial variability around the survival estimates and that replicates (Durham Ferry to Mossdale and Mossdale to Jersey Point) were not significantly different from each other. These findings are not consistent with results of the statistical analysis using proportions that showed, when using Chipps Island data alone, that the survival rates for the first release groups were higher than the second.

Transit Time

Data on transit times for marked salmon from the release to recapture sites during VAMP 2001 is summarized in tabular and graphic form in Appendix C-4. CWT salmon released April 30 at Durham Ferry took between 5 and 11 days to arrive at Antioch and Chipps Island. The May 1 Mossdale release took between 4 and 11 days to arrive at Antioch and Chipps Island. Jersey Point release groups were recovered between 0 and 10 days after release at Antioch and between 1 and 7 days at Chipps Island. The May 7 Durham Ferry release group arrived at Antioch between 4 and 15 days and between 5 and 13 days at Chipps Island. The May 8 release group at Mossdale was recovered at Antioch between 4 and 12 days and between 5 and 10 days at Chipps Island. The second Jersey Point release group was recovered between 1 and 12 days after release at Antioch and 1 and 11 days after release at Chipps Island. The transit time from release location to Antioch and Chipps Island of both sets of releases was similar. The number of individual recoveries by tag code and the number of minutes towed per day for both Antioch and Chipps Island recoveries are shown in Appendix C-4.

TABLE 5-6

Estimates of Survival Between Durham Ferry and Mossdale (S DF TO MD) and Between Mossdale and Jersey Point (S MD TO JP), and Survival Minus (S-2se) and Plus (S +2se) two Standard Errors.

	REC. AT ANTIOCH	REC. AT CL	# RELEASED	A+C	A+C/R	S DF TO MD	S MD TO JP	S–2SD	S+2SD
Durham 1	28	14	23,354	42	0.001798407				
	30	22	22,837	52	0.002277007				
	18	17	22,491	35	0.001556178				
	76	53	68,682	129	0.001878221	1.33		1.12	1.53
MD 1	18	17	23,000	35	0.001521739				
	15	14	22,177	29	0.001307661				
	33	31	45,177	64	0.00141665		0.16	-0.13	0.45
JP 1	156	50	24,443	206	0.008427771				
	173	61	24,992	234	0.009362996				
	329	111	49,435	440	0.008900577				
Durham 2	8	2	24,025	10	0.000416233				
	11	5	24,029	16	0.000665862				
	10	2	24,177	12	0.000496339				
	29	8	72,231	38		0.96		0.74	1.17
MD 2	8	4	23,878	12	0.000502555				
	11	4	25,308	15	0.000592698				
	19	8	49,186	27	0.000548937		0.20	0.00	0.40
JP 2	43	17	25,909	60	0.002315798				
	53	27	25,465	80	0.003141567				
	96	44	51,374	140	0.002725114				

TABLE 5-7

Absolute Survival Estimates for VAMP Survival Studies

	VAMP 2000		VAMP 2001	
Vernalis Flow (cfs)	5,869		4,220	
SWP/CVP exports (cfs)	2,155		1,420	
Durham Ferry Survival	Release 1	Release 2	Release 1	Release 2
Antioch	0.20	0.14	0.17	0.20
Chipps Island	0.31	0.19	0.34	0.14
Mossdale Survival	Release 1	Release 2	Release 1	Release 2
Antioch	0.34	–	0.11	0.18
Chipps Island	0.31	–	0.31	0.19

Role of Flow and Exports on Absolute Survival

Survival of juvenile Chinook salmon emigrating from the San Joaquin River system has been evaluated within the framework established by the VAMP experimental design during 2000 and 2001. Absolute survival estimates from these studies are summarized in Table 5-7 for the two San Joaquin River flow-export conditions tested.

Results of statistical analysis of these two years of data showed that the proportion of CWT salmon recovered were not significantly different ($P > 0.05$) from the combined Durham Ferry and Mossdale groups relative to the Jersey Point groups under the two flow-export conditions tested during VAMP 2000 and 2001. Given the relatively high variability inherent in conducting salmon smolt survival studies within the lower San Joaquin River and Delta, the lack of statistically significant differences in survival estimates between the two relatively close flow-export conditions tested was not unexpected. Results of these analysis underscore the importance of collecting salmon smolt survival data under the most extreme flow-export conditions identified as VAMP targets. The greater the separation between flow and export condition among tests, the greater the ability of these survival studies to detect the true effects of flow and/or export rate on juvenile Chinook salmon survival.

> *The transit time from release location to Antioch and Chipps Island of both sets of releases was similar.*

The U.S. Fish and Wildlife Service has conducted a number of previous investigations on the effects of San Joaquin River flow and export conditions on juvenile Chinook salmon survival. Although these previous studies vary somewhat from the experimental design established by VAMP, results of these tests provide a useful context and foundation for evaluating and interpreting survival information collected as part of the VAMP investigations (San Joaquin River Group Authority 2000 Annual Technical Report and Appendix D).

Survival estimates from Mossdale to Jersey Point (obtained using Chipps Island recovery information) gathered in 2001 are compared with past years survival data in Table 5-8. The absolute survival estimates obtained from the first groups in 2001 are similar to those obtained during the VAMP 2000 investigations and are relatively high in comparison to survival estimates from similar studies starting in 1994. Only 1999 and 1995 had higher absolute survival estimates between Mossdale and Jersey Point than those obtained in 2000 and for the first groups of 2001. Releases in 1995 were from Feather River Hatchery origin Chinook salmon, which have been shown to survive at lower levels than salmon from the Merced River Hatchery – thus the estimate in 1995 may be biased low. In contrast, data collected in 1999 is thought to be biased (high), based on potentially low recovery of Jersey Point released fish.

As in 2000, comparative releases in 2001 of CWT salmon were made at both Mossdale and Durham Ferry. Prior to 2000, all upstream releases had been made at Mossdale. Using the past data will help in evaluating the effects of SWP and CVP exports and San Joaquin River flow on salmon survival. If the survival estimates from the two release locations were found to be significantly different, then using only Durham Ferry releases would increase the number of years needed to complete the VAMP study. Results in 2001 indicated that survival was not significantly different for salmon smolts released at Durham Ferry and Mossdale and that the absolute survival between the two locations was relatively high.

The relationship to date between absolute survival estimates between Mossdale and Jersey Point and San Joaquin River flow at Vernalis is shown in Figure 5-8. Linear regression analyses were used to assess the potential relationship between absolute survival estimates and river flow at Vernalis. Two regression lines have been developed based on survival data with and without the HORB. The barrier can not be installed and operated at flows greater than 7000 cfs. Statistically neither regression line is significant, although prior to adding the data from 1999, the without barrier relationship was significant ($R^2 = 0.75$, $P = 0.25$).

Figure 5-9 shows the relationship between absolute salmon smolt survival and flow with the HORB, but uses estimated net flow on the San Joaquin River downstream of upper Old River instead of the flow at Vernalis. Because the HORB has had different permeability (culvert operations) over the years, the estimated flow in the San Joaquin River downstream of upper Old River has been used to better reflect the river flow the juvenile salmon experience as they migrate down the San Joaquin River. This estimate is calculated by subtracting the estimated mean daily flow in upper Old River 840 feet downstream of the barrier from the USGS gauged mean daily flow at Vernalis. Figure 5-9 also includes survival estimates between Mossdale (and Durham Ferry) and Jersey Point using recovery information from the Antioch sampling. There is substantial variability at any one flow level based on this combined data from the variety of sources (Antioch and Chipps recoveries, Mossdale and Durham Ferry releases). Variation in estimates of survival

FIGURE 5-8 Absolute Smolt Survival Between Mossdale and Jersey Point and San Joaquin River Flow at Vernalis, With and Without the HORB.

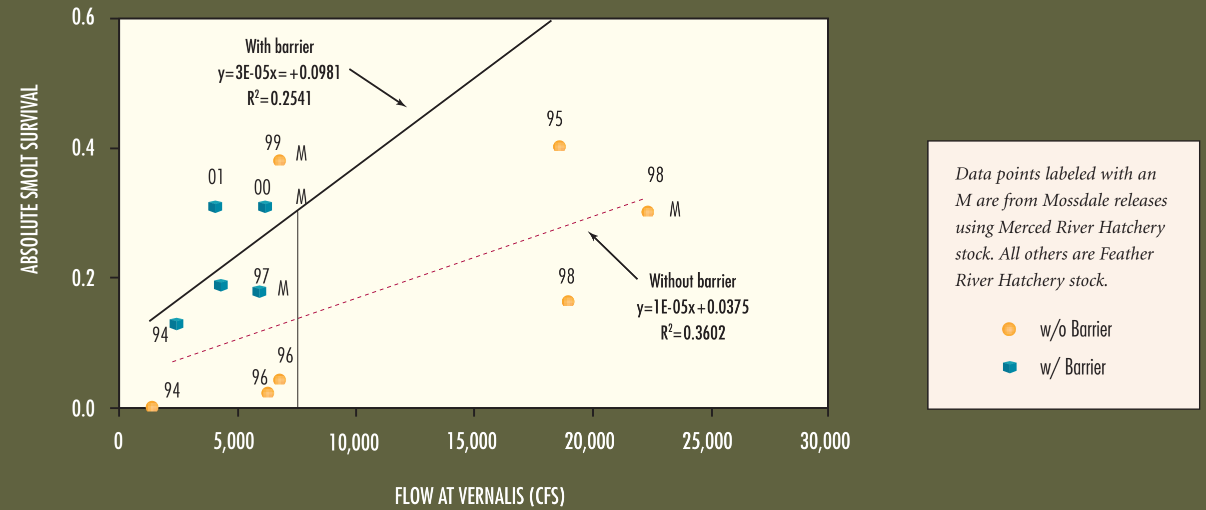


FIGURE 5-9 Absolute Smolt Survival Between Mossdale (M)/Durham Ferry (DF) and Jersey Point and River Flow on the San Joaquin River Downstream of the Upper Old River With the HORB in Place.

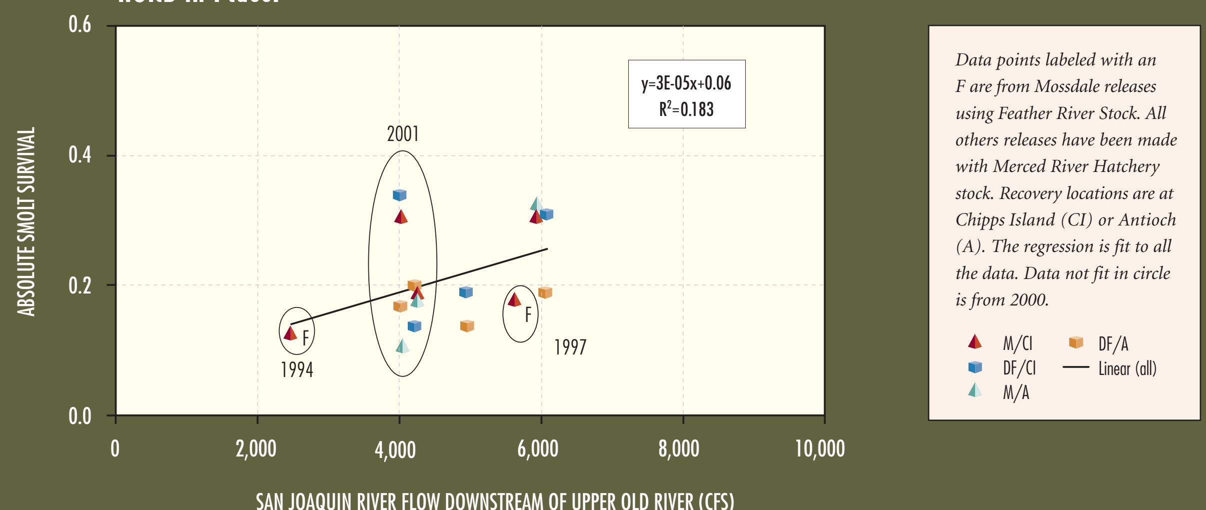


FIGURE 5-10 Absolute Smolt Survival Between Mossdale/Durham Ferry (DF) and Jersey Point and CVP+SWP Exports (Daily Average in cfs).

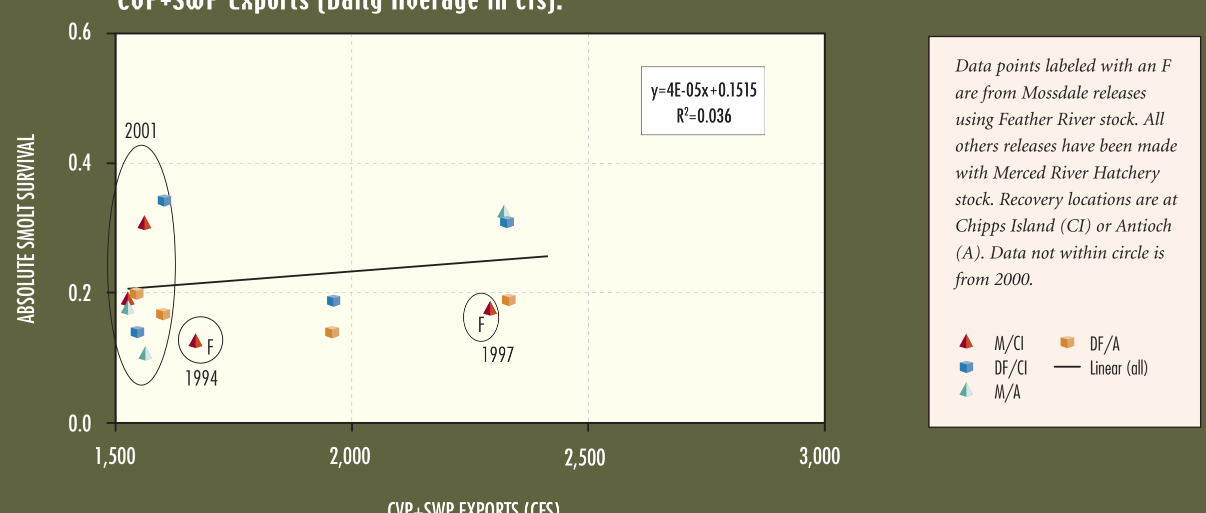


TABLE 5-8

Smolt Survival Data for Smolts Released at Mossdale, Durham Ferry (DF) and Jersey Point Between 1994 and 2000.

YEAR	SURVIVAL INDEX	# FISH RECOV-ERED	RELEASE TEMP	SIZE AT RELEASE	SURVIVAL INDEX	# FISH RECOV-ERED	RELEASE TEMP	SIZE AT RELEASE	HATCHERY STOCK	RATIO	SJR FLOW DOWN-STREAM OF OLD RIVER (CFS)	FLOW AT VERNALIS	CVP+SWP EXPORTS	BARRIER STATUS
	Mossdale				Jersey Point									
1994	0	0	63	74	0.18	10	64	72	FRH	0.00	437	1,387	1,268	no barrier
1994	0.04	2	60	77	0.28	16	63	78	FRH	0.13	2,468	2,468	1,671	barrier
1995	0.19	20	57	70	0.48	26	60	70	FRH	0.40	7,363	18,450	3,666	no barrier
1996	0.02	2	59.5	78	0.5	25	62	78	FRH	0.04	2,631	6,673	1,651	no barrier
1996	0.01	1	64	81	0.45	24	64	87	FRH	0.02	2,475	6,269	1,517	no barrier
1997	0.19	10	60	100	1.03	55	63	99	FRH	0.18	5,605	5,905	2,302	barrier (with 2 culverts)
1998	0.1	7	66	84	0.63	40	66	78	FRH	0.16	7,692	18,850	2,004	no barrier
1998	0.56	88	57	86	1.84	187	62	89	MRFF	0.30	9,140	22,220	1,616	no barrier
1999	0.28	36	62	79	0.73	59	63	81	MRFF	0.38	3,161	6,762	3,161	no barrier
2000	0.19	18	56	79	0.62	65	64	82	MRFF	0.31	5,936	6,196	2,332	barrier (with 2 open culverts
2000	0.19 (DF)	28	57	80	0.62	65	64	82	MRFF	0.31	6,077	6,339	2,335	barrier (with 2 open culverts)
2000	0.15 (DF)	22	62	77	0.78	78	63	77	MRFF	0.19	4,959	5,702	1,964	barrier (with 4 open culverts)
2001	0.32	31	67	91	1.06	111	68	88	MRFF	0.31	4,011	4,126	1,567	barrier (with 6 culverts open)
2001	0.36 (DF)	53	70	89	1.06	111	68	88	MRFF	0.34	4,013	4,125	1,609	barrier (with 6 culverts open)
2001	0.076	8	69.8	88.5	0.4	44	72.5	87.5	MRFF	0.19	4,225	4,337	1,529	barrier (with 6 culverts open)
2001	0.052 (DF)	9	66.2	85	0.4	44	72.5	87.5	MRFF	0.13	4,206	4,297	1,548	barrier (with 6 culverts open)

between the two recovery locations (Antioch and Chipps Island) adds a level of uncertainty to the survival investigations, however, the benefit of having two rather than only one survival estimate per year is of major value.

Figure 5-10 shows salmon smolt survival regressed against averaged CVP+SWP exports for the 10 days after release. The 10-day averaging period used in these analysis has been based on expected exposure periods during emigration as reflected in transit time estimates to the Antioch and Chipps Island recovery locations. In 2000, it was reported that absolute salmon survival appeared to increase as exports increased from 1600 to 2300 cfs. With the addition of the 2001 data the positive relationship between exports in this range and survival is less apparent. There is so much variability in the various estimates that a relationship is not clear.

Evaluating the role of SWP and CVP exports, the HORB, and flow on salmon smolt survival through the south Delta are key elements of VAMP. Presence of the HORB affects both the emigration route of salmon smolts and hydraulic conditions in the lower San Joaquin River and Delta that are thought to alter the vulnerability of juvenile salmon to export-related effects.

Figure 5-11 shows the relationship between salmon survival (between Mossdale and Jersey Point using survival estimates derived from Chipps Island recoveries), San Joaquin River flow downstream of upper Old River and SWP/CVP exports with the HORB in place. It appears that as flows increase, survival increases. High survival has been observed with lower (1,500 cfs) and somewhat higher exports (2,300 cfs).

FIGURE 5-11

Survival from Mossdale to Jersey Point (MDJPSUR) Versus San Joaquin Flow Downstream of Upper Old River (SJRIVERFLOW) and Average Daily Combined CVP+SWP Exports (EXPORTS).

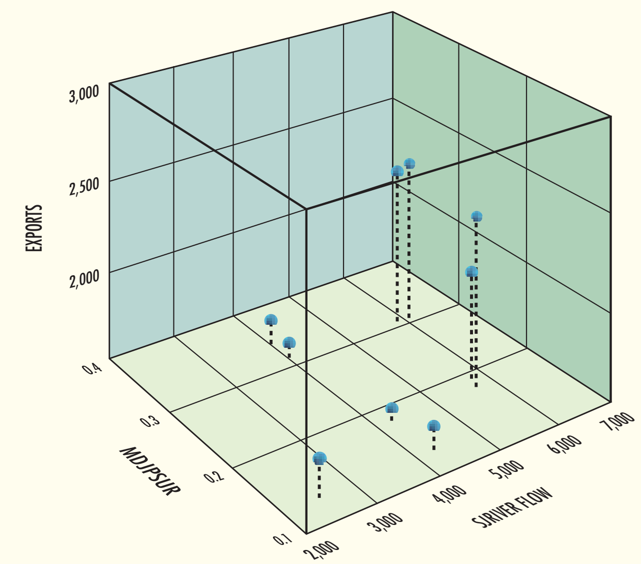
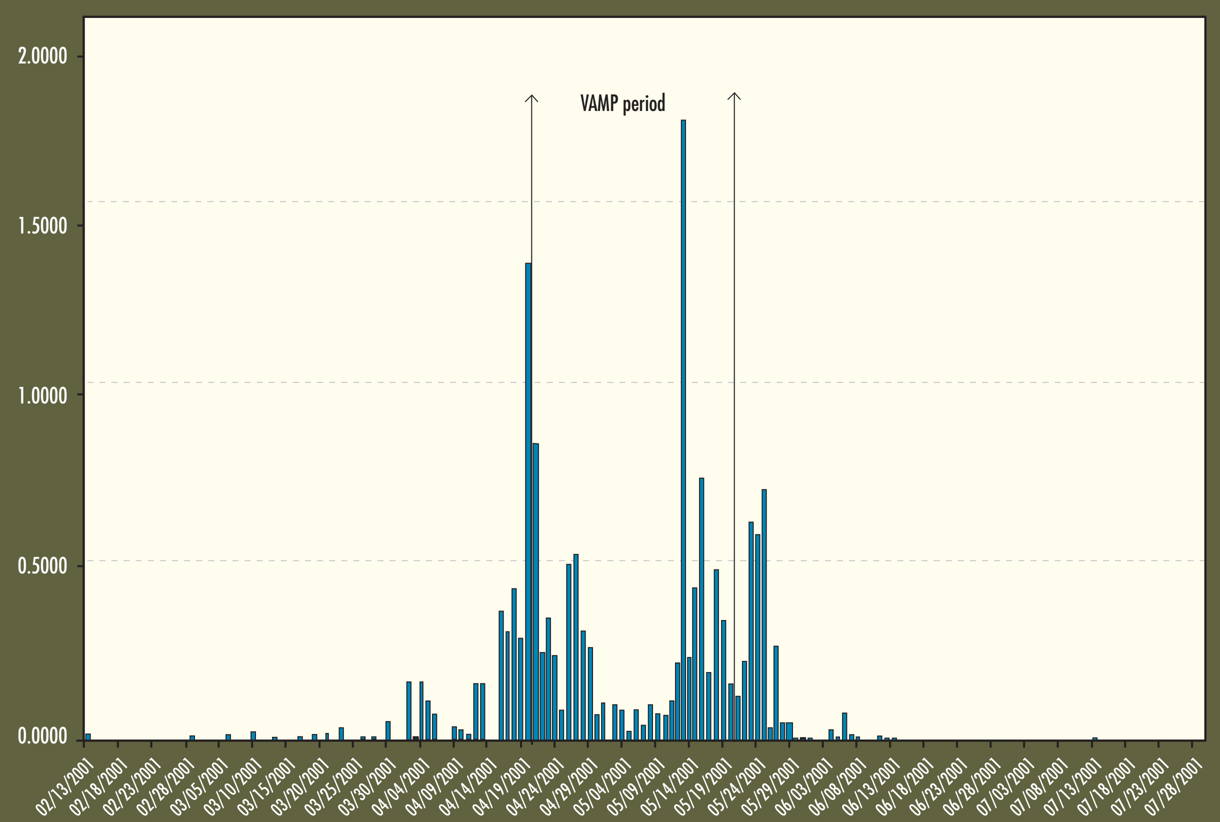


FIGURE 5-12

Average Catch/minute/day of all Non-clipped Chinook Per Day Captured in the Mossdale Kodiak Trawl Between February 13, 2001, and July 31, 2001.

Up to 20 tows per day were conducted between April 24, 2001, and May 28, 2001.



The separate roles of SWP and CVP exports and San Joaquin River flow with the HORB in place is difficult to determine at this time as a result of (1) the few survival studies completed with the HORB in place; (2) variable permeability of the barrier within and among years, and 3) the lack of measuring survival at the extremes of the VAMP flow and export targets. Releases at both Mossdale and Jersey Point have only been made in four years when the HORB was in place. Also, during those four years the barrier design and permeability has changed. In 1994, the HORB was installed without culverts, while in 1997 the barrier had two open culverts that diverted approximately 300 cfs into upper Old River. In 2000, the HORB had six gated culverts, with two open during the Mossdale and first Durham Ferry release and four open during the second Durham Ferry release. In 2001, six culverts were installed and operated throughout the VAMP test period. The varying designs and changes in the culvert operations of the barrier add variability to the limited data, making it more difficult to detect the effects of flow and exports on salmon survival.

In the four years of measuring survival with the barrier in place, average total combined CVP/SWP exports have varied between 1,500 and 2,300 cfs. This is only an 800 cfs difference in exports—a relatively small difference in export rates. No data has been generated with the barrier at exports of 3,000 cfs—the highest export level under the VAMP targets. Gathering data at a 3000 cfs export level may help us further our understanding of the relationship between exports, with the barrier in upper Old River, and juvenile salmon smolt survival. Measuring survival with flows at 7,000 cfs and 3,200 cfs would also help for the same reasons. Future studies should prioritize, to the extent possible, VAMP target levels to be tested at 3,000 cfs exports and 7,000 cfs flow, and 1,500 cfs exports with 3,200 cfs and 7,000 cfs flow. Focusing our survival experiments on these extremes within the VAMP design will enable us to better determine the role of flow and export on salmon smolt survival.

Definitive conclusions about the respective roles of flow and exports on salmon smolt survival are not possible from the VAMP data at this time. It is recommended that further evaluation of VAMP 2000 and 2001 results occur prior to determining the study plan for VAMP 2002. It is also recommended that VAMP experiments continue. Results of these future studies will provide information to make the most appropriate management decisions to protect salmon smolts emigrating from the San Joaquin River basin.

OCEAN RECOVERY INFORMATION FROM PAST YEARS

Ocean recovery data of CWT salmon groups can contribute to a more complete understanding and evaluation of salmon smolt survival studies. These data can provide another independent estimate of the ratio of survival of a test release group relative to a control release group, or "absolute survival", and can be compared with estimates based on juvenile salmon recoveries at Chipps Island and Antioch. Past recoveries at Jersey Point (1997–1999) can not be compared since the Jersey Point trawling site was located upstream of the Jersey Point release site and a ratio between the upstream and downstream sites can not be generated. The ocean harvest data may be particularly reliable due to the number of tag recoveries and the extended recovery period.

Adult recovery data are gathered from commercial and sport ocean harvest checked at various ports by DFG. The Pacific States Marine Fisheries Commission maintains the database of ocean recovery CWT data, which is current through 2000. The ocean CWT recovery data are usually recorded over a 1-4 year period after the year a study release is made as nearly all of a given year class of salmon have either been harvested or spawned by age 5. Consequently, these data are essentially complete for releases made through 1996 and partially available for CWT releases made through 1999, prior to the VAMP evaluations starting in 2000.

Survival estimates based on ocean recoveries for salmon produced at the Merced River Hatchery, and released as part of south Delta survival evaluations, were compared to survival estimates based on Chipps Island recoveries (Table 5-9). Releases were made at Dos Reis (on the San Joaquin River downstream of the upper Old River junction), Mossdale, and Jersey Point. Survival estimates are based on Mossdale or Dos Reis recovery rates relative to the Jersey Point recovery rates. Ocean absolute survival ratios were very similar to those at Chipps Island for the releases made in 1996 and 1999. And although ocean absolute survival ratios were higher than those to Chipps Island for releases in 1997 and 1998, they were generally similar (in the mid-range of survival). The ocean recovery data is incomplete for the 1997-99 releases. No data is yet available for releases made in 2000 and recovered at Chipps Island as well as Antioch. Once the data for these releases and for future releases is available it will be used to compare the three independent estimates of survival (using Antioch, Chipps Island and ocean recoveries).

Results of these comparative analysis of survival estimates for Chinook salmon produced in the Merced River Hatchery show (1) there is generally good agreement between survival estimates based on juvenile CWT salmon recoveries in Chipps Island trawling and adult recoveries from the ocean fishery, (2) survival estimates using Chipps Island recoveries were lower in some years than estimates based on ocean recoveries, and (3) additional comparisons need to be made, as data becomes available from VAMP releases, for recoveries at Antioch, Chipps Island, and the ocean fishery. Information on survival of juvenile salmon and the contribution to the adult salmon population will be valuable in evaluating the biological benefits of changes in flow and export rates under VAMP.

TABLE 5-9

Survival Estimates Based on Chipps Island and Ocean Recoveries of Merced River Hatchery Salmon Released as Part of South Delta Studies Between 1996 and 1999.

RELEASE YEAR	SAN JOAQUIN RIVER *(Merced River Origin)* TAG NO.	RELEASE NUMBER	RELEASE SITE	RELEASE DATE	CHIPPS IS. RECOVS.	EXPANDED ADULT OCEAN RECOVS. (AGE 1+ TO 4+) TOTAL	CHIPPS ISLAND	OCEAN CATCH
		Juvenile Salmon CWT Releases						
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	0.14	0.15
	Effective Release	51,737	JERSEY PT		39	187		
1997	H62545	50,695	DOS REIS	29APR97	9	178		
	H62546	55,315	DOS REIS	29APR97	7	167		
	H62547	51,588	JERSEY PT	02MAY97	27	349		
	Effective Release	106,010	DOS REIS		16	345	0.29	0.48
	Effective Release	51,588	JERSEY PT		27	349		
	H62548	46,728	DOS REIS	08MAY97	5	91	0.28	0.48
	H62549	47,254	JERSEY PT	12MAY97	18	191		
1998	61110809	26,465	MOSSDALE	16APR98	25	52		
	61110810	25,264	MOSSDALE	16APR98	31	39		
	61110811	25,926	MOSSDALE	16APR98	32	56		
	61110806	26,215	DOS REIS	17APR98	33	46		
	61110807	26,366	DOS REIS	17APR98	23	35		
	61110808	24,792	DOS REIS	17APR98	34	57		
	61110812	24,598	JERSEY PT	20APR98	87	104		
	61110813	25,673	JERSEY PT	20APR98	100	90		
	Effective Release	77,655	MOSSDALE		88	147	0.30	0.49
	Effective Release	77,373	DOS REIS		90	138	0.31	0.46
	Effective Release	50,271	JERSEY PT		187	194		
1999	064606	25,005	MOSSDALE	20APR99	2	1		
	062642	24,715	MOSSDALE	19APR99	8	12		
	062643	24,725	MOSSDALE	19APR99	15	14		
	062644	25,433	MOSSDALE	19APR99	13	0		
	062645	25,014	DOS REIS	19APR99	20	9		
	062646	24,841	DOS REIS	19APR99	19	18		
	0601110815	24,927	JERSEY PT	21APR99	34	25		
	062647	24,193	JERSEY PT	21APR99	25	19		
	Effective Release	99,878	MOSSDALE		38	27	0.32	0.30
	Effective Release	49,855	DOS REIS		39	27	0.65	0.60
	Effective Release	49,120	JERSEY PT		59	44		

NOTE: Ocean recoveries are based on data through 2000

SAN JOAQUIN RIVER SALMON PROTECTION

One of the VAMP objectives is to provide improved conditions and increased survival of juvenile Chinook salmon smolts produced in the San Joaquin River tributaries during their downstream migration through the lower river and Delta. To determine if VAMP in 2001 was successful in protecting juvenile salmon emigrating from the San Joaquin River tributaries, catches of unmarked salmon at Mossdale and in salvage at the CVP and SWP facilities were reviewed prior to and during the VAMP period.

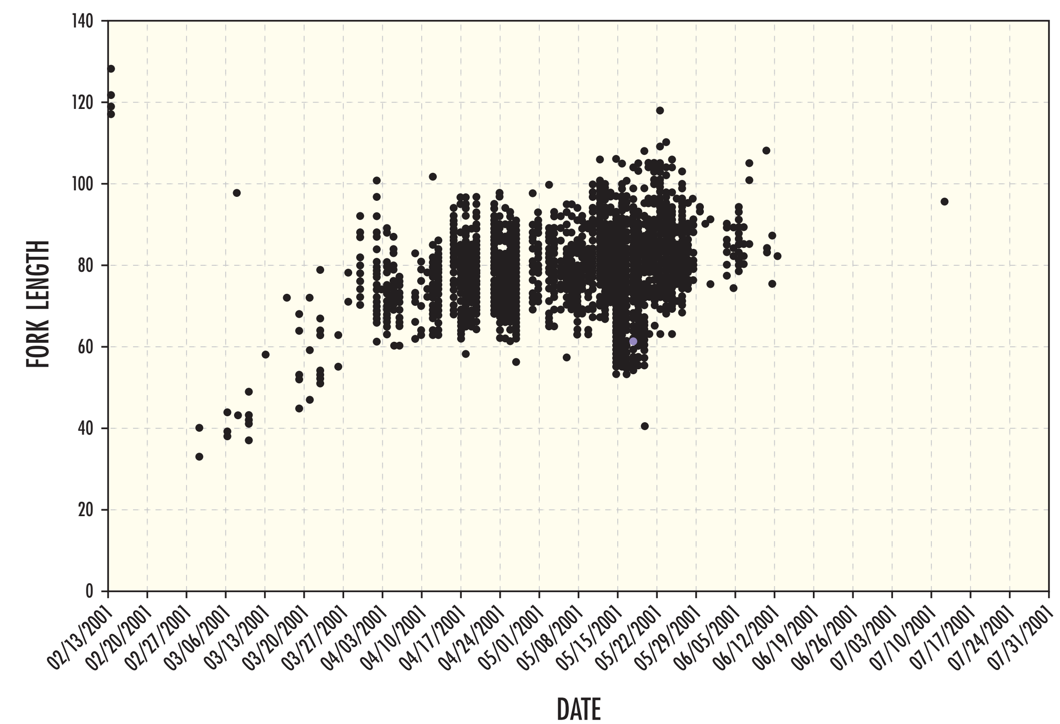
Unmarked Salmon Recovered at Mossdale

The original time period for VAMP (April 15 to May 15) was chosen based on historical data that indicated a high percentage of the juvenile salmon emigrating from the San Joaquin tributaries was passing into the Delta at Mossdale during that time period. In 2001, the VAMP period was delayed until April 20 due to permitting problems associated with installing the barrier at the HORB. Figure 5-12 shows the average catch per minute per day of unmarked juvenile salmon caught in kodiak trawling at Mossdale between February 13 and July 28, 2001. Unmarked salmon do not have an adipose clip and could be unmarked fish from the Merced River Hatchery or juveniles from natural spawning. Figure 5-12 indicates that the majority of juvenile salmon (65%) migrated past Mossdale during the VAMP period. Delaying removal of the HORB until May 26 and continuing export curtailments until early June affected an even greater percent of the population. Reducing flows while continuing the export curtailments and keeping the barrier in place for a week after the VAMP period may provide a way to stimulate movement of the juvenile salmon out of the system, while protecting these last remaining out-migrants. These additional protection measures after VAMP appear to have been beneficial to protecting a greater proportion of the population of unmarked juvenile salmon emigrating from the San Joaquin basin.

Most of the unmarked juveniles passing Mossdale during this time were between 60 and 100 mm in length, although there were a few below 60 mm observed towards the end of the VAMP period (Figure 5-13). It is also interesting to note that there were a few large juveniles (between 115 and 130 mm) migrating past Mossdale in mid-February. Although the VAMP period protects many of the juvenile salmon migrating during the time it is in place, it is also important to protect the diversity of emigration timing and life history expression in the basin.

FIGURE 5-13

Fork Lengths of all Non-clipped Chinook Per Day Captured in the Mossdale Kodiak Trawl Between February 13, 2001, and July 31, 2001.



Up to 20 tows per day were conducted between April 24, 2001, and May 28, 2001.

Salmon Salvage and Losses at Delta Export Pumps

Fish salvage operations at the Central Valley Project (CVP) and State Water Project (SWP) export facilities capture unmarked salmon for transport by tanker truck and release downstream in the western Sacramento-San Joaquin Delta. The untagged salmon are either naturally produced or are untagged hatchery salmon, 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 at the facilities to provide some general indications. Data from 2000 are included here since they were not in the 2000 report and provide a comparison with the 2001 data.

Results of these analyses showed that the VAMP 2001 test period coincided with much of the peak period of salmon smolt emigration.

The salvage at the facilities is based on expansions from sub-samples taken throughout the day. Loss is estimated at approximately 4-5 salmon lost per salvaged salmon in the SWP Clifton Court Forebay based on high predation rates. The CVP pumps divert directly from the Old River channel and the loss estimates range from about 50–80% of the number salvaged, or about 6–8 times less per salvaged salmon than for the SWP. The loss estimates do not include any indirect mortality in the Delta due to water operations or additional export operations or additional mortality associated with trucking and handling. Salvage density of salmon is the number of salvaged per acre foot of water pumped.

The number 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 would influence the number and density of juvenile salmon salvaged and lost. Density may be the best indicator of when the most juvenile salmon were moving through the salvage system.

A review of the weekly salvage data around the 2001 VAMP period indicates that the highest salvage and losses occurred during the second week of the VAMP period at the SWP and in the week prior to VAMP at the CVP (Figures 5-14 and 5-15). Salmon density was highest in the first week of the VAMP period at both facilities, with the next highest density at CVP in the week before VAMP and at SWP in the second week of VAMP (Figure 5-16). This salvage, loss and density information indicates that delaying the VAMP period in 2001 may have resulted in higher impacts to juvenile salmon adversely affected by the CVP facility than would have occurred had the VAMP period started on April 15 as originally planned.

Comparable data for 2000 show a pattern of high salvage and loss at the CVP and SWP prior to the 2000 VAMP period (Figures 5-17 and 5-18). CVP density was highest prior to the VAMP period and SWP density was highest in the second week of the 2000 VAMP period (Figure 5-19). The data from 2000 also indicates that salvage numbers and densities were high at both facilities just prior to the VAMP period and initiating the VAMP earlier or extending the VAMP could have benefits by reducing the loss of juvenile salmon at the salvage facilities at this time. In 2000, the VAMP period started on April 15. Reducing exports during this earlier period of time would not only provide better conditions for juvenile salmon emigrating from the San Joaquin River basin, but from the Sacramento River basin as well. Juvenile spring-, winter-, and fall- run Chinook salmon migrate through the Delta in early April from the Sacramento River basin.

Salvaged salmon in 2001 showed a length pattern similar to 2000 during the VAMP period, although it generally appears there were more salmon less than 80 mm forklength and fewer greater than 100 mm forklength in 2001 (Figures 5-20 and 5-21).* The size distribution of unmarked salmon in the Mossdale trawl (Figure 5-13) and at the salvage facilities were similar in 2001.

Results of these analysis showed that the VAMP 2001 test period coincided with much of the peak period of salmon smolt emigration. Reductions in SWP and CVP exports and increased San Joaquin River flow provided improved conditions for salmon survival, although starting the VAMP period a week earlier may have had substantial benefits in both 2000 and 2001. Additional VAMP studies are required, however, to improve quantification of biological benefits over a broader range of environmental conditions.

* *Provided by Sheila Greene, Department of Water Resources*

FIGURE 5-14
2001 SWP Salmon Salvage and Loss.

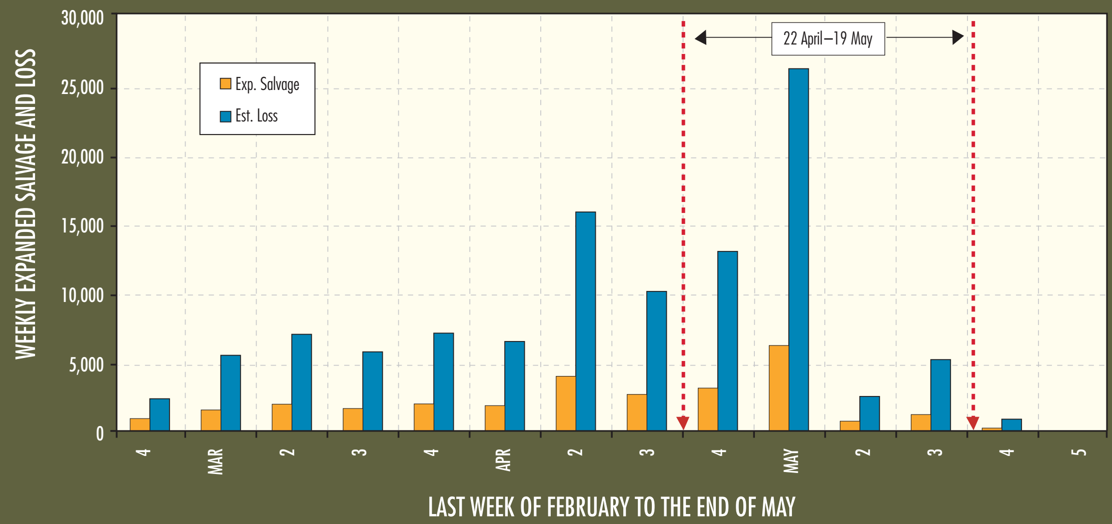


FIGURE 5-15
2001 CVP Salmon Salvage and Loss.

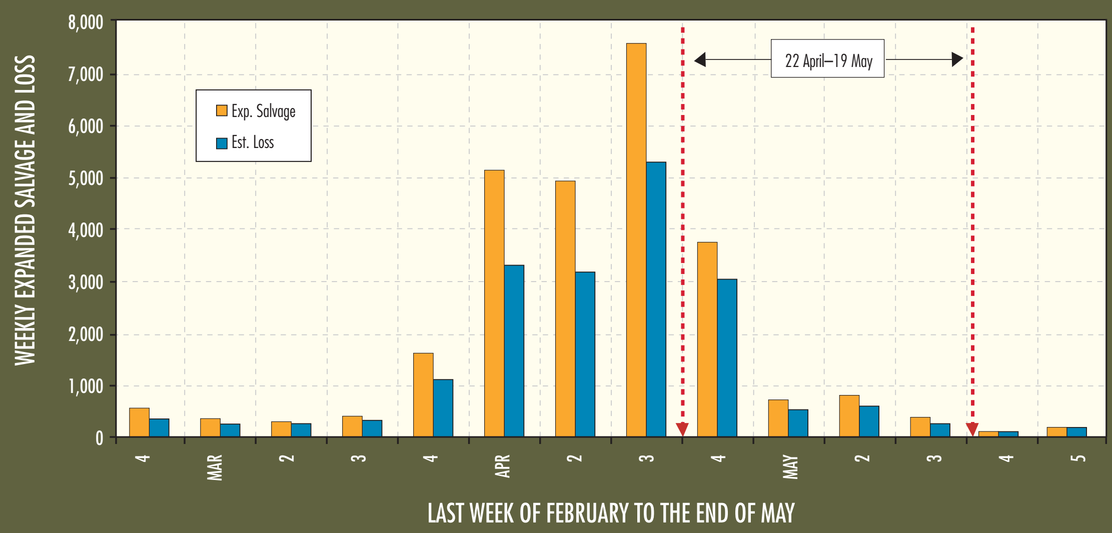


FIGURE 5-16
2001 SWP & CVP Expanded Salmon Salvage Density.

