Appendix A

Joint stipulation

IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF CALIFORNIA

THE CONSOLIDATED SALMON CASES

SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, et al. v. GARY F. LOCKE, et al. (Case No. 1:09-cv-1053)

STOCKTON EAST WATER DISTRICT v. NOAA, et al. (Case No. 1:09-cv-1090)

STATE WATER CONTRACTORS v. GARY F. LOCKE, et al. (Case No. 1:09-cv-1378)

KERN COUNTY WATER AGENCY, et al. v. U.S. DEPARTMENT OF COMMERCE, et al. (Case No. 1:09-cv-1520)

OAKDALE IRRIGATION DISTRICT, et al. v. U.S. DEPARTMENT OF COMMERCE, et al. (Case No. 1:09-cv-2452)

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA v. NMFS, et al. (Case No. 1:09-cv-1625)

1:09-cv-1053-LJO-DLB
1:09-cv-1090-LJO-DLB
1:09-cv-1378-LJO-DLB
1:09-cv-1520-LJO-DLB
1:09-cv-2452-LJO-DLB
1:09-cv-1625-LJO-SMS

JOINT STIPULATION REGARDING CVP AND SWP OPERATIONS IN 2012

Judge: Honorable Lawrence J. O'Neill

RECITALS

1. On March 5, 2010, the Court entered its Memorandum Decision Re Cross-Motions for Summary Judgment On NEPA Issues (Doc. 266), and on March 17, 2010 entered its Order Granting In Part Motion for Summary Judgment On NEPA Issues (Doc. 288). This decision found that the United States Bureau of Reclamation and the Secretary of the Interior have violated the National Environmental Policy Act by failing to perform any NEPA analysis prior to adopting and implementing the 2009 Salmonid Biological Opinion ("2009 Salmonid BiOp"). On September 20, 2011, the Court entered its Memorandum Decision re Cross Motions for Summary Judgment (Doc. 633) in these Consolidated Salmonid Cases regarding the 2009 Salmonid BiOp. This decision found the 2009 Salmonid BiOp and its reasonable and prudent alternative ("RPA") arbitrary, capricious, and unlawful. On September 29, 2011, the Court entered its Order Re Cross-Motions for Summary Judgment (Doc. 643) and remanding without vacatur the 2009 Salmonid BiOp to the National Marine Fisheries Service ("NMFS") for further consideration in accordance with the Court's rulings and the requirements of law. The September 29 Order provides that the remand without vacatur is without prejudice to "the hearing or decision of any provisional remedy justified in law or equity," and further that the Court "retains jurisdiction over this matter to the fullest extent permitted by law."

2. On December 7, 2011, the Court issued a minute order in the Salmonid Cases acknowledging the joint report filed by the parties to the litigation. In addition, the Court indicated that parties may present stipulations on other matters, including project operations in 2012, to the Court and if agreement on such matters cannot be reached, the parties shall file a joint status report no later than January 6, 2012, briefly summarizing the nature of any remaining disputes and articulating the anticipated need for, and timing of, further motions practice. On December 12, 2011, the Court issued a Final Judgment (Including Schedule for Remand) (Doc. 655) in the case in accordance with the Memoranda and Orders described above that included a schedule for reconsidering the remanded biological opinion and compliance with NEPA.

3. Consistent with the Court's minute order, the parties have been engaged in discussions to reach agreement on the manner in which the RPA will be modified and applied

during Water Year 2012. The parties executing this agreement have reached an agreement on certain actions and agree to modifications to the RPA Action IV.2.1 as described below for April 1 through May 31, 2012 operations only. The parties intend to continue discussions regarding other Water Year 2012 operations over the coming weeks, and intend to bring additional settlement stipulation(s) on 2012 operations before the Court if agreement can be reached prior to the onset of those operational actions. In addition to 2012 operations, the parties executing this agreement have agreed upon specific monitoring, studies and other actions described below.

STIPULATION

In the context of the foregoing recitals, Plaintiffs San Luis & Delta-Mendota Water Authority, Westlands Water District, State Water Contractors, Metropolitan Water District of Southern California, Coalition for a Sustainable Delta, and Kern County Water Agency ("Plaintiffs"), Oakdale Irrigation District, South San Joaquin Irrigation District, and Stockton East Water District ("Stanislaus River Plaintiffs"), Plaintiff-Intervenor California Department of Water Resources ("DWR"), and Federal Defendants by and through their respective counsel, hereby stipulate and agree as follows:

1. All parties agree to the following operations of the Central Valley Project ("CVP") and State Water Project ("SWP"), and related actions herein, for April 1, 2012 through May 31, 2012. This agreement was reached based on consideration of specific hydrologic, storage and fish conditions. This agreement is not intended to be used as a basis for a new biological assessment or biological opinion. The agreement in Section 2 below regarding 2012 operations is limited to operation of RPA Action IV.2.1, and applies only if the barrier at the Head of Old River is installed.

2. The CVP and SWP projects shall implement the following actions in 2012:

a. Operation at the Head of Old River from April 1 through May 31 if a rock barrier is installed.

i. DWR will install a rock barrier at the Head of Old River, if flows at Vernalis allow for its installation and maintenance from April 1 through May 31 [approximately less than 6,000 cubic feet per second ("cfs")]. Up to eight culverts (of approximately the same

size and configuration as used in previous barrier designs) may be installed in the rock barrier.

ii. When the rock barrier is installed, the SWP and CVP shall be operated to maintain Old and Middle River ("OMR") flows between -1,250 and -3,500 cfs in April, and between -1,250 and -5,000 cfs in May, depending on the real-time operations process described below in subsections iii-vi. Nothing in this section is intended to, or does, prevent the projects from operating more conservatively for delta smelt protection. While the rock barrier is in place and the SWP and CVP are operating to the OMR flows as provided herein, the SWP and CVP will not operate to the San Joaquin River Inflow to Export ratio described under RPA Action IV.2.1.

iii. The exception procedure for health and safety in RPA Action IV.2.1 for minimum combined SWP and CVP pumping of 1,500 cfs will be maintained.

iv. NMFS, DWR, and the U.S. Bureau of Reclamation ("Reclamation") will co-host a technical workshop in early February, with Delta Operations for Salmonids and Sturgeon group ("DOSS") members and other outside experts, to review data availability, modeling tools and outputs and other scientific approaches for establishing real-time operations screening criteria for OMR parameter selection within the specified ranges.

v. At least two weeks prior to April 1, 2012, NMFS, with information submitted by members of the DOSS and other outside experts, will prepare a real-time operations technical memorandum to guide weekly or daily decision-making. Real-time operations screening criteria will be developed based on hydrodynamics and Particle Tracking Model ("PTM") runs, and other relevant available scientific information and considerations, such as:

(a) the fraction of particles that reach Chipps Island; (b) particle residence time; (c) results showing particle capture at various diversions in the delta, and (d) relevant available information from trawls and rotary screw trap information, salvage, hydrodynamics, empirical data from previous VAMP studies, survival equations, and a modified Delta Passage Model. The DOSS will advise the Water Operations Management Team ("WOMT") and NMFS on the appropriate OMR parameter within the specified ranges. The DOSS will consider all relevant available scientific information, such as listed above, in determining its advice. The DOSS will provide its

information and advice to the WOMT for its consideration in developing a recommendation to NMFS for actions to protect salmonids and green sturgeon. The WOMT will supply information for NMFS to consider, including water supply impacts. NMFS shall make the final determination on OMR flow within the specified ranges to be implemented by Reclamation and DWR, after attempting to first meet with WOMT, and shall explain its determination in writing based on the best available science. NMFS will increase the transparency of the decision process by documenting the basis for its decisions and providing a written explanation of them and the basis for them to interested parties via NMFS' website. All parties to this agreement agree that the final determinations made by NMFS pursuant to this Section 2 are binding and in consideration of this agreement hereby waive all rights to seek relief from the court from these determinations and from operation of the projects by DWR and Reclamation in accordance with those determinations; however, this stipulation shall not waive any party's right to raise other claims or defenses as to other CVP and SWP operations or actions under the 2009 Salmonid BiOp.[1]

vi. In order to facilitate availability of real-time information to the agencies, DWR will convene a Delta Conditions Team ("DCT") consisting of scientists and engineers from the state and Federal agencies, Plaintiffs, and Defendant-Intervenors to review the real time operations and Delta conditions, including potential modeling utilizing the Delta Passage Model, PTM, and other applicable modeling tools, in conjunction with the real time monitoring, to assist in evaluating the potential effects of planned water operations on salmonids and sturgeon. The members of the DCT will provide its individual information to DOSS in accordance with a process provided by the DOSS, which currently meets on Tuesday mornings, to assess risks to salmonids and sturgeon based upon Delta conditions and the other factors set forth above.

vii. In order to generate information on migration routes and survivals across variable operating conditions in order to inform decision-making for project operations, DWR and Reclamation agree to fund the development and deployment of a broadened acoustic tagging and release program in 2012, which will track juvenile salmon and juvenile steelhead migrations

[1] Furthermore, nothing in this agreement waives the right of any party to assert whatever privileges may otherwise be available to it by law.

through the south Delta for the purpose of generating better information by which to manage south Delta operations and other activities to improve fish survival efficiently and effectively. The person or organization selected by the parties to conduct such studies will collaborate with the NMFS-Southwest Fisheries Science Center ("NMFS-SWFSC") in designing and conducting these studies. To the extent any information from such studies is available for use in 2012, the parties agree that the information will be used in the decision-making process in determining 2012 operations pursuant to this stipulation. Such an acoustic tag program may include:

1. Weekly releases of hatchery-origin steelhead and salmon at key locations in the south Delta;

2. Deployment of monitoring capabilities to detect juvenile migrations through the south Delta through various routes of migration;

3. Deployment of monitoring capabilities to develop improved information on the effect of water operations of the SWP and the CVP on juvenile salmon and juvenile steelhead migrations through the Delta under varying hydraulic conditions; and

4. Development of data gathering and reporting capabilities to support improved in-season real time water operations over the course of juvenile migrations.

b. NMFS, the other Federal agencies, plaintiff-intervenor DWR, plaintiffs, and defendant-intervenors have engaged in discussions pertaining to south Delta operations if flows at Vernalis are greater than that which would allow a rock barrier to be installed at the Head of Old River. This stipulated agreement for operation in lieu of RPA Action IV.2.1 in 2012 does not address CVP and SWP operations under that scenario but parties may continue to meet to develop possible operations under such high flow conditions where a rock barrier cannot be installed.

3. DWR will submit to NMFS and the California Department of Fish and Game ("DFG") a predator monitoring study for their review and permit compliance procedures, as appropriate. If a rock barrier is installed, the predator monitoring study will evaluate predation associated with the installation and operation of the rock barrier. If the rock barrier is not installed, the predator monitoring study will evaluate predation at the scour hole downstream of the junction of the San Joaquin River and the Head of Old River. In addition, predator

monitoring efforts will be implemented at location(s) to be determined, for example, at the CVP export facility in front of trash racks, at the scour hole mentioned above, or in other location(s) in the Delta. In addition, DWR commits to developing a study for a pilot predator removal and control program that will be submitted to NMFS and DFG for review and comment.

4. NMFS will have an opportunity to be involved in design and development of studies and will work with DWR, DFG and Public Water Agencies[2] to further refine the following actions:

a. **Examination of other monitoring systems**. DWR and Reclamation will commence in the first quarter of 2012 to examine the opportunities to deploy other monitoring and tracking tools for tracking juvenile and adult migrations of salmonids and other fish species within and through the Delta, utilizing PIT tags or other technologies as may be available. In examining such opportunities, DWR and Reclamation agree to utilize the available expertise of the fishery agencies, the university community, the consulting community and other sources of expertise.

b. **Life-cycle modeling**: The parties agree that the timely development of a Central Valley salmon life-cycle model is vital to inform Bay-Delta decision-making. The model will be developed by and under the control of the NMFS-SWFSC, and, subject to the availability of funding, the NMFS-SWFSC shall utilize a broad array of expertise outside of NMFS as appropriate. Such an expanded program may also be guided by a panel of experts convened by the Interagency Ecosystem Program or other appropriate expert agency. DWR and Reclamation will consider providing funding to the NMFS-SWFSC to accelerate the development of the model.

[2] "Public Water Agencies" consist of state and federal water contractors who receive water from the SWP and CVP and are Metropolitan Water Agency of Southern California, Kern County Water Agency, San Luis & Delta-Mendota Water Authority, Westlands Water District, and Santa Clara Valley Water District, and State Water Project Contractors Authority ("SWPCA") and State and Federal Contractors Water Agency ("SFCWA"). The Stanislaus River Plaintiffs are also considered "Public Water Agencies" for the purpose of this stipulation and for the purposes of any engagement process related to ESA Section 7 consultation involving New Melones operations.

c. DWR and Reclamation will continue the Chinook salmon acoustic tag survival studies that have been implemented through the Vernalis Adaptive Management Program, in conjunction with the 6-year acoustic tagging experiment.

5. DWR, Reclamation and the Public Water Agencies agree to work with NMFS to design, develop, and fund a program to provide additional fish tagging and monitoring that could further inform Bay-Delta decision-making.

6. As authorized under the State Water Resources Control Board Decision 1641, Reclamation and DWR may divert or redivert water of the SWP and CVP between Jones Pumping Plant and Banks Pumping Plant in April and May to reduce fish losses and to benefit fish. The CVP will develop and implement standard operating procedures to minimize longfin and Delta smelt losses and salmonid losses, as specified in the 2009 BiOp, during the cleaning of the louvers.

7. This stipulated agreement for operations does not address or include RPA Action IV.2.3, which provides for OMR Flow Management from January through June 15. However, the parties commit in 2012 to continue discussions to develop a monitoring-based trigger, or other real-time operations approach, that would modify in 2013 the January 1 onset of Action IV.2.3.

8. By June 2012, DWR and Reclamation will submit to NMFS for review a list of possible habitat restoration projects targeted to improve survival of steelhead migrating out of the San Joaquin Basin. The parties expect that DWR and Reclamation will confer with DFG in compiling this list.

SO STIPULATED.

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Dated: January 12, 2012

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ORDER

Good cause appearing, and based on the stipulation of the parties, the court hereby orders as follows:

1. IT IS HEREBY ORDERED ADJUDGED, AND DECREED, that the Joint Stipulation Regarding CVP And SWP Operations in 2012 is approved.

2. IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that all actions in the Joint Stipulation Regarding CVP And SWP Operations in 2012 be carried out as described therein and that the parties to the stipulation have waived any right to seek relief from this court from such actions through May 31, 2012.

3. IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that, except as specified in the Joint Stipulation Regarding CVP and SWP Operations in 2012, all parties otherwise retain rights to seek further relief to the extent permitted by law.

IT IS SO ORDERED.

Dated: **January 17, 2012**

/s/ Lawrence J. O'Neill
UNITED STATES DISTRICT JUDGE

Appendix B

RPA Action IV.2.1

address that recommendation. Years of studies have shown that the loss of migrating salmonids within Georgiana Slough and the Delta interior is approximately twice that of fish remaining in the Sacramento River main stem (Kjelson and Brandes 1989; Brandes and McLain 2001; Vogel 2004, 2008; and Newman 2008). Based on the estimated survival rate of 35 percent in Georgiana Slough (Perry and Skalski 2008), the fraction of emigrating salmonids that would be lost to the population is 6 to 15 percent of the number entering the Delta from the Sacramento River basin. Keeping emigrating fish in the Sacramento River would increase their survival rate. This action is also intended to allow for engineering experiments and possible solutions to be explored on the San Joaquin river/Southern Delta corridor to benefit out-migrating steelhead. For example, non-physical barrier (i.e., "bubble curtain") technology can be further vetted through this action.

Action Suite IV.2 Delta Flow Management

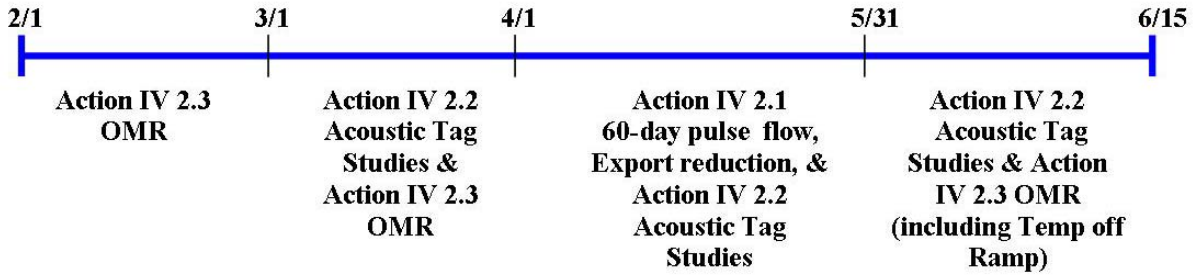
Objective: Maintain adequate flows in both the Sacramento River and San Joaquin River basins to increase survival of steelhead emigrating to the estuary from the San Joaquin River, and of winter-run, spring-run, CV steelhead, and green sturgeon emigrating from the Sacramento River through the Delta to Chipps Island.

Rationale for the Suite of Actions: Numerous studies have found positive associations between increased river flows and increased survival of salmon smolts through the Delta and the adult escapement of that cohort several years later when they return to spawn. Increased flows and greater smolt survival have been positively associated in other river systems as well Increased flows reduce the travel time of smolts moving through the river and Delta system, thus reducing the duration of their exposure to adverse effects from predators, water diversions, and exposure to contaminants.

Action IV.2.1 San Joaquin River Inflow to Export Ratio

Objectives: To reduce the vulnerability of emigrating CV steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: The following timeline indicates the annual schedule for implementing related San Joaquin actions that will occur concurrent with this action.



Phase I: Interim Operations in 2010-2011.

From April 1 through May 31:

1. Flows at Vernalis (7-day running average shall not be less than 7 percent of the target requirement) shall be based on the New Melones Index[9]. In addition to the Goodwin flow schedule for the Stanislaus River prescribed in Action III.1.3 and Appendix 2-E, Reclamation shall increase its releases at Goodwin Reservoir, if necessary, in order to meet the flows required at Vernalis, as provided in the following table. NMFS expects that tributary contributions of water from the Tuolumne and Merced rivers, through the SJRA, will continue through 2011 and that the installation of a fish barrier at the Head of Old River will continue to occur during this period as permitted.

New Melones Index (TAF)	Minimum flow required at Vernalis (cfs)
0-999	No new requirements
1000-1399	D1641 requirements or 1500, whichever is greater
1400-1999	D1641 requirements or 3000, whichever is greater
2000-2499	4500
2500 or greater	6000

[9] The New Melones Index is a summation of end of February New Melones Reservoir storage and forecasted inflow using 50% exceedance from March through September.

2. Combined CVP and SWP exports shall be restricted through the following:

Flows at Vernalis (cfs)	Combined CVP and SWP Export
0-6,000	1,500 cfs
6,000-21,750[10]	4:1 (Vernalis flow:export ratio)
21,750 or greater	Unrestricted until flood recedes below 21,750

In addition:

1) Reclamation/DWR shall seek supplemental agreement with the SJRGA as soon as possible to achieve minimum long term flows at Vernalis (see following table) through all existing authorities.

San Joaquin River Index (60-20-20)	Minimum long-term flow at Vernalis (cfs)
Critically dry	1,500
Dry	3,000
Below normal	4,500
Above normal	6,000
Wet	6,000

Rationale:

1) Flows at Vernalis: Reclamation has limited discretion to require additional flows from the Tuolumne and Merced rivers that are necessary in the long run to meet the needs of outmigrating juvenile steelhead. Modeling for our analysis of the East Side Division show that relying on New Melones Reservoir to provide the flows at Vernalis cannot be sustained, and attempting to do so would likely have additional adverse effects on CV steelhead. Reclamation and DWR have obtained additional flows in the Tuolumne and Merced rivers through CVPIA authorities, including options to purchase water from willing sellers, and entered into the SJRA which expires on December 31, 2009. Reclamation is in negotiations to extend the current agreement to 2011. The flows required in Phase I at Vernalis were developed through iterative modeling and will provide an important increment of additional flow to provide for outmigration of steelhead smolts, while not unduly depleting New Melones Reservoir storage. Using CVPIA authorities, it is important that Reclamation seek to immediately change the terms of the existing SJRA to achieve the long-term flows.

[10] Flood warning stage at Vernalis is 24.5 feet, flow is 21,750 cfs at this point. Flood stage is 29 feet with a corresponding flow of 34,500 cfs. Data from CDEC looking at April 8-9, 2006 period. As such, recognizing that the flows associated with these stages do vary, the trigger allowing unrestricted exports will be a Vernalis stage of 24.5 feet.

2) The rationale for the export curtailments is provided in the rationale for Phase II.

3) The SWRCB has initiated proceedings to establish minimum flows in the San Joaquin River basin. The proceedings are scheduled to conclude in 2011. Flow requirements for fish will be provided by this action in the interim.

Phase II: Beginning in 2012:

From April 1 through May 31:

1. Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action III.1.3 and Appendix 2-E.

2. Reclamation and DWR shall implement the Vernalis flow-to-combined export ratios in the following table, based on a 14-day running average.

San Joaquin Valley Classification	Vernalis flow (cfs):CVP/SWP combined export ratio[11]
Critically dry	1:1[12]
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1
Vernalis flow equal to or greater than 21,750 cfs	Unrestricted exports until flood recedes below 21,750.

Exception procedure for multiple dry years: If the previous 2 years plus current year of San Joaquin Valley "60-20-20" Water Year Hydrologic Classification and Indicator as defined in D-1641 and provided in following table, is 6 or less, AND the New Melones Index is less than 1 MAF, exports shall be limited to a 1:1 ratio with San Joaquin River inflow, as measured at Vernalis.

San Joaquin Valley Classification	Indicator
Critically dry	1
Dry	2
Below normal	3
Above normal	4
Wet	5

[11] Exception to the ratio is provided for floods, where exports are not restricted until the flood recedes. See footnote 2 above.
[12] Minimum combined CVP and SWP exports is for health and safety.

Exception procedure for Health and Safety: If, by February 28 of a given year, Reclamation and DWR predict that they will not be able to achieve these ratios and make deliveries required for human health and safety, even after pursuing all options to augment inflow while preserving the ability to meet fish flow needs in all seasons, the agencies may submit a plan to NMFS to maximize anadromous fish benefits while meeting health and safety needs. The project agencies' current estimate of health and safety needs is a combined CVP/SWP export rate of 1,500 cfs. The plan must demonstrate that all opportunities for purchasing water in the San Joaquin Basin have been or will be exhausted, using b(3) or other water purchasing authority.

Meeting the long-term biological requirements of listed species and providing adequate water deliveries for these needs under the current system configuration may not be compatible, particularly considering anticipated hydrologic patterns associated with climate change. For this reason, Reclamation and DWR may propose a reconfiguration of the water conveyance system to allow diversion from the Sacramento River. Such an alteration of the conveyance system is being considered in the BDCP planning process. The operation of a conveyance structure that diverts water directly from the Sacramento River carries additional risk for listed species that migrate, spawn, or rear in the Sacramento River or North Delta. As detailed in this Opinion, the status of those species is precarious. Any new conveyance will be subject to section 7 consultation, and issues of injury or mortality of juvenile fish associated with all diversion facilities, reduction of flow variability for fish life history functions, reduction of Shasta Reservoir storage necessary for mainstem temperature control, and other potential adverse effects must be adequately addressed in any conveyance proposal.

Rationale: VAMP studies of CWT Chinook salmon smolts indicate that in general, fish released downstream of the zone of entrainment created by the export pumps (*e.g.*, Jersey Point) have higher survival indices to Chipps Island than fish released higher up in the system (*e.g.*, Durham Ferry, Mossdale, or Dos Reis). Studies identify increased flows as a factor that increases survival of tagged Chinook salmon smolts. To date, most VAMP experiments have utilized San Joaquin River flows to export pumping ratios of approximately 2:1. Survival to Chipps Island of smolts released upstream has been relatively low under these conditions. (Kjelson *et al*. 1981, Kjelson and Brandes 1989, SJRGA 2007). Historical data indicates that high San Joaquin River flows in the spring result in higher survival of outmigrating Chinook salmon smolts and greater adult returns 2.5 years later (Kjelson *et al.* 1981, Kjelson and Brandes 1989, USFWS 1995) and that when the ratio between spring flows and exports increase, Chinook salmon production increases (CDFG 2005, SJRGA 2007). NMFS, therefore, concludes that San Joaquin River Basin and Calaveras River steelhead would likewise benefit under higher spring flows in the San Joaquin River in much the same way as fall-run do. For a full explanation of data and analysis supporting this action, see appendix 5.

Increased flows within the San Joaquin River portion of the Delta will also enhance the survival of Sacramento River salmonids. Those fish from the Sacramento River which have been diverted through the interior Delta to the San Joaquin River will benefit by the increased net flow towards the ocean caused by the higher flows in the San Joaquin River from upstream and the reduced influence of the export pumps. Such flows will reduce the proportion of Sacramento River fish that continue southwards toward the pumps and increase the percentage that move

westwards toward Chipps Island and the ocean. Although the real environment is much more complex than this generality, in theory, increasing the speed of migration through a particular reach of river, or shortening the length of the migratory route decrease the extent of exposure to factors causing loss (Anderson *et al.* 2005)

Action IV.2.2 Six-Year Acoustic Tag Experiment

Objective: To confirm proportional causes of mortality due to flows, exports and other project and non-project adverse effects on steelhead smolts out-migrating from the San Joaquin basin and through the southern Delta.

Action: Reclamation and DWR shall fund a 6-year research-oriented action concurrent with Action IV.2.1.

The research shall be composed of studies utilizing acoustically-tagged salmonids, and will be implemented to assess the behavior and movement of the outmigrating fish in the lower San Joaquin River. The studies will include three releases of acoustic tagged fish, timed to coincide with different periods and operations: March 1 through March 31, April 1 through May 31, and June 1 through June 15. NMFS anticipates that studies will utilize clipped hatchery steelhead and hatchery fall-run as test fish.

During the period from March 1 through March 30, the exports will be operated in accordance with the requirements dictated by action IV.2.3. During the 60-day period between April 1 and May 30, exports will be dictated by the requirements of action IV.2.1. Reclamation shall operate to a minimum 1:1 inflow to export ratio during the period between June 1 and June 15, allowing exports to vary in relation to inflows from the San Joaquin to test varying flow to export ratios during this period. If daily water temperatures at Mossdale exceed 72^{o}F for seven consecutive days during the period between June 1 and June 15, then the inflow to export ratio may be relaxed. NMFS anticipates that warm water conditions in the lower San Joaquin River will not be suitable for steelhead under these conditions.

Implementation procedures:

1) By September 1, 2009, Reclamation/DWR shall convene DOSS for the purpose of refining the study design for this experiment. The experiments shall be developed to ensure that results are statistically robust and uncertainties due to experimental design have been minimized to the fullest extent possible. Additional expertise may be included in the workgroup, at the discretion of the agencies.

2) Issues relevant to listed anadromous fish species that shall be addressed include, but are not limited to:
   a) Increasing survival of emigrating smolts from the tributaries into the main stem of the San Joaquin River.
   b) Increasing survival of emigrating smolts through the main stem of the San Joaquin River downstream into the Delta.

Appendix C

Summary of expected benefits from alternative operations

SUMMARY OF THE EXPECTED BENEFITS TO SALMONID SURVIVAL OF A ROCK BARRIER AT THE HEAD OF OLD RIVER & PREFERENTIAL USE OF THE CENTRAL VALLEY PROJECT EXPORT FACILITY

December 16, 2011

(1) NMFS concludes that a rock barrier at the head of Old River will increase the overall through-Delta survival of San Joaquin basin steelhead by directing both fish and flow into the mainstem San Joaquin River. The preponderance of empirical data (collected on juvenile Chinook salmon) shows that (a) survival in the mainstem San Joaquin River is greater than the survival in Old River, and (b) survival tends to increase as channel flow increases.

