SAN JOAQUIN RIVER AGREEMENT SAN JOAQUIN RIVER GROUP AUTHORITY







2007 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

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EXECUTIVE SUMMARY



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

The lack of returning adults to the Merced River Hatchery and subsequent low salmon smolt production resulted in the California Department of Fish and Game's (CDFG) inability to provide test fish for a coded wire tag study in 2007 VAMP. The SJRA technical committee (SJRATC) concluded that an acoustic telemetry monitoring program, relying on 1,000 acoustic tagged salmon smolts, would be conducted over the same VAMP period. The VAMP test period was delayed one week from the default period of April 15-May 15 to April 22-May 22 to allow the test fish to increase in size to better accommodate the acoustic tag to body weight ratio standard of less than 5 percent. Water Year 2007 was very dry on the San Joaquin River watershed, with the four-basin April-July forecasted runoff ranging from 41% to 52% of average. The VAMP Vernalis test flow over the April 22-May 22 period was set at 3,200 cfs based on the SJRA criteria.

The 2007 Annual Technical Report consolidates the annual SJRA Operations and the Vernalis Adaptive Management Plan (VAMP) Monitoring Reports. The VAMP 2007 program represents the eighth 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 2007 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 salmon acoustic tag study; 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. 2007 represented the first year of a monitoring program relying fully on the use of acoustic telemetry technology. Implementation of this new technology was not without some difficulties. The lack of two key monitoring stations, receiver malfunctions and the unexplained mortality near Stockton of a sizable number of test fish impacted our ability to complete a survival analysis. In addition to providing improved protection for juvenile Chinook salmon emigrating from the San Joaquin River system, specific experimental objectives of VAMP 2007 included:

- Quantification of Chinook salmon smolt survival along individual river segments between Durham Ferry, Mossdale, Head of Old River, Bowman Road (near Dos Reis), and Stockton by detection of acoustic signals from transmitters implanted in the test fish.
- Evaluation of the San Joaquin River Old River flow split at the Head of Old River under the 2007 flow conditions with the installed HORB.
- Monitoring in Old River to evaluate the movement of salmon smolts in Old River under the 2007 flow conditions with the installed HORB.
- Evaluation of fish mortality across Clifton Court Forebay between the Clifton Court Forebay inlet structure and the Skinner Fish Facility.
- Health and physiology testing of VAMP fish was conducted at the MRH, Durham Ferry and Mossdale 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.

Hydrologic conditions in 2007 were similar to those experienced in 2002. In the March 21 operation plan the existing a flow was forecasted to be between 2,182 and 2,582 cfs calling for a VAMP target flow of either 3,200 cfs or 4,450 cfs. The forecasts throughout the weeks leading up to the VAMP period indicated the HORB could safely be installed; however the uncertain condition of the Delta smelt controlled the final decision on its installation. A decision by the Delta smelt working group allowed for the barrier to be constructed and closed on April 22. The HORB culverts remained closed until May 16 when they were opened due to Delta smelt concerns. As the dry conditions continued through the spring it became evident the double step criteria would not be a factor in determining the target flow for VAMP. By April 13 forecasts of existing flow at Vernalis was projected to be about 2,770 cfs between April 22 and May 22. In planning for the VAMP the SJRA Technical Committee recommended delaying the start of the VAMP pulse period until April 22 in an effort to provide larger smolt sized fish for the implantation of acoustic tags. The study was designed to measure survival along three segments of the San Joaquin River; Durham Ferry to Mossdale, Mossdale to Bowman Road and Bowman Road to Jersey Point.

EX - 1 Proposed Fish Release and Detection Locations.								
Fish Release Locations								
	Durham Ferry to	Mossdale Bowman to Road to		Stockton to	Downstream of HORB			
Planned	Upstream of HORB	Upstream of HORB			Tracy Fish Facility			
Detection Locations	Bowman Road	Bowman Road			Clifton Court Inlet			
	Stockton	Stockton	Stockton		Old River at Highway 4			
	Jersey Point*	Jersey Point*	Jersey Point*	Jersey Point*				
	Chipps Island*	Chipps Island*	Chipps Island*	Chipps Island*	Chipps Island*			

* Jersey Point and Chipps Island receivers not installed in 2007.



In an effort to document migratory behavior of salmon entering the Old River 100 acoustically tagged fish were released in the Old River immediately downstream of the HORB.

Unfortunately due to physical and technical difficulties beyond the control of the SJRA parties the acoustic receiver stations at Jersey Point and Chipps Island could not be installed in time for the 2007 VAMP. Thus survival to Jersey Point and Chipps Island could not be estimated.

Vamp experimental test conditions that have occurred over the past eight years are summarized below:

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 remained below 20 *C*, which is considered suitable for salmon smolts.

Survival of fish between Mossdale and Stockton was relatively high, but survival estimates in some reaches were suspect due to periods of receiver malfunction. Survival between Durham Ferry and Mossdale appeared lower. As mentioned earlier without the deployment of acoustic receivers at Jersey Point and Chipps Island

EX - 2 VAMP Experimental Test Conditions.								
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				
2007	April 22 - May 22	3,263	1,486	Installed				

survival through the Delta could not be estimated. Deploying receivers at these two stations are being given high priority for the 2008 study.

The health of the CWT fish in 2007 was relatively good, but all test fish examined were infected with the parasite that causes PKD. It is uncertain how such infection affects long term survival of the smolts released as part of VAMP. Dummy tags were implanted in twenty fish during tagging and held for 7 to 14 days to assess tagging and handling stress. No mortalities were observed and the condition characteristics assessed were normal.

The relationship of survival to exports is 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. These relationships could not be tested in 2007. To further refine the relationship between survival and exports with the HORB, the VAMP experiments were designed to estimate survival at a flow of 7,000 cfs at two export levels, 1,500 and 3,000 cfs. We have not yet been able to estimate survival under these experimental conditions. In addition to recommending these conditions to test, it is noteworthy that survival from Dos Reis to Jersey Point in 2003, 2004, 2005 and the second release group in 2006, was significantly less then prior years (Figure 5-10, SJRG 2007). Flows and exports during the VAMP tests in 2003-2004 were similar to those in 2002 (Table 2), but survival was significantly less. Although, 2007 had the same VAMP targets as in 2002-2004, we were not able to estimate survival to Jersey Point. The high mortality observed near Stockton may explain some of the poor survival in past years. Future studies to estimate survival through the Delta are important in documenting these types of occurrences. Measuring survival at 3200 flow at an export rate of 1500 will help document whether survival has rebounded to pre-2003 levels.

The decline in fish production at the Merced River Hatchery and the continued concern for the abundance of Delta smelt will greatly influence future VAMP designs. A priority will be to design future acoustic monitoring studies so that results can be compared to those generated from the previous coded wire tag studies.





INTRODUCTION

CHAPTER



Actions associated with the Vernalis Adaptive Management Plan (VAMP) were implemented between April 22 and May 22, 2007 to protect juvenile Chinook salmon and evaluate the survival of marked juvenile Chinook salmon migrating through the Sacramento - San Joaquin Delta. Diminished adult salmon returns and low smolt production at the Merced River Fish Hatchery did not allow for the standard VAMP coded wire tag study. As an alternative an acoustic telemetry study was conducted in 2007. The VAMP period was postponed 7 days from previous years to allow for additional growth of the experimental fish. Fish, tagged with acoustic transmitters, were released on May 3-4 and 10-11, 2007. The water districts maintained stable flow in accordance with the SJRA throughout the April - May study period, as were the export rates. The Delta Smelt workgroup permitted installing the HORB for the 2007 VAMP period. Survival estimates through the Delta were not possible in 2007 due to the lack of acoustic receivers at Jersey Point and Chipps Island. Studies conducted in 2007, represented the eighth year of the VAMP. Results from previous VAMP experiments are available in San Joaquin River Agreement Technical Reports, for each respective year. River Agreement Technical Reports, for each respective year. prior to the official implementation of VAMP with results available in South Delta Temporary Barriers Annual Reports (DWR 2001 and DWR 1998). This report will describe the experimental design used in 2007, the hydrologic planning and implementation, the additional water supply arrangements and deliveries, fishery monitoring within the San Joaquin River and Old River with the HORB, the acoustic tag experiment and complimentary studies related to VAMP. Conclusions and recommendations for future VAMP studies are also included.

Experimental Design Elements

The VAMP experimental design used in previous years measured salmon smolt survival through the Delta under six different combinations of flow and export rates. The experimental design includes two markrecapture studies performed each year during the April-May juvenile salmon outmigration period that provide estimates of salmon survival under each set of conditions. During 2007, for the first time since inception of the program, test fish were not available from the Merced River Fish Hatchery to permit a coded wire tag (CWT) study. In lieu of a CWT study an acoustic telemetry study was conducted. A total of 1,000 juvenile Chinook salmon were made available from the Merced River Hatchery (MRH) for the VAMP acoustic study. Study fish were surgically implanted with acoustic transmitters, capable of emitting an electronic signal for up to 3 weeks. It was not possible to estimate Chinook salmon survival through the entire Delta due to the lack of acoustic receivers at Jersey Point and Chipps Island. However, data was collected on salmon smolt behavior and mortality conditions within the South Delta and survival was estimated on the San Joaquin River from Durham Ferry and Mossdale to Stockton.

As described the SJRA and VAMP is an experimental/ management program designed to protect juvenile Chinook salmon migrating from the San Joaquin River while at the same time conducting a scientific experiment to determine how salmon survival changes in response to alterations in San Joaquin River flows, SWP/CVP export rates, and the operation of the HORB.



Even though survival estimates could not be determined from the 2007 experiment valuable information on how to implement an acoustic tag experiment was collected. This annual technical report describes the flow and HORB conditions encountered in 2007, the alternative experimental plan, and the findings.

Due to a decline of the delta smelt population in the Bay-Delta estuary the delta smelt workgroup analyzed the potential impacts of installing the HORB. Based on

Figure 1-1 Fish release locations and acoustic receiver locations

during the 2007 VAMP experiments.

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delta smelt monitoring and particle tracking models the workgroup permitted the HORB be installed in 2007. The 2007 VAMP experimental design included both multiple release locations (Durham Ferry, Mossdale, Old River, Bowman Road and Highway 4 at Stockton), and multiple detection locations, Figure 1-1.

During the 2007 VAMP period the Acoustic Telemetry study was conducted to evaluate movement and survival of acoustic tagged fish detected by acoustic receivers as they moved downstream. Fish were released at Durham Ferry, Mossdale, Old River, Bowman Road and near Stockton over 2 one week period during the VAMP. Ten acoustic receivers located along the lower San Joaquin River, Old River, in south Delta channels and at the export fish facilities were used to track smolt movement throughout the south Delta.

For the 2007 acoustic telemetry study a cadre of biologists were trained by the U.S. Geological Survey's Columbia River Research Laboratory in the proper surgical tagging procedures. The 2007 VAMP program used net pen studies to assess overall condition and health of marked fish used in the acoustic tag study. Improvements were made in 2007 relative to measuring flow in the San Joaquin River downstream of the confluence with Old River.

CHAPTER 2

VAMP HYDROLOGIC Planning and Implementation

This section documents the planning and implementation undertaken by the Hydrology Group of the San Joaquin River Technical Committee (SJRTC) for the 2007 VAMP investigations. Implementation of VAMP is guided by the framework provided in the San Joaquin River Agreement (SJRA) and anticipated hydrologic conditions within the watershed. The Hydrology Group was established for the purpose of forecasting hydrologic conditions and for planning, coordinating, scheduling and implementing the flows required to meet the test flow target in the San Joaquin River near Vernalis. The Hydrology Group is also charged with exchanging information relevant to the forecasted flows, and coordinating with others in the SJRTC, in particular the Biology Group, responsible for planning and implementing the salmon smolt survival study. Participation in the Hydrology Group is open to all interested parties, with the core membership consisting of the designees of the agencies responsible for the water project operations that would be contributing flow to meet the target flow. In 2007, the agencies belonging to the Hydrology Group included: Merced Irrigation District (Merced), Turlock Irrigation District (TID), Modesto Irrigation District (MID), Oakdale Irrigation District (OID), South San Joaquin Irrigation District (SSJID), San Joaquin River Exchange Contractors (SJRECWA), and the U.S. Bureau of Reclamation (USBR). Though not a water provider, the California Department of Water Resources (DWR) was closely involved with the coordination of operations relating to the potential installation of the HORB and the planning of Delta exports consistent with the VAMP.

2007 VAMP Summary

The Water Year 2007¹ winter was very dry in the San Joaquin River watershed, with seasonal precipitation in the San Joaquin Hydrologic Region (Cosumnes, Mokelumne, Stanislaus, Merced and San Joaquin Rivers) measuring only 65% of average on April 1, 2007. The forecasted April-July runoff as of April 1 in the four basins above Vernalis (Stanislaus, Tuolumne, Merced and San Joaquin) ranged from 41% to 52% of average. Water Year 2006 was classified as a Wet year as per the San Joaquin Valley Water Year Type Index (60-20-20), therefore a forecasted 90% exceedence forecast Water Year Type classification for 2007 of Dry or wetter would result in a double-step VAMP target flow for 2007. The only way for the 2007 VAMP not to be a double-step was for the 2007 Water Year Type Classification to be Critical. Due to continuing dry conditions, interrupted briefly by above average precipitation in March, the 90% exceedence forecast Water Year Type classification for 2007 as of April 1 was indeed Critical, thereby making the 2007 VAMP a single-step operation. Also, as a result of the critically dry conditions, the forecasted mean flow in the San Joaquin River near Vernalis for the VAMP test flow period of April 22 through May 22 was approximately 2,600 cfs, setting the VAMP target flow at the minimum value of 3,200 cfs.

The planning and implementation process for the VAMP operation remained nearly unchanged from those of prior VAMP years and that outlined in the SJRA. Daily operation plans were updated on a frequent basis to keep the SJRTC informed of changed conditions. VAMP planners and reservoir operators took part in conference calls twice a week during the implementation phase of VAMP to discuss the current status of the operation and make adjustments as needed. Monitoring of real-time flow data was maintained throughout the planning and implementation phases.

VAMP Background and Description

This section provides information on the background and description of the water operations and factors to be considered when planning for the VAMP each year. The VAMP provides for a steady 31-day pulse flow (target flow) at the Vernalis gage on the San Joaquin River (Figure 2-1, inside front cover) during the months of April and May, along with a corresponding reduction in State Water Project (SWP) and Central Valley Project (CVP) Sacramento-San Joaquin Delta exports. The VAMP target flow and reduced Delta export are determined based on a forecast of the San Joaquin River flow that would occur during the pulse flow period absent the VAMP (Existing Flow) as shown in Table 2-1. The Existing Flow is defined in the SJRA as "the

¹Water Year 2007 is October 2006 through September 2007.

forecasted flows in the San Joaquin River at Vernalis during the Pulse Flow Period that would exist absent the VAMP or water acquisitions," including such flows as minimum in-stream flows, water quality or scheduled fishery releases from New Melones Reservoir, flood control releases, uncontrolled reservoir spills, and/or local runoff. Achieving the target flow requires the coordinated operation of the three major San Joaquin River tributaries upstream of Vernalis: the Merced River, the Tuolumne River and the Stanislaus River.

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

* Suggested rates at higher flows.

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

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

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

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

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

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

Table 2-2 San Joaquin Valley Water Year Hydrologic Year Classifications Used in VAMP							
60-20-20 Water Year Classification	VAMP Numerical Indicator						
Wet	5						
Above Normal	4						
Below Normal	3						
Dry	2						
Critical	1						

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

Hydrologic Planning for 2007 VAMP

The SJRTC met four times between January 23 and April 16 to discuss and plan the 2007 VAMP experiment and operation. At these meetings, forecasts of hydrologic and operational conditions on the San Joaquin River and its tributaries were discussed and refined.

Monthly Operation Forecast

As part of the initial planning efforts in February, a monthly operation forecast was developed by the Hydrology Group to provide an initial estimate of the Existing Flow and VAMP Target Flow. Inflows to the tributary reservoirs used in these forecasts were based on DWR Bulletin 120 runoff forecasts. The monthly operation forecasts used the 90 percent and 50 percent probability of exceedence runoff forecasts to provide a range of estimates. The initial monthly operation forecast was presented at the February 22 SJRTC meeting. Based upon the February 14 runoff forecast the VAMP target flow would follow the single-step criteria. The 90 percent exceedence runoff forecast indicated an existing flow of about 1,800 cfs and a corresponding VAMP target flow of 2,000 cfs. The 50 percent exceedence runoff forecast at a corresponding VAMP target flow of 3,200 cfs.

Daily Operation Plan Development

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

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

Flow Travel Times

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

The forecast of the ungaged flow is the factor with the greatest uncertainty in the development of the daily operation plan. By definition, the ungaged flow at Vernalis is the unmeasured flow entering or leaving

Table 2-3 Summary of Daily Operation Plans											
Phase	VAMP Forecast Date	DWR Runoff Forecast Date	VAMP Target Flow Period	Single or Double Step	Assumed Ungaged Flow at Vernalis (cfs)	Existing Flow (cfs)	VAMP Target Flow (cfs)	Other Supplemental Water (acre- feet)	SJRGA Supplemental Water Requirement (acre-feet)		
Planning	3/21/07	3/13/07	April 22	Single	100	2,182	3,200	46,080 [1]	16,520		
			- May 22		500	2,582	3,200	46,080 [1]	0		
			April 22	Double	100	2,182	4,450	24,070 [1]	115,400		
			- May 22		500	2,582	4,450	28,060 [1]	86,800		
	4/6/07	3/27/07	April 22 - May 22	Single	100	1,880	2,000	0	7,300		
					300	2,080	3,200	0	68,790		
					100	1,880	2,000	46,080 [1]	0		
					300	2,080	3,200	46,080 [1]	22,670		
	4/13/07	4/1/07	April 22	pril 22 Single May 22	100	2,570	3,200		38,730		
			- May 22		300	2,770	3,200	-	26,430		
	4/16/07	4/1/07	April 22 - May 22	Single	300	2,770	3,200	-	26,430		
	4/18/07	4/1/07	April 22 - May 22	Single	300	2,700	3,200	-	30,500		
Implementation	5/4/07		April 22 - May 22	Single	200 (5/4 - 5/22)	2,720	3,200	_	29,420		

 Assumed b(2) water used on Stanislaus River was not part of existing flow, but offset a portion of the VAMP Supplemental Water requirement.

the system between the Vernalis gage and the upstream measuring points and is calculated as follows:

Ungaged flow at Vernalis = VNS - GDWlag - LGNlag - CRSlag - USJRlag

Where:

- VNS = San Joaquin River near Vernalis
- GDW = Stanislaus River below Goodwin Dam lagged 2 days
- LGN_{lag} = Tuolumne River below LaGrange Dam lagged 2 days
- CRS_{lag} = Merced River at Cressey lagged 3 days
- USJR_{lag} = San Joaquin River above Merced River lagged 2 days

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

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

The VAMP 31-day pulse flow period can occur anytime between April 1 and May 31. Factors that are considered in the determination of the timing of the VAMP pulse flow period include installation of HORB, availability of salmon smolt at the MRH, and manpower and equipment availability for salmon releases and recapture. Until a specific start date is defined, a default pulse flow period of April 15 to May 15 is used for the VAMP operation planning. In its February meeting the SJRTC defined a VAMP target flow period of April 22 to May 22 for 2007 to allow the test smolt to mature to the desirable size.

As part of the daily operation plan development, the determination must be made on whether the current year is likely to fall into the "off-ramp" or "doublestep" category. As noted earlier, an "off-ramp" condition would occur in critically dry periods when the sum of VAMP numerical indicators for the previous two years

Table 2-4 Real-time Mean Daily Flow Data Sources <mark>च</mark> ि							
Measurement Location	Data Source						
San Joaquin River near Vernalis	USGS, station 11303500 (http://waterdata.usgs.gov/ca/nwis/ dv?format=pre.=31&site_no=11303500)						
Stanislaus River below Goodwin Dam	USBR, Goodwin Dam Daily Operation Report (http://www.usbr. gov/mp/cvo/vungvari/gdwdop.pdf)						
Tuolumne River below LaGrange Dam	USGS, station 11289650 (http://waterdata.usgs.gov/ca/nwis/ dv?format=pre.=31&site_no=11289650)						
Merced River at Cressey	CDEC, station CRS (http://cdec.water.ca.gov/cgi-progs/ queryDgroups?s=fw2)						
Merced River near Stevinson	CDEC, station MST (http://cdec.water.ca.gov/cgi-progs/ queryDgroups?s=fw2)						
San Joaquin River at Newman	USGS, station 11274000 (http://waterdata.usgs.gov/ca/nwis/ dv?format=pre.=31&site_no=11274000)						

Table 2-5

Summary of USGS Flow Measurements at the San Joaquin River near Vernalis Gage

Date	Time	Gage Height (ft)	Measured Flow (cfs)	Reported Real- time Flow (cfs)	Percent Difference	Rating Curve Shift Adjustment (ft.)
2/14/07	11:18	11.34	2,760	2,670	3.4%	-0.61
3/22/07	10:32	10.66	2,180	2,110	3.3%	-0.61
4/17/07	12:13	10.18	1,840	1,780	3.4%	-0.61
4/23/07	10:52	11.95	3,800	3,210	18.4%	0
4/30/07	11:26	11.88	3,230	3,700	-12.7%	-0.56
5/7/07	11:01	11.66	3,010	3,030	-0.7%	-0.59
5/15/07	11:05	11.79	3,440	3,170	8.5%	-0.25
6/18/07	11:42	10.10	1,690	2,560	-34.0%	-0.74

and the current year is equal to or less than four. The 60-20-20 water year classification for both 2005 and 2006 was "Wet" (VAMP numerical indicator of five), therefore there was no possibility of 2007 being an off-ramp year since the off-ramp criterion was already exceeded without including the current year's numerical indicator. A "double-step" condition would occur if the sum of the VAMP numerical indicators for the previous year and current year is equal to or greater than seven, with the current year's indicator based on the 90% probability of exceedence forecast of the 60-20-20 water year classification. Since 2006 was a Wet year, a 2007 classification of Dry or wetter would result in a doublestep target. The April 1 90% probability of exceedence forecast of the 60-20-20 water year classification was "Critical" making 2007 a "single-step" condition.

The initial daily operation plan was prepared on March 21. The daily operation plan was modified as hydrologic conditions and operational requirements changed. Table 2-3 provides a summary of the daily operation plans developed during the VAMP planning and implementation. The complete daily operation plans are provided in Appendix A-1, Tables 1 through 13.

Tributary Flow Coordination

Although the primary goal of the VAMP operation is to provide a stable target flow in the San Joaquin River near Vernalis, an important consideration in the planning and operation is that the flows that are scheduled on the Merced, Tuolumne and Stanislaus Rivers to achieve this goal are beneficial and do not conflict with studies or flow requirements on those rivers. During the development of the daily operation plan, the Hydrology Group consults with DFG and the tributary biological teams to determine periods when pulse flows and stable flows are desirable on the tributaries, what flow rates are desired, what rates of change are acceptable, and what minimum and maximum flows are acceptable.

For the 2007 VAMP operation the Stanislaus River was expected to be at a steady flow of 1,500 cfs and therefore providing no operational flexibility. For the other tributaries the plan was for a single pulse of about 12 days on the Merced River during the middle of the VAMP period surrounded by 7 to 9 day pulses on the Tuolumne River.

Implementation

Operation Conference Calls

During implementation of the VAMP pulse flow, conference calls were conducted every Tuesday and Thursday between April 24 and May 18 at 6:30 A.M. to discuss the status of the pulse flow and to make operational changes if needed. The calls were held at 6:30 A.M. so that if operational changes were called for they could be implemented on that day.

Operation Monitoring

The planning and implementation of the VAMP spring pulse flow operation was accomplished using the best available real-time data from the sources listed in Table 2-4. The real-time flow data used during the implementation of the VAMP flow have varying degrees of quality. The CDEC real-time data has not been reviewed for accuracy or adjusted for rating shifts, whereas the USGS real-time data has had some preliminary review and adjustment. During the VAMP flow period, the real-time flows at Vernalis and in the San Joaquin River tributaries are continuously monitored. Similarly, the computed ungaged flow at Vernalis and the flow in the San Joaquin River upstream of the Merced River are continuously updated. The monitoring is done to assure that the supplemental water deliveries are adhering to the tributary allocations contained in the SJRA Division Agreement to the extent possible, as well as to determine if adjustments need to be made to the operation plan.

Normally, the USGS makes monthly measurements of the flow at Vernalis to check the current rating shift. The real-time flows reported by the USGS and CDEC are dependent on the most current rating shift, therefore a new measurement and shift can result in a sudden and significant change in the reported real-time flow. In order to minimize the potential for these sudden and significant changes, arrangements were made with the USGS to measure the flow at Vernalis on a weekly basis between April 17 and May 15. The results of these measurements are summarized in Table 2-5.

The April 17 measurement indicated no change from the effective rating shift at that time which was -0.61 feet. However, on April 25 the USGS reported that they had measured a flow of 3,800 cfs on April 23, almost 600 cfs greater than the real-time flow of 3,210 cfs, and significantly exceeding the VAMP target flow of 3,200 cfs. This measurement resulted in a change in the rating curve shift from -0.61 feet to 0.0 feet. In response, the VAMP operation was adjusted by reducing tributary releases in an attempt to reduce the flow at Vernalis to bring it in line with the target flow. On May 1, just as the operation adjustments that had been made in response to the April 23rd measurement were being seen at Vernalis, the USGS reported that they had measured a flow of 3,280 cfs on April 30, 420 cfs less than the reported real-time flow of about 3,700 cfs. This measurement resulted in a change in the rating curve shift from 0.0 feet to -0.56 feet, almost identical to the shift in effect prior to the April 23rd measurement. Once again VAMP operations were adjusted in response, this time with increased tributary releases. The next flow measurement by the USGS was made May 7th and it agreed with the rating curve shift from the April 30th measurement. On May 16 the USGS reported that they had measured a flow of 3,440 cfs on May15, 270 cfs greater than the reported real-time flow of 3,170 cfs, changing the rating curve shift from -0.59 feet to -0.25 feet. It should be noted that the first flow measurement following the VAMP period was made on June 18th and resulted in a change in the rating curve shift from -0.25 feet to -0.74 feet. The Hydrology Group made every effort to manage the VAMP flow based on the available real-time flow data. Adjusting the 2007 operations to the changing USGS measurements resulted in a greater than desirable fluctuation in the VAMP flow. It is the author's opinion that the flow measurements made on April 23rd and May 15th are questionable for the following reasons:

• Numerous flow measurements surrounding the two questionable measurements were all in agreement with a rating curve shift of about -0.6 feet. The questionable measurements imply the repeated occurrence of significant sediment scour and deposition at the gage site, which seems unlikely considering the mean velocity at the gage site was no greater than 1.2 feet per second.

• Previous VAMP periods with similar target flows (2002, 2003 and 2004) showed little or no change in rating curve shifts during the VAMP operation.

• The variability in the mean daily flow is not reflected in the DWR Mossdale gage which is located about 12 miles downstream of the Vernalis gage and about 3 miles upstream of Old River as shown in Figure 2-2. There are no significant inflows or diversions from the San Joaquin River between the Vernalis and Mossdale gages at the subject flow rates.

Results of Operations

The final accounting for the VAMP operation was accomplished using provisional mean daily flow data available from USGS and DWR as of July 30, 2007. Provisional data is data that has been reviewed and adjusted for rating shifts but is still considered preliminary and subject to change. Plots of the real-time and provisional flows at the primary measuring points are provided in Appendix A-2, Figures 1 through 7, to illustrate the differences between the real-time and the provisional data.

The mean daily flow in the San Joaquin River at the Vernalis gage averaged 3,260 cfs during the VAMP target flow period (April 22 - May 22). Figure 2-3 shows the observed flow and the estimated existing (no VAMP) flow, along with the supplemental water contributions. The flow varied between 2,830 cfs and 3,790 cfs during the target flow period. The flow variability was the result of operations adjustments made in response to the reported USGS flow measurements and accompanying rating curve shifts. It is the author's opinion that the flow variability during the target flow period is likely not as large as indicated for the reasons noted previously. During the VAMP target flow period the gage height at the Vernalis gage varied from a maximum of 11.99 feet to a minimum of 11.38 feet, a difference of 0.61 feet. This gage height difference represents a flow of 510 cfs on the unadjusted rating curve, somewhat less than the 960 cfs range indicated by the gage record.

The sources of the flow at Vernalis are shown in Figure 2-4. Figures 2-5, 2-6 and 2-7 show the with and without VAMP flows at the tributary measurement points for the Merced River, Tuolumne River and Stanislaus River, respectively. A tabulation of the observed mean daily flows during and around the VAMP target flow period is provided in Table 2-6.

The mean daily ungaged flow at Vernalis averaged 214 cfs during the VAMP target flow period, ranging from a minimum of -62 cfs to a maximum of 749 cfs. A plot of the ungaged flow is provided in Figure 2-8.

As previously stated, the combined CVP and SWP Delta export rate target was 1,500 cfs. The observed exports, shown in Figure 2-9, averaged 1,486 cfs during the target flow period.

Hydrologic Impacts

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

Due to the flood control operations in 2006 there were no SJRA storage impacts entering the 2007.

If it is assumed that Merced ID diversions from the Merced River are the same as they would have been without the SJRA, then the storage impact on Lake McClure following the 2007 VAMP operation and Fall SJRA transfer would be 41,460 acre-feet, as shown in Figure 2-10. However, as a result of the SJRA, Merced ID has undertaken a number of conservation measures that have resulted in a reduced reliance on Merced River diversions. Any reductions in Merced River diversions would offset the storage deficit shown in Figure 2-10. The impact of the Merced ID SJRA related conservation measures on Merced River diversions have not yet been quantified. It should be noted that even under the assumption that the storage deficit is equal to the supplemental water contribution, the SJRA has resulted in no reductions in Merced River flow during the eight years of VAMP operation as shown in Appendix B-1, Figure 3.

The cumulative storage impact to Don Pedro Reservoir as a result of the 2007 VAMP operation is 4,370 acrefeet, as shown in Figure 2-11.

Summary of Historical VAMP Operations

2007 marks the eighth year of VAMP operation in compliance with D-1641. A summary of the VAMP target flows for these first eight years is provided in Table 2-7. A summary of the SJRGA supplemental water contributions is provided in Table 2-8. The SJRTC Hydrology Group monitors the cumulative impact of the SJRA on reservoir storage and stream flows. Plots of storage and flow impacts throughout the seven years of VAMP operation are provided in Appendix B-1, Figures 1 through 4.

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



Figure 2-2 2007 VAMP - Flow Comparison, San Joaquin River near Vernalis and San Joaquin River at Mossdale

Figure 2-3 2007 VAMP - San Joaquin River near Vernalis with and without VAMP





Figure 2-4 2007 VAMP: San Joaquin River near Vernalis With Lagged Contributions from Primary Sources

Figure 2-5 2007 VAMP - Merced River at Cressey with and without VAMP



HAPTER 2

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2,000 VAMP Supplemental Flow Existing Flow 1,500 Mean Daily Flow (cfs) Target Flow Operation Period April 20 - May 20 1,000 500 0 4/1/07 4/11/07 4/21/07 5/1/07 5/11/07 5/21/07 5/31/07

Figure 2-6 2007 VAMP - Tuolumne River below LaGrange Dam with and without VAMP

Figure 2-7 2007 VAMP - Stanislaus River below Goodwin Dam with and without VAMP



Table 2-6 2007 Vernalis Adaptive Management Plan (VAMP) Final Flows and Accounting of Supplemental Water Contributions Target Flow Period: April 22 - May 22 • Target Flow: greater than 3,200 cfs

	Merced R. at Cressey (3 day Travel Time to Vernalis)			Tuolumne (2 day Tr	R. blw LaGra avel Time to	inge Dam Vernalis)	Stanisla (2 day Tra	aus R. blw G Dam avel Time to	oodwin Vernalis)	Upper SJR [2]	Vernalis Ungaged	San Joaq	uin River at V	/ernalis
Date	Existing Flow [1] (cfs)	Observed Flow (cfs)	VAMP Supple- mental Water (cfs)	Existing Flow [1] (cfs)	Observed Flow (cfs)	VAMP Supple- mental Water (cfs)	Existing Flow [1] (cfs)	Observed Flow (cfs)	VAMP Supple- mental Water (cfs)	Observed Flow (cfs)	Observed Flow (cfs)	Existing Flow [1] (cfs)	Observed Flow (cfs)	VAMP Supple- mental Water (cfs)
04/01/07	213	213		351	351		500	500		442	372	1,950	1,950	
04/02/07	231	231		350	350		502	502		431	378	1,930	1,930	
04/04/07	223	225		349	349		503	503		373	204	1,730	1,730	
04/05/07	216	216		348	348		500	500		352	196	1.680	1.680	
04/06/07	204	204		349	349		502	502		318	224	1,680	1,680	
04/07/07	213	213		350	350		510	510		304	280	1,710	1,710	
04/08/07	224	224		350	350		508	508		324	389	1,780	1,780	
04/09/07	100	225		350	350		508	508		318	260	1,880	1,880	
04/11/07	183	183		355	355		504	504		298	203	1.630	1,630	
04/12/07	187	187		353	353		500	500		325	330	1,730	1,730	
04/13/07	188	188		352	352		503	503		328	318	1,680	1,680	
04/14/07	213	213		352	352		503	503		326	363	1,730	1,730	
04/15/07	247	247		304	304		507	507		332	534	1,910	1,910	
04/16/07	253	253		303	303		503	503		352	488	1,990	1,990	
04/18/07	265	265		303	303		503	503		352	315	1,760	1,760	
04/19/07	250	318	68	590	590		1,032	1,032		343	364	1,780	1,780	
04/20/07	250	367	117	600	863	263	1,503	1,503	0	312	469	1,880	1,880	
04/21/07	250	388	138	600	870	270	1,503	1,503	0	302	468	2,700	2,700	224
04/22/07	250	430	193	600	870	270	1,507	1,507	0	275	504 749	3,109	3,500	331
04/24/07	250	448	198	600	860	260	1.504	1.504	Ő	316	634	3.262	3.670	408
04/25/07	250	438	188	600	774	174	1,501	1,501	0	324	488	3,144	3,590	446
04/26/07	250	429	179	600	637	37	1,500	1,500	0	312	397	3,067	3,520	453
04/27/07	250	542	292	600	592	0	1,502	1,502	0	265	323	2,998	3,370	372
04/28/07	250	676 777	426 527	475	591 486	11	1,502	1,502	0	243	273	2,935	3,160	225
04/30/07	250	743	493	375	406	31	1,502	1,502	0	273	322	2,908	3,200	292
05/01/07	250	749	499	270	326	56	1,500	1,500	0	286	189	2,653	3,090	437
05/02/07	250	711	461	270	322	52	1,497	1,497	0	264	(16)	2,402	2,960	558
05/03/07	250	708	458	270	372	102	1,504	1,504	0	207	(32)	2,281	2,830	549
05/04/07	250	723	473	270	412	142	1,502	1,502	0	230	163	2,349	2,900	563
05/06/07	250	1.129	879	270	341	71	1.502	1.502	0	130	178	2,450	3.050	600
05/07/07	250	1,172	922	270	286	16	1,498	1,498	0	190	194	2,470	3,050	580
05/08/07	250	1,121	871	270	287	17	1,503	1,503	0	270	357	2,520	3,090	570
05/09/07	250	1,129	879	270	288	18	1,504	1,504	0	300	67	2,275	3,170	895
05/10/07	250	989	739	375	301	31 10	1,504	1,504	0	350	(62)	2,231	3,170	939
05/12/07	250	857	607	475	469	0	1.500	1.500	Ő	316	44	2,420	3.330	910
05/13/07	250	834	584	600	565	0	1,505	1,505	0	307	111	2,606	3,390	784
05/14/07	250	810	560	600	579	0	1,501	1,501	0	299	165	2,711	3,450	739
05/15/07	250	785	535	600	590	0	1,505	1,505	0	303	176	2,803	3,410	607
05/16/07	250	764	508	600	593	0	1,503	1,503	0	314	156	2,810	3,400	560
05/18/07	250	727	477	600	583	0	1.508	1.508	Ő	301	179	2,835	3.370	535
05/19/07	250	609	359	600	589	0	1,503	1,503	0	317	142	2,786	3,300	514
05/20/07	329	329		600	591	0	1,501	1,501	0	382	134	2,772	3,280	508
05/21/07	278	278		541	541		1,504	1,504		404	128	2,783	3,260	477
05/22/07	245	245		447	447		1,500	1,500		413	20	2,741	3,100	359
05/24/07	222	222		290	290		1,504	1,504		392	160	2,810	2,810	
05/25/07	157	157		229	229		1,503	1,503		385	123	2,670	2,670	
05/26/07	116	116		232	232		1,502	1,502		377	161	2,570	2,570	
05/27/07	132	132		234	234		1,502	1,502		359	191	2,530	2,530	
05/28/07	138	138		234	234		1,501	1,501		345	267	2,540	2,540	
05/30/07	144	144		234	229		1,499	1,499		363	203	2,430	2,430	
05/31/07	154	154		203	203		1,504	1,504		326	70	2,340	2,340	
						VAI	MP Period							
Average (cfs): Supplemental Water (ac-ft):	250	721	28,960	471	538	4,370	1,502	1,502	0	285	214	2,721	3,263	33,330

VAMP Period

[1] Existing Flow: Flow that would have occured without VAMP operation.

[2] Upper SJR = Flow in San Joaquin River above Merced River = San Joaquin River at Newman minus Merced River at Stevinson.

Observed Flow Sources:

Observed Flow Sources: Merced River at Cressey (CA DWR B05155): California DWR, Water Data Library, 7/30/07 Merced River near Stevinson (CA DWR B05125): California DWR, Water Data Library, 7/30/07 Tuolumne River below LaGrange Dam near LaGrange (USGS 11289650): USGS, provisional data as of 7/30/07 Stanislaus River below Goodwin Dam: USBR, Goodwin Reservoir Daily Operations Report - OID/SSJID/Tri-Dams, 6/18/07 (April report) and 6/26/07 (May report) San Joaquin River near Vernalis (USGS 11203500): USGS, provisional data as of 7/30/07 San Joaquin River at Newman (USGS 11274000): USGS, provisional data as of 7/30/07

Table 2-7 Summary of VAMP Flows, 2000-2007										
VAMP Target Flow Period	60-20-20 Water Year Hydrologic Classification	VAMP Numerical Indicator	VAMP Target Flow (cfs)	Observed VAMP Flow (cfs)	Existing Flow (cfs)	VAMP Supplemental Water (acre-feet)	Delta Export Target (cfs)	Observed Delta Exports (cfs)		
4/15 - 5/15, 2000	Above Normal	4	5,700	5,869	4,800	77,680	2,250	2,155		
4/20 - 5/20, 2001	Dry	2	4,450	4,224	2,909	78,650	1,500	1,420		
4/15 - 5/15, 2002	Dry	2	3,200	3,301	2,757	33,430	1,500	1,430		
4/15 - 5/15, 2003	Below Normal	3	3,200	3,235	2,290	58,065	1,500	1,446		
4/15 - 5/15, 2004	Dry	2	3,200	3,155	2,088	65,591	1,500	1,331		
5/1 - 5/31, 2005	Wet	5	>7,000	10,390	10,390	0	2,250	2,986 [a]		
5/1 - 5/31, 2006	Wet	5	>7,000	26,220/24,262 [b]	26,020	0	1,500/6,000	1,559/5,748 [b]		
4/22 - 5/22,	Critical	1	3,200	3,263	2,721	33,330	1,500	1,486		

[a] May 1 through 25 average was 2,260 cfs; exports were increased starting May 26 inconjunction with increasing existing flow; May 26 through 31 average was 6,012 cfs.
[b] "First fish release-recapture period"/"Second fish release-recapture period"

Table 2-8 Summary of VAMP Supplemental Water Contributions, 2000-2007									
	VAMP		Supplemental Water (acre-feet)						
Year	Supplemental Water (acre- feet)		Merced ID	Oakdale ID	South San Joaquin ID	SJRECWA	Modesto ID	Turlock ID	
2000	77,680	Observed:	46,750	[a]	[b]	8,280	15,200	7,450	
		Division Agreement:	45,160	[a]	[b]	7,300	16,920	8,300	
		Deviation:	+ 1590			+ 980	- 1,720	- 850	
2001	78,650	Observed:	42,120	7,365	7,365	7,740	7,030	7,030	
		Division Agreement:	42,150	7,300	7,300	7,300	7,300	7,300	
		Deviation:	- 30	+ 65	+ 65	+ 440	- 270	- 270	
2002	33,430	Observed:	25,840	3,795	3,795	0	0	0	
		Division Agreement:	25,000	4,215	4,215	0	0	0	
		Deviation:	+ 840	- 420	- 420	0	0	0	
2003	58,065	Observed:	38,257	5,039	5,039	[C]	4,864.5	4,864.5	
		Division Agreement:	38,065	5,000	5,000	[c]	5,000	5,000	
		Deviation:	+ 192	+ 39	+ 39		-135.5	-135.5	
2004	65,591	Observed:	42,680	5,880	5,880	[C]	5,575.5	5,575.5	
		Division Agreement:	41,500	7,045.5	7,045.5	[c]	5,000	5,000	
		Deviation:	+ 1,180	- 1165.5	- 1165.5		+ 575.5	+ 575.5	
2005	0	Observed:	0	0	0	0	0	0	
		Division Agreement:	0	0	0	0	0	0	
		Deviation:	0	0	0	0	0	0	
2006	0	Observed:	0	0	0	0	0	0	
		Division Agreement:	0	0	0	0	0	0	
		Deviation:	0	0	0	0	0	0	
2007	33,330	Observed:	28,960	2,185 [d]	2,185 [d]	0	0	0	
		Division Agreement:	25,000	4,165	4,165	0	0	0	
		Deviation:	+ 3,960	- 1,980	- 1,980	0	0	0	

[a] Provided by Modesto ID

[b] Provided by Merced ID (54.55%), Oakdale ID (15.91%), Modesto ID (15.91%) and Turlock ID (13.64%)
[c] Provided by Merced ID
[d] Provided by Modesto ID/Turlock ID on the Tuolumne River due to flow constraints on the Stanislaus River

1000 Target Flow Period April 22 - May 22 Mean Daily Flow (cfs) 500 0 Observed (real-time) Observed (provisional) Observed - VAMP period mean (provisional) April 16 Forecast -500 4/11/07 4/21/07 5/1/07 5/11/07 5/21/07 4/1/07 5/31/07

Figure 2-8 2007 VAMP - Ungaged Flow in San Joaquin River at Vernalis

Figure 2-9 2007 VAMP - Federal and State Delta Exports





Figure 2-11 San Joaquin River Agreement Storage and Flow Impacts Tuolumne River - New Don Pedro Reservoir Storage and Release - 2007





ADDITIONAL WATER SUPPLY ARRANGEMENTS & DELIVERIES

Paragraph 8.4 of the SJRA states that "Merced Irrigation District (Merced) shall provide, and the USBR shall purchase 12,500 acre-feet of water...during October of all years." The SJRA also states in Paragraph 8.4.4 that "Water purchased pursuant to Paragraph 8.4 may be scheduled for months other than October provided Merced, DFG and USFWS all agree." Paragraph 8.5 of the SJRA states that "Oakdale Irrigation District (OID) shall sell 15,000 acre-feet of water to the USBR in every year of this Agreement." Paragraph 8.5 also states that "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," which is referred to as the Difference Water. The purpose of additional water supply deliveries in the fall months is to provide instream flows to attract and assist adult salmon during spawning.



