



Executive Summary



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

High spring flows, exceeding the upper target flow objective of 7,000 cfs, prevented installation of the HORB in 2006. In

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

The 2006 Annual Technical Report consolidates the annual SJRA Operations and the Vernalis Adaptive Management Plan (VAMP) Monitoring Reports. The VAMP 2006 program represents the seventh year of formal compliance with SWRCB Decision 1641 (D-1641).  D-1641 requires the preparation of an annual report documenting the implementation and results of the VAMP program. Specifically, this 2006 report includes the



following information on the implementation of the SJRA: the hydrologic chronicle; management of any additional SJRA water; flow and fisheries monitoring in the lower San Joaquin River, Old River, and Delta; results of the juvenile Chinook salmon smolt survival investigations; discussion of complementary investigations; and conclusions and recommendations.

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

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

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

In planning for the VAMP the 2006 hydrologic conditions were similar to those of 2005. In the March 23 operation plan the existing a flow was forecasted to be between

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

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

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

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



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

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

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

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

Chinook salmon smolt survival indices were calculated based on the number of marked salmon released and the number recaptured. Releases at Jersey Point serve as controls for releases at Mossdale and Dos Reis. Recapture data from Antioch, Chipps Island (for 2004-2006) and in the ocean fishery (releases made prior to 2004) thereby allowed calculation of survival estimates based on the ratio of recovery rates from marked salmon recaptured

from upstream (Durham Ferry and Mossdale/Dos Reis) and downstream (Jersey Point) releases. Use of ratio estimates as part of the VAMP study design factors out the potential differential gear efficiency at Antioch and Chipps Island for each release group catch and differences in Ocean survival when the ocean recovery data is used as part of the ratio. These ratio estimates were used to evaluate relationships between salmon smolt survival and San Joaquin River flow and CVP and SWP exports with and without the HORB in place.

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

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

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

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

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

- Survival from Durham Ferry and Mossdale/Dos Reis in 2003, 2004, 2005 and the second release group in 2006, was significantly less than prior years. Continued evaluation of survival rate versus flow and export rate is needed to detect differences in survival tests at extreme target levels (e.g. 7,000 cfs flow and 3,000 or 1,500 cfs exports), or equivalent high flow/export ratios are necessary.

- The flow data collected in 2005 and 2006 at San Joaquin River near Lathrop and the Head of Old River provided a useful evaluation of the flow split at the Head of Old River. Comparison of these 2005/2006 flow data against DWR-DSM2 modeling results should be conducted and may provide useful information.
- The Clifton Court Forebay was treated in early June with the aquatic herbicide Komeen, known to be toxic to salmon. While the treatment likely did not affect test fish, the treatment may have negatively affected natural smolts emigrating from the San Joaquin River in late May and early June.
- The numbers of CWT salmon, from Mossdale releases recovered at the SWP and CVP salvage facilities was less than prior years without an HORB. Only a few Mossdale and Dos Reis fish were recovered at the SWP and CVP salvage facilities in 2006.
- During the second release of experimental fish it was determined that the CWT lots were mixed between the Mossdale lots and Jersey Point lots resulting in not using the data from one tag group of the second Mossdale release and the need to adjust release numbers from the second Jersey Point release.
- The historical data indicates that the reach between Dos Reis and Jersey Point, in years when no HORB is installed, has the highest mortality. The relationship between the survival of the Dos Reis groups relative to the Jersey Point groups indicate that survival will improve as flows increase for smolts that remain within the main stem San Joaquin River when there is no HORB.

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

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