(2) An adaptive range of Old and Middle River flows (OMR flows) is included in the plan for 2012 operations in order to manage risks for steelhead emigrating from the Calaveras River or Mokelumne River. The effect of the rock barrier has greater uncertainty for these populations than for steelhead entering the Delta upstream of the head of Old River.

(3) NMFS will use Particle Tracking Modeling (PTM) and other tools to screen alternative operational scenarios within the adaptive range of OMR flows specified in the settlement. NMFS expects to hold a workshop for technical staff in February to discuss possible screening criteria, and will issue a technical memo in March that can be used to help guide weekly operations decisions regarding OMR flow management.

(4) Preferential diversion of water through the Central Valley Project (CVP) facility instead of the State Water Project (SWP) facility (without changing combined exports) will reduce the loss of juvenile salmonids at the export facilities by reducing exposure to predation in Clifton Court Forebay.

BACKGROUND

1. NMFS concludes that a rock barrier at the head of Old River will increase the overall through-Delta survival of San Joaquin basin steelhead

Data overview: 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 are not yet available.

Excellent 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. The survival estimates that follow are based on 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-1990's.

According to the Newman equations, survival in the mainstem San Joaquin River is at least 5% higher than the fairly constant survival of 9% observed in Old River. Because the effect of flow on survival rate is much more pronounced in the mainstem San Joaquin River route, the potential gain in survival increases with increasing flow. For example, survival is predicted to increase 9% if each route contained a flow of 1,500 cfs (9% in Old River vs. 18% in the mainstem San Joaquin route) but 15% if each route contained a flow of 10,000 cfs cfs (9% in Old River vs. 24% in the mainstem San Joaquin route; Figure 1, dashed lines). 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 relative to a nonphysical barrier that directs fewer fish and no additional flow into the mainstem San Joaquin route. 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).

While the single digit gains in survival expected at flows that allow installation of a rock barrier might seem small, it is important to note that a combined increase in survival of 9% represents a *doubling* of the survival chances of an individual in the mainstem San Joaquin route relative to the survival expected for an individual in the Old River route.

It is important to note that overall survival through the Delta shows a general decline since the late 1990's, from a high of 79% in 1995 to less than 20% since 2001, and less than 10% in recent years. Because the survival relationships used in our analysis were parameterized with a data set that includes the higher survival years, the absolute survivals are higher than would be expected during 2012. However, NMFS assumes that the proportional changes in survival in different routes and at different flows still hold.

Recent data and new technology:

The most recent survival estimates based on acoustic tag data from 2009 and 2010 have shown a slightly lower survival rate in the mainstem San Joaquin vs. Old River route. The 2010 data estimated through-Delta survival from upstream of the head of Old River to Chipps Island (approximately 25 river kilometers west of Jersey Point) and showed 7% survival in the Old River route compared to 4% survival in the mainstem San Joaquin route. The 2009 data did not allow calculation of survival through the entire Delta, but did show slightly higher survival of tagged fish in a reach of Old River compared to in a reach of the mainstem San Joaquin River. Survival estimates based on acoustic tag data from 2008 showed the expected relationship of a higher survival rate (9% vs. 5%) in the mainstem San Joaquin vs. Old River route. No barrier of any type was installed at the head of Old River in 2008; an experimental non-physical barrier

(which uses air bubbles, light, and sound to deter fish from entering Old River) was installed in both 2009 and 2010. The apparent switch in relative survival in the two routes of interest could be due to a recent change in the underlying risk in those routes for outmigrating juvenile salmonids, some interaction of predation risk with the new barrier type, or some other factor. For 2012 operations, NMFS proposed a rock barrier based on the preponderance of data (including the 2008 acoustic tag study) supporting a trend of higher survival on the mainstem San Joaquin River route.

2. **An adaptive range of Old and Middle River flows (OMR flows) is included in the plan for 2012 operations in order to manage risks for steelhead emigrating from the Calaveras River or Mokelumne River**.

Installation of a rock barrier at the Head of Old River causes the flows in Old and Middle River (OMR flows) 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, 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, and may experience increased entrainment vulnerability if they enter channels of the interior Delta which have higher negative flows due to barrier effects. Because NMFS does not have 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.

Existing Particle Tracking Model (PTM) runs (Figure 2) suggest that particles released near the junction of the Calaveras River with the San Joaquin River at OMR flows of up to -3500 cfs show minimal vulnerability to entrainment at the project facilities.

Approximate proportion of particles (inserted near the junction of the Calaveras River with the San Joaquin River) entrained at the CVP/SWP			
		Rock barrier IN	**Rock barrier OUT**
OMR flow	-1,250 cfs	0%	0%
	-2,500 cfs	3%	0%
	-3,500 cfs	6%	0%

Although NMFS understands that juvenile salmonids do not behave like neutrally-buoyant particles, NMFS believes that the use of PTM is a useful tool to understand how flows in the Delta are affected by hydrology and project operations.

3. **NMFS will use Particle Tracking Modeling (PTM) and other tools to screen alternative operational scenarios within the adaptive range of OMR flows specified in the settlement.**

Upon NMFS's request, DWR has conducted a series of PTM runs over a wide range of operational scenarios. Currently under review, these results will be used by NMFS and others to better understand (a) how operations with and without the rock barrier might change the hydrodynamics of the mainstem San Joaquin River and interior delta, and (b) how those hydrodynamic changes may affect both salmonids and delta smelt. Note that the settlement does not in any way restrict the implementation of OMR limits under NMFS RPA Action IV.2.3 (which provides protection primarily for Sacramento basin salmonids) or the FWS RPA (which provides protection for delta smelt)..

These PTM results will be used as part of the evaluation to screen alternative operational scenarios within the adaptive range of OMR flows specified as part of this settlement NMFS expects to hold a workshop for technical staff in February to discuss possible screening criteria, and will issue a technical memo in March that can be used to help guide weekly operations decisions regarding OMR flow management.

4. **Preferential diversion of water through the Central Valley Project (CVP) facility instead of the State Water Project (SWP) facility (without changing combined exports) will reduce the loss of juvenile salmonids at the export facilities by reducing exposure to predation in Clifton Court Forebay**

While predation is a source of fish mortality at both the State Water Project (SWP) and Central Valley Project (CVP) export facilities, predation loss is much higher at the SWP due to predation impacts in Clifton Court Forebay. During April and May, when we expect that the CVP may have capacity to pump SWP water, there is opportunity to reduce salmonid loss associated with the export facilities by preferentially diverting through the CVP facility.

NMFS used the loss formulas for the CVP and SWP facilities provided on the California Department of Fish and Game (CDFG) salvage ftp site (ftp://ftp.delta.dfg.ca.gov/salvage/Salmon%20Loss%20Estimation/) to calculate the expected overall survival of fish entrained into both facilities under different export combinations. As described below, for a combined export rate of 2,000 cfs, shifting 500 cfs of SWP exports to the CVP facility would improve overall survival by 11% if the nominal louver efficiency were achieved. This benefit is reduced as realized louver efficiencies decrease, but recent survival estimates through the delta are so low that even small improvements in survival can be proportionally important.

CVP Louver efficiency*	Overall survival rate through the export facilities for combined exports of 2,000 cfs	
	SWP: 1,000 cfs *CVP: 1,000 cfs*	*SWP: 500 cfs* *CVP: 1,500 cfs*
78%	42%	53%
60%	35%	42%
35%	24%	27%

**The loss equations assume 78% as the nominal louver efficiency at both facilities, though realized louver efficiency at the CVP is expected to be lower due to inefficiencies in the louver cleaning process.*

REFERENCES

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Newman, Ken B. 2008. An evaluation of four Sacramento-San Joaquin River Delta juvenile salmon survival studies. Project Report for CalFed Science Program Project number SCI-06-G06-299. March 31, 2008.

San Joaquin River Technical Committee. 2008. Summary Report of the Vernalis Adaptive Management Plan (VAMP) for 2000-2008. Prepared for the Advisory Panel Review Conducted by the Delta Science Program. December 22, 2008.

Figure 1: 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 fish)

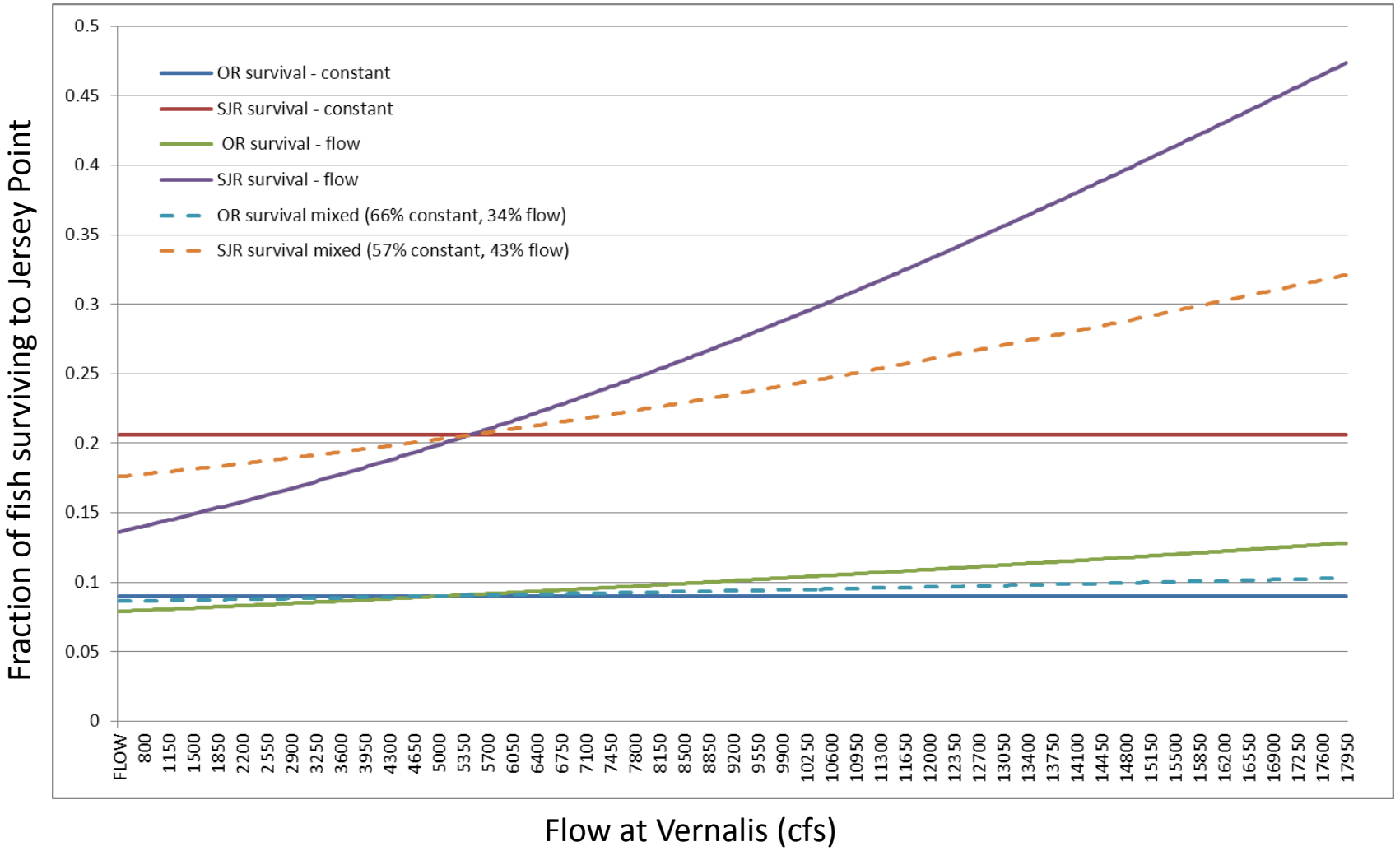
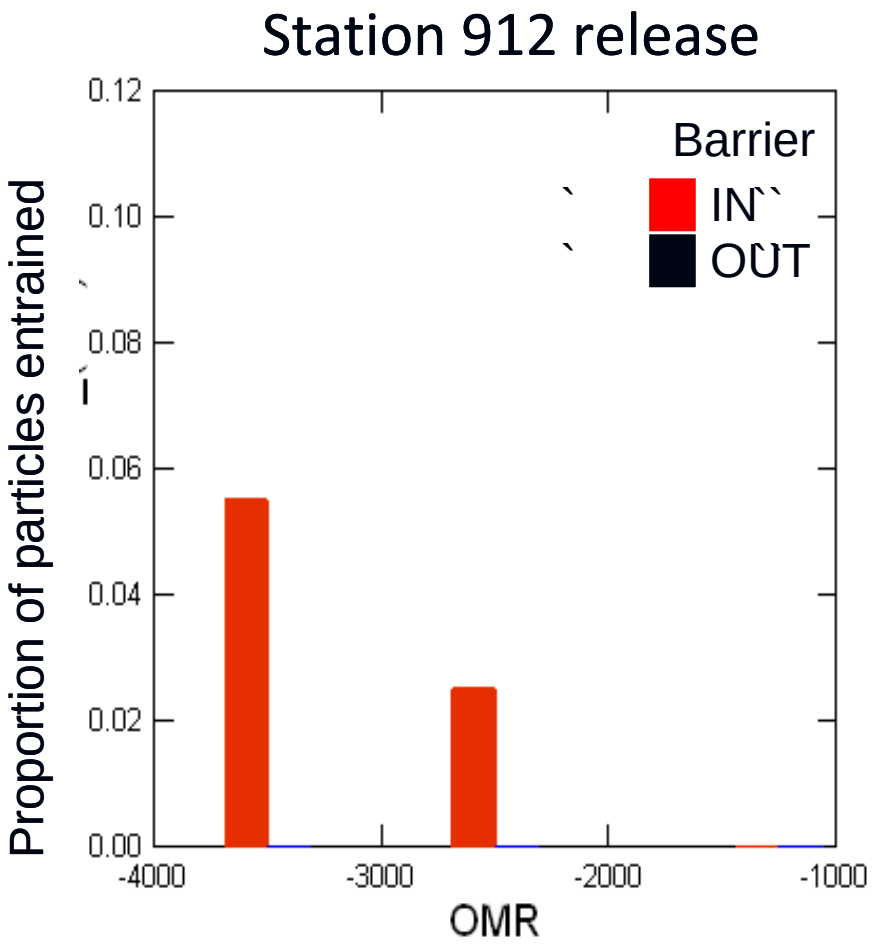


Figure 2: Relative entrainment at the CVP & SWP of particles inserted on the Calaveras River under different OMR conditions



Summary of particle fates inserted on San Joaquin at Calaveras River at the beginning of May and June 2005/08 at three OMR flows as a function of barrier 'In' (red bars) and 'Out' (black bars). Fate of particles at the CVP and SWP export facilities reported after 12 days. There was a general trend of higher entrainment of particles with the barrier in at more negative OMR flows. The percent entrained with barrier hydrodynamics was 2%, however, there were no statistical differences between barrier or among OMRs (ANCOVA; barrier p=0.17; OMR p=0.25). Note: The proportions entrained without the barrier do not appear on the graph because their values were '0' among all 3 values of OMRs. PTM data courtesy of DWR.

Appendix D

NMFS Technical Memorandum
issued March 16, 2012

UNITED STATES DEPARTMENT OF COMMERCE
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MAR 16 2012

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Dear Mr. Glaser and Mr. Cowin:

On January 12, 2012, Plaintiffs, Plaintiff-Intervenor, and Federal Defendants to the Consolidated Salmonid Cases (Case 1:09-cv-01053-LJO –DLB) signed and filed with the Federal court a joint stipulation (Document 659-2) that included Central Valley Project and State Water Project operations for April and May 2012. This letter transmits the real-time operations technical memorandum required as part of the joint stipulation (Paragraph 2.a.v).

The preparation of the enclosed memorandum was aided by discussions with an "OMR planning committee" of technical experts, including agency representatives from the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Bureau of Reclamation, the California Department of Fish and Game, the California Department of Water Resources, as well as other technical experts representing the Coalition for a Sustainable Delta, the Natural Resources Defense Council, the San Luis Delta Mendota Water Authority (a Central Valley Project contractor), and the State Water Contractors.

I express my sincere appreciation to you and your staffs, as well as to the other members of the planning committee, for their professionalism and commitment throughout the development of the technical memorandum. In addition, I acknowledge all of the folks who participated in the preparation and attendance at the February 3, 2012, acoustic tagging workshop and February 7, 2012, technical workshop.

In summary, in my view, implementation of the joint stipulation has created important new opportunities for augmenting the science needed to support these important and complex

decisions related to water supply and Endangered Species Act-listed species protection in the Delta. My hope is that this technical memorandum approach represents the beginning of new interagency and outside expert scientific collaborations that will benefit the co-equal goals of Delta management.

Sincerely

Rodney R. McInnis
Regional Administrator

Enclosure

Technical Memorandum to Guide Adaptive Management of OMR during April and May 2012 for the Protection of listed San Joaquin Basin Steelhead

I. INTRODUCTION

In January 2012, plaintiffs, plaintiff-intervenors, and Federal defendants in the litigation relating to the Biological Opinion on long-term operations of the State Water Project (SWP) and Central Valley Project (CVP) issued by NOAA's National Marine Fisheries Service (NMFS BiOp, NMFS 2009a) filed with the court a joint stipulation regarding project operations during April and May 2012 (Attachment 1). The parties stipulated that, if a rock barrier were installed at the head of Old River, the SWP and CVP (the projects) would operate within an adaptive range of Old and Middle River (OMR) flows in lieu of operating to the inflow:export (I:E) ratio specified in Action IV.2.1 of the Reasonable and Prudent Alternative (RPA) of the NMFS BiOp. During April and May, the projects shall be operated to maintain OMR flows between -1,250 and -3,500 cubic feet per second (cfs), and -1,250 and -5,000 cfs, respectively.

The objectives of Action IV.2.1 are to reduce the vulnerability of emigrating Central Valley steelhead[1] (*Oncorhynchus mykiss*) within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio; and to enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic condition in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows. Thus, OMR management under the stipulation, in combination with the barrier at the head of Old River, is designed to provide protection for steelhead entering the Delta from (a) the San Joaquin River upstream of Vernalis, (b) the Calaveras River, and (c) the Mokelumne River. Nothing in the stipulation is intended to, or does, prevent the projects from operating to more positive OMR flows as may be required by the U.S. Fish and Wildlife Service (FWS) for the protection of delta smelt, by the California Department of Fish and Game (DFG) for the protection of longfin smelt, or by NMFS under RPA Action IV.2.3.

Additionally, the stipulation includes a broadened acoustic tagging and release program during 2012 which provides an opportunity for generating improved information about route selection and reach-specific survival under different hydrodynamic conditions. The stipulation also identifies the opportunity to reduce the direct loss of fish at the export facilities, particularly due to high predation estimated to occur in Clifton Court Forebay, by shifting SWP exports to the CVP as capacity allows.

A planning committee, comprised of representatives from the Project and resource agencies, as well as technical experts from the parties to the Consolidated Salmonid Cases, was involved in the preparations for the 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 supplemental 2012 acoustic tag experimental study and potential triggers for OMR management during spring 2012.

[1] All naturally produced steelhead, and hatchery-produced steelhead from the Coleman National Fish Hatchery and the Feather River Hatchery, are part of the CV steelhead distinct population segment (DPS). Hatchery-produced steelhead from the Nimbus and Mokelumne hatcheries are not part of the CV steelhead DPS.

This memorandum includes two approaches for managing Old and Middle river flows for the protection of San Joaquin basin steelhead: one based on a characterization of hydrodynamics using the particle tracking model (PTM), and another based on in-season monitoring of acoustically-tagged steelhead. Both approaches depend on assumptions relating to the expected response of steelhead to hydrodynamic conditions in the South Delta. Uncertainties about steelhead behavior during outmigration and mechanisms underlying survival differences open the door to many management approaches; the approaches identified in this memorandum are based on NMFS' assessment of a balance between gaining new empirical information and providing protection for the listed Central Valley steelhead. This assessment was made in consideration of the discussions at the workshops and among the planning committee members.

Because of the experimental component of these approaches, particularly from mid-April through May when supplemental tagged steelhead will be released in the lower San Joaquin River, NMFS expects that these supplemental data, in combination with results from other experimental studies, can be used to evaluate some of the many assumptions that are inherent in the approaches that will be used this spring 2012. Relative survival rates in the mainstem San Joaquin River and interior Delta, changes in survival or migration speed in response to different hydrodynamic conditions, and behavioral responses of steelhead to flow conditions will be evaluated during the summer and fall of 2012 and results may inform management approaches for operations in 2013.

II. BACKGROUND ON THE DIFFERENTIAL EFFECTS OF A ROCK BARRIER AT THE HEAD OF OLD RIVER EXPECTED FOR CENTRAL VALLEY STEELHEAD ENTERING THE DELTA UPSTREAM, VS. DOWNSTREAM, OF THE HEAD OF OLD RIVER.

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 near 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 survival study using tagged steelhead was implemented, but results are not yet available. Excellent summaries of the CWT and early acoustic tag studies are provided in San Joaquin River Technical Committee (SJRTC, 2008), San Joaquin River Group Authority (SJRGA, 2010, 2011), 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 rock barrier at the head of Old River on steelhead. The survival estimates that follow are based on the survival relationships provided by Dr. Ken Newman [U.S. Fish and Wildlife Service (USFWS)] to Cramer Fish Sciences for the purposes of modeling through Delta survival in the Delta Passage Model. These survival relationships for the Old River and mainstem San Joaquin routes are based on data from CWT studies since the mid-1990s. Our analysis followed the approach currently implemented in the Delta Passage Model, which is to model survival in both the mainstem San Joaquin and Old River routes using probabilistic sampling of the two most probable survival models. For both the mainstem San

Joaquin River route and the Old River route, the most probable model was one in which survival was modeled as a constant (not affected by either flow or export effects), followed by a model in which survival was modeled as a function of flow. The average effect of flow on survival was positive and was more pronounced in the mainstem San Joaquin River route than the Old River route, and the potential gain in survival increases with increasing flow. For example, if each route contained a flow of 1,500 cfs, survival is predicted to be 9% in Old River compared to 18% in the mainstem San Joaquin route. If each route contained a flow of 10,000 cfs, survival is predicted to be the constant 9% in Old River compared to 24% in the mainstem San Joaquin route (Figure 1, dashed lines).

Because a rock barrier directs both fish and flow into the mainstem San Joaquin River, these relationships support the conclusion that a rock barrier is likely to improve overall through-Delta survival of Merced, Tuolumne, and Stanislaus river populations of Central Valley steelhead relative to a nonphysical barrier that directs fewer fish and no additional flow into the mainstem San Joaquin route. 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).

Newman (2008) also analyzed the effect of South Delta exports on estimated survival of juvenile salmon through the mainstem San Joaquin River and Old River routes. He concludes:

> *"For the various models fitted, there were two in-common conclusions: (1) flow is positively associated with the probablility of surviving from Dos Reis to Jersey Point and (2) the survival probability for that reach is generally greater than the survival probability for fish traveling down Old River. Assuming that the HORB effectively keeps out-migrating salmon from entering Old River, the second conclusion implies that the HORB can increase salmon survival. For fish that do enter Old River, there was some evidence that flow in Old River was positively associated with survival between Old River and Jersey Point, but the evidence was not as consistently strong as for the Dos Reis to Jersey Point reach. There was little evidence for any association between exports and survival, and what evidence there was pointed towards a somewhat surprising postivie association with exports."* (Newman 2008, end of Section 7.1)

It is important to note that a combined increase in survival of 9% represents a *doubling* of the survival chances of an individual in the mainstem San Joaquin route relative to the survival expected for an individual in the Old River route. Overall survival through the Delta via the lower San Joaquin River has shown a general decline since the late 1990s (SJRTC 2008), from a high of 79% in 1995 to less than 20% since 2001, less than 10% in recent years, with a survival of just 4% reported in the mainstem San Joaquin River in 2010 (SJRGA 2011). Given that past survival estimates are higher than those observed recently, and because the survival relationships used in our analysis were parameterized with a data set that includes these past years with higher survival observations, the absolute survivals are higher than would be expected during 2012. However, NMFS expects that the proportional changes in survival in different routes and at different flows are beneficial regardless of the absolute change in survival given the high level of mortality observed through this segment of the CV steelhead outmigration.

The most recent through-Delta survival estimates based on acoustic tag data from a field study conducted in 2010 have shown a slightly lower survival rate in the mainstem San Joaquin River than the Old River route. The 2010 data estimated through-Delta survival from upstream of the head of Old River to Chipps Island (approximately 25 river kilometers west of Jersey Point) and showed, for the total of 7 releases, that survival was 7% in the Old River route compared to 4% survival in the mainstem San Joaquin route. However, only one of the releases showed significant differences between the two routes with the first release showing survival was significantly higher on the San Joaquin River than in Old River. The 2009 data (SJRGA 2010) did not allow calculation of survival through the entire Delta, but did show slightly higher survival of tagged fish in a reach of Old River to the fish facilities compared to in a reach of the mainstem San Joaquin River to the channel markers. Survival estimates based on acoustic tag data from 2008 showed the expected relationship of a higher survival rate (9% vs. 5%) in the mainstem San Joaquin River than the Old River route (Holbrook *et al*. 2009), but these results should be interpreted cautiously due to premature tag failure problems, which confound tag failure with mortality of tagged fish. No barrier of any type was installed at the head of Old River in 2008; an experimental non-physical barrier (which uses air bubbles, light, and sound to deter fish from entering Old River) was installed in both 2009 and 2010. Recent survival estimates showing higher survival in the Old River route compared to the mainstem San Joaquin River route may indicate a change in the underlying risk in those routes for outmigrating juvenile salmonids, some interaction of predation risk with the non-physical barrier, or some other factor. For 2012 operations, NMFS proposed a rock barrier based on the longer-term CWT data (as well as the 2008 acoustic tag study) supporting a trend of higher survival on the mainstem San Joaquin River route. Acoustic telemetry studies and reports completed this year should help to better assess the mechanisms underlying through-Delta survival, including effects of inflow and operations.

Adaptive management of Old and Middle River flows to manage risks for steelhead emigrating from the Calaveras River or Mokelumne River: Installation of a rock barrier at the head of Old River causes the flows in Old and Middle River (OMR flows) to be more negative than without the rock barrier. Because salmonids may enter the interior Delta channels at a higher rate at higher OMR flows and those that enter 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, 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, and may experience increased entrainment vulnerability if they enter channels of the interior Delta which have higher negative flows due to barrier effects. Because NMFS does not have 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.

III. OMR MANAGEMENT DURING SPRING 2012

Objective: Provide minimum protections necessary to avoid jeopardy by managing hydrodynamics conditions in the Delta, in combination with the rock barrier at the head of Old River, in a manner expected to enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island, while also providing an opportunity to collect empirical information regarding responses (for example, route selection and route-specific survival) of hatchery steelhead to flow conditions. While the installation of the barrier at the head of Old River is expected to provide a net benefit to steelhead entering the Delta from upstream of the head of Old River, the impact of the rock barrier on steelhead outmigrating from the Calaveras or Mokelumne rivers is less certain. The OMR flow adaptive management specified in the stipulation is intended to provide protection for steelhead from the Calaveras and Mokelumne basins by creating more suitable hydraulic conditions in the lower San Joaquin River for emigrating fish, including greater net downstream flows.

Action: In addition to installing a rock barrier (with 8 culverts that may be open all the time) at the head of Old River to be in place from April 1 through May 31, OMR flows will be managed between -1,250 and -3,500 cfs during April, and between -1,250 and -5,000 cfs during May.

Implementation procedures:

Timing of Delta entry: Steelhead may be entering the Delta from upstream of the head of Old River, from the Calavaras[2] or Mokelumne rivers during April and May (Figure 2). Because of the sparse population numbers and low sampling efficiency of current monitoring methods, and in order to protect variability of life history expression in terms of outmigration timing, OMR management under the stipulation will be implemented during the entire April-May period.