Merced Irrigation District

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

In addition to providing water in the fall of 2007 pursuant to the Agreement, Merced entered into a contract with USBR 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 Water. The EWA Transfer Water was to be delivered south of the Delta via the CVP Jones Pumping Plant and/or the SWP Banks Pumping Plant, depending on the availability of excess pumping capacity. Since the likelihood of having excess pumping capacity decreases near the end of the year, the EWA Transfer Water was scheduled to be provided first followed by the Fall SJRA Transfer Water. The schedule for the Merced 2007 fall water transfers was finalized on September 27, 2007, with the EWA Transfer Water to be provided from October 24 through November 8 and the Fall SJRA Transfer Water to be provided from November 6 through December 31, as shown in Table 3-1 and Figure 3-1. Table 3-1 also includes the final accounting for the period with provisional flow data available at the time of the writing of this report.

Oakdale Irrigation District

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

OID provided 2,185 acre-feet of supplemental water for the 2007 VAMP operation, therefore the amount of additional water purchased by the USBR from OID was 23,815 acre-feet (15,000 acre-feet plus 8,815 acre-feet of Difference Water). The OID additional water is made available in New Melones reservoir for use by the USBR for any authorized purpose of the New Melones project.

The 23,815 ac-ft of OID Additional Water was released from May 21, 2007 through June 1, 2007 to provide supplemental flow to the Stanislaus River for fishery purposes.

CHAPTER 3

Table 3-12007 Merced Irrigation District Fall Water TransfersDaily Summary

		SCHEDULED				OBSERVED					
		SJRA Transfe [Nov. 6 - Dec.		EWA Transfer] [Oct. 24 - Nov. 8]				SJRA Transfer [Nov. 6 - Dec. 31]		EWA Transfer [Oct. 24 - Nov. 8]	
Date	Base Flow at Shaffer Br/ Cressey (cfs)	SJRA Transfer Water Flow (cfs)	Cumulative SJRA Transfer Water Volume (acre-ft)	EWA Transfer Water (cfs)	EWA Transfer Balance (acre-ft)	Target Flow at Shaffer Br/ Cressey (cfs)	Shaffer Br/ Cressey Flow (cfs)	SJRA Transfer Water Flow (cfs)	Cumulative SJRA Transfer Water Volume (acre-ft)	EWA Transfer Water Flow (cfs)	Cumulative EWA Transfer Water Volume (acre-ft)
20-0ct	85	0	0	0	0	85	154	(· · · /	(, , , , , , , , , , , , , , , , , , ,	()	
21-0ct	85	0	0	0	0	85	158				
22-0ct	85	0	0	0	0	85	163				
23-0ct	85	0	0	500	0	85	166			507	1 1 9 /
24-001 25-0ct	85	0	0	900	2 777	985	1 050			965	3 098
26-0ct	85	õ	õ	900	4.562	985	1.050			965	5.012
27-0ct	85	0	0	900	6,347	985	1,060			975	6,946
28-0ct	85	0	0	900	8,132	985	1,070			985	8,900
29-0ct	85	0	0	900	9,917	985	1,080			995	10,874
30-00L	85	0	0	900	13/88	985	1,090			1,005	1/ 8/1
1-Nov	220	ŏ	Ő	900	15.273	1.120	1.200			980	16.785
2-Nov	220	0	0	900	17,058	1,120	1,160			940	18,649
3-Nov	220	0	0	900	18,843	1,120	1,150			930	20,494
4-Nov	220	0	0	900	20,628	1,120	1,120			900	22,279
5-Nov	220	0	0	900	22,413	1,120	1,110	05	100	890	24,044
7-Nov	220	180	545	450	23,702	850	834	180	545	434	25,321
8-Nov	220	180	902	204	25,000	604	632	180	902	232	26,642
9-Nov	220	180	1,260	0	.,	400	452	232	1,362		
10-Nov	220	115	1,488	0		335	371	151	1,662		
11-Nov	220	115	1,716	0		335	367	147	1,954		
12-Nov	220	115	2 1 7 2	0		335	364	144	2,240		
14-Nov	220	115	2,400	0		335	362	142	2,808		
15-Nov	220	115	2,628	Ō		335	363	143	3,092		
16-Nov	220	115	2,856	0		335	362	142	3,374		
17-Nov	220	115	3,084	0		335	359	139	3,650		
19-Nov	220	115	3,312	0		335	358	132	3,924		
20-Nov	220	115	3,769	0		335	353	133	4,180		
21-Nov	220	115	3,997	0		335	344	124	4,696		
22-Nov	220	115	4,225	0		335	360	140	4,974		
23-Nov	220	115	4,453	0		335	364	144	5,260		
24-INOV 25-Nov	220	115	4,681	0		335	368	148	5,554		
26-Nov	220	115	5.137	Ő		335	374	154	6.160		
27-Nov	220	115	5,365	Ō		335	377	157	6,471		
28-Nov	220	115	5,593	0		335	376	156	6,780		
29-Nov	220	110	5,812	0		330	373	153	7,083		
1-Dec	220	110	6 248	0		330	372	161	7,364		
2-Dec	220	110	6,466	Ő		330	381	161	8,022		
3-Dec	220	110	6,684	0		330	378	158	8,335		
4-Dec	220	110	6,902	0		330	372	152	8,636		
5-Dec	220	110	7,121	0		330	368	148	8,930		
7-Dec	220	110	7,557	0		330	395	175	9,580		
8-Dec	220	110	7,775	0		330	386	166	9,909		
9-Dec	220	110	7,993	0		330	374	154	10,214		
10-Dec	220	110	8,212	0		330	371	151	10,514		
12-Dec	220	110	8,648	0		330	368	148	11,102		
13-Dec	220	110	8.866	0		330	358	138	11.376		
14-Dec	220	110	9,084	0		330	353	133	11,640		
15-Dec	220	110	9,302	0		330	[1]				
16-Dec	220	110	9,521	0		330	[1]				
18-Dec	220	110	9,739	0		330	[1]				
19-Dec	220	110	10,175	Õ		330	[1]				
20-Dec	220	110	10,393	0		330	[1]				
21-Dec	220	110	10,612	0		330	[1]				
22-Dec	220	110	10,830	0		330	[1]				
23-Dec 24-Dec	220	110	11,266	0		330	[1]				
25-Dec	220	110	11,484	0		330	[1]				
26-Dec	220	110	11,702	0		330	[1]				
27-Dec	220	110	11,921	0		330	[1]				
28-Dec	220	105	12,139	0		330	[1]				
30-Dec	220	52	12,450	0		272	[1]				
31-Dec	220	25	12.500	0		245	[1]				

[1] Provisional mean daily flow data not available at time of publication.



Figure 3-1 Merced I.D. Fall 2007 Water Transfers Merced River at Shaffer Bridge/Cressey

CHAPTER 4

HEAD OF OLD RIVER BARRIER Barrier Design, Installation and Operation

Installation of the2007 temporary spring Head of Old River Barrier (HORB) was completed on April 20, two days earlier than scheduled, with the initial operation commencing on April 22. Construction clean-up continued for a short period of days following the initial operation. 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



Figure 4-1 Spring Head of Old River Barrier Cross Section

The spring HORB was first constructed in 1992. Since then, the barrier has been installed in 1994, 1996, 1997, 2000, 2001, 2002, 2003, 2004 and 2007. The 1997 barrier included two open culverts, while the 2000 through 2007 barriers included six operable culverts. The HORB was not installed in 1993, 1995, 1998, 2005, and 2006 due to high San Joaquin River flows. The HORB was not installed in 1999 due to landowner access problems. The HORB, a key component of VAMP, is intended to increase San Joaquin River Chinook salmon smolt survival by preventing them from entering Old River.

Beginning in 2001, the barrier design included two versions. A "low-flow" barrier when San Joaquin River target flows are below 7,000 cfs would be built to a height of 10 feet mean sea level (MSL). A "high-flow" barrier for the target flow of 7,000 cfs 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 2007, the low-flow version was installed.

The dimensions of the 2007 HORB (Figure 4-1) were similar to the 2000, 2001, 2002, 2003, and 2004 HORB. The base width of the HORB in 2007 was 100 feet and the crest elevation was 10 feet MSL. The top of HORB was constructed with a 75-foot wide notch, protected with concrete grid mats and back-filled with clay. The 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 beginning in 1997, and six operable culverts were installed beginning in 2000. Operation of the culverts is controlled by slide gates 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 actual levels observed in the field. Consequently, DWR takes this into consideration when making decisions regarding the culvert operations.

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 2007 HORB operations.

Permitting and Construction

The various permit conditions that are placed on the Temporary Barriers Program, by the USFWS, National Marine Fisheries Service (NMFS), and DFG, require that in-water construction activities for the Head of Old River (HOR), Middle River (MR), and Old River at Tracy (ORT) barriers can begin no earlier than April 7. In addition, construction of the northern abutment and boat ramps of the Grant Line Canal (GLC) barrier and construction of out-of-water portions of the HOR, MR, and ORT barriers may not be started any earlier than April 1. Full closure of the GLC barrier is not required but construction of the north abutment and boat ramps must be completed to the extent that full barrier closure and operation can be readily achieved in a reasonable time frame, if and when directed by DWR. The permit conditions also require that all the above work be completed by April 15th, a total of 15 working days. Following is a brief summary of the various permit conditions:

USFWS Biological Opinion (1-1-01-F-81 dated March 30, 2001)

1) The spring HORB barrier installation may begin on April 1 but in-water work shall not occur until April 7, except for construction necessary to place the scour pad and the pad for the culverts (item No. 8, page 6);

2) DWR may begin construction of the Middle River barrier on April 1 but in-water work shall not occur until after April 7 (item No. 1, page 4);

3) DWR may begin construction of the Old River at Tracy barrier on April 1 but in-water work shall not commence before April 7 (item No. 2, page 4);

4) DWR may begin construction of the northern abutment and the boat ramp of the GLC barrier on April 1 provided that the HOR barrier is being constructed concurrently (item No. 3, page 5).

NMFS Biological Opinion

(SWR-00-SA-289: MEA on the proposed ACOE permit (200000696) filed on December 4, 2000)

1) The spring HORB installation shall begin on April 1 (item 8, page 8);

2) The MR barrier construction may begin on April 7 (item 1, page6);

3) The ORT barrier construction may begin on April 1 (item2, page 6);

4) The northern abutment and boat ramp of the GLC barrier may begin construction on April 1 provided that the HORB is being constructed concurrently (item 3, page 7).

DFG 1601 – HORB (2081-2001-009-BD dated April 4, 2001)

HORB Spring Installation – All work in or near the stream zone will be confined to the period beginning no earlier than April 1

DFG 1601 – Agricultural Barriers

MR - All work in or near the stream zone will be confined to the period beginning no earlier than March 1

ORT – All work in or near the stream zone will be confined to the period beginning no earlier than April 1

GLC - All work in or near the stream zone will be confined to the period beginning no earlier than April 1

In addition to the above conditions, water users of the South Delta Water Agency (SDWA) and the fisheries agencies impose separate mitigation requirements on DWR for installation and operation of the HORB by itself. As a result, DWR's contractor must sequentially close and start operation of the MR and ORT barriers, and complete as much construction of north abutment and boat ramps on the GLC barrier as possible, before they can close and operate the HORB.

From the contractors point of view there are really two milestones that must be completed in sequence. First and foremost is to obtain closure and operation of the barriers in accordance with the conditions imposed by the project permits/biological opinions and mitigation requirements. The second is to satisfy DWR's contract specifications. The first milestone can be achieved within the required 15 working days but it is unlikely that the contractor can complete the entire amount of work required to satisfy DWR's contract specifications within the same time period.

Figure 4-2 South Delta Temporary Barriers



Therefore, the contractor's construction activities consist of placing enough materials to make sure they obtain closure and operation by April 15th, then following closure they continue placing barrier material above the water line until barrier construction is completed in accordance with DWR's contract specifications. The contractor then conducts site cleanup and demobilizes from the site. This is why work usually continues above water line beyond the April 15 deadline.

Barrier Operations and Monitoring Plan

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 and Grant Line above Doughty Cut would remain above 0.0 feet MSL and Middle River near Howard Road above 0.3 feet MSL. Based on modeling results and/or field monitoring of water levels in the south delta, six culverts were open after the barrier's closure date of April 20, 2007. On April 26, 2007 three of the culverts were closed, but were reopened on May 16, 2007 because of the concern over the Delta Smelt.

Flow Measurements at and Around the Head of Old River

DWR operates two Acoustic Doppler Current Meters (ADCM) in the vicinity of head of Old River, one in the San Joaquin River 1,500 feet downstream of Old River (San Joaquin River below Old River near Lathrop, SJL) and another in Old River 840 feet downstream of the head of Old River (Old River at Head, OH1). A third acoustical Doppler was installed last year at the abutment of the railroad bridge near Mossdale (Figure 4-2). The ADCMs record velocity measurements at a 15 minute interval from which flow values can be determined. Table 4-1 lists the daily minimum, maximum and mean flows for the March 25, 2007 through June 30, 2007 period for the three ADCMs. Figures 4-3, 4-4, and 4-5 show the daily flow range and the mean for the Old River at Head gage, the San Joaquin River below Old River gage, and the San Joaquin River at Mossdale gage respectively.

Table 4-2 shows the mean daily flow of the San Joaquin River gage at Mossdale and the San Joaquin River near Vernalis gage for the duration from April 1, 2007

	Old River at Head (OH1)			San Joaquin River below Old River (SJL)			San Joaquin River at Mossdale (MSD)			Flow Split (% of Total Flow)	
Date	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)	Mean Flow (cfs)	OH1	SJL
3/25/2007	1,210	2,100	1,700	-1,070	1,900	638	1,110	2,900	2,190	72.7%	27.3%
/26/2007	898	2,210	1,680	-1.090	1,960	682 556	1,340	2,920	2,190	71.1%	28.9%
/28/2007	870	2,120	1,570	-899	1,880	580	1,330	2,580	2,090	73.0%	27.0%
/29/2007	941	2,210	1,610	-915	1,660	482	1,350	2,510	2,050	76.9%	23.1%
/30/2007 /31/2007	1,070	2,250	1,600	-1,130	1,560	404	1,200	2,430	1,920	79.9%	20.1%
1/1/2007	1,020	2,230	1,690	-1,300	1,720	356	1,170	2,410	1,910	82.6%	17.4%
/2/2007	921	2,190	1,590	-1,070	1,560	417	1,120	2,550	1,950	79.2%	20.8%
1/3/2007	806	1,970	1,530	-1,060	1,560	369	969	2,400	1,810	80.6%	19.4%
1/5/2007	632	2,000	1,510	-1,210	1,630	314 227	597	2,410	1,760	82.8%	13.3%
1/6/2007	567	2,050	1,500	-1,290	1,730	225	301	2,340	1,600	87.0%	13.0%
1/7/2007	544	2,000	1,470	-1,350	1,910	401	365	2,410	1,650	78.6%	21.4%
/8/2007	564	1,990	1,480	-1,210	1,860	408	688	2,500	1,740	78.4%	21.6%
/9/2007	623	1,780	1,330	-1,100	1,910	476	856	2,380	1,660	73.6%	26.4%
/11/2007	663	2,050	1,360	-1,180	1,730	309	562	2,210	1,470	81.5%	18.5%
/12/2007	621	2,080	1,380	-1,410	1,790	322	784	2,310	1,590	81.1%	18.9%
/13/2007	683	2,100	1,400	-1,190	1,420	259	817	2,050	1,600	84.4%	15.6%
/15/2007	836	2,020	1,460	-1.320	1,520	297	1.070	2,390	1,710	83.1%	16.9%
/16/2007	926	2,250	1,570	-1,110	1,670	422	1,040	2,470	1,880	78.8%	21.2%
/17/2007	870	2,090	1,600	-1,280	1,600	269	725	2,370	1,680	85.6%	14.4%
/18/2007	836 875	2,200	1,410	-1,460	1,710	349	410	2,370	1,660	80.1%	19.9%
/20/2007	511	2,280	1,060	-1,530	2,460	1,010	-44	2,430	1,640	51.2%	48.8%
/21/2007	464	928	665	-18	2,900	1,920	866	3,000	2,180	25.7%	74.3%
/22/2007	389	928	668	852	3,300	2,440	1,800	3,410	2,750	21.5%	78.5%
/23/2007	559	951 825	673	2,020	3,390	2,850	2,570	3,570	3,100	20.0%	80.0%
/25/2007	513	811	658	2,240	3,210	2,790	2,630	3,390	3,030	19.1%	80.9%
/26/2007	368	703	533	2,070	3,300	2,830	2,550	3,400	3,030	15.9%	84.1%
/27/2007	388	633	482	2,310	3,270	2,880	2,610	3,290	3,010	14.3%	85.7%
/28/2007	323	585	445	2,040	3 240	2,720	2,390	3,270	2,910	13.9%	86.1%
/30/2007	230	657	420	2,180	3,510	2,900	2,590	3,530	3,100	12.7%	87.3%
/1/2007	230	500	379	2,130	3,430	2,830	2,380	3,470	2,990	11.8%	88.2%
/2/2007	256	485	381	2,000	3,310	2,710	2,210	3,280	2,880	12.3%	87.7%
5/3/2007	107	488	347	1,590	3,200	2,630	2.020	3,210	2,720	11.7%	88.3%
5/2007	275	616	437	1,890	3,350	2,770	2,150	3,240	2,820	13.6%	86.4%
6/2007	277	599	416	1,990	3,360	2,830	2,230	3,420	2,930	12.8%	87.2%
0/7/2007 5/8/2007	124	571	403	2,080	3,430	2,850	2,290	3,390	2,940	12.4%	87.6%
5/9/2007	233	522	356	2,000	3,400	2,790	2,320	3,410	2,890	11.3%	88.7%
/10/2007	223	467	358	2,250	3,310	2,800	2,580	3,330	2,970	11.3%	88.7%
/11/2007	269	523	396	2,230	3,220	2,800	2,600	3,310	2,990	12.4%	87.6%
/12/2007	302	564	437	2,050	3,230	2,790	2,480	3,340	2,970	13.6%	86.4%
/14/2007	339	621	466	2,030	3,430	2,870	2,530	3,550	3,160	14.0%	86.0%
/15/2007	297	546	450	1,730	3,420	2,780	2,340	3,490	3,030	13.9%	86.1%
/16/2007	329	777	555	1,520	3,340	2,720	2,160	3,550	3,030	17.0%	83.0%
/18/2007	491	785	583	1,170	3,360	2,620	2 1 2 0	3,560	3,010	18.9%	81.1%
/19/2007	425	800	578	1,420	3,350	2,640	2,120	3,530	3,010	18.0%	82.0%
/20/2007	360	711	567	1,310	3,310	2,600	2,110	3,440	2,970	17.9%	82.1%
/21/2007	462	812	606	1,650	3,330	2,680	2,340	3,550	3,020	18.5%	81.5%
/22/2007	1 260	2 710	1,210	882	2,840	2,320	2,630	3,490	2 820	34.3%	51.0%
/24/2007	1,020	2,500	1,530	-188	2,100	1,410	2,010	2,930	2,600	52.0%	48.0%
/25/2007	925	2,280	1,340	-515	2,060	1,270	1,760	2,790	2,450	51.3%	48.7%
/26/2007	827	2,310	1,230	-816	2,150	1,220	1,520	2,770	2,330	50.2%	49.8%
/28/2007	755	2,130	1.210	-840	2,270	1,240	1,390	2,790	2,290	49.4%	48.4%
/29/2007	784	2,260	1,290	-1,290	2,410	1,040	1,150	2,930	2,230	55.4%	44.6%
/30/2007	679	2,040	1,170	-1,070	2,470	1,150	1,230	2,960	2,270	50.4%	49.6%
/31/2007	671 759	2,130	1,190	-1,080	2,470	1,140	985	2,930	2,240	51.1%	48.9%
/2/2007	742	2,120	1.240	-972	2,440	1.140	1.100	2.910	2,260	52.1%	47.9%
/3/2007	753	2,190	1,230	-1,210	2,600	1,200	1,100	2,950	2,300	50.6%	49.4%
/4/2007	691	2,160	1,190	-1,030	2,400	1,110	1,050	2,770	2,140	51.7%	48.3%
/5/2007	409	2,080	1,160	-1,050	2,410	1,030	1,020	2,580	2,000	53.0%	47.0%
6/7/2007	504	1.880	971	-660	2,280	1.060	1.320	2,350	1.940	47.8%	52.2%
/8/2007	513	1,900	962	-699	1,840	1,000	1,230	2,260	1,900	49.0%	51.0%
/9/2007	528	1,930	995	-840	1,850	969	1,140	2,220	1,850	50.7%	49.3%
/10/2007	358	1,980	932	-1,040	1,980	867	840	2,100	1,710	51.8%	48.2%
/12/2007	434	2,030	1.030	-1,280	2,190	973	609	2,370	1.880	51.4%	49.3%
/13/2007	568	2,260	1,140	-1,380	2,360	984	799	2,670	2,040	53.7%	46.3%
/14/2007	419	2,330	1,100	-1,490	2,350	794	587	2,480	1,760	58.1%	41.9%
/15/2007	109	2,100	944	-1,510	2,520	727	60	2,340	1,490	56.5%	43.5%
/17/2007	90	2 120	800	-1,570	2,550	829 957	326	2,310	1,500	48.2%	49.1%
/18/2007	205	2,120	972	-1,420	2,460	876	596	2,360	1,720	52.6%	47.4%
/19/2007	159	2,160	994	-1,390	2,360	721	591	2,290	1,600	58.0%	42.0%
/20/2007	6	1,880	777	-1,100	2,240	876	618	1,970	1,510	47.0%	53.0%
/21/2007	-82	1,660	635	-1,120	1,920	813	584	1,740	1,350	43.8%	56.2%
/23/2007	-10	1.740	682	-1.490	1.780	527	261	1.530	1.030	56.4%	43.6%
/24/2007	-104	1,680	619	-1,540	1,800	516	-11	1,390	906	54.5%	45.5%
/25/2007	-73	1,700	656	-1,510	1,880	523	-68	1,470	953	55.6%	44.4%
/26/2007	-97	1,780	703	-1,660	1,960	378	-73	1,450	859	65.1%	34.9%
/28/2007	-155	1,710	698 715	-1,660	2,130	441	-135	1,480	863	60.5%	38.7%
/29/2007	-219	1 710	715	-1,080	2,150	407	-104	1,720	828	64.0%	36.0%
/30/2007	-325	1,490	596	-1,670	2,160	430	-275	1,450	763	58.1%	41.9%

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through June 30, 2007. Moreover, Figure 4-6 presents in graphical format the mean daily flow for the San Joaquin River gage at Mossdale and the San Joaquin River near Vernalis gage for the same period.

DWR at the end of each year conducts a Delta Simulation Model 2 (DSM2) modeling run to be included in the yearly published South Delta Temporary Barriers Monitoring Report. Data collected from the two ADCMs will be used to verify the flow split of the San Joaquin River and Old River at the confluence against the output generated using the model.

Seepage Monitoring

A seepage-monitoring program was initiated in April 2000, to evaluate the effects of HORB operations on seepage and groundwater on Upper Roberts Island. In 2007 no seepage was observed at any of the monitoring sites. A link to the continuous time series data in the water data library is available on the internet.

In 2007, DWR installed Doppler "Argonaut" flow measuring devices inside culverts 1, 4 and 6. Data was recorded every 15 minutes during the period when the HORB was in operation. The flow through a completely submerged culvert is primarily dependent on the water levels at the two ends of the culvert, but is also dependent on culvert inlet geometry, slope, size and roughness. If it is assumed that all of these factors are similar for all six of the culverts, then the measured flow in any of these culverts would be a reasonable estimate of the flow in each of the other culverts. Table 4-3 summarizes the measured flows in culverts 1, 4, and 6 and estimates the total mean daily flow in all six culverts.

Barrier Emergency Response Plan

In addition to the operation and monitoring plan, DWR has also prepared an "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. Vernalis flows and stages at the barrier were not high enough in 2007 to warrant action under the emergency operations plan.

Fish Entrainment Monitoring at the Head of Old **River Barrier**

All six culverts in the Head of Old River Barrier (HORB) were installed for the 2007 VAMP test period. However, only three of the six culverts were open during entrainment monitoring. The six culverts are installed to maintain water quality and water levels in the south Delta, downstream of the HORB. Since the culverts are

	Mean Daily Flow (cfs)						
	San Joaquin River	San Joaquin River					
	at Mossdale	near Vernalis					
Date	[A]	[B]					
4/1/07	1,910	1,950					
4/2/07	1,950	1,930					
4/3/07	1,810	1,790					
4/4/07	1,760	1,730					
4/6/07	1.600	1.680					
4/7/07	1,650	1,710					
4/8/07	1,740	1,780					
4/9/07	1,870	1,880					
4/10/07	1.470	1.630					
4/12/07	1,590	1,730					
4/13/07	1,600	1,680					
4/14/07	1,540	1,730					
4/16/07	1.880	1.990					
4/17/07	1,680	1,850					
4/18/07	1,660	1,760					
4/19/07	1,610	1,780					
4/21/07	2.180	2,700					
4/22/07	2,750	3,500					
4/23/07	3,100	3,790					
4/24/07	3,080	3,670					
4/26/07	3,030	3,520					
4/27/07	3,010	3,370					
4/28/07	2,910	3,160					
4/29/07	2,940	3,160					
5/1/07	2.990	3,200					
5/2/07	2,880	2,960					
5/3/07	2,720	2,830					
5/4/07	2,730	2,900					
5/6/07	2,930	3.050					
5/7/07	2,940	3,050					
5/8/07	2,890	3,090					
5/9/07	2,950	3,170					
5/11/07	2,970	3,250					
5/12/07	2,970	3,330					
5/13/07	3,090	3,390					
5/14/07	3,160	3,450					
5/16/07	3,030	3,400					
5/17/07	3,010	3,360					
5/18/07	3,050	3,370					
5/19/07	3,010	3,300					
5/21/07	3,020	3,260					
5/22/07	3,000	3,100					
5/23/07	2,820	2,960					
5/24/07	2,600	2,810					
5/26/07	2,330	2,570					
5/27/07	2,290	2,530					
5/28/07	2,350	2,540					
5/29/07	2,230	2,430					
5/31/07	2,240	2,340					
6/1/07	2,260	2,350					
6/2/07	2,260	2,390					
6/4/07	2,140	2,200					
6/5/07	2,000	2,090					
6/6/07	2,020	2,020					
6/7/07	1,940	1,950					
6/9/07	1,850	1,880					
6/10/07	1,710	1,740					
6/11/07	1,830	1,860					
6/13/07	2 040	2 040					
6/14/07	1,760	1,760					
6/15/07	1,490	1,610					
6/16/07	1,500	1,590					
6/18/07	1,720	1,680					
6/19/07	1,600	1,550					
6/20/07	1,510	no data					
6/21/07	1,350	no data					
6/23/07	1,170	1.110					
6/24/07	906	1,100					
6/25/07	953	1,130					
6/26/07	859	1,060					
6/28/07	893	1.090					
6/29/07	828	1.040					

763

6/30/07

Table 4-2

San Joaquin River Old River Mean Daily Flows

1.000

Figure 4-3 Daily Flow Range - Old River at Head



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



Figure 4-5 Daily Flow Range - San Joaquin River at Mossdale



Figure 4-6 San Joaquin River Flow near Vernalis and at Mossdale



not screened, juvenile Chinook salmon and other fish species that pass near the culverts are vulnerable to entrainment. A fish monitoring program was designed and implemented by the DFG to evaluate and quantify fish entrainment at the HORB. Results from this fishery investigation are intended, in part, to provide information on the design and operation of a future permanent operable barrier at the head of Old River.

Materials and Methods

Fish entrained into the culverts were caught with fyke nets. The nets have a 48-inch cylindrical mouth tapering down to a 1-foot square cod-end, and are made of 1/2 inch braided mesh. Five of the six nets are 60 feet long and one net is 40 feet long. A live-box (15.5 x 19.5 x 36 inches), constructed of perforated aluminum sheet metal, was attached to the cod-end of each net. Each live-box has an aluminum baffle designed to reduce water velocities within the live-box and improve survival of captured fish. The culverts were numbered from 1 to 6 with number 1 located next to the shoreline (viewed from downstream) and number 6 located mid-channel (Figure 4-7). On April 27, fyke nets were attached to the downstream slide gate flanges of all six culverts. These gates were not lowered over the culverts at this time and thus, were not sampling. The slide gates on culvert numbers 1, 4 and 6, with attached nets and live boxes, were lowered over the culvert outfalls at 14:00 hours on Monday, April 29 to commence fish entrainment monitoring. Only culvert numbers 1, 4 and 6 were opened and remained opened throughout the monitoring period. On Friday, May 4, at 13:00, the nets were raised, checked, and then piled onto the frames. The nets did not fish over the weekend. The following Monday, at 13:00 hours, the nets for culvert numbers 1, 4 and 6 were lowered back into the water. All nets were removed at noon on Friday, May 11.

The fyke nets were checked at 01:00, 06:00, 13:00, and 20:00 hours Monday through Friday. The nets were checked by closing the culvert slides gate (upstream side) for about 20 minutes, enabling the live-boxes to be pulled onto a boat. Fish were removed from the live-boxes and placed into buckets. Once all the nets had been checked and reset, the collected fish were processed. All the fish were identified and counted. Salmon were checked for a clipped adipose fin and for the presence of a color-mark on the dorsal, anal, or caudal fin. Salmon that had a clipped adipose fin were saved for CWT processing. All salmon were measured (fork-lengths) to the nearest millimeter. Culvert number, date, time, water temperature, and diel-period were recorded for each net check. Except for adipose fin clipped salmon, all fish were released downstream of the HORB into Old River.

Figure 4-7

Culverts in the HORB were numbered from 1 to 6, with number 1 closest to shore. Culvert numbers 2, 3 and 5 were closed throughout the monitoring period.



4.2 Elour in LODD Cul

	Mean Daily Flow (cfs)								
		Measured	l .						
Date	Culvert 1	Culvert 4	Culvert 6	Open Culverts	Total [1]				
4/26/07 [2]	82	79	89	1,4,6	251				
4/27/07	78	78	88	1,4,6	245				
4/28/07	72 75		86	1,4,6	233				
4/29/07	69	72	83	1,4,6	224				
4/30/07	66	67	72	1,4,6	205				
5/1/07	60	58	60	1,4,6	178				
5/2/07	60	58	61	1,4,6	179				
5/3/07	57	56	58	1,4,6	171				
5/4/07	59	59	65	1,4,6	183				
5/5/07	62	61	70	1,4,6	192				
5/6/07	64	63	73	1,4,6	200				
5/7/07	60	58	64	1,4,6	182				
5/8/07	57	55	59	1,4,6	171				
5/9/07	56	54	59	1,4,6	168				
5/10/07	54	53	57	1,4,6	164				
5/11/07	55	56	62	1,4,6	173				
5/12/07	56	57	67	1,4,6	179				
5/13/07	57	58	68	1,4,6	183				
5/14/07	59	59	70	1,4,6	188				
5/15/07	56	56	66	1,4,6	179				
5/16/07 [3]	53	53	65	1,2,3,4,5,6	256				
5/17/07	49	50	62	1,2,3,4,5,6	322				
5/18/07	49	49	62	1,2,3,4,5,6	320				
5/19/07	48	48	61	1,2,3,4,5,6	315				
5/20/07	50	49	63	1,2,3,4,5,6	325				
5/21/07 [4]	47	47	60	1,2,3,4,5,6	309				

 $\left[1 \right]$ Assumes average of measured flows for Culverts 2, 3 and 5 when open

[2] Partial day record of flow: 10:30 to 23:45

[3] Culverts 2, 3 and 5 were opened on May 16; estimate of total flow assumes these culverts were open for half of May 16.

[4] Partial day record of flow: 0:00 to 10:15
Unlike in previous years, there were no VAMP salmon releases upstream of the HORB at Mossdale or Durham Ferry. Consequently, no entrainment loss indices were calculated for 2007. Instead, an unmarked salmon average daily entrainment index (Entrainment Index) was generated from the HORB fish entrainment results to track relative changes in entrainment among years. For each year of entrainment monitoring, an Entrainment Index was calculated by dividing the total number of unmarked salmon caught by the number of days sampled. The index was not adjusted for the number of open culverts or the occasional lost entrainment samples due to gravel or debris. The Entrainment Index represents overall entrainment regardless of HORB culvert gate operation.

To track relative changes in unmarked salmon abundance just upstream of the barrier, salmon catch from the Mossdale Kodiak Trawl (MKT) was used to calculate an average 5 hour daily abundance index (Abundance Index). The Abundance Index was calculated by summing the daily catch of unmarked salmon (standardized to fifteen 20 minute tows) and dividing by the number of days sampled. The Abundance Index was calculated for the same days in which there was entrainment monitoring. Abundance and Entrainment Indices are calculated for a two to three week period during the VAMP test period. No indices were calculated for 2005 and 2006 because the HORB was not installed due to high San Joaquin River flows.

Fish catch was calculated for each culvert. Catch-Per-Unit-Effort (CPUE) for salmon comparison among years was calculated as the number of fish collected per hour per culvert. Standard deviation is used to describe the variability round the mean. DWR installed flow meters in culverts number 1, 4 and 6. Unmarked salmon entrainment density (fish/af) was calculated per culvert sampling period by dividing the catch by the amount of water that flowed through the culvert (mean flow (cfs) * sampling duration (s) * 43,560 (af/cf)).

Results

The HORB was closed on April 22; however, construction on the barrier continued for another four days. As mentioned previously, only culvert numbers 1, 4 and 6 were open during the fish monitoring period. The remaining culverts were opened May 16, after fish monitoring was completed. DFG monitored the HORB culverts over 10 days, for approximately 167 hours of sampling per culvert, and collected 95 samples. Two samples from culvert number 4 were loss due to the process of clearing the net of gravel and resetting the net at the next net check.

Table 4-4

The raw abundance and composition of fishes entrained at the HORB in 2007. Chinook salmon catch is divided into CWT salmon, unmarked salmon, color-marked salmon and radio-tagged salmon.

Species	Catch
White Catfish	185
Common Carp	85
Sacramento Sucker	81
Channel Catfish	29
Bluegill	12
Tule Perch	11
Redear Sunfish	3
Lamprey Spp.	2
Striped Bass	2
Prickly Sculpin	2
Green Sunfish	2
Golden Shiner	2
Brown Bullhead	1
Goldfish	1
Largemouth Bass	1
Threadfin Shad	1
Inland Silverside	1
Total Chinook Salmon	51
CWT Salmon	1
Unmarked Salmon	48
Color-Marked Salmon	0
Acoustically tagged Salmon	2
Total	472

Almost 500 fish were collected representing 17 species from 10 families of fish. No delta smelt (Hypomesus transpacificus), juvenile steelhead (Oncorhynchus mykiss), or splittail (Pogonichthys macrolepidotus) were collected in the fyke nets. The most abundant species was white catfish (Ictalurus catus), followed by common carp (Cyprinus carpio) (Table 4-4). Of the 51 salmon caught; 1 had a CWT; 46 were unmarked; and 2 were acoustically tagged. No color-marked salmon were caught this year. Overall, the number of salmon entrained per hour (0.1 \pm 0.2) was lower than it was in previous years (0.7 in 2004, 3.4 in 2003, 2.5 in 2002, 1.4 in 2001). The mean fork length for unmarked salmon was 85 \pm 7.6 mm and the one CWT salmon was 93 mm.

Unmarked salmon were caught throughout the monitoring period (Figure 4-8). The average unmarked salmon CPUE over the entire monitoring period was 0.1 \pm 0.2 fish/hour/culvert. The highest unmarked salmon

Figure 4-8



The daily average number of unmarked salmon entrained per culvert hour at the HORB in 2007. The catch is separated by day and night. No sampling occurred on May 5 and 6.

Figure 4-9

Mean unmarked salmon Abundance Index and Entrainment Index during the annual VAMP period when both Mossdale Kodiak Trawl and HORB entrainment monitoring were sampling. Indices were not calculated for 2005 and 2006 because the HORB was not installed due to high San Joaquin River flows. Mean San Joaquin River flow during VAMP was measured at Vernalis, CA.



Table 4-5

The percentage of the total number of unmarked salmon caught by culvert and year, and 2007 culvert flow and entrainment fish density. Catch comparisons made only for time periods when culverts were fully operational and fyke nets were fishing. An "X" indicates the culvert was closed. Days indicate the number of days the culverts were compared in the given culvert operational status.

				Culvert Number					
	Year	Days		1	2	3	4	5	6
Catch									
	2001	6.2	Percent	3%	7%	7%	18%	20%	44%
	2002	11.0	Percent	10%	12%	16%	33%	16%	12%
	2003	19.7	Percent	Х	Х	Х	17%	39%	45%
	2004	2.0	Percent	Х	Х	Х	15%	39%	46%
	2004	5.9	Percent	22%	Х	11%	0%	5%	62%
	2007	7.3	Percent	21%	Х	Х	24%	Х	55%
Flow (cfs)									
	2007	7.3	Percent	33%	Х	Х	32%	Х	34%
			Avg \pm SD	59 ± 8.8	Х	Х	58 ± 8.5	Х	61 ± 8.9
Density ((Fish/ af)*100)									
	2007	7.3	Avg \pm SD	1.2 ± 3.0			1.5 ± 2.9		3.0 ± 4.1

CPUE (0.8 fish/hour/culvert) occurred on May 4 and May 8. The average CWT salmon CPUE over the entire monitoring period was 0.002 ± 0.020 fish/hour/culvert. The highest CWT salmon CPUE (0.2 fish/hour/culvert) occurred on May 10.

In order to compare relative trends in unmarked salmon entrainment, an Entrainment Index and Abundance Index was calculated for each of the previous years in which we conducted entrainment monitoring. The 2007 Abundance Index was similar to the 2001, 2003 and 2004 Abundance indices (Figure 4-9). For the most part, the Entrainment Index tracked the Abundance Index, except in 2007. Although 2003 and 2007 had nearly identical Abundance Indices, the 2007 Entrainment Index was approximately 15 times lower. Both 2003 and 2007 had 3 open culverts. Although river flow can influence emigration patterns, San Joaquin River flow was similar among study years (2001-2004 and 2007) and flow probably had a negligible affect (Figure 4-4).

