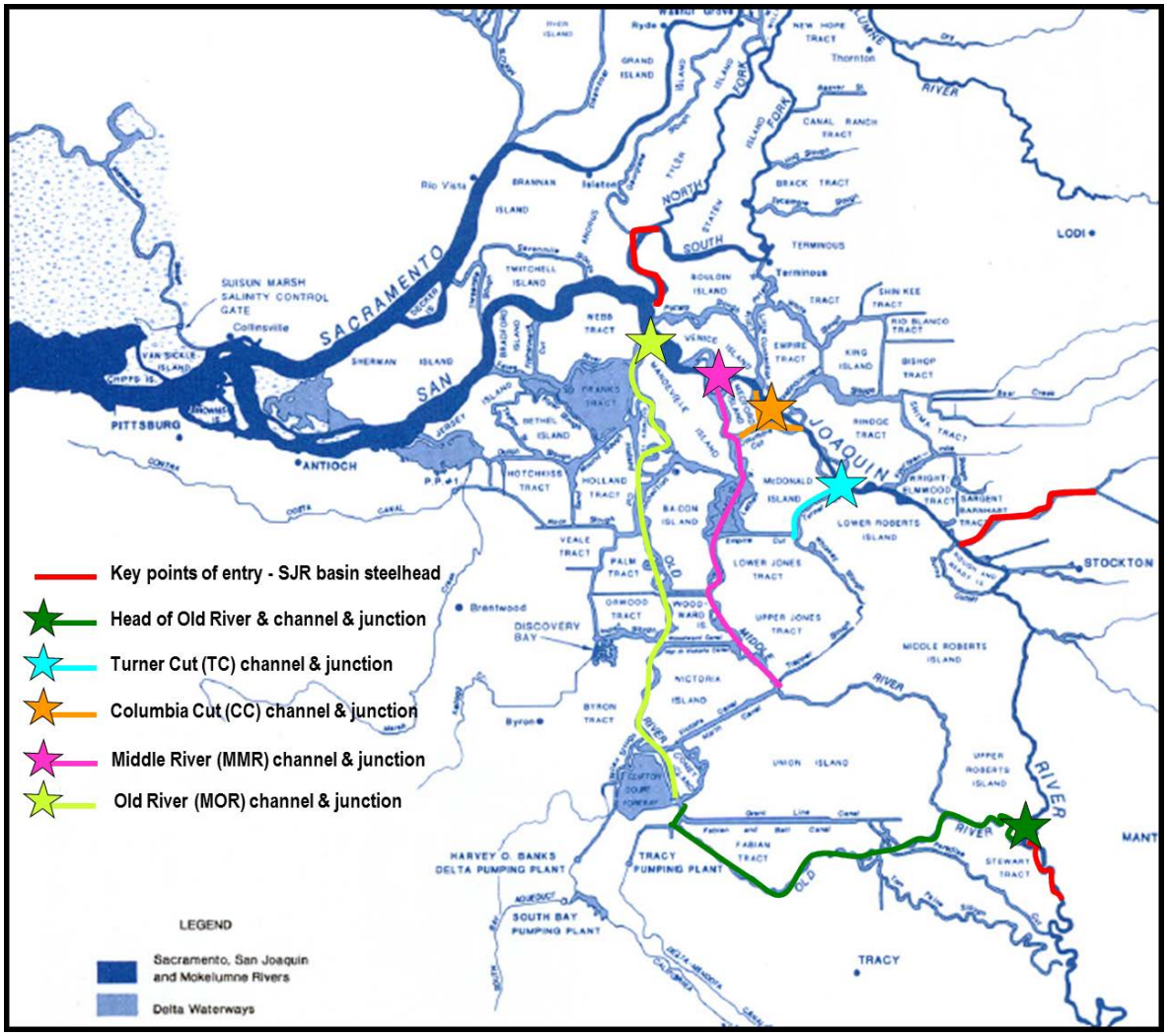
Spring 2012 Delta Operations in lieu of Action IV.2.1 per Joint Stipulation



October 2012

Acronyms and Abbreviations

BiOp	NMFS Biological Opinion on the long-term operations of the CVP and SWP
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CDEC	California Data Exchange Center
CDFG	California Department of Fish & Game
DCT	Delta Conditions Team
DOSS	Delta Operations for Salmonids and Sturgeon technical team
DWR	California Department of Water Resources
ESA	Endangered Species Act
NMFS	National Marine Fisheries Service
OMR	Old and Middle River flow
PWA	Public Water Agencies
Reclamation	U.S. Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
SWP	State Water Project
SWRCB	State Water Resources Control Board
USFWS	U.S. Fish & Wildlife Service
VAMP	Vernalis Adaptive Management Program
VNS	San Joaquin River at Vernalis (CDEC station)
WOMT	Water Operations Management Team

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Foreword

Key documents related to implementation of the Joint Stipulation, many of which are included in this report as appendices, are available at: http://swr.nmfs.noaa.gov/ocap/2012_stipulation.htm.