OMR flow adaptive range:
The stipulated OMR flows in lieu of the I:E ratio from Action IV.2.1 will be implemented during April and May 2012 using two different approaches (Table 1, details below).

April 1-14 – OMR levels determined by DSM2 modeling approach until supplemental acoustic-tagged fish are released
The first approach will use DSM2 Hydro and PTM data to set OMR flows. This approach is expected to be implemented only during the first two weeks of April, until the first release of the supplemental acoustic-tagged fish. Compared to the implementation of the I:E ratio and installation of a non-physical barrier expected absent the stipulation, installation of the rock barrier at the head of Old River is expected to increase the amount of flow in the mainstem San Joaquin and to cause OMR flows to be more negative. The increased flow in the mainstem San Joaquin River is expected to enhance the likelihood of Calaveras and Mokelumne steelhead

[2] Modifications to the flashboard dams in Mormon Slough and the Stockton Diverting Canal are expected to allow steelhead outmigration from the Calaveras River during April and May of 2012, even after the dams are installed mid-April.

successfully exiting the Delta at Chipps Island, while the more negative OMR flows may decrease outmigration success for steelhead from these basins, particularly for any individuals that enter South Delta channels. PTM output will be used to characterize the hydrodynamics under different scenarios, and the OMR level for each of the first two weeks of April will be set to a level that is expected to provide hydrodynamic conditions for Calaveras and Mokelumne steelhead (with the rock barrier at the head of Old River in place) similar to the hydrodynamic conditions that would be expected under implementation of the I:E ratio with a non-physical barrier.

The PTM screening criteria are calculated based on the particle fluxes and fates observed at 28[3] days because existing PTM results show that shorter simulation periods do not allow differentiation of alternative operational scenarios, particularly in the low San Joaquin River flow conditions expected for spring 2012 (see, for example, the summaries of particle flux past Chipps (Page 15 of Attachment 2-B), and the percent of particles reaching certain fates (Page 11 of Attachment 2-B) for a Calaveras particle insertion point). Because NMFS is using PTM to provide a representation of how the distribution of particles is affected by different hydrodynamics condition, the simulation window must be long enough for particle fates to be resolved. In order to accurately represent hydrodynamic conditions expected during, for example, the first week of April, the HYDRO run paired with each PTM run will model only the conditions expected for that week, either by "repeating" the week four times, or by modeling the average conditions for the week for the full 28 days. Thus, while the particles need 28 days for a sufficient number to resolve according to the modeled hydrodynamics conditions, the underlying hydrodynamic conditions will represent only the conditions of the first week of April, and the PTM results will not be confounded by particles reacting to, *e.g.*, the augmented flows expected at Vernalis in mid-April.

Prior to each week of operations, the California Department of Water Resources (DWR) will provide to the Delta Operations of Salmonids and Sturgeon (DOSS) working group the following HYDRO scenarios and PTM output[4].

<u>HYDRO Scenarios</u>

SCENARIO 1 -- baseline

Hydrology and Operations: characterization of SJR flow and hydrology expected over the first week of April, exports according to I:E ratio (based on current San Joaquin yeartype; 1:1 based on March 2012 forecast), no barrier at head of Old River, simulation length of 28 days.

Output: expected OMR at specified level of exports

[3] DWR has notified NMFS that in PTM runs under forecasted hydrology, the fates of a significant number of particles may not be resolved within 28 days. If DWR submits PTM information based on a simulation period longer than 28 days, DOSS will consider that information and may advise that the PTM screening criterion be amended.

[4] The USFWS may request additional PTM runs under forecasted hydrology, based on particle insertion at a node near the Station 815 monitoring location, both with and without a rock barrier in place, to evaluate the potential impacts of hydrodynamic conditions on juvenile delta smelt. These data will be provided to the Smelt working Group or USFWS.

SCENARIO 2 – alternative operations scenario – higher export[5] option

Hydrology and Operations: characterization of SJR flow and hydrology expected over the first week of April, higher export option , rock barrier with eight open culverts at head of Old River, simulation length of 28 days.

Output: expected OMR at specified level of exports

SCENARIO 3 – alternative operations scenario-- intermediate export option

Hydrology and Operations: characterization of SJR flow and hydrology expected over the first week of April, intermediate export option, rock barrier with eight open culverts at head of Old River, simulation length of 28 days.

Output: expected OMR at specified level of exports

SCENARIO 4 – alternative operations scenario – lower export option

Hydrology and Operations: characterization of SJR flow and hydrology expected over the first week of April, lower export option , rock barrier with eight open culverts at head of Old River, simulation length of 28 days.

Output: expected OMR at specified level of exports

PTM Scenarios (same for each HYDRO run)

Particle insertions: 1,000 or more particles each at the mouth of the Calaveras (Node 21) and the mouth of the Mokelumne (Node 40), trickled in over a 24 hour period to average over a tidal cycle.

Output: % particle flux past Chipps Island at 28 days, % particles entrained at the CVP at 28 days, % particles entrained at the SWP at 28 days.

BASELINE PTM SCREENING CRITERION = (% particle flux past Chipps Island at 28 days) - (% particles entrained at the CVP at 28 days) - (% particles entrained at the SWP); particle fluxes and fates measured 28 days after insertion for SCENARIO 1 (the "baseline" scenario).

ALTERNATIVE OPERATIONS PTM SCREENING CRITERION = (% particle flux past Chipps Island at 28 days) - (% particles entrained at the CVP at 28 days) - (% particles entrained at the SWP); particle fluxes and fates measured 28 days after insertion for the "potential operations" scenario of proposed operations with a rock barrier with eight open culverts.

Based on the PTM runs to be provided to DOSS (described above), DOSS will set the OMR level such that the Alternative Operations PTM Screening Criterion minus the Baseline PTM Screening Criterion is more positive than -5. Existing PTM runs (modeling overview provided in Attachment 2-A, results highlights provided in Attachment 2-B) may provide some guidance as to the approximate OMR likely to meet the PTM criterion.

[5] Alternative scenarios are specified in terms of exports since exports, not OMR, are a boundary condition in a DSM2 HYDRO run. While scenarios will be compared in terms of their expected OMR levels, defining scenarios based on an export level avoids having to do an iterative modeling step to determine the export level associated with a specific OMR. Since the target OMR level may be an interpolation of the exploratory scenarios, no specific OMRs need to be modeled exactly. Existing DSM2 runs performed by DWR that show particle fates at different export/OMR levels for a Calaveras particle insertion, provided in Attachment 2-B, may suggest the approximate export/OMR level that will meet the specified condition.

Hydrodynamic benefits of increased mainstem flow due to the barrier may result in more particles reaching Chipps Island and fewer reaching the facilities within 28 days. The PTM Screening Criterion balances this positive effect against the potential negative hydrodynamic effect of the more negative OMR flows (for a constant export) caused by installation of the rock barrier. Sample calculations are provided in Table 2a and Table 2b.

April 15-May 31 – OMR levels determined by pilot "managed-risk experimental" approach
Beginning in mid-April, when supplemental steelhead releases are expected to begin, OMR flow targets will shift to a pilot "managed-risk experimental" approach. This approach implements different OMR "treatment levels" for each stipulation study release of acoustically tagged steelhead (to gather information about responses of tagged fish to different hydrodynamic conditions within the adaptive range), and includes an "exposure trigger" as a screening criterion for OMR flow management. If the "exposure trigger" is reached or exceeded, OMR flows will shift from the experimental OMR level to -1,250 cfs (the most positive OMR level within the adaptive range, Table 1). The shift to the most positive OMR flow is intended to protect steelhead by shifting hydrodynamic conditions in a direction that may be less disruptive to outmigration routing or timing, offsetting the potential risk to wild steelhead posed by the experimental OMR levels. Additionally, depending on the number of supplemental tagged steelhead still present in the receiver array, shifting to the most positive OMR flow *within* an experimental period may allow analysis of how individual fish respond to different hydrodynamic conditions since the same fish will be exposed to different OMR conditions during the early and late experimental period. If the only substantive changes to OMR flows occur *between* experimental periods (possible under the experiment as designed, if no exposure trigger is hit), the analysis of how fish respond to different hydrodynamic conditions is (more likely) restricted to a comparison of the aggregate behaviors of entire release groups. The current ordering of OMR flow management targets through April and May is intended to maximize feasibility and minimize confounding OMR flow management targets with temperature; DOSS may adjust the ordering of OMR flow management targets opportunistically during April and May 2012. A full description of the supplemental study design is included in Attachment 3.

The exposure trigger is measured as the cumulative fraction of the supplemental release group of acoustically-tagged steelhead that moves southward past a pair of dual receiver arrays on Old River and Middle River near Railroad Cut. Daily downloads of tag detection data from the receivers located near Railroad Cut on both Old River and Middle River will allow DOSS to implement this exposure trigger for use in adaptive management of OMR flows. This management approach was designed to reduce exposure of steelhead to the most hydrodynamically disrupted areas (*i.e.*, reverse flows) of the Delta. This "Railroad Cut trigger" is calculated as the % of the release group reaching the receivers at Railroad Cut that would be expected to result in a 2% loss[6] of the release group at the fish collection facilities (Table 2).

[6] For this pilot study, the 2% loss trigger was selected as generally consistent with the incidental take limit for winter-run Chinook salmon, which limits the loss of winter-run sized Chinook salmon to 2% of the estimated number of winter-run Chinook salmon juveniles entering the Delta. While the actual expected take limit of winter-run Chinook salmon juveniles is expected to be 1% (because roughly half of the individuals classified as winter-run Chinook salmon by size are not genetically winter-run Chinook salmon), the loss trigger for steelhead was not adjusted to 1% for the following reason: only a portion of the winter-run juveniles that enter the Delta near Sacramento experience conditions in the lower San Joaquin River and South Delta, yet all steelhead entering the

Under current assumptions regarding the expected export split during April and May, South Delta mortality, and the release group size, the Railroad Cut trigger has been calculated at 5%. If new information suggests that any of these three assumptions should be modified, the trigger value may be recalculated and updated via DOSS discussion and recommendation. Further details of the calculation of trigger percentage can be found in Table 4. It is assumed that juvenile steelhead migrate fairly rapidly through the Delta and likely do not spend more than 14 days in the Delta. Thus, for each stipulation study release, the Railroad Cut trigger is based on fish only from that release and not from prior releases.

A second exposure trigger, based on the cumulative fraction of the supplemental release group that enters either the CVP or SWP, has been identified as a backstop to the Railroad Cut trigger in the event that tagged steelhead are not detected by the receivers near Railroad Cut but are reaching the facilities through some other routes. However, it is uncertain whether or not the tag detection data from the receivers located at the CVP and SWP can be processed in time to be used as the basis for a second exposure trigger for the supplemental steelhead release groups. In past studies, tagged fish detection data collected at the CVP and SWP facilities have taken a long time to process due to the high number of tags deposited in those areas as a result of tag defecation by predatory fish. The prototype receivers deployed at the CVP and SWP this year may allow for faster processing, but given that the equipment is prototype and the data processing methods still need to be developed, the secondary trigger may not be employed in 2012.

If tag detection data from the CVP and SWP can be processed and made available to DOSS, the second trigger will be measured as the cumulative fraction of the supplemental release group that enters either the CVP or SWP. This "CVP or SWP entry trigger" is calculated as the % of the release group reaching either the SWP or CVP that would be expected to result in a 2% loss of the release group at the fish collection facilities (Table 3), using the assumed (row 2 of Table 3), not observed, facility entry rate. Similar to the Railroad Cut trigger, for each stipulation study release, the second trigger is based on fish only from that release and not from prior releases.

A limited amount of data about acoustically-tagged fish, in addition to the fraction of supplemental steelhead passing the Railroad Cut receivers, will be available during April and May 2012, and may be used by DOSS to adjust the implementation of these procedures. For example, the in-Delta mortality estimate that is used to calculate the trigger based on arrival of acoustically-tagged fish at the detectors in Old and Middle River may be updated based on rough mortality estimates that can be estimated for early releases using the cabled receivers at Middle River and the export facilities.

Rationale:
For OMR management: Steelhead outmigration through the Delta may be disrupted due to hydrodynamic effects (*e.g.*, shifts in velocity to the upstream direction, changes in the extent and duration of tidal dynamics) of project operations. One summary measure of hydrodynamics in the Old and Middle River corridors of the Delta is that of OMR flow, an aggregate measure of the direction and magnitude of average daily flow in Old and Middle River. OMR flows are

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Delta from upstream of the head of Old River, the Calaveras River, or the Mokelumne River will experience those conditions.

affected by hydrology (precipitation, inflows to the Delta), project operations (export operations, barrier condition), other in-Delta channel depletions and diversions, and tidal dynamics.

For the DSM2-based trigger: DWR used the DSM2 model to model hydrodynamics conditions over a matrix of hydrologic and operational scenarios, and to evaluate the fate of particles inserted at different locations within the Delta under those hydrodynamic conditions. A modeling overview and key output summaries are provided in Attachments 2-A and 2-B. These modeling efforts allow one to evaluate the effect of alternate hydrodynamic conditions on the movement and fate of particles inserted at different locations. While passive particles are not necessarily representative of steelhead juveniles that have strong swimming ability and may behave differently over diel or tidal cycles, PTM output provides information about how water moves through the Delta under different conditions and is one possible proxy for comparing hydrodynamic conditions.

For the acoustic-tagged fish-based trigger: Supplemental fish releases possible during April and May 2012 provide an opportunity to evaluate the effect of observed hydrodynamic conditions on juvenile steelhead. While the hatchery-raised steelhead juveniles available for release this year may behave differently than wild steelhead juveniles, they will provide information about hatchery-fish movement under different hydrodynamic conditions, including route selection, speed of travel, and survival. In 2012, these supplemental steelhead releases will be piloted as a proxy for steelhead movement in the South Delta that triggers a shift to less disrupted hydrodynamic conditions to avoid, rather than react to, direct loss of steelhead at the fish collection facilities.

IV. ADDITIONAL SOURCES OF INFORMATION THAT MAY BE PROVIDED TO DOSS FOR CONSIDERATION DURING SPRING 2012

Delta Conditions Team: The Delta Conditions Team, convened by DWR, may provide information to assist DOSS in evaluating the potential effects of planned water operations on salmonids.

Tag detection data from receivers location just inside Turner Cut, Columbia Cut, mouth of Middle River, and mouth of Old River: Data from these receivers will be downloaded at the end of each two-week experimental period, *i.e.*, at the end of April, mid-May, and at the end of May. Depending on the time necessary for processing, these data may be presented to DOSS to provide some additional information and context for the detection data from the Railroad Cut receivers. Currently, no change to the experimental design or exposure trigger is expected even if these data become available to DOSS before the end of May.

Delta Passage Model with increased spatial resolution: Cramer Fish Sciences is developing a new version of the Delta Passage Model (DPM) that includes additional spatial structure in the South Delta. Data collected in 2012 will help to parameterize functions describing route selection rates and route-specific survival rates. This version of the DPM may be used to "game" different scenarios and assumptions during spring 2012 and information from this model may be provided to DOSS for its consideration.

Additional information: Information from other cabled receivers or from manual downloads of non-cabled receivers may become available during spring 2012 based on preliminary analyses by the resource agencies, project agencies, or members of the Delta Conditions Team.

DOSS will review and consider any data provided in advance of each week's DOSS meeting. If it is believed that the additional information supports a change to the OMR management strategy described in this technical memo, the party(ies) submitting those data should also submit a formal proposal for the adjustment to the OMR management strategy. DOSS will review the suggested adjustment, provide advice to NMFS and WOMT as to whether or not to adopt the adjustment, and NMFS will determine whether or not the adjustment is consistent with the management approach outlined here.

V. ANALYSES PLANNED FOR AFTER SPRING 2012 USING TAG DETECTION DATA TO TEST HYPOTHESES ABOUT THE EFFECT OF HYDRODYNAMIC CONDITION ON FISH

In the "retrospective" analysis (*i.e.*, the full analysis that will be completed after spring 2012 once data from all receivers are downloaded and processed) of the proposed study, an inter-agency group will analyze the tag detection data from the supplemental releases in the context of four related sets of objectives. Analyses will include an assessment of the effect size (*e.g.*, change in survival under different flow or velocity conditions) detectable by the 2012 experimental design, and a discussion of what range of effect sizes may be biologically relevant.

Objective 1: What hydrodynamic factors influence the route entrainment into the interior Delta from Turner Cut, Colombia Cut and Middle River?

Hypothesis 1.1: Route Selection over Short Time Intervals (~2-hours)

H1.1$_o$: The proportion of tagged fish taking the interior Delta route is not related to proportion and direction of flow at the time of fish arrival at the junction.

Hypothesis 1.2: Route Selection over 24 hours (DSM2 Hydro)

H1.2$_o$: The proportion of tagged fish taking the interior Delta route is not related to the proportion of time (over 24 hours) during which flows go toward the interior Delta at the junction.

Hypothesis 1.3: Route Selection over 1 day+ (PTM)

H1.3$_o$: The proportion of tagged fish taking the interior Delta route is not related to the fraction of particles entering the junction after 1 day+.

Hypothesis 1.4: Route Selection over 45 day time interval (PTM)

H1.4$_o$: The proportion of tagged fish taking the interior Delta route is not related to the fraction of particles entering the junction over 45 days.

Objective 2: How do hydrodynamic conditions and OMR influence migration behavior and survival in the interior Delta?

Hypothesis 2.1: Probability of fish returning to mainstem SJR

H2.1$_o$: Percent positive flows, average flows, average velocities and OMR are not significant covariates in estimating the probability that tagged fish will return to the mainstem San Joaquin River after entering the interior Delta study area.

Hypothesis 2.2: Residence time within the interior Delta

H2.2$_o$: Percent positive flows, average flows, average velocities and OMR are not significant covariates in analyzing the time spent within the interior Delta study area.

Hypothesis 2.3: Survival within the interior Delta

H2.3$_o$: Percent positive flows, average flows, average velocities and OMR are not significant covariates in estimating survival within the interior Delta study area.

Objective 3: How do hydrodynamic conditions and OMR influence survival in the mainstem San Joaquin River?

Hypothesis 3.1: Interior Delta vs. Mainstem San Joaquin River Survival

H3.1$_o$: The estimated survival of tagged fish migrating through the interior Delta to Chipps Island is not different from the estimated survival of tagged fish migrating through the mainstem San Joaquin River to Jersey Point.

Hypothesis 3.2: Mainstem San Joaquin River survival rate

H3.2$_o$: OMR is not a significant covariate in estimating survival of tagged fish migrating through the mainstem San Joaquin River route.

Objective 4: If hydrodynamic conditions affected by OMR are found to influence survival and/or behavior of tagged fish, what is a well-supported trigger to protect ESA listed salmonids in future operations?

After Spring 2012 – Using tag detection data to compare actual fish distributions to particle distributions resulting from PTM with alternate particle behavior rules (preliminary focus on Chinook salmon; approach could be adapted for steelhead behavior)

Given the paucity of data on salmon movement and survival as they transit the Delta an alternate approach is required to provide input for the Central Valley Chinook life cycle model. The PTM routine in the DSM2 software seems well-suited to simulating salmon movement in response to changes in hydrological conditions. However, as currently implemented, the PTM does not capture the behavior of salmon very well. Specific shortcomings include a lack of directed swimming behavior (*i.e.*, passive transit), extremely long transit times, and immortality.

The NMFS Southwest Fisheries Science Center (SWFSC) proposes to modify the existing model to allow for the following types of behaviors:

- Salmon swim with the current on an ebb tide;
- Salmon swim against the current and/or hold their position on a flood tide;
- Salmon swim towards areas of elevated salinity;
- Salmon experience mortality that is related to distance travelled (*e.g.*, survival is inversely related to the number of river kilometers traversed by the salmon) or to the time spent in an area.

These sorts of behaviors are biologically realistic and would be expected to make the particles in the model behave more like salmon. Moreover, the PTM can be easily programmed (by someone familiar with it) to incorporate these behaviors (some are harder than others). NMFS anticipates seeking the necessary the expertise to implement particle behavioral rules.

The NMFS-SWFSC would then run the PTM separately with each of the changes suggested above; following that, we would run the PTM with combinations of the changes until all sensible

permutations had been tried. At that point, we would compare the output of the runs (percent of fish that reach Chipp's Island, local channel entry rates, *etc*.) with empirical results based on various coded-wire tag and acoustic tags releases. This will require running DSM2 under the hydrological and operational conditions at the time of the releases. The modification or set of modifications to the PTM that best approximates salmon behavior in the Delta can then be used as a tool to examine how various operational scenarios would affect survival of migrating juvenile salmon. This sort of modified PTM could be used not only to inform in-season management of OMR flows or other hydrodynamic conditions, but also to simulate the behavior and survival of salmon juveniles in the Central Valley Chinook life cycle model under alternative operational scenarios.

VI. REFERENCES CITED

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Table 1. Summary of action triggers and action responses for Old and Middle River flow management per the joint stipulation during April and May 2012. The specified trigger levels of 5% (Railroad Cut trigger) and 3% (CVP/SWP entry) of the release group are based on specific assumptions (outlined in Table 3) and may be adjusted from one release period to the next if DOSS receives information that allows updating of the assumptions.

Stipulation Period	OMR Experimental Treatment	Release	Action Trigger	Action Response
April 1 – April 7	As determined by DSM2 modeling and the specified "PTM metric[7]" to provide hydrodynamic conditions for Calaveras and Mokelumne basin fish similar to the conditions expected under I:E implementation with a non-physical barrier	None	None, specified OMR level will be implemented for one-week period.	N/A. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow.
April 7 – April 14	As determined by DSM2 modeling[8] and the specified "PTM metric" to provide hydrodynamic conditions for Calaveras and Mokelumne basin fish similar to the conditions expected under I:E implementation with a non-physical barrier	None	None, specified OMR level will be implemented for one-week period.	N/A. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow.

[7] Using the particle fluxes and fates at 28 days, the PTM screening criterion (% particle flux past Chipps Island - % particles entrained at the CVP - % particles entrained at the SWP) of the alternative operations scenario minus the PTM screening criterion of the baseline scenario must be more positive than -5.
[8] If conditions for the second week of April are similar to the first week of April, DWR and Reclamation may propose to DOSS that OMR levels continue at the level determined for the first week of April.

Stipulation Period	OMR Experimental Treatment	Release	Action Trigger	Action Response
April 15 – April 30	-3,500 cfs	As early as April 15	Either: (1) Cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing southward on Old and Middle Rivers near Railroad Cut receivers reaches that exceeds the specified Railroad Cut trigger of 5% of tags released within 14 days of release date, or (2) If available[9], cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing receivers inside the SWP radial gates and CVP primary louvers reaches or exceeds the specified CVP/SWP entry trigger of 3% of tags released within 14 days of the release date.	Within 48 hours of exceeding trigger, manage exports to a level that produces a 5-day running average of the tidally filtered OMR flow of -1,250 cfs for the remainder of the period. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow. If the trigger is exceeded after April 25, the tidally filtered OMR flow of -1,250 cfs will be targeted for the 5-day average, while preparing for the next acoustic tagged steelhead release. If no OMR change is triggered, the 14-day average of the tidally filtered OMR flow should not be more negative than the specified treatment OMR target.

[9] It is uncertain whether or not the tag detection data from the receivers located at the CVP and SWP can be processed in time to be used as the basis for a secondary exposure trigger for the supplemental steelhead release groups. In past studies, tagged fish detection data collected at the CVP and SWP facilities has taken a long time to process due to the high number of tags deposited in those areas as a result of tag defecation by predatory fish. The prototype receivers deployed at the CVP and SWP this year may allow for faster processing, but given that the equipment is prototype and the data processing methods still need to be developed, the secondary trigger may not be employed in 2012.

Stipulation Period	OMR Experimental Treatment	Release	Action Trigger	Action Response
May 1 – May 14	-1,250 cfs	As early as May1	None, since treatment level is at most positive OMR level within the adaptive range. However, the cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing southward on Old and Middle Rivers near Railroad Cut receivers within 14 days of the release date will be monitored for informational purposes.	N/A. The 14-day average of the tidally filtered OMR flow should not be more negative than the specified treatment OMR target.
May 15 – May 31	-5,000 cfs	As early as May 15	Either: (1) Cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing southward on Old and Middle Rivers near Railroad Cut receivers reaches that exceeds the specified Railroad Cut trigger of 5% of tags released within 14 days of release date, or (2) If available, cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing receivers inside the SWP radial gates and CVP primary louvers reaches or exceeds the specified CVP/SWP entry trigger of 3% of tags released within 14 days of the release date.	Within 48 hours of exceeding trigger, manage exports to a level that produces a 5-day running average of the tidally filtered OMR flow of -1,250 cfs for the remainder of the period. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow. If no OMR change is triggered, the 14-day average of the tidally filtered OMR flow should not be more negative than the specified treatment OMR target.

Health and Safety Exception: If either the initial OMR treatment levels, or in the event of a trigger, the -1,250 cfs OMR level, would require that exports drop below the health and safety export level of 1,500 cfs, the projects shall operate at a combined export level of 1500 cfs.

Table 2a. Sample evaluation of DSM2-based OMR management approach (hypothetical numbers)

Average forecast SJR flow = 3,000 cfs; same for all scenarios	% past Chipps at 28 days	% to SWP at 28 days	% to CVP at 28 days	PTM Screening Criterion at 28 days
Baseline scenario (I:E = 1:1 if SJ yeartype is critical , barrier OUT)	2	8	8	-14
Alternative operations scenario 2 (combined exports= 1,600 cfs, OMR = -2,000 cfs , barrier IN)	8	2	5	1
Alternative operations scenario 3 (combined exports= 2,000 cfs , OMR = -2,500, barrier IN)	7	5	10	-8
Alternative operations scenario 4 (combined exports= 2,500 cfs, OMR = -3,000 , barrier IN)	4	7	15	-18

DOSS will set the OMR level such that the Alternative Operations PTM Screening Criterion minus the Baseline PTM Screening Criterion is more positive than -5. In the example in the table above, the Alternative Operations PTM Screening Criterion should be no more negative than -14 minus 5, or -19. Based on the hypothetical numbers provided above, OMR for the upcoming week should be set at -3000. DWR and Reclamation may provide additional runs to fine-tune the allowed OMR; in the above case, for example, an OMR of -3100 might meet the PTM metric criterion. If the PTM runs bracket the allowed PTM metric, DOSS will linearly interpolate between the modeled OMRs and specify OMR rounded to the nearest 250 cfs. See example in Table 2b.

Table 2b. Sample evaluation of DSM2-based OMR management approach using interpolation between modeled scenarios (slightly different hypothetical numbers)

Average forecast SJR flow = 3,000 cfs; same for all scenarios	% past Chipps at 28 days	% to SWP at 28 days	% to CVP at 28 days	PTM Screening Criterion at 28 days
Baseline scenario (I:E = 1:1 if SJ yeartype is critical , barrier OUT)	4	8	5	-9
Alternative operations scenario 2 (combined exports= 1,600 cfs, OMR = -2,000 cfs , barrier IN)	8	2	5	1
Alternative operations scenario 3 (combined exports= 2,000 cfs , OMR = -2,500, barrier IN)	7	5	10	-8
Alternative operations scenario 4 (combined exports= 2,500 cfs, OMR = -3,000 , barrier IN)	4	7	15	-18

DOSS will set the OMR level such that the Alternative Operatations PTM Screening Criterion minus the Baseline PTM Screening Criterion is more positive than -5. In the example in the table above, the Alternative Operations PTM Screening Criterion should be no more negative than -9 minus 5, or -14. Based on the new set of hypothetical numbers provided above, OMR for the upcoming week should be set at -2,750, per the linear interpolation as shown below.