Unmarked salmon entrainment was highest in culvert number 6 and lowest in culvert number 1. Approximately half of the salmon entrained in 2007 were entrained through culvert number 6, which is similar to 2003 and 2004 (Table 4-5). Although 55 % of the entrained salmon went through culvert number 6, only 34 % of the water flowed through this culvert (Table 4-5). Salmon density for fish entrained through culvert number 6 was 0.03 fish/af, twice the density of culvert numbers 1 and 4. Salmon entrainment differed greatly between diel periods. More unmarked salmon were entrained at night (47) than during the day (2). This year's nighttime entrainment is higher than in previous years when approximately 75% of the salmon were caught at night.

Discussion

The HORB is relatively effective in keeping salmon on the San Joaquin side of the barrier. Previous studies at the HORB indicate typically less than one percent of the VAMP CWT salmon released upstream of the HORB is entrained through the HORB culverts(SJRGA, 2001, 2002, 2003, 2004). Because there was no VAMP CWT salmon releases in 2007, we were unable to estimate the percentage of salmon entrained at the HORB. As an alternative to directly estimating entrainment using CWT salmon, entrainment and abundance indices were generated for unmarked salmon to compare relative changes in entrainment among years.

Total fish entrainment at the HORB was much lower this year than in previous years. Due to a staff shortage, the fyke nets were fished over a period of 10 days. Although the number of days sampled was reduced, the proportional decrease in overall salmon entrainment was much greater than expected, even when we account for the number of operational culverts. There was an 86% decrease in CPUE compared to 2004, the previous low. A large contributing factor for the overall decline in salmon entrainment was the practically non-existent CWT salmon catch. In previous years, CWT salmon can account for more than half of all the salmon entrained. This year's single CWT salmon catch is by far the lowest on record.

Although CWT salmon typically account for a large percentage of the overall salmon entrainment, there was also a sharp decline in unmarked salmon entrainment. This decline in entrainment might be due to a decline in the number of outmigrating juvenile salmon. However, the unmarked salmon Abundance Index during the 2007 VAMP period was similar to previous years with a barrier. While we were sampling at the HORB, it appears there was no sharp decline in the number of unmarked salmon just upstream of the barrier.

The decline in the 2007 Entrainment Index might be related to culvert gate operation. In previous years when only three culverts were opened (2003 and part of 2004), the three culverts closest to the channel were opened and the three closest to shore were closed. This year, the culvert at the end, one in the middle, and the one closest to shore were open. The zone of entrainment might be higher with three adjacent open culverts. There is probably a larger draw of water at a fixed distance from an open culvert if the adjacent culverts are also open.

Over the years, we've noticed the culvert closest to the shore (number 1) typically entrains the fewest number of salmon. It was thought that the lower entrainment might be related to lower flows in culvert number 1. Visually, it appears less water flows through culvert number 1 compared to the other culverts. Theoretically, flows should be the same in all culverts since it's the head difference between upstream and downstream water levels that is responsible for flow. In 2002, a cursory check of flows among culverts using a hand held flowmeter suggested flow through culvert number 1 was about 10 cfs lower than flow through the other five culverts (SJRGA, 2002). However, in 2007, flowmeters in culvert numbers 1, 4 and 7 indicate flow was similar among culverts.

The position of outmigrating salmon in the water column probably is the biggest factor affecting entrainment. The proximity of culvert number 1 to the shore and culvert number 6 to the center of the channel, may account for the large entrainment discrepancies between the two culverts. Salmon entrainment densities suggest salmon are more abundant in the center of the channel. Juvenile salmon may prefer to migrate down the middle of the channel rather than along the shoreline. Predation might also be higher along the shore which would reduce the number of salmon vulnerable to entrainment at culvert number 1.

The data collected over the HORB monitoring years strongly suggests salmon are more vulnerable to entrainment at night. Salmon entrainment at night was higher in 2007 than in previous years. In 2004, 80% of the unmarked salmon were entrained at night. In 2007, approximately 95 % of the entrained unmarked salmon were caught at night. Although the MKT caught between 40 and 208 unmarked salmon per day (for a total of 678) just upstream of the barrier using surface tows, the HORB entrained between 0 and 1 salmon (for a total of two) during that same daylight timeframe. This suggests salmon are more surface oriented during the day than at night. Since the culverts are placed on the bottom of the channel, salmon are less likely to be entrained if they remain near the surface.

Although overall salmon entrainment was lower this year, it appears the approximately 400 acoustically tagged salmon released upstream of the HORB were entrained at a similar rate as VAMP CWT salmon from previous studies. Acoustically tagged salmon were released at Durham Ferry and Mossdale as part of juvenile migration study in the south Delta (see Chapter 5). No acoustically tagged juvenile salmon from the first set of releases and two acoustically tagged salmon from the second set of releases were entrained at the HORB. The overall entrainment loss for acoustically tagged salmon was 0.5 % which is similar to VAMP CWT entrainment losses at the HORB from 2001-2004. It appears the modified gate operation did not benefit acoustically tagged salmon to the degree that it benefited unmarked salmon. However, the acoustically tagged salmon releases were very small compared to the relatively large VAMP CWT salmon releases of previous years. A single acoustically tagged salmon has a bigger impact on the entrainment loss calculation than a single CWT salmon has on the VAMP CWT entrainment loss calculation.

As in previous years with a barrier, a large amount of gravel was caught in the nets which resulted in three loss samples. It is recommended that VAMP delay any future CWT salmon releases by at least 5 days beyond the closure of the HORB. The delay allows for completion of the barrier and minimizes the field crew's exposure to heavy equipment operation. It also allows time for any loose material near the barrier to pass through the culverts before the nets are attached. If keeping outmigrating salmon out of Old River and in the San Joaquin River is beneficial to their survival, then it might be prudent to only open culvert numbers 1, 4 and 6 during peak salmon migration. It might be possible to further reduce salmon entrainment by opening the culverts closest to shore and only open culverts during daylight hours. A possible experiment to further test culvert gate operations on salmon entrainment is to only open culvert numbers 1, 2 and 3 for the first VAMP CWT salmon release and only open culvert numbers 4, 5 and 6 for the second VAMP release.



CHAPTER 5

SALMON SMOLT SURVIVAL INVESTIGATIONS Acoustic–Tagged Smolt Distribution Study

One of the primary objectives of the VAMP study, in addition to providing enhanced protection of juvenile Chinook salmon emigrating from the San Joaquin River system, is to determine the effects of San Joaquin River flows, SWP and CVP water exports, and HORB placement on survival of Chinook salmon smolts emigrating from the San Joaquin River through the Delta. Early in 2007, it was determined that Merced River Hatchery (MRH) would not meet their production needs. Thus production at the hatchery was not sufficient to provide study fish for a traditional VAMP coded-wire tag experiment. A fully supported coded-wire tag VAMP experiment would require 400,000 juvenile Chinook salmon from MRH. As an alternative, an acoustic-tag experiment using only 1,000 salmon was planned to estimate survival from Durham Ferry to Jersey Point and Chipps Island and look at mortality and distribution by reach within the San Joaquin River with the Head of Old River Barrier (HORB) in place. However, due to logistical constraints, acoustic receivers were not actually installed at Chipps Island and Jersey Point and survival was not estimated.

Introduction

A pilot acoustic-tagging salmon study was conducted in the south Delta during the spring of 2006. A summary of the results is available in the 2006 VAMP annual report (San Joaquin River Group Authority 2007). The 2006 study indicated that without the HORB in place and during high-flow conditions many (half or more) of the acoustic-tagged fish, released near Mossdale, migrated into Old River. Survival through the Delta could not be estimated in the spring of 2006 because receivers available were not effective in large channels (Chipps Island or Jersey Point). In 2007, we explored renting and deploying multi-hydrophone receivers in these large channels, however logistical problems prevented their installation in 2007.

Fish Tagging

Fish used for the acoustic study were obtained from MRH. Originally, the plan was to tag and release 1,000 fish; 30 fewer fish than planned were released due to receipt of fewer tags for the experiments, tag failure, or fish mortality shortly after surgery. Ultimately, 970 juvenile Chinook salmon were surgically implanted (tagged) with Hydroacoustic Technology, Inc. (HTI) individually-identifiable acoustic transmitters (tags) and released for the experiments (Figures 1 and 2). Prior to tagging the fish at MRH, an extensive training session was conducted at Mokelumne River Fish Hatchery.

Figure 5-1 Example acoustic transmitter, comparison to pen (Vogel 2006).



Figure 5-2 Chinook salmon smolt with implanted acoustic transmitter (Vogel 2006).



Because fish for training were unavailable at MRH, Mokelumne River Fish Hatchery provided 2,000 fish needed for training. Tagging personnel were trained by U.S. Geological Survey's Cook, Washington, Lab. Procedures for tagging followed a strict standard operating procedure (Appendix D). Tagging consisted of surgically implanting an acoustic tag in the fish's body cavity. Size and weight of fish for training were similar to those later used at MRH for the VAMP experiments. Four individuals were trained to surgical implant the tags and eight others were trained to assist and to record data. Training was conducted between April 16 and April 26.

Prior to surgical implantation, acoustic tags were weighed and programmed, and fish were weighed and measured. The duration of surgical procedure was also recorded and was usually less than 4 minutes. Tagging and support personnel began conducting actual surgical operations at MRH on April 30 and May 7. The fish were held at MRH for 48 hours prior to release. The Durham Ferry and Mossdale groups were tagged on April 30 and May 7 with the three remaining groups (upper Old River, Bowman Road, and Stockton) tagged on May 1 and May 8. Throughout the tagging process, some fish were tagged with non-operational "dummy" tags that were of a similar size and weight as the functional tags.

Fish Releases

The acoustic-tagged MRH Chinook salmon were released at four sites on the San Joaquin River and one site in Old River. The intent was to release approximately 100 fish at each location during each of two weeks of experiments. Release locations were:

- Durham Ferry
- Mossdale
- Upper Old River (downstream of the HORB)
- San Joaquin River at Bowman Road
- San Joaquin River near the Stockton Waste Water Treatment Facility (SWWTF) (Figure 3).

The fish releases were made twice over a two-week period for a total of 10 releases. The number of tagged fish released in the first week was 495. Releases were made at Durham Ferry and Mossdale on May 3 and in upper Old River, Bowman Road, and Stockton on May 4. The number of tagged fish for the second week of releases was 475. Releases were made at Durham Ferry and Mossdale on May 10 and in upper Old River, Bowman Road, and Stockton on May 11. (Table 1).

The tagged fish were acclimated for a short time prior to release. At each release location, two holding tubs, fitted with mesh covers, were filled with water from the hatchery vehicle. The groups of tagged fish were split approximately in half and transferred from the hatchery truck into the tubs. The temperature of the water from the hatchery was colder than that of the river; thus the fish were acclimated for approximately one hour prior to release. Once the fish were in the tubs and water temperatures measured, small amounts of river water were added to the tubs to slowly raise the temperature to the river temperature. Once the water temperature in the tubs was close to the river temperature (within a couple of degrees Fahrenheit), the fish were held for the balance of the hour prior to release. A GPS reading was taken at each of the five release sites.

Water Temperature Monitoring

Water temperature was monitored during the VAMP 2007 study using individual computerized temperature recorders (e.g., Onset Stowaway Temperature Monitoring/Data Loggers). Water temperatures were measured at locations along the longitudinal gradient of the San Joaquin River and interior Delta channels between Durham Ferry and Chipps Island – locations along the migratory pathway for the juvenile Chinook salmon released as part of these tests (Appendix C-1). As part of the 2007 VAMP monitoring program, additional temperature recorders were deployed in the south and central Delta (Appendix C-1) to provide geographic coverage for characterizing water temperature conditions while juvenile salmon emigrate from the lower San

Table 5-1 Release dates/times of acoustic-tagged juvenile Chinook salmon at each location during the first and second weeks of the 2007 VAMP experiments.									
Release Location	First Release		Second Release						
	Date/Time	No. Fish	Date/Time	No. Fish					
Durham Ferry	May 3, 2007 1130 hours	98	May 10, 2007 1140 hours	96					
Mossdale	May 3, 2007 1300 hours	99	May 10, 2007 1230 hours	97					
Old River (downstream of HORB)	May 4, 2007 1017 hours	99	May 11, 2007 1122 hours	95					
Bowman Road	May 4, 2007 1215 hours	99	May 11, 2007 1205 hours	95					
Stockton	May 4, 2007 1250-1253 hours	100	May 11, 2007 1243 hours	92					

Figure 5-3 Fish release locations and acoustic receiver locations during the 2007 VAMP experiments.



Figure 5-4 Hatchery 1, Water Temperature in Holding Tank



Joaquin River through the Delta. Water temperature was recorded at 24-minute intervals throughout the period of the VAMP 2007 investigations. Water temperatures were also recorded within the hatchery raceways at the MRH coincident with the period when juvenile Chinook salmon were being tagged and held (Appendix C-1).

A number of temperature recorders deployed as part of this year's VAMP temperature monitoring could not be relocated and were probably lost to vandalism or removed by recreational boaters.

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°- 16° C (52° - 61° F) prior to release into the lower San Joaquin River (Figures 5-4 and 5-5; Appendix C-2). Results of water temperature monitoring at Durham Ferry, Dos Reis, and Werner Cut, near Woodward Island, during the April-June fall-run Chinook salmon smolt emigration from the San Joaquin River through the Delta are shown in Figures 5-6, 5-7, and 5-8. Water temperature monitoring showed that water temperatures throughout the lower San Joaquin River and Delta (Appendix C-2) were higher than those at the hatchery during the spring months, which is consistent with results of temperature monitoring in all previous years of the VAMP tests. Water temperatures measured within the lower San Joaquin River and Delta (Figures 5-6, 5-7, and 5-8; Appendix C-2) were within a range considered to be suitable (typically < 20 C; 68 F) during April and May in the mainstem San Joaquin River (e.g., Durham Ferry, Old River at HORB, and Dos Reis (Appendix C-2) but exceeded 20 C (68 F) further downstream within the Delta (e.g., Old River/Indian Slough Confluence, Werner Cut - Channel above Woodward Isle; Appendix C-2). Results of the 2007 water temperature monitoring showed a longitudinal gradient of temperatures that generally increased as a function of distance downstream within the mainstem river and Delta. Water temperatures measured in the river during April-May would not be expected to result in adverse effects or reduced survival of emigrating juvenile Chinook salmon released as part of the VAMP 2007 investigations. Water temperatures measured downstream within the Delta during April and early May were within the general range considered to be suitable for juvenile fall-run Chinook salmon migration, however temperatures during the late May and June were within the range considered to be stressful for juvenile Chinook salmon.

Net Pen and Health Assessments

A fish health assessment was conducted to determine if delayed mortality would occur in the acoustically tagged fish. For the first set of releases, 10 fish tagged with "dummy" tags were held in net pens at both Mossdale and Durham Ferry. For the second release, 20 tagged fish were held at each of the same locations. Fish were transported similarly to the other tagged fish but instead of releasing them they were placed into a net pen, held for 48 hours and then assessed for condition.. After 48 hours, fish were removed from the net pens, euthanized and examined. Each fish was measured (fork length in millimeters) and examined for scale loss, color, fin hemorrhaging, eye condition and gill color. One fish from the first Mossdale release died during the 48 hour period. One other, from the second Mossdale release had caudal fin hemorrhaging. All other characteristics examined were normal (Appendix C-3).

Dummy-tagged fish were also held at the hatchery. One set of 10 fish were tagged during the first week of tagging, on 4/30 and a second set of 10 fish were tagged during the second week of tagging on 5/7. Both sets of fish were euthanized on May 14th and examined for the same parameters as above. No mortalities were observed from either of the two groups and the condition characteristics assessed were normal.

Health and Physiological Tests

Ten fish from the first Durham Ferry and Mossdale releases (five from each location) and the twenty fish from the hatchery were used to obtain kidney samples for histological examination by the USFWS California/ Nevada Fish Health Center. Prior VAMP studies using coded wire tag fish from Merced River Hatchery has regularly found infection by the parasite (*T. bryosalmonae*) that causes Proliferative kidney disease. Findings for the samples in 2007 indicated that all 30 fish examined were infected with *T. bryosalmonae* (Table 5-2). Kidney lesions were observed in 5 of the 30 infected kidney sections. Short term survival (<2 weeks) was not likely influenced by these infections; however, Proliferative Kidney Disease is progressive and can continue after fish enter the ocean.

Table 5-2Incidence and severity of Tetracapsuloidesbryosalmonae in VAMP dummy-tagged acoustic groupsreleased in 2007.							
Group	Infected	Clinical					
MRH1	10-Oct	10-Feb					
MRH2	10-0ct	10-Mar					
Durham Ferry	5-May	0/5					
Mossdale	5-May	0/5					

35 30 25 20 20 15 40 15 40 4/21 4/28 5/5

Figure 5-5 Hatchery 2, Water Temperature in Holding Tank

Figure 5-6 Water Temperature Monitoring at Durham Ferry



CHAPTER 5

Figure 5-7 Water Temperature Monitoring at Dos Reis



Figure 5-8 Water Temperature Monitoring at Werner Cut - Channel above Woodward Isle



Figure 5-9 Typical deployment of acoustic receiver (Vogel 2006).



Figure 5-10 Typical acoustic receiver detection range (Vogel 2006).



CHAPTER 5

Detection of Acoustic-Tagged Fish

Ten HTI acoustic receivers were distributed at various locations in the south and central Delta to detect acoustic-tagged fish as they migrated through the Delta (Figure 5-3). The fixed-station receivers electronically logged a time stamp when each individually-identifiable tag passed the sites. Figure 5-9 shows an example deployment of a receiver in the Delta. The receivers were positioned in the channel to provide coverage across the channel to detect acoustic-tagged salmon (Figure 5-10). As previously mentioned, additional receiver sites were planned for Chipps Island and Jersey Point although logistical constraints prevented equipment being deployed. The USGS's Acoustic Doppler Current Profiler (ADCP) created frequency interference at Jersey Point and debris at the bottom of the channel at Chipps Island created logistical obstacles of laying miles of cable that could not be overcome in the timeframe available.

The ten locations where receivers were deployed in 2007 were:

- 1) San Joaquin River near the head of the HORB (U/S HORB),
- Old River just downstream of the HORB (D/S HORB),
- 3) San Joaquin River near Bowman Road,
- 4) San Joaquin River near the Stockton Waste Water Treatment Plant,
- 5) Turner Cut,
- 6) San Joaquin River downstream of Turner Cut (R16),
- Old River north of Clifton Court Forebay (Highway 4),
- 8) Inlet to Clifton Court Forebay (CCF),
- 9) Skinner Fish Facility (FF), and
- 10) Tracy Fish Facility (FF) (Figure 5-3).

Fish releases at Old River, Bowman Road, and Stockton were made near the acoustic receivers (Figure 3) to verify that tags were functioning at the time of release. A mobile receiver was used at the Durham Ferry and Mossdale release sites to confirm that transmitters were functioning just prior to the fish release.

Fish Transit Time

Because each acoustic receiver recorded the detection time of acoustic-tagged salmon within reception range (Figure 5-10) and each acoustic transmitter was individually identifiable, transit times and migration rates from release locations to each receiver site could be calculated. These calculations used the time of first detection by a receiver and the estimated in-channel distances between sites. Actual average speed of fish in the water would likely be faster because fish may not



take the most-direct route between locations. Net fish migration rates in the San Joaquin River were more rapid in upstream reaches as compared to downstream reaches (Tables 5-3 and 5-4), a phenomenon attributed to tidal influence further downstream. Fish released at Durham Ferry generally took about one day to reach the Old River flow split, whereas fish released at Mossdale took only about four hours. Fish released at Mossdale and Durham Ferry took about one to two days to reach Stockton, respectively. Although the sample sizes were small in the downstream-most areas, fish released at Durham Ferry and Mossdale took about three to six days to reach the San Joaquin River near R16 or Turner Cut. Fish released at Bowman Road took about a day and a half to reach Stockton. Fish released at Stockton exhibited the slowest overall net migration rates due to the large tidal seiching effects on fish migration in the lower San Joaquin River. Fish released in Old River just downstream of the HORB exhibited much slower migration rates than fish released in the San Joaquin River, undoubtedly because of the lower flows and slower water in Old River, Grant Line Canal, and Fabian

Table 5-3

Average transit time in hours (h), standard deviation (in parentheses), range in times (h), and average migration rate (mph) from fish release location to fish detection location during the first week of fish releases (May 3 - 4, 2007).

Deleges Cite			Detection Location		
Release Sile	U/S HORB	Bowman Road	Stockton	Turner Cut	R16
Durham Ferry N = 98 fish	N = 69 fish 29.3 h (23.1 h) 12.2 h – 162.5 h 0.50 mph	N = 66 fish 35.6 h (18.0 h) 17.8 h – 98.9 h 0.58 mph	N = 25 fish 50.9 h (23.8 h) 26.2 h – 101.9 h 0.52 mph	N = 6 fish 78.9 h (20.5 h) 64.5 h – 115.0 h 0.47 mph	N = 9 fish 161.5 h (56.1 h) 123.4 h - 302.7 h 0.23 mph
Mossdale N = 99 fish	N = 97 fish 3.6 h (1.8 h) 1.8 h – 10.6 h 0.78 mph	N = 83 fish 14.5 h (7.9 h) 6.7 h – 44.9 h 0.60 mph	N = 33 fish 24.6 h (8.5 h) 19.4 h – 52.6 h 0.58 mph	N = 4 fish 72.4 h (32.4 h) 42.3 h – 105.8 h 0.35 mph	N = 9 fish 154.6 h (31.6 h) 122.6 h – 212.4 h 0.17 mph
Bowman Road N = 99 fish			N = 31 fish 34.4 h (14.4 h) 27.3 h - 81.1 h 0.16 mph	N = 2 fish 84.0 h (23.9) 67.1 h – 100.9 h 0.20 mph	N = 4 fish 136.8 h (13.2 h) 123.4 h – 151.0 h 0.12 mph
Stockton N = 100 fish				N = 3 fish 50.7 h (10.3 h) 43.5 h – 62.5 h 0.21 mph	N = 9 fish 112.9 h (15.9 h) 98.7 h – 149.8 h 0.10 mph

Table 5-4

Average transit time in hours (h), standard deviation (in parentheses), range in times (h), and average migration rate (mph) from fish release location to fish detection location during the second week of fish releases (May 10 - 11, 2007).

Deleges Cite	Detection Location									
Release Site	U/S HORB	Bowman Road	Stockton	Turner Cut	R16					
Durham Ferry N = 96 fish	N = 56 fish ¹ 17.7 h (4.5 h) 9.8 h – 27.4 h 0.83 mph	N = 36 fish 25.7 h (4.8 h) 15.4 h – 34.9 h 0.80 mph	N = 9 fish 41.2 h (10.8 h) 27.0 h – 60.4 h 0.64 mph	N = 1 fish 68.4 h (N.A.) N.A. 0.54 mph	N = 8 fish 75.3 h (11.4 h) 55.4 h – 95.4 h 0.50 mph					
Mossdale N = 97 fish	N = 95 fish 4.0 h (1.1 h) 2.5 h - 8.1 h 0.70 mph	N = 76 fish 12.2 h (13.0 h) 6.5 h - 103.3 h 0.72 mph	N = 32 fish 22.8 h (11.7 h) 14.4 h - 60.8 h 0.63 mph	N = 7 fish 71.4 h (28.4 h) 37.2 h – 124.9 h 0.35 mph	N = 13 fish 75.6 h (26.8 h) 29.8 h – 143.3 h 0.34 mph					
Bowman Road N = 95 fish			N = 25 fish 34.0 h (49.2 h) 3.7 h – 201.7 h 0.17 mph	N = 2 fish 63.9 h (17.0) 51.9 h – 76.0 h 0.26 mph	N = 11 fish 48.7 h (14.6 h) 29.0 h – 80.3 h 0.35 mph					
Stockton N = 92 fish				N = 2 fish 32.1 h (13.7 h) 22.4 h - 41.7 h 0.34 mph	N = 9 fish 44.1 h (15.5 h) 19.6 h – 69.7 h 0.26 mph					

¹ The acoustic receiver U/S HORB was not operational from 1800 May 11 to 1400 May 14, 2007 so some of the Durham Ferry fish likely passed the site during that period. Therefore, the data shown is probably biased toward a rapid migration rate and average travel time and migration rate would likely be slower than shown here.

Table 5-5

Average transit time in hours (h), standard deviation (in parentheses), range in times (h), and average migration rate (mph) from fish release location to fish detection location during the first week of fish releases (May 3 – 4, 2007).

Release Site	Detection Location							
	Tracy FF	Clifton Court	Skinner FF	Highway 4				
Downstream HORB N = 99 fish	N = 22 fish 101.8 h (62.2 h) 33.7 h – 294.5 h 0.15 mph	N = 19 fish 69.0 h (25.3 h) 40.2 h - 115.6 h 0.23 mph	N = 4 fish 96.5 h (31.8 h) 68.0 h - 129.9 h 0.19 mph	N = 23 fish 85.4 h (44.0 h) 50.1 h - 242.2 h 0.24 mph				

and Bell Canal. It took about three-and-a-half to fourand-a-half days for fish released in Old River to reach the Tracy FF, CCF, Skinner FF, and Highway 4 (Tables 5-5 and 5-6).

Chinook Salmon Distribution and Survival

Tables 5-7 and 5-8 provide the numbers of acoustictagged salmon detected at each acoustic receiver site. During the course of the study there were receivers that either did not work properly during a specific period or were not placed in the river until after some of the tagged fish may have passed by. For instance, the acoustic receiver at U/S HORB was not operational between May 11, 1800 hrs and May 14, 1400 hours. In addition, the acoustic receiver in Clifton Court Forebay did not record data from May 11, 2100 hrs to May 14, 1000 hours. The acoustic receiver placed at the Stockton site had only partial channel coverage during the study and an operational acoustic receiver was not positioned at Channel Marker R16 until May 8 at 1500 hrs due to USGS boat problems. Although the probability of detecting an individual fish does not have to be 100% to estimate survival, it is necessary to have downstream receivers to determine the detection probability for an individual receiver.

The probability of detection of each receiver for each release was estimated using the formula:

$$\hat{p}_i = \frac{r_i}{r_i + z_i} \tag{1}$$

where i = estimated probability of detection at site i, conditional on the fish being alive at site i.

 r_i = the total number of fish detected downstream of site i of those detected at site i and

 z_i = the total number of fish that were not detected at site i, but were detected downstream of the site i.

Although detection probabilities were estimated to be 100% or close to 100% for the acoustic receivers positioned just upstream of the HORB and at Bowman Road (Tables 5-9 and 5-10), we know this is incorrect, based on mobile monitoring conducted near Stockton (see later section of this report and Table 5-11). During mobile monitoring near Stockton on May 17 and 18 some tags from both Durham Ferry releases were detected that hadn't been detected previously at any of the stationary monitors upstream (U/S HORB, Bowman Rd., or Stockton). But because this mobile monitoring was not conducted systematically throughout the study period, we could not use these detections to help estimate detection efficiency. We can understand how some of the Durham Ferry fish from the second release likely missed detection at the U/S HORB receiver because it was not operational for three days after release (May 11, 1800 hours to May 14, 1400 hrs.). However, it's not clear how they would have been missed at the Bowman Road receiver or why two tags from the first Durham Ferry release were also not detected at any of the stationary receivers upstream. Given the questionable issues surrounding the Durham Ferry releases, survival estimates obtained using the Durham Ferry release groups are likely more uncertain that those using the Mossdale and Bowman Road release groups to estimate survival to Stockton. Even though the Stockton receiver only had partial coverage of the channel (and low probability of detection) we have tried to account for this limitation when estimating survival

Estimates of Survival

Survival in a reach is based on the number of tags detected and the probability of detection, and is calculated as shown in the following formula:

S = <u># detected/(# released or observed upstream)</u>. Detection probability

Where possible, the survival of the acoustic fish by reach was estimated. Survival by reach is estimated using the proportion detected at the receiver at the end of the reach and the probability of detection by that receiver. Standard errors can also be generated.

The longest reach where survival could be estimated was between Durham Ferry and Stockton. Reaches within this larger reach could also be estimated – Durham Ferry and Mossdale to Upstream HORB, Bowman Road and Stockton. Stockton is the end point to where survival can be estimated because the most downstream receivers were at Turner Cut and R16 and were used to estimate the probability of detection of the Stockton receiver.

Survival down the San Joaquin River for three release groups (Durham Ferry, Mossdale and Bowman Road) was estimated and shown in Figures 5-11 through 5-16. Survival estimates for all reaches between Mossdale and Stockton were relatively high. Survival seemed lower between Durham Ferry and Mossdale. A survival estimate of greater than 1.0, was estimated for the reach between Bowman Road and Stockton for the second Bowman Road release and is likely due to the combination of high survival but low detection probability calculated for the Stockton receiver. Although to confidently make assessments of differences in survival between reaches, standard errors would need to be generated to determine if significant differences exist. For our purposes it is useful to understand how survival can be generated to help plan where to place receivers in 2008 for maximum coverage and for estimating survival by reach.

Table 5-6

Average transit time in hours (h), standard deviation (in parentheses), range in times (h), and average migration rate (mph) from fish release location to fish detection location during the first week of fish releases (May 10 - 11, 2007).

Release Site	Detection Location						
	Tracy FF	Skinner FF ¹	Highway 4				
Downstream HORB N = 95 fish	N = 31 fish 69.4 h (31.2 h) 31.8 h - 174.2 h 0.23 mph	N = 3 fish 96.9 h (66.0 h) 52.6 h – 172.7 h 0.19 mph	N = 10 fish 64.6 h (10.3 h) 54.2 h - 82.3 h 0.32 mph				

¹ The acoustic receiver at the entrance to CCF was not operational for part of the time during the second fish release and transit times from HORB to CCF could not be determined. However, three fish were detected at Skinner FF which undoubtedly entered CCF during the down time of the CCF receiver.

Table 5-7 Numbers of acoustic-tagged salmon released at five locations on May 3 – 4, 2007 and detected passing acoustic receiver sites ¹ (see Figure 3).											
Deleges	Location of Acoustic Receivers										
Location	U/S Horb	D/S Horb	Bowman Road	Stockton ²	Turner Cut	R16 ³	Tracy FF	Clifton Court	Skinner FF	Hwy 4	
Durham Ferry N = 98 fish	69	0	66	25	6	9	0	1	0	1	
Mossdale N = 99 fish	97	0	83	33	4	9	1	0	0	1	
Bowman Road N = 99 fish	0	0		31	2	4	0	0	0	0	
Stockton N = 100 fish	0	0	0		3	9	0	0	0	0	
D/S HORB N = 99 fish	1		0	0	0	0	22	19	4	23	

^{1,2} The acoustic receiver placed at the Stockton site had only partial channel coverage during the study.

³ An operational acoustic receiver was not positioned at Channel Marker R16 until May 8 at 1500 hrs due to boat problems.

Table 5-8 Numbers of acoustic-tagged salmon released at five locations on May 10 – 11, 2007 detected at acoustic receiver sites (see Figure 3).											
Delegen	Location of Acoustic Receivers										
Location	U/S HORB ¹	D/S Horb	Bowman Road	Stockton	Turner Cut	R16	Tracy FF	Clifton Court ²	Skinner FF	Hwy 4	
Durham Ferry N = 96 fish	56	2	36	9	1	8	1	0	0	0	
Mossdale N = 97 fish	95	0	76	32	7	13	1	0	0	1	
Bowman Road N = 95 fish	0	0		25	2	11	0	0	0	0	
Stockton N = 92 fish	0	0	0		2	9	1	0	0	0	
D/S HORB N = 95 fish	0		0	0	0	0	31	6	3	10	

¹ The acoustic receiver at Old River was not operational from 1800 hrs. May 11 to 1400 hrs. May 14, 2007. Based on travel times, some of the Durham Ferry fish likely passed the site during that period whereas all fish released at Mossdale and passing the Old River flow split were assumed to have been detected.

² Acoustic receiver did not record data from 2100 hrs. May 11 to 1000 hrs. May 14; fish entering CCF during this period would not have been detected.

Table 5-9 Detection probability for receivers during the first week of releases, May 3-4, 2007.							
Release	Receiver Locations						
Locations	U/S HORB	Bowman Road	Stockton				
Durham Ferry N = 98 fish	1	1	0.46				
Mossdale N = 99 fish	1	1	0.38				
Bowman Road N = 99 fish	-		0.5				

Table 5-10 Detection probabilities for receivers during the second week of releases May 10-11, 2007.									
Release	Receiver Locations								
Location	U/S HORB	Bowman Road	Stockton						
Durham Ferry N = 96 fish	0.947	0.875	0.125						
Mossdale N = 97 fish	1	0.976	0.35						
Bowman Road N = 95 fish	-		0.18						

Table 5-11

Number of acoustic transmitters detected in the San Joaquin River near the railroad bridge at Stockton on May 17 and 18, 2007. The number never detected elsewhere is included in parentheses.

Fish Release location	Release Date	Number of Acoustic Tags Detected
Durham Ferry	3-May-07	12 (2)
Mossdale	3-May-07	1(0)
Bowman Road	4-May-07	5 (2)
Stockton	4-May-07	6 (6)
Durham Ferry	10-May-07	21 (7)
Mossdale	10-May-07	14 (0)
Bowman Road	11-May-07	26 (14)
Stockton	11-May-07	31 (31)

Most fish released at Durham Ferry and Mossdale migrated downstream via the San Joaquin River, although some were found to arrive at the Fish Facilities using multiple pathways. For instance, two individuals (3374, 3381) from the second Durham Ferry release presumably migrated into Old River through the HORB culverts, as they were detected at the receiver in Old River downstream of the HORB (Appendix C-6). One of these individuals (3374) was later detected at the Tracy Fish Facility. One additional individual from the first Durham Ferry release (3294) was detected at the U/S HORB, D/S Bowman Road and at Highway 4 receivers prior to being detected at the Clifton Court Forebay receiver, indicating that it had migrated down the San Joaquin River but turned south at one of the junctions downstream of Bowman Road. In addition, two fish released from Mossdale (3910 from the first release and 3801 from the second release) were detected at the Tracy Fish Facility, with both being detected at the receivers at U/S HORB, Bowman Road, Stockton and Turner Cut, (Appendices C-4 and C-6) One individual (3801) was observed at Hwy 4 after being observed at Tracy while another (3910) was observed at Hwy 4 prior to being detected at the Federal Fish Facility.

In at least one case, a fish released at Stockton also migrated to the Tracy Fish Facility. One individual from the second Stockton release (5978) was detected at the Tracy Fish Facility after being detected at R16 (Appendix C-6). These cases seem to show that not only do juvenile salmon migrate through the culverts of the HORB to arrive at the Fish Facilities, they also get there through Turner Cut or from other areas further downstream in the San Joaquin River.

Figure 5-11 Survival by reach for fish released at Durham Ferry during the first week of releases

Release Point			Detection Locations		
Durham Ferry		U/S HORB Bowman			
			Road		
I F I	0.70	0.56	4 I		

Figure 5-12 Survival by reach for fish released at Mossdale during the first week of releases

Release Point		Detection Locations				
Mossdale		U/S HORB	Bowman	Stockton		
			Road			
I0.980.84 -		·I	I T			

Figure 5-13 Survival by reach for fish released at Bowman Road during the first week of releases

Re	Release		Detection	
Po	oint		Location	
E	Bowman		Stockton	
	Road			
	I	0.63 -	– – -I	

Figure 5-14

Survival by reach for fish released at Durham Ferry during the second week of releases

Release Point		Detection Locations				
Durham Ferry	U/S HORB	U/S HORB Bowman				
		Road				
I 0.62	I					
I0.43 -		I				
I	0.75		I			

Figure 5-15 Survival by reach for fish released at Mossdale during the second week of releases

Release Point	Detection Locations							
Mossdale		U/S	J/S Bowman					
		HORB	Road					
I 0.98 I								
II								
II								

Figure 5-16 Survival by reach for fish released at Bowman Road during the second week of releases

Release		Detection Location
Point		
Bowman		Stockton
Road		
I	1.46	I

Figure 5-17 Lower San Jaoquin River near Stockton



Head Of Old River Barrier Releases

Survival was not estimated for the group of tagged fish released in Old River, downstream of HORB, because there were insufficient acoustic receivers to provide coverage in all channels where fish could subsequently migrate (e.g., Middle River, Victoria Canal). However, these fish were detected downstream at the Tracy Fish Facility near Tracy, at the entrance to Clifton Court Forebay (CCF), at the Skinner Fish Facility, and in Old River at the Highway 4 Bridge. Of the 99 fish released for the first release, 22 were detected at the Tracy FF, 19 at CCF, and 23 at Highway 4. Some of the fish were detected at more than one of the locations, with fish being detected at CCFB or Hwy 4 after being detected at Tracy or being detected at Tracy or CCFB after being detected at Hwy 4 (Appendix C-5). In one case, an individual (4673) was detected at Tracy after it had been detected in CCFB (perhaps inside a predator). If we assume the remaining 18 salmon detected in CCFB were in live salmon and stayed in CCFB, we can estimate survival through the Forebay. With four individuals detected at the Skinner FF, we estimate survival across Clifton Court Forebay to be 22% assuming 100% detection probability at both locations.

In addition, one of the individuals (4799) from the first release in Old River was detected at the U/S HORB receiver indicating that it had moved through the HORB culverts to the San Joaquin River. This tag was likely in a preditor as it would seem unusual for a salmon to move against the flow through a HORB culvert.

During the second week of fish releases in Old River, the CCF receiver did not record data a portion of the time when fish could have entered the Forebay. This was empirically documented when 3 fish detected at the Skinner FF were not detected by the CCF receiver (Appendix C-7). Of the 95 salmon released in Old River during the second week, 31 were detected at the Tracy FF and 10 at Highway 4. Again, some of these individuals were detected at more than one location (Appendix C-7). For instance, three fish detected at Tracy were also later detected at Skinner (4424) and at Hwy 4 (4515, 4760). One of these (4424) had also been detected previously at Hwy 4. One of the three fish detected in CCF (5096) had previously been detected at Tracy. For both weeks of fish releases in Old River, the numbers detected at the receivers in the south Delta were higher than we assumed; our assumption was that the numbers would have been very low because of slow water, longer exposure time to predators and unscreened diversions, and routes where fish could have migrated without detection.

Mobile Monitoring

A week after the last fish releases, a mobile acoustic receiver was used in several Delta channels in an attempt to locate non-moving transmitters. During mobile monitoring in the San Joaquin River from Mossdale to the Stockton Deep Water Ship Channel, a high number of acoustic transmitters were detected at a very small, localized site at Stockton. The area was approximately 0.75 miles downstream of the Highway 4 Bridge, 1.7 miles upstream of the Stockton Deep Water Ship Channel, and adjacent to a railroad bridge and the Stockton waste water treatment facilities (Figure 5-17). This site was just downstream of our stationary receiver and release site near the Stockton waste water treatment facility. A total of 116 tags were found at this site which included some fish from all of the releases made on the San Joaquin River during the two weeks of releases (Table 5-11). This may be a minimum number lost at that location as the mobile monitoring was done on May 17 and 18 after the battery life of some of the tags from the first week fish releases may have ended. These tags were motionless indicating the tags were either in dead fish or had been defecated by a predator. An investigation by the Regional Water Quality Control Board found that the waste water treatment facility was in compliance with discharge permit requirements. The cause of this high mortality remains unknown, but this area was apparently a hostile place for juvenile salmon in May.

The history of some of these individual tags was odd in that some had moved downstream past this site earlier and many of the others had never been detected upstream. For instance, three tags observed at this site from the first Durham Ferry release had been detected at R16, 9-10 days earlier. In addition, a total of ten individuals detected in the mobile monitoring from the releases at Durham Ferry (3441, 3042, 3140, 3017, 3031, 3094, 3115, 3150, 3157, 3185), had never been detected at any of the receivers upstream (Table 5-11). Because the receiver at the HORB was not operating between May 11 and May 14, it is likely that some of the fish released on May 10 at Durham Ferry may have passed that receiver without being detected becausue it took about a day for the Durham Ferry fish to reach the HORB. However, it is unclear why they wouldn't have been detected at Bowman Road. It is also understandable that they weren't detected at receivers at Stockton, in Turner Cut and at R16 as the receivers weren't very efficient because they weren't covering the entire channel. In addition, two of the eight fish detected at R16 from the second release at Durham Ferry were also never detected upstream (Appendix C-6). It is noteworthy that these odd cases were restricted to fish released at Durham Ferry. All of the fish detected in the mobile monitoring at Stockton from the Mossdale releases had been detected at the upstream receivers (Appendices C-4 and C-6).