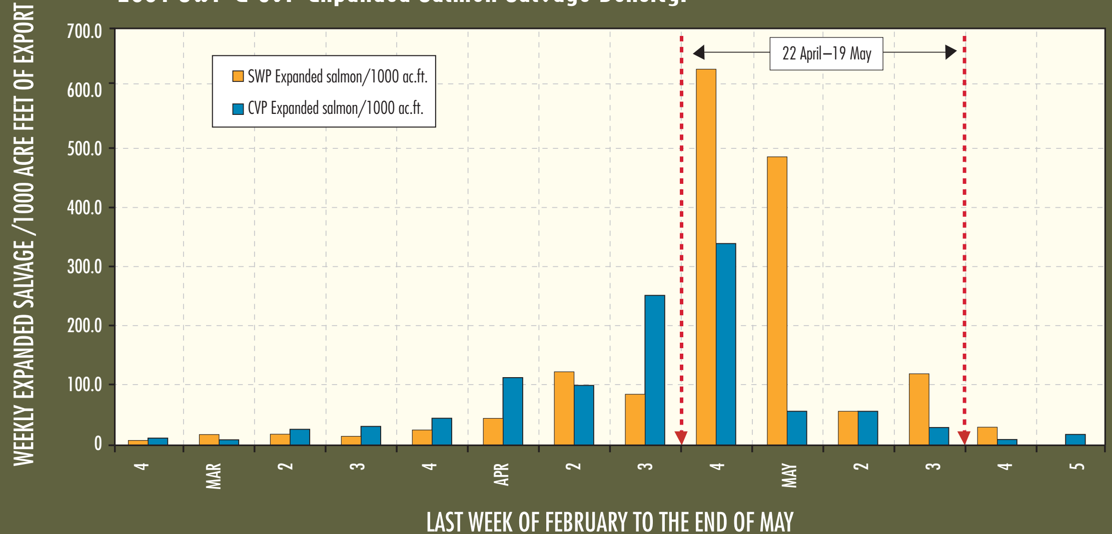


FIGURE 5-17
2000 SWP Salmon Salvage and Loss.

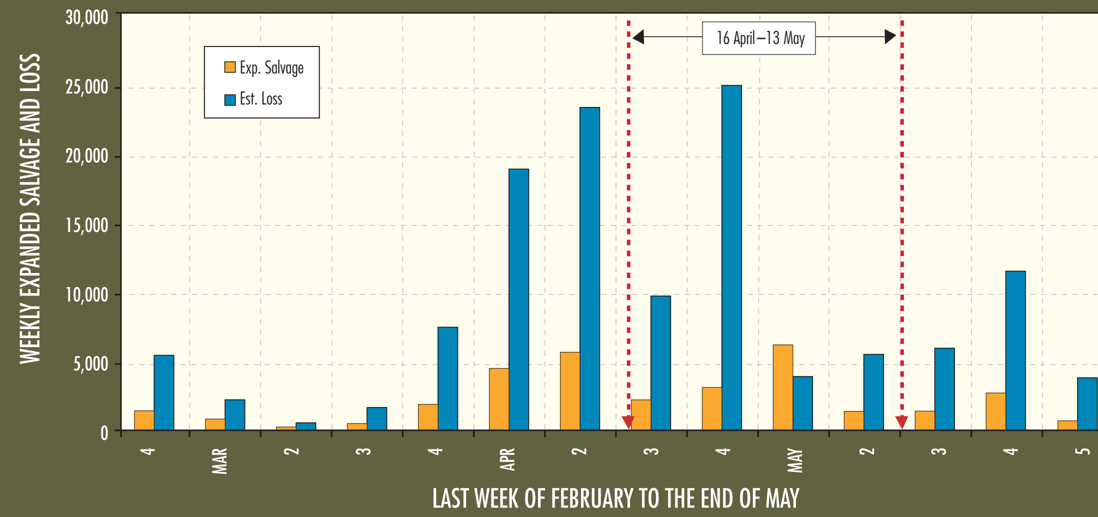


FIGURE 5-18
2000 CVP Salmon Salvage and Loss.

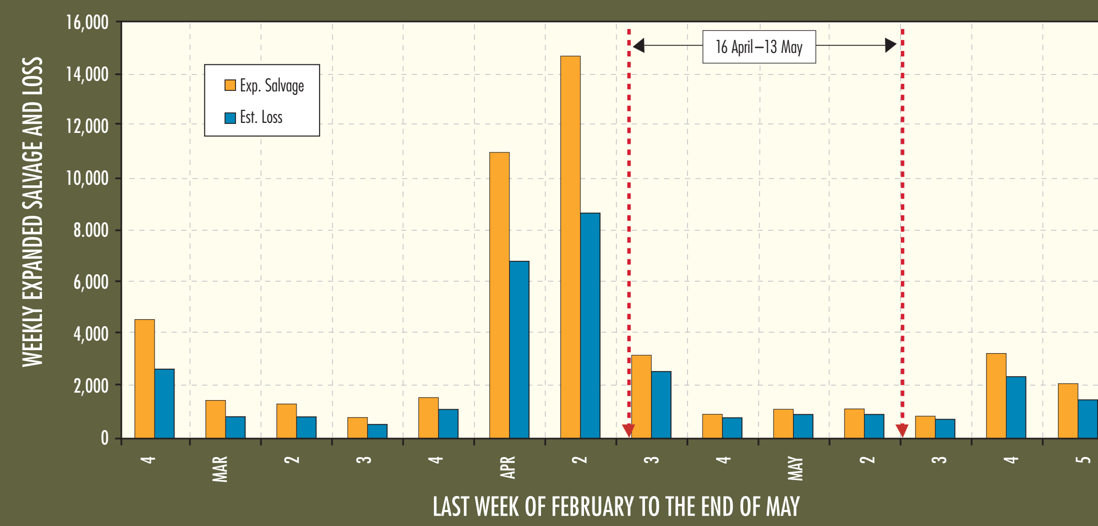


FIGURE 5-19
2000 SWP & CVP Expanded Salmon Salvage Density.

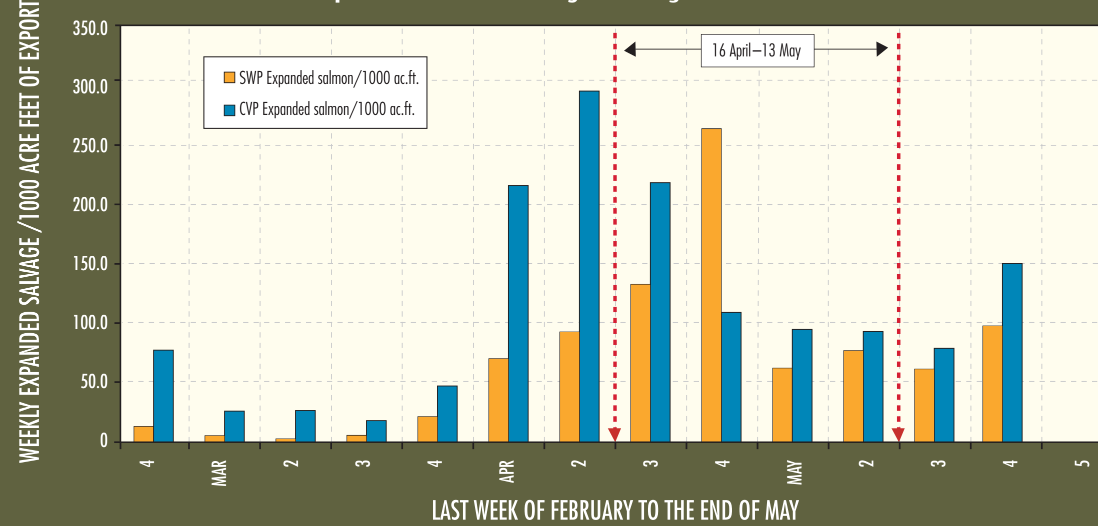


FIGURE 5-20

Salvage Salmon Size Data and Export and Flow Data for 2000–2001 From DWR.

Observed Chinook Salvage at the SWP & CVP Delta Fish Facilities 8/1/00 through 7/31/01.

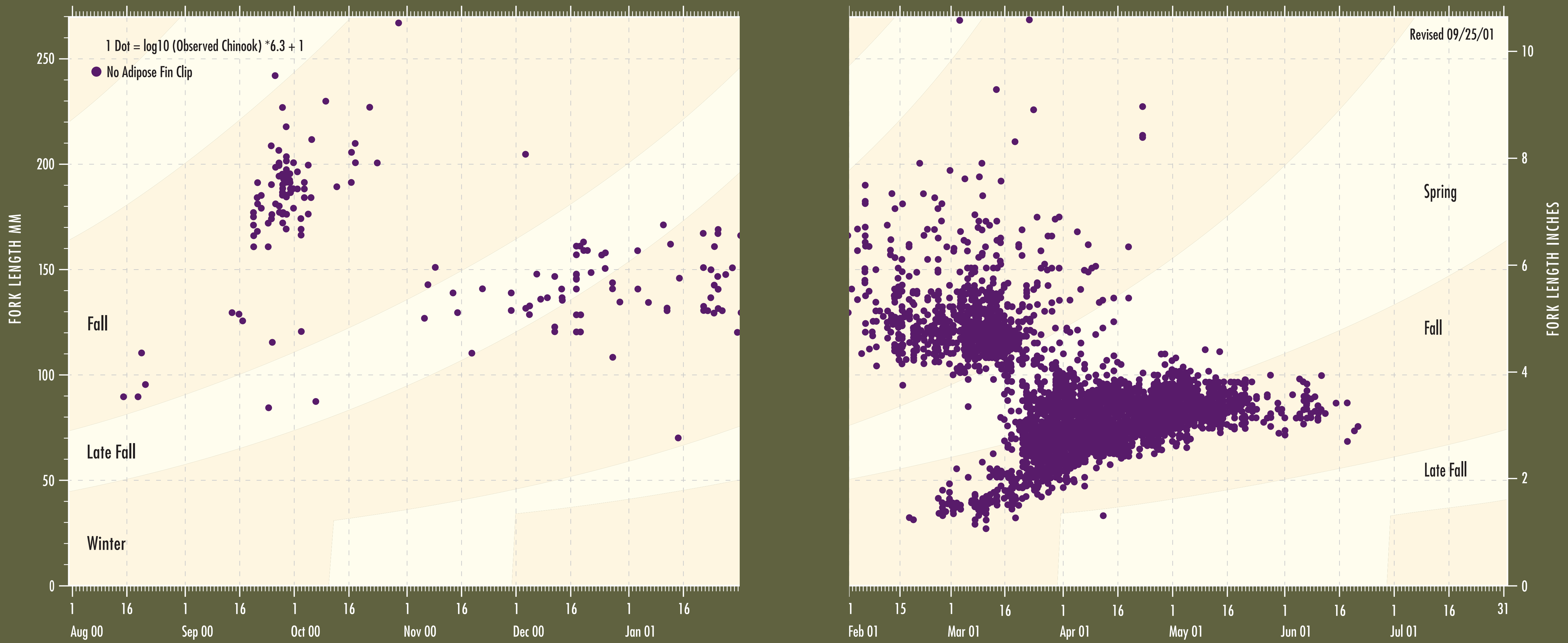
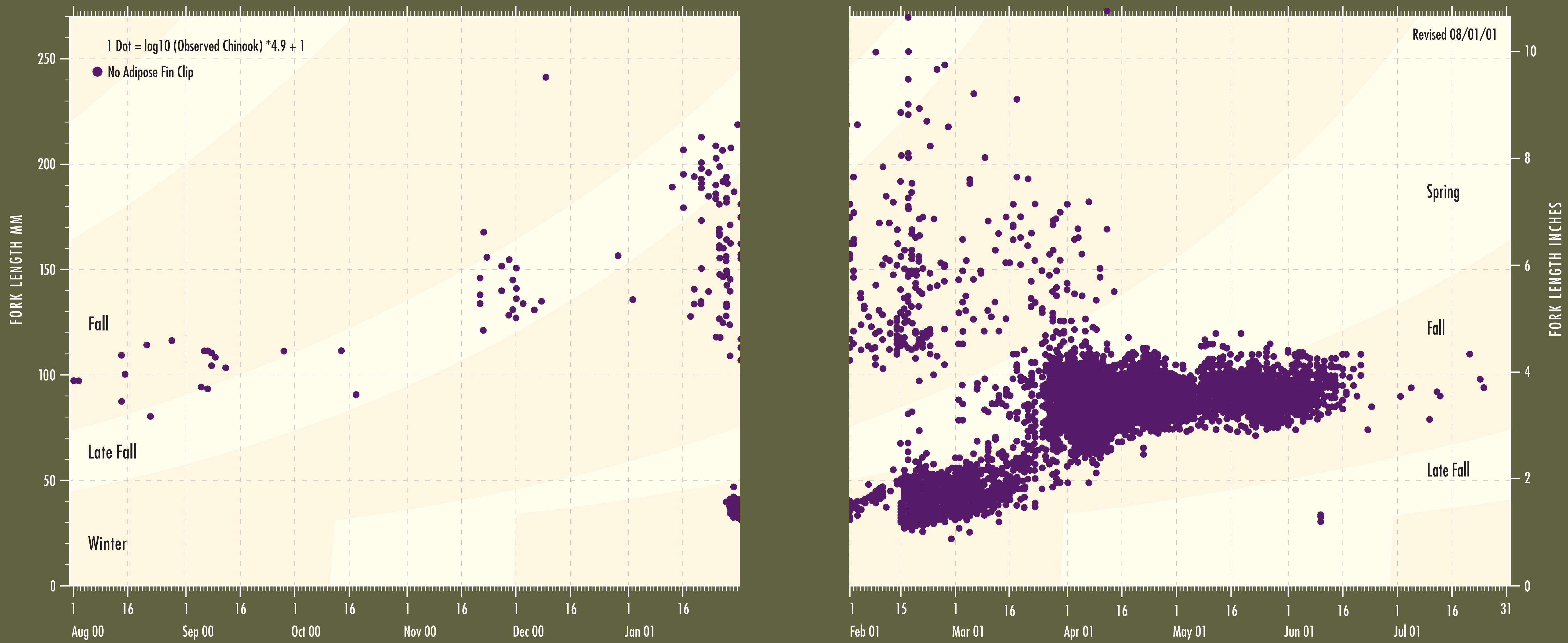


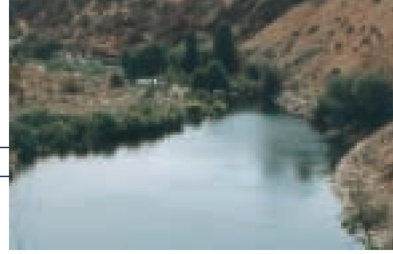
FIGURE 5-21

Salvaged Salmon Size Data and Export and Flow Data for 1999-2000 From DWR.

Observed Chinook Salvage at the SWP & CVP Delta Fish Facilities 8/1/99 through 7/31/00.



COMPLEMENTARY STUDIES RELATED TO VAMP



During the VAMP 2001 test period, several complementary scientific investigations were also conducted to provide additional information on factors affecting survival of juvenile Chinook salmon emigrating from the San Joaquin River and Delta. These complementary investigations included (1) releases of coded-wire tagged juvenile Chinook salmon within San Joaquin River tributaries, which were subsequently recaptured as part of VAMP fisheries sampling, which can be used to provide estimates of salmon smolt survival, (2) results of in-situ toxicity testing within the San Joaquin River and Old River, (3) water velocity and current measurements within the San Joaquin River at the confluence with Old River in the vicinity of the HORB, and (4) pilot studies to investigate the potential use of hydro-acoustic technology to determine the seasonal distribution and density of juvenile Chinook salmon emigrating from the San Joaquin River system. Results of these complementary studies are briefly summarized below.

SURVIVAL ESTIMATES FOR JUVENILE CHINOOK SALMON EMIGRATING FROM THE SAN JOAQUIN RIVER TRIBUTARIES

CWT salmon releases were made in the San Joaquin River tributaries between April 21 and May 13 as part of independent (complementary) fishery investigations. Releases were made in the upper Merced River (Merced River Hatchery), lower Merced River (Hatfield State Park), upper Tuolumne River (La Grange), and on the mainstem San Joaquin River downstream of the confluence with the Tuolumne River (Old Fisherman's Club). Groups of CWT salmon were also released in the upper (Knights Ferry) and lower (Two Rivers) Stanislaus River in late May. Salmon released as part of these studies were produced in the Merced River Hatchery and coded wire tagged using methods similar to those described in Chapter 5.

Coded-wire tagged juvenile salmon released within the tributaries were subsequently recaptured as part of the VAMP sampling program at Antioch and Chipps Island (see Chapter 5). Based upon information regarding the number of coded-wire tagged salmon released, and the number recaptured, estimates of survival for each group of CWT salmon released in the tributaries were calculated.

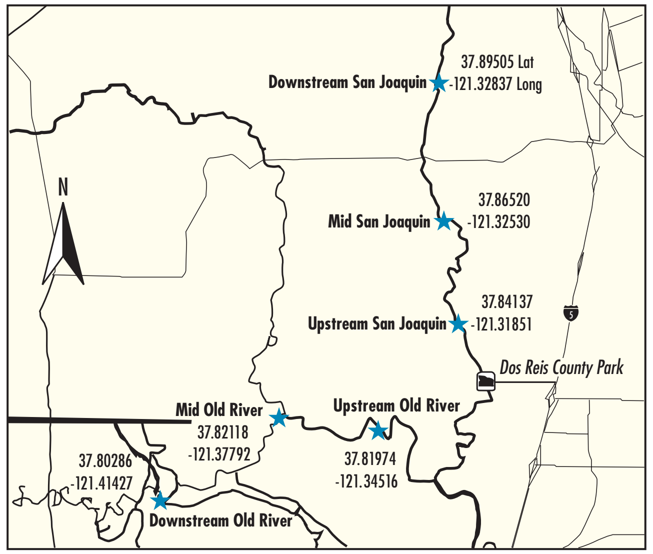
Group survival indices for salmon released in the tributaries and recovered at Antioch ranged between 0.04 and 0.30 (Appendix C-5). Since the groups released in the Stanislaus River were not released until late May, recoveries were not made at Antioch. Group survival indices ranged between 0.02 and 0.28 to Chipps Island and include the Stanislaus River releases (Appendix C-5). Comparisons of upstream groups relative to downstream groups provide a way to index survival through the tributaries (Appendix C-5). It appears that in 2001, survival through both the Merced and Tuolumne rivers was moderate and ranged between 17 and 52 percent. Estimates using recoveries from Antioch and Chipps Island were generally similar. No recoveries were made at Chipps Island from the Stanislaus River releases, even though two shifts of daily sampling continued through June 2 and one shift continued until June 15 (with the exception of June 10 when no sampling occurred). It is unclear from this result whether survival through the Stanislaus River and/or survival through the Delta was low for smolts released in the Stanislaus River. Releases in the Stanislaus were made later in the season than the rest of the releases, which could have adversely affected their survival through both the tributary and Delta.

Information on the transit time between release of CWT groups in the San Joaquin River mainstem and tributaries and recovery at Antioch and Chipps Island is summarized in Appendix C-6. As observed for VAMP releases, recovery times were generally similar between Antioch and Chipps Island for the various groups released upstream in the mainstem San Joaquin River and tributaries.

EVALUATION OF CHINOOK SALMON SMOLT SURVIVAL IN OLD RIVER: BIOLOGICAL RESPONSES TO TOXICANTS

Results of previous salmon smolt survival studies have shown that the survival of fall-run Chinook salmon smolts is generally higher in the San Joaquin River as compared to Old River during their migration to Chipps Island in the western Delta. While it is known that a variety of toxicants are widespread in the Delta, their role in the decreased survival of salmon smolts passing down Old River as compared to the San Joaquin River is unknown. The objective of this complementary investigation is to determine if toxicants play a role in the decreased survival of Chinook salmon smolts that emigrate through Old River. Specific goals of this study were to (1) determine if there are biological effects (DNA strand breaks, acetylcholinesterase activity, stress protein expression, and cytochrome P450 expression) that correspond to chemical exposure in salmon smolts caged in Old River versus the San Joaquin River and (2) test the hypothesis that biomarker responses in salmon smolts vary temporally and spatially in this river system.

FIGURE 6-1
Salmon Caging Sites in the Old and San Joaquin Rivers.



Numbers located by caging sites indicate latitude (Lat) and longitude (Long) positions.

In-situ field studies were scheduled to occur before and after the VAMP test period and during April–May when hydraulic and water quality conditions in south Delta channels vary as a result of VAMP. As described earlier, the VAMP program includes (1) construction of the HORB, (2) augmentation of the San Joaquin River flows by releasing water from reservoirs on upstream tributaries and (3) a reduction in SWP and CVP export rates. In addition to augmented San Joaquin River flows, these actions cause a reduction in Old River flow rates and water turnover. Thus, during the VAMP period of modified flows, toxicants from agricultural runoff or other sources are more concentrated in Old River than before or after and higher concentrations of toxicants in Old River are more likely to affect the survival of outmigrant salmon smolts than in the San Joaquin River. Before the VAMP period, 60% or more of the daily average flow of the San Joaquin River goes down Old River so that differences in toxicity and survival of salmon smolts between rivers should be minimal. After the VAMP period, opening of the Cross Channel gates (combined with a return to higher export rates) causes Sacramento River water to dominate the channels of Old River. As a result, water quality is likely to be less harmful in Old River than in the San Joaquin River, where reservoir releases and total flows decline and the contribution of agricultural return flows in the San Joaquin Valley dominate.

During each of three flow regimes (pre-VAMP, VAMP and post-VAMP) salmon smolts were delivered from the Merced River Hatchery to Dos Reis county park. Fish (n=12 per site) were transported to field sites, and caged at three sites in Old River (OR) and three sites in the San Joaquin River (SJR) for four days (Figure 6-1). Fish and fish cages were obtained, placed, monitored, and retrieved by USFWS personnel. After the four-day exposure, fish were removed from the cages and dissected. During each flow regime, composite water samples were collected for metals analysis (Desert Research Institute, Reno, NV) and pesticides including organophosphates and pyrethroids (USGS, Sacramento, CA). During the VAMP period (not pre- or post-VAMP), non-composite water samples were collected for analysis of organics (PCB, PAHs, and organochlorines, Severn Trent Laboratory, Sacramento, CA), analysis of dissolved and total copper (Desert Research Institute), and mercury analysis (Higashi Laboratory, UC Davis).

FIGURE 6-2

Temperature in the San Joaquin River and Old River on Days in Which Fish Were Caged and Retrieved From Cages.

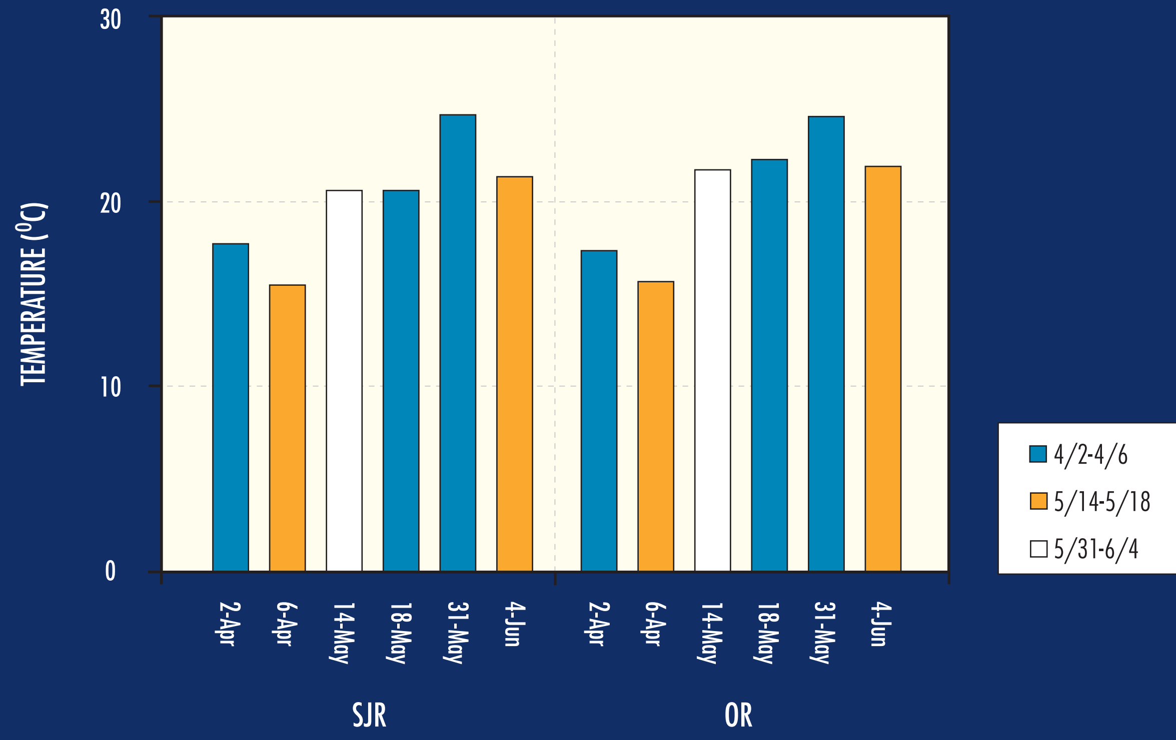
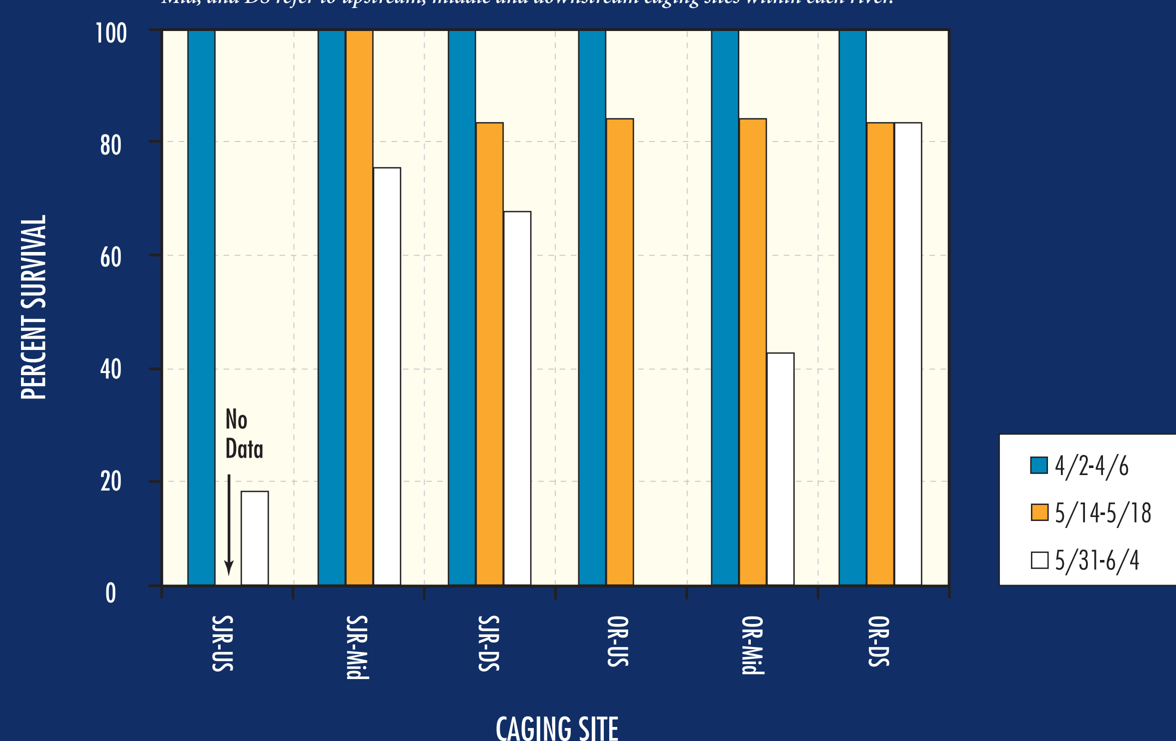


FIGURE 6-3

Percent Survival of Chinook Salmon Smolts in Net Pens During Pre-VAMP (4/2–4/6), VAMP 5/14–5/18), Post-VAMP (5/31–6/4) Flow Regimes in the San Joaquin and Old Rivers.

Mid, and DS refer to upstream, middle and downstream caging sites within each river.



During the pre-VAMP test period, water temperatures on April 2–6 were 15–17°C at all test sites (Figure 6-2). Because completion of the HORB was delayed, the VAMP test period was delayed to May 14–18, at which time water temperatures had reached at least 20°C at all test sites. During the post-VAMP period, temperatures were extremely high the day we placed our cages in both the San Joaquin and Old River sites; water temperatures reached as high as 24°C in both rivers. By the time we retrieved the fish (6/4/01), temperatures had dropped to about 21°C in both rivers (Figure 6-2).

Survival of salmon smolts in the net pens was 100% at all sites during pre-VAMP (4/2–4/6) and varied from 83% (San Joaquin River downstream, Old River all sites) to 100% (San Joaquin River middle site) during the VAMP period (5/14–5/18) as shown in Figure 6-3. During the post-VAMP test period, survival in net pens was 0% at the Old River upstream site, 42% at Old River middle site, 83% at the Old River downstream site, 17% at the San Joaquin River upstream site, 75% at the San Joaquin River middle site, and 67% at the San Joaquin River downstream site.

Analysis of the biological responses of juvenile salmon are currently underway and include acetylcholinesterase activity (Wilson Lab, UC Davis), DNA strand breaks (Anderson Lab, Bodega Marine Laboratory), cytochrome P450 expression (Snyder Lab, Bodega Marine Laboratory), and stress protein expression (Werner Lab, UD Davis). A portion of the controls for background DNA damage in Chinook salmon smolts have been completed (n=9 hatchery controls and n=8 transport controls from the post-VAMP flow regime). Hatchery and transport controls demonstrate 50% and 43% DNA damage levels, respectively, and there was no significant difference in mean DNA damage between treatments.

Analysis of water samples for pesticides is currently underway in the laboratory of Kathy Kuivila (USGS). Data from the analysis of PAHs, PCBs, and organochlorines has been received and shows non-detectable concentrations at all sites during the VAMP period at 1 ppb detection limits (Severn Trent Laboratory). The general metals analysis in water samples from both the San Joaquin River and Old River sites have been completed for all three flow regimes (Desert Research Institute). During the pre-VAMP period, Al levels were approximately 300 ppb at all sites in the SJR and OR. During the VAMP, all levels increased in the SJR sites to 900 or 1000 ppb (but not OR sites) and returned to pre-VAMP levels during the post-VAMP period. A similar trend was observed with Mn and Ni during all three time periods. Mn levels were approximately 100 ppb at all sites in both rivers and increased to 200 ppb in all SJR sites and the OR downstream site during VAMP. Ni levels were approximately 4 ppb or not detected prior to VAMP but increased at all SJR sites and at the OR downstream site to about 8 ppb during VAMP. Cu levels were about 2 ppb in all OR sites but increased to about 6 ppb in all SJR and the OR middle site during the VAMP. Additional metals were analyzed in water samples but did not fluctuate substantially during the three flow regimes or between the two rivers and include the following: Sb (<1 ppb), As (4-10 ppb), Ba (50-70 ppb), Be (<1 ppb), Cd (<1-4 ppb), Cr (1-3 ppb), Co (<1 ppb), Pb (<1 ppb), Mo (3-8 ppb), Se (<20 ppb), Ag (<1 ppb), Tl (<1 ppb), Th (<1 ppb), U (7-10 ppb), V (4-7 ppb), and Zn (4-10 ppb).

HYDRAULIC INVESTIGATIONS ASSOCIATED WITH THE OLD RIVER BARRIER

As part of the VAMP 2001 test program, field measurements were made within the San Joaquin River at the confluence with Old River to evaluate hydraulic characteristics associated with operation of the HORB. Acoustic Doppler current meters and other field measurements were made to determine current patterns and water velocities. Hydraulic measurements were made over a variety of tidal conditions to assess the effects of changes in tidal hydrodynamics and water surface elevation on current patterns and velocities. Information from these field measurements is currently being compiled and analyzed and will be used in designing subsequent complementary field investigations to provide additional information useful in evaluating the role of the HORB on hydraulic conditions within the lower San Joaquin River, and potential effects on salmon smolt survival. One of the concerns that has been identified through field measurements and observations relates to eddies and hydraulic turbulence immediately adjacent to the confluence between the lower San Joaquin River and Old River, related to HORB operations, that may affect the behavioral response and emigration patterns for juvenile Chinook salmon. Turbulence and eddies in the area may also affect the vulnerability of juvenile Chinook salmon to predation mortality. Results of the VAMP 2001 hydraulic measurements will be used to help refine the design and measurement of hydraulic conditions during VAMP 2002, and will also be used to evaluate the affects of various culvert operational strategies as they relate to hydraulic conditions within the San Joaquin River.

HYDRO-ACOUSTIC MONITORING OF JUVENILE CHINOOK SALMON EMIGRATION

A pilot study was designed and conducted as a complementary investigation during the VAMP 2001 test period to evaluate the potential application of hydro-acoustic technologies for monitoring the seasonal patterns in juvenile Chinook salmon movement and salmon densities within the lower San Joaquin River. Currently fisheries monitoring is conducted using conventional trawling methods, (e.g., Kodiak trawl, mid-water trawl) which requires extensive field effort and the capture and handling of juvenile Chinook salmon and other fish species. Development of an alternative fishery monitoring technique, such as hydro-acoustic technologies which have been used for fishery monitoring elsewhere, would offer the potential benefits of reduced monitoring costs, monitoring juvenile salmonid emigration continuously throughout an extended seasonal period, providing continuous monitoring during both day and nighttime conditions, and avoids concerns regarding the capture and handling of protected fish species including both steelhead and Sacramento splittail. Hydro-acoustic technologies, however, do not provide information on the species of fish detected and have not been demonstrated to provide reliable and quantitative information on juvenile salmonid emigration from the lower San Joaquin River. Results of the pilot scale hydro-acoustic studies conducted complementary to VAMP 2001 will be analyzed and evaluated. Results of these evaluations will be used, in part, to help design further field testing and validation of the application of alternative monitoring techniques such as hydro-acoustic technologies as part of the overall VAMP investigations. Results of the pilot scale study conducted during VAMP 2001 will be used to help evaluate and design additional field testing of the technology, if the VAMP 2001 results appear promising, as part of VAMP 2002.

STATISTICAL ANALYSIS OF VAMP DATA

The U.S. Fish and Wildlife Service has contracted to have Dr. Ken Newman conduct various statistical analysis on VAMP salmon smolt survival data. During 2001, Dr. Newman evaluated several aspects of the VAMP data as briefly discussed below.

During his first evaluation, Dr. Newman used CWT salmon recoveries, at Antioch and Chipps Island, of releases made at Durham Ferry, Mossdale and Jersey Point in 2000 to estimate survival between Durham Ferry and Mossdale and between Mossdale and Jersey Point (Newman, Ken,. Pers. com. (a)). He also estimated the standard errors associated with the estimates of survival. The number of recoveries at Antioch and Chipps Island were modeled as trinomial random variables. Implicit in this modeling is the assumption that the three releases have the same survival probabilities over identical reaches of the river and the same capture probabilities. Maximum likelihood estimates for survival in each reach and variances were calculated. The standard errors were the square roots of the estimated variances.

Survival was estimated to be 0.329 between Mossdale and Jersey Point in 2000. Standard errors ranged between 0.031 and 0.054, respectively. Survival (and standard error) between Durham Ferry and Mossdale was estimated at 0.73 (0.145). These estimates compare to survival estimates using the ratio of survival indices of the Mossdale group to the Jersey Point group of 0.33 and 0.31 for the Antioch and Chipps Island recoveries respectively. These two independent methods seem complementary since estimates are very similar using both methods. The maximum likelihood estimates are more informative since they provide standard errors and a way to assess if differences between survival estimates are significant.

It was concluded that maintaining a uniform recovery effort at any given recovery site is crucial to minimizing the bias in estimating survival. Variation in capture probabilities between recovery locations, however, is not a problem. Increasing capture probability lowers the standard error of estimates of survival. Capture probability can be increased by increasing the number of salmon released or increasing the recapture effort. Use of replicate tag codes is valuable for detecting over dispersion, which is a violation of the assumptions underlying the trinomial distribution used for parameter estimation.

In his second evaluation, Dr. Newman conducted a power analysis to determine the probability of detecting flow and export effects on juvenile Chinook salmon survival in the VAMP experiments (Newman, Ken,. Pers. com. (b)). Using 1997, 1998, and 2000 CWT recovery data at Chipps Island, the survival in each year between Mossdale and Jersey Point was estimated. (The 1999 data was not used as it appeared to be an "outlier".) These estimates were used to fit a logistic regression model of survival to flow at Vernalis, export pumping and the presence or absence of the HORB. This analysis also simulated the effect of changing the number of fish released and the recapture rates at Antioch and Chipps Island to detect statistically significant differences in survival for the different VAMP export and flow targets experiments. The probability of detecting a significant difference between targets was greater as release numbers and capture probability increased. The probability of detecting significant differences is greater when the underlying differences are greater between the two different flow and export combinations.

Table 6-1 shows the probabilities that an observed difference in survival for two flow and export combinations would be significantly different at the 0.05 level. It is clear that significant differences are more likely when flow and export target extremes are compared.

This model was then used to compare estimates of survival observed in 2001 to those predicted by the model. The model estimated survival between Mossdale and Jersey Point to be 0.47 for the first group and 0.57 for the second group of releases. This compared to observed estimates of 0.16 and 0.20 (Table 5-6). It appears, from these comparisons, that the model is not tracking the observed data well. The increase from the first group to the second group seems consistent between the model and the data.

Further statistical and power analysis of the available salmon smolt survival data are planned to help in the design of the VAMP 2002 experiments.

TABLE 6-1
Probability That an Observed Difference in Survival for two Flow and Export Combinations is Found Significantly Different at the 0.05 Level.

The probability is labeled Pr, where R is the number released per group, and p equals the capture probability.

					p=0.001			p=0.002		
COMBINATION 1		COMBINATION 2			R=50K	R=100K	R=150K	R=50K	R=100K	R=150K
Flow	Exp	Flow	Exp	Diff.	Pr	Pr	Pr	Pr	Pr	Pr
3,200	1,500	4,500	1,500	0.372	0.846	0.993	1.000	0.988	1.000	1.000
3,200	1,500	5,700	2,250	0.018	0.058	0.048	0.056	0.059	0.078	0.072
3,200	1,500	7,000	1,500	0.666	0.994	1.000	1.000	1.000	1.000	1.000
3,200	1,500	7,000	3,000	0.125	0.389	0.669	0.834	0.627	0.928	0.983
4,500	1,500	5,700	2,250	-0.354	0.797	0.982	0.819	0.984	1.000	1.000
4,500	1,500	7,000	1,500	0.294	0.390	0.649	0.997	0.659	0.898	0.987
4,500	1,500	7,000	3,000	-0.497	0.996	1.000	1.000	1.000	1.000	1.000
5,700	2,250	7,000	1,500	0.649	0.992	1.000	1.000	1.000	1.000	1.000
5,700	2,250	7,000	3,000	-0.143	0.501	0.781	0.906	0.740	0.968	0.995
7,000	1,500	7,000	3,000	-0.791	1.000	1.000	1.000	1.000	1.000	1.000

CHAPTER 7

CONCLUSIONS & RECOMMENDATIONS

The VAMP experimental investigation of juvenile Chinook salmon survival was implemented during spring 2001. The Vernalis target flow was 4,450 cfs, with SWP and CVP export flow of 1,500 cfs. The HORB was successfully installed and maintained throughout the VAMP test period. Estimates of juvenile Chinook salmon smolt survival were calculated based upon releases of CWT juvenile salmon produced in the Merced River Hatchery and released at Durham Ferry, Mossdale, and Jersey Point. Marked salmon were subsequently recaptured in sampling at the HORB, SWP and CVP export facility salvage, and through intensive fisheries sampling at Antioch and Chipps Island. Based upon the data and experience gained during the VAMP 2001 investigations, conclusions and recommendations have been developed, as summarized in Table 7-1. The conclusions and recommendations include both technical and policy/management issues that will affect the design and implementation of VAMP 2002 operations and investigations.

TABLE 7-1
Summary of VAMP 2001 Conclusions and Recommendations

CONCLUSIONS	RECOMMENDATIONS
The quality of the real-time flow data at Vernalis was improved by weekly measurements.	Continue weekly measurements. Investigate alternative flow measurement methods and/or locations.
Estimation of ungauged flow (accretions, depletions) at Vernalis should be improved.	Continue hydrology investigation to improve predictions.
Coordination with upstream tributary operations was successful.	Continue coordination among tributary operators.
Design of the HORB was improved, however debris accumulation on trash screens was a problem.	Modify trash screen design to facilitate trash removal and provide routine maintenance.
Operation of the HORB was successful in maintaining south Delta water levels.	Continue to refine operational criteria for culverts.
Permitting delayed HORB installation.	Secure all permits early and schedule construction to avoid delay in installation.
Hydraulic measurements of flow through HORB culverts need to be taken.	Take flow measurements within each culvert.
HORB has limited impacts on seepage.	Continue monitoring.
Sampling using fyke nets was successful in collecting entrained fish at the culverts.	Continue monitoring culverts using fyke nets to document entrainment.
Experimental design for barrier evaluation did not support consistent quantitative hypothesis testing.	Re-design experimental design of barrier investigations.
CWT retention rate was relatively low.	Investigate CWT quality control to improve retention rates.
Problem with logistics of release at Durham Ferry.	Modify release procedures.
Water temperatures were elevated during the second set of releases and may have adversely affected survival.	Avoid seasonal delays in barrier installation and survival testing.
Results of net pen studies showed evidence of disease and reduced condition of test fish.	Continue net pen studies and fish health inspections.
Results showed substantially lower survival for the second set of releases at all locations compared to the first release. Disease and temperature stress were identified as factors potentially affecting survival.	Do not delay releases otherwise high temperatures may affect results. Second set of CWT survival indices are not comparable to the first set of indices.
Differences in survival between Durham Ferry and Mossdale were not found to be statistically significant.	Continue statistical analysis of survival data. Continue to evaluate need for releases at both Durham Ferry and Mossdale.
Differences in survival from Durham Ferry in 2001 were not significantly different from 2000.	Conduct survival testing at VAMP flow and export extremes.
Flow in the lower San Joaquin River downstream of upper Old River appears to be more relevant than Vernalis flow because of flow through the HORB culverts.	Measure the flow in the San Joaquin River downstream of upper Old River.
Hydrologic conditions during 2001 were close to the threshold separating two alternative flow targets.	If hydrologic conditions are close to a decision threshold, select target flow representing a new VAMP test condition rather than repeating a previously tested flow/export case.
Complementary studies to evaluate mechanisms affecting survival were conducted.	Encourage an expansion of complementary studies to provide additional information on factors and mechanisms affecting salmon survival.
Relatively few CWT salmon from VAMP releases were recovered at the SWP and CVP salvage facilities.	Continue salvage monitoring to document direct losses.
Conclusions are not yet possible on the respective roles of San Joaquin River flow and SWP/CVP exports on juvenile Chinook salmon smolt survival.	Continue VAMP test program.