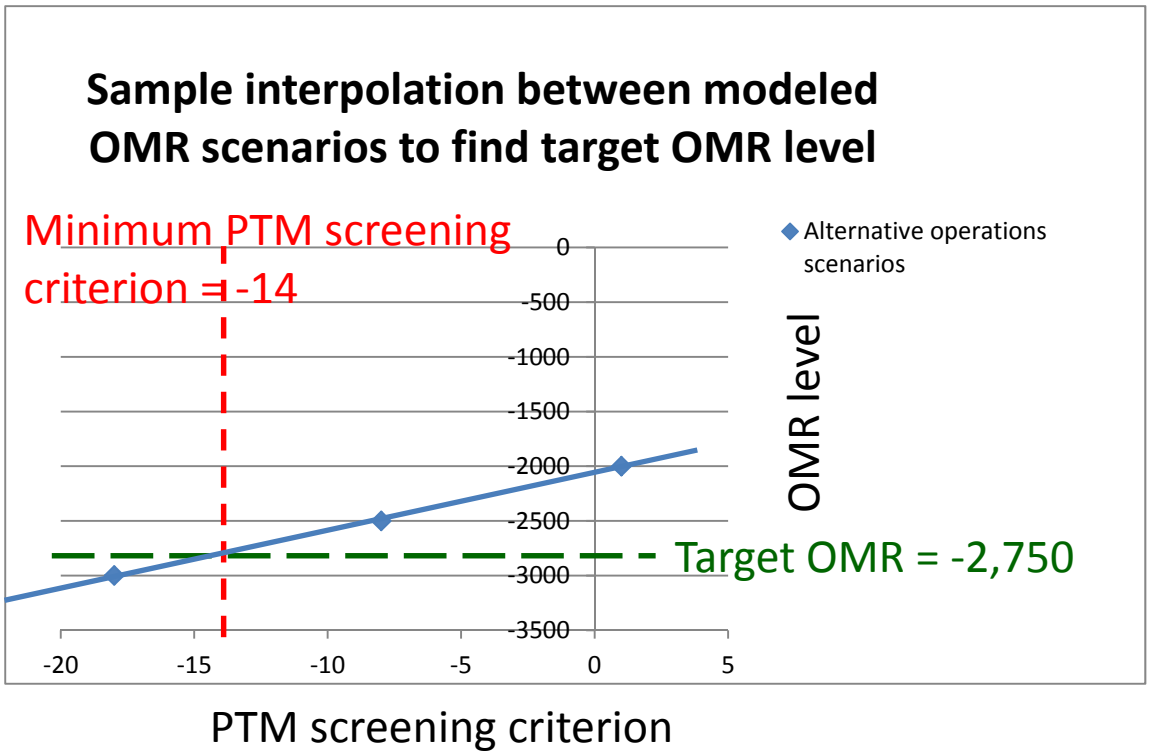

Table 3. Calculated stipulation study trigger levels. Green-shaded rows highlight the release group size and several assumptions that effect the calculated trigger level. These factors will be reassessed before each supplemental release of steelhead and may be adjusted on the basis of new information.

Number of Acoustically Tagged Fish Released Per Release Group	168
Assumed fraction of fish entering the CVP or SWP that enter the SWP (assumed equal to SWP exports as fraction of total exports)	0.5
Assumed survival rate per km between the Railroad Cut receivers and the CVP & SWP	97%
Railroad Cut Trigger (Number of tagged fish)	9
Railroad Cut Trigger (Percentage of Tagged Fish Released)	5%
CVP or SWP Entry Trigger[10] (Number of tagged fish)	6
CVP or SWP Entry Trigger (Percentage of Tagged Fish Released)	3%

[10] As noted in the text, this trigger will not be implemented during April-May 2012 unless tag detection data from the CVP and SWP can be downloaded, processed, and provided to DOSS along with the tag detection data from Railroad Cut.

Table 4. Description of the calculations to determine the exposure triggers. This framework uses a simplified estimator relating salvage and loss; additional information on the full calculation of loss at the SWP and CVP is provided at: ftp://ftp.delta.dfg.ca.gov/salvage/Salmon%20Loss%20Estimation/

ROW ID	VALUE	FORMULA	DESCRIPTION
Calculation of average travel distance between Railroad Cut receivers and the SWP and CVP			
A1	12	Fixed value	Approximate distance (km) from Railroad Cut receiver on Old River to SWP Clifton Court intake
A2	18	Fixed value	Approximate distance (km) from Railroad Cut receiver on Middle River to SWP Clifton Court intake
A3	2	Fixed value	Approximate distance (km) from SWP Clifton Court intake to CVP intake
A4	13	=(A11*A1)+[A12*(A1+A3)]	Average approximate distance(km) from Railroad Cut receiver on Old River to SWP or CVP intake, weighted according to estimated split of facility entry (value assumed in A13)
A5	19	=(A11*A2)+[A12*(A2+A3)]	Average approximate distance(km) from Railroad Cut receiver on Middle River to SWP or CVP intake, weighted according to estimated split of facility entry (value assumed in A13)
A6	0.5	**Assumption**	Of fish passing the Railroad Cut receivers, assumed proportion that are in Old River
A7	16	=(A6*A4) + [(1-A6)* (A5)]	Average approximate distance (km) traveled by all fish reaching the SWP or CVP, weighted by origin (Old River or Middle River) and split of facility entry.
Calculation of exposure trigger			
A8	168	**Assumption**; this will be set to the actual release group size for each treatment period	Number of Acoustically Tagged Fish in release group
A9	2%	Fixed value	Loss at the SWP and CVP not to exceed this value (percent of release group)
A10	3.36	=A8*A9	Loss at the SWP and CVP not to exceed this value (number of fish from release group)
A11	0.5	=A13	Of fish that enter the CVP or SWP, assumed proportion that enter the SWP
A12	0.5	=(1-A13)	Of fish that enter the CVP or SWP, assumed proportion that enter the CVP
A13	0.5	**Assumption;** this will be set to the expected export split for each treatment period	Of fish that enter the CVP or SWP, assumed proportion that enter the SWP
A14	4.33	Fixed value	SWP approximate salvage-to-loss factor

ROW ID	VALUE	FORMULA	DESCRIPTION
Calculation of exposure trigger, continued			
A15	0.68	Fixed value	CVP approximate salvage-to-loss factor
A16	0.187617261	=1*[1/(1+A14)]	For each fish entering the SWP, expected SWP salvage
A17	0.595238095	=1*[1/(1+A15)]	For each fish entering the CVP, expected CVP salvage
A18	0.812382739	=1*[A14/(1+A14)]	For each fish entering the SWP, expected SWP loss
A19	0.404761905	=1*[A15/(1+A15)]	For each fish entering the CVP, expected CVP loss
A20	TRUE	Logical formula as used in excel: =IF(A16*A14=A18, TRUE, FALSE)	Check that expected SWP salvage (A16) * SWP approximate salvage-to-loss factor (A14) = expected SWP loss (A18)
A21	TRUE	Logical formula as used in excel: =IF(A17*A15=A19, TRUE, FALSE)	Check that expected CVP salvage (A17) * CVP approximate salvage-to-loss factor (A15) = expected CVP loss (A19)
A22	TRUE	Logical formula as used in excel: =IF(A16+A18=1, TRUE, FALSE)	Check that expected SWP salvage (A16) + expected SWP loss (A18) = 1
A23	TRUE	Logical formula as used in excel: =IF(A17+A19=1, TRUE, FALSE)	Check that expected CVP salvage (A17) + expected CVP loss (A19) = 1
A24	0.608572322	=(A11*A18)+(A12*A19)	Expected loss per fish that enter the SWP or CVP, given the assumed entry proportion to each facility and the loss rate at each facility
A25	5.521118655	=A10/A24	How many fish from the release group may encounter the SWP & CVP without exceeding the loss trigger?
A26	**3%**	**=A25/A8**	**What percent of fish from the release group may encounter the SWP & CVP without exceeding the loss trigger?**
A27	2.24	=A11*A25*A18	Expected SWP Loss if A25 fish enter the facilities at the expected ratio
A28	1.12	=A12*A25*A19	Expected CVP Loss if A25 fish enter the facilities at the expected ratio
A29	TRUE	Logical formula as used in excel: =IF(A27+A28=A10, TRUE, FALSE)	Check that SWP loss + CVP Loss add up to loss trigger
A30	0.03	**Assumption**	Assumed mortality rate (per km) between the Railroad Cut receivers and the SWP and CVP, based on an estimate of South Delta mortality from the 2010 VAMP studies.
A31	0.61	=(1-A30)^A7	Survival from the Railroad Cut receivers to the SWP and CVP, based on the average distance in A7.
A32	9	=A25/A31	How many fish from the release group may encounter the Railroad Cut receivers without exceeding the loss trigger?
A33	**5%**	**=A32/A8**	**What percent of fish from the release group encounter the Railroad Cut receivers without exceeding the loss trigger?**

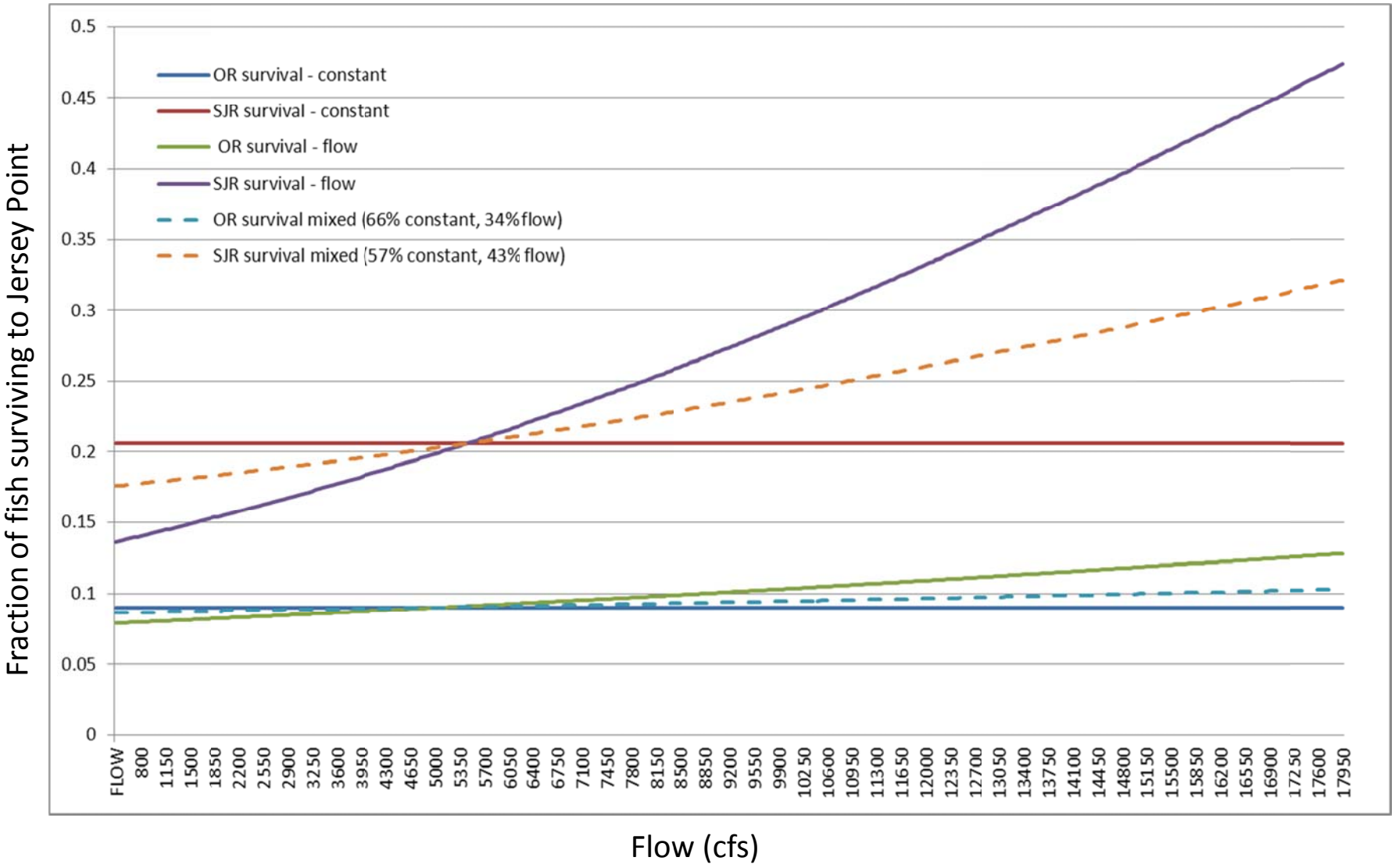

Figure 1: Estimated survival relationships on the Old River (OR) and mainstem San Joaquin River (SJR) route, based on equations from Ken Newman's analysis of recoveries of coded wire tagged fish.

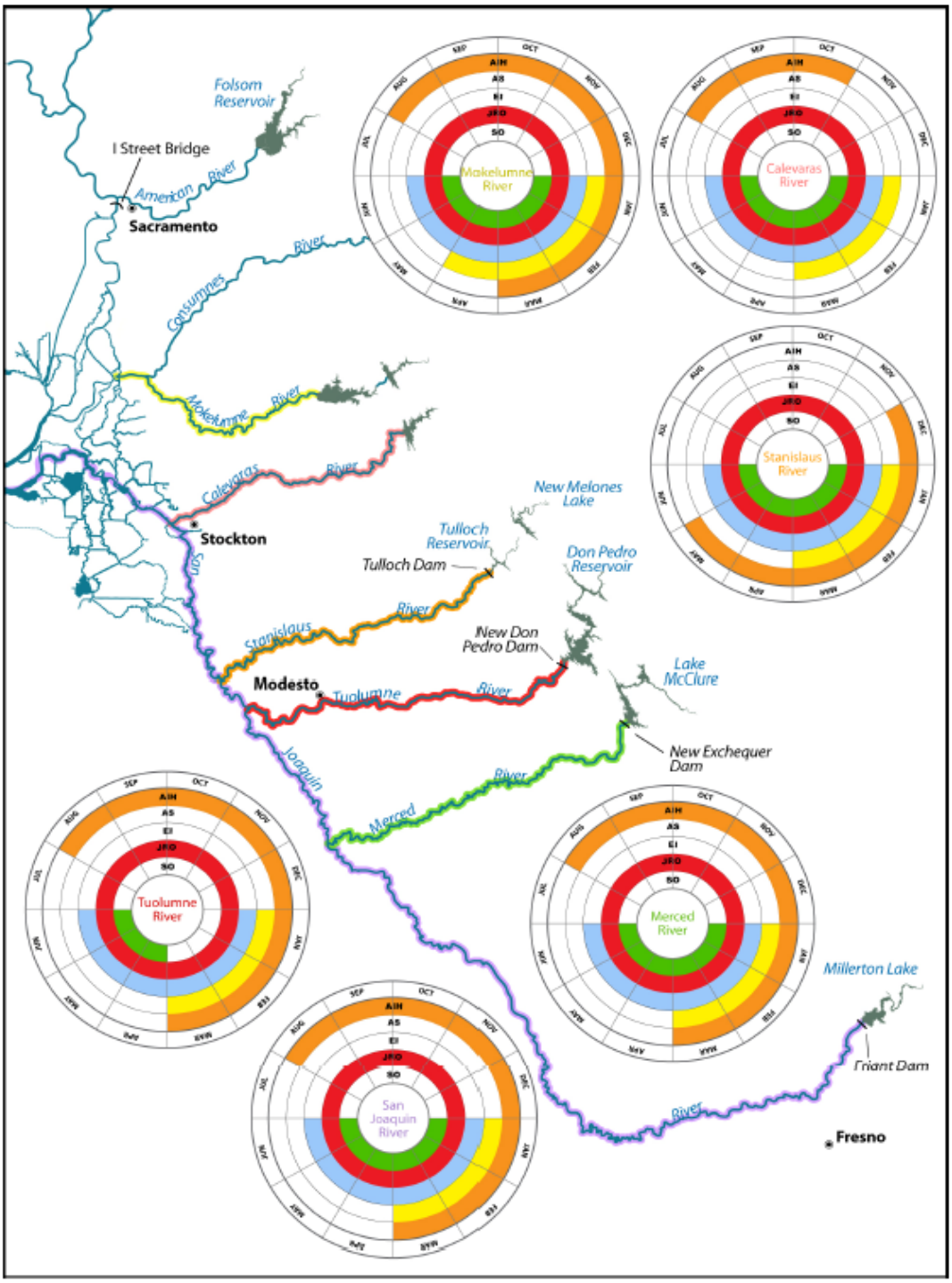

Figure 4-5. Life Stage Timing for Steelhead Populations in the Southern Sierra Nevada Diversity Group

Sources: Mokelumne River (EBMUD Website 2007); Calaveras River (Fishery Foundation of California 2004); Stanislaus River (Castleberry et al. 1991; CDFG 1986; McEwan 2001); Tuolumne River (Castleberry et al. 1991; CDFG 1986; McEwan 2001; Reynolds et al. 1993); Merced River (Castleberry et al. 1991; CDFG 1986; McEwan 2001); San Joaquin River (Castleberry et al. 1991; CDFG 1986; McEwan 2001)

Figure 2: Chart of life stage timing of Central Valley Steelhead from the San Joaquin River, Calaveras River, and Mokelumne River basins. From page 4-11 of NMFS (2009b)

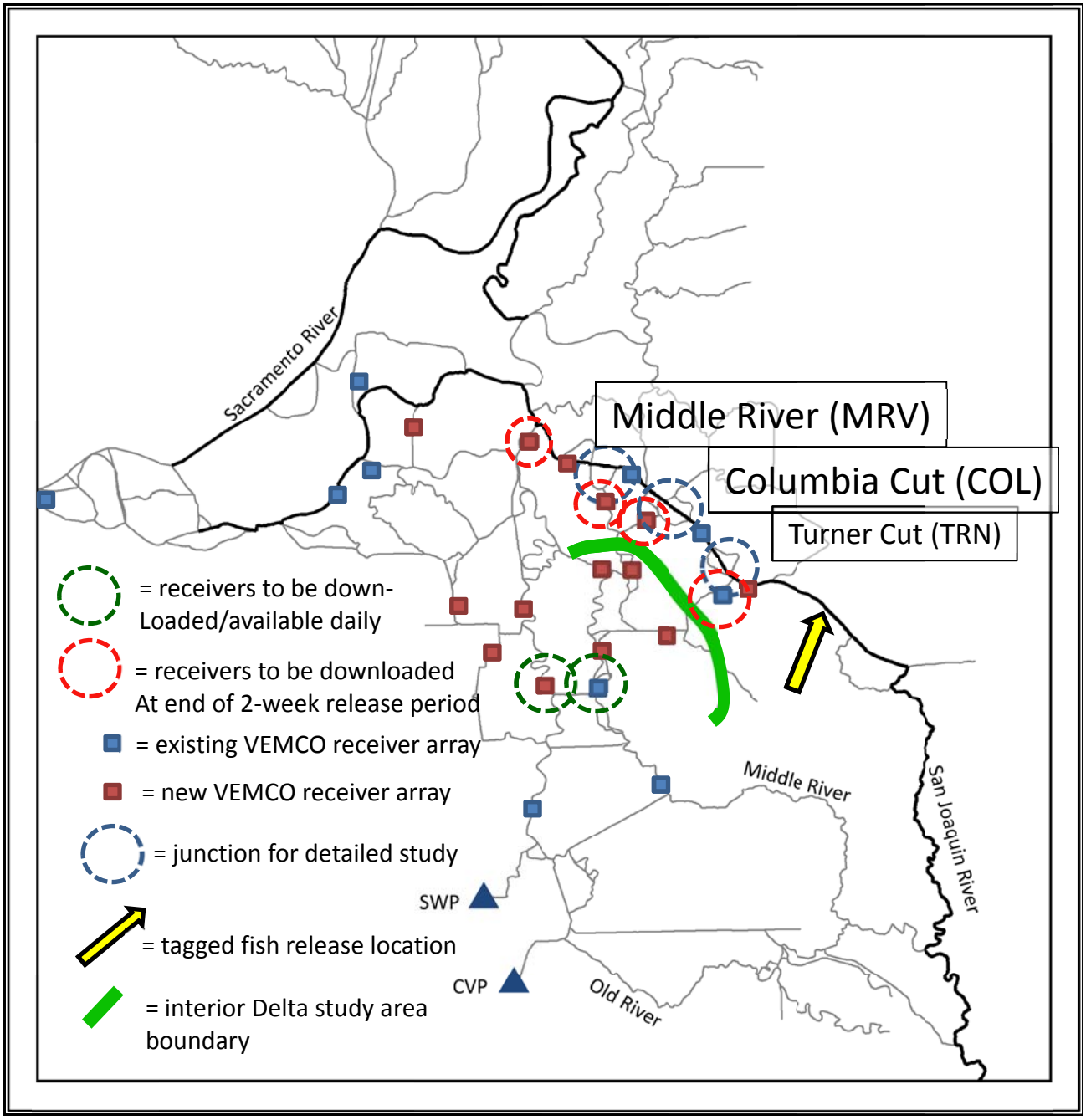

Figure 3: Map of supplemental acoustic tagged steelhead release site and supplemental receiver sites. Note: only receiver locations directly relevant to the proposed study are indicated on this map

ATTACHMENT 1

January 12, 2012,
Joint Stipulation

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IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF CALIFORNIA

THE CONSOLIDATED SALMON CASES

SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, et al. v. GARY F. LOCKE, et al. (Case No. 1:09-cv-1053)

STOCKTON EAST WATER DISTRICT v. NOAA, et al. (Case No. 1:09-cv-1090)

STATE WATER CONTRACTORS v. GARY F. LOCKE, et al. (Case No. 1:09-cv-1378)

KERN COUNTY WATER AGENCY, et al. v. U.S. DEPARTMENT OF COMMERCE, et al. (Case No. 1:09-cv-1520)

OAKDALE IRRIGATION DISTRICT, et al. v. U.S. DEPARTMENT OF COMMERCE, et al. (Case No. 1:09-cv-2452)

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA v. NMFS, et al. (Case No. 1:09-cv-1625)

1:09-cv-1053-LJO-DLB
1:09-cv-1090-LJO-DLB
1:09-cv-1378-LJO-DLB
1:09-cv-1520-LJO-DLB
1:09-cv-2452-LJO-DLB
1:09-cv-1625-LJO-SMS

JOINT STIPULATION REGARDING CVP AND SWP OPERATIONS IN 2012

Judge: Honorable Lawrence J. O'Neill

RECITALS

1. On March 5, 2010, the Court entered its Memorandum Decision Re Cross-Motions for Summary Judgment On NEPA Issues (Doc. 266), and on March 17, 2010 entered its Order Granting In Part Motion for Summary Judgment On NEPA Issues (Doc. 288). This decision found that the United States Bureau of Reclamation and the Secretary of the Interior have violated the National Environmental Policy Act by failing to perform any NEPA analysis prior to adopting and implementing the 2009 Salmonid Biological Opinion ("2009 Salmonid BiOp"). On September 20, 2011, the Court entered its Memorandum Decision re Cross Motions for Summary Judgment (Doc. 633) in these Consolidated Salmonid Cases regarding the 2009 Salmonid BiOp. This decision found the 2009 Salmonid BiOp and its reasonable and prudent alternative ("RPA") arbitrary, capricious, and unlawful. On September 29, 2011, the Court entered its Order Re Cross-Motions for Summary Judgment (Doc. 643) and remanding without vacatur the 2009 Salmonid BiOp to the National Marine Fisheries Service ("NMFS") for further consideration in accordance with the Court's rulings and the requirements of law. The September 29 Order provides that the remand without vacatur is without prejudice to "the hearing or decision of any provisional remedy justified in law or equity," and further that the Court "retains jurisdiction over this matter to the fullest extent permitted by law."

2. On December 7, 2011, the Court issued a minute order in the Salmonid Cases acknowledging the joint report filed by the parties to the litigation. In addition, the Court indicated that parties may present stipulations on other matters, including project operations in 2012, to the Court and if agreement on such matters cannot be reached, the parties shall file a joint status report no later than January 6, 2012, briefly summarizing the nature of any remaining disputes and articulating the anticipated need for, and timing of, further motions practice. On December 12, 2011, the Court issued a Final Judgment (Including Schedule for Remand) (Doc. 655) in the case in accordance with the Memoranda and Orders described above, that included a schedule for reconsidering the remanded biological opinion and compliance with NEPA.

3. Consistent with the Court's minute order, the parties have been engaged in discussions to reach agreement on the manner in which the RPA will be modified and applied

during Water Year 2012. The parties executing this agreement have reached an agreement on certain actions and agree to modifications to the RPA Action IV.2.1 as described below for April 1 through May 31, 2012 operations only. The parties intend to continue discussions regarding other Water Year 2012 operations over the coming weeks, and intend to bring additional settlement stipulation(s) on 2012 operations before the Court if agreement can be reached prior to the onset of those operational actions. In addition to 2012 operations, the parties executing this agreement have agreed upon specific monitoring, studies and other actions described below.

STIPULATION

In the context of the foregoing recitals, Plaintiffs San Luis & Delta-Mendota Water Authority, Westlands Water District, State Water Contractors, Metropolitan Water District of Southern California, Coalition for a Sustainable Delta, and Kern County Water Agency ("Plaintiffs"), Oakdale Irrigation District, South San Joaquin Irrigation District, and Stockton East Water District ("Stanislaus River Plaintiffs"), Plaintiff-Intervenor California Department of Water Resources ("DWR"), and Federal Defendants by and through their respective counsel, hereby stipulate and agree as follows:

1. All parties agree to the following operations of the Central Valley Project ("CVP") and State Water Project ("SWP"), and related actions herein, for April 1, 2012 through May 31, 2012. This agreement was reached based on consideration of specific hydrologic, storage and fish conditions. This agreement is not intended to be used as a basis for a new biological assessment or biological opinion. The agreement in Section 2 below regarding 2012 operations is limited to operation of RPA Action IV.2.1, and applies only if the barrier at the Head of Old River is installed.