There were indications of piscivorous predation on some of the acoustic-tagged salmon during the study. Uncharacteristic behavior of an acoustic-tagged salmon compared to the majority of observed behavior patterns suggested some tagged fish were consumed by a predator and the transmitter inside the predator was subsequently detected passing a receiver. For example, there were instances where a transmitter was detected in a sequential downstream direction then eventually moved back upstream. Although predation could not be empirically confirmed in these cases, this behavior was considered unlikely for a salmon smolt. There were some instances where predation could be confirmed because of multiple predation events on acoustic-tagged salmon by a single predator (e.g., a predator eating two acoustic-tagged salmon). In one instance, one predator ate four acoustictagged salmon. This phenomenon can be observed during data processing which shows identical detailed movements of transmitters. Lastly, the acoustic receivers can determine if a transmitter remains motionless. In these latter cases, fish mortality was certain but the reason for the mortality could not be determined.

An additional site of relatively high fish mortality was located at the head of Old River flow split downstream of Mossdale. In 2006, five acoustic transmitters among 100 fish released at Mossdale were located at the same site. Based on observations of striped bass feeding activity in this area during the 2006 VAMP study, it was hypothesized that acoustic-tagged salmon were consumed by predatory fish and the transmitters were subsequently defecated and deposited on the bottom of the channel. A description of the unusual scour hole near the Old River flow split is provided in the 2006 VAMP Annual Report (SJRGA 2007). In 2007, it appeared that 19 acoustictagged salmon from both weeks of fish releases may have been preyed on in the same vicinity.

Numerous acoustic transmitters were also located in front of the trash racks just upstream of the Tracy FF. As with other sites where motionless transmitters were found or the transmitters exhibited unusual movements, it could not be determined where the acoustic-tagged salmon were preyed upon, only where the transmitters were found. For example, an acoustictagged salmon could have been eaten by a predator at another location and the predator subsequently swam to the Tracy FF trashracks where the tag was detected for long periods (anomalous behavior for a smolt at this location) or was defecated (motionless transmitter). Alternatively, the acoustic-tagged salmon may have followed the flow toward the Tracy FF but were eaten by predators residing in front of the trashracks. A total

Table 5-12 Absolute survival estimates and differential recovery rates based on Chipps Island, Antioch, or ocean recoveries of Merced River Hatchery salmon released as part of South Delta studies betweeen 1996 and 2006.

Release	San Joaquin River (Merced River	Release Number	Release Site	Release Date	Chipps	Expand s Antioch Reco	Expanded Adult Ocean	Chipps Island	Antioch	DRR or CDRR	Ocean DRR
Year	origin) Tag Number		CWT Smolt Release	es	Island Recovs.	Recovs.	Recovs. (Age 1+ to 4+) Total	Absolute Estim	Survival ates	Differe Recovery	ential y Rates
1996	061110412 061110413 061110414 061110415 061110501 Effective Release	22,198 25,414 16,050 31,208 46,190 94,870 46,190	Dos Reis Dos Reis Dos Reis Jersey Point Dos Reis Jersey Point	1-May-96 1-May-96 1-May-96 1-May-96 3-May-96	2 2 1 5 39 10		3 37 8 10 186 58 186	0.120		0.125	0.152
1997	062545 062546 062547 Effective Release Effective Release 062548 062549	48,973 53,483 51,576 102,456 51,576 46,674 47,534	Jorsey Point Dos Reis Jersey Point Dos Reis Jersey Point Dos Reis Jersey Point	29-Apr-97 29-Apr-97 2-May-97 8-May-97 12-May-97	9 7 27 16 27 5 18		180 168 356 348 356 90 192	0.290 0.300		0.298 0.283	0.492 0.477
1998	61110809 61110810 61110811 61110806 61110807 61110807 61110812 61110813 Effective Release Effective Release	26,465 25,264 25,926 26,215 26,366 24,792 24,598 25,673 77,655 77,373 50,271	Mossdale Mossdale Mossdale Dos Reis Dos Reis Jersey Point Jersey Point Mossdale Dos Reis Jersey Point	16-Apr-98 16-Apr-98 16-Apr-98 17-Apr-98 17-Apr-98 17-Apr-98 20-Apr-98 20-Apr-98	25 31 32 34 25 34 87 100 88 93 187		60 39 58 48 35 62 110 91 157 145 201	0.300 0.320		0.305 0.323	0.506 0.469
1999	062642 062643 062643 062644 062645 062645 062646 0601110815 062647 Effective Release Effective Release	24,765 24,773 25,279 25,014 24,841 25,101 24,359 74,817 49,855	Mossdale Mossdale Mossdale Dos Reis Dos Reis Jersey Point Jersey Point Mossdale Dos Reis	19-Apr-99 19-Apr-99 19-Apr-99 19-Apr-99 19-Apr-99 21-Apr-99 21-Apr-99	8 15 13 20 19 34 25 36 39		128 135 132 151 225 334 387 395 376	0.380 0.600		0.403 0.656	0.362 0.517
2000	Effective Release 06-45-63 06-04-01 06-04-02 06-44-01 06-44-02 06-44-04 Effective Release Effective Release Effective Release 601060914 601060915 0601110814 0601061002 Effective Release Effective Release	49,460 24,457 23,529 24,177 23,465 22,784 72,163 46,249 51,351 23,698 26,805 23,889 25,572 24,661 74,392 50,233	Jersey Point Durham Ferry Durham Ferry Mossdale Jersey Point Jersey Point Jersey Point Durham Ferry Mossdale Jersey Point Durham Ferry Durham Ferry Durham Ferry Jersey Point Durham Ferry Jersey Point	17-Apr-00 17-Apr-00 18-Apr-00 18-Apr-00 20-Apr-00 20-Apr-00 28-Apr-00 28-Apr-00 28-Apr-00 28-Apr-00 1-May-00 1-May-00	59 11 7 10 9 9 24 41 28 18 65 7 5 10 48 30 22 78	11 6 10 14 16 50 47 27 30 97 8 15 8 76 31 152	721 296 215 232 207 174 649 704 743 381 1353 46 45 70 358 230 161 588	0.310 0.310 0.190	0.190 0.330 0.140	0.242 0.329 0.156	0.391 0.313 0.185
2001	06-44-29 06-44-30 06-44-31 06-44-32 06-44-32 06-44-35 Effective Release Effective Release Effective Release 06-44-37 06-44-37 06-44-39 06-44-39 06-44-42 Effective Release Effective Release Effective Release Effective Release Effective Release Effective Release Effective Release Effective Release Effective Release	23,351 22,720 22,376 23,022 22,191 24,444 24,993 68,447 45,213 49,437 24,029 23,907 24,054 23,882 25,310 25,910 25,466 71,990 49,192 51,376	Durham Ferry Durham Ferry Durham Ferry Mossdale Jersey Point Jersey Point Durham Ferry Mossdale Jersey Point Durham Ferry Durham Ferry Durham Ferry Mossdale Jersey Point Jersey Point Jersey Point Durham Ferry Mossdale Jersey Point Durham Ferry Mossdale Jersey Point Durham Ferry Mossdale Jersey Point Durham Ferry Mossdale Jersey Point	30-Apr-01 30-Apr-01 30-Apr-01 1-May-01 4-May-01 4-May-01 7-May-01 7-May-01 8-May-01 8-May-01 11-May-01 11-May-01	14 22 17 17 14 50 61 53 31 111 2 5 2 4 4 4 17 27 9 8 8 44	28 30 18 15 156 173 76 33 329 8 11 10 8 11 43 53 29 19 96 6 11	95 158 111 122 106 470 556 364 228 1026 17 45 28 25 27 243 335 90 52 578 33	0.340 0.310 0.130 0.130 0.190	0.170 0.110 0.200 0.180	0.212 0.159 0.194 0.201	0.256 0.243 0.111 0.094
2002	00-44-71 06-44-72 06-44-73 06-44-74 06-44-57 06-44-58 06-44-59	23,920 25,176 23,872 24,747 25,515 25,272 24,802	Durham Ferry Durham Ferry Durham Ferry Durham Ferry Mossdale Mossdale Jersey Point	18-Apr-02 18-Apr-02 18-Apr-02 18-Apr-02 19-Apr-02 19-Apr-02 22-Apr-02	4 9 4 6 7 46	11 20 12 20 13 29 101	33 96 74 67 76 69 494				

Table 5-12Absolute survival estimates and differential recovery rates based on Chipps Island, Antioch, or ocean recoveries of
Merced River Hatchery salmon released as part of South Delta studies betweeen 1996 and 2006.

Release	San Joaquin River	Release Number	Release Site	Release Date	Chipps Antioch	Chipps Antioch	Expanded Adult Ocean	Chipps Island	Antioch	DRR or CDRR	Ocean DRR
Year	origin) Tag Number		CWT Smolt Release	es	Island Recovs.	Recovs.	Recovs. (Age 1+ to 4+) Total	Absolute Estin	Survival nates	Differe Recovery	ential y Rates
	06-44-60 Effective Release	24,128 97,715 50,787	Jersey Point Durham Ferry Mossdale	22-Apr-02	37 21 13	89 63 42	456 270 145	0.130	0.160	0.154	0.142
2002	Effective Release 06-44-70	48,930	Jersey Point Durham Ferry	25-Apr-02	83	190	950 23	0.100	0.210	0.101	0.111
2002	06-44-75	24,659	Durham Ferry	25-Apr-02 25-Apr-02	5	2	21				
	06-44-77	24,381	Durham Ferry	25-Apr-02	4	6	6				
	06-44-79	24,819	Mossdale Mossdale	26-Apr-02	3	4	14				
	06-44-80	22,880	Jersey Point	30-Apr-02 30-Apr-02	28	43 32	290	0.400	0.440	0.400	0.045
	Effective Release	98,503 49,339	Mossdale		15 5	18	57 40	0.160 0.110	0.110 0.090	0.130 0.094	0.045 0.064
2003	Effective Release 06-02-82	46,912 24,453	Jersey Point Durham Ferry	21-Apr-03	46 0	75 1	597				
	06-02-83	25,927	Durham Ferry	21-Apr-03	2	4	0				
	06-27-42	24,069 24 471	Durham Ferry Mossdale	21-Apr-03 22-Apr-03	1	1	10				
	06-27-43	25,212	Mossdale	22-Apr-03	3	2	5				
	06-27-44 Effective Release	24,414 74 449	Jersey Point	25-Apr-03	57 3	71 6	265 19	0.019	0.015	0.023	0 024
	Effective Release	49,683	Mossdale		5	4	8	0.013	0.015	0.035	0.015
	Effective Release	24,414	Jersey Point	29 Apr 02	57	71	265				
	06-27-46	24,085	Durham Ferry	28-Apr-03	0	0	0				
	06-27-47	24,628	Durham Ferry	28-Apr-03	0	0	4				
	06-27-50	24,180	Mossdale	29-Apr-03	1	0	0				
	06-27-51	25,692	Jersey Point	2-May-03	39	35	426			0.000	0.000
	Effective Release	48,526	Mossdale		1	0	5	0.010		0.000	0.008
2004	Effective Release	25,692	Jersey Point	00 Amr 04	39	35	426				
2004	06-27-52	23,440 21,714	Durham Ferry	22-Apr-04 22-Apr-04	1	1	0				
	06-27-54	23,328	Durham Ferry	22-Apr-04	1	0	0				
	06-46-70	23,783	Mossdale	22-Apr-04 23-Apr-04	0	1	0				
	06-45-82	23,586	Mossdale	23-Apr-04	1	0	0				
	06-45-83	24,803 22,911	Jersey Point	23-Apr-04 26-Apr-04	2	22	117				
	Effective Release	92,265	Durham Ferry		3	2	3	0.030	0.020	0.026	0.006
	Effective Release	22,911	Jersey Point		25	22	117	0.040	0.010	0.026	0.005
2005	06-46-72	23,414	Durham Ferry	2-May-05	5	0	0				
	06-46-73	23,193	Durham Ferry	2-May-05 2-May-05	2 4	2 3	3				
	06-46-75	23,567	Durham Ferry	2-May-05	1	1	0				
	06-46-97	22,302 24,149	Dos Reis	3-May-05 3-May-05	1	1 3	0				
	06-45-91	22,675	Dos Reis	3-May-05	1	3	0				
	Effective Release	93,834	Durham Ferry	6-May-05	32 12	6	3	0.099	0.049	0.069	0.243
	Effective Release	69,126	Dos Reis		3	7	0	0.035	0.110	0.052	0.000
	06-45-84	22,767	Durham Ferry	9-May-05	2	31 1	0				
	06-45-85	22,968	Durham Ferry	9-May-05	1	1	0				
	06-45-86 06-45-87	23,012 22.806	Durham Ferry Durham Ferry	9-May-05 9-May-05	3	3	0				
	06-45-89	21,443	Dos Reis	10-May-05	3	5	0				
	06-45-90 06-46-99	23,755 23.448	Dos Reis Dos Reis	10-May-05 10-May-05	2	2	0				
	06-47-00	23,231	Jersey Point	13-May-05	38	27	14	0.044	0.004	0.054	0.000
	Effective Release	91,563 68.646	Durham Ferry Dos Reis		6 6	7	0	0.044	0.094 0.127	0.051 0.068	0.000
	Effective Release	23,231	Jersey Point		38	27	14				
2006	06-47-13 06-47-14	24,703 24,315	Mossdale Mossdale	4-May-06 4-May-06	7	5 4	0				
	06-47-16	25,602	Dos Reis	5-May-06	7	3	0				
	06-47-15 Effective Release	26,192 49.018	Jersey Point Mossdale	8-May-06	58 9	26 9	0	0.080	0.180	0.115	
	Effective Release	25,602	Dos Reis		7	3	0	0.120	0.110	0.122	
	Effective Release	26,192	Jersey Point	19-May-06	58 2	26	0				
	06-47-22	24,008	Mossdale	19-May-06	0	0	0				
	06-47-24	23,980	Jersey Point	22-May-06	44	14	0	0.020	0.000	0.017	
	Effective Release	23,980	Jersey Point		44	14	0	0.030	0.000	0.017	

Note: Ocean recoveries are based on data through 2006

of 57 transmitters were detected just upstream of the Tracy FF trashracks and potentially had been consumed by predators. Fifty-three acoustic tagged fish were detected at the stationary receiver at the Tracy FF from the downstream of HORB release. Four of these were later detected at other locations (Skinner, CCFB or Hwy 4). Determining which acoustic tagged fish have been eaten with certainty is problematic.

A limitation of the acoustic tag methodology is the ability to determine whether a tag is still inside a live juvenile salmon. Without this assurance it is possible that survival is biased. Although some types of behavior do indicate the tagged fish has been eaten, or that the fish has died, there are probably some cases where fish are assumed to be live and they are not. Thus it is likely survival would be overestimated using these methods. Traditional coded-wire tag VAMP studies did not have this limitation, although they had other technical challenges.

Comparison with Past Years

Ocean Recovery Information

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

Adult ocean recovery data are gathered from commercial and sport ocean harvest checked at various ports by DFG. The Pacific States Marine Fisheries Commission database of ocean harvest CWT data was the source of recoveries through 2006. The ocean CWT recovery data accumulate over a one to four year period after the year a study release is made as nearly all of a given year-class of salmon have been either harvested or spawned by age five. Consequently, these data are essentially complete for releases made through 2002 and partially available for CWT releases made from 2003 to 2005 - no ocean recovery data is available yet for the 2006 releases. Differential recovery rates (DRR) based on Chipps Island or ocean recoveries and combined differential recovery rates (CDRR) based on both Antioch and Chipps Island recoveries for salmon produced at the MRH are shown in Table 5-12. Absolute survival estimates based on Chipps Island and Antioch survival indices are also included. The earlier releases were made as part of south Delta survival evaluations (1996-1999) with the later releases associated with VAMP (2000-2006). Releases have been made at several locations: Dos Reis, Mossdale, Durham Ferry, and Jersey Point. The Chipps Island and Antioch survival estimates and combined differential (Antioch and Chipps Island recoveries summed) or differential recovery rates (Chipps Island recoveries only) are

graphed in relation to the differential recovery rate using the ocean recovery information in Figure 5-18.

Results of this comparative analysis of survival estimates and differential recovery rates for Chinook salmon produced in the MRH show: (1) there is general agreement between survival estimates and differential recovery rates based on juvenile CWT salmon recoveries at Chipps Island and adult recoveries from the ocean fishery (r²=0.76), (2) there is less agreement with Antioch trawling which has fewer years of data, and (3) additional comparisons need to be made, as more data becomes available from VAMP releases for recoveries at Antioch, Chipps Island, and the ocean fishery.

San Joaquin River Salmon Protection

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

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

Unmarked and Marked Salmon Captured at Mossdale

The typical time period for VAMP (April 15 to May 15) was chosen based on historical data that indicated a high percentage of the juvenile salmon emigrating from the San Joaquin tributaries passed into the Delta at Mossdale during that time. The peak average catch per 10,000 cubic meters per day of unmarked juvenile salmon captured at Mossdale occurred on 23 Apr - densities may have been as high or higher on 21-22 Apr when no sampling was conducted at Mossdale and river flows were increasing. In 2007, the VAMP period was April 22 to May 22. The average daily density of unmarked juvenile salmon caught in Kodiak trawling at Mossdale during January through June is shown in Figure 5-19. Unmarked salmon do not have an adipose clip and can be juveniles from natural spawning or unmarked hatchery fish from the MRH. On May 15 a total of 35,756 unmarked smolts were released at MRH and this was the only release of unmarked hatchery smolts from MRH conducted during 2007. Peak density of unmarked juvenile salmon at Mossdale was observed on April 23 and immediately followed the leading edge of the VAMP

Figure 5-18



Comparison of Antioch and Chipps Island survival estimates and differential or combined differential recovery rates compared to differential ocean recovery rates for 1996-2006 CWT releases.

Figure 5-19 Average daily densities of unmarked salmon caught in the Mossdale Kodiak

9 salmon/10,000 cubic meters -- No sample 8 Unmarked release at Merced Hatchery: 35,756 on 15 May 7 6 5 4 3 2 1 0 5/1 5/16 1/1 1/16 1/31 2/15 3/2 3/17 4/1 4/16 5/31 6/15 6/30

Salmon/10,000 cubic meters

pulse flow. (Figure 5-19). The size of the juvenile salmon captured in the Mossdale trawl during January through June is shown in Figure 5-20. Recaptures of adipose finclipped CWT salmon released at Merced River Hatchery on 20 Apr and 4 May and at Hatfield on 24-26 Apr and 08-09 May were prominent in the catch at Mossdale during 27-30 Apr and 9-13 May. The adipose fin clipped juvenile salmon captured at Mossdale on 04 April was a wild migrant captured and tagged on the Stanislaus River at Caswell.

Salmon Salvage and Losses at Delta Export Pumps

Fish salvage operations at the CVP and SWP export facilities capture juvenile salmon and transport them by tanker truck to release sites in the western Sacramento-San Joaquin Delta. The untagged salmon are potentially from any source in the Central Valley. It is not certain which unmarked salmon recovered are of San Joaquin basin origin, although the timing of salvage and fish size can be compared with Mossdale trawl data and CWT recovery data for MRH smolts at the salvage facilities to provide indications as to the origin of the unmarked fish.

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

Density of salmon encountering both of the export and fish salvage facilities off Old River is represented by the combined salvage and loss estimated per acre-foot of water pumped. The DFG and DWR maintain a database of daily, weekly, and monthly salvage data. The number and density of juvenile salmon that migrated through the system, the placement of the HORB, and the amount of water pumped by each facility are some of the factors that influence the number of juvenile salmon salvaged and lost. Density is an indicator of when concentrations of juvenile salmon may be more susceptible to the export facilities and salvage system. Additionally, salvage efficiency is lower for smaller-sized salmon (fry and presmolts), so their salvage numbers and estimated losses are underrepresented.

The weekly data covering the period of April 23 to May 20 approximated the 2007 VAMP period. A review of weekly data for January through June indicates that the highest CVP salvage and losses occurred during the two weeks preceding the VAMP period, with lesser peaks during early March, (Figure 5-21). Highest SWP salvage and losses occurred during the week immediately preceding the VAMP period, with lesser peaks during early March and early April (Figure 5-22). Salmon densities based on combined salvage and loss estimates were highest at the CVP during the two weeks immediately preceding the VAMP period and during the three weeks immediately following the VAMP period, with a smaller peak during early March (Figure 5-23). At the SWP, salmon densities were highly variable with peak densities occurring immediately preceding the VAMP period, during the VAMP period, and late May into early June (Figure 5-23); lesser peaks were observed during early March and early April. The peak at both facilities during April preceding VAMP occurred when exports greatly exceeded Vernalis flow; the peaks observed after VAMP occurred during decreasing flow and export (Figure 5-24).

The size distribution of unmarked salmon during January through June in the Mossdale trawl (Figure 5-20) generally overlaps with the size distribution of those salvaged at the fish facilities (Figure 5-25, Source E. Chappell, DWR). Based on comparisons with Mossdale data, some salmon salvaged before, during, and after the VAMP period could have been from the San Joaquin basin (Figure 5-19).

The 2007 VAMP test period coincided with part of the peak period of San Joaquin River salmon smolt emigration. The highest daily density observed at Mossdale was on the second day of the VAMP period (April 23), and it is unfortunate that sampling was not conducted during the two days preceding the observed peak when flows were increasing. Smolt abundance and production estimates at Mossdale could be improved by ensuring that sampling is conducted daily when salmon smolts are emigrating. The most concentrated period of estimated losses in 2007 occurred in April prior to VAMP export reduction, as has been recorded in other years. Export curtailments may be more protective if based on real-time migration activity observed at Mossdale or observed salvage/density at the export facilities.



Figure 5-20

Figure 5-21 2007 CVP estimated salmon salvage and loss



Figure 5-22 2007 SWP estimated salmon salvage and loss







Figure 5-23 2007 SWP & CVP Combined salvage and loss density

10,000 SWP CVP Combined Export Vernalis flow 7,500 Weekly average cfs 5,000 2,500 0 1/14/07 1/28/07 2/4/07 2/18/07 2/25/07 3/4/07 4/22/07 4/29/07 5/6/07 6/24/07 7/1/07 1/7/07 1/21/07 3/18/07 3/25/07 4/1/07 4/8/07 5/13/07 5/27/07 6/3/07 6/17/07 2/11/07 3/11/07 5/20/07 4/15/07 6/10/07 Week ending date

Figure 5-24 2007 weekly export rates and Vernalis flow



 Figure 5-25

 Observed Chinook Salvage at the SWP & CVP Delta Fish Facilities 8/1/06 Through 7/31/07

CHAPTER 5



COMPLIMENTARY STUDIES RELATED TO THE VAMP

CHAPTE

Throughout 2007 several fishery studies were conducted to advance the understanding of juvenile salmon abundance and survival in the San Joaquin River basin. Following are summary reports of the information developed in each study.

Review of Juvenile Salmon Data from the San Joaquin River Tributaries to the South Delta During January through June, 2007

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

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

During 2007, rotary screw trapping was conducted near the confluences of the Stanislaus, Tuolumne, and Merced Rivers with the SJR. Seining was also conducted in the SJR from below the HOR to upstream of the Tuolumne River confluence. This review presents data from those rotary screw traps (RST) and seining to identify the presence and movement of juvenile salmon from the tributaries into the mainstem San Joaquin River relative to observations at the Mossdale Trawl and in CVP and SWP salvage facilities. Stanislaus River RST monitoring was conducted at River Mile (RM) 9 (Caswell site) during 11 Jan – 22 Jun; Tuolumne River RST monitoring was conducted at RM 5 (Grayson site) during 23 Mar - 29 May; and Merced River RST monitoring was conducted at RM 2 (Hatfield site) during 25 Jan - 01 Jun. Weekly seining during Jan-Jun was done at up to 8 sites from River Mile 51 (Dos Reis) to River Mile 83 (North of Tuolumne River) and 2 other sites were seined every 2 weeks from mid-January to late May at River Mile 78 and 90. Trawling was conducted in the San Joaquin River at Mossdale near RM 54 (downstream of the

tributaries, and just upstream of the Head of Old River) with a schedule of three days/week 03 Jan – 30 Mar; five days per week 02 Apr – 20 Apr; daily during 23 Apr – 25 May; and three to five days per week during 29 May – 30 Jun. Trawling was suspended during 02 Jun – 10 Jun due to Delta smelt concerns. Although salvage data of unmarked salmon does not distinguish which salmon originate from the San Joaquin tributaries, they can be compared to timing, abundance, and size of salmon collected in the San Joaquin basin monitoring. Flow and rainfall patterns in the basin are shown in Figure 6-1.

The seasonal peak catch of fry in the Stanislaus River RST (Figure 6-2) occurred on March 1 following increasing reservoir releases and rain events during 25 Feb - 01 Mar. The Merced River RST sampling suggests that fry did not migrate out of the Merced River during 2007 (Figure 6-3). RST sampling was not conducted during the fry outmigration season on the Tuolumne River, but Tuolumne seining recorded no salmon down to, or below, Modesto, where Dry Creek runoff enters the river, thus fry outmigration also likely did not occur in the Tuolumne River (Figure 6-4). Relatively few early fish were observed at the Mossdale trawl (Figure 6-5). It appears that peak fry migration from the Stanislaus River in 2007 was not detected at Mossdale indicating that the juveniles may have remained in the lower San Joaquin River above Mossdale and/or the relative efficiency of the trawl for fry-size salmon is less than at the rotary screw trap. However, high densities of fry at Mossdale have been detected by the Mossdale trawl in other years (SJRGA 2005). Seasonal peak catch occurred at Mossdale on 23 Apr (Figure 6-5), shortly after peak smolt catches on the Stanislaus River on 21 Apr (Figure 6-2) and coincident to the peak densities recorded at the salvage facilities (Figure 5-23). Many salmon may have also passed Mossdale undetected during 21-22 Apr as a result of no sampling effort on these days. Seasonal peak catches were observed on the Merced River on 24 Apr (Figure 6-3) and on the Tuolumne River during

Figure 6-1 San Joaquin Basin Flows and Rainfall



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



100 1,500 Unmarked release at Catch Merced Hatchery: 35,756 on 15 May River Flow 80 No sample 1,200 Estimated River flow at Cressey (CRS) 60 900 Daily catch 40 600 20 300 0 . 0 2/15 4/16 5/16 6/15 1/1 1/16 1/31 3/2 3/17 4/1 5/1 5/31 6/30

Figure 6-3 Merced screw trap catch of unmarked juvenile Chinook salmon

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



23-26 Apr (Figure 6-4), and these peaks were detected at Mossdale during 28-29 Apr. Seining in the SJR only captured two salmon prior to VAMP: one yearling salmon (155 mm) captured at Sturgeon Bend (RM 74) on 01 Mar and one young-of-year salmon (56 mm) captured at Big Beach (RM 63) on 29 Mar.

Average size in RST and trawl catch and salvage (Figure 6-6) shows that most fish observed prior to mid-March averaged <50 mm fork length (FL). Both the trawl and salvage are relatively less effective at capture of fry (salmon less than 50 mm long). Average size at all locations typically increased by early April to >70 mm FL and to >80 mm FL by early May (Figure 6-6). Low abundance of juvenile salmon was observed by 01 May in the Tuolumne River, mid-May in the Merced River, and mid June in the Stanislaus River and at Mossdale. To obtain more useful information on salmon movement into the Delta, daily monitoring at the lower end of each of the three San Joaquin tributaries and at Mossdale for the entire season (January through June) is a high priority. Further evaluation of the trawl and salvage efficiency on smaller juvenile salmon is necessary. These data would help to refine existing protective measures for smolts, if warranted, and to identify alternative strategies that may protect a larger proportion of the juvenile salmon population migrating from the San Joaquin tributaries.

2007 Mossdale Trawl Summary

Contributed by Jason Guignard California Department of Fish and Game

Introduction

Monitoring for the fall-run chinook salmon smolt outmigrant population, from the San Joaquin drainage, is conducted by CDFG two miles downstream of Mossdale Landing, County Park (river mile 56), and just upstream of the Old River confluence (Figure 6-7). This measurement of timing and production of the out-migrating fall-run Chinook salmon smolts has been performed at this location since 1988 in order to:

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

2) Develop smolt production trend information,

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

Methods

Sampling is performed with a 6 x 25 foot (1.87m x 7.6m) Kodiak trawl net. The Kodiak trawl uses two boats to pull a net equipped with spreader bars, wings, and a "belly" in the throat of the net (to improve capture vulnerability).

The cod end of the trawl net is secured using a rope. The sampling intensity was 5 days a week from April 2 to April 20, and then increased into 7 days a week from April 23 to May 25. The sampling effort was reduced back to 5 days a week during May 29 to June 15, and sampling was actually suspended briefly from June 4 to June 8 due to delta smelt concerns. The entire sampling period was from April 2 to June 15, 2007 with a total of 57 sample days out of the study period of 75 days. All trawling occurred during daylight hours, starting around 0800 hours. A sampling day usually consisted of 15 tows at 20 minutes per tow, although the first three weeks and last four weeks of sampling had 10 tows per day. Sampling is also conducted 3 days per week between mid- June and April by the USFWS in Stockton.

Water temperature, turbidity, weather, and beginning tow time were recorded for each tow. Velocity was recorded by using a digital flow meter model 2030R that is made by General Oceanics Inc. A Garmin GPSMap 172c was used to map the location of all sampling tows. This mapping is being done to evaluate differences in catch rate throughout the sampling area (Figure 6-8). The mean daily river flow data that is used in this report were taken from the U.S. Geological Survey mean daily stream flow gauge at Vernalis.

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

Analysis

The 2007 natural smolt production from the San Joaquin drainage was estimated by two different methods. The first method (smolt/ac-ft method) involves taking the actual number of non-marked Chinook salmon and dividing by the actual volume sampled to get Chinook/acft. This number is then expanded by the daily mean flow recorded at Vernalis for a 5-hour index and expanded again for a 24-hour daily estimate. These daily average smolt densities are then expanded by multiplying by the daily mean flow recorded at Vernalis (Figure 6-9). Production for days not sampled within the study period were estimated by averaging smolt/ac-ft for the 2 days before and 2 days after the non-sampled period.

The second estimate (regression vulnerability method), which we believe to be a more accurate estimate, due to the uneven distribution of smolts in the channel, is determined based on the recapture rates of dye marked



Figure 6-5 Mossdale kodiak trawl catch of unmarked juvenile Chinook salmon

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


Figure 6-7 Tow Location, Mossdale to Old River



Figure 6-8 Mossdale Sampling Tows





Figure 6-9 Expanded daily catch of non-marked Chinook based on vulnerability estimates and flow at Vernalis

Figure 6-10 Natural log of 1989- 2006 efficiency estimates vs. flow at Vernalis.





vulnerability release groups. Due to the low number of smolts produced at Merced River Hatchery, there were no vulnerability tests performed during the 2007 sampling period. Instead, vulnerability was estimated based on the natural log of vulnerability versus flow at Vernalis from previous years tests (1989-2006) (Figure 6-10). This number is then extrapolated out to a 5-hour index and a 24-hour seasonal estimate. Production, for days not sampled within the study period was estimated based on the average smolt catch and minutes towed for the 2 days before and 2 days after the non-sampled period.

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

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

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

Where:

n = days in the index period
C = daily non-marked Chinook catch
VT = daily volume of trawl sampled
VP = daily 5-hour volume of water passing Mossdale
i = ith Day

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

Vulnerability Expansion Calculation (Regression Vulnerability Method):

$$E_{V} = \sum_{i+1}^{n=75} \left[\frac{\frac{C_{i}}{V_{i}} (60 * 24)}{T_{i}} \right]$$

Where:

n = days in the index period C = daily non-marked Chinook catch V= daily vulnerability estimate T= minutes towed i = ith Day

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

Results

Between April 2 and June 15, 2007 3,392 non-marked Chinook salmon smolts were captured in the Mossdale trawl. Daily capture of non-marked salmon ranged from 0 - 225 individuals with an average of 61. Average forklength of non-marked Chinook was 85.2 millimeters (mm) and ranged from 62 - 162 mm. A total of 378 adipose fin clipped Chinook were captured between April 25 and May 18, 2007. The average forklength of marked Chinook was 96.4 mm and ranged from 80 – 118 mm.

Smolt production estimates for the San Joaquin basin ranged between 273,798 using the smolt/ac-ft estimate and 920,006 using the trawl vulnerability estimate (Table 6-1). The regression vulnerability estimate is thought to be more accurate than the smolt/ac-ft index method because it should account for an uneven distribution of migrating smolts in the river channel.

However we have assumed that the average vulnerability estimate applies to the catch in 2007. That may make the estimate of abundance using the trawl vulnerability method more uncertain than in past years where vulnerability was actually measured and applied. Forty steelhead/ rainbow trout (RBT) were captured during the 2007 sampling period. All RBTs were measured and returned to the river. Forklength ranged from 200- 330 mm (238 mm average), and all samples exhibited advanced stages of the smoltification process. This is the highest number of steelhead captured since CDFG started sampling at Mossdale in 1988 (Figure 6-11).

Survival Estimated for CWT Releases Made in the Merced River

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

Coded wire tagged salmon from the MRH were released in the Merced River between April 20 and May 8, 2007 as part of independent (complimentary to VAMP) fishery investigations. Releases were made in the upper and lower reaches of the Merced River (Merced River Hatchery and Hatfield State Park, respectively).

Survival indices to Chipps Island of lower Merced releases made at Hatfield State Park include mortality down the mainstem San Joaquin River, as well as, through the Delta (Figure 6-7). Chipps Island survival indices of the lower Merced River groups were 0.036 for the first group released on April 24. No recoveries were made at Chipps Island from the later group released on May 8th. Survival indices using Chipps Island recoveries in 2006 ranged between 0.019 - 0.106 for the groups released in the lower Merced River at Hatfield State Park. In past years survival has been similar for these groups to those released at Durham Ferry and Mossdale.

If sufficient numbers of fish are recovered in the Chipps Island trawl, survival indices can be generated for groups released on the upper Merced River (MRH). Comparison of survival indices of groups released upstream and downstream and recovered at Chipps Island provides an estimate of survival through the Merced River. This is accomplished by dividing the upstream group survival index by the downstream survival index. Unfortunately, insufficient numbers of fish were recovered from the first release group to generate survival extimates (i.e., only 1 fish from the upper Merced River and 2 fish from the lower Merced River.) No recoveries were made at Chipps Island for the second release groups from either the upper or lower Merced River release groups. Ocean recoveries will be available for these groups in future years and will provide an additional source of recoveries of which to use to estimate survival through the Merced River in 2007.

Recoveries at Chipps Island in 2007 were made prior to May 5, 2007. Sampling at Chipps Island was terminated on May 26, 2007 due to concerns related to the low population levels of delta smelt and the potential to catch some at Chipps Island.

Comparison of Lower Merced Releases with Sacramento River Delta Releases

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

As in previous years, marked fish from the Feather River were released on the Sacramento River near West Sacramento in 2007. Three groups were released to index survival through the Delta for juvenile salmon originating in the Sacramento basin. Comparison of survival between the Sacramento released fish and those released in the lower Merced may provide some insight on the variation in survival between basins.

As mentioned previously, in late May of 2007, trawling at Chipps Island was suspended due to delta smelt concerns and affected the recoveries of some of the groups released at Sacramento. For instance there were no recoveries for the last group released at Sacramento on 5/14/07. The survival index for the first release on 4/16/07 at Sacramento was 0.369. This may index the true survival as it is likely most of the released fish had passed Chipps Island prior to the termination of sampling. The survival index for the second release made at Sacramento on 4/30 was 0.039. This group may have also been affected by the lack of sampling in late May. However, if we just restrict the comparison between the first Sacramento group and the first lower Merced River group, survival was much greater for the Sacramento group (0.369) than the lower Merced group (0.036).

Survival indices are typically higher for smolts migrating through the Delta from Sacramento than for smolts emigrating past Mossdale. It is unclear why this is the case although smolts entering the Delta from Mossdale are generally exposed to lower river flows than on the Sacramento River and smolts from the San Joaquin basin migrate in closer proximity to the CVP and SWP pumping plants. In 2007, samples taken from the acoustically tagged fish used in the VAMP studies had PKD as many of the VAMP fish have had in past years. All of these factors and others may result in the lower survival detected through the Delta for juvenile salmon originating from the San Joaquin basin.

Figure 6-11 Annual rainbow trout/steelhead catch and average foklength at Mossdale



	Smolt production s	easonal estimates a	Table 6-1 and sampling period for th	e duration of the study.
Year	Sampling Period (Days)	Percentage of Days Sampled (%)	Smolt/ac-ft Estimate	Vulnerability Smolt Production Seasonal Estimate** (95% confidence range)
2007	75	76.0	273,798+ 7,490	920,006
2006	75	85.3	848,394 + 12,888	1,808,143 : (1,749,531- 1,866,755)
2005	89	80.9	363,800 + 14,700	621,403 : (388,884- 1,119,550)
2004	61	88.5	92,500 + 66,500	297,348 : (191,222- 665,160)
2003	88	80.7	107,500 + 60,300	368,424 : (277,626- 545,121)
2002	74	87.8	229,100 + 557,100	2,254,647 : (1,455,066- 5,179,591)
2001	103	78.6	279,800 + 286,000	928,996 : (586,790- 2,228,789)
2000	88	81.8	211,100 + 181,900	484,703
1999	119	71.4	146,900 + 63,500	438,979
1998	99	67.7	1,075,000 + 562,800	2,844,637
1997	92	69.6	168,600 + 89,400	635,517
1996	89	85.4	381,900 + 626,900	1,155,319
1995	60	78.3	1,108,900 + 2,640,000	3,361,384
1994	63	73.0	67,500 + 62,200	453,245
1993	83	61.4	54,200 + 21,800	269,035
1992	72	44.4	23,600 + 6,300	280,395
1991	59	66.1	*	538,005
1990	82	69.5	*	263,932
1989	54	100	*	4,241,862

*Data is currently being reevaluated. **2001- 2006 production estimates based on the annual vulnerability tests, 1989-2000 estimates based on the natural log of all vulnerability tests (1989-2005).

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 7



After some uncertainty regarding the HORB relative to Delta smelt it was installed on April 20, two days prior to the start of the VAMP pulse flow period of April 22 to May 22. The average Vernalis pulse flow was 3,260 cfs, varying between 2,830 cfs and 3,790 cfs. Combined exports averaged 1,486 cfs. Flow monitoring was conducted in the San Joaquin River downstream of the HOR and in the Old River. Kodiak trawling was conducted in the San Joaquin River between Mossdale and the Old River. An acoustic telemetry study was implemented in 2007 to estimate movement of tagged Chinook salmon smolts. Survival estimates across the Delta were not possible in 2007, however limited survival estimates to individual receiver sites were possible. Conclusions and recommendations have been developed, and summarized in Table 7-1. The conclusions and recommendations include both technical and policy/ management issues that will affect the implementation of future VAMP operations and investigations.

From past VAMP releases, the relationship of salmon survival to San Joaquin River flow has shown that survival increases as flows increase, with the HORB in place (SJRGA 2007). The survival to flow relationship is statistically significant when recovery from all available sources both in the trawls and ocean (Antioch, Chipps Island, and ocean fishery) are combined (SJRGA 2007). However, in 2007 survival through the Delta could not be measured due to the lack of study fish for a coded wire tag study and the inability to install receivers at Jersey Point and Chipps Island for the acoustic study. Thus the role of survival to flow with the HORB in place could not be confirmed in 2007. However, the acoustic study results appeared to indicate that predation and possibly toxicity, may contribute to the mortality of migrating salmon smolts through the Delta. These factors will require further investigation in future years.

The relationship of survival to flow without the HORB is more variable especially when including data from 2005 and 2006 (SJRG 2007). Relationships of flow to adult escapement 2 1/2 years later, indicates these relationships are likely real and that survival is improved as flows and flows relative to exports increase.

The role of exports has been difficult to identify from past VAMP CWT studies because survival with the HORB has not been estimated at VAMP targets of 7,000 cfs flow with exports at 1,500 and 3,000 cfs.

The VAMP program provides increased flows at a wide range of flows along with corresponding decreased exports and likely increases the survival of migrating salmon through the Delta.

The VAMP study was forced to change in 2007 due to the study fish limitation. Acoustic telemetry was used in 2007, but for acoustic studies to measure survival through the Delta receivers must be deployed at Jersey Point and Chipps Island. While logistically challenging, it appears it can be done given enough time and resources to overcome the challenges. Acoustic telemetry is also more expensive than the traditional CWT studies, but if the downstream receivers can be successfully installed, the acoustic telemetry study can estimate survival with greater precision in addition to providing more detailed mortality information through-out the Delta. Further effort will be spent on these deployments in 2008 for the work to be completed prior to releasing the acoustically tagged fish. Without these key detector locations, survival cannot be measured through the Delta using acoustic telemetry. CWT studies no longer appear feasible due to the continued study fish limitation. If the deployment of the downstream acoustic receivers is successful then acoustic telemetry will allow additional measurements of survival to be made at the VAMP targets to continue the assessment of the relative roles of flow and exports on survival through the Delta with and without the HORB.