Chapter 1 – Background

1.1 Background

In January 2012, Public Water Agencies (PWA), State of California and Federal agencies filed a joint stipulation (Appendix A[1]) regarding project operations during April and May 2012 in the litigation relating to the Biological Opinion (BiOp) on long-term operations of the State Water Project and Central Valley Project[2] (the Projects) issued by NOAA's National Marine Fisheries Service (NMFS). The parties stipulated that, if a rock barrier were installed at the head of Old River, the SWP and CVP would operate within an adaptive range of Old and Middle River (OMR) flows in lieu of operating to the inflow:export ratio[3] specified in the Reasonable and Prudent Alternative (RPA) of the NMFS BiOp.

The objectives of the joint stipulation were (1) to provide minimum protections for out-migrating juvenile steelhead by managing flow conditions in the Delta in a manner expected to allow salmonids to successfully exit the Delta; (2) attempting to increase water exports consistent with (1), above; and (3) generating real-time tracking information to better understand how pumping rates, flows in OMR and juvenile migrations relate to one another. In addition to installing a rock barrier, the stipulation called for OMR flows to be managed at an adaptive range between -1,250 and -3,500 cubic feet per second (cfs) during April, and between -1,250 and -5,000 cfs during May. Export levels would be adjusted to ensure adequate protection was afforded to out-migrating steelhead.

Rock Barrier at the head of Old River

NMFS concluded that a rock barrier at the head of Old River (Figure 1) would increase the overall through-Delta survival of San Joaquin basin steelhead by directing both fish and flow into the mainstem San Joaquin River.

[1] Joint stipulation also available at: http://swr.nmfs.noaa.gov/ocap/2012_stipulation.htm
[2] BiOp available at: http://swr.nmfs.noaa.gov/ocap.htm
[3] Inflow:export ratio of RPA Action IV.2.1 excerpted from BiOp in Appendix B