2. The CVP and SWP projects shall implement the following actions in 2012:

a. Operation at the Head of Old River from April 1 through May 31 if a rock barrier is installed.

i. DWR will install a rock barrier at the Head of Old River, if flows at Vernalis allow for its installation and maintenance from April 1 through May 31 [approximately less than 6,000 cubic feet per second ("cfs")]. Up to eight culverts (of approximately the same

size and configuration as used in previous barrier designs) may be installed in the rock barrier.

ii. When the rock barrier is installed, the SWP and CVP shall be operated to maintain Old and Middle River ("OMR") flows between -1,250 and -3,500 cfs in April, and between -1,250 and -5,000 cfs in May, depending on the real-time operations process described below in subsections iii-vi. Nothing in this section is intended to, or does, prevent the projects from operating more conservatively for delta smelt protection. While the rock barrier is in place and the SWP and CVP are operating to the OMR flows as provided herein, the SWP and CVP will not operate to the San Joaquin River Inflow to Export ratio described under RPA Action IV.2.1.

iii. The exception procedure for health and safety in RPA Action IV.2.1 for minimum combined SWP and CVP pumping of 1,500 cfs will be maintained.

iv. NMFS, DWR, and the U.S. Bureau of Reclamation ("Reclamation") will co-host a technical workshop in early February, with Delta Operations for Salmonids and Sturgeon group ("DOSS") members and other outside experts, to review data availability, modeling tools and outputs and other scientific approaches for establishing real-time operations screening criteria for OMR parameter selection within the specified ranges.

v. At least two weeks prior to April 1, 2012, NMFS, with information submitted by members of the DOSS and other outside experts, will prepare a real-time operations technical memorandum to guide weekly or daily decision-making. Real-time operations screening criteria will be developed based on hydrodynamics and Particle Tracking Model ("PTM") runs, and other relevant available scientific information and considerations, such as:

(a) the fraction of particles that reach Chipps Island; (b) particle residence time; (c) results showing particle capture at various diversions in the delta, and (d) relevant available information from trawls and rotary screw trap information, salvage, hydrodynamics, empirical data from previous VAMP studies, survival equations, and a modified Delta Passage Model. The DOSS will advise the Water Operations Management Team ("WOMT") and NMFS on the appropriate OMR parameter within the specified ranges. The DOSS will consider all relevant available scientific information, such as listed above, in determining its advice. The DOSS will provide its

information and advice to the WOMT for its consideration in developing a recommendation to NMFS for actions to protect salmonids and green sturgeon. The WOMT will supply information for NMFS to consider, including water supply impacts. NMFS shall make the final determination on OMR flow within the specified ranges to be implemented by Reclamation and DWR, after attempting to first meet with WOMT, and shall explain its determination in writing based on the best available science. NMFS will increase the transparency of the decision process by documenting the basis for its decisions and providing a written explanation of them and the basis for them to interested parties via NMFS' website. All parties to this agreement agree that the final determinations made by NMFS pursuant to this Section 2 are binding and in consideration of this agreement hereby waive all rights to seek relief from the court from these determinations and from operation of the projects by DWR and Reclamation in accordance with those determinations; however, this stipulation shall not waive any party's right to raise other claims or defenses as to other CVP and SWP operations or actions under the 2009 Salmonid BiOp.[1]

vi. In order to facilitate availability of real-time information to the agencies, DWR will convene a Delta Conditions Team ("DCT") consisting of scientists and engineers from the state and Federal agencies, Plaintiffs, and Defendant-Intervenors to review the real time operations and Delta conditions, including potential modeling utilizing the Delta Passage Model, PTM, and other applicable modeling tools, in conjunction with the real time monitoring, to assist in evaluating the potential effects of planned water operations on salmonids and sturgeon. The members of the DCT will provide its individual information to DOSS in accordance with a process provided by the DOSS, which currently meets on Tuesday mornings, to assess risks to salmonids and sturgeon based upon Delta conditions and the other factors set forth above.

vii. In order to generate information on migration routes and survivals across variable operating conditions in order to inform decision-making for project operations, DWR and Reclamation agree to fund the development and deployment of a broadened acoustic tagging and release program in 2012, which will track juvenile salmon and juvenile steelhead migrations

[1] Furthermore, nothing in this agreement waives the right of any party to assert whatever privileges may otherwise be available to it by law.

through the south Delta for the purpose of generating better information by which to manage south Delta operations and other activities to improve fish survival efficiently and effectively. The person or organization selected by the parties to conduct such studies will collaborate with the NMFS-Southwest Fisheries Science Center ("NMFS-SWFSC") in designing and conducting these studies. To the extent any information from such studies is available for use in 2012, the parties agree that the information will be used in the decision-making process in determining 2012 operations pursuant to this stipulation. Such an acoustic tag program may include:

1. Weekly releases of hatchery-origin steelhead and salmon at key locations in the south Delta;

2. Deployment of monitoring capabilities to detect juvenile migrations through the south Delta through various routes of migration;

3. Deployment of monitoring capabilities to develop improved information on the effect of water operations of the SWP and the CVP on juvenile salmon and juvenile steelhead migrations through the Delta under varying hydraulic conditions; and

4. Development of data gathering and reporting capabilities to support improved in-season real time water operations over the course of juvenile migrations.

b. NMFS, the other Federal agencies, plaintiff-intervenor DWR, plaintiffs, and defendant-intervenors have engaged in discussions pertaining to south Delta operations if flows at Vernalis are greater than that which would allow a rock barrier to be installed at the Head of Old River. This stipulated agreement for operation in lieu of RPA Action IV.2.1 in 2012 does not address CVP and SWP operations under that scenario but parties may continue to meet to develop possible operations under such high flow conditions where a rock barrier cannot be installed.

3. DWR will submit to NMFS and the California Department of Fish and Game ("DFG") a predator monitoring study for their review and permit compliance procedures, as appropriate. If a rock barrier is installed, the predator monitoring study will evaluate predation associated with the installation and operation of the rock barrier. If the rock barrier is not installed, the predator monitoring study will evaluate predation at the scour hole downstream of the junction of the San Joaquin River and the Head of Old River. In addition, predator

monitoring efforts will be implemented at location(s) to be determined, for example, at the CVP export facility in front of trash racks, at the scour hole mentioned above, or in other location(s) in the Delta. In addition, DWR commits to developing a study for a pilot predator removal and control program that will be submitted to NMFS and DFG for review and comment.

4. NMFS will have an opportunity to be involved in design and development of studies and will work with DWR, DFG and Public Water Agencies[2] to further refine the following actions:

a. **Examination of other monitoring systems**. DWR and Reclamation will commence in the first quarter of 2012 to examine the opportunities to deploy other monitoring and tracking tools for tracking juvenile and adult migrations of salmonids and other fish species within and through the Delta, utilizing PIT tags or other technologies as may be available. In examining such opportunities, DWR and Reclamation agree to utilize the available expertise of the fishery agencies, the university community, the consulting community and other sources of expertise.

b. **Life-cycle modeling**: The parties agree that the timely development of a Central Valley salmon life-cycle model is vital to inform Bay-Delta decision-making. The model will be developed by and under the control of the NMFS-SWFSC, and, subject to the availability of funding, the NMFS-SWFSC shall utilize a broad array of expertise outside of NMFS as appropriate. Such an expanded program may also be guided by a panel of experts convened by the Interagency Ecosystem Program or other appropriate expert agency. DWR and Reclamation will consider providing funding to the NMFS-SWFSC to accelerate the development of the model.

[2] "Public Water Agencies" consist of state and federal water contractors who receive water from the SWP and CVP and are Metropolitan Water Agency of Southern California, Kern County Water Agency, San Luis & Delta-Mendota Water Authority, Westlands Water District, and Santa Clara Valley Water District, and State Water Project Contractors Authority ("SWPCA") and State and Federal Contractors Water Agency ("SFCWA"). The Stanislaus River Plaintiffs are also considered "Public Water Agencies" for the purpose of this stipulation and for the purposes of any engagement process related to ESA Section 7 consultation involving New Melones operations.

c. DWR and Reclamation will continue the Chinook salmon acoustic tag survival studies that have been implemented through the Vernalis Adaptive Management Program, in conjunction with the 6-year acoustic tagging experiment.

5. DWR, Reclamation and the Public Water Agencies agree to work with NMFS to design, develop, and fund a program to provide additional fish tagging and monitoring that could further inform Bay-Delta decision-making.

6. As authorized under the State Water Resources Control Board Decision 1641, Reclamation and DWR may divert or redivert water of the SWP and CVP between Jones Pumping Plant and Banks Pumping Plant in April and May to reduce fish losses and to benefit fish. The CVP will develop and implement standard operating procedures to minimize longfin and Delta smelt losses and salmonid losses, as specified in the 2009 BiOp, during the cleaning of the louvers.

7. This stipulated agreement for operations does not address or include RPA Action IV.2.3, which provides for OMR Flow Management from January through June 15. However, the parties commit in 2012 to continue discussions to develop a monitoring-based trigger, or other real-time operations approach, that would modify in 2013 the January 1 onset of Action IV.2.3.

8. By June 2012, DWR and Reclamation will submit to NMFS for review a list of possible habitat restoration projects targeted to improve survival of steelhead migrating out of the San Joaquin Basin. The parties expect that DWR and Reclamation will confer with DFG in compiling this list.

SO STIPULATED.

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Dated: January 12, 2012

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[PROPOSED] ORDER

Good cause appearing, and based on the stipulation of the parties, the court hereby orders as follows:

1. IT IS HEREBY ORDERED ADJUDGED, AND DECREED, that the Joint Stipulation Regarding CVP And SWP Operations in 2012 is approved.

2. IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that all actions in the Joint Stipulation Regarding CVP And SWP Operations in 2012 be carried out as described therein and that the parties to the stipulation have waived any right to seek relief from this court from such actions through May 31, 2012.

3. IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that except as specified in the Joint Stipulation Regarding CVP and SWP Operations in 2012, all parties otherwise retain rights to seek further relief to the extent permitted by law.

IT IS SO ORDERED.

Dated: _____

_____
UNITED STATES DISTRICT JUDGE

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ATTACHMENT 2A

Overview of DSM2 modeling
requested by NMFS

Request for DWR assistance in PTM – Updated scenario specifications
August 8, 2011

The request for PTM modeling assistance made on August 4, 2011, outlined the general structure of our intended analysis, which remains the same. This document outlines additional modeling assumptions and scenario specifications based on the team's technical discussion with DWR on August 5, 2011.

MODELING SET-UP & ASSUMPTIONS:

Run duration: 45 days

Number of particles inserted: 1000

Timing of particle insertion: Particles will be inserted gradually over the 24 hours of Day 1 of the simulation. Day 1 of the simulation will be set to be intermediate between the neap and spring tides.

Boundary conditions: The set of boundary conditions will be selected from the historical range of values associated with an intermediate Vernalis flow. Except for Vernalis flows and combined Central Valley Project (CVP) and State Water Project (SWP) exports, the boundary conditions of all scenarios will be the same. If the sensitivity analysis of the effect of Sacramento River inflow suggests that this assumption is not warranted, an appropriate Sacramento River inflow will be chosen for each level of Vernalis flow.

Delta Cross Channel: All scenarios assume that the Delta Cross Channel is closed for the entire simulation.

Head of Old River Barrier (HORB): All "HORB IN" scenarios assume that the HORB is in place for the entire simulation. DWR will model the HORB as a rock barrier (with "leakiness", if appropriate). We assume that when Vernalis flows are above 7000 cfs, a physical barrier at the Head of Old River cannot be installed or maintained. So, for any set of conditions in which Vernalis flows prevent barrier installation (e.g. the 12,000 cfs factor level), no "HORB IN" scenario will be run.

Temporary Agricultural Barriers: All "HORB IN" scenarios assume that the temporary agricultural barriers are also in place.

Delta Island Consumptive Use (DICU): All scenarios assume a "May" level of consumptive use for the entire simulation.

Export split: Combined exports will be split between the CVP and SWP as would be expected during April and May – generally[1] an even split of exports until the CVP reaches capacity. Modeled exports will be reported in the "Hydrologic Conditions" summary for each scenario.

FACTOR COMBINATIONS

Factor combinations to establish "baseline" hydrodynamics under the I:E ratio for comparison with results from below runs

4 levels of Vernalis Flows (1,500 cfs, 3,000 cfs, 6,000 cfs, 12,000 cfs)
Exports according to the I:E ratio in the NMFS RPA (full RPA provided in Attachment A; suggested simulation combinations provided below[2]).

Table 1: Suggested simulation combinations of Vernalis flow and the I:E ratio

Vernalis Flow (cfs)	Vernalis flow (cfs):CVP/SWP combined export ratio
1,500 cfs	1:1
3,000 cfs	1:1, 2:1, 3:1[3]
6,000 cfs	3:1, 4:1
12,000 cfs	4:1

2 levels of barrier (IN vs. OUT)
For a given scenario, Vernalis flows and combined Central Valley Project (CVP) and State Water Project (SWP) exports will be fixed; OMR will vary because of tidal effects.

7 Vernalis & I:E ratio combinations x 2 barrier combinations = 14 possible scenarios. Subtracting the single "HORB IN" scenario at Vernalis flows of 12,000 cfs leaves 13 desired scenarios.

[1] The SWP facility has greater flexibility in adjusting exports than the CVP facility, which is essentially limited to export steps of 700-800 cfs at a time, based on unit capacity. Therefore, the "even split" is often implemented over time, rather than on a day-to-day basis.

[2] Action IV.2.1 of the NMFS RPA sets the I:E ratio based on the San Joaquin Valley Hydrologic classification. The factor combinations of Vernalis flow and I:E ratio in Table 1 are intended to capture the likely implementation of this RPA Action within the constraints of the "synthetic hydrology" (not associated with any hydrologic classification) assumed for this set of scenarios.

[3] If Vernalis flows of 3,000 cfs occurred in a Below Normal San Joaquin Hydrologic Classification, the 3:1 I:E ratio associated with the Below Normal yeartype would apply. Because the resulting combined exports of 1,000 cfs, would be lower than the health and safety pumping levels of 1,500 cfs, this combination will be modeled with combined exports at 1,500 cfs.

Factor combinations to explore hydrodynamics in "alternative operations space"
4 levels of Vernalis flows (1,500 cfs, 3,000 cfs, 6,000 cfs, 12,000 cfs)
3 levels of OMR[4] (-2,000 cfs, -3,500 cfs, -5,000 cfs)
2 levels of barrier (IN vs. OUT)
For a given scenario, Vernalis flows and combined Central Valley Project (CVP) and State Water Project (SWP) exports will be fixed; OMR will vary around the specified factor level because of tidal effects.

4 x 3 x 2 = 24 possible scenarios. Subtracting the three "HORB IN" scenarios at Vernalis flows of 12,000 cfs leaves 21 desired scenarios.

Total number of desired scenarios: 34

INSERTION POINTS AND FLUX LOCATIONS

For each factor combination, PTM simulations will be run with the following insertion points and associated flux locations. Specified DSM2 nodes were selected from the map available at: http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/models/dsm2v6/DSM2_Grid2.0.pdf; a partial scan of this map with the flux locations (not including the "standard" flux locations used to track the fates of all particles) is included as Attachment B.

Insertion points and flux locations to compare movement and fates of particles inserted from three basins
Insertions will be made at the following locations *(DSM2 node)*:

- Mossdale *(at the node typically used for "Mossdale" insertions;, we assume Node 6 or Node 7)*
- San Joaquin River at Calaveras River *(at RCAL009 if possible, else at Node 21)*
- Rio Vista *(at the node typically used for "Rio Vista" insertions; we assume Node 350 or 351)*

For these three insertion points, particles will be tracked at the following flux locations *(DSM2 nodes, flux direction)*:

- San Joaquin River at Head of Old River to just inside Head of Old River *(Node 8 to Node 48)*
- San Joaquin River at Head of Old River to San Joaquin River just downstream of Head of Old River *(Node 8 to Node 9)*
- San Joaquin River at Turner Cut to just inside Turner Cut *(Node 26 to Node 140)*
- San Joaquin River at Turner Cut to San Joaquin River just downstream of Turner Cut *(Node 29 to Node 30)*
- San Joaquin River at Columbia Cut to just inside Columbia Cut *(Node 31 to Node 133)*

[4] DSM2-HYDRO calculates OMR based on input conditions such as Vernalis flow and exports. In order to model each level of OMR, DWR will run DSM2-HYDRO with the export estimate (based on the Hutton equation, probably) expected to result in the desired OMR given the level of Vernalis flow, and iteratively adjust as necessary. Once the appropriate export level condition is determined, the DSM2-PTM module can then be run using the appropriate HYDRO data.

- San Joaquin River at Columbia Cut to San Joaquin River just downstream of Columbia Cut *(Node 33 to Node 34)*
- San Joaquin River at Mouth of Middle River to just inside Mouth of Middle River *(Node 134 to Node 133)*
- San Joaquin River at Mouth of Middle River to San Joaquin River just downstream of Mouth of Middle River *(Node 37 to Node 38)*
- San Joaquin River at Mouth of Old River to just inside Mouth of Old River *(Node 38 to Node 103)*
- San Joaquin River at Mouth of Old River to San Joaquin River just downstream of Mouth of Old River *(Node 38 to Node 39)*
- Past Jersey Point *(Node 44 to Node 469)*
- All "standard" flux locations (listed in the column headings of Attachment C) that, when summed, represent all possible fates of particles, namely: CVP fish collection facility, SWP fish collection facility, Chipps Island, all agricultural diversions, all Contra Costa diversions, and the number of particles remaining in the delta.

For the Rio Vista insertion point only, particles will be tracked at two additional flux locations *(DSM2 nodes, flux direction)*:

- Sacramento River at Threemile Slough to just inside Three Mile Slough *(Node 352 to Node 240)*
- Sacramento River at Threemile Slough to Sacramento River just downstream of Three Mile Slough *(Node 352 to Node 353)*

Insertion points and flux locations to compare fates of particles inserted into different delta channels

Insertions will be made at the following locations *(DSM2 node)*:

- Just inside Head of Old River *(Node 48)*
- Just inside Turner Cut *(Node 140)*
- Just inside Columbia Cut (or just inside Middle River[5]) *(Node 133)*
- Just inside mouth of Old River *(Node 103)*
- San Joaquin River just downstream of Jersey Point *(Node 469)*
- Just inside Threemile Slough *(Node 240)*

For these six insertion points, particles will be tracked at the following flux locations:

- All "standard" flux locations (listed in the column headings of Attachment C) that, when summed, represent all possible fates of particles, namely: CVP fish collection facility, SWP fish collection facility, Chipps Island, all agricultural diversions, all Contra Costa diversions, and the number of particles remaining in the delta.

[5] The insertion nodes selected to represent particles already in specific channels are the "tips" of the flux vectors into those channels. For both Columbia Cut and the Mouth of Middle River, that node is Node 133.

OUTPUT

- DWR will provide the daily particle tracking data (for Days 1-45) for each simulation in Excel (no charts necessary).
- DWR will perform some initial data summarization and graphics for each simulation, with the reporting timing (e.g. 5, 15, 30, 45 days post-insertion) to be determined by DWR based on convenient, existing charting routines.
- DWR will include a table of daily hydrologic conditions for each simulation, similar to that in Attachment D, and including daily OMR[6] and daily 5QWEST.

PHASING

Phase 1: DWR will (a) run a scenario at a combination of intermediate factor levels to get a sense of how long it will take to set-up, run, and post-process date from each scenario, and (b) perform a sensitivity analysis in which this initial scenario will be simulated assuming different Sacramento River inflow boundary conditions.

Phase 2: DWR and the Southern Delta Operations Technical Team will review the results of the sensitivity analysis of Sacramento River inflow, and decide on the final set of boundary conditions for each factor combination.

Phase 3: DWR will begin to simulate all factor combinations, working from the extreme factor level combinations to intermediate factor combinations. Rather than waiting until all results are available, results will be provided to the Southern Delta Operations Technical Team on an ongoing basis (specific timing to be determined).

Phase 4: Sensitivity analyses of tidal effects (to evaluate the effects of insertion on spring vs. neap tides) and screening of agricultural and Contra Costa diversions (to evaluate the effects of screening some or all of the agricultural or Contra Costa diversions) may be pursued if deemed necessary by the Southern Delta Operations Technical Team after additional discussion.

[6] The daily OMR should be calculated in the manner it is calculated for the purposes of daily operations; NMFS is checking with operations staff at Reclamation for confirmation of the appropriate formula.

ATTACHMENT 2B

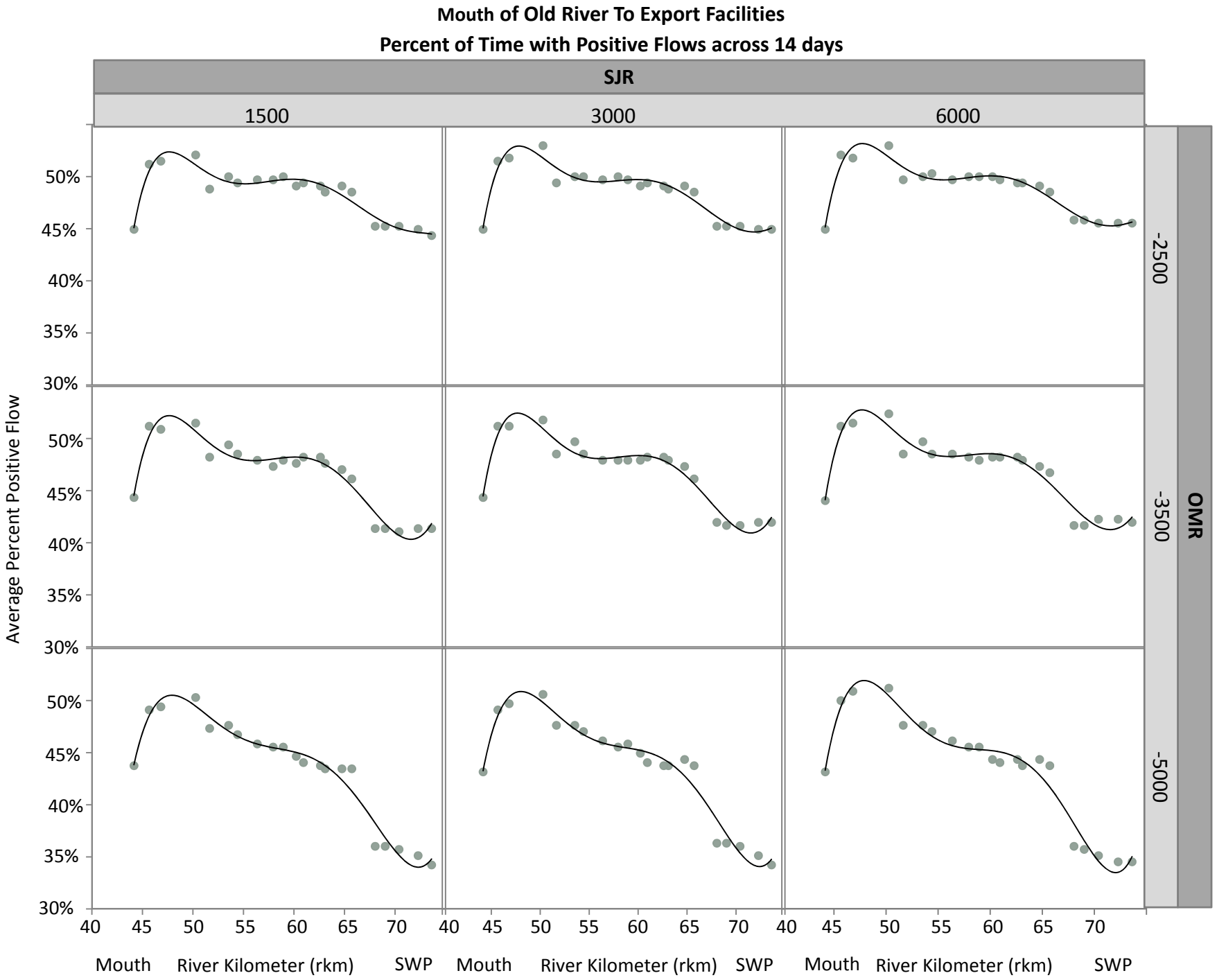
Selected DSM2 modeling results

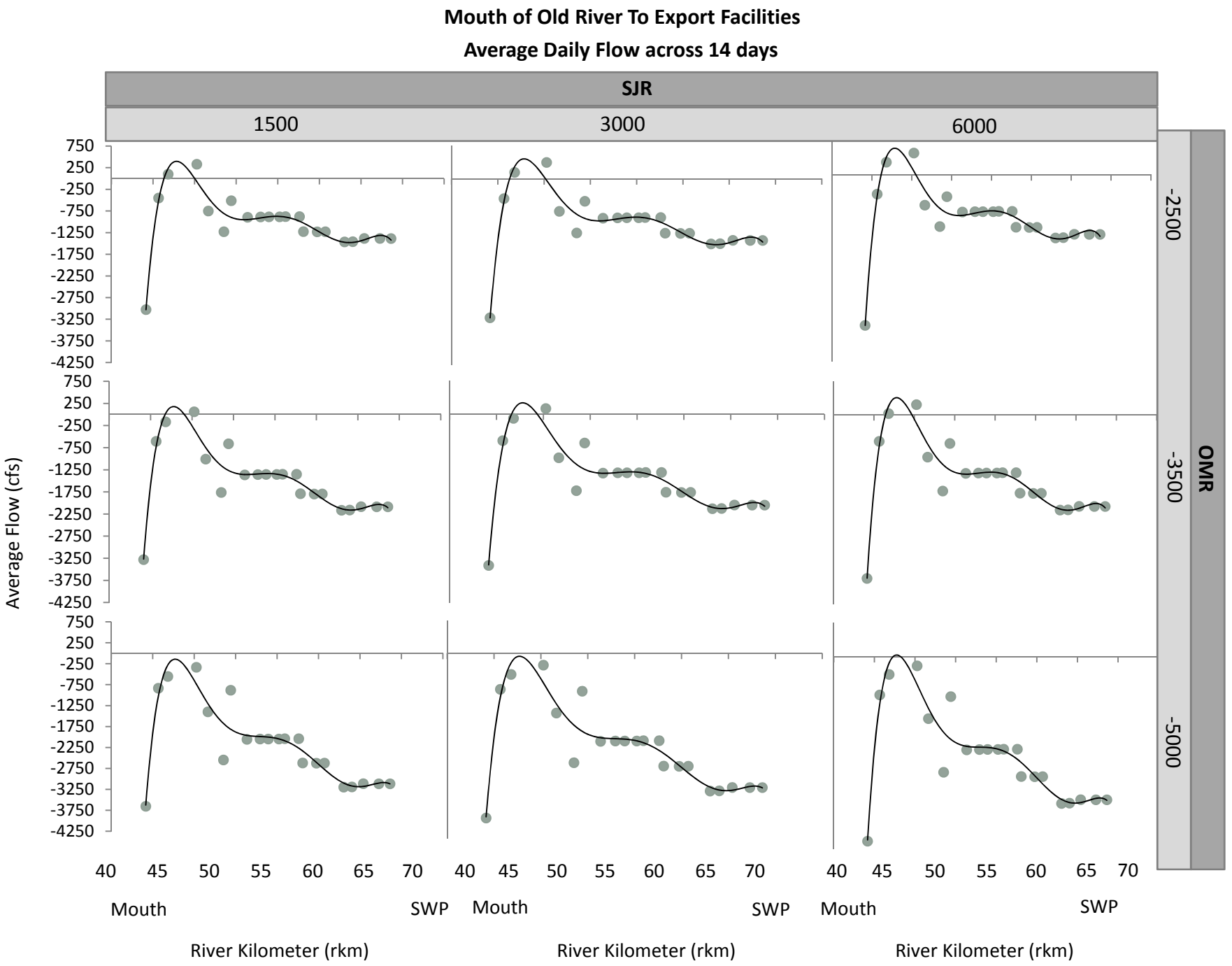
Attachment 2B Table of Contents

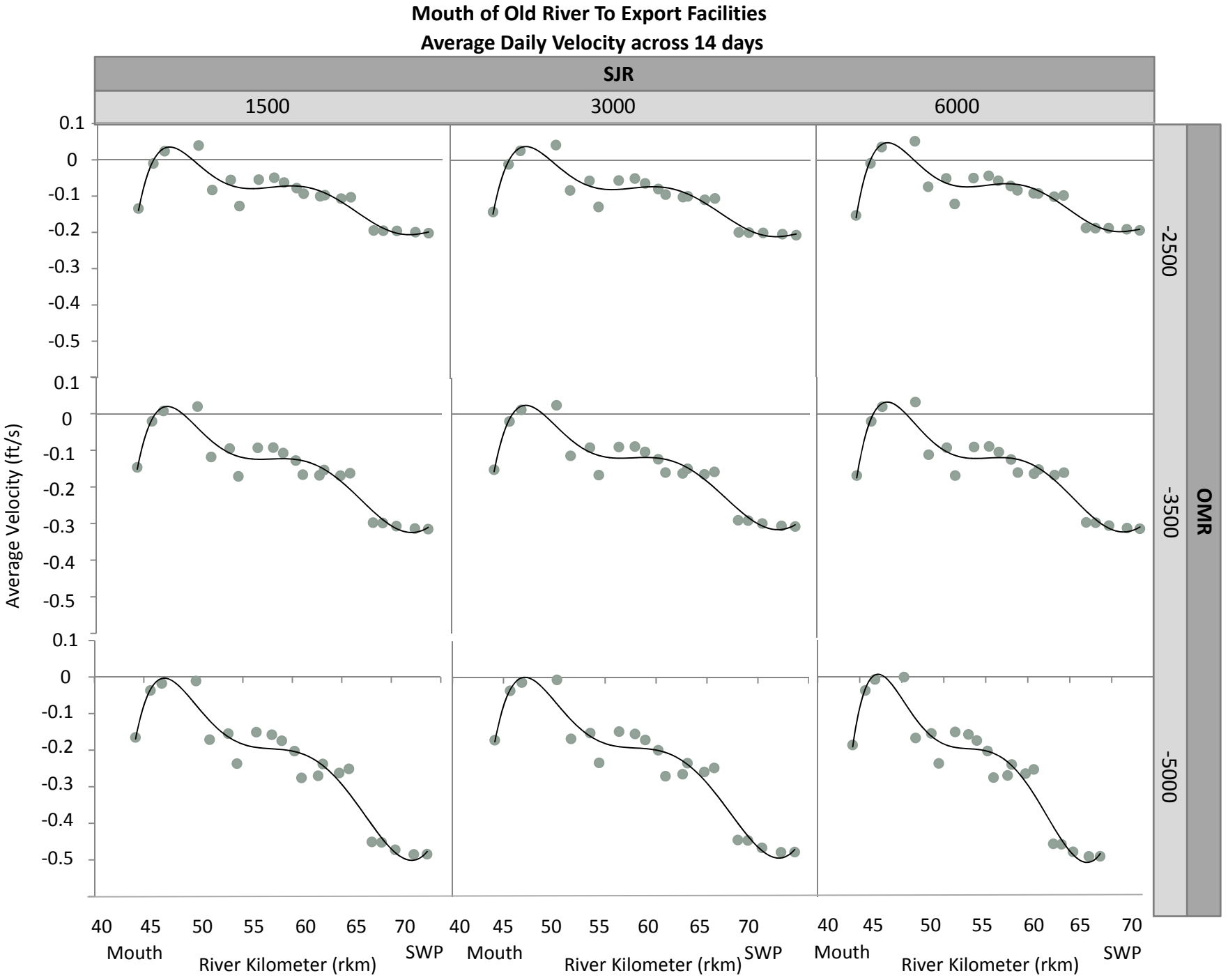
Summary of exports and OMR flows in all scenarios