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SIGNATORIES TO THE SAN JOAQUIN RIVER AGREEMENT

U.S. BUREAU OF RECLAMATION

U.S. FISH AND WILDLIFE SERVICE

CALIFORNIA DEPARTMENT OF WATER RESOURCES

CALIFORNIA DEPARTMENT OF FISH AND GAME

OAKDALE IRRIGATION DISTRICT*

SOUTH SAN JOAQUIN IRRIGATION DISTRICT*

MODESTO IRRIGATION DISTRICT*

TURLOCK IRRIGATION DISTRICT*

MERCED IRRIGATION DISTRICT*

SAN JOAQUIN RIVER EXCHANGE CONTRACTORS WATER AUTHORITY*

- San Luis Canal Company
- Firebaugh Canal Water District
- Central California Irrigation District
- Columbia Canal Company

FRIANT WATER USERS AUTHORITY*

25 agencies including:

- Delano-Earlimart Irrigation District
- Lower Tule River Irrigation District
- South San Joaquin Municipal Utility District
- Madera Irrigation District

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

NATURAL HERITAGE INSTITUTE

SAN JOAQUIN RIVER GROUP AUTHORITY

*San Joaquin River Group Authority Members

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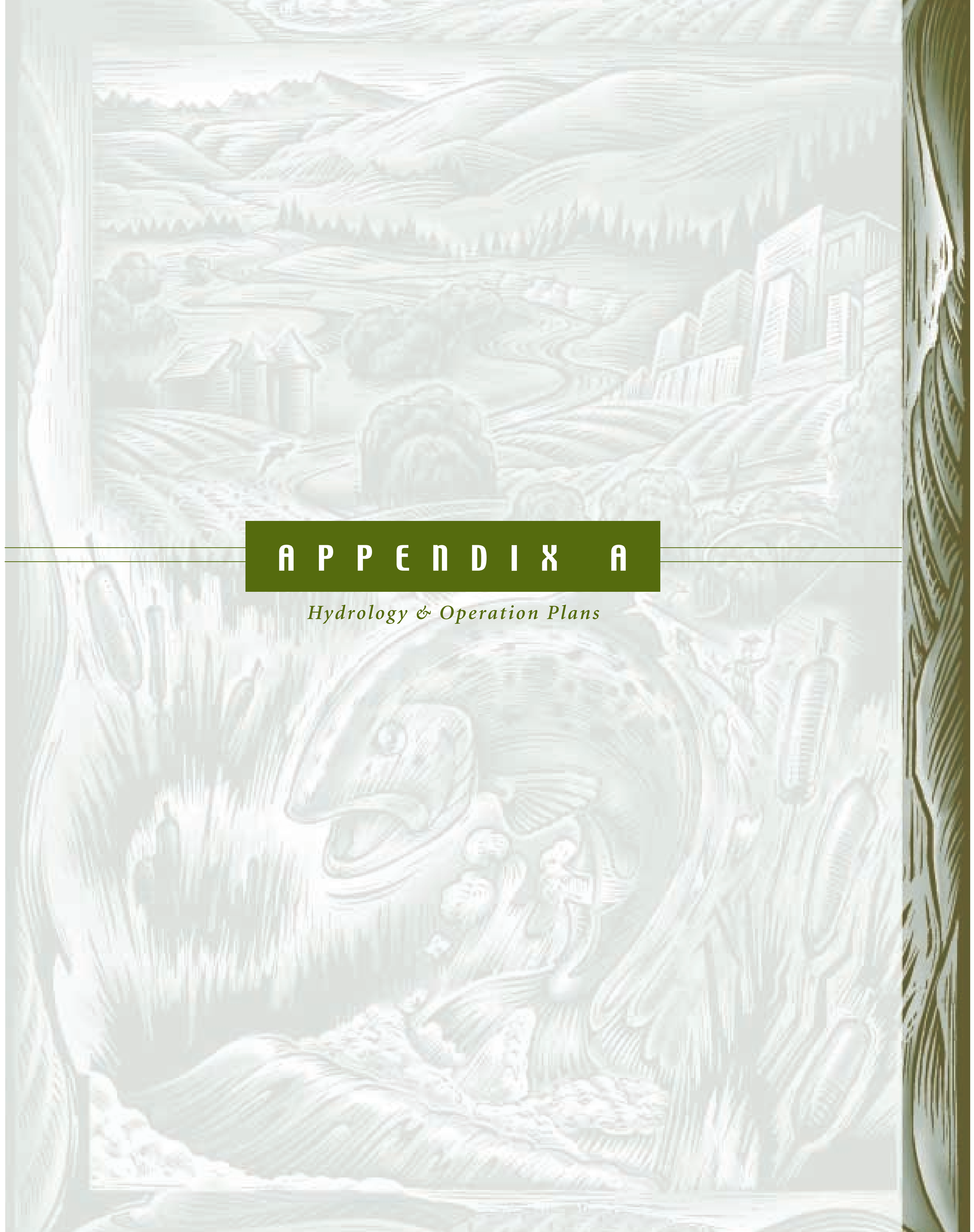


APPENDIX A

Hydrology & Operation Plans

DAILY OPERATION PLAN, MARCH 14

Pulse Period: April 15–May 15 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 700cfs

	San Joaquin River near Vernalis						Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stan. R blw Goodwin	
	Existing Flow	VAMP Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2-day lag)	Ungaged Flow above Vernalis	Existing Flow	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]	[calc]	[calc]					[calc]					[calc]		
Apr 01					456	700	250		250			175		175	1,500	
Apr 02					452	700	250		250			175		175	1,500	
Apr 03					448	700	250		250			175		175	1,500	
Apr 04	3,077			3,077	444	700	250		250			175		175	1,500	
Apr 05	3,073			3,073	440	700	250		250			175		175	1,500	
Apr 06	3,069			3,069	436	700	250		250			175		175	1,500	
Apr 07	3,065			3,065	432	700	250		250			175		175	1,500	
Apr 08	3,061			3,061	428	700	250		250			175		175	1,500	
Apr 09	3,057			3,057	424	700	250		250			175		175	1,500	
Apr 10	3,053			3,053	420	700	250		250			175		175	1,500	
Apr 11	3,049	0		3,049	416	700	250	0	250			175		175	1,500	
Apr 12	3,045	0		3,045	412	700	250	300	550	0		175		175	1,500	M
Apr 13	3,041	0		3,041	408	700	250	300	550	0	725	725	300	1,025	1,500	M
Apr 14	3,037	0	0	3,037	404	700	250	250	500	0	1,200	1,200	100	1,300	1,500	M
Apr 15	3,583	600	1.19	4,183	400	700	250	250	500	0	1,400	1,400	0	1,400	1,500	M
Apr 16	4,054	400	1.98	4,454	396	700	250	250	500	0	1,400	1,400	0	1,400	1,500	M
Apr 17	4,250	250	2.48	4,500	392	700	250	250	500	0	1,400	1,400	0	1,400	1,500	M
Apr 18	4,246	250	2.98	4,496	388	700	250	250	500	0	1,400	1,400	0	1,400	1,500	M
Apr 19	4,242	250	3.47	4,492	384	700	250	830	1,080	0	1,400	1,400	0	1,400	1,500	
Apr 20	4,238	250	3.97	4,488	380	700	250	900	1,150	0	700	720	80	800	1,500	
Apr 21	4,234	250	4.46	4,484	376	700	250	900	1,150	0	400	400	320	720	1,500	
Apr 22	3,550	910	6.27	4,460	372	700	250	900	1,150	0	400	400	320	720	1,500	
Apr 23	3,226	1,220	8.69	4,446	368	700	250	900	1,150	0	400	400	320	720	1,500	
Apr 24	3,222	1,220	11.11	4,442	364	700	250	400	650	0	400	400	320	720	1,500	
Apr 25	3,218	1,220	13.53	4,438	360	700	250	50	300	0	1,000	1,000	250	1,250	1,500	T
Apr 26	3,214	1,220	15.95	4,434	356	700	250	50	300	0	1,600	1,600	0	1,600	1,500	T
Apr 27	3,810	650	17.24	4,460	352	700	250	50	300	0	1,600	1,600	0	1,600	1,500	T
Apr 28	4,406	50	17.34	4,456	348	700	250	60	310	0	1,600	1,600	0	1,600	1,500	T
Apr 29	4,402	50	17.43	4,452	344	700	250	60	310	0	1,600	1,600	0	1,600	1,500	T
Apr 30	4,398	50	17.53	4,448	340	700	250	60	310	0	1,600	1,600	0	1,600	1,500	T
May 01	4,394	60	17.65	4,454	336	700	250	70	320	0	1,600	1,600	0	1,600	1,500	T
May 02	4,390	60	17.77	4,450	332	700	250	70	320	0	1,600	1,600	0	1,600	1,500	T
May 03	4,386	60	17.89	4,446	328	700	250	300	550	0	1,600	1,600	0	1,600	1,500	T
May 04	4,382	70	18.03	4,452	324	700	250	700	950	0	1,600	1,400	0	1,400	1,500	M
May 05	4,378	70	18.17	4,448	320	700	250	700	950	0	1,375	1,000	0	1,000	1,500	M
May 06	4,174	300	18.76	4,474	316	700	250	700	950	0	950	1,000	0	1,000	1,500	M
May 07	3,770	700	20.15	4,470	312	700	250	700	950	0	950	1,000	0	1,000	1,500	M
May 08	3,766	700	21.54	4,466	308	700	250	700	950	0	950	1,000	0	1,000	1,500	M
May 09	3,762	700	22.93	4,462	304	700	250	700	950	0	950	1,000	0	1,000	1,500	M
May 10	3,758	700	24.32	4,458	300	700	250	700	950	0	950	1,000	0	1,000	1,500	M
May 11	3,754	700	25.71	4,454	296	700	250	600	850	0	950	1,000	0	1,000	1,500	M
May 12	3,750	700	27.09	4,450	292	700	250	500	750	0	950	1,000	100	1,100	1,500	
May 13	3,746	700	28.48	4,446	288	700	250	0	250		950	1,050	150	1,200	1,500	
May 14	3,742	700	29.87	4,442	284	700	250	0	250		950	1,000		1,000	1,500	
May 15	3,788	650	31.16	4,438	280	700	250		250		950	1,000		1,000	1,500	
May 16	3,734	0		3,734	276	700	250		250			175		175	1,500	
May 17	3,730	0		3,730	272	700	250		250			175		175	1,500	
May 18	2,901	0		2,901	268	700	250		250			175		175	1,500	
May 19	2,897	0		2,897	264	700	250		250			175		175	1,500	
May 20	2,893	0		2,893	260	700	250		250			175		175	1,500	
May 21	2,889	0		2,889	256	700	250		250			175		175	1,500	
May 22	2,885	0		2,885	252	700	250		250			175		175	1,500	
May 23	2,881	0		2,881	248	700	250		250			175		175	1,500	
May 24	2,877	0		2,877	244	700	250		250			175		175	1,500	
May 25	2,873	0		2,873	240	700	250		250			175		175	1,500	
May 26	2,869	0		2,869	236	700	250		250			175		175	1,500	
May 27	2,865	0		2,865	232	700	250		250			175		175	1,500	
May 28	2,861	0		2,861	228	700	250		250			175		175	1,500	
May 29	2,857	0		2,857	224	700	250		250			175		175	1,500	
May 30	2,853	0		2,853	220	700	250		250			175		175	1,500	
May 31	2,849	0		2,849	216	700	250		250			175		175	1,500	
	VAMP period															
Mean (cfs):	3,943	507		4,450	348	700		434	684	0		1,145	73	1,218		
Suppl. Water (TAF)																
Provided		31.16						26.68		0.00			4.48			
Target		31.17						26.68		0.00			4.49			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, MARCH 14

Pulse Period: April 15–May 15 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 1,000cfs

San Joaquin River near Vernalis						Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stan. R blw Goodwin		
Existing Flow	VAMP Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2-day lag)	Ungaged Flow above Vernalis	Existing Flow	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	Maintain Priority Flow Level M=Merced T=Tuol.	
(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		
[calc]	[calc]	[calc]	[calc]					[calc]					[calc]			
				456	1,000	250		250			175		175	1,500		Apr 01
				452	1,000	250		250			175		175	1,500		Apr 02
				448	1,000	250		250			175		175	1,500		Apr 03
3,377			3,377	444	1,000	250		250			175		175	1,500		Apr 04
3,373			3,373	440	1,000	250		250			175		175	1,500		Apr 05
3,369			3,369	436	1,000	250		250			175		175	1,500		Apr 06
3,365			3,365	432	1,000	250		250			175		175	1,500		Apr 07
3,361			3,361	428	1,000	250		250			175		175	1,500		Apr 08
3,357			3,357	424	1,000	250		250			175		175	1,500		Apr 09
3,353			3,353	420	1,000	250		250			175		175	1,500		Apr 10
3,349	0		3,349	416	1,000	250	0	250			175		175	1,500		Apr 11
3,345	0		3,345	412	1,000	250	0	250	0		175		175	1,500	M	Apr 12
3,341	0		3,341	408	1,000	250	0	250	0	725	1,025	0	1,025	1,500	M	Apr 13
3,337	0	0	3,337	404	1,000	250	0	250	0	1,200	1,200	0	1,200	1,500	M	Apr 14
4,183	0	0.00	4,183	400	1,000	250	0	250	0	1,400	1,350	0	1,350	1,500	M	Apr 15
4,354	0	0.00	4,354	396	1,000	250	0	250	0	1,400	1,350	0	1,350	1,500	M	Apr 16
4,500	0	0.00	4,500	392	1,000	250	0	250	0	1,400	1,350	0	1,350	1,500	M	Apr 17
4,496	0	0.00	4,496	388	1,000	250	0	250	0	1,400	1,350	0	1,350	1,500	M	Apr 18
4,492	0	0.00	4,492	384	1,000	250	500	750	0	1,400	1,350	0	1,350	1,500		Apr 19
4,488	0	0.00	4,488	380	1,000	250	500	750	0	700	850	0	850	1,500		Apr 20
4,484	0	0.00	4,484	376	1,000	250	500	750	0	400	850	0	850	1,500		Apr 21
3,980	500	0.99	4,480	372	1,000	250	500	750	0	400	850	0	850	1,500		Apr 22
3,976	500	1.98	4,476	368	1,000	250	500	750	0	400	850	0	850	1,500		Apr 23
3,972	500	2.98	4,472	364	1,000	250	200	450	0	400	850	0	850	1,500		Apr 24
3,968	500	3.97	4,468	360	1,000	250	0	250	0	1,000	1,100	0	1,100	1,500	T	Apr 25
3,964	500	4.96	4,464	356	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	Apr 26
4,210	200	5.36	4,410	352	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	Apr 27
4,506	0	5.36	4,506	348	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	Apr 28
4,502	0	5.36	4,502	344	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	Apr 29
4,498	0	5.36	4,498	340	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	Apr 30
4,494	0	5.36	4,494	336	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	May 01
4,490	0	5.36	4,490	332	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	May 02
4,486	0	5.36	4,486	328	1,000	250	0	250	0	1,600	1,400	0	1,400	1,500	T	May 03
4,482	0	5.36	4,482	324	1,000	250	300	550	0	1,600	1,400	0	1,400	1,500	M	May 04
4,478	0	5.36	4,478	320	1,000	250	450	700	0	1,375	1,075	0	1,075	1,500	M	May 05
4,474	0	5.36	4,474	316	1,000	250	450	700	0	950	950	0	950	1,500	M	May 06
4,145	300	5.95	4,445	312	1,000	250	450	700	0	950	950	0	950	1,500	M	May 07
4,016	450	6.84	4,466	308	1,000	250	450	700	0	950	950	0	950	1,500	M	May 08
4,012	450	7.74	4,462	304	1,000	250	450	700	0	950	950	0	950	1,500	M	May 09
4,008	450	8.63	4,458	300	1,000	250	450	700	0	950	950	0	950	1,500	M	May 10
4,004	450	9.52	4,454	296	1,000	250	450	700	0	950	950	0	950	1,500	M	May 11
4,000	450	10.41	4,450	292	1,000	250	160	410	0	950	950	0	950	1,500		May 12
3,996	450	11.31	4,446	288	1,000	250	0	250		950	950	0	950	1,500		May 13
3,992	450	12.20	4,442	284	1,000	250	0	250		950	950		950	1,500		May 14
3,988	160	12.52	4,148	280	1,000	250		250		950	950		950	1,500		May 15
3,984	0		3,984	276	1,000	250		250			175		175	1,500		May 16
3,980	0		3,980	272	1,000	250		250			175		175	1,500		May 17
3,201	0		3,201	268	1,000	250		250			175		175	1,500		May 18
3,197	0		3,197	264	1,000	250		250			175		175	1,500		May 19
3,193	0		3,193	260	1,000	250		250			175		175	1,500		May 20
3,189	0		3,189	256	1,000	250		250			175		175	1,500		May 21
3,185	0		3,185	252	1,000	250		250			175		175	1,500		May 22
3,181	0		3,181	248	1,000	250		250			175		175	1,500		May 23
3,177	0		3,177	244	1,000	250		250			175		175	1,500		May 24
3,173	0		3,173	240	1,000	250		250			175		175	1,500		May 25
3,169	0		3,169	236	1,000	250		250			175		175	1,500		May 26
3,165	0		3,165	232	1,000	250		250			175		175	1,500		May 27
3,161	0		3,161	228	1,000	250		250			175		175	1,500		May 28
3,157	0		3,157	224	1,000	250		250			175		175	1,500		May 29
3,153	0		3,153	220	1,000	250		250			175		175	1,500		May 30
3,149	0		3,149	216	1,000	250		250			175		175	1,500		May 31
VAMP period																
4,246	204		4,450	348	1,000		204	454	0		1,148	0	1,148			Mean (cfs):
																Suppl. Water (TAF)
	12.52						12.52		0.00			0.00				Provided
	12.52						12.52		0.00			0.00				Target

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, MARCH 20

Pulse Period: April 15–May 15 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 700cfs

	San Joaquin River near Vernalis						Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin			
	Existing Flow	VAMP Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2-day lag)	Ungaged Flow above Vernalis	Existing Flow	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]	[calc]	[calc]					[calc]					[calc]			[calc]	
Apr 01					456	700	250		250			300		300	704		704	
Apr 02					452	700	250		250			300		300	704		704	
Apr 03					448	700	250		250			300		300	704		704	
Apr 04	2,406			2,406	444	700	250		250			300		300	704		704	
Apr 05	2,402			2,402	440	700	250		250			300		300	704		704	
Apr 06	2,398			2,398	436	700	250		250			300		300	704		704	
Apr 07	2,394			2,394	432	700	250		250			300		300	704		704	
Apr 08	2,390			2,390	428	700	250		250			300		300	704		704	
Apr 09	2,386			2,386	424	700	250		250			300		300	704		704	
Apr 10	2,382			2,382	420	700	250		250			300		300	704		704	
Apr 11	2,378	0		2,378	416	700	250	0	250			300		300	704		704	
Apr 12	2,374	0		2,374	412	700	250	450	700	0		300		300	704		704	M
Apr 13	2,370	0		2,370	408	700	250	530	780	0	510	540	0	540	704	0	704	M
Apr 14	2,366	0	0	2,366	404	700	250	530	780	0	510	540	0	540	704	0	704	M
Apr 15	2,602	450	0.89	3,052	400	700	250	530	780	0	510	540	0	540	780	0	780	M
Apr 16	2,598	530	1.94	3,128	396	700	250	530	780	0	510	540	0	540	780	0	780	M
Apr 17	2,670	530	3.00	3,200	392	700	250	530	780	0	510	540	0	540	780	0	780	M
Apr 18	2,666	530	4.05	3,196	388	700	250	530	780	0	510	540	0	540	780	0	780	M
Apr 19	2,662	530	5.10	3,192	384	700	250	530	780	0	510	540	0	540	780	0	780	
Apr 20	2,658	530	6.15	3,188	380	700	250	530	780	0	510	540	0	540	780	0	780	
Apr 21	2,654	530	7.20	3,184	376	700	250	310	560	0	510	540	0	540	780	0	780	
Apr 22	2,650	530	8.25	3,180	372	700	250	0	250	0	775	790	0	790	780	0	780	
Apr 23	2,646	530	9.30	3,176	368	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	
Apr 24	2,892	310	9.92	3,202	364	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	
Apr 25	3,298	0	9.92	3,298	360	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	T
Apr 26	3,294	0	9.92	3,294	356	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	T
Apr 27	3,290	0	9.92	3,290	352	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	T
Apr 28	3,286	0	9.92	3,286	348	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	T
Apr 29	3,282	0	9.92	3,282	344	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	T
Apr 30	3,278	0	9.92	3,278	340	700	250	0	250	0	1,260	1,200	0	1,200	780	0	780	T
May 01	3,274	0	9.92	3,274	336	700	250	0	250	0	1,260	1,200	0	1,200	758	0	758	T
May 02	3,270	0	9.92	3,270	332	700	250	370	620	0	1,260	1,200	0	1,200	758	0	758	T
May 03	3,244	0	9.92	3,244	328	700	250	600	850	0	775	790	0	790	758	0	758	T
May 04	3,240	0	9.92	3,240	324	700	250	620	870	0	510	540	0	540	758	0	758	M
May 05	2,826	370	10.65	3,196	320	700	250	620	870	0	510	540	0	540	758	0	758	M
May 06	2,572	600	11.84	3,172	316	700	250	620	870	0	510	540	0	540	758	0	758	M
May 07	2,568	620	13.07	3,188	312	700	250	620	870	0	510	540	0	540	758	0	758	M
May 08	2,564	620	14.30	3,184	308	700	250	620	870	0	510	540	0	540	758	0	758	M
May 09	2,560	620	15.53	3,180	304	700	250	620	870	0	510	540	0	540	758	0	758	M
May 10	2,556	620	16.76	3,176	300	700	250	620	870	0	510	540	0	540	758	0	758	M
May 11	2,552	620	17.99	3,172	296	700	250	620	870	0	510	540	0	540	758	0	758	M
May 12	2,548	620	19.22	3,168	292	700	250	450	700	0	510	540	0	540	758	0	758	
May 13	2,544	620	20.45	3,164	288	700	250	0	250		510	540	0	540	758	0	758	
May 14	2,540	620	21.68	3,160	284	700	250	0	250		345	345		345	758		758	
May 15	2,536	450	22.57	2,986	280	700	250		250			175		175	758		758	
May 16	2,337	0		2,337	276	700	250		250			175		175	694		694	
May 17	2,163	0		2,163	272	700	250		250			175		175	694		694	
May 18	2,095	0		2,095	268	700	250		250			175		175	694		694	
May 19	2,091	0		2,091	264	700	250		250			175		175	694		694	
May 20	2,087	0		2,087	260	700	250		250			175		175	694		694	
May 21	2,083	0		2,083	256	700	250		250			175		175	694		694	
May 22	2,079	0		2,079	252	700	250		250			175		175	694		694	
May 23	2,075	0		2,075	248	700	250		250			175		175	694		694	
May 24	2,071	0		2,071	244	700	250		250			175		175	694		694	
May 25	2,067	0		2,067	240	700	250		250			175		175	694		694	
May 26	2,063	0		2,063	236	700	250		250			175		175	694		694	
May 27	2,059	0		2,059	232	700	250		250			175		175	694		694	
May 28	2,055	0		2,055	228	700	250		250			175		175	694		694	
May 29	2,051	0		2,051	224	700	250		250			175		175	694		694	
May 30	2,047	0		2,047	220	700	250		250			175		175	694		694	
May 31	2,043	0		2,043	216	700	250		250			175		175	694		694	
	VAMP period																	
Mean (cfs):	2,833	367		3,200	348	700		367	617	0		769	0	769		0	766	
Suppl. Water (TAF)																		
Provided		22.57						22.57		0.00			0.00			0.00		
Target		22.57						22.57		0.00			0.00			0.00		

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, MARCH 20

Pulse Period: April 15–May 15 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 1,000cfs

San Joaquin River near Vernalis						Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin				
Existing Flow	VAMP Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2-day lag)	Ungaged Flow above Vernalis	Existing Flow	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.	
(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		
[calc]	[calc]	[calc]	[calc]					[calc]					[calc]			[calc]		
				456	1,000	250		250			300		300	704		704		Apr 01
				452	1,000	250		250			300		300	704		704		Apr 02
				448	1,000	250		250			300		300	704		704		Apr 03
2,706			2,706	444	1,000	250		250			300		300	704		704		Apr 04
2,702			2,702	440	1,000	250		250			300		300	704		704		Apr 05
2,698			2,698	436	1,000	250		250			300		300	704		704		Apr 06
2,694			2,694	432	1,000	250		250			300		300	704		704		Apr 07
2,690			2,690	428	1,000	250		250			300		300	704		704		Apr 08
2,686			2,686	424	1,000	250		250			300		300	704		704		Apr 09
2,682			2,682	420	1,000	250		250			300		300	704		704		Apr 10
2,678	0		2,678	416	1,000	250	0	250			300		300	704		704		Apr 11
2,674	0		2,674	412	1,000	250	55	305	0		300		300	704		704	M	Apr 12
2,670	0		2,670	408	1,000	250	55	305	0	510	720	0	720	704	0	704	M	Apr 13
2,666	0	0	2,666	404	1,000	250	55	305	0	510	720	0	720	704	0	704	M	Apr 14
3,082	55	0.11	3,137	400	1,000	250	55	305	0	510	720	0	720	780	0	780	M	Apr 15
3,078	55	0.22	3,133	396	1,000	250	55	305	0	510	720	0	720	780	0	780	M	Apr 16
3,150	55	0.33	3,205	392	1,000	250	55	305	0	510	720	0	720	780	0	780	M	Apr 17
3,146	55	0.44	3,201	388	1,000	250	55	305	0	510	720	0	720	780	0	780	M	Apr 18
3,142	55	0.55	3,197	384	1,000	250	50	300	0	510	720	0	720	780	0	780		Apr 19
3,138	55	0.65	3,193	380	1,000	250	50	300	0	510	720	0	720	780	0	780		Apr 20
3,134	55	0.76	3,189	376	1,000	250	0	250	0	510	720	0	720	780	0	780		Apr 21
3,130	50	0.86	3,180	372	1,000	250	0	250	0	775	800	0	800	780	0	780		Apr 22
3,126	50	0.96	3,176	368	1,000	250	0	250	0	1,260	860	0	860	780	0	780		Apr 23
3,202	0	0.96	3,202	364	1,000	250	0	250	0	1,260	860	0	860	780	0	780		Apr 24
3,258	0	0.96	3,258	360	1,000	250	0	250	0	1,260	860	0	860	780	0	780	T	Apr 25
3,254	0	0.96	3,254	356	1,000	250	0	250	0	1,260	860	0	860	780	0	780	T	Apr 26
3,250	0	0.96	3,250	352	1,000	250	0	250	0	1,260	860	0	860	780	0	780	T	Apr 27
3,246	0	0.96	3,246	348	1,000	250	0	250	0	1,260	860	0	860	780	0	780	T	Apr 28
3,242	0	0.96	3,242	344	1,000	250	0	250	0	1,260	860	0	860	780	0	780	T	Apr 29
3,238	0	0.96	3,238	340	1,000	250	0	250	0	1,260	860	0	860	780	0	780	T	Apr 30
3,234	0	0.96	3,234	336	1,000	250	0	250	0	1,260	860	0	860	758	0	758	T	May 01
3,230	0	0.96	3,230	332	1,000	250	0	250	0	1,260	860	0	860	758	0	758	T	May 02
3,204	0	0.96	3,204	328	1,000	250	160	410	0	775	860	0	860	758	0	758	T	May 03
3,200	0	0.96	3,200	324	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 04
3,196	0	0.96	3,196	320	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 05
3,042	160	1.28	3,202	316	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 06
3,038	160	1.60	3,198	312	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 07
3,034	160	1.91	3,194	308	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 08
3,030	160	2.23	3,190	304	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 09
3,026	160	2.55	3,186	300	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 10
3,022	160	2.87	3,182	296	1,000	250	160	410	0	510	710	0	710	758	0	758	M	May 11
3,018	160	3.18	3,178	292	1,000	250	160	410	0	510	710	0	710	758	0	758		May 12
3,014	160	3.50	3,174	288	1,000	250	0	250		510	710	0	710	758	0	758		May 13
3,010	160	3.82	3,170	284	1,000	250	0	250		345	345		345	758		758		May 14
3,006	160	4.14	3,166	280	1,000	250		250			175		175	758		758		May 15
2,637	0		2,637	276	1,000	250		250			175		175	694		694		May 16
2,463	0		2,463	272	1,000	250		250			175		175	694		694		May 17
2,395	0		2,395	268	1,000	250		250			175		175	694		694		May 18
2,391	0		2,391	264	1,000	250		250			175		175	694		694		May 19
2,387	0		2,387	260	1,000	250		250			175		175	694		694		May 20
2,383	0		2,383	256	1,000	250		250			175		175	694		694		May 21
2,379	0		2,379	252	1,000	250		250			175		175	694		694		May 22
2,375	0		2,375	248	1,000	250		250			175		175	694		694		May 23
2,371	0		2,371	244	1,000	250		250			175		175	694		694		May 24
2,367	0		2,367	240	1,000	250		250			175		175	694		694		May 25
2,363	0		2,363	236	1,000	250		250			175		175	694		694		May 26
2,359	0		2,359	232	1,000	250		250			175		175	694		694		May 27
2,355	0		2,355	228	1,000	250		250			175		175	694		694		May 28
2,351	0		2,351	224	1,000	250		250			175		175	694		694		May 29
2,347	0		2,347	220	1,000	250		250			175		175	694		694		May 30
2,343	0		2,343	216	1,000	250		250			175		175	694		694		May 31
VAMP period																		
3,133	67		3,200	348	1,000		67	317	0		769	0	769		0	766		Mean (cfs):
																		Suppl. Water (TAF)
	4.14						4.14		0.00			0.00			0.00			Provided
	4.13						4.13		0.00			0.00			0.00			Target

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, MARCH 23

Pulse Period: April 15–May 15 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 500cfs

	San Joaquin River near Vernalis						Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin			
	Existing Flow	VAMP Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2-day lag)	Ungaged Flow above Vernalis	Existing Flow	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]	[calc]	[calc]					[calc]					[calc]			[calc]	
Apr 01					456	500	250		250			300		300	704		704	
Apr 02					452	500	250		250			300		300	704		704	
Apr 03					448	500	250		250			300		300	704		704	
Apr 04	2,206			2,206	444	500	250		250			300		300	704		704	
Apr 05	2,202			2,202	440	500	250		250			300		300	704		704	
Apr 06	2,198			2,198	436	500	250		250			300		300	704		704	
Apr 07	2,194			2,194	432	500	250		250			300		300	704		704	
Apr 08	2,190			2,190	428	500	250		250			300		300	704		704	
Apr 09	2,186			2,186	424	500	250		250			300		300	704		704	
Apr 10	2,182			2,182	420	500	250		250			300		300	704		704	
Apr 11	2,178	0		2,178	416	500	250	0	250			300		300	704		704	
Apr 12	2,174	0		2,174	412	500	250	600	850	0		300		300	704		704	M
Apr 13	2,170	0		2,170	408	500	250	600	850	0	510	510	0	510	704	230	934	M
Apr 14	2,166	0	0	2,166	404	500	250	580	830	0	510	510	0	510	704	230	934	M
Apr 15	2,372	830	1.65	3,202	400	500	250	580	830	0	510	510	0	510	780	200	980	M
Apr 16	2,368	830	3.29	3,198	396	500	250	580	830	0	510	510	0	510	780	200	980	M
Apr 17	2,440	780	4.84	3,220	392	500	250	580	830	0	510	510	0	510	780	200	980	M
Apr 18	2,436	780	6.39	3,216	388	500	250	580	830	0	510	510	0	510	780	200	980	M
Apr 19	2,432	780	7.93	3,212	384	500	250	580	830	0	510	510	0	510	780	200	980	
Apr 20	2,428	780	9.48	3,208	380	500	250	580	830	0	510	510	0	510	780	200	980	
Apr 21	2,424	780	11.03	3,204	376	500	250	320	570	0	510	510	0	510	780	200	980	
Apr 22	2,420	780	12.58	3,200	372	500	250	0	250	0	775	775	0	775	780	200	980	
Apr 23	2,416	780	14.12	3,196	368	500	250	0	250	0	1,260	1,260	0	1,260	780	60	840	
Apr 24	2,677	520	15.15	3,197	364	500	250	0	250	0	1,260	1,260	0	1,260	780	60	840	
Apr 25	3,158	60	15.27	3,218	360	500	250	0	250	0	1,260	1,260	0	1,260	780	60	840	T
Apr 26	3,154	60	15.39	3,214	356	500	250	0	250	0	1,260	1,260	0	1,260	780	60	840	T
Apr 27	3,150	60	15.51	3,210	352	500	250	0	250	0	1,260	1,260	0	1,260	780	60	840	T
Apr 28	3,146	60	15.63	3,206	348	500	250	0	250	0	1,260	1,260	0	1,260	780	60	840	T
Apr 29	3,142	60	15.75	3,202	344	500	250	0	250	0	1,260	1,260	0	1,260	780	65	845	T
Apr 30	3,138	60	15.87	3,198	340	500	250	0	250	0	1,260	1,260	0	1,260	780	70	850	T
May 01	3,134	65	16.00	3,199	336	500	250	0	250	0	1,260	1,260	0	1,260	758	100	858	T
May 02	3,130	70	16.14	3,200	332	500	250	395	645	0	1,260	1,260	0	1,260	758	100	858	T
May 03	3,104	100	16.33	3,204	328	500	250	670	920	0	775	775	0	775	758	195	953	T
May 04	3,100	100	16.53	3,200	324	500	250	670	920	0	510	510	0	510	758	190	948	M
May 05	2,611	590	17.70	3,201	320	500	250	670	920	0	510	510	0	510	758	190	948	M
May 06	2,342	860	19.41	3,202	316	500	250	670	920	0	510	510	0	510	758	195	953	M
May 07	2,338	860	21.11	3,198	312	500	250	670	920	0	510	510	0	510	758	200	958	M
May 08	2,334	865	22.83	3,199	308	500	250	670	920	0	510	510	0	510	758	205	963	M
May 09	2,330	870	24.56	3,200	304	500	250	670	920	0	510	510	0	510	758	205	963	M
May 10	2,326	875	26.29	3,201	300	500	250	670	920	0	510	510	0	510	758	210	968	M
May 11	2,322	875	28.03	3,197	296	500	250	670	920	0	510	510	0	510	758	210	968	M
May 12	2,318	880	29.77	3,198	292	500	250	600	850	0	510	510	0	510	758	210	968	
May 13	2,314	880	31.52	3,194	288	500	250	0	250		510	510	0	510	758	210	968	
May 14	2,310	880	33.26	3,190	284	500	250	0	250		345	345		345	758		758	
May 15	2,306	810	34.87	3,116	280	500	250		250			175		175	758		758	
May 16	2,137	0		2,137	276	500	250		250			175		175	694		694	
May 17	1,963	0		1,963	272	500	250		250			175		175	694		694	
May 18	1,895	0		1,895	268	500	250		250			175		175	694		694	
May 19	1,891	0		1,891	264	500	250		250			175		175	694		694	
May 20	1,887	0		1,887	260	500	250		250			175		175	694		694	
May 21	1,883	0		1,883	256	500	250		250			175		175	694		694	
May 22	1,879	0		1,879	252	500	250		250			175		175	694		694	
May 23	1,875	0		1,875	248	500	250		250			175		175	694		694	
May 24	1,871	0		1,871	244	500	250		250			175		175	694		694	
May 25	1,867	0		1,867	240	500	250		250			175		175	694		694	
May 26	1,863	0		1,863	236	500	250		250			175		175	694		694	
May 27	1,859	0		1,859	232	500	250		250			175		175	694		694	
May 28	1,855	0		1,855	228	500	250		250			175		175	694		694	
May 29	1,851	0		1,851	224	500	250		250			175		175	694		694	
May 30	1,847	0		1,847	220	500	250		250			175		175	694		694	
May 31	1,843	0		1,843	216	500	250		250			175		175	694		694	
VAMP period																		
Mean (cfs):	2,633	567		3,200	348	500		407	657	0		769	0	769		160	926	
Suppl. Water (TAF) Provided		34.87						25.00		0.00			0.00			9.87		
Target		34.87						25.00		0.00			0.00			9.87		

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 3

Pulse Period: April 15–May 15 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 500cfs • 24 TAF "other" supplemental water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	b(2) or other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	447	408	350		350			347		347	569			569	
Apr 02					2,069	451	490	340		340			350		350	572			572	
Apr 03						448	500	250		250			300		300	704			704	
Apr 04	2,223				2,223	444	500	250		250			300		300	704			704	
Apr 05	2,292				2,292	440	500	250		250			300		300	704			704	
Apr 06	2,198				2,198	436	500	250		250			300		300	704			704	
Apr 07	2,194				2,194	432	500	250		250			300		300	704			704	
Apr 08	2,190				2,190	428	500	250		250			300		300	704			704	
Apr 09	2,186				2,186	424	500	250		250			300		300	704			704	
Apr 10	2,182				2,182	420	500	250		250			300		300	704			704	
Apr 11	2,178	0			2,178	416	500	250	0	250			300		300	704			704	
Apr 12	2,174	0			2,174	412	500	250	440	690	0		300		300	704			704	M
Apr 13	2,170	0			2,170	408	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M
Apr 14	2,166	0		0	2,166	404	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M
Apr 15	2,448	440	720	0.87	3,608	400	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M
Apr 16	2,444	440	720	1.75	3,604	396	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M
Apr 17	2,440	440	720	2.62	3,600	392	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M
Apr 18	2,436	440	720	3.49	3,596	388	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M
Apr 19	2,432	440	720	4.36	3,592	384	500	250	440	690	0	510	510	0	510	780	0	720	1,500	
Apr 20	2,428	440	720	5.24	3,588	380	500	250	440	690	0	510	510	0	510	780	0	720	1,500	
Apr 21	2,424	440	720	6.11	3,584	376	500	250	440	690	0	510	510	0	510	780	0	720	1,500	
Apr 22	2,420	440	720	6.98	3,580	372	500	250	240	490	0	775	775	0	775	780	0	420	1,200	
Apr 23	2,416	440	720	7.85	3,576	368	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	
Apr 24	2,677	440	420	8.73	3,537	364	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	
Apr 25	3,158	440	0	9.60	3,598	360	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	T
Apr 26	3,154	440	0	10.47	3,594	356	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	T
Apr 27	3,150	440	0	11.35	3,590	352	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	T
Apr 28	3,146	440	0	12.22	3,586	348	500	250	290	540	0	1,260	1,260	0	1,260	780	200	0	980	T
Apr 29	3,142	440	0	13.09	3,582	344	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T
Apr 30	3,138	440	0	13.96	3,578	340	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T
May 01	3,112	490	0	14.94	3,602	336	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T
May 02	3,108	490	0	15.91	3,598	332	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T
May 03	3,104	490	0	16.88	3,594	328	500	250	540	790	0	775	775	0	775	758	645	0	1,403	T
May 04	3,100	490	0	17.85	3,590	324	500	250	540	790	0	510	510	0	510	758	742	0	1,500	M
May 05	2,611	935	0	19.71	3,546	320	500	250	540	790	0	510	510	0	510	758	742	0	1,500	M
May 06	2,342	1,282	0	22.25	3,624	316	500	250	540	790	0	510	510	0	510	758	742	0	1,500	M
May 07	2,338	1,282	0	24.79	3,620	312	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M
May 08	2,334	1,282	0	27.33	3,616	308	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M
May 09	2,330	540	742	28.41	3,612	304	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M
May 10	2,326	540	742	29.48	3,608	300	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M
May 11	2,322	540	742	30.55	3,604	296	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M
May 12	2,318	540	742	31.62	3,600	292	500	250	455	705	0	510	510	0	510	758	0	742	1,500	
May 13	2,314	540	742	32.69	3,596	288	500	250	0	250		510	510	0	510	758	0	742	1,500	
May 14	2,310	540	742	33.76	3,592	284	500	250	0	250		345	345		345	694			694	
May 15	2,306	455	742	34.66	3,503	280	500	250		250			175		175	694			694	
May 16	2,073	0			2,073	276	500	250		250			175		175	694			694	
May 17	1,899	0			1,899	272	500	250		250			175		175	694			694	
May 18	1,895	0			1,895	268	500	250		250			175		175	694			694	
May 19	1,891	0			1,891	264	500	250		250			175		175	694			694	
May 20	1,887	0			1,887	260	500	250		250			175		175	694			694	
May 21	1,883	0			1,883	256	500	250		250			175		175	694			694	
May 22	1,879	0			1,879	252	500	250		250			175		175	694			694	
May 23	1,875	0			1,875	248	500	250		250			175		175	694			694	
May 24	1,871	0			1,871	244	500	250		250			175		175	694			694	
May 25	1,867	0			1,867	240	500	250		250			175		175	694			694	
May 26	1,863	0			1,863	236	500	250		250			175		175	694			694	
May 27	1,859	0			1,859	232	500	250		250			175		175	694			694	
May 28	1,855	0			1,855	228	500	250		250			175		175	694			694	
May 29	1,851	0			1,851	224	500	250		250			175		175	694			694	
May 30	1,847	0			1,847	220	500	250		250			175		175	694			694	
May 31	1,843	0			1,843	216	500	250		250			175		175	694			694	
VAMP period																				
Mean (cfs):	2,636	564			3,590	348	500		407	657	0		769	0	769		157	390	1,317	
Suppl. Water (TAF) Provided		34.66							25.00		0.00			0.00			9.66	23.99		
Target		34.66							25.00		0.00			0.00			9.66			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 3

Pulse Period: April 15–May 15 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 1,000cfs • 45 TAF "other" supplemental water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	b(2) or other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	447	408	350		350			347		347	569			569	
Apr 02					2,069	451	490	340		340			350		350	572			572	
Apr 03						448	500	250		250			300		300	704			704	
Apr 04	2,223				2,223	444	500	250		250			300		300	704			704	
Apr 05	2,292				2,292	440	500	250		250			300		300	704			704	
Apr 06	2,198				2,198	436	500	250		250			300		300	704			704	
Apr 07	2,194				2,194	432	500	250		250			300		300	704			704	
Apr 08	2,190				2,190	428	500	250		250			300		300	704			704	
Apr 09	2,186				2,186	424	500	250		250			300		300	704			704	
Apr 10	2,182				2,182	420	500	250		250			300		300	704			704	
Apr 11	2,178	0			2,178	416	500	250	0	250			300		300	704			704	
Apr 12	2,174	0			2,174	412	500	250	0	250	0		300		300	704			704	M
Apr 13	2,170	0			2,170	408	500	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 14	2,166	0		0	2,166	404	500	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 15	2,948	0	720	0.00	3,668	400	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 16	2,944	0	720	0.00	3,664	396	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 17	2,940	0	720	0.00	3,660	392	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 18	2,936	0	720	0.00	3,656	388	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 19	2,932	0	720	0.00	3,652	384	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	
Apr 20	2,928	0	720	0.00	3,648	380	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	
Apr 21	2,924	0	720	0.00	3,644	376	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	
Apr 22	2,920	0	720	0.00	3,640	372	1,000	250	0	250	0	775	775	0	775	780	0	720	1,500	
Apr 23	2,916	0	720	0.00	3,636	368	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	
Apr 24	3,177	0	720	0.00	3,897	364	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	
Apr 25	3,658	0	720	0.00	4,378	360	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
Apr 26	3,654	0	720	0.00	4,374	356	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
Apr 27	3,650	0	720	0.00	4,370	352	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
Apr 28	3,646	0	720	0.00	4,366	348	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
Apr 29	3,642	0	720	0.00	4,362	344	1,000	250	0	250	0	1,260	1,260	0	1,260	758	0	742	1,500	T
Apr 30	3,638	0	720	0.00	4,358	340	1,000	250	0	250	0	1,260	1,260	0	1,260	758	0	742	1,500	T
May 01	3,612	0	742	0.00	4,354	336	1,000	250	0	250	0	1,260	1,260	0	1,260	758	0	742	1,500	T
May 02	3,608	0	742	0.00	4,350	332	1,000	250	0	250	0	1,260	1,260	0	1,260	758	0	742	1,500	T
May 03	3,604	0	742	0.00	4,346	328	1,000	250	210	460	0	775	775	0	775	758	0	742	1,500	T
May 04	3,600	0	742	0.00	4,342	324	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 05	3,111	0	742	0.00	3,853	320	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 06	2,842	210	742	0.42	3,794	316	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 07	2,838	220	742	0.85	3,800	312	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 08	2,834	220	742	1.29	3,796	308	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 09	2,830	220	742	1.73	3,792	304	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 10	2,826	220	742	2.16	3,788	300	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 11	2,822	220	742	2.60	3,784	296	1,000	250	220	470	0	510	510	0	510	758	0	742	1,500	M
May 12	2,818	220	742	3.03	3,780	292	1,000	250	0	250	0	510	510	0	510	758	0	742	1,500	
May 13	2,814	220	742	3.47	3,776	288	1,000	250	0	250		510	510	0	510	758	0	742	1,500	
May 14	2,810	220	742	3.91	3,772	284	1,000	250	0	250		345	345		345	694			694	
May 15	2,806	0	742	3.91	3,548	280	1,000	250		250			175		175	694			694	
May 16	2,573	0			2,573	276	1,000	250		250			175		175	694			694	
May 17	2,399	0			2,399	272	1,000	250		250			175		175	694			694	
May 18	2,395	0			2,395	268	1,000	250		250			175		175	694			694	
May 19	2,391	0			2,391	264	1,000	250		250			175		175	694			694	
May 20	2,387	0			2,387	260	1,000	250		250			175		175	694			694	
May 21	2,383	0			2,383	256	1,000	250		250			175		175	694			694	
May 22	2,379	0			2,379	252	1,000	250		250			175		175	694			694	
May 23	2,375	0			2,375	248	1,000	250		250			175		175	694			694	
May 24	2,371	0			2,371	244	1,000	250		250			175		175	694			694	
May 25	2,367	0			2,367	240	1,000	250		250			175		175	694			694	
May 26	2,363	0			2,363	236	1,000	250		250			175		175	694			694	
May 27	2,359	0			2,359	232	1,000	250		250			175		175	694			694	
May 28	2,355	0			2,355	228	1,000	250		250			175		175	694			694	
May 29	2,351	0			2,351	224	1,000	250		250			175		175	694			694	
May 30	2,347	0			2,347	220	1,000	250		250			175		175	694			694	
May 31	2,343	0			2,343	216	1,000	250		250			175		175	694			694	
											VAMP period									
Mean (cfs):	3,136	64			3,931	348	1,000		64	314	0		769	0	769		0	731	1,500	
Suppl. Water (TAF)																				
Provided		3.91							3.91		0.00			0.00			0.00	44.93		
Target		3.91							3.91		0.00			0.00			0.00			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 3

Pulse Period: April 15–May 15 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 500cfs • 45 TAF "other" supplemental water on Stanislaus R.