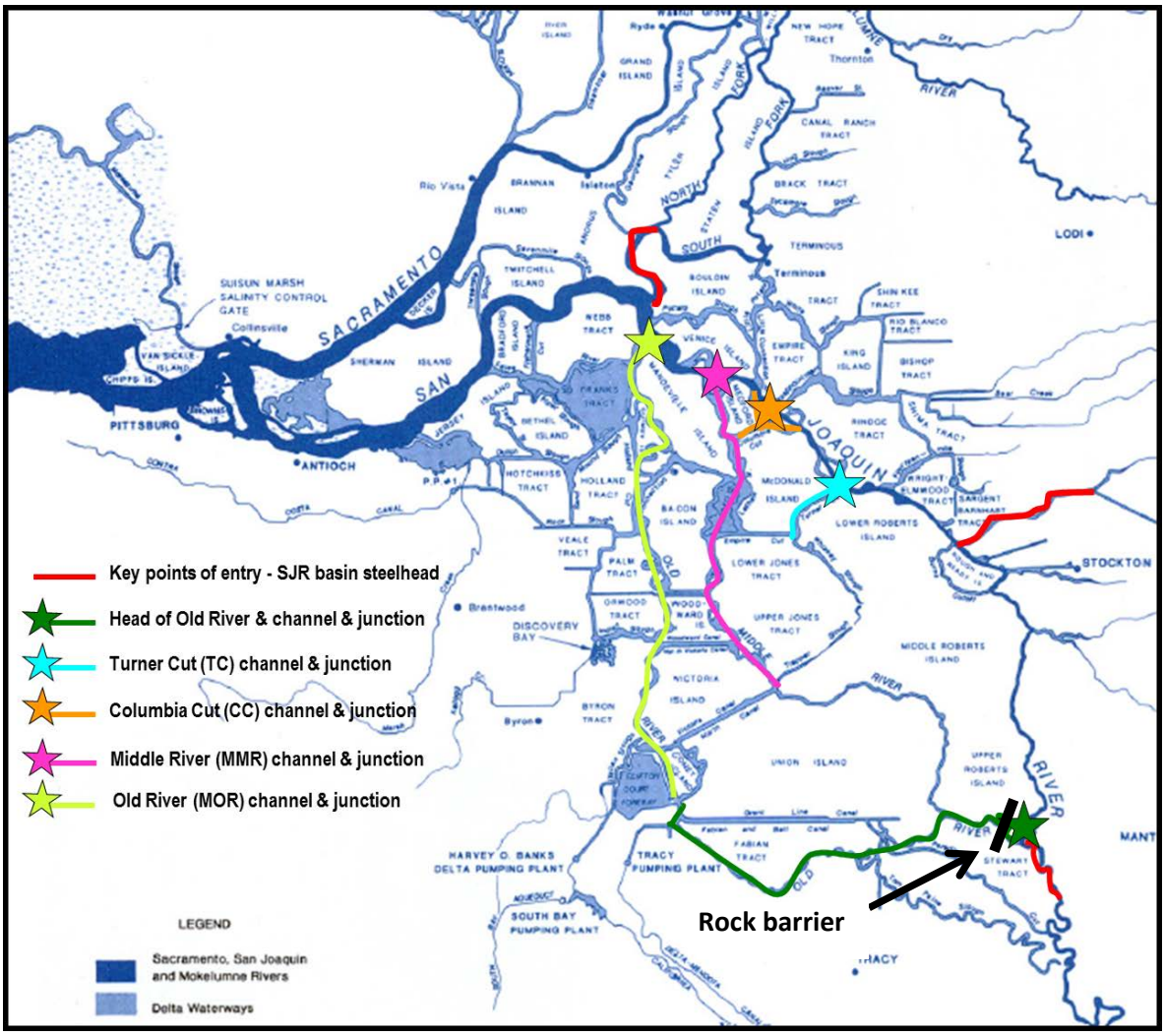

Figure 1. Map of Sacramento-San Joaquin delta highlighting the head of Old River and barrier (green star and black line), Old River (light green and dark green lines), Middle River (pink line), and the sources of juvenile steelhead entering the delta (red lines). The rock barrier at the head of Old River is built in the Old River channel near the junction with the San Joaquin River and limits the San Joaquin flow that enters Old River; some flow enters through culverts in the barrier. The Mokelumne River enters the San Joaquin River near the mouth of Old River (light green star) and the Calaveras River enters the San Joaquin between the head of Old River (green star) and the junction with Turner Cut (turquoise star).

Most of the estimates of salmonid survival during through-Delta migration are based on juvenile Chinook salmon tagged with coded wire tags (CWTs) and estimate survival from upstream of the head of Old River to Jersey Point in the western Delta, near the confluence of the Sacramento River and San Joaquin River. More recently, through-Delta survival has been estimated using acoustically tagged juvenile Chinook salmon. In 2011, the first year of a survival study using tagged steelhead was implemented, but results were not yet available during discussions leading to the joint stipulation. Summaries of the CWT and early acoustic

tag studies are provided in San Joaquin River Technical Committee, (2008), Newman (2008), and Holbrook *et al*. (2009).

Absent steelhead-specific data, NMFS relied on the results of the available studies on Chinook salmon to estimate effects of a barrier on steelhead, specifically the survival relationships determined by Ken Newman for the Old River and mainstem San Joaquin routes based on data from CWT studies since the mid-1990s (Figure 2).