Scenario	SJR	target OMR	HORB IN			HORB OUT			IN - OUT	
			CVP+SWP	Calc. OMR	Approx. IE Ratio	CVP+SWP	Calc. OMR	Approx. IE Ratio	CVP+SWP	IE Ratio
sjr1500_omr1250	1500	-1250	600	-1214.45	5/2	1100	-1282.19	4/3	-500	1.14
sjr1500_omr2500		-2500	2000	-2507.23	3/4	2400	-2472.94	5/8	-400	0.13
sjr1500_omr3500		-3500	3100	-3526.83	1/2	3500	-3478.65	3/7	-400	0.06
sjr1500_omr5000		-5000	4700	-5009.61	1/3	5200	-5038.08	2/7	-500	0.03
sjr3000_omr1250	3000	-1250	800	-1239.41	15/4	1700	-1220.89	7/4	-900	1.99
sjr3000_omr2500		-2500	2200	-2537.38	4/3	3100	-2507.77	1/1	-900	0.40
sjr3000_omr3500		-3500	3200	-3468.31	1/1	4200	-3521.6	5/7	-1000	0.22
sjr3000_omr5000		-5000	4800	-4956.79	5/8	5800	-5004.56	1/2	-1000	0.11
sjr6000_omr2500	6000	-2500	2400	-2458.29	5/2	4500	-2490.81	4/3	-2100	1.17
sjr6000_omr3500		-3500	3500	-3485.41	12/7	5600	-3518.2	1/1	-2100	0.64
sjr6000_omr5000		-5000	5100	-4978.16	7/6	7200	-5017.91	5/6	-2100	0.34
sjr12000_omr2500	12000	-2500	N/A			7700	-2533.88	14/9	N/A	
sjr12000_omr3500		-3500				8700	-3474.75	11/8		
sjr12000_omr5000		-5000				10300	-4984.99	7/6		

Scenario	SJR	CVP+SWP	IE Ratio	OMR		IN-OUT	
				HORB-IN	HORB-OUT	OMR diff	OMR diff ratio (over HORB-OUT)
sjr1500_ie11	1500	1500	1	-2045.14	-1648.64	-396.50	0.24
sjr3000_ie11	3000	3000	1	-3282.05	-2415.77	-866.28	0.36
sjr3000_ie21	3000	1500	2	-1887.96	-1036.87	-851.09	0.82
sjr4500_ie21	4500	2250	2	-2438.21	-1092.27	-1345.94	1.23
sjr4500_ie31	4500	1500	3	-1741.27	-397.38	-1343.89	3.38
sjr6000_ie31	6000	2000	3	-2085.88	-163.00	-1922.88	11.80
sjr6000_ie41	6000	1500	4	-1621.03	302.79	-1923.82	-6.35
sjr12000_ie41	1500	1500	4	N/A	1864.19	N/A	


Mouth of Old River To Export Facilities
Percent of Time with Positive Flows across 14 days
SJR
1500
3000
6000
OMR
-2500
-3500
-5000
Average Percent Positive Flow
50%
45%
40%
35%
30%
40
45
50
55
60
65
70
Mouth
River Kilometer (rkm)
SWP

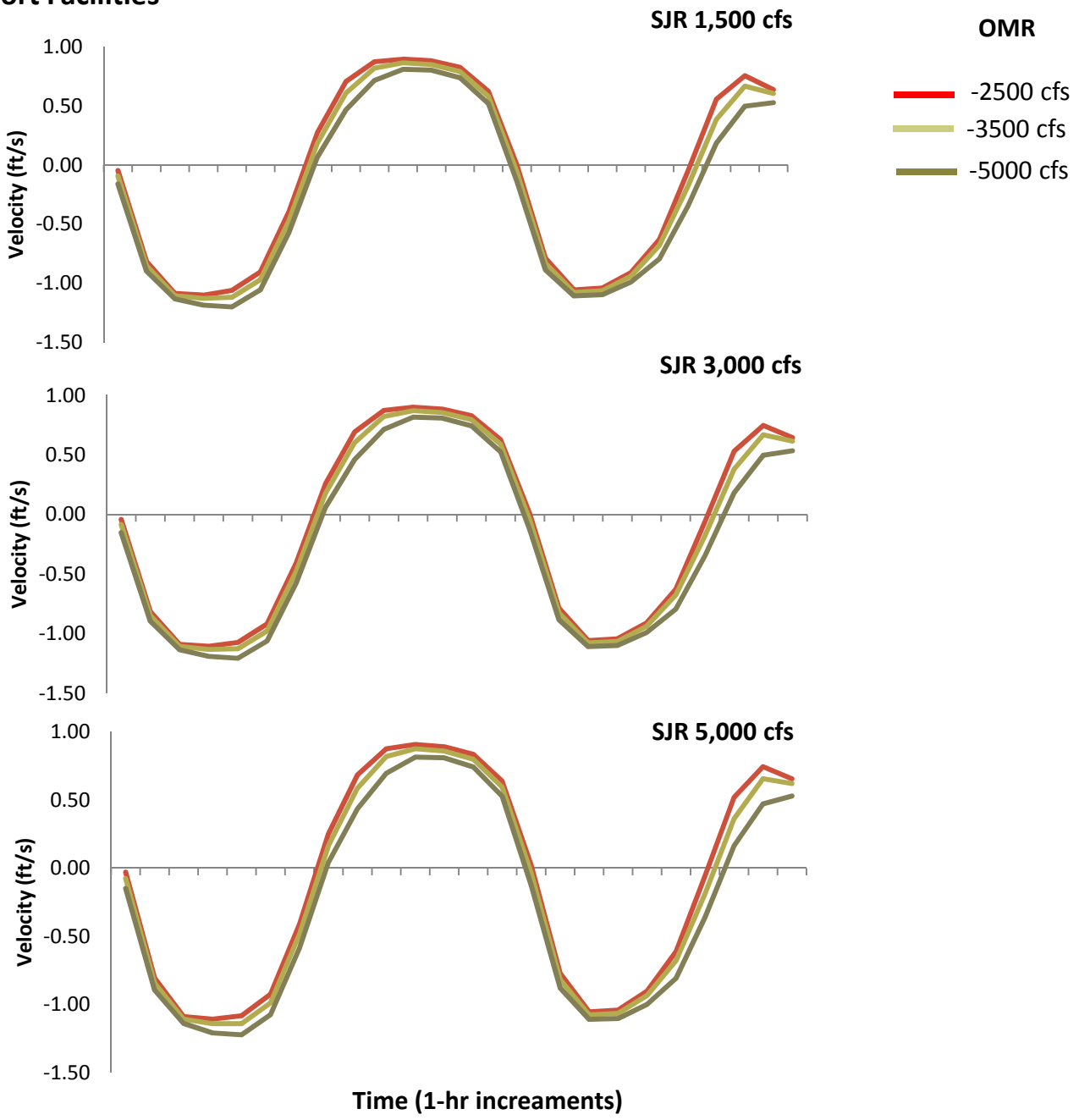

Mouth of Old River To Export Facilities
Average Daily Flow across 14 days
SJR
1500
3000
6000
OMR
-2500
-3500
-5000
Average Flow (cfs)
750
250
-250
-750
-1250
-1750
-2250
-2750
-3250
-3750
-4250
40
45
50
55
60
65
70
Mouth
SWP
River Kilometer (rkm)


Mouth of Old River To Export Facilities
Average Daily Velocity across 14 days
SJR
1500
3000
6000
OMR
-2500
-3500
-5000
Average Velocity (ft/s)
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
40
45
50
55
60
65
70
Mouth
SWP
River Kilometer (rkm)

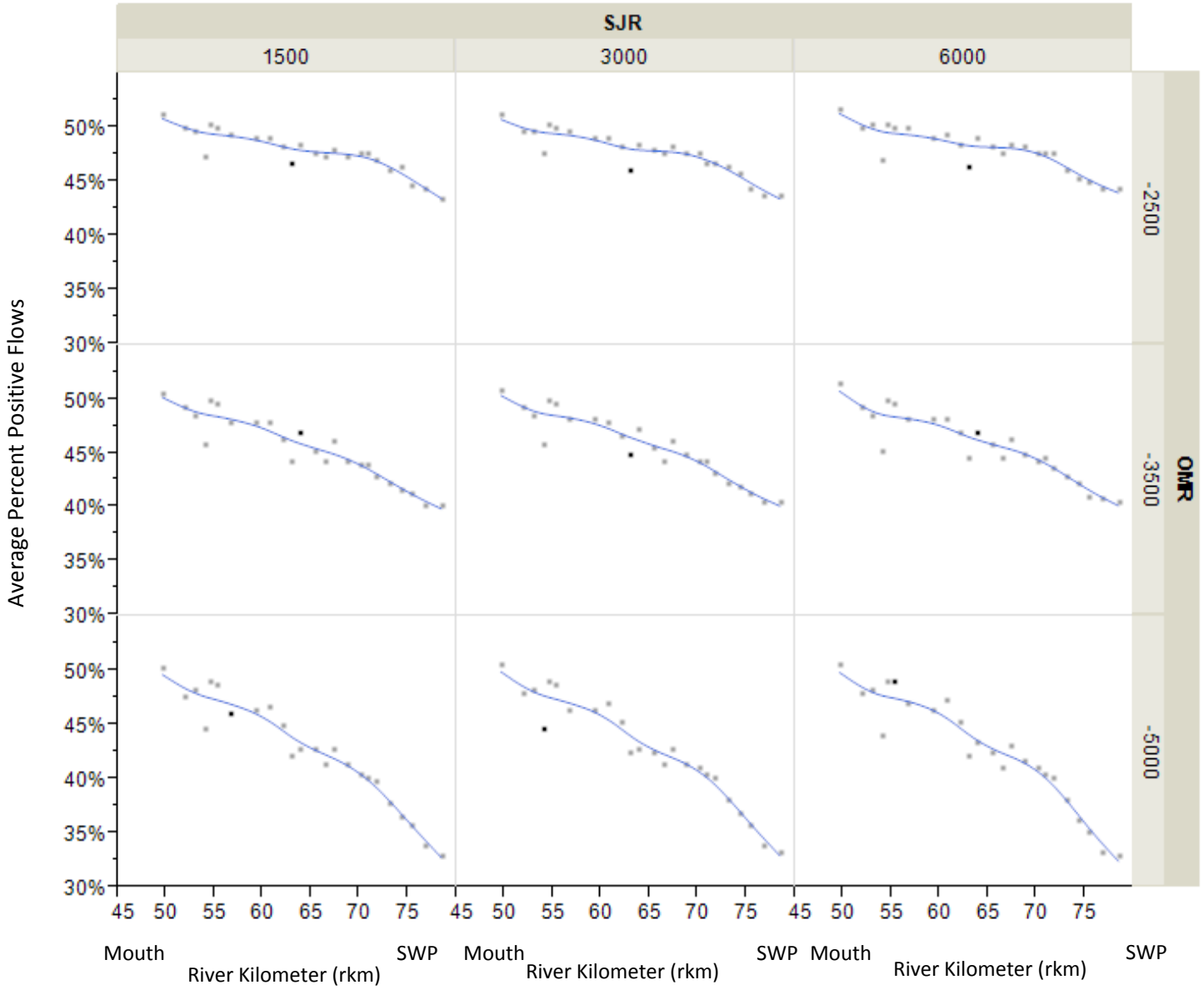
Mouth of Old River To Export Facilities

(24-hr velocity values)

Instantaneous average velocity values across 24 channel segments from the mouth of Middle river to Export facilities. Velocity data for each channel were taken from a single day (May 7, 2007)

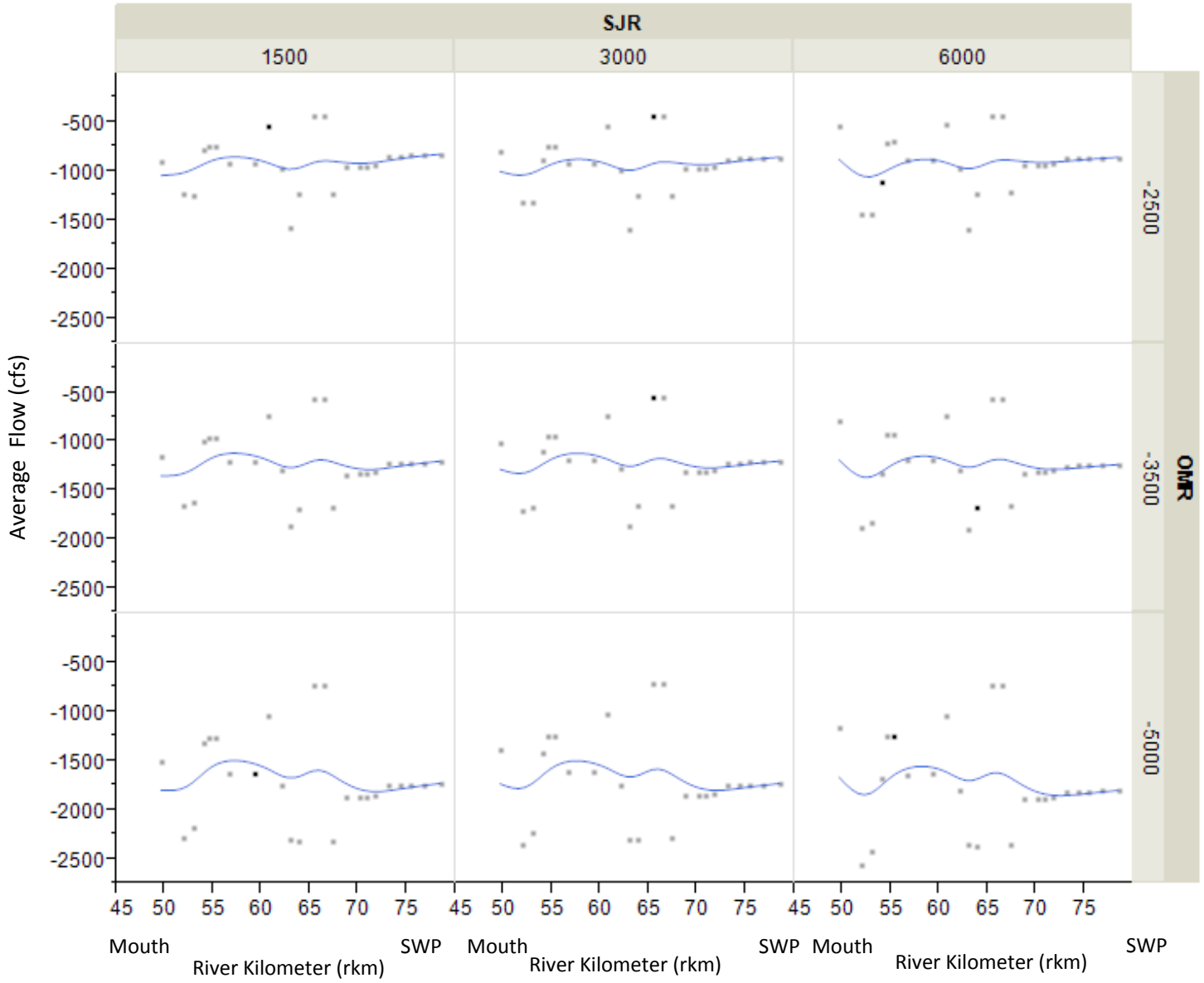


Mouth of Middle River To Export Facilities
Percent of Time with Positive Flows across 14 days

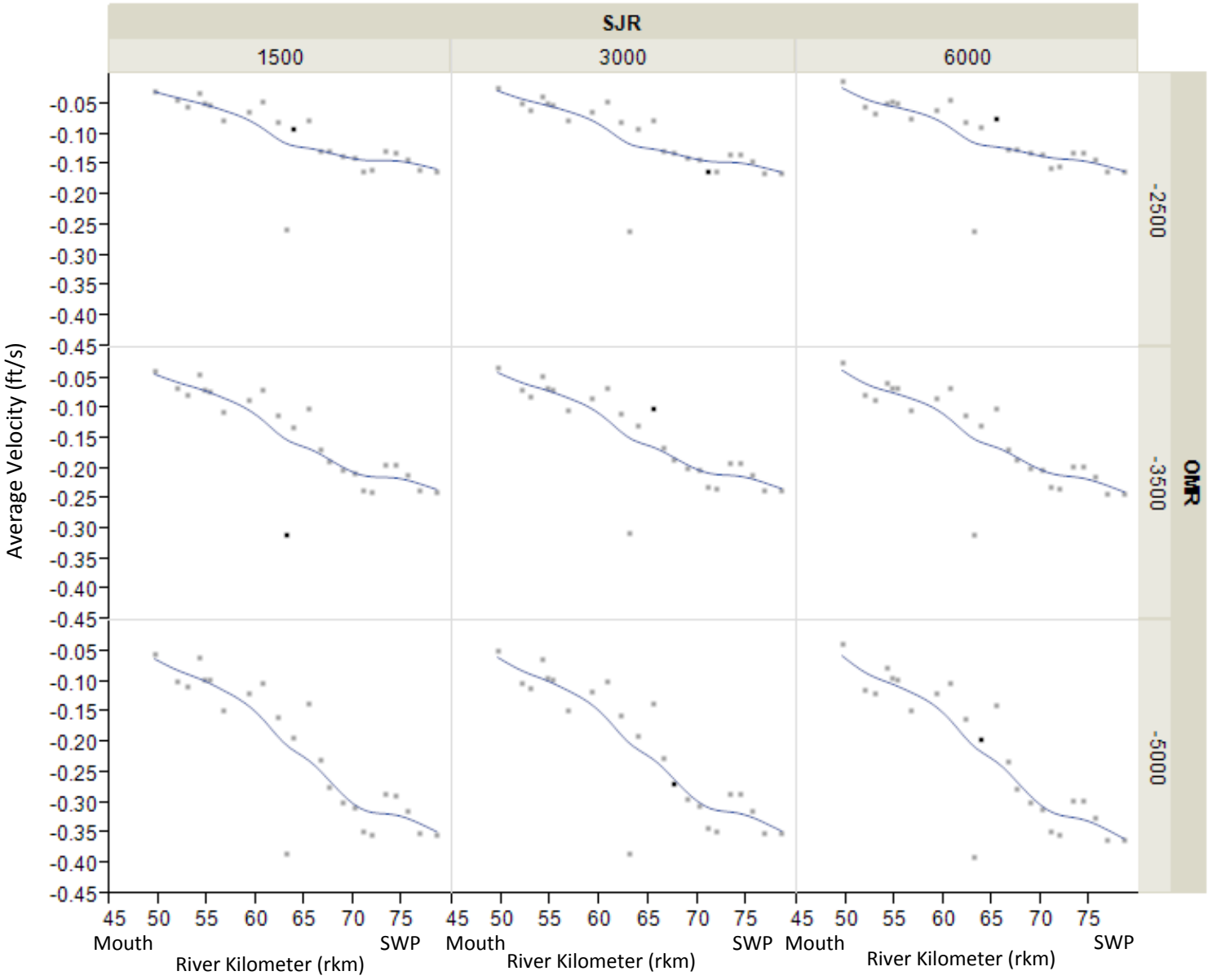


Mouth of Middle River To Export Facilities

Average Daily Flow across 14 days



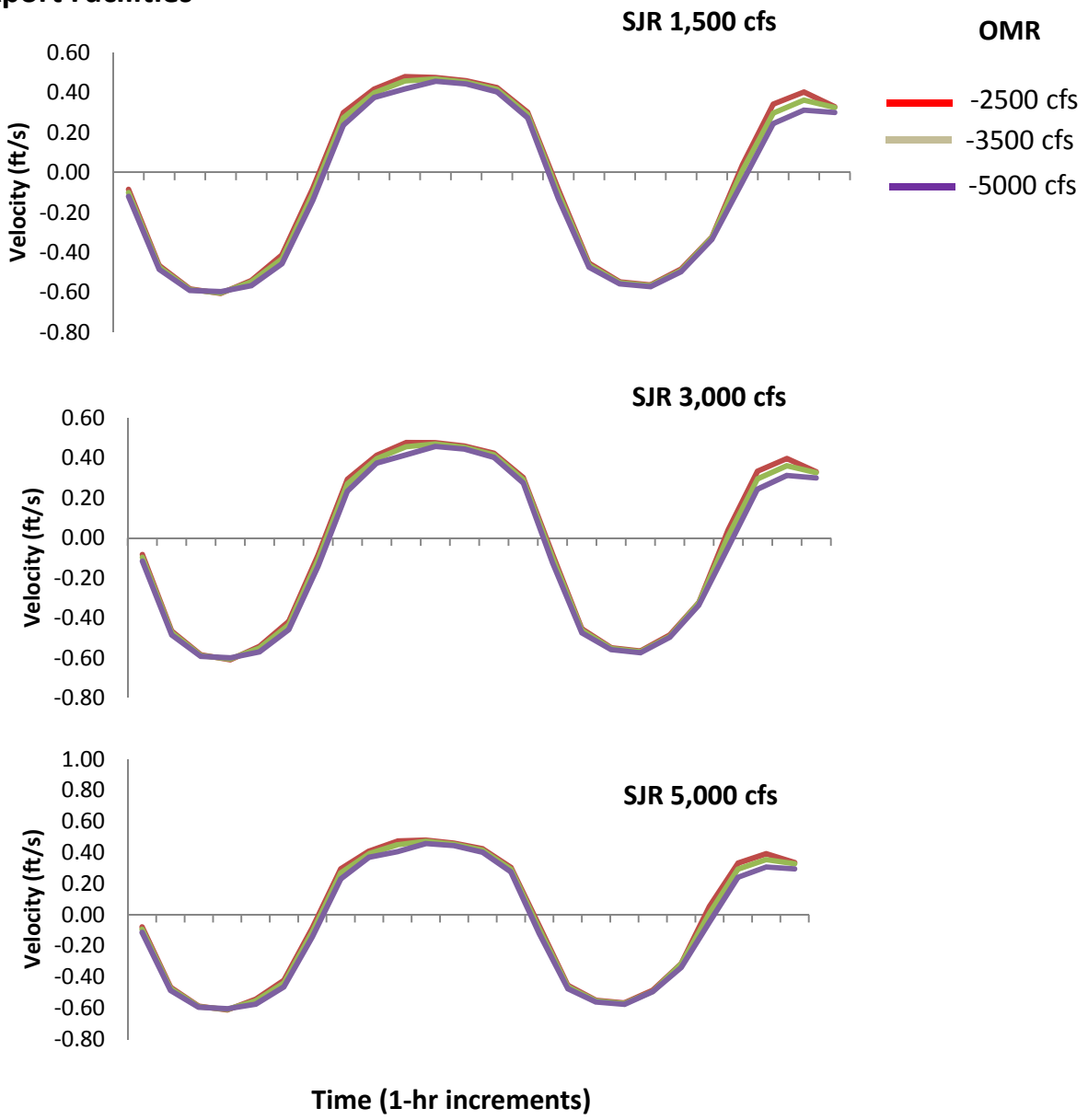
Mouth of Middle River To Export Facilities
Average Daily Velocity across 14 days



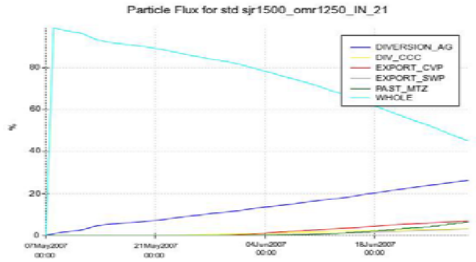
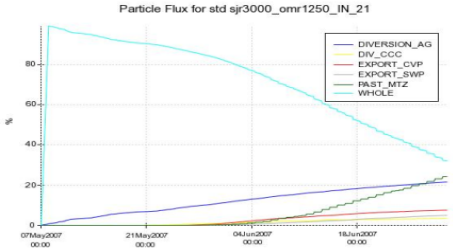
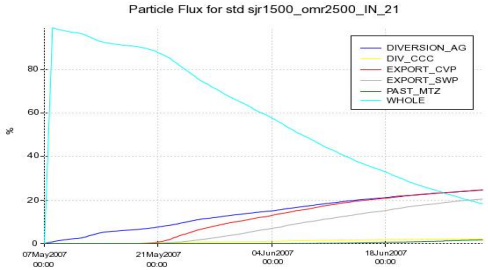
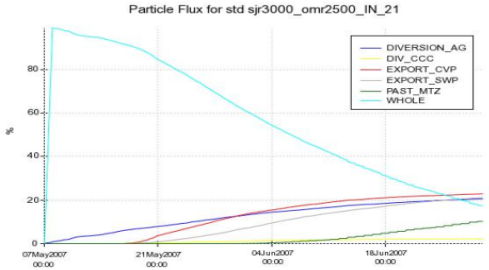
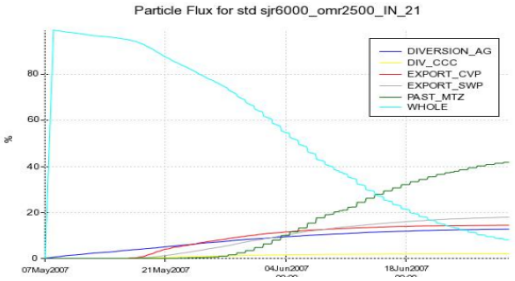
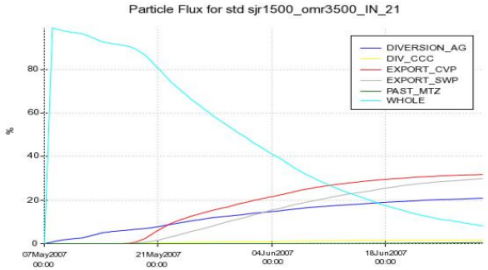
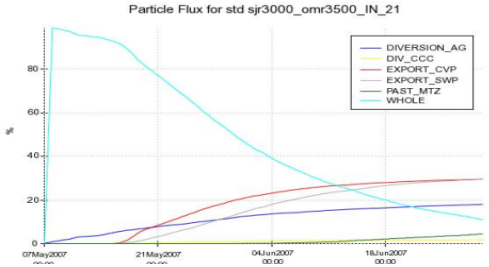
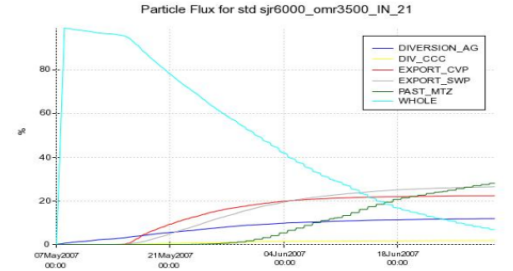
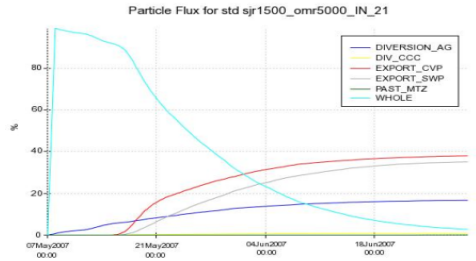
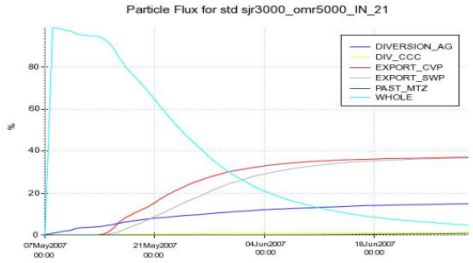
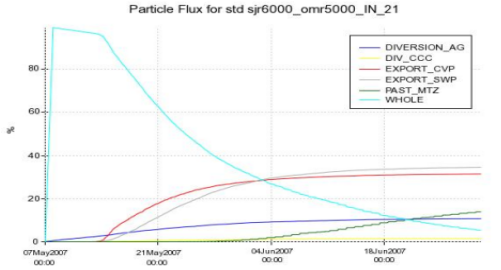
Mouth of Middle River To Export Facilities