San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)					
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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.	
(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		
[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]		
				2,071	447	408	350		350			347		347	569			569		Apr 01
				2,069	451	490	340		340			350		350	572			572		Apr 02
					448	500	250		250			300		300	704			704		Apr 03
2,223				2,223	444	500	250		250			300		300	704			704		Apr 04
2,292				2,292	440	500	250		250			300		300	704			704		Apr 05
2,198				2,198	436	500	250		250			300		300	704			704		Apr 06
2,194				2,194	432	500	250		250			300		300	704			704		Apr 07
2,190				2,190	428	500	250		250			300		300	704			704		Apr 08
2,186				2,186	424	500	250		250			300		300	704			704		Apr 09
2,182				2,182	420	500	250		250			300		300	704			704		Apr 10
2,178	0			2,178	416	500	250	0	250			300		300	704			704		Apr 11
2,174	0			2,174	412	500	250	550	800	0		300		300	704			704	M	Apr 12
2,170	0			2,170	408	500	250	700	950	0	510	510	90	600	780	0	720	1,500	M	Apr 13
2,166	0		0	2,166	404	500	250	700	950	0	510	510	100	610	780	0	720	1,500	M	Apr 14
2,448	640	720	1.27	3,808	400	500	250	700	950	0	510	510	100	610	780	0	720	1,500	M	Apr 15
2,444	800	720	2.86	3,964	396	500	250	700	950	0	510	510	100	610	780	0	720	1,500	M	Apr 16
2,440	800	720	4.44	3,960	392	500	250	700	950	0	510	510	100	610	780	0	720	1,500	M	Apr 17
2,436	800	720	6.03	3,956	388	500	250	700	950	0	510	510	100	610	780	0	720	1,500	M	Apr 18
2,432	800	720	7.62	3,952	384	500	250	580	830	0	510	510	100	610	780	0	720	1,500		Apr 19
2,428	800	720	9.20	3,948	380	500	250	430	680	0	510	510	235	745	780	0	720	1,500		Apr 20
2,424	800	720	10.79	3,944	376	500	250	230	480	0	510	510	390	900	780	0	720	1,500		Apr 21
2,420	815	720	12.41	3,955	372	500	250	80	330	0	775	775	325	1,100	780	0	720	1,500		Apr 22
2,416	820	720	14.03	3,956	368	500	250	80	330	0	1,260	1,260	0	1,260	780	0	720	1,500		Apr 23
2,677	555	720	15.13	3,952	364	500	250	80	330	0	1,260	1,260	0	1,260	780	0	720	1,500		Apr 24
3,158	80	720	15.29	3,958	360	500	250	80	330	0	1,260	1,260	0	1,260	780	0	720	1,500	T	Apr 25
3,154	80	720	15.45	3,954	356	500	250	80	330	0	1,260	1,260	0	1,260	780	0	720	1,500	T	Apr 26
3,150	80	720	15.61	3,950	352	500	250	80	330	0	1,260	1,260	0	1,260	780	0	720	1,500	T	Apr 27
3,146	80	720	15.77	3,946	348	500	250	80	330	0	1,260	1,260	0	1,260	780	0	720	1,500	T	Apr 28
3,142	80	720	15.93	3,942	344	500	250	80	330	0	1,260	1,260	0	1,260	758	0	742	1,500	T	Apr 29
3,138	80	720	16.09	3,938	340	500	250	100	350	0	1,260	1,260	0	1,260	758	0	742	1,500	T	Apr 30
3,112	80	742	16.24	3,934	336	500	250	100	350	0	1,260	1,260	0	1,260	758	0	742	1,500	T	May 01
3,108	80	742	16.40	3,930	332	500	250	550	800	0	1,260	1,260	0	1,260	758	0	742	1,500	T	May 02
3,104	100	742	16.60	3,946	328	500	250	650	900	0	775	775	0	775	758	0	742	1,500	T	May 03
3,100	100	742	16.80	3,942	324	500	250	680	930	0	510	510	190	700	758	0	742	1,500	M	May 04
2,611	550	742	17.89	3,903	320	500	250	680	930	0	510	510	190	700	758	0	742	1,500	M	May 05
2,342	840	742	19.56	3,924	316	500	250	690	940	0	510	510	190	700	758	0	742	1,500	M	May 06
2,338	870	742	21.28	3,950	312	500	250	700	950	0	510	510	190	700	758	0	742	1,500	M	May 07
2,334	870	742	23.01	3,946	308	500	250	700	950	0	510	510	190	700	758	0	742	1,500	M	May 08
2,330	880	742	24.75	3,952	304	500	250	700	950	0	510	510	190	700	758	0	742	1,500	M	May 09
2,326	890	742	26.52	3,958	300	500	250	700	950	0	510	510	190	700	758	0	742	1,500	M	May 10
2,322	890	742	28.28	3,954	296	500	250	700	950	0	510	510	190	700	758	0	742	1,500	M	May 11
2,318	890	742	30.05	3,950	292	500	250	350	600	0	510	510	190	700	758	0	742	1,500		May 12
2,314	890	742	31.81	3,946	288	500	250	0	250		510	510	190	700	758	0	742	1,500		May 13
2,310	890	742	33.58	3,942	284	500	250	0	250		345	345		345	694			694		May 14
2,306	540	742	34.65	3,588	280	500	250		250			175		175	694			694		May 15
2,073	0			2,073	276	500	250		250			175		175	694			694		May 16
1,899	0			1,899	272	500	250		250			175		175	694			694		May 17
1,895	0			1,895	268	500	250		250			175		175	694			694		May 18
1,891	0			1,891	264	500	250		250			175		175	694			694		May 19
1,887	0			1,887	260	500	250		250			175		175	694			694		May 20
1,883	0			1,883	256	500	250		250			175		175	694			694		May 21
1,879	0			1,879	252	500	250		250			175		175	694			694		May 22
1,875	0			1,875	248	500	250		250			175		175	694			694		May 23
1,871	0			1,871	244	500	250		250			175		175	694			694		May 24
1,867	0			1,867	240	500	250		250			175		175	694			694		May 25
1,863	0			1,863	236	500	250		250			175		175	694			694		May 26
1,859	0			1,859	232	500	250		250			175		175	694			694		May 27
1,855	0			1,855	228	500	250		250			175		175	694			694		May 28
1,851	0			1,851	224	500	250		250			175		175	694			694		May 29
1,847	0			1,847	220	500	250		250			175		175	694			694		May 30
1,843	0			1,843	216	500	250		250			175		175	694			694		May 31
										VAMP period										
2,636	564			3,931	348	500		449	699	0		769	114	883		0	731	1,500		Mean (cfs):
																				Suppl. Water (TAF)
	34.65							27.63		0.00			7.02			0.00	44.93			Provided
	34.66							27.63		0.00			7.02			0.00				Target

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 3

Pulse Period: April 17–May 17 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 1,000cfs • 45 TAF "other" supplemental water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	b(2) or other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	447	408	350		350			347		347	569			569	
Apr 02					2,069	451	490	340		340			350		350	572			572	
Apr 03						448	500	250		250			300		300	704			704	
Apr 04	2,223				2,223	444	500	250		250			300		300	704			704	
Apr 05	2,292				2,292	440	500	250		250			300		300	704			704	
Apr 06	2,198				2,198	436	500	250		250			300		300	704			704	
Apr 07	2,194				2,194	432	500	250		250			300		300	704			704	
Apr 08	2,190				2,190	428	500	250		250			300		300	704			704	
Apr 09	2,186				2,186	424	500	250		250			300		300	704			704	
Apr 10	2,182				2,182	420	500	250		250			300		300	704			704	
Apr 11	2,178				2,178	416	500	250		250			300		300	704			704	
Apr 12	2,174				2,174	412	500	250		250			300		300	704			704	
Apr 13	2,670	0			2,670	408	1,000	250	0	250			300		300	704			704	
Apr 14	2,666	0			2,666	404	1,000	250	0	250	0		300		300	704			704	M
Apr 15	2,662	0			2,662	400	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 16	2,658	0		0	2,658	396	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 17	2,940	0	720	0.00	3,660	392	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 18	2,936	0	720	0.00	3,656	388	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 19	2,932	0	720	0.00	3,652	384	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 20	2,928	0	720	0.00	3,648	380	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	M
Apr 21	2,924	0	720	0.00	3,644	376	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	
Apr 22	2,920	0	720	0.00	3,640	372	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	
Apr 23	2,916	0	720	0.00	3,636	368	1,000	250	0	250	0	510	510	0	510	780	0	720	1,500	
Apr 24	2,912	0	720	0.00	3,632	364	1,000	250	0	250	0	775	775	0	775	780	0	720	1,500	
Apr 25	2,908	0	720	0.00	3,628	360	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	
Apr 26	3,169	0	720	0.00	3,889	356	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	
Apr 27	3,650	0	720	0.00	4,370	352	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
Apr 28	3,646	0	720	0.00	4,366	348	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
Apr 29	3,642	0	720	0.00	4,362	344	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
Apr 30	3,638	0	720	0.00	4,358	340	1,000	250	0	250	0	1,260	1,260	0	1,260	780	0	720	1,500	T
May 01	3,634	0	720	0.00	4,354	336	1,000	250	0	250	0	1,260	1,260	0	1,260	758	0	742	1,500	T
May 02	3,630	0	720	0.00	4,350	332	1,000	250	0	250	0	1,260	1,260	0	1,260	758	0	742	1,500	T
May 03	3,604	0	742	0.00	4,346	328	1,000	250	0	250	0	1,260	1,260	0	1,260	758	0	742	1,500	T
May 04	3,600	0	742	0.00	4,342	324	1,000	250	170	420	0	1,260	1,260	0	1,260	758	0	742	1,500	T
May 05	3,596	0	742	0.00	4,338	320	1,000	250	210	460	0	775	775	0	775	758	0	742	1,500	T
May 06	3,592	0	742	0.00	4,334	316	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 07	3,103	170	742	0.34	4,015	312	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 08	2,834	210	742	0.75	3,786	308	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 09	2,830	230	742	1.21	3,802	304	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 10	2,826	230	742	1.67	3,798	300	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 11	2,822	230	742	2.12	3,794	296	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 12	2,818	230	742	2.58	3,790	292	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 13	2,814	230	742	3.03	3,786	288	1,000	250	230	480	0	510	510	0	510	758	0	742	1,500	M
May 14	2,810	230	742	3.49	3,782	284	1,000	250	0	250	0	510	510	0	510	758	0	742	1,500	
May 15	2,806	230	742	3.95	3,778	280	1,000	250	0	250		510	510	0	510	758	0	742	1,500	
May 16	2,802	230	742	4.40	3,774	276	1,000	250	0	250		345	345		345	694			694	
May 17	2,798	0	742	4.40	3,540	272	1,000	250		250			175		175	694			694	
May 18	2,565	0			2,565	268	1,000	250		250			175		175	694			694	
May 19	2,391	0			2,391	264	1,000	250		250			175		175	694			694	
May 20	2,387	0			2,387	260	1,000	250		250			175		175	694			694	
May 21	2,383	0			2,383	256	1,000	250		250			175		175	694			694	
May 22	2,379	0			2,379	252	1,000	250		250			175		175	694			694	
May 23	2,375	0			2,375	248	1,000	250		250			175		175	694			694	
May 24	2,371	0			2,371	244	1,000	250		250			175		175	694			694	
May 25	2,367	0			2,367	240	1,000	250		250			175		175	694			694	
May 26	2,363	0			2,363	236	1,000	250		250			175		175	694			694	
May 27	2,359	0			2,359	232	1,000	250		250			175		175	694			694	
May 28	2,355	0			2,355	228	1,000	250		250			175		175	694			694	
May 29	2,351	0			2,351	224	1,000	250		250			175		175	694			694	
May 30	2,347	0			2,347	220	1,000	250		250			175		175	694			694	
May 31	2,343	0			2,343	216	1,000	250		250			175		175	694			694	
	VAMP period																			
Mean (cfs):	3,128	72			3,931	340	1,000		72	322	0		769	0	769		0	731	1,500	
Suppl. Water (TAF)																				
Provided		4.40							4.40		0.00			0.00			0.00	44.93		
Target		4.40							4.40		0.00			0.00			0.00			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 3

Pulse Period: April 17–May 17 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 500cfs • 24 TAF "other" supplemental water on Stanislaus R.

San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)					
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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	b(2) or other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.	
(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		
[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]		
				2,071	447	408	350		350			347		347	569			569		Apr 01
				2,069	451	490	340		340			350		350	572			572		Apr 02
					448	500	250		250			300		300	704			704		Apr 03
2,223				2,223	444	500	250		250			300		300	704			704		Apr 04
2,292				2,292	440	500	250		250			300		300	704			704		Apr 05
2,198				2,198	436	500	250		250			300		300	704			704		Apr 06
2,194				2,194	432	500	250		250			300		300	704			704		Apr 07
2,190				2,190	428	500	250		250			300		300	704			704		Apr 08
2,186				2,186	424	500	250		250			300		300	704			704		Apr 09
2,182				2,182	420	500	250		250			300		300	704			704		Apr 10
2,178				2,178	416	500	250		250			300		300	704			704		Apr 11
2,174				2,174	412	500	250		250			300		300	704			704		Apr 12
2,170	0			2,170	408	500	250	0	250			300		300	704			704		Apr 13
2,166	0			2,166	404	500	250	440	690	0		300		300	704			704	M	Apr 14
2,162	0			2,162	400	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M	Apr 15
2,158	0		0	2,158	396	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M	Apr 16
2,440	440	720	0.87	3,600	392	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M	Apr 17
2,436	440	720	1.75	3,596	388	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M	Apr 18
2,432	440	720	2.62	3,592	384	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M	Apr 19
2,428	440	720	3.49	3,588	380	500	250	440	690	0	510	510	0	510	780	0	720	1,500	M	Apr 20
2,424	440	720	4.36	3,584	376	500	250	440	690	0	510	510	0	510	780	0	720	1,500		Apr 21
2,420	440	720	5.24	3,580	372	500	250	440	690	0	510	510	0	510	780	0	720	1,500		Apr 22
2,416	440	720	6.11	3,576	368	500	250	440	690	0	510	510	0	510	780	0	720	1,500		Apr 23
2,412	440	720	6.98	3,572	364	500	250	240	490	0	775	775	0	775	780	0	420	1,200		Apr 24
2,408	440	720	7.85	3,568	360	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980		Apr 25
2,669	440	420	8.73	3,529	356	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980		Apr 26
3,150	440	0	9.60	3,590	352	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	T	Apr 27
3,146	440	0	10.47	3,586	348	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	T	Apr 28
3,142	440	0	11.35	3,582	344	500	250	240	490	0	1,260	1,260	0	1,260	780	200	0	980	T	Apr 29
3,138	440	0	12.22	3,578	340	500	250	290	540	0	1,260	1,260	0	1,260	780	200	0	980	T	Apr 30
3,134	440	0	13.09	3,574	336	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T	May 01
3,130	440	0	13.96	3,570	332	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T	May 02
3,104	490	0	14.94	3,594	328	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T	May 03
3,100	490	0	15.91	3,590	324	500	250	290	540	0	1,260	1,260	0	1,260	758	200	0	958	T	May 04
3,096	490	0	16.88	3,586	320	500	250	540	790	0	775	775	0	775	758	645	0	1,403	T	May 05
3,092	490	0	17.85	3,582	316	500	250	540	790	0	510	510	0	510	758	742	0	1,500	M	May 06
2,603	935	0	19.71	3,538	312	500	250	540	790	0	510	510	0	510	758	742	0	1,500	M	May 07
2,334	1,282	0	22.25	3,616	308	500	250	540	790	0	510	510	0	510	758	742	0	1,500	M	May 08
2,330	1,282	0	24.79	3,612	304	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M	May 09
2,326	1,282	0	27.33	3,608	300	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M	May 10
2,322	540	742	28.41	3,604	296	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M	May 11
2,318	540	742	29.48	3,600	292	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M	May 12
2,314	540	742	30.55	3,596	288	500	250	540	790	0	510	510	0	510	758	0	742	1,500	M	May 13
2,310	540	742	31.62	3,592	284	500	250	455	705	0	510	510	0	510	758	0	742	1,500		May 14
2,306	540	742	32.69	3,588	280	500	250	0	250		510	510	0	510	758	0	742	1,500		May 15
2,302	540	742	33.76	3,584	276	500	250	0	250		345	345		345	694			694		May 16
2,298	455	742	34.66	3,495	272	500	250		250			175		175	694			694		May 17
2,065	0			2,065	268	500	250		250			175		175	694			694		May 18
1,891	0			1,891	264	500	250		250			175		175	694			694		May 19
1,887	0			1,887	260	500	250		250			175		175	694			694		May 20
1,883	0			1,883	256	500	250		250			175		175	694			694		May 21
1,879	0			1,879	252	500	250		250			175		175	694			694		May 22
1,875	0			1,875	248	500	250		250			175		175	694			694		May 23
1,871	0			1,871	244	500	250		250			175		175	694			694		May 24
1,867	0			1,867	240	500	250		250			175		175	694			694		May 25
1,863	0			1,863	236	500	250		250			175		175	694			694		May 26
1,859	0			1,859	232	500	250		250			175		175	694			694		May 27
1,855	0			1,855	228	500	250		250			175		175	694			694		May 28
1,851	0			1,851	224	500	250		250			175		175	694			694		May 29
1,847	0			1,847	220	500	250		250			175		175	694			694		May 30
1,843	0			1,843	216	500	250		250			175		175	694			694		May 31
VAMP period																				
2,628	564			3,582	340	500		407	657	0		769	0	769		157	390	1,317		Mean (cfs):
																				Suppl. Water (TAF)
	34.66							25.00		0.00			0.00			9.66	23.99			Provided
	35.15							25.00		0.15			0.00			10.00				Target

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 10

Pulse Period: April 19–May 19 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 500cfs • No "other" supplemental water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	447	407	350		350			347		347	569			569	
Apr 02					2,069	451	481	340		340			350		350	572			572	
Apr 03					2,163	459	466	310		310			345		345	572			572	
Apr 04	2,041				2,041	466	318	323		323			339		339	572			572	
Apr 05	1,974				1,974	447	258	348		348			328		328	638			638	
Apr 06	2,069				2,069	425	382	370		370			317		317	666			666	
Apr 07	2,303				2,303	393	567	396		396			325		325	710			710	
Apr 08	2,535				2,535	386	779	376		376			323		323	725			725	
Apr 09	2,533				2,533	422	735	370		370			318		318	722			722	
Apr 10	2,330				2,330	420	500	250		250			300		300	704			704	
Apr 11	2,338				2,338	416	500	250		250			300		300	704			704	
Apr 12	2,294				2,294	412	500	250		250			300		300	704			704	
Apr 13	2,170	0			2,170	408	500	250	0	250			300		300	704			704	
Apr 14	2,166	0			2,166	404	500	250	0	250			300		300	704			704	
Apr 15	2,162	0			2,162	400	500	250	250	500			150		150	704			704	
Apr 16	2,158	0			2,158	396	500	250	655	905	0		150		150	704			704	M
Apr 17	2,004	0	0		2,004	392	500	250	660	910	0	475	700	0	700	704	0	0	704	M
Apr 18	2,000	250	0		2,250	388	500	250	660	910	0	475	700	0	700	704	0	0	704	M
Apr 19	2,546	655	0	1.30	3,201	384	500	250	665	915	0	475	700	0	700	704	0	0	704	M
Apr 20	2,542	660	0	2.61	3,202	380	500	250	670	920	0	475	700	0	700	704	0	0	704	M
Apr 21	2,538	660	0	3.92	3,198	376	500	250	675	925	0	475	700	0	700	704	0	0	704	M
Apr 22	2,534	665	0	5.24	3,199	372	500	250	180	430	0	475	700	0	700	704	0	0	704	M
Apr 23	2,530	670	0	6.57	3,200	368	500	250	180	430	0	475	1,200	0	1,200	704	0	0	704	
Apr 24	2,526	675	0	7.90	3,201	364	500	250	185	435	0	475	1,200	0	1,200	704	0	0	704	
Apr 25	3,022	180	0	8.26	3,202	360	500	250	190	440	0	475	1,200	0	1,200	704	0	0	704	
Apr 26	3,018	180	0	8.62	3,198	356	500	250	195	445	0	750	1,200	0	1,200	704	0	0	704	
Apr 27	3,014	185	0	8.99	3,199	352	500	250	200	450	0	1,230	1,200	0	1,200	704	0	0	704	
Apr 28	3,010	190	0	9.36	3,200	348	500	250	200	450	0	1,230	1,200	0	1,200	704	0	0	704	
Apr 29	3,006	195	0	9.75	3,201	344	500	250	205	455	0	1,230	1,200	0	1,200	704	0	0	704	T
Apr 30	3,002	200	0	10.15	3,202	340	500	250	65	315	0	1,230	1,200	0	1,200	704	0	0	704	T
May 01	2,998	200	0	10.54	3,198	336	500	250	70	320	0	1,230	550	0	550	1,500	0	0	1,500	T
May 02	2,994	205	0	10.95	3,199	332	500	250	70	320	0	1,230	550	0	550	1,500	0	0	1,500	T
May 03	3,136	65	0	11.08	3,201	328	500	250	75	325	0	1,230	550	0	550	1,500	0	0	1,500	T
May 04	3,132	70	0	11.22	3,202	324	500	250	80	330	0	1,230	550	0	550	1,500	0	0	1,500	T
May 05	3,128	70	0	11.36	3,198	320	500	250	85	335	0	1,230	550	0	550	1,500	0	0	1,500	T
May 06	3,124	75	0	11.50	3,199	316	500	250	90	340	0	1,230	550	0	550	1,500	0	0	1,500	T
May 07	3,120	80	0	11.66	3,200	312	500	250	130	380	0	750	550	0	550	1,500	0	0	1,500	T
May 08	3,116	85	0	11.83	3,201	308	500	250	130	380	0	475	515	0	515	1,500	0	0	1,500	M
May 09	3,112	90	0	12.01	3,202	304	500	250	135	385	0	475	515	0	515	1,500	0	0	1,500	M
May 10	3,073	130	0	12.27	3,203	300	500	250	140	390	0	475	515	0	515	1,500	0	0	1,500	M
May 11	3,069	130	0	12.53	3,199	296	500	250	140	390	0	475	515	0	515	1,500	0	0	1,500	M
May 12	3,065	135	0	12.79	3,200	292	500	250	150	400	0	475	515	0	515	1,500	0	0	1,500	M
May 13	3,061	140	0	13.07	3,201	288	500	250	150	400	0	475	515	0	515	1,500	0	0	1,500	M
May 14	3,057	140	0	13.35	3,197	284	500	250	155	405	0	475	515	0	515	1,500	0	0	1,500	M
May 15	3,053	150	0	13.65	3,203	280	500	250	740	990	0	475	515	0	515	1,500	0	0	1,500	M
May 16	3,049	150	0	13.94	3,199	276	500	250	740	990	0	475	515	0	515	918	0	0	918	
May 17	3,045	155	0	14.25	3,200	272	500	250	250	500		475	515	0	515	918	0	0	918	
May 18	2,459	740	0	15.72	3,199	268	500	250		250		300	300		300	918			918	
May 19	2,455	740	0	17.19	3,195	264	500	250		250			150		150	918			918	
May 20	2,236	250			2,486	260	500	250		250			150		150	918			918	
May 21	2,082	0			2,082	256	500	250		250			150		150	918			918	
May 22	2,078	0			2,078	252	500	250		250			150		150	918			918	
May 23	2,074	0			2,074	248	500	250		250			150		150	918			918	
May 24	2,070	0			2,070	244	500	250		250			150		150	918			918	
May 25	2,066	0			2,066	240	500	250		250			150		150	918			918	
May 26	2,062	0			2,062	236	500	250		250			150		150	918			918	
May 27	2,058	0			2,058	232	500	250		250			150		150	918			918	
May 28	2,054	0			2,054	228	500	250		250			150		150	918			918	
May 29	2,050	0			2,050	224	500	250		250			150		150	918			918	
May 30	2,046	0			2,046	220	500	250		250			150		150	918			918	
May 31	2,042	0			2,042	216	500	250		250			150		150	918			918	
	VAMP period																			
Mean (cfs):	2,920	280			3,200	332	500		280	530	0		735	0	735		0	0	1,103	
Suppl. Water (TAF)																				
Provided		17.19							17.19		0.00			0.00			0.00	0.00		
Target		17.19							17.19		0.00			0.00			0.00			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 10

Pulse Period: April 19–May 19 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 800cfs • No "other" supplemental water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	447	407	350		350			347		347	569			569	
Apr 02					2,069	451	481	340		340			350		350	572			572	
Apr 03					2,163	459	466	310		310			345		345	572			572	
Apr 04	2,041				2,041	466	318	323		323			339		339	572			572	
Apr 05	1,974				1,974	447	258	348		348			328		328	638			638	
Apr 06	2,069				2,069	425	382	370		370			317		317	666			666	
Apr 07	2,303				2,303	393	567	396		396			325		325	710			710	
Apr 08	2,535				2,535	386	779	376		376			323		323	725			725	
Apr 09	2,533				2,533	422	735	370		370			318		318	722			722	
Apr 10	2,630				2,630	420	800	250		250			300		300	704			704	
Apr 11	2,638				2,638	416	800	250		250			300		300	704			704	
Apr 12	2,594				2,594	412	800	250		250			300		300	704			704	
Apr 13	2,470	0			2,470	408	800	250	0	250			300		300	704			704	
Apr 14	2,466	0			2,466	404	800	250	0	250			300		300	704			704	
Apr 15	2,462	0			2,462	400	800	250	200	450			150		150	704			704	
Apr 16	2,458	0			2,458	396	800	250	610	860	100		150		150	704			704	M
Apr 17	2,304	0	0		2,304	392	800	250	610	860	100	475	475	325	800	704	796	0	1,500	M
Apr 18	2,300	200	0		2,500	388	800	250	615	865	100	475	475	325	800	704	796	0	1,500	M
Apr 19	2,621	1,831	0	3.63	4,452	384	800	250	620	870	100	475	475	325	800	704	796	0	1,500	M
Apr 20	2,617	1,831	0	7.26	4,448	380	800	250	625	875	100	475	475	325	800	704	796	0	1,500	M
Apr 21	2,613	1,836	0	10.91	4,449	376	800	250	630	880	100	475	475	325	800	704	796	0	1,500	M
Apr 22	2,609	1,841	0	14.56	4,450	372	800	250	680	930	100	475	475	325	800	704	796	0	1,500	M
Apr 23	2,605	1,846	0	18.22	4,451	368	800	250	1,185	1,435	150	475	475	325	800	704	751	0	1,455	
Apr 24	2,601	1,851	0	21.89	4,452	364	800	250	1,165	1,415	150	475	475	425	900	704	96	0	800	
Apr 25	2,597	1,856	0	25.57	4,453	360	800	250	915	1,165	100	475	475	450	925	704	96	0	800	
Apr 26	2,593	1,856	0	29.25	4,449	356	800	250	915	1,165	100	750	750	480	1,230	704	96	0	800	
Apr 27	2,589	1,861	0	32.94	4,450	352	800	250	920	1,170	100	1,230	1,230	0	1,230	704	96	0	800	
Apr 28	2,860	1,591	0	36.10	4,451	348	800	250	920	1,170	100	1,230	1,230	0	1,230	704	96	0	800	
Apr 29	3,336	1,111	0	38.30	4,447	344	800	250	890	1,140	100	1,230	1,230	0	1,230	704	96	0	800	T
Apr 30	3,332	1,116	0	40.52	4,448	340	800	250	390	640	0	1,230	1,230	0	1,230	704	96	0	800	T
May 01	3,328	1,116	0	42.73	4,444	336	800	250	240	490	100	1,230	1,230	0	1,230	1,500	0	0	1,500	T
May 02	3,324	1,086	0	44.88	4,410	332	800	250	240	490	100	1,230	1,230	0	1,230	1,500	0	0	1,500	T
May 03	4,116	390	0	45.66	4,506	328	800	250	245	495	100	1,230	1,230	0	1,230	1,500	0	0	1,500	T
May 04	4,112	340	0	46.33	4,452	324	800	250	250	500	100	1,230	1,230	0	1,230	1,500	0	0	1,500	T
May 05	4,108	340	0	47.01	4,448	320	800	250	255	505	100	1,230	1,230	0	1,230	1,500	0	0	1,500	T
May 06	4,104	345	0	47.69	4,449	316	800	250	260	510	100	1,230	1,230	0	1,230	1,500	0	0	1,500	T
May 07	4,100	350	0	48.38	4,450	312	800	250	650	900	130	750	750	480	1,230	1,500	0	0	1,500	T
May 08	4,096	355	0	49.09	4,451	308	800	250	650	900	150	475	475	325	800	1,500	0	0	1,500	M
May 09	3,612	840	0	50.76	4,452	304	800	250	650	900	150	475	475	325	800	1,500	0	0	1,500	M
May 10	3,333	1,105	0	52.95	4,438	300	800	250	655	905	150	475	475	325	800	1,500	0	0	1,500	M
May 11	3,329	1,125	0	55.18	4,454	296	800	250	660	910	150	475	475	325	800	1,500	0	0	1,500	M
May 12	3,325	1,125	0	57.41	4,450	292	800	250	660	910	150	475	475	325	800	1,500	0	0	1,500	M
May 13	3,321	1,130	0	59.65	4,451	288	800	250	665	915	150	475	475	325	800	1,500	0	0	1,500	M
May 14	3,317	1,135	0	61.90	4,452	284	800	250	670	920	150	475	475	325	800	1,500	0	0	1,500	M
May 15	3,313	1,135	0	64.15	4,448	280	800	250	625	875	200	475	475	325	800	1,500	0	0	1,500	M
May 16	3,309	1,140	0	66.41	4,449	276	800	250	625	875	200	475	475	325	800	918	582	0	1,500	
May 17	3,305	1,145	0	68.69	4,450	272	800	250	0	250		475	475	325	800	918	582	0	1,500	
May 18	2,719	1,732	0	72.12	4,451	268	800	250		250		300	300		300	918			918	
May 19	2,715	1,732	0	75.56	4,447	264	800	250		250			150		150	918			918	
May 20	2,536	0			2,536	260	800	250		250			150		150	918			918	
May 21	2,382	0			2,382	256	800	250		250			150		150	918			918	
May 22	2,378	0			2,378	252	800	250		250			150		150	918			918	
May 23	2,374	0			2,374	248	800	250		250			150		150	918			918	
May 24	2,370	0			2,370	244	800	250		250			150		150	918			918	
May 25	2,366	0			2,366	240	800	250		250			150		150	918			918	
May 26	2,362	0			2,362	236	800	250		250			150		150	918			918	
May 27	2,358	0			2,358	232	800	250		250			150		150	918			918	
May 28	2,354	0			2,354	228	800	250		250			150		150	918			918	
May 29	2,350	0			2,350	224	800	250		250			150		150	918			918	
May 30	2,346	0			2,346	220	800	250		250			150		150	918			918	
May 31	2,342	0			2,342	216	800	250		250			150		150	918			918	
	VAMP period																			
Mean (cfs):	3,221	1,229			4,450	332	800		635	885	119		736	237	974		238	0	1,340	
Suppl. Water (TAF)																				
Provided		75.56							39.05		7.30			14.60			14.60	0.00		
Target		75.55							39.05		7.30			14.60			14.60			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 10

Pulse Period: April 19–May 19 • Flow Target: 3,200cfs

Ungaged Flow at Vernalis = 500cfs • 24.4 "other" supplemental water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	447	407	350		350			347		347	569			569	
Apr 02					2,069	451	481	340		340			350		350	572			572	
Apr 03					2,163	459	466	310		310			345		345	572			572	
Apr 04	2,041				2,041	466	318	323		323			339		339	572			572	
Apr 05	1,974				1,974	447	258	348		348			328		328	638			638	
Apr 06	2,069				2,069	425	382	370		370			317		317	666			666	
Apr 07	2,303				2,303	393	567	396		396			325		325	710			710	
Apr 08	2,535				2,535	386	779	376		376			323		323	725			725	
Apr 09	2,533				2,533	422	735	370		370			318		318	722			722	
Apr 10	2,330				2,330	420	500	250		250			300		300	704			704	
Apr 11	2,338				2,338	416	500	250		250			300		300	704			704	
Apr 12	2,294				2,294	412	500	250		250			300		300	704			704	
Apr 13	2,170	0			2,170	408	500	250	0	250			300		300	704			704	
Apr 14	2,166	0			2,166	404	500	250	0	250			300		300	704			704	
Apr 15	2,162	0			2,162	400	500	250	0	250			150		150	704			704	
Apr 16	2,158	0			2,158	396	500	250	250	500	0		150		150	704			704	M
Apr 17	2,004	0	0		2,004	392	500	250	250	500	0	475	700	0	700	704	0	796	1,500	M
Apr 18	2,000	0	0		2,000	388	500	250	250	500	0	475	700	0	700	704	0	796	1,500	M
Apr 19	2,546	250	796	0.50	3,592	384	500	250	250	500	0	475	700	0	700	704	0	796	1,500	M
Apr 20	2,542	250	796	0.99	3,588	380	500	250	250	500	0	475	700	0	700	704	0	796	1,500	M
Apr 21	2,538	250	796	1.49	3,584	376	500	250	250	500	0	475	700	0	700	704	0	796	1,500	M
Apr 22	2,534	250	796	1.98	3,580	372	500	250	250	500	0	475	700	0	700	704	0	796	1,500	M
Apr 23	2,530	250	796	2.48	3,576	368	500	250	250	500	0	475	700	0	700	704	0	796	1,500	
Apr 24	2,526	250	796	2.98	3,572	364	500	250	250	500	0	475	700	0	700	704	0	796	1,500	
Apr 25	2,522	250	796	3.47	3,568	360	500	250	225	475	0	475	700	0	700	704	0	796	1,500	
Apr 26	2,518	250	796	3.97	3,564	356	500	250	125	375	0	750	770	0	770	704	0	796	1,500	
Apr 27	2,514	250	796	4.46	3,560	352	500	250	125	375	0	1,230	900	0	900	704	0	796	1,500	
Apr 28	2,580	225	796	4.91	3,601	348	500	250	125	375	0	1,230	900	0	900	704	0	796	1,500	
Apr 29	2,706	125	796	5.16	3,627	344	500	250	125	375	0	1,230	900	0	900	704	0	796	1,500	T
Apr 30	2,702	125	796	5.40	3,623	340	500	250	125	375	0	1,230	900	0	900	704	0	796	1,500	T
May 01	2,698	125	796	5.65	3,619	336	500	250	130	380	0	1,230	900	0	900	1,500	0	0	1,500	T
May 02	2,694	125	796	5.90	3,615	332	500	250	130	380	0	1,230	900	0	900	1,500	0	0	1,500	T
May 03	3,486	125	0	6.15	3,611	328	500	250	135	385	0	1,230	900	0	900	1,500	0	0	1,500	T
May 04	3,482	130	0	6.41	3,612	324	500	250	135	385	0	1,230	900	0	900	1,500	0	0	1,500	T
May 05	3,478	130	0	6.66	3,608	320	500	250	125	375	0	1,230	900	0	900	1,500	0	0	1,500	T
May 06	3,474	135	0	6.93	3,609	316	500	250	275	525	0	1,230	900	0	900	1,500	0	0	1,500	T
May 07	3,470	135	0	7.20	3,605	312	500	250	360	610	0	750	770	0	770	1,500	0	0	1,500	T
May 08	3,466	125	0	7.45	3,591	308	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 09	3,332	275	0	7.99	3,607	304	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 10	3,258	360	0	8.71	3,618	300	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 11	3,254	360	0	9.42	3,614	296	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 12	3,250	360	0	10.14	3,610	292	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 13	3,246	360	0	10.85	3,606	288	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 14	3,242	360	0	11.56	3,602	284	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 15	3,238	360	0	12.28	3,598	280	500	250	360	610	0	475	700	0	700	1,500	0	0	1,500	M
May 16	3,234	360	0	12.99	3,594	276	500	250	360	610	0	475	700	0	700	918	0	582	1,500	
May 17	3,230	360	0	13.71	3,590	272	500	250	0	250		475	700	0	700	918	0	582	1,500	
May 18	2,644	360	582	14.42	3,586	268	500	250		250		300	345		345	918			918	
May 19	2,640	360	582	15.13	3,582	264	500	250		250			150		150	918			918	
May 20	2,281	0			2,281	260	500	250		250			150		150	918			918	
May 21	2,082	0			2,082	256	500	250		250			150		150	918			918	
May 22	2,078	0			2,078	252	500	250		250			150		150	918			918	
May 23	2,074	0			2,074	248	500	250		250			150		150	918			918	
May 24	2,070	0			2,070	244	500	250		250			150		150	918			918	
May 25	2,066	0			2,066	240	500	250		250			150		150	918			918	
May 26	2,062	0			2,062	236	500	250		250			150		150	918			918	
May 27	2,058	0			2,058	232	500	250		250			150		150	918			918	
May 28	2,054	0			2,054	228	500	250		250			150		150	918			918	
May 29	2,050	0			2,050	224	500	250		250			150		150	918			918	
May 30	2,046	0			2,046	220	500	250		250			150		150	918			918	
May 31	2,042	0			2,042	216	500	250		250			150		150	918			918	
	VAMP period																			
Mean (cfs):	2,954	246			3,597	332	500		246	496	0		769	0	769		0	397	1,500	
Suppl. Water (TAF)																				
Provided		15.13							15.13		0.00			0.00			0.00	24.41		
Target		15.13							15.13		0.00			0.00			0.00			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 12