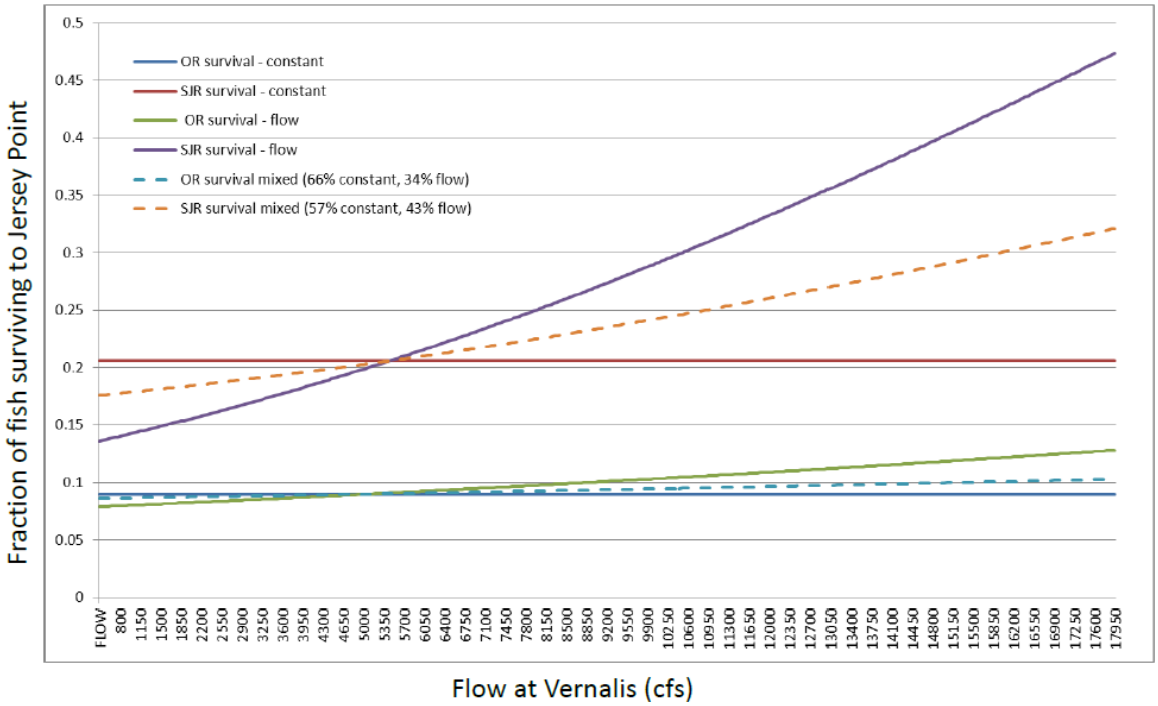

Figure 2. Estimated survival relationships on the Old River (OR) and mainstem San Joaquin River (SJR) routes (based on equations from Ken Newman's analysis of recoveries of coded wire tagged juvenile Chinook salmon).

Because a rock barrier directs both fish and flow into the mainstem San Joaquin River, these relationships support the conclusion that a rock barrier improves overall through-delta survival. The 2010 VAMP panel came to a similar conclusion, noting that "We believe that both empirical evidence and logical inference support a conclusion that installation of a barrier at the Head of Old River improves survival of downstream migrating juvenile Chinook salmon." (page 7 of Dauble *et al*., 2010).

Installation of the non-physical barrier previously tested at the head of Old River (a "bio-acoustic fish fence" which uses air bubbles, light, and sound to deter fish from entering Old River) was initially considered, but, based on uncertainties regarding the non-physical barrier, the benefits to outmigrating salmonids from the San Joaquin River were considered more certain with a rock barrier. First, the deterrence of the non-physical barrier (23% in a high flow year and 84% in lower flow year) was considered less reliable than the deterrence from a rock barrier. Second,

because the non-physical barrier would not affect the flow split at the head of Old River junction, it would not provide the incremental gain in survival expected from keeping most of the flow reaching the head of Old River in the mainstem San Joaquin route. Third, studies with the non-physical barrier installed observed predation that may have been associated with the non-physical barrier. No equivalent predation studies have been conducted with the rock barrier installed. The uncertainties in deterrence effect and predation risk associated with the different barrier types were discussed during the development of the joint stipulation in the fall of 2011 and the overall through-delta survival under different assumptions was estimated using a simple spreadsheet model[4].