(24-hr velocity values)

Instantaneous average velocity values across 24 channel segments from the mouth of Middle river to Export facilities. Velocity data for each channel were taken from a single day (May 7, 2007)



Calaveras Insertion – BARRIER IN

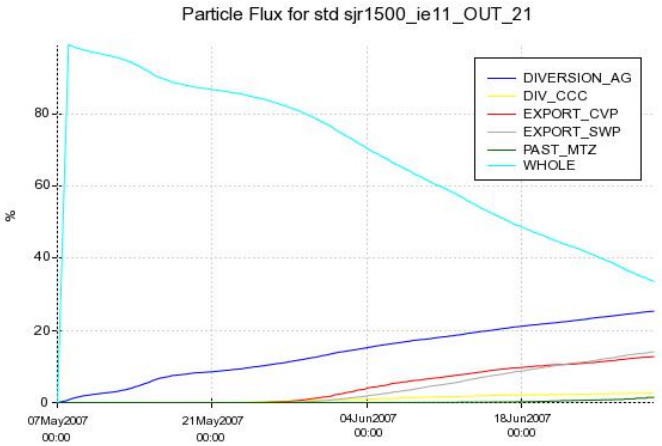
	1500 SJR	3000 SJR	6000 SJR
-1250 OMR			
-2500 OMR			
-3500 OMR			
-5000 OMR			

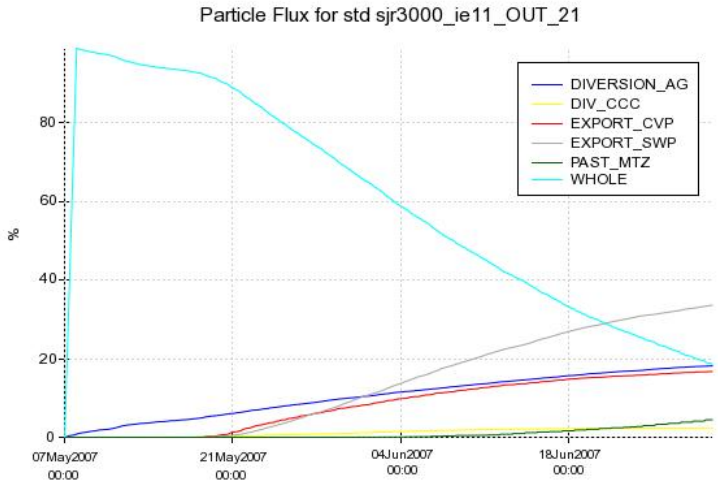
Calaveras Insertion – BARRIER OUT

1500 SJR

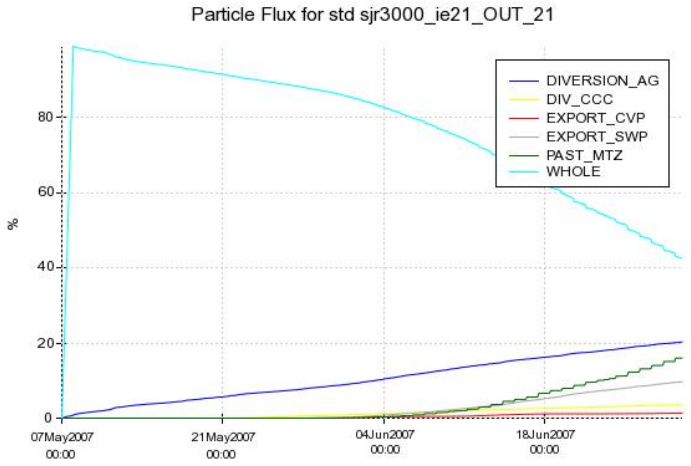
3000 SJR

1:1 I:E ratio





2:1 I:E ratio



Mossdale Insertion – BARRIER IN

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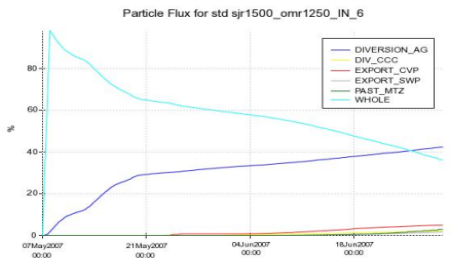
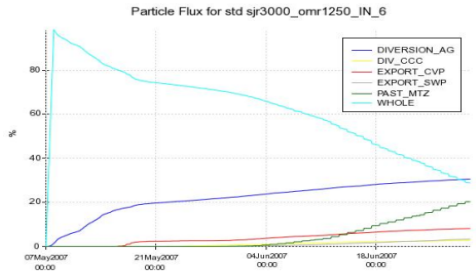
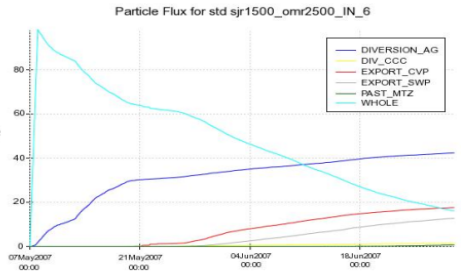
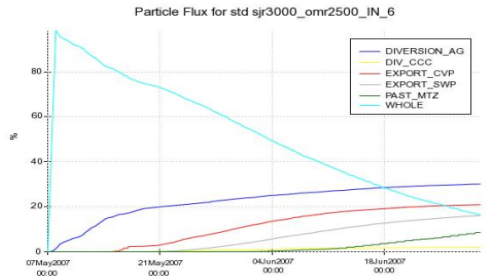
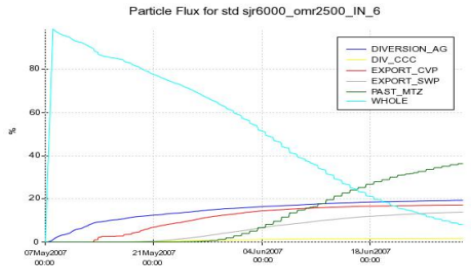
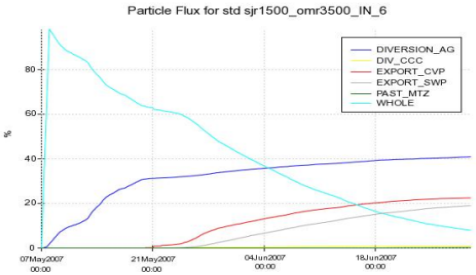
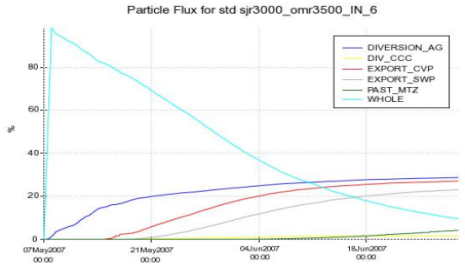
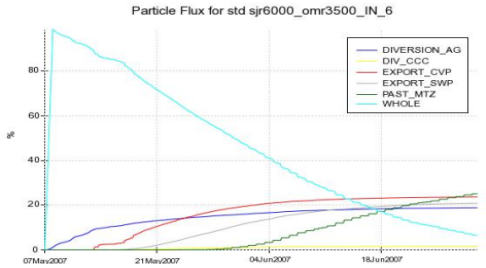
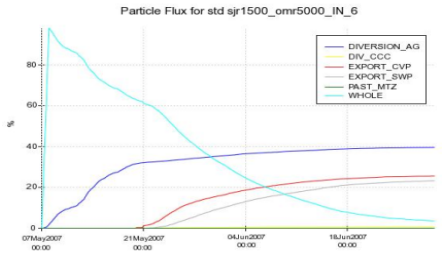
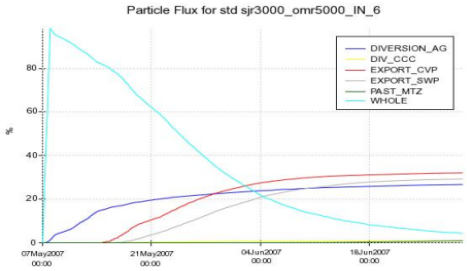
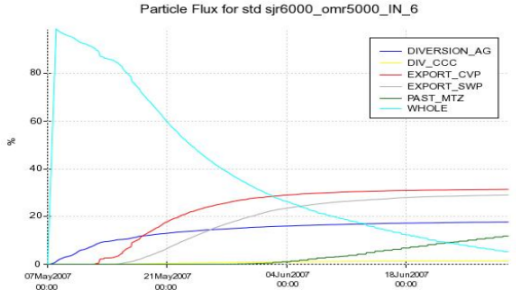
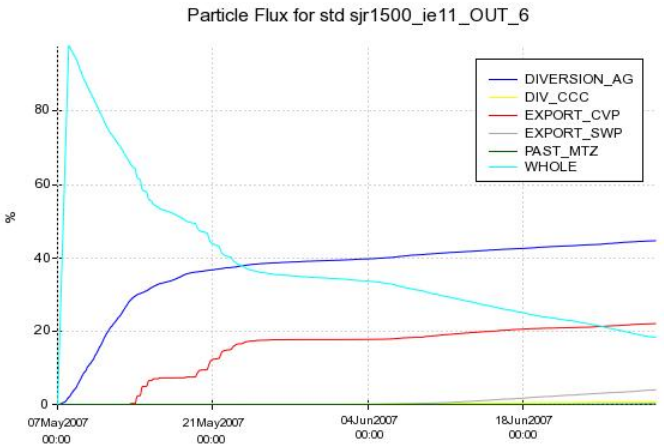
-1250 OMR			
-2500 OMR			
-3500 OMR			
-5000 OMR			

Mossdale Insertion – BARRIER OUT

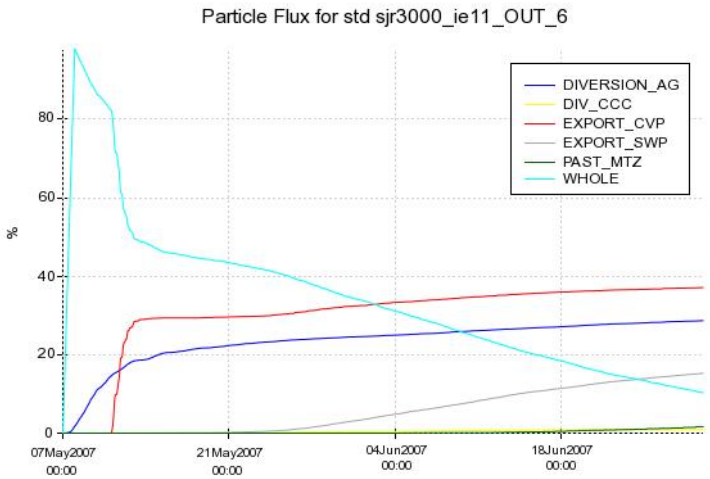
1500 SJR

1:1 I:E ratio

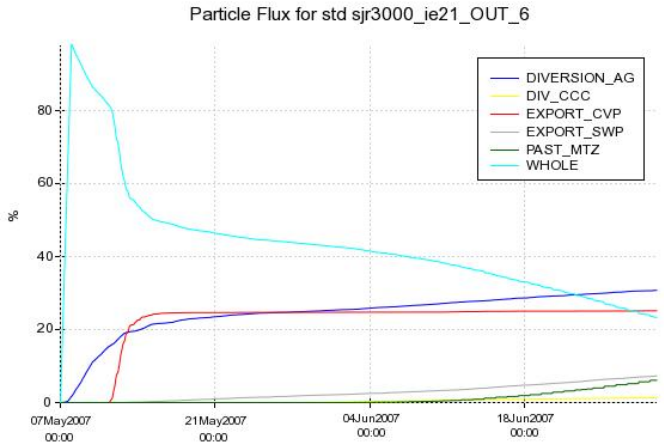


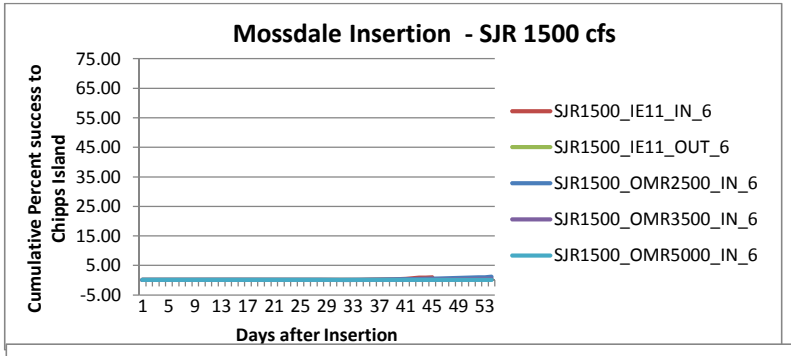
3000 SJR

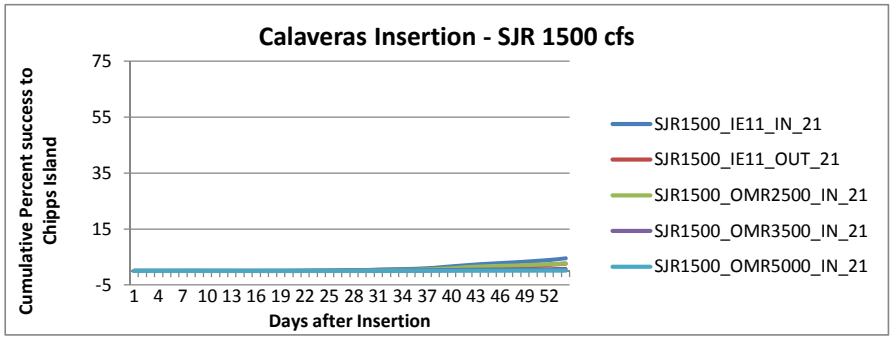
1:1 I:E ratio

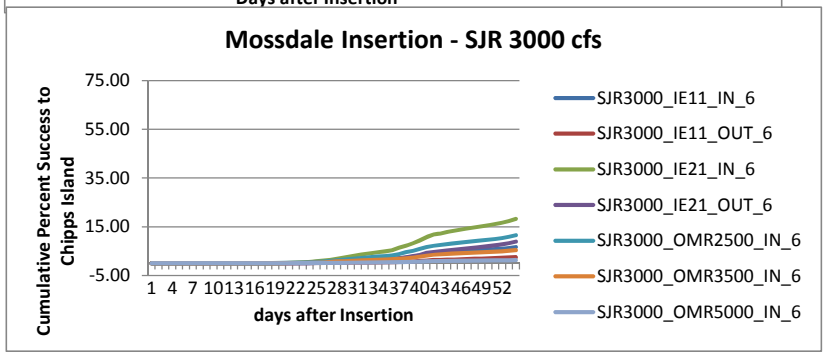


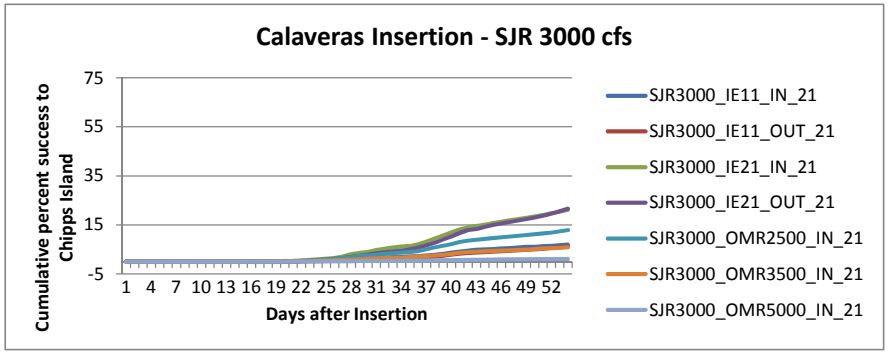
2:1 I:E ratio

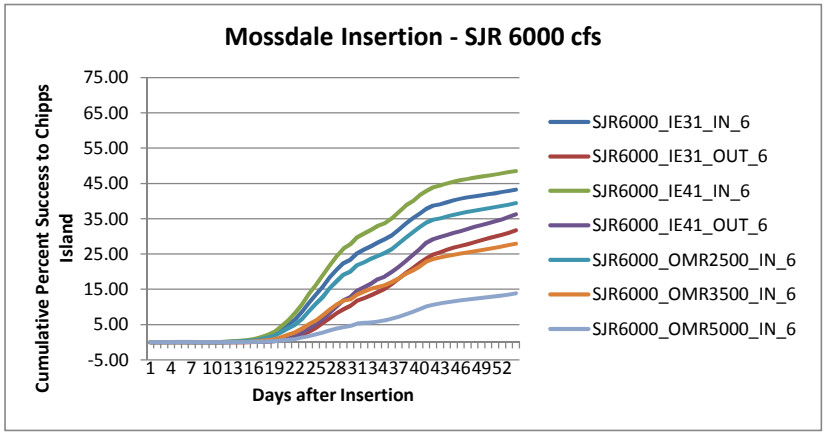


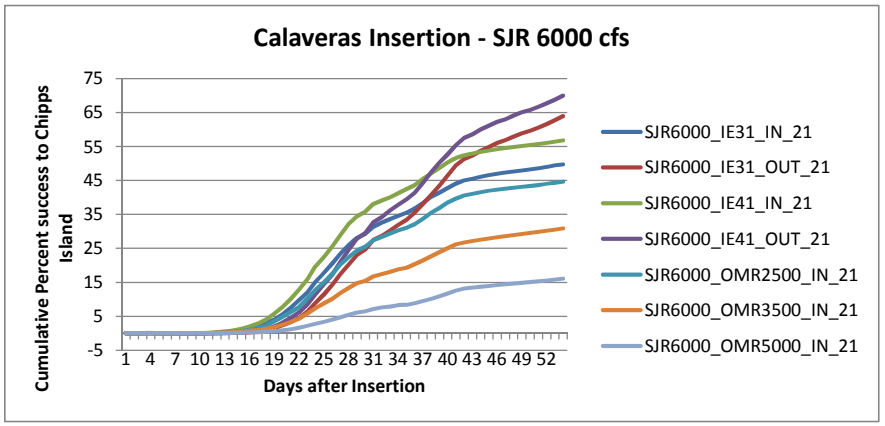

Mossdale Insertion - SJR 1500 cfs
Cumulative Percent success to Chipps Island
75.00
65.00
55.00
45.00
35.00
25.00
15.00
5.00
-5.00
1 5 9 13 17 21 25 29 33 37 41 45 49 53
Days after Insertion
SJR1500_IE11_IN_6
SJR1500_IE11_OUT_6
SJR1500_OMR2500_IN_6
SJR1500_OMR3500_IN_6
SJR1500_OMR5000_IN_6


Calaveras Insertion - SJR 1500 cfs
Cumulative Percent success to Chipps Island
75
55
35
15
-5
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
Days after Insertion
SJR1500_IE11_IN_21
SJR1500_IE11_OUT_21
SJR1500_OMR2500_IN_21
SJR1500_OMR3500_IN_21
SJR1500_OMR5000_IN_21


Mossdale Insertion - SJR 3000 cfs
Cumulative Percent Success to Chipps Island
75.00
55.00
35.00
15.00
-5.00
1 4 7 10131619222528313437404346495 2
days after Insertion
SJR3000_IE11_IN_6
SJR3000_IE11_OUT_6
SJR3000_IE21_IN_6
SJR3000_IE21_OUT_6
SJR3000_OMR2500_IN_6
SJR3000_OMR3500_IN_6
SJR3000_OMR5000_IN_6


Calaveras Insertion - SJR 3000 cfs
Cumulative percent success to Chipps Island
75
55
35
15
-5
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
Days after Insertion
SJR3000_IE11_IN_21
SJR3000_IE11_OUT_21
SJR3000_IE21_IN_21
SJR3000_IE21_OUT_21
SJR3000_OMR2500_IN_21
SJR3000_OMR3500_IN_21
SJR3000_OMR5000_IN_21


Mossdale Insertion - SJR 6000 cfs
Cumulative Percent Success to Chipps Island
75.00
65.00
55.00
45.00
35.00
25.00
15.00
5.00
-5.00
1 4 7 10131619222528313437404346495 2
Days after Insertion
SJR6000_IE31_IN_6
SJR6000_IE31_OUT_6
SJR6000_IE41_IN_6
SJR6000_IE41_OUT_6
SJR6000_OMR2500_IN_6
SJR6000_OMR3500_IN_6
SJR6000_OMR5000_IN_6


Calaveras Insertion - SJR 6000 cfs
Cumulative Percent success to Chipps Island
75
65
55
45
35
25
15
5
-5
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52
Days after Insertion
SJR6000_IE31_IN_21
SJR6000_IE31_OUT_21
SJR6000_IE41_IN_21
SJR6000_IE41_OUT_21
SJR6000_OMR2500_IN_21
SJR6000_OMR3500_IN_21
SJR6000_OMR5000_IN_21

ATTACHMENT 3

Study design for supplemental steelhead releases

I. Project Title

Steelhead route selection and survival of steelhead smolts in the south Delta with adaptive management of Old and Middle River flows

II. Project Investigator:

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Project Co-investigators:

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Charles Hanson, Hanson Environmental, Inc.
Bradley Cavallo, Cramer Fish Sciences

III. Study Timeline

The proposed "stipulation" study has been initiated by California Department of Water Resources (DWR) during February 2012. This study will occur between February 1 and November 1, 2012. The 2012 study plan focuses on the tasks of operation and maintenance of an acoustic receiver array in the lower San Joaquin River and Delta, fish tagging and releases, adaptive management of Old and Middle River (OMR) flows, and data analysis and report writing. DWR is undertaking logistics for tag purchase, coordination for fish transport, tagging and holding, and receiver placement and deployment. Tagging of fish, release of tagged fish, and receiver monitoring and reporting will occur in April and May. Final data set quality control checks and analyses will occur in June-August. A draft technical report will be produced by October 1, 2012. A final report will be produced by November 1, 2012.

IV. Overall Study Objective

The National Marine Fisheries Service (NMFS) issued a biological opinion in June of 2009 which included a Reasonable and Prudent Alternative (RPA) that required specific actions to protect juvenile steelhead originating from the San Joaquin Basin. One of these RPA actions (IV.2.1) would limit south Sacramento-San Joaquin Delta (Delta) exports during April and May as a function of San Joaquin River flows. This action in the NMFS biological opinion was remanded, without vacatur, in 2011 followed by settlement discussions regarding interim operations of the State Water Project (SWP) and Central Valley Project (CVP) export facilities during the spring of 2012. As part of the settlement discussions, augmentation of currently planned steelhead acoustic telemetry studies was proposed to gain additional information on the effects of SWP and CVP export operations on juvenile steelhead and fall-run Chinook salmon that would support evaluation of the NMFS RPA. Specific objectives of the 2012 experimental investigation include evaluation of:

- Evaluating potential effects of Old and Middle River flows during April and May on the reach-scale survival, migration rate, and net migration direction of acoustically tagged juvenile steelhead and Chinook salmon in the lower San Joaquin River, Turner Cut, Columbia Cut, Middle River and Old River.

- Estimating route entrainment of juvenile steelhead and salmon into Middle River, Turner Cut, Columbia Cut, and Old River under different tidal conditions and OMR flows; and

- Performing daily and weekly data processing of detection data for acoustically tagged steelhead and Chinook salmon at key locations for use in monitoring the movement of juvenile salmonids through the Delta in order to provide information that can be used to adaptively manage OMR flows within the adaptive range specified in the joint stipulation.

V. Background

Juvenile steelhead and Chinook salmon migrating downstream in the San Joaquin River are vulnerable to entrainment at the SWP and CVP export facilities and the associated exposure to pre-screen predation losses within Clifton Court Forebay (direct effects) and near the trashracks at the CVP fish collection facility. These facilities are located more than 40kms south from the confluence of the San Joaquin and Sacramento Rivers. Thus, by the time Endangered Species Act (ESA) listed salmonids are detected at salvage facilities, OMR changes may be enacted too late to achieve fish protection. In addition, changes in the direction and/or magnitude of flows in central and south Delta channels (e.g., OMR reverse flows, flows passing into Old River, etc.) have been hypothesized to result in altered migration pathways, migration delays, and other indirect effects that contribute to reduced survival of juvenile salmonids passing through the lower river and Delta. In response to these concerns, NMFS included several RPA actions in the biological opinion that focused on Delta flow management during the winter and spring. SWP and CVP export rates in the late winter and spring months have been regulated to reduce the magnitude of OMR reverse flows. Action IV.2.1 of the biological opinion restricts south Delta exports in April and May to a fraction of the flow in the lower San Joaquin River. Flow management during winter and spring has become the focus of management actions for fish protection along the Old and Middle River corridor. These management actions are calendar and trigger based during the period when ESA covered salmonids are present in the Delta (Table 1). If salmonid protection measures could be taken based on fish presence farther from the export facilities, it is hypothesized that: a) the duration of direct risks and indirect risks to salmonids, associated with the export facilities, may be reduced, b) the take of ESA covered salmonids at the facilities can be reduced, and c) exposure to ESA covered salmonids to predation in south Delta channels can be reduced.

The NMFS biological opinion included an RPA action that required the design and implementation of a six-year acoustic tag study (six-year study) of juvenile steelhead in the San

Joaquin River. Studies of the survival and movement patterns of juvenile Chinook salmon in the San Joaquin River and Delta have also been conducted in the past as part of VAMP and other programs (e.g., south Delta temporary barrier project, etc.). The experimental design outlined in this proposal represents an augmentation and expansion of the six-year study. The proposed experimental study will monitor the movement patterns and survival of acoustically tagged steelhead released during April and May in tidal reaches of the San Joaquin River downstream of Stockton and in channels leading into the interior Delta.

In addition to providing information about the effects of OMR flows on route selection and survival in the south Delta, the proposed study pilots an alternative approach to manage water export risks to ESA listed salmonids. This approach relies upon releases of "sentinel fish" and monitoring stations to detect patterns of movement of these fish within the south Delta. Seninel fish are acoustically tagged fish assumed to represent wild fish in the system. A number of key assumptions are taken with sentinel fish (e.g. behavior, smoltification level, timing of migration, etc).

Rather than using modeling results to predict broad scale, often subtle hydrodynamic changes which are hypothesized to cause indirect effects on fish survival through the Delta, this approach sets a protection threshold based on the observed movement of sentinel fish within the Delta. Comparing results of the proposed experimental investigation will provide novel data that can be used to assess the relationship between OMR flows and the migration and survival of juvenile salmonids, contribute to improving analytic tools such as OMR-survival relationships and the Delta Passage Model, and test the ability to use acoustic tag technology in an adaptive management experiment to further refine decision making for San Joaquin River steelhead protection and water operations. The study will be implemented by DWR and DWR contractors, with collaboration from USBR, USFWS, and USGS, and will meet the study obligations outlined in the 2012 settlement for interim operations.