Pulse Period: April 20–May 20 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 650cfs • 18.14 "other" supplemental water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	515	639	220		220			347		347	412			412	
Apr 02					2,069	519	749	210		210			350		350	447			447	
Apr 03					2,163	527	685	180		180			345		345	463			463	
Apr 04	2,041				2,041	534	505	193		193			339		339	448			448	
Apr 05	1,978				1,978	515	433	218		218			328		328	488			488	
Apr 06	2,078				2,078	493	577	240		240			317		317	578			578	
Apr 07	2,329				2,329	461	805	266		266			325		325	650			650	
Apr 08	2,610				2,610	454	1,004	246		246			323		323	627			627	
Apr 09	2,654				2,654	490	978	240		240			318		318	592			592	
Apr 10	2,578				2,578	541	908	232		232			327		327	553			553	
Apr 11	2,478				2,478	546	832	241		241			326		326	564			564	
Apr 12	2,361				2,361	505	700	250		250			300		300	600			600	
Apr 13	2,318	0			2,318	486	650	250	0	250			300		300	600			600	
Apr 14	2,296	0			2,296	468	650	250	0	250			300		300	600			600	
Apr 15	2,286	0			2,286	450	650	250	0	250		250	250		250	600			600	
Apr 16	2,268	0			2,268	446	650	250	0	250		250	250		250	600			600	
Apr 17	2,200	0	0		2,200	442	650	250	250	500	50	250	250	0	250	600	0		600	
Apr 18	2,196	0	0		2,196	438	650	250	740	990	100	475	475	575	1,050	1,205	0	295	1,500	
Apr 19	2,192	0	0		2,192	433	650	250	840	1,090	100	475	475	360	835	1,205	0	295	1,500	
Apr 20	3,018	875	295	1.74	4,188	429	650	250	840	1,090	100	475	475	225	700	1,205	0	295	1,500	T
Apr 21	3,013	1,200	295	4.12	4,508	425	650	250	840	1,090	100	475	475	225	700	1,205	0	295	1,500	T
Apr 22	3,009	1,165	295	6.43	4,469	421	650	250	840	1,090	100	475	475	225	700	1,205	0	295	1,500	T
Apr 23	3,005	1,165	295	8.74	4,465	417	650	250	840	1,090	100	475	475	225	700	1,205	0	295	1,500	T
Apr 24	3,001	1,165	295	11.05	4,461	413	650	250	840	1,090	100	475	475	225	700	1,205	0	295	1,500	T
Apr 25	2,997	1,165	295	13.36	4,457	408	650	250	840	1,090	100	475	475	225	700	1,205	0	295	1,500	T
Apr 26	2,993	1,165	295	15.67	4,453	404	650	250	840	1,090	100	475	475	225	700	1,205	0	295	1,500	T
Apr 27	2,988	1,165	295	17.98	4,448	400	650	250	385	635	60	700	700	0	700	1,205	0	295	1,500	T
Apr 28	2,984	1,165	295	20.29	4,444	396	650	250	130	380	50	1,230	1,230	0	1,230	1,205	0	295	1,500	
Apr 29	3,205	940	295	22.16	4,440	392	650	250	130	380	50	1,230	1,230	270	1,500	1,205	0	295	1,500	
Apr 30	3,731	445	295	23.04	4,471	388	650	250	130	380	50	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 01	3,727	450	295	23.93	4,472	383	650	250	130	380	50	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 02	3,723	450	295	24.82	4,468	379	650	250	135	385	50	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 03	3,718	450	295	25.72	4,463	375	650	250	140	390	50	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 04	3,714	450	295	26.61	4,459	371	650	250	140	390	50	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 05	3,710	455	295	27.51	4,460	367	650	250	140	390	50	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 06	3,706	460	295	28.42	4,461	363	650	250	140	390	60	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 07	3,702	460	295	29.34	4,457	358	650	250	140	390	100	1,230	1,230	270	1,500	1,205	0	295	1,500	
May 08	3,698	460	295	30.25	4,453	354	650	250	520	770	100	800	800	700	1,500	1,205	0	295	1,500	
May 09	3,693	470	295	31.18	4,458	350	650	250	725	975	100	475	475	620	1,095	1,205	0	295	1,500	M
May 10	3,259	940	295	33.04	4,494	346	650	250	725	975	100	475	475	425	900	1,205	0	295	1,500	M
May 11	2,930	1,240	295	35.50	4,465	342	650	250	725	975	100	475	475	425	900	1,205	0	295	1,500	M
May 12	2,926	1,250	295	37.98	4,471	338	650	250	725	975	100	475	475	425	900	1,205	0	295	1,500	M
May 13	2,922	1,250	295	40.46	4,467	333	650	250	725	975	100	475	475	425	900	1,205	0	295	1,500	M
May 14	2,918	1,250	295	42.94	4,463	329	650	250	725	975	100	475	475	425	900	1,205	0	295	1,500	M
May 15	2,913	1,250	295	45.42	4,458	325	650	250	725	975	100	475	475	425	900	1,205	0	295	1,500	M
May 16	2,909	1,250	295	47.90	4,454	321	650	250	725	975	100	475	475	425	900	1,205	0	295	1,500	M
May 17	2,905	1,250	295	50.38	4,450	317	650	250	725	975	50	475	475	425	900	1,205	0	295	1,500	
May 18	2,901	1,250	295	52.86	4,446	313	650	250	250	500		475	475	425	900	1,205	0	295	1,500	
May 19	2,897	1,250	295	55.34	4,442	309	650	250		250		300	300		300	600			600	
May 20	2,893	1,200	295	57.72	4,388	305	650	250		250			150		150	600			600	
May 21	2,109	250			2,359	301	650	250		250			150		150	600			600	
May 22	1,955	0			1,955	297	650	250		250			150		150	600			600	
May 23	1,951	0			1,951	293	650	250		250			150		150	600			600	
May 24	1,947	0			1,947	289	650	250		250			150		150	600			600	
May 25	1,943	0			1,943	285	650	250		250			150		150	600			600	
May 26	1,939	0			1,939	281	650	250		250			150		150	600			600	
May 27	1,935	0			1,935	277	650	250		250			150		150	600			600	
May 28	1,931	0			1,931	273	650	250		250			150		150	600			600	
May 29	1,927	0			1,927	269	650	250		250			150		150	600			600	
May 30	1,923	0			1,923	265	650	250		250			150		150	600			600	
May 31	1,919	0			1,919	261	650	250		250			150		150	600			600	
	VAMP period																			
Mean (cfs):	3,216	939			4,450	375	650		532	782	81		736	325	1,062	1,205	0	295	1,500	
Suppl. Water (TAF)																				
Provided		57.72							32.72		5.00			20.00			0.00	18.14		
Target		57.72							32.72		5.00			20.00			0.00			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 16

Pulse Period: April 20–May 20 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 650cfs • 2.8 TAF "other" supplemetntal water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	515	639	220		220			347		347	410			410	
Apr 02					2,069	519	749	210		210			350		350	450			450	
Apr 03					2,163	527	685	180		180			345		345	460			460	
Apr 04	2,044				2,041	534	505	193		193			339		339	450			450	
Apr 05	1,975				1,978	515	433	218		218			328		328	490			490	
Apr 06	2,080				2,078	493	577	240		240			317		317	580			580	
Apr 07	2,331				2,329	461	805	266		266			325		325	650			650	
Apr 08	2,612				2,610	454	1,004	246		246			323		323	630			630	
Apr 09	2,654				2,654	490	978	240		240			318		318	590			590	
Apr 10	2,581				2,578	541	908	232		232			327		327	550			550	
Apr 11	2,476				2,478	546	832	241		241			326		326	560			560	
Apr 12	2,429				2,432	547	771	245		245			328		328	570			570	
Apr 13	2,428	0			2,432	545	764	253		253			329		329	570			570	
Apr 14	2,425	0			2,422	499	739	255		255			319		319	570			570	
Apr 15	2,419	0			2,423	469	730	263		263		250	256		256	570			570	
Apr 16	2,291	0			2,291	446	650	250	0	250		250	250		250	600			600	
Apr 17	2,200	0	0		2,200	442	650	250	140	390	0	250	250	0	250	600	0		600	
Apr 18	2,209	0	0		2,209	438	650	250	180	430	0	475	475	825	1,300	1,205	250	45	1,500	
Apr 19	2,192	0	0		2,192	433	650	250	585	835	50	475	475	825	1,300	1,205	250	45	1,500	
Apr 20	3,018	1,215	45	2.41	4,278	429	650	250	950	1,200	150	475	475	425	900	1,205	250	45	1,500	T
Apr 21	3,013	1,255	45	4.90	4,313	425	650	250	950	1,200	150	475	475	135	610	1,205	250	45	1,500	T
Apr 22	3,009	1,310	45	7.50	4,364	421	650	250	900	1,150	150	475	475	135	610	1,205	250	45	1,500	T
Apr 23	3,005	1,485	45	10.44	4,535	417	650	250	900	1,150	150	475	475	135	610	1,205	250	45	1,500	T
Apr 24	3,001	1,485	45	13.39	4,531	413	650	250	900	1,150	150	475	475	135	610	1,205	250	45	1,500	T
Apr 25	2,997	1,435	45	16.23	4,477	408	650	250	900	1,150	150	475	475	135	610	1,205	250	45	1,500	T
Apr 26	2,993	1,435	45	19.08	4,473	404	650	250	850	1,100	150	475	475	135	610	1,205	250	45	1,500	T
Apr 27	2,988	1,435	45	21.93	4,468	400	650	250	400	650	150	700	650	0	650	1,205	250	45	1,500	T
Apr 28	2,984	1,435	45	24.77	4,464	396	650	250	350	600	150	1,230	1,230	0	1,230	1,205	200	45	1,450	
Apr 29	3,155	1,250	45	27.25	4,450	392	650	250	250	500	100	1,230	1,230	0	1,230	1,205	200	45	1,450	
Apr 30	3,731	750	45	28.74	4,526	388	650	250	250	500	100	1,230	1,230	160	1,390	1,205	200	45	1,450	
May 01	3,727	700	45	30.13	4,472	383	650	250	250	500	100	1,230	1,230	160	1,390	1,205	200	45	1,450	
May 02	3,723	710	45	31.54	4,478	379	650	250	250	500	100	1,230	1,230	160	1,390	1,205	200	45	1,450	
May 03	3,718	710	45	32.95	4,473	375	650	250	250	500	100	1,230	1,230	160	1,390	1,205	200	45	1,450	
May 04	3,714	710	45	34.35	4,469	371	650	250	250	500	100	1,230	1,230	160	1,390	1,205	220	45	1,470	
May 05	3,710	710	45	35.76	4,465	367	650	250	250	500	100	1,230	1,230	160	1,390	1,205	230	45	1,480	
May 06	3,706	730	45	37.21	4,481	363	650	250	250	500	100	1,230	1,230	160	1,390	1,205	230	45	1,480	
May 07	3,702	740	45	38.68	4,487	358	650	250	550	800	130	1,230	1,230	160	1,390	1,205	230	45	1,480	
May 08	3,698	740	45	40.15	4,483	354	650	250	700	950	150	800	850	180	1,030	1,205	250	45	1,500	
May 09	3,693	740	45	41.61	4,478	350	650	250	800	1,050	150	475	475	420	895	1,205	250	45	1,500	M
May 10	3,309	1,110	45	43.81	4,464	346	650	250	800	1,050	150	475	475	290	765	1,205	250	45	1,500	M
May 11	2,930	1,520	45	46.83	4,495	342	650	250	800	1,050	150	475	475	290	765	1,205	250	45	1,500	M
May 12	2,926	1,490	45	49.79	4,461	338	650	250	800	1,050	150	475	475	290	765	1,205	250	45	1,500	M
May 13	2,922	1,490	45	52.74	4,457	333	650	250	800	1,050	150	475	475	290	765	1,205	250	45	1,500	M
May 14	2,918	1,490	45	55.70	4,453	329	650	250	800	1,050	150	475	475	290	765	1,205	250	45	1,500	M
May 15	2,913	1,490	45	58.65	4,448	325	650	250	800	1,050	150	475	475	290	765	1,205	250	45	1,500	M
May 16	2,909	1,490	45	61.61	4,444	321	650	250	800	1,050	100	475	475	290	765	1,205	250	45	1,500	M
May 17	2,905	1,490	45	64.56	4,440	317	650	250	790	1,040	50	475	475	290	765	1,205	250	45	1,500	
May 18	2,901	1,490	45	67.52	4,436	313	650	250	250	500		475	475	275	750	1,205	250	45	1,500	
May 19	2,897	1,440	45	70.37	4,382	309	650	250		250		300	300		300	600			600	
May 20	2,893	1,365	45	73.08	4,303	305	650	250		250			150		150	600			600	
May 21	2,109	250			2,359	301	650	250		250			150		150	600			600	
May 22	1,955	0			1,955	297	650	250		250			150		150	600			600	
May 23	1,951	0			1,951	293	650	250		250			150		150	600			600	
May 24	1,947	0			1,947	289	650	250		250			150		150	600			600	
May 25	1,943	0			1,943	285	650	250		250			150		150	600			600	
May 26	1,939	0			1,939	281	650	250		250			150		150	600			600	
May 27	1,935	0			1,935	277	650	250		250			150		150	600			600	
May 28	1,931	0			1,931	273	650	250		250			150		150	600			600	
May 29	1,927	0			1,927	269	650	250		250			150		150	600			600	
May 30	1,923	0			1,923	265	650	250		250			150		150	600			600	
May 31	1,919	0			1,919	261	650	250		250			150		150	600			600	
	VAMP period																			
Mean (cfs):	3,216	1,189			4,450	375	650		595	845	119		736	237	974	1,205	237	45	1,487	
Suppl. Water (TAF)																				
Provided		73.08							36.59		7.30			14.60			14.60	2.77		
Target		73.09							36.59		7.30			14.60			14.60			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, APRIL 23

Pulse Period: April 20–May 20 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 650cfs • 2.8 TAF "other" supplemetntal water on Stanislaus R.

San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)					
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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.	
(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		
[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]		
				2,071	515	534	220		220			347		347	407			407		Apr 01
				2,069	519	543	210		210			350		350	409			409		Apr 02
				2,163	527	560	180		180			345		345	411			411		Apr 03
1,911				2,041	534	413	193		193			339		339	439			439		Apr 04
1,848				1,978	515	355	218		218			328		328	558			558		Apr 05
1,948				2,078	493	456	240		240			317		317	556			556		Apr 06
2,199				2,329	461	605	266		266			325		325	551			551		Apr 07
2,480				2,610	454	896	246		246			323		323	561			561		Apr 08
2,524				2,654	490	947	240		240			318		318	347			347		Apr 09
2,448				2,578	541	844	232		232			327		327	548			548		Apr 10
2,348				2,478	546	947	241		241			326		326	551			551		Apr 11
2,302				2,432	547	646	245		245			328		328	551			551		Apr 12
2,432	0			2,432	545	777	253		253			329		329	550			550		Apr 13
2,422	0			2,422	499	755	255		255			319		319	555			555		Apr 14
2,423	0			2,423	469	754	263		263		250	256		256	548			548		Apr 15
2,489	0			2,489	453	863	261	0	261		250	255		255	552			552		Apr 16
2,284	0	0		2,284	422	756	250	124	374	0	250	255	0	255	553	0		553		Apr 17
2,128	0	0		2,128	357	605	250	172	422	0	475	475	667	1,142	1,205	0	0	967		Apr 18
2,206	0	0		2,206	282	715	250	585	835	50	475	475	966	1,441	1,205	311	90	1,606		Apr 19
2,984	791	0	1.57	3,537	203	697	250	939	1,189	150	475	475	547	1,022	1,205	260	45	1,510	T	Apr 20
3,067	1,449	90	4.44	4,606	239	855	250	1,009	1,259	150	475	475	150	625	1,205	254	45	1,504	T	Apr 21
3,310	1,442	45	7.30	4,796	379	1,177	250	999	1,249	150	475	475	148	623	1,205	251	45	1,501	T	Apr 22
3,169	1,493	45	10.26	4,707	417	1,000	250	900	1,150	150	475	475	135	610	1,205	200	45	1,450	T	Apr 23
2,959	1,558	45	13.35	4,562	413	650	250	900	1,150	150	475	475	135	610	1,205	150	45	1,400	T	Apr 24
2,997	1,484	45	16.30	4,526	408	650	250	900	1,150	150	475	475	135	610	1,205	200	45	1,450	T	Apr 25
2,993	1,335	45	18.95	4,373	404	650	250	900	1,150	150	475	475	135	610	1,205	235	45	1,485	T	Apr 26
2,988	1,385	45	21.69	4,418	400	650	250	900	1,150	150	700	610	0	610	1,205	250	45	1,500	T	Apr 27
2,984	1,420	45	24.51	4,449	396	650	250	350	600	150	1,230	650	0	650	1,205	250	45	1,500		Apr 28
3,115	1,300	45	27.09	4,460	392	650	250	200	450	100	1,230	1,230	0	1,230	1,205	250	45	1,500		Apr 29
3,151	1,300	45	29.67	4,496	388	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500		Apr 30
3,727	750	45	31.15	4,522	383	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500		May 01
3,723	680	45	32.50	4,448	379	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500		May 02
3,718	680	45	33.85	4,443	375	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500		May 03
3,714	680	45	35.20	4,439	371	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500		May 04
3,710	680	45	36.55	4,435	367	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500		May 05
3,706	680	45	37.90	4,431	363	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500		May 06
3,702	680	45	39.25	4,427	358	650	250	535	785	130	1,230	1,230	130	1,360	1,205	250	45	1,500		May 07
3,698	680	45	40.60	4,423	354	650	250	640	890	150	800	850	135	985	1,205	250	45	1,500		May 08
3,693	680	45	41.94	4,418	350	650	250	775	1,025	150	475	535	355	890	1,205	250	45	1,500	M	May 09
3,309	1,050	45	44.03	4,404	346	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M	May 10
2,990	1,395	45	46.79	4,430	342	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M	May 11
2,986	1,440	45	49.65	4,471	338	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M	May 12
2,982	1,440	45	52.51	4,467	333	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M	May 13
2,978	1,440	45	55.36	4,463	329	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M	May 14
2,973	1,440	45	58.22	4,458	325	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M	May 15
2,969	1,440	45	61.08	4,454	321	650	250	775	1,025	100	475	535	265	800	1,205	250	45	1,500	M	May 16
2,965	1,440	45	63.93	4,450	317	650	250	750	1,000	50	475	535	265	800	1,205	250	45	1,500		May 17
2,961	1,440	45	66.79	4,446	313	650	250	250	500		475	535	265	800	1,205	250	45	1,500		May 18
2,957	1,390	45	69.54	4,392	309	650	250		250		300	300		300	600			600		May 19
2,953	1,315	45	72.15	4,313	305	650	250		250			150		150	600			600		May 20
2,109	250			2,359	301	650	250		250			150		150	600			600		May 21
1,955	0			1,955	297	650	250		250			150		150	600			600		May 22
1,951	0			1,951	293	650	250		250			150		150	600			600		May 23
1,947	0			1,947	289	650	250		250			150		150	600			600		May 24
1,943	0			1,943	285	650	250		250			150		150	600			600		May 25
1,939	0			1,939	281	650	250		250			150		150	600			600		May 26
1,935	0			1,935	277	650	250		250			150		150	600			600		May 27
1,931	0			1,931	273	650	250		250			150		150	600			600		May 28
1,927	0			1,927	269	650	250		250			150		150	600			600		May 29
1,923	0			1,923	265	650	250		250			150		150	600			600		May 30
1,919	0			1,919	261	650	250		250			150		150	600			600		May 31
VAMP period																				
3,230	1,173			4,441	353	686		594	844	119		736	224	959	1,205	237	45	1,480		Mean (cfs):
																				Suppl. Water (TAF)
	72.15							36.50		7.30			13.75			14.60	2.77			Provided
	72.25							36.50		7.30			13.85			14.60				Target

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, MAY 2

Pulse Period: April 20–May 20 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 650cfs • 2.8 TAF "other" supplemetntal water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,071	515	534	220		220			347		347	407			407	
Apr 02					2,069	519	543	210		210			350		350	409			409	
Apr 03					2,163	527	560	180		180			345		345	411			411	
Apr 04	1,911				2,041	534	413	193		193			339		339	439			439	
Apr 05	1,848				1,978	515	355	218		218			328		328	558			558	
Apr 06	1,948				2,078	493	456	240		240			317		317	556			556	
Apr 07	2,199				2,329	461	605	266		266			325		325	551			551	
Apr 08	2,480				2,610	454	896	246		246			323		323	561			561	
Apr 09	2,524				2,654	490	947	240		240			318		318	347			347	
Apr 10	2,448				2,578	541	844	232		232			327		327	548			548	
Apr 11	2,348				2,478	546	947	241		241			326		326	551			551	
Apr 12	2,302				2,432	547	646	245		245			328		328	551			551	
Apr 13	2,432	0			2,432	545	777	253		253			329		329	550			550	
Apr 14	2,422	0			2,422	499	755	255		255			319		319	555			555	
Apr 15	2,423	0			2,423	469	754	263		263		250	256		256	548			548	
Apr 16	2,489	0			2,489	453	863	261	0	261		250	255		255	552			552	
Apr 17	2,284	0	0		2,284	422	756	250	124	374	0	250	255	0	255	553	0		553	
Apr 18	2,135	0	0		2,135	357	612	250	172	422	0	475	475	667	1,142	1,205	0	0	967	
Apr 19	2,214	0	0		2,206	282	723	250	585	835	50	475	475	966	1,441	1,205	311	90	1,606	
Apr 20	2,994	791	0	1.57	3,537	202	707	250	939	1,189	150	475	475	547	1,022	1,205	260	45	1,510	T
Apr 21	3,078	1,449	90	4.44	4,606	236	866	250	1,009	1,259	150	475	475	150	625	1,205	254	45	1,504	T
Apr 22	3,323	1,442	45	7.30	4,796	376	1,192	250	999	1,249	150	475	475	148	623	1,205	251	45	1,501	T
Apr 23	3,187	1,493	45	10.26	4,714	519	1,022	250	970	1,220	150	475	475	148	623	1,205	212	45	1,462	T
Apr 24	3,102	1,558	45	13.35	4,695	509	797	250	978	1,228	150	475	475	147	622	1,205	149	45	1,399	T
Apr 25	3,031	1,509	45	16.35	4,585	450	583	250	982	1,232	150	475	475	149	624	1,205	176	45	1,426	T
Apr 26	2,913	1,416	45	19.16	4,372	392	475	250	999	1,249	150	475	475	147	622	1,205	249	45	1,499	T
Apr 27	2,903	1,453	45	22.04	4,400	351	523	250	1,010	1,260	150	700	610	9	619	1,205	252	45	1,502	T
Apr 28	2,901	1,528	45	25.07	4,473	406	579	250	435	685	150	1,230	650	4	654	1,205	252	45	1,502	
Apr 29	3,027	1,410	45	27.87	4,482	381	612	250	324	574	100	1,230	1,230	0	1,221	1,205	254	45	1,504	
Apr 30	2,903	1,416	45	30.67	4,364	362	393	250	298	548	100	1,230	1,230	140	1,370	1,205	251	45	1,501	
May 01	3,556	839	45	32.34	4,431	361	491	250	271	521	100	1,230	1,230	145	1,375	1,205	254	45	1,504	
May 02	3,697	815	45	33.96	4,557	379	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500	
May 03	3,696	797	45	35.54	4,538	375	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500	
May 04	3,714	751	45	37.03	4,510	371	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500	
May 05	3,710	680	45	38.37	4,435	367	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500	
May 06	3,706	680	45	39.72	4,431	363	650	250	200	450	100	1,230	1,230	130	1,360	1,205	250	45	1,500	
May 07	3,702	680	45	41.07	4,427	358	650	250	535	785	130	1,230	1,230	130	1,360	1,205	250	45	1,500	
May 08	3,698	680	45	42.42	4,423	354	650	250	640	890	150	800	850	135	985	1,205	250	45	1,500	
May 09	3,693	680	45	43.77	4,418	350	650	250	775	1,025	150	475	535	355	890	1,205	250	45	1,500	M
May 10	3,309	1,050	45	45.85	4,404	346	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M
May 11	2,990	1,395	45	48.62	4,430	342	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M
May 12	2,986	1,440	45	51.48	4,471	338	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M
May 13	2,982	1,440	45	54.33	4,467	333	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M
May 14	2,978	1,440	45	57.19	4,463	329	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M
May 15	2,973	1,440	45	60.04	4,458	325	650	250	775	1,025	150	475	535	265	800	1,205	250	45	1,500	M
May 16	2,969	1,440	45	62.90	4,454	321	650	250	775	1,025	100	475	535	265	800	1,205	250	45	1,500	M
May 17	2,965	1,440	45	65.76	4,450	317	650	250	750	1,000	50	475	535	265	800	1,205	250	45	1,500	
May 18	2,961	1,440	45	68.61	4,446	313	650	250	250	500		475	535	265	800	1,205	250	45	1,500	
May 19	2,957	1,390	45	71.37	4,392	309	650	250		250		300	300		300	600			600	
May 20	2,953	1,315	45	73.98	4,313	305	650	250		250			150		150	600			600	
May 21	2,109	250			2,359	301	650	250		250			150		150	600			600	
May 22	1,955	0			1,955	297	650	250		250			150		150	600			600	
May 23	1,951	0			1,951	293	650	250		250			150		150	600			600	
May 24	1,947	0			1,947	289	650	250		250			150		150	600			600	
May 25	1,943	0			1,943	285	650	250		250			150		150	600			600	
May 26	1,939	0			1,939	281	650	250		250			150		150	600			600	
May 27	1,935	0			1,935	277	650	250		250			150		150	600			600	
May 28	1,931	0			1,931	273	650	250		250			150		150	600			600	
May 29	1,927	0			1,927	269	650	250		250			150		150	600			600	
May 30	1,923	0			1,923	265	650	250		250			150		150	600			600	
May 31	1,919	0			1,919	261	650	250		250			150		150	600			600	
	VAMP period																			
Mean (cfs):	3,211	1,203			4,450	357	664		620	870	119		736	227	962	1,205	238	45	1,480	
Suppl. Water (TAF)																				
Provided		73.98							38.12		7.30			13.93			14.63	2.77		
Target		73.39							36.89		7.30			14.60			14.60			

Pulse flow period
Period of desired flow stability

DAILY OPERATION PLAN, MAY 4

Pulse Period: April 20–May 20 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 500cfs • 1.4 TAF "other" supplemetntal water on Stanislaus R.

San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)					
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	VAMP Suppl. Flow	VAMP Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.	
(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		
[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]		
				2,071	515	534	220		220			347		347	407			407		Apr 01
				2,069	519	543	210		210			350		350	409			409		Apr 02
				2,163	527	560	180		180			345		345	411			411		Apr 03
1,911				2,041	534	413	193		193			339		339	439			439		Apr 04
1,848				1,978	515	355	218		218			328		328	558			558		Apr 05
1,948				2,078	493	456	240		240			317		317	556			556		Apr 06
2,199				2,329	461	605	266		266			325		325	551			551		Apr 07
2,480				2,610	454	896	246		246			323		323	561			561		Apr 08
2,524				2,654	490	947	240		240			318		318	347			347		Apr 09
2,448				2,578	541	844	232		232			327		327	548			548		Apr 10
2,348				2,478	546	947	241		241			326		326	551			551		Apr 11
2,302				2,432	547	646	245		245			328		328	551			551		Apr 12
2,432	0			2,432	545	777	253		253			329		329	550			550		Apr 13
2,422	0			2,422	499	755	255		255			319		319	555			555		Apr 14
2,423	0			2,423	469	754	263		263		250	256		256	548			548		Apr 15
2,489	0			2,489	453	863	261	0	261		250	255		255	552			552		Apr 16
2,284	0	0		2,284	422	756	250	124	374	0	250	255	0	255	553	0		553		Apr 17
2,135	0	0		2,135	357	612	250	172	422	0	475	475	667	1,142	1,205	0	0	967		Apr 18
2,014	0	0		2,206	282	523	250	535	785	50	475	475	966	1,441	1,205	311	90	1,606		Apr 19
2,794	791	0	1.57	3,347	202	507	250	889	1,139	150	475	475	547	1,022	1,205	260	45	1,510	T	Apr 20
2,878	1,449	90	4.44	4,417	236	666	250	959	1,209	150	475	475	150	625	1,205	254	45	1,504	T	Apr 21
3,123	1,392	45	7.20	4,560	376	992	250	949	1,199	150	475	475	148	623	1,205	251	45	1,501	T	Apr 22
2,987	1,443	45	10.07	4,475	519	822	250	920	1,170	150	475	475	148	623	1,205	212	45	1,462	T	Apr 23
2,902	1,508	45	13.06	4,455	509	597	250	928	1,178	150	475	475	147	622	1,205	149	45	1,399	T	Apr 24
2,831	1,459	45	15.95	4,335	450	383	250	932	1,182	150	475	475	149	624	1,205	176	45	1,426	T	Apr 25
2,713	1,366	45	18.66	4,124	392	275	250	949	1,199	150	475	475	147	622	1,205	249	45	1,499	T	Apr 26
2,703	1,403	45	21.44	4,151	351	323	250	960	1,210	150	700	610	9	619	1,205	252	45	1,502	T	Apr 27
2,701	1,478	45	24.37	4,224	406	379	250	385	635	150	1,230	650	4	654	1,205	252	45	1,502		Apr 28
2,827	1,360	45	27.07	4,232	381	412	250	274	524	100	1,230	1,230	0	1,221	1,205	254	45	1,504		Apr 29
2,703	1,366	45	29.78	4,114	362	193	250	248	498	100	1,230	1,230	140	1,370	1,205	251	45	1,501		Apr 30
3,356	789	45	31.35	4,181	361	291	250	221	471	100	1,230	1,230	145	1,375	1,205	254	45	1,504		May 01
3,392	765	45	32.86	4,202	340	345	250	225	475	100	1,230	1,230	139	1,369	1,205	253	45	1,503		May 02
3,436	747	45	34.35	4,228	287	390	250	202	452	100	1,230	1,230	143	1,373	1,205	251	45	1,501		May 03
3,425	713	45	35.76	4,183	371	400	250	200	450	100	1,230	1,230	130	1,360	1,205	295	0	1,500		May 04
3,472	719	45	37.19	4,236	367	500	250	200	450	100	1,230	1,230	130	1,360	1,205	295	0	1,500		May 05
3,556	727	0	38.63	4,283	363	500	250	200	450	100	1,230	1,230	130	1,360	1,205	295	0	1,500		May 06
3,552	725	0	40.07	4,277	358	500	250	535	785	150	1,230	1,230	130	1,360	1,205	295	0	1,500		May 07
3,548	725	0	41.50	4,273	354	500	250	640	890	200	800	850	135	985	1,205	295	0	1,500		May 08
3,543	725	0	42.94	4,268	350	500	250	1,000	1,250	200	475	535	355	890	1,205	295	0	1,500	M	May 09
3,159	1,115	0	45.15	4,274	346	500	250	1,000	1,250	200	475	535	265	800	1,205	295	0	1,500	M	May 10
2,840	1,490	0	48.11	4,330	342	500	250	1,000	1,250	200	475	535	265	800	1,205	295	0	1,500	M	May 11
2,836	1,760	0	51.60	4,596	338	500	250	1,000	1,250	200	475	535	265	800	1,205	295	0	1,500	M	May 12
2,832	1,760	0	55.09	4,592	333	500	250	1,000	1,250	200	475	535	265	800	1,205	295	0	1,500	M	May 13
2,828	1,760	0	58.58	4,588	329	500	250	1,000	1,250	200	475	535	265	800	1,205	295	0	1,500	M	May 14
2,823	1,760	0	62.07	4,583	325	500	250	1,000	1,250	150	475	535	265	800	1,205	295	0	1,500	M	May 15
2,819	1,760	0	65.56	4,579	321	500	250	1,000	1,250	100	475	535	265	800	1,205	295	0	1,500	M	May 16
2,815	1,760	0	69.05	4,575	317	500	250	750	1,000	50	475	535	265	800	1,205	295	0	1,500		May 17
2,811	1,710	0	72.45	4,521	313	500	250	250	500		475	535	265	800	1,205	295	0	1,500		May 18
2,807	1,660	0	75.74	4,467	309	500	250		250		300	300		300	600			600		May 19
2,803	1,360	0	78.44	4,163	305	500	250		250			150		150	600			600		May 20
1,959	250			2,209	301	500	250		250			150		150	600			600		May 21
1,805	0			1,805	297	500	250		250			150		150	600			600		May 22
1,801	0			1,801	293	500	250		250			150		150	600			600		May 23
1,797	0			1,797	289	500	250		250			150		150	600			600		May 24
1,793	0			1,793	285	500	250		250			150		150	600			600		May 25
1,789	0			1,789	281	500	250		250			150		150	600			600		May 26
1,785	0			1,785	277	500	250		250			150		150	600			600		May 27
1,781	0			1,781	273	500	250		250			150		150	600			600		May 28
1,777	0			1,777	269	500	250		250			150		150	600			600		May 29
1,773	0			1,773	265	500	250		250			150		150	600			600		May 30
1,769	0			1,769	261	500	250		250			150		150	600			600		May 31
VAMP period																				
3,026	1,276			4,317	353	483		658	908	131		736	227	963	1,205	260	23	1,480		Mean (cfs):
																				Suppl. Water (TAF)
	78.44							40.46		8.03			13.97			15.97	1.43			Provided
	86.12							45.00		8.52			14.60			18.00				Target

Pulse flow period
Period of desired flow stability

DAILY OPERATION PLAN, MAY 7

Pulse Period: April 20–May 20 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 500cfs • 2.8 TAF "other" supplemetntal water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,070	515	663	220		220			347		347	407			407	
Apr 02					2,170	519	674	210		210			350		350	409			409	
Apr 03					2,160	527	687	180		180			345		345	411			411	
Apr 04	2,040				2,040	534	542	193		193			339		339	439			439	
Apr 05	1,980				1,980	515	487	218		218			328		328	558			558	
Apr 06	2,080				2,080	493	588	240		240			317		317	556			556	
Apr 07	2,330				2,330	461	736	266		266			325		325	551			551	
Apr 08	2,610				2,610	454	1,026	246		246			323		323	561			561	
Apr 09	2,660				2,660	490	1,083	240		240			318		318	347			347	
Apr 10	2,580				2,580	541	976	232		232			327		327	548			548	
Apr 11	2,480				2,480	546	1,079	241		241			326		326	551			551	
Apr 12	2,430				2,430	547	774	245		245			328		328	551			551	
Apr 13	2,430	0			2,430	545	775	253		253			329		329	550			550	
Apr 14	2,420	0			2,420	499	753	255		255			319		319	555			555	
Apr 15	2,420	0			2,420	469	751	263		263		250	256		256	548			548	
Apr 16	2,490	0			2,490	453	864	261	0	261		250	255		255	552			552	
Apr 17	2,280	0	0		2,280	422	752	250	74	324	0	250	255	0	255	553	0		553	
Apr 18	2,130	0	0		2,130	357	607	250	122	372	0	475	475	667	1,142	1,205	0	0	967	
Apr 19	2,200	0	0		2,200	282	709	250	535	785	50	475	475	966	1,441	1,205	311	90	1,606	
Apr 20	2,937	741	0	1.47	3,440	202	650	250	889	1,139	150	475	475	547	1,022	1,205	260	45	1,510	T
Apr 21	2,911	1,399	90	4.24	4,400	236	699	250	959	1,209	150	475	475	150	625	1,205	254	45	1,504	T
Apr 22	3,093	1,392	45	7.01	4,530	376	962	250	949	1,199	150	475	475	148	623	1,205	251	45	1,501	T
Apr 23	2,952	1,443	45	9.87	4,440	519	787	250	920	1,170	150	475	475	148	623	1,205	212	45	1,462	T
Apr 24	2,877	1,508	45	12.86	4,430	509	572	250	928	1,178	150	475	475	147	622	1,205	149	45	1,399	T
Apr 25	2,806	1,459	45	15.75	4,310	450	358	250	932	1,182	150	475	475	149	624	1,205	176	45	1,426	T
Apr 26	2,691	1,366	45	18.46	4,102	392	253	250	949	1,199	150	475	475	147	622	1,205	249	45	1,499	T
Apr 27	2,682	1,403	45	21.24	4,130	351	303	250	960	1,210	150	700	610	9	619	1,205	252	45	1,502	T
Apr 28	2,677	1,478	45	24.18	4,200	406	356	250	385	635	150	1,230	650	4	654	1,205	252	45	1,502	
Apr 29	2,805	1,360	45	26.87	4,210	382	390	250	274	524	100	1,230	1,230	0	1,221	1,205	254	45	1,504	
Apr 30	2,679	1,366	45	29.58	4,090	366	169	250	248	498	100	1,230	1,230	140	1,370	1,205	251	45	1,501	
May 01	3,335	789	45	31.15	4,160	360	269	250	221	471	100	1,230	1,230	145	1,375	1,205	254	45	1,504	
May 02	3,370	765	45	32.67	4,180	346	319	250	225	475	100	1,230	1,230	139	1,369	1,205	253	45	1,503	
May 03	3,438	747	45	34.15	4,230	287	393	250	202	452	100	1,230	1,230	143	1,373	1,205	251	45	1,501	
May 04	3,352	713	45	35.56	4,110	281	321	250	199	449	100	1,230	1,230	134	1,364	1,205	255	45	1,505	
May 05	3,296	719	45	36.99	4,060	282	324	250	192	442	100	1,230	1,230	106	1,336	1,205	249	45	1,499	
May 06	3,374	691	45	38.36	4,110	296	408	250	209	459	100	1,230	1,230	140	1,370	1,205	250	45	1,500	
May 07	3,467	654	45	39.66	4,166	358	500	250	535	785	130	1,230	1,230	130	1,360	1,205	250	45	1,500	
May 08	3,481	682	45	41.01	4,208	354	500	250	640	890	150	800	850	135	985	1,205	250	45	1,500	
May 09	3,543	689	45	42.37	4,277	350	500	250	1,000	1,250	150	475	535	400	935	1,205	250	45	1,500	M
May 10	3,159	1,050	45	44.46	4,254	346	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 11	2,840	1,440	45	47.31	4,325	342	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 12	2,836	1,700	45	50.69	4,581	338	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 13	2,832	1,700	45	54.06	4,577	333	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 14	2,828	1,700	45	57.43	4,573	329	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 15	2,823	1,700	45	60.80	4,568	325	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 16	2,819	1,700	45	64.17	4,564	321	500	250	1,000	1,250	100	475	535	300	835	1,205	250	45	1,500	M
May 17	2,815	1,700	45	67.55	4,560	317	500	250	750	1,000	50	475	535	300	835	1,205	250	45	1,500	
May 18	2,811	1,700	45	70.92	4,556	313	500	250	250	500		475	535	265	800	1,205	250	45	1,500	
May 19	2,807	1,650	45	74.19	4,502	309	500	250		250		300	300		300	600			600	
May 20	2,803	1,315	45	76.80	4,163	305	500	250		250			150		150	600			600	
May 21	1,959	250			2,209	301	500	250		250			150		150	600			600	
May 22	1,805	0			1,805	297	500	250		250			150		150	600			600	
May 23	1,801	0			1,801	293	500	250		250			150		150	600			600	
May 24	1,797	0			1,797	289	500	250		250			150		150	600			600	
May 25	1,793	0			1,793	285	500	250		250			150		150	600			600	
May 26	1,789	0			1,789	281	500	250		250			150		150	600			600	
May 27	1,785	0			1,785	277	500	250		250			150		150	600			600	
May 28	1,781	0			1,781	273	500	250		250			150		150	600			600	
May 29	1,777	0			1,777	269	500	250		250			150		150	600			600	
May 30	1,773	0			1,773	265	500	250		250			150		150	600			600	
May 31	1,769	0			1,769	261	500	250		250			150		150	600			600	
	VAMP period																			
Mean (cfs):	3,004	1,249			4,291	345	469		655	905	119		736	237	973	1,205	238	45	1,480	
Suppl. Water (TAF)																				
Provided		76.80							40.26		7.30			14.60			14.64	2.77		
Target based on provided									40.30		7.30			14.60			14.60			
Target for perfect op		86.11							45.00		8.51			14.60			18.00			

Pulse flow period

Period of desired flow stability

DAILY OPERATION PLAN, MAY 14

Pulse Period: April 20–May 20 • Flow Target: 4,450cfs

Ungaged Flow at Vernalis = 500cfs • 2.8 TAF "other" supplemetntal water on Stanislaus R.