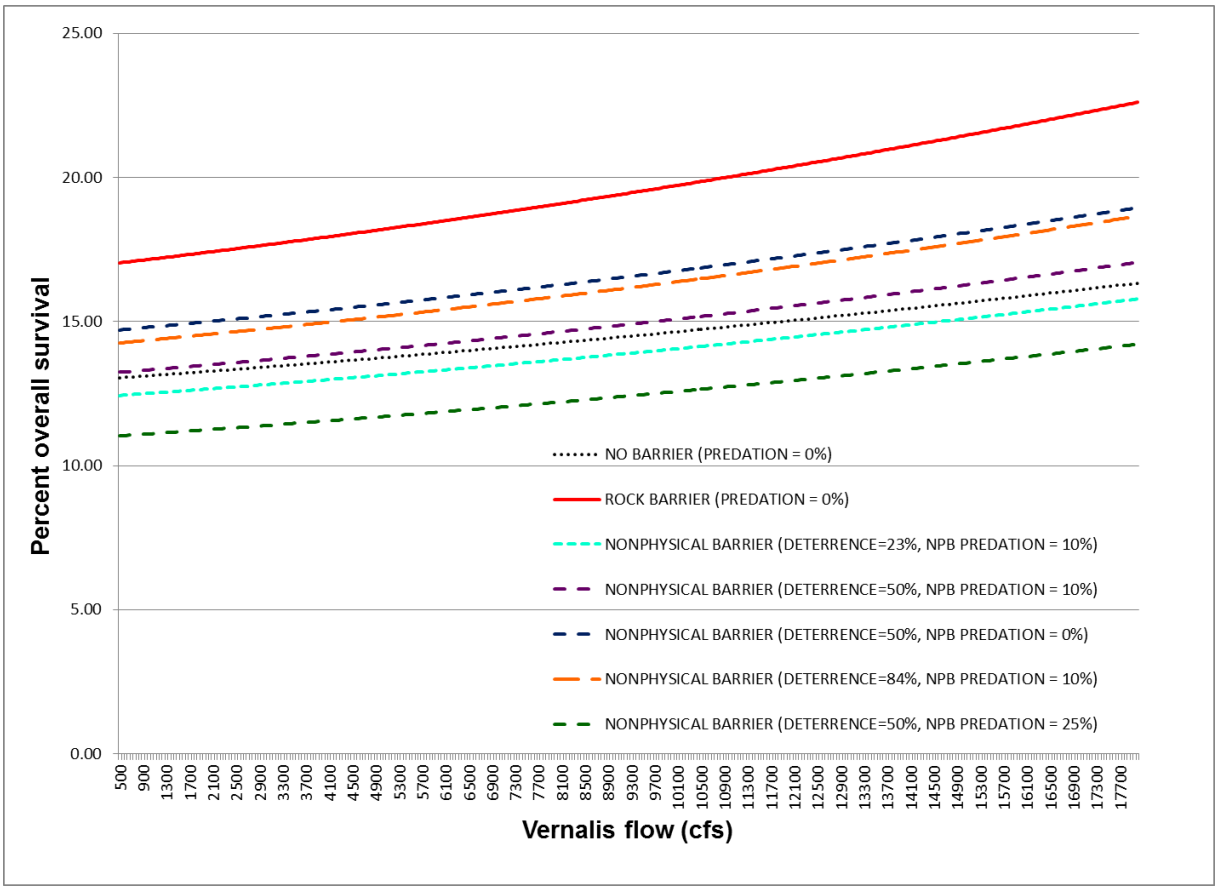

Figure 3. Comparison of percent overall through-delta survival estimated using the "mixed model" flow relationships shown in Figure 2. These scenarios were selected and presented in the fall of 2011 based on preliminary results for deterrence (23% in a high flow year; 84% in a lower flow year) and predation (10-25%) associated with the non-physical barrier; other combinations of predation (for any barrier type) and deterrence (for non-physical barrier type) are possible, and can be explored using the "HORB and survival exploration tool".

Old River and Middle River flow management

Management of OMR flows was included as a component of the stipulated operations for spring 2012 because the installation of a rock barrier at the Head of Old River causes the OMR flows

[4] The spreadsheet model (HORB and survival_exploration tool.xls) is included in the review materials for the panel.

to be more negative than without the rock barrier. Because salmonids that enter the interior delta channels such as Old River or Middle River may be more vulnerable to entrainment at the export facilities when the flows in those channels are more negative, the operations for Spring 2012 limit OMR flows within an adaptive range (-1,250 cfs to -3,500 cfs during April; -1,250 cfs to -5,000 cfs during May).

This adaptive range of OMR is particularly important for managing the hydrodynamic impacts of a barrier on steelhead emigrating from the Calaveras River or Mokelumne River. Because steelhead on the Calaveras and Mokelumne Rivers enter the mainstem San Joaquin River downstream of the rock barrier (Figure 1), they do not benefit from the direct effects of the rock barrier in preventing movement into Old River. They, as well as steelhead entering the Delta near the Head of Old River, do benefit from the increased river flows in the San Joaquin River mainstem provided by the rock barrier, yet may experience increased entrainment vulnerability if they enter channels of the interior Delta which have higher negative flows due to barrier effects. Because of a lack of empirical information about the relative survival of Calaveras or Mokelumne river fish with and without the rock barrier, the relative benefit of the rock barrier has greater uncertainty for these populations.

A more detailed summary of the expected benefits of the alternative spring 2012 operations, including the rock barrier at the Head of Old River (and uncertainties associated with recent survival data and new barrier technology), OMR management, and the potential for reducing loss of juvenile salmonids by preferentially diverting water through the Central Valley Project instead of the State Water Project, is provided in Appendix C.

1.2 The Process

A planning committee, comprised of representatives from the Federal and State agencies, as well as technical experts from non-governmental organizations and the PWA, was involved in two workshops (an acoustic tag workshop on February 3, 2012, and a technical workshop on OMR management on February 7, 2012), and subsequent discussions regarding the design of the acoustic tag experimental study and potential triggers for OMR management during spring 2012. This resulted in two approaches for managing OMR flows for the protection of San Joaquin basin steelhead: one based a method using the particle tracking model (PTM) for the period April 1-15, and another based on in-season monitoring of acoustically-tagged steelhead for the period April 16-May 31. Details of these two approaches are described in the NMFS Technical Memorandum issued by NMFS on March 16, 2012 (Appendix D[5]).

The acoustically-tagged sentinel steelhead experiment was the first of its kind to study the fine scale movements of acoustically-tagged steelhead within and throughout the Delta, and to utilize some of the data to inform in-season management and water operations. Receivers to

[5] NMFS Technical Memorandum also available at: http://swr.nmfs.noaa.gov/ocap/2012_stipulation.htm

monitor the sentinel steelhead migration were established at a location specifically selected as an indication that the steelhead were migrating toward the pumps. This spot in the southern Delta is known as Railroad Cut. The reason why PTM was used for April 1-15, 2012, was that the experiment with tagged fish was delayed two weeks due to an unanticipated equipment requisition problem.