One additional complication for future VAMP studies is the recent court order to prevent the installation of the HORB in 2008 for the protection of delta smelt. It is uncertain how this court order will affect the installation of the HORB for VAMP studies and the protection of juvenile Chinook salmon migrating from the San Joaquin tributaries after 2008.

le 7-1 clusions and recommendations
Recommendations for 2008
Acoustic receivers at Chipps Island and Jersey Point need to be installed to allow survival estimates through the Delta to be completed.
Hydrology committee to continue refining estimates of ungaged flow and develop a management scheme to accommodate variability.
The 2005 through 2007 flow data should be compared against DWR-DSM2 modeling results.
Continue to calibrate the stage and flow monitoring at the San Joaquin River near Lathrop station.
Continue net pen studies and fish health inspections.
Maintain the Mossdale Kodiak trawl at existing or higher level of effort throughout the year.
Evaluate the possibility of amending the San Joaquin River Agreement to achieve needed test conditions of 7000 cfs flow with a HORB at exports of 1500 or 3000 cfs. Prescribing target conditions will allow the most critical data to be obtained quickly so that the role of exports can be identified in the most efficient manner.
Encourage an expansion of complementary studies to provide additional information on factors and mechanisms affecting salmon survival.

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2007 Useful Web Pages

- Page 3 San Joaquin River Agreement www.sjrg.org/agreement.htm
- Page 3 SWRCB Decision 1641 www.waterrights.ca.gov/hearings/Decisions.htm
- Page 8 VAMP Annual Technical Reports www.sjrg.org
- Page 9 VAMP Experimental Design www.sjrg.org/agreement.htm
- Page 14 Operation Monitoring, CDEC Daily http://cdec.water.ca.gov/cgi-progs/ queryDgroups?s=fw2

Vernalis USGS Real-Time http://waterdata.usgs.gov/ca/nwis/dv?format= pre&period=31&site_no=11303500

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

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

LaGrange, USGS Daily http://waterdata.usgs.gov/ca/nwis/dv?format= pre&period=31&site_no=11289650 Goodwin, USBR Daily www.usbr.gov/mp/cvo/vungvari/gdwdop.pdf

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

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

- Page 27 Temporary Barrier Program http://sdelta.water.ca.gov/web_pg/tempmesr.html
- Page 31 Reclamation District 544 Seepage Monitoring Study http://sdelta.water.ca.gov/web_pg/tempmesr.html
- Page 60 CVP and SWP Salvage Data www.iep.ca.gov

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

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

Common Acronyms and Abbreviations

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

APPENDIX

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APPENDIX A

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APPENDIX A

Appendix A-1, Table 1 2007 VAMP DAILY OPERATION PLAN – MARCH 21, 2007 (A1) DOUBLE-STEP; LOW UNGAGED FLOW Target Flow Period: April 22 - May 22 • Flow Target: 4,450 cfs Bold Numbers: observed real-time mean daily flows

Partie Number Number Number Same Partie Number Partie Partie <th></th> <th>Sa</th> <th>n Joaqui</th> <th>n River</th> <th>near Ver</th> <th>nalis</th> <th></th> <th></th> <th>Merc</th> <th>ed River</th> <th>at Cress</th> <th>ey</th> <th>Tuolui</th> <th>nne River a</th> <th>it LaGrai</th> <th>ıge</th> <th></th> <th>Stanisla</th> <th>ıs R blw G</th> <th>Goodwin</th> <th></th> <th></th>		Sa	n Joaqui	n River	near Ver	nalis			Merc	ed River	at Cress	ey	Tuolui	nne River a	it LaGrai	ıge		Stanisla	ıs R blw G	Goodwin		
	Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Exis Flow resh	tingVAMP /- Suppl. apedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merceo T=Tuol. S=Stan.
31-107 2330 2330 723 730 74 745 74 745 74 745 745 74 745 <th></th> <th>(cfs)</th> <th>(cfs)</th> <th>(cfs)</th> <th>(TAF)</th> <th>(cfs)</th> <th></th> <th>(cfs)</th> <th>(cfs)</th> <th>(cfs)</th> <th>1</th>		(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	1
3/39/07 Fight	3/15/07 3/16/07 3/17/07 3/18/07 3/20/07 3/21/07 3/22/07 3/23/07 3/24/07 3/25/07	2,330 2,210 2,260 2,230 2,220 2,060				2,330 2,210 2,260 2,230 2,220 2,060	782 753 733 723 701 794	4 23 110 108 119 99	215 228 213 212 216 208			215 228 213 212 216 208	349 348 338 338 337 337 337	349 348 338 338 337 337		349 348 338 338 337 337 337	804 806 802 687 603 609	804 806 802 687 603 609			804 806 802 687 603 609	
VAMP Period Avg. (cfs): 2,182 1,789 4,362 435 100 250 894 179 1,323 647 647 358 1,005 751 751 358 391 1,500 Supplemental Water (TAF): 110.00 110 54.97 11.01 100 22.01 22.01 22.01	3/25/07 3/26/07 3/27/07 3/27/07 3/28/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/4/07 4/4/07 4/4/07 4/4/07 4/4/07 4/4/07 4/10/07 4/10/07 4/10/07 4/10/07 4/11/07 4/12/07 4/11/07 4/12/07 4/11/07 4/12/07 4/11/07 4/12/07 4/11/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/12/07 4/22/07 4/22/07 4/22/07 4/22/07 4/22/07 4/22/07 4/26/07 5/2/07 5/5/07 5/5/07 5/5/07 5/10/07 5/11/07 5/11/07 5/11/07 5/12/07 5/11/07 5/12/07 5/22/07	2,002 1,998 1,994 1,990 1,986 1,982 1,978 1,974 1,970 1,966 1,946 1,942 1,958 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 1,954 2,255 2,255 2,255 2,255 2,226 2,225 2,226 2,225 2,215 2,216 2,215 2,154 2,154 2,154 2,154 2,155 2,114 2,155 2,114 2,155 2,114 2,155 2,157 2,157	$egin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 $	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 $	0.00 0.00 0.00 0.00 0.00 0.00 10.65 14.19 17.74 21.29 24.84 28.39 31.94 35.48 39.03 42.58 46.13 49.68 53.23 56.77 60.32 56.77 60.32 56.77 60.32 56.77 74.52 78.07 81.61 85.16 85.76 95.81 99.36 102.90 016.45 110.00	$\begin{array}{c} 1,990\\ 1,986\\ 1,982\\ 1,978\\ 1,978\\ 1,970\\ 1,966\\ 1,962\\ 1,958\\ 1,954\\ 1,950\\ 1,946\\ 1,952\\ 1,958\\ 1,954\\ 1,950\\ 1,946\\ 1,952\\ 4,383\\ 1,872\\ 4,414\\ 4,409\\ 4,405\\ 4,418\\ 4,414\\ 4,409\\ 4,405\\ 4,304\\ 4,306\\ 4,336\\ 4,377\\ 4,383\\ 4,379\\ 4,370\\ 4,366\\ 4,366\\ 4,367\\ 4,377\\ 4,313\\ 4,370\\ 4,366\\ 4,366\\ 4,367\\ 4,377\\ 4,313\\ 4,370\\ 4,366\\ 4,366\\ 1,582\\ 4,317\\ 4,313\\ 4,304\\ 4,304\\ 4,306\\ 1,586\\ 1,582\\ 1,578\\ 1,574\\ 1,$	588 584 580 572 568 564 556 552 548 544 540 556 552 528 528 524 520 516 532 528 524 520 516 532 528 524 520 512 508 504 504 504 504 504 504 504 504 504 504	100 100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	894 894 894 894 894 894 894 894 894 894	179 179 179 179 179 179 179 179 179 179	250 250 250 250 250 250 250 250 250 250	300 300 300 300 300 300 300 300 300 300	300 650 650 650 650 650 650 650 650 650 650 650 650 650	358 358 358 358 358 358 358 358 358 358	300 300 300 300 300 300 300 300 300 300	768 768	768 768	358 358 358 358 358 358 358 358 358 358	374 374 374 374 374 374 374 374 374 374	768 768 768 768 768 768 768 768 768 768	
	Avg. (cfs): Supplement	2,182 al Water (1,789 TAF):		110.00	4,362	435	100	250	VA 894	MP Peri 179	od 1,323 54.97	647 11.01	647	358	1,005	751 22.01	751	358	391	1,500 22.01	

Appendix A-1, Table 2 2007 VAMP DAILY OPERATION PLAN – MARCH 21, 2007 (A2) SINGLE-STEP; LOW UNGAGED FLOW Target Flow Period: April 22 - May 22 • Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	in River	near Ver	nalis			Merc	ed River	at Cress	sey	Tuolun	nne River a	nt LaGrar	ıge		Stanislaus R blw (Goodwin	1	
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	ExistingVAMP Flow- Suppl. reshapedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
3/15/07 3/16/07 3/17/07 3/19/07 3/20/07 3/21/07 3/22/07 3/22/07 3/22/07 3/22/07	2,330 2,210 2,260 2,230 2,220 2,060				2,330 2,210 2,260 2,230 2,220 2,060	782 753 733 723 701 794	4 23 110 108 119 99	215 228 213 212 216 208			215 228 213 212 216 208	349 348 338 338 337 337	349 348 338 338 337 337		349 348 338 338 337 337	804 806 802 687 603 609			804 806 802 687 603 609	
3/26/07 3/27/07 3/28/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/2/07 4/2/07	2,002 1,998 1,994				1.000	588 584 580 576 572 568	100 100 100	250 250 250 250 250 250 250			250 250 250	300 300 300 300 300	300 300 300 300 300 300		300 300 <u>300</u>	768 768 768 768 768	768 768 768 768 768 768		768 768 768	
4/4/07 4/5/07 4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07	1,990 1,986 1,982 1,978 1,974 1,970 1,966 1,962 1,958 1,954	0			1,990 1,986 1,982 1,978 1,974 1,970 1,966 1,962 1,958 1,954	564 560 556 552 548 544 540 536 532 528	100 100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250 250	300 300 300 300 300 300 300 300 300 300	300 300 300 300 300 300 300 300 300 300		300 300 300 300 300 300 300 300 300 300	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768		768 768 768 768 768 768 768 768 768 768	
4/14/07 4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/21/07 4/22/07 4/23/07	1,950 1,946 1,942 1,888 1,884 1,880 1,876 1,872 2,268 2,264	0 0 0 0 0 0 0 269 269	0 0 0 0 0 732 732	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.53 1.07	1,950 1,946 1,942 1,888 1,884 1,880 1,876 1,872 3,269 3,265	524 520 516 512 508 504 500 496 491 487	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	269 269 269 269 269 269	0 0 0 0 0	250 250 250 250 519 519 519 519 519 519	300 250 250 250 250 250 650 650 650 650	300 250 250 250 250 250 650 650 650 650	0 0 0 0	300 250 250 250 250 250 650 650 650 650	768 768 768 768 768 768 768 768 768 768	768 7	732 732 732 732	768 768 768 768 768 768 1,500 1,500 1,500 1,500	
4/24/07 4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/3/07	2,259 2,255 2,251 2,246 2,242 2,237 2,233 2,229 2,224 2,193	269 269 269 269 269 269 269 269 269 269	732 732 732 732 732 732 732 732 732 732	1.60 2.13 2.67 3.20 3.73 4.27 4.80 5.34 5.87 6.40	3,260 3,256 3,252 3,247 3,243 3,238 3,238 3,234 3,230 3,225 3,221	483 478 474 469 465 461 456 452 448 443	100 100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	269 269 269 269 269 269 269 269 269 269		519 519 519 519 519 519 519 519 519 519	650 650 650 650 650 650 650 650 650 650	650 650 650 650 650 650 650 650 650 650		650 650 650 650 650 650 650 650 650 650	768 768 768 768 768 768 768 768 768 741 741 741	$\begin{array}{cccc} 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ \end{array}$	732 732 732 732 732 732 732 732 732 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/4/07 5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/10/07 5/11/07 5/12/07 5/13/07	2,189 2,184 2,180 2,176 2,171 2,167 2,162 2,158 2,154 2,154 2,149	269 269 269 269 269 269 269 269 269 269	759 759 759 759 759 759 759 759 759 759	6.94 7.47 8.00 8.54 9.07 9.60 10.14 10.67 11.20 11.74	3,217 3,212 3,208 3,204 3,199 3,195 3,190 3,186 3,182 3,182 3,177	439 435 430 426 421 417 413 408 404 400	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	269 269 269 269 269 269 269 269 269 269		519 519 519 519 519 519 519 519 519 519	650 650 650 650 650 650 650 650 650 650	650 650 650 650 650 650 650 650 650 650		650 650 650 650 650 650 650 650 650 650	741 741 741 741 741 741 741 741 741 741	$\begin{array}{cccc} 741 & 0 \\ 741 & $	759 759 759 759 759 759 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/14/07 5/15/07 5/16/07 5/17/07 5/18/07 5/19/07 5/20/07 5/21/07 5/22/07 5/23/07	2,145 2,141 2,136 2,132 2,127 2,123 2,119 2,114 2,010 1,905	269 269 269 269 269 269 269 269 269 269	759 759 759 759 759 759 759 759 759 759	12.27 12.81 13.34 13.87 14.41 14.94 15.47 16.01 16.54	3,173 3,169 3,164 3,160 3,155 3,151 3,147 3,142 3,038 1,905	395 391 386 382 378 373 369 365 361 357	100 100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	269 269 269 269 269 269	0 0 0 0 0	519 519 519 519 519 250 250 250 250 250	650 650 650 650 650 650 550 450 350 250	650 650 650 650 650 650 550 450 350 250	0 0 0 0 0 0	650 650 650 650 650 650 550 450 350 250	741 741 741 741 741 741 741 740 740 740	$ \begin{array}{cccc} 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 740 \\$	759 759 759 759 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 740 740 740	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,801 1,697 1,593 1,589 1,585 1,581 1,577 1,573	0 0 0 0 0 0	0 0 0 0 0 0 0		1,801 1,697 1,593 1,589 1,585 1,581 1,577 1,573	353 349 345 341 337 333 329 325	100 100 100 100 100 100 100	250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250	150 150 150 150 150 150 150 150	150 150 150 150 150 150 150		150 150 150 150 150 150 150 150	740 740 740 740 740 740 740 740	740 740 740 740 740 740 740 740		740 740 740 740 740 740 740 740 740	
Avg. (cfs): Supplement	2,182 al Water (269 TAF):		16.54	3,200	435	100	250	269	O O	519 16.54	647 0.00	647	0	647	751 0.00	751 0	749	1,500 0.00	

Appendix A-1, Table 3 2007 VAMP DAILY OPERATION PLAN – MARCH 21, 2007 (B1) DOUBLE-STEP; HIGH UNGAGED FLOW Target Flow Period: April 22 - May 22 • Flow Target: 4,450 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	n River	near Ver	nalis			Merc	ed River	at Cress	sey	Tuolur	nne River a	t LaGran	ige	:	Stanislaus R blw (Goodwin		
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	ExistingVAMP Flow- Suppl. reshapedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
3/15/07 3/16/07 3/17/07 3/18/07 3/20/07 3/21/07 3/22/07 3/23/07 3/24/07 3/25/07	2,330 2,210 2,260 2,230 2,220				2,330 2,210 2,260 2,230 2,220	782 753 733 723 701	4 23 110 108 119	215 228 213 212 216			215 228 213 212 216	349 348 338 338 338 337	349 348 338 338 338 337		349 348 338 338 337	804 806 802 687 603			804 806 802 687 603	
3/26/07 3/28/07 3/28/07 3/30/07 3/31/07 4/1/07 4/2/07 4/4/07 4/5/07 4/4/07 4/5/07 4/6/07 4/7/07 4/8/07 4/10/07 4/10/07	2,402 2,398 2,394 2,380 2,382 2,378 2,378 2,374 2,370 2,366 2,362				2,390 2,386 2,382 2,378 2,374 2,370 2,366 2,362	588 584 580 572 568 564 564 556 556 556 555 552 548 544 540 536	500 500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250 250	300 300 300 300 300 300 300 300 300 300	300 300 300 300 300 300 300 300 300 300		300 300 300 300 300 300 300 300 300 300	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768		768 768 768 768 768 768 768 768 768 768	
4/13/07 4/14/07 4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/22/07 4/22/07 4/22/07 4/22/07 4/25/07 4/26/07	2,358 2,354 2,350 2,346 2,342 2,288 2,288 2,288 2,276 2,272 2,668 2,664 2,659 2,655 2,651	0 0 0 0 0 0 0 0 1,412 1,412 1,412 1,412 1,412	0 0 0 0 0 0 0 439 439 439 439	0.00 0.00 0.00 0.00 0.00 0.00 2.80 5.60 8.40 11.20 14.00	2,358 2,354 2,350 2,346 2,342 2,288 2,284 2,280 2,276 2,276 2,272 4,519 4,515 4,510 4,506 4,502	532 528 524 520 516 512 508 504 500 496 491 487 483 478 474	500 500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250	732 732 732 732 732 732 732 732 732	146 146 146 146 146 146 146 146	250 250 250 250 250 250 1,128 1,128 1,128 1,128 1,128 1,128 1,128 1,128	300 300 250 250 250 250 250 650 650 650 650 650 650 650 650	300 300 250 250 250 250 250 250 650 650 650 650 650 650 650	241 241 241 241 241 241 241 241	300 300 250 250 250 250 250 891 891 891 891 891 891	768 768 768 768 768 768 768 768 768 768	Tos 768 768 768 768 768 768 768 768 768 768 768 768 768 768 768 768 768 293 768 768 293 768 293 768 293 768 293 768 293 768 293	439 439 439 439 439 439 439 439	$\begin{array}{r} 768 \\ 768 \\ 768 \\ 768 \\ 768 \\ 768 \\ 768 \\ 768 \\ 1,500 \\ 1,500 \\ 1,500 \\ 1,500 \\ 1,500 \\ 1,500 \\ 1,500 \end{array}$	
4/21/07 4/28/07 4/29/07 5/1/07 5/2/07 5/3/07 5/4/07 5/5/07 5/6/07 5/6/07 5/8/07 5/9/07 5/9/07 5/10/07	2,646 2,642 2,637 2,633 2,629 2,624 2,593 2,589 2,584 2,576 2,571 2,567 2,567	1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412	439 439 439 439 439 439 466 466 466 466 466 466 466 466	16.80 19.60 22.41 25.21 28.01 30.81 33.61 33.61 42.01 44.81 47.61 50.41 53.21	4,497 4,493 4,484 4,484 4,484 4,475 4,475 4,471 4,467 4,462 4,458 4,454 4,454 4,449 4,445	469 465 461 456 452 448 443 439 435 430 426 421 417 413	500 500	250 250 250 250 250 250 250 250 250 250	732 732 732 732 732 732 732 732 732 732	$ \begin{array}{r} 146 \\ 146 $	$\begin{array}{c} 1,128\\ 1,$	650 650 650 650 650 650 650 650 650 650	650 650 650 650 650 650 650 650 650 650	241 241 241 241 241 241 241 241 241 241	891 891 891 891 891 891 891 891 891 891	768 768 768 768 741 741 741 741 741 741 741 741 741 741	768 293 768 293 768 293 768 293 741 293 744 293 744 293 744 293 744 293 744	$\begin{array}{r} 439\\ 439\\ 439\\ 439\\ 439\\ 466\\ 466\\ 466\\ 466\\ 466\\ 466\\ 466\\ 46$	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/11/07 5/12/07 5/13/07 5/14/07 5/15/07 5/16/07 5/17/07 5/18/07 5/20/07 5/21/07 5/22/07 5/22/07 5/23/07	2,558 2,554 2,549 2,545 2,536 2,532 2,527 2,523 2,519 2,514 2,514 2,536 2,532 2,527 2,523 2,519 2,514 2,514	1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412 1,412	466 466 466 466 466 466 466 466 466 466	56.01 58.81 61.61 64.42 67.22 70.02 72.82 75.62 78.42 81.22 84.02 86.82	4,436 4,432 4,427 4,423 4,419 4,414 4,410 4,405 4,401 4,397 4,392 4,288 2,305 2,201	408 404 395 391 386 382 378 373 369 365 361 357 353	500 500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250	732 732 732 732 732 732 732 732 732 732	146 146 146 146 146 146 146 146 146	1,128 1,128 1,128 1,128 1,128 1,128 1,128 1,128 1,128 1,128 1,128 250 250 250 250	650 650 650 650 650 650 650 650 650 650	650 650 650 650 650 650 650 650 650 650	241 241 241 241 241 241 241 241 241 241	891 891 891 891 891 891 891 891 891 791 450 350 250 150	741 741 741 741 741 741 741 741 741 741	141 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 741 293 740 740 740 740	466 466 466 466 466 466 466 466 466 466	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 740 740 740	
5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	2,201 2,097 1,993 1,989 1,985 1,981 1,977 1,973 2,582	0 0 0 0 0 0 0 0 1,412			2,201 2,097 1,993 1,989 1,985 1,981 1,977 1,973 4,450	333 349 345 341 337 333 329 325 435	500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250	VA 732	MP Peri 146	250 250 250 250 250 250 250 250 250	150 150 150 150 150 150 150 150	150 150 150 150 150 150 150 150	241	150 150 150 150 150 150 150 150	740 740 740 740 740 740 740 740	740 740 740 740 740 740 740 740 740 740	456	740 740 740 740 740 740 740 740 740	
Supplemen	tal Water (TAF):		86.82							45.01	8.98				14.82			18.02	

Appendix A-1, Table 4 2007 VAMP DAILY OPERATION PLAN – MARCH 21, 2007 (B2) SINGLE-STEP; HIGH UNGAGED FLOW Target Flow Period: April 22 - May 22 * Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	in River	near Ver	nalis			Merc	ed River	at Cress	sey	Tuolur	nne River a	it LaGrai	ıge		Stanislaus R blw	Goodwin	I	
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	ExistingVAMF Flow- Suppl. reshapedFlov	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	o otalii
3/15/07 3/16/07 3/17/07 3/18/07 3/20/07 3/20/07 3/21/07 3/22/07 3/23/07 3/24/07	2,330 2,210 2,260 2,230 2,220				2,330 2,210 2,260 2,230 2,220	782 753 733 723 701	4 23 110 108 119	215 228 213 212 216			215 228 213 212 216	349 348 338 338 338 337	349 348 338 338 338 337		349 348 338 338 338 337	804 806 802 687 603			804 806 802 687 603	
3/25/07 3/26/07 3/27/07 3/28/07 3/30/07 3/31/07 4/1/07 4/2/07 4/3/07 4/4/07	2,402 2,398 2,394 2,390				2,390	588 584 580 576 572 568 564	500 500 500 500	250 250 250 250 250 250 250			250 250 250 250	300 300 300 300 300 300 300	300 300 300 300 300 300		300 300 <u>300</u> 300	768 768 768 768 768 768 768	768 768 768 768 768 768 768		768 768 768 768	
4/5/07 4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07 4/13/07	2,386 2,382 2,378 2,374 2,370 2,366 2,362 2,358 2,354 2,350	00			2,386 2,382 2,378 2,374 2,370 2,366 2,362 2,358 2,354 2,350	560 556 552 548 544 540 536 532 528 524	500 500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250 250	300 300 300 300 300 300 300 300 300 300	300 300 300 300 300 300 300 300 300 300		300 300 300 300 300 300 300 300 300 300	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768		768 768 768 768 768 768 768 768 768 768	
4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/22/07 4/22/07 4/23/07	2,346 2,342 2,288 2,284 2,280 2,276 2,272 2,668 2,664 2,659		0 0 0 0 0 0 732 732 732	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	2,346 2,342 2,288 2,284 2,280 2,276 2,272 3,400 3,396	520 516 512 508 504 500 496 491 487 483	500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250	0 0 0 0 0	0 0 0 0 0	250 250 250 250 250 250 250 250 250 250	250 250 250 250 650 650 650 650 650	250 250 250 250 650 650 650 650	0 0 0 0	250 250 250 250 650 650 650 650	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768 768 768 768 768 768	732 732 732 732 732	768 768 768 768 768 1,500 1,500 1,500 1,500	
4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/2/07 5/2/07	2,655 2,651 2,646 2,642 2,637 2,633 2,629 2,624 2,593 2,589		732 732 732 732 732 732 732 732 732 732	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	3,387 3,383 3,378 3,374 3,369 3,365 3,361 3,356 3,352 3,348	478 474 469 465 461 456 452 448 443 439	500 500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250 250	650 650 650 650 650 650 650 650 650 650	650 650 650 650 650 650 650 650 650		650 650 650 650 650 650 650 650 650	768 768 768 768 768 768 768 768 741 741 741 741	$\begin{array}{cccc} 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 768 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ \end{array}$	732 732 732 732 732 732 732 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/13/07 5/13/07	2,584 2,580 2,576 2,571 2,567 2,562 2,558 2,558 2,554 2,549		759 759 759 759 759 759 759 759 759 759	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	3,343 3,339 3,335 3,330 3,326 3,321 3,317 3,313 3,308	435 430 426 421 417 413 408 404 400 295	500 500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250 250	650 650 650 650 650 650 650 650 650 650	650 650 650 650 650 650 650 650 650		650 650 650 650 650 650 650 650 650	741 741 741 741 741 741 741 741 741 741	$\begin{array}{cccc} 741 & 0 \\ 741 & $	759 759 759 759 759 759 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/15/07 5/16/07 5/17/07 5/18/07 5/19/07 5/20/07 5/21/07 5/22/07 5/23/07	2,541 2,536 2,532 2,527 2,523 2,519 2,514 2,410 2,305		759 759 759 759 759 759 759 759 759 759	0.00	3,300 3,295 3,291 3,286 3,282 3,278 3,273 3,169 2,305	391 386 382 378 373 369 365 361 357	500 500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250 250 250	0 0 0 0	0 0 0 0	250 250 250 250 250 250 250 250 250 250	650 650 650 650 650 550 450 350 250	650 650 650 650 650 650 550 450 350 250	0 0 0 0 0	650 650 650 650 650 550 450 350 250	741 741 741 741 741 741 741 740 740 740	$\begin{array}{cccc} 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 741 & 0 \\ 740 $	759 759 759 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 740 740 740	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	2,201 2,097 1,993 1,989 1,985 1,981 1,977 1,973	0 0 0 0 0 0			2,201 2,097 1,993 1,989 1,985 1,981 1,977 1,973	353 349 345 341 337 333 329 325	500 500 500 500 500 500 500 500	250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250	150 150 150 150 150 150 150 150	150 150 150 150 150 150 150		150 150 150 150 150 150 150 150	740 740 740 740 740 740 740 740	740 740 740 740 740 740 740 740		740 740 740 740 740 740 740 740 740	
Avg. (cfs): Supplemen	2,582 tal Water (0 TAF):		0.00	3,331	435	500	250	VA 0	0 O	od 250 0.00	647 0.00	647	0	647	751 0.00	751 0	749	1,500 0.00	

Appendix A-1, Table 5 2007 VAMP DAILY OPERATION PLAN – APRIL 6, 2007 (A) SINGLE-STEP; HIGH UNGAGED FLOW; NO STANISLAUS b(2) WATER Target Flow Period: April 22 - May 22 • Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	in River	near Ver	nalis			Merc	ed River	at Cress	ey	Tuolui	nne River a	it LaGrar	ige		Stanislau	s R blw G	oodwin		
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Exist Flow resh	ingVAMP - Suppl. apedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	5-Stall.
3/15/07 3/16/07 3/17/07 3/18/07 3/19/07 3/20/07 3/21/07 3/22/07 3/22/07 3/22/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230	870 840 820 813 791 782 744 741 703 630	10 17 112 111 122 99 297 236 307 335	215 228 213 212 216 208 215 223 212 213			215 228 213 212 216 208 215 223 212 213	349 348 338 337 337 334 335 334 335 334 335	349 348 338 337 337 334 335 334 335 334 335		349 348 338 337 337 334 335 334 335	804 806 802 687 603 609 607 604 547 504	804 806 802 687 603 609 607 604 547 504			804 806 802 687 603 609 607 604 547 504	
3/25/07 3/27/07 3/27/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/4/07 4/5/07 4/6/07 4/6/07 4/6/07 4/6/07 4/6/07 4/9/07 4/9/07 4/10/07	2,210 2,160 2,050 2,030 2,000 1,910 1,950 1,950 1,920 1,720 1,698 1,733 1,950 1,987 1,987 1,980				2,210 2,160 2,030 2,030 1,910 1,950 1,950 1,790 1,720 1,678 1,733 1,950 1,987 1,980	563 544 545 534 516 518 494 472 465 421 414 383 376 369 362 355 348	403 479 436 426 402 295 363 364 281 213 182 230 300 300 300 300 300	214 215 234 229 229 229 221 214 213 206 250 250 250 250 250			214 215 234 229 223 198 202 221 214 213 206 250 250 250 250 250	336 335 335 337 337 338 339 338 339 338 337 337 300 300 300 300 300 300	336 335 335 337 337 338 339 338 339 338 339 338 337 300 300 300 300 300 300		336 335 335 337 337 338 338 338 338 338 337 337 337	502 503 503 503 503 503 501 502 509 503 500 768 768 768 768 768	502 503 503 503 503 501 500 502 509 503 500 768 768 768 768 768			502 509 503 503 503 501 500 502 509 503 503 503 503 503 503 503 503 503 503 503 503 503 503 503 503 505 503 505 503 505 503 505 503 505 503 505 503 505 503 505 503 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 505 7 6 6 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 8 7 6 6 516 1111111111111	
4/11/07 4/12/07 4/13/07 4/15/07 4/16/07 4/16/07 4/16/07 4/17/07 4/18/07 4/20/07 4/20/07 4/22/07 4/22/07 4/25/07 4/26/07 4/26/07 4/28/07 4/29/07 5/3/07 5/5/07	$\begin{array}{c} 1,973\\ 1,969\\ 1,959\\ 1,952\\ 1,945\\ 1,938\\ 1,881\\ 1,874\\ 1,867\\ 1,860\\ 1,875\\ 2,526\\ 2,522\\ 2,514\\ 2,510\\ 2,552\\ 2,514\\ 2,510\\ 2,502\\ 2,498\\ 2,594\\ 2,502\\ 2,498\\ 2,494\\ 2,340\\ 1,936\\ 1,572\\ 1,618\end{array}$	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 720 720		0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.33 2.76 4.19 5.61 7.04 8.47 9.90 11.33 12.75 14.18 15.91 18.53 21.52 24.73	$\begin{array}{c} 1,973\\ 1,969\\ 1,959\\ 1,952\\ 1,945\\ 1,938\\ 1,881\\ 1,874\\ 1,860\\ 1,875\\ 3,200\\ 3,246\\ 3,242\\ 3,234\\ 3,234\\ 3,222\\ 3,218\\ 3,224\\ 3,222\\ 3,218\\ 3,224\\ 3,222\\ 3,218\\ 3,224\\ 3,226\\ 3,225\\ 3,236\\ 3,256\\ 3,236\\ 3,246\\ 3,226\\ 3,226\\ 3,226\\ 3,226\\ 3,236\\ 3,226\\ 3,236\\ 3,266\\ 3,$	341 327 320 313 306 299 292 307 300 296 292 288 284 284 284 284 276 276 276 272 268 264 260 256 252 248 244 240	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	0 50 50 50 50 50 50 50 50 50 50 200 450 880 81,120 1,120 1,110	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	250 250 250 250 250 250 250 250 250 300 300 300 300 300 300 300 300 300 3	300 300 250 250 250 250 250 537 537 537 537 537 537 537 537 537 537	300 300 300 250 250 250 250 680 680 680 680 680 680 680 680 680 68	170 170 170 170 170 170 170 170 170 170	300 300 300 250 250 250 250 850 850 850 850 850 850 850 850 850 8	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768	500 500 500 500 500 500 500 500 500 500		768 768 768 768 768 768 768 768 768 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 500 500	
5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/13/07 5/13/07 5/14/07	1,614 1,610 1,607 1,604 1,601 1,598 1,595 1,592 1,589	1,620 1,620 1,620 1,620 1,620 1,620 1,620 1,620 1,620		$\begin{array}{r} 27.95\\ 31.16\\ 34.37\\ 37.59\\ 40.80\\ 44.01\\ 47.23\\ 50.44\\ 53.65\\ 56.87\end{array}$	3,234 3,230 3,227 3,224 3,221 3,218 3,215 3,212 3,209	237 234 231 228 225 222 219 216 213 210	300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	1,110 1,110 1,110 1,120 1,120 1,120 1,120 950 600	340 340 340 330 330 330 330 0 0	1,700 1,700 1,700 1,700 1,700 1,700 1,700 1,700 1,200 850	537 537 537 537 537 537 537 537 537 537	320 320 320 320 320 320 320 320 680 810	170 170 170 170 170 170 170 170 170	490 490 490 490 490 490 490 490 490 850	741 741 741 741 741 741 741 741 741 741	500 500 500 500 500 500 500 610 820	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	500 500 500 500 500 500 500 500 710	
5/15/07 5/16/07 5/17/07 5/18/07 5/19/07 5/20/07 5/22/07 5/22/07 5/22/07	1,586 2,053 2,390 2,387 2,384 2,381 2,378 1,965 1,733	1,620 1,220 870 870 870 870 870 820 490 0		50.87 59.29 61.01 62.74 64.46 66.19 67.81 68.79	3,206 3,273 3,260 3,257 3,254 3,251 3,198 2,455 1,733	210 207 204 201 198 195 192 189 186	300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	600 600 550 250	0 0 0 0	850 850 850 250 250 250 250 250	537 537 537 537 537 537 250 200 200	810 810 810 810 400 250 200 200	170 170 170 170 170 140	980 980 980 980 980 540 250 200 200	741 741 741 741 741 741 741 741 741 741	820 820 820 820 820 820 741 741 741	100 100 100 100 100	0 0 0 0	920 920 920 920 920 920 741 741 741	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,680 1,677 1,624 1,621 1,618 1,615 1,612 1,609	0 0 0 0 0 0 0			1,680 1,677 1,624 1,621 1,618 1,615 1,612 1,609	183 180 177 174 171 168 165 162	300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250	150 150 150 150 150 150 135 120	150 150 150 150 150 150 135 120		150 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	2,081 tal Water (1,119 TAF):		68.79	3,200	244	300	250	VA 594	MP Peri 119	od 962 36.50	537 7.30	537	169	706	751 10.39	751	237	0	988 14.60	

Appendix A-1, Table 6 2007 VAMP DAILY OPERATION PLAN – APRIL 6, 2007 (B) SINGLE-STEP; HIGH UNGAGED FLOW; STANISLAUS b(2) WATER Target Flow Period: April 22 - May 22 * Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	in River	near Ver	nalis			Merc	ed River	at Cress	ey	Tuolu	nne River a	it LaGrai	ıge		Stanislaus	R blw G	oodwin		
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existir Flow- resha	ngVAMP Suppl. pedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	J-Stan.
3/15/07 3/16/07 3/17/07 3/18/07 3/19/07 3/20/07 3/21/07 3/22/07 3/22/07 3/22/07 3/24/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230				2,420 2,290 2,350 2,310 2,150 2,240 2,180 2,200 2,230	870 840 820 813 791 782 744 741 703 630	10 17 112 111 122 99 297 236 307 335	215 228 213 212 216 208 215 223 212 213			215 228 213 212 216 208 215 223 212 213	349 348 338 337 337 334 335 334 335	349 348 338 337 337 334 335 334 335 334 335		349 348 338 337 337 334 335 334 335	804 806 802 687 603 609 607 604 547 504	804 806 802 687 603 609 607 604 547 504			804 806 802 687 603 609 607 604 547 504	
3/25/07 3/26/07 3/28/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/2/07 4/4/07	2,210 2,160 2,050 2,000 1,910 1,880 1,950 1,920 1,790 1,720				2,210 2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720	563 546 545 534 516 518 494 472 465 421 414	403 479 436 426 402 302 295 363 364 281 213	214 215 234 229 229 223 198 202 221 214 213			214 215 234 229 229 223 198 202 221 214 213	336 335 335 337 337 337 338 339 338 339 338 337	336 335 335 337 337 338 339 338 339 338 339 338 337		336 335 335 337 337 338 339 338 339 338 337	502 509 503 505 503 503 501 500 502 509 503	502 509 503 505 503 503 503 501 500 502 509 503			502 509 503 505 503 503 501 500 502 509 503	
4/5/07 4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07	1,720 1,670 1,698 1,733 1,950 1,987 1,980 1,973 1,966 1,959	0			1,720 1,698 1,733 1,950 1,987 1,980 1,973 1,966 1,959	383 376 369 362 355 348 341 334 327	182 230 300 300 300 300 300 300 300 300 300	213 206 250 250 250 250 250 250 250 250			213 206 250 250 250 250 250 250 250 250	337 300 300 300 300 300 300 300 300 300 30	337 300 300 300 300 300 300 300 300 300		337 300 300 300 300 300 300 300 300 300	500 768 768 768 768 768 768 768 768 768	500 768 768 768 768 768 768 768 768 768 768			503 500 768 768 768 768 768 768 768 768 768	
4/14/07 4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/21/07 4/22/07 4/22/07 4/23/07	1,952 1,945 1,938 1,881 1,874 1,867 1,860 1,875 2,218 2,254	0 0 0 0 0 0 0 250 250	0 0 0 0 0 732 732 732	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.50 0.99	1,952 1,945 1,938 1,881 1,874 1,867 1,860 1,875 3,200 3,236	320 313 306 299 292 307 300 296 292 288 284	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	250 250 250 250 250 250	0 0 0 0 0	250 250 250 250 500 500 500 500 500	250 250 250 250 250 250 537 537 537 537	300 250 250 250 250 250 600 640 640 640	0 0 0 0	250 250 250 250 250 250 600 640 640 640	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768	0 0 0 0	732 732 732 732 732	768 768 768 768 768 768 1,500 1,500 1,500	
4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/3/07 5/4/07	2,246 2,242 2,238 2,234 2,230 2,226 2,222 2,218 2,187 2,183	250 250 250 250 250 250 250 250 250 250	732 732 732 732 732 732 732 732 732 732	1.98 2.48 2.98 3.47 3.97 4.46 4.96 5.45 5.95 6.45	3,228 3,224 3,220 3,216 3,212 3,208 3,204 3,200 3,196 3,192	280 276 272 268 264 260 256 252 248 244	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	250 250 250 250 250 250 250 250 500 600		500 500 500 500 500 500 500 500 750 850 850	537 537 537 537 537 537 537 537 537 537	640 640 640 640 640 640 640 640 640 380 320		640 640 640 640 640 640 640 640 640 380 320	768 768 768 768 768 768 768 741 741 741 741	768 768 768 768 768 768 768 768 741 741 741 741		732 732 732 732 732 732 732 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/12/07 5/13/07	1,919 1,855 1,851 1,848 1,848 1,845 1,842 1,839 1,836 1,833 1,830	500 600 600 600 600 600 600 600 600	759 759 759 759 759 759 759 759 759 759	7.44 8.63 9.82 11.01 12.20 13.39 14.58 15.77 16.96	3,178 3,214 3,210 3,207 3,204 3,201 3,198 3,195 3,192	240 237 234 231 228 225 222 219 216 213	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	600 600 600 600 600 600 600 530 250		850 850 850 850 850 850 850 780 500	537 537 537 537 537 537 537 537 537 537	320 320 320 320 320 320 320 320 320 420 700		320 320 320 320 320 320 320 320 320 420	741 741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741 741		759 759 759 759 759 759 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/15/07 5/16/07 5/17/07 5/18/07 5/19/07 5/20/07 5/21/07 5/22/07 5/23/07	1,030 1,927 2,204 2,201 2,198 2,195 2,192 2,189 1,986 1,733	530 250 250 250 250 250 250 250 250 0	759 759 759 759 759 759 759 759 759 759	19.20 19.70 20.19 20.69 21.18 21.68 22.18 22.67	3,216 3,213 3,210 3,207 3,204 3,201 3,198 2,995 1,733	213 210 207 204 201 198 195 192 189 186	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	250 250 250 250 250 250	0 0 0 0	500 500 500 500 500 250 250 250 250	537 537 537 537 537 537 537 250 200 200	700 700 700 700 700 700 500 250 200 200	0 0 0 0 0	700 700 700 700 700 500 250 250 200 200	741 741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741 741		759 759 759 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,680 1,677 1,624 1,621 1,618 1,615 1,612 1,609	0 0 0 0 0 0 0	0 0 0 0 0 0 0		1,680 1,677 1,624 1,621 1,618 1,615 1,612 1,609	183 180 177 174 171 168 165 162	300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250	150 150 150 150 150 150 135 120	150 150 150 150 150 150 135 120		150 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	2,082 tal Water (369 TAF):		22.67	3,200	244	300	250	VA 369	O O	od 619 22.67	537 0.00	537	0	537	751 0.00	751	0	749	1,500 0.00	