	San Joaquin River near Vernalis							Merced River at Cressey			Exchange Contractors	Tuolumne River at LaGrange				Stanislaus R blw Goodwin (at Orange Blossom Bridge)				
	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	VAMP Suppl. Flow	Flow (3-day lag)	VAMP Suppl. Flow (3-day lag)	Desired FERC Pulse	Existing Flow – Adjusted FERC Pulse	VAMP Suppl. Flow	Flow (2-day lag)	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
	[calc]	[calc]		[calc]	[calc]					[calc]					[calc]				[calc]	
Apr 01					2,070	515	663	220		220			347		347	407			407	
Apr 02					2,170	519	674	210		210			350		350	409			409	
Apr 03					2,160	527	687	180		180			345		345	411			411	
Apr 04	2,040				2,040	534	542	193		193			339		339	439			439	
Apr 05	1,980				1,980	515	487	218		218			328		328	558			558	
Apr 06	2,080				2,080	493	588	240		240			317		317	556			556	
Apr 07	2,330				2,330	461	736	266		266			325		325	551			551	
Apr 08	2,610				2,610	454	1,026	246		246			323		323	561			561	
Apr 09	2,660				2,660	490	1,083	240		240			318		318	347			347	
Apr 10	2,580				2,580	541	976	232		232			327		327	548			548	
Apr 11	2,480				2,480	546	1,079	241		241			326		326	551			551	
Apr 12	2,430				2,430	547	774	245		245			328		328	551			551	
Apr 13	2,430	0			2,430	545	775	253		253			329		329	550			550	
Apr 14	2,420	0			2,420	499	753	255		255			319		319	555			555	
Apr 15	2,420	0			2,420	469	751	263		263		250	256		256	548			548	
Apr 16	2,490	0			2,490	453	864	261	0	261		250	255		255	552			552	
Apr 17	2,280	0	0		2,280	422	752	250	74	324	0	250	255	0	255	553	0		553	
Apr 18	2,130	0	0		2,130	357	607	250	122	372	0	475	475	667	1,142	1,205	0	0	967	
Apr 19	2,200	0	0		2,200	282	709	250	535	785	50	475	475	966	1,441	1,205	311	90	1,606	
Apr 20	2,937	741	0	1.47	3,440	202	650	250	889	1,139	150	475	475	547	1,022	1,205	260	45	1,510	T
Apr 21	2,911	1,399	90	4.24	4,400	236	699	250	959	1,209	150	475	475	150	625	1,205	254	45	1,504	T
Apr 22	3,093	1,392	45	7.01	4,530	376	962	250	949	1,199	150	475	475	148	623	1,205	251	45	1,501	T
Apr 23	2,952	1,443	45	9.87	4,440	519	787	250	920	1,170	150	475	475	148	623	1,205	212	45	1,462	T
Apr 24	2,877	1,508	45	12.86	4,430	509	572	250	928	1,178	150	475	475	147	622	1,205	149	45	1,399	T
Apr 25	2,806	1,459	45	15.75	4,310	450	358	250	932	1,182	150	475	475	149	624	1,205	176	45	1,426	T
Apr 26	2,691	1,366	45	18.46	4,102	392	253	250	949	1,199	150	475	475	147	622	1,205	249	45	1,499	T
Apr 27	2,682	1,403	45	21.24	4,130	351	303	250	960	1,210	150	700	610	9	619	1,205	252	45	1,502	T
Apr 28	2,677	1,478	45	24.18	4,200	406	356	250	385	635	150	1,230	650	4	654	1,205	252	45	1,502	
Apr 29	2,805	1,360	45	26.87	4,210	382	390	250	274	524	100	1,230	1,230	0	1,221	1,205	254	45	1,504	
Apr 30	2,679	1,366	45	29.58	4,090	366	169	250	248	498	100	1,230	1,230	140	1,370	1,205	251	45	1,501	
May 01	3,335	789	45	31.15	4,160	360	269	250	221	471	100	1,230	1,230	145	1,375	1,205	254	45	1,504	
May 02	3,370	765	45	32.67	4,180	346	319	250	225	475	100	1,230	1,230	139	1,369	1,205	253	45	1,503	
May 03	3,438	747	45	34.15	4,230	287	393	250	202	452	100	1,230	1,230	143	1,373	1,205	251	45	1,501	
May 04	3,352	713	45	35.56	4,110	281	321	250	199	449	100	1,230	1,230	134	1,364	1,205	255	45	1,505	
May 05	3,296	719	45	36.99	4,060	282	324	250	192	442	100	1,230	1,230	106	1,336	1,205	249	45	1,499	
May 06	3,374	691	45	38.36	4,110	296	408	250	209	459	100	1,230	1,230	140	1,370	1,205	250	45	1,500	
May 07	3,411	654	45	39.66	4,110	261	444	250	556	806	130	1,230	1,230	134	1,364	1,205	252	45	1,502	
May 08	3,423	682	45	41.01	4,150	196	442	250	671	921	150	800	850	137	987	1,205	253	45	1,503	
May 09	3,390	695	45	42.39	4,130	134	444	250	994	1,244	150	475	535	377	912	1,205	254	45	1,504	M
May 10	2,899	1,076	45	44.52	4,020	152	398	250	1,040	1,290	150	475	535	302	837	1,205	254	45	1,504	M
May 11	2,664	1,452	45	47.40	4,160	182	540	250	1,069	1,319	150	475	535	316	851	1,205	255	45	1,505	M
May 12	2,446	1,700	45	50.77	4,190	194	304	250	1,075	1,325	150	475	535	306	841	1,205	256	45	1,506	M
May 13	2,511	1,761	45	54.27	4,320	195	340	250	1,091	1,341	150	475	535	304	839	1,205	253	45	1,503	M
May 14	2,684	1,781	45	57.80	4,510	329	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 15	2,685	1,782	45	61.33	4,512	325	500	250	1,000	1,250	150	475	535	300	835	1,205	250	45	1,500	M
May 16	2,819	1,791	45	64.89	4,655	321	500	250	1,000	1,250	100	475	535	300	835	1,205	250	45	1,500	M
May 17	2,815	1,700	45	68.26	4,560	317	500	250	750	1,000	50	475	535	300	835	1,205	250	45	1,500	
May 18	2,811	1,700	45	71.63	4,556	313	500	250	250	500		475	535	265	800	1,205	250	45	1,500	
May 19	2,807	1,650	45	74.90	4,502	309	500	250		250		300	300		300	600			600	
May 20	2,803	1,315	45	77.51	4,163	305	500	250		250			150		150	600			600	
May 21	1,959	250			2,209	301	500	250		250			150		150	600			600	
May 22	1,805	0			1,805	297	500	250		250			150		150	600			600	
May 23	1,801	0			1,801	293	500	250		250			150		150	600			600	
May 24	1,797	0			1,797	289	500	250		250			150		150	600			600	
May 25	1,793	0			1,793	285	500	250		250			150		150	600			600	
May 26	1,789	0			1,789	281	500	250		250			150		150	600			600	
May 27	1,785	0			1,785	277	500	250		250			150		150	600			600	
May 28	1,781	0			1,781	273	500	250		250			150		150	600			600	
May 29	1,777	0			1,777	269	500	250		250			150		150	600			600	
May 30	1,773	0			1,773	265	500	250		250			150		150	600			600	
May 31	1,769	0			1,769	261	500	250		250			150		150	600			600	
	VAMP period																			
Mean (cfs):	2,950	1,261			4,247	309	450		665	915	119		736	238	973	1,205	239	45	1,481	
Suppl. Water (TAF)																				
Provided		77.51							40.90		7.30			14.62			14.70	2.77		
Target based on provided									41.01		7.30			14.60			14.60			
Target for perfect op		89.48							45.00		9.00			17.48			18.00			

Pulse flow period

Period of desired flow stability

2001 VERNALIS ADAPTIVE MANAGEMENT PLAN (VAMP)

ACCOUNTING OF SUPPLEMEMTAL WATER CONTRIBTIONS

Hydrology Subgroup of the San Joaquin River Technical Committee

Pulse Flow Period: April 20–May 20

	Merced R. at Cresy (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)				SJRECWA (3day)	San Joaquin River at Vernalis		
	Existing Flow	Observed Flow	VAMP Suppl. Water	Exisitng Flow	Observed Flow	VAMP Suppl. Water	Existing Flow	Observed Flow	Other Suppl. Water	VAMP Suppl. Water	VAMP Suppl. Water	Existing Flow	Observed Flow	VAMP Suppl. Water
	(cfs)		(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
Apr 01	220	225		347	343		407	407				2,070	2,070	
Apr 02	210	210		350	344		409	409				2,170	2,170	
Apr 03	180	177		345	336		411	411				2,160	2,160	
Apr 04	193	195		339	331		439	439				2,039	2,039	
Apr 05	218	224		328	319		558	558				1,980	1,980	
Apr 06	240	246		317	309		556	556				2,080	2,080	
Apr 07	266	267		325	316		551	551				2,330	2,330	
Apr 08	246	252		323	314		561	561				2,610	2,610	
Apr 09	240	247		318	307		347	347				2,650	2,650	
Apr 10	232	245		327	314		548	548				2,580	2,580	
Apr 11	241	255		326	315		551	551				2,480	2,480	
Apr 12	245	260		328	316		551	551				2,430	2,430	
Apr 13	253	270		329	316		550	550				2,430	2,430	
Apr 14	255	274		319	305		555	555				2,420	2,420	
Apr 15	263	285		256	245		548	548				2,418	2,420	
Apr 16	261	284		255	243		552	552				2,487	2,490	
Apr 17	250	404	154	255	243		553	553			0	2,272	2,280	
Apr 18	250	458	208	475	1,100	625	1,205	967	0	0	0	2,120	2,130	
Apr 19	250	876	626	475	1,400	925	1,205	1,606	90	311	67	2,189	2,200	
Apr 20	250	1,240	990	475	1,000	525	1,205	1,510	45	260	152	2,908	3,449	779
Apr 21	250	1,310	1,060	475	601	126	1,205	1,504	45	254	207	2,876	4,410	1,444
Apr 22	250	1,310	1,060	475	598	123	1,205	1,501	45	251	160	3,007	4,530	1,478
Apr 23	250	1,290	1,040	475	598	123	1,205	1,462	45	212	199	2,873	4,440	1,522
Apr 24	250	1,280	1,030	475	595	120	1,205	1,399	45	149	183	2,734	4,420	1,641
Apr 25	250	1,280	1,030	475	594	119	1,205	1,426	45	176	163	2,710	4,310	1,555
Apr 26	250	1,260	1,010	475	593	118	1,205	1,499	45	249	170	2,547	4,100	1,508
Apr 27	250	1,220	970	610	601	0	1,205	1,502	45	252	174	2,577	4,130	1,508
Apr 28	250	656	406	650	654	4	1,205	1,502	45	252	205	2,595	4,200	1,560
Apr 29	250	544	294	1,230	1,210	0	1,205	1,504	45	254	177	2,742	4,210	1,432
Apr 30	250	515	265	1,230	1,360	130	1,205	1,501	45	251	149	2,644	4,089	1,400
May 01	250	486	236	1,230	1,380	150	1,205	1,504	45	254	71	3,270	4,160	865
May 02	250	485	235	1,230	1,370	140	1,205	1,503	45	253	66	3,283	4,180	852
May 03	250	458	208	1,230	1,370	140	1,205	1,501	45	251	94	3,367	4,230	818
May 04	250	449	199	1,230	1,370	140	1,205	1,505	45	255	168	3,365	4,110	700
May 05	250	436	186	1,230	1,340	110	1,205	1,499	45	249	107	3,313	4,050	692
May 06	250	450	200	1,230	1,370	140	1,205	1,500	45	250	85	3,368	4,110	697
May 07	250	788	538	1,230	1,370	140	1,205	1,502	45	252	78	3,339	4,110	726
May 08	250	899	649	850	994	144	1,205	1,503	45	253	97	3,432	4,160	683
May 09	250	1,190	940	535	916	381	1,205	1,504	45	254	80	3,408	4,130	677
May 10	250	1,230	980	535	838	303	1,205	1,504	45	254	134	2,952	4,010	1,013
May 11	250	1,250	1,000	535	850	315	1,205	1,505	45	255	183	2,744	4,170	1,381
May 12	250	1,250	1,000	535	841	306	1,205	1,506	45	256	114	2,568	4,190	1,577
May 13	250	1,260	1,010	535	837	302	1,205	1,503	45	253	116	2,591	4,320	1,684
May 14	250	1,260	1,010	535	833	298	1,205	1,502	45	252	167	2,730	4,520	1,745
May 15	250	1,240	990	535	839	304	1,205	1,504	45	254	118	2,746	4,460	1,669
May 16	250	1,240	990	535	843	308	1,205	1,506	45	256	138	2,834	4,510	1,676
May 17	250	971	721	535	845	310	1,205	1,502	45	252	79	2,765	4,500	1,735
May 18	250	569		535	755	220	1,205	1,502	45	252		2,888	4,560	1,672
May 19	250	449		300	333		600	1,271				2,620	4,310	1,690
May 20	250	405		150	167		600	1,017				2,598	3,870	1,272
May 21	250	372		150	173		600	772				2,330	3,320	
May 22	250	356		150	170		600	603				2,124	2,740	
May 23	250	360		150	176		600	603				2,360	2,360	
May 24	250	341		150	177		600	603				2,140	2,140	
May 25	250	322		150	175		600	604				2,050	2,050	
May 26	250	294		150	160		600	604				2,010	2,010	
May 27	250	293		150	175		600	604				2,010	2,010	
May 28	250	283		150	165		600	605				2,070	2,070	
May 29	250	284		150	160		600	604				2,100	2,100	
May 30	250	286		150	171		600	604				1,980	1,980	
May 31	250	293		150	162		600	604				1,910	1,910	
Total Supplemental Water (TAF):			**42.12**			**14.06**			**2.77**	**14.73**	**7.74**			**78.65**
Pulse Period Average:												2,916	4,224	

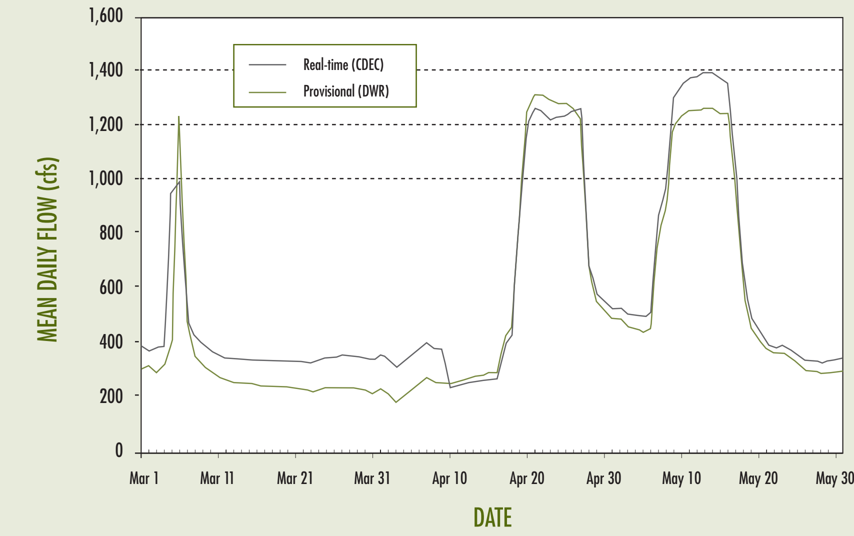
Observed Flow Sources:

Merced River at Cressey (CA DWR B05155): DWR San Joaquin District, provisional data received June 12, 2001. • Tuolumne River below LaGrange Dam near LaGrange (USGS 11289650): USGS, provisional data dated July 25, 2001.

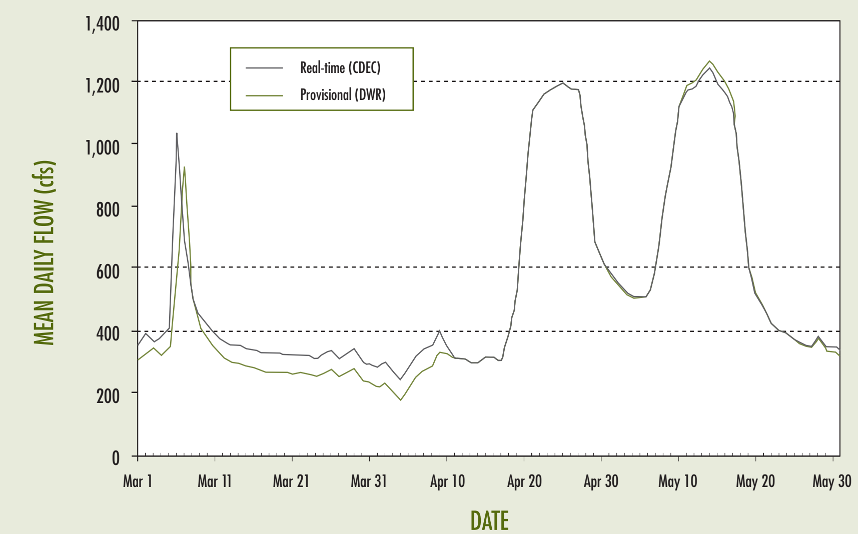
Stanislaus River below Goodwin Dam: Goodwin Reservoir Daily Operations report, OID/SSJID/Tri-Dams (published by USBR CVO) • San Joaquin River near Vernalis (USGS 11303500): USGS, provisional data dated July 25, 2001.

COMPARISON OF "REAL-TIME" AND PROVISIONAL FLOWS

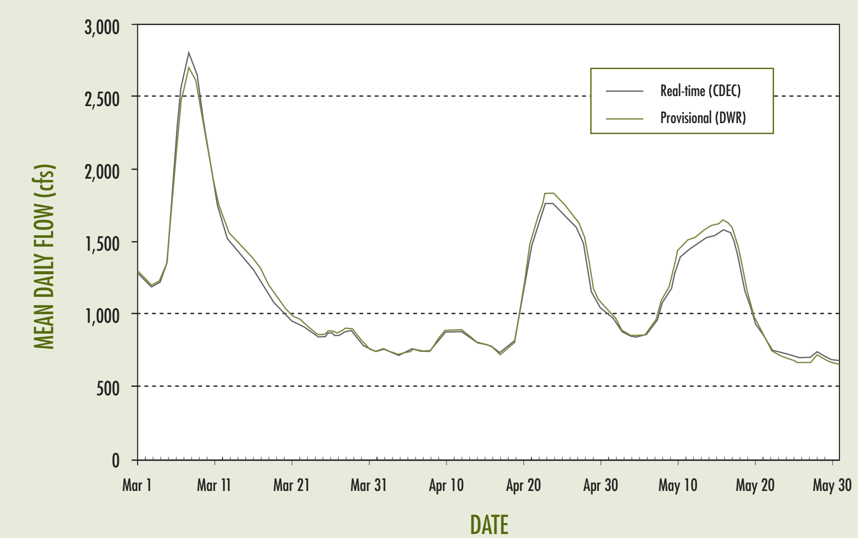
Merced River Near Cressey



Merced River Near Stevinson

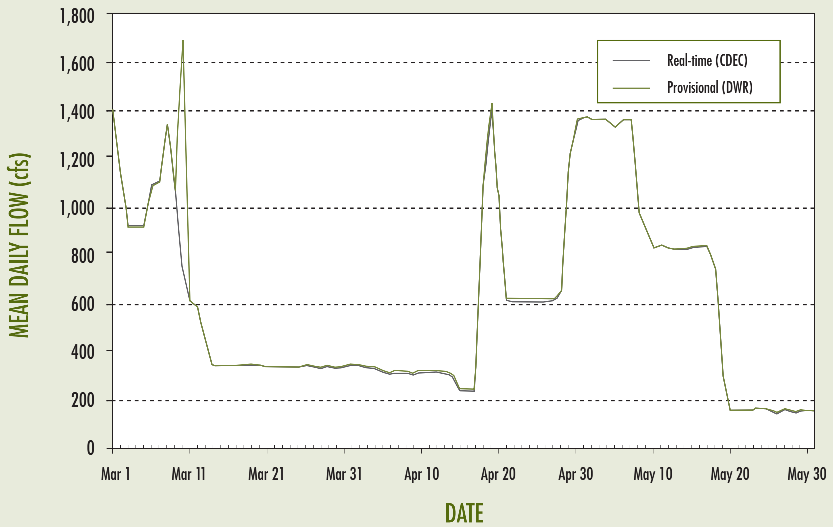


San Joaquin River Near Newman

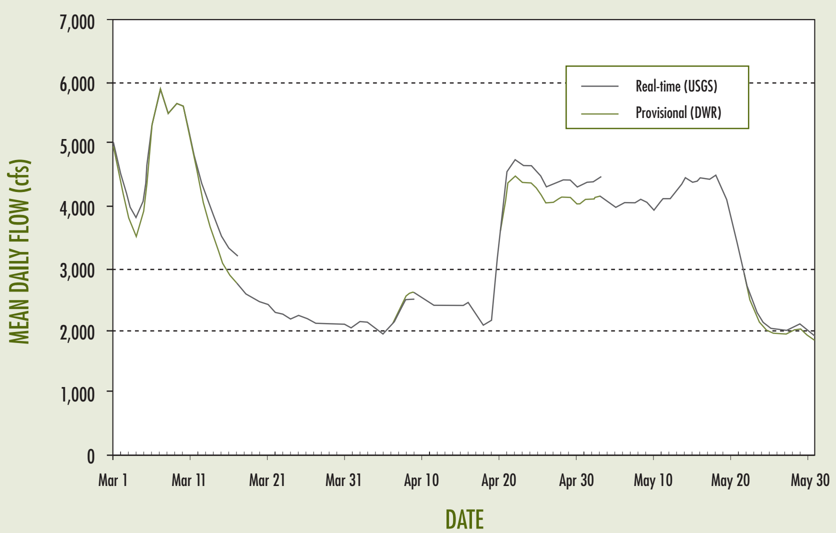


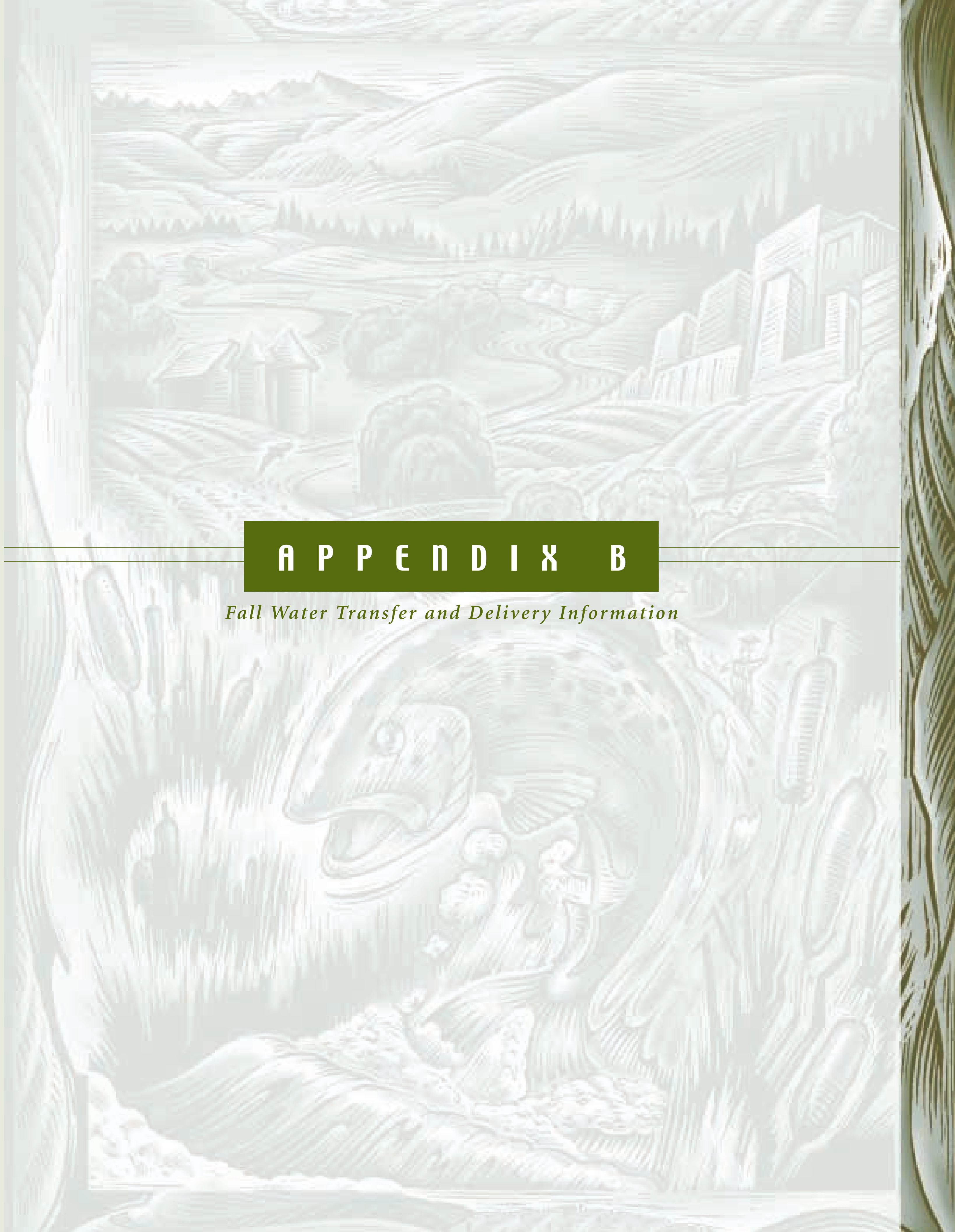
COMPARISON OF "REAL-TIME" AND PROVISIONAL FLOWS

Tuolumne River Below LaGrange Dam



San Joaquin River Near Vernalis





APPENDIX B

Fall Water Transfer and Delivery Information

MERCED IRRIGATION DISTRICT (PRELIMINARY)

2001 Fall SJRA and EWA Water Transfers • Initial Daily Flow Schedule

October 11, 2001

	SJRA Transfer Water			EWA Transfer Water					
	Shaffer Br/Cressey Base Flow for SJRA Transfer Water	SJRA Transfer Water Schedule	Cumulative SJRA Transfer Water Volume	Shaffer Br/Cressey Base Flow for EWA Transfer Water [1] + [2]	EWA Transfer Water Schdule – RIVER	Shaffer Br/Cressey Target Flow [4] + [5]	EWA Transfer Water Schedule – BYPASS	EWA Transfer Water [5] + [7]	EWA Transfer Balance
	(cfs)	(cfs)	(acre-foot)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(acre-foot)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Oct 01	30	0	0	30	0	30	0	0	0
Oct 02	30	0	0	30	0	30	0	0	0
Oct 03	30	0	0	30	0	30	0	0	0
Oct 04	30	0	0	30	0	30	0	0	0
Oct 05	30	0	0	30	0	30	0	0	0
Oct 06	30	0	0	30	0	30	0	0	0
Oct 07	30	0	0	30	0	30	0	0	0
Oct 08	30	0	0	30	0	30	0	0	0
Oct 09	30	0	0	30	0	30	0	0	0
Oct 10	30	0	0	30	0	30	0	0	0
Oct 11	30	0	0	30	0	30	0	0	0
Oct 12	30	0	0	30	0	30	0	0	0
Oct 13	30	0	0	30	0	30	0	0	0
Oct 14	30	0	0	30	0	30	0	0	0
Oct 15	30	0	0	30	0	30	0	0	0
Oct 16	85	0	0	85	215	300	0	215	426
Oct 17	85	0	0	85	615	700	0	615	1,646
Oct 18	85	0	0	85	615	700	0	615	2,866
Oct 19	85	0	0	85	615	700	0	615	4,086
Oct 20	85	0	0	85	615	700	0	615	5,306
Oct 21	85	0	0	85	615	700	0	615	6,526
Oct 22	85	0	0	85	615	700	0	615	7,745
Oct 23	85	0	0	85	615	700	0	615	8,965
Oct 24	85	0	0	85	615	700	0	615	10,185
Oct 25	85	0	0	85	615	700	0	615	11,405
Oct 26	85	0	0	85	615	700	0	615	12,625
Oct 27	85	0	0	85	615	700	0	615	13,845
Oct 28	85	0	0	85	615	700	0	615	15,064
Oct 29	85	0	0	85	615	700	0	615	16,284
Oct 30	85	0	0	85	615	700	0	615	17,504
Oct 31	85	0	0	85	615	700	0	615	18,724
Nov 01	220	0	0	220	265	485	100	365	19,448
Nov 02	220	0	0	220	180	400	100	280	20,003
Nov 03	220	0	0	220	180	400	100	280	20,559
Nov 04	220	0	0	220	180	400	100	280	21,114
Nov 05	220	0	0	220	180	400	100	280	21,669
Nov 06	220	0	0	220	180	400	100	280	22,225
Nov 07	220	0	0	220	180	400	100	280	22,780
Nov 08	220	0	0	220	180	400	100	280	23,336
Nov 09	220	0	0	220	180	400	100	280	23,891
Nov 10	220	0	0	220	180	400	100	280	24,446
Nov 11	220	0	0	220	180	400	100	280	25,002
Nov 12	220	140	278	360	0	360	0	0	25,002
Nov 13	220	140	555	360	0	360	0	0	25,002
Nov 14	220	140	833	360	0	360	0	0	25,002
Nov 15	220	140	1,111	360	0	360	0	0	25,002

MERCED IRRIGATION DISTRICT (PRELIMINARY)

2001 Fall SJRA and EWA Water Transfers • Initial Daily Flow Schedule

October 11, 2001

SJRA Transfer Water			EWA Transfer Water						
Shaffer Br/Cressey Base Flow for SJRA Transfer Water	SJRA Transfer Water Schedule	Cumulative SJRA Transfer Water Volume	Shaffer Br/Cressey Base Flow for EWA Transfer Water [1] + [2]	EWA Transfer Water Schdule – RIVER	Shaffer Br/Cressey Target Flow [4] + [5]	EWA Transfer Water Schedule – BYPASS	EWA Transfer Water [5] + [7]	EWA Transfer Balance	
(cfs)	(cfs)	(acre-foot)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(acre-foot)	
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	
220	140	1,388	360	0	360	0	0	25,002	Nov 16
220	140	1,666	360	0	360	0	0	25,002	Nov 17
220	140	1,944	360	0	360	0	0	25,002	Nov 18
220	140	2,221	360	0	360	0	0	25,002	Nov 19
220	140	2,499	360	0	360	0	0	25,002	Nov 20
220	140	2,777	360	0	360	0	0	25,002	Nov 21
220	140	3,055	360	0	360	0	0	25,002	Nov 22
220	140	3,332	360	0	360	0	0	25,002	Nov 23
220	140	3,610	360	0	360	0	0	25,002	Nov 24
220	140	3,888	360	0	360	0	0	25,002	Nov 25
220	140	4,165	360	0	360	0	0	25,002	Nov 26
220	120	4,403	340	0	340	0	0	25,002	Nov 27
220	120	4,641	340	0	340	0	0	25,002	Nov 28
220	120	4,879	340	0	340	0	0	25,002	Nov 29
220	120	5,117	340	0	340	0	0	25,002	Nov 30
220	120	5,355	340	0	340		0	25,002	Dec 01
220	120	5,593	340	0	340		0	25,002	Dec 02
220	120	5,831	340	0	340		0	25,002	Dec 03
220	120	6,069	340	0	340		0	25,002	Dec 04
220	120	6,307	340	0	340		0	25,002	Dec 05
220	120	6,545	340	0	340		0	25,002	Dec 06
220	120	6,783	340	0	340		0	25,002	Dec 07
220	120	7,021	340	0	340		0	25,002	Dec 08
220	120	7,260	340	0	340		0	25,002	Dec 09
220	120	7,498	340	0	340		0	25,002	Dec 10
220	120	7,736	340	0	340		0	25,002	Dec 11
220	120	7,974	340	0	340		0	25,002	Dec 12
220	120	8,212	340	0	340		0	25,002	Dec 13
220	120	8,450	340	0	340		0	25,002	Dec 14
220	120	8,688	340	0	340		0	25,002	Dec 15
220	120	8,926	340	0	340		0	25,002	Dec 16
220	120	9,164	340	0	340		0	25,002	Dec 17
220	120	9,402	340	0	340		0	25,002	Dec 18
220	120	9,640	340	0	340		0	25,002	Dec 19
220	120	9,878	340	0	340		0	25,002	Dec 20
220	120	10,116	340	0	340		0	25,002	Dec 21
220	120	10,354	340	0	340		0	25,002	Dec 22
220	120	10,592	340	0	340		0	25,002	Dec 23
220	120	10,830	340	0	340		0	25,002	Dec 24
220	120	11,068	340	0	340		0	25,002	Dec 25
220	120	11,306	340	0	340		0	25,002	Dec 26
220	120	11,544	340	0	340		0	25,002	Dec 27
220	120	11,782	340	0	340		0	25,002	Dec 28
220	120	12,020	340	0	340		0	25,002	Dec 29
220	120	12,258	340	0	340		0	25,002	Dec 30
220	120	12,496	340	0	340		0	25,002	Dec 31

	Oct	Nov	Dec	Total
SJRA Transfer Water (AF):	0	5,117	7,379	12,496
EWA Transfer Water (AF):	18,724	6,278	0	25,002

MERCED IRRIGATION DISTRICT (PRELIMINARY)

2001 Fall SJRA and EWA Water Transfers

Using data available as of Dec. 19, 2001 • Subject to change

		SJRA Transfer Water				EWA Transfer Water							
	Merced River at Cressey Flow (cfs)	Base Flow	SJRA Transfer Water Flow (cfs)		SJRA Transfer Water Cumulative Volume (ac-ft)	Base Flow	EWA Transfer Water Flow-RIVER (CFS)		EWA Transfer Water BYPASS - Livingston Spill (cfs)		Total EWA Transfer Water Flow (cfs)	Daily EWA Transfer Water Volume (ac-ft)	Cumulative EWA Transfer Water Volume (ac-ft)
	DWR Provisional		Scheduled	Observed			Scheduled	Observed	Scheduled	Observed			
Oct 01	111	30	0				0		0				
Oct 02	112	30	0				0		0				
Oct 03	105	30	0				0		0				
Oct 04	105	30	0				0		0				
Oct 05	102	30	0				0		0				
Oct 06	86	30	0				0		0				
Oct 07	111	30	0				0		0				
Oct 08	111	30	0				0		0				
Oct 09	115	30	0				0		0				
Oct 10	114	30	0				0		0				
Oct 11	113	30	0				0		0				
Oct 12	114	30	0				0		0				
Oct 13	116	30	0				0		0				
Oct 14	116	30	0				0		0				
Oct 15	119	30	0				0		0				
Oct 16	173	85	0	0	0	85	215	88	0		88	175	175
Oct 17	422	85	0	0	0	85	615	337	0		337	668	843
Oct 18	598	85	0	0	0	85	615	513	0		513	1,018	1,861
Oct 19	684	85	0	0	0	85	615	599	0		599	1,188	3,049
Oct 20	699	85	0	0	0	85	615	614	0		614	1,218	4,267
Oct 21	732	85	0	0	0	85	615	615	0		615	1,220	5,487
Oct 22	747	85	0	0	0	85	615	615	0		615	1,220	6,707
Oct 23	738	85	0	0	0	85	615	615	0		615	1,220	7,927
Oct 24	744	85	0	0	0	85	615	615	0		615	1,220	9,147
Oct 25	738	85	0	0	0	85	615	615	0		615	1,220	10,367
Oct 26	726	85	0	0	0	85	615	615	0		615	1,220	11,587
Oct 27	716	85	0	0	0	85	615	615	0		615	1,220	12,807
Oct 28	724	85	0	0	0	85	615	615	0		615	1,220	14,027
Oct 29	737	85	0	0	0	85	615	615	0		615	1,220	15,247
Oct 30	733	85	0	0	0	85	615	615	0		615	1,220	16,467
Oct 31	735	85	0	0	0	85	615	615	0		615	1,220	17,687
Nov 01	220	0				265		100	86				
Nov 02	220	0				180		100	111				
Nov 03	220	0				180		100	106				
Nov 04	220	0				180		100	91				
Nov 05	220	0				180		100	90				
Nov 06	220	0				180		100	96				
Nov 07	220	0				180		100	95				
Nov 08	220	0				180		100	101				
Nov 09	220	0				180		100	105				
Nov 10	220	0				180		100	107				
Nov 11	220	0				180		100	106				
Nov 12	220	140				0		0					
Nov 13	220	140				0		0					
Nov 14	220	140				0		0					
Nov 15	220	140				0		0					

MERCED IRRIGATION DISTRICT (PRELIMINARY)

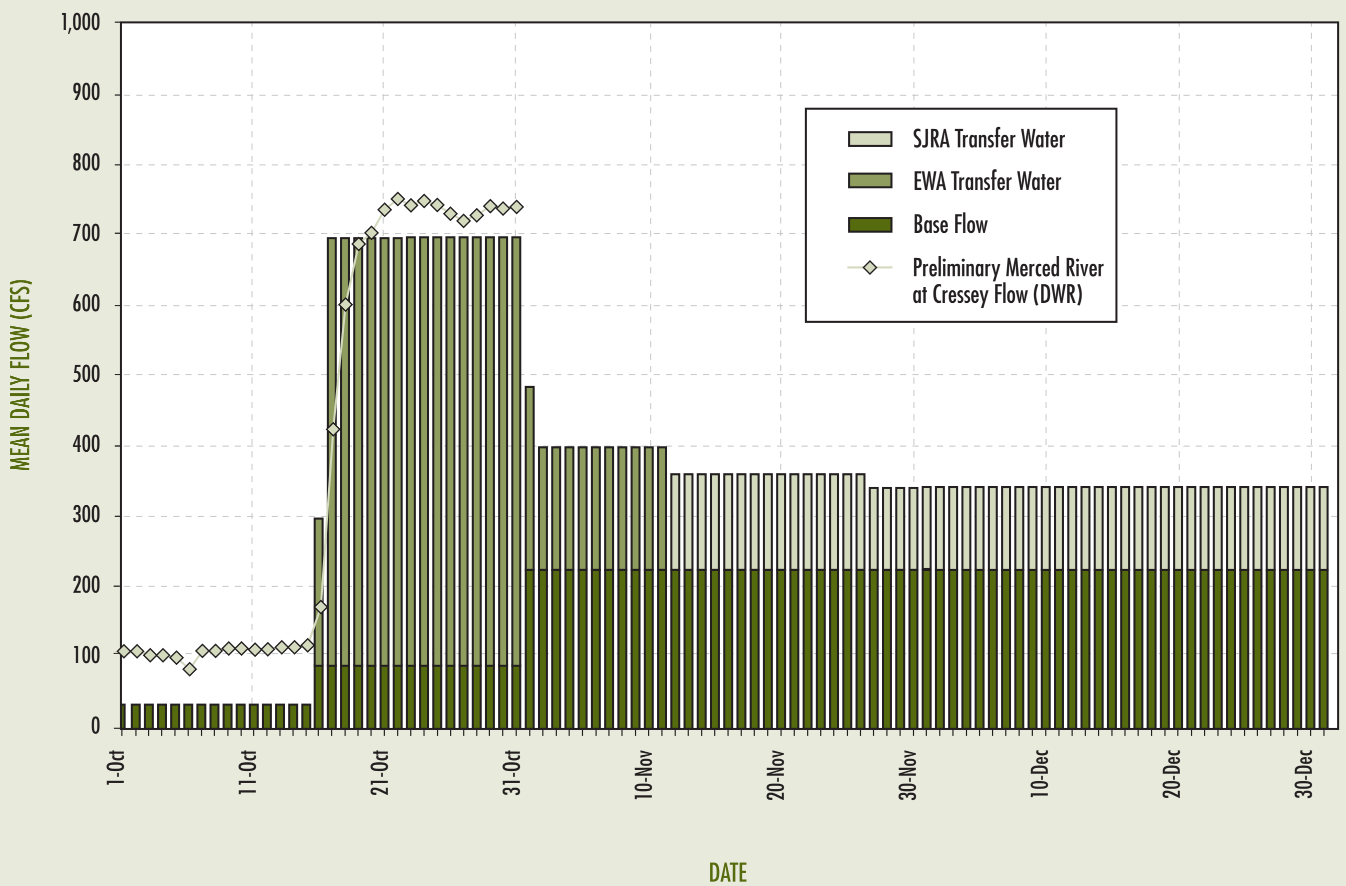
2001 Fall SJRA and EWA Water Transfers

Using data available as of Dec. 19, 2001 • Subject to change

Merced River at Cressey Flow (cfs)	SJRA Transfer Water: Base Flow	SJRA Transfer Water Flow (cfs)		SJRA Transfer Water Cumulative Volume (ac-ft)	EWA Transfer Water: Base Flow	EWA Transfer Water Flow-RIVER (CFS)		EWA Transfer Water BYPASS - Livingston Spill (cfs)		Total EWA Transfer Water Flow (cfs)	Daily EWA Transfer Water Volume (ac-ft)	Cumulative EWA Transfer Water Volume (ac-ft)	
DWR Provisional		Scheduled	Observed			Scheduled	Observed	Scheduled	Observed				
220	140				0		0						Nov 16
220	140				0		0						Nov 17
220	140				0		0						Nov 18
220	140				0		0						Nov 19
220	140				0		0						Nov 20
220	140				0		0						Nov 21
220	140				0		0						Nov 22
220	140				0		0						Nov 23
220	140				0		0						Nov 24
220	140				0		0						Nov 25
220	140				0		0						Nov 26
220	120				0		0						Nov 27
220	120				0		0						Nov 28
220	120				0		0						Nov 29
220	120				0		0						Nov 30
220	120				0		0						Dec 01
220	120				0		0						Dec 02
220	120				0		0						Dec 03
220	120				0		0						Dec 04
220	120				0		0						Dec 05
220	120				0		0						Dec 06
220	120				0		0						Dec 07
220	120				0		0						Dec 08
220	120				0		0						Dec 09
220	120				0		0						Dec 10
220	120				0		0						Dec 11
220	120				0		0						Dec 12
220	120				0		0						Dec 13
220	120				0		0						Dec 14
220	120				0		0						Dec 15
220	120				0		0						Dec 16
220	120				0		0						Dec 17
220	120				0		0						Dec 18
220	120				0		0						Dec 19
220	120				0		0						Dec 20
220	120				0		0						Dec 21
220	120				0		0						Dec 22
220	120				0		0						Dec 23
220	120				0		0						Dec 24
220	120				0		0						Dec 25
220	120				0		0						Dec 26
220	120				0		0						Dec 27
220	120				0		0						Dec 28
220	120				0		0						Dec 29
220	120				0		0						Dec 30
220	120				0		0						Dec 31