Real-time operations were then carried out by weekly and/or daily decision-making for April and May, 2012. On Monday afternoon of each week, the Delta Conditions Team (DCT), was convened by California's Department of Water Resources (DWR), to provide any information to assist the Delta Operations for Salmonids and Sturgeon (DOSS) technical group in evaluating the potential effects of planned water operations. On Tuesday morning of each week, the DOSS group, consisting of technical staff from all relevant Federal and State agencies, met to advise the Water Operations Management Team (WOMT) and NMFS. The WOMT then met Tuesday afternoon of each week, and consisted of management representatives from all relevant Federal and State agencies. NMFS then made the final determinations on OMR flows shortly thereafter and explained them in writing and posted them on the NMFS' website.

Chapter 2 – Summary of Spring 2012 operations and sentinel releases

2.1 Barrier installation, flow and export conditions

The rock barrier at the head of Old River, with 6 open culverts, was in place for all of April and May of 2012.

Exports and OMR flows are summarized in Figure 4; a tabular summary of daily OMR flows, Vernalis flows, and exports is provided in Appendix E.

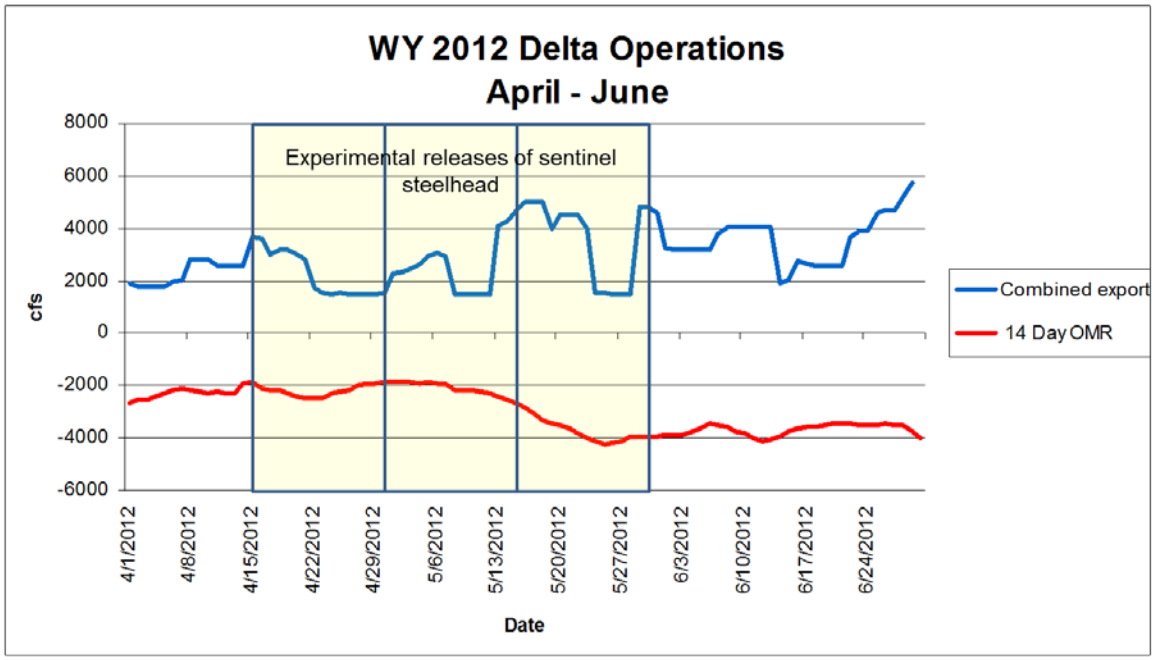

Figure 4. Summary of exports and Old and Middle River Flows for April and May 2012

During portions of spring 2012, the relatively low flows at Vernalis, in combination with a State Water Resources Control Board requirement that the volume of CVP and SWP exports not exceed the volume of delta inflow at Vernalis, limited exports to a degree that limited implementation of the most negative OMR experimental flow of -5,000 cfs. WOMT agencies[6] engaged in multiple meetings with the Tuolumne Irrigation District and Merced Irrigation District to coordinate releases on the San Joaquin tributaries; the link between Vernalis flow and the feasibility of implementing the experimental OMR targets per the NMFS Technical Memorandum was one factor (among many) considered in those discussions. The schedule of San Joaquin tributary releases proposed in early May is shown in Figure 5.

[6] NMFS, U.S. Fish and Wildlife Service, California Department of Fish and Game, Reclamation, and DWR.