Appendix A-1, Table 7 2007 VAMP DAILY OPERATION PLAN – APRIL 6, 2007 (C) SINGLE-STEP; LOW UNGAGED FLOW; NO STANISLAUS b(2) WATER Target Flow Period: April 22 - May 22 • Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	in River	near Ver	nalis			Merce	ed River	at Cress	ey	Tuolur	nne River a	t LaGrar	ige		Stanislau	s R blw G	oodwin		
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Exist Flow resh	ingVAMP - Suppl. apedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	• • • •
3/15/07 3/16/07 3/17/07 3/19/07 3/20/07 3/21/07 3/22/07 3/22/07 3/22/07 3/24/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230	870 840 820 813 791 782 744 741 703 630	10 17 112 111 122 99 297 236 307 335	215 228 213 212 216 208 215 223 212 212 213			215 228 213 212 216 208 215 223 212 213	349 348 338 337 337 334 335 334 335	349 348 338 337 337 337 334 335 334 335		349 348 338 337 337 334 335 334 335	804 806 802 687 603 609 607 604 547 504	804 806 802 687 603 609 607 604 547 504			804 806 802 687 603 609 607 604 547 504	
3/25/07 3/26/07 3/27/07 3/28/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/2/07 4/4/07 4/5/07 4/6/07 4/7/07 4/8/07	2,210 2,160 2,050 2,030 1,910 1,880 1,950 1,950 1,920 1,790 1,670 1,653 1,860				2,210 2,160 2,050 2,000 1,910 1,880 1,950 1,920 1,790 1,720 1,698 1,653 1,860	563 546 545 534 516 518 494 494 465 421 414 383 376 369 362	403 479 436 426 402 302 295 363 364 281 213 182 230 220 210	214 215 234 229 229 223 198 202 221 214 213 206 250 250 250			214 215 234 229 229 223 198 202 221 214 213 206 250 250 250	336 335 335 337 337 337 338 339 338 339 338 339 338 337 337 300 300 300	336 335 335 337 337 337 338 338 339 338 339 338 337 337 337 300 300 300		336 335 335 337 337 337 338 339 338 339 338 337 337 337 300 300 300	502 509 503 505 503 503 501 500 502 509 503 500 768 768 768	502 503 503 503 503 503 501 500 502 509 503 500 768 768 768			502 509 503 505 503 501 500 502 503 500 768 768 768	
4/9/07 4/10/07 4/11/07 4/12/07 4/13/07 4/14/07 4/15/07	1,887 1,870 1,853 1,836 1,819 1,752 1,745	0	0	0.00	1,887 1,870 1,853 1,836 1,819 1,752 1,745	355 348 341 334 327 320 313	200 190 180 170 160 100 100	250 250 250 250 250 250 250			250 250 250 250 250 250 250	300 300 300 300 300 300 250	300 300 300 300 300 250		300 300 300 300 300 300 250	768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768			768 768 768 768 768 768 768 768	
4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/21/07 4/22/07 4/23/07 4/24/07	$1,738 \\ 1,681 \\ 1,674 \\ 1,667 \\ 1,660 \\ 1,675 \\ 2,121 \\ 2,117 \\ 2,113$	0 0 0 0 0 119 119 119	0 0 0 0 0 0 0	0.00 0.00 0.00 0.00 0.00 0.00 0.24 0.47 0.71	1,738 1,681 1,674 1,667 1,660 1,675 2,240 2,236 2,232	306 299 292 307 300 296 292 288 284	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250	119 119 119 119 119 119 119	0 0 0 0 0	250 250 250 369 369 369 369 369 369	250 250 250 537 537 537 537 537 537	250 250 250 703 703 703 703 703 703	0 0 0 0	250 250 250 703 703 703 703 703 703	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768	0 0 0 0	0 0 0 0	768 768 768 768 768 768 768 768 768 768	
4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/3/07 5/4/07	2,109 2,105 2,101 1,987 1,872 1,776 1,772 1,768 1,737 1,733	119 119 119 119 119 119 119 119 119 119	0 0 0 0 0 0 0 0 0	0.94 1.18 1.42 1.65 1.89 2.12 2.36 2.60 2.83 3.07	2,228 2,224 2,220 2,106 1,991 1,895 1,891 1,887 1,856 1,852	280 276 272 268 264 260 256 252 248 244	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	119 119 119 119 119 119 119 119 119 119	0 0 0 0 0 0 0 0 0	369 369 369 369 369 369 369 369 369 369	537 537 537 537 537 537 537 537 537 537	703 593 482 390 390 390 390 390 390 390	0 0 0 0 0 0 0 0 0	703 593 482 390 390 390 390 390 390 390	768 768 768 768 768 768 768 741 741 741 741	768 768 768 768 768 768 768 741 741 741 741	0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	768 768 768 768 768 768 768 741 741 741 741	
5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/13/07	1,729 1,725 1,813 1,921 2,028 2,025 2,022 2,019 2,016	119 119 119 119 119 119 119 119 119 119		3.30 3.54 3.78 4.01 4.25 4.48 4.72 4.96 5.19	1,848 1,844 1,932 2,040 2,147 2,144 2,141 2,138 2,135	240 237 234 231 228 225 222 219 216	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	119 119 119 119 119 119 119 119 119 119		369 369 369 369 369 369 369 369 369	537 537 537 537 537 537 537 537 537 537	482 593 703 703 703 703 703 703 703 703 593		482 593 703 703 703 703 703 703 703 593	741 741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741 741	
5/14/07 5/15/07 5/16/07 5/18/07 5/18/07 5/20/07 5/20/07 5/22/07 5/22/07 5/23/07	1,900 1,786 1,691 1,688 1,685 1,682 1,679 1,586 1,533	119 119 119 119 119 119 119 119 119 119		5.43 5.66 5.90 6.14 6.37 6.61 6.84 7.08 7.32	2,152 2,019 1,905 1,810 1,807 1,804 1,801 1,798 1,705 1,533	213 210 207 204 201 198 195 192 189 186	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	119 119 119 119 119 119	0 0 0 0	369 369 369 369 369 250 250 250 250	537 537 537 537 537 537 537 537 250 200 200	482 390 390 390 390 390 300 250 200 200	0 0 0 0 0	390 390 390 390 390 390 300 250 200 200	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741 741	0 0 0 0 0	0 0 0 0 0	741 741 741 741 741 741 741 741 741 741	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,480 1,477 1,424 1,421 1,418 1,415 1,412 1,409	0 0 0 0 0 0 0	0 0 0 0 0 0 0		1,480 1,477 1,424 1,421 1,418 1,415 1,412 1,409	183 180 177 174 171 168 165 162	100 100	250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250	150 150 150 150 150 150 150 135 120	150 150 150 150 150 150 135 120		150 150 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	1,881 tal Water (119 TAF):		7.32	2,000	244	100	250	VA 119	O O O	od 369 7.32	537 0.00	537	0	537	751 0.00	751	0	0	751 0.00	

Appendix A-1, Table 8

2007 VAMP DAILY OPERATION PLAN – APRIL 6, 2007 (D) SINGLE-STEP; LOW UNGAGED FLOW; STANISLAUS b(2) WATER Target Flow Period: April 22 - May 22 • Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	in River	near Ver	nalis			Merc	ed River	at Cress	еу	Tuolui	mne River a	nt LaGrar	ige		Stanislaus	R blw G	oodwin		
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existi Flow- resha	ngVAMP Suppl. pedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	3-3tan.
3/15/07 3/16/07 3/17/07 3/18/07 3/20/07 3/20/07 3/22/07 3/22/07 3/23/07 3/23/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230	870 840 813 791 782 744 741 703 630	10 17 112 111 122 99 297 236 307 335	215 228 213 212 216 208 215 223 212 213			215 228 213 212 216 208 215 223 212 213	349 348 338 337 337 337 334 335 334 335	349 348 338 337 337 337 334 335 334 335		349 348 338 337 337 334 335 334 335	804 806 802 687 603 609 607 604 547 504	804 806 802 687 603 609 607 604 547 504			804 806 802 687 603 609 607 604 547 504	
3/25/07	2,210				2,210	563	403	214			214	336	336		336	502	502			502	
3/26/07 3/27/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/3/07 4/4/07	2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720				2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720	546 545 534 516 518 494 472 465 421 414	475 436 426 402 302 295 363 364 281 213	215 234 229 229 223 198 202 221 214 213			215 234 229 223 198 202 221 214 213	335 335 337 337 338 339 338 339 338 337 337	335 335 337 337 338 338 339 338 338 337 337		335 335 337 337 338 339 338 339 338 337 337	509 503 505 503 503 501 500 502 509 503	509 503 505 503 503 501 500 502 509 503			509 503 505 503 503 501 500 502 509 503	
4/5/07 4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07	1,670 1,698 1,653 1,860 1,887 1,870 1,853 1,836 1,819	0			1,670 1,698 1,653 1,860 1,887 1,870 1,853 1,836 1,819	383 376 369 362 355 348 341 334 327	182 230 220 210 200 190 180 170 160	206 250 250 250 250 250 250 250 250 250 250			206 250 250 250 250 250 250 250 250 250 250	337 300 300 300 300 300 300 300 300 300	337 300 300 300 300 300 300 300 300		337 300 300 300 300 300 300 300 300	500 768 768 768 768 768 768 768 768 768	500 768 768 768 768 768 768 768 768 768			500 768 768 768 768 768 768 768 768 768	
4/14/07 4/16/07 4/16/07 4/19/07 4/19/07 4/20/07 4/20/07 4/22/07 4/22/07 4/22/07 4/26/07 4/26/07 4/26/07 4/28/07 4/28/07 4/29/07 5/2/07	$\begin{array}{c} 1,752\\ 1,745\\ 1,748\\ 1,681\\ 1,674\\ 1,667\\ 2,121\\ 2,117\\ 2,113\\ 2,109\\ 2,105\\ 2,105\\ 2,101\\ 1,987\\ 1,872\\ 1,776\\ 1,772\\ 1,776\\ 1,772\\ 1,768\\ 1,772\end{array}$		0 0 0 0 732 732 732 732 732 732 732 732 732 732	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	1,752 1,745 1,738 1,681 1,674 1,667 1,660 1,675 2,853 2,849 2,845 2,845 2,841 2,833 2,719 2,604 2,508 2,500	320 313 306 299 292 307 300 296 292 288 284 280 276 272 268 264 260 256 252	100 100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250 250	300 250 250 250 250 537 537 537 537 537 537 537 537 537 537	300 250 250 250 250 250 703 703 703 703 703 703 703 703 703 70		300 250 250 250 250 703 703 703 703 703 703 703 703 703 70	768 768 768 768 768 768 768 768 768 768	768 768 768 768 768 768 768 768 768 768	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	732 732 732 732 732 732 732 732 732 732	768 768 768 768 768 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/3/07 5/4/07 5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/10/07 5/12/07 5/12/07 5/12/07	1,737 1,733 1,729 1,725 1,813 1,921 2,028 2,025 2,022 2,019 2,016	0 0 0 0 0 0 0 0 0 0 0 0	759 759 759 759 759 759 759 759 759 759	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	2,496 2,492 2,488 2,484 2,572 2,680 2,787 2,784 2,781 2,778 2,775	248 244 240 237 234 231 228 225 222 219 216	100 100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0	250 250 250 250 250 250 250 250 250 250	537 537 537 537 537 537 537 537 537 537	390 390 482 593 703 703 703 703 703 703 703 593	0 0 0 0 0 0 0 0 0 0 0 0	390 390 482 593 703 703 703 703 703 703 703 593	741 741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741 741		759 759 759 759 759 759 759 759 759 759	$\begin{array}{r} 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\end{array}$	
5/14/07 5/15/07 5/16/07 5/18/07 5/18/07 5/19/07 5/20/07 5/21/07 5/22/07 5/23/07	2,013 1,900 1,786 1,691 1,688 1,685 1,682 1,679 1,586 1,533	0 0 0 0 0 0 0 0 0 0 0	759 759 759 759 759 759 759 759 759 759	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	2,772 2,659 2,545 2,450 2,447 2,444 2,441 2,438 2,345 1,533	213 210 207 204 201 198 195 192 189 186	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	0 0 0 0 0		250 250 250 250 250 250 250 250 250 250	537 537 537 537 537 537 537 537 250 200 200	482 390 390 390 390 390 300 250 200 200	0 0 0 0 0 0	482 390 390 390 390 390 390 300 250 200 200	741 741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741 741	0 0 0 0 0 0	759 759 759 759 759 759 759 759	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741 741	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/29/07 5/30/07 5/31/07	1,480 1,477 1,424 1,421 1,418 1,415 1,412 1,409	0 0 0 0 0 0 0	0 0 0 0 0 0 0		1,480 1,477 1,424 1,421 1,418 1,415 1,412 1,409	183 180 177 174 171 168 165 162	100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250	150 150 150 150 150 150 150 135 120	150 150 150 150 150 150 150 135 120		150 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	1,881 tal Water (0 TAF):		0.00	2,631	244	100	250	VA 0	O O	250 0.00	537 0.00	537	0	537	751 0.00	751	0	749	1,500 0.00	

Appendix A-1, Table 9 2007 VAMP DAILY OPERATION PLAN – APRIL 13, 2007 (A) SINGLE-STEP; HIGH UNGAGED FLOW Target Flow Period: April 22 - May 22 • Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	n Joaqui	in River	near Ver	nalis			Merced River at Cressey					nne River a	t LaGrar	Stanislaus R blw Goodwin						
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppi. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Exist Flow resha	ingVAMP - Suppl. apedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan.
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	
3/15/07 3/16/07 3/17/07 3/19/07 3/20/07 3/21/07 3/22/07 3/22/07 3/22/07 3/24/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230	788 759 739 727 710 702 659 659 609 536	97 97 194 203 185 378 316 392 417	215 228 213 212 216 208 215 223 212 213			215 228 213 212 216 208 215 223 212 213	349 348 338 337 337 334 335 334 335 334 335	349 348 338 337 337 334 335 334 335 334 335		349 348 338 337 337 334 335 334 335	804 806 802 687 603 609 607 604 547 504	804 806 802 687 603 609 607 604 547 504			804 806 802 687 603 609 607 604 547 504	
3/25/07 3/26/07 3/27/07 3/28/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/2/07 4/3/07 4/5/07 4/6/07 4/6/07	2,210 2,160 2,050 2,030 2,000 1,910 1,880 1,950 1,920 1,790 1,720 1,670 1,670 1,700				2,210 2,160 2,050 2,030 1,910 1,950 1,950 1,920 1,790 1,670 1,670 1,700	476 460 461 437 437 414 393 380 342 328 296 271 260	497 573 523 512 486 389 374 444 444 444 360 298 261 288 354	214 215 234 229 223 198 202 221 214 214 213 206 195 203			214 215 234 229 223 198 202 221 214 213 206 195 203	336 335 335 337 337 338 339 338 339 338 337 337 337 337 337 337	336 335 335 337 337 338 339 338 339 338 337 337 337 337 337 337 338		336 335 335 337 337 338 339 338 339 338 337 337 337 337 337 338	502 509 503 503 503 503 501 500 502 509 503 500 502 510	502 509 503 503 503 503 501 500 502 509 503 500 502 500 502 510			502 509 503 505 503 503 501 500 502 509 503 500 502 502 510	
4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07 4/14/07	1,770 1,860 1,650 1,620 1,710 1,606 1,916	0			1,770 1,860 1,650 1,620 1,710 1,606 1.916	279 274 276 267 299 290 281	454 557 322 285 375 300 300	215 216 192 176 179 250 250			215 216 192 176 179 250 250	338 338 339 343 341 300 300	338 339 343 341 300 300		338 339 343 341 300 300	508 508 504 504 800 768 768	508 508 504 504 800 768 768			508 508 504 504 800 768	
4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/21/07 4/22/07 4/23/07	1,837 1,899 1,840 1,831 1,822 1,813 1,804 3,081 3,078	0 0 0 0 0 0 0 0 0 100 150		0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.20 0.50	1,837 1,899 1,840 1,831 1,822 1,813 1,804 3,181 3,228	272 263 254 245 236 231 228 225 221 218	300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	50 100 100 100 100	0 0 0 0 0	250 250 250 300 350 350 350 350 350	250 250 250 250 250 537 537 537 537	250 250 250 250 250 800 800 800 800 800	50 50 50 50	250 250 250 250 250 850 850 850 850 850	768 768 768 768 768 1,500 1,500 1,500 1,500	768 768 768 768 768 1,500 1,500 1,500 1,500	0 0 0 0	0 0 0 0	768 768 768 768 768 1,500 1,500 1,500 1,500	
4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/2/07	3,071 3,068 3,065 3,062 3,059 3,055 2,752 2,449 2,446	150 150 150 150 150 150 450 780 780	0 0 0 0 0 0 0 0	1.09 1.39 1.69 1.98 2.28 2.58 3.47 5.02 6.57	3,221 3,218 3,215 3,212 3,209 3,205 3,202 3,202 3,229 3,226	215 215 209 205 202 199 196 193 189	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	100 100 100 450 780 780 780 780 780		350 350 350 700 1,030 1,030 1,030 1,030 1,030	537 537 537 537 537 537 537 537 537 537	800 800 800 800 500 200 200 200 200 200	50 50 50 50 0 0 0 0 0	850 850 850 850 200 200 200 200	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500			1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/4/07 5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/12/07 5/13/07	2,443 2,439 2,436 2,433 2,430 2,427 2,423 2,420 2,417 2,414	780 780 780 780 780 780 780 780 780 780	0 0 0 0 0 0 0 0 0	8.11 9.66 11.21 12.75 14.30 15.85 17.40 18.94 20.49 22.04	3,223 3,219 3,216 3,213 3,210 3,207 3,203 3,200 3,197 3,194	186 183 180 177 173 170 167 164 161 157	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	780 780 780 780 780 780 780 510 180 180	0 0 0 0 0 0 0 0 0	1,030 1,030 1,030 1,030 1,030 1,030 760 430 430	537 537 537 537 537 537 537 537 537 537	200 200 200 200 200 200 200 200 450 800	0 0 0 0 0 0 30 30	200 200 200 200 200 200 200 200 480 830	$\begin{array}{c} 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\end{array}$	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/14/07 5/15/07 5/16/07 5/18/07 5/19/07 5/20/07 5/21/07 5/22/07 5/23/07	2,661 3,007 3,004 3,001 2,998 2,995 2,991 2,988 2,685 1,673	540 210 210 210 210 210 210 210 210 210 21		23.11 23.52 23.94 24.36 24.77 25.19 25.61 26.02 26.44	3,201 3,217 3,214 3,211 3,208 3,205 3,201 3,198 2,895 1,673	154 151 148 145 141 138 135 132 129 126	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	180 180 180 180 180 180	0 0 0 0 0	430 430 430 430 430 430 250 250 250 250 250	537 537 537 537 537 537 537 537 250 200 200	800 800 800 800 800 800 500 250 200 200 200	30 30 30 30 30 30 30	830 830 830 830 830 830 530 250 200 200	$\begin{array}{c} 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 741\\ 741\\ 741\\ 741\\ \end{array}$	$\begin{array}{c} 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 1,500\\ 741\\ 741\\ 741\\ 741\\ 741\\ \end{array}$	0 0 0 0 0 0	0 0 0 0 0	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741 741	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,620 1,617 1,564 1,561 1,558 1,555 1,552 1,549	0 0 0 0 0 0 0			1,620 1,617 1,564 1,561 1,558 1,555 1,552 1,549	123 120 117 114 111 108 105 102	300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250	150 150 150 150 150 150 135 120	150 150 150 150 150 150 135 120		150 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	2,770 Ital Water (430 TAF):		26.44	3,200	183	300	250	VA 407	MP Peri 0	od 657 25.01	537 0.00	537	23	560	1,500 1.43	1,500	0	0	1,500 0.00	

Appendix A-1, Table 10 2007 VAMP DAILY OPERATION PLAN – APRIL 13, 2007 (A) SINGLE-STEP; LOW UNGAGED FLOW Target Flow Period: April 22 - May 22 • Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merce	ed River	at Cress	ey	Tuolur	nne River a	Stanislaus R blw Goodwin							
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existin Flow- reshap	gVAMP Suppl. edFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	3-3tall.
3/15/07 3/16/07 3/17/07 3/18/07 3/20/07 3/21/07 3/22/07 3/22/07 3/23/07 3/24/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230	788 759 739 727 710 702 659 659 609 536	97 97 194 192 203 185 378 316 392 417	215 228 213 212 216 208 215 223 212 213			215 228 213 212 216 208 215 223 212 213	349 348 338 337 337 334 335 334 335 334 335	349 348 338 337 337 334 335 334 335 334 335		349 348 338 337 337 334 335 334 335	804 806 802 687 603 609 607 604 547 504	804 806 802 687 603 609 607 604 547 504			804 806 802 687 603 609 607 604 547 504	
3/25/07 3/26/07 3/27/07 3/28/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/2/07 4/4/07 4/2/07	2,210 2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720				2,210 2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720	476 460 461 447 437 437 414 393 380 342 328	497 573 523 512 486 389 374 444 444 444 360 298 261	214 215 234 229 229 223 198 202 221 214 214 213 206			214 215 234 229 229 223 198 202 221 214 213 206	336 335 335 337 337 338 339 338 339 338 337 337	336 335 335 337 337 338 339 338 339 338 339 338 337 337		336 335 335 337 337 338 339 338 339 338 337 337	502 509 503 505 503 503 501 500 502 509 503 503	502 509 503 505 503 503 501 500 502 509 503 503			502 509 503 505 503 503 501 500 502 509 503 503	
4/5/07 4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07	1,670 1,670 1,700 1,770 1,860 1,650 1,620 1,620 1,664	0			1,670 1,670 1,700 1,770 1,860 1,650 1,620 1,710 1,664	296 271 260 279 274 276 267 299 290	261 288 354 454 557 322 285 375 358	206 195 203 215 216 192 176 179 250			206 195 203 215 216 192 176 179 250	337 337 338 338 338 338 339 343 343 341 300	337 337 338 338 338 338 338 339 343 341 300		337 338 338 338 338 339 343 343 341 300	500 502 510 508 508 504 504 504 800 768	500 502 510 508 508 504 504 504 800 768			500 502 510 508 508 504 504 504 800 768	
4/14/07 4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/21/07 4/22/07 4/23/07	1,957 1,861 1,906 1,830 1,804 1,778 1,752 1,726 2,881 2,878	0 0 0 0 0 0 0 0 260 330	0 0 0 0 0 0 0 0	0.00 0.00 0.00 0.00 0.00 0.00 0.52 1.17	1,957 1,861 1,906 1,830 1,804 1,778 1,752 1,726 3,141 3,205	281 272 263 254 245 236 231 228 225 221	341 324 307 290 273 256 239 222 100 100	250 250 250 250 250 250 250 250 250 250	50 100 100 100 100	60 60 60 60	250 250 250 250 250 360 410 410 410 410	300 250 250 250 250 250 537 537 537 537	300 250 250 250 250 250 800 800 800 800	150 170 170 170	300 250 250 250 250 250 950 970 970 970	768 768 768 768 768 768 1,500 1,500 1,500 1,500	768 768 768 768 768 768 1,500 1,500 1,500 1,500	0 0 0 0	0 0 0 0	768 768 768 768 768 768 1,500 1,500 1,500 1,500	
4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/3/07 5/4/07	2,871 2,871 2,868 2,865 2,862 2,859 2,855 2,552 2,552 2,552 2,249 2,246	330 330 330 330 330 330 330 690 1,000 1,000		2.48 3.13 3.79 4.44 5.10 5.75 7.12 9.10 11.09	3,205 3,201 3,198 3,195 3,192 3,189 3,185 3,242 3,249 3,246	218 215 212 209 205 202 199 196 193 193 193 189	100 100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	100 100 100 450 780 780 780 780 780 780	60 60 60 70 60 60 60 60 60 60	410 410 410 770 1,090 1,090 1,090 1,090 1,090	537 537 537 537 537 537 537 537 537 537	800 800 800 800 500 200 200 200 200 200	170 170 170 170 170 170 160 160 160 160	970 970 970 970 970 670 360 360 360 360	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500			1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/13/07 5/13/07	2,239 2,236 2,233 2,230 2,227 2,223 2,220 2,217 2,214 2,461	1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000 1,000		15.05 17.04 19.02 21.00 22.99 24.97 26.96 28.94 30.92	3,239 3,236 3,233 3,230 3,227 3,223 3,220 3,217 3,214 3,201	183 183 177 173 170 167 164 161 157 154	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	780 780 780 780 780 780 780 510 180 180	60 60 60 60 60 60 70 60 60 60	1,090 1,090 1,090 1,090 1,090 1,090 1,090 830 490 490	537 537 537 537 537 537 537 537 537 537	200 200 200 200 200 200 200 200 450 800	160 160 160 160 160 160 160 160 160	360 360 360 360 360 360 360 610 960	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	0 0 0 0 0 0 0 0 0 0		1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/15/07 5/16/07 5/17/07 5/18/07 5/19/07 5/20/07 5/21/07 5/22/07 5/22/07	2,401 2,807 2,804 2,801 2,798 2,795 2,791 2,788 2,485 1,473	400 400 400 400 400 400 400 400 400 0		33.18 33.98 34.77 35.56 36.36 37.15 37.94 38.74	3,207 3,204 3,201 3,198 3,195 3,191 3,188 2,885 1,473	151 151 148 145 141 138 135 132 129 126	100 100 100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250 250	180 180 180 180 180	60 60 60 60 60	490 490 490 490 490 250 250 250 250	537 537 537 537 537 537 537 250 200 200	800 800 800 800 800 500 250 200 200	160 160 160 160 160 160	960 960 960 960 960 660 250 200 200	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741 741	0 0 0 0 0 0	0 0 0 0 0	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741	
5/25/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,420 1,417 1,364 1,358 1,358 1,355 1,352 1,349	0 0 0 0 0 0			1,420 1,417 1,364 1,358 1,358 1,355 1,352 1,349	123 120 117 114 111 108 105 102	100 100 100 100 100 100 100	250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250	150 150 150 150 150 150 135 120	150 150 150 150 150 150 135 120		150 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	2,570 tal Water (630 TAF):		38.74	3,200	183	100	250	VA 407	61	od 717 25.01	537 3.73	537	163	700	1,500 10.00	1,500	0	0	1,500 0.00	

Appendix A-1, Table 11 2007 VAMP DAILY OPERATION PLAN – APRIL 16, 2007 Target Flow Period: April 22 - May 22 • Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis							Merce	ed River	at Cress	еу	Tuolur	nne River a	Stanislaus R blw Goodwin							
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existii Flow- resha	ngVAMP Suppl. pedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	o-otan.
3/15/07 3/16/07 3/17/07 3/18/07 3/19/07 3/20/07 3/21/07 3/22/07 3/23/07 3/24/07 3/25/07 3/25/07	2,420 2,290 2,350 2,310 2,150 2,240 2,180 2,200 2,230 2,210				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,280 2,200 2,230 2,210	788 759 739 727 710 702 659 659 609 536 476	97 97 194 192 203 185 378 316 392 417 497 572	215 228 213 212 216 208 215 223 215 223 212 213 214			215 228 213 212 216 208 215 223 215 212 213 214	349 348 338 337 337 334 335 334 335 334 335 336	349 348 338 337 337 337 334 335 334 335 334 335 336		349 348 338 337 337 334 335 334 335 334 335 336	804 806 802 687 603 609 607 604 547 504 502	804 806 802 687 603 609 607 604 547 504 502			804 806 802 687 603 609 607 604 547 504 502	
3/26/07 3/28/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/3/07 4/4/07	2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720 1,670				2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720 1,670	460 461 447 437 437 414 393 380 342 328 296	573 523 512 486 389 374 444 444 360 298 261	215 234 229 229 223 198 202 221 214 213 206			215 234 229 229 223 198 202 221 214 213 206	335 335 337 337 338 339 338 337 337 337	335 335 337 337 337 338 339 338 337 337 337		335 335 337 337 338 339 338 337 337 337	509 503 505 503 503 501 500 502 509 509 503 500	509 503 505 503 503 501 500 502 509 509 503 500			509 503 505 503 503 501 500 502 509 503 500	
4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07 4/14/07	1,670 1,670 1,700 1,770 1,860 1,650 1,620 1,720 1,660 1,710				1,670 1,670 1,770 1,860 1,650 1,620 1,720 1,660 1,710	230 271 260 279 274 276 267 299 290 291	201 288 354 454 557 322 285 385 354 394	195 203 215 216 192 176 179 181 204			195 203 215 216 192 176 179 181 204	337 338 338 338 338 339 343 341 340 343	337 338 338 338 338 339 343 341 340 343		337 338 338 338 339 343 341 340 343	500 502 510 508 508 508 504 504 504 500 503 503	500 502 510 508 508 504 504 504 504 500 503			502 510 508 508 504 504 504 500 503 503	
4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/21/07 4/22/07 4/22/07 4/23/07	1,890 1,618 1,600 1,843 1,843 1,843 1,834 1,825 3,081 3,078	100 150	0	0.20	1,890 1,618 1,600 1,843 1,843 1,843 1,834 1,825 3,181 3,228	293 284 275 266 257 231 228 225 221	578 300 300 300 300 300 300 300 300 300 30	241 250 250 250 250 250 250 250 250 250	50 100 100 100 100	0 0 0 0 0	241 250 250 300 350 350 350 350	296 250 250 250 250 537 537 537 537	296 250 250 250 250 800 800 800 800	50 50 50 50	296 250 250 250 250 850 850 850 850	507 768 768 768 1,500 1,500 1,500 1,500	507 768 768 768 1,500 1,500 1,500 1,500	0 0 0 0	0 0 0 0	507 768 768 768 768 1,500 1,500 1,500 1,500	
4/24/07 4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/3/07	3,075 3,071 3,068 3,065 3,062 3,059 3,055 2,752 2,449 2,446	150 150 150 150 150 150 450 780 780		0.79 1.09 1.39 1.69 1.98 2.28 2.58 3.47 5.02 6.57 8.11	3,225 3,221 3,218 3,215 3,212 3,209 3,205 3,202 3,229 3,229 3,226	218 215 212 209 205 202 199 196 193 189	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	100 100 100 450 780 780 780 780 780		350 350 350 700 1,030 1,030 1,030 1,030 1,030	537 537 537 537 537 537 537 537 537 537	800 800 800 800 500 200 200 200 200 200	50 50 50 50 50 0 0 0 0 0	850 850 850 850 200 200 200 200 200	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500			1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/4/07 5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/13/07	2,443 2,439 2,436 2,433 2,430 2,427 2,423 2,420 2,417 2,414 2,661	780 780 780 780 780 780 780 780 780		8.11 9.66 11.21 12.75 14.30 15.85 17.40 18.94 20.49 22.04	3,223 3,219 3,216 3,213 3,210 3,207 3,203 3,200 3,197 3,194	180 183 180 177 173 170 167 164 161 157	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	780 780 780 780 780 780 780 510 180 180		1,030 1,030 1,030 1,030 1,030 1,030 1,030 760 430 430	537 537 537 537 537 537 537 537 537 537	200 200 200 200 200 200 200 200 450 800	0 0 0 0 0 0 0 30 40	200 200 200 200 200 200 200 200 480 840	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500			1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/14/07 5/15/07 5/16/07 5/17/07 5/19/07 5/20/07 5/20/07 5/22/07 5/22/07 5/23/07	2,661 3,007 3,004 3,001 2,998 2,995 2,991 2,988 2,685 1,673	540 220 220 220 220 220 220 180 180 0		23.11 23.54 23.98 24.42 24.85 25.29 25.73 26.08 26.44	3,201 3,227 3,224 3,221 3,218 3,215 3,211 3,168 2,865 1,673	154 151 148 145 141 138 135 132 129 126	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	180 180 180 180 180 180	0 0 0 0 0	430 430 430 430 430 250 250 250 250	537 537 537 537 537 537 537 537 537 250 200 200	800 800 800 800 800 800 500 250 250 200 200	40 40 40 40 40 0 0	840 840 840 840 840 800 500 250 200 200	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741	0 0 0 0 0	0 0 0 0 0	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741 741	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,620 1,617 1,564 1,551 1,558 1,555 1,552 1,549	0 0 0 0 0 0 0	0 0 0 0 0 0 0		1,620 1,617 1,564 1,561 1,558 1,555 1,552 1,549	123 120 117 114 111 108 105 102	300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250	150 150 150 150 150 150 150 135 120	150 150 150 150 150 150 150 135 120		150 150 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	2,770 tal Water (430 TAF):		26.44	3,200	183	300	250	VA 407	O O	657 25.01	537 0.00	537	23	560	1,500 1.43	1,500	0	0	1,500 0.00	

Appendix A-1, Table 12 2007 VAMP DAILY OPERATION PLAN – APRIL 18, 2007 Target Flow Period: April 22 - May 22 * Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	San Joaquin River near Vernalis						Merced River at Cressey					Tuolun	nne River a	Stanislaus R blw Goodwin							
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existi Flow- resha	ngVAMP Suppl. pedFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	o-otali.
3/15/07 3/16/07 3/17/07 3/19/07 3/20/07 3/22/07 3/22/07 3/22/07 3/23/07 3/24/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,230	788 759 739 727 710 702 659 659 609 536	97 97 194 192 203 185 378 316 392 417	215 228 213 212 216 208 215 223 212 213			215 228 213 212 216 208 215 223 212 213	349 348 338 337 337 337 334 335 334 335	349 348 338 337 337 337 334 335 334 335		349 348 338 337 337 334 335 334 335	804 806 802 687 603 609 607 604 547 504	804 806 802 687 603 609 607 604 547 504			804 806 802 687 603 609 607 604 547 504	
3/25/07 3/26/07 3/28/07 3/28/07 3/30/07 3/31/07 4/1/07 4/2/07 4/3/07	2,210 2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720				2,210 2,160 2,050 2,030 1,910 1,880 1,950 1,920 1,790 1,720	476 460 461 447 437 437 414 393 380 342 328	497 573 523 512 486 389 374 444 444 360 298	214 215 234 229 229 223 198 202 221 214 213			214 215 234 229 229 223 198 202 221 214 213	336 335 335 337 337 337 338 339 338 339 338 337 337	336 335 335 337 337 338 339 338 339 338 337 337		336 335 335 337 337 338 339 338 339 338 337	502 509 503 505 503 503 501 500 502 509 503	502 509 503 505 503 503 501 500 502 509 503			502 509 503 505 503 503 501 500 502 509 503	
4/5/07 4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07	1,670 1,670 1,700 1,770 1,860 1,650 1,620 1,720 1,660				1,670 1,670 1,700 1,770 1,860 1,650 1,620 1,720 1,660	296 271 260 279 274 276 267 299 290	261 288 354 454 557 322 285 385 385 354	206 195 203 215 216 192 176 179 181			206 195 203 215 216 192 176 179 179 179	337 337 338 338 338 338 339 343 341 340	337 337 338 338 338 338 339 343 341 340		337 337 338 338 338 338 339 343 341 341 340	500 502 510 508 508 508 504 504 504 500 503	500 502 510 508 508 508 504 504 504 504 500 503			500 502 510 508 508 508 504 504 504 500 503	
4/14/07 4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/21/07 4/22/07 4/23/07	1,710 1,890 1,970 1,850 1,685 1,659 1,839 1,822 2,881 2,878	300 350	0 0	0.60	1,710 1,890 1,970 1,850 1,685 1,659 1,839 1,822 3,181 3,228	291 293 346 314 284 254 231 228 225 221	394 578 652 550 300 300 300 300 300 300 300	204 241 247 237 250 250 250 250 250 250 250	50 100 100 100 100	0 0 0 0	204 241 247 237 250 300 350 350 350 350 350	343 296 295 250 250 250 599 599 599 599	343 296 295 250 250 600 600 600 600 600	250 250 250 250	343 296 295 295 250 250 850 850 850 850 850	503 507 503 503 768 768 1,500 1,500 1,500 1,500	503 507 503 503 768 768 1,500 1,500 1,500 1,500	0 0 0 0	0 0 0 0	503 507 503 503 768 768 1,500 1,500 1,500 1,500	
4/24/07 4/25/07 4/26/07 4/27/07 4/28/07 4/29/07 4/30/07 5/1/07 5/2/07 5/3/07	2,875 2,871 2,868 2,865 2,862 2,859 2,855 2,727 2,624 2,516	350 350 350 350 350 350 475 575 700		1.98 2.68 3.37 4.07 4.76 5.45 6.15 7.09 8.23 9.62	3,225 3,221 3,218 3,215 3,212 3,209 3,205 3,202 3,199 3,216	218 215 212 209 205 202 199 196 193 189	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	100 100 250 375 500 650 700 700 700		350 350 500 625 750 900 950 950 950	599 599 599 599 476 374 272 272 272 272	600 600 600 600 475 375 270 270 270 270	250 250 250 100 100 75 50 0 0	850 850 850 700 575 450 320 270 270	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500			1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/4/07 5/5/07 5/6/07 5/7/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/13/07	2,513 2,509 2,506 2,503 2,500 2,497 2,493 2,490 2,487 2,589	700 700 700 700 700 700 700 700 700 575		11.01 12.40 13.79 15.17 16.56 17.95 19.34 20.73 22.12 23.26	3,213 3,209 3,206 3,203 3,200 3,197 3,193 3,193 3,190 3,187 3,164	186 183 180 177 173 170 167 164 161 157	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	700 700 700 700 700 575 450 350 350		950 950 950 950 950 825 700 600 600	272 272 272 272 272 272 272 272 272 272	270 270 270 270 270 270 270 270 270 375 475 600	0 0 0 0 0 0 50 50	270 270 270 270 270 270 270 375 525 650	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500			1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500	
5/14/07 5/15/07 5/16/07 5/17/07 5/18/07 5/19/07 5/20/07 5/21/07 5/22/07 5/23/07	2,686 2,807 2,804 2,801 2,798 2,795 2,791 2,788 2,785 1,973	500 400 400 400 400 400 400 355 0		24.25 25.04 25.83 26.63 27.42 28.21 29.01 29.80 30.51	3,186 3,207 3,204 3,201 3,198 3,195 3,195 3,191 3,188 3,140 1,973	154 151 148 145 141 138 135 132 129 126	300 300 300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250 250	350 350 350 350 350 305	0 0 0 0 0	600 600 600 600 555 250 250 250 250 250	599 599 599 599 599 599 599 550 425 325	600 600 600 600 600 600 600 550 425 325	50 50 50 50 50 50 50	650 650 650 650 650 650 650 550 425 325	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741 741	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741 741	0 0 0 0 0	0 0 0 0 0	1,500 1,500 1,500 1,500 1,500 1,500 1,500 741 741 741	
5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/29/07 5/30/07 5/31/07	1,845 1,742 1,639 1,561 1,558 1,555 1,552 1,549	0 0 0 0 0 0 0	0 0 0 0 0 0 0		1,845 1,742 1,639 1,561 1,558 1,555 1,552 1,549	123 120 117 114 111 108 105 102	300 300 300 300 300 300 300 300	250 250 250 250 250 250 250 250 250			250 250 250 250 250 250 250 250 250	225 150 150 150 150 150 135 120	225 150 150 150 150 150 135 120		225 150 150 150 150 150 135 120	741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	2,704 tal Water (496 TAF):		30.51	3,200	183	300	250	VA 407	MP Peri 0	od 657 25.00	471 0.00	471	90	560	1,500 5.50	1,500	0	0	1,500 0.00	

Appendix A-1, Table 13 2007 VAMP DAILY OPERATION PLAN — MAY 4, 2007 Target Flow Period: April 22 - May 22 * Flow Target: 3,200 cfs Bold Numbers: observed real-time mean daily flows