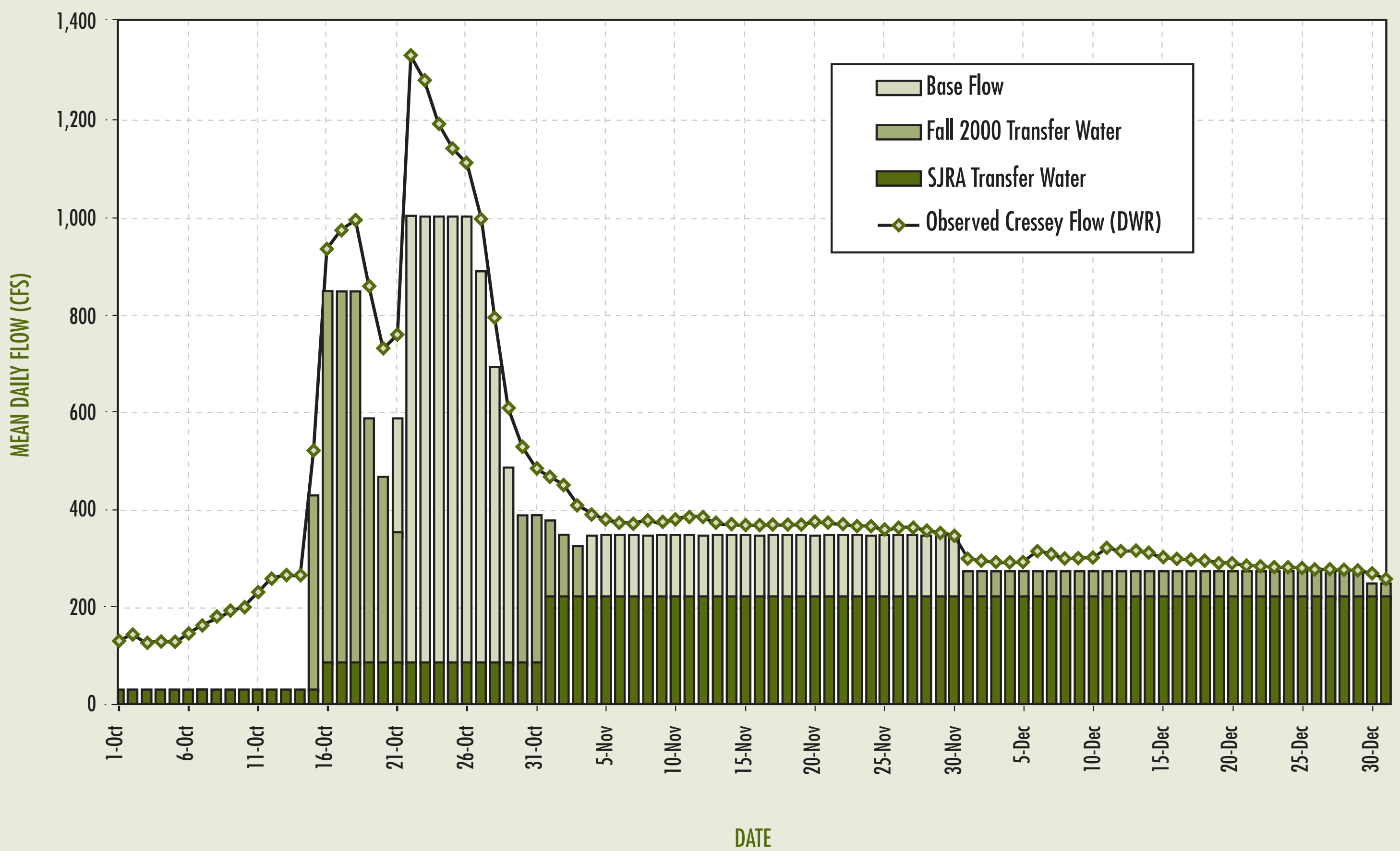
MERCED IRRIGATION DISTRICT FALL 2001 WATER TRANSFERS (PRELIMINARY)

Merced River Flow at Shaffer Bridge/Cressey



MERCED IRRIGATION DISTRICT FALL 2000 WATER TRANSFERS (FINAL)

Merced River Flow at Shaffer Bridge/Cressey



MERCED IRRIGATION DISTRICT (FINAL)

2000 Fall Water Transfers

Date		SJRA Transfer Water				Fall 2000 Transfer Water							
	Merced River at Cressey Flow (cfs)	Base Flow	SJRA Transfer Water Flow (cfs)		SJRA Transfer Water Cumulative Volume (ac-ft)	Base Flow	Fall 2000 Transfer Water Flow RIVER (cfs)		Fall 2000 Transfer Water-BYPASS - Livingston Spill (cfs)		Total Fall 2000 Transfer Water Flow (cfs)	Daily Fall 2000 Transfer Water Volume (ac-ft)	Cumulative Fall 2000 Transfer Water Volume (ac-ft)
	DWR		Scheduled	Observed			Scheduled	Observed	Scheduled	Observed			
Oct 01	130	30	0				0		0				
Oct 02	144	30	0				0		0				
Oct 03	129	30	0				0		0				
Oct 04	130	30	0				0		0				
Oct 05	129	30	0				0		0				
Oct 06	147	30	0				0		0				
Oct 07	164	30	0				0		0				
Oct 08	182	30	0				0		0				
Oct 09	195	30	0				0		0				
Oct 10	201	30	0				0		0				
Oct 11	232	30	0				0		0				
Oct 12	256	30	0				0		0				
Oct 13	266	30	0				0		0				
Oct 14	266	30	0				0		0				
Oct 15	518	30	397	397	787	427	0	0	0		0	0	0
Oct 16	933	85	760	760	2,295	845	0	0	0		0	0	0
Oct 17	972	85	760	760	3,802	845	0	0	0		0	0	0
Oct 18	993	85	760	760	5,310	845	0	0	0		0	0	0
Oct 19	859	85	500	500	6,301	585	0	0	0		0	0	0
Oct 20	731	85	380	380	7,055	465	0	0	0		0	0	0
Oct 21	758	85	265	265	7,581	350	235	235	0		235	466	466
Oct 22	1,310	85	0	0	7,581	85	915	915	0		915	1,815	2,281
Oct 23	1,260	85	0	0	7,581	85	915	915	0		915	1,815	4,096
Oct 24	1,180	85	0	0	7,581	85	915	915	0		915	1,815	5,911
Oct 25	1,140	85	0	0	7,581	85	915	915	0		915	1,815	7,726
Oct 26	1,100	85	0	0	7,581	85	915	915	0		915	1,815	9,540
Oct 27	993	85	0	0	7,581	85	800	800	0		800	1,587	11,127
Oct 28	793	85	0	0	7,581	85	605	605	0		605	1,200	12,327
Oct 29	606	85	0	0	7,581	85	400	400	0		400	793	13,121
Oct 30	527	85	300	300	8,176	385	0	0	0		0	0	13,121
Oct 31	484	85	300	300	8,771	385	0	0	0		0	0	13,121
Nov 01	462	220	155	155	9,078	375	0	0	0	51	0	0	13,121
Nov 02	450	220	125	125	9,326	345	0	0	0	34	0	0	13,121
Nov 03	407	220	100	100	9,525	320	0	0	0	10	0	0	13,121
Nov 04	392	220	0	0	9,525	220	125	125	0	6	125	248	13,369
Nov 05	382	220	0	0	9,525	220	125	125	0	37	125	248	13,617
Nov 06	379	220	0	0	9,525	220	125	125	100	94	219	434	14,051
Nov 07	376	220	0	0	9,525	220	125	125	100	123	225	446	14,497
Nov 08	381	220	0	0	9,525	220	125	125	100	122	225	446	14,943
Nov 09	382	220	0	0	9,525	220	125	125	100	115	225	446	15,390
Nov 10	384	220	0	0	9,525	220	125	125	100	113	225	446	15,836
Nov 11	391	220	0	0	9,525	220	125	125	100	114	225	446	16,282
Nov 12	393	220	0	0	9,525	220	125	125	100	113	225	446	16,729
Nov 13	380	220	0	0	9,525	220	125	125	100	111	225	446	17,175
Nov 14	368	220	0	0	9,525	220	125	125	100	111	225	446	17,621
Nov 15	363	220	0	0	9,525	220	125	125	100	110	225	446	18,067

MERCED IRRIGATION DISTRICT (FINAL)

2000 Fall Water Transfers

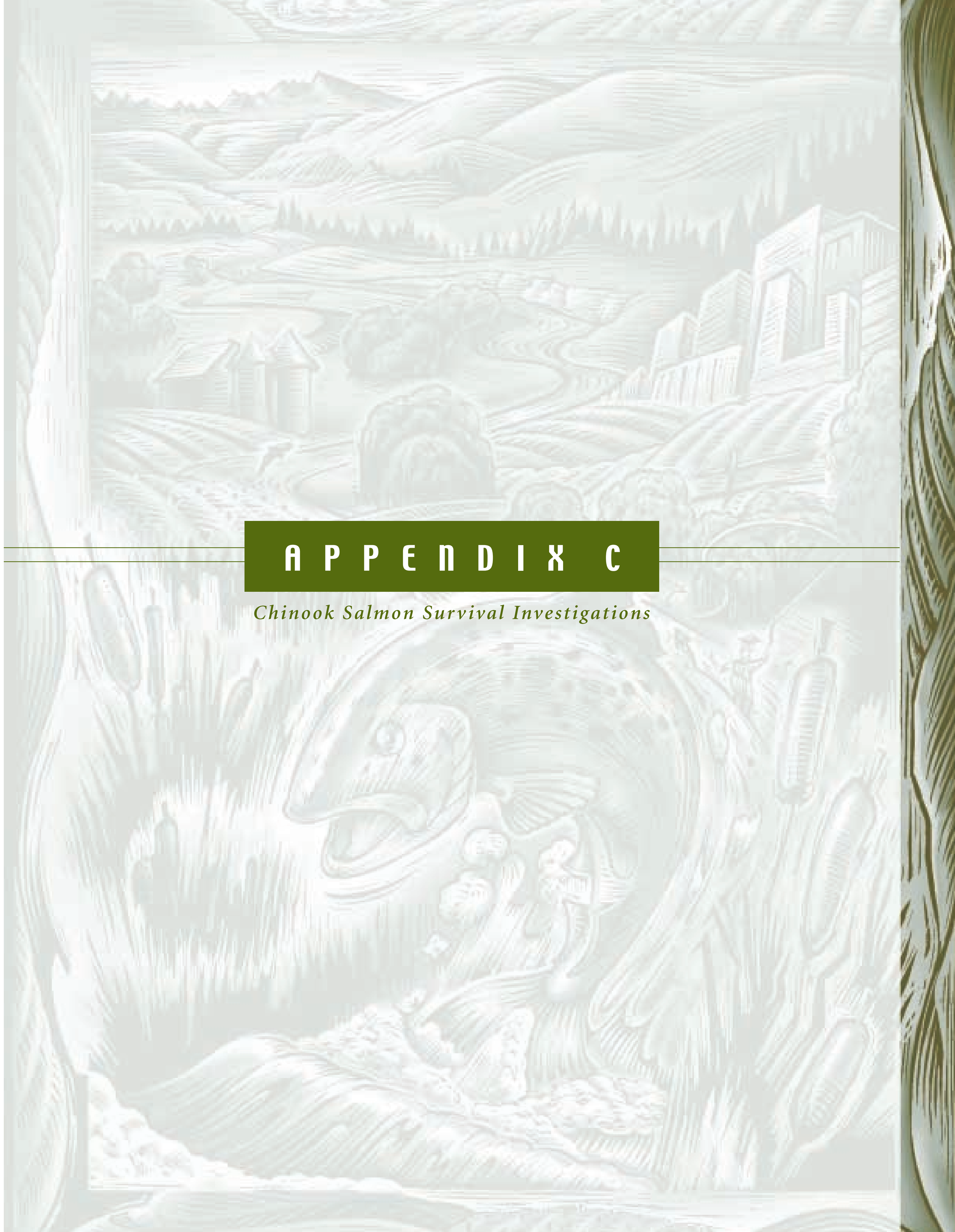
	SJRA Transfer Water					Fall 2000 Transfer Water							Date
Merced River at Cressey Flow (cfs)	Base Flow	SJRA Transfer Water Flow (cfs)		SJRA Transfer Water Cumulative Volume (ac-ft)	Base Flow	Fall 2000 Transfer Water Flow RIVER (cfs)		Fall 2000 Transfer Water-BYPASS - Livingston Spill (cfs)		Total Fall 2000 Transfer Water Flow (cfs)	Daily Fall 2000 Transfer Water Volume (ac-ft)	Cumulative Fall 2000 Transfer Water Volume (ac-ft)	
DWR		Scheduled	Observed			Scheduled	Observed	Scheduled	Observed				
363	220	0	0	9,525	220	125	125	100	111	225	446	18,514	Nov 16
363	220	0	0	9,525	220	125	125	100	112	225	446	18,960	Nov 17
359	220	0	0	9,525	220	125	125	100	110	225	446	19,406	Nov 18
359	220	0	0	9,525	220	125	125	100	111	225	446	19,853	Nov 19
364	220	0	0	9,525	220	125	125	100	111	225	446	20,299	Nov 20
362	220	0	0	9,525	220	125	125	100	111	225	446	20,745	Nov 21
359	220	0	0	9,525	220	125	125	100	111	225	446	21,191	Nov 22
362	220	0	0	9,525	220	125	125	100	111	225	446	21,638	Nov 23
361	220	0	0	9,525	220	125	125	100	111	225	446	22,084	Nov 24
353	220	0	0	9,525	220	125	125	100	113	225	446	22,530	Nov 25
357	220	0	0	9,525	220	125	125	100	114	225	446	22,977	Nov 26
355	220	0	0	9,525	220	125	125	100	111	225	446	23,423	Nov 27
348	220	0	0	9,525	220	125	125	100	111	225	446	23,869	Nov 28
344	220	0	0	9,525	220	125	125	100	112	225	446	24,315	Nov 29
336	220	0	0	9,525	220	125	118	100	112	218	432	24,748	Nov 30
306	220	50	50	9,624	270	0	0	0		0	0	24,748	Dec 01
295	220	50	50	9,723	270	0	0	0		0	0	24,748	Dec 02
291	220	50	50	9,822	270	0	0	0		0	0	24,748	Dec 03
290	220	50	50	9,921	270	0	0	0		0	0	24,748	Dec 04
287	220	50	50	10,020	270	0	0	0		0	0	24,748	Dec 05
289	220	50	50	10,120	270	0	0	0		0	0	24,748	Dec 06
310	220	50	50	10,219	270	0	0	0		0	0	24,748	Dec 07
304	220	50	50	10,318	270	0	0	0		0	0	24,748	Dec 08
295	220	50	50	10,417	270	0	0	0		0	0	24,748	Dec 09
295	220	50	50	10,516	270	0	0	0		0	0	24,748	Dec 10
297	220	50	50	10,616	270	0	0	0		0	0	24,748	Dec 11
317	220	50	50	10,715	270	0	0	0		0	0	24,748	Dec 12
311	220	50	50	10,814	270	0	0	0		0	0	24,748	Dec 13
311	220	50	50	10,913	270	0	0	0		0	0	24,748	Dec 14
306	220	50	50	11,012	270	0	0	0		0	0	24,748	Dec 15
297	220	50	50	11,111	270	0	0	0		0	0	24,748	Dec 16
294	220	50	50	11,211	270	0	0	0		0	0	24,748	Dec 17
294	220	50	50	11,310	270	0	0	0		0	0	24,748	Dec 18
291	220	50	50	11,409	270	0	0	0		0	0	24,748	Dec 19
288	220	50	50	11,508	270	0	0	0		0	0	24,748	Dec 20
283	220	50	50	11,607	270	0	0	0		0	0	24,748	Dec 21
280	220	50	50	11,706	270	0	0	0		0	0	24,748	Dec 22
279	220	50	50	11,806	270	0	0	0		0	0	24,748	Dec 23
277	220	50	50	11,905	270	0	0	0		0	0	24,748	Dec 24
276	220	50	50	12,004	270	0	0	0		0	0	24,748	Dec 25
274	220	50	50	12,103	270	0	0	0		0	0	24,748	Dec 26
273	220	50	50	12,202	270	0	0	0		0	0	24,748	Dec 27
273	220	50	50	12,301	270	0	0	0		0	0	24,748	Dec 28
272	220	50	50	12,401	270	0	0	0		0	0	24,748	Dec 29
263	220	25	25	12,450	245	0	0	0		0	0	24,748	Dec 30
255	220	25	25	12,500	245	0	0	0		0	0	24,748	Dec 31

OAKDALE IRRIGATION DISTRICT (PRELIMINARY)

Daily Tabulation of Additional Water Release • Additional Water Available: 18,635 acre-feet

Using data available as of December 19, 2001 • Subject to change

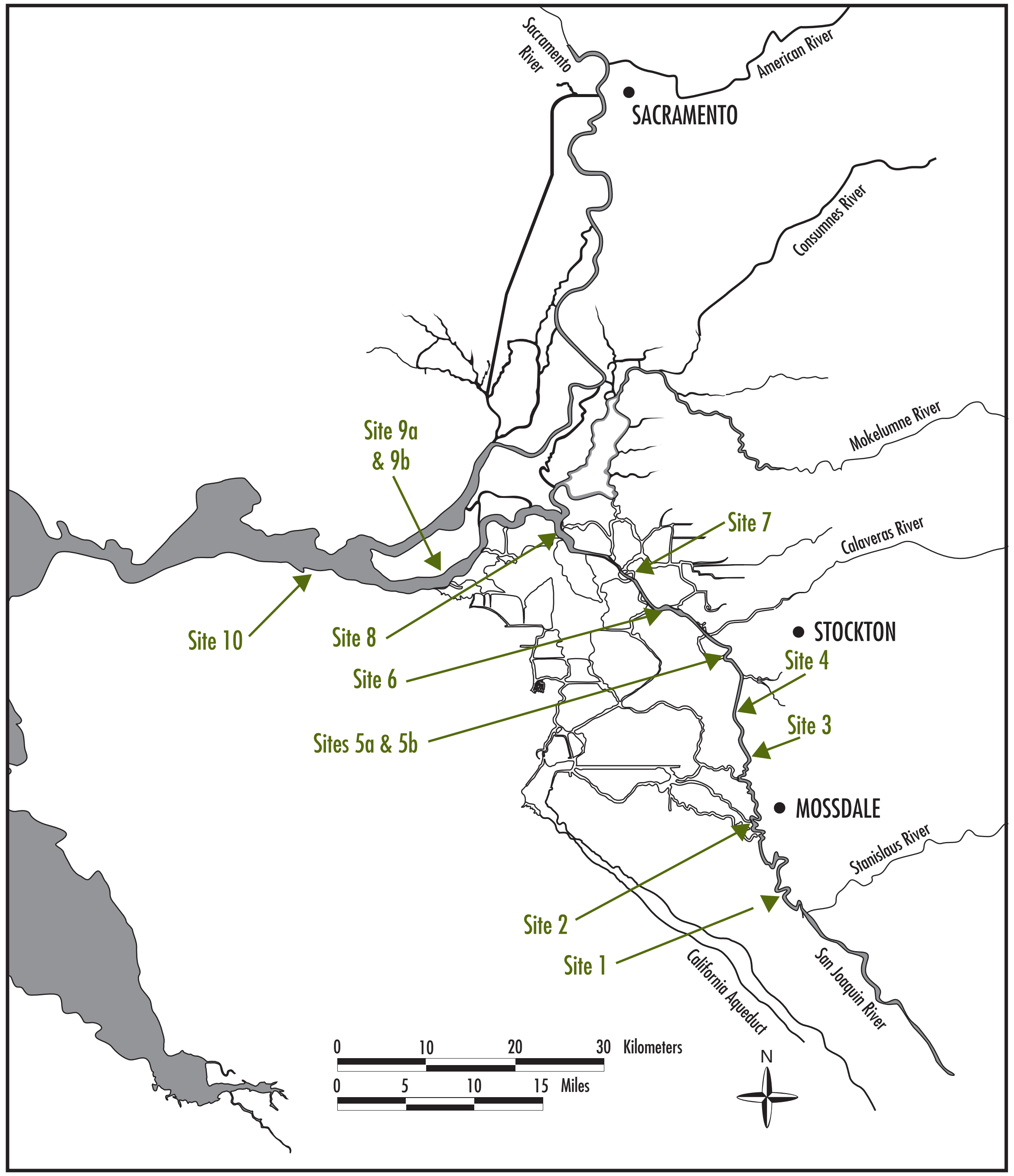
	Pre CVPIA Base Condition Release (cfs)	Goodwin Dam Release (cfs)	B(2) Water (cfs)	Flow (cfs)	Cumulative Volume (ac-ft)
				Oakdale ID Additional Water	
	[1]	[2]		[2] - [1]	
Oct 19	355	235		0	0
Oct 20	355	942		587	1,164
Oct 21	355	1,009		654	2,461
Oct 22	355	1,009		654	3,759
Oct 23	355	1,011		656	5,060
Oct 24	355	1,011		656	6,361
Oct 25	355	1,008		653	7,656
Oct 26	355	1,002		647	8,939
Oct 27	355	1,003		648	10,225
Oct 28	355	913		558	11,332
Oct 29	200	363		163	11,655
Oct 30	200	349		149	11,950
Oct 31	200	351		151	12,250
Nov 01	200	347		147	12,541
Nov 02	200	349		149	12,837
Nov 03	200	352		152	13,139
Nov 04	200	354		154	13,444
Nov 05	200	364		164	13,769
Nov 06	200	363		163	14,093
Nov 07	200	354		154	14,398
Nov 08	200	354		154	14,703
Nov 09	200	357		157	15,015
Nov 10	200	357		157	15,326
Nov 11	200	355		155	15,634
Nov 12	200	355		155	15,941
Nov 13	200	353		153	16,245
Nov 14	200	357		157	16,556
Nov 15	200	356		156	16,865
Nov 16	200	354		154	17,171
Nov 17	200	354		154	17,476
Nov 18	200	353		153	17,780
Nov 19	200	353		153	18,083
Nov 20	200	355		155	18,391
Nov 21	200	354	31	123	18,635
Nov 22	200	353	153		



APPENDIX C

Chinook Salmon Survival Investigations

SACRAMENTO-SAN JOAQUIN ESTUARY

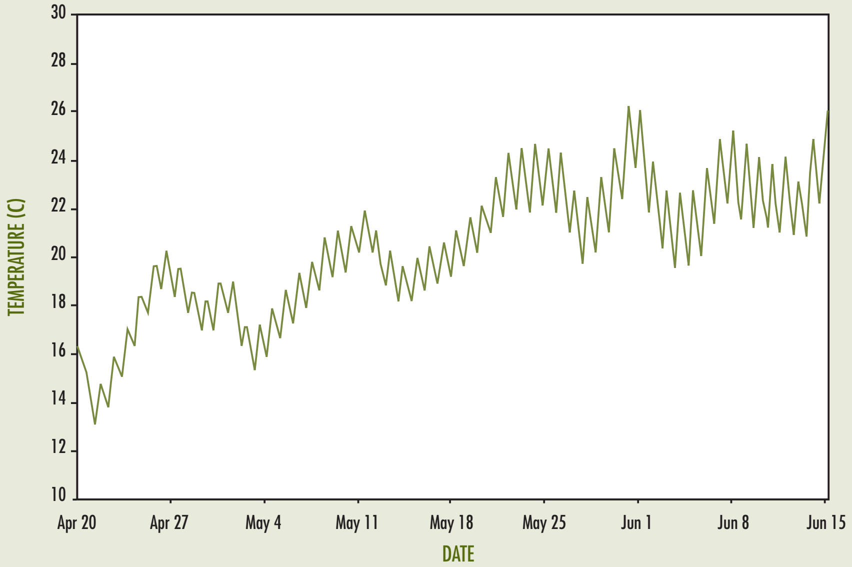


Water temperature monitoring locations during the VAMP 2001 experiment.

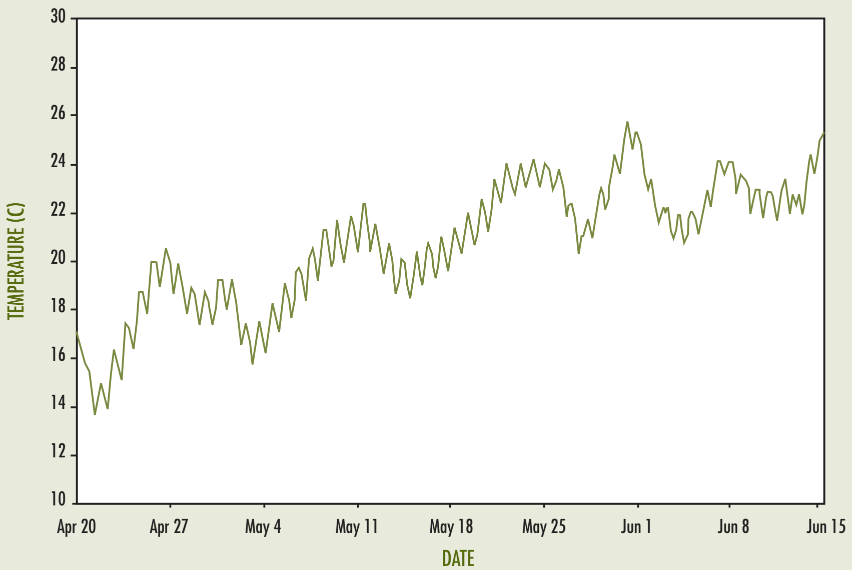
VAMP 2001 WATER TEMPERATURE MONITORING LOCATIONS

Site no.	Temperature Monitoring Location	Latitude	Longitude	Distance from Durham Ferry (mi)	Date Deployed	Date Retrieved	Notes
	Merced River Hatchery			n/a	March 21	May 3	In river April 30
1	Durham Ferry	N 37 41.381	W 121 15657	n/a	April 19	June 17	In 2.5 feet of water
2	Mossdale	N 37 47.180	W 121 18.425	11.2	April 19	June 17	In 2 feet of water
3	Dos Reis	N 37 49.808	W 121 18.665	16.4	April 19	June 17	In 2 feet of water
4	DWR Monitoring Station	N 37 51.869	W 121 19.376	19.4	April 19	June 17	In 1 foot of water
5a	Confluence – Top	N 37 56.818	W 121 20.285	26.5	April 19	June 17	2 feet below surface
5b	Confluence – Bottom	N 37 56.818	W 121 20.285	26.5	April 19	June 17	On river bottom
6	Downstream of Channel Marker 30	N 37 59.611	W 121 25.805	33.3	April 19	June 17	In 1.5 feet of water
7	1/2 mile Upstream of Channel Marker 13	N 38 01.940	W 121 28.769	37.3	April 19	June 17	In 1.5 feet of water
8	Downstream of Channel Marker 36	N 38 04.522	W 121 34.413	44.7	April 19	June 17	In 2 feet of water
9a	Jersey Point USGS Gauging Station – top	N 38 03.172	W121 41.637	56.0	April 19	June 17	In 3 feet of water
9b	Jersey Point USGS Gauging Station – bottom	N 38 03.172	W121 41.637	56.0	April 19	June 17	Completely on the bottom
10	Chipps Island	N 38 03.084	W 121 55.463	71.5	April 19		Logger lost

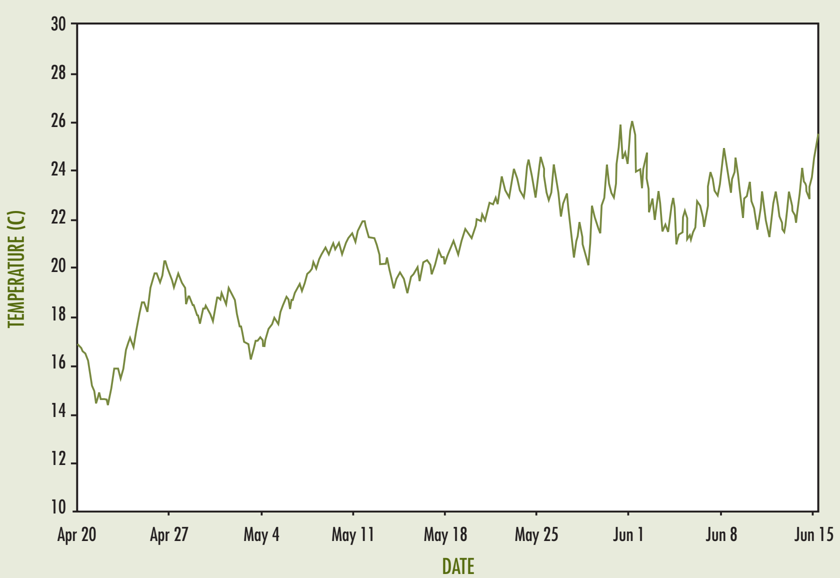
Site 1 • Durham Ferry



Site 2 • Mossdale

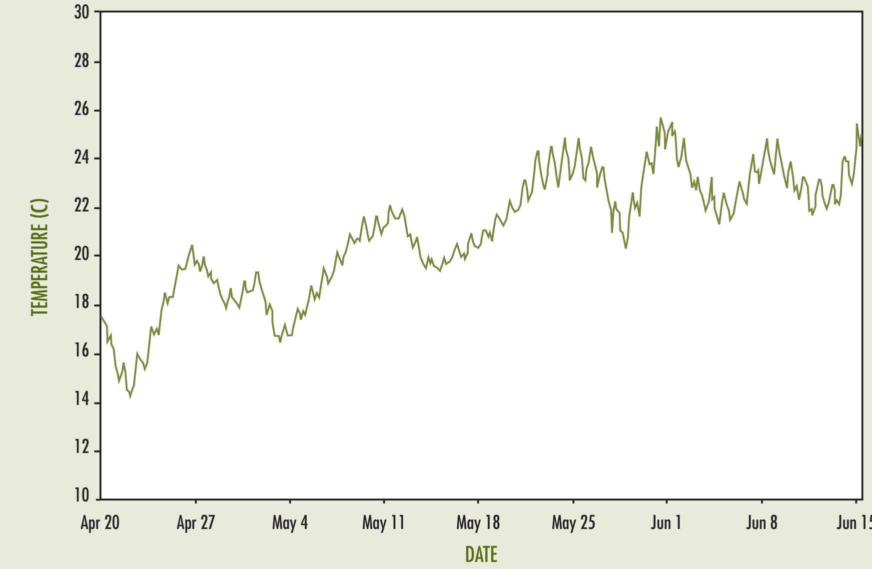


Site 3 • Dos Reis

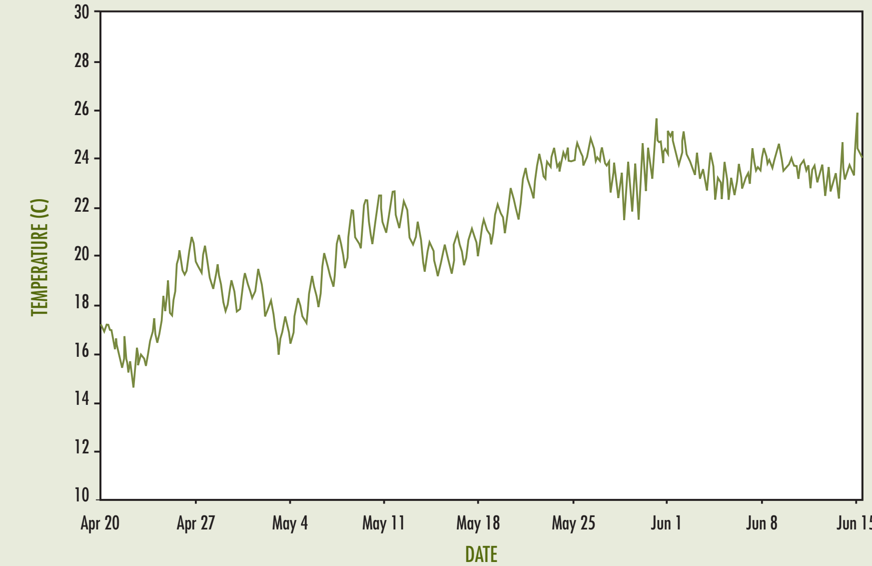


WATER TEMPERATURE MONITORING

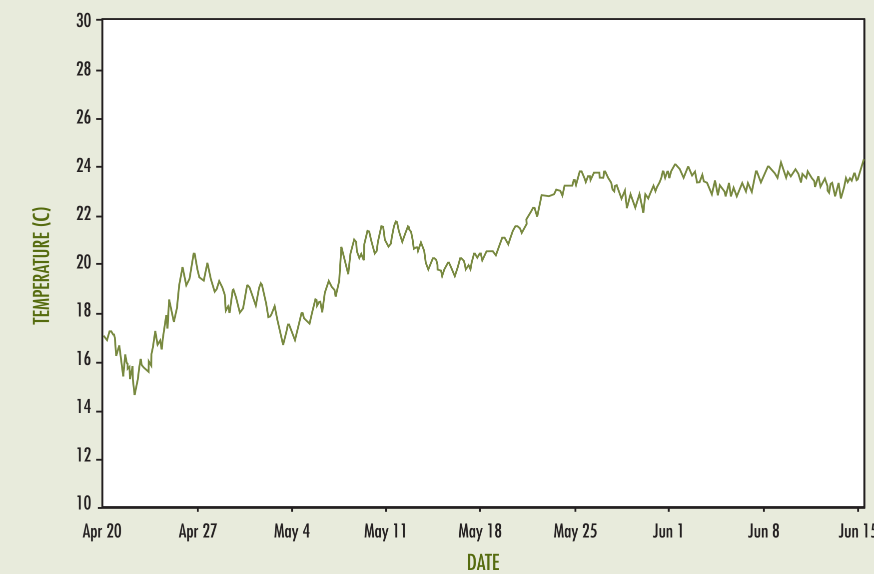
Site 4 • DWR Monitoring Station



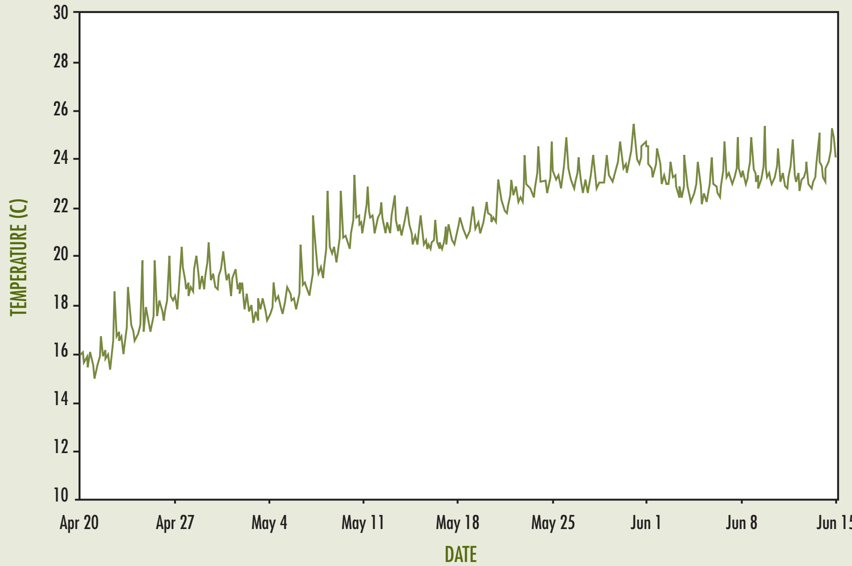
Site 5a • Confluence-Top



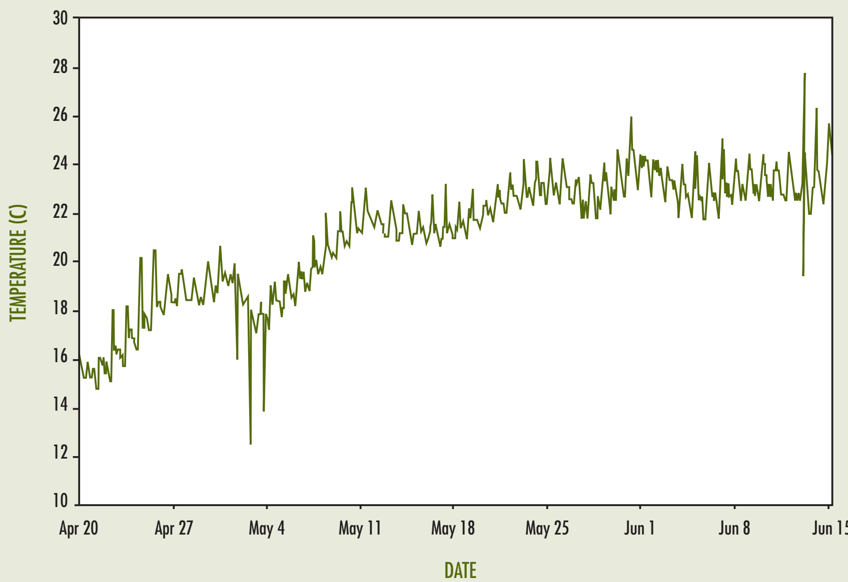
Site 5b • Confluence-Bottom



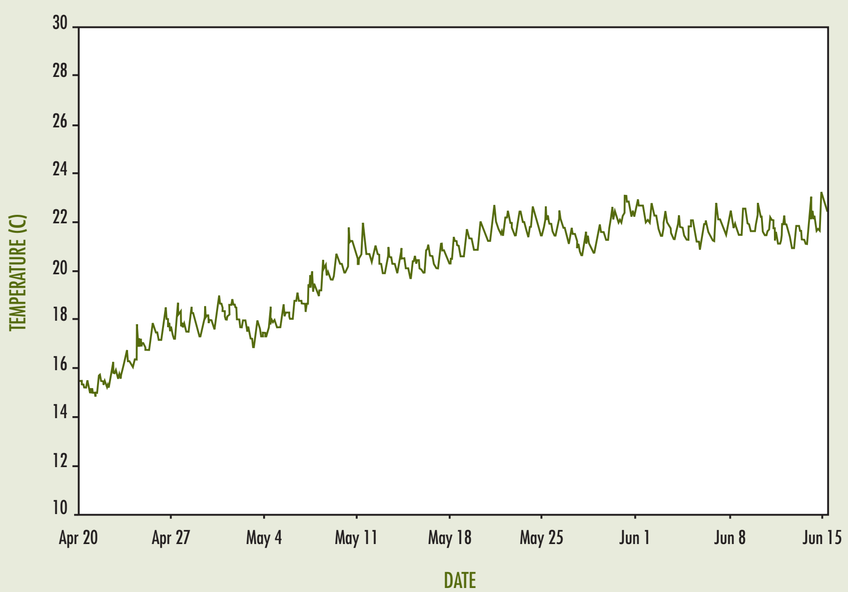
Site 6 • Downstream of Channel Marker 30



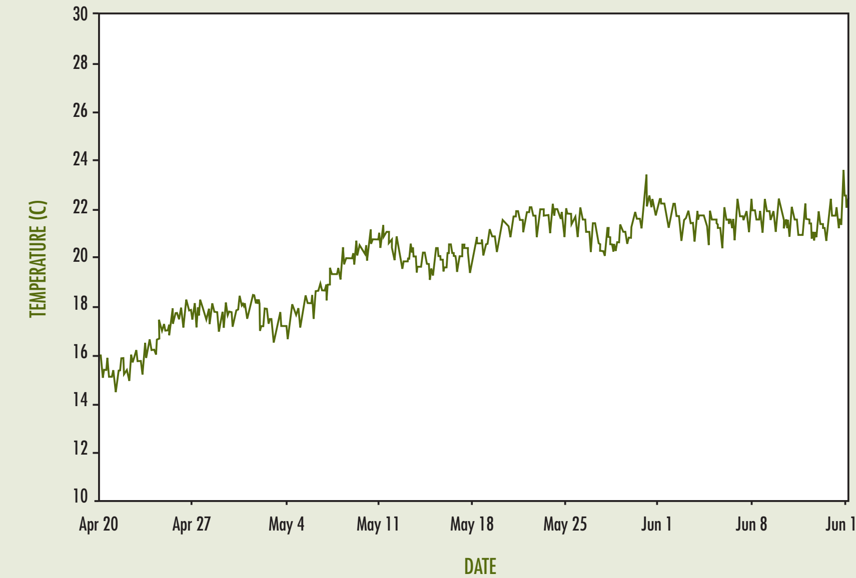
Site 7 • 1/2 Mile Upstream of Channel Marker 13



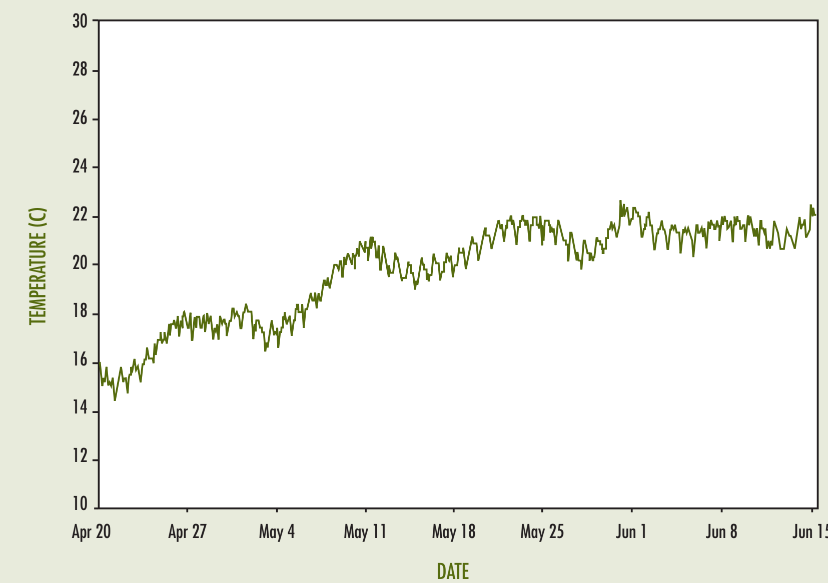
Site 8 • Downstream of Channel Marker 36