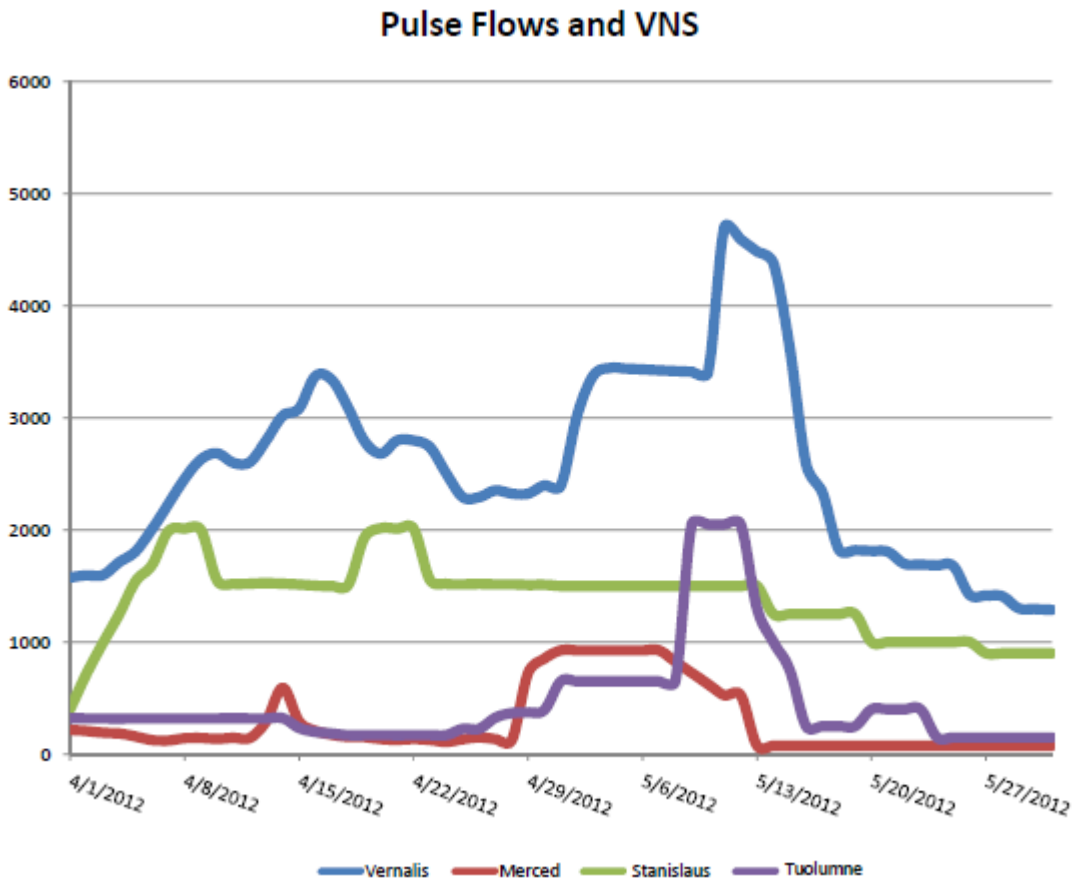

Figure 5. Proposed pulse flows (in cfs) from each San Joaquin River tributary, including the total estimated flow at Vernalis. The Vernalis flow estimate assumes that Stanislaus and Tuolumne releases reach Vernalis in two days, and that Merced releases reach Vernalis in three days.

2.2 Sentinel releases and tag detections at Railroad Cut

Cumulative tag detections at the Railroad Cut receivers are summarized in Table 1; a tabular summary of daily tag detections (and resulting action responses) is provided in Appendix E.

Table 1: Summary of releases of sentinel steelhead and number of tags detected at the receivers near Railroad Cut (southern end of Bacon Island) in the Old River and Middle River channels during each experimental period. These preliminary tag detection data were reported daily during April and May 2012 and have not been filtered for predator-type behavior. The cumulative totals include detections ONLY during the two-week experimental period, so, for example, if a tag from the first release group was detected on May 7th, it is not included in the cumulative total of 49. All sentinel steelhead were released in the mainstem San Joaquin River downstream of the Port of Stockton, near Buckley Cove Park.

Experimental Period	**1st: 4/15-4/30**	**2nd: 5/1-5/15**	**3rd: 5/16-5/31**
Number of sentinel steelhead released	166	167	167
Number of tags detected at the Railroad Cut receivers by the end of the experimental period	49	51	42
Trigger (date that tag detections were reported to exceed trigger)	9 (4/19/2012)	24 (5/4/2012)	31 (5/21/2012)

2.3 Summary of NMFS determinations for Spring 2012 operations

Table 2: NMFS determinations relating to operational decisions during Spring 2012. All documents are available at: http://swr.nmfs.noaa.gov/ocap/2012_stipulation.htm. Further background on the DOSS discussion that led to the DOSS advice referred to in these determinations is available at: http://swr.nmfs.noaa.gov/ocap/doss.htm.