	Sa	in River	near Ver	nalis			Merced River at Cressey				Tuolun	nne River a	t LaGran	Stanislaus R blw Goodwin							
Date	Existing Flow	VAMP Suppl. Flow	Other Suppl. Flow	Cum. VAMP Suppl. Flow	VAMP Flow	SJR above Merced R. (2 day lag)	Ungaged Flow above Vernalis	Existing Flow	MeID VAMP Suppl. Flow	Exch Contr VAMP Suppl. Flow	VAMP Flow (3 day lag)	Existing Flow - base FERC Volume	Existing Flow - Adjusted FERC Pulse	VAMP Suppl. Flow	VAMP Flow (2 day lag)	Existing Flow - Base	Existin Flow- S reshap	gVAMP Suppl. edFlow	Other Suppl. Flow	VAMP Flow (2-day lag)	Maintain Priority Flow Level M=Merced T=Tuol. S=Stan
	(cfs)	(cfs)	(cfs)	(TAF)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	o otam
3/15/07 3/16/07 3/17/07 3/18/07 3/19/07 3/20/07 3/21/07 3/22/07 3/22/07 3/23/07	2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200 2,220				2,420 2,290 2,350 2,320 2,310 2,150 2,240 2,180 2,200	788 759 739 727 710 702 659 659 609 526	80 79 176 174 185 167 360 298 375	215 228 213 212 216 208 215 223 212 212			215 228 213 212 216 208 215 223 212 212	349 348 338 337 337 337 334 335 334 225	349 348 338 337 337 337 334 335 334 225		349 348 338 337 337 337 334 335 334 225	804 806 802 687 603 609 607 604 547	804 806 802 687 603 609 607 604 547			804 806 802 687 603 609 607 604 547	
3/25/07 3/26/07 3/26/07 3/28/07 3/29/07 3/29/07 3/30/07 3/31/07 4/1/07 4/2/07 4/4/07	2,210 2,160 2,050 2,030 2,000 1,910 1,880 1,950 1,920 1,790				2,210 2,160 2,050 2,030 2,000 1,910 1,880 1,950 1,920 1,790	460 461 447 437 437 414 393 380 342	479 555 505 494 469 371 356 426 436 436 342	214 215 234 229 229 223 198 202 221 214			214 215 234 229 229 223 198 202 221 221 214	336 335 335 335 337 337 338 339 338 339 338 337	335 335 335 337 337 338 339 338 339 338 339		336 335 335 335 337 337 337 338 339 338 339 338 337	502 509 503 505 503 503 503 503 501 500 502 509	502 509 503 505 503 503 503 501 500 502 509			502 509 503 505 503 503 503 501 500 502 509	
4/4/07 4/5/07 4/6/07 4/7/07 4/8/07 4/9/07 4/10/07 4/11/07 4/12/07 4/13/07	1,720 1,670 1,670 1,700 1,770 1,860 1,650 1,620 1,720 1,660				1,712 1,662 1,662 1,693 1,762 1,862 1,652 1,612 1,712 1,662	328 296 271 260 279 274 276 267 299 290	290 253 280 347 446 559 324 277 377 356	213 206 195 203 215 216 192 176 179 181			213 206 195 203 215 216 192 176 179 181	337 337 338 338 338 338 338 338 339 343 341 340	337 337 338 338 338 338 338 338 339 343 341 340		337 337 337 338 338 338 339 343 341 340	503 500 502 510 508 508 508 504 504 504 504 500 503	503 500 502 510 508 508 508 504 504 504 504 500 503			503 500 502 510 508 508 508 504 504 504 500 500	
4/14/07 4/15/07 4/16/07 4/17/07 4/18/07 4/19/07 4/20/07 4/20/07 4/22/07 4/22/07 4/23/07	1,710 1,890 1,972 1,834 1,744 1,764 1,874 2,703 3,202 3,435	308 355	0	0.61 1.32	1,712 1,892 1,972 1,834 1,744 1,764 1,874 2,703 3,510 3,790	291 293 346 314 317 311 278 271 242 273	396 580 654 534 359 405 522 525 571 811	204 241 247 237 246 250 250 250 250 250	41 80 92 124 128	0 0 0 0 0	204 241 247 237 246 291 330 342 374 378	343 296 295 295 295 589 599 599 599 599	343 296 295 295 295 589 600 600 600 600	267 275 275 271	343 296 295 295 295 589 867 875 875 875	503 507 503 503 1,032 1,503 1,503 1,507 1,501	503 507 503 503 1,032 1,503 1,503 1,503 1,507 1,501	0 0 0 0	0 0 0	503 507 503 503 503 1,032 1,503 1,503 1,507 1,501	
4/24/07 4/25/07 4/26/07 4/27/07 4/29/07 4/29/07 4/30/07 5/1/07 5/2/07 5/3/07	3,313 3,195 3,123 3,059 3,012 3,060 3,003 2,758 2,523 2,404	367 395 397 311 158 100 198 332 437 416	0 0 0 0 0 0 0 0	2.04 2.83 3.61 4.23 4.54 4.74 5.14 5.79 6.66 7.49	3,680 3,590 3,520 3,370 3,170 3,160 3,200 3,090 2,960 2,820	282 291 281 238 218 204 243 256 237 180	714 571 487 417 381 470 433 327 153 128	250 250 250 250 250 250 250 250 250 250	128 113 100 198 318 405 370 369 329 321	0 0 0 0 0 0 0 0	378 363 350 448 655 620 619 579 571	599 599 599 599 476 374 272 272 272 272	600 600 600 600 475 375 270 270 270	269 183 45 0 14 32 46 42 101	869 783 645 600 599 489 407 316 312 371	1,504 1,501 1,502 1,502 1,502 1,502 1,502 1,500 1,497 1,504	1,504 1,501 1,500 1,502 1,502 1,502 1,502 1,500 1,497 1,504	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	1,504 1,501 1,500 1,502 1,502 1,502 1,502 1,500 1,497 1,504	
5/5/07 5/5/07 5/6/07 5/8/07 5/9/07 5/10/07 5/11/07 5/12/07 5/12/07 5/13/07 5/14/07 5/15/07 5/16/07 5/16/07 5/19/07 5/19/07 5/20/07 5/21/07	2,404 2,406 2,406 2,400 2,397 2,393 2,390 2,387 2,489 2,586 2,707 2,704 2,704 2,704 2,695 2,695 2,695 2,695 2,695 2,688 2,685 2,685	$\begin{array}{c} 430\\ 471\\ 525\\ 520\\ 700\\ 800\\ 800\\ 800\\ 725\\ 625\\ 500\\ 500\\ 500\\ 500\\ 500\\ 500\\ 500\\ 5$		$\begin{array}{c} 9.15\\ 9.15\\ 10.09\\ 11.13\\ 12.16\\ 13.55\\ 15.14\\ 16.72\\ 18.31\\ 19.75\\ 20.99\\ 21.98\\ 22.97\\ 23.96\\ 24.95\\ 25.95\\ 26.94\\ 27.93\\ 26.94\\ 27.93\\ 28.77\\ \end{array}$	2,834 2,834 2,877 2,928 2,920 3,097 3,193 3,190 3,187 3,214 3,214 3,214 3,207 3,204 3,201 3,198 3,195 3,191 3,188 3,191 3,188 3,110	$\begin{array}{c} 183\\ 183\\ 180\\ 177\\ 173\\ 170\\ 167\\ 164\\ 161\\ 157\\ 154\\ 151\\ 148\\ 145\\ 141\\ 138\\ 135\\ 132\\ 129\\ 192\end{array}$	200 200 200 200 200 200 200 200 200 200	250 250 250 250 250 250 250 250 250 250	420 700 800 800 800 800 500 500 500 500 500 5		700 950 1,050 1,050 1,050 975 875 750 750 750 750 750 750 750 750 750 7	272 272 272 272 272 272 272 272 272 272	210 270 270 270 270 270 270 270 270 270 27	100 70 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	$\begin{array}{c} +25\\ 370\\ 340\\ 270\\ 270\\ 270\\ 270\\ 375\\ 475\\ 600\\ 600\\ 600\\ 600\\ 600\\ 600\\ 600\\ 60$	$\begin{array}{c} 1,500\\ 1,$	$\begin{array}{c} 1,500\\ 1,$			$\begin{array}{c} 1,500\\ 1,$	
5/23/07 5/24/07 5/25/07 5/26/07 5/27/07 5/28/07 5/28/07 5/29/07 5/30/07 5/31/07	$1,673 \\ 1,645 \\ 1,542 \\ 1,464 \\ 1,461 \\ 1,458 \\ 1,455 \\ 1,455 \\ 1,452 \\ 1,449 \\ 1,44$	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0		$\begin{array}{c} 1,673\\ 1,645\\ 1,542\\ 1,464\\ 1,461\\ 1,458\\ 1,455\\ 1,455\\ 1,452\\ 1,449\end{array}$	126 123 120 117 114 111 108 105 102	200 200 200 200 200 200 200 200 200 200	250 250 250 250 250 250 250 250 250	VA	MP Peri	250 250 250 250 250 250 250 250 250 250	325 225 150 150 150 150 150 135 120	225 150 150 150 150 150 150 135 120		225 150 150 150 150 150 150 135 120	/41 741 741 741 741 741 741 741 741 741	741 741 741 741 741 741 741 741 741 741			741 741 741 741 741 741 741 741 741 741	
Avg. (cfs): Supplemen	2,721 Ital Water (1	468 TAF):		28.77	3,189	201	299	250	399	0	649 24.53	471 0.00	471	69	540	1,501 4.24	1,501	0	0	1,501 0.00	

Appendix A-2, Figure 1 Merced River at Cressey



Appendix A-2, Figure 2 Merced River near Stevinson



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



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



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



Appendix A-2, Figure 6 San Joaquin River near Vernalis



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



San Joaquin River Group Authority

P.O. Box 4060 • Modesto, CA 95352 • (209) 526-7405 • fax (209) 526-7315

Modesto Irrigation District Turlock Irrigation District Oakdale Irrigation District Merced Irrigation District Frian Water Users Authority City and County of San Francisco South San Joaquin Irrigation District San Joaquin River Exchange Contractors

APPENDIX B



Appendix B-1, Figure 1 SJRA Storage Impacts, 2000-2007 Lake McClure (Merced River)

Appendix B-1, Figure 2 SJRA Storage Impacts, 2000-2007 Don Pedro Reservoir (Tuolumne River)



Appendix B-1, Figure 3 Merced River below Crocker-Huffman Dam 2000-2007



Appendix B-1, Figure 4 Tuolumne River below LaGrange Dam 2000-2007



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APPENDIX C



Appendix C-1 Water Temperature Monitoring Locations


Appendix C-1 VAMP 2007 Water Temperature Monitoring									
Site #	Logger Number	Temperature Monitoring Location	Lat	Long	Distance from Durham Ferry	Date Deployed	Date Retrieved	Notes	
n/a	900618	Hatchery 1	n/a	n/a	n/a	4/6/07			
n/a	877664	Hatchery 2	n/a	n/a	n/a	4/6/07			
n/a	900619	Hatchery 3	n/a	n/a	n/a	4/6/07			
n/a	900620	Hatchery 4	n/a	n/a	n/a	4/6/07			
1	900616	Durham Ferry	N 37 41.381	W 121 15.657	0	4/3/07	7/19/07	Near intake pump on tree at water line	
2	877665	Mossdale	N 37 47.180	W 121 18.425	11	4/3/07	Missing	Under bridge on cable	
3	900625	Old River at HORB	N 37 48.457	W 121 19.872	14	4/3/07	7/19/07	On tree near flagging across from intake pump	
4	900617	Dos Reis	N 37 49.808	W 121 18.665	16	4/3/07	7/19/07	On tree normally used across from launch ramp	
5	877669	DWR Monitoring Station	N 37 51.869	W 121 19.376	19	4/3/07	Missing	As normal	
6a	900615	Confluence – Top	N 37 56.818	W 121 20.285	27	4/3/07	Missing	As normal	
6b	626431	Confluence- Bottom	N 37 56.818	W 121 20.285	27	4/3/07	Missing	As normal	
7	626437	Downstream of Channel Marker 30	N 37 59.776	W 121 25.569	33	4/3/07	Missing	As normal	
8	877666	Turner Cut	N 37 59.468	W121 27.267	35	4/3/07	Missing	On USGS gaging station	
9	900622	"Q" Piling 1/2 mile upstream of channel marker 13	N 38 01.940	W 121 28.769	37	4/3/07	Missing	As normal	
10	900624	All Pro abandoned boat	N 38 04.522	W 121 34.413	45	4/3/07	Missing	As normal	
11	551654	Jersey Point USGS Gauging Station	N 38 03.172	W121 41.637	56	4/3/07	Missing	As normal	
12	562570	Antioch Marina	N 38 01.147	W121 48.829	64	4/3/07	Missing	On pilings across channel from marina upstream	
13	551657	Chipps Island	N 38 03.084	W 121 55.463	72	4/3/07	Missing	As normal	
14	562563	Holland Riverside Marina	N 37 58.323	W 121 34.887	South Delta	4/2/07	Missing	On "No Wake" sign	
15	900623	Old River / Indian Slough Confluence	N 37 54.954	W 121 33.949	South Delta	4/2/07	7/13/07	On "Indian Slough" sign	
16	877663	CCF Radial Gates	N 37 49.773	W 121 33.096	South Delta	4/2/07	Missing	on DWR gaging station near intake gates	
17	900626	Grant Line Canal at Travy Blvd Bridge	N 37 49.143	W 121 27.026	South Delta	4/2/07	Missing	under bridge near repairs	
18	540810	Middle River at Victoria Canal Confluence	N37 53.323	W121 29.334	South Delta	4/2/07	Missing	On Staff gage	
19	877668	Werner Cut: Channel above Woodward Isle	N 37 56.319	W 121 30.584	South Delta	4/2/07	7/13/07	On old pilings	
Total Log	ggers: 24 -	Set to record every 24 n	nins (132 days)						



Appendix C-2 Hatchery 2 Water Temperature in Holding Tank





Appendix C-2 Hatchery 3 Water Temperature in Holding Tank



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Appendix C-2 Old River at HORB





Appendix C-2 Old River/Indian Slough Confluence





Appendix C-2 Werner Cut - Channel above Woodward Isle

Appendix C-3. Chinook salmon smolt conditon 48-hours post-release.																					
Release Location	CWT codes	Exam. Date	n	min FL	max FL	mean FL	river temp C	truck temp C	Delivery Time	Fish released	min scale loss	max scale loss	mean scale loss	color (% norm.)	Fin hemor- rhaging (% none)	Eyes (% norm.)	Gill color (% norm.)	Partial adclips (number)	Missing ad clips (number)	mortalities	comments or other abnormal- ities
Durham Ferry I	acoustic tagged	5/5/07	10	104	113	109	11.0	17.0	10:30	11:30	1.0	3.0	2.2	100	100	100	100	0	0	0	
Mossdale I	acoustic tagged	5/5/07	10	105	111	109.0	13.0	17.0	12:00	13:00	1.0	4.0	2.0	100	100	100	100	0	0	0	
MRH I	acoustic tagged	5/14/07	10	103	113	110.0			11:15		1.0	6.0	2.7	100	100	100	96	0	0	0	mortality; scale loss
Durham Ferry II	acoustic tagged	5/12/07	20	103	126	113.0	11.0	19.0	10:45	11:40	1.0	6.0	3.3	100	100.0	100.0	100.0	0.0	0.0	0	
Mossdale II	acoustic tagged	5/12/07	20	107	122	112.8	11.5	21.0	11:30	12:30	1.0	7.0	2.1	100	100.0	100.0	100.0	0.0	0.0	0	
MRH II	acoustic tagged	5/14/07	10	109	119	113.8			12:15		1.0	5.0	2.6	100	100.0	100.0	100.0	0.0	0.0	0	

Appendix C-4 Detections of acoustic-tagged salmon from May 3 & 4 releases upstream of the Head of Old River Barrier.

Release Dates: May 3 and May 4, 2007 Relase Locations: Durham Ferry, Mossdale, Bowman Road, Stockton

									Mobile Mon	itoring
Release Date	Release Time	Release Site	Tag Code	Upstream of HORB Date/Time	Bowman Road Date/Time	Stockton Date/Time	Turner cut Date/Time	R16 Date/Time	Near Stockton Date/Comment	Other Locations Date/Comment
5/3/07	11:30	Durham Ferry	3000	5/4/07 9:51	5/4/07 16:54			5/16/07 2:14		
5/3/07	11:30	Durham Ferry	3007	5/4/07 10:13	5/5/07 20:03	5 / 1 / 0 7 / 0 / 1				
5/3/07	11:30	Durham Ferry	3014	5/4/07 10:18	5/4/07 15:01	5/4/07 19:41		5/8/07 14:56	5/17-18 Tag Not Moving	
5/3/07	11:30	Durham Ferry	3035	5/4/07 4:03	5/4/07 10:53	5/5/07 21:14		5/6/07 14.50	5/17-16,18g NUL MOVINg	
5/3/07	11:30	Durham Ferry	3042	0, 1, 01, 1100	0, 1, 01 10100	0, 0, 01 2111 1			5/17-18,Tag Not Moving	
5/3/07	11:30	Durham Ferry	3049	5/4/07 10:14	5/4/07 15:41	5/4/07 22:29			5/17-18,Tag Not Moving	
5/3/07	11:30	Durham Ferry	3056	5/6/07 12:00	5/7/07 0:43	5/7/07 11:13		5/10/07 19:40	5/17-18,Tag Not Moving	
5/3/07	11:30	Durham Ferry	3077	5/4/07 8:30	5/4/07 13:04	5/4/07 16:48				
5/3/07	11:30	Durham Ferry	3084	5/4/07 4:04	5/4/07 17:01		5/7/07 7:49			
5/3/07	11:30	Durham Ferry	3098	5/4/07 12:01	5/4/07 17:29		0,1,011.10		5/17-18,Tag Not Moving	
5/3/07	11:30	Durham Ferry	3105	5/4/07 4:42	5/4/07 13:22				, , , , , , ,	
5/3/07	11:30	Durham Ferry	3112	5/4/07 13:15	5/4/07 17:10					
5/3/07	11:30	Durham Ferry	3119	5/4/07 0:34	5/4/07 5:19					
5/3/07	11:30	Durnam Ferry	3120	5/4/07 4:08	5/1/07 18.12	5/5/07 22:23			5/17-18, lag Not Moving	
5/3/07	11:30	Durham Ferry	3133	5/4/07 15.25	5/4/07 18.12	5/5/01 22.25			5/17-18, Tag Not Moving	
5/3/07	11:30	Durham Ferry	3147	5/4/07 4:34	5/4/07 13:16				-,,,	
5/3/07	11:30	Durham Ferry	3154	5/4/07 12:49	5/4/07 17:25	5/5/07 9:06		5/8/07 18:59	5/17-18, Tag Not Moving	
5/3/07	11:30	Durham Ferry	3182	5/4/07 2:16	5/4/07 10:20	5/4/07 14:47				
5/3/07	11:30	Durham Ferry	3189	5/4/07 4:51	5/4/07 11:54	E/E/07 12:22	E /0 /07 6:00		E /17 19 Tex Not Moving	
5/3/07	11:30	Durham Ferry	3203	5/4/07 14:14	5/5/07 8:02	5/5/07 13:22	5/8/07 6:28		5/17-18, Tag Not Moving	
5/3/07	11:30	Durham Ferry	3210	5/4/07 6:25	5/4/07 12:24	5/4/07 15:28			0/11/10,105 101 1101115	
5/3/07	11:30	Durham Ferry	3217	5/4/07 13:00	5/4/07 17:27					
5/3/07	11:30	Durham Ferry	3231	5/4/07 10:55	5/4/07 16:00					
5/3/07	11:30	Durham Ferry	3238	5/4/07 15:46	5/4/07 23:13					
5/3/07	11:30	Durham Ferry	3245	5/4/07 11:36	5/4/07 18:00					
5/3/07	11:30	Durham Ferry	3259	5/4/07 13:51	5/4/07 18:18					
5/3/07	11:30	Durham Ferry	3266	5/4/07 6:00	5/4/07 13:37	5/4/07 17:38				
5/3/07	11:30	Durham Ferry	3280	5/4/07 12:30	5/4/07 16:25					
5/3/07	11:30	Durham Ferry	3287	5/4/07 14:23	5 (4 (07 40 00					5 (0 (07, 005D
5/3/07	11:30	Durham Ferry	3294	5/4/07 13:54	5/4/07 18:20			5/8/07 16:40		5/8/07, CCFB
5/3/07	11:30	Durham Ferry	3308	5/4/07 14:39	5/4/07 19:57	5/5/07 18:38		5/8/07 10.49		
5/3/07	11:30	Durham Ferry	3315	5/4/07 8:08	5/4/07 14:00	5/4/07 18:17		5/9/07 7:02		
5/3/07	11:30	Durham Ferry	3322	5/4/07 12:39	5/4/07 16:21		5/6/07 6:11			
5/3/07	11:30	Durham Ferry	3350	5/4/07 13:46	5/6/07 10:38					
5/3/07	11:30	Durham Ferry	3357	5/4/07 11:43	5/4/07 16:13					
5/3/07	11:30	Durham Ferry	3378	5/4/07 3:11	5/4/07 11:09					
5/3/07	11:30	Durham Ferry	3399	5/4/07 13:16	5/4/07 18:16	5/5/07 11:26		5/9/07 9:01		
5/3/07	11:30	Durham Ferry	3413	5/4/07 8:15	5/4/07 13:44	, ,				
5/3/07	11:30	Durham Ferry	3427	5/4/07 1:51	5/4/07 10:01	5/4/07 13:40	5/6/07 8:41			
5/3/07	11:30	Durham Ferry	3434	5/4/07 3:47	5/4/07 12:40	5/4/07 19:11				
5/3/07	11:30	Durnam Ferry	3441	5/4/07 11:57	5/4/07 16:37			5/10/07 12:39	5/17-18,18g Not Moving	
5/3/07	11:30	Durham Ferry	3469	5/4/07 12:50	5/4/07 17:30	5/5/07 11:39		3/10/07 12.33		
5/3/07	11:30	Durham Ferry	3490	5/3/07 23:43	5/4/07 8:44	, ,				
5/3/07	11:30	Durham Ferry	3497	5/4/07 2:02	5/4/07 9:09					
5/3/07	11:30	Durham Ferry	3504	5/4/07 5:52	5/4/07 12:24					
5/3/07	11:30	Durham Ferry	3511	5/4/07 5:51	5/4/07 12:33	5/6/07 0:56				
5/3/07	11:30	Durham Ferry	3539	5/10/07 8:01	5/ 5/ 07 11.24	3/0/01 0.30				
5/3/07	11:30	Durham Ferry	3546	5/6/07 0:14	5/6/07 5:54					
5/3/07	11:30	Durham Ferry	3553	5/4/07 16:25	5/4/07 21:50	5/5/07 14:37		5/9/07 15:24		
5/3/07	11:30	Durham Ferry	3560	5/6/07 7:12	5/6/07 13:45	E (4 (07 40 07				
5/3/07	11:30	Durham Ferry	3567	5/4/07 10:20	5/4/07 14:36	5/4/07 19:37	5/6/07 1:01			
5/3/07	11:30	Durham Ferry	3602	5/5/07 1:08	5/5/07 8:55	5/5/07 12:37	5/0/07 4.01			
5/3/07	11:30	Durham Ferry	3616	5/4/07 10:16	5/4/07 14:36	0,0,0112.01				
5/3/07	11:30	Durham Ferry	3623	5/4/07 19:47	5/5/07 4:51					
5/3/07	11:30	Durham Ferry	3637	5/4/07 4:26	5/4/07 12:34		5/6/07 7:34			
5/3/07	11:30	Durham Ferry	3651	5/4/07 11:29	5/4/07 16:07	5/7/07 17:00				
5/3/07	11:30	Durnam Ferry	3665	5/1/07 1:54	5/6/07 16:40	5/7/07 9:31				
5/3/07	11:30	Durham Ferry	3672	5/4/07 10:12	5/4/07 16:06	0/1/01 3.31				
5/3/07	11:30	Durham Ferry	3679	5/4/07 4:38	5/4/07 17:17					
5/3/07	11:30	Durham Ferry	3686	5/4/07 5:32	5/4/07 20:37					
5/3/07	11:30	Durham Ferry	3693	5/5/07 1:41	5/5/07 10:37	5/5/07 14:12				
5/3/07	13:00	Mossdale	3700	5/3/07 15:17	5/3/07 22:08					
5/3/07	13:00	Mossdale	3714	5/3/07 18:30	5/4/07 1:16					
5/3/07	13:00	Mossdale	3721	5/3/07 15:58	5/4/07 0:39					

Appendix C-4 Detections of acoustic-tagged salmon from May 3 & 4 releases upstream of the Head of Old River Barrier.

Release Dates: May 3 and May 4, 2007 Relase Locations: Durham Ferry, Mossdale, Bowman Road, Stockton

									Mobile Mo	nitoring
Release Date	Release Time	Release Site	Tag Code	Upstream of HORB Date/Time	Bowman Road Date/Time	Stockton Date/Time	Turner cut Date/Time	R16 Date/Time	Near Stockton Date/Comment	Other Locations Date/Comment
5/3/07	13:00	Mossdale	3728	5/3/07 15:41	5/4/07 0:20					
5/3/07	13:00	Mossdale	3735	5/3/07 15:27	5/3/07 23:06			5/8/07 15:36		
5/3/07	13:00	Mossdale	3742	5/3/07 18:05	5/5/07 9:24	5/5/07 13:20				
5/3/07	13:00	Mossdale	3749	5/3/07 15:00	5/3/07 20:30					
5/3/07	13:00	Mossdale	3756	5/3/07 16:14	5/4/07 10:06	5/4/07 13:53				
5/3/07	13:00	Mossdale	3763	5/3/07 15:49	5/3/07 22:21	5/4/07 9:10				
5/3/07	13.00	Mossdale	3777	5/3/07 15:23	5/3/07 23:38	5/1/07 0.52		5/8/07 20.36		
5/3/07	13:00	Mossdale	3784	5/3/07 15:59	5/3/07 23:40	5/4/07 8:30		5/6/01 20.50		
5/3/07	13:00	Mossdale	3791	5/3/07 16:56	5/4/07 9:31	5/4/07 19:23				
5/3/07	13:00	Mossdale	3798	5/3/07 14:49	5/4/07 0:29			5/9/07 11:14		
5/3/07	13:00	Mossdale	3805	5/3/07 15:53	5/3/07 22:49					
5/3/07	13:00	Mossdale	3812	5/3/07 16:22	5/4/07 0:45	5/4/07 11:52				
5/3/07	13:00	Mossdale	3819	5/3/07 15:51	5/4/07 7:36					
5/3/07	13:00	Mossdale	3826	5/3/07 17:32	F / 4 / 07 0.40					
5/3/07	13:00	Mossdale	3833	5/3/07 10:12	5/4/07 9:42	5/5/07 12:06				
5/3/07	13:00	Mossdale	3840	5/3/07 16:00	5/3/07 23:18	5/5/07 15.00				
5/3/07	13:00	Mossdale	3854	5/3/07 16:10	5/3/07 23:36	5/4/07 8:55				
5/3/07	13:00	Mossdale	3861	5/3/07 15:50	5/3/07 22:27	-, .,				
5/3/07	13:00	Mossdale	3868	5/3/07 15:44	5/3/07 21:04	5/4/07 9:24				
5/3/07	13:00	Mossdale	3875	5/3/07 16:11	5/4/07 6:20	5/4/07 13:34				
5/3/07	13:00	Mossdale	3882	5/3/07 15:27						
5/3/07	13:00	Mossdale	3889	5/3/07 17:00	5/3/07 23:27					
5/3/07	13:00	Mossdale	3896	5/3/07 15:57	5/3/07 22:25	5/4/07 8:53				
5/3/07	13:00	Mossdale	3903	5/3/07 15:03	5/3/07 22:41	5/4/07 10:58	E /E /07 10:00			E (0 (07 00 E0 11 Hum 4
5/3/07	13:00	Mossdale	3910	5/3/07 15:17	5/3/07 21:44	5/4/07 8:24	5/5/07 12:09			5/9/07 00:58, HWy 4
5/3/07	13:00	Mossdale	3917	5/3/07 15:10	5/4/07 0.16	5/4/01 0.24	5/5/07 12.05			5/ 5/ 07 13.27, hdby
5/3/07	13:00	Mossdale	3924	5/3/07 22:08	5/4/07 9:16					
5/3/07	13:00	Mossdale	3931	5/3/07 15:14	5/4/07 10:09					
5/3/07	13:00	Mossdale	3938	5/3/07 15:50	5/4/07 10:27			5/12/07 9:25		
5/3/07	13:00	Mossdale	3945	5/3/07 15:52	5/4/07 3:17	5/4/07 11:56				
5/3/07	13:00	Mossdale	3952	5/3/07 15:58	5/3/07 23:02	5/4/07 9:03		5/10/07 11:53		
5/3/07	13:00	Mossdale	3959	5/3/07 17:16	5/4/07 1:51					
5/3/07	13:00	Mossdale	3966	5/3/07 15:29	5/3/07 22:52					
5/3/07	13:00	Mossdale	3973	5/3/07 15:58	5/3/07 23.13					
5/3/07	13:00	Mossdale	3987	5/3/07 17:53	5/5/01 25.15					
5/3/07	13:00	Mossdale	3994	5/3/07 15:13						
5/3/07	13:00	Mossdale	4001	5/3/07 15:57	5/3/07 22:05	5/4/07 10:53				
5/3/07	13:00	Mossdale	4008	5/3/07 15:28	5/4/07 13:16	5/4/07 16:48				
5/3/07	13:00	Mossdale	4015	5/3/07 22:05	5/4/07 5:29	5/4/07 14:38	5/7/07 22:47			
5/3/07	13:00	Mossdale	4022	5/3/07 16:14	5/3/07 23:32					
5/3/07	13:00	Mossdale	4029	5/3/07 16:31	5/4/07 1:13					
5/3/07	13:00	Mossdale	4036	5/3/07 14:48	5/3/07 23:42					
5/3/07	13:00	Mossdale	4045	5/3/07 18:22	5/4/07 2:02					
5/3/07	13:00	Mossdale	4057	5/3/07 14:49	5/3/07 19:42	5/4/07 10:05				
5/3/07	13:00	Mossdale	4064	5/3/07 15:29	5/4/07 10:00	5/4/07 17:35				
5/3/07	13:00	Mossdale	4071	5/3/07 15:41	5/3/07 21:51	5/4/07 10:06				
5/3/07	13:00	Mossdale	4078	5/3/07 16:43	5/4/07 0:42	5/4/07 10:35				
5/3/07	13:00	Mossdale	4092	5/3/07 15:59						
5/3/07	13:00	Mossdale	4099	5/3/07 19:43	5/4/07 14:00	5/4/07 40 45				
5/3/07	13:00	Mossdale	4106	5/3/07 15:57	5/4/07 0:25	5/4/07 10:15		5/0/07 6:21		
5/3/07	13:00	Mossdale	4120	5/3/07 21.30	5/4/07 5.40	5/4/07 10:13		5/9/07 0.21		
5/3/07	13:00	Mossdale	4134	5/3/07 16:45	3/ 4/ 01 0.04	5/ 4/ 07 10:15				
5/3/07	13:00	Mossdale	4141	5/3/07 15:59	5/5/07 6:03					
5/3/07	13:00	Mossdale	4148	5/3/07 17:05	5/4/07 12:37			5/11/07 18:58		
5/3/07	13:00	Mossdale	4155	5/3/07 15:50						
5/3/07	13:00	Mossdale	4162	5/3/07 15:58	5/5/07 4:12					
5/3/07	13:00	Mossdale	4169	5/3/07 15:47	5/3/07 22:23	E /4 /07 0 00				
5/3/07	13:00	Mossdale	41/6	5/3/0/ 15:31	5/3/07 21:26	5/4/07 9:03	5/5/07 7:20		5/17-18, lag Not Moving	
5/3/07	13.00	Mossdale	4103	5/3/07 22:28	5/4/07 0:37		5/5/07 7:20			
5/3/07	13:00	Mossdale	4197	5/3/07 15:19	5/4/07 9.33					
5/3/07	13:00	Mossdale	4204	5/3/07 15:10	5/3/07 20:12	5/4/07 9:06				
5/3/07	13:00	Mossdale	4211	5/3/07 15:46	5/3/07 21:19					
5/3/07	13:00	Mossdale	4218	5/3/07 16:04	5/4/07 0:58	5/5/07 17:38				
5/3/07	13:00	Mossdale	4225	5/3/07 15:52	5/4/07 0:42					
5/3/07	13:00	Mossdale	4232	5/3/07 19:28	5/4/07 1:47	5/4/07 10:35				
5/3/07	13:00	Mossdale	4239	5/3/07 11:14	5/5/07 9:53					
5/3/07	13.00	Mossdale	4240	5/3/07 15:58	5/3/07 21:57					
0,0,01	10.00	moodulic	1200	3/ 0/ 01 10.00	5/ 5/ 5/ 21.5/					

Appendix C-4 Detections of acoustic-tagged salmon from May 3 & 4 releases upstream of the Head of Old River Barrier.

Release Dates: May 3 and May 4, 2007 Relase Locations: Durham Ferry, Mossdale, Bowman Road, Stockton

									Mobile Mon	itoring
Release Date	Release Time	Release Site	Tag Code	Upstream of HORB Date/Time	Bowman Road Date/Time	Stockton Date/Time	Turner cut Date/Time	R16 Date/Time	Near Stockton Date/Comment	Other Locations Date/Comment
5/3/07	13:00	Mossdale	4260	5/3/07 15:27	5/3/07 22:08					
5/3/07	13:00	Mossdale	4267	5/3/07 15:40						
5/3/07	13:00	Mossdale	4274	5/3/07 18:16	5/4/07 9:37	E / 4 / 07 10:20		5/9/07 4:38		
5/3/07	13:00	Mossdale	4281	5/3/07 15:27	5/3/07 22:09	5/4/07 10:36				
5/3/07	13:00	Mossdale	4200	5/3/07 18:38	5/5/07 22.19	5/4/01 8.22				
5/3/07	13:00	Mossdale	4309	5/3/07 18:56	5/4/07 13:03					
5/3/07	13:00	Mossdale	4316	5/3/07 16:09	, ,					
5/3/07	13:00	Mossdale	4323	5/3/07 16:27	5/3/07 23:25					
5/3/07	13:00	Mossdale	4330	5/3/07 15:04	5/4/07 0:28	E (4 (07 0 4 4				
5/3/07	13:00	Mossdale	4337	5/3/07 15:54	5/3/07 23:22	5/4/07 9:11				
5/3/07	13:00	Mossdale	4344	5/3/07 14.57	5/3/07 22:05					
5/3/07	13:00	Mossdale	4358	5/3/07 16:20	5/3/07 23:25					
5/3/07	13:00	Mossdale	4365	5/3/07 17:01	-, -,					
5/3/07	13:00	Mossdale	4372	5/3/07 15:59	5/3/07 23:20					
5/3/07	13:00	Mossdale	4379	5/3/07 15:51	5/3/07 23:15		5/7/07 11:30			
5/3/07	13:00	Mossdale	4386	5/3/07 15:57	5/4/07 1:36	5/4/07 11:47		5/9/07 17:40		
5/3/07	13:00	Mossdale Rowman Rd	4393	5/3/07 16:23	5/4/07 9:42	5/4/07 19:26				
5/3/07	12.15	Bowman Rd	5107			5/4/07 18:59				
5/3/07	12:15	Bowman Rd.	5156			5/4/07 16:26				
5/3/07	12:15	Bowman Rd.	5163			-, ,			5/17-18,Tag Not Moving	
5/3/07	12:15	Bowman Rd.	5177			5/5/07 9:56				
5/3/07	12:15	Bowman Rd.	5184			5/4/07 15:42				
5/3/07	12:15	Bowman Rd.	5196			E (C (07 01-00			5/17-18, lag Not Moving	
5/3/07	12:15	Bowman Rd.	5198			5/6/07 21:20				
5/3/07	12:15	Bowman Rd.	5205			5/ 4/ 01 15:55			5/17-18.Tag Not Moving	
5/3/07	12:15	Bowman Rd.	5233			5/4/07 16:19			-,,	
5/3/07	12:15	Bowman Rd.	5240			5/4/07 15:30				
5/3/07	12:15	Bowman Rd.	5247			5/4/07 18:25				
5/3/07	12:15	Bowman Rd.	5254			5/4/07 16:13		E (0 (07 7 04		
5/3/07	12:15	Bowman Rd.	5261			5/4/07 16:55		5/6/07 7:21		
5/3/07	12.15	Bowman Rd	5282			5/4/07 16:55				
5/3/07	12:15	Bowman Rd.	5303			5/4/07 17:22				
5/3/07	12:15	Bowman Rd.	5317			5/4/07 17:00				
5/3/07	12:15	Bowman Rd.	5331			5/4/07 16:00				
5/3/07	12:15	Bowman Rd.	5352			5/4/07 19:58				
5/3/07	12:15	Bowman Rd.	5359			E (4 (07 10:22		5/8/07 15:37		
5/3/07	12:15	Bowman Rd.	5373			5/4/07 19:33				
5/3/07	12:15	Bowman Rd.	5401			5/4/07 18:41	5/7/07 17:09			
5/3/07	12:15	Bowman Rd.	5408			5/6/07 21:20	0, 1, 01 11100		5/17-18,Tag Not Moving	
5/3/07	12:15	Bowman Rd.	5429					5/9/07 19:15	, , , , , ,	
5/3/07	12:15	Bowman Rd.	5527			5/4/07 18:12				
5/3/07	12:15	Bowman Rd.	5548			5/4/07 18:45		E (0 (07 00 00		
5/3/07	12:15	Bowman Rd.	5583			5/4/07 16:04		5/8/07 20:28		
5/3/07	12.15	Bowman Rd	5632			5/4/07 19:19			5/17-18 Tag Not Moving	
5/3/07	12:15	Bowman Rd.	5688			5/4/07 16:36			5/11/10,10g Not woving	
5/3/07	12:15	Bowman Rd.	5716			5/4/07 16:36				
5/3/07	12:15	Bowman Rd.	5751			5/4/07 17:17		5/9/07 13:00		
5/3/07	12:15	Bowman Rd.	5765			5/4/07 19:18				
5/3/07	12:15	Bowman Rd.	5786			5/4/07 18:48	F /7 /07 0.00			
5/4/07	12:51	Stockton	5800				5/1/01 3:22			
5/4/07	12:51	Stockton	6381				5/6/07 10:57			
5/4/07	12:51	Stockton	5912				0, 0, 01 10101	5/9/07 6:31		
5/4/07	12:51	Stockton	5919					5/8/07 22:20		
5/4/07	12:51	Stockton	6003					5/9/07 17:07		
5/4/07	12:51	Stockton	6031					5/8/07 17:42		
5/4/07	12:51	Stockton	6038					E /0 /07 01:0E	5/17-18, lag Not Moving	
5/4/07	12:51	Stockton	6122					5/8/07 15:3/		
5/4/07	12:51	Stockton	6171					5/9/07 7.28		
5/4/07	12:51	Stockton	6022					.,.,	5/17-18,Tag Not Moving	
5/4/07	12:51	Stockton	6262						5/17-18,Tag Not Moving	
5/4/07	12:51	Stockton	6269						5/17-18, Tag Not Moving	
5/4/07	12:51	Stockton	6276					E/10/07 10:00	5/17-18,Tag Not Moving	
5/4/07	12:51	Stockton	6367					5/10/07 18:38	5/17-18 Ted Not Movind	
5/4/07	12:51	Stockton	6458					5/8/07 21:25	5/ 11-10, iag ivot iviovilig	

Appendix C-5 Detections of acoustic-tagged salmon released May 4 downstream of the Head of Old River Barrier. Release Date: May 4, 2007 **Release Location: Old River downtstream of HORB Old River at** Release Release Release Tag **Tracy Fish Clifton Court Skinner Fish** Facilities Facilities Date Time Site Code Inlet Hwy 4 Date/Time Date/Time Date/Time Date/Time 5/4/07 10:17 D/S of HORB 4400 5/6/07 6:04 5/9/07 5:47 5/4/07 10:17 D/S of HORB 4407 5/6/07 18:40 4449 5/4/07 10:17 D/S of HORB 5/10/07 11:14 5/7/07 3:54 5/4/07 10:17 D/S of HORB 4456 5/14/07 12:29 5/4/07 10:17 D/S of HORB 4477 5/6/07 13:10 5/4/07 10:17 D/S of HORB 4505 5/10/07 0:26 5/4/07 10:17 D/S of HORB 4512 5/5/07 23:07 5/11/07 5:14 5/4/07 10:17 D/S of HORB 4519 5/4/07 10:17 D/S of HORB 4526 5/9/07 20:09 5/4/07 10:17 D/S of HORB 4547 5/7/07 15:03 5/4/07 10:17 D/S of HORB 4561 5/9/07 6:16 5/4/07 10:17 D/S of HORB 4568 5/6/07 12:18 10:17 D/S of HORB 4610 5/11/07 1:42 5/8/07 19:46 5/4/07 5/4/07 10:17 D/S of HORB 4617 5/7/07 14:02 5/4/07 10:17 D/S of HORB 4631 5/9/07 6:51 5/7/07 18:14 5/4/07 10:17 D/S of HORB 4645 5/6/07 12:20 5/4/07 10:17 D/S of HORB 4659 5/8/07 1:26 5/4/07 10:17 D/S of HORB 4673 5/9/07 12:38 5/7/07 4:29 5/6/07 16:20 5/4/07 10:17 D/S of HORB 4694 5/6/07 14:16 10:17 D/S of HORB 4701 5/8/07 0:40 5/7/07 15:18 5/4/07 5/4/07 10:17 D/S of HORB 4708 5/9/07 7:24 5/4/07 10:17 D/S of HORB 4715 5/6/07 6:56 5/8/07 16:50 5/4/07 10:17 D/S of HORB 4722 5/5/07 23:13 5/6/07 16:44 5/4/07 10:17 D/S of HORB 4743 5/6/07 2:26 5/7/07 9:00 10:17 4771 5/4/07 D/S of HORB 5/16/07 16:46 5/6/07 13:08 5/4/07 10:17 D/S of HORB 4757 5/4/07 10:17 D/S of HORB 4785 5/8/07 4:48 5/9/07 20:09 5/7/07 17:23 5/4/07 10:17 D/S of HORB 4799 5/9/07 5:48 5/4/07 10:17 D/S of HORB 4834 5/7/07 10:31 5/4/07 10:17 D/S of HORB 4841 5/7/07 4:45 10:17 D/S of HORB 4848 5/6/07 13:37 5/4/07 10:17 4855 5/4/07 D/S of HORB 5/9/07 14:24 5/4/07 10:17 D/S of HORB 4862 5/7/07 17:41 5/4/07 10:17 D/S of HORB 4869 5/6/07 11:49 5/4/07 10:17 D/S of HORB 4883 5/6/07 2:52 5/9/07 7:50 5/4/07 10:17 D/S of HORB 4897 5/8/07 4:18 5/4/07 10:17 D/S of HORB 4904 5/7/07 11:37 5/4/07 10:17 D/S of HORB 4932 5/6/07 5:40 5/9/07 5:54 5/8/07 18:08 5/7/07 12:01 5/4/07 10:17 D/S of HORB 4939 5/4/07 10:17 D/S of HORB 4946 5/7/07 5:09 5/4/07 10:17 D/S of HORB 4988 5/6/07 13:11 5/7/07 6:18 5/4/07 10:17 D/S of HORB 4995 5/5/07 19:58 5/6/07 15:03 10:17 5002 5/4/07 D/S of HORB 5/6/07 12:14 5/4/07 5009 5/6/07 19:47 10:17 D/S of HORB 5/4/07 10:17 D/S of HORB 5016 5/7/07 14:00 5044 5/4/07 10:17 D/S of HORB 5/7/07 12:18 5/4/07 10:17 D/S of HORB 5051 5/12/07 18:13 5/7/07 18:13 5/4/07 10:17 D/S of HORB 5065 5/7/07 13:20

5/4/07

10:17

D/S of HORB

5072

5/6/07 15:43

5/7/07 14:15

Appendix C-6 Detections of acoustic-tagged salmon from May 10 & 11 releases upstream of the Head of Old River Barrier.