VI. Experimental Design

Study Fish and Release Strategy

The proposed 2012 acoustic tag experimental study is based on the release of acoustically tagged juvenile steelhead during April and May at a single location in the lower San Joaquin River downstream of Stockton, and upstream of Turner Cut. Up to 550 yearling steelhead, produced in the Mokelumne River Hatchery, are available for use in the study.

The release strategy for this study is developed specifically to provide measurement of survival, route entrainment, and migration times under three OMR flow targets (-1250, -3500, and -5000) hypothesized to provide different levels of fish protection. The strategy provides opportunities to change OMR flows through adaptive management actions when observations of tagged steelhead exceed predefined levels of exposure in channels in the interior Delta. The release schedule for supplemental releases on the San Joaquin River will not start until April 15, due to

critical path acquisitions. In total, 504 tagged steelhead will be released, with a release of 168 juvenile steelhead planned every two weeks (Table 2).

Old and Middle River Flow Management and Triggers

Under our proposed study plan, beginning in early to mid-April, when supplemental steelhead releases are expected to begin, OMR flow targets will shift to a pilot "managed-risk experimental" approach. This approach implements different OMR "treatment levels" for each stipulation study release of acoustically tagged steelhead (to gather information about responses of tagged fish to different hydrodynamic conditions), and includes an "exposure trigger" that, if reached or exceeded, will shift operations from the experimental OMR level to the most positive OMR level within the adaptive range (intended to protect steelhead by shifting hydrodynamic conditions in a direction that may be less disruptive to outmigration routing or timing) (Table 2)[1]. The current ordering of OMR flow management targets through April and May is intended to maximize feasibility and avoid confounding OMR flow management targets with temperature.

The exposure trigger is measured as the cumulative fraction of the supplemental release group that passes a pair of dual receiver arrays on Old River and Middle River near Railroad Cut and is designed to limit exposure of steelhead to the most hydrodynamically disrupted areas of the Delta. This "Railroad Cut trigger" is calculated as the % of the release group reaching the receivers at Railroad Cut that would be expected to result in a 2% loss of the release group at the fish collection facilities (Table 3). Under current assumptions regarding the expected export split during April and May, south delta mortality, and the release group size, the Railroad Cut trigger has been calculated at 5%. If new information suggests that any of these assumptions should be modified, the trigger value may be recalculated and updated. Further details of the calculation of trigger percentage can be found in Appendix A. It is assumed that juvenile steelhead migrate fairly rapidly through the Delta and likely do not spend more than 14-days in the Delta. Thus, for each stipulation study release, the primary trigger is based on fish only from that release and not from prior releases.

A secondary exposure trigger, based on the cumulative fraction of the supplemental release group that enters either the CVP or SWP, has been identified as a useful backstop to the primary trigger in the event that tagged steelhead aren't detected by the receivers near Railroad Cut but are reaching the facilities through some other routes. However, it is uncertain whether or not the tag detection data from the receivers located at the CVP and SWP can be processed in time to be used as the basis for a secondary exposure trigger for the supplemental steelhead release groups. In past studies, tagged fish detection data collected at the CVP and SWP facilities has taken a long time to process due to the high number of tags deposited in those areas as a result of tag defecation by predatory fish. The prototype receivers deployed at the CVP and SWP this year may allow for faster processing, but given that the equipment is prototype and the data

[1] We note that other regulatory requirements may require operational changes that would modify OMR Flows.

processing methods still need to be developed, the secondary trigger may not be employed in 2012.

If tag detection data from the CVP and SWP can be processed and made available to DOSS, the secondary trigger will bemeasured as the cumulative fraction of the supplemental release group that enters either the CVP or SWP. This "CVP or SWP entry trigger" is calculated as the % of the release group reaching either the SWP or CVP that would be expected to result in a 2% loss of the release group at the fish collection facilities (Table 3). Because the small number of fish expected to arrive at either facility means that a single fish can swing the observed entry ratio by a large amount, this backup trigger is based on controlling loss to 2% based on the assumed, not observed, entry ratio. If information received in-season suggests that the entry ratio should be something other than export ratio, the entry ratio for both triggers may be adjusted. As for the primary exposure trigger, for each stipulation study release, the secondary trigger is based on fish only from that release and not from prior releases.

Receiver Deployment and Data Retrieval

Acoustically tagged fish will be monitored using continuously operating acoustic receivers located at strategic monitoring locations (Figure 1). Data from receivers deployed as part of this study, along with data from additional receivers deployed as part of the six-year study (Figure 2a and 2b), will be collected to assess the passage and reach-specific survival of juvenile steelhead that successfully migrate past the mouth of Turner Cut, Columbia Cut, and Middle River and to determine the movement of tagged fish from the mainstem San Joaquin River into the interior Delta. After completion of the study period, additional data and statistical analyses will be performed to estimate survival rates, migration pathways, and migration rates for each of the released steelhead groups.

The cumulative exposure of juvenile steelhead to the interior Delta under different OMR flows will be measured as the cumulative proportion of a release group passing to the south past two dual receiver arrays on Old and Middle River within 14 days of their release. Two cabled receivers on Middle River will be monitored daily; two un-cabled receivers in Old River will be downloaded daily. All daily data downloads will be posted to an ftp site set up by the USGS California Water Resource Center, and will be viewed by Reclamation and DWR biologists. This information will be provided daily, as necessary, to the Delta Operations for Salmonids and Sturgeon (DOSS) group and during the Tuesday DOSS calls (and Delta Conditions Team, as requested).

A simple filter is proposed to remove "predator type" tags from the detection data during the study. The filter will remove from the data any stipulation study released steelhead moving from south to north past the receivers used for the trigger during the study. The supplemental steelhead will be released well to the north of the receivers located near Railroad Cut and are not

expected to pass the receivers from the south on first approach. While some tags moving north to south past the receivers may also be in a predator, the proposed filter tends to err in the direction of increased salmonid protection, in that the trigger is more likely to be tripped as there will be no removal of "predator type" tags as they move north to south. A more refined predator filter may be applied as part of the full data analysis.

The tags and receivers used in this proposed study will be compatible with the tags and receivers used in the six-year study. Protocols for surgically implanting the tags into the juvenile salmonids will be standardized with methods used in other Central Valley acoustic tagging studies.

Measurements and Outcomes

In the real-time component of the proposed study we will evaluate one objective.

Objective 1: Measure the fraction of acoustically tagged steelhead that reach and are observed to be moving southward at Middle and Old rivers near Railroad Cut and use as an exposure risk trigger to manage OMR flows.

In the retrospective analysis of the proposed study (i.e. not for real-time operations) we will evaluate three related sets of objectives. Analyses will include an assessment of the effect size (e.g. change in survival under different flow or velocity conditions) detectable by the 2012 experimental design, and a discussion of what range of effect sizes may be biologically relevant.

Objective 2: What hydrodynamic factors influence the route entrainment into the interior Delta from Turner Cut, Colombia Cut and Middle River

Hypothesis 2.1: Route Selection over Short Time Intervals (~2-hours)

> $H2.2_o$: The proportion of tagged fish taking the interior Delta route is not related to proportion and direction of flow at the time of fish arrival at the junction.

Hypothesis 2.2: Route Selection over 24-hours (DSM2 Hydro)

> $H2.2_o$: The proportion of tagged fish taking the interior Delta route is not related to the proportion of time (over 24-hours) during which flows go toward the interior Delta at the junction.

Hypothesis 2.3: Route Selection over 1 day+ (PTM)

> $H2.3_o$: The proportion of tagged fish taking the interior Delta route is not related to the fraction of particles entering the junction after 1 day+.

Hypothesis 2.4: Route Selection over 45 day time interval (PTM)

$H2.4_o$: The proportion of tagged fish taking the interior Delta route is not related to the fraction of particles entering the junction over 45 days.

Objective 3: How do hydrodynamic conditions and OMR influence migration behavior and survival in the interior Delta?

Hypothesis 3.1: Probability of fish returning to mainstem SJR

$H3.1_o$: Percent positive flows, average flows, average velocities and OMR are not significant covariates in estimating the probability that tagged fish will return to the mainstem San Joaquin River after entering the interior Delta study area.

Hypothesis 3.2: Residence time within the interior Delta

$H3.2_o$: Percent positive flows, average flows, average velocities and OMR are not significant covariatse in analyzing the time spent within the interior Delta study area.

Hypothesis 3.3: Survival within the interior Delta

$H3.3_o$: Percent positive flows, average flows, average velocities and OMR are not significant covariates in estimating survival within the interior Delta study area.

Objective 4: How do hydrodynamic conditions and OMR influence survival in the mainstem San Joaquin River?

Hypothesis 4.1: Interior Delta vs. Mainstem San Joaquin River Survival

$H4.1_o$: The estimated survival of tagged fish migrating through the interior Delta to Chipps Island is not different from the estimated survival of tagged fish migrating through the mainstem San Joaquin River to Jersey Point.

Hypothesis 4.2: Mainstem San Joaquin River survival rate

$H4.2_o$: OMR is not a significant covariate in estimating survival of tagged fish migrating through the mainstem San Joaquin River route.

Objective 5: If hydrodynamic conditions affected by OMR are found to influence survival and/or behavior of tagged fish, what is a well-supported trigger to protect ESA listed salmonids in future operations?

VII. Feasibility

The project is based on the application of known and proven acoustic tag and detection technology. Logistic challenges include the purchase of the acoustic tags and receivers with sufficient lead time that the equipment is available for deployment by late March. The acoustic tags are custom made to individual specifications and tag manufacturing lead time can limit flexibility in setting the start date for a project. Downloading and preparing presence/absence data summaries on a weekly basis is feasible (receivers at Georgiana Slough record and can be processed in real-time) as long as resources are available to rapidly access trigger related receiver sites (primarily via boat) for data downloading and processing. All non-triggered related receiver sites will be downloaded monthly.

VIII. Integration with Existing Monitoring and Other Studies

The utilization of VEMCO receivers and tags for this study will allow us to take advantage of deployed equipment for the six-year study, San Joaquin River Flow Modification Project and Central Valley Project Improvement Act (CVPIA) long term Chinook salmon survival monitoring studies, which are already planned for spring 2012 in the Lower San Joaquin River and south Delta (Figure 2a and 2b). Although we do not propose to use the tagged fish from these studies in calculating the trigger for OMR management per the stipulation, we do intend to track movement of these release groups past the receivers on Old River and Middle River near Railroad Cut during spring 2012. Independent estimates of route entrainment and survival through this study's reaches of the San Joaquin River and south Delta will be calculated with the releases from the six-year study and other related studies.

IX. Deliverables

A final technical report documenting the experimental design, methods, results of the investigation, including tags detected by recorders deployed as part of other Delta acoustic studies, will be prepared and distributed to interested parties by November 1. This report will be developed during the 2012 summer and fall.

Table 1. NMFS biological opinion actions that impact Old and Middle River flow management between January and June.

Action	Period	Action response
Action IV.2.1	Not in effect in 2012 (*April 1-May 31*)	Depending on San Joaquin Basin year type classification, manage exports to attain exports adjusted to Vernalis flows.
Action IV.2.3	January 1-June 15	Manage OMR to no more negative than -5000 cfs throughout the period. Depending on biological trigger, manage exports to more positive OMR flows of -3500 or -2500 cfs.
Stipulation	April 1-April 30	Depending on triggers in 2012 DOSS Technical Memo, manage OMR adaptive range of -1250 to -3500 cfs.
Stipulation	May 1- May 31	Depending on triggers in 2012 DOSS Technical Memo, manage OMR adaptive range of -1250 to -5000 cfs.

Table 2. Summary of action triggers and action responses for Old and Middle River flow management during the proposed study period, April and May 2012.

Stipulation Period	OMR Experimental Treatment	Release	Action Trigger	Action Response
April 1 – April 7	As determined by DSM2 modeling and the specified "PTM metric" to provide hydrodynamic conditions for Calaveras and Mokelumne basin fish similar to the conditions expected under I:E implementation with a non-physical barrier	None	None, specified OMR level will be implemented for one-week period.	N/A. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow.
April 7 – April 14	As determined by DSM2 modeling and the specified "PTM metric" to provide hydrodynamic conditions for Calaveras and Mokelumne basin fish similar to the conditions expected under I:E implementation with a non-physical barrier	None	None, specified OMR level will be implemented for one-week period.	N/A. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow.

Stipulation Period	OMR Experimental Treatment	Release	Action Trigger	Action Response
April 15 – April 30	-3,500 cfs	As early as April 15	Either: (1) Cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing southward on Old and Middle Rivers near Railroad Cut receivers reaches that exceeds the specified Railroad Cut trigger of 5% of tags released within 14 days of release date, or (2) If available[2], cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing receivers inside the SWP radial gates and CVP primary louvers reaches or exceeds the specified CVP/SWP entry trigger of 3% of tags released within 14 days of the release date.	Within 48 hours of exceeding trigger, manage exports to a level that produces a 5-day running average of the tidally filtered OMR flow of -1,250 cfs for the remainder of the period. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow. If the trigger is exceeded after April 25, the tidally filtered OMR flow of -1,250 cfs will be targeted for the 5-day average, while preparing for the next acoustic tagged steelhead release. If no OMR change is triggered, the 14-day average of the tidally filtered OMR flow should not be more negative than the specified treatment OMR target.

[2] It is uncertain whether or not the tag detection data from the receivers located at the CVP and SWP can be processed in time to be used as the basis for a secondary exposure trigger for the supplemental steelhead release groups. In past studies, tagged fish detection data collected at the CVP and SWP facilities has taken a long time to process due to the high number of tags deposited in those areas as a result of tag defecation by predatory fish. The prototype receivers deployed at the CVP and SWP this year may allow for faster processing, but given that the equipment is prototype and the data processing methods still need to be developed, the secondary trigger may not be employed in 2012.

Stipulation Period	OMR Experimental Treatment	Release	Action Trigger	Action Response
May 1 – May 14	-1,250 cfs	As early as May1	None, since treatment level is at most positive OMR level within the adaptive range. However, the cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing southward on Old and Middle Rivers near Railroad Cut receivers within 14 days of the release date will be monitored for informational purposes.	N/A. The 14-day average of the tidally filtered OMR flow should not be more negative than the specified treatment OMR target.

Stipulation Period	OMR Experimental Treatment	Release	Action Trigger	Action Response
May 15 – May 31	-5,000 cfs	As early as May 15	Either: (1) Cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing southward on Old and Middle Rivers near Railroad Cut receivers reaches that exceeds the specified Railroad Cut trigger of 5% of tags released within 14 days of release date, or (2) If available, cumulative proportion of sentinel (acoustic tagged) steelhead from stipulation study release passing receivers inside the SWP radial gates and CVP primary louvers reaches or exceeds the specified CVP/SWP entry trigger of 3% of tags released within 14 days of the release date.	Within 48 hours of exceeding trigger, manage exports to a level that produces a 5-day running average of the tidally filtered OMR flow of -1,250 cfs for the remainder of the period. The 5-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 5-day average flow. If no OMR change is triggered, the 14-day average of the tidally filtered OMR flow should not be more negative than the specified treatment OMR target.

Health and Safety Exception: If either the initial OMR treatment levels, or in the event of a trigger, the -1,250 cfs OMR level, would require that exports drop below the health and safety export level of 1,500 cfs, the projects shall operate at a combined export level of 1500 cfs.

Table 3. Calculated stipulation study trigger levels. Green-shaded rows highlight the release group size and several assumptions that effect the calculated trigger level.

Number of Acoustically Tagged Fish Released Per Release Group	168
Assumed fraction of fish entering the CVP or SWP that enter the SWP (assumed equal to SWP exports as fraction of total exports)	0.5
Assumed survival rate per km between the Railroad Cut receivers and the CVP & SWP	97%
Railroad Cut Trigger (Number of tagged fish)	9
Railroad Cut Trigger (Percentage of Tagged Fish Released)	5%
CVP or SWP Entry Trigger[3] (Number of tagged fish)	6
CVP or SWP Entry Trigger (Percentage of Tagged Fish Released)	3%

[3] As noted in the text, this trigger will not be implemented during April-May 2012 unless tag detection data from the CVP and SWP can be downloaded, processed, and provided to DOSS along with the tag detection data from Railroad Cut.

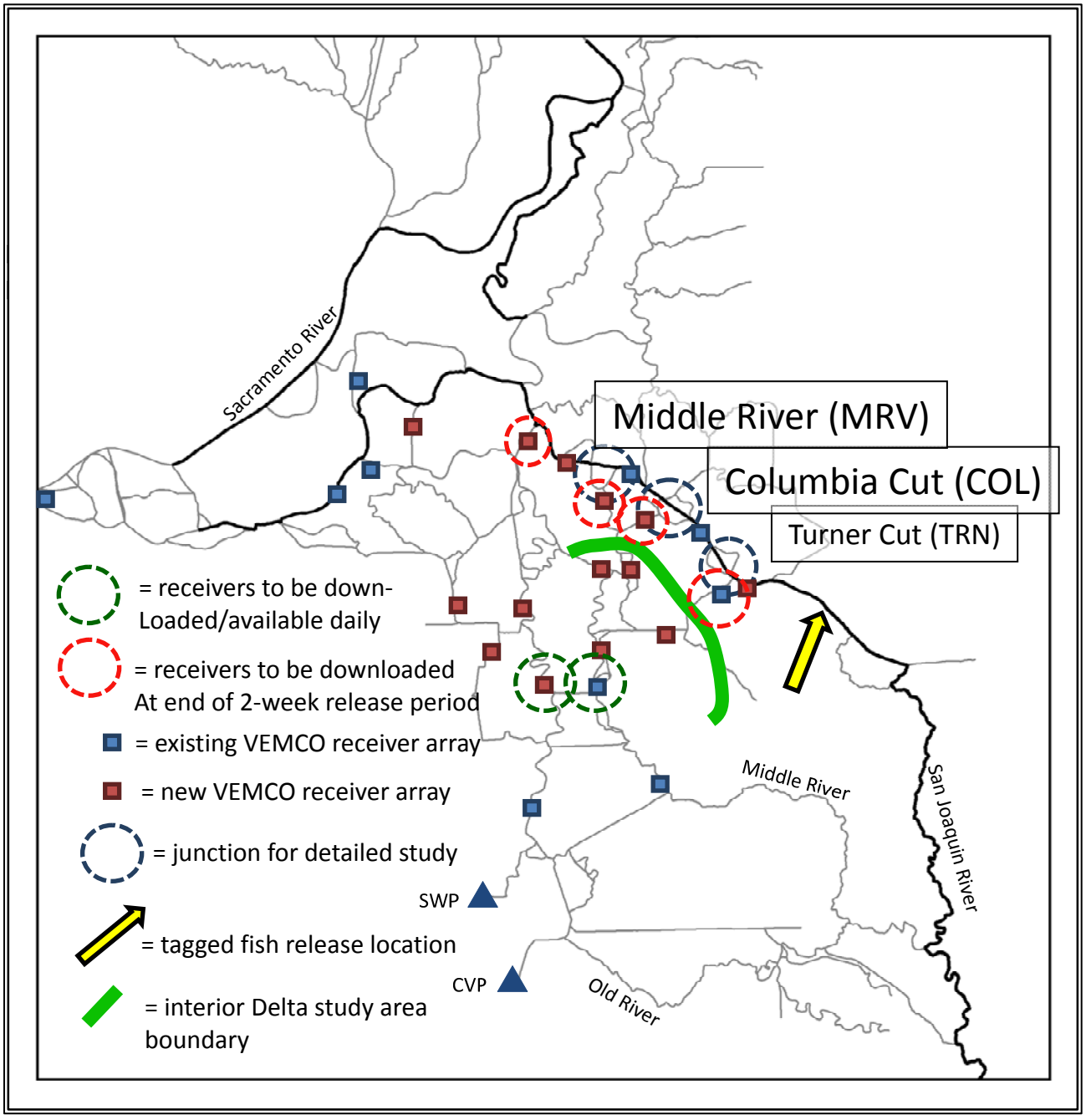
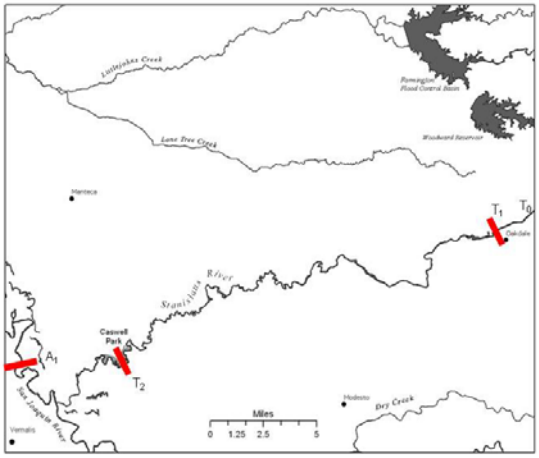


Figure 1. Acoustic tag release and receiver sites. Note: only receiver locations directly relevant to the proposed study are indicated on this map.

2a.



2b.

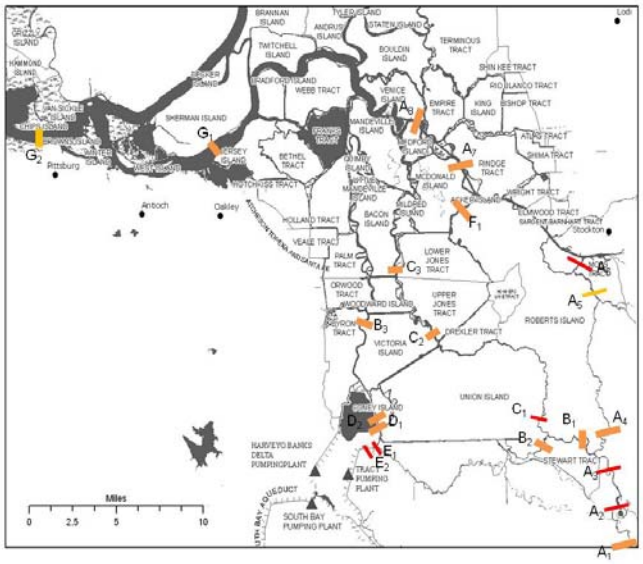


Figure 2 a and 2b. Receiver location for primary and complementary release-recapture acoustic telemetry studies considered for study design of Action IV.2.2. These receiver locations are between Goodwin and Chipps Island are identified with labels used in the statistical model. Site T_0 is a potential complementary release site above Oakdale, CA and T_1 and T_2 are potential receiver sites upstream of the San Joaquin River on the Stanislaus River. Dual receiver lines are noted with orange lines, while redundant and single receiver locations are red lines. Dual receivers that are not part of the model are also found at Three Mile slough and False River. (source: Israel, J. 2012. Draft six-year study proposal: OCAP RPA IV.2.2: Survival of steelhead smolts during outmigration in the San Joaquin River and Delta)

Appendix A.

Description of the calculations to determine the exposure triggers. This framework uses a simplified estimator relating salvage and loss; additional information on the full calculation of loss at the SWP and CVP is provided at: ftp://ftp.delta.dfg.ca.gov/salvage/Salmon%20Loss%20Estimation/

ROW ID	VALUE	FORMULA	DESCRIPTION
Calculation of average travel distance between Railroad Cut receivers and the SWP and CVP			
A1	12	Fixed value	Approximate distance (km) from Railroad Cut receiver on Old River to SWP Clifton Court intake
A2	18	Fixed value	Approximate distance (km) from Railroad Cut receiver on Middle River to SWP Clifton Court intake
A3	2	Fixed value	Approximate distance (km) from SWP Clifton Court intake to CVP intake
A4	13	=(A11*A1)+[A12*(A1+A3)]	Average approximate distance(km) from Railroad Cut receiver on Old River to SWP or CVP intake, weighted according to estimated split of facility entry (value assumed in A13)
A5	19	=(A11*A2)+[A12*(A2+A3)]	Average approximate distance(km) from Railroad Cut receiver on Middle River to SWP or CVP intake, weighted according to estimated split of facility entry (value assumed in A13)
A6	0.5	Assumption	Of fish passing the Railroad Cut receivers, assumed proportion that are in Old River
A7	16	=(A6*A4) + [(1-A6)* (A5)]	Average approximate distance (km) traveled by all fish reaching the SWP or CVP, weighted by origin (Old River or Middle River) and split of facility entry.
Calculation of exposure trigger			
A8	168	Assumption; this will be set to the actual release group size for each treatment period	Number of Acoustically Tagged Fish in release group
A9	2%	Fixed value	Loss at the SWP and CVP not to exceed this value (percent of release group)
A10	3.36	=A8*A9	Loss at the SWP and CVP not to exceed this value (number of fish from release group)
A11	0.5	=A13	Of fish that enter the CVP or SWP, assumed proportion that enter the SWP
A12	0.5	=(1-A13)	Of fish that enter the CVP or SWP, assumed proportion that enter the CVP
A13	0.5	Assumption; this will be set to the expected export split for each treatment period	Of fish that enter the CVP or SWP, assumed proportion that enter the SWP

A14	4.33	Fixed value	SWP approximate salvage-to-loss factor
A15	0.68	Fixed value	CVP approximate salvage-to-loss factor
A16	0.187617261	=1*[1/(1+A14)]	For each fish entering the SWP, expected SWP salvage
A17	0.595238095	=1*[1/(1+A15)]	For each fish entering the CVP, expected CVP salvage
A18	0.812382739	=1*[A14/(1+A14)]	For each fish entering the SWP, expected SWP loss
A19	0.404761905	=1*[A15/(1+A15)]	For each fish entering the CVP, expected CVP loss
A20	TRUE	Logical formula as used in excel: =IF(A16*A14=A18, TRUE, FALSE)	Check that expected SWP salvage (A16) * SWP approximate salvage-to-loss factor (A14) = expected SWP loss (A18)
A21	TRUE	Logical formula as used in excel: =IF(A17*A15=A19, TRUE, FALSE)	Check that expected CVP salvage (A17) * CVP approximate salvage-to-loss factor (A15) = expected CVP loss (A19)
A22	TRUE	Logical formula as used in excel: =IF(A16+A18=1, TRUE, FALSE)	Check that expected SWP salvage (A16) + expected SWP loss (A18) = 1
A23	TRUE	Logical formula as used in excel: =IF(A17+A19=1, TRUE, FALSE)	Check that expected CVP salvage (A17) + expected CVP loss (A19) = 1
A24	0.608572322	=(A11*A18)+(A12*A19)	Expected loss per fish that enter the SWP or CVP, given the assumed entry proportion to each facility and the loss rate at each facility
A25	5.521118655	=A10/A24	How many fish from the release group may encounter the SWP & CVP without exceeding the loss trigger?
A26	**3%**	**=A25/A8**	**What percent of fish from the release group may encounter the SWP & CVP without exceeding the loss trigger?**
A27	2.24	=A11*A25*A18	Expected SWP Loss if A25 fish enter the facilities at the expected ratio
A28	1.12	=A12*A25*A19	Expected CVP Loss if A25 fish enter the facilities at the expected ratio
A29	TRUE	Logical formula as used in excel: =IF(A27+A28=A10, TRUE, FALSE)	Check that SWP loss + CVP Loss add up to loss trigger
A30	0.03	Assumption	Estimated mortality rate (per km) between the Railroad Cut receivers and the SWP and CVP, based on an estimate of south delta mortality from the 2010 VAMP studies.
A31	0.61	=(1-A30)^A7	Survival from the Railroad Cut receivers to the SWP and CVP, based on the average distance in A7.
A32	9	=A25/A31	How many fish from the release group may encounter the Railroad Cut receivers without exceeding the loss trigger?
A33	**5%**	**=A32/A8**	**What percent of fish from the release group encounter the Railroad Cut receivers without exceeding the loss trigger?**