Document	Topic(s) covered	Location in Report
NMFS Determination for Operations per Joint Stipulation During April 1-7, 2012	First implementation of the PTM-based approach to OMR management.	*Appendix F*
NMFS Determination for Operations per Joint Stipulation During April 8-14, 2012	Second implementation of the PTM-based approach to OMR management, adjustment to the PTM simulation period	*Appendix G*
NMFS Determination on April 12, 2012	Response to the OMR flow proposal from DWR and PWA	*Appendix H*
NMFS Determination on April 27, 2012	Reduction in OMR flows after trigger hit, initial response to PWA questions regarding action response, adjustment in ordering of target experimental OMR flows	*Appendix I*
NMFS Determination on May 4, 2012	Adjustment to calculation of trigger, action response limited to no more than five days	*Appendix J*
NMFS determination on May 11, 2012	Further adjustment to calculation of trigger, further adjustment in ordering of target experimental OMR flows	*Appendix K*

The San Joaquin Basin water year type changed in mid-May from Critical to Dry, which changed the D-1641 requirements for Vernalis flows as well as the inflow:export ratio that would have been implemented under RPA Action IV.2.1 absent the joint stipulation. DCT, DOSS, & WOMT discussed whether or not that shift in year type would require any additional adjustments to the action response; NMFS did not determine that any further adjustment was necessary.

Chapter 3 – Summary of preliminary results

3.1 Preliminary in-season results

The overall results included a modest increase in water exports of approximately 57,000 acre feet over what would have occurred under the NMFS BiOp (Appendix L), significantly improved real-time tracking of migration patterns of the juveniles over the course of differing flow and pumping regimes, and higher than expected straying of juvenile steelhead into the south Delta.

The original determination for the acoustic study period was to manage OMR flows in real-time through constant monitoring of sentinel acoustically-tagged steelhead under experimental flows of -3500 cubic feet per second (cfs) from April 16-30, -1250 cfs from May 1-15 and -5000 cfs from May 16-31. The first set of 166 tagged fish was released into the San Joaquin River on April 15-16. Four days later, 13 tags had been detected by the receivers which surpassed the trigger of 9 set by NMFS. Therefore, OMR flows were required to be reduced to -1250 cfs from April 22-30, 2012. All total for the two-week period, over 30% of the tags (49) were detected as heading toward the southern Delta, not downstream toward the San Francisco Bay.

In response, DWR and the PWA proposed raising the trigger number and switching the experimental periods for May, so that May 1-15 would operate OMR at -5000 cfs and May 16-31 would be -1250 cfs. DOSS and NMFS agreed to the following operations: the switch in experimental OMR flows; a new trigger set at 24 fish, based on data from the first experimental period and adjustments to the mortality rate in the calculation of the trigger number; operating at the experimental OMR flow for at least 5 days, even if the trigger was met; and limiting the action response of OMR at -1,250 cfs to 5 days before OMR can resume to the initial experimental flow. The second set of 167 acoustically-tagged steelhead were released on May 1-2. By May 4, the newly raised trigger was met and OMR flows were again reduced to -1250 cfs from May 8-12, 2012. For this period, over 30% of the tags (51) in total were detected as heading toward the southern Delta, not downstream toward the San Francisco Bay.

Due to the high number of tags detected and other regulatory constraints (i.e., State Water Board), the Projects were not able to implement the higher (more negative) OMR flows within the allowable range set out in the study design. Therefore, in consideration of information provided by members of the DCT, and DOSS advice, the Federal and State agencies came up with a proposal that created the greatest experimental value for the acoustic study while still maintaining minimum protections for steelhead. The result was increasing the trigger number again to 31 (based on further adjustments to the mortality rate in the calculation of the trigger number), operating to an OMR of -5,000 cfs from May 16-20, even if the new trigger was surpassed, and if the trigger was exceeded, reducing flows to -1250 cfs for five consecutive days beginning as soon as possible after May 20. The third and final set of 167 acoustically-tagged steelhead was then released on May 15-16. By May 21, the new trigger was met. OMR flows were then reduced to -1250 cfs from May 23-28. Overall, over 25% of the tags (42) were detected as heading toward the southern Delta, not downstream toward the San Francisco Bay.

3.2 Preliminary analysis of tag detection data from full receiver array

A summary of the data processing and first phase of analyses of tagged steelhead behavior is provided in the data report from Cramer Fish Sciences. While the data report was not yet available at the time this Spring 2012 Operations Report was written, that data report is expected to include an evaluation of fish behavior entering the Turner Cut junction from upstream and several routing analyses that assess whether or not tagged fish observed in the southern delta are observed to move northward or southward under different flow conditions. Further analysis of the data from the "stipulation study" will continue in 2012 and 2013.

Chapter 4 – Requests for Feedback

NMFS is particularly interested in feedback from the panel on the questions pertaining to Spring 2012 Operations per the Joint Stipulation that are included in the charge to the panel.

References

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