Release Dates: May 10 and May 11, 2007 Relase Locations: Durham Ferry, Mossdale, Bowman Road, Stockton

									Mobile Moni	toring
Release Date	Release Time	Release Site	Tag Code	Upstream of HORB Date/Time	Bowmand Road Date/Time	Stockton Date/Time	Turner Cut Date/Time	R16 Date/Time	Near Stockton Date/Comment	Other Locations Date/Comment
5/10/07	11:40	Durham Ferry	3003	5/10/07 23:05				5/13/07 13:51		
5/10/07	11:40	Durham Ferry	3017					5/15/07 15.51	5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3031	E/11/07 1.EE	E /11 /07 9:0E	E/11/07 22:00			5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3038	5/11/07 13:15	5/11/07 20:31	5/11/07 23:09			5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3052	5/11/07 3:51	5/11/07 14:16	5/11/07 19:10			5/17-18, Tag Not Moving	
5/10/07	11:40 11:40	Durham Ferry	3059	5/11/07 9:29	5/11/07 18:26				5/17-18, lag Not Moving	
5/10/07	11:40	Durham Ferry	3073	5/11/07 4:22	5/11/07 10:32	5/11/07 14:38				
5/10/07	11:40	Durham Ferry	3080	5/11/07 1:58	5/11/07 8:15	5/13/07 0:04			5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3094	5/11/07 1.25	5/11/07 11:25				5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3101	5/11/07 11:24	5/11/07 11:34				5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3115	5/11/07 4.54	5/11/07 11.54				5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3122	5/11/07 8:38	F /11 /07 10.10				E /17 10 Tex Net Maying	
5/10/07	11:40	Durham Ferry	3129	5/11/07 9:04	5/11/07 16:12				5/17-18, lag Not Moving	
5/10/07	11:40	Durham Ferry	3143	5/11/07 7:07	5/11/07 12:25					
5/10/07	11:40	Durham Ferry	3150						5/17-18, lag Not Moving	
5/10/07	11:40	Durham Ferry	3171	5/11/07 1:29					5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3185	5/11/07 0:20	5/11/07 9:25				5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3192	5/11/07 5:10	5/11/07 8.55				5/11-16, ldg Not Woving	
5/10/07	11:40	Durham Ferry	3206	E (11 (07 11:00	F (11 (07 00.00			5/13/07 19:41		
5/10/07	11:40	Durham Ferry Durham Ferry	3213	5/11/07 11:02 5/11/07 15:02	5/11/07 22:32			5/13/07 9:11		
5/10/07	11:40	Durham Ferry	3227	5/11/07 14:43	5/11/07 20:34			5/14/07 11:01		
5/10/07	11:40	Durham Ferry	3262	5/11/07 6:11	5/11/07 12:14					
5/10/07	11:40	Durham Ferry	3276	5/11/07 0:36	5/11/07 9:18					
5/10/07	11:40	Durham Ferry	3290	5/10/07 21:40	5/11/07 12:24				5/17 19 Tag Not Moving	
5/10/07	11:40	Durham Ferry	3311	5/11/07 0:01	5/11/07 12.54				5/11-16, ldg Not Woving	
5/10/07	11:40	Durham Ferry	3332	5/11/07 1:06	5/11/07 7:39			E (42 (07 0.00		
5/10/07	11:40	Durham Ferry Durham Ferry	3339	5/11/07 4:57	5/11/07 13:00 5/11/07 16:12			5/13/07 9:29		
5/10/07	11:40	Durham Ferry	3367	5/11/07 2:11	5/11/07 9:16					
5/10/07	11:40	Durham Ferry	3374	5/11/07 0:49						
5/10/07	11:40	Durham Ferry	3409	5/11/07 2:19	5/11/07 8:43					
5/10/07	11:40	Durham Ferry	3437	5/11/07 5:00	5/11/07 10:54					
5/10/07	11:40	Durham Ferry	3465	5/11/07 9:00	5/11/07 14:38					
5/10/07	11:40	Durham Ferry	3472	5/11/07 8:52	5/11/07 18:00	5/11/07 21:47				
5/10/07	11:40	Durham Ferry	3500	5/11/07 5.31	5/11/07 18:23	5/12/07 8:58		5/13/07 19:03		
5/10/07	11:40	Durham Ferry	3507	5/11/07 3:39	5/11/07 10:28			E (12 /07 19:02		
5/10/07	11:40	Durham Ferry	3521	5/11/07 8:29	5/11/07 13:34	5/12/07 8:25		5/13/07 18:03		
5/10/07	11:40	Durham Ferry	3549	5/11/07 14:41	-,,	-,,				
5/10/07	11:40	Durham Ferry	3556	5/10/07 23:05						
5/10/07	11:40	Durham Ferry	3584	5/11/07 11:44	5/11/07 19:12					
5/10/07	11:40	Durham Ferry	3591	5/11/07 4:47	5/11/07 19:08	5/12/07 2:41				
5/10/07	11:40	Durham Ferry	3612	5/11/07 4:32						
5/10/07	11:40	Durham Ferry	3619	5/10/07 21:29	5/11/07 3:04		E /12 /07 9:06	E /12 /07 10:0E		
5/10/07	11:40	Durham Ferry	3640	5/11/07 0:41	5/11/07 8:21		5/15/07 8.00	5/12/07 19.05	5/17-18, Tag Not Moving	
5/10/07	11:40	Durham Ferry	3668	5/11/07 4:46	F (44 (07 0-04					
5/10/07	11:40	Durham Ferry Durham Ferry	3689	5/11/07 2:00	5/11/07 8:01				5/17-18, lag Not Moving	
5/10/07	12:30	Mossdale	3703	5/10/07 16:24	5/10/07 21:30	5/11/07 5:12				
5/10/07	12:30	Mossdale	3710	5/10/07 16:54	5/10/07 21:32	5/11/07 5:25				
5/10/07	12:30	Mossdale	3724	5/10/07 18:57	5/11/07 0:12				5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	3731	5/10/07 16:27	5/10/07 10.18			5/13/07 20:21		
5/10/07	12:30	Mossdale	3745	5/10/07 15:45	5/11/07 7:08		5/12/07 15:19	0/ 10/ 07 20.21		
5/10/07	12:30	Mossdale	3752	5/10/07 17:40	5/11/07 10:10					
5/10/07	12:30	Mossdale	3766	5/10/07 15:41	5/10/07 19:22					
5/10/07	12:30	Mossdale	3773	5/10/07 15:16	5/10/07 22:47		E/1E/07 17:00	E /12 /07 0:00		
5/10/07	12:30	Mossdale	3780	5/10/07 18:01 5/10/07 16:53	5/10/07 21:06		5/15/07 17:23	5/13/07 8:26		
5/10/07	12:30	Mossdale	3794	5/10/07 16:26	E (44 (65 6 6)	F / 4 / 10 - 10	E (40) (6 = 1) (6			E (1 1 / 0 = ···)
5/10/07	12:30	Mossdale	3801 3808	5/10/07 17:56 5/10/07 16:13	5/11/07 6:01 5/10/07 20:25	5/11/07 10:50	5/12/07 1:42			5/14/07, Hwy 4
5/10/07	12:30	Mossdale	3815	5/10/07 15:29	-, 10, 01 20.20					
5/10/07	12:30	Mossdale	3822	5/10/07 15:07	5/10/07 19:00	5/11/07 5:22			5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	3836	5/10/07 16:00	5/10/07 23:29				5/17-18, Tag Not Moving	

Appendix C-6 Detections of acoustic-tagged salmon from May 10 & 11 releases upstream of the Head of Old River Barrier.

Release Dates: May 10 and May 11, 2007 Relase Locations: Durham Ferry, Mossdale, Bowman Road, Stockton

									Mobile Moni	toring
Release Date	Release Time	Release Site	Tag Code	Upstream of HORB Date/Time	Bowmand Road Date/Time	Stockton Date/Time	Turner Cut Date/Time	R16 Date/Time	Near Stockton Date/Comment	Other Locations Date/Comment
5/10/07	12:30	Mossdale	3843	5/10/07 16:19	E (40 (07 4 E0					
5/10/07	12:30	Mossdale	3850	5/10/07 17:28	5/12/07 4:53					
5/10/07	12:30	Mossdale	3871	5/10/07 16:16	5/11/07 3:12					
5/10/07	12:30	Mossdale	3878	5/10/07 17:06	5/11/07 6:24					
5/10/07	12:30	Mossdale	3885	5/10/07 16:54	5/10/07 22:06	5/11/07 8:04			5/17 19 Tog Not Moving	
5/10/07	12:30	Mossdale	3899	5/10/07 15:42	5/10/07 19:22	5/11/07 5:09		5/13/07 20:34	5/17-16, ldg NUL WOVINg	
5/10/07	12:30	Mossdale	3906	5/10/07 16:43	5/10/07 21:01	5/11/07 4:55		-,,		
5/10/07	12:30	Mossdale	3913	5/10/07 15:16	5/10/07 20:15	5/11/07 2:57	5/13/07 15:12	5/12/07 19:28		
5/10/07	12:30	Mossdale	3920	5/10/07 17:01	5/11/07 5:40			5/13/07 12:01		
5/10/07	12:30	Mossdale	3934	5/10/07 16:50	5/10/07 22:35	5/11/07 6:20		-,,	5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	3948	5/10/07 16:47	E/10/07 01/20					
5/10/07	12:30	Mossdale	3955	5/10/07 15:57	5/10/07 19:28					
5/10/07	12:30	Mossdale	3969	5/10/07 16:46	5/10/07 21:42					
5/10/07	12:30	Mossdale	3976	5/10/07 15:43	5/10/07 19:53	E (44 (07 7 00				
5/10/07	12:30	Mossdale	3983	5/10/07 15:39	5/10/07 19:55	5/11/07 1:06				
5/10/07	12:30	Mossdale	3997	5/10/07 17:34	5/11/07 0:42	0/11/01 11/02				
5/10/07	12:30	Mossdale	4004	5/10/07 16:54	E /11 /07 0.00				E /17 10 Tex Net Mauins	
5/10/07	12:30	Mossdale	4011	5/10/07 17:54	5/11/07 3:39	5/11/07 5:40			5/17-18, lag Not Moving	
5/10/07	12:30	Mossdale	4025	5/10/07 17:21	0, 10, 01 21.11	0/11/01 0.10				
5/10/07	12:30	Mossdale	4032	5/10/07 17:07	5/10/07 22:41				5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	4039	5/10/07 16:39	5/10/07 22:08	5/12/07 13:50				
5/10/07	12:30	Mossdale	4053	5/10/07 18:56	5/11/07 1:01	5/11/07 15:10		5/13/07 12:04		
5/10/07	12:30	Mossdale	4060	5/10/07 15:28	5/10/07 19:47					
5/10/07	12:30	Mossdale	4074	5/10/07 15:06	5/10/07 20:08	5/11/07 7:37			5/17-18 Tag Not Moving	
5/10/07	12:30	Mossdale	4088	5/10/07 15:28	0, 10, 01 2100	0, 11, 01 1101			o/ 11 10, 100 Hot Hot Hig	
5/10/07	12:30	Mossdale	4095	5/10/07 15:51	5/11/07 4:40				5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	4102	5/10/07 16:25	5/10/07 20:32		5/13/07 6:09	5/12/07 21:04	5/17-18, lag Not Moving	
5/10/07	12:30	Mossdale	4116	5/10/07 15:00			-, -,	-, , -		
5/10/07	12:30	Mossdale	4123	5/10/07 15:21	5/10/07 19:45		5/13/07 1:06			
5/10/07	12:30	Mossdale	4137	5/10/07 15:15	5/10/07 19:56	5/11/07 8:03			5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	4144	5/10/07 17:22	5/10/07 21:56	5/11/07 20:11			, , , , , , , , , , , , , , , , , , , ,	
5/10/07	12:30	Mossdale	4151	5/10/07 16:33	5/10/07 20:43	5/11/07 23:35				
5/10/07	12:30	Mossdale	4165	5/10/07 15:01	5/10/07 15:25					
5/10/07	12:30	Mossdale	4179	5/10/07 16:54	5/10/07 21:50	5/11/07 5:57			E (47.40 To a Net Maria d	
5/10/07	12:30	Mossdale	4186	5/10/07 15:39	5/10/07 21:35	5/11/07 6:09			5/17-18, lag Not Moving	
5/10/07	12:30	Mossdale	4200	5/10/07 15:57	5/10/07 19:29					
5/10/07	12:30	Mossdale	4207	5/10/07 18:01	5/10/07 22:24			5/14/07 22:42		
5/10/07	12:30	Mossdale	4214	5/10/07 15:41	5/10/07 19:45			5/14/07 22.45	5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	4228	5/10/07 15:40	5/10/07 20:05	5/11/07 4:52				
5/10/07	12:30	Mossdale	4235	5/10/07 15:39	5/10/07 20:29	5/11/07 4.48		5/13/07 20:55		
5/10/07	12:30	Mossdale	4249	5/10/07 16:54	5/10/07 21:47	5/11/07 5:47				
5/10/07	12:30	Mossdale	4256	5/10/07 17:01	5/10/07 21:21	5/11/07 4:31				
5/10/07	12:30	Mossdale	4263	5/10/07 18:29	5/11/07 0:02	5/13/07 1:18				
5/10/07	12:30	Mossdale	4277	5/10/07 20:34	0, 10, 01 21101	0, 11, 01 10100				
5/10/07	12:30	Mossdale	4284	5/10/07 15:06	5/10/07 20:20	5/12/07 21:11				
5/10/07	12:30	Mossdale	4291	5/10/07 15:57	5/10/07 19:34					
5/10/07	12:30	Mossdale	4305	5/10/07 15:05	5/10/07 21:32	5/11/07 7:00			5/17-18, Tag Not Moving	
5/10/07	12:30	Mossdale	4312	5/10/07 15:21	5/11/07 3:35		5/1//07 2:25			
5/10/07	12:30	Mossdale	4326	5/10/07 15:28	5/10/07 19:55		5/14/01 2.25			
5/10/07	12:30	Mossdale	4333	5/10/07 16:54	5/11/07 2:47			5 (40 (07 40 07		
5/10/07	12:30	Mossdale	4340	5/10/07 15:33	5/11/07 5:24	5/11/07 10:29		5/13/07 12:27		
5/10/07	12:30	Mossdale	4354	5/10/07 16:43	5/10/07 20:30	0/11/01 10:20		5/16/07 11:48		
5/10/07	12:30	Mossdale	4361	5/10/07 16:34	E /10 /07 01 /1E	E (11 (07 E E)		E /11 /07 10-10		
5/10/07	12:30	Mossdale	4368	5/10/07 15:28	5/10/07 21:45	5/11/07 5:52		5/11/07 18:16		
5/10/07	12:30	Mossdale	4382	5/10/07 17:51	-,,	-,,				
5/10/07	12:30	Mossdale Rowman Rd	4396	5/10/07 16:33		5/11/07 19:/1			5/17 19 Tod Not Moving	
5/11/07	12:05	Bowman Rd.	5110			5/19/07 21:47			5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5131					5/13/07 20:01		
5/11/07	12:05 12:05	Bowman Rd.	5145 5166			5/11/07 19:02			5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5229			5/11/07 20:08		5/13/07 9:00		
5/11/07	12:05	Bowman Rd.	5243			5/11/07 00:00			5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5285			5/15/07 20:50			5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5313						5/17-18, Tag Not Moving	

Appendix C-6 Detections of acoustic-tagged salmon from May 10 & 11 releases upstream of the Head of Old River Barrier.

Release Dates: May 10 and May 11, 2007 Relase Locations: Durham Ferry, Mossdale, Bowman Road, Stockton

									Mobile Monitoring	
Release Date	Release Time	Release Site	Tag Code	Upstream of HORB Date/Time	Bowmand Road Date/Time	Stockton Date/Time	Turner Cut Date/Time	R16 Date/Time	Near Stockton Date/Comment	Other Locations Date/Comment
5/11/07	12:05	Bowman Rd.	5327						5/17-18, Tag Not Moving	
5/11/07 5/11/07	12:05	Bowman Rd. Bowman Rd.	5334 5341				5/14/07 16:03	5/13/07 18:12	5/17-18, lag Not Moving	
5/11/07	12:05	Bowman Rd.	5348					5/13/07 21:21	5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5390			5/11/07 18:25		5/15/07 21.21	5/17-18, Tag Not Moving	
5/11/07	12:05 12:05	Bowman Rd. Bowman Rd.	5404 5411			5/12/07 23:31			5/17-18. Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5418					5/14/07 20:24	-,,,,,,,,, -	
5/11/07	12:05	Bowman Rd.	5425 5432			5/11/07 19:43		5/12/07 17:04		
5/11/07	12:05 12:05	Bowman Rd.	5446 5453			5/11/07 16:16			5/17-18 Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5460			E (14 (07 4E 47	5 440 407 45 50	5 440 407 40 00	5/17-18, Tag Not Moving	
5/11/07 5/11/07	12:05	Bowman Rd. Bowman Rd.	5474 5481			5/11/07 15:47 5/11/07 16:48	5/13/07 15:59	5/13/07 12:39		
5/11/07	12:05	Bowman Rd.	5502			5/11/07 15:47		5/12/07 10:22	5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5523			5/11/07 22:04		5/15/07 19.52		
5/11/07	12:05	Bowman Rd.	5530 5537					5/12/07 20:55	5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5544					3/ 12/ 01 20:33	5/17-18, Tag Not Moving	
5/11/07	12:05 12:05	Bowman Rd. Bowman Rd.	5565 5579			5/15/07 3:45			5/17-18. Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5593			5/12/07 15:30				
5/11/07 5/11/07	12:05	Bowman Rd. Bowman Rd.	5600			5/11/07 18:14		5/13/07 9:36	5/17-18, lag Not Moving	
5/11/07	12:05	Bowman Rd.	5628			5/11/07 18:20			5/17 19 Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5663			5/11/07 19:43			5/17-18, Tag Not Moving	
5/11/07	12:05 12:05	Bowman Rd.	5698 5677					5/12/07 20:02	5/17-18 Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5684						5/17-18, Tag Not Moving	
5/11/07	12:05 12:05	Bowman Rd. Bowman Rd.	5691 5705						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:05	Bowman Rd.	5719			5/13/07 17:24			5/17-18, Tag Not Moving	
5/11/07 5/11/07	12:05	Bowman Rd. Bowman Rd.	5754 5761			5/13/07 10:06 5/11/07 19:51				
5/11/07	12:05	Bowman Rd.	5782			5/12/07 6:02			5/17-18 Tag Not Moving	
5/11/07	12:43	Stockton	5803			5/11/01 2.50			5/17-18, Tag Not Moving	
5/11/07	12:43 12:43	Stockton	5824 5838					5/13/07 19:13	5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	5845					5/12/07 17:57		
5/11/07	12:43	Stockton	5873						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	5915 5936					5/13/07 8.50	5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	5943					5/15/07 8.50	5/17-18, Tag Not Moving	
5/11/07	12:43 12:43	Stockton	5950 5971						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	5978					5/12/07 8:16	5/17 10, kig Hot Moting	5/13/07 21:12, Tracy
5/11/07 5/11/07	12:43	Stockton	5985 5999						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6020					5/13/07 13:51	E /17 19 Tog Not Moving	
5/11/07	12:43	Stockton	6083						5/17-18, Tag Not Moving	
5/11/07	12:43 12:43	Stockton	6090 6097						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6111						5/17-18, Tag Not Moving	
5/11/07 5/11/07	12:43 12:43	Stockton Stockton	6118 6174						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6181					5/13/07 9:54	E /17 10 Teg Net Maxing	
5/11/07	12:43	Stockton	6188						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6202						5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6251						5/17-18, Tag Not Moving	
5/11/07	12:43 12:43	Stockton Stockton	6258 6265						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6293					5/14/07 10:26	E /17 10 Tog Net Mering	
5/11/07	12:43	Stockton	6300 6307						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6314				5/13/07 6:25		5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6328				5/15/07 0.25	5/12/07 19:00		
5/11/07 5/11/07	12:43 12:43	Stockton	6342 6384						5/17-18, Tag Not Moving 5/17-18, Tag Not Moving	
5/11/07	12:43	Stockton	6391						5/17-18, Tag Not Moving	
5/11/07 5/11/07	12:43	Stockton	6405 6412					5/13/07 19:40	5/17-18, lag Not Moving	
5/11/07	12:43	Stockton	6419				5/12/07 11:07			

Appendix C-7 Detections of acoustic-tagged salmon released May 11 downstream of the Head of Old River Barrier.										
Release Date:	May 11, 2007			Release	e Location: Old I	River downtstream	of HORB			
Release Date	Release Time	Release Site	Tag Code	Tracy Fish Facilities Date/Time	Clifton Court Inlet Date/Time	Skinner Fish Facilities Date/Time	Old River at Hwy 4 Date/Time			
5/11/07	11:22	D/S of HORB	4403			5/13/07 15:58				
5/11/07	11:22	D/S of HORB	4424	5/14/07 14:32		5/18/07 16:06	5/13/07 20:41			
5/11/07	11:22	D/S of HORB	4431	5/13/07 17:00						
5/11/07	11:22	D/S of HORB	4438	5/13/07 17:19						
5/11/07	11:22	D/S of HORB	4452	5/15/07 17:11						
5/11/07	11:22	D/S of HORB	4466	5/13/07 20:30						
5/11/07	11:22	D/S of HORB	4487			5/14/07 4:48				
5/11/07	11:22	D/S of HORB	4494	5/15/07 14:32						
5/11/07	11:22	D/S of HORB	4501	5/13/07 14:56						
5/11/07	11:22	D/S of HORB	4515	5/14/07 2:15			5/14/07 12:14			
5/11/07	11:22	D/S of HORB	4522	5/13/07 14:40						
5/11/07	11:22	D/S of HORB	4529	5/15/07 11:01						
5/11/07	11:22	D/S of HORB	4536				5/13/07 21:50			
5/11/07	11:22	D/S of HORB	4543				5/14/07 21:42			
5/11/07	11:22	D/S of HORB	4564	5/15/07 1:08						
5/11/07	11:22	D/S of HORB	4585				5/13/07 17:36			
5/11/07	11:22	D/S of HORB	4592	5/14/07 0:45						
5/11/07	11:22	D/S of HORB	4599	5/12/07 19:58						
5/11/07	11:22	D/S of HORB	4606	5/13/07 9:25						
5/11/07	11:22	D/S of HORB	4620				5/13/07 18:14			
5/11/07	11:22	D/S of HORB	4669	5/13/07 14:51						
5/11/07	11:22	D/S of HORB	4683	5/13/07 0:00						
5/11/07	11:22	D/S of HORB	4704				5/14/07 1:40			
5/11/07	11:22	D/S of HORB	4725	5/16/07 2:11						
5/11/07	11:22	D/S of HORB	4746	5/13/07 2:12						
5/11/07	11:22	D/S of HORB	4760	5/14/07 14:28			5/13/07 21:00			
5/11/07	11:22	D/S of HORB	4781	5/12/07 19:11						
5/11/07	11:22	D/S of HORB	4802	5/15/07 14:09						
5/11/07	11:22	D/S of HORB	4809	5/18/07 17:34						
5/11/07	11:22	D/S of HORB	4830	5/13/07 11:58						
5/11/07	11:22	D/S of HORB	4837				5/14/07 18:39			
5/11/07	11:22	D/S of HORB	4844	5/14/07 1:37						
5/11/07	11:22	D/S of HORB	4879	5/13/07 23:07						
5/11/07	11:22	D/S of HORB	4900	5/15/07 1:00						
5/11/07	11:22	D/S of HORB	4942	5/13/07 18:04						
5/11/07	11:22	D/S of HORB	5033	5/13/07 8:33						
5/11/07	11:22	D/S of HORB	5054	5/13/07 8:09						
5/11/07	11:22	D/S of HORB	5068				5/14/07 6:11			
5/11/07	11:22	D/S of HORB	5082	5/14/07 15:08						
5/11/07	11:22	D/S of HORB	5096	5/16/07 18:38						

APPENDIX D

FIELD STANDARD OPERATING PROCEDURE Surgical Tag Implantation Procedures Used in VAMP Studies

Purpose

To provide guidelines and standard protocols for surgical tagging of juvenile salmonids for VAMP studies.

Area of Applicability

All staff involved in surgical tagging of juvenile salmonids for VAMP studies.

References

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Techniques, 2nd edition. American Fisheries Society 121-155.

Martinelli, T.L., H.C. Hansel, and R. S. Shively. 1998. Growth and physiological responses to surgical and gastric radio transmitter implantation techniques in subyearling Chinook salmon. Hydrobiologia 371/372: 79-87.

Summerfelt, R. C. and L. S. Smith. 1990. Anesthesia, surgery, and related techniques. Pages 213-272 in C. B. Schreck and P. B. Moyle, editors. Methods for fish biology. American Fisheries Society, Bethesda, Maryland.

Materials Needed

- Thermometer
- YSI 55 dissolved oxygen (DO) meter
- Acoustic tags and acoustic tag equipment
- Chlorhexidine solution (30mL/L D-H2O)
- Saline solution (7g/L D-H2O)
- Tricaine methanesulfonate (MS-222; 100g/L),
- Sodium bicarbonate solution (buffer; 100g/L)
- Stress coat stock concentration and 25% solution (250mL/L D-H2O)
- 70% ethanol or isopropyl alcohol solution
- 19 L bucket(s) marked at 10 L and clearly labeled 'Anesthesia'
- 19 L perforated recovery buckets (7 L holding capacity)
- 19 L bucket clearly labeled 'Reject' for fish that are not tagged
- Pair of gravity feed containers marked at 10 L, and connected by rubber tubing with in-line shut-off valves one labeled 'anesthesia' and one labeled 'freshwater'
- Syringes for measuring anesthetic, buffer, and stress coat
- Oxygen delivery system or bubblers
- Dip nets
- Nitrile gloves
- Scale measuring to the nearest 0.1 g
- Large plastic weigh boats
- Measuring board with ruler to the nearest millimeter
- Surgery table (tray with foam pad and groove cut)
- Trays for holding solutions used to disinfect surgical tools
- Needle drivers

- Forceps
- Scalpel handle and blades
- Oxytetracycline (100 mg/mL concentration)
- Pipette (2-20 microliter (_L) volume) and tips
- Sutures (size: 5-0 and 4-0) with an RB-1 needle
- Spray bottles for alcohol
- Timer(s)
- Sharps container
- Datasheets and writing tools

Procedures

1) Collection and Pre-Tag Holding

- A. The pre-tag holding period begins once the fish are placed in holding tanks. Prior to tag implantation, the pre-tag holding period should be at least 12-36 h. Fish should not have access to food during the pre-tagging holding period.
- B. Each species collected is held in a separate holding tank to reduce stress. Record the species and collection date on each pre-tag holding container.

2) Fish Size Criteria

A. Size of fish tagged is dependent on the type of tag being used. A maximum tag weight to body weight ratio of 5% is used to calculate minimum fish size.

3) Pre-Tag Preparations

- A. Environmental conditions
 - i. Dissolved oxygen (DO): will be measured as percent saturation in a pre- and post-tag holding tank or raceway during each tag session.
 - 1. Measurements will be taken using a YSI model 55 DO meter
 - 2. DO concentrations in pre- and post-tag holding tanks should be between 80% and 130% saturation.

ii. Temperature: will be measured in °C in a pre- and post-tag holding tank during each tag session.

- 1. Changes in water temperature exceeding 2°C require tempering (Kelsch and Shields 1996). "Tempering" means "to bring to a suitable state by mixing in or adding a usually liquid ingredient". Therefore, prior to exposing fish to a new water source the fish holding temperature and the temperature of the new water source need to be measured to ensure that the difference between the two water sources is $\leq 2^{\circ}$ C. If the temperature difference is > 2°C then water in the container holding fish should be tempered at a rate of 0.5°C/15 min until the temperature difference between the two water sources is $\leq 2^{\circ}$ C. New source water should be added in small amounts multiple times over 15 min to gradually change the temperature by 0.5°C. Once the temperature difference between the two water sources is $\leq 2^{\circ}$ C fish can be transferred to the new water source.
- B. Setup of equipment
 - i. Tags should be programmed and prepared for implantation.
 - ii. Disinfect all tags in chlorhexidine solution and thoroughly rinse in saline. Line tags up near the surgery table.
 - iii. Prepare surgical table and equipment for use.

- iv. Setup measuring board and scale
 - 1. Ensure the scale is functioning properly. Scales should be calibrated at the start of the season, checked each week for accuracy, and recalibrated as necessary.
 - 2. Put approximately 1-2 mL of diluted stress coat on the weigh boat and the measuring board.
- C. Recovery buckets must be filled with untreated river water and supplied with oxygen or a bubbler just prior to tagging. The concentration of DO in recovery buckets should be between 120 and 150% saturation.
- D. Administration of anesthetic: The effectiveness of MS-222 as an anesthetic varies with factors such as temperature and fish density. Adjustments of the anesthesia concentration should be based on the amount of time it takes for a fish to lose equilibrium (induction time).
 - i. Fill the anesthesia bucket with 10 L of untreated river water. As a starting concentration, add 7 mL (1 mL= 1 cc) of MS-222 stock solution. This will yield an anesthetic concentration of 70 mg/L.
 - ii. Fill both gravity feed containers with 10 L of untreated river water. Add 2 mL of MS-222 stock solution to the container marked anesthesia. This will yield an anesthetic concentration of 20 mg/L.
 - iii. For each mL of MS-222 added to a container, add the same amount of bicarbonate solution (buffer).
 - iv. Water in all containers (anesthesia and gravity feed) should be changed periodically to minimize dilution of anesthesia water and temperature changes and to ensure you do not run out of water during a surgery.
 - v. Add a small amount of diluted stress coat for each liter of water in the anesthesia, gravity feed, and recovery containers to protect fish from loss/damage to the slime layer.
 - vi. Containers should be filled and prepared just prior to tagging to avoid temperature changes.

4) Implantation of Tags

- A. Anesthetizing fish
 - i. Net one fish from the pre-tag holding source and place directly into an anesthesia bucket. Secure the lid as soon as the fish is in the bucket. Start a timer to keep track of how long a fish has been in the anesthesia bucket.
 - 1. Time of sedation for a fish should normally be 2 4 minutes, with an average time of about 3 minutes. If loss of equilibrium takes less than 1 min or greater than 5 min, reject that fish. If after sedating a few fish, they are consistently losing equilibrium in more or less time than typical, adjust the concentration of the anesthetic (up or down) in 0.5 ml increments of stock MS-222 solution.
 - 2. Remove the lid after one minute to observe the fish for loss of equilibrium. Once the fish loses equilibrium, visually screen the fish for tags, fin clips, fungus, disease, descaling, bloated belly, or any obvious abnormalities. Make sure to keep the fish submerged during this examination. Relay any information to the data recorder.
 - 3. Keep the fish in the water for an additional 30 60 sec after it has lost equilibrium.
 - 4. Rejects If the fish is unacceptable for tagging, place the fish in the bucket labeled Rejects, and relay the information to the data recorder.
- B. Recording fish length and weight
 - i. Transfer the fish to the scale and weigh the fish to the nearest 0.1 g.
 - ii. Transfer the fish to the measuring board and measure the fork length to the nearest millimeter (mm).
 - iii. Data must be vocally relayed to the data recorder to avoid data errors. The data recorder should then record this information and repeat numbers back to avoid any miscommunication.

iv. Any fish that is dropped on the floor during this process must be rejected. A fish dropped on the table during surgery may still be tagged. If a fish is dropped on the floor after it is tagged, remove the tag and reject the fish.

C. Surgery

- i. Place the fish on the surgery table ventral side up. Anesthesia should be administered through the gravity feed tubing as soon as the fish is on the surgery table. The tubing must be placed just inside the mouth so the water flows across the gills. If the flow is too low, the fish will flare its opercula and become agitated. Adjust the flow so that the gilling rate of the fish is steady. Use the in-line valve to control the flow of anesthesia, fresh water, or a mixture of both. Start with a constant flow of anesthesia and monitor the condition of the fish.
- ii. Using a scalpel, make an incision, approximately 5 mm in length (dependent on tag size), about 3 mm away from and parallel to the mid-ventral line. Start your incision a few millimeters in front of the pelvic girdle, approximately 20% of the distance from the base of the pelvic fins to the base of the pectoral fins, and draw the blade toward the head of the fish. (For example, in Figure 1, the distance between the base of the pelvic and pectoral fins is ~45 mm, so the incision should start ~9 mm in front of the base of the pelvic fins.) The incision should be just deep enough to penetrate the peritoneum (the thin membrane separating the gut cavity from the musculature), avoiding the internal organs. The spleen is generally near the incision point, so pay close attention to the depth of the incision. Refer to Figure 1 for location of internal organs and Figure 2 for placement of incision. Avoid getting anesthesia water in the incision.



Figure 1 Lateral view of a juvenile salmonid, showing the location of internal organs.

Figure 2

Ventral view of a juvenile salmonid, showing the location external organs and proper placement of incision and antenna exit (if applicable). This view corresponds to a left-handed surgeon's view and placement of the incision. For right-handed surgeons, the fish would be facing the right and the incision and antenna exit would be on the opposite side of the midline.



- 1. There is no exact specification for what size scalpel blade to use for each fish. We use a 5 mm blade for hatchery steelhead, which typically weigh more than 50.0 g. We use a 3 mm blade for smaller fish, such as yearling and subyearling Chinook salmon that typically weigh less than 50.0 g.
- 2. One scalpel blade can be used on about seven fish before it becomes dull. If the blade is pulling roughly or making jagged incisions, it needs to be changed prior to tagging the next fish.
- 3. Use forceps to open the incision to ensure you did not damage any internal organs or cause excessive bleeding. If you observe damage or think you damaged an organ, do not implant the tag, and reject that fish. Excessive bleeding should be noted on the datasheet.
- iii. Gently push the tag into the body cavity, and position it so that it lies directly under the incision. This positioning will provide a barrier between the suture needle and internal organs. Through time the tag location will naturally move posterior in the fish.
- iv. Use a pipette to administer oxytetracycline in the incision at a dosage of 50 mg/kg of body weight. Calculate the amount to administer for each fish using 1 _L of oxytetracycline for every 2 g of body weight (weight in g/2 = # of _L of oxytetracycline). For example, a 24.0 g fish would get 12 _L of oxytetracycline (Summerfelt and Smith 1990). Change the pipette tip after each fish.
- v. Begin suturing the incision. Two or three interrupted stitches are used to close the incision, depending on the size of the tag and incision.
 - To make a stitch, lock the needle (at the end of the suture) in the needle drivers so the needle point faces you. Enter the outside edge of the incision on the side farthest from you and exit through the other edge of the incision, pulling the suture perpendicular through the two edges. The needle should enter and exit the skin as close to the edge of the incision as possible without tearing the skin (~ 2 mm from edge of incision). Pull the needle and suture through the skin to leave a tag end of about 2 3 cm of suture material protruding from the needle entrance location, then release the needle from the needle drivers. With your non-dominant hand, grasp the long end of the suture material (usually

with thumb and forefinger) at or below the needle, and make two forward wraps (i.e., away from your body) around the tip of the needle driver, which should be held in your dominant hand. With the two wraps still around the needle driver, grasp the short tag end of suture material with the needle driver and tighten the stitch by pulling the wraps off the needle driver and pulling both ends of suture material perpendicular to the incision. On the first knot, the dominant hand holding the needle driver should pull toward your body and the non-dominant hand should pull away from your body. Tighten the suture lightly, just so the edges of the incision meet, but do not overlap, pucker, or bulge the edges of the incision. The second knot is the same as the first, but in reverse order. On the second knot, grasp the long end of suture material with your non-dominant hand, make two reverse wraps (i.e., toward you body) around the end of the needle driver, grasp the short end of suture with the needle driver, and tighten the stitch. This time, the knot should be tightened by pulling your dominant hand (holding the needle drivers) away from you and your non-dominant hand toward you. The second knot can be slightly tighter than the first, again taking care not to overlap, pucker, or bulge the edges of the incision. The third knot is a repeat of the first and should be tightened snug to prevent the stitch from coming loose. This completes one stitch. Cut the suture with the needle drivers, leaving ends approximately 5 mm in length.

- a. An alternative stitch consists of two knots, each with three wraps around the needle driver. The first knot consists of three forward wraps around the needle driver, and then is tightened by pulling the needle driver toward your body. The second is the same as the first, but in reverse order as described above.
- b. When pulling a knot tight, be sure the knot lays flat and does not twist onto itself into a "balled-up" knot
- 2. There is no exact specification for what size suture to use. Generally, 4-0 suture is used for hatchery steelhead, which typically weigh greater than 50.0 g. For fish weighing less than 50.0 g, such as yearling and subyearling Chinook salmon, 5-0 suture is used.
- 3. Generally, a good time to switch the in-line valve on the gravity feed buckets to untreated river water is just prior to the last stitch. This initiates recovery from anesthesia as early as possible. However, if the fish appears to be inadequately gilling, provide a mixture or all fresh water as soon as possible. If the fish is too active to finish the surgery safely do not switch to fresh water, but maintain sedation.
- 4. If the incision is too long to close with two stitches, it is acceptable to add a 3rd stitch. Relay this information to the data recorder so they can note the extra stitch on the datasheet.
- 5. Because sutures are long, each individual suture (one packet) can be used on 2-4 fish. Rinse the suture material and the needle in the sanitizing solution used for instruments.
- vi. Transfer the fish from the surgery table directly to a labeled recovery bucket. If a direct transfer is not possible, use a container filled with untreated river water to make the transfer.
- vii. Between surgeries, the surgeon should prepare their tools for the next surgery. Disinfect the tools in chlorhexidine solution and rinse thoroughly with saline, load a new pipette tip, and ensure that the scalpel blade and suture are acceptable to use on the next fish.
- viii. When all fish in a recovery bucket have spent 10 minutes in the bucket and gained equilibrium, transfer the bucket to the post-tag holding container (tank or raceway that has a constant flow of untreated river water).

5) Cleanup at the end of the tagging day

- A. Wipe down all counter tops, scales and measuring boards with ethanol or isopropyl alcohol to disinfect.
- B. Soak scalpels, catheters, forceps, and scissors in chlorhexidine solution for 15 minutes, rinse in saline solution, and thoroughly dry to prevent rusting.
- C. Spray tagging platform (foam) with ethanol to disinfect.
- D. Scrub needle drivers with a small brush and spray with ethanol or isopropyl alcohol.
- E. Buckets should be rinsed thoroughly with untreated river water and placed upside down to dry. In addition, all buckets need to be cleaned weekly in accordance with Sterilization of 5 Gallon Buckets; FIE732.0.

APPROVED BY:		DATE	
	QUALITY ASSURANCE OFFICER		
		DATE	
KEVIEWED BY		DALE	
	LABORATORY SUPERVISOR		