Site 9a • Jersey Point USGS Gauging Station



Site 9b • Jersey Point USGS Gauging Station



RESULTS OF NET PEN SAMPLING CONDUCTED IMMEDIATELY AFTER RELEASE AS PART OF VAMP STUDIES IN 2001

Release location, release date, tag code, number in sample	Mean fork length (and range in millimeters)	Mean weight (and range in grams)	Mean scale loss (and range) percent	Color	Fin hemorrhaging	Eyes	Gill color	Ad clips, comments
Durham Ferry I Apr 30 06-44-29, 30, 31 25 at release	88.7 (78-94)	7.3 (5.9-9.4)	3.3 (2-10)	Normal	None	Normal	1 with pale gill	
Mossdale I May 1 06-44-32 25 at release	88.4 (62-95)	7.2 (2-8.7)	3.2 (2-7)	Normal	None	Normal	Normal	All fish netted out of truck and placed in 2 separate net pens
Mossdale I May 1 06-44-33 25 at release	89.6 (77-103)	7.5 (5.4-10)	4.6 (2-8)	Normal	None	Normal	Normal	All fish netted out of truck and placed in 2 separate net pens
Jersey Point I May 4 06-44-35 25 at release	89.4 (79-98)	7.7 (5.3-9.7)	1.6 (1-6)	Normal	None	Normal	1 pale 4% pale gills	one poor ad clip
Jersey Point I May 4 06-44-34 25 at release	91.4 (84-100)	8.1 (5.3-11.2)	2.4 (1-4)	Normal	None	Normal	2 pale 8% pale gills	
Durham Ferry II May 7 06-44-36, 37, 38 25 at release	84.5 (77-91)	6.4 (5.3-7.7) only 11 fish weighed	5.3 (3-12)	Normal	None	Normal	3 pale 12% pale gills	
Mossdale II May 8 06-44-40 25 at release	87.9 (80-99)	7.7 (5.6-10.2)	3.2 (1-6)	Normal	one with anal and pelvic (pink)	Normal	5 pale 1 very pale 24% pale gills	2 poor ad clips All fish netted out of truck and placed in 2 separate net pens
Mossdale II May 8 06-44-39 25 at release	88.9 (86-97)	7.8 (5.7-9.6)	4.3 (2-8)	Normal	None	Normal	5 pale 20% pale gills	1 poor ad clip All fish netted out of truck and placed in 2 separate net pens
Jersey Point II May 11 06-44-41 25 at release	88.1 (80-105)	7.4 (5.1-11.8)	5 (3-9)	Normal	None	Normal	9 pale 40% pale gills	5 morts removed from pens immediately after release
Jersey Point II May 11 06-44-42 25 at release	87.5 (80-99)	7.2 (5-10.4)	5.9 (3-15)	Normal	None	Normal	8 pale 32% pale gills	5 morts removed from pens immediately after release

RESULTS OF NET PEN AFTER FISH WERE HELD FOR 48 HOURS, CONDUCTED AS PART OF VAMP STUDIES IN 2001

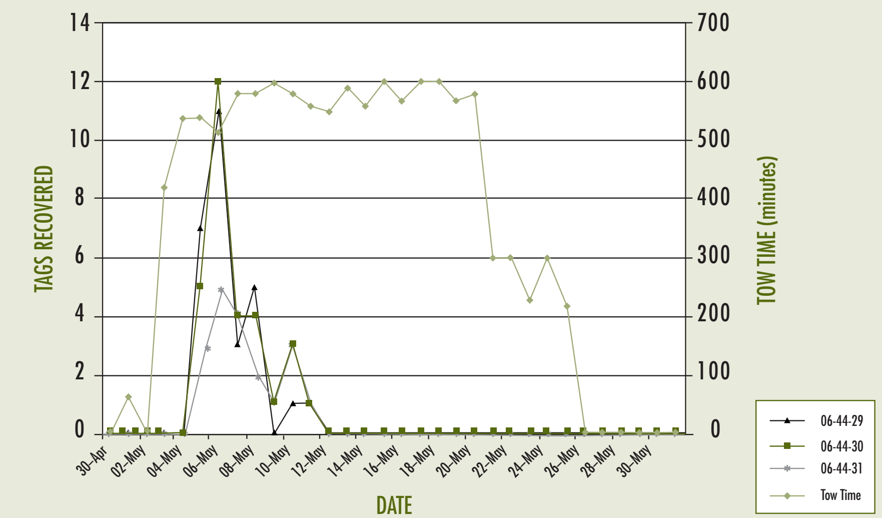
Release location, release date, tag code, number in sample	Mean fork length (and range in millimeters)	Mean weight (and range in grams)	Mean scale loss (and range) percent	Color	Fin hemorrhaging	Eyes	Gill color	Ad clips, comments and mortalities
Durham Ferry I Apr 30 06-44-29, 30, 31 200 processed	87.2 (75-96)	6.9 (3.8-9.8)	3.6 (2-15)	Normal	None	Normal	5 pale 20% pale gills	one fish bloated 4 mortalities
Mossdale I May 1 06-44-32 131 processed	88.7 (76-97)	7.2 (4.7-9.6)	3.6 (1-8)	Normal	None	Normal	3 pale 12% pale gills	
Mossdale I May 1 06-44-33 79 processed	90.3 (79-105)	7.6 (5.7-10.4)	3.8 (1-7)	Normal	None	Normal	3 pale 12% pale gills	
Jersey Point I May 4 06-44-35 92 processed	90.4 (70-104)	6.0 (3.8-12.2)	2.9 (1-8)	Normal	None	Normal	Normal	
Jersey Point I May 4 06-44-34 94 processed	91 (83-101)	7.8 (5.3-10.6)	3.2 (1-8)	Normal	None	Normal	3 pale 12% pale gills	1 mortality
Durham Ferry II May 7 06-44-36, 37, 38 185 processed	86.1 (74-97)	6.7 (4.1-8.9)	4.1 (2-10)	Normal	None	Normal	Normal	one w/partial operculum 3 mortalities
Mossdale II May 8 06-44-40 91 processed	88 (78-100)	7 (4.7-10.3)	3.7 (1-10)	Normal	None	Normal	Normal	one w/left pectoral eroded 1 mortality
Mossdale II May 8 06-44-39 102 processed	87.6 (74-102)	6.9 (4.4-11.3)	6.4 (3-12)	Normal	None	Normal	1 pale 4% pale gills	one with left pectoral eroded
Jersey Point II May 11 06-44-41 85 processed	89.1 (74-102)	7.4 (3-10.6)	5.6 (2-20)	Normal	None	Normal	2 pale 8% pale gills	
Jersey Point II May 11 06-44-42 88 processed	88.1 (73-101)	7.2 (3.9-12.2)	3.8 (1-8)	Normal	None	Normal	3 pale 12% pale gills	

2001 CODED WIRE TAG RECOVERY INFORMATION

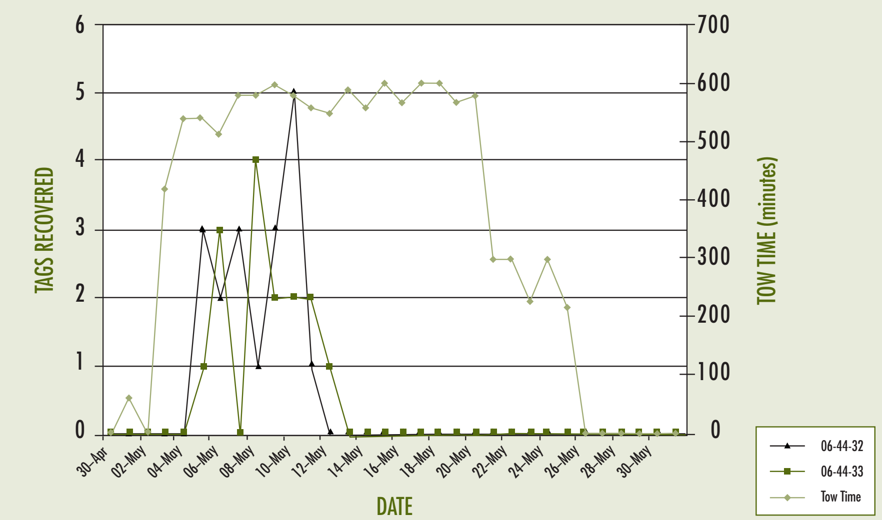
at Antioch and Chipps Island for Marked Fish Release as part of
the Vernalis Adaptive Management Program

Tag Code	Release Site/Stock	Date	First Day Recovered	Last Day Recovered	Number Recovered	Minutes Fished	Survival Index	Group Index	First Day Recovered	Last Day Recovered	Number Recovered	Minutes Fished	Survival Index	Group Index
		Antioch Recovery Information							Chipps Island Recovery Information					
06-44-29	Durham Ferry		May 05	May 11	28	3,955	0.220		May 06	May 10	14	1,994	0.281	
06-44-30	Durham Ferry		May 05	May 11	30	3,955	0.241		May 05	May 11	22	2,782	0.454	
06-44-31	Durham Ferry		May 05	May 10	18	3,395	0.147		May 05	May 10	17	2,384	0.356	
	Total	Apr 30	May 05	May 11	76	3,955		0.203	May 05	May 11	53	2,782		0.363
06-44--32	Mossdale		May 05	May 11	18	3,955	0.144		May 07	May 12	17	2,392	0.347	
06-44-33	Mossdale		May 05	May 12	15	4,505	0.125		May 05	May 11	14	2,782	0.297	
	Total	May 01	May 05	May 12	33	4,505		0.134	May 05	May 12	31	3,182		0.323
06-44-34	Jersey Point		May 04	May 09	156	3,355	1.183		May 05	May 11	50	2,782	0.964	
06-44-35	Jersey Point		May 04	May 14	173	6,195	1.274		May 05	May 11	61	2,782	1.150	
	Total	May 04	May 04	May 14	329	6,195		1.225	May 05	May 11	111	2,782		1.058
06-44-36	Durham Ferry		May 12	May 15	8	2,300	0.060		May 13	May 15	2	1,200	0.039	
06-44-37	Durham Ferry		May 11	May 21	11	6,080	0.086		May 12	May 17	4	3,593	0.078	
06-44-38	Durham Ferry		May 14	May 22	10	4,680	0.082		May14	May 20	2	2,800	0.039	
	Total	May 07	May 11	May 22	29	6,380		0.078	May 09	May 20	8	4,793		0.052
06-44-39	Mossdale		May 12	May 17	8	3,470	0.060		May 13	May 16	4	1,600	0.078	
06-44-40	Mossdale		May 13	May 20	11	4,670	0.077		May 14	May 18	4	2,000	0.074	
	Total	May 08	May 12	May 20	19	5,220		0.069	May 13	May 18	8	2,400		0.076
06-44-41	Jersey Point		May 12	May 20	43	5,220	0.297		May 12	May 17	17	2,400	0.307	
06-44-40	Jersey Point		May 12	May 23	53	6,050	0.428		May 12	May 22	27	4,400	0.496	
	Total	May 11	May 12	May 23	96	6,050		0.384	May 12	May 22	44	4,400		0.401

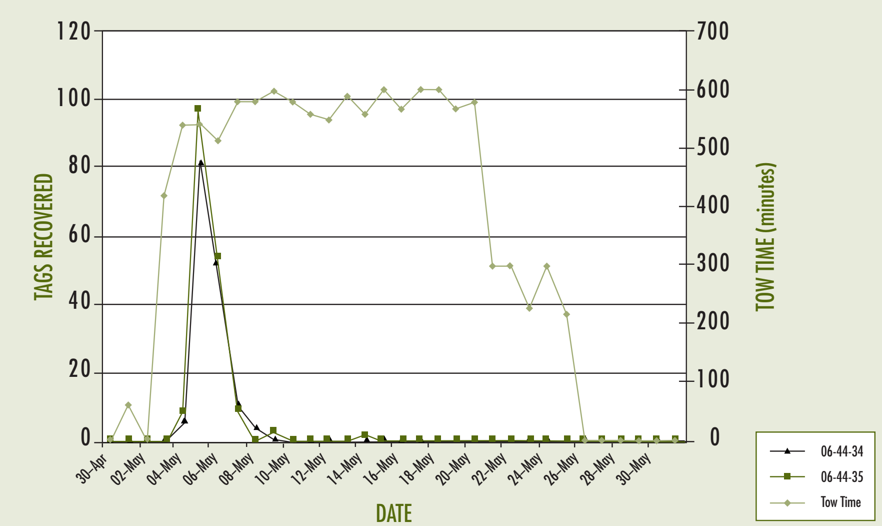
April 30th Durham Ferry Release Recovered at Antioch



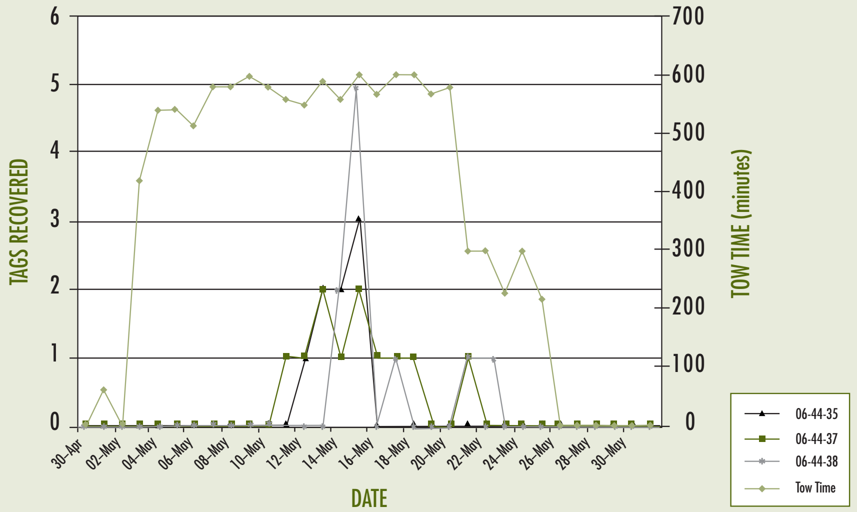
May 1st Mossdale Release Recovered at Antioch



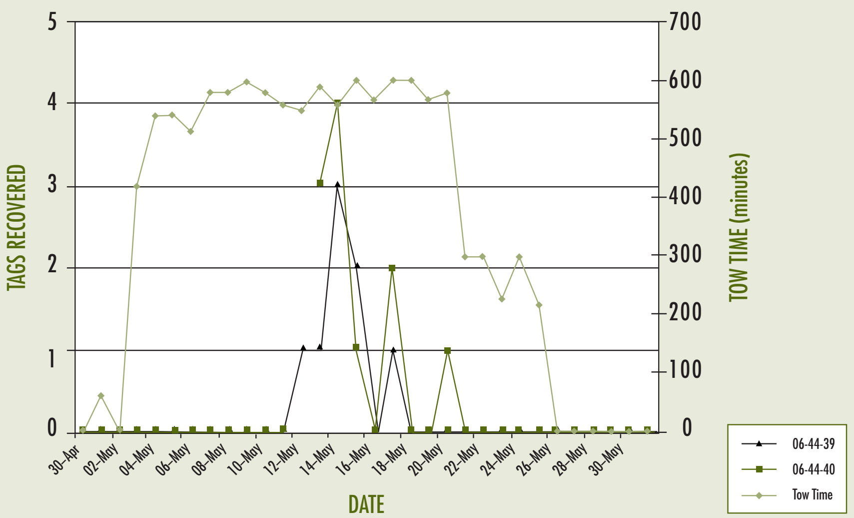
May 4th Jersey Point Release Recovered at Antioch



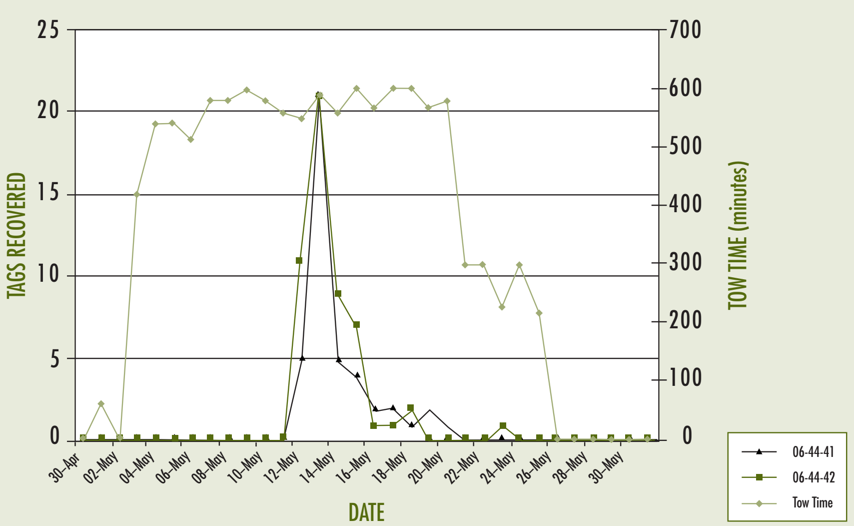
May 7th Durham Ferry Release Recovered at Antioch



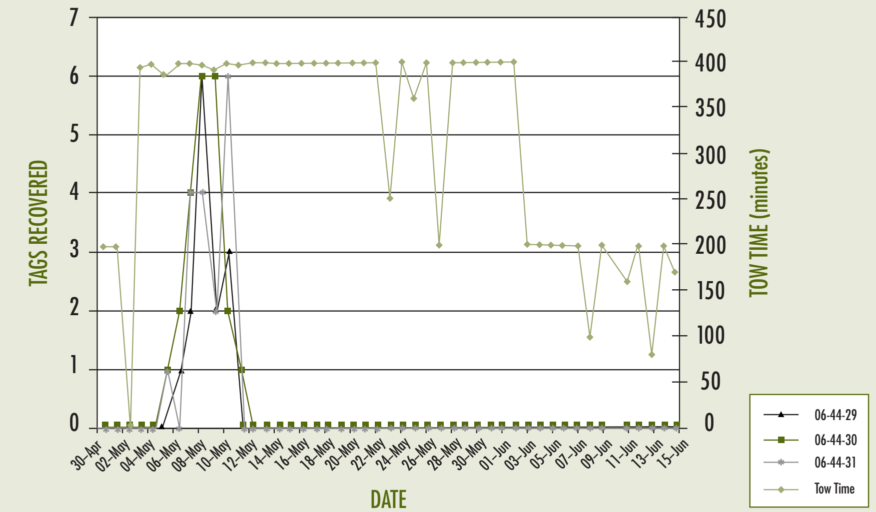
May 8th Mossdale Release Recovered at Antioch



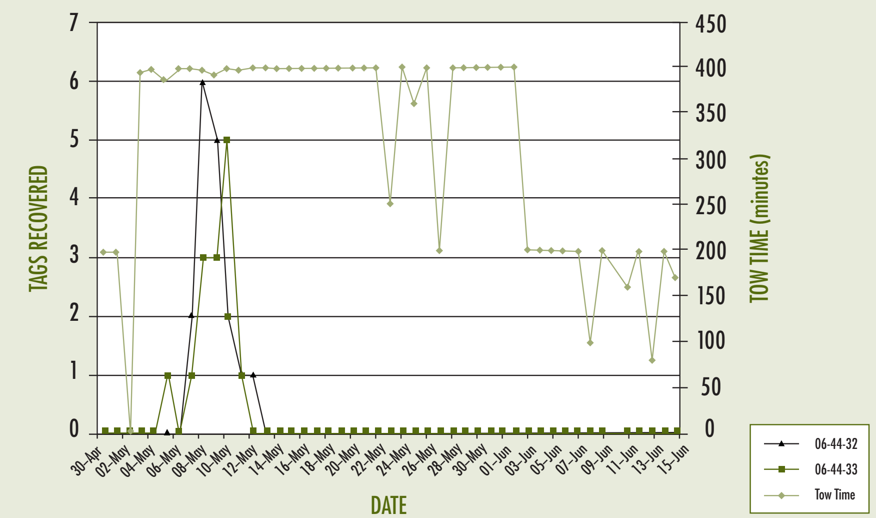
May 11th Jersey Point Release Recovered at Antioch



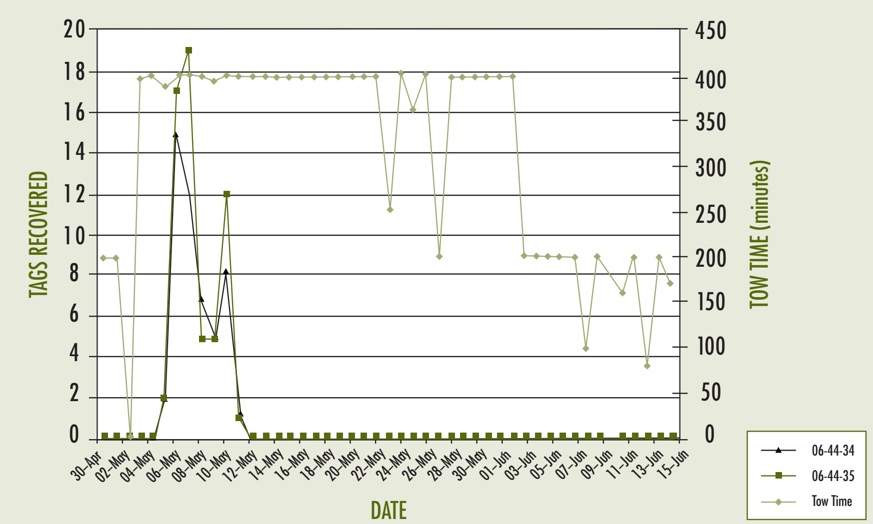
April 30th Durham Ferry Release Recovered at Chipps Island



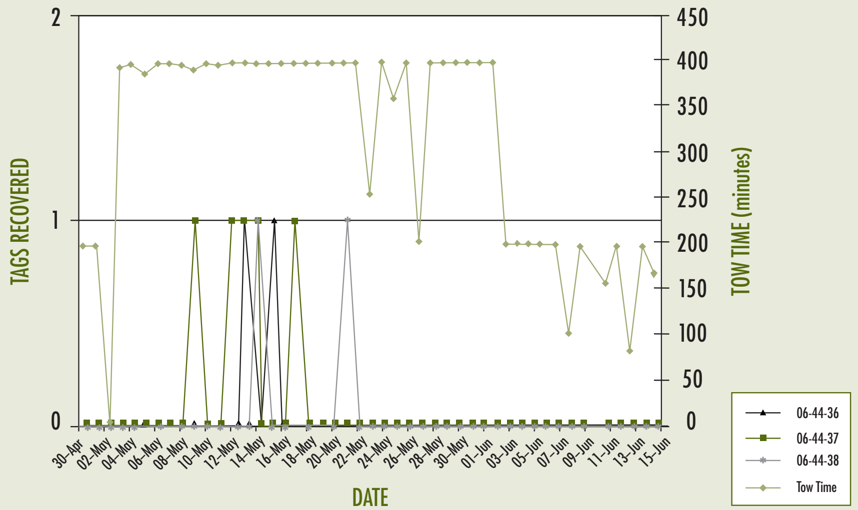
May 1st Mossdale Release Recovered at Chipps Island



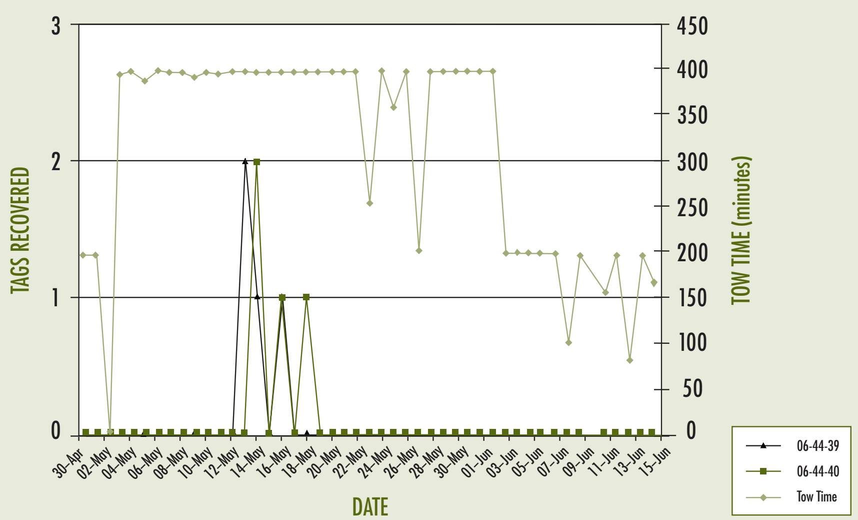
May 4th Jersey Point Release Recovered at Chipps Island



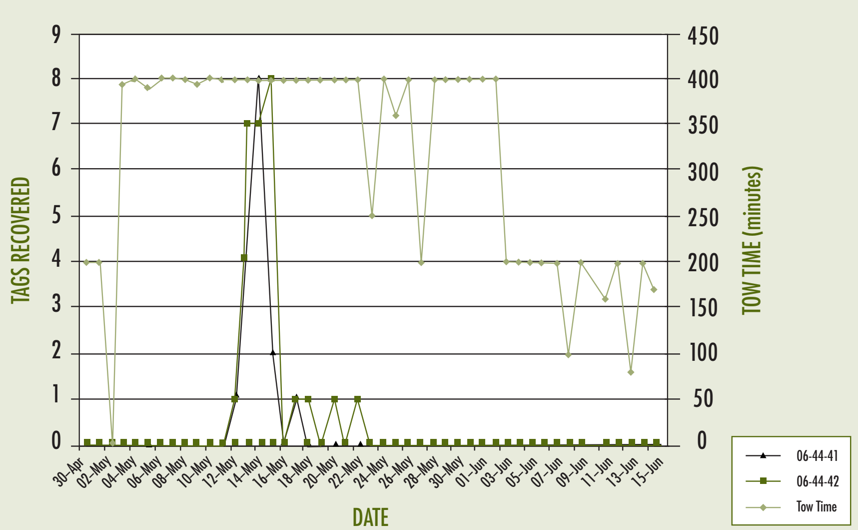
May 7th Durham Ferry Release Recovered at Chipps Island



May 8th Mossdale Release Recovered at Chipps Island



May 11th Jersey Point Release Recovered at Chipps Island



2001 CODED WIRE TAG RELEASE

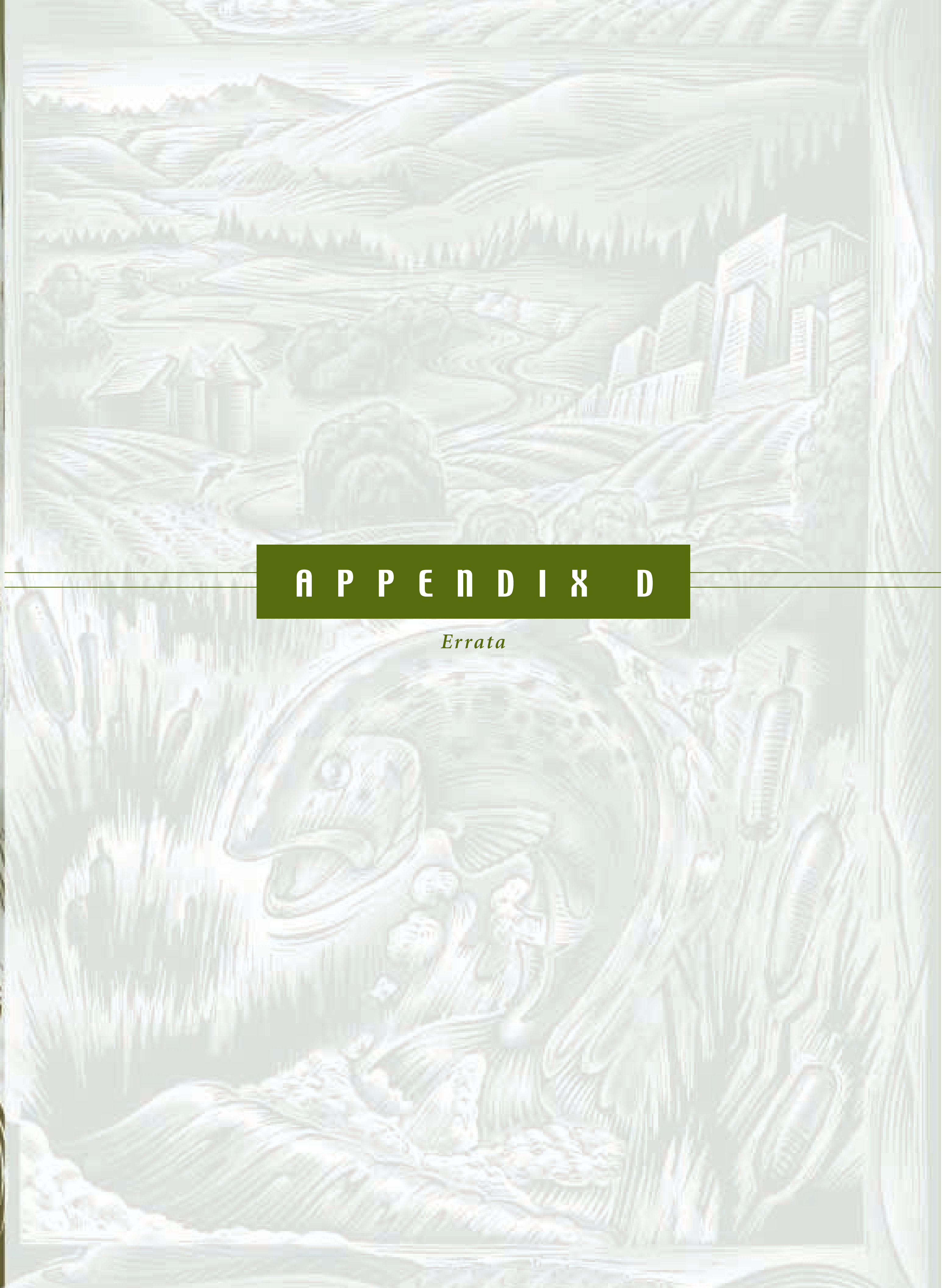
Release and Recovery Information for Coded Wire-Tagged Smolts
Released in the San Joaquin River and Tributaries

							Antioch				Chipps Island				Salvage		Survival through tributary	
Tag Code	Release Site/ Stock	Date	Truck Temp C	River Temp C	No. Released	Average Size (mm)	No. Recovered	Percent Sampled	Survival Index	Group Survival	No. Recovered	Percent Sampled	Survival Index	Group Survival	Expanded CVP	Expanded SWP	Antioch	Chipps Island
Merced River																		
06-44-15	Merced River Fish Facility			10.0	25,029	81	3	0.369	0.023		3	0.275	0.057		0	20		
06-44-16	Merced River Fish Facility			10.0	24,077	81	10	0.378	0.079		3	0.276	0.059		0	51		
06-44-17	Merced River Fish Facility			10.0	24,342	81	1	0.375	0.008		1	0.278	0.019		0	41		
06-44-18	Merced River Fish Facility			10.0	24,034	81	7	0.378	0.055		0				0	47		
Total		Apr 21			97,482		21	0.378		0.041	7	0.276		0.034			0.32	0.17
06-44-19	Hatfield (lower Merced)		13.0	16.5	24,925	85	11	0.391	0.081		8	0.276	0.151		0	18		
06-44-20	Hatfield (lower Merced)		13.0	16.5	24,958	85	17	0.390	0.126		6	0.276	0.113		24	18		
06-44-21	Hatfield (lower Merced)		13.0	16.5	24,885	85	24	0.390	0.178		17	0.276	0.322		0	18		
Total		Apr 26			74,768		52	0.390		0.128	31	0.276		0.195				
06-44-22	Merced River Fish Facility				24,722	83	10	0.408	0.071		2	0.278	0.038		0	0		
06-44-23	Merced River Fish Facility				24,121	83	9	0.373	0.072		1	0.278	0.019		0	0		
06-44-24	Merced River Fish Facility				25,972	83	12	0.408	0.082		1	0.278	0.018		0	0		
06-44-25	Merced River Fish Facility				23,074	83	7	0.326	0.067		0				0	0		
Total		May 08			97,889		38	0.349		0.080	4	0.278		0.019			0.52	0.36
06-44-26	Hatfield (lower Merced)	May 11	13.0	18.0	23,038	85	19	0.299	0.199		1	0.278	0.020		0	0		
06-44-27	Hatfield (lower Merced)		13.0	18.0	23,227	85	20	0.341	0182		1	0.278	0.020		0	0		
06-44-28	Hatfield (lower Merced)		13.0	18.0	23,428	85	14	0.356	0.121		4	0.262	0.085		0	6		
Total		May 13			46,655		34	0.341		0.154	5	0.262		0.053				
Tuolumne River																		
06-44-12	La Grange		10.0	11.0	24,572	82	2	0.403	0.015		2	0.275	0.038		0	0		
06-44-12	La Grange				22,757	82	6	0.367	0.052		2	0.275	0.041		12	0		
06-44-13	La Grange				21,524	82	10	0.391	0.086		4	0.275	0.088		0	0		
Total		Apr 22			68,853		18	0.379		0.050	8	0.276		0.055			0.20	0.21
San Joaquin River																		
06-44-44	Old Fisherman's Club	Apr 26	14.0	21.0	24,303	85	25	0.390	0.190		12	0.275	0.233		12	12		
06-44-45	Old Fisherman's Club	Apr 28	12.5	19.0	21,965	91	35	0.388	0.295		13	0.277	0.278		0	0		
Stanislaus River																		
06-01-11-08-04	Knights Ferry		11.5	13.5	24,137	90	0				0				24	0		
06-01-11-08-05	Knights Ferry		11.0	13.0	24,037	91	0				0				24	0		
Total		May 22			48,174						0							
06-01-11-07-15	Two Rivers	May 25	10.0	20.0	23,630	94	0				0							
05-24-18	Head of Old River Barrier	May 12	15.0	20.0	24,401	84	1	0.396	0.007		4	0.278	0.077		390	267		

TIMING OF RECOVERY AT ANTIOCH AND CHIPPS ISLAND FOR CODED WIRE TAGGED SMOLTS RELEASED IN SAN JOAQUIN RIVER AND TRIBUTARIES IN THE SPRING OF 2001

							Antioch						Chipps Island					
Tag Code	Release Site/Stock	Date	Truck Temp C	River Temp C	Number Released	Average Size (mm)	First Day Recovered	Last Day Recovered	Number Recovered	Minutes Sampled	Survival Index	Group Index	First Day Recovered	Last Day Recovered	Number Recovered	Percent Sampled	Survival Index	Group Index
Merced River																		
06-44-15	Merced River Fish Facility			10.0	25,029	81	May 4	May 6	3	0.369	0.023		May 4	May 6	3	0.275	0.057	
06-44-16	Merced River Fish Facility			10.0	24,077	81	May 3	May 10	10	0.378	0.079		May 5	May 9	3	0.276	0.059	
06-44-17	Merced River Fish Facility			10.0	24,342	81	May 5	May 5	1	0.375	0.008		May 6	May 6	1	0.278	0.019	
06-44-18	Merced River Fish Facility			10.0	24,034	81	May 3	May 10	7	0.378	0.055				0	–	–	
	Total	Apr 21			97,482		May 3	May 10	21	0.378		0.041	May 4	May 9	7	0.276		0.034
06-44-19	Hatfield (lower Merced)		13.0	16.5	24,925	85	May 5	May 9	11.000	0.391	0.081		May 5	May 9	8	0.276	0.151	
06-44-20	Hatfield (lower Merced)		13.0	16.5	24,958	85	May 4	May 10	17.000	0.390	0.126		May 5	May 9	6	0.276	0.113	
06-44-21	Hatfield (lower Merced)		13.0	16.5	24,885	85	May 3	May 18	24.000	0.390	0.178		May 3	May 9	17	0.276	0.322	
	Total	Apr 26			74,768		May 3	May 18	52.000	0.390		0.128	May 3	May 9	31	0.276		0.195
06-44-22	Merced River Fish Facility				24,722	83	May 17	May 20	10	0.408	0.071		May 17	May 22	2	0.278	0.038	
06-44-23	Merced River Fish Facility				24,121	83	May 16	May 21	9	0.373	0.072		MAy 22	May 22	1	0.278	0.019	
06-44-24	Merced River Fish Facility				25,972	83	MAy 17	May 20	12	0.408	0.082		May 19	May 19	1	0.278	0.018	
06-44-25	Merced River Fish Facility				23,074	83	May 18	May 22	7	0.326	0.067				0	–	–	
	Total	May 8			97,889		May 16	May 22	38	0.349		0.080	May 17	May 22	4	0.278		0.019
06-44-26	Hatfield (lower Merced)	May 11	13.0	18.0	23,038	85	May 18	May 23	19	0.299	0.199		May 20	May 20	1	0.278	0.020	
06-44-27	Hatfield (lower Merced)		13.0	18.0	23,227	85	May 17	May 22	20	0.341	0.182		May 21	May 21	1	0.278	0.020	
06-44-28	Hatfield (lower Merced)		13.0	18.0	23,428	85	May 18	May 21	14	0.356	0.121		May 19	May 26	4	0.262	0.085	
	Total	May 13			46,655		May 17	May 22	34	0.341		0.154	May 19	May 26	5	0.262		0.053
Tuolumne River																		
06-44-12	La Grange		10.0	11.0	24,572	82	May 9	May 11	2	0.403	0.015		May 3	May 5	2	0.275	0.038	
06-44-13	La Grange				22,757	82	May 3	May 8	6	0.367	0.052		May 5	May 7	2	0.275	0.041	
06-44-14	La Grange				21,524	82	May 5	May 9	10	0.391	0.086		May 4	May 6	4	0.275	0.088	
	Total	Apr 22			68,853		May 3	May 11	18	0.379		0.050	May 3	May 7	8	0.276		0.055
San Joaquin River																		
06-44-44	Old Fisherman's Club	Apr 26	14.0	21.0	24,303	85	May 3	May 18	25	0.390	0.190		May 5	May 7	12	0.275	0.233	
06-44-43	Old Fisherman's Club	Apr 28	12.5	19.0	21,965	91	May 4	May 9	35	0.388	0.295		May 6	May 13	13	0.277	0.278	
06-01-11-08-04	Knights Ferry		11.5	13.5	24,137	90			0	–	–				0	–	–	
06-01-11-08-05	Knights Ferry		11.0	13.0	24,037	91			0	–	–				0	–	–	
	Total	May 22			48,174							–			0			–
06-01-11-07-15	Two Rivers	May 25	10.0	20.0	23,630	94			0	–	–				0	–	–	
05-24-18	Head of Old River Barrier	May 12	15.0	20.0	24,401	84	May 16	May 16	1	0.396	0.007		May 14	May 17	4	0.278	0.077	

*tag code 06-44-45 was released between 4/11/01 to 5/24/01; these fish were also spray-dyed



APPENDIX D

Errata

ERRATA FOR THE YEAR 2000 ANNUAL TECHNICAL REPORT
ON IMPLEMENTATION AND MONITORING OF THE SAN JOAQUIN RIVER AGREEMENT AND THE VERNALIS ADAPTIVE MANAGEMENT PLAN

Page 22, Paragraph 5, 4th sentence: Delete "further"

Page 31, Paragraph 1, last sentence should read: "Statistically, neither regression line is significant, although prior to adding the data from 1999, the without barrier relationship was significant ($R2= 0.75$, $p=0.025$, $n=6$)."

Page 32, First full paragraph, first and second sentences should read: "However, even given this noise, the data to date appears to show that smolt survival between Mossdale/Durham Ferry and Jersey Point increases as exports increase from 1600 to 2300 with the barrier in place (figure 5-2). This relationship is not statistically significant, likely because of small sample size."

Page 32, 3rd full paragraph, 3rd sentence: replace sentence 3 through 6 with: "One set of studies allows the approximation of the relative effects of flows and exports on smolt survival with a barrier in place, although the barrier was not installed during most of the releases. (Only one release had been made with the Barrier in place.) Marked fish released at Dos Reis (on the San Joaquin River downstream of the Upper Old River junction) and at Jersey Point were used to estimate survival between these two locations. Absolute survival was then compared with river flow and project exports. The results of this analysis indicated that there was a significant relationship of smolt survival from Dos Reis to Jersey Point with San Joaquin River flow at Stockton ($R2 = 0.33$, $p < 0.03$, $n= 14$), even with an obvious outlier from data obtained in 1999. There was not a significant relationship between survival and exports either alone or in combination with flow, although survival did appear to decrease as exports increased. The effect of exports is likely underrepresented using this approximation, since the effects of exports are likely less in this reach of the river when there is no Barrier.

A second set of studies evaluated the role of exports on smolt survival, without a barrier in place. The data for releases made at Mossdale and Jersey Point (absolute survival), were regressed against flow at Vernalis and CVP and SWP exports. The absolute survival estimate between Mossdale and Jersey Point was positively correlated to exports ($R2= 0.71$, $p=0.017$, $n= 7$) and flow and exports ($R2= 0.84$, $p=0.025$, $n=7$) and were statistically significant. These data appear to show that as exports and flows increase survival increases when there is no Barrier in place. However, data has only been gathered at exports between approximately 1500 and 4000 cfs.

Some data gathered in 1989 and 1990 may support the conclusion that survival between Mossdale and Jersey Point, without a barrier in place, is greater at higher exports. These data appeared to show that survival through Upper Old River relative to that at Jersey Point was higher during the higher export period, but overall still about half that of the survival of smolts released at Dos Reis (Brandes and McLain, forthcoming). Unfortunately, survival indices for the smolts released in Upper Old River in these years were all low making conclusions based on comparisons suspect. However, if these differences are true, and many of the smolts migrate through Upper Old River when there is no barrier in place, survival may be higher through this reach at higher exports.

Other confounding aspects to these data include using different stocks of hatchery fish to conduct the experiments, changing the level of sampling effort in recent years, getting biased results at times and not being able to measure survival at high flows with low exports with the barrier in place. For further explanation of these limitations see Brandes, 2000. These limitations may have lessened our ability to draw definitive conclusions from the past data. While future efforts will attempt to minimize changes in the study design, it is possible that confounding aspects of the data will continue and studies will need to be extended beyond the anticipated twelve years before relationships between smolt survival and flow and exports are definitive."

LITERATURE CITED:

Add: Brandes, P. 2000. 1999 South Delta Salmon Smolt Survival Studies. U.S. Fish and Wildlife Service, 4001 N. Wilson Way, Stockton CA. 95205. 5/26/00

Delete: Brandes, P and M. Pierce, 1998. 1997 Salmon smolt survival studies in the South Delta. Interagency Ecological Program for the Sacramento-San Joaquin estuary Newsletter., Vol 11, No. 1 - Winter 1998.

As a result of final revisions to the 2000 coded-wire tag database, a few calculations for the trawling effort and survival data from Chipps Island need to be updated. The following changes should be made to Table 5.2, pp. 24-25 and Appendix C, pg. 76.

Tag Code	Release Site	Release Date	Minutes Fished	Percent Sampled	Survival Index	Group Minutes Fished	Group Percent Sampled	Group Survival Index
06-01-11-08-14	Durham Ferry	4/28/00	6655	0.257	0.212	6955	0.254	0.151

In addition, the following changes should be made in Appendix C, pp. 82 and 84.

Tag Code	Release Site	Release Date	Minutes Fished	Percent Sampled	Survival Index	Group Minutes Fished	Group Percent Sampled	Group Survival Index
06-45-58	La Grange	4/15/00	10675	0.247	0.120	10675	0.247	0.072
06-44-07	Knights Ferry	5/19/00	1060	0.082	0.187	N/A	N/A	N/A
06-44-10	Two Rivers	5/20/00	980	0.136	0.149	980	0.136	